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

SNAP4CITY

Powered by KM4CITY

Snap4City platform: from cloud to data analytic as a Living Lab for Student and Researchers

https://www.snap4City.org https://www.Km4City.org



https://www.disit.org/

Paolo Nesi, paolo.nesi@unifi.it

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Course Segments

- **Qualification of the speaker** ←
- **Cloud-based Infrastructures for Smart Cities**
- **IOT Registration and Management**
- **Supporting the Analysis of Smart City Data**
- **From Data to Applications and Dashboards**
- ***Not on this course and available in Our others Courses***
  - *Strategies: definition and operationalization*
  - *IOT Applications Development*
  - *Data Analytics plan and development*
  - *Managing the Smart City Infrastructure*

Qualification & references



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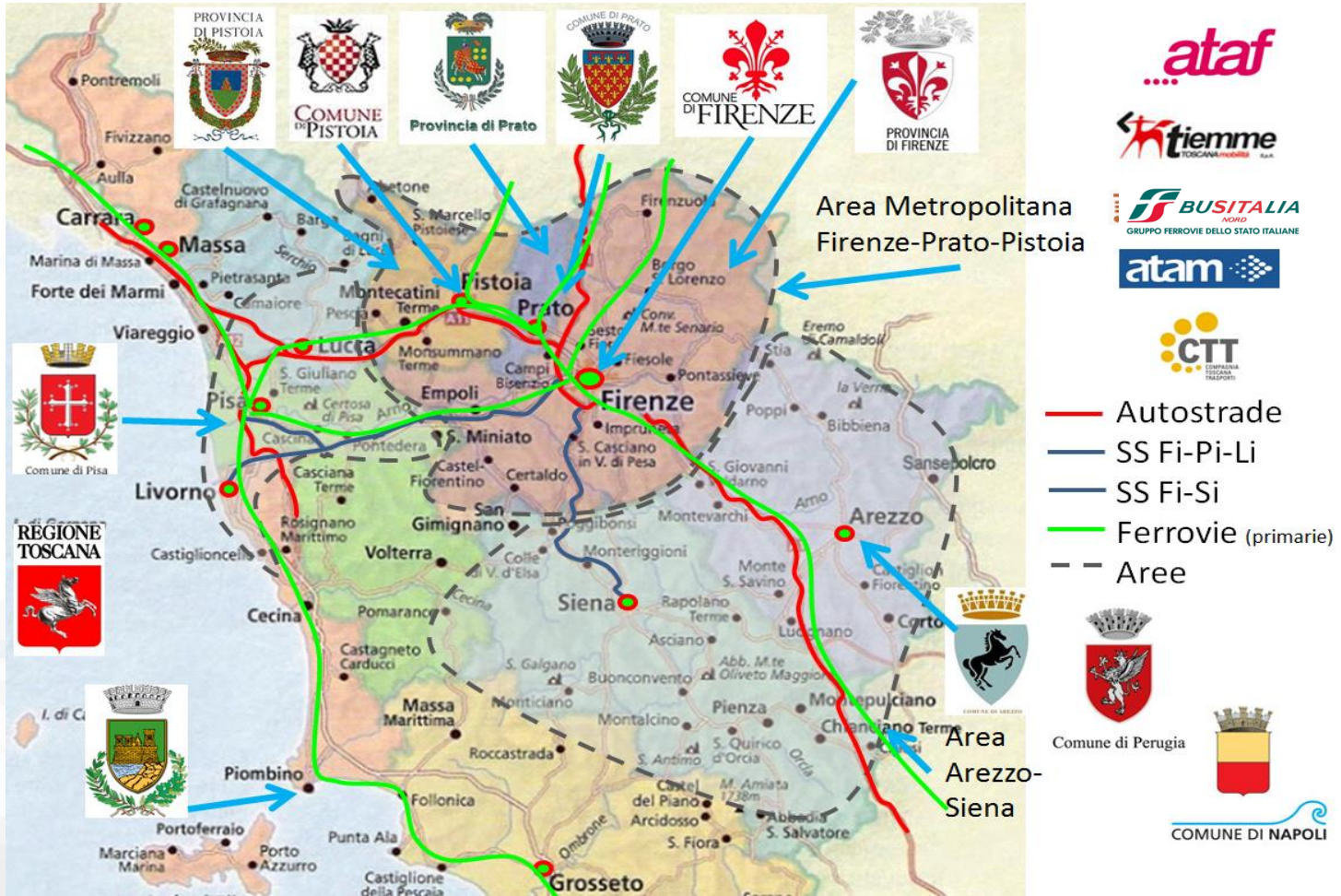
Sii-Mobility

http://www.Sii-Mobility.org

- *Experimentations and validation in Tuscany*
- *Integration with present central station and subsystems*
- *DISIT lab, Università di Firenze, is the tech-scientific coordinator*



ECM; Swarco Mizar; Inventi In20; Geoin; QuestIT; Softec; T.I.M.E.; LiberoLogico; MIDRA (autostrade, motorola); ATAF; Tiemme; CTT Nord; BUSITALIA; A.T.A.M.; Effective Knowledge; eWings; Argos Engineering; Elfi; Calamai & Agresti; Project; Negentis

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Sii-Mobility

http://www.Sii-Mobility.org

MIUR MINISTERO DELL'ISTRUZIONE DELL'UNIVERSITÀ E DELLA RICERCA

KM 4 CITY

Commenti dei cittadini, Social Media





AVM trasporto Pubblico

Merci







Sensori su trasporto Privato



Sensori, sistema monitoraggio

Sensori Parcheggi





UTC





Infomobility





Varchi Telematici, ZTL

Monitoraggio traffico, autostrade



Rete Ferroviaria



Parametri ambientali



Servizi ed enti



Ordinanze: eventi, lavori pubblici, ..



Emergenze, polizia, 118



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.
- **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
- **Testing on municipalities and provinces of Tuscany**
- **Contribute to the improvement of national and international standards**

Main Delibere of Sii-Mobility

PA	Tipo di atto
Provincia di Prato	Delibera di Giunta n.267 del 30.10.2012
Comune di Prato	Delibera di Giunta n.474 del 30.10.2012
Provincia di Firenze	Delibera di Giunta n.147 del 06.11.2012
Comune di Firenze	Delibera di Giunta n.403 del 06.11.2012
Provincia di Pistoia	Delibera di Giunta n.156 del 08.11.2012
Comune di Pistoia	Delibera di Giunta n.321 del 08.11.2012
Comune di Pisa	Delibera di Giunta n.203 del 06.11.2012
Comune di Arezzo	Delibera di Giunta n.498 del 07.11.2012
Regione Toscana	Delibera di Giunta n.249 del 15.04.2013

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

UNIVERSITÀ DEGLI STUDI FIRENZE

REPLICATE

Horizon 2020
European Union Funding
for Research & Innovation

REnaissance of PLaces
with Innovative Citizenship
And TEchnology

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

1 (coordinator) FOMENTO DE SAN SEBASTIAN FSS SPAIN
2 AYUNTAMIENTO DE SAN SEBASTIAN SAN SEBASTIAN SPAIN
3 COMUNE DI FLORENCE FLORENCE ITALY
4 BRISTOL COUNCIL BRISTOL UNITED KINGDOM
5 STADT ESSEN ESSEN GERMANY
6 NILUFER BELEDIYESI NILUFER TURKEY
7 VILLE DE LAUSANNE LAUSANNE SWITZERLAND
8 IKUSI ANGEL IGLESIAS, S.A. IKUSI SPAIN
9 ENDESA ENERGÍA, S.A. ENDESA SPAIN
10 EUROHELP CONSULTING, S.L. EUROHELP SPAIN
11 ILUMINACION INTELIGENTE LUIX, S.L. LUIX SPAIN
12 FUNDACION TECNALIA RESEARCH & INNOVATION TECNALIA SPAIN
13 EUSKALTEL, S.A. EUSKALTEL SPAIN
14 COMPAÑÍA DEL TRANVÍA DE SAN SEBASTIÁN DBUS SPAIN
15 CONSIGLIO NAZIONALE DELLE RICERCHE CNR ITALY
16 ENEL DISTRIBUZIONE, SPA ENEL ITALY
17 MATHEMA, SRL MATHEMA ITALY
18 SPES CONSULTING SPES ITALY
19 TELECOM ITALIA, SPA TELECOM ITALY
20 UNIVERSITA DEGLI STUDI DI FLORENCE UNIFI ITALY: DINFO.DISIT Lab and DIEF
21 THALES ITALIA, SPA THALES ITALY
22 ZABALA INNOVATION CONSULTING ZABALA SPAIN
23 TECHNOMAR TECHNOMAR GERMANY
24 UNIVERSITY OF BRISTOL UOB UNITED KINGDOM
25 UNIVERSITY OF OXFORD UOXF UNITED KINGDOM
26 BRISTOL IS OPEN, LTD BIO UNITED KINGDOM
27 ZEETTA NETWORKS ZEETTA UNITED KINGDOM
28 KNOWLE WEST MEDIA CENTRE, LGB KWMC UNITED KINGDOM
29 TOSHIBA RESEARCH EUROPE, LTD TREL UNITED KINGDOM
30 ROUTE MONKEY, LTD ROUTE MONKEY UNITED KINGDOM
31 ESOTERIX SYSTMES, LTD ESOTERIX UNITED KINGDOM
32 NEC LABORATORIES EUROPE, LTD NEC UNITED KINGDOM
33 COMMONWHEELS CAR CLUB CIC CO-WHEELS UNITED KINGDOM
34 UNIVERSITY OF THE WEST OF ENGLAND UWE UNITED KINGDOM
35 ESADE BUSINESS SCHOOL ESADE SPAIN
36 SISTELEC SOLUCIONES DE TELECOMUNICACION, S.L. SISTELEC SPAIN

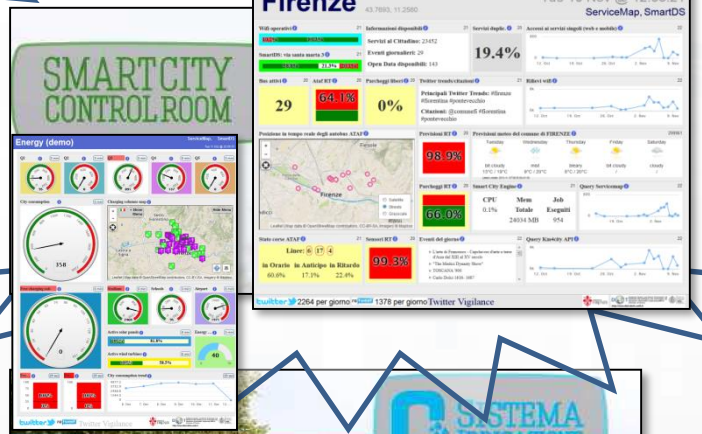
REPLICATE in Firenze: Energy, ICT & Mobility













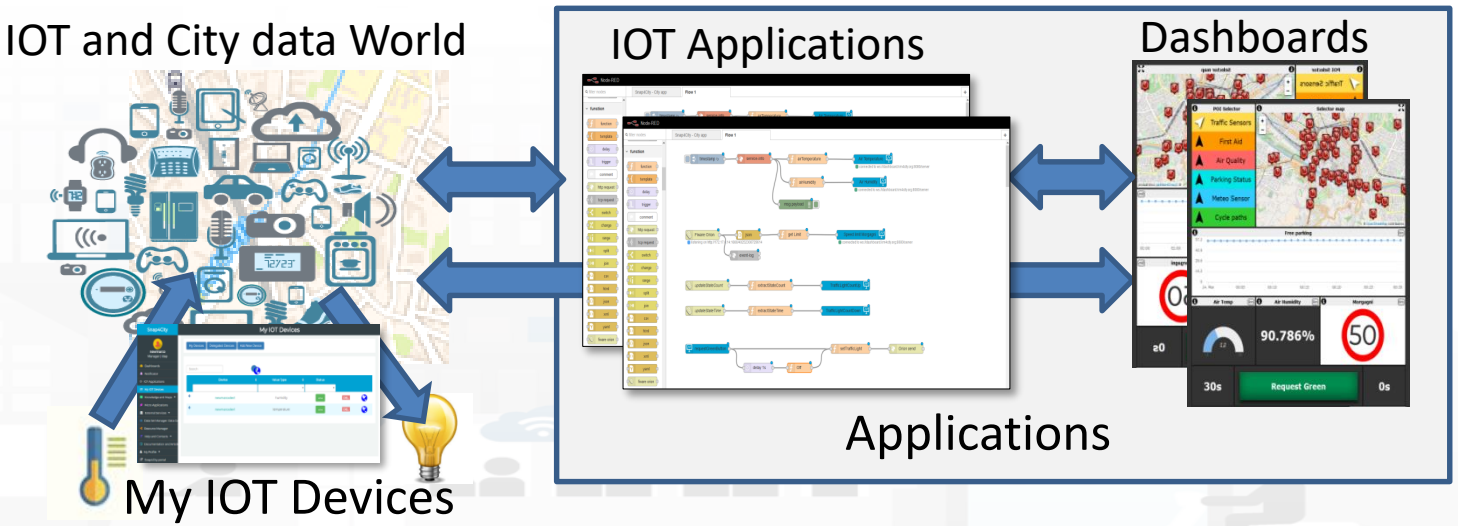






COMUNE DI FIRENZE
Smart Florence Plan

- Snap4City is an open, standardized, data-driven, service-oriented, user-centric platform enabling large-scale co-creation IOT/IOE applications. It has been developed in the context of Select4Cities project of Helsinki and Antwerp.
- 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.
- validated in multiple devices (PC, Android, Raspberry, ..), and domains: mobility and transport, tourism, health, welfare, social
- The innovation on semantic reasoning, IOT interoperability, microservices, automated dashboard production, .. thus
- ***smart city solutions in a***





Horizon 2020
European Union Funding
for Research & Innovation

http://www.resolute-eu.org

- 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	UNIFI	IT
THALES	THALES	IT
ATTIKOMetro	ATTIKO	GR
Comune di Firenze	CDF	IT
Centre for Research and Technology Hellas	CERTH	GR
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.	FHG	DE
HUMANIST	HUMANIST	FR
SWARCO Mizar	SWMIZ	IT
Associação para o Desenvolvimento da Investigação no Instituto Superior de Gestão	ADI-ISG	PT
Consorzio Milano Ricerche	CMR	IT

Governing tHe smart city: a gOvernance-centred approach to SmarT urbanism – GHOST

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

COMUNE DI CAGLIARI

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

http://sites.unica.it/ghost

Interoperability

Powered by FIWARE

http://marketplace.fiware.org/pages/solutions/b8905e91973b420189cce972

https://partners.sigfox.com/companies/disit-lab-university-of-florence
https://partners.sigfox.com/products/snap4city

sigfox partner

Node-RED

https://flows.nodered.org/?num_pages=1
https://flows.nodered.org/?term=snap4city&num_pages=1

Compliant ckan

Supporting: AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, SMTP, TCP, UDP, NGSI, LoraWan, SigFOX, DATEX II, SOAP, WSDL, Twitter, FaceBook, Telegram, SMS, OLAP, MySQL, Mongo, HBASE, SOLR, SPARQL, EMAIL, FTP, FTPS, WebSocket, WebSocket Secure, ModBUS, WFS, WMS, ODBC, JDBC, Phoenix, JSON, XML, GeoJSON, WFS, Android, Raspberry, etc.

partnership in the large

swarco First in Traffic Solutions. · VARgroup · THALES · BUSITALIA NORD GRUPPO FERROVIE DELLO STATO ITALIANE · BBC

TIM · LEONARDO · ALTAIR CHIMICA · CM · COSTRUZIONI NOVICROM · ataf · NORD CTT · BMG · europeana think culture

COMPUTER GROSS · Hewlett Packard Enterprise · eutelsat · liberologico · SIAE Società Italiana degli Autori ed Editori · Rai

ENGINEERING · Effective Knowledge s.r.l. · GIUNTI EDITORE

PHILIPS · tiscali: · Fondazione per la ricerca e l'innovazione

e-distribuzione

ENTE CASSA DI RISPARMIO DI FIRENZE · CITTÀ METROPOLITANA DI FIRENZE · COMUNE DI FIRENZE

CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

Fraunhofer · Consiglio Nazionale delle Ricerche · cini · cnit consorzio nazionale interuniversitario per le telecomunicazioni

University of Pittsburgh · Camera di Commercio Firenze · ARPAT Agenzia regionale per la protezione ambientale della Toscana · REGIONE TOSCANA

National Technical University of Athens · EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE · UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA · UNIVERSITÀ DEGLI STUDI DI CAGLIARI · APRE TOSCANA AGENZIA PER LA PROMOZIONE DELLA RICERCA EUROPEA · ACCADEMIA NAZIONALE DI SANTA CECILIA · CONSORZIO LaMMA

Roadmap

2013

Km4City 1.1
- Tuscany Map
- Services
- AVM
- Sensors
- Parking
- Cultural Heritage
- Enrichment cities
- Event in the city
- Digital Locations
- Fresh places

2014

- Weather
- Cultural Heritage
- Energy recharhe pillar
- Wi-Fi
- Events in the city

2015

RESilience management guidelines and Operationalization appLied to Urban Transport Environment

Km4City 1.4
- Embed
- More API
- iBeacon

- http://servicemap.km4city.org API
- http://log.disit.org
- http://www.disit.org/fodd
- http://www.disit.org/tv Twitter Vigilance
- http://smartds.km4city.org

Km4City 1.5
- SmartDS
- Km4City App

RESOLUTE H2020
2015-2018 - Started

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

Sii-Mobility SCN
2016-2018 – Started
Km4City 1.6.2

2016

REPLICATE H2020
2016-2021- Started

REPLICATE
REnaissance of PLaces with Innovative Citizenship And TEchnology

- Suggestions on demand
- User Behaviour Analysis
- Trajectories and OD

12/2017

WEEE
2017-2020

6/2017

ALTAIR
- More Sensors, IOE, IOT
- Dashboard Builder
- Territorial areas and paths
- User Engagement
- Mobility and transport
- Resilience Decision Support

GHOST SIR
2016-2019 - Started

- waste
- Territorial areas and paths
- Health, Bike sharing
- Statistics, Energy, ICT, ...
- E-vehicles

- Risk analysis
- Environmental, water
- Data Licensing models
- Energy Meters
- Fi-Ware compliant

FIWARE

European Commission
SELECT for Cities
Snap4City

- IOT/IOE
- Monitoring
- Smart City IOT integration
- Living Lab

5G
- Smart City vs IOT, Industria 4.0

MOSAIC

6/2018

Trafair CEF

SMARTCITY EXPO WORLD CONGRESS
11/2018

ICT2018 IMAGINE DIGITAL CONNECT EUROPE
12/2018

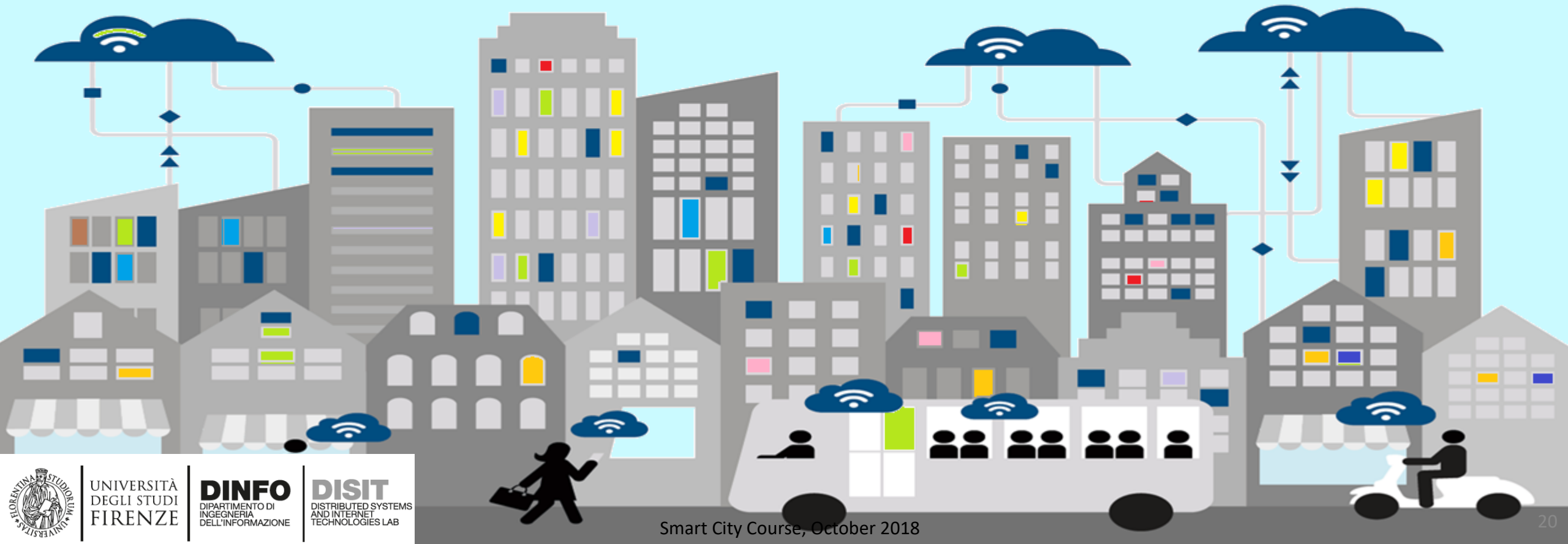
2021

- **Snap4City: https://www.snap4city.org**
- **Trafair: mobility and environment**
- **MOSIC: models for OD and mobility demand, whatif tools**
- **Smart City of Florence Metropolitan Area**
- **Km4City**: http://www.km4city.org
- **RESOLUTE H2020, EC:**
  - http://www.resolute-eu.org
- **REPLICATE H2020, SCC1, EC flagship**
  - http://replicate-project.eu/
- **Sii-Mobility SCN MIUR**:
  - http://www.sii-mobility.org
- **Coll@bora Social Innovation, MIUR:**
  - http://www.disit.org/5479
- **TRACE-IT, RAISSS, TESYSRAIL, ….**
- **Mobile Emergency:**
  - http://www.disit.org/5404

Acknowledgements

- Thanks to the European Commission for founding. All slides reporting logo of **RESOLUTE H2020** are representing tools and research founded by European Commission for the RESOLUTE project. **RESOLUTE** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement n° 653460).
- 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).
- Thanks to the MIUR for co-fouding and to the University of Florence and companies involved. All slides reporting logo of **Sii-Mobility** are representing tools and research founded by MIUR for the Sii-Mobility SCN MIUR project.
- Thanks to the European Commission for founding. All slides reporting logo of **Snap4City** **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)
- **Km4City** is an open technology exploited by those projects and line of research of DISIT Lab. Some of the innovative solutions and research issues developed into the above mentioned projects are also compliant and contributing to the Km4City approach and thus are contributing to the open Km4City model of DISIT lab.

Cloud-based Infrastructures for Smart Cities



Course Segments

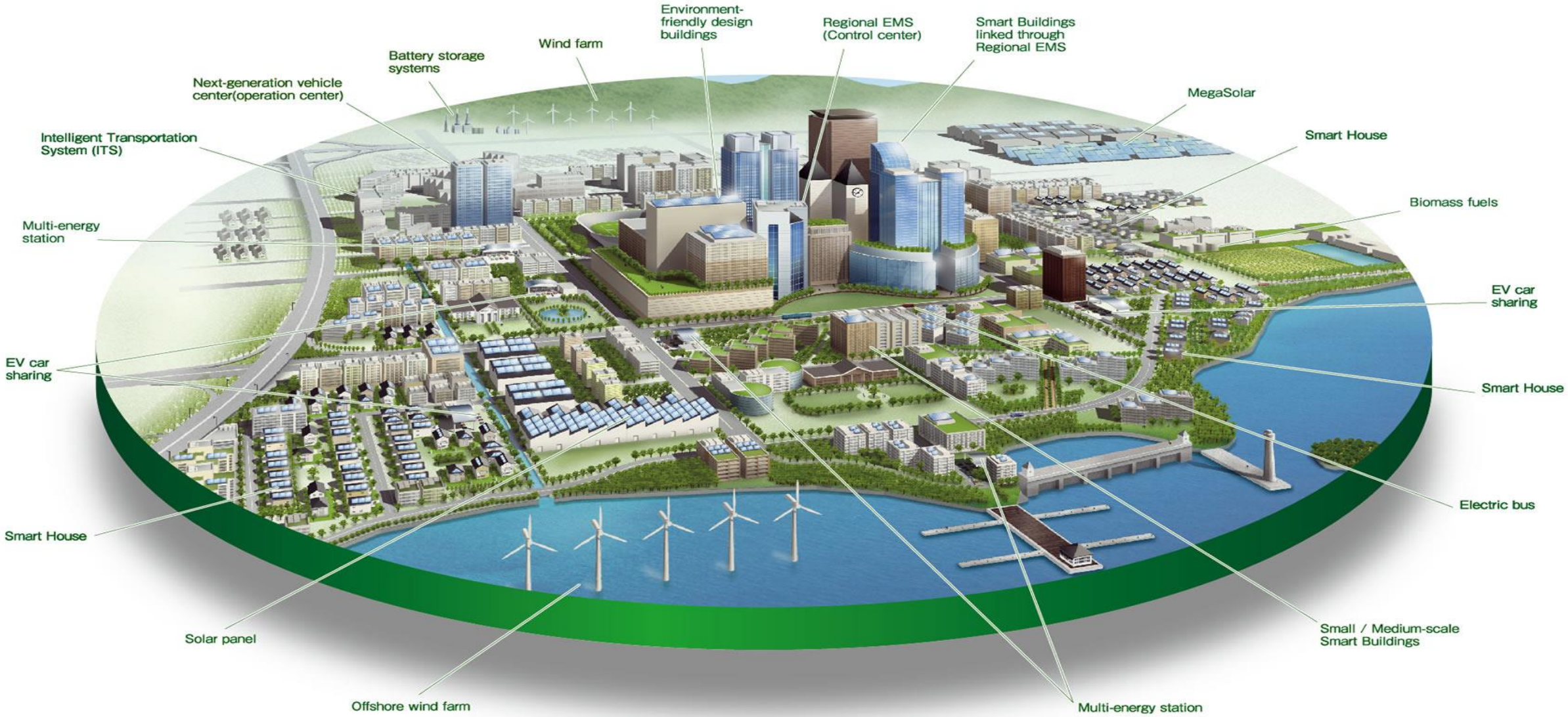
- Qualification of the speaker
- Cloud-based Infrastructures for Smart Cities
- IOT Registration and Management
- Supporting the Analysis of Smart City Data
- From Data to Applications and Dashboards

Course Segments

- **Cloud-based Infrastructures for Smart Cities**
  - Open Data, Private Data, Real Time data, etc. 
  - General Requirements for Smart City
  - Data Ingestion and aggregation
  - Semantic Modeling and City Knowledge Base, Km4City
  - Data Storage and Data Shadow
  - Data Indexing
  - KB vs Smart City API
  - Data processing and scheduling

Open Data, Private Data, Real Time data, etc




Environment-friendly design buildings
Regional EMS (Control center)
Smart Buildings linked through Regional EMS
Wind farm
Battery storage systems
Next-generation vehicle center(operation center)
MegaSolar
Intelligent Transportation System (ITS)
Smart House
Biomass fuels
Multi-energy station
EV car sharing
EV car sharing
Smart House
Electric bus
Smart House
Small / Medium-scale Smart Buildings
Solar panel
Offshore wind farm
Multi-energy station

Private and static

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

- Personal movements
- GPS traces
- Relationships among people

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

Real time private

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

Static Public (open data)

statistics: accidents, census, votations

- # Accesses to RTZ ZTL
- Data from Public GOV

Position of commercial activities, POI

- Museums
- City services data, almost
- Active services

- Info traffico
- video camere
- Info weather
- Info environment
- Status of the queue at Museums
- earthquake data
- parking

- Stato accessi alla ZTL
- Stato dei servizi

Real time public (open data)

Smart Mobility







- Public transportation:
  - bus, railway, taxi, metro, etc.,
- Public transport for services:
  - garbage collection, ambulances,
- Private transportation:
  - cars, delivering material, etc.
- New solutions (public and/or private):
  - electric cars, car sharing, car pooling, bike sharing, bicycle paths
- Online:
  - ticketing, monitoring travel, infomobility, access to RTZ, parking, etc.

Smart Mobility and urbanization

- **Monitoring** the city status,
  - learn city behavior on mobility
  - learn people behavior, how the city users use the city
  - create collective profiles
  - tracking people flows, single, collective
- **Providing Info/service**
  - personalized
  - **Info** about city status, info mobility
  - help moving people and material
  - education on mobility
  - moderate the peak of consumption
- **Reasoning to**
  - make services sustainable
  - make services accessible
  - Increase the quality of service





Smart Energy

- **Smart building:**
  - saving and optimizing energy consumption, district heating
  - renewable energy: photovoltaic, wind energy, solar energy hydropower, etc.
- **Smart lighting**:
  - turning on/off on the basis of the real needs
- **Energy points for electric**:
  - cars, bikes, scooters,
- **Monitoring** consumption, learn people/city behavior on energy consumption, learn people behavior, create collective profiles
- Suggesting info and opportunities to consumers
  - different behavior for consumption: different time to use the washing machine
- Suggesting administrations
  - restructuring to reduce the global consumption,
  - moderate the peak of consumption





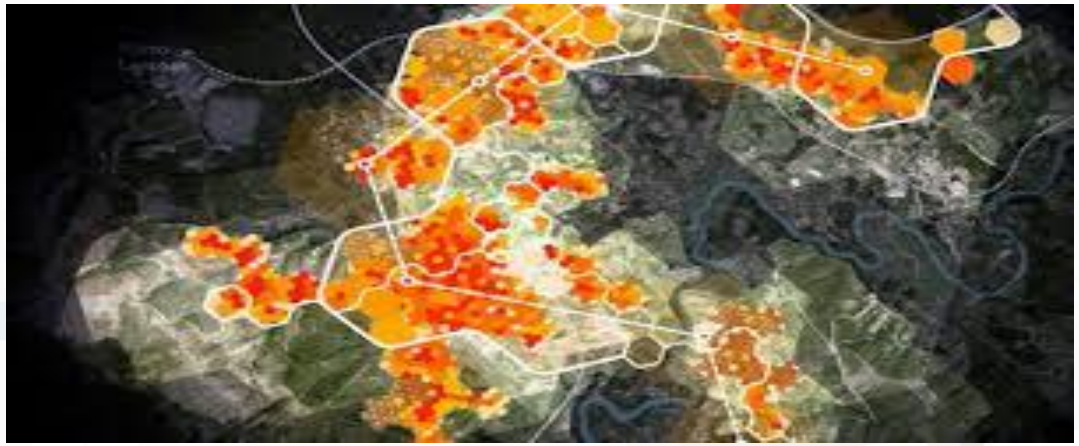




Smart Governmental Services

- Service toward citizens:
  - on-line services:
    - register, certification, civil services, taxes, use of soil, …
  - Payments and banking:
    - taxes, schools, accesses
    - Paying with QR, WeChat
  - Garbage collection:
    - regular and exceptional
    - Closer waste with space for you
  - Quality of air:
    - monitoring pollution, pollination
  - Water control:
    - monitoring water quality, water dispersion, river status





Smart Governmental Services

- **Service toward citizens**:
  - **Cultural Heritage**: ticketing on museums
    - Booking ticket to avoid waiting on the street
  - **Tourism**: ticketing, visiting, planning, booking (hotel and restaurants, etc.)
  - **social networking:** getting service feedbacks, monitoring
- **Social sustainability of services**:
  - crowd services
- **Social recovering** of infrastructure,
  - New services, exploiting infrastructures
- **Monitoring** consumption and exploitation of services, learn people behavior, create collective profiles
  - Discovering problems of services,
  - Finding collective solutions and new needs…







Telecommunication, broadband

- **Fixed Connectivity**:
  - ADSL or more, fiber,
- **Mobile Connectivity**:
  - Public Wi-Fi, Services on Wi-Fi, HSPDA, LTE
  - Tracking users, producing OD matrices from/to cities
  - Commuter analysis
  - Tourism attraction analysis
- **Monitoring** communication infrastructure
- Providing information and formation on:
  - how to exploit the communication infrastructure
  - Exploiting the communication for the other services,
  - moderate the peak of consumption





Smart health

(can be regarded as smart governmental)

- Online accessing to health services:
  - booking and paying, paying with QR, MAV
  - selecting doctor
  - access to EPR (Electronic Patient Record)
- **Monitoring** services and users for,
  - learn people behavior, create collective profiles
  - personalized health/medicine
  - Inform citizens to the risks of their habits
  - Improve efficiency of services
  - redistribute workload, thus reducing the peak of consumption







Smart Education

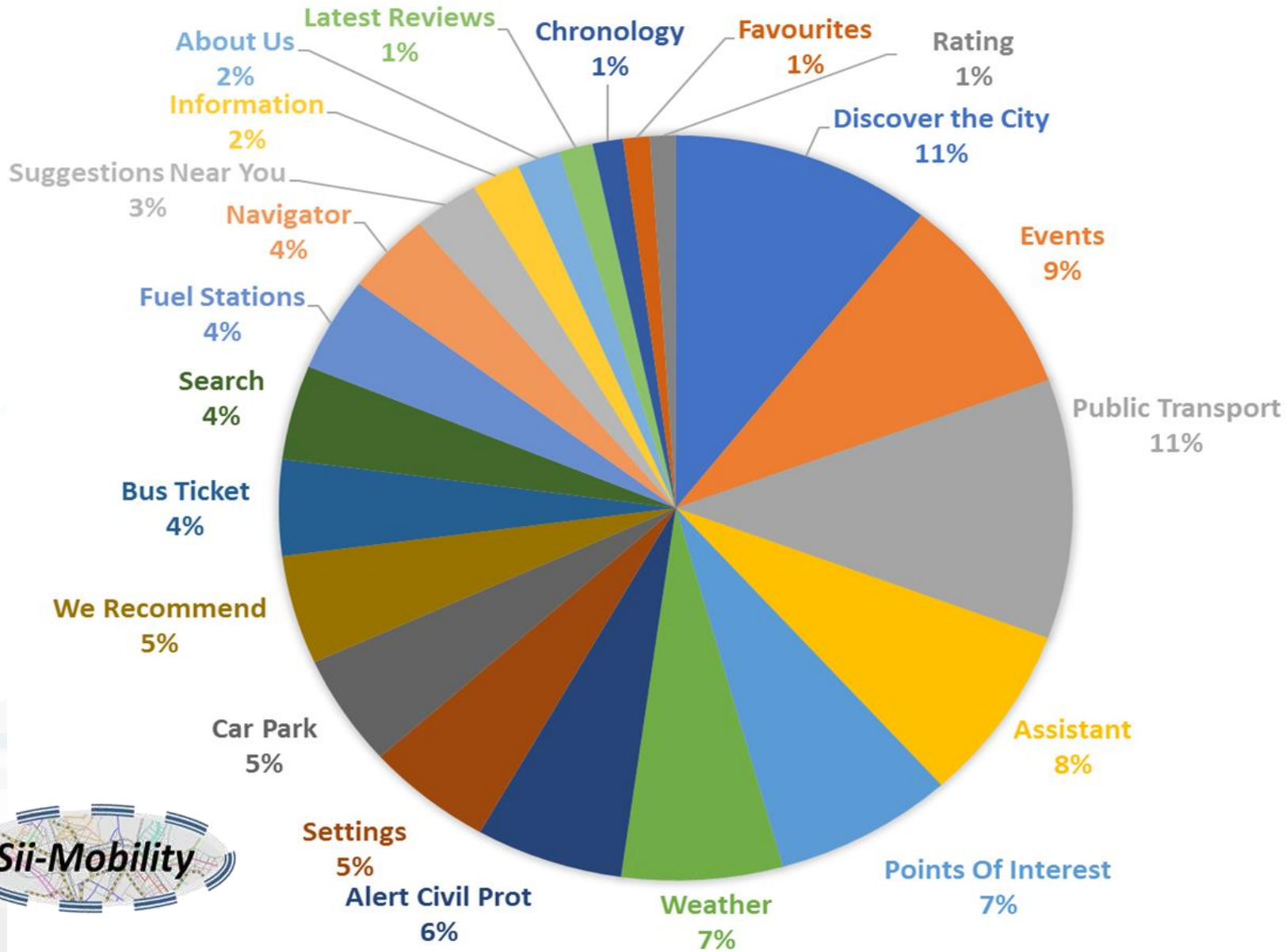
(can be regarded as smart governmental)

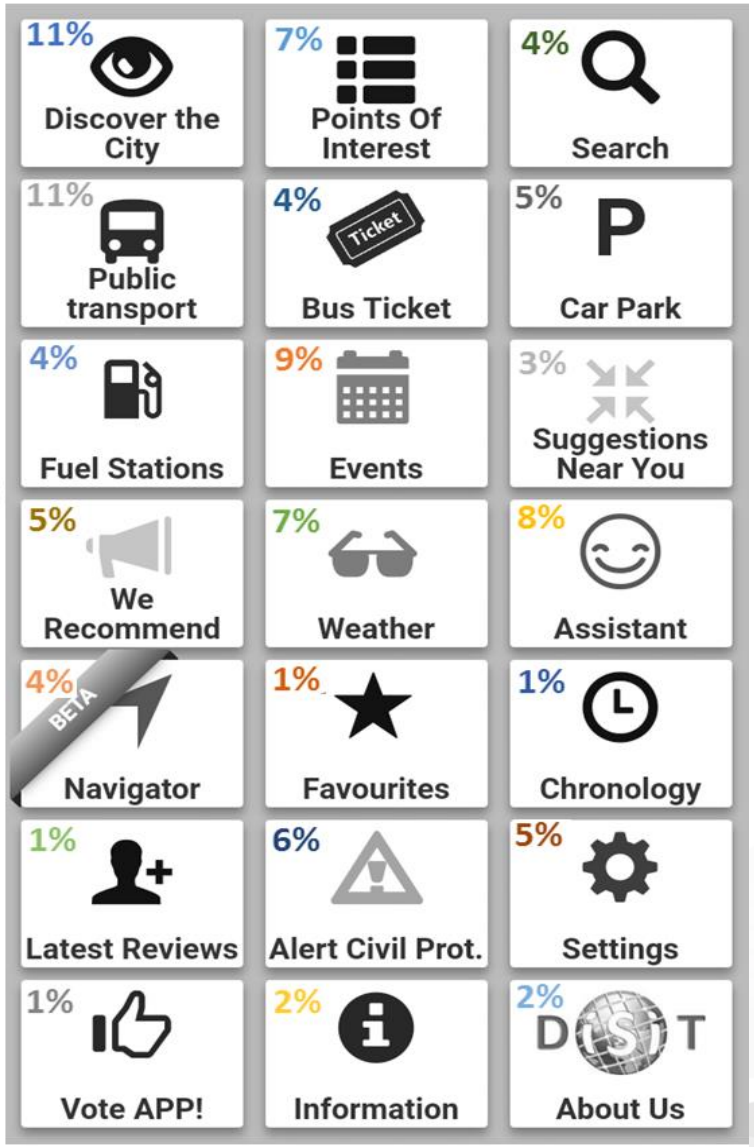
- Diffusion of ICT into the schools:
  - LIM, PAD, internet connection, tables, ..
- Primary and secondary schools → university → industry & services
- **Monitoring** the students and quality of service,
  - learn student behavior, create collective profiles,
  - personalized education
- suggesting behavior to
  - Informing the families
  - moderate the peak of consumption
  - increase the competence in specific needed sectors, etc.
  - Increase formation impact and benefits

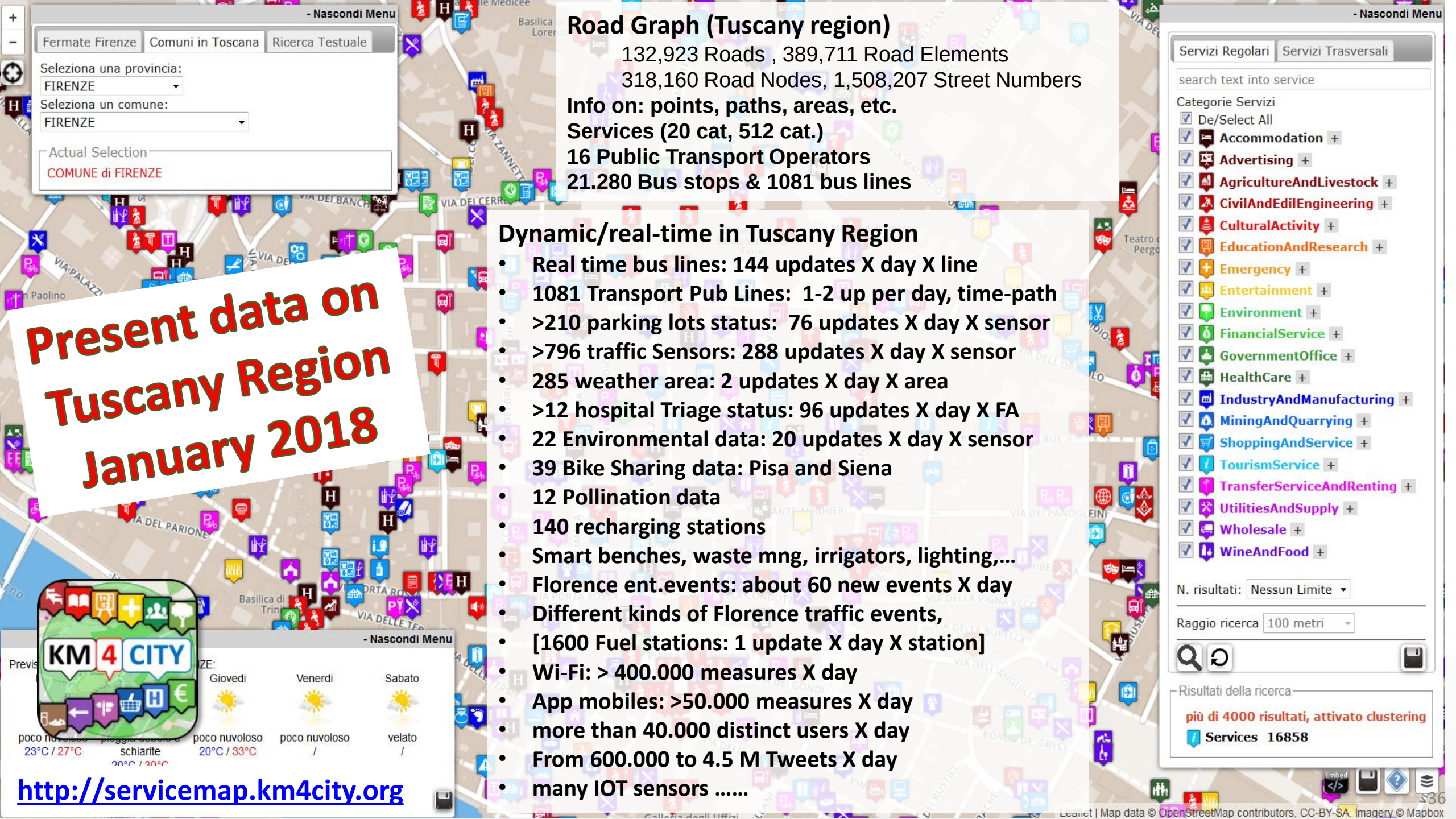


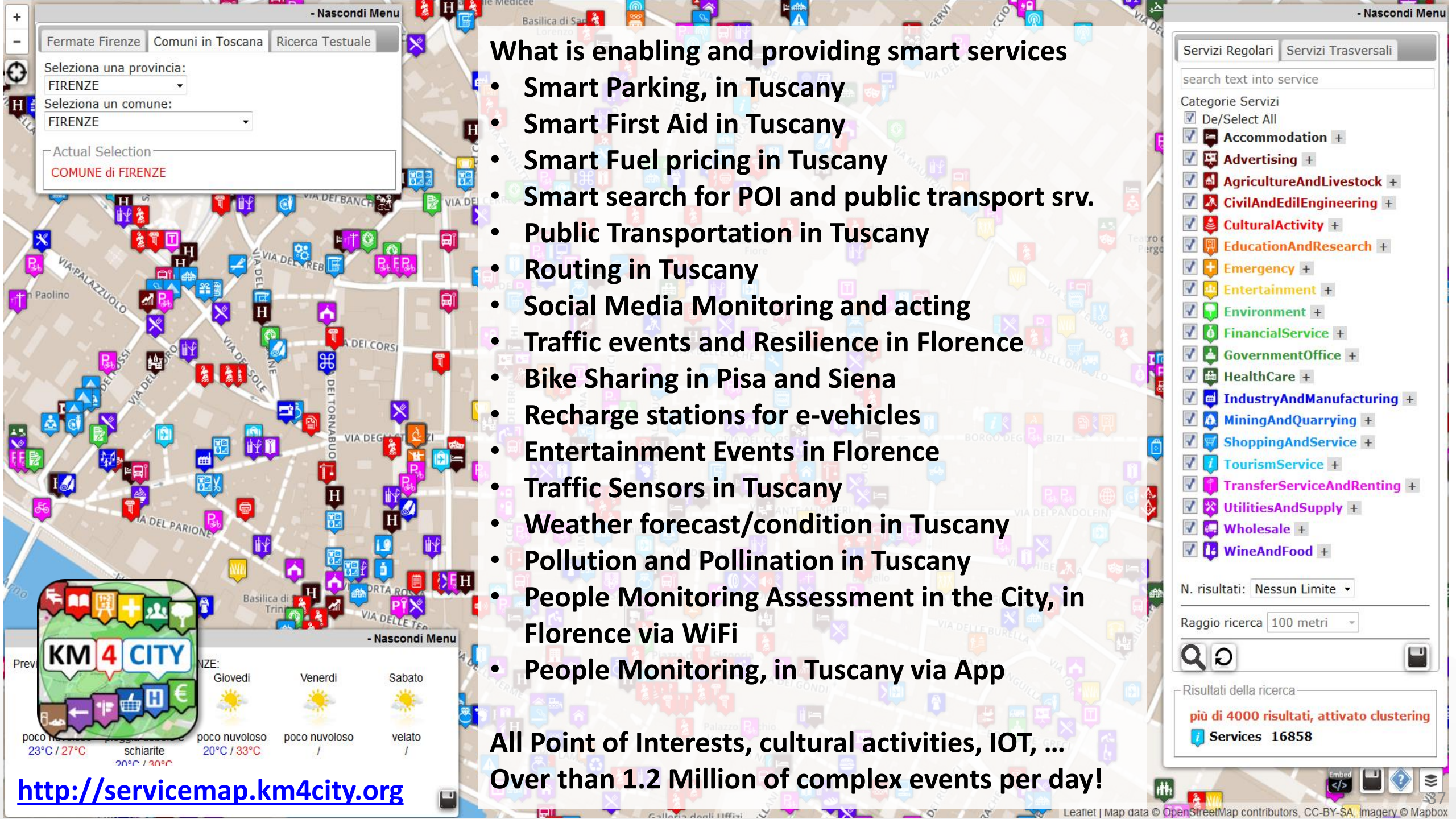


Usage of the main Menu






- Nascondi Menu
Fermate Firenze
Comuni in Toscana
Ricerca Testuale
Seleziona una provincia:
FIRENZE
Seleziona un comune:
FIRENZE
Actual Selection
COMUNE di FIRENZE
Road Graph (Tuscany region)
132,923 Roads , 389,711 Road Elements
318,160 Road Nodes, 1,508,207 Street Numbers
Info on: points, paths, areas, etc.
Services (20 cat, 512 cat.)
16 Public Transport Operators
21.280 Bus stops & 1081 bus lines
Present data on Tuscany Region January 2018
Dynamic/real-time in Tuscany Region
• Real time bus lines: 144 updates X day X line
• 1081 Transport Pub Lines: 1-2 up per day, time-path
• >210 parking lots status: 76 updates X day X sensor
• >796 traffic Sensors: 288 updates X day X sensor
• 285 weather area: 2 updates X day X area
• >12 hospital Triage status: 96 updates X day X FA
• 22 Environmental data: 20 updates X day X sensor
• 39 Bike Sharing data: Pisa and Siena
• 12 Pollination data
• 140 recharging stations
• Smart benches, waste mng, irrigators, lighting,…
• Florence ent.events: about 60 new events X day
• Different kinds of Florence traffic events,
• [1600 Fuel stations: 1 update X day X station]
• Wi-Fi: > 400.000 measures X day
• App mobiles: >50.000 measures X day
• more than 40.000 distinct users X day
• From 600.000 to 4.5 M Tweets X day
• many IOT sensors ……
- Nascondi Menu
Servizi Regolari
Servizi Trasversali
search text into service
Categorie Servizi
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
N. risultati: Nessun Limite
Raggio ricerca 100 metri
Risultati della ricerca
più di 4000 risultati, attivato clustering
Services 16858
KM 4 CITY
Giovedi
Venerdi
Sabato
poco nuvoloso
20°C / 33°C
poco nuvoloso
velato
23°C / 27°C
schiarite
http://servicemap.km4city.org
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox



What is enabling and providing smart services

- Smart Parking, in Tuscany
- Smart First Aid in Tuscany
- Smart Fuel pricing in Tuscany
- Smart search for POI and public transport srv.
- Public Transportation in Tuscany
- Routing in Tuscany
- Social Media Monitoring and acting
- Traffic events and Resilience in Florence
- Bike Sharing in Pisa and Siena
- Recharge stations for e-vehicles
- Entertainment Events in Florence
- Traffic Sensors in Tuscany
- Weather forecast/condition in Tuscany
- Pollution and Pollination in Tuscany
- People Monitoring Assessment in the City, in Florence via WiFi
- People Monitoring, in Tuscany via App

All Point of Interests, cultural activities, IOT, …

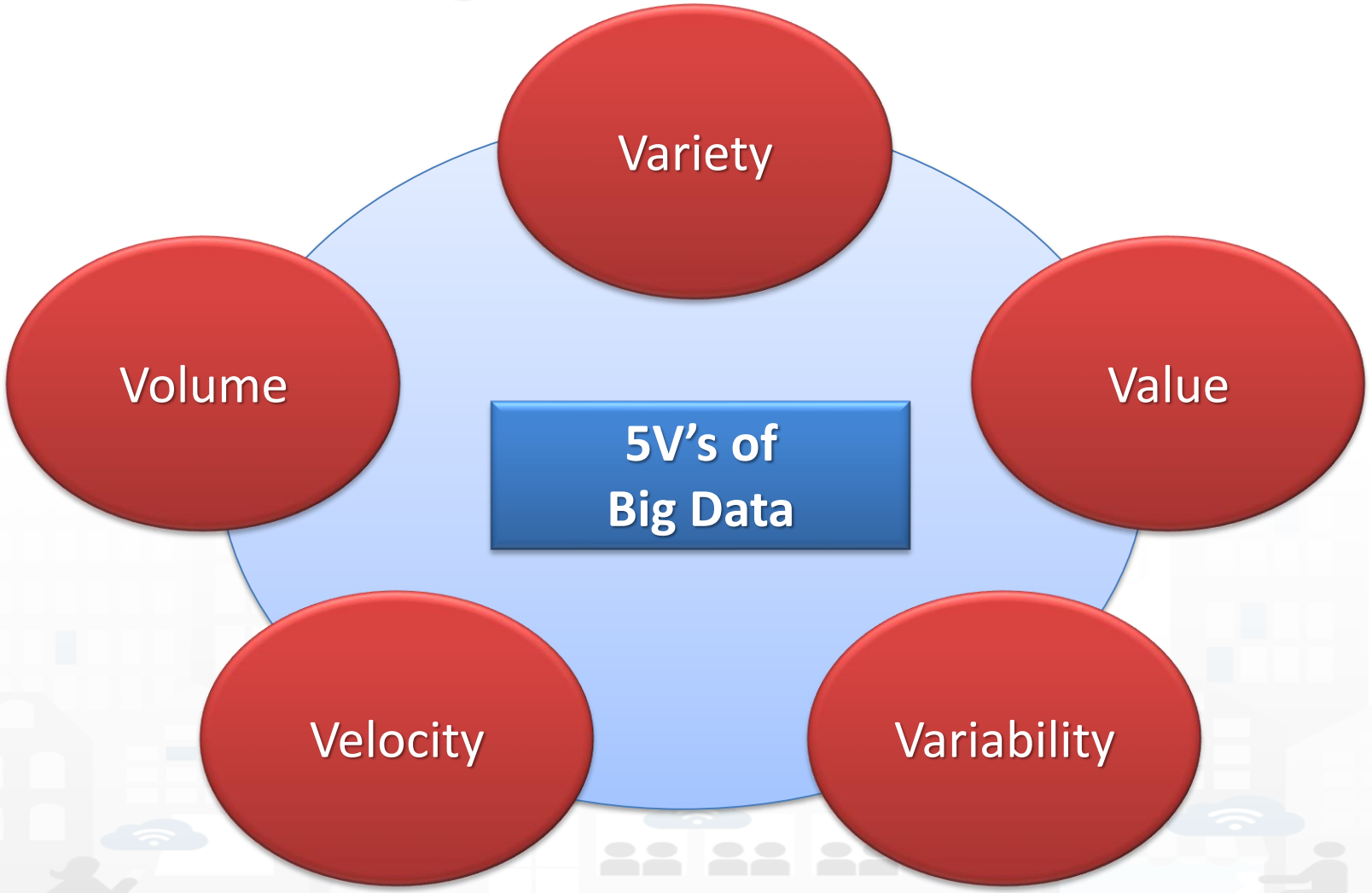
Over than 1.2 Million of complex events per day!

http://servicemap.km4city.org

5V of Big Data

When data are BIG data?

The excel file size?



General Requirements for Smart City



Course Segments

- **Cloud-based Infrastructures for Smart Cities**
  - Open Data, Private Data, Real Time data, etc.
  - General Requirements for Smart City
  - Data Ingestion and aggregation
  - Semantic Modeling and City Knowledge Base, Km4City
  - Data Storage and Data Shadow
  - Data Indexing
  - KB vs Smart City API
  - Data processing and scheduling

Sustainability of the Growth

- To be **planned and managed** with respect to increment of population and their needs
  - increment of efficiency:
    - compensation of the increments of costs
  - Increment of quality of life:
    - compensation of the decrement of quality of life
  - provisioning of new services:
    - compensation of the inadequacy of 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

Smart-City

- ***Main Aim***
  - Provide a platform able to ingest and take advantage a large number of the above data, big data:
    - ***Exploit data integration and reasoning***
    - ***Deliver new services and applications to citizens,*** Leverage on the ongoing Semantic Web effort
- ***Problems & Challenges***
  - Data are provided in many different formats and protocols and from many different institutions, different convention and protocols, a different time, …. !
  - Data are typically not aligned (e.g., street names, dates, geolocations, tags, …). That is, they are n**ot semantically interoperable**
  - resulting a big data problem: volume, velocity, variability, variety, …..

Challenges: Requests and Deductions

Public Admin.



Pub. Admin: detection of critical conditions, improving services

Mobility Operators





Tune the service, reselling data and services , prediction





Retails



Commercial: customers prediction and profiles, promotions via ads

Tourism Museums



Tune the service, prediction

API for SME

Smart City Solution

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



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







User profiling
Collective profiles
User segmentation

User Behavior Crowd Sources



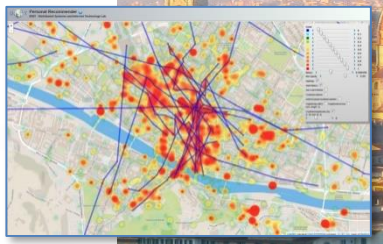
Data: Public and Private, Static and Real Time

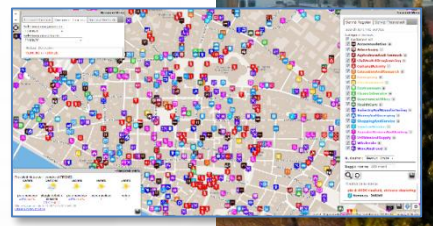
Private: user movements, social media, crowd sources, commercial (retail)
Public: infomobility, traffic flow, TV cameras, flows, ambient, weather, statistic, accesses to LTZ, services, museums, point of interests, ...

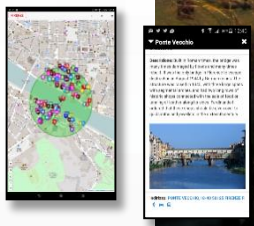
Integrated Urban Platform

- **Aggregate & integrate data**
  - Multiple protocols from urban operators, ...
  - open data, IOT, sensors, internet of everything, cloud, mobile devices, Wi-Fi, social media, ...
- **Data Exploitation performing**
  - predictions, reasoning, business intelligence, ..
  - users behavior analysis, decision support system, ..
  - Control Room, Real Time Monitoring tools, ...
- **Produce value from data supporting Living lab**
  - Stimulate virtuous behavior, influence City Users!
  - Put in action CITY Strategies









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, ...

Data Ingestion and aggregation



Course Segments

- **Cloud-based Infrastructures for Smart Cities**
  - Open Data, Private Data, Real Time data, etc.
  - General Requirements for Smart City
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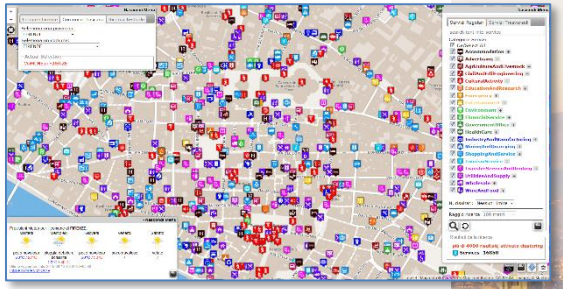
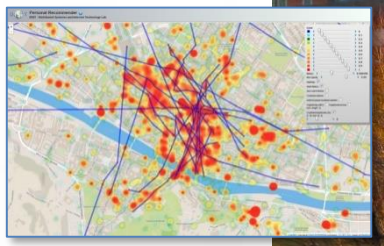
  - Semantic Modeling and City Knowledge Base, Km4City
  - Data Storage and Data Shadow
  - Data Indexing
  - KB vs Smart City API
  - Data processing and scheduling

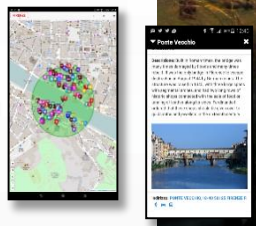
Urban Platform: Control Room

- **Aggregate & integrate data**
  - Multiple protocols from urban operators, ...
  - open data, IOT, sensors, internet of everything, cloud, mobile devices, Wi-Fi, social media, ...
- **Data Exploitation performing**
  - predictions, reasoning, business intelligence, ..
  - users behavior analysis, decision support system, ..
  - Control Room, Real Time Monitoring tools, ...
- **Produce value from data enabling** to
  - Stimulate virtuous behavior, influence City Users!
  - Put in action CITY Strategies

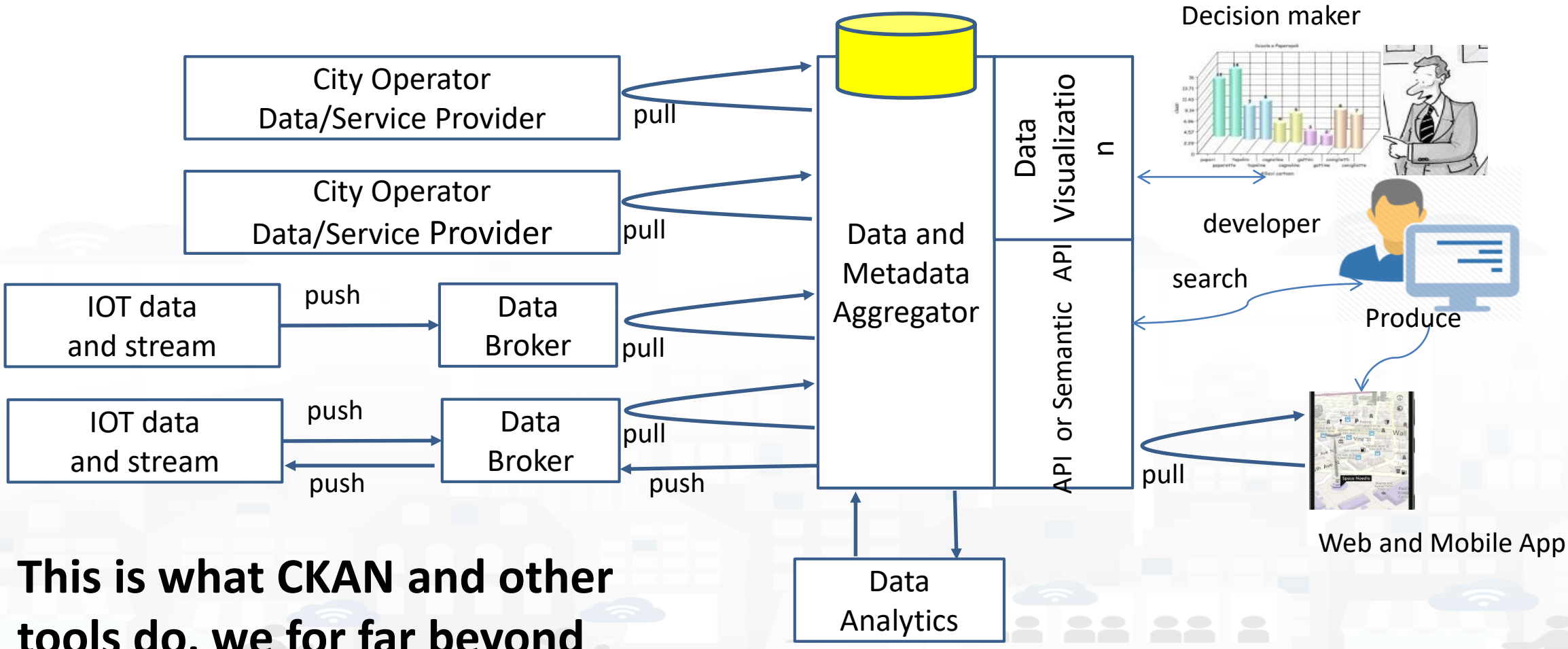






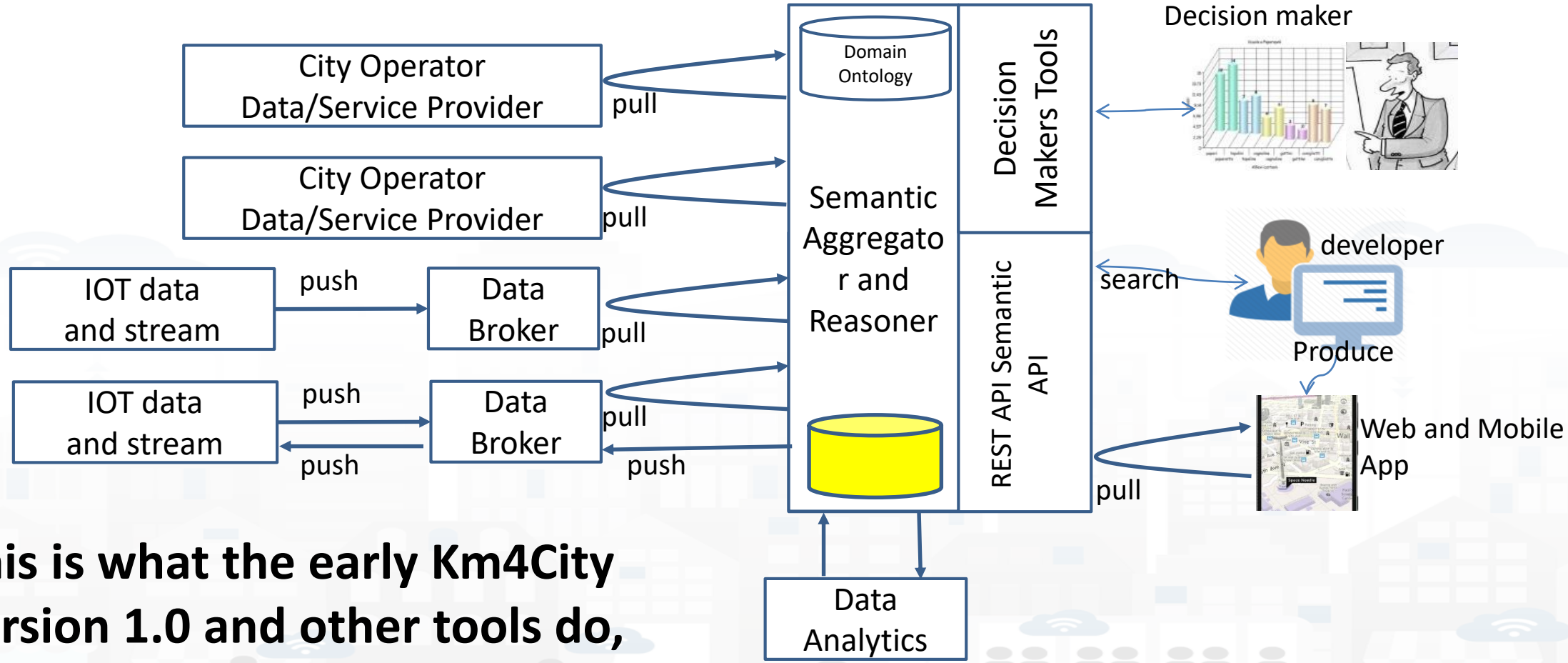


Data aggregation basic



This is what CKAN and other tools do, we for far beyond

Semantic Data Aggregator



This is what the early Km4City version 1.0 and other tools do, we for far beyond

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

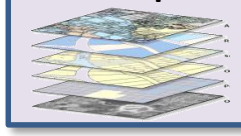
SNAP4CITY

KM4CITY

Open Data



GIS + Map Data



Proprietary Data



Personal Data



IoT/IoE



Industry 4.0



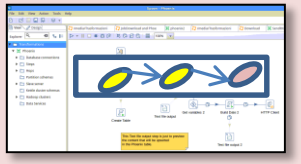
Social Media



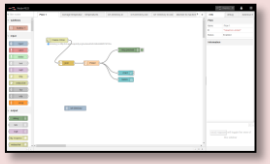
Static, Quasi static and Real Time data flows

Data Processing Tools

ETL Processes, Data Analytic, R; IOT App; etc.



ETL Processes

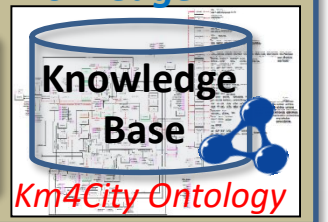


IoT/IoE Applications

Elastic Management of Containers

Big Data Storage Knowledge

Phoenix, Hbase + indexing



Smart City Cloud Infrastructure

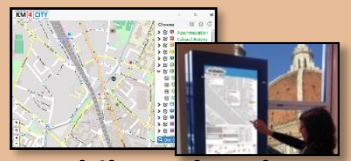
Km4City Smart City API

Final Users' Tools

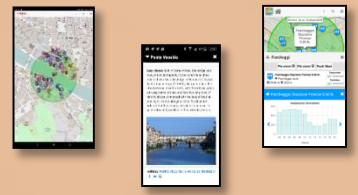


Dashboards

IOT / IOE Apps

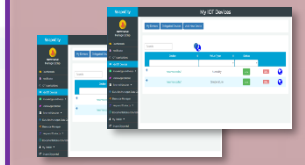


Mobile and Web Apps



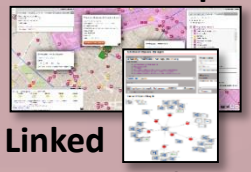
Living Lab, Development and Management Tools

Management



IOT Directory

ServiceMap



Linked Open Graph

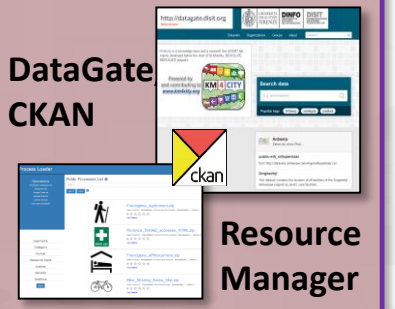
Data Flow Analysis

DevDash



AMMA

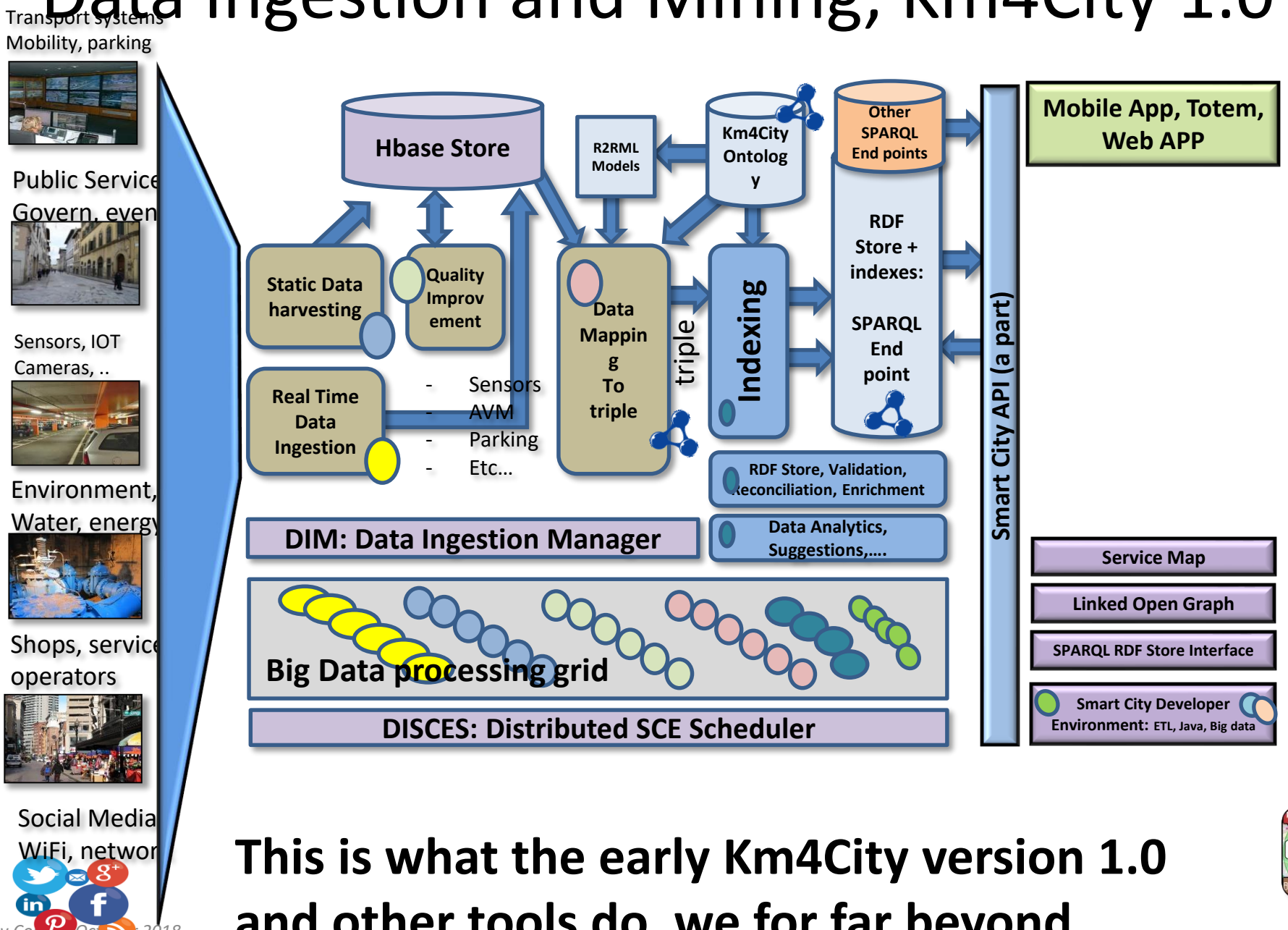
DataGate CKAN



Resource Manager

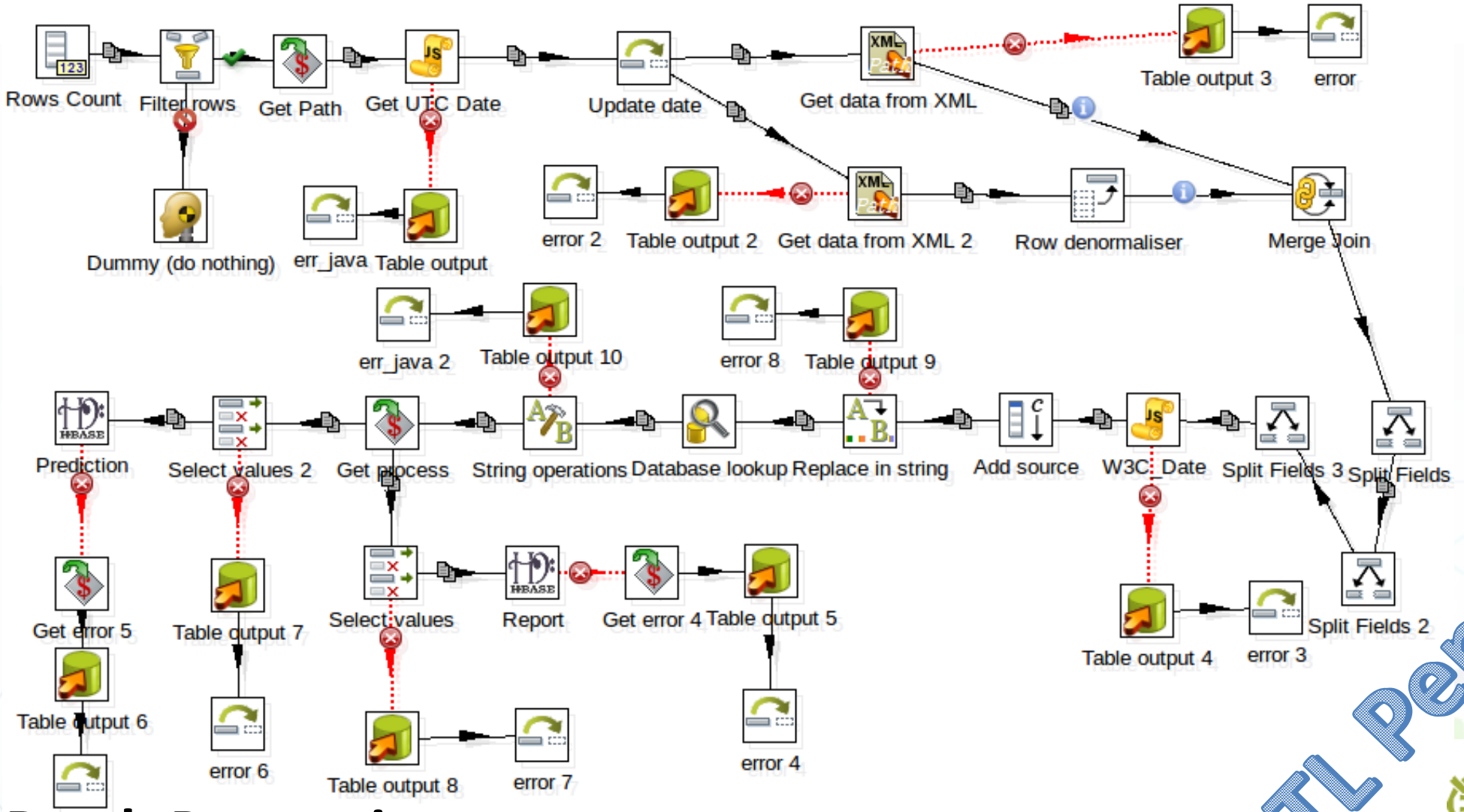
Authentication, Authorization, GDPR, Security Assessment

Data Ingestion and Mining, Km4City 1.0



This is what the early Km4City version 1.0 and other tools do, we for far beyond

Example of ETL

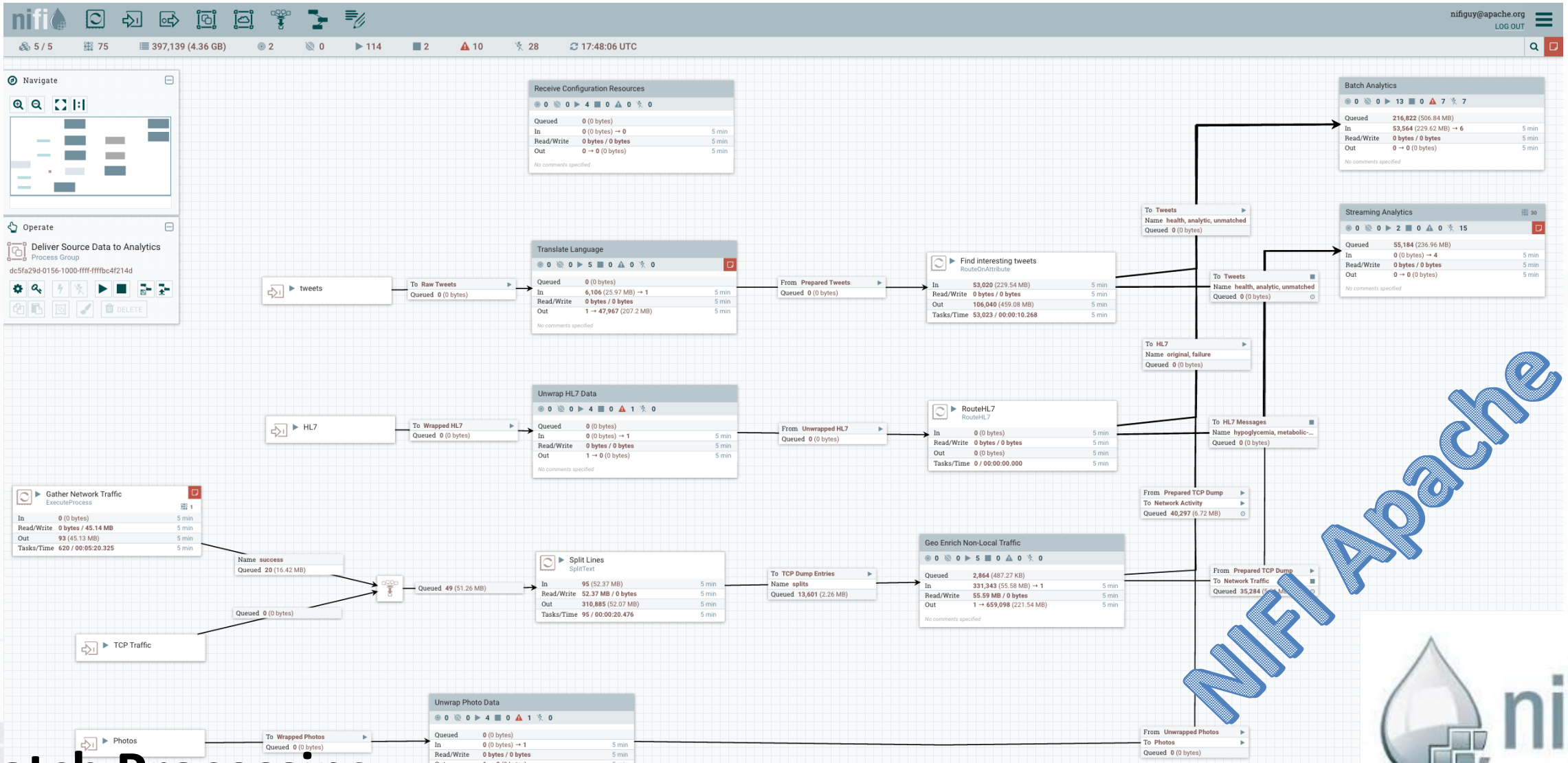


ETL Penthao Kettle

kettle™ pentaho data integration

Batch Processing

Example of NIFI



NIFI Apache

nifi

Batch Processing

Semantic Modeling and City Knowledge Base, Km4City



Course Segments

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  - Open Data, Private Data, Real Time data, etc.
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  - Data Storage and Data Shadow
  - Data Indexing
  - KB vs Smart City API
  - Data processing and scheduling

Transport systems
Mobility, parking



Public Services
Govern, events, …



Sensors, IOT
Cameras, ..



Environment,
Water, energy



Shops, services,
operators



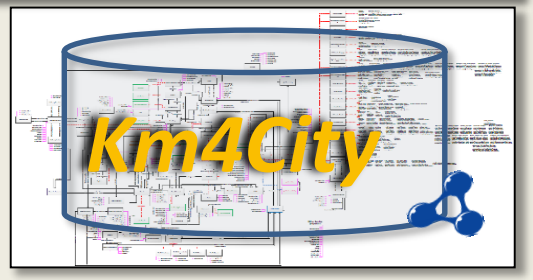
Social Media
WiFi, network



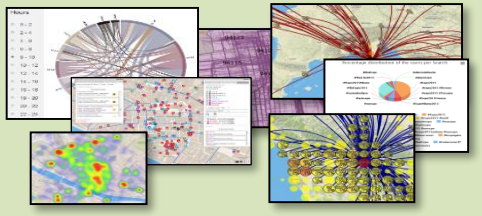
Static, Slow and Real Time data flows

DISCES -- Distributed and parallel architecture on Cloud

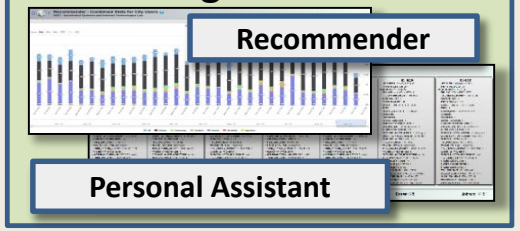
Km4City Smart City Engine



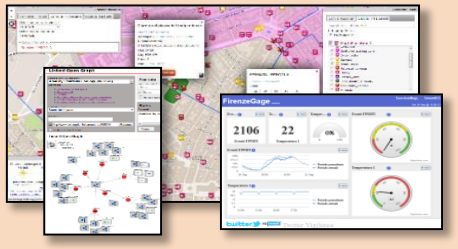
Big Data Analytics



Smartening Tools



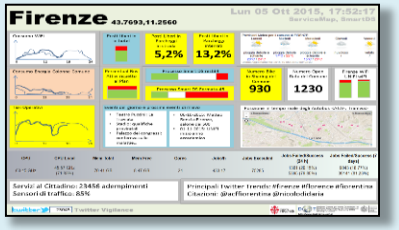
Development Tools



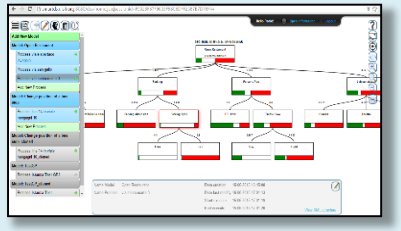
Km4City Smart City API

City Operators and Decision Makers

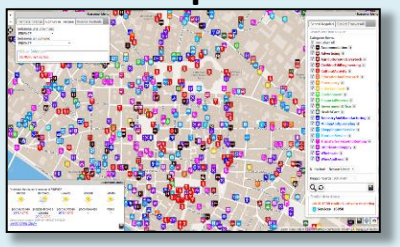
Dashboards



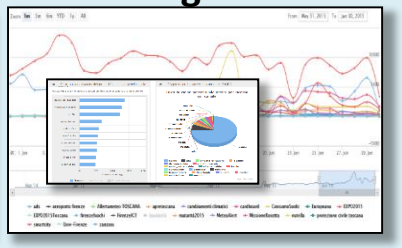
Smart Decision Support



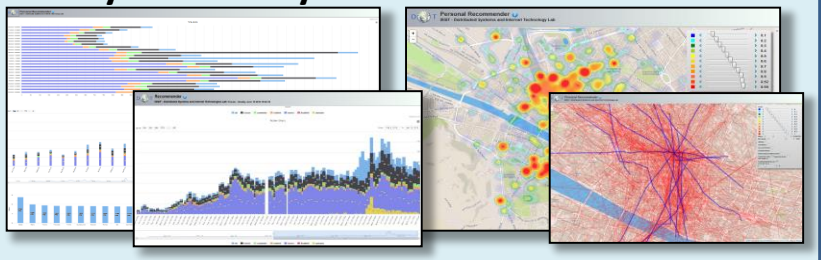
ServiceMap browser



Twitter Vigilance



Analyzers of City User Behavior

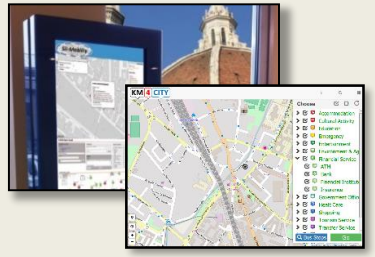


Tools for Final Users

Mobile e Web Apps



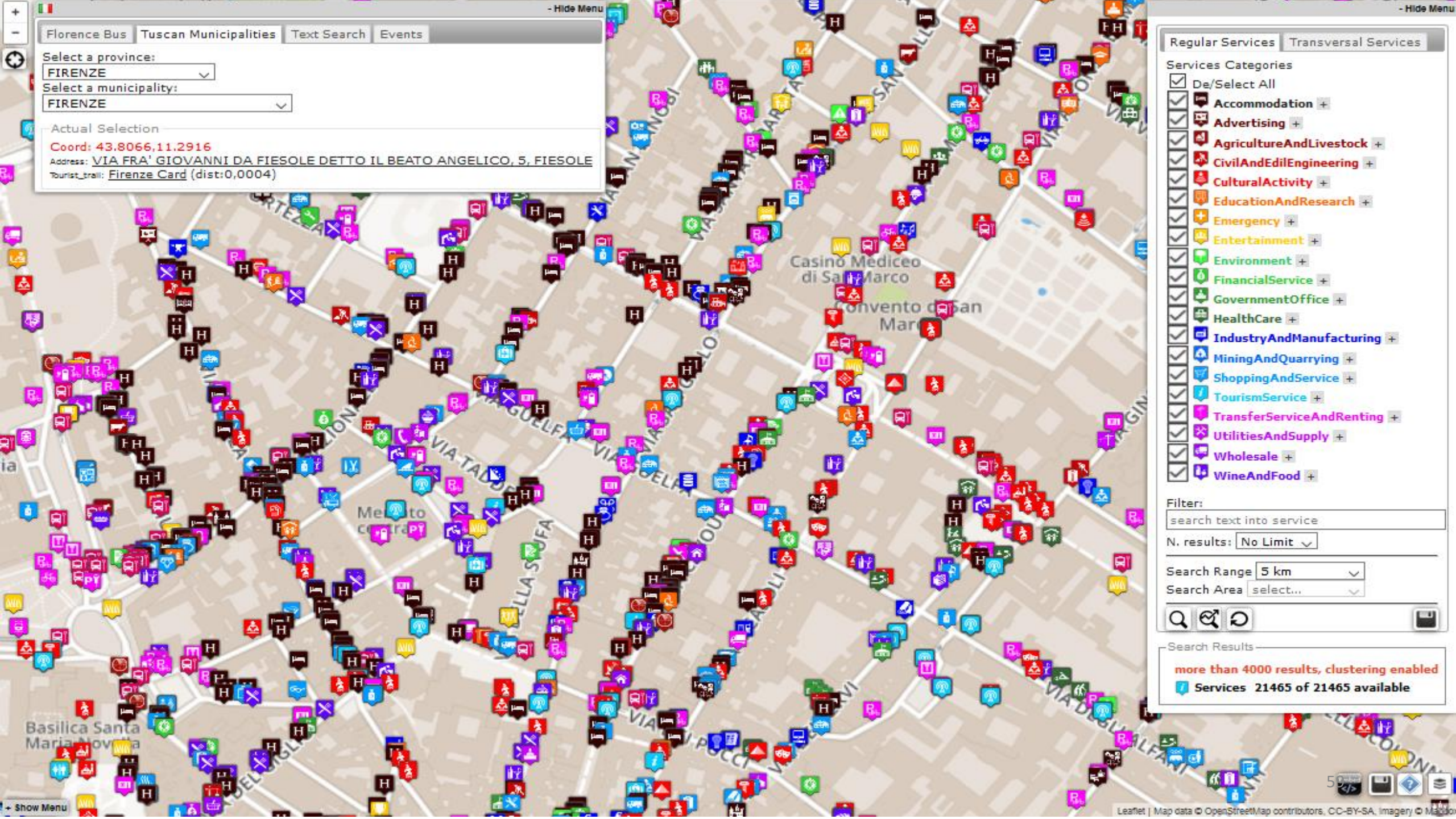




KM4CITY

Sii-Mobility

Http://www.km4city.org

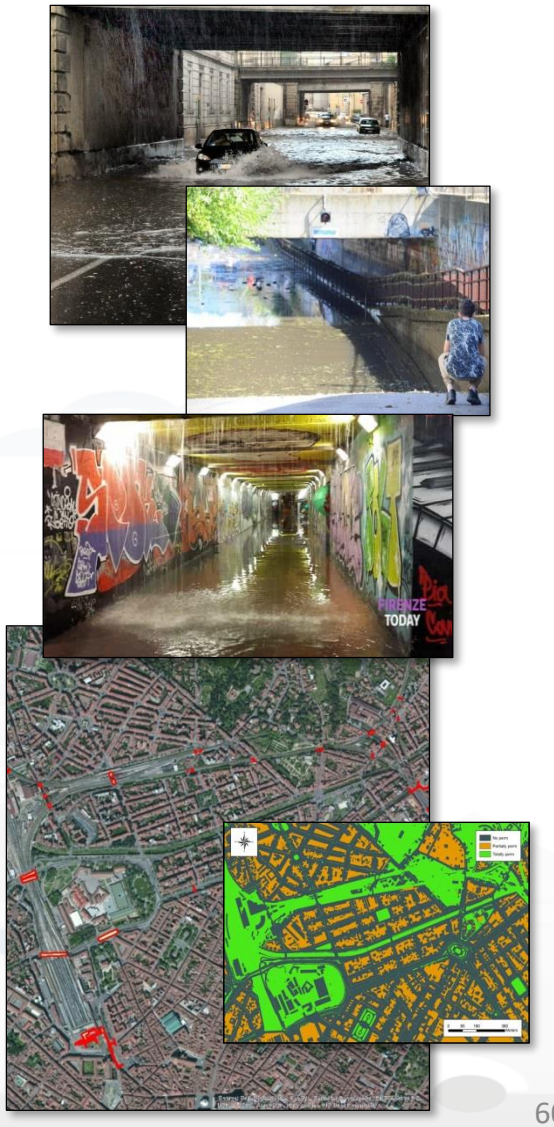

- Hide Menu
Florence Bus
Tuscan Municipalities
Text Search
Events
Select a province:
FIRENZE
Select a municipality:
FIRENZE
Actual Selection
Coord: 43.8066,11.2916
Address: VIA FRA' GIOVANNI DA FIESOLE DETTO IL BEATO ANGELICO, 5, FIESOLE
Tourist_trail: Firenze Card (dist:0,0004)
- Hide Menu
Regular Services
Transversal Services
Services Categories
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
Filter:
search text into service
N. results: No Limit
Search Range 5 km
Search Area select...
Search Results
more than 4000 results, clustering enabled
Services 21465 of 21465 available
Casino Mediceo di San Marco
Convento di San Marco
Basilica Santa Maria Novella
+ Show Menu
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

Other Sensors and Actuators, IOT

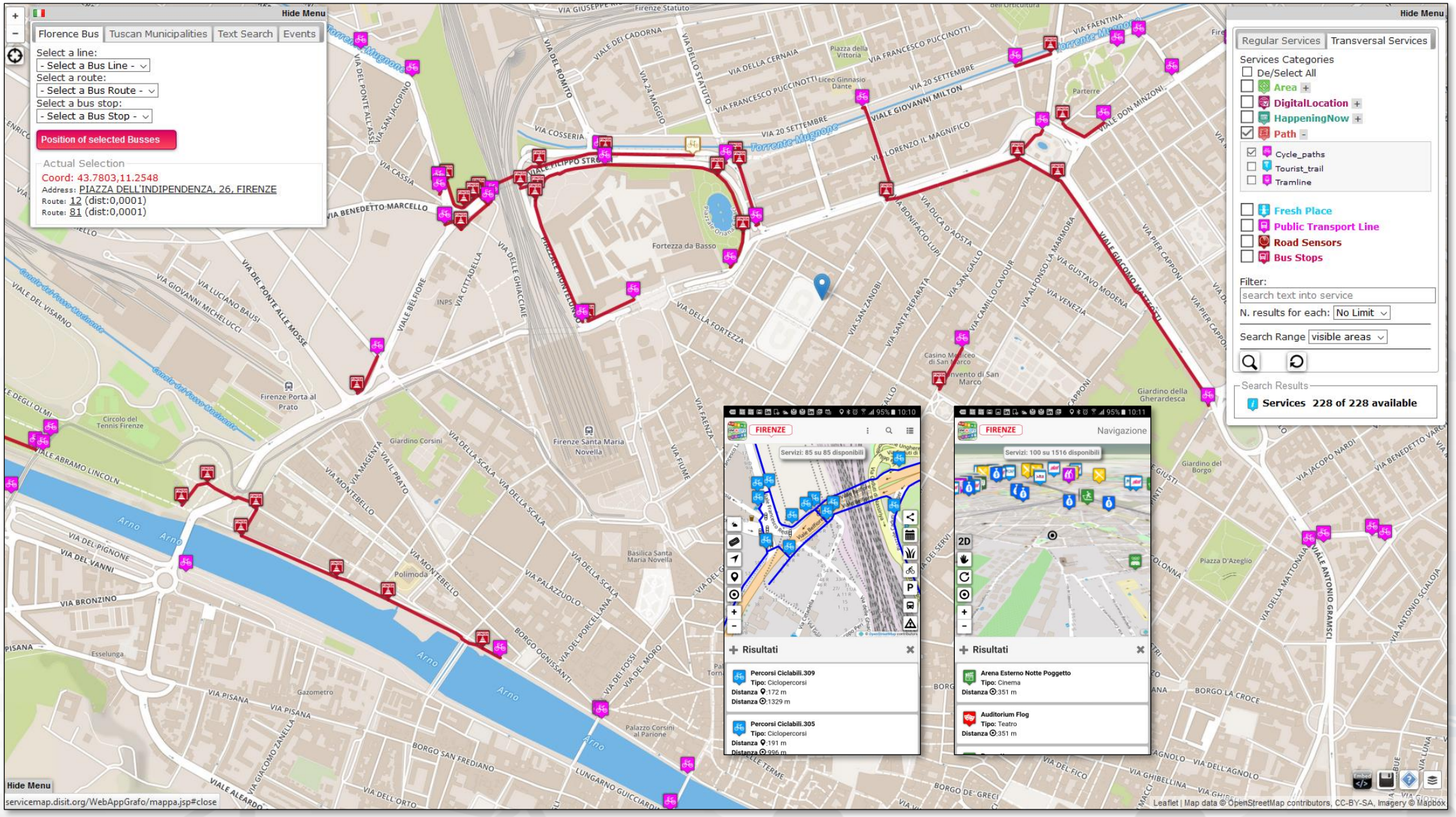
- Restricted Traffic Zone Gates
  - Passages, payment, alerts,
  - Wi-Fi control, RFI control, etc.
- Road Direction manager: panel, red-light, etc.
  - Status and action
- Environmental Sensors:
  - Air quality, pollution, rain, allergens, temperature,
  - humidity,…
- Public Light Pillar
  - Traffic flows, environment,
  - Wi-Fi, Tv-Camera, BT servers, on/off, percentage of light, ..
- Waste Manager
  - Level, kind, status, on/off
- Recharge station, column
  - Free slots, consumption, next time slot, …



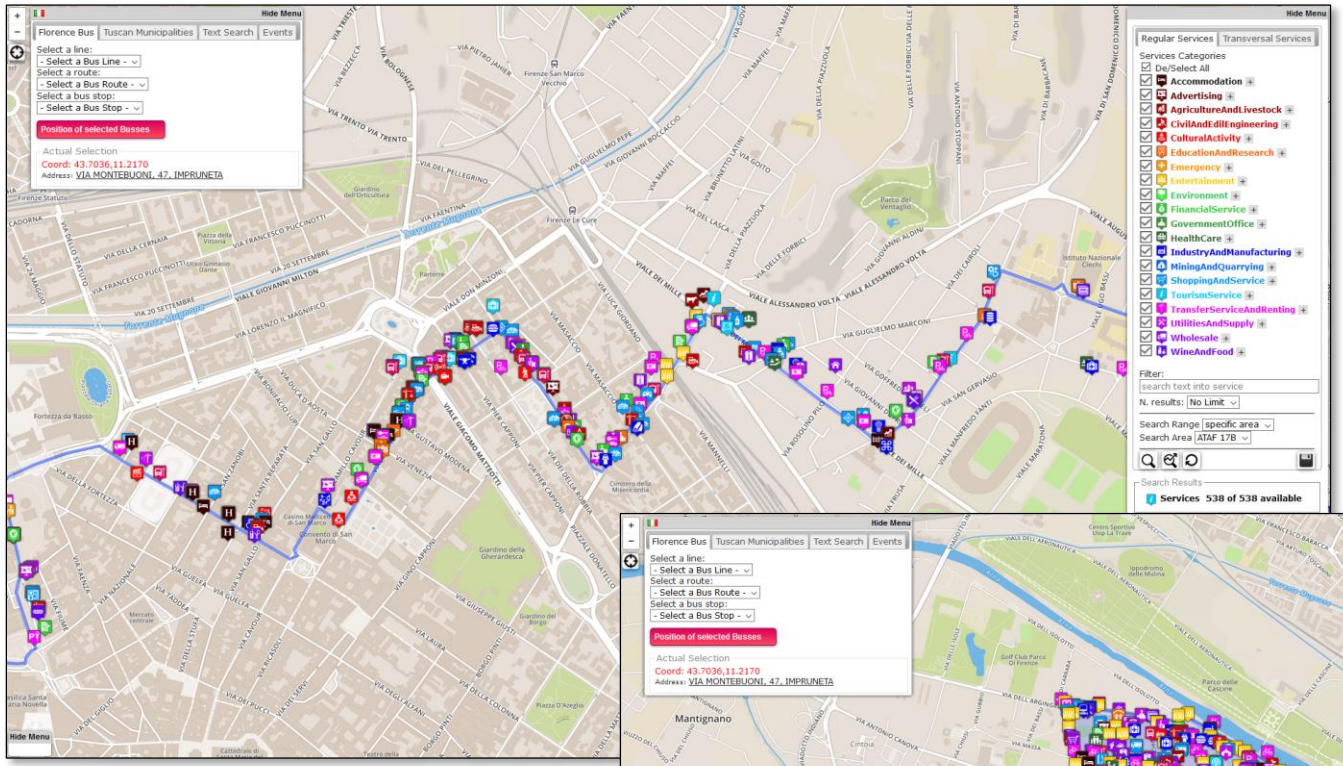
- **Environmental Sensors**:
  - Air, temperature, humidity,
  - water level in rivers
  - Status of underpass and bridges
- **Risk assessment**
  - Value of the buildings,
  - hydrogeological risk map,
  - earthquake risk map, …
  - people distribution and location
  - Position of recover places,
- **Traffic Zone Gates**
  - Passages, alerts,
  - etc.

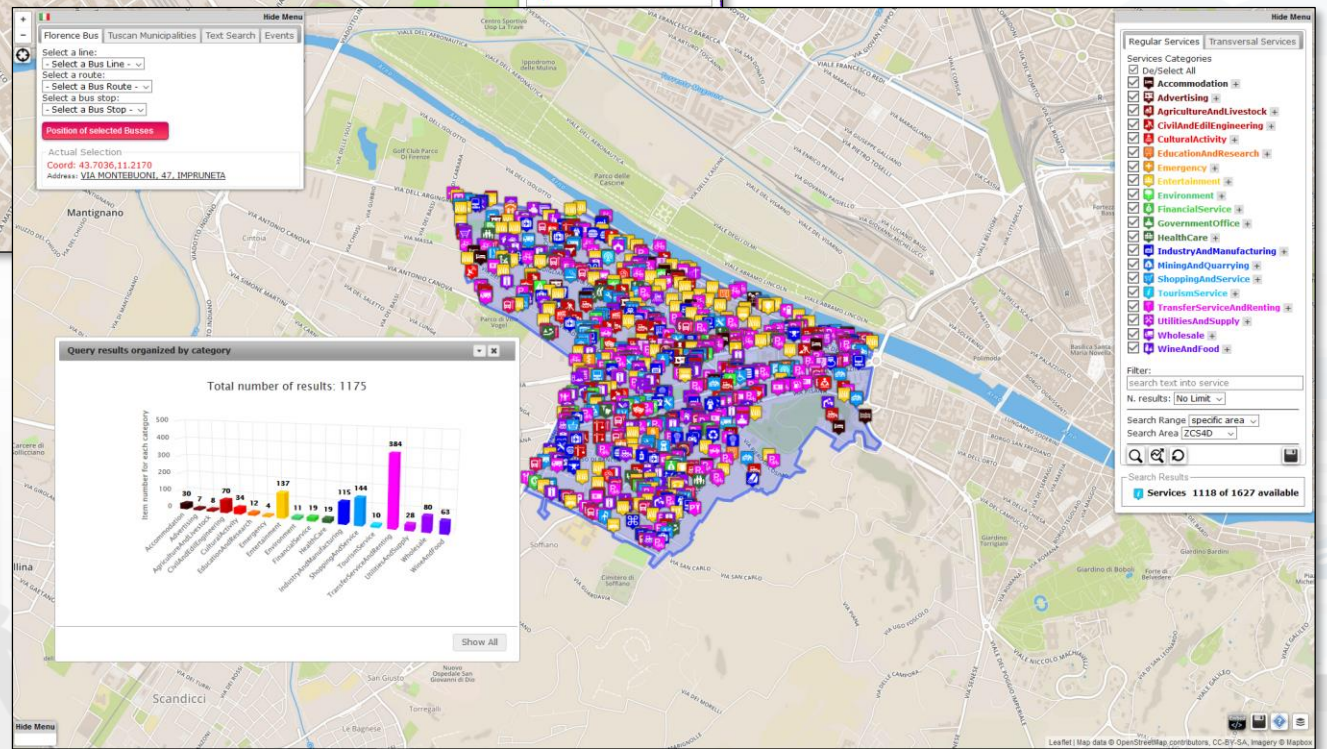


Cycling Paths



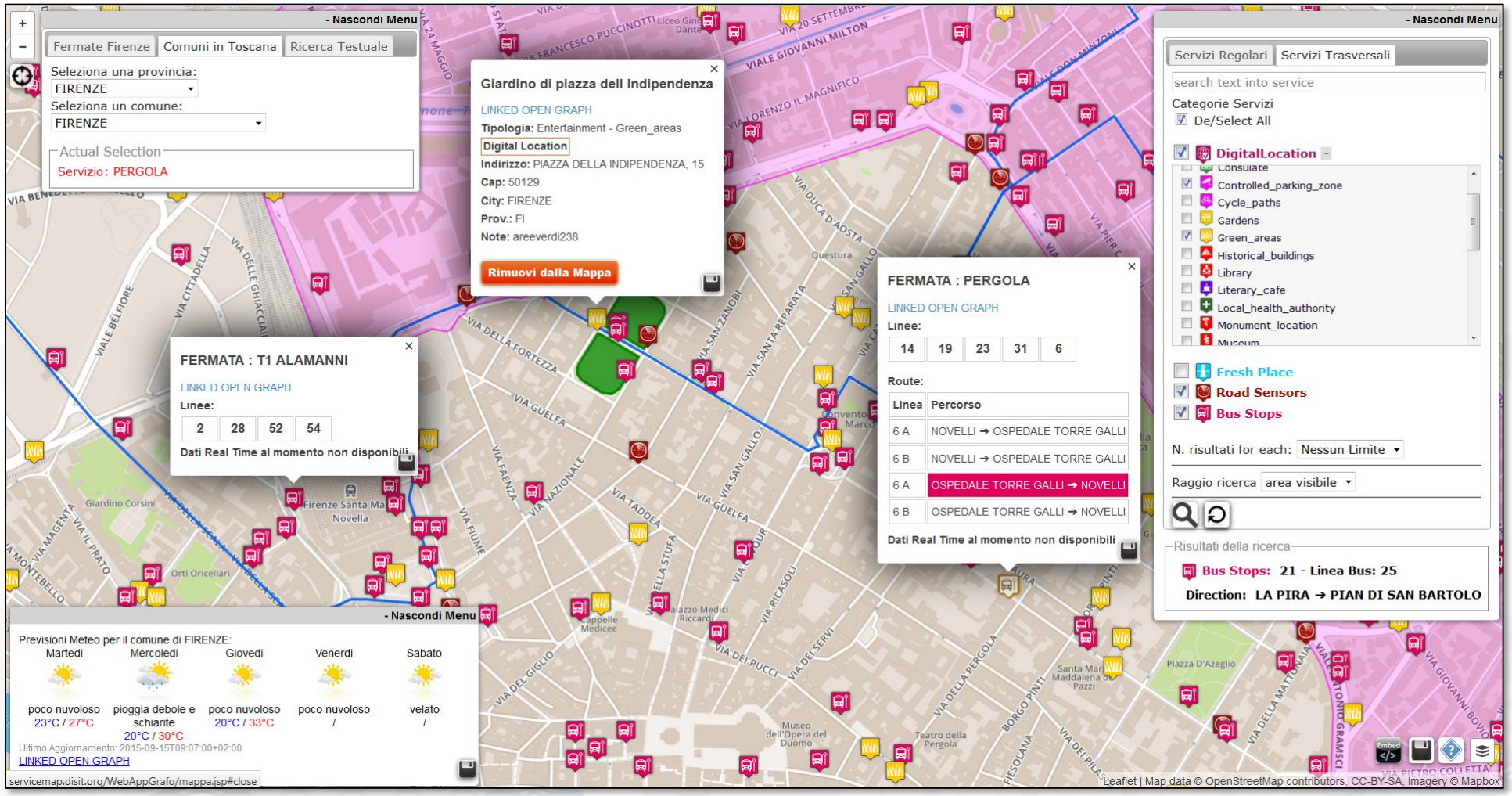
Along a Line



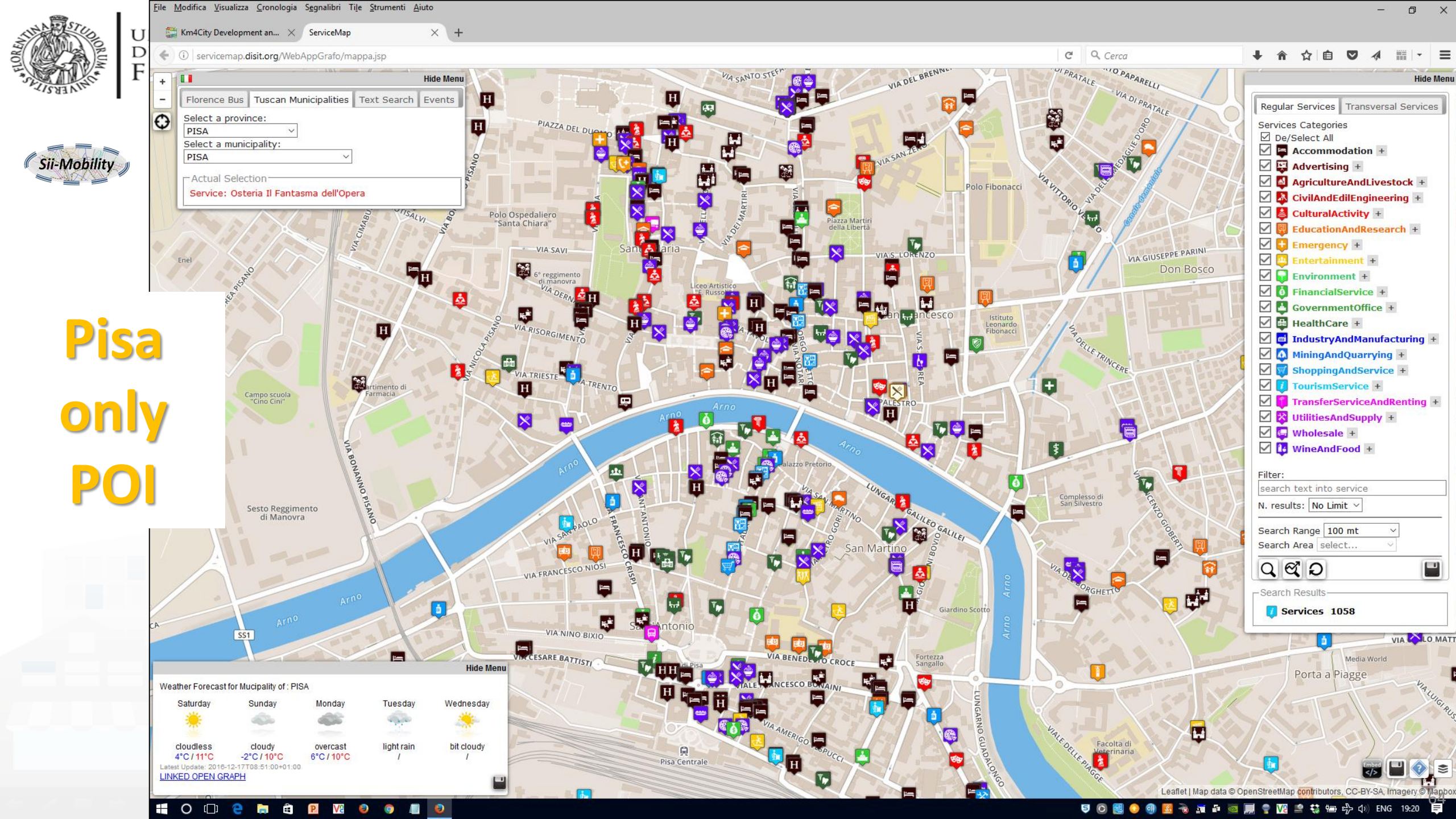


Into an Area

Km4City in Firenze



- **Areas, Bus lines, bike lanes, tram, RTZ, etc.**


Pisa
only
POI
Hide Menu
Florence Bus
Tuscan Municipalities
Text Search
Events
Select a province:
PISA
Select a municipality:
PISA
Actual Selection
Service: Osteria Il Fantasma dell'Opera
Hide Menu
Regular Services
Transversal Services
Services Categories
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
Filter:
search text into service
N. results: No Limit
Search Range 100 mt
Search Area select...
Search Results
Services 1058
Hide Menu
Weather Forecast for Mucipality of : PISA
Saturday
cloudless
4°C / 11°C
Sunday
cloudy
-2°C / 10°C
Monday
overcast
6°C / 10°C
Tuesday
light rain
/
Wednesday
bit cloudy
/
Latest Update: 2016-12-17T08:51:00+01:00
LINKED OPEN GRAPH
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

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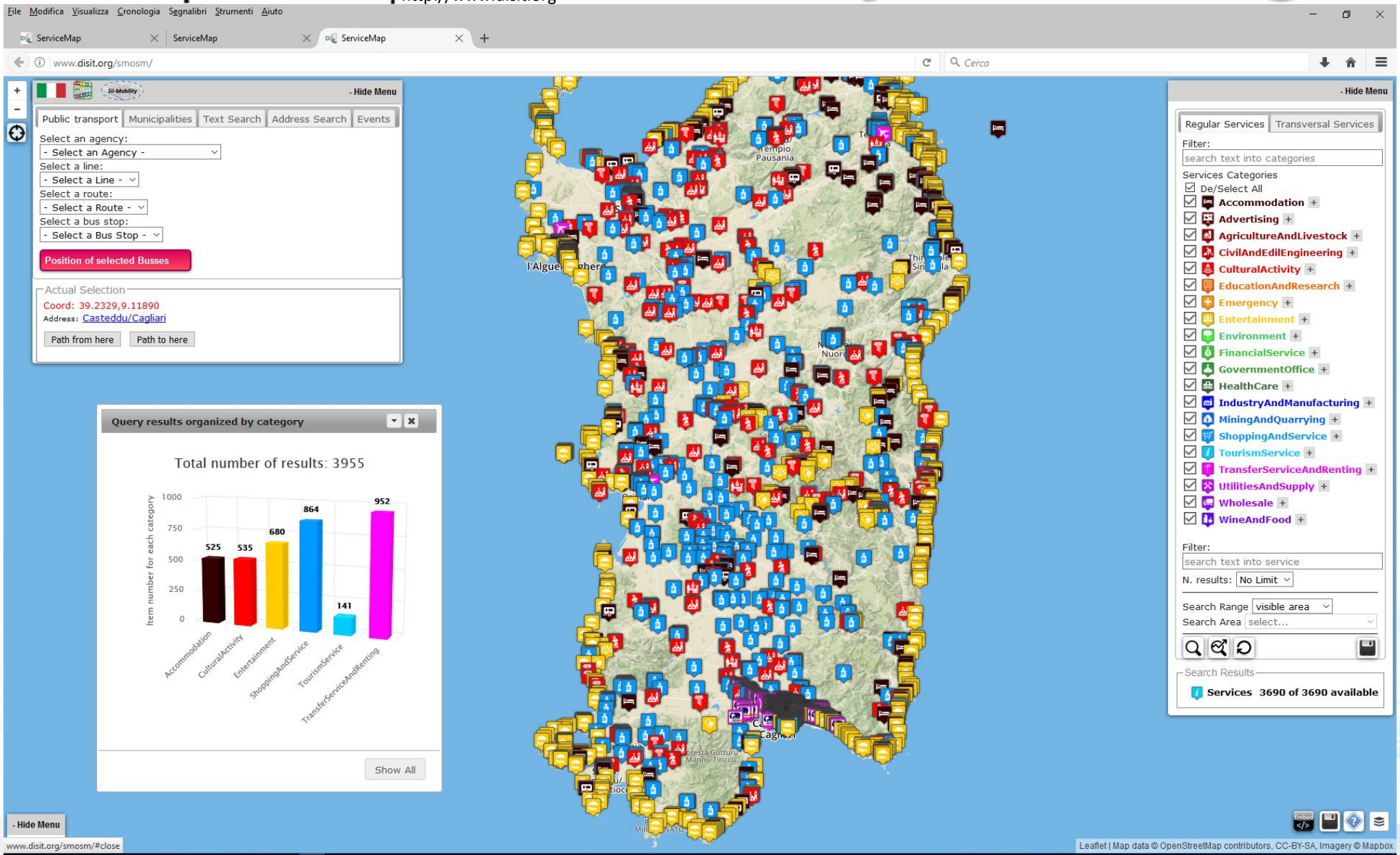
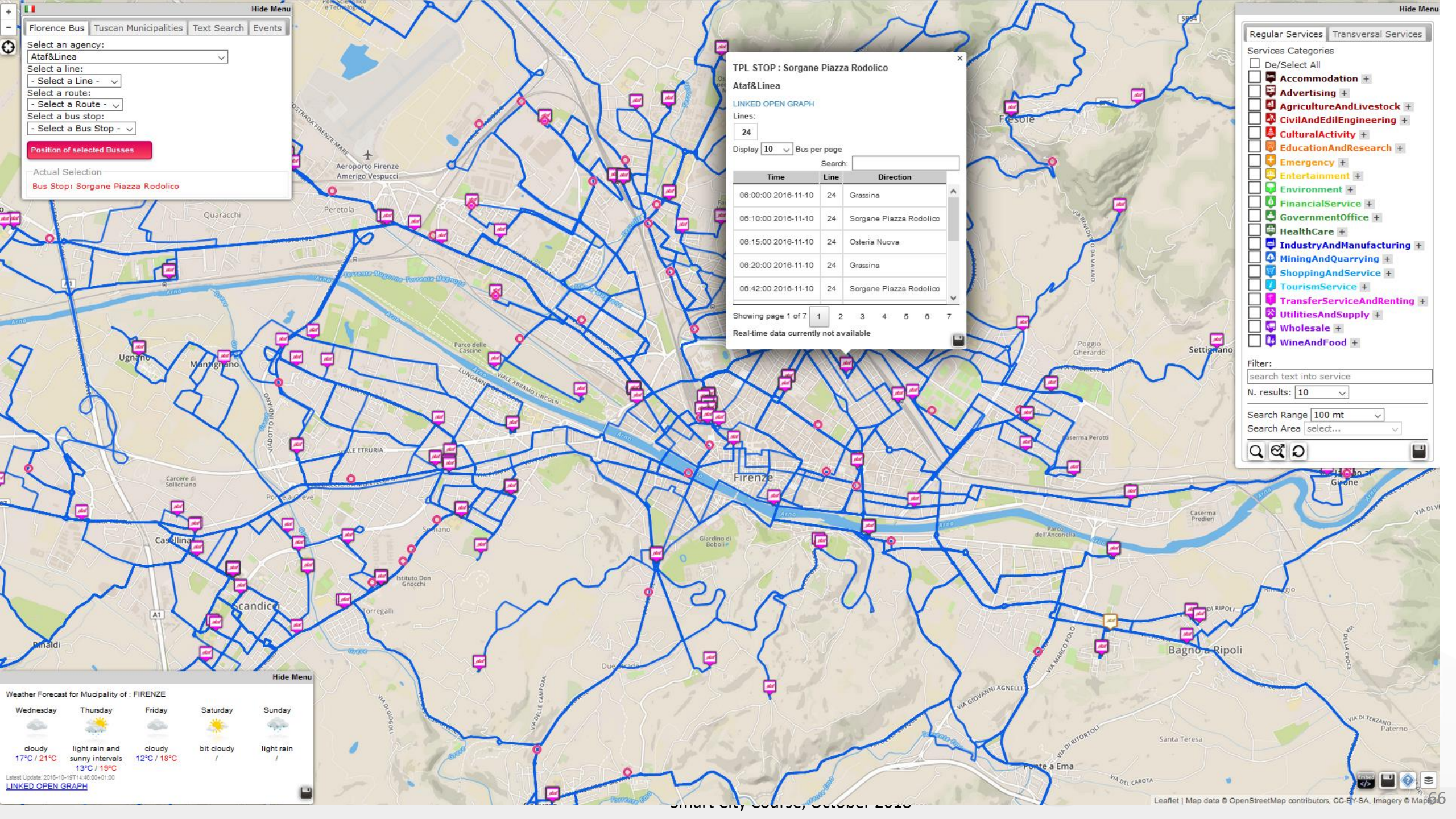
http://www.disit.org

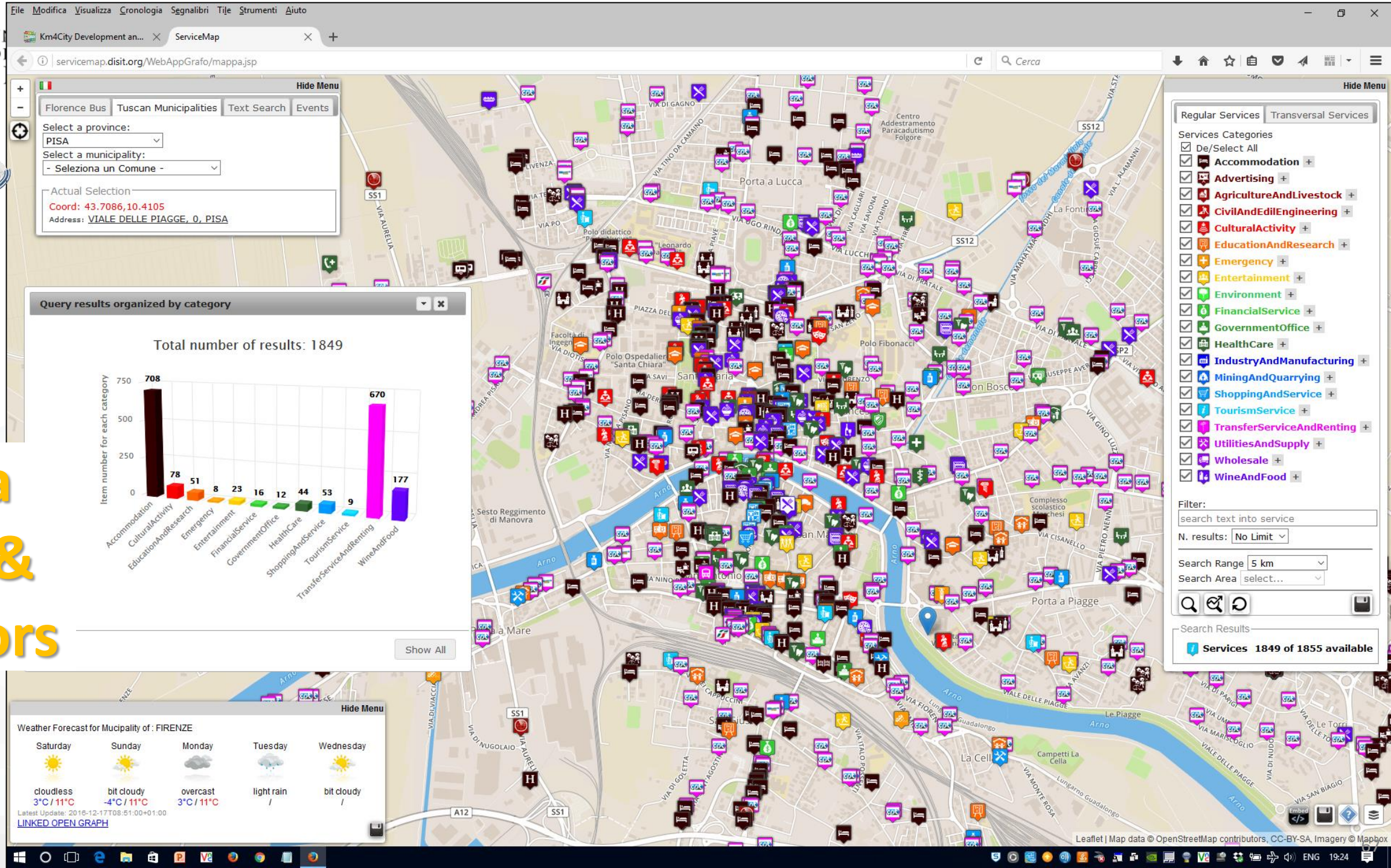
Km4City in Sardegna




Hide Menu
Florence Bus
Tuscan Municipalities
Text Search
Events
Select an agency:
Ataf&Linea
Select a line:
- Select a Line -
Select a route:
- Select a Route -
Select a bus stop:
- Select a Bus Stop -
Position of selected Busses
Actual Selection
Bus Stop: Sorgane Piazza Rodolico
TPL STOP : Sorgane Piazza Rodolico
Ataf&Linea
LINKED OPEN GRAPH
Lines:
24
Display 10 Bus per page
Search:
Time
Line
Direction
06:00:00 2016-11-10 24 Grassina
06:10:00 2016-11-10 24 Sorgane Piazza Rodolico
06:15:00 2016-11-10 24 Osteria Nuova
06:20:00 2016-11-10 24 Grassina
06:42:00 2016-11-10 24 Sorgane Piazza Rodolico
Showing page 1 of 7
1 2 3 4 5 6 7
Real-time data currently not available
Hide Menu
Regular Services
Transversal Services
Services Categories
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
Filter:
search text into service
N. results: 10
Search Range 100 mt
Search Area select...
Hide Menu
Weather Forecast for Mucipality of : FIRENZE
Wednesday
Thursday
Friday
Saturday
Sunday
cloudy
17°C / 21°C
light rain and sunny intervals
13°C / 19°C
cloudy
12°C / 18°C
bit cloudy
/
light rain
/
Latest Update: 2016-10-19T14:46:00+01:00
LINKED OPEN GRAPH
Aeroporto Firenze Amerigo Vespucci
Peretola
Quaracchi
Ugnano
Mantignano
Parco delle Cascine
Firenze
Giardino di Boboli
Fiesole
Settignano
Poggio Gherardo
Girone
Caserma Perotti
Caserma Predieri
Parco dell'Anconella
Bagno a Ripoli
Santa Teresa
Ponte a Ema
Paterno
Casellina
Scandicci
Rinaldi
Istituto Don Gnocchi
Torregalli
Carcere di Sollicciano
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

Sii-Mobility

Pisa TPL & sensors



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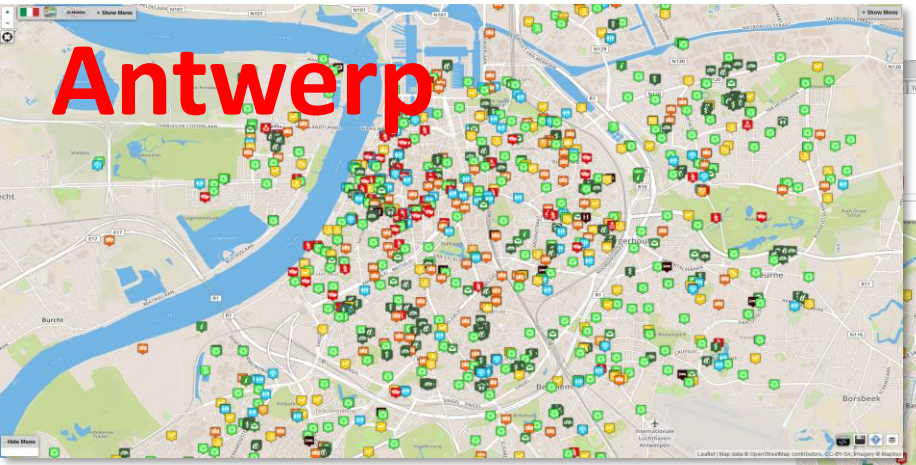
Km4City in …

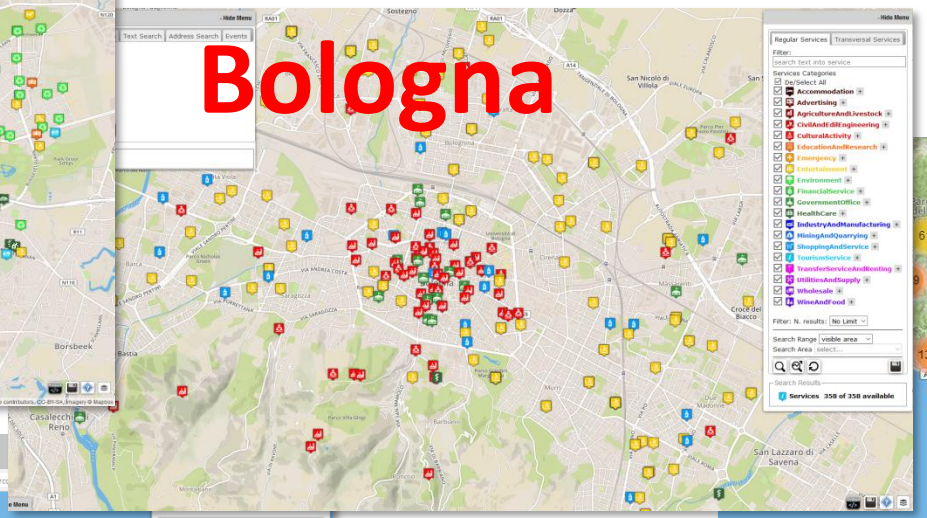




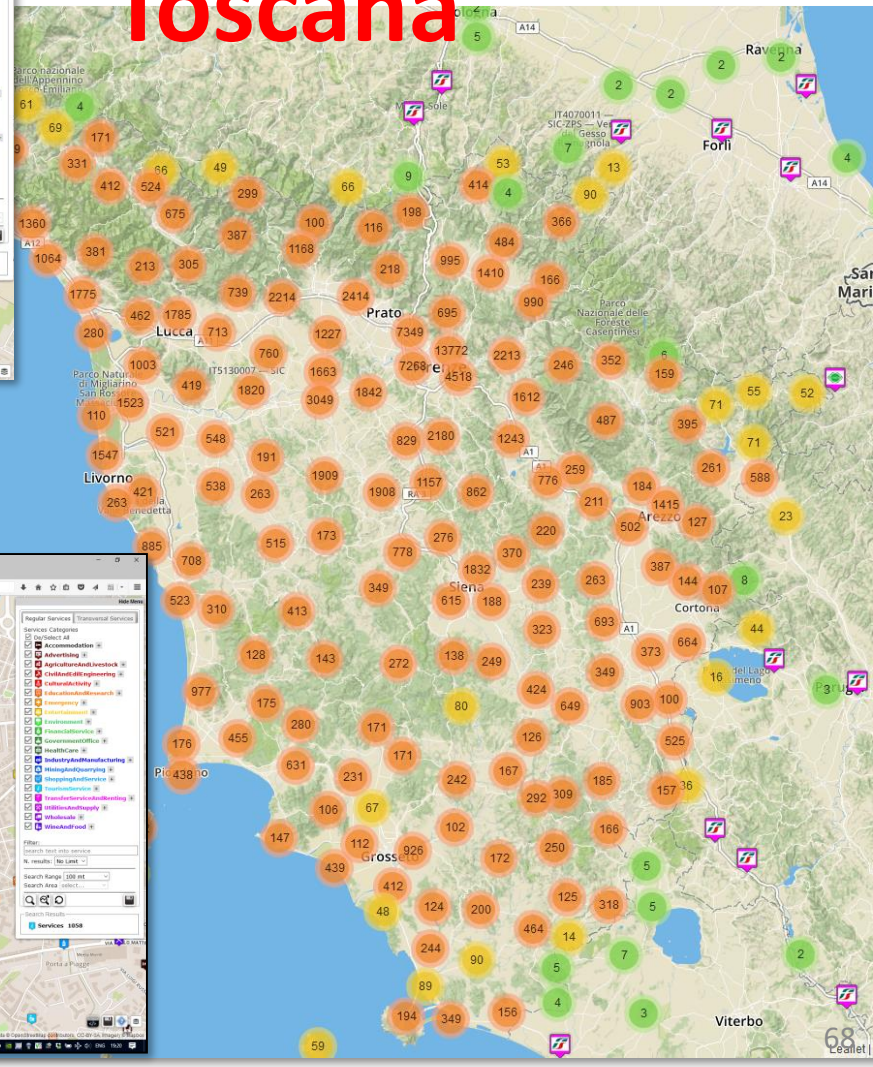
Antwerp



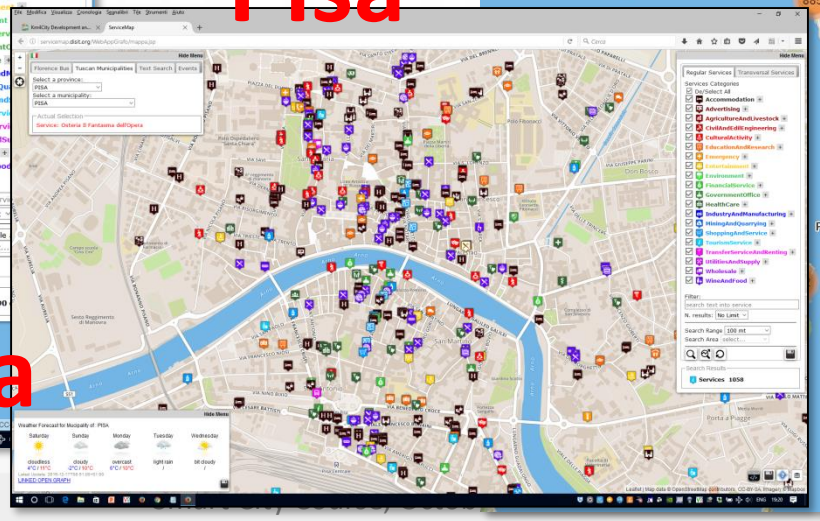
Bologna



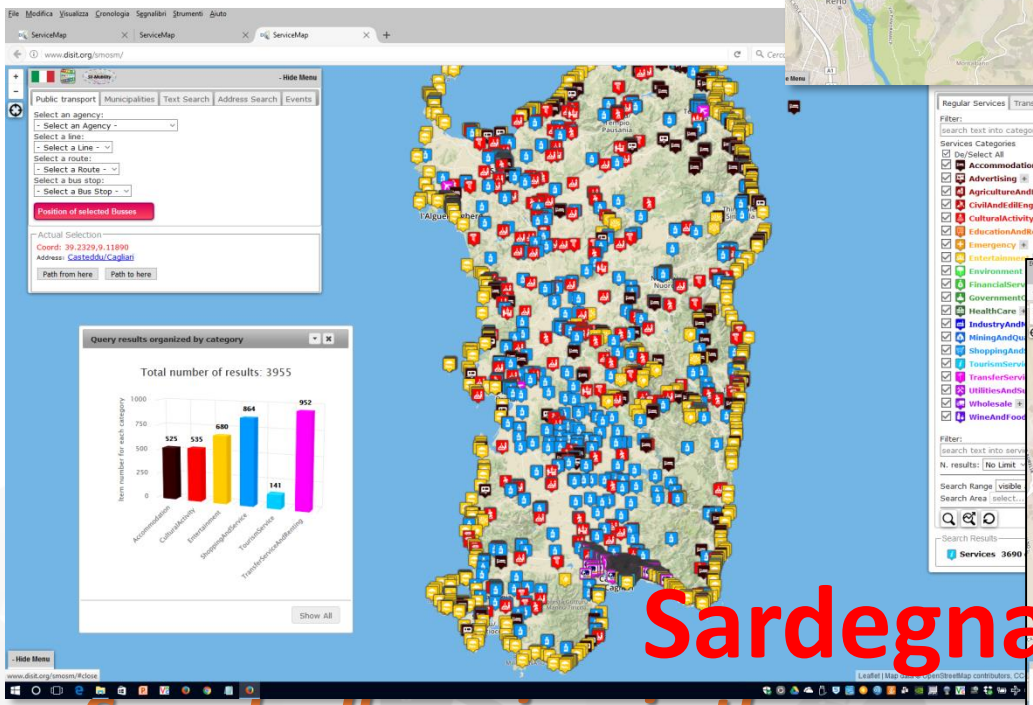
Toscana



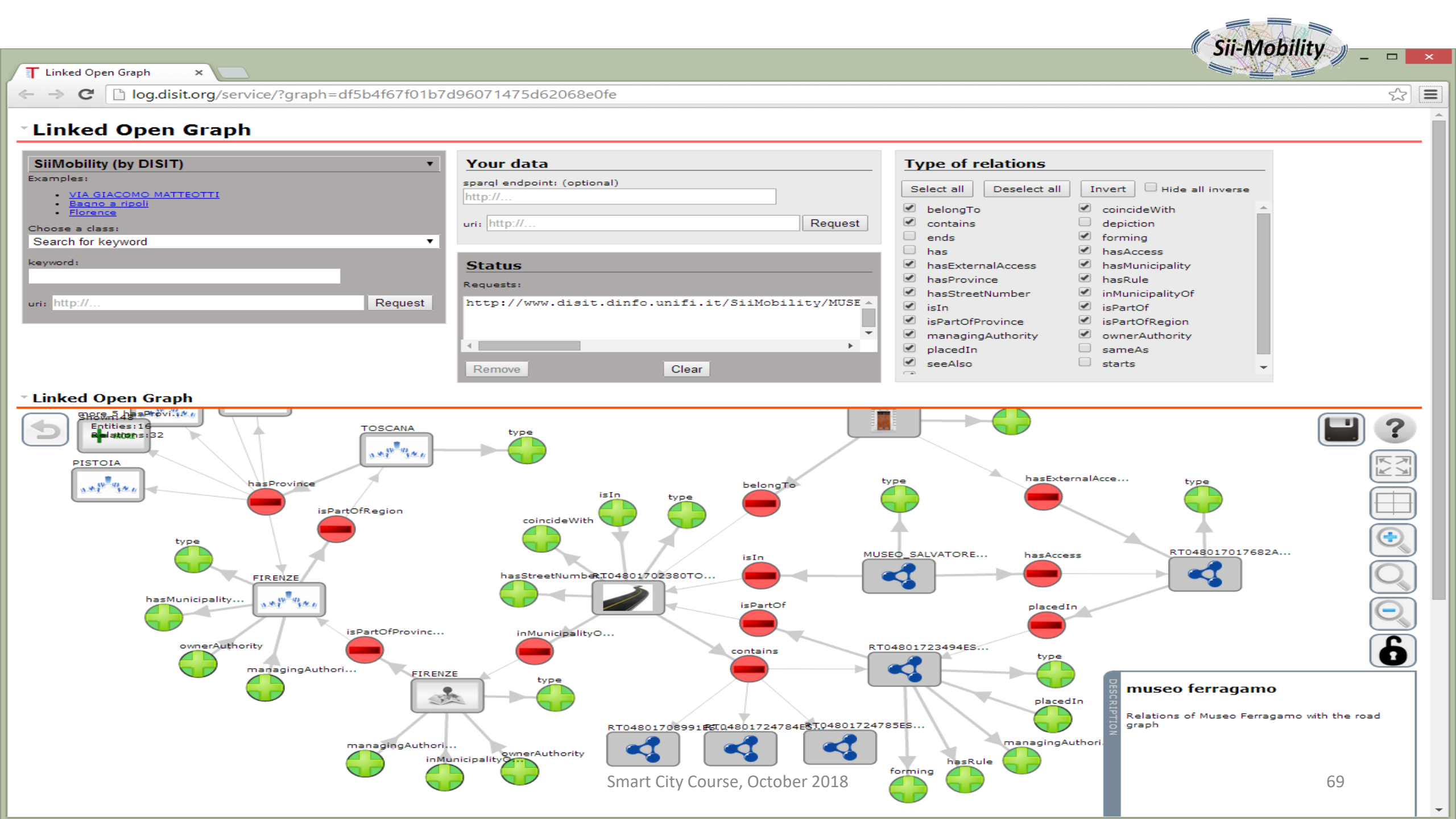
Pisa



Sardegna

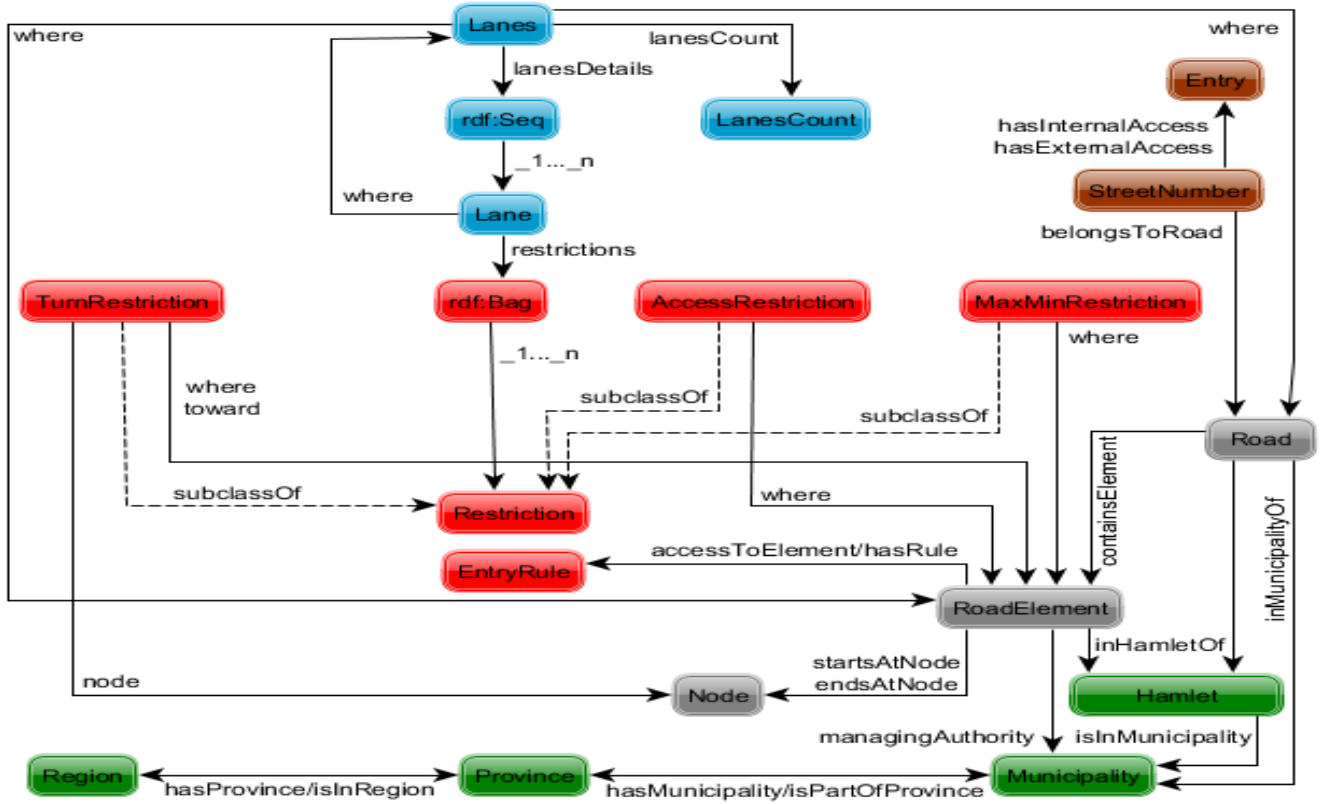


- *Search all services in the area*


Sii-Mobility
Linked Open Graph
log.disit.org/service/?graph=df5b4f67f01b7d96071475d62068e0fe
Linked Open Graph
SiiMobility (by DISIT)
Examples:
VIA GIACOMO MATTEOTTI
Bagno a ripoli
Florence
Choose a class:
Search for keyword
keyword:
uri: http://...
Request
Your data
sparql endpoint: (optional)
http://...
uri: http://...
Request
Status
Requests:
http://www.disit.dinfo.unifi.it/SiiMobility/MUSE
Remove
Clear
Type of relations
Select all
Deselect all
Invert
Hide all inverse
belongTo
contains
ends
has
hasExternalAccess
hasProvince
hasStreetNumber
isIn
isPartOfProvince
managingAuthority
placedIn
seeAlso
coincideWith
depiction
forming
hasAccess
hasMunicipality
hasRule
inMunicipalityOf
isPartOf
isPartOfRegion
ownerAuthority
sameAs
starts
Linked Open Graph
TOSCANA
type
PISTOIA
hasProvince
isPartOfRegion
type
FIRENZE
hasMunicipality...
ownerAuthority
managingAuthori...
isPartOfProvinc...
FIRENZE
type
managingAuthori...
inMunicipalityO...
ownerAuthority
isIn
type
coincideWith
hasStreetNumber
RT048017023801O...
inMunicipalityO...
belongTo
isIn
isPartOf
contains
type
MUSEO_SALVATORE...
hasExternalAcce...
type
hasAccess
RT048017017682A...
placedIn
RT04801723494ES...
type
placedIn
managingAuthori...
hasRule
forming
RT04801724785ES...
museo ferragamo
Relations of Museo Ferragamo with the road graph
DESCRIPTION

Km4City Extended Knowledge Model (1)

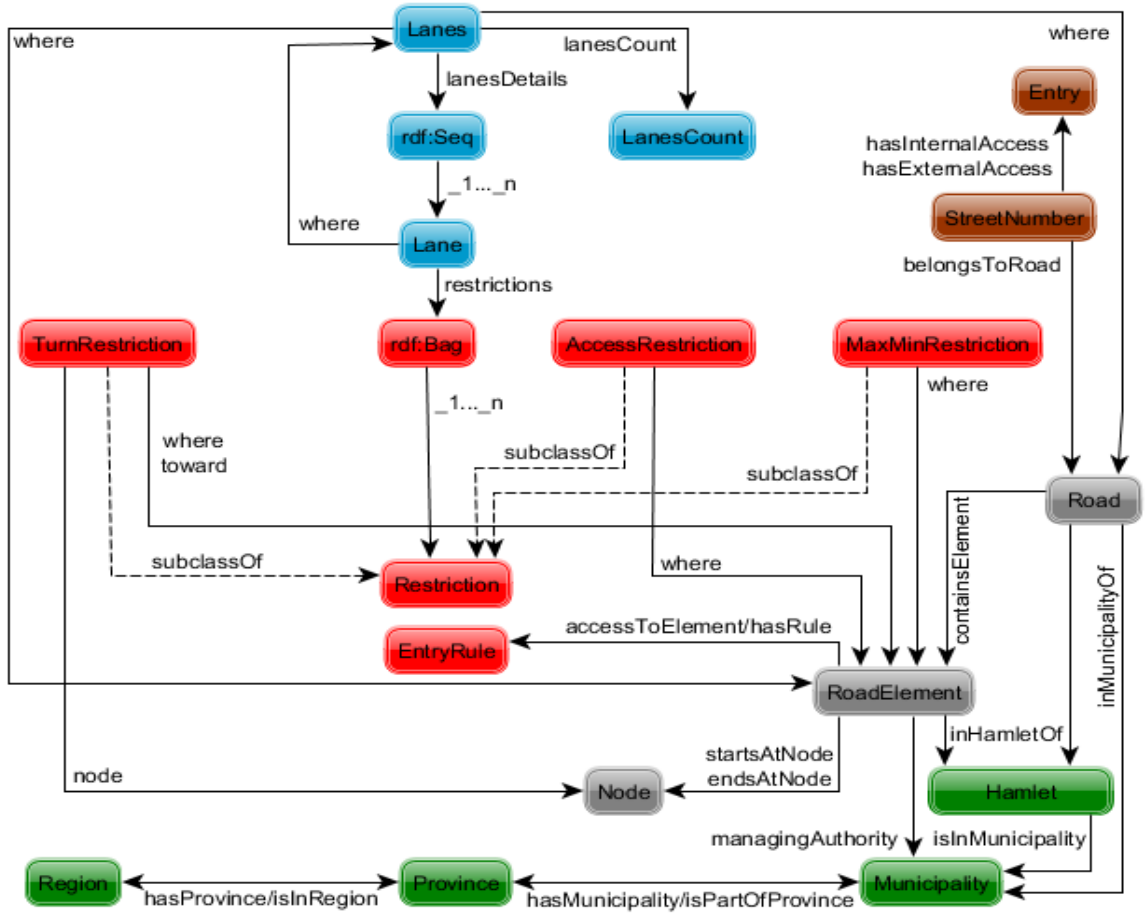
- In the Km4City KM are represented:
  - *Regions*, *Provinces*, *Municipalities (roads* > each partitioned into a set of small linear segments that outline its path, the *RoadElements)* and *Hamlets*



  - The StreetNumbers are also modelled and linked to the Roads and RoadElements where they locate, and to the Entries that model the geolocated entrance doors where the street numbers are affixed.

Km4City Extended Knowledge Model (2)

- In Km4City are also represented:
  - Number of lanes drawn on the asphalt
  - Lanes traffic directions and possible restrictions
  - Set of Restrictions applied to entire roads or parts of them (it integrates the temporary modifications to the viability)



Km4City: Roads modeling

- The name of the road is modelled through four different properties:
  - *roadType (categorization)*, *roadName*, *extendName*, *alternative* (name)
- The road path is outlined by short linear segments that join two consecutive nodes (*RoadElement*s)
- The *RoadElement*s junctions are modelled as geolocated *Node*s and are connected to the *RoadElement*s through the *startsAtNode* and *endsAtNode* properties

Km4City: Roads partitioning

- Road elements are contextualized, and the context is provided through the *elementType* property
- Road elements have a class (motorway, primary, secondary, etc.) modelled through the property *elementClass*
- Are also modelled dedicated properties that are crucial for routing applications and traffic predictions:
  - length, width, operating status (under construction, in use, or abandoned), traffic direction (positive, negative, both, or none)

Km4City: Road Lanes

- Lanes have a key role for routing applications leverage them for suggesting the lane to traverse. Traffic reconstruction applications use them to assess the road capability
- Lanes properties:
  - *Where (Road* or *RoadElement* in which the lanes are)
  - *Direction* (traffic direction)
  - *lanesCount (*number of the lanes)
  - *lanesDetails* (e.g. possible restrictions, turn, etc.)

Km4City: Road Restrictions

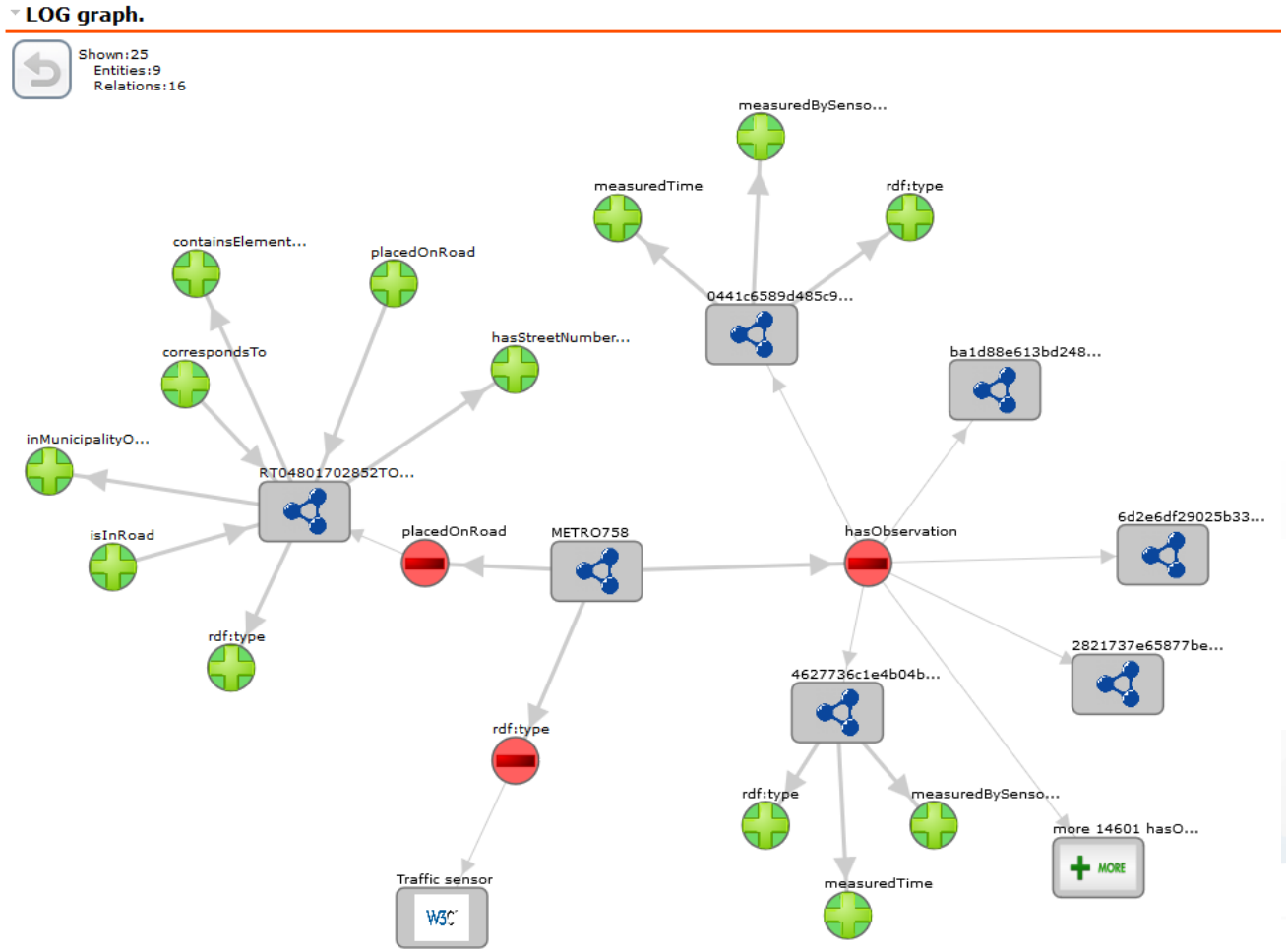
- Macro categories identified to model routing and traffic reconstruction services:
  - mandatory maneuvers at the crossroads
  - access regulations that apply to roads and segments of road
  - maximum/minimum speeds, weights, sizes, and similar

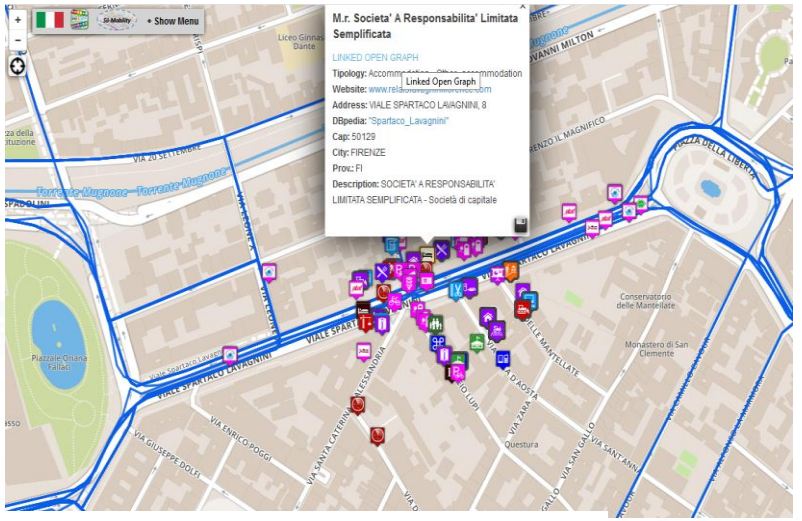
Modelling Restrictions in Km4City Ont.

- *TurnRestriction:* the mandatory maneuvers at crossroads are modelled
- *AccessRestriction*, the access regulations for roads and segments of road are modelled
- *MaxMinRestriction*, models the limitations that are expressed in the form of maximum or minimum speed, weight, width, length, and similar

Access to a road sensor (LOG/Servicemap)

http://log.disit.org/service/?graph=9cf1ec16fbba429ae55a5597ee028afe





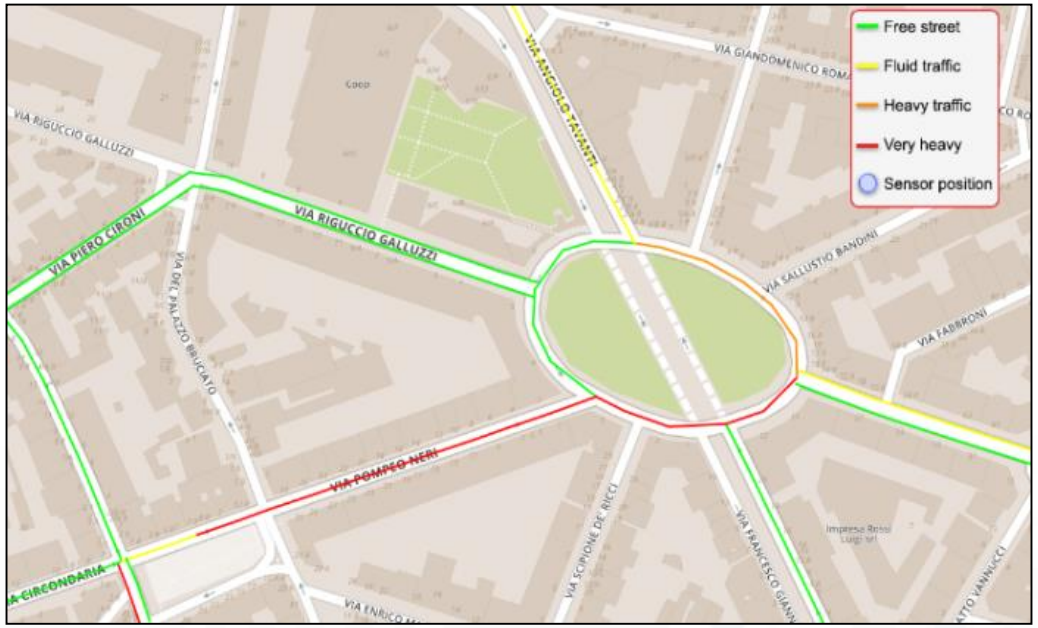
https://servicemap.disit.org/WebAppGrafo/api/v1/?queryId=121fe068e5b521d3b7e303ba3062ec63&format=html

Km4City KB Construction

- Datasources:
  - **OSM** (Open Street Map, periodic)
  - Public Administration Open Data: road graph, POIs, etc. (static and real time)
  - Public transport data (GTFS, periodic)
  - Data coming from sensing devices: IoT perspective, such as **traffic flow sensors**, ice detectors, smart benches detectors, smart waste detectors, smart beacons, street lights (static and real time)

KM4City Traffic Reconstruction

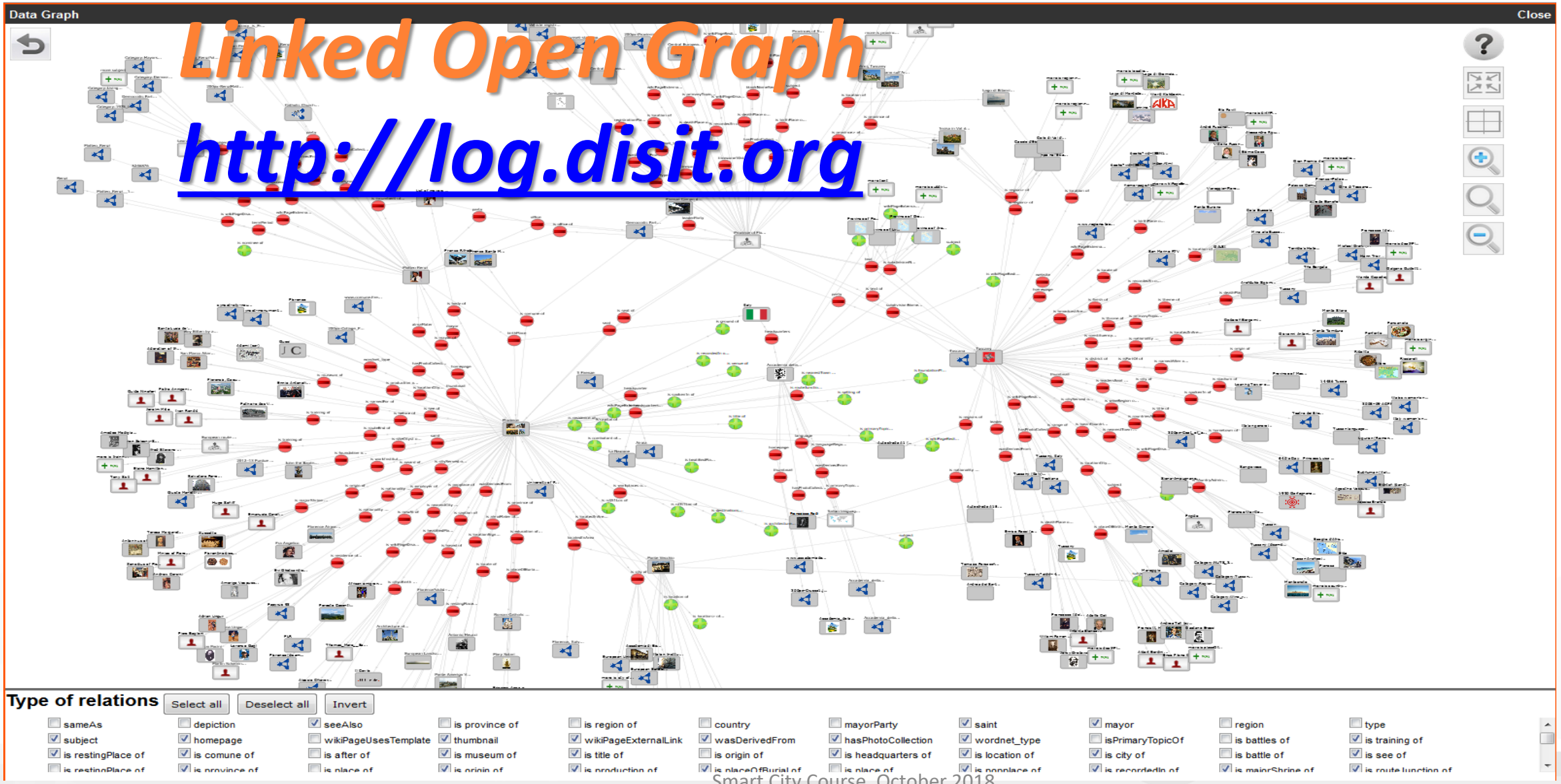
- For the traffic reconstruction, a directed graph is built from the road infrastructure that is stored in the KM4City KB (each two-way road is represented through two edges)
- Moreover, U-turns are considered to be prohibited at crossroads, and the *TurnRestriction* instances are also leveraged



Ways opened in both directions in the area of Florence (Real Time traffic flow)

Linked Open Graph

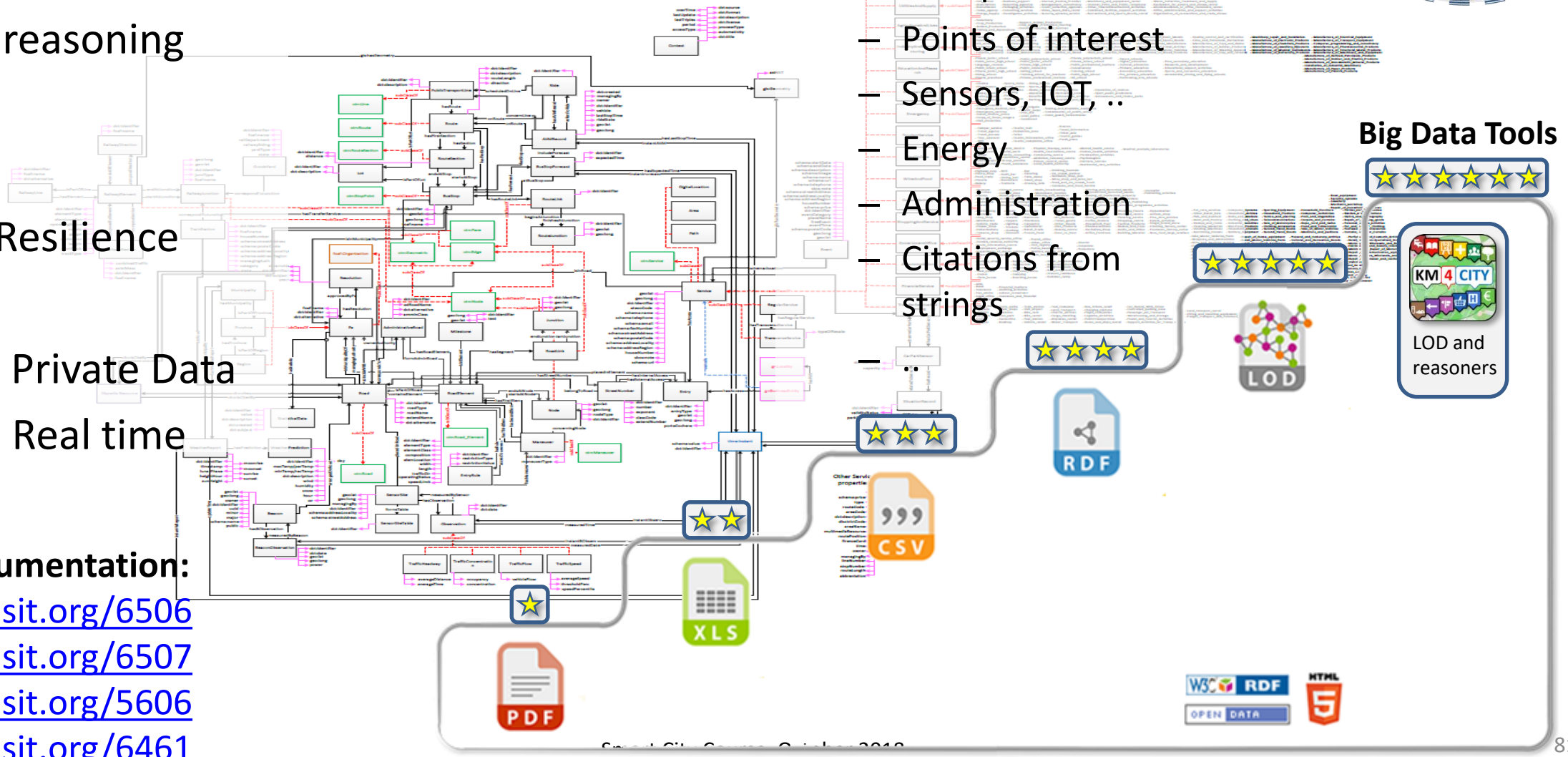
http://log.disit.org



Km4City: Knowledge Base

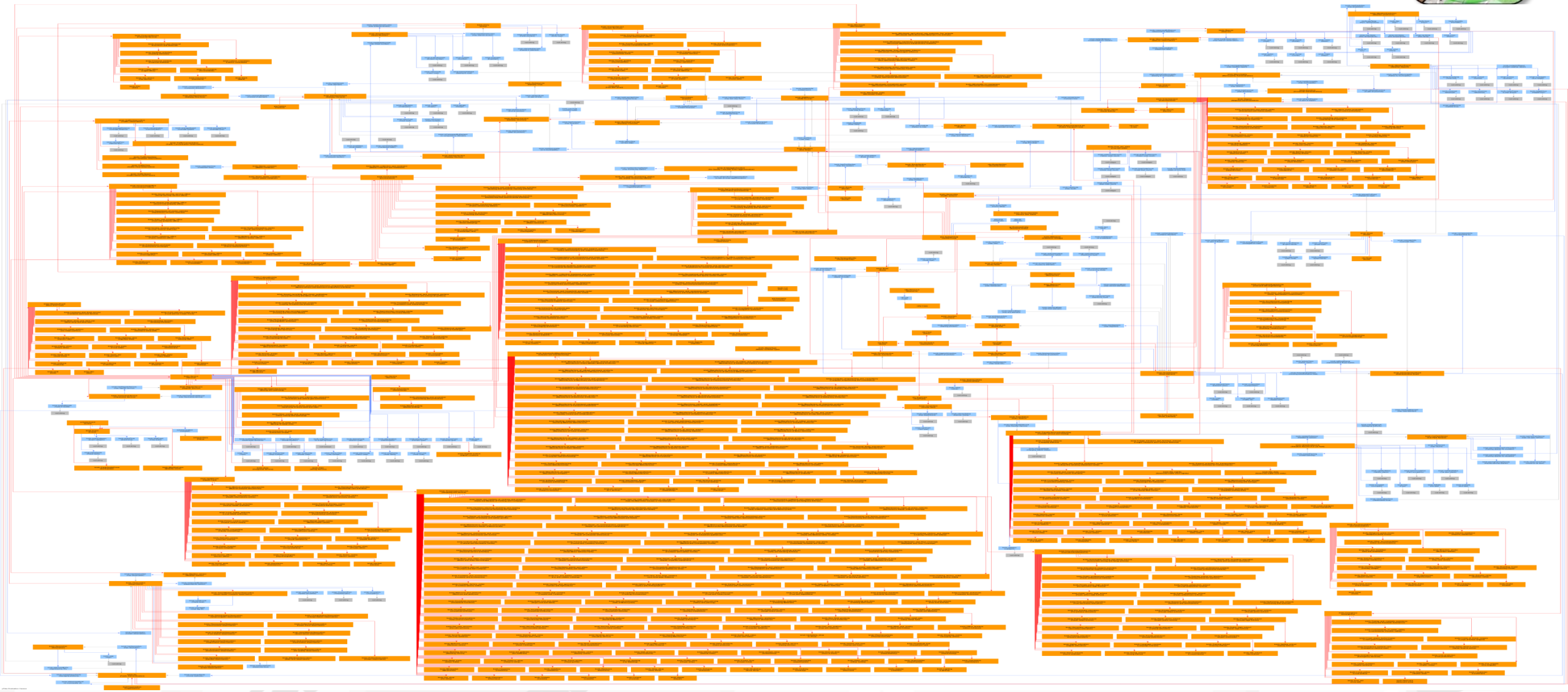
- **Multiple DOMAINS**
- Geospatial reasoning
- Temporal reasoning
- Metadata
- Statistics
- Risk and Resilience
- Licensing
- Open and Private Data
- Static and Real time

- Street-Guide
- Mobility and transport
- Points of interest
- Sensors, IOT, ..
- Energy
- Administration
- Citations from strings
- ..

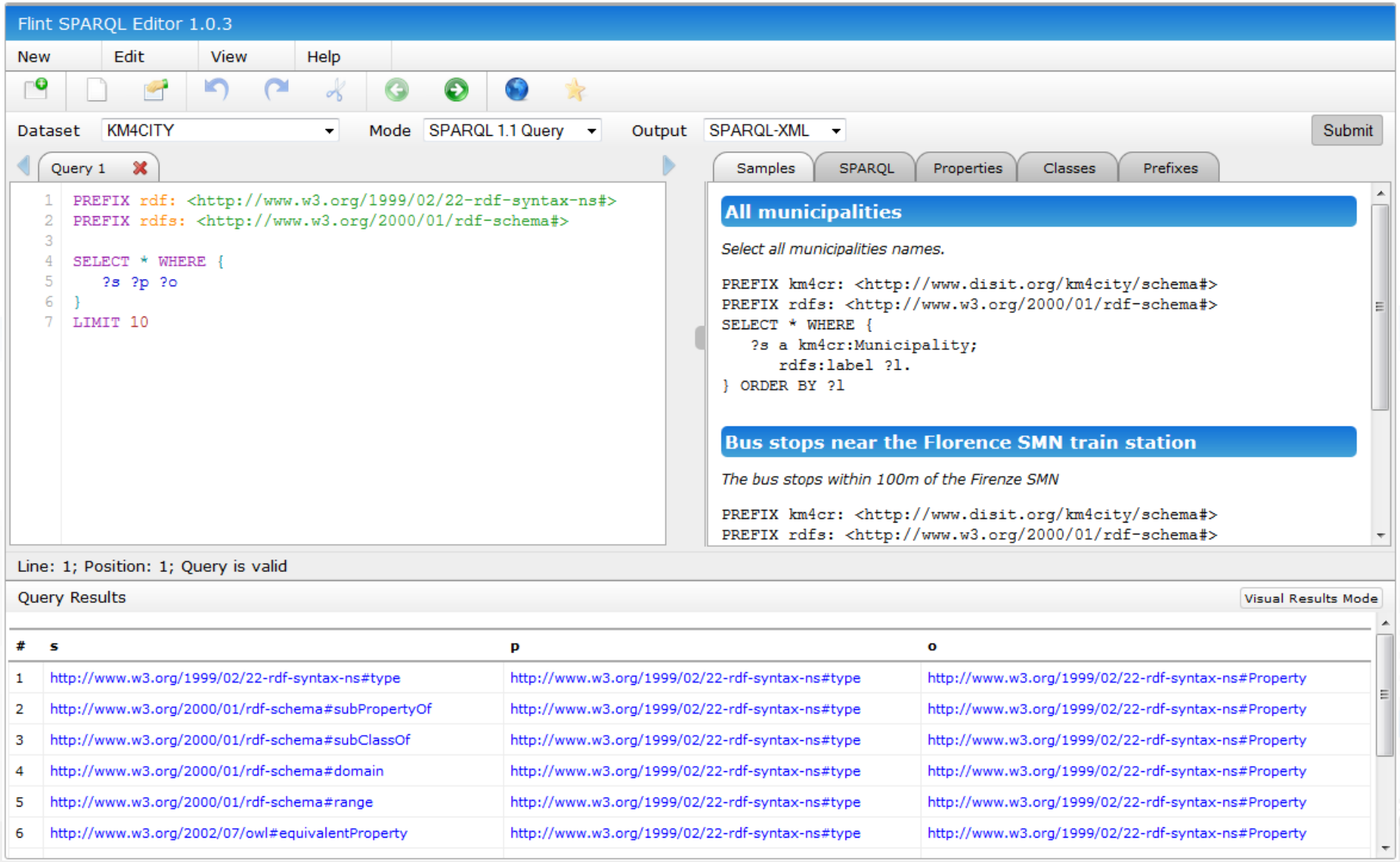


Ontology Documentation:

http://www.disit.org/6506
http://www.disit.org/6507
http://www.disit.org/5606
http://www.disit.org/6461



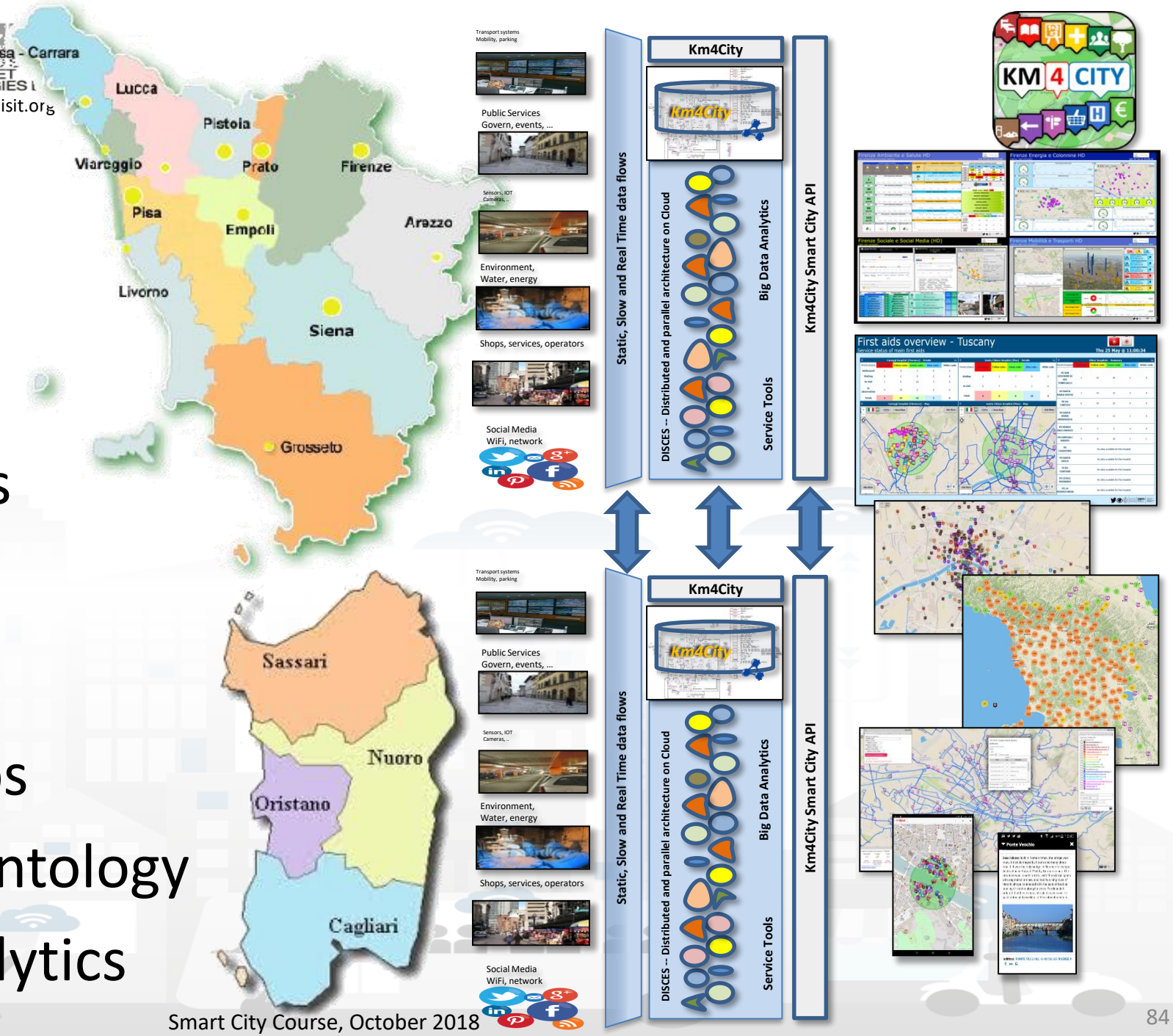
http://log.disit.org/spqlquery/



#	s	p	o
1	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
2	http://www.w3.org/2000/01/rdf-schema#subPropertyOf	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
3	http://www.w3.org/2000/01/rdf-schema#subClassOf	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
4	http://www.w3.org/2000/01/rdf-schema#domain	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
5	http://www.w3.org/2000/01/rdf-schema#range	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
6	http://www.w3.org/2002/07/owl#equivalentProperty	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property

Interoperability

- **At different levels:**
  - Among cities/regions
  - Among data providers
  - Among Operators
- **By Means of:**
  - Smart City API → Apps
  - Km4City Smart City Ontology
  - Dashboards/data analytics



Data Storage and Data Shadow



Course Segments

- **Cloud-based Infrastructures for Smart Cities**
  - Open Data, Private Data, Real Time data, etc.
  - General Requirements for Smart City
  - Data Ingestion and aggregation
  - Semantic Modeling and City Knowledge Base, Km4City
  - Data Storage and Data Shadow
  - Data Indexing
  - KB vs Smart City API
  - Data processing and scheduling

Architettura di base Big Data, IOT, Industry 4.0

Data Sources

Transations sys, sensors Social media, ws, etc.

Data Stream analysis

Spark, Storm, Kafka

Big Data Cluster

HDFS, noSQL

Indexing

SOLR, Elastic search

Search and Query

Facet, cluster

Rendering acting

User interface, Dashboard Drill down

Data Transformation

ETL, NIFI

Data Analytics

R, TF, …

Visual Analytics

Spec Dash

Data Management: security, privacy, licensing, etc.

Lambda Architecture



Data Sources Static Data

Scheduling and preproc

Batch

Unified aggregation and regularization

Big Data Cluster
HDFS, noSQL

Indexing
SOLR, Elastic search

Search and Query
Facet, cluster

Rendering acting
User interface, Dashboard Drill down

Data Transformation
ETL, NIFI

Data Analytics
R, TF, …

Visual Analytics
Spec dash

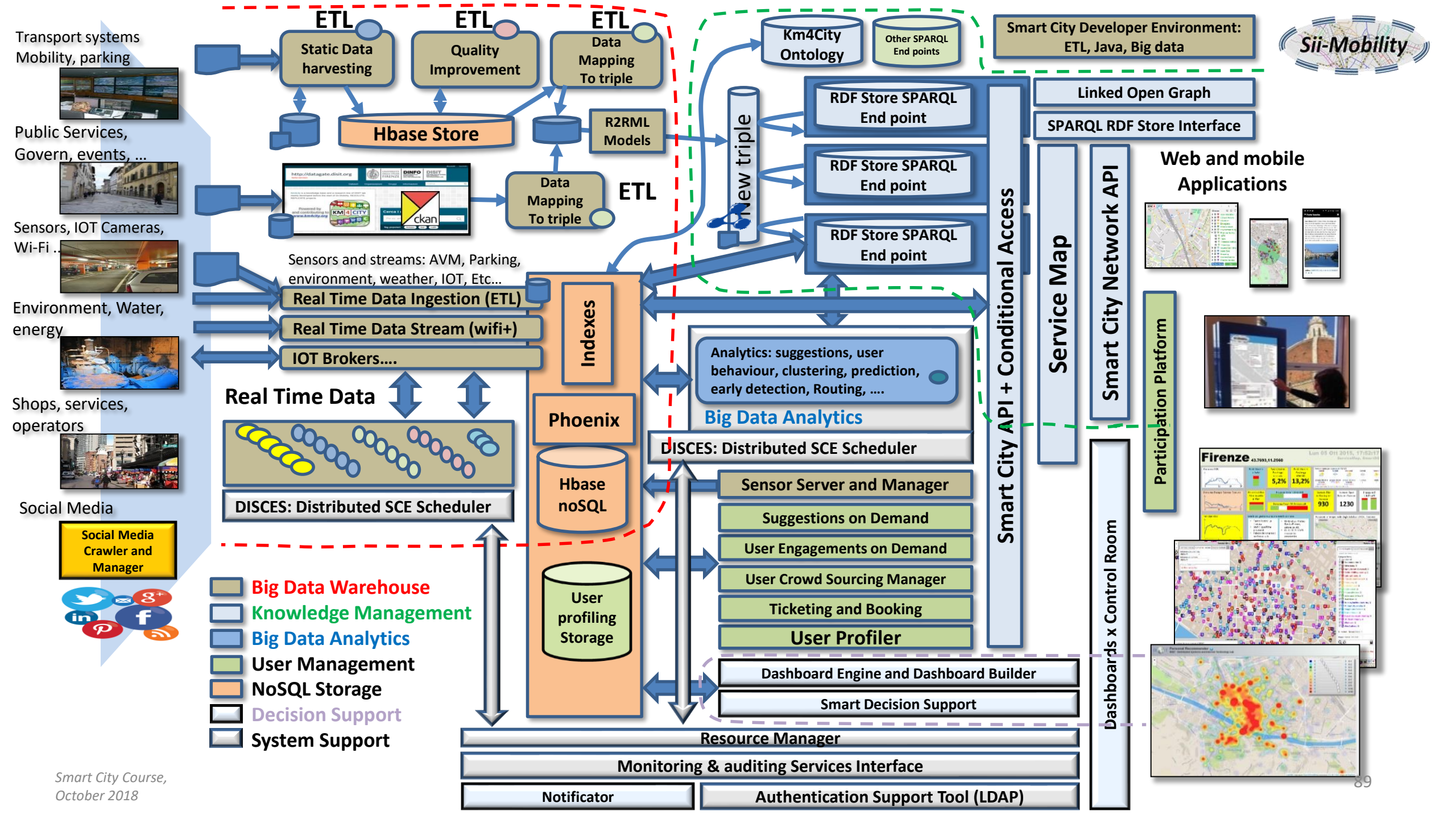
Data Sources Data Driven

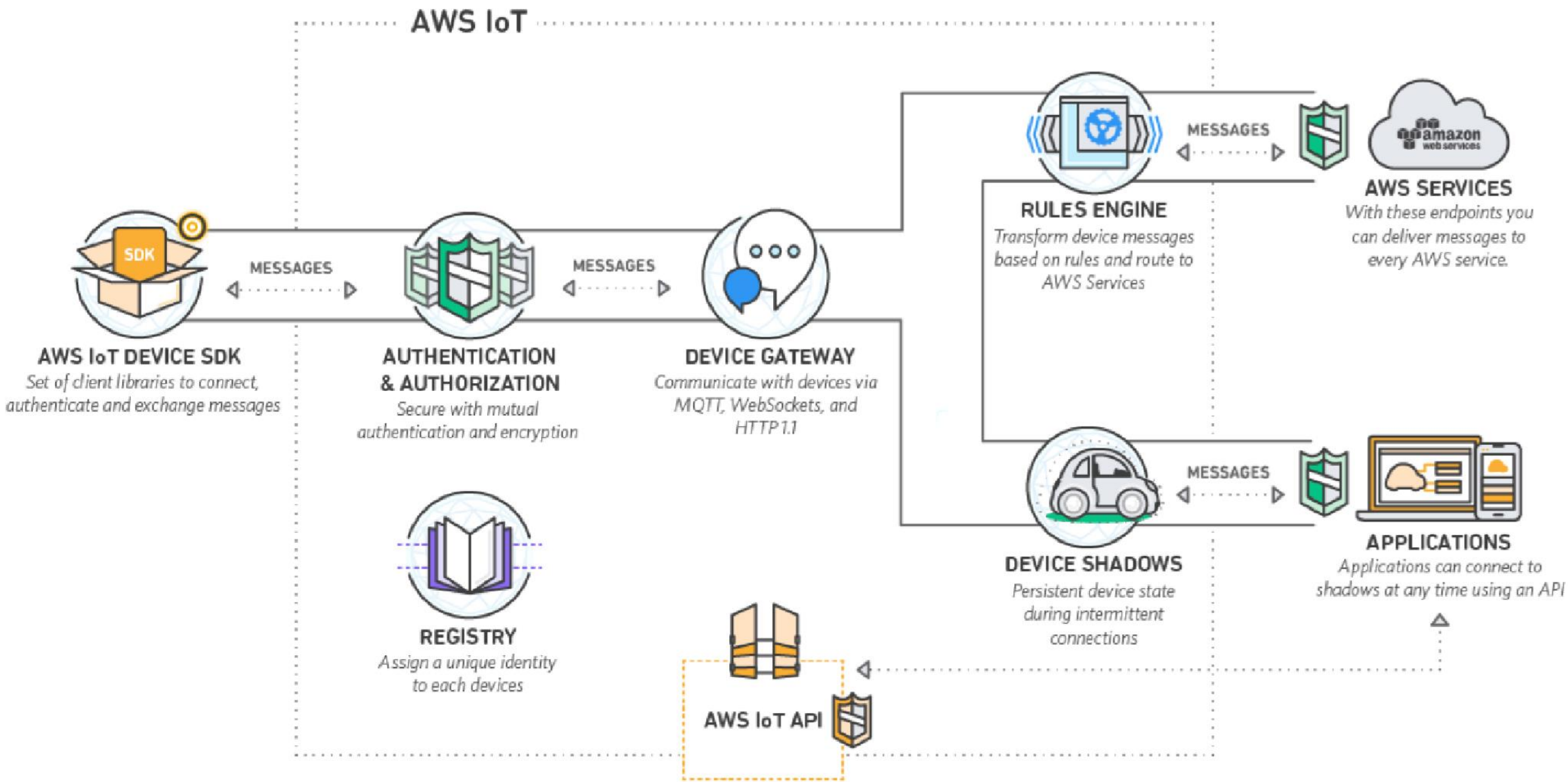
Broker, Stream processing

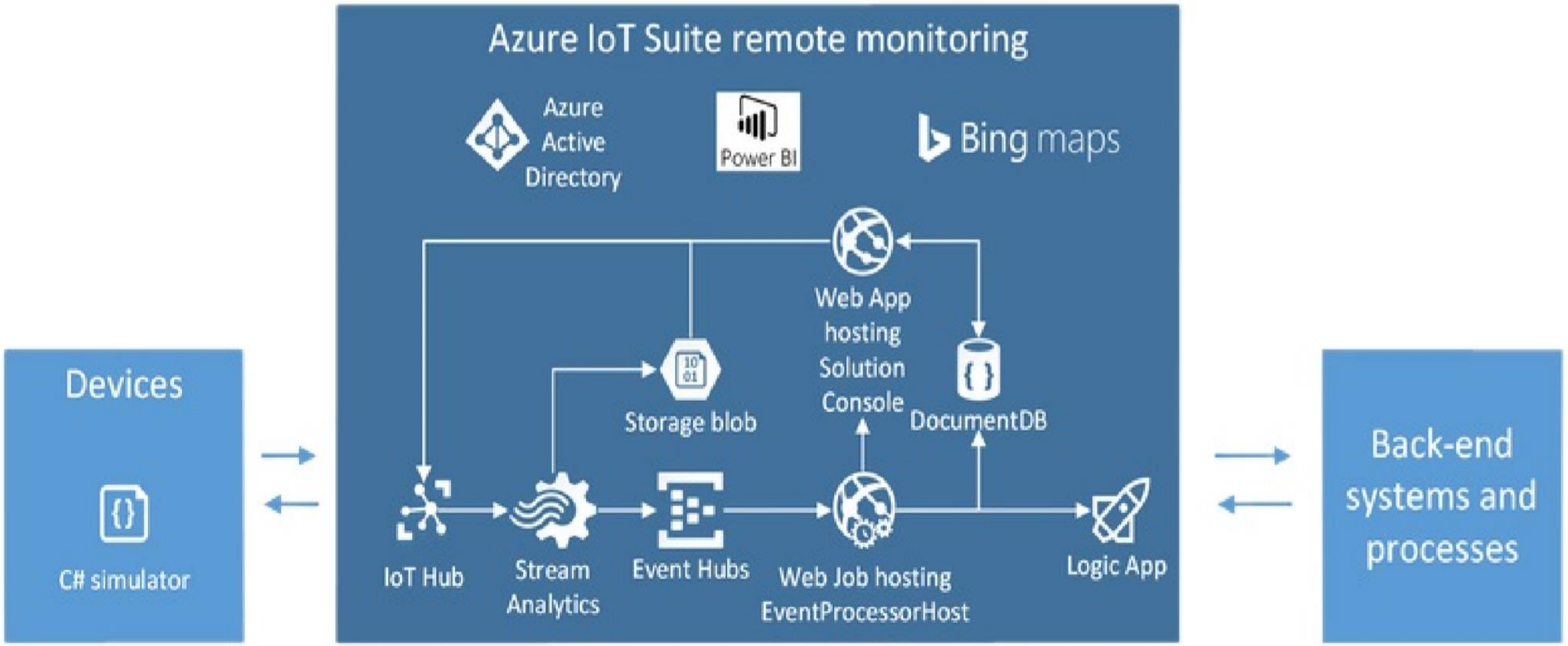
Stream

Knowledge base

Optionally


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
ETL
Static Data harvesting
ETL
Quality Improvement
ETL
Data Mapping To triple
Hbase Store
R2RML Models
Data Mapping To triple
ETL
Sensors and streams: AVM, Parking, environment, weather, IOT, Etc…
Real Time Data Ingestion (ETL)
Real Time Data Stream (wifi+)
IOT Brokers….
Real Time Data
DISCES: Distributed SCE Scheduler
Indexes
Phoenix
Hbase noSQL
User profiling Storage
Km4City Ontology
Other SPARQL End points
New triple
RDF Store SPARQL End point
RDF Store SPARQL End point
RDF Store SPARQL End point
Smart City Developer Environment: ETL, Java, Big data
Linked Open Graph
SPARQL RDF Store Interface
Analytics: suggestions, user behaviour, clustering, prediction, early detection, Routing, ….
Big Data Analytics
DISCES: Distributed SCE Scheduler
Sensor Server and Manager
Suggestions on Demand
User Engagements on Demand
User Crowd Sourcing Manager
Ticketing and Booking
User Profiler
Dashboard Engine and Dashboard Builder
Smart Decision Support
Resource Manager
Monitoring & auditing Services Interface
Notificator
Authentication Support Tool (LDAP)
Smart City API + Conditional Access
Service Map
Smart City Network API
Participation Platform
Dashboards x Control Room
Web and mobile Applications
Big Data Warehouse
Knowledge Management
Big Data Analytics
User Management
NoSQL Storage
Decision Support
System Support
Sii-Mobility


AWS IoT
SDK
MESSAGES
MESSAGES
MESSAGES
MESSAGES
amazon web services
AWS IoT DEVICE SDK
Set of client libraries to connect, authenticate and exchange messages
AUTHENTICATION & AUTHORIZATION
Secure with mutual authentication and encryption
DEVICE GATEWAY
Communicate with devices via MQTT, WebSockets, and HTTP 1.1
RULES ENGINE
Transform device messages based on rules and route to AWS Services
AWS SERVICES
With these endpoints you can deliver messages to every AWS service.
REGISTRY
Assign a unique identity to each devices
AWS IoT API
DEVICE SHADOWS
Persistent device state during intermittent connections
APPLICATIONS
Applications can connect to shadows at any time using an API


Azure IoT Suite remote monitoring
Azure Active Directory
Power BI
Bing maps
Web App hosting Solution Console
Storage blob
DocumentDB
Devices
C# simulator
IoT Hub
Stream Analytics
Event Hubs
Web Job hosting EventProcessorHost
Logic App
Back-end systems and processes

Data Indexing

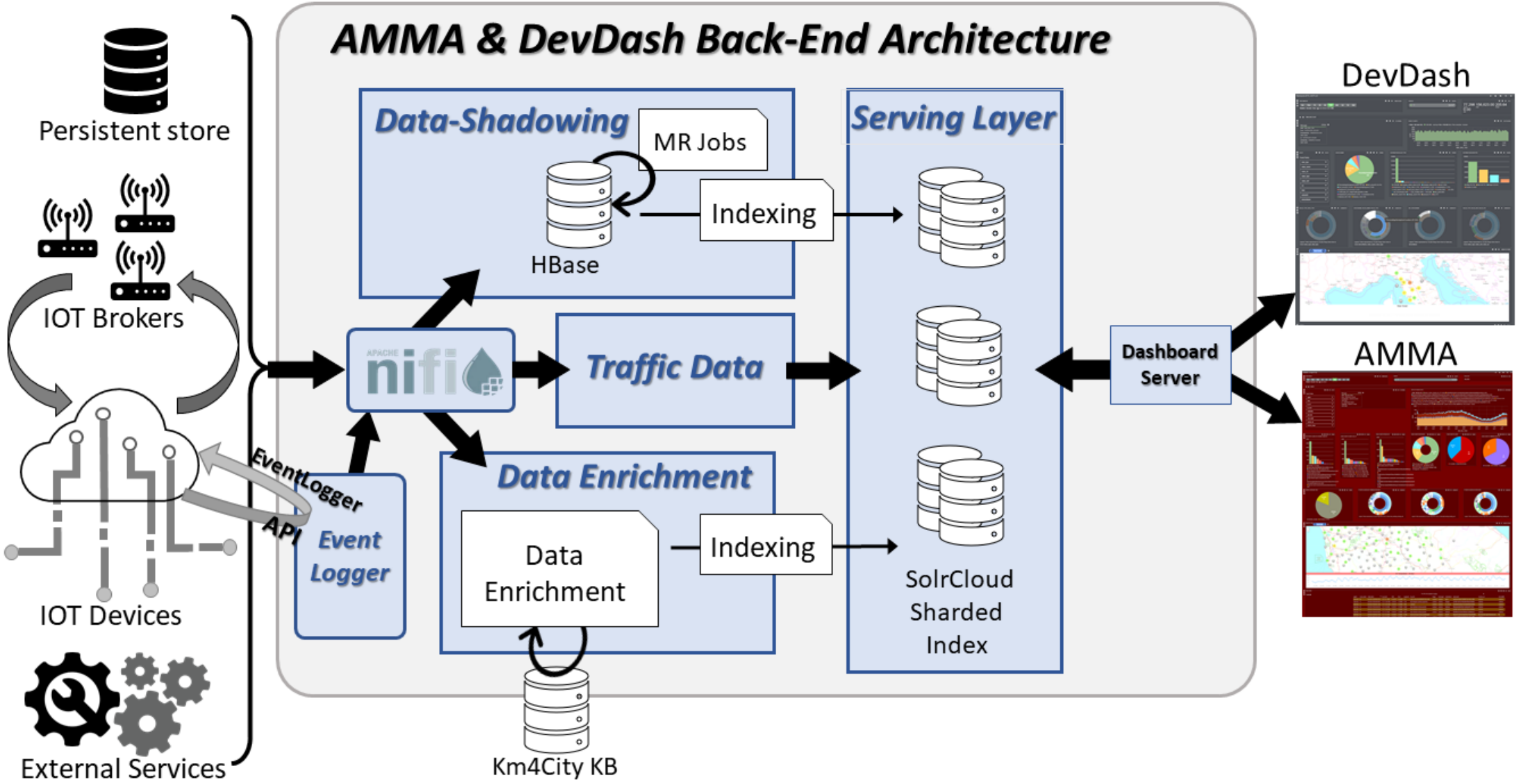


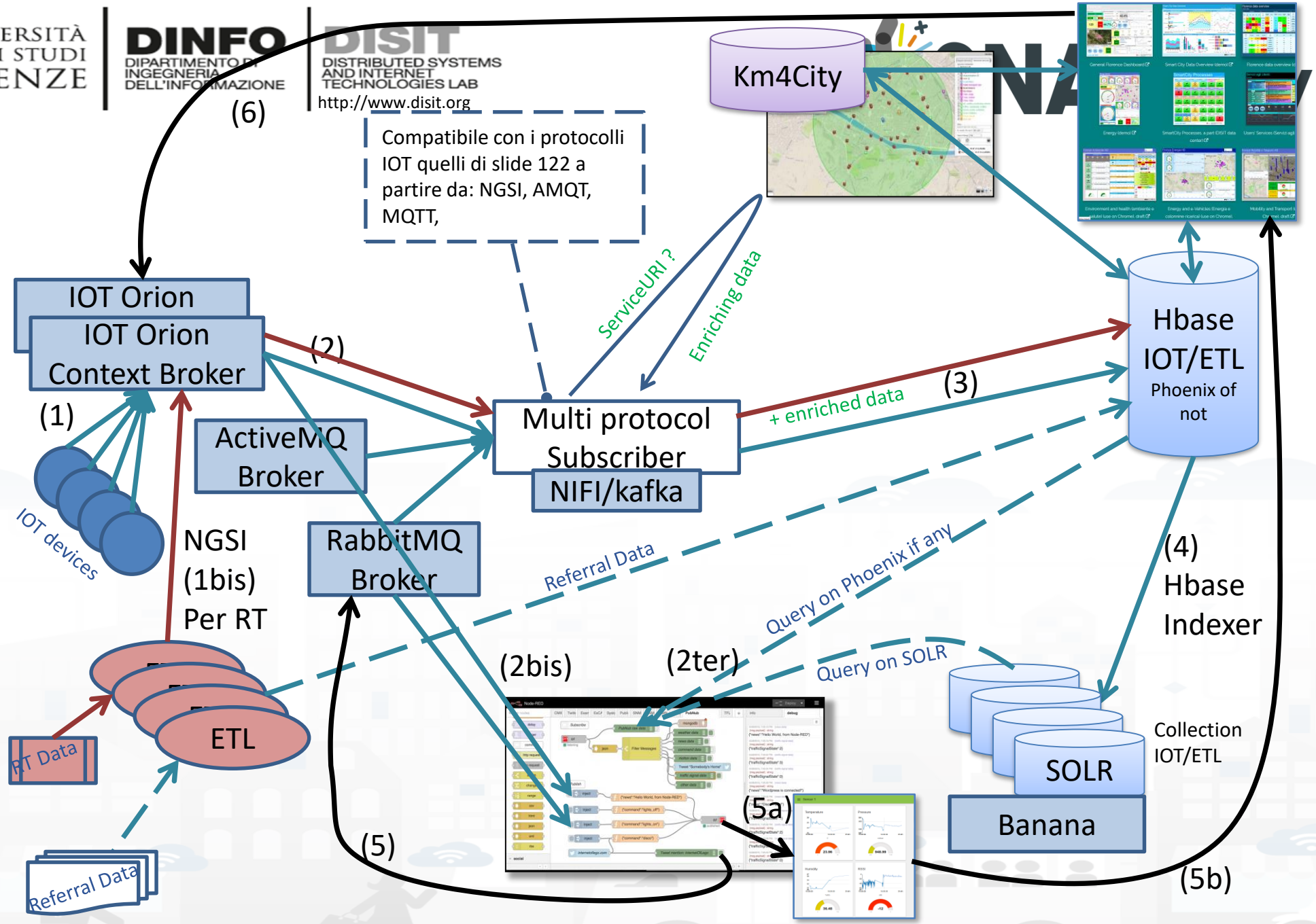
Course Segments

- **Cloud-based Infrastructures for Smart Cities**
  - Open Data, Private Data, Real Time data, etc.
  - General Requirements for Smart City
  - Data Ingestion and aggregation
  - Semantic Modeling and City Knowledge Base, Km4City
  - Data Storage and Data Shadow
  - Data Indexing
  - KB vs Smart City API
  - Data processing and scheduling

Data Indexing

- **Textual**, multilingual, NLP
  - For social media data, but also for metadata, descriptions
- **Spatial**, geographical, georeversing → KB, Km4City
  - Around a point, along a line/path, near a path, into a polyline, etc.
- **Temporal** → Historical data
- **Data Value** (Data Lake/normalization), different data type, data unit, etc. → shadowing
  - Relating to KB reciprocal
- **Traffic** of Data (KBps) → Network Analysis (AMMA tool)


AMMA & DevDash Back-End Architecture
Persistent store
IOT Brokers
IOT Devices
External Services
Data-Shadowing
MR Jobs
Indexing
HBase
Serving Layer
nifi
Traffic Data
Data Enrichment
Data Enrichment
Indexing
SolrCloud Sharded Index
EventLogger API
Event Logger
Km4City KB
Dashboard Server
DevDash
AMMA


(6)
Km4City
Compatibile con i protocolli IOT quelli di slide 122 a partire da: NGSI, AMQT, MQTT,
ServiceURI ?
Enriching data
IOT Orion
IOT Orion Context Broker
(2)
(1)
ActiveMQ Broker
Multi protocol Subscriber
NIFI/kafka
+ enriched data
(3)
Hbase IOT/ETL
Phoenix of not
IOT devices
NGSI
(1bis)
Per RT
RabbitMQ Broker
Referral Data
Query on Phoenix if any
(4)
Hbase
Indexer
(2bis)
(2ter)
Query on SOLR
ETL
RT Data
Referral Data
(5)
(5a)
SOLR
Collection IOT/ETL
Banana
(5b)

KB vs Smart City API



Course Segments

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  - Open Data, Private Data, Real Time data, etc.
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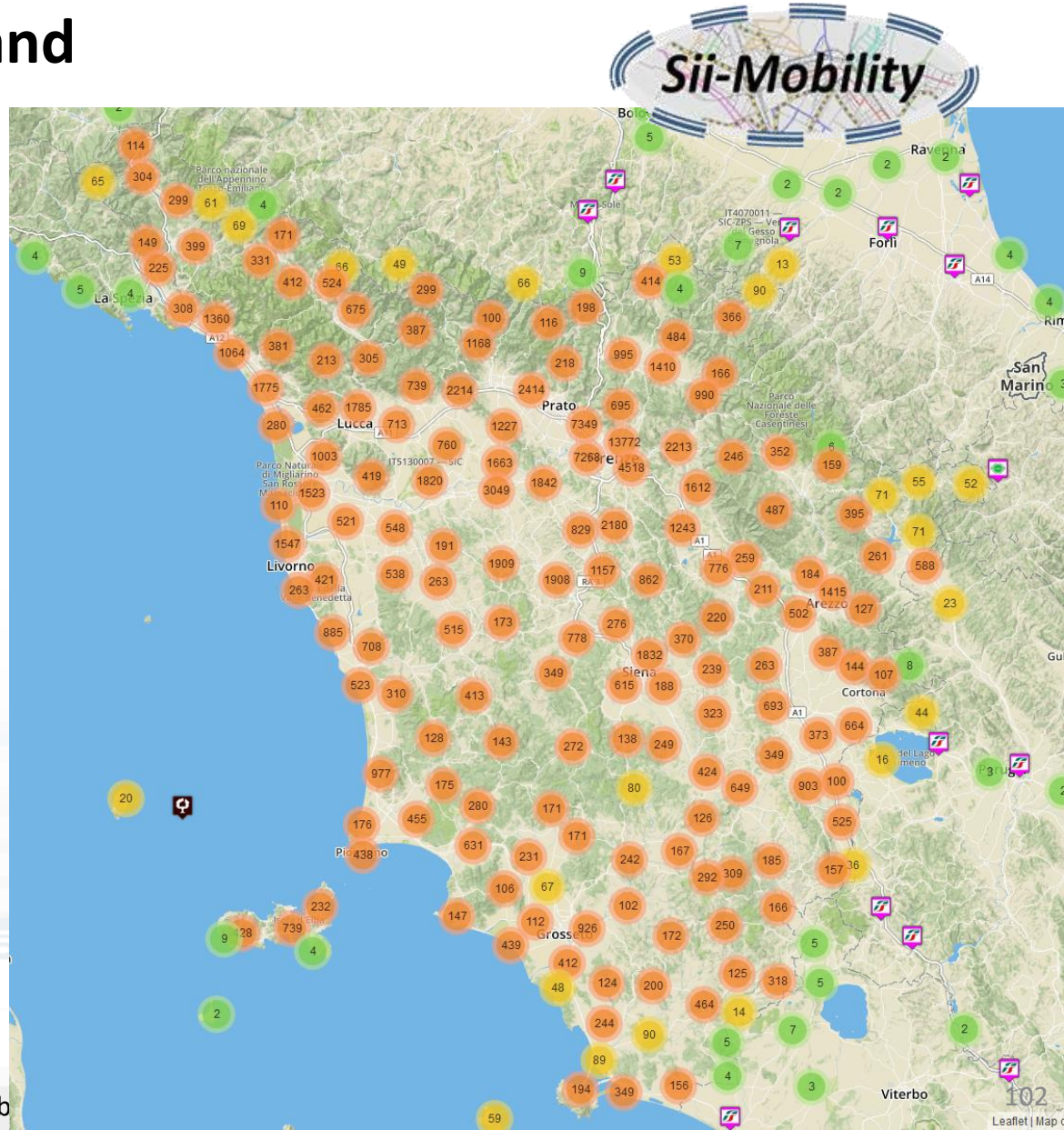
  - Data Storage and Data Shadow
  - Data Indexing
  - KB vs Smart City API
  - Data processing and scheduling

Scenarious vs SmartCity API

- Search data: by text, near, along, etc...
  - Resolving text to GPS and formal city nodes model
- Empowering the city users
- Access to event information
- Supporting City Users in using Public Mobility
- Supporting City Users in using Private Mobility
- New Experience to access at Cultural and Touristic info
- New way to access at health services
- Access at Environmental information
- Profiled Suggestions to City Users
- Personal Assistant
- Sharing knowledge among cities

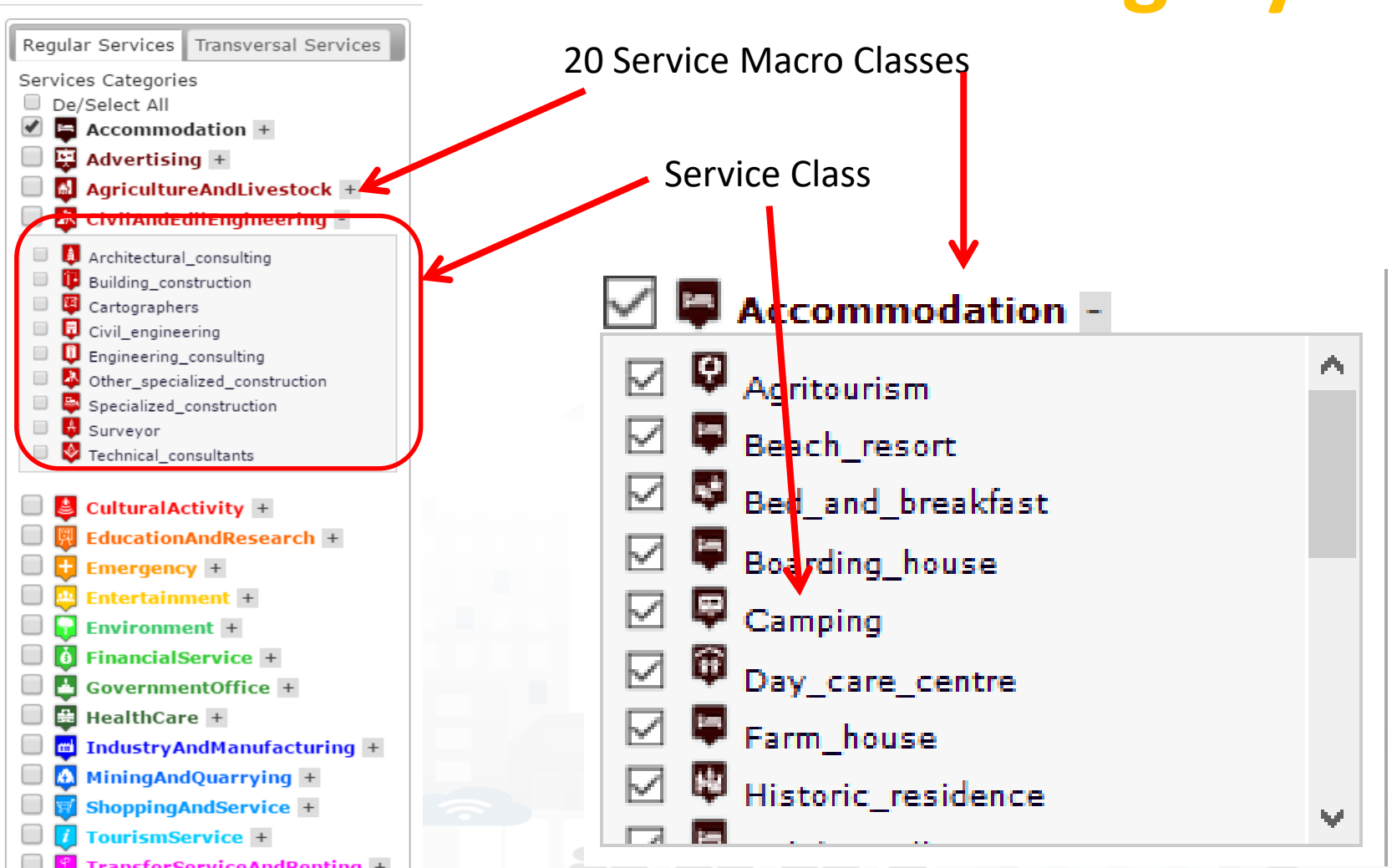
Thematic Data Domain Tuscany

- **Street and geoinformation of the territory and details for routing, navigation, …**
- **Mobility and Transport**: public and private, public transport, parking status, fuel stations prices, traffic sensors, etc.
- **Culture and Tourism**: POI, churches, museum, schools, university, theatres, events in Florence
- **Environmental**: pollution real time, weather forecast, etc.
- **Social Media**: twitter data
- **Health**: hospital, pharmacies, status of the first aid triage in major hospitals, …
- **Alarms**: civil protection alerts, hot areas, …



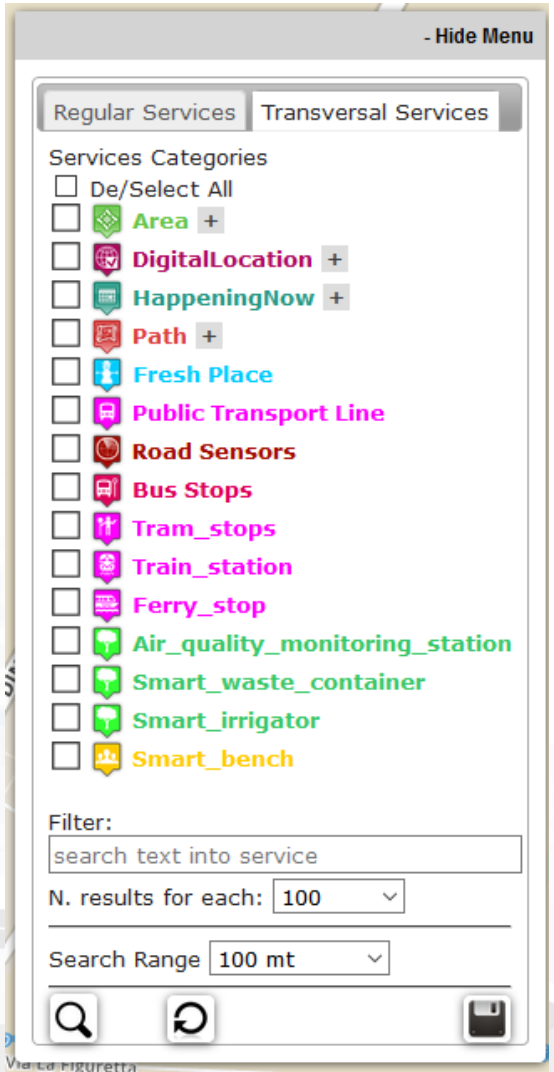
Concepts of Services: Macro and subcathegory

A SKOS area into the Km4CIty Ontology and Knowledge base for modeling POI and any element on map

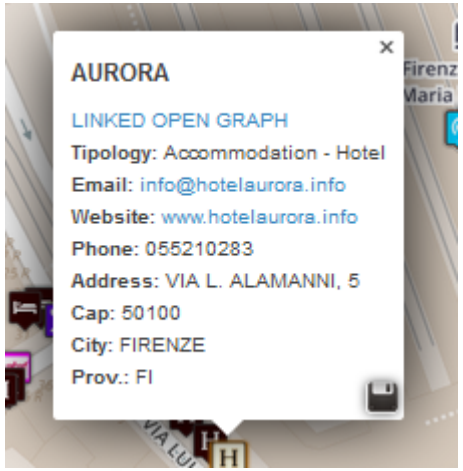


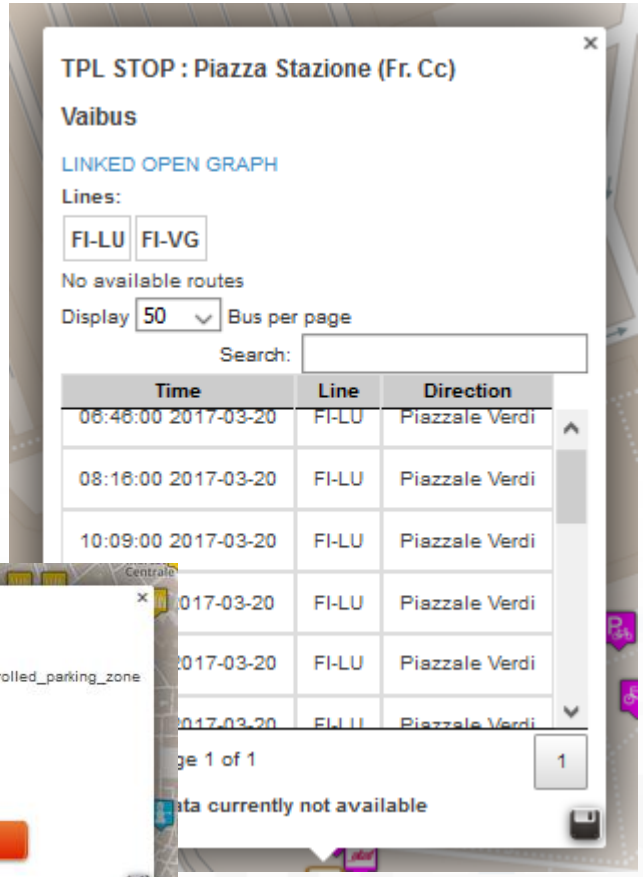
Access to Point of Interest information, POI

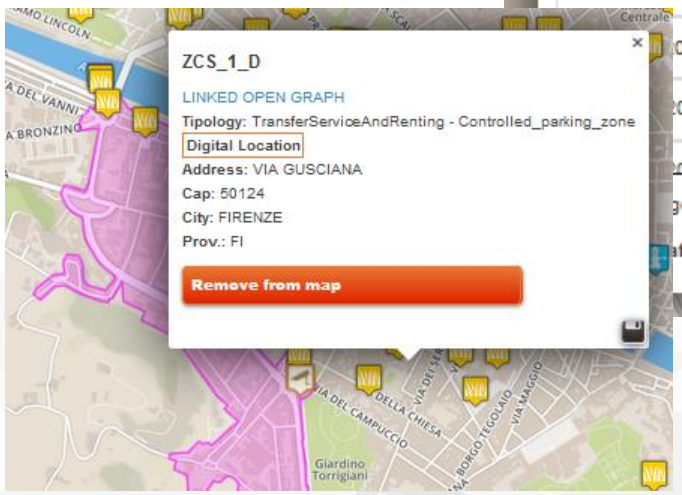
- **POI**: point of interest
- **type**: macro and subcategories
- **Position**: GPS, address, telephone, fax, email, URL, ..
- **Description**: textual, multilingual, with images, …
- **Link** to dbPedia, Linked Open Data
- **Links to other services**
- **Real time data if any:** sensors data, timeline, events, prices, opening time, rules of access, status of services, status of queue, etc..
- *See transversal services on ServiceMap*
  - *Regular and in test platform*

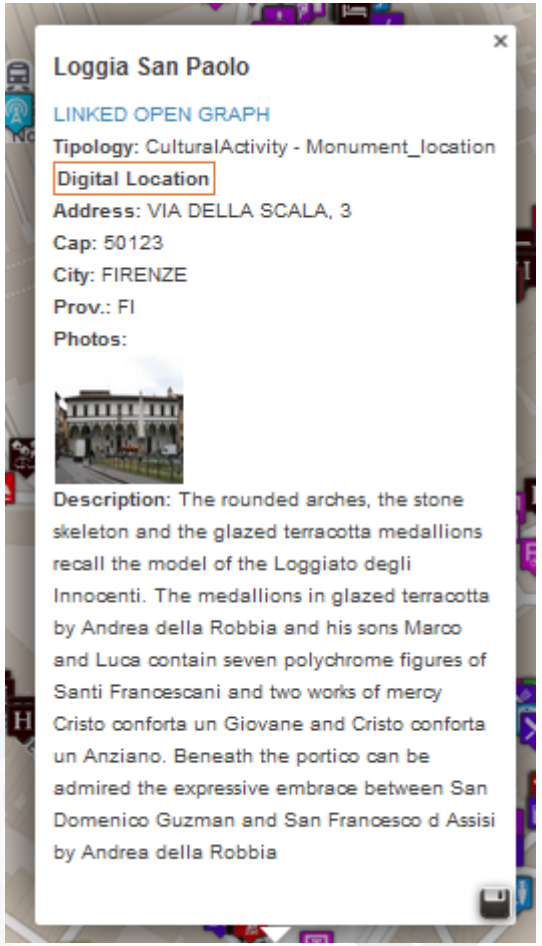


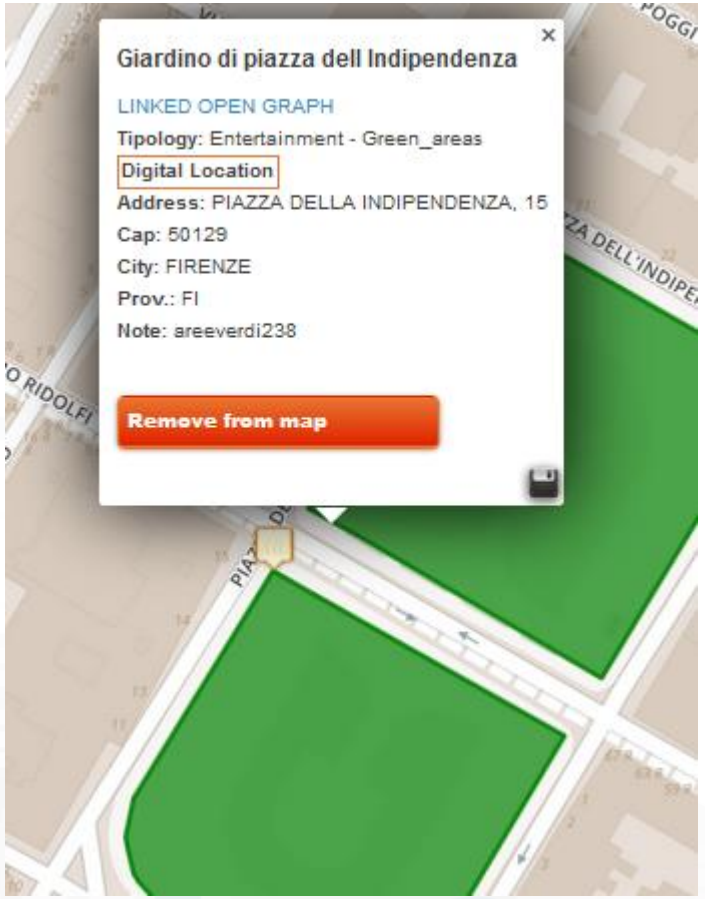
Service Information: different kind of services





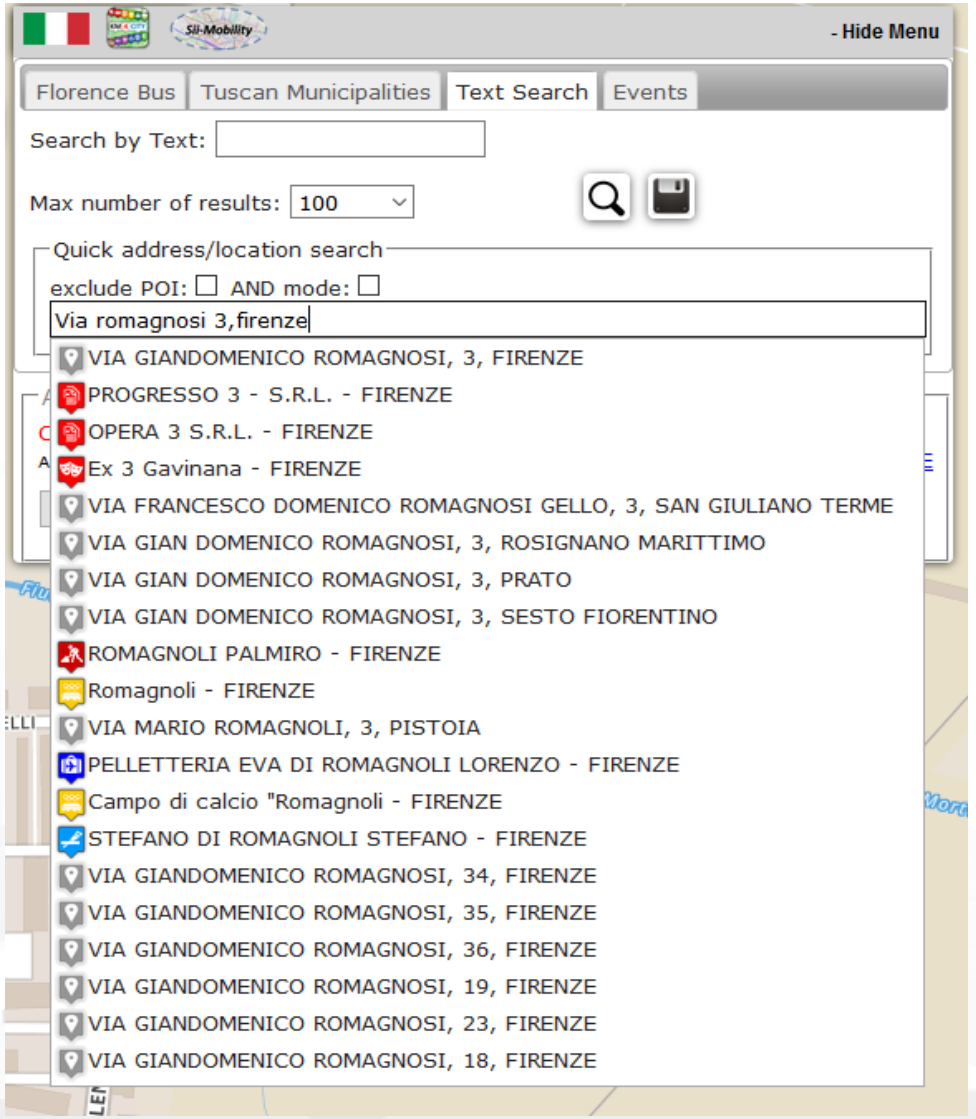






General Text Search Features

- **Search by text for POIs via**
  - Full text: description, title, macro and category name
  - Filtering by macro-cat and subcategory
  - Filtering on distance and geometric shape
- **Search by text with assisted suggestion to get:**
  - Streets and civic numbers, or POI, locations



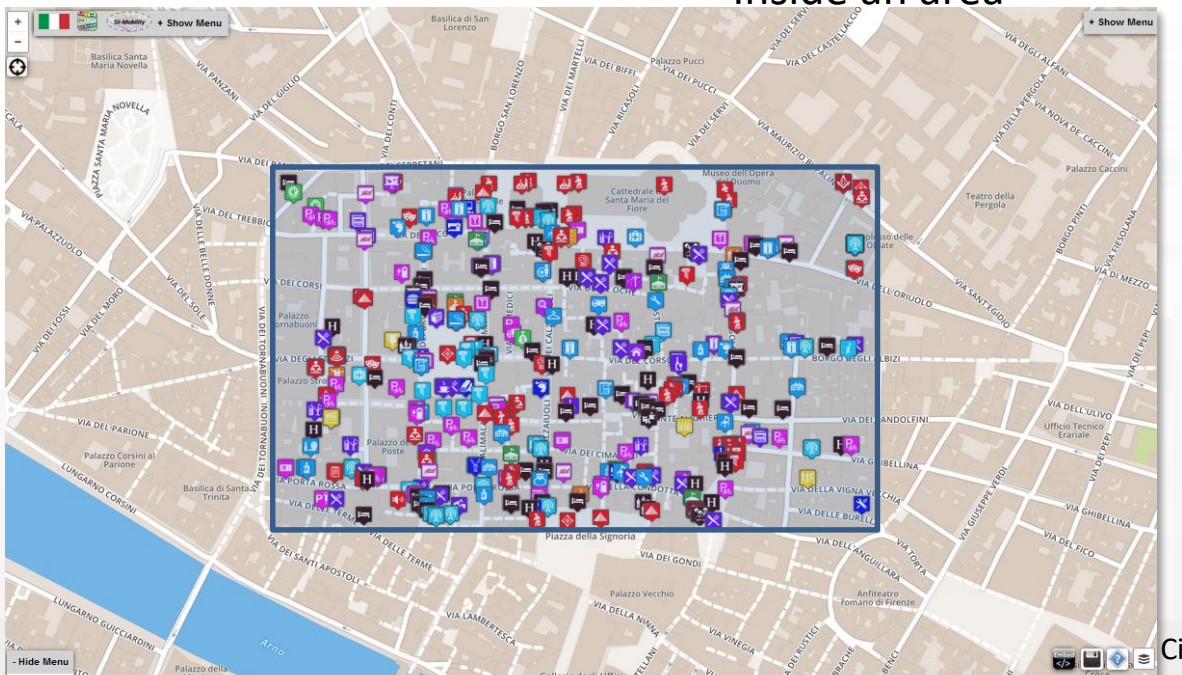
Search by Shape and Distance

Each request or search in the Km4City model can be referred to a point and a ray, to an area, to a polyline

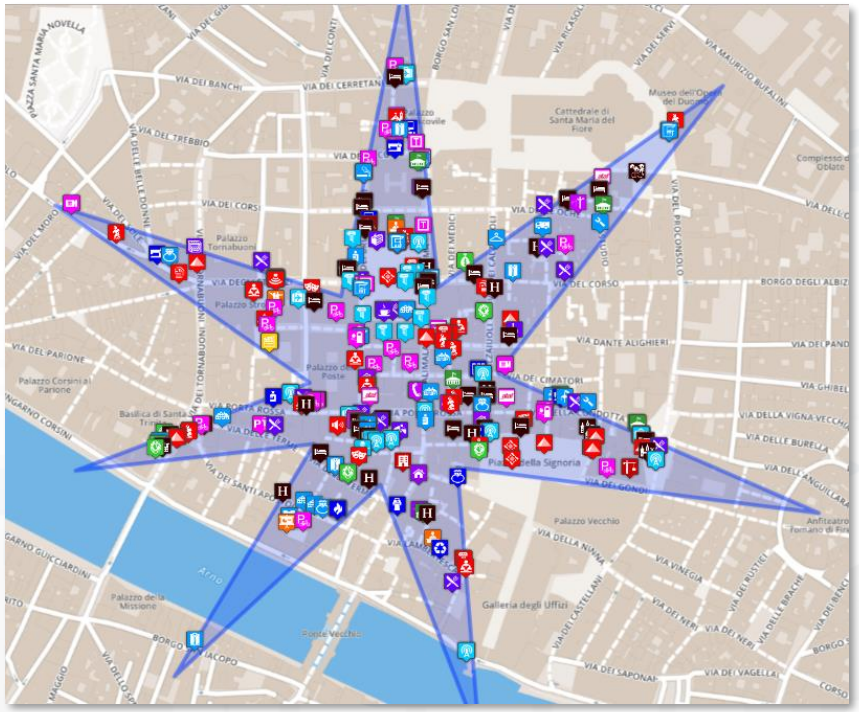
Around a point or POI



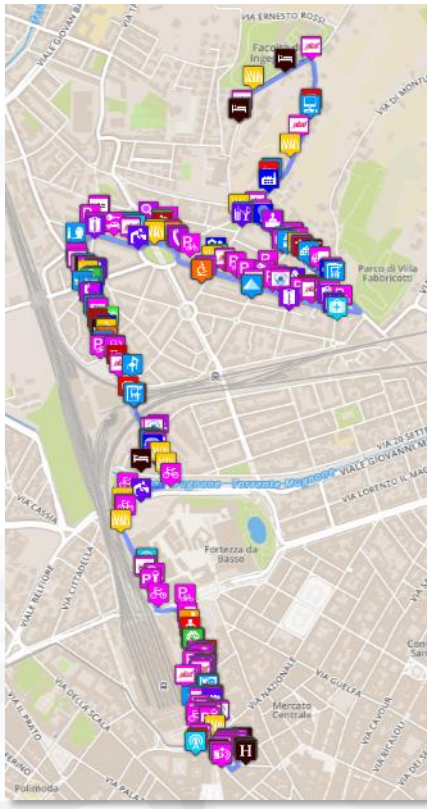
Inside an area



Inside a closed polyline



Along a polyline



Main ServiceMap features

- **Search**: provides a set of different searches on MAP and LOG
- **Save & Get API Call**: saves the performed visual query to send via e-mail the Rest call to the developer
- **Save & Get QueryID API Call**: saves the performed visual queries and send via e-mail a Rest call with a simplified syntax referring to a QueryID and not reporting the complexity of the query.
- **Save & Get Embed Code**: saves the visual query of the user in visually recall smart city elements on the map, and gives the HTML Iframe code for embedding the view on a third party web page;

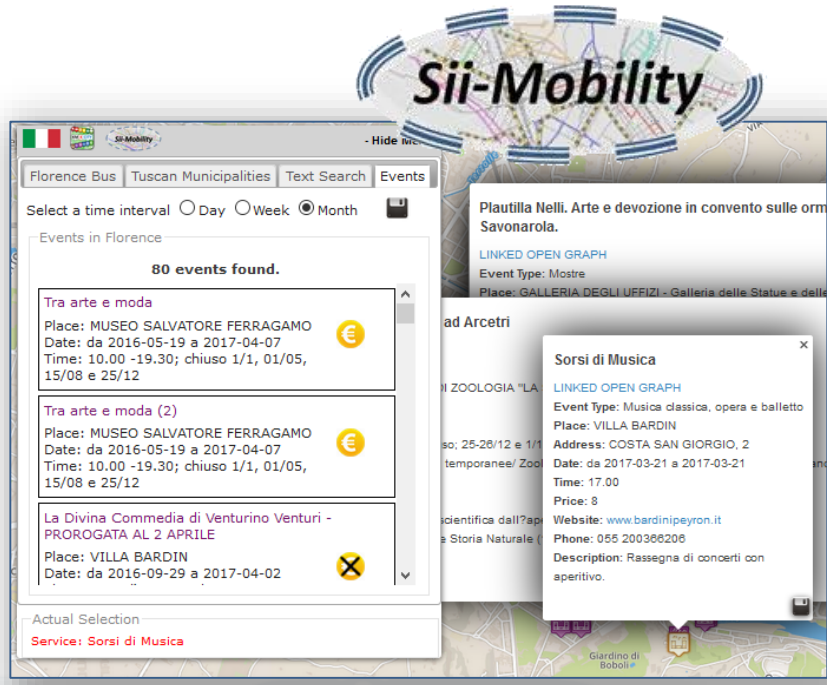
Empowering City Users

- Allow city users to
  - provide comments, images and scores associated with a certain Service (or place, via GPS)
  - Get list of last contributions of the same kind provided by other users
- They can be:
  - used as feedbacks
  - moderated by a back office personnel
  - ..
- Connection with powerful servers based on 311 standard it also possible



Access to Event information

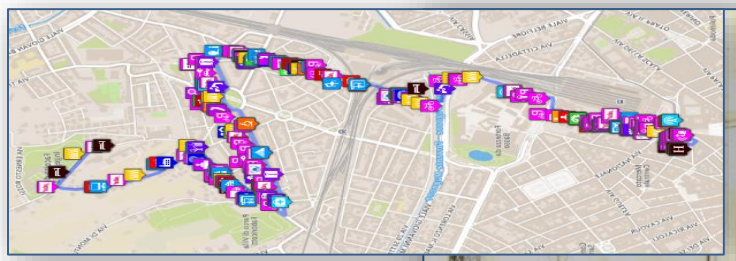
- **Getting Traffic Events: ESB, etc.**
- **Getting Critical Events: CAP standard**
- **Getting Events** in the city
  - Theater, museum, show, sport, etc.
  - **Getting Event details**
    - Event kind, and thus ordering
    - in the day, week, and month
    - Location, and thus ordering, or selecting events per area, per residence
    - General information
    - Opening and cost (if any)
    - Etc.





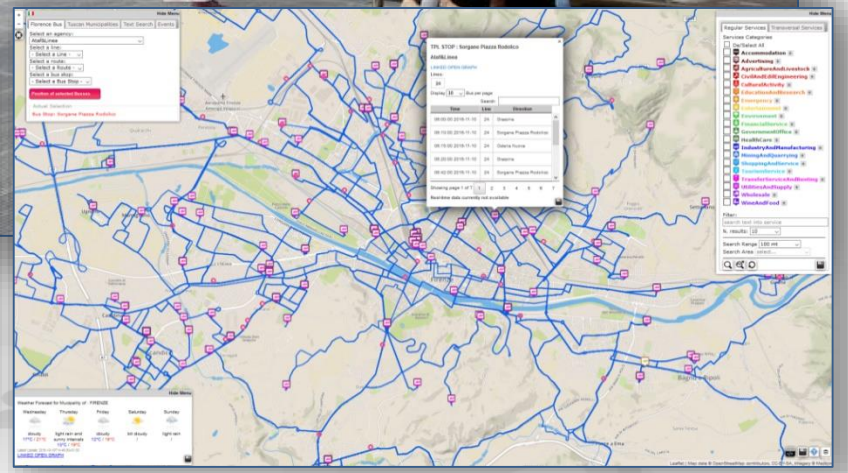
Supporting City Users in using Public Mobility

- **Public Transport, PT**
  - Getting tickets
  - Getting bus stops, lines, and timelines for bus, train and tramline (GTFS, ETL, ..)
  - Searching Services along a Pub. Transport line or closer to a stop
  - Searching the closest bus stops
  - searching for BUS stops via name
  - real time delays of busses
  - modal routing for Pub. Transport







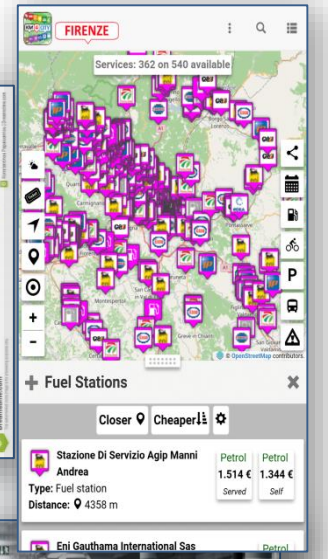


Supporting City Users using Private Mobility

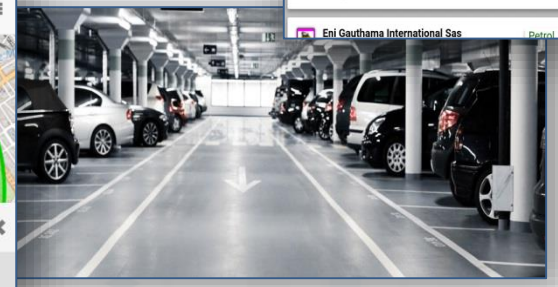
- **Private Transport**
  - Parking status (DATEX II, …)
  - Getting **closer parking**
  - **Getting parking forecast: short and log term**
  - Getting **closer free space on parking**
  - Getting **fuel stations** location and fuel product prices
  - Getting bike sharing rack status
  - Searching Services along a **path** or closer to a point or Service as Hotel, Restaurants, square, etc.
  - Getting closer **cycling paths**
  - Recharging stations: location and status
  - Getting traffic information







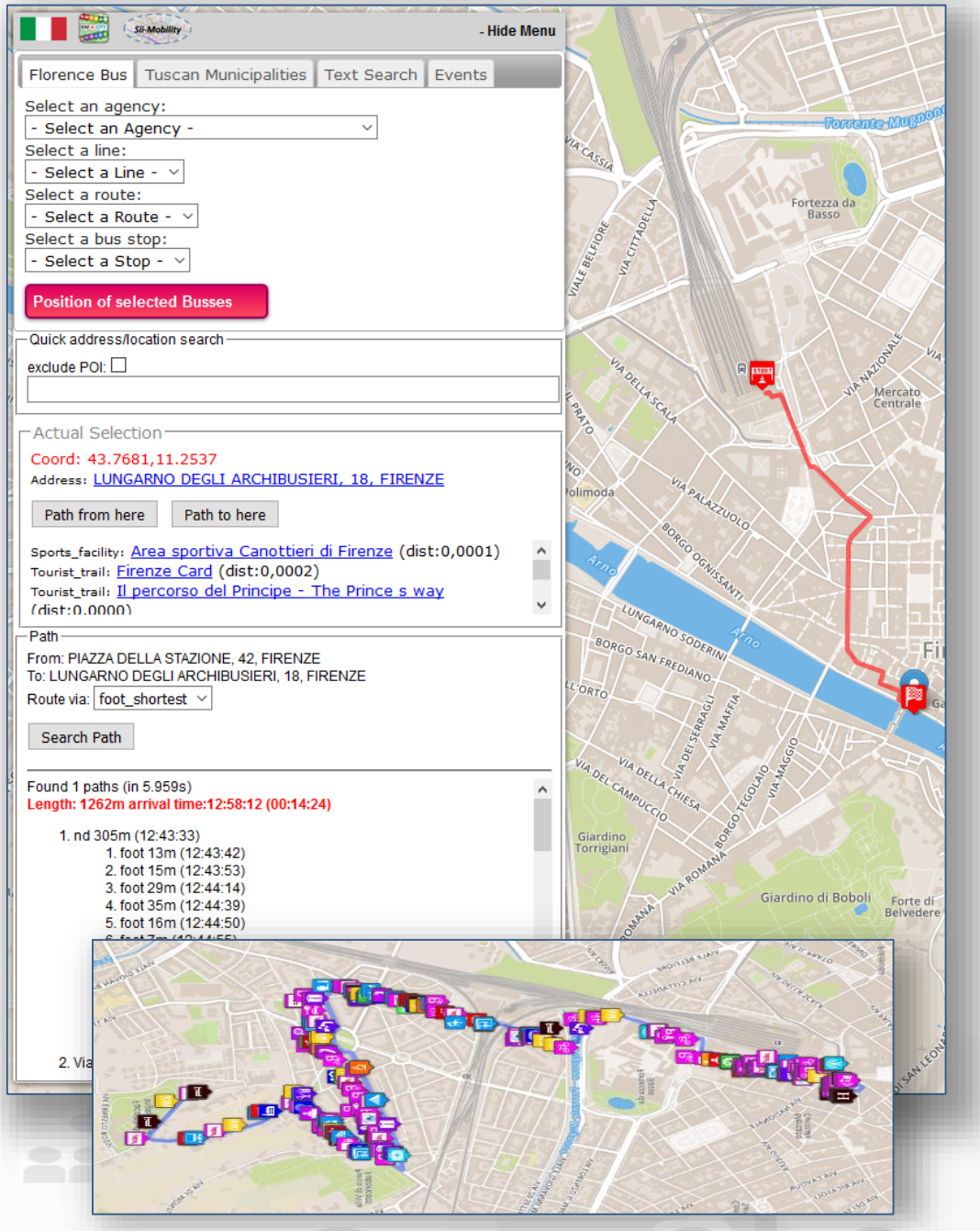






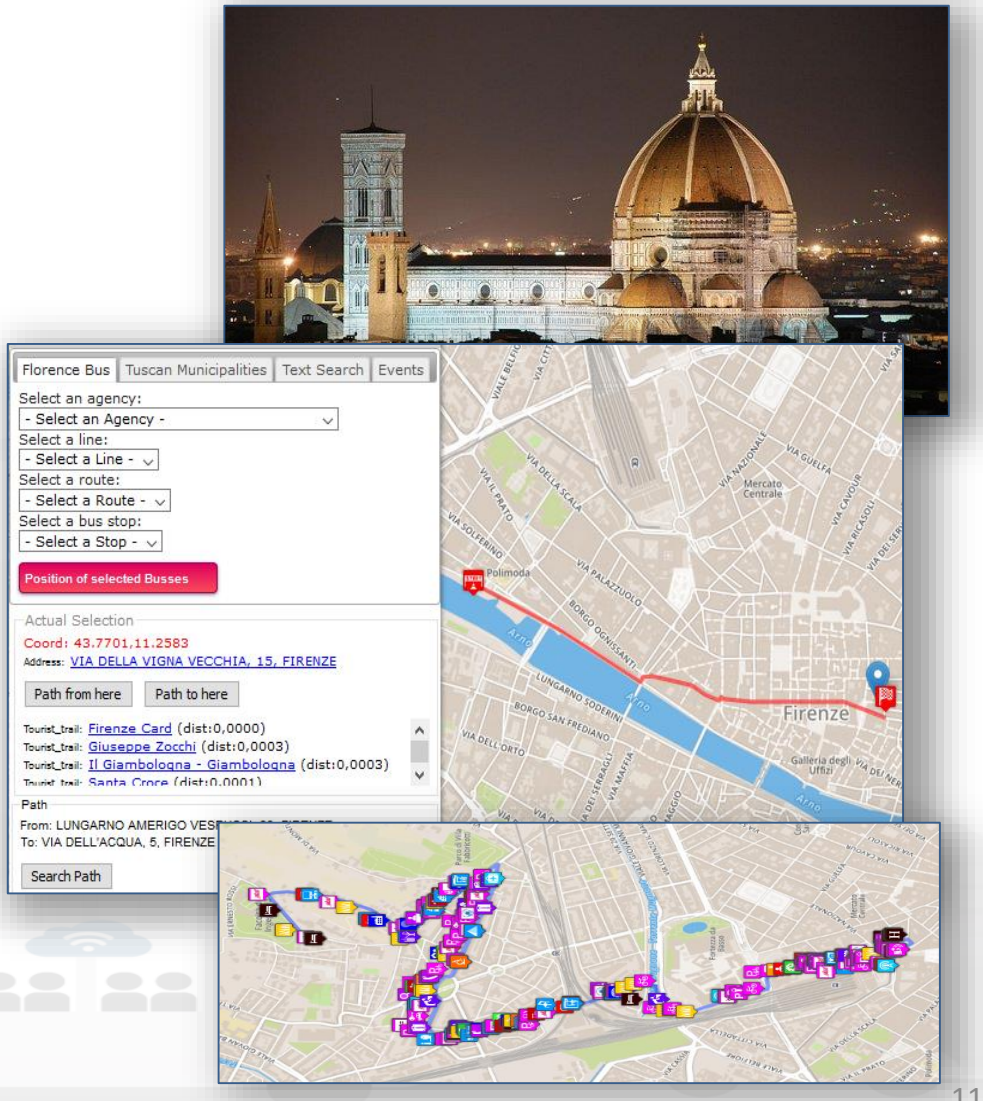
Private Mobility: routing and navigation paths

- To get the path from two points/POIs:
  - Shortest for pedestrian
  - Quietest for pedestrian
  - Shortest for private vehicles
- Search for POIs along the identified Path!
- http://www.disit.org/ServiceMap



New Experience to access at Cultural and Touristic info

- Getting location and description of Point of Interests, POIs: culture and tourism first
  - Location, images, phone, URL, etc.
  - Get image, video, audio, …
- Search for POIs in areas and closer
- Get routing to reach location or POI by walking downtown
  - searching Services along the path
- Search for location, full text assisted
- Leave a score, take a picture, etc..



New way to access at health services

- Searching for pharmacies and hospitals
- Getting the closest hospital first aid locations and status
- Getting real time updated information about the first aid status of major hospitals (triage)

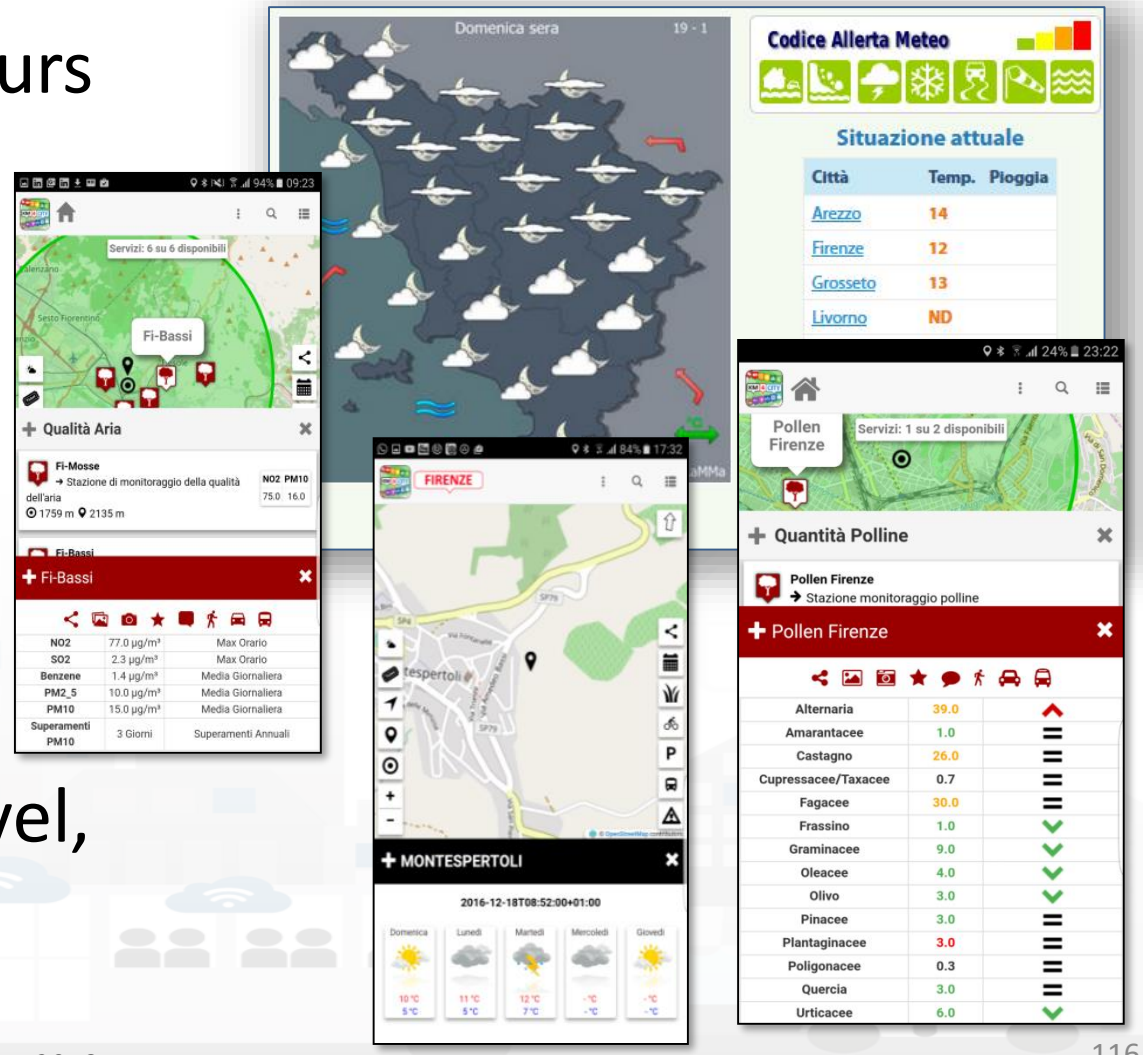






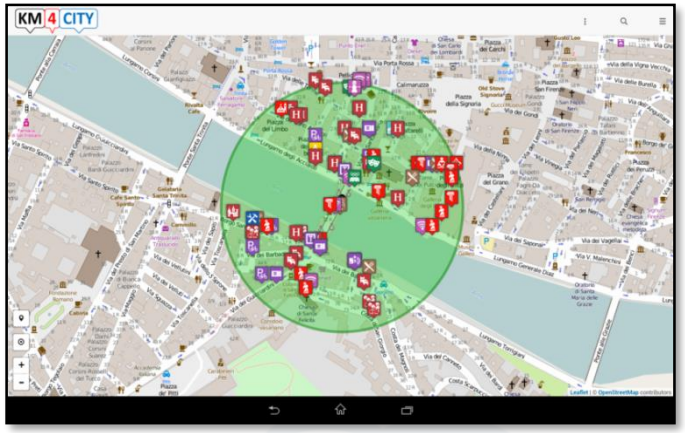
Access at Environmental information

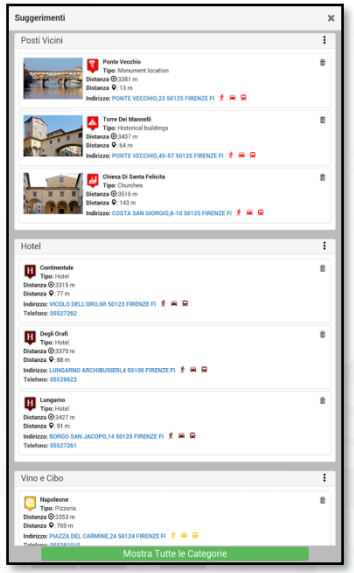
- Getting weather forecast for the next hours and days
- Getting alert information from Civil protection
- Getting air quality status
- Getting pollination status
- getting actual weather status: temperature, humidity, pressure, rain level,
- etc.



Profiled Suggestions to City Users

- Personalized suggestions
  - The server provide suggestions in the user context (location and time) arranged in a number of categories
    - Culture, mobility, food and drink, etc.
    - Alerts: civil protection, city council, twitter data, etc.
  - The city user may reject some of them, thus the suggestion engine learns about preferred topics and category



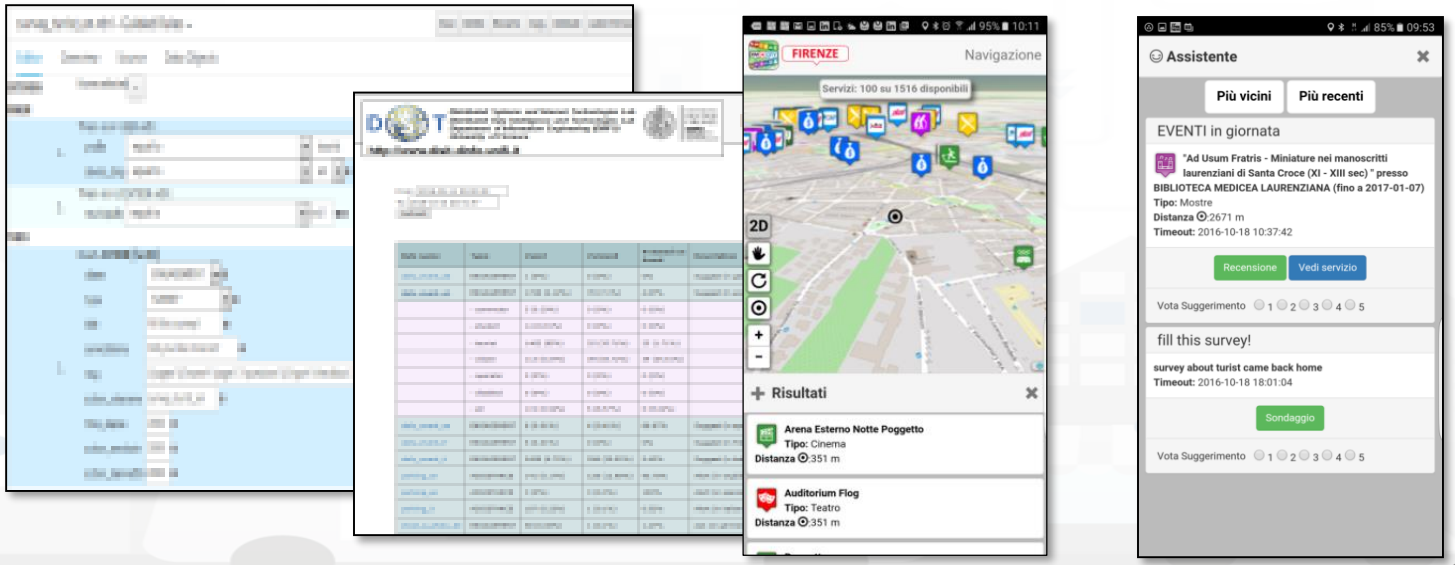




Profiled Engagements to City Users

- The user are profiled to learn habits:
  - Personal POI and paths
  - Mobility habits
- Information and engagements sent to the city users are programmed according to the user evolution to:
  - Stimulate virtuous habits
  - More sustainable habits
  - More healthy habits, etc.
  - Get feedbacks
  - Provide bonus and prices, …..
  - Send alerts, ….

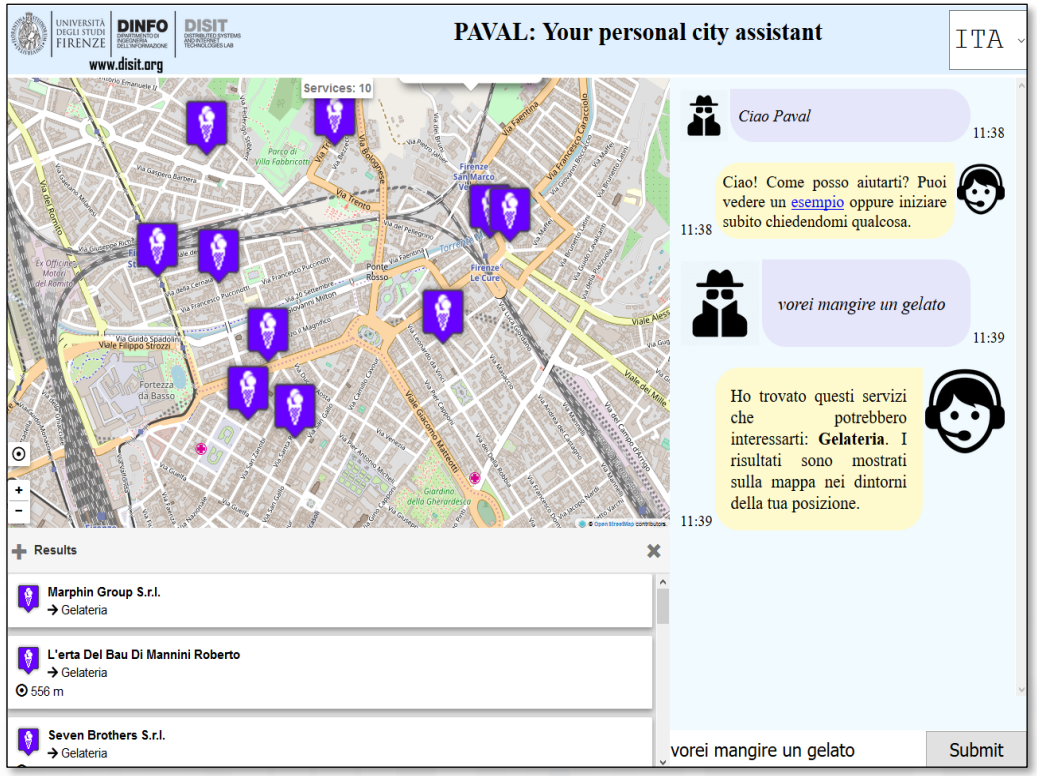




PAVAL: Personal Assistant

- **Your Personal Assistant** for navigating in the city
- Ask PAVAL to get help and information about the city services
- ITA, ENG
- Active on Florence and whole Tuscany
- Mobile and PC

https://assistant.disit.org





ADK features





- **Exploiting Km4City Smart City API**
  - Open Source
  - Multiplatform: exploiting Apache Cordova Framework
  - Active since 2015
  - Adopted by a community of several Projects, Cities and SME.

- **Respecting user privacy:**
  - Anonymous usage vs Authenticated usage (OAuth, email, ..)
- **Modular & Dynamic:**
  - loading new modules from the WEB, and/or creating App by modular approach
- **Personalization and Profiling:**
  - personalized menu, proposed POI for search,
- **Reaching City Users:**
  - alerting and notifications by location, by user behaviour

Data processing And Scheduling



Course Segments

- **Cloud-based Infrastructures for Smart Cities**
  - Open Data, Private Data, Real Time data, etc.
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  - Data Indexing
  - KB vs Smart City API
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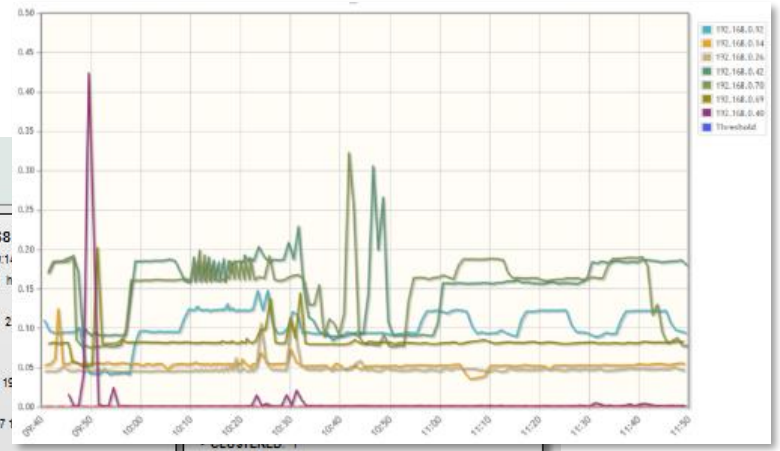
Distributed SCE Scheduler



Smart City Engine
DISIT - Distributed Systems and Internet Technology Lab

192.168.0.14
- LAST_CHECK: 2016-10-26 19:14:01
- SCHEDULER_INSTANCE_ID: hadoopnode01b1475834638160
- CPU_LOAD: 0.92%
- FREE_PHYSICAL_MEMORY: 6.04 GB
- JOBS_EXECUTED: 15333
- SCHEDULER_NAME: SCE
- CURRENT_TIME: 2016-10-26 19:14:36
- JOBS/h: 33.1
- RUNNING_SINCE: 2016-10-07 12:03:58
- CLUSTERED: 1
- PERSISTENCE: 1
- REMOTE_SCHEDULER: 0
- CURRENTLY_EXECUTING_JOBS: 0
- CPU_LOAD_JVM: 0.02%
- SYSTEM_LOAD_AVERAGE: 0.86
- OPERATING_SYSTEM_VERSION: 3.13.0-24-generic
- COMMITTED_VIRTUAL_MEMORY: 9.02 GB
- OPERATING_SYSTEM_NAME: Linux
- FREE_SWAP_SPACE: 11.98 GB
- PROCESS_CPU_TIME: 15519410000000
- TOTAL_PHYSICAL_MEMORY: 11.73 GB
- NUMBER_OF_PROCESSORS: 16
- OPERATING_SYSTEM_ARCHITECTURE: amd64
- TOTAL_SWAP_SPACE: 12 GB
- IS_SCHEDULER_STANDBY: 0
- IS_SCHEDULER_SHUTDOWN: 0
- IS_SCHEDULER_STARTED: 1
- TOTAL_DISK_SPACE: 2.11 TB
- UNALLOCATED_DISK_SPACE: 1003.31 GB
- USABLE_DISK_SPACE: 894.03 GB
- PREV_FIRE_TIME: 2016-10-26 19:11:59
- CPU: Intel(R) Xeon(R) CPU X5690 @ 3.47GHz

192.168.0.40
- LAST_CHECK: 2016-10-26 19:14:06
- SCHEDULER_INSTANCE_ID: hadoopnode01d1475834644986
- CPU_LOAD: 17.08%
- FREE_PHYSICAL_MEMORY: 1.62 GB
- JOBS_EXECUTED: 17379
- SCHEDULER_NAME: SCE
- CURRENT_TIME: 2016-10-26 19:14:36
- JOBS/h: 37.52
- RUNNING_SINCE: 2016-10-07 12:04:05
- CLUSTERED: 1
- PERSISTENCE: 1
- REMOTE_SCHEDULER: 0
- CURRENTLY_EXECUTING_JOBS: 1
- CPU_LOAD_JVM: 1.46%
- SYSTEM_LOAD_AVERAGE: 0.35
- OPERATING_SYSTEM_VERSION: 3.13.0-24-generic
- COMMITTED_VIRTUAL_MEMORY: 3.28 GB
- OPERATING_SYSTEM_NAME: Linux
- FREE_SWAP_SPACE: 11.96 GB
- PROCESS_CPU_TIME: 17961070000000
- TOTAL_PHYSICAL_MEMORY: 11.74 GB
- NUMBER_OF_PROCESSORS: 4
- OPERATING_SYSTEM_ARCHITECTURE: amd64
- TOTAL_SWAP_SPACE: 12 GB
- IS_SCHEDULER_STANDBY: 0
- IS_SCHEDULER_SHUTDOWN: 0
- IS_SCHEDULER_STARTED: 1
- TOTAL_DISK_SPACE: 2.11 TB
- UNALLOCATED_DISK_SPACE: 995.75 GB
- USABLE_DISK_SPACE: 886.48 GB
- PREV_FIRE_TIME: 2016-10-26 19:12:59
- CPU: Intel(R) Xeon(R) CPU E5420 @ 2.50GHz

192.168.0.42
- LAST_CHECK: 2016-10-26 19:14:13
- SCHEDULER_INSTANCE_ID: hadoopnode061475834650348
- CPU_LOAD: 1.66%
- FREE_PHYSICAL_MEMORY: 3.76 GB
- JOBS_EXECUTED: 15512
- SCHEDULER_NAME: SCE
- CURRENT_TIME: 2016-10-26 19:14:36
- JOBS/h: 33.49
- RUNNING_SINCE: 2016-10-07 12:04:10
- CLUSTERED: 1
- PERSISTENCE: 1
- REMOTE_SCHEDULER: 0
- CURRENTLY_EXECUTING_JOBS: 0
- CPU_LOAD_JVM: 0.02%
- SYSTEM_LOAD_AVERAGE: 0.33
- OPERATING_SYSTEM_VERSION: 3.13.0-24-generic
- COMMITTED_VIRTUAL_MEMORY: 8.32 GB
- OPERATING_SYSTEM_NAME: Linux
- FREE_SWAP_SPACE: 11.91 GB
- PROCESS_CPU_TIME: 11769360000000
- TOTAL_PHYSICAL_MEMORY: 11.73 GB
- NUMBER_OF_PROCESSORS: 16
- OPERATING_SYSTEM_ARCHITECTURE: amd64
- TOTAL_SWAP_SPACE: 12 GB
- IS_SCHEDULER_STANDBY: 0
- IS_SCHEDULER_SHUTDOWN: 0
- IS_SCHEDULER_STARTED: 1
- TOTAL_DISK_SPACE: 2.11 TB
- UNALLOCATED_DISK_SPACE: 998.77 GB
- USABLE_DISK_SPACE: 889.49 GB
- PREV_FIRE_TIME: 2016-10-26 19:14:21
- CPU: Intel(R) Xeon(R) CPU E5-2650 v3 @ 2.30GHz

192.168.0.69
- LAST_CHECK: 2016-10-26 19:14:18
- SCHEDULER_INSTANCE_ID: hadoopnode021475834654997
- CPU_LOAD: 3.77%
- FREE_PHYSICAL_MEMORY: 4.45 GB
- JOBS_EXECUTED: 14770
- SCHEDULER_NAME: SCE
- CURRENT_TIME: 2016-10-26 19:14:36
- JOBS/h: 31.89
- RUNNING_SINCE: 2016-10-07 12:04:15
- CLUSTERED: 1
- PERSISTENCE: 1
- REMOTE_SCHEDULER: 0
- CURRENTLY_EXECUTING_JOBS: 1
- CPU_LOAD_JVM: 0.01%
- SYSTEM_LOAD_AVERAGE: 0.58
- OPERATING_SYSTEM_VERSION: 3.13.0-24-generic
- COMMITTED_VIRTUAL_MEMORY: 8.38 GB
- OPERATING_SYSTEM_NAME: Linux
- FREE_SWAP_SPACE: 11.98 GB
- PROCESS_CPU_TIME: 10180410000000
- TOTAL_PHYSICAL_MEMORY: 11.73 GB
- NUMBER_OF_PROCESSORS: 16
- OPERATING_SYSTEM_ARCHITECTURE: amd64
- TOTAL_SWAP_SPACE: 12 GB
- IS_SCHEDULER_STANDBY: 0
- IS_SCHEDULER_SHUTDOWN: 0
- IS_SCHEDULER_STARTED: 1
- TOTAL_DISK_SPACE: 2.11 TB
- UNALLOCATED_DISK_SPACE: 1004.16 GB
- USABLE_DISK_SPACE: 894.89 GB
- PREV_FIRE_TIME: 2016-10-26 19:14:04
- CPU: Intel(R) Xeon(R) CPU E5-2650 v3 @ 2.30GHz

192.168
- LAST_CHECK: 2016-10-26 19:14:
- SCHEDULER_INSTANCE_ID: h
- CPU_LOAD: 0.96%
- FREE_PHYSICAL_MEMORY: 2
- JOBS_EXECUTED: 15492
- SCHEDULER_NAME: SCE
- CURRENT_TIME: 2016-10-26 19
- JOBS/h: 33.45
- RUNNING_SINCE: 2016-10-07 1
- CLUSTERED: 1
- PERSISTENCE: 1
- REMOTE_SCHEDULER: 0
- CURRENTLY_EXECUTING_JOBS: 0
- CPU_LOAD_JVM: 0.02%
- SYSTEM_LOAD_AVERAGE: 0.02
- OPERATING_SYSTEM_VERSION: 3.13.0-24-generic
- COMMITTED_VIRTUAL_MEMORY: 8.38 GB
- OPERATING_SYSTEM_NAME: Linux
- FREE_SWAP_SPACE: 11.97 GB
- PROCESS_CPU_TIME: 14778010000000
- TOTAL_PHYSICAL_MEMORY: 11.73 GB
- NUMBER_OF_PROCESSORS: 16
- OPERATING_SYSTEM_ARCHITECTURE: amd64
- TOTAL_SWAP_SPACE: 12 GB
- IS_SCHEDULER_STANDBY: 0
- IS_SCHEDULER_SHUTDOWN: 0
- IS_SCHEDULER_STARTED: 1
- TOTAL_DISK_SPACE: 2.11 TB
- UNALLOCATED_DISK_SPACE: 1.01 TB
- USABLE_DISK_SPACE: 924.57 GB
- PREV_FIRE_TIME: 2016-10-26 19:10:21
- CPU: Intel(R) Xeon(R) CPU X5690 @ 3.47GHz

192.168.0.[illegible]
- LAST_CHECK: 2016-10-26 19:13:
- SCHEDULER_INSTANCE_ID: h
- CPU_LOAD: 0.96%
- FREE_PHYSICAL_MEMORY: 2
- JOBS_EXECUTED: 15492
- SCHEDULER_NAME: SCE
- CURRENT_TIME: 2016-10-26 19
- JOBS/h: 33.45
- RUNNING_SINCE: 2016-10-07 1
- CLUSTERED: 1
- PERSISTENCE: 1
- REMOTE_SCHEDULER: 0
- CURRENTLY_EXECUTING_JOBS: 0
- CPU_LOAD_JVM: 0.02%
- SYSTEM_LOAD_AVERAGE: 0.27
- OPERATING_SYSTEM_VERSION: 3.13.0-24-generic
- COMMITTED_VIRTUAL_MEMORY: 8.32 GB
- OPERATING_SYSTEM_NAME: Linux
- FREE_SWAP_SPACE: 11.97 GB
- PROCESS_CPU_TIME: 14856240000000
- TOTAL_PHYSICAL_MEMORY: 11.73 GB
- NUMBER_OF_PROCESSORS: 16
- OPERATING_SYSTEM_ARCHITECTURE: amd64
- TOTAL_SWAP_SPACE: 12 GB
- IS_SCHEDULER_STANDBY: 0
- IS_SCHEDULER_SHUTDOWN: 0
- IS_SCHEDULER_STARTED: 1
- TOTAL_DISK_SPACE: 2.11 TB
- UNALLOCATED_DISK_SPACE: 1.01 TB
- USABLE_DISK_SPACE: 924.12 GB
- PREV_FIRE_TIME: 2016-10-26 19:13:21
- CPU: Intel(R) Xeon(R) CPU X5690 @ 3.47GHz

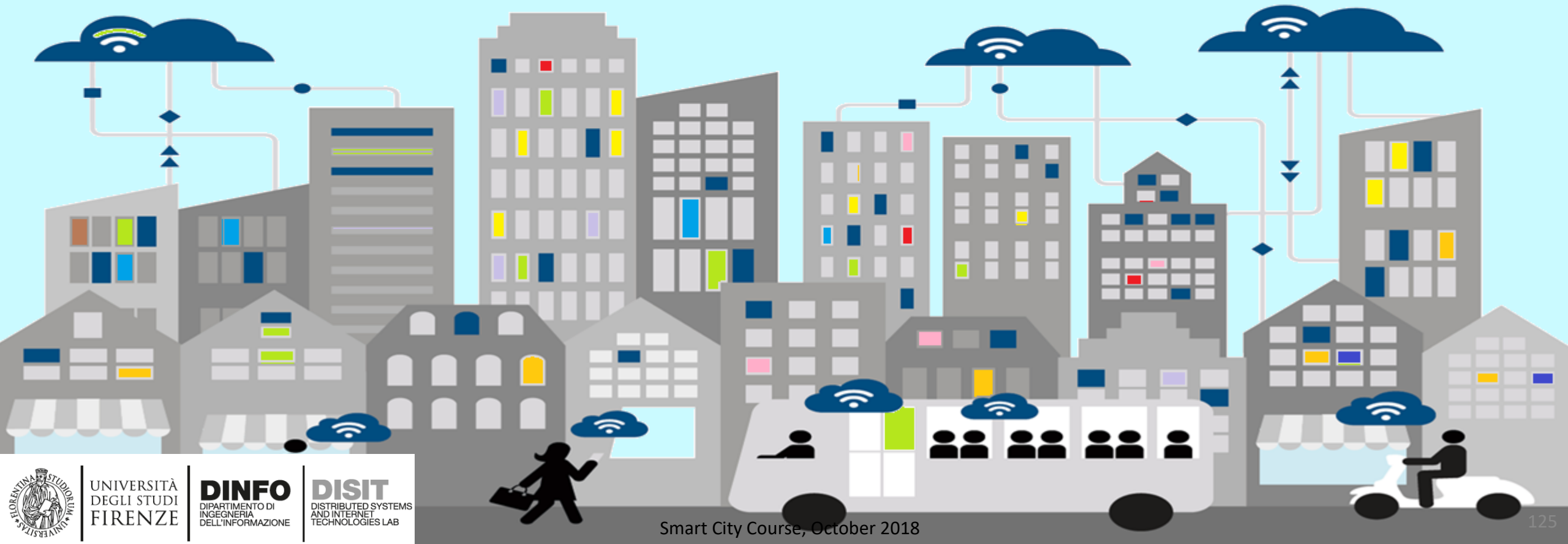
CPU	CPU Load	Mem Total	Mem Free	Cores	Jobs/h	Jobs Executed	Jobs Failed/Success (24 h)	Jobs Failed/Success (7 days)
244.07 GHz	5.41 GHz (2.22%)	70.41 GB	20.36 GB	84	203.56	94283	221 (4.45%) 4742 (95.55%)	2879 (8.41%) 31356 (91.59%)

Distributed SCE Scheduler

Smart Cloud Engine
DISIT - Distributed Systems and Internet Technology Lab

SCHEDULER NAME	ID	FIRE INSTANCE ID	DATE	JOB NAME	JOB GROUP	JOB DATA	STATUS
SCE	297230	hadoopnode01d14183077042351418307705019	2014-12-15 15:25:33	sensori47_A	sensori47	#processParameters=[{"processPath":"/ho	RUNNING
SCE	297229	hadoopnode06c14183076279641418307629359	2014-12-15 15:25:33	sensori44_A	sensori44	#processParameters=[{"processPath":"/ho	RUNNING
SCE	297228	hadoopnode02141830838738214183083917758	2014-12-15 15:22:39	ZTL_notturna_shp_I	ZTL_notturna_shp	#processParameters=null;#isNonConcurrent=t	SUCCESS
SCE	297227	hadoopnode02141830838738214183083917757	2014-12-15 15:22:39	ZTL_notturna_kmz_I	ZTL_notturna_kmz	#processParameters=null;#isNonConcurrent=t	SUCCESS
SCE	297226	hadoopnode01c14183085186101418308520365	2014-12-15 15:21:49	sensori45_A	sensori45	#processParameters=[{"processPath":"/ho	RUNNING
SCE	297225	hadoopnode06141830832370214183083258668	2014-12-15 15:21:49	sensori40_A	sensori40	#processParameters=[{"processPath":"/ho	RUNNING
SCE	297224	hadoopnode01b14183075646221418307566749	2014-12-15 15:21:49	sensori46_A	sensori46	#processParameters=[{"processPath":"/ho	RUNNING
SCE	297223	hadoopnode02141830838738214183083917756	2014-12-15 15:21:37	ZTL_notturna_kmz_I	ZTL_notturna_kmz	#processParameters=null;#isNonConcurrent=t	SUCCESS
SCE	297222	hadoopnode02141830838738214183083917755	2014-12-15 15:21:00	sensori31_C	sensori31	#processParameters=[{"processPath":"/ho	SUCCESS
SCE	297221	hadoopnode06c14183076279641418307629358	2014-12-15 15:21:00	sensori30_C	sensori30	#processParameters=[{"processPath":"/ho	SUCCESS
SCE	297220	hadoopnode02141830838738214183083917754	2014-12-15 15:18:58	ZTL_notturna_shp_I	ZTL_notturna_shp	#processParameters=null;#isNonConcurrent=t	SUCCESS
		hadoopnode01c14183				#processParameter	

IOT Registration and Management



Course Segments

- Qualification of the speaker
- Cloud-based Infrastructures for Smart Cities
- IOT Registration and Management
- Supporting the Analysis of Smart City Data
- From Data to Applications and Dashboards

IOT Devices, management and construction

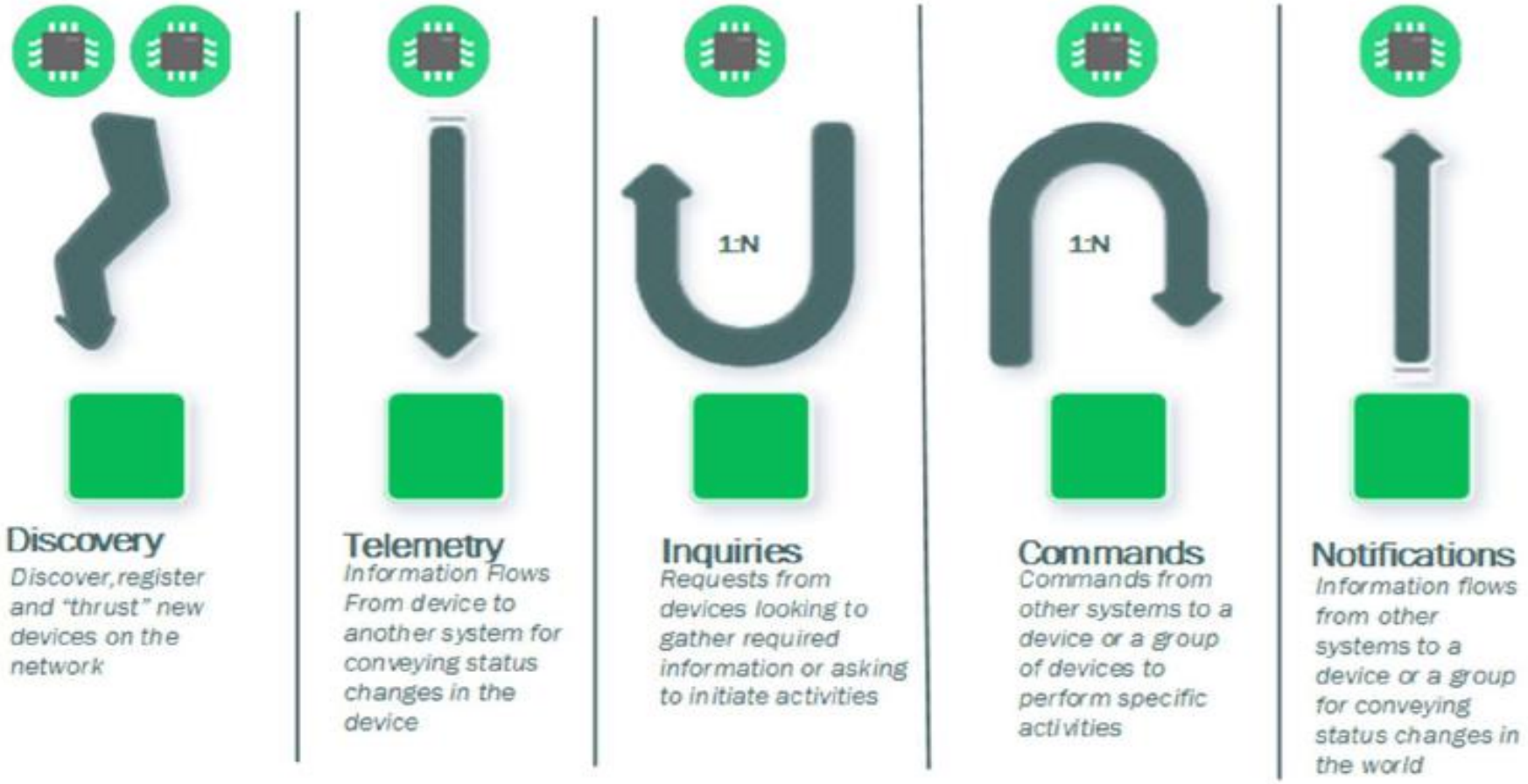


IOT Management: activities

- **IOT Devices**: a large range of protocols, formats and kind
  - IOT Devices (single or in bulk) are **registered** on IOT Directory and thus according to Knowlege base are registered to be used in IOT Applications, Dashboards, etc. with Shadow values, etc.
  - IOT Models are saved on IOT Directory for shortening the registration process
  - IOT Device healthiness is monitored automatically
- **IOT Devices can be public or private**
  - **Full support of Proprietary protocols and devices**
  - **Providing Open Hardware and Open Software** IOT Devices/IOT Edge: NGSI fully secure
- **IOT Edge** are devices: Raspberry, Android, Linux, Windows, etc.
- IOT Devices are connected via **Secure Encrypted Multual Autenticated** channell of communication

IOT/IOE Protocols

Communication Patterns



- MQTT
- HTTP(s)
- AMQP
- COAP
- NGSI
- OneM2M
- WebSocket
- Etc.
- Etc.

Interoperability

Powered by FIWARE

http://marketplace.fiware.org/pages/solutions/b8905e91973b420189cce972

https://partners.sigfox.com/companies/disit-lab-university-of-florence
https://partners.sigfox.com/products/snap4city

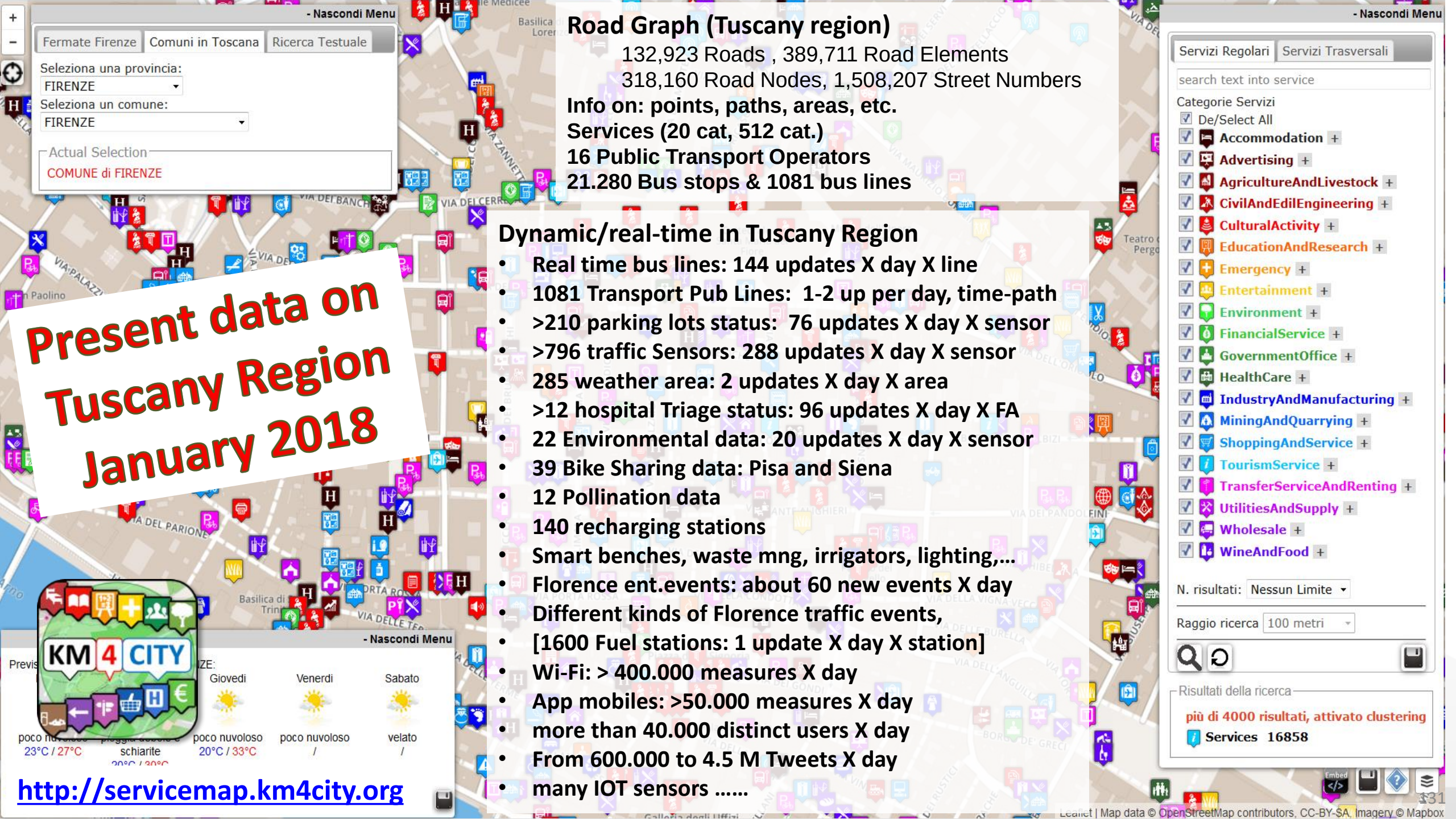
sigfox partner

Node-RED

https://flows.nodered.org/?num_pages=1
https://flows.nodered.org/?term=snap4city&num_pages=1

Compliant ckan

Supporting: AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, SMTP, TCP, UDP, NGSI, LoraWan, SigFOX, DATEX II, SOAP, WSDL, Twitter, FaceBook, Telegram, SMS, OLAP, MySQL, Mongo, HBASE, SOLR, SPARQL, EMAIL, FTP, FTPS, WebSocket, WebSocket Secure, ModBUS, WFS, WMS, ODBC, JDBC, Phoenix, JSON, XML, GeoJSON, WFS, Android, Raspberry, etc.


- Nascondi Menu
Fermate Firenze
Comuni in Toscana
Ricerca Testuale
Seleziona una provincia:
FIRENZE
Seleziona un comune:
FIRENZE
Actual Selection
COMUNE di FIRENZE
Road Graph (Tuscany region)
132,923 Roads , 389,711 Road Elements
318,160 Road Nodes, 1,508,207 Street Numbers
Info on: points, paths, areas, etc.
Services (20 cat, 512 cat.)
16 Public Transport Operators
21.280 Bus stops & 1081 bus lines
Present data on Tuscany Region January 2018
Dynamic/real-time in Tuscany Region
• Real time bus lines: 144 updates X day X line
• 1081 Transport Pub Lines: 1-2 up per day, time-path
• >210 parking lots status: 76 updates X day X sensor
• >796 traffic Sensors: 288 updates X day X sensor
• 285 weather area: 2 updates X day X area
• >12 hospital Triage status: 96 updates X day X FA
• 22 Environmental data: 20 updates X day X sensor
• 39 Bike Sharing data: Pisa and Siena
• 12 Pollination data
• 140 recharging stations
• Smart benches, waste mng, irrigators, lighting,…
• Florence ent.events: about 60 new events X day
• Different kinds of Florence traffic events,
• [1600 Fuel stations: 1 update X day X station]
• Wi-Fi: > 400.000 measures X day
• App mobiles: >50.000 measures X day
• more than 40.000 distinct users X day
• From 600.000 to 4.5 M Tweets X day
• many IOT sensors ……
- Nascondi Menu
Servizi Regolari
Servizi Trasversali
search text into service
Categorie Servizi
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
N. risultati: Nessun Limite
Raggio ricerca 100 metri
Risultati della ricerca
più di 4000 risultati, attivato clustering
Services 16858
KM 4 CITY
Giovedì
Venerdì
Sabato
poco nuvoloso
20°C / 33°C
poco nuvoloso
/
velato
/
23°C / 27°C
schiarite
http://servicemap.km4city.org
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

Level 3 user: add personal devices and create Dash

- With Smart city data and information +
- Personal IOT/IOE, which can be registered and created

IOT and City data World

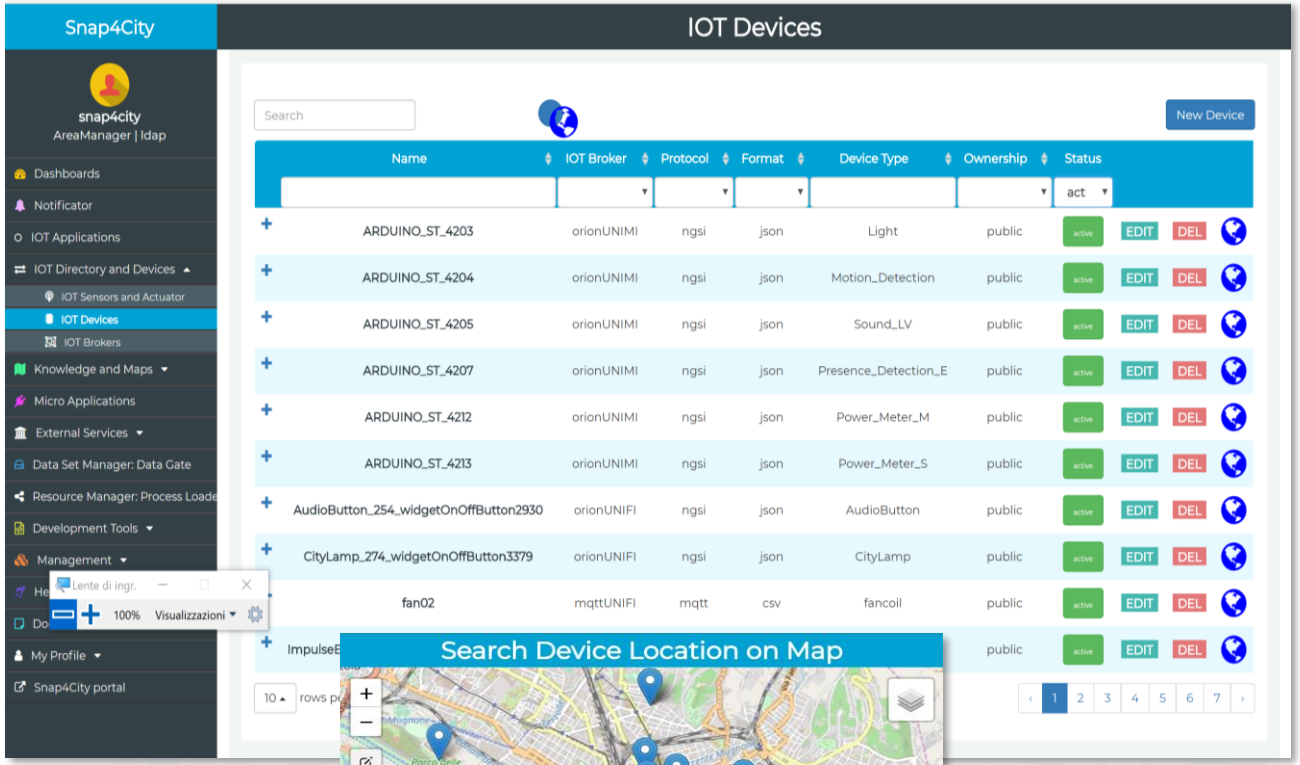


My Dashboard

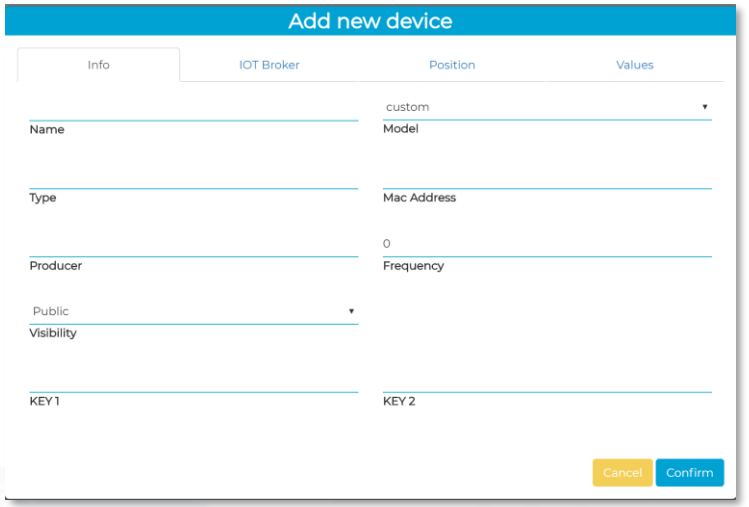


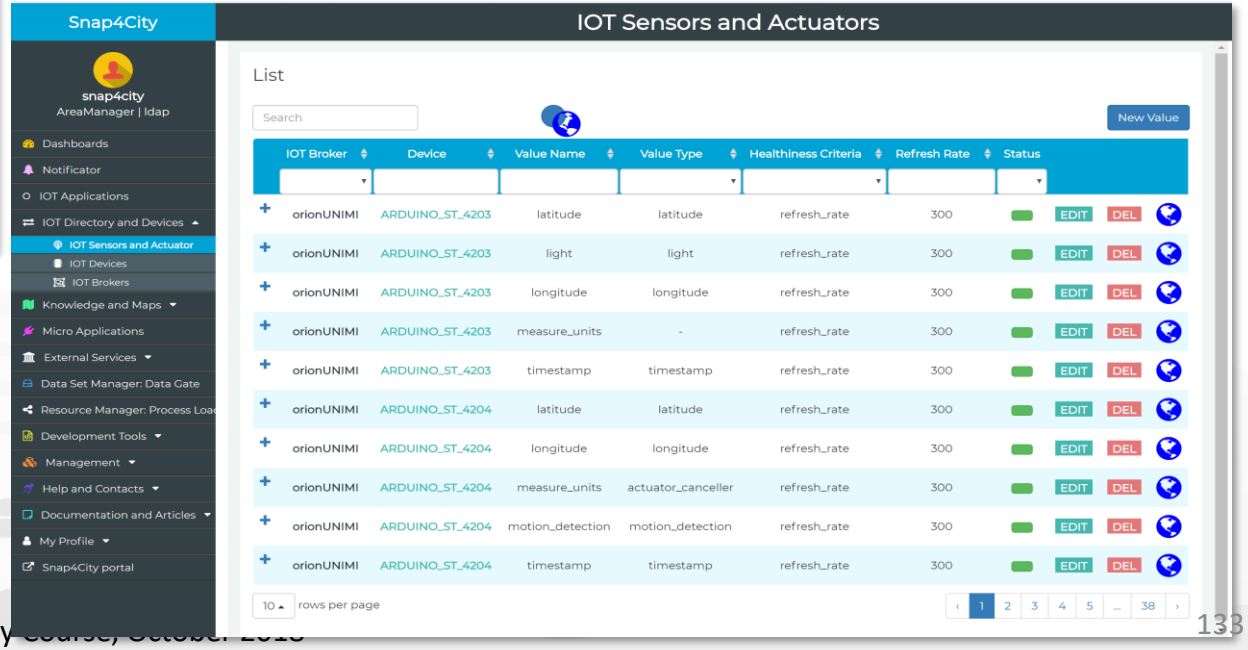
Registration of My IOT Devices

IOT Directory



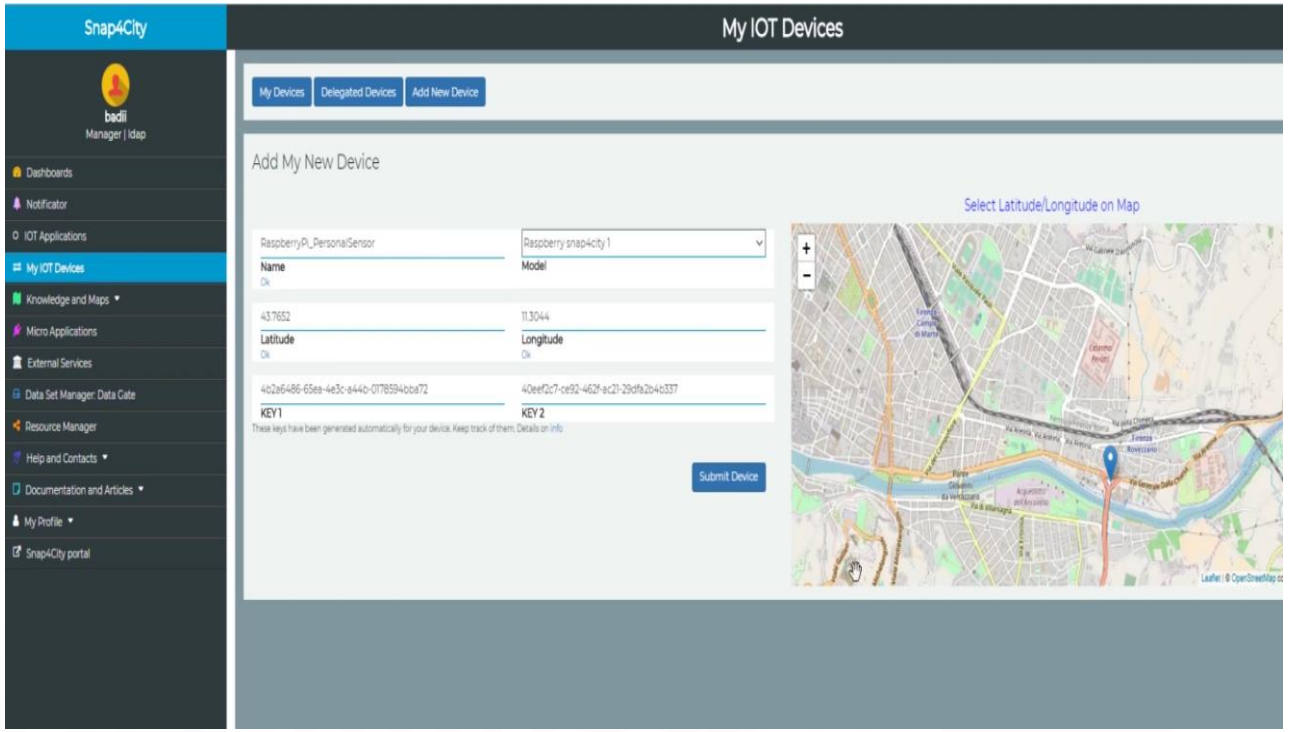






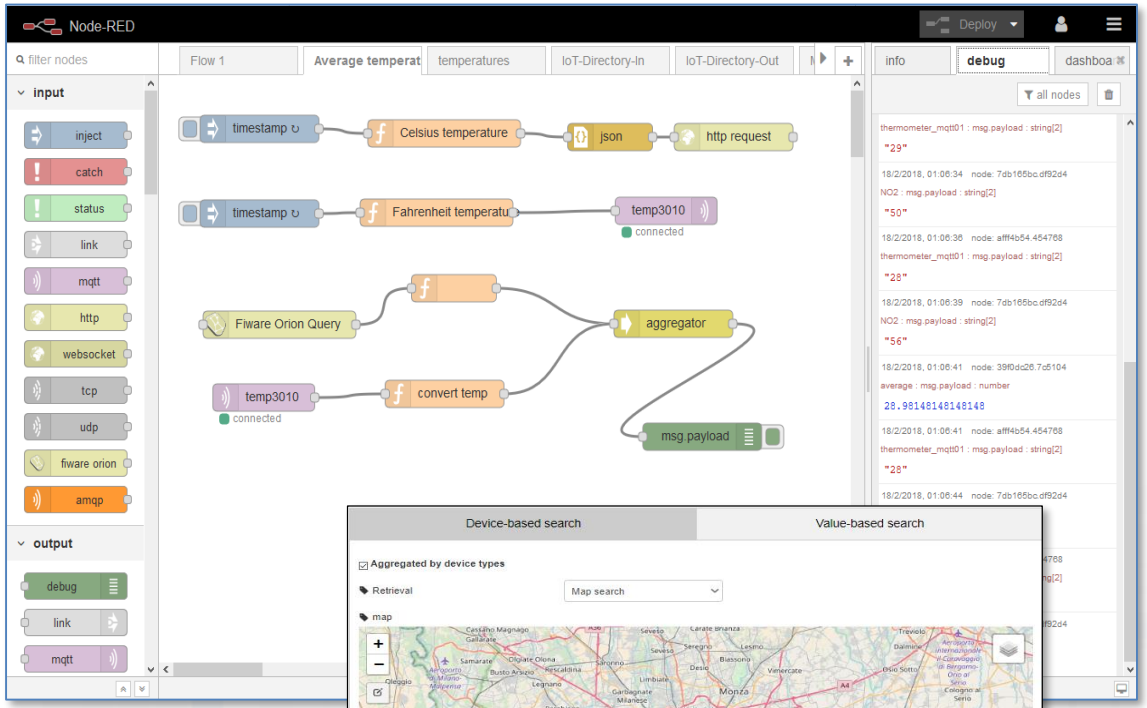
Add IOT/IOE Devices

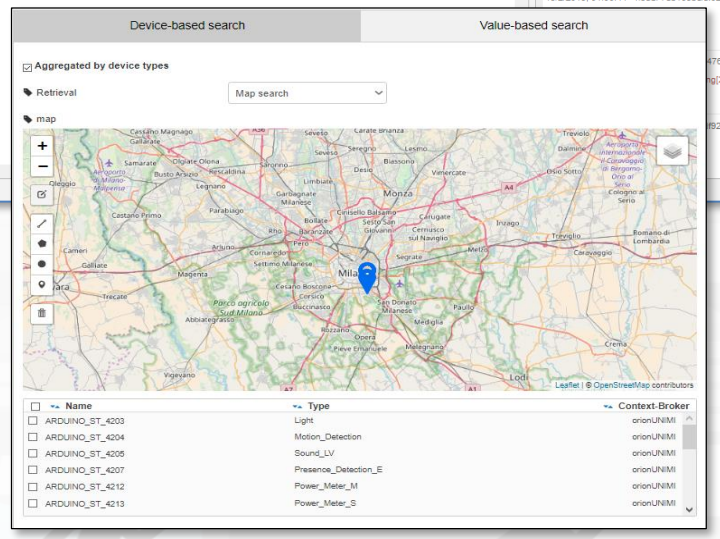
- Just Buy an IOT Device and register: SigFOX, MQTT, FiWare, …..
  - Attach them by
    - Models
  - A range of protocols, formats, approaches
- Create your own devices:
  - Arduino,
  - Raspberry,
  - Android,
  - LoraWAN + Arduino,
  - etc.

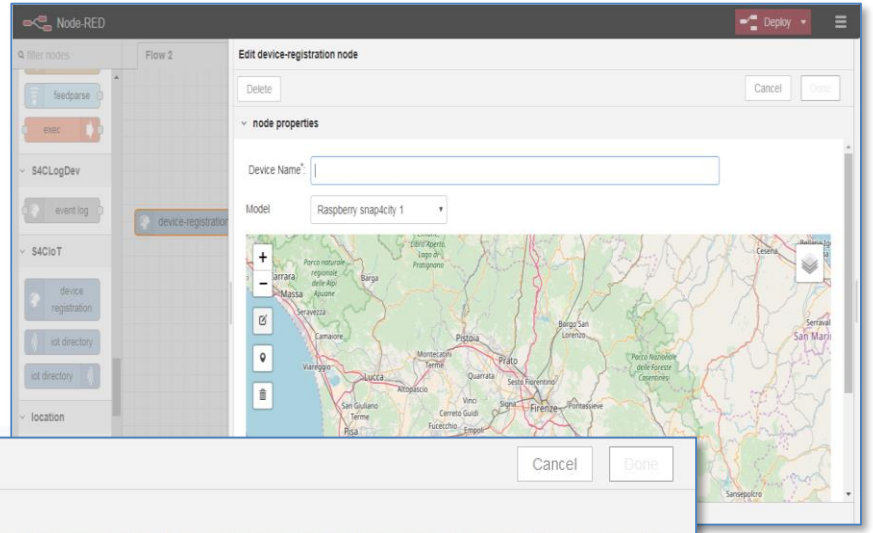


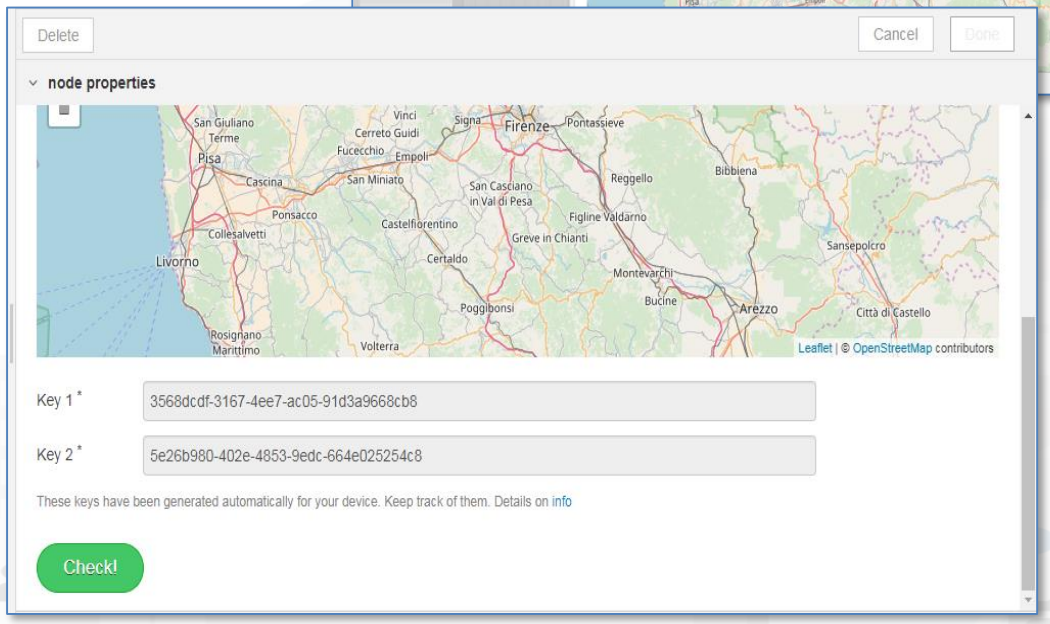
Secure Communication:
HTTPS, TLS (K1, K2)

IOT Discovery









Custom IOT Edge, and IOT Devices

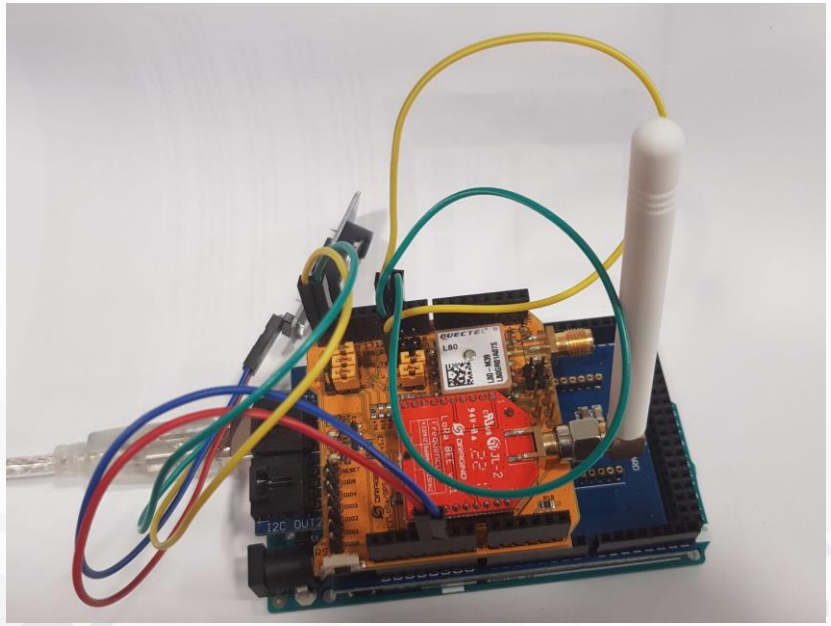


SigFOX
Arduino



Sensors/
Actuators

LoraWAN + Arduino + I2C

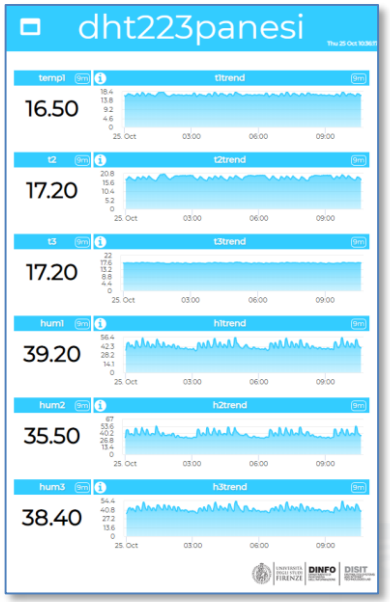


IOT Edge NodeRED:
Raspberry

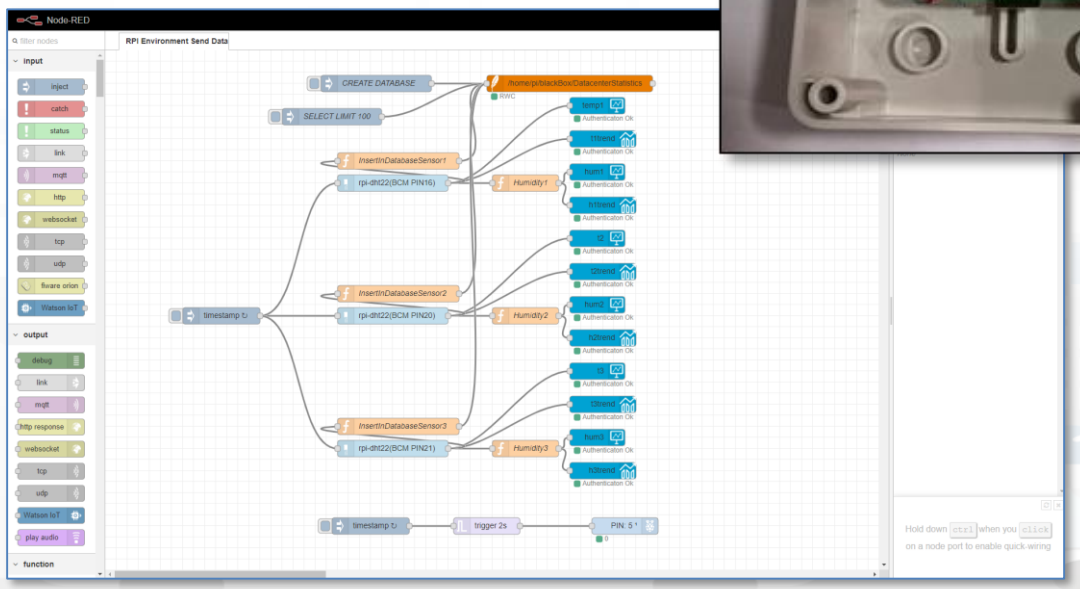


IOT Edge on Raspberry

- Raspberry Pi
- Mutual Authentication secure encrypted certified connection
- IOT Application inside
- Any sensor
- Any protocol from IOT devices
- NGSI or any other protocol
- Fully Customizable
- Local and Cloud Dashboard

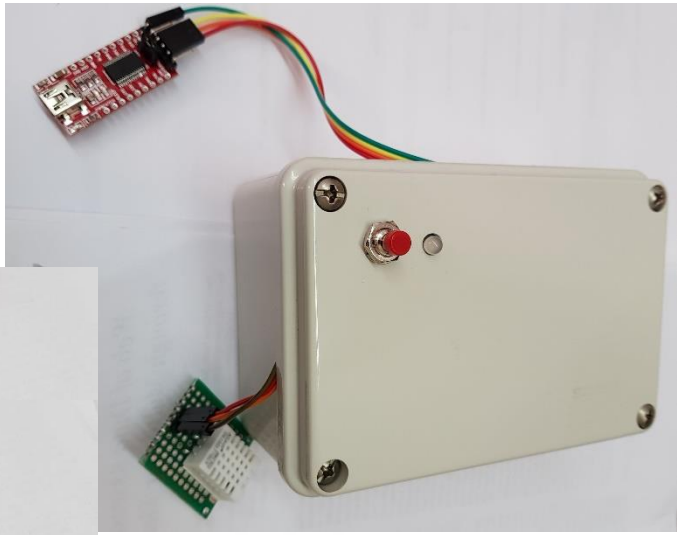


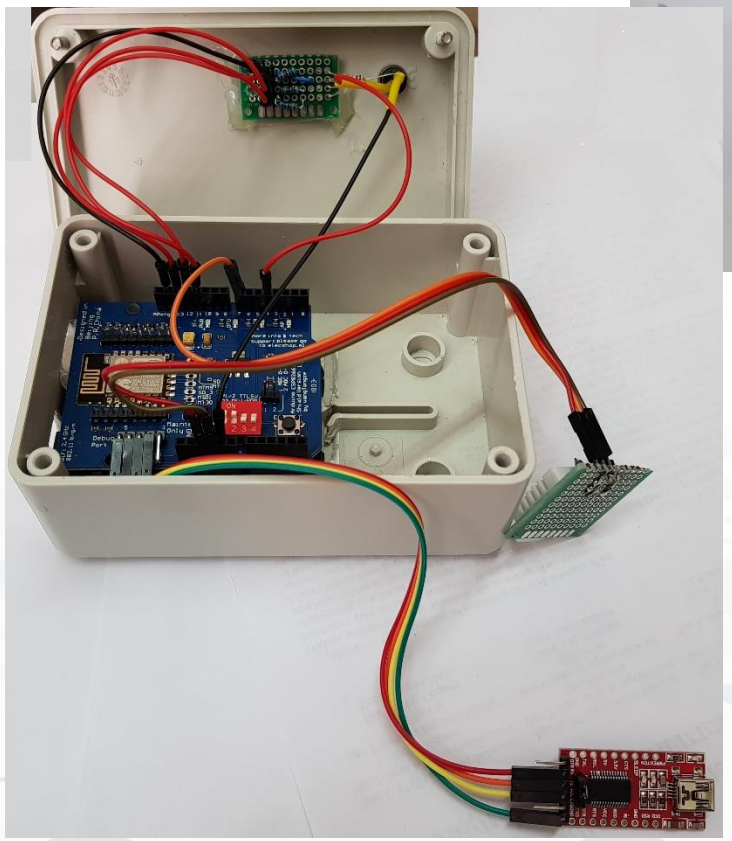




IOT Device with Arduino

- Arduino
- Wifi shield
- Mutual Authentication secure encrypted certified connection
- Any sensor
- NGSI or any other protocol
- Fully Customizable





Snap4All IOT Button

- Mutual Authentication secure encrypted certified connection, NGSI
- Fully Customizable
- Multi Wi-Fi
- Two versions: 1 and 2
- ESP based
- Very cheap
- low/no energy consumption in standby





version: 1

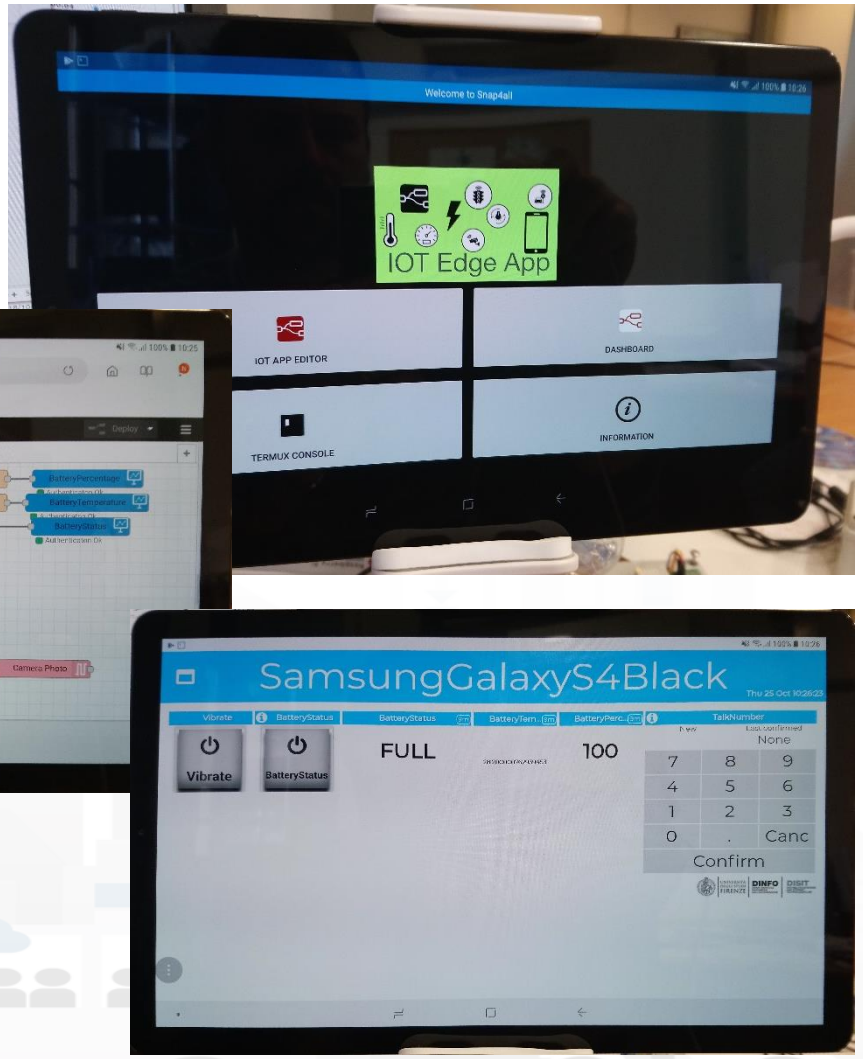


version: 2

https://www.snap4city.org/drupal/node/276

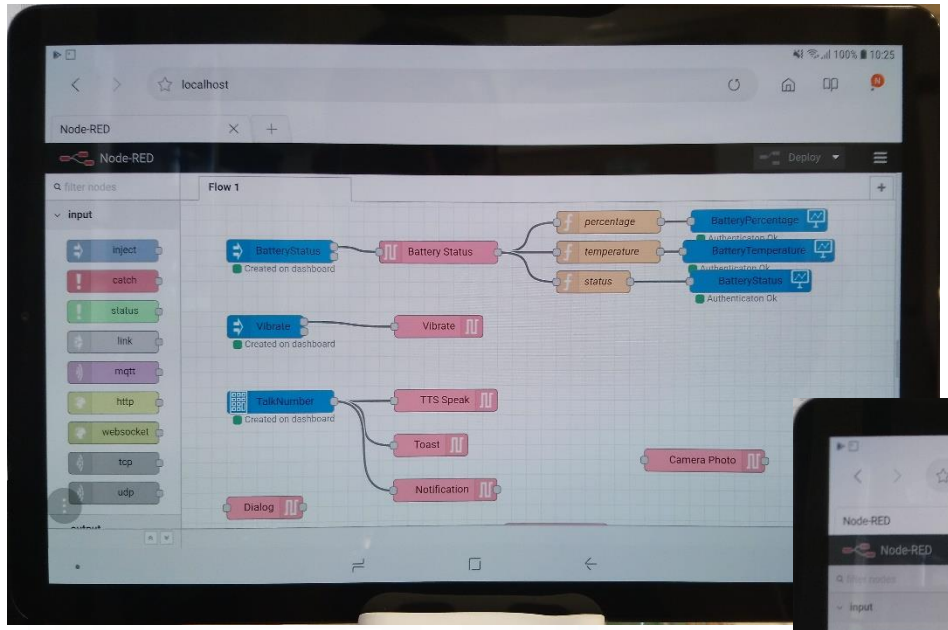
IOT Edge Snap4All App for Android

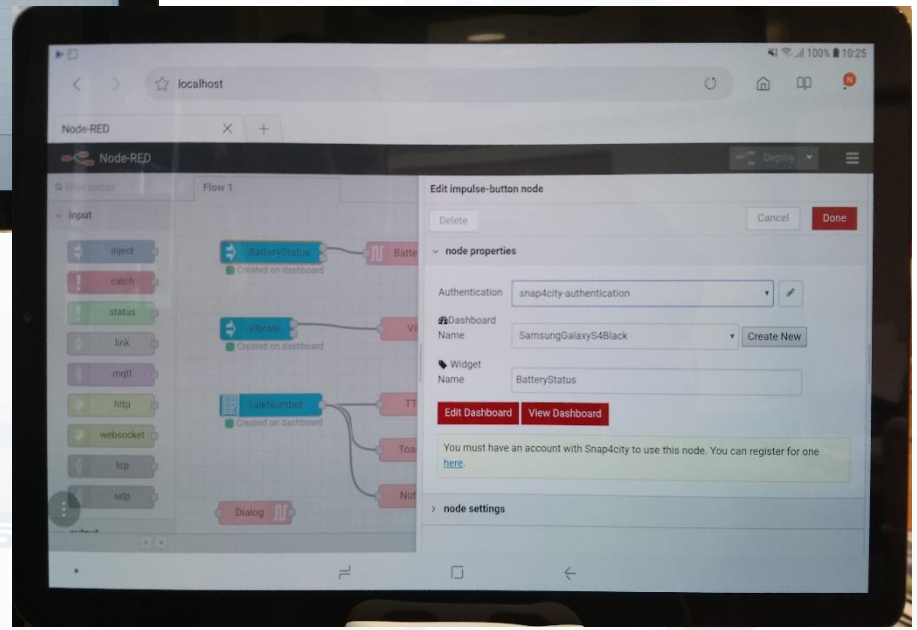
- Android, any version
- App from: https://www.snap4city.org/download/video/Snap4All.apk
- Mutual Authentication secure encrypted certified connection
- IOT Application inside
- Any sensor + Local device sensors
- Any protocol from IOT devices
- NGSI or any other protocol
- Fully Customizable
- Local and Cloud Dashboard



IOT Edge Snap4All App for Android

- termux-battery-status
- termux-camera-info
- termux-clipboard-get
- termux-contact-list
- termux-telephony-cellinfo
- termux-telephony-deviceinfo
- termux-tts-engines
- termux-camera-photo
- termux-clipboard-set
- termux-dialog
- termux-download
- termux-location
- termux-tts-speak
- termux-vibrate
- termux-sms-inbox
- termux-toast
- termux-sms-send
- termux-share
- termux-notification
- termux-wifi-connectioninfo
- termux-wifi-scaninfo





IOT Edge on the field

(0) Sensors & Actuators

(1) Registration

Raspberry pi

Sensors/ Actuators

Sensors/ Actuators

Sensors/ Actuators

-- PC: Win, Linux

Sensors/ Actuators

Sensors/ Actuators

Android

Sensors/Actuators

Internet

IOT Devices

IOT Edge
With IOT App distributed

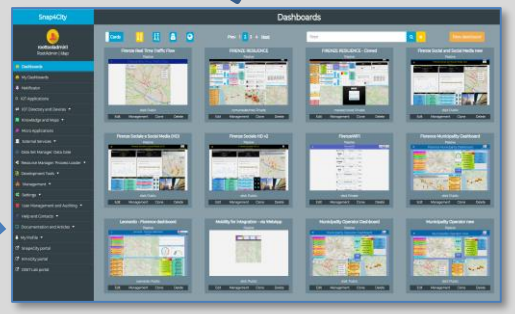
On Cloud

IOT Directory



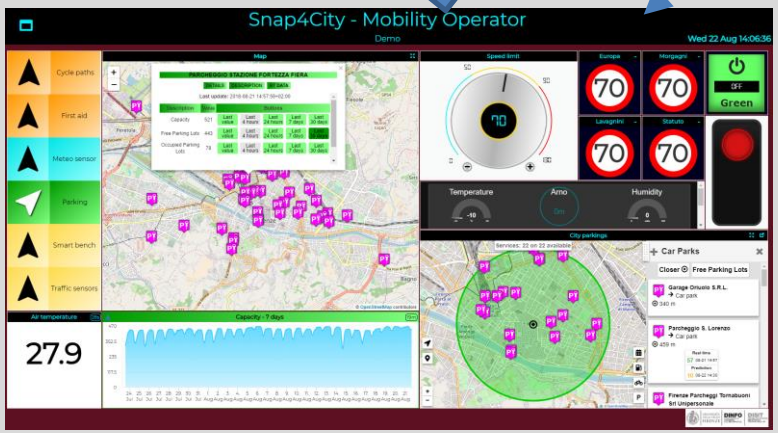
Other Connected IOT App

(2) Production of IOT App on IOT edge



(3) Production of Dashboard user interface

(4) IOT App and its Dashboard are executed

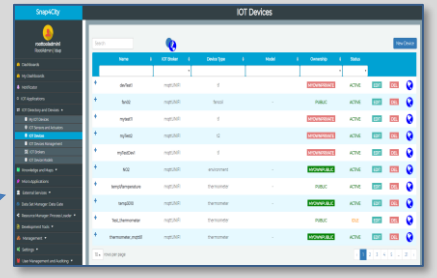


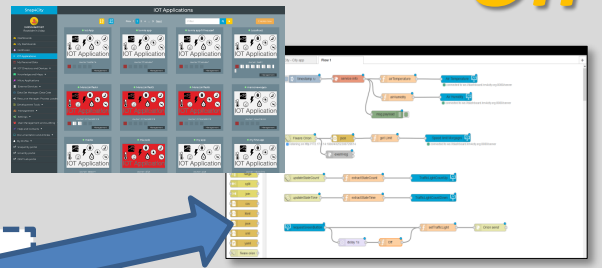
IOT App can be executed on IOT Edge and/or on Cloud. MicroServices calling Dashboards, Storage and Analytics are executed on Cloud.

IOT/IOE on the field

On Cloud

IOT Directory

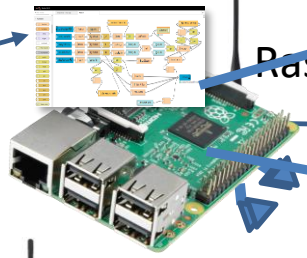




Other Connected IOT App

(0) Sensors & Actuators

(1) Registration



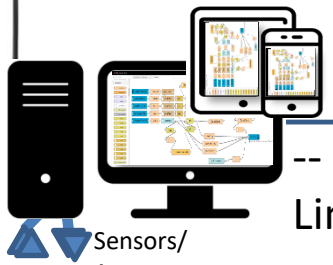
Raspberry pi

Sensors/ Actuators

Sensors/ Actuators

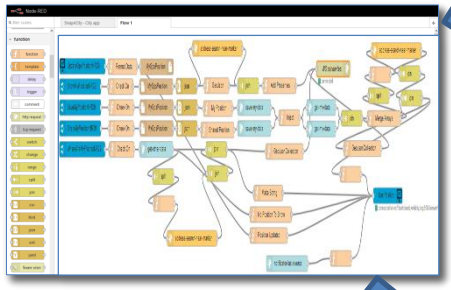
Sensors/ Actuators

Sensors/ Actuators

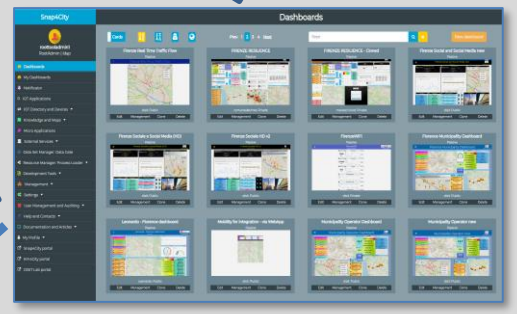


-- PC: Win, Linux

Internet



(2) Production of IOT App on IOT edge



IOT Edge With IOT App distributed

(4) IOT App and its Dashboard are executed

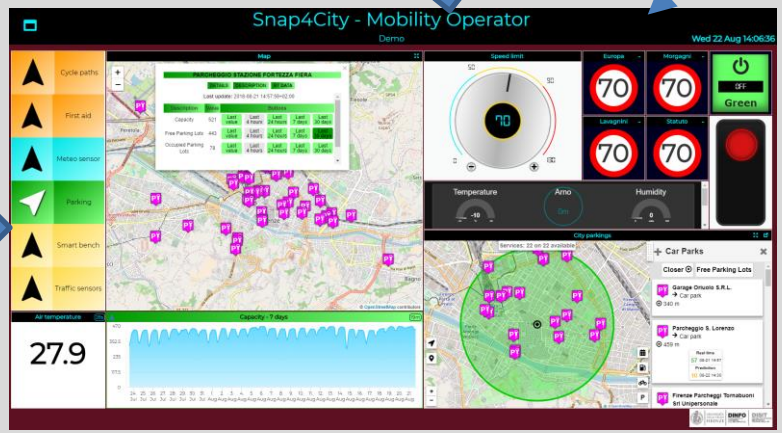
(3) Production of Dashboard user interface

Sensors/ Actuators



IOT Button

IOT Brokers





Mobiles

IOE Devices

Sensors/Actuators

IOT App can be executed on IOT Edge and/or on Cloud. MicroServices calling Dashboards, Storage and Analytics are executed on Cloud.

Supporting the Analysis of Smart City Data



Course Segments

- Qualification of the speaker
- Cloud-based Infrastructures for Smart Cities
- IOT Registration and Management
- Supporting the Analysis of Smart City Data
- From Data to Applications and Dashboards



Course Segments

- **Supporting the Analysis of Smart City Data**
  - Computational Requirements for Smart City
  - IOT Applications VS Data Analytics: MicroServices, External Services, legacy integration, etc.
  - Managing Data Analytics tools: processes vs Containers
  - IOT Applications on cloud and MicroServices
  - Data Analytics: predictions and anomaly detection
  - Examples of Data Analytics: predicting parking
  - Traffic flow reconstruction
  - Social Media Analysis.

Computational Requirements for Smart City



Computational Requirements

- **Managing:**
  - **Periodic Processes** → ETL, IOT App (Node-RED)
  - **Asynchronous processes**, data driven, real time → Node-RED, IOT Applications
- **Scalability**
  - Horizontal
    - Increasing processes performing activities, demand on new processes for new users, for new applications, for new IOT applications: VM, Hosts, clusters, Storage SAN
  - Vertical
    - Increasing resources on processes: CPU, MEM, Storage, Network

Robustness and Resilience

- Means that the solution has to be robust with respect to failure regarding:
  - Hosts, VM, applicative services (web server, Vhost manager, WS server, ….)
    - **Technologies:** HA, DRS, FT at level of Cloud, and when possible
  - Processes (ETL, Data Analytics), IOT Applications (containers), Connections
    - **Technologies:** Recovering from failure on the other levels

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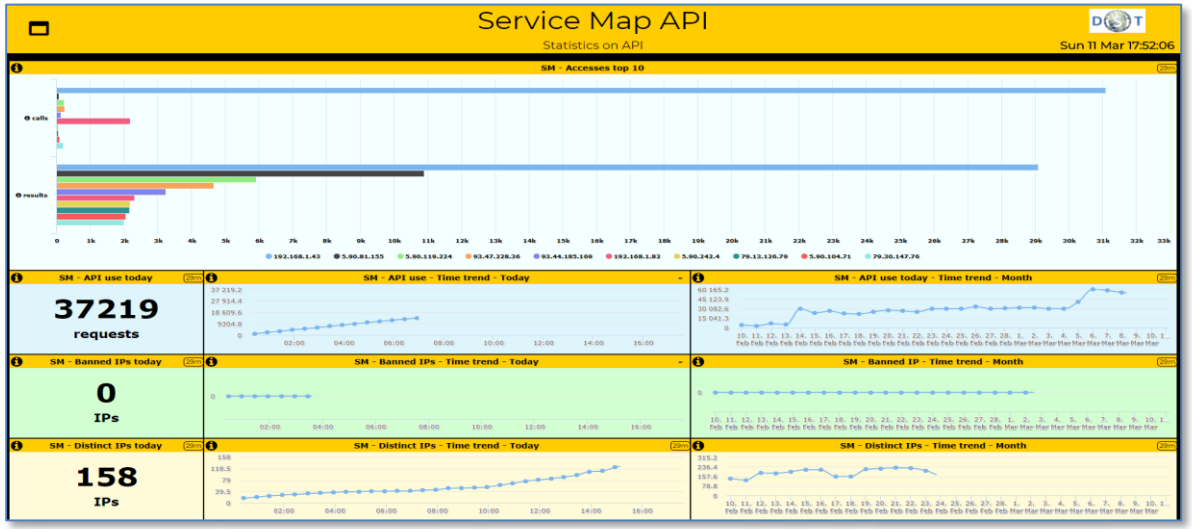
http://www.disit.org

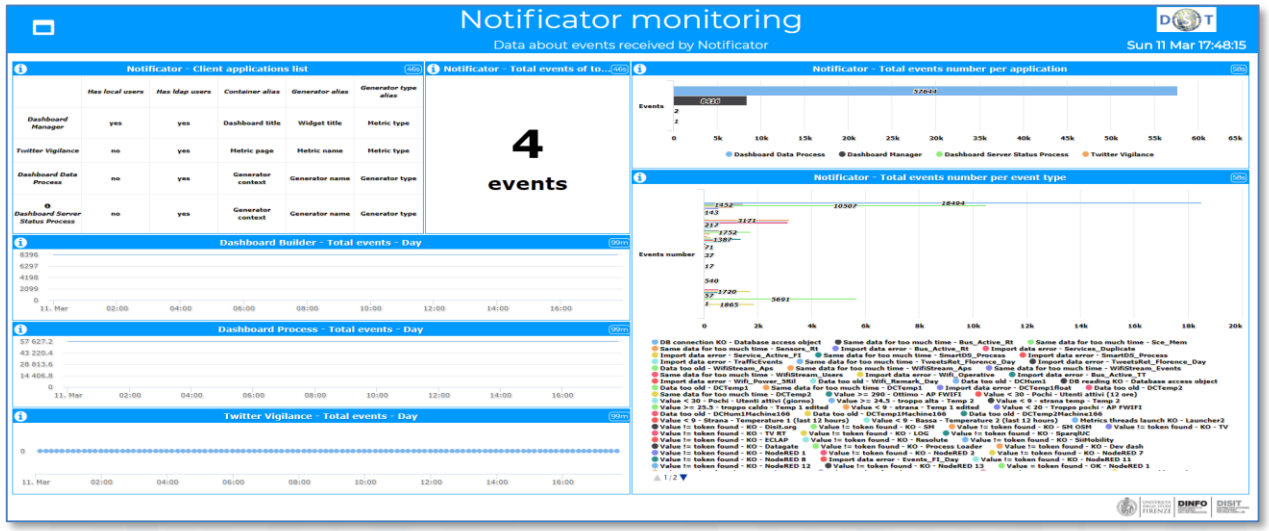
SNAP4CITY

Figura 2.1.1e
Strumenti di monitoraggio dei servizi e delle API

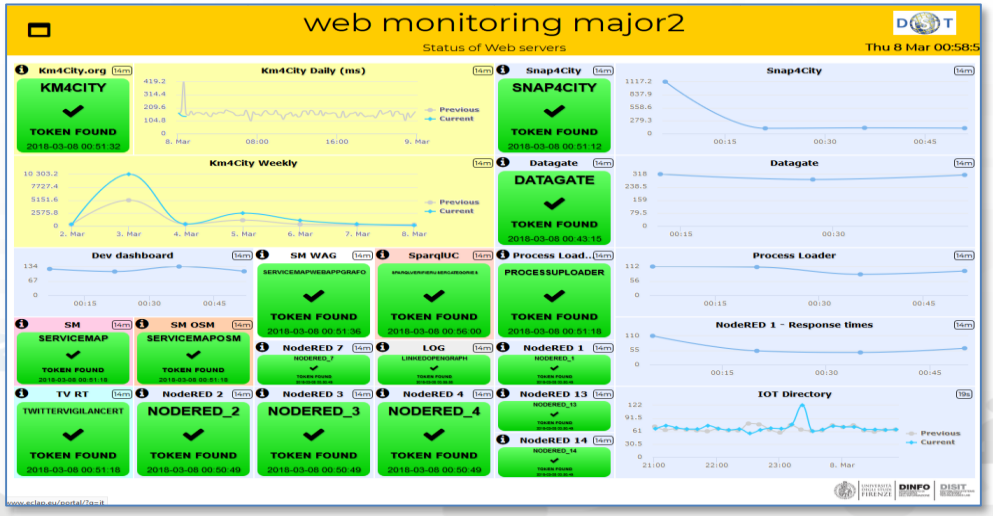
http://www.disit.org/dashboardSmartCity/view/index.php?iddasboard=MTkw



http://www.disit.org/dashboardSmartCity/view/index.php?iddasboard=MTQ4



http://www.disit.org/dashboardSmartCity/view/index.php?iddasboard=MjQ5



Cloud Resource Manager Snap4City

TIME WINDOW — TIMEPICKER

5m | 10m | 15m | 1h | 3h | 6h | 12h | 24h | 7d | 30d | 90d | 1y | 5y

Relative | Absolute | Since | Auto-refresh

(1)

SEARCH — QUERY

:

(2)

TOTAL HITS — HITS

16,308

(4)

COUNT VM — HITS

16,308.000

FILTERING

time must

field : date10m
from : NOW/HOUR-24HOUR
fromDateObj : 17/2/2018 16:24:14 GMT+0100
to : NOW/HOUR+1HOUR
toDateObj : 18/2/2018 16:24:14 GMT+0100

(3)

FACET

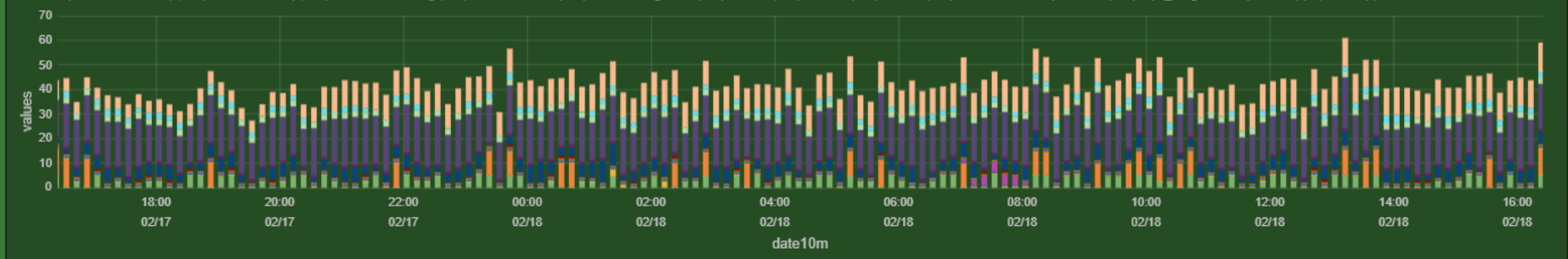
Facet Fields

- name
- group
- ip
- host

(5)

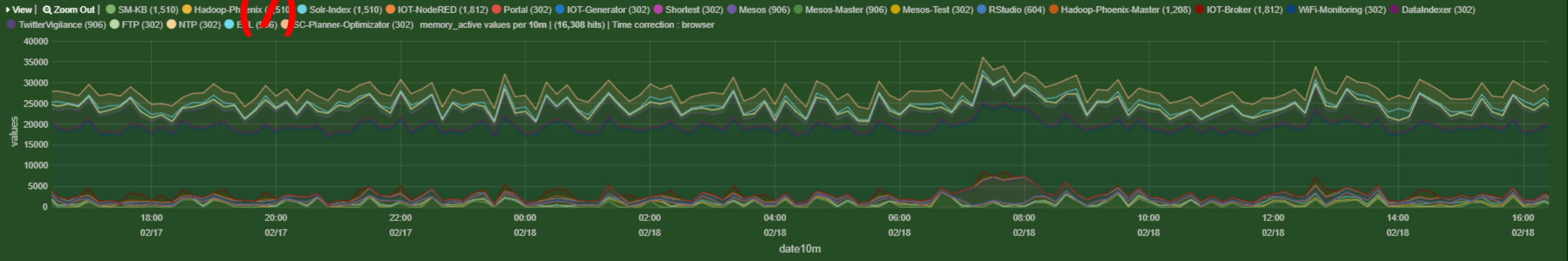
CPU USAGE — HISTOGRAM

(6)



MEMORY — HISTOGRAM

(7)



DISK READ — HISTOGRAM

(8)



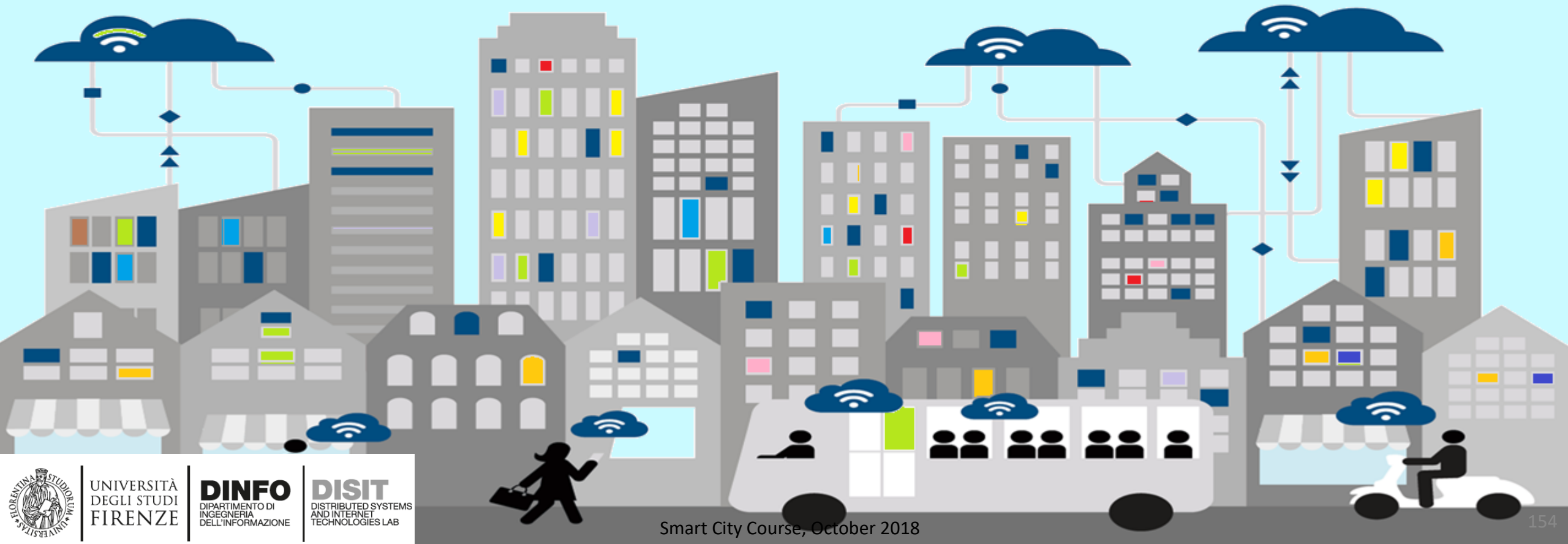
IOT Applications VS Data Analytics: MicroServices, External Services, legacy integration, etc



Course Segments

- **Supporting the Analysis of Smart City Data**
  - Computational Requirements for Smart City
  - IOT Applications VS Data Analytics: MicroServices, External Services, legacy integration, etc.
  - Managing Data Analytics tools: processes vs Containers
  - IOT Applications on cloud and MicroServices
  - Data Analytics: predictions and anomaly detection
  - Examples of Data Analytics: predicting parking
  - Traffic flow reconstruction
  - Social Media Analysis.

Level 3 users



Level 3 user: add personal devices and create Dash

- With Smart city data and information +
- Personal IOT/IOE, which can be registered and created

IOT and City data World



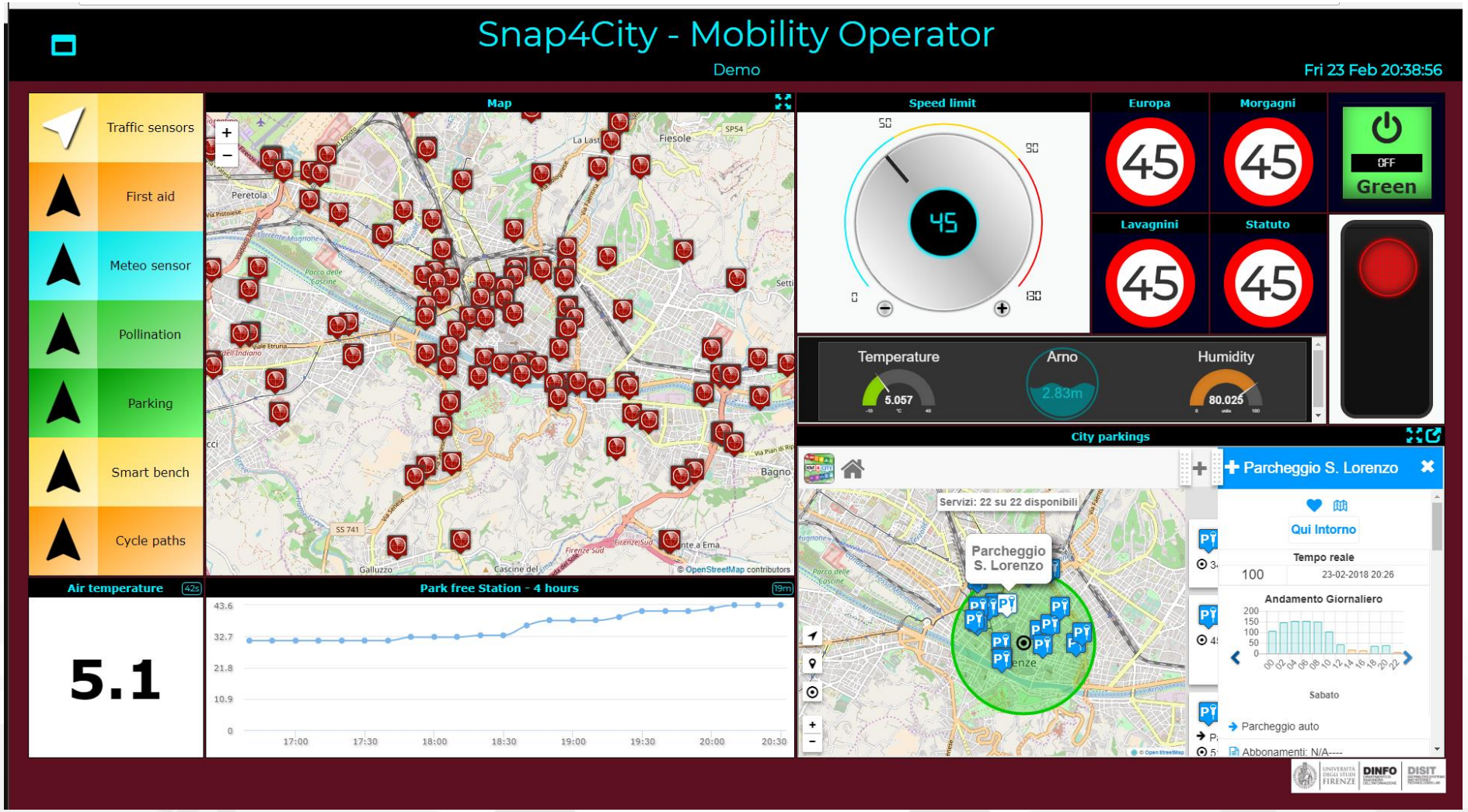
My Dashboard

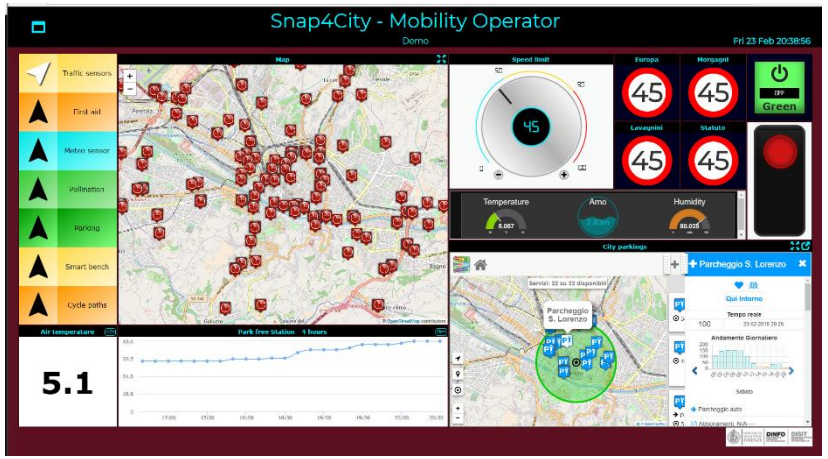


Registration of My IOT Devices

Dash with city data and your data/actuators

- Sensors
  - Values
  - status
- Actuators:
  - Buttons
  - Dimers
  - Etc.



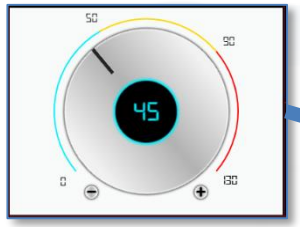


Dashboard vs IOT Devices

Dashboards also provide rendering for actuator-sensor values

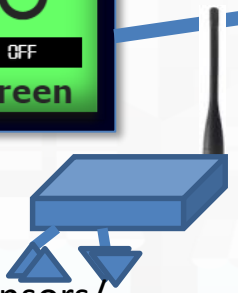


Snap4city Platform



Actuator device on Dashboard are regarded as Virtual Sensors





Sensors/ Actuators

From any IOT Device and/or Dashboard

Snap4City IOT Brokers

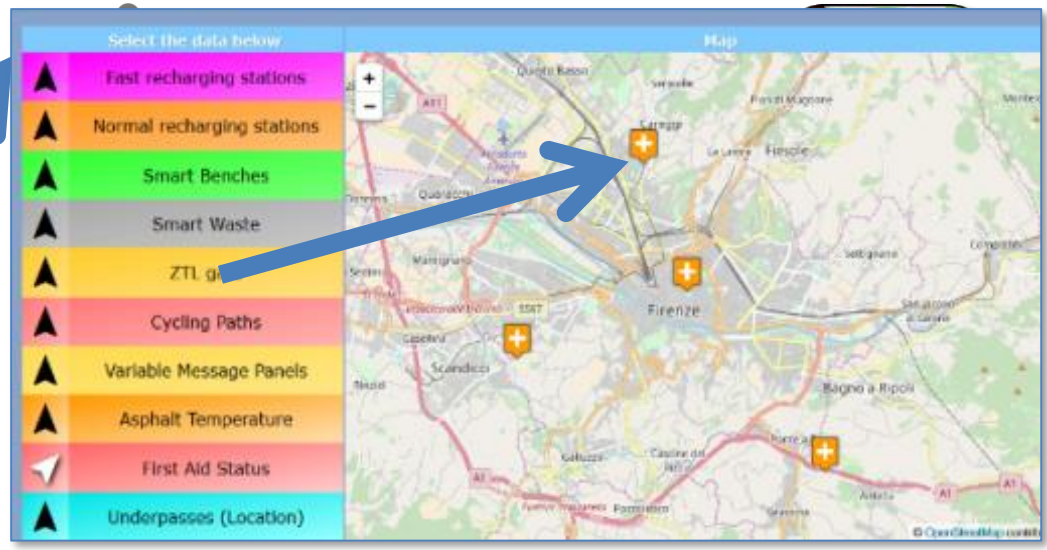
Managing Public and Private IOT/IOE Devices

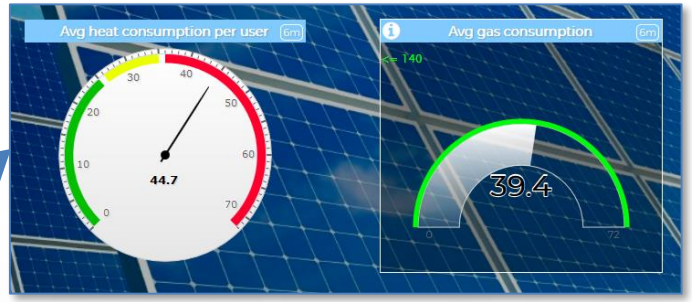
Towards any IOT Device and/or Dashboard

Data Kinds vs Widgets:

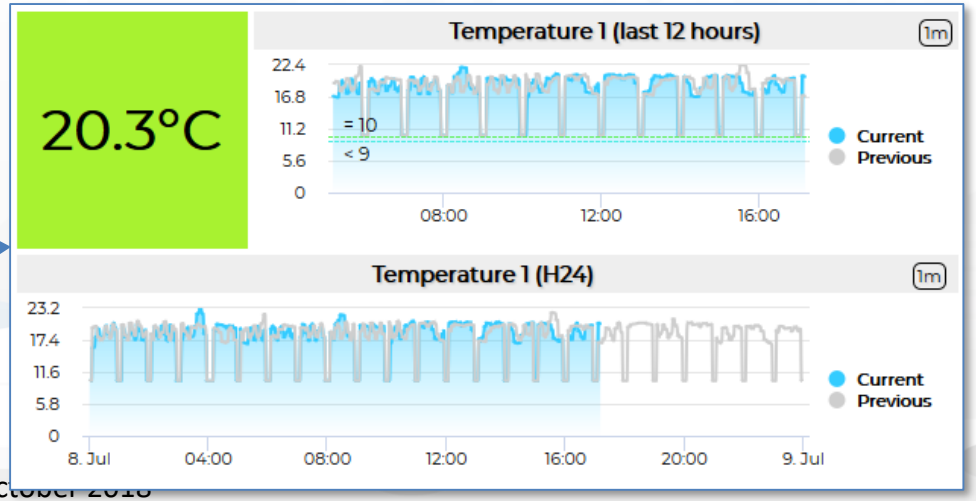
- Complex Event
- External Service
- MicroApplication
- Special Widget
- POI, Point of Interest
- KPI, Key Performance Indicator
- Sensor
- Sensor-Actuator
- **My Personal Data**
- Dashboard-IOT App

MyPersonalData

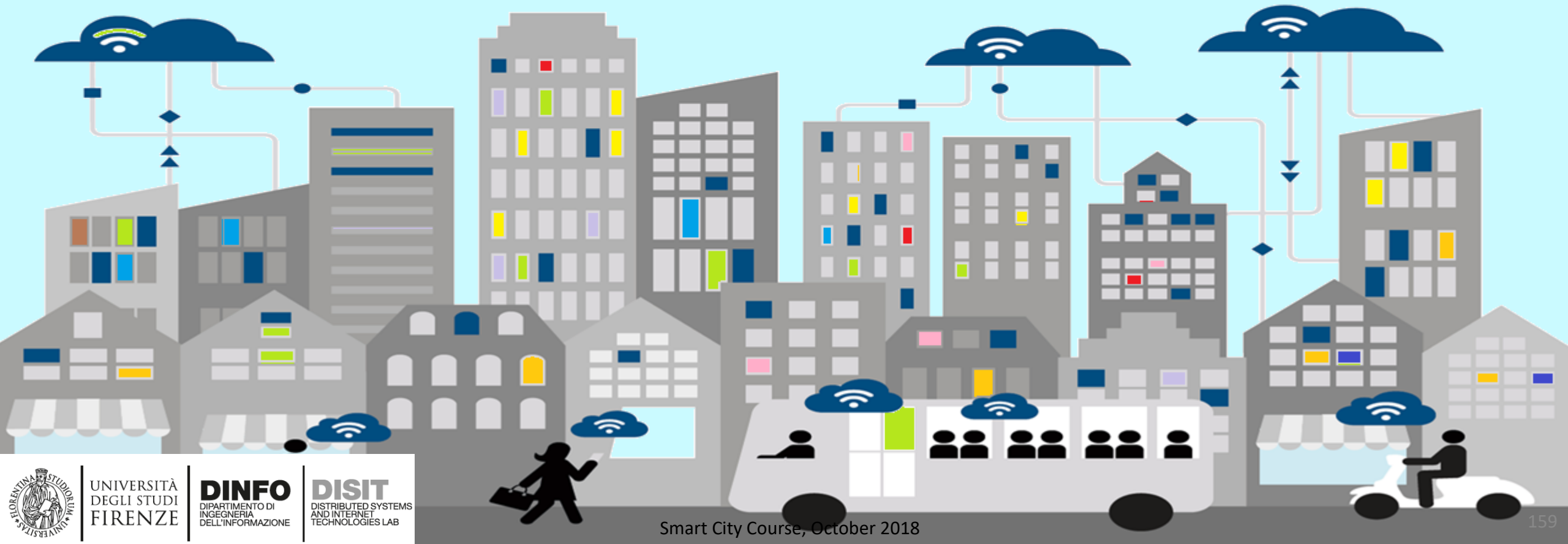




Real Time
Event Driven
Historical Data



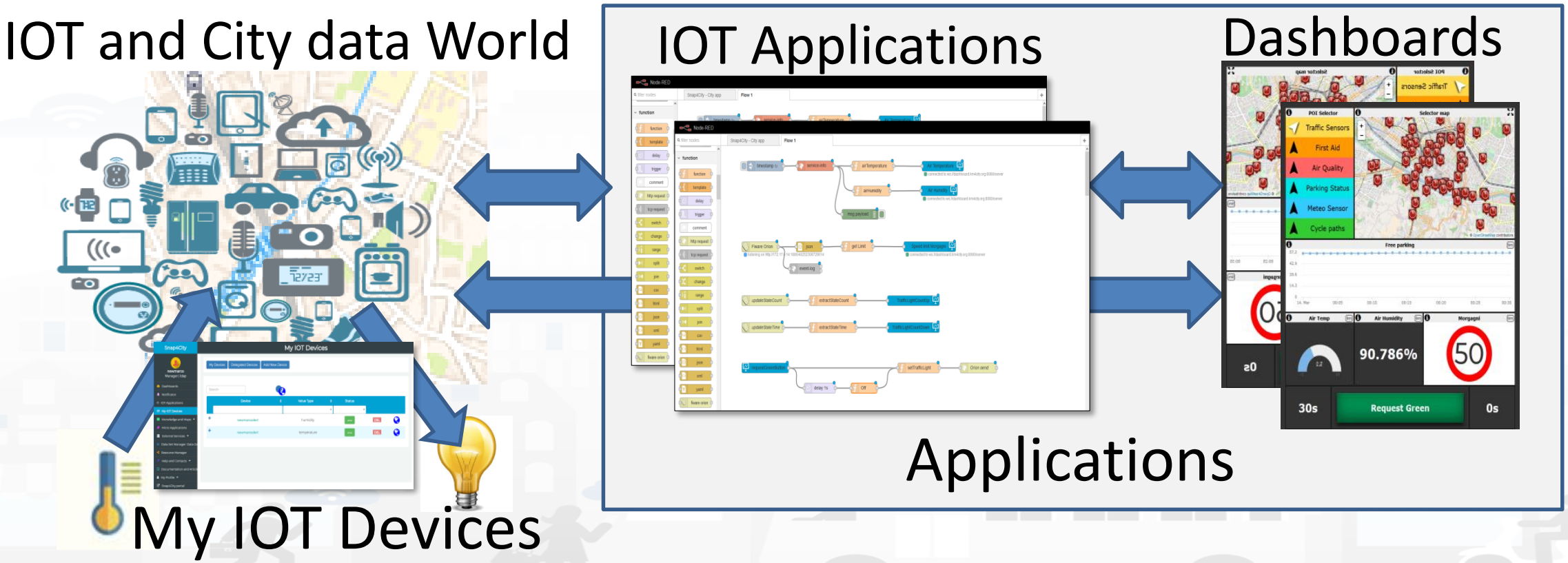
Level 4 users



Level 4 users: dashboard with intelligence App

- Dashboards with IOT Applications for enforcing smart and intelligence into them.

Dashboard-IOT App



IOT Applications

Snap4City

roottooladmin1
RootAdmin | ldap

- Dashboards
- My Dashboards
- Notificator
- IOT Applications
- My Personal Data
- IOT Directory and Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles
- My Profile
- Snap4City portal
- Km4City portal
- DISIT Lab portal

Prev 1 2 3 4 ... 9 Next

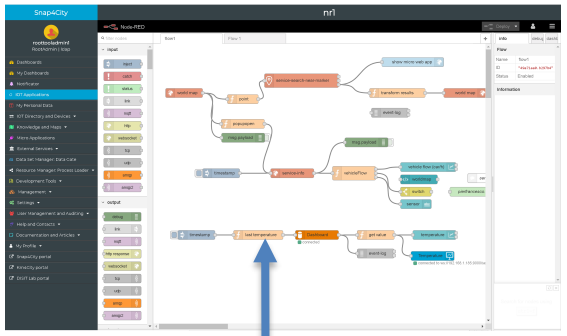
Filter

Create new

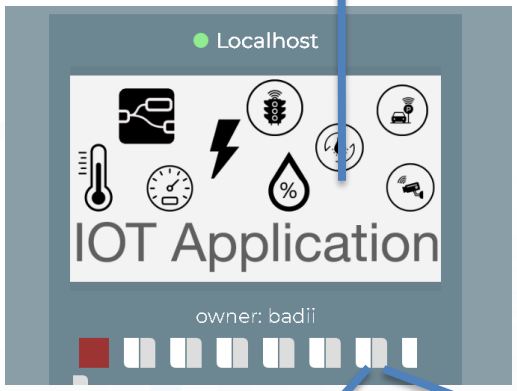
Iot-App owner: tester14 Management	la mia app owner: finaluser1 Management	la mia app fi finauser1 owner: finaluser1 Management	Localhost owner: badii Management
MarazziniTest4 owner: mmarazzini2 Management	MarazziniTest5 owner: mmarazzini2 Management	MarazziniTest6 owner: mmarazzini2 Management	marconewappa owner: newmarco Management
media owner: tester11	mia solo owner: disit	my app owner: pb3	my first app owner: newpiero

IOT Applications

- Basic / Advanced
- On IOT Edge Raspberry
- On IOT Edge Android
- On IOT Edge Win/Linux



EDIT IOT APP



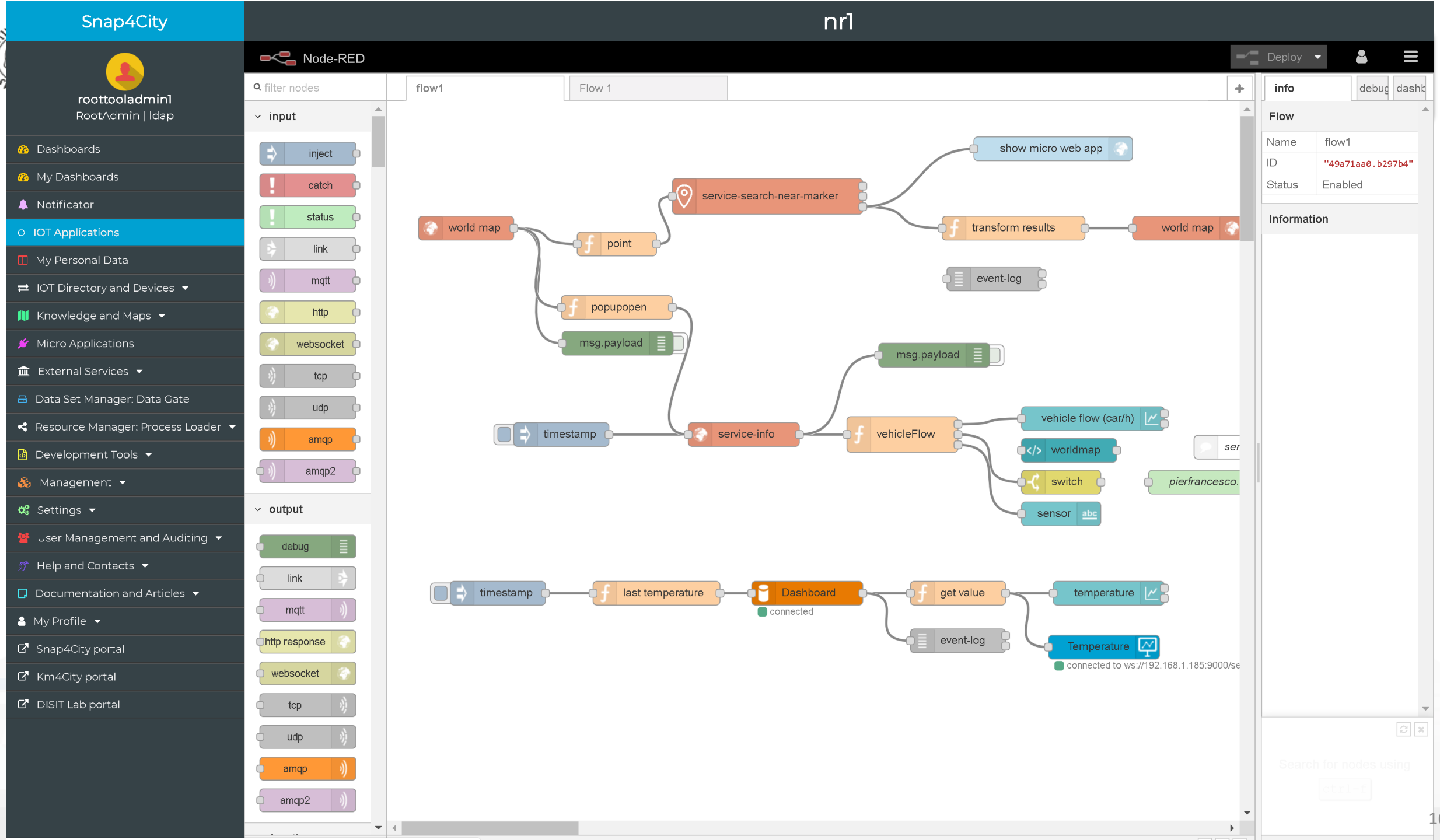
VIEW

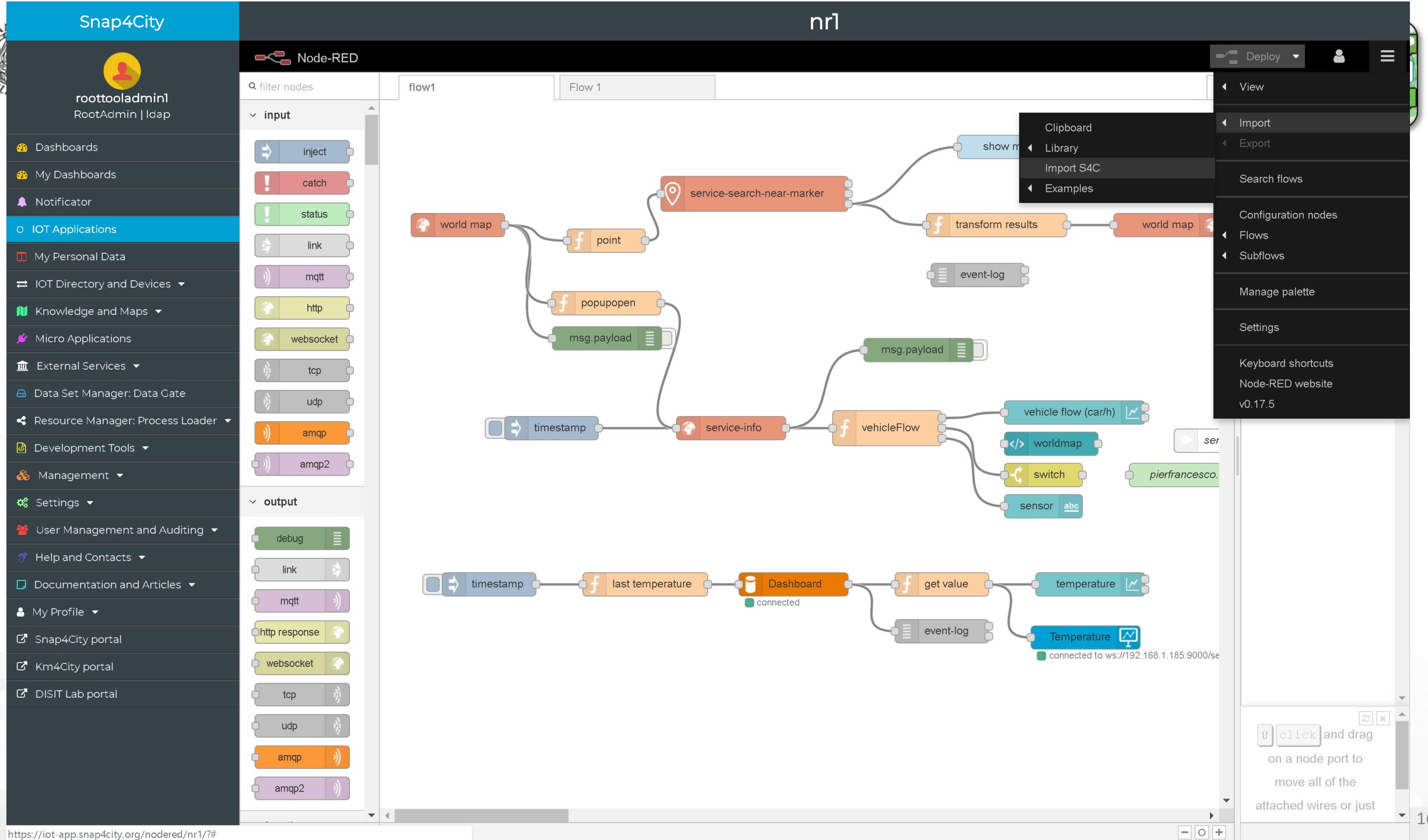
EDIT








Snap4City
nr1
roottooladmin1
RootAdmin | ldap
Dashboards
My Dashboards
Notificator
IOT Applications
My Personal Data
IOT Directory and Devices
Knowledge and Maps
Micro Applications
External Services
Data Set Manager: Data Gate
Resource Manager: Process Loader
Development Tools
Management
Settings
User Management and Auditing
Help and Contacts
Documentation and Articles
My Profile
Snap4City portal
Km4City portal
DISIT Lab portal
Node-RED
Deploy
filter nodes
input
inject
catch
status
link
mqtt
http
websocket
tcp
udp
amqp
amqp2
output
debug
link
mqtt
http response
websocket
tcp
udp
amqp
amqp2
flow1
Flow 1
world map
point
service-search-near-marker
show micro web app
transform results
world map
event-log
popupopen
msg.payload
msg.payload
timestamp
service-info
vehicleFlow
vehicle flow (car/h)
worldmap
switch
sensor
timestamp
last temperature
Dashboard
connected
get value
temperature
event-log
Temperature
connected to ws://192.168.1.185:9000/se
info
debug
dashb
Flow
Name
flow1
ID
"49a71aa0.b297b4"
Status
Enabled
Information


Snap4City
nr1
roottooladmin1
RootAdmin | ldap
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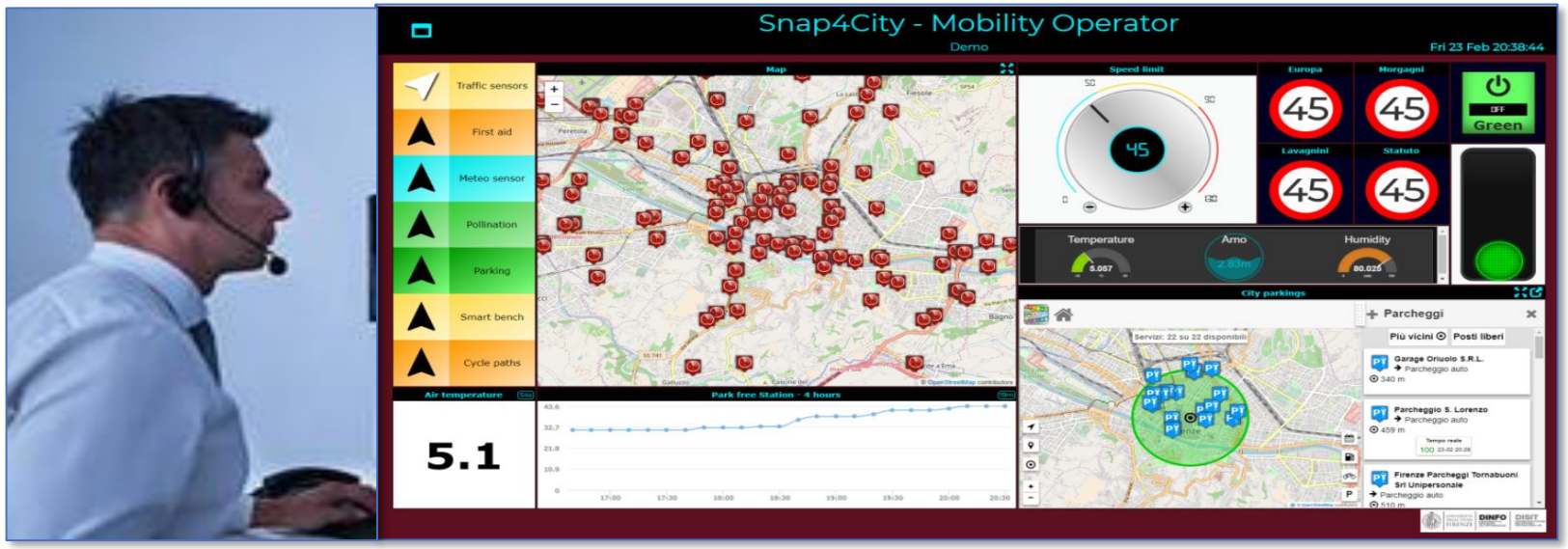
My Profile
Snap4City portal
Km4City portal
DISIT Lab portal
Node-RED
Deploy
filter nodes
input
inject
catch
status
link
mqtt
http
websocket
tcp
udp
amqp
amqp2
output
debug
link
mqtt
http response
websocket
tcp
udp
amqp
amqp2
flow1
Flow 1
world map
point
service-search-near-marker
transform results
world map
event-log
popupopen
msg.payload
msg.payload
timestamp
service-info
vehicleFlow
vehicle flow (car/h)
worldmap
switch
sensor
timestamp
last temperature
Dashboard
connected
get value
temperature
event-log
Temperature
connected to ws://192.168.1.185:9000/se
View
Import
Export
Search flows
Configuration nodes
Flows
Subflows
Manage palette
Settings
Keyboard shortcuts
Node-RED website
v0.17.5
Clipboard
Library
Import S4C
Examples
click and drag
on a node port to
move all of the
attached wires or just
https://iot-app.snap4city.org/nodered/nr1/?#

City Dashboard + IOT App

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

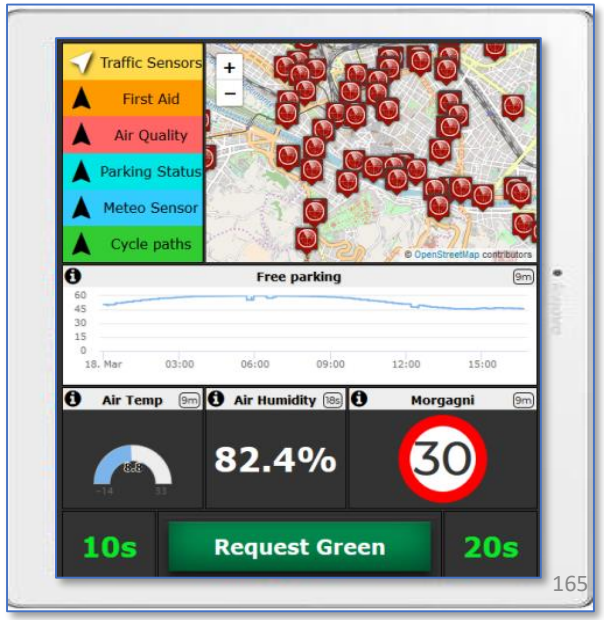


Driver, Policeman

Would like to:

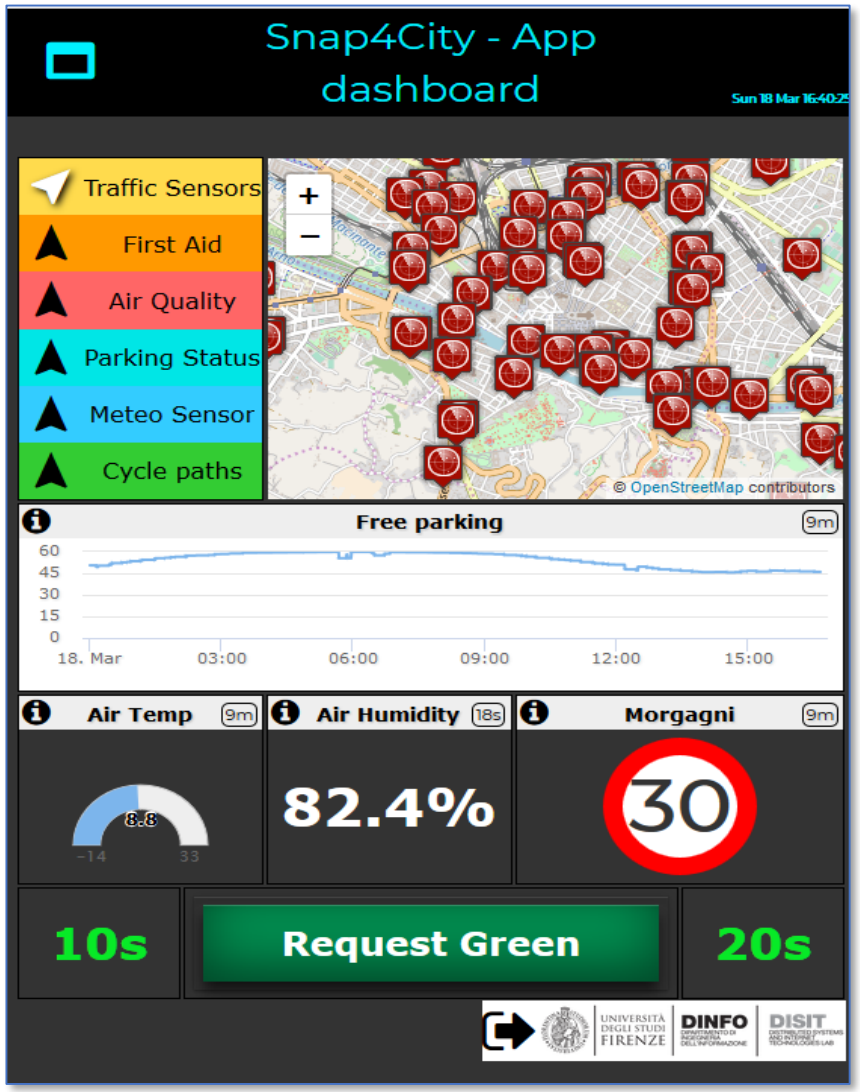
- Monitor traffic, Parking, env., speed limit, …
- **Act and** monitor red lights

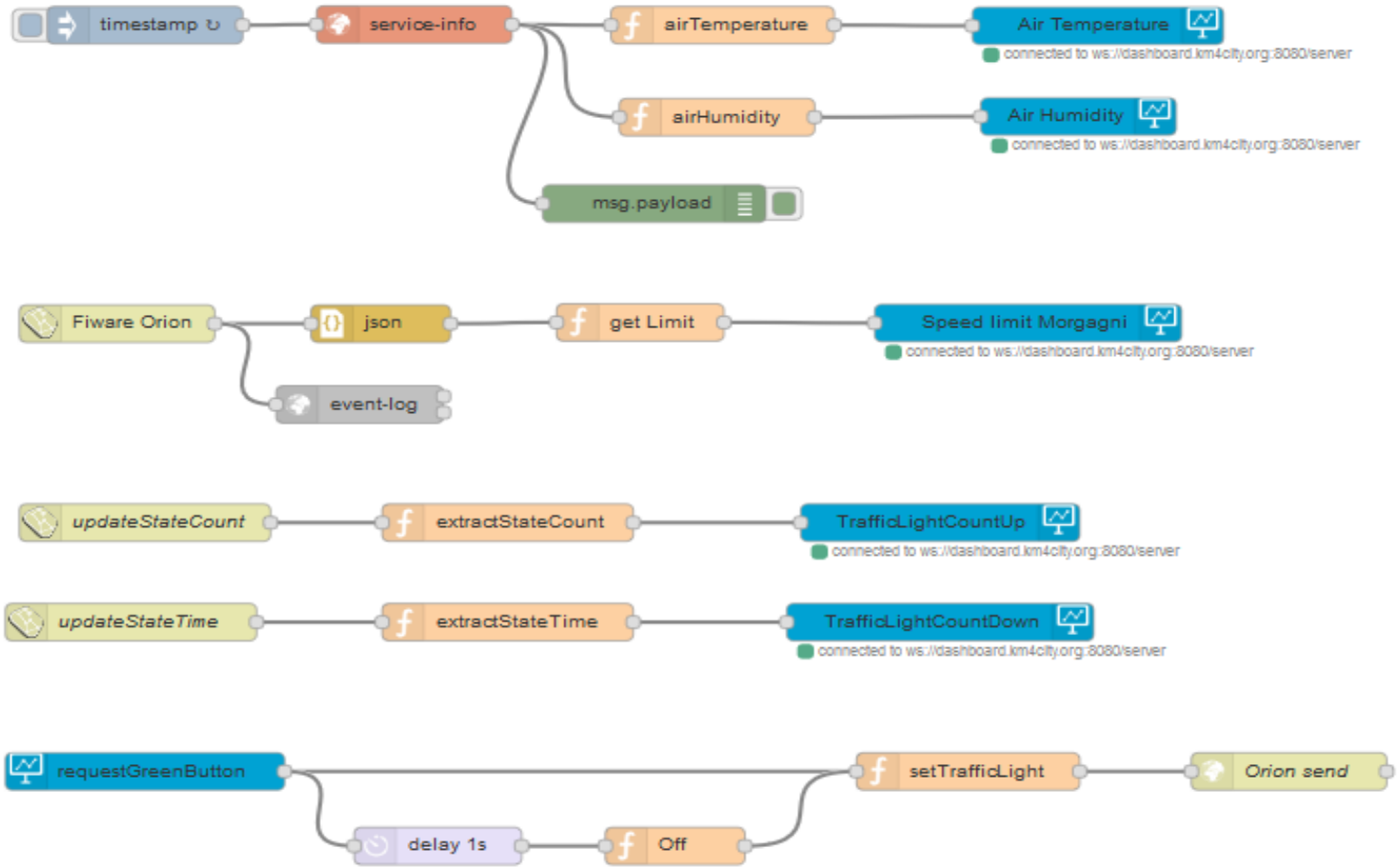


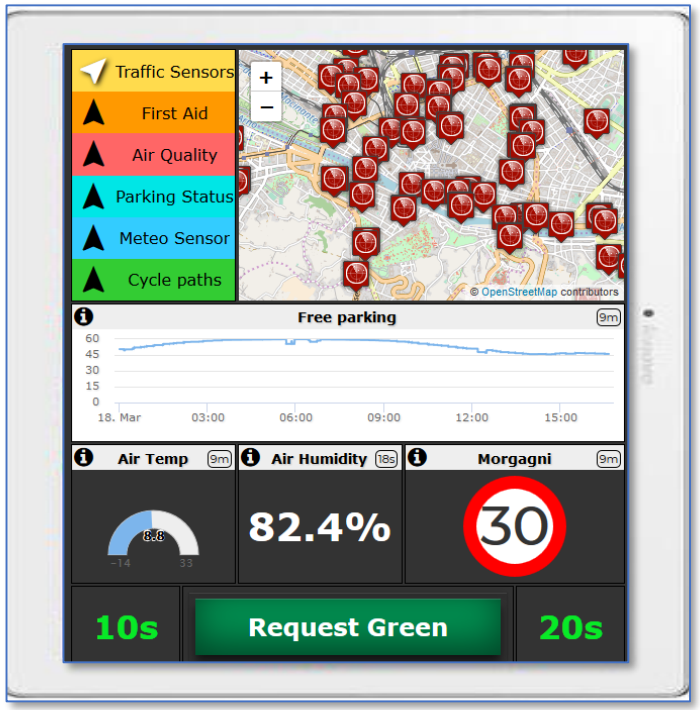


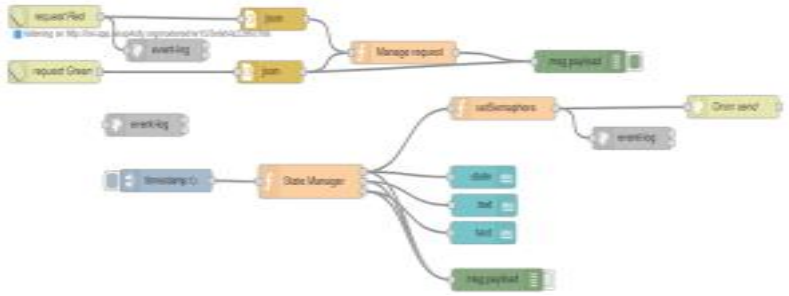
IOT Application with City Dash simpler development








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







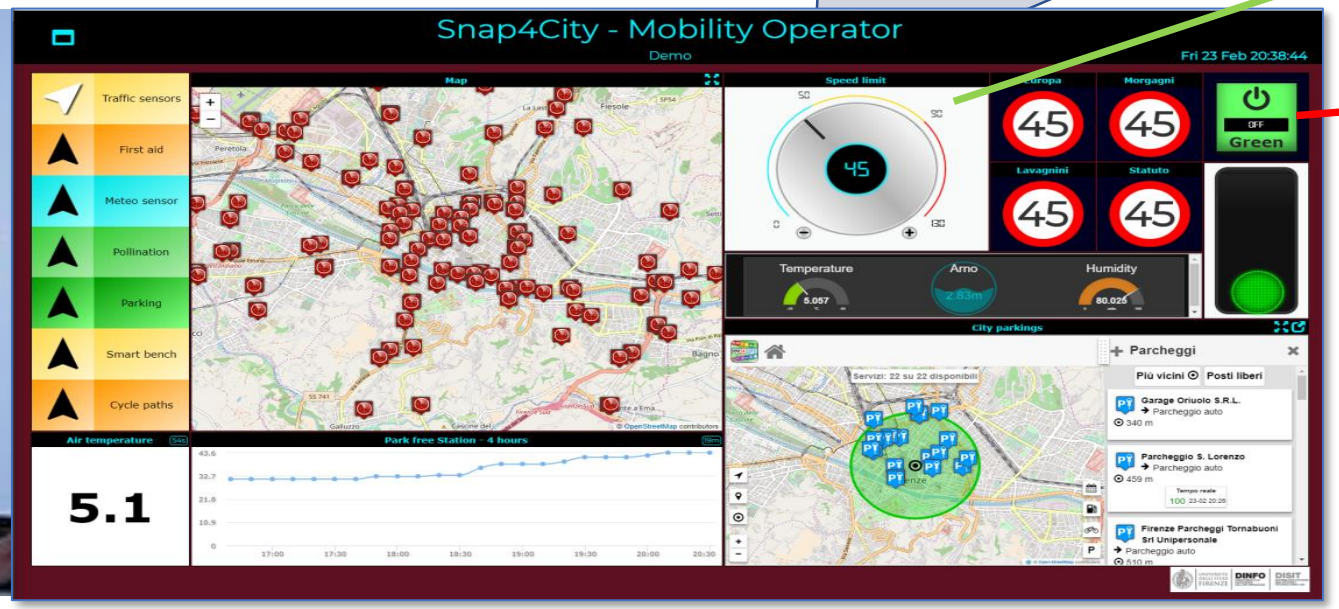


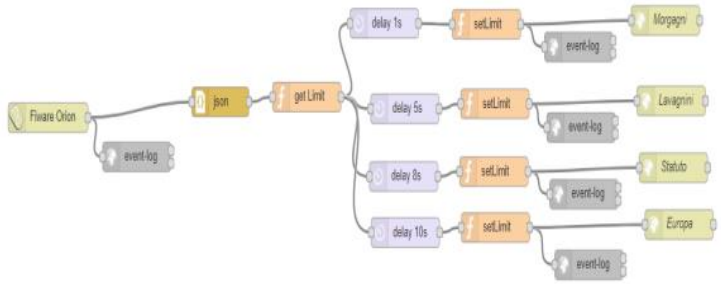









Snap4City - Mobility Operator
Demo
Fri 23 Feb 20:38:44
Traffic sensors
First aid
Meteo sensor
Pollination
Parking
Smart bench
Cycle paths
Map
Speed limit
Europa
Morgagni
Lavagnini
Statuto
45
OFF
Green
Temperature
Arno
Humidity
City parkings
Parcheggi
Air temperature
Park free Station - 4 hours
5.1

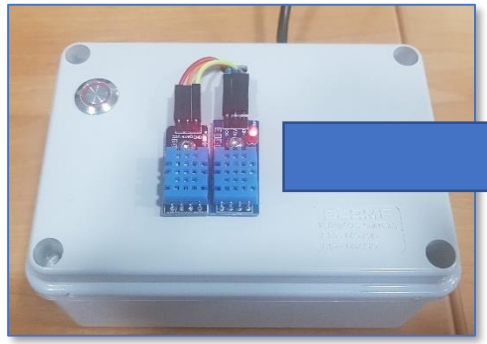

Fiware Orion
event-log
json
get Limit
delay 1s
delay 5s
delay 8s
delay 10s
setLimit
event-log
Morgagni
Lavagnini
Statuto
Europa

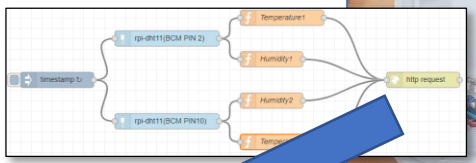
IOT Edge Computing

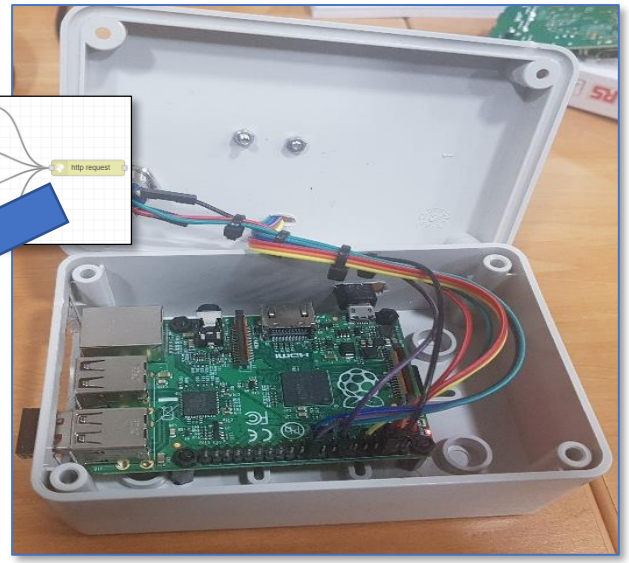
City user

Would like to:

- **Monitor and exploit temperature and humidity**
- **Manage sensors**
- **Perform edge computing**
- **Using these data for multiple applications**







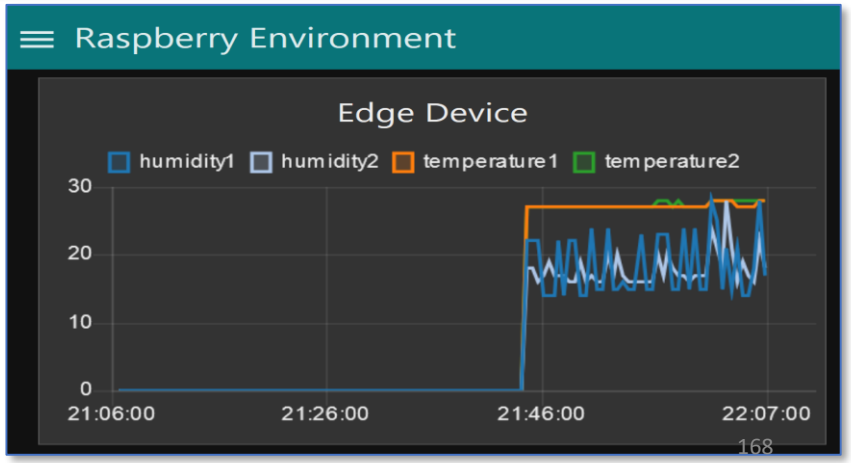
IOT Broker

Click here



Steps:

1. **Registering the device and sensors**
2. **Create flow on edge device using NodeRed with Snap4City, sending data to Broker**
3. **Use data from Broker on Snap4City IOT App**

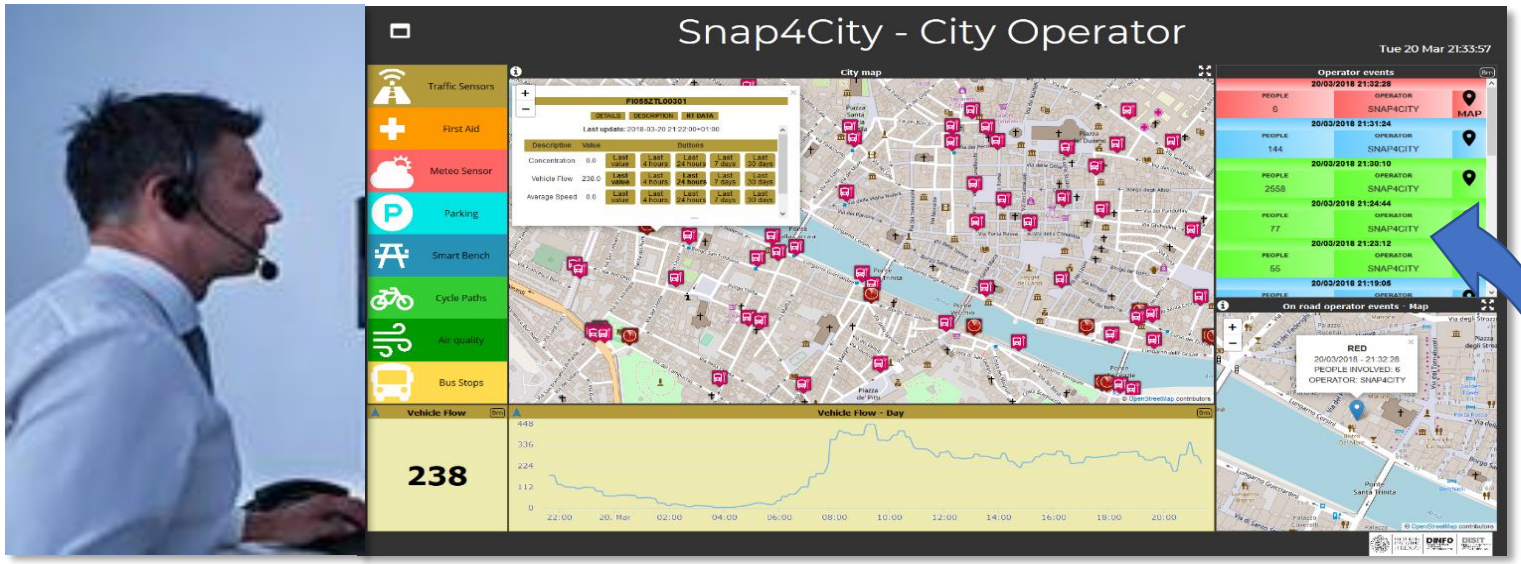


Reporting Critical Events

Control Room Operator

Would like to:

- **Monitor** events vs services in the city and receive critical event notifications from on the road operators.
- **Assess contextual condition,** services status



On the road operator

Would like to:

- Monitor traffic, Parking, env., speed limit, services,
- **Send critical event notifications via coded description**

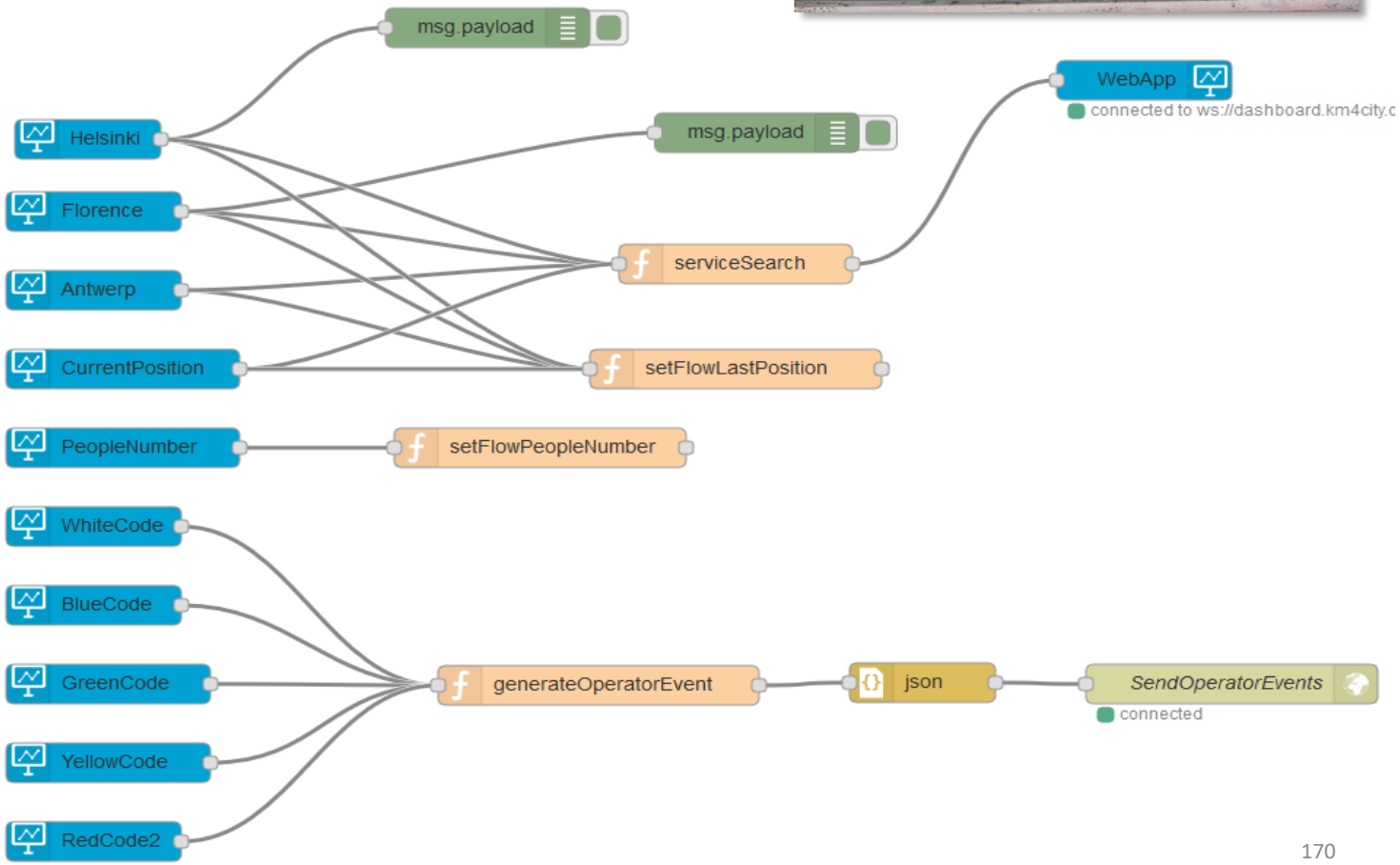




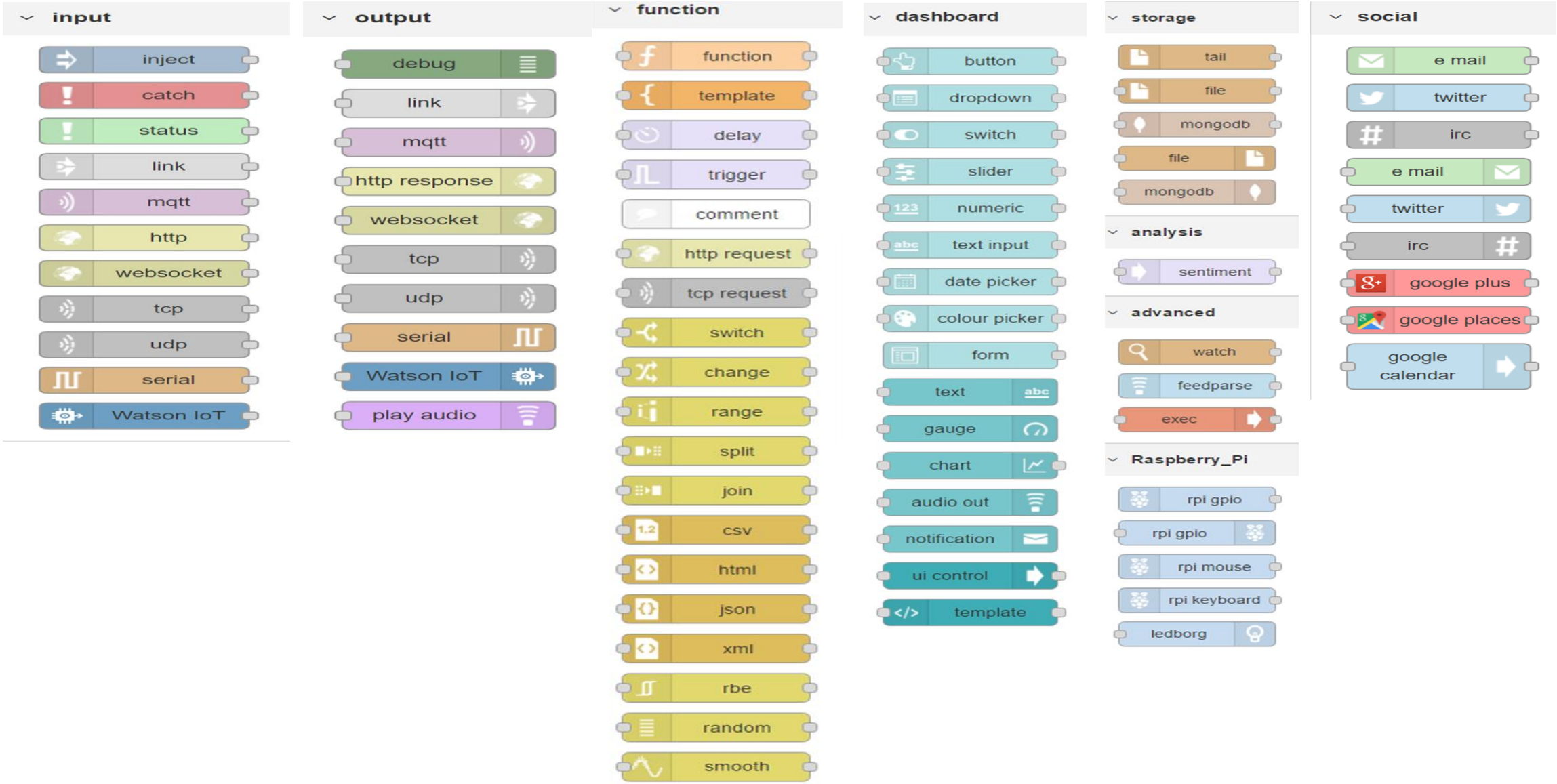
IOT Application with City Dash simpler development







Node.js Blocks on NodeRed SotA



Snap4City MicroServices: Basic

- S4CIoT
- S4CInfo
- S4CSearch
- S4CView
- S4CDataAnalytic
- S4CDashboard
- S4CSearchDev
- S4CInfoDev
- S4CLogDev
- S4CManagement
- S4CSearchExp
- S4CSearchUsr

fiware orion

fiware orion

ckants

- ckants insert
- ckants search
- ckants create

S4CIoT

- iot directory
- iot directory

S4CInfo

- service info
- tpl agencies
- tpl lines
- tpl routes by agency
- tpl routes by line
- tpl routes by stop name
- tpl routes by line stop name
- tpl stops by route

S4CSearch

- service search by queryid

S4CView

- show general iframe
- show micro web app

S4CDataAnalytic

- descriptive statistics
- trend plot
- time series predictions
- machine learning predictions

S4CDashboard

- city dashboard
- city dashboard
- geolocation

S4CSearchDev

- service search
- full text search dev
- event search dev
- address geometry search near gps position
- address poi search by text
- bus routes search

S4CInfoDev

- tpl routes
- tpl stops

S4CLogDev

- event log

S4CSearchExp

- service search near gps position
- service search near service
- service search within gps area
- service search within wkt area
- service search within stored wkt area
- service search by municipality
- full text search within wkt area
- full text search within gps area
- full text search near gps position
- full text search exp
- event search within wkt area
- event search within gps area
- event search near gps position
- event search exp
- address search near gps position
- geometry search near gps position
- address poi search by text exp

- address poi search by text near gps position
- bus routes search near gps position
- bus routes search within gps area
- bus routes search within wkt area
- bus routes search within stored wkt area

S4CSearchUsr

- service search near marker
- service search within circle
- service search within polygon
- service search along path
- full text search near marker
- full text search within circle
- full text search within polygon
- full text search along path
- full text search usr
- event search near marker
- event search within circle
- event search within polygon
- event search along path
- event search usr

- address search near marker
- geometry search near marker
- address poi search by text usr
- address poi search by text near marker
- address poi search by text within circle
- bus routes search near marker
- bus routes search within circle
- bus routes search within polygon

S4CManagement

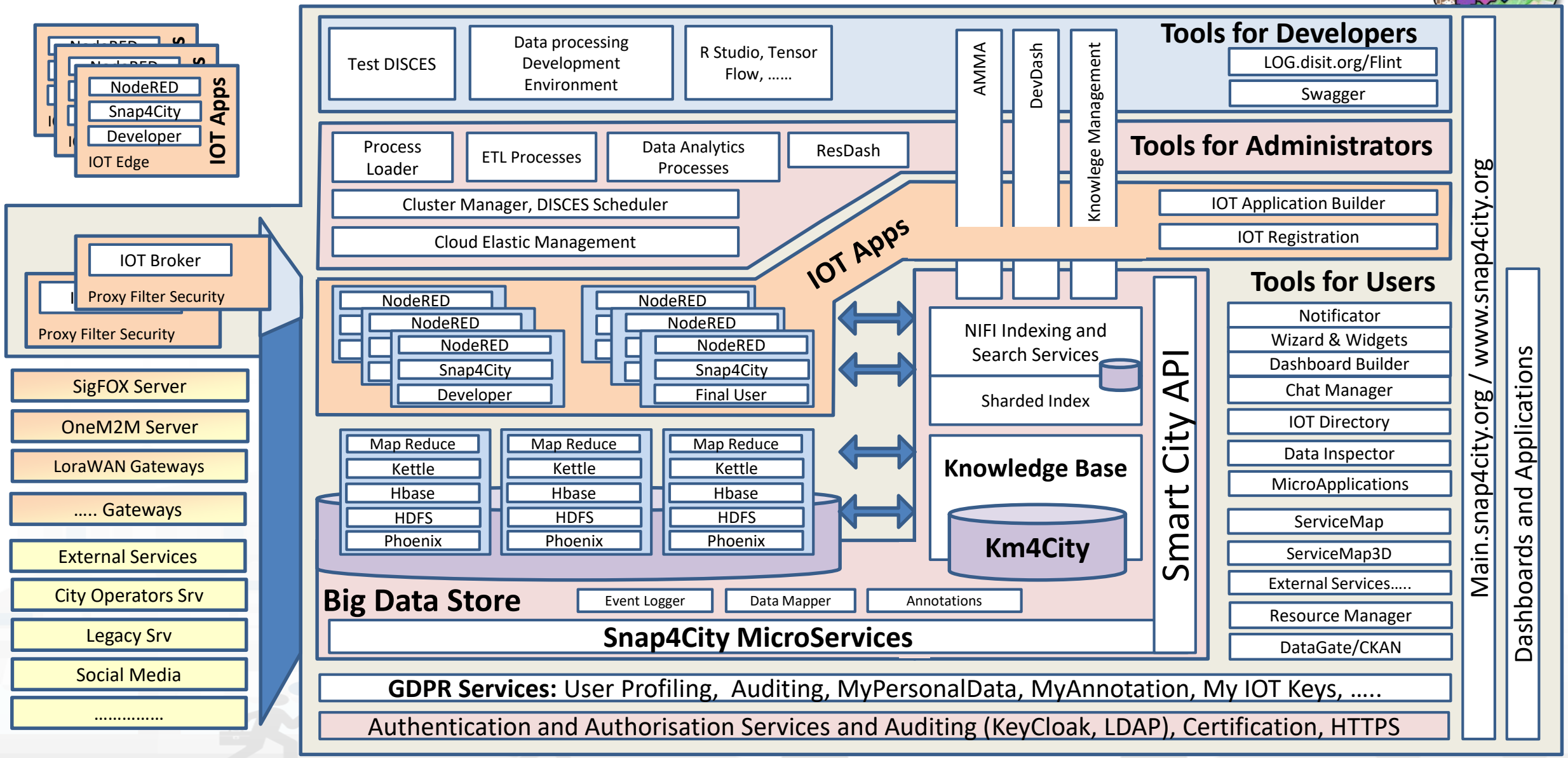
- check exist job
- check exist trigger
- get currently executing jobs
- get job detail
- get triggers of job
- get job group names
- get trigger group names
- get paused trigger groups
- trigger job

Managing Data Analytics tools: processes vs Containers

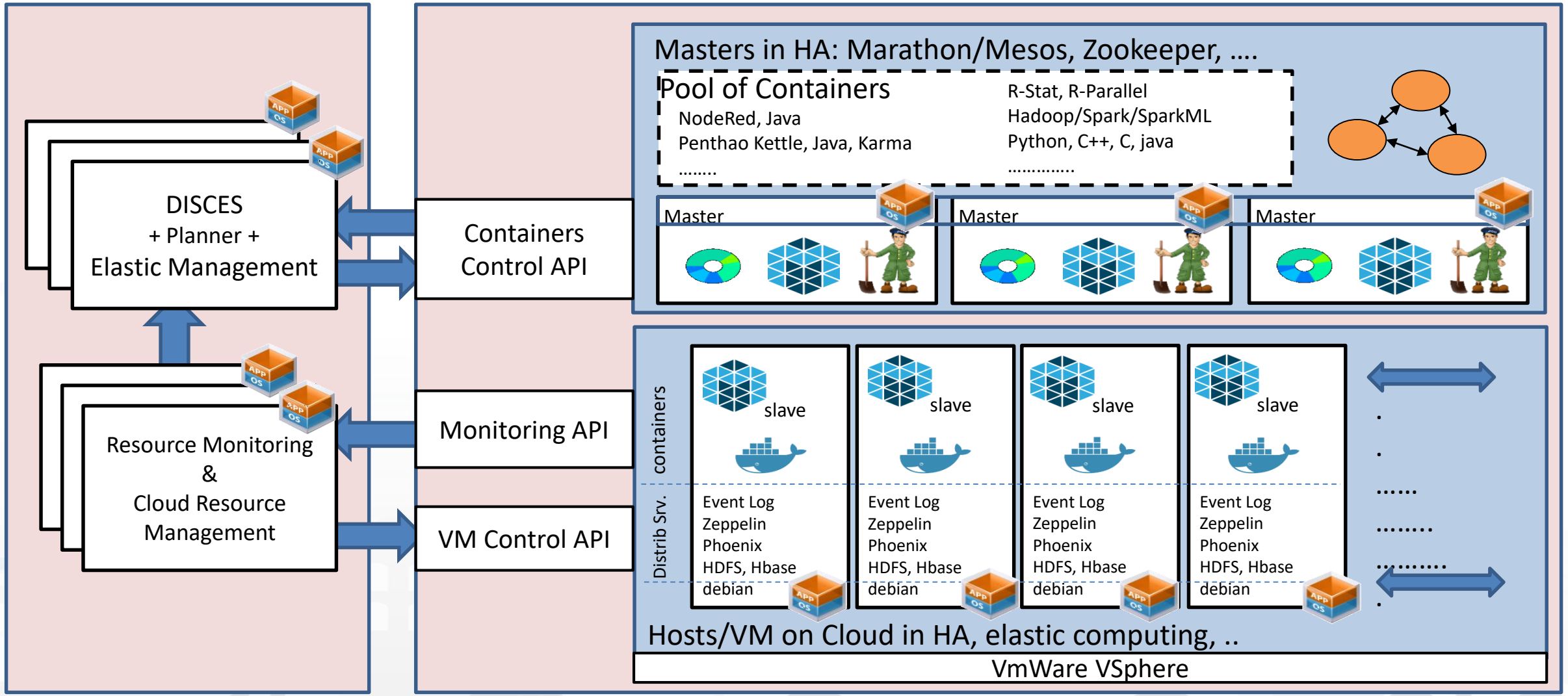


Course Segments

- **Supporting the Analysis of Smart City Data**
  - Computational Requirements for Smart City
  - IOT Applications VS Data Analytics: MicroServices, External Services, legacy integration, etc.
  - Managing Data Analytics tools: processes vs Containers
    - IOT Applications on cloud and MicroServices
  - Data Analytics: predictions and anomaly detection
  - Examples of Data Analytics: predicting parking
  - Traffic flow reconstruction
  - Social Media Analysis.


NodeRED
Snap4City
Developer
IOT Edge
IOT Apps
Test DISCES
Data processing Development Environment
R Studio, Tensor Flow, ……
AMMA
DevDash
Knowlege Management
Tools for Developers
LOG.disit.org/Flint
Swagger
Process Loader
ETL Processes
Data Analytics Processes
ResDash
Cluster Manager, DISCES Scheduler
Cloud Elastic Management
Tools for Administrators
IOT Application Builder
IOT Registration
IOT Broker
Proxy Filter Security
Proxy Filter Security
IOT Apps
NodeRED
NodeRED
NodeRED
Snap4City
Developer
NodeRED
NodeRED
NodeRED
Snap4City
Final User
NIFI Indexing and Search Services
Sharded Index
Knowledge Base
Km4City
Smart City API
Tools for Users
Notificator
Wizard & Widgets
Dashboard Builder
Chat Manager
IOT Directory
Data Inspector
MicroApplications
ServiceMap
ServiceMap3D
External Services…..
Resource Manager
DataGate/CKAN
SigFOX Server
OneM2M Server
LoraWAN Gateways
….. Gateways
External Services
City Operators Srv
Legacy Srv
Social Media
……
Map Reduce
Kettle
Hbase
HDFS
Phoenix
Map Reduce
Kettle
Hbase
HDFS
Phoenix
Map Reduce
Kettle
Hbase
HDFS
Phoenix
Big Data Store
Event Logger
Data Mapper
Annotations
Snap4City MicroServices
GDPR Services: User Profiling, Auditing, MyPersonalData, MyAnnotation, My IOT Keys, …..
Authentication and Authorisation Services and Auditing (KeyCloak, LDAP), Certification, HTTPS
Main.snap4city.org / www.snap4city.org
Dashboards and Applications

Hosts with VM on Cloud HA, DRS, FT



UNIVERSITÀ DEGLI STUDI FIRENZE

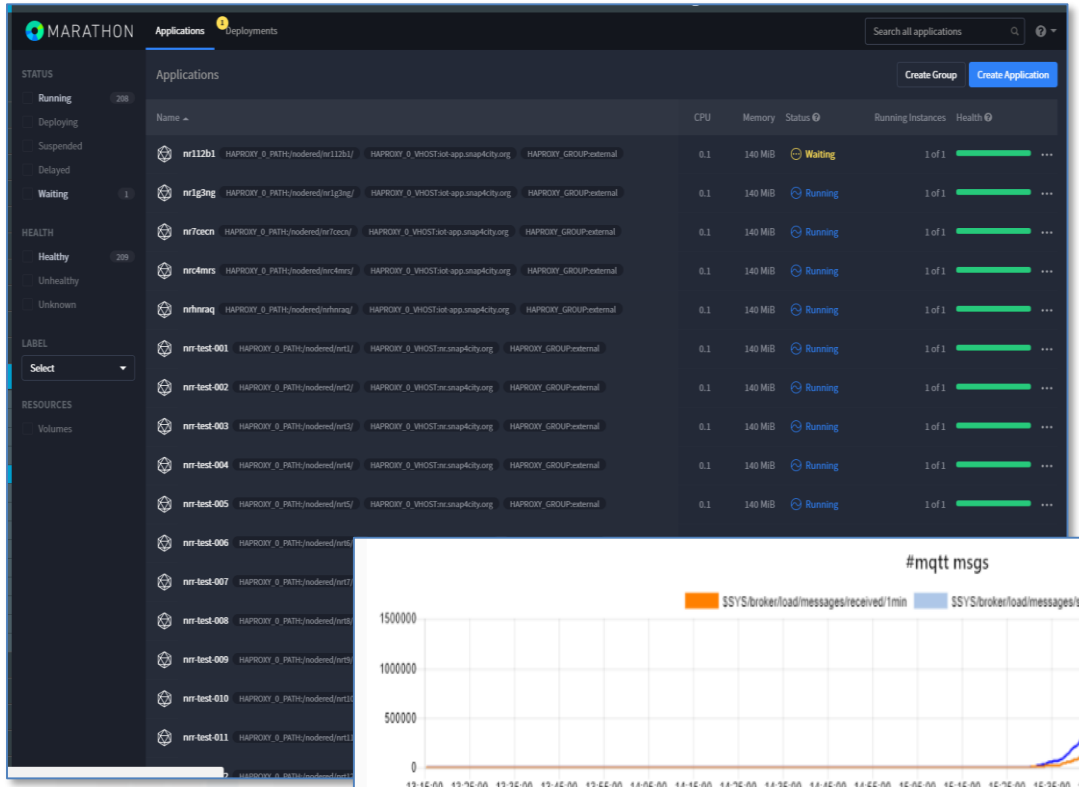
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

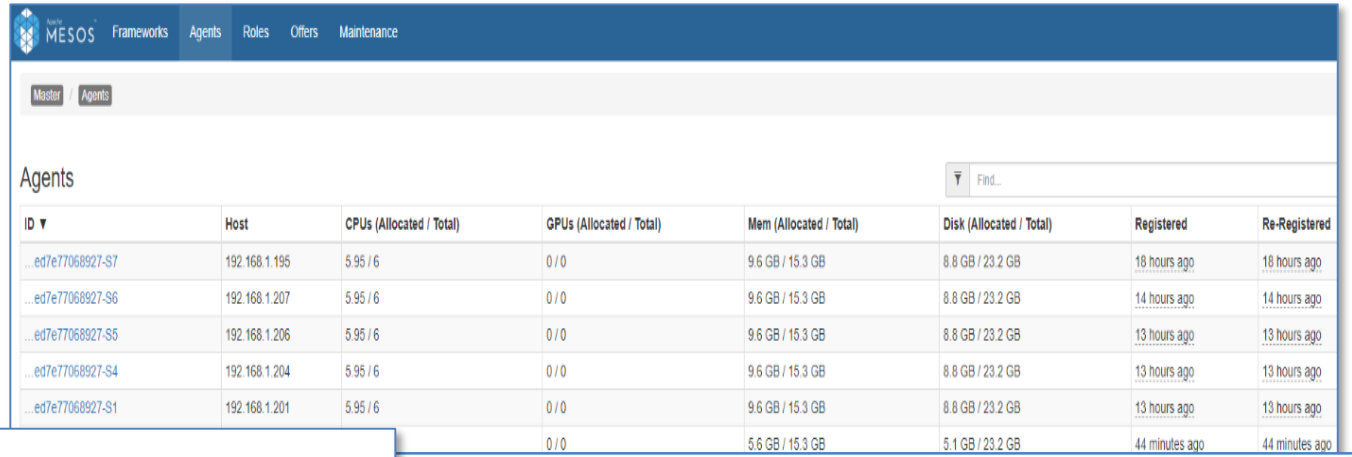
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
http://www.disit.org

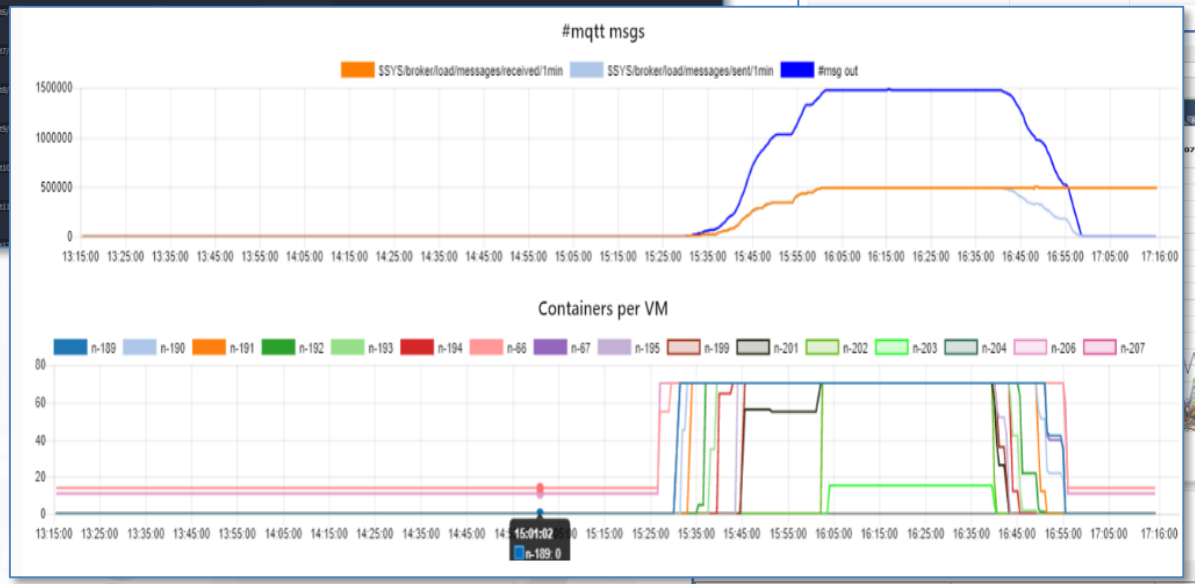
SNAP4CITY

KM4CITY

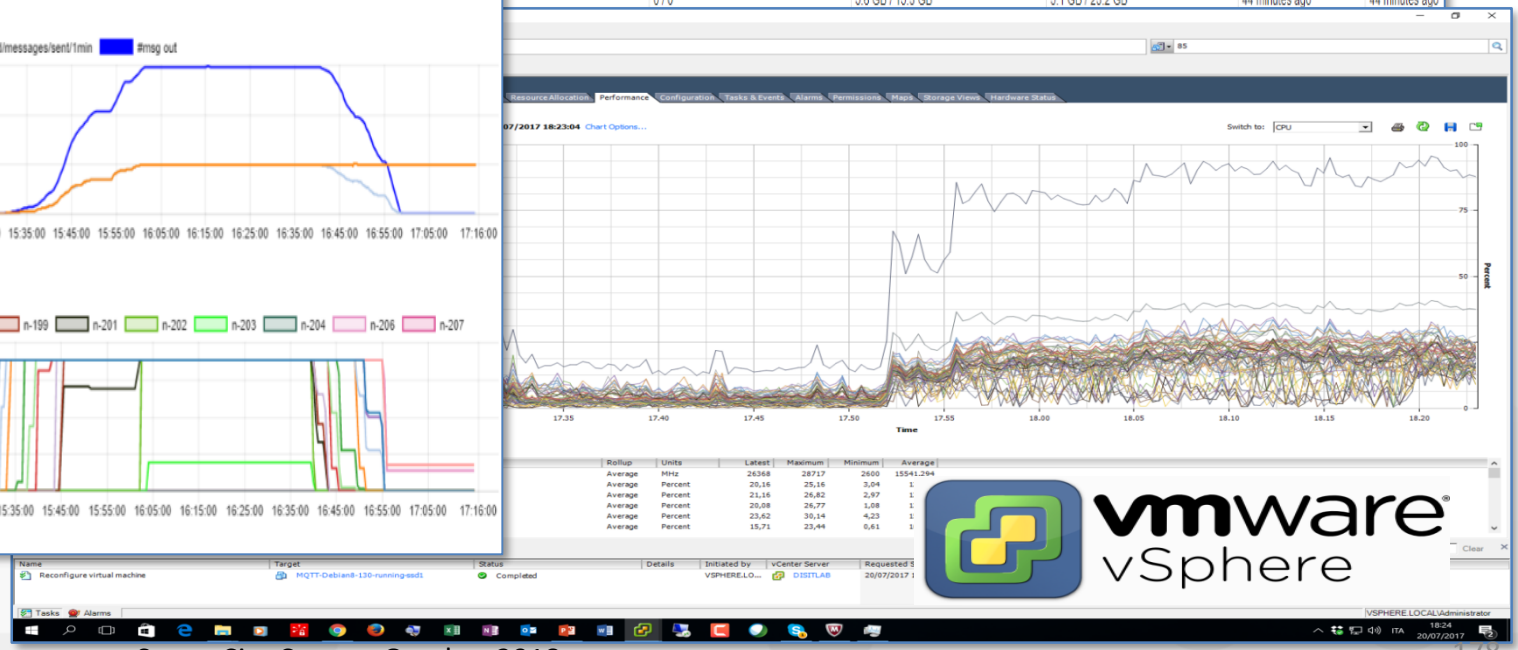
Container





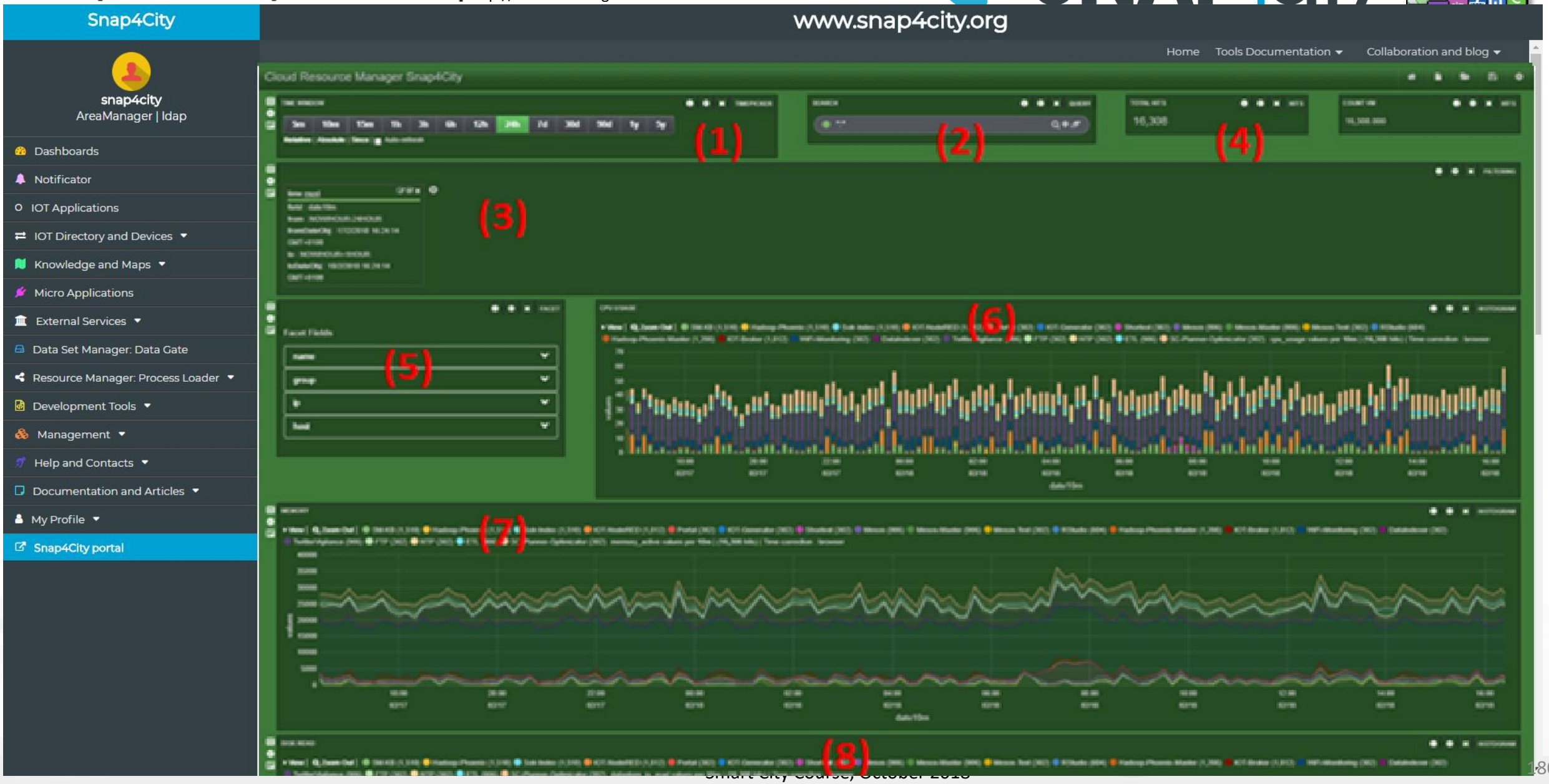






Elastic Scaling: allocating / deallocating

- Allocation/ deallocation, Rebalancing vs compacting
  - Vertical of resources: Docker and/or VM: CPU, Mem
    - NodeJS multi-flow for each Docker, the user request data flows and IOT App, Snap4City allocates them dynamically on demand and perform workload optimization
    - VM: management of Mem, CPU; transparent and automatic in DRS VMware
  - Horizontal of resources of Dockers and/or VM and/or [Host]:
    - Docker: addition of containers, migrations/moving, balancing (per moving) of IOT App
    - VM: on/off
- Monitoring resources:
  - VM via VMware API, Docker via Marathon and Mesos APIs
- Algorithm in Python for scaling, actions via APIs: VMware, Marathon,..


Snap4City
www.snap4city.org
Home
Tools Documentation
Collaboration and blog
snap4city
AreaManager | ldap
Dashboards
Notificator
IOT Applications
IOT Directory and Devices
Knowledge and Maps
Micro Applications
External Services
Data Set Manager: Data Gate
Resource Manager: Process Loader
Development Tools
Management
Help and Contacts
Documentation and Articles
My Profile
Snap4City portal
Cloud Resource Manager Snap4City
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)


Snap4City
Container Cluster Monitoring
panesi
ToolAdmin | ldap
Dashboards
Notificator
IOT Applications
IOT Directory and Devices
Knowledge and Maps
Micro Applications
External Services
Data Set Manager: Data Gate
Resource Manager: Process Loader
Development Tools
Management
Traffic Analyzer: AMMA
Data Analyzer: DevDash
Back Office Res. Analyzer: ResDash
Container Cluster Monitoring
Back Office Container Monitoring
Smart City API Monitoring
Notificator Monitoring
Web Server Monitoring
Back Office Scheduler DISCES
Mobile Application Monitoring
Auditing Elements vs Ownership
Auditing Personal Data
Auditing Data Access Try-out
Auditing Accesses
Settings
Cluster status
Containers
850
Tasks
850
#Healthy
850
#Unhealthy
0
CPU trend
#VMs running
15
#VMs up
15
CPU
76.87
Memory
86.63
memory trend
Memory usage %
CPU usage %
#Containers
Total
Healthy
RESET GRAPH CPU/MEM USAGE
RESET GRAPH TASKS


Snap4City
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panesi
ToolAdmin | ldap
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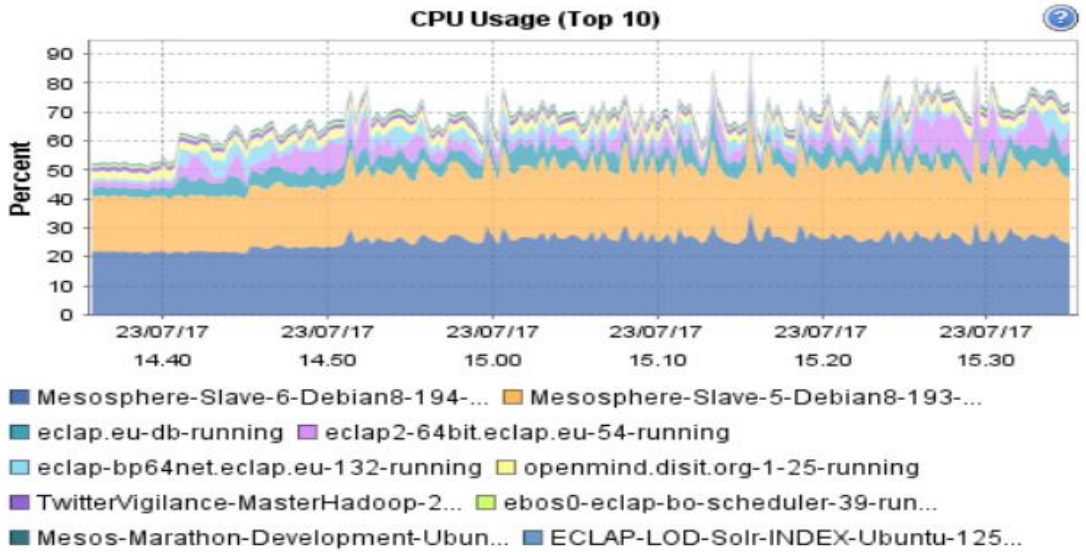
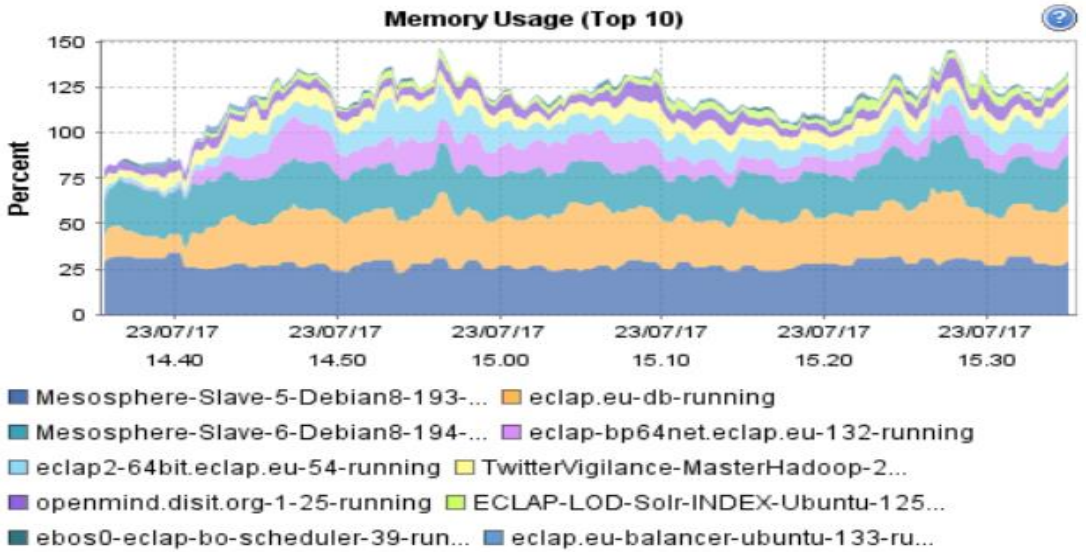
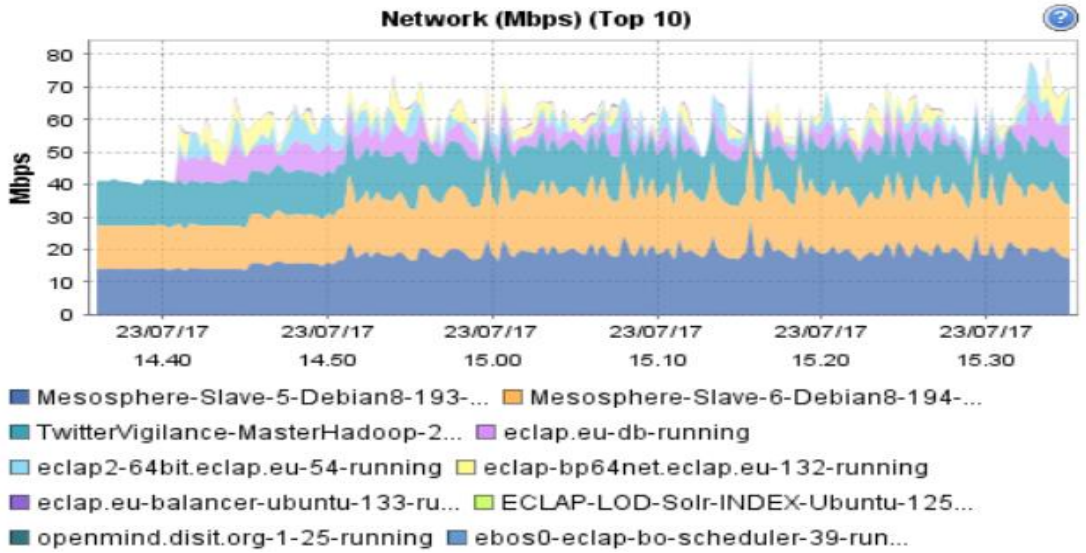
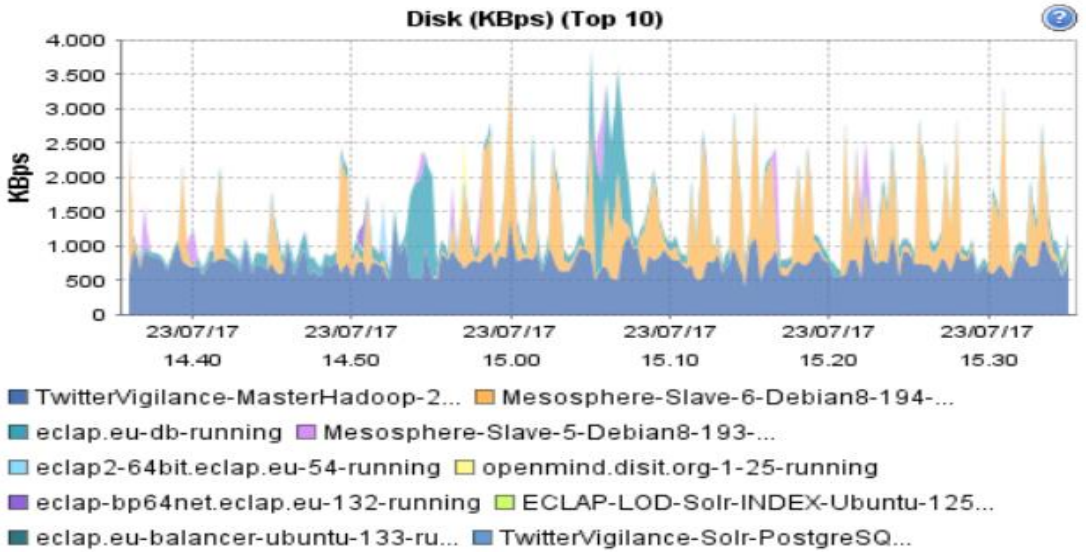
Mobile Application Monitoring
Auditing Elements vs Ownership
Auditing Personal Data
Auditing Data Access Try-out
Auditing Accesses
Settings
Help and Contacts
Documentation and Articles
My Profile
Snap4City portal
#mqtt msg recvd/min
#mqtt msg sent/min
#msg in output/min
1185305.07
1072894.99
808999
Total MSG:
1.054.566.71
RESET TOTAL
RESET CHART
START 100 TEST APPS
test apps 837
STOP 100 TEST APPS
START MQTT MSGS /2
START MQTT MSGS
#mqtt gens: 22
STOP LAST MQTT GEN
STOP ALL MQTT MSGS
#VMs
#mqtt msgs
$SYS/broker/load/messages/received/1min
$SYS/broker/load/messages/sent/1min
#msg out
Containers per VM
Unhealthy Containers per VM
Docker Containers per VM

Monitoring on Cloud



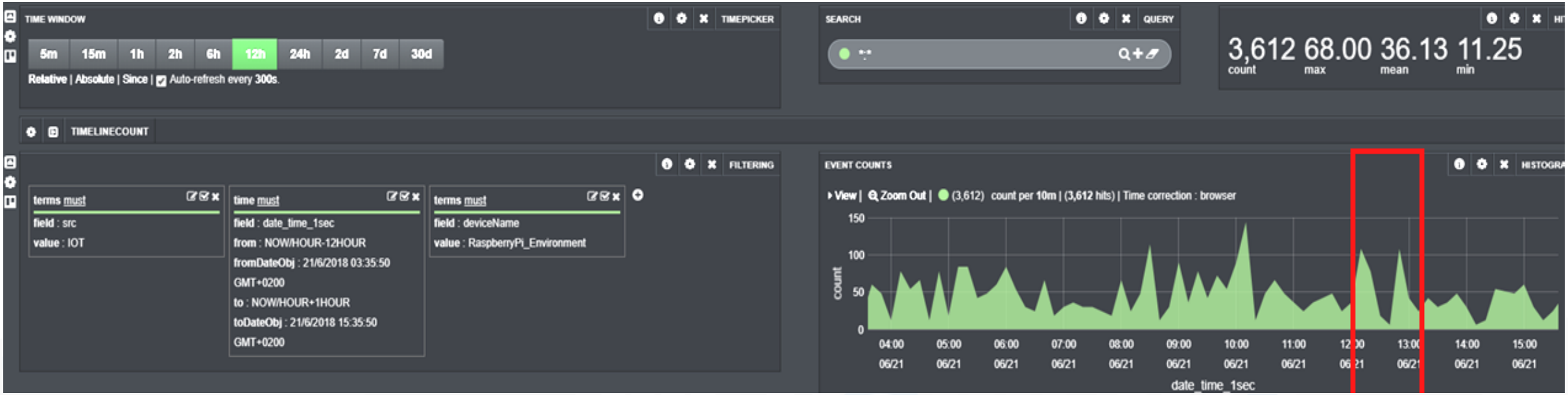






DevDash Case Study (2)

- Detect potential anomalies or disfunctions by inspecting the DevDash tool time trend

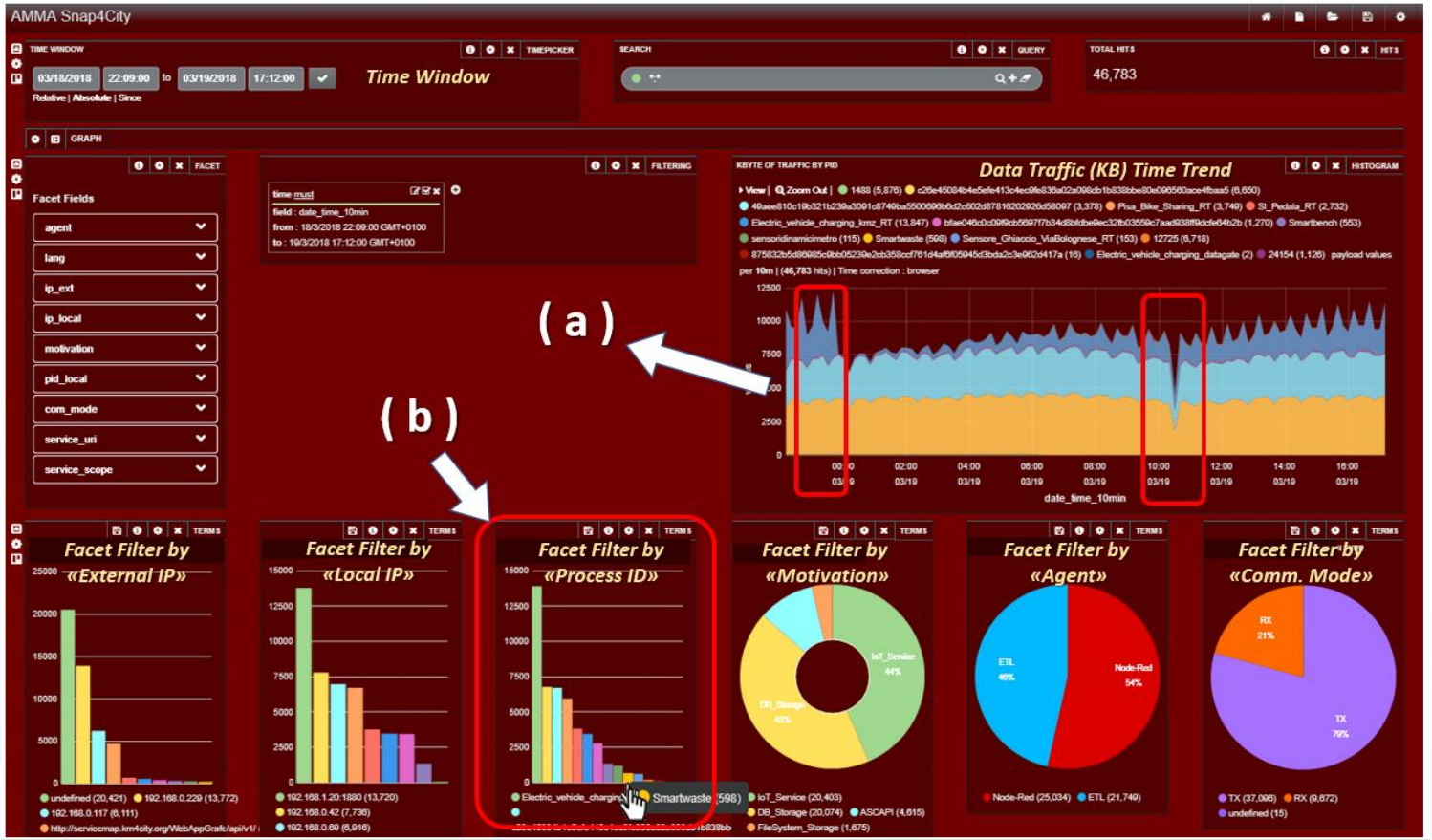


AMMA Case Study (1)

- Monitor data traffic flows among IoT devices, services, applications etc. and detect potential anomalies

- Unexpected behaviors can be revealed by inspecting the data flow time trend:
  - a) detecting peaks or valleys in the trend
  - b) drill-down on data to identify single/more malfunctioning devices and/or services

Requirement II solved: quantitatively monitoring data/message traffic and flows



AMMA Case Study (2)

- Make drill-down activities on data related to a single Process ID and check for unexpected behavior in the Time Trend panel:
  - **c)** Filtering data by the Process ID (e.g for example those related to a SmartWaste container)
  - **d)** Detect a peak with more data traffic than expected during its scheduled activity, by properly filtering on time, the single data portion corresponding to the unexpected data flow can be viewed
  - **e)** Locate on map the single involved device or service





Data Analytics: predictions and anomaly detection



Course Segments

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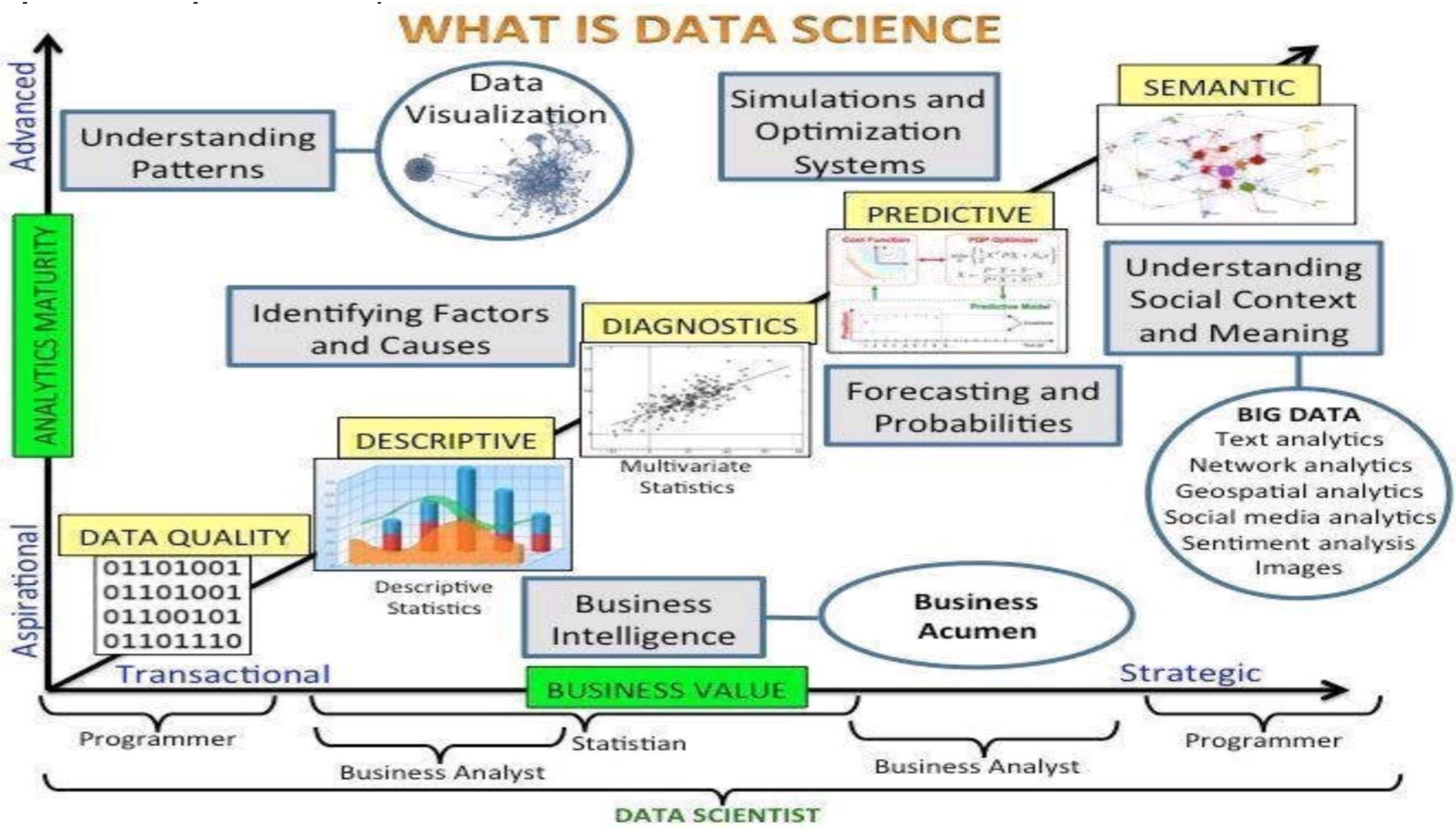
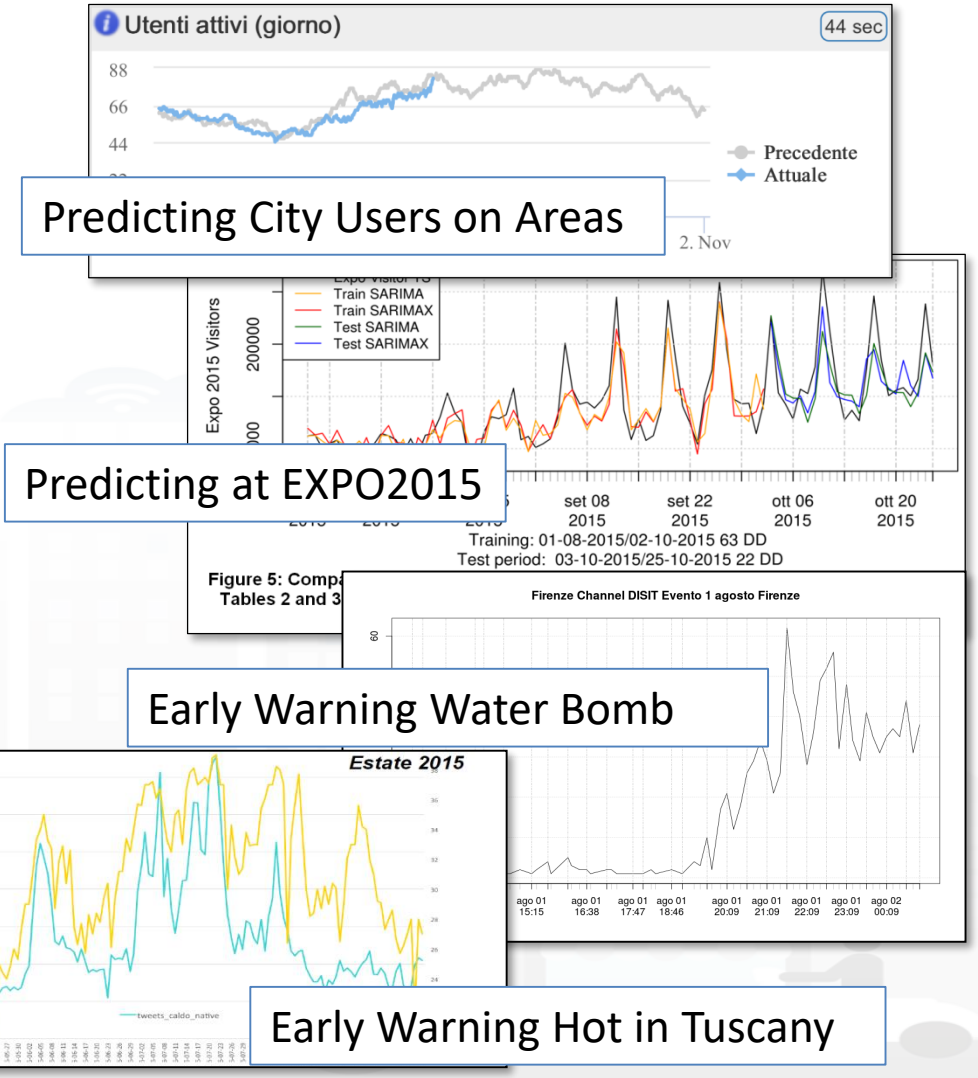
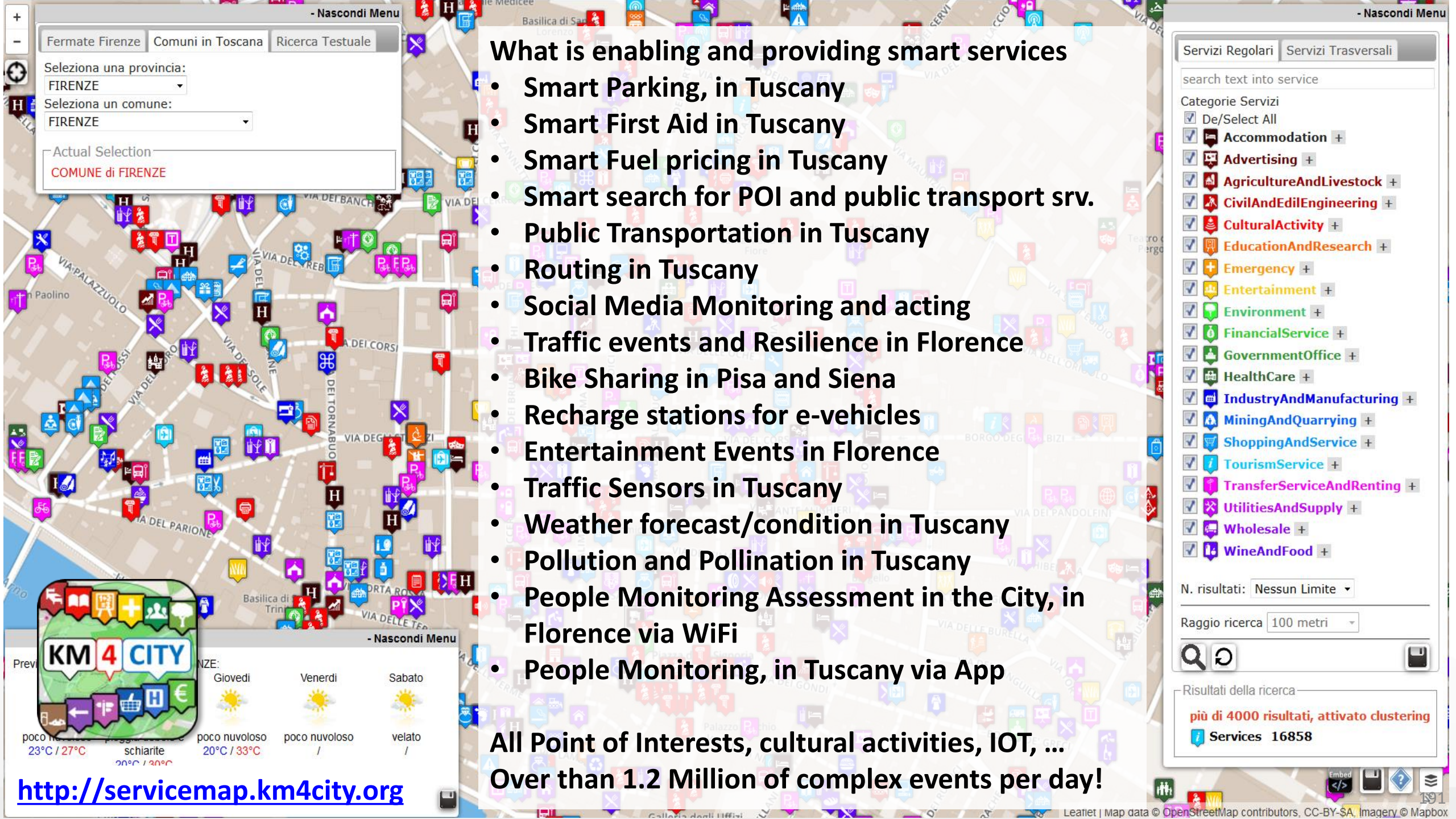

WHAT IS DATA SCIENCE
Advanced
ANALYTICS MATURITY
Aspirational
Understanding Patterns
Data Visualization
Simulations and Optimization Systems
SEMANTIC
PREDICTIVE
Identifying Factors and Causes
DIAGNOSTICS
Multivariate Statistics
Understanding Social Context and Meaning
Forecasting and Probabilities
DESCRIPTIVE
Descriptive Statistics
DATA QUALITY
01101001
01101001
01100101
01101110
BIG DATA
Text analytics
Network analytics
Geospatial analytics
Social media analytics
Sentiment analysis
Images
Business Intelligence
Business Acumen
Transactional
BUSINESS VALUE
Strategic
Programmer
Statistian
Business Analyst
Business Analyst
Programmer
DATA SCIENTIST

Predicting Models for Admin. & 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 → multi-flow reconstruction
  - Parking Status → free slots
  - People Flows (Wi-Fi, Twitter)
    → crowd , #number of people





What is enabling and providing smart services

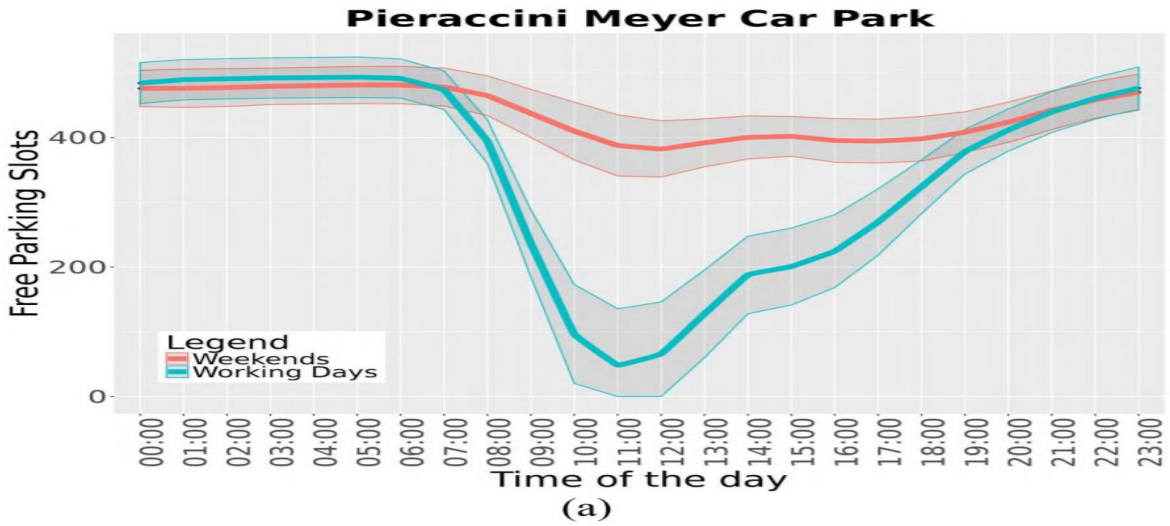
- Smart Parking, in Tuscany
- Smart First Aid in Tuscany
- Smart Fuel pricing in Tuscany
- Smart search for POI and public transport srv.
- Public Transportation in Tuscany
- Routing in Tuscany
- Social Media Monitoring and acting
- Traffic events and Resilience in Florence
- Bike Sharing in Pisa and Siena
- Recharge stations for e-vehicles
- Entertainment Events in Florence
- Traffic Sensors in Tuscany
- Weather forecast/condition in Tuscany
- Pollution and Pollination in Tuscany
- People Monitoring Assessment in the City, in Florence via WiFi
- People Monitoring, in Tuscany via App

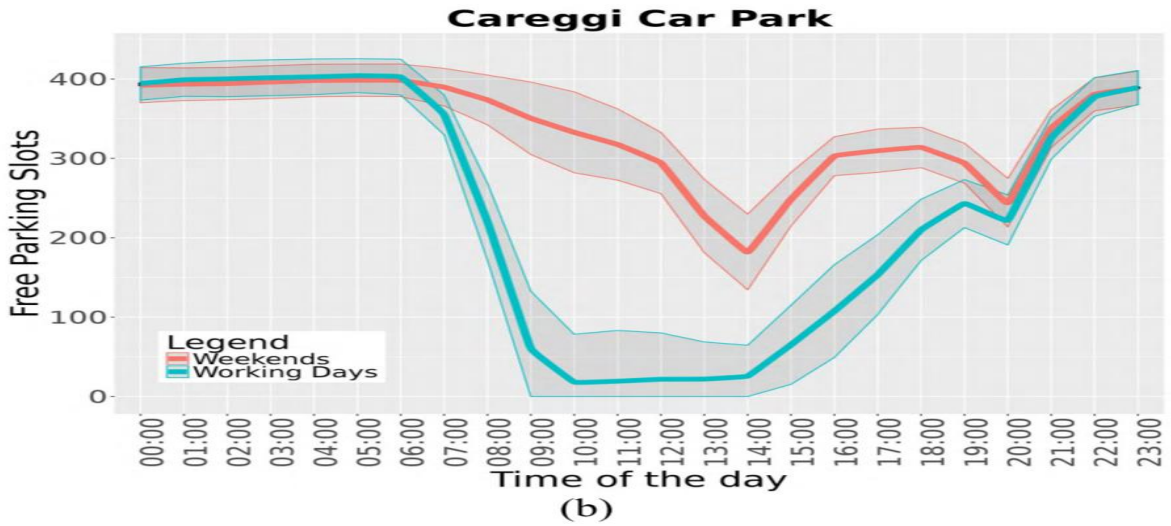
All Point of Interests, cultural activities, IOT, …

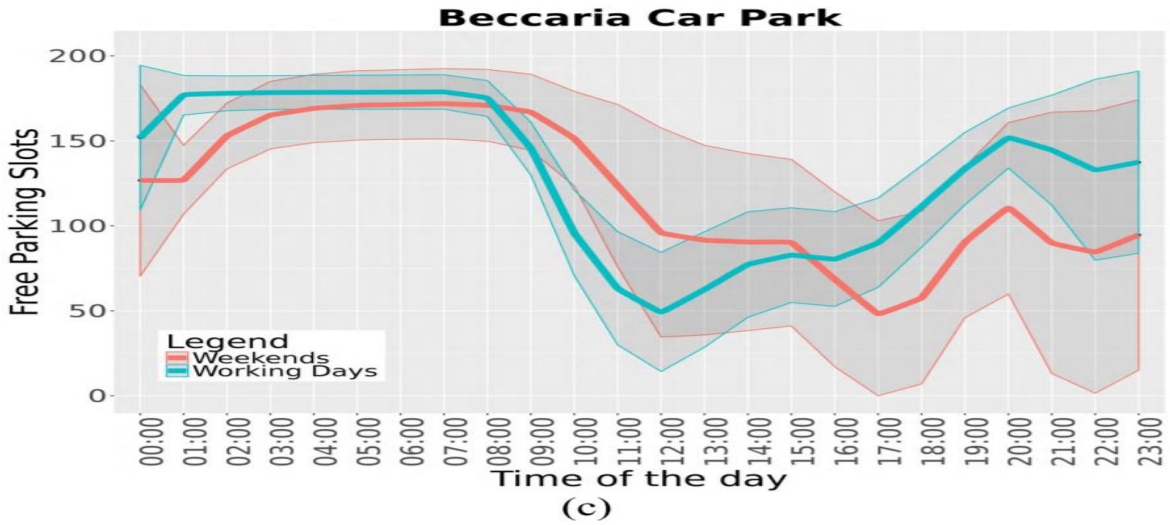
Over than 1.2 Million of complex events per day!

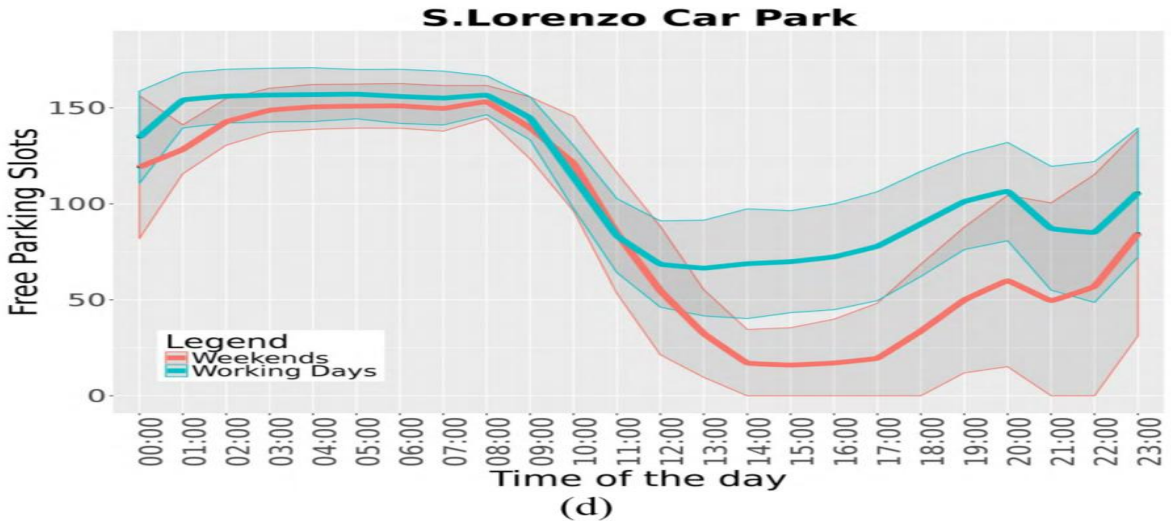
http://servicemap.km4city.org

Free Parking space trends









12 parking areas in Florence

Free Parking PREDICTIONS

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

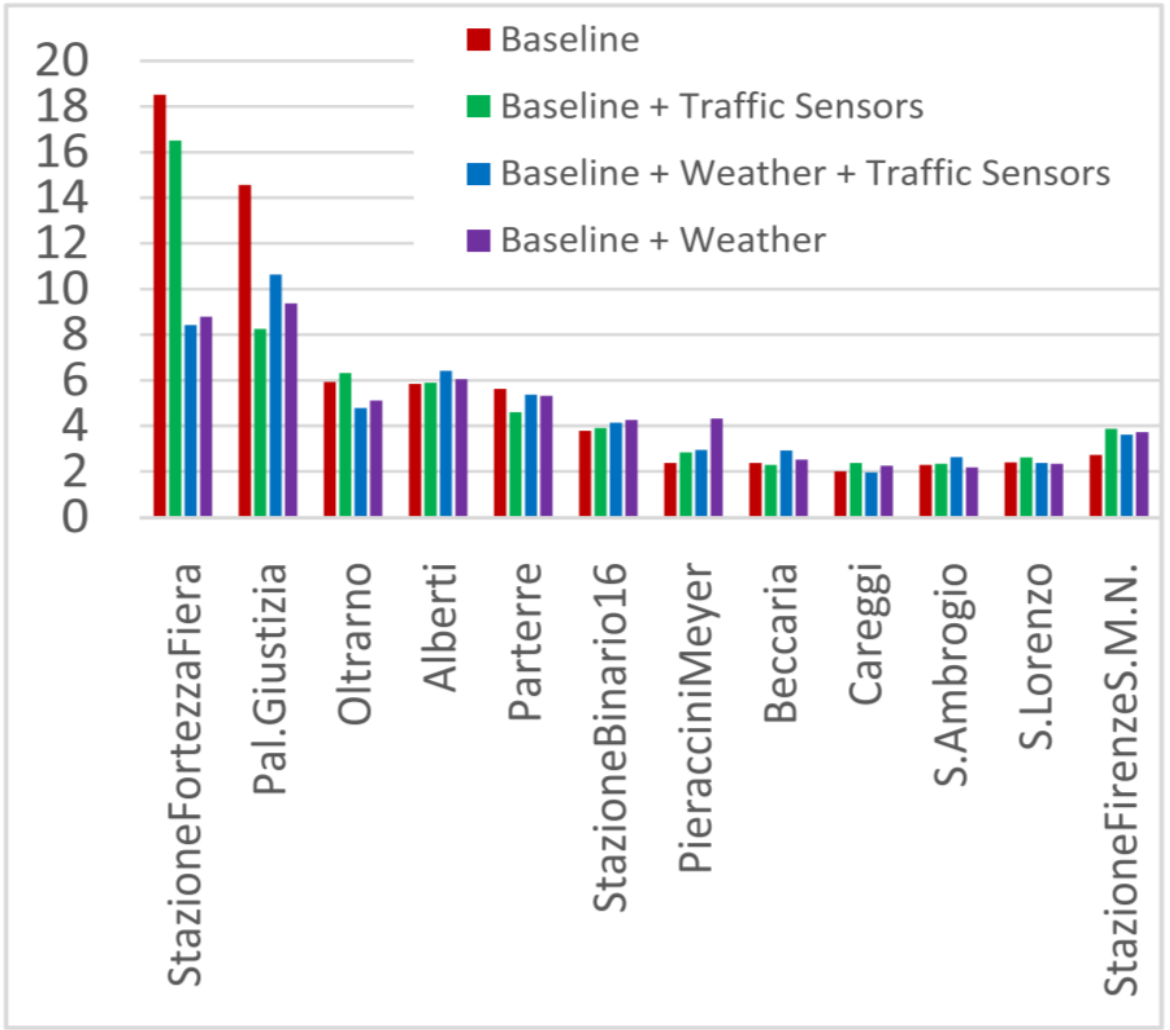


- Active on Mobile Apps as:
  - «Firenze dove cosa»
  - «Toscana dove cosa»

Free Parking PREDICTIONS

C. Badii, P. Nesi, I. Paoli, "Predicting available parking slots on critical and regular services exploiting a range of open data", IEEE Access, preprint, 2018, https://ieeexplore.ieee.org/abstract/document/8430514/

Comparison Error	Forecasting Techniques		
	BRANN	SVR	RNN
Careggi car park			
MASE Night	34.85	16.29	20.01
MASE Morning	0.76	1.42	2.82
MASE Afternoon	1.89	4.34	3.66
MASE Evening	1.99	1.51	2.33
MASE	1.87	2.34	3.16
Pieraccini Meyer car park			
MASE Night	6.08	12.83	10.03
MASE Morning	0.86	1.27	4.90
MASE Afternoon	1.87	2.91	6.75
MASE Evening	1.36	1.57	10.23
MASE	1.37	2.06	6.67
S. Lorenzo car park			
MASE Night	10.33	11.81	18.34
MASE Morning	2.13	1.91	3.93
MASE Afternoon	2.70	3.15	2.37
MASE Evening	2.15	3.09	3.82
MASE	2.72	3.21	4.19
Beccaria car park			
MASE Night	9.32	7.80	12.47
MASE Morning	0.95	1.25	4.87
MASE Afternoon	2.49	2.14	2.45
MASE Evening	2.96	4.75	5.91
MASE	2.13	2.67	4.85

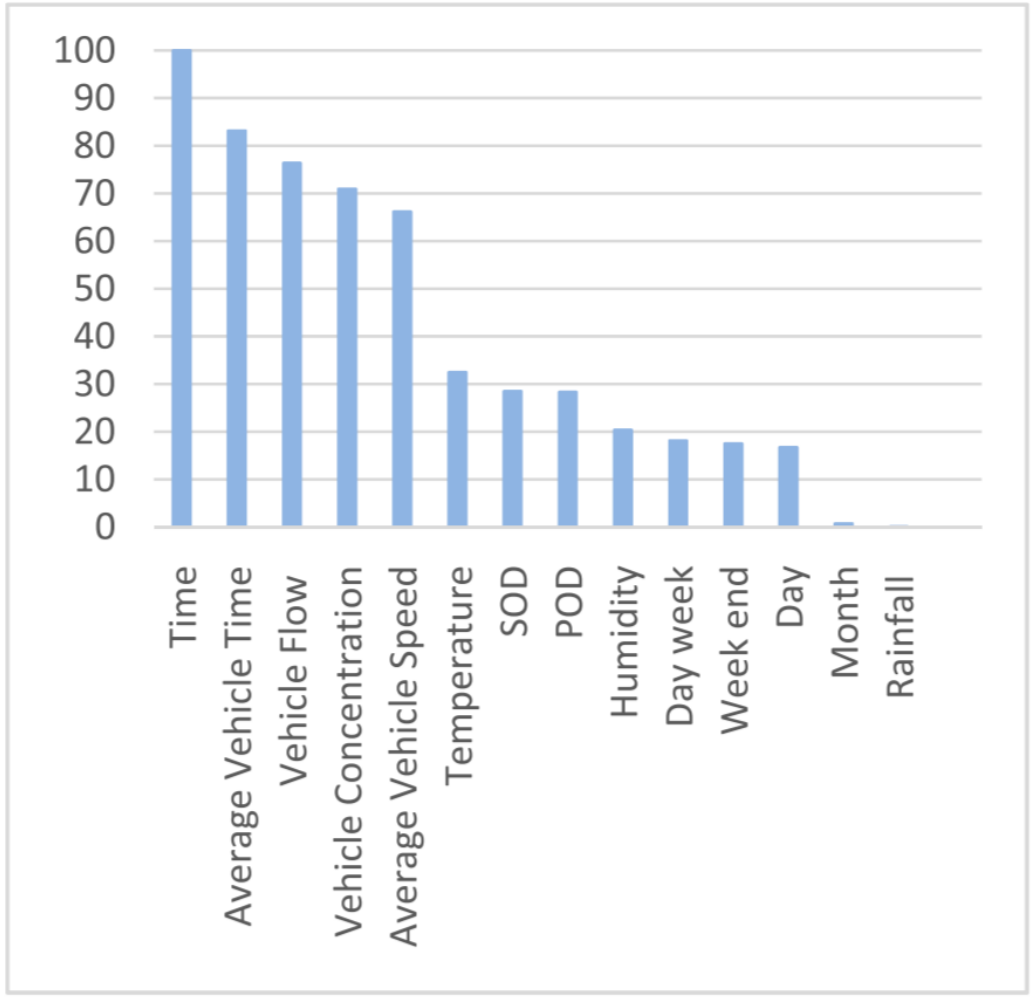


Free Parking PREDICTIONS

Performances

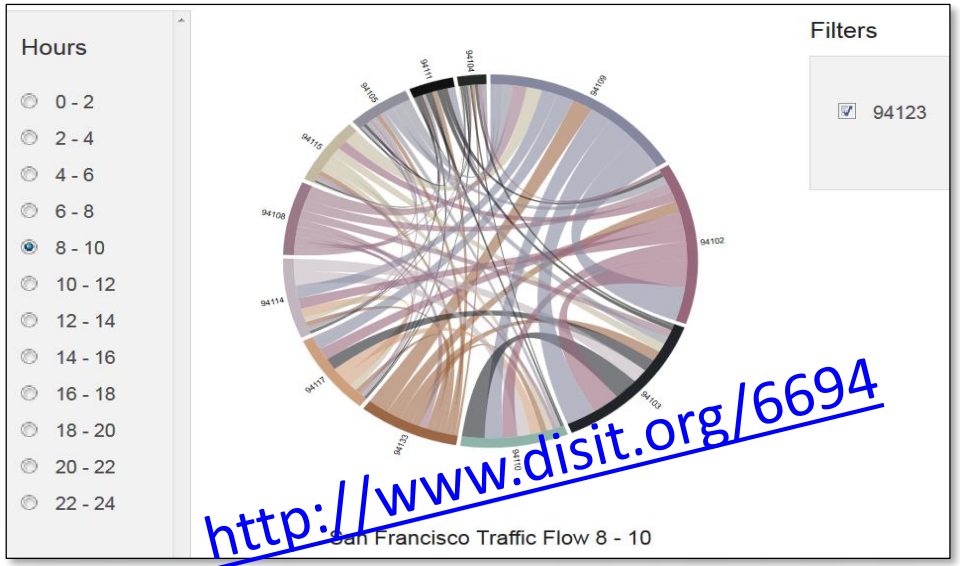
Training	Forecasting Techniques			
	BRANN	SVR	RNN	ARIMA
Average Training processing time (sec)	76.3	9.1	598.7	9.2
Re-Training frequency	Daily	Daily	Daily	Hourly
Training period	3 months	3 months	3 months	3 months
Estimation	**BRANN**	**SVR**	**RNN**	**ARIMA**
Average Estimation time (sec)	0.0031	0.0052	0.034	0.0015
Estimation frequency	Hourly	Hourly	Hourly	Hourly
Estimation predicted period	1 hour	1 hour	1 hour	1 hour

Relevance of Variable

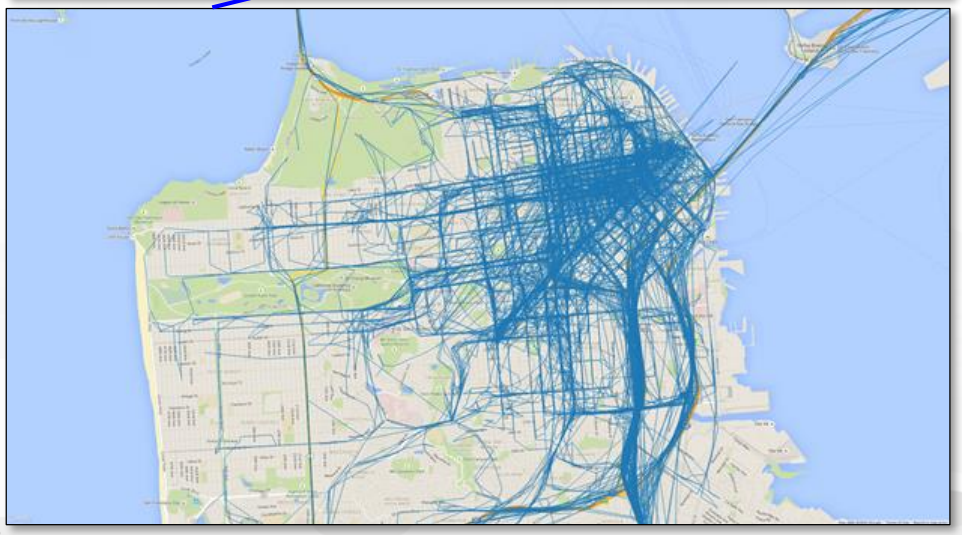


Traffic and People Flow Assessment

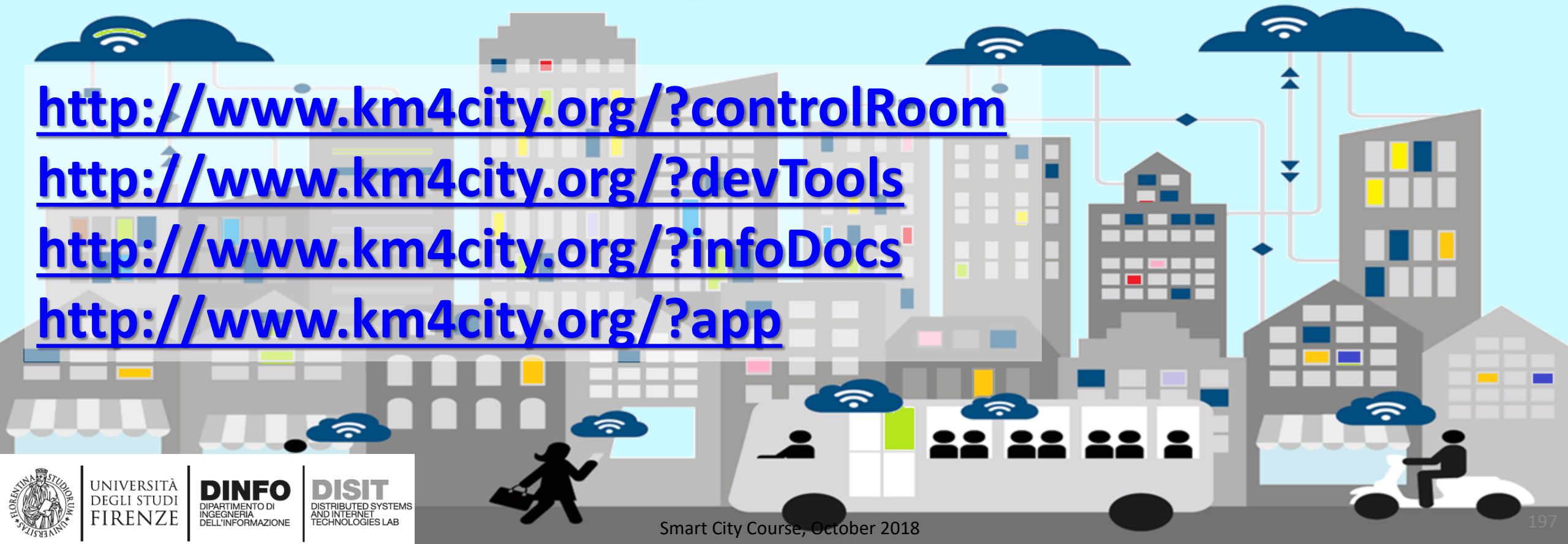
- **Origin Destination Matrix**
  - Specific Sensors, vehicle Kits, mobile App, Wi-Fi Access Points, etc.
  - Data from Taxi in San Francisco
- **Assess people and traffic flows to**
  - improve services
  - predict critical conditions on Crit. Infra.
  - take real time decisions and sending messages in push to population
  - Increase city resilience
  - optimize traffic flow
  - take decision of routing



http://www.disit.org/6694



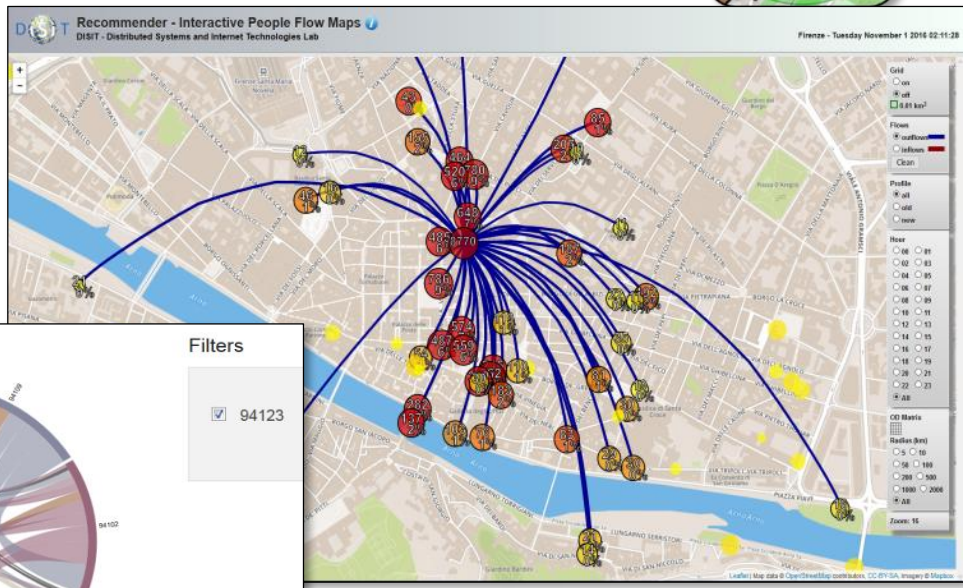
Monitoring City users Via Wi-Fi

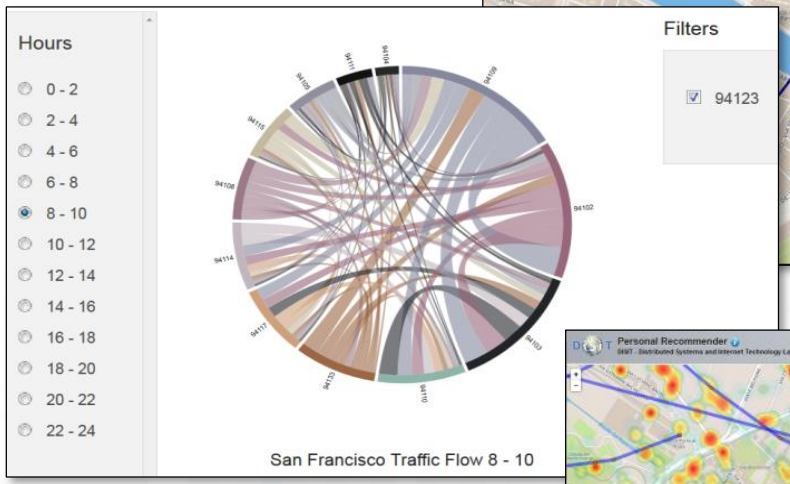


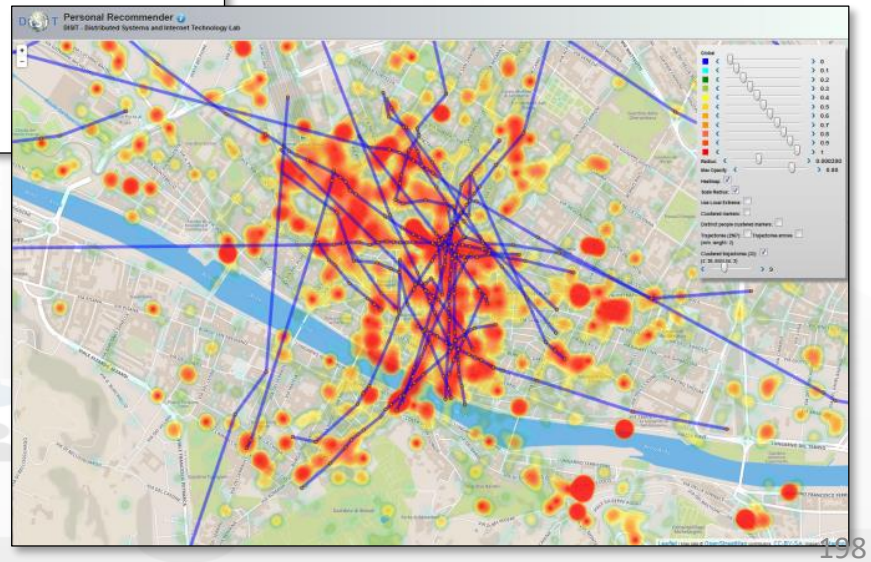
http://www.km4city.org/?controlRoom
http://www.km4city.org/?devTools
http://www.km4city.org/?infoDocs
http://www.km4city.org/?app

User Behaviour Analysis

- **Monitoring movements by traffic flow sensors**
  - Spires and virtual spires
- **Monitoring movements from Mobile Cells**
  - Unsuitable for precise tracking and OD production
- **Monitoring movements from Wi-Fi**
- **Monitoring movements** and much more from mobile Apps

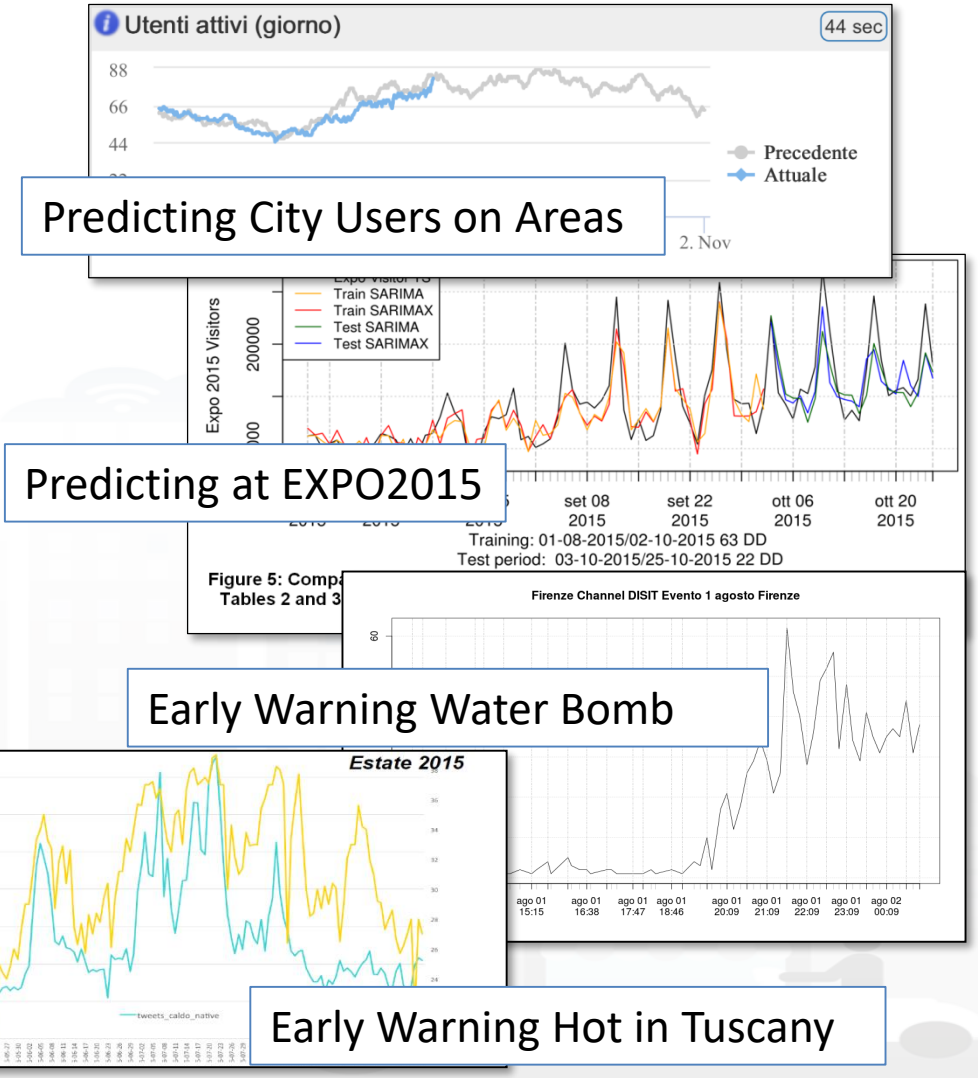




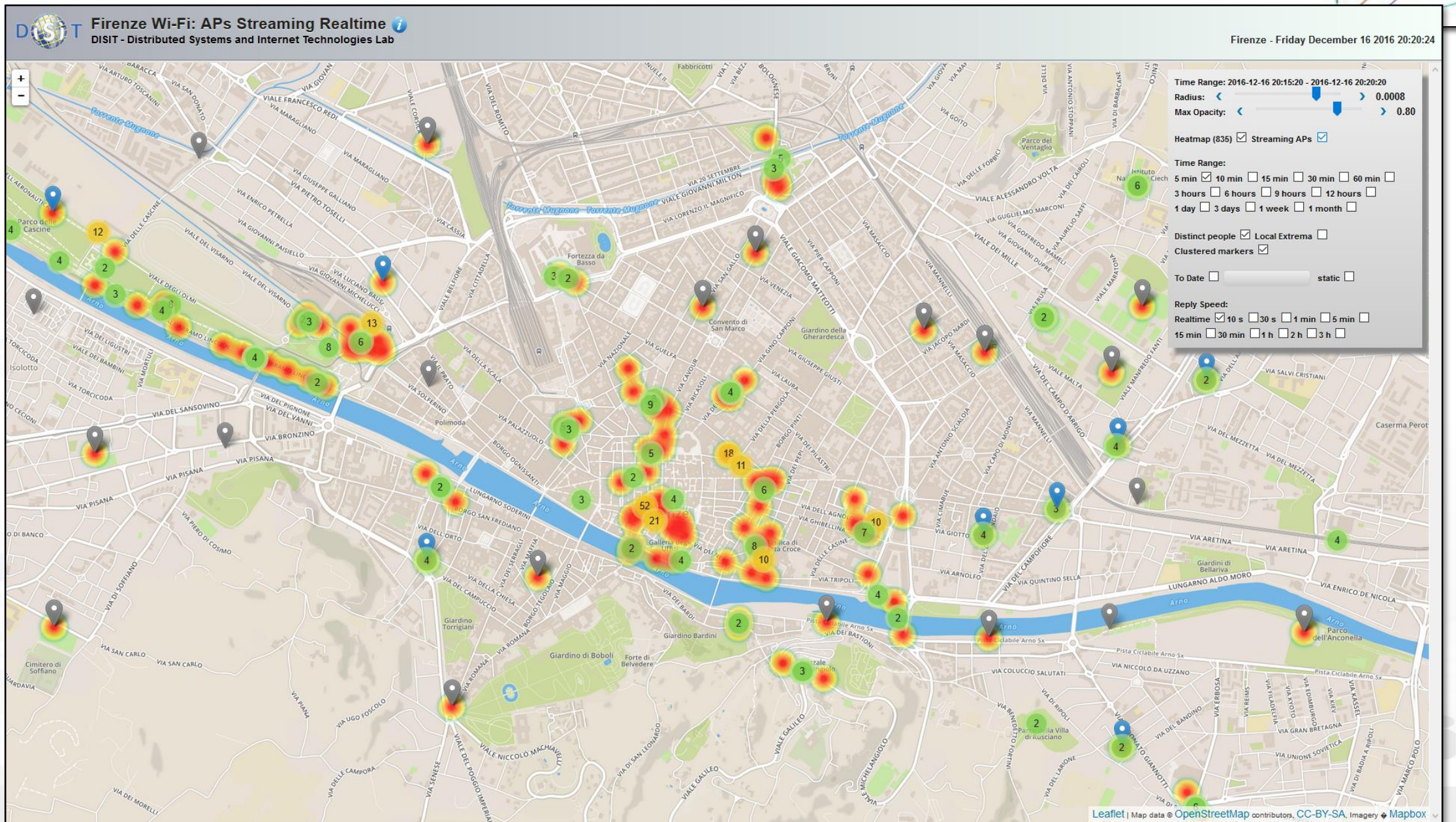


Predicting Models for Admin. & City Users

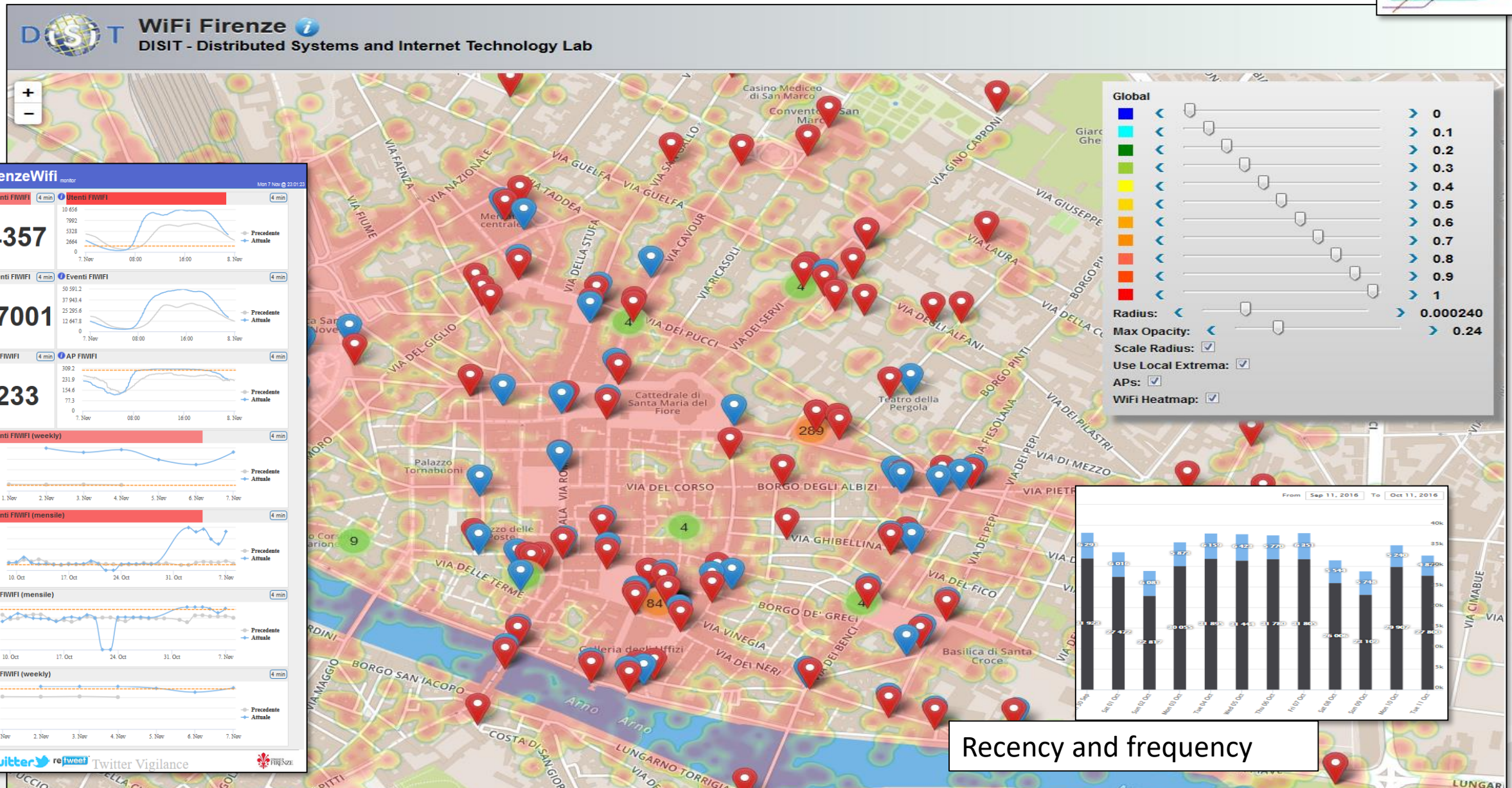
- **Aiming at improving**
  - quality of service, distributing workload
  - early warning
- **Predictions**: **Short** (15 min, 30 Min) and mid Term (1 week)
- **Data Analytics**: ML, NLP/SA, Clust…
  - Traffic Flows → multiflow reconstruction
  - Parking Status → free slots
  - People Flows (WiFi, Twitter)
    → crowd , #number of people



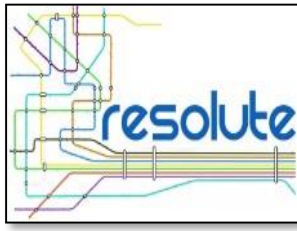
Real Time Monitoring of Wi-Fi network



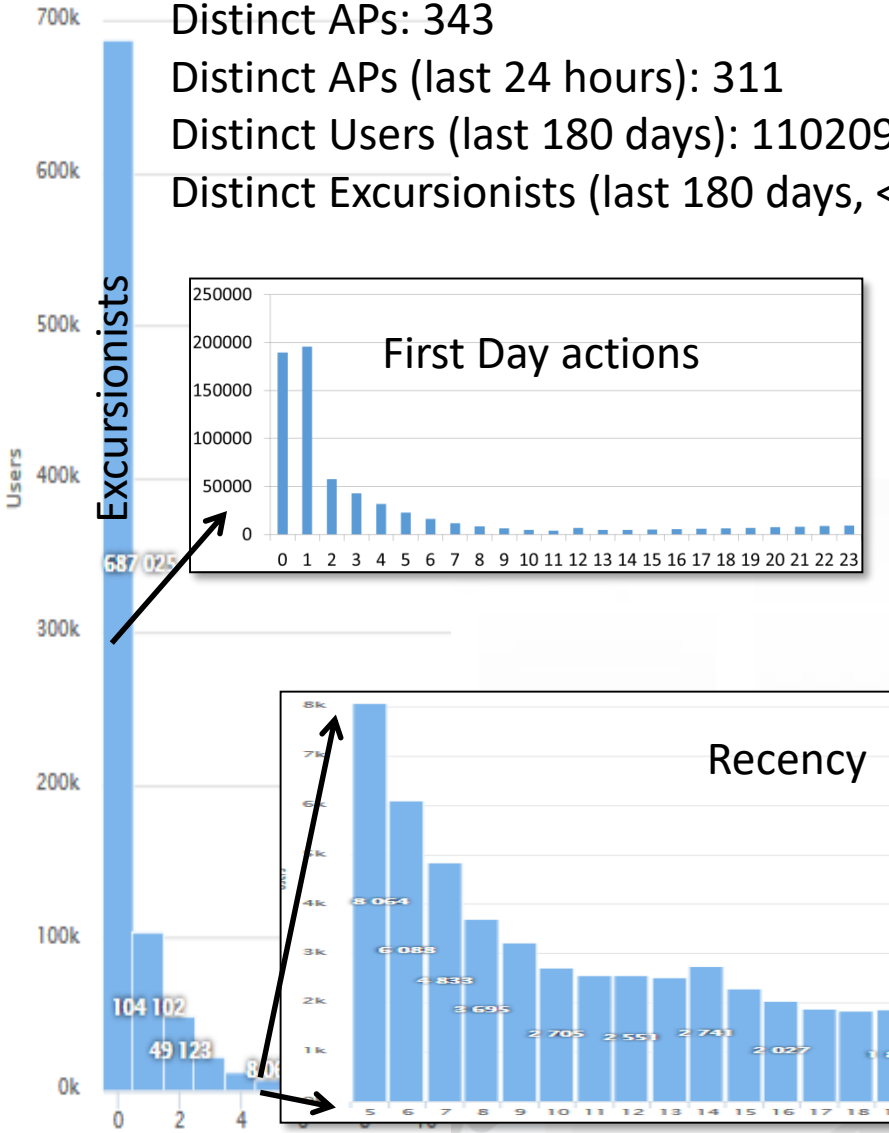
WiFi Monitor tool

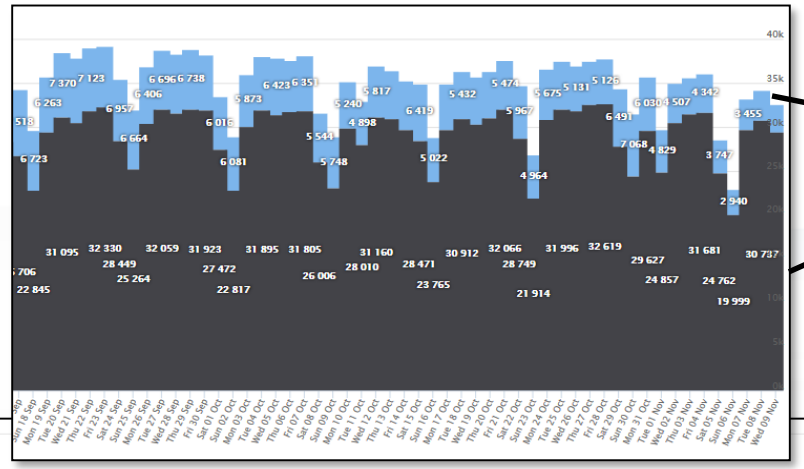


User Behavior Analysis



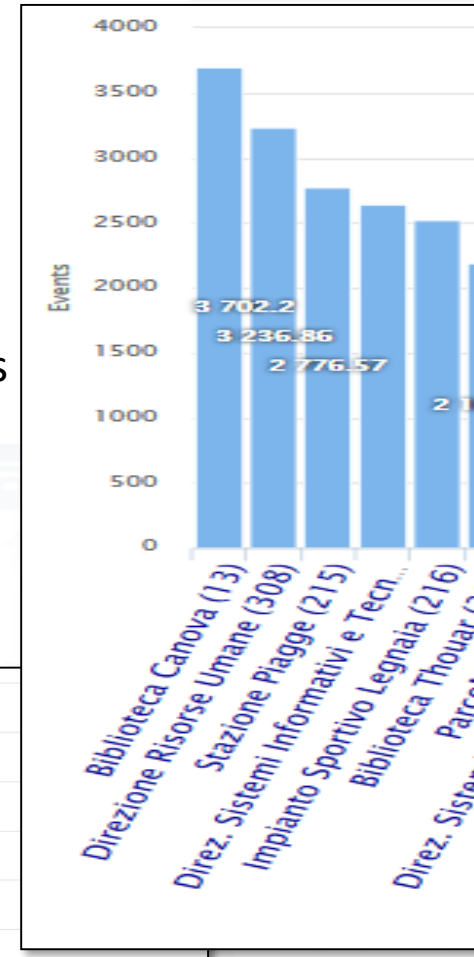
Distinct APs: 343
Distinct APs (last 24 hours): 311
Distinct Users (last 180 days): 1102098
Distinct Excursionists (last 180 days, < 24 h): 687025



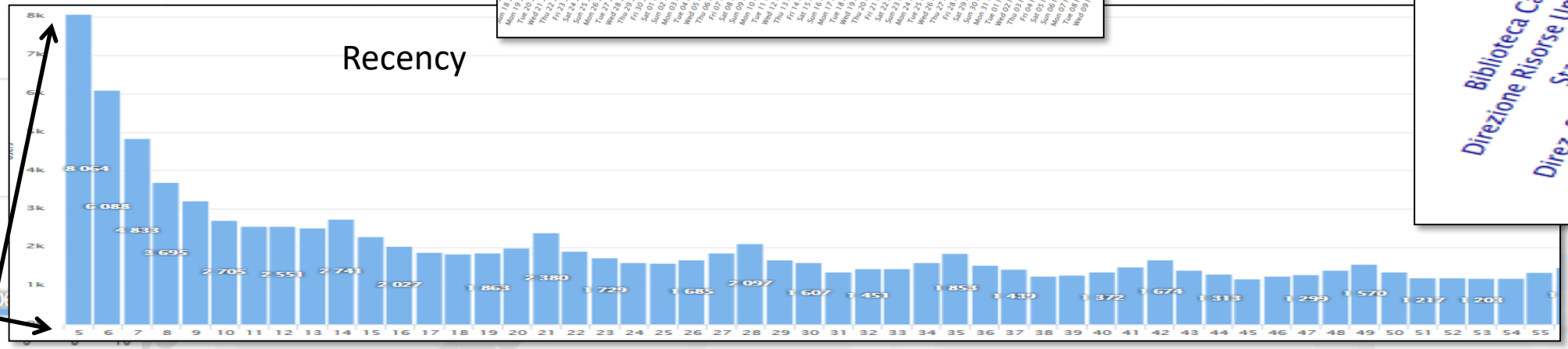


Where

New City Users
VS
Returning



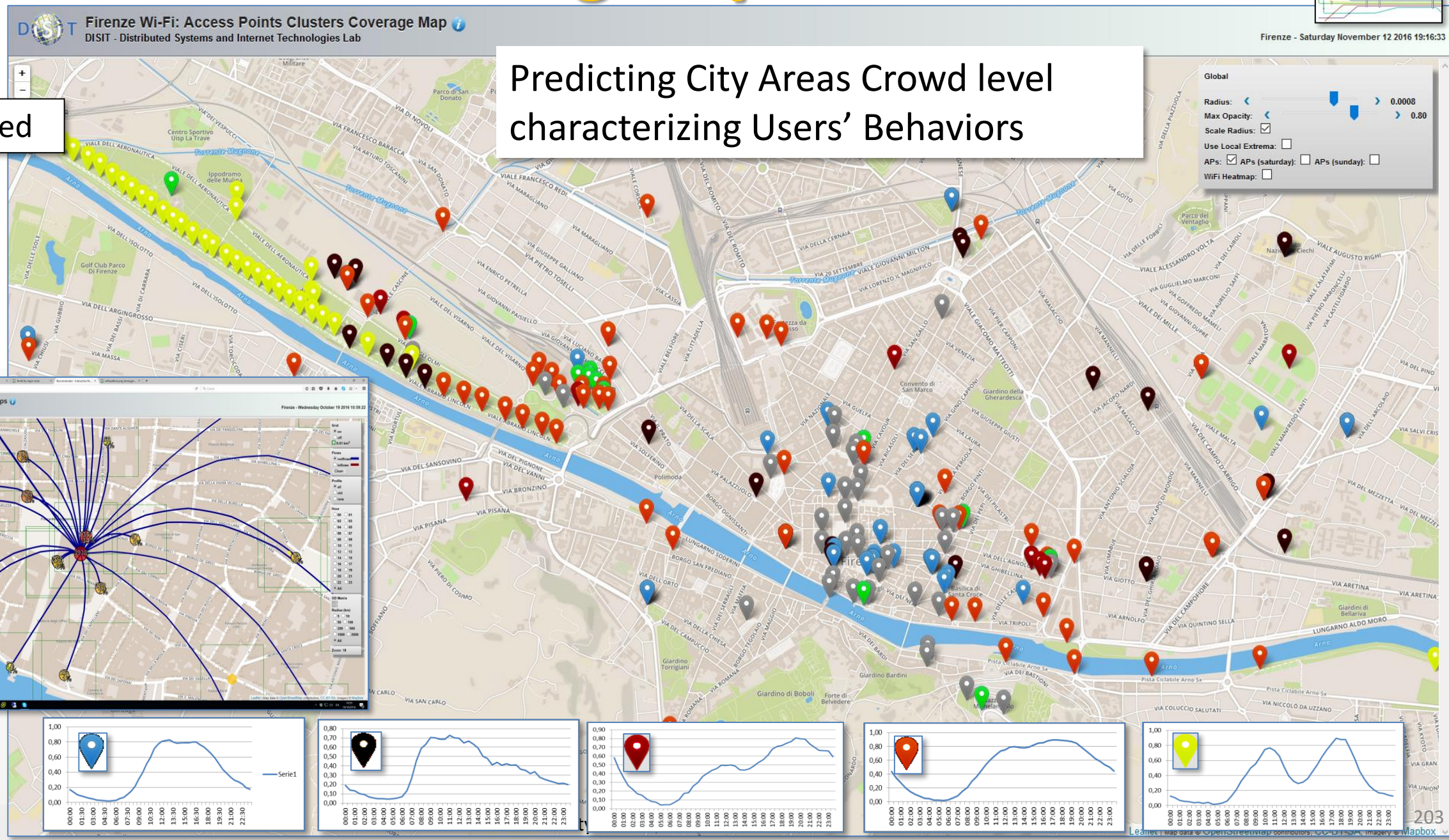
Recency



Characterizing City Areas

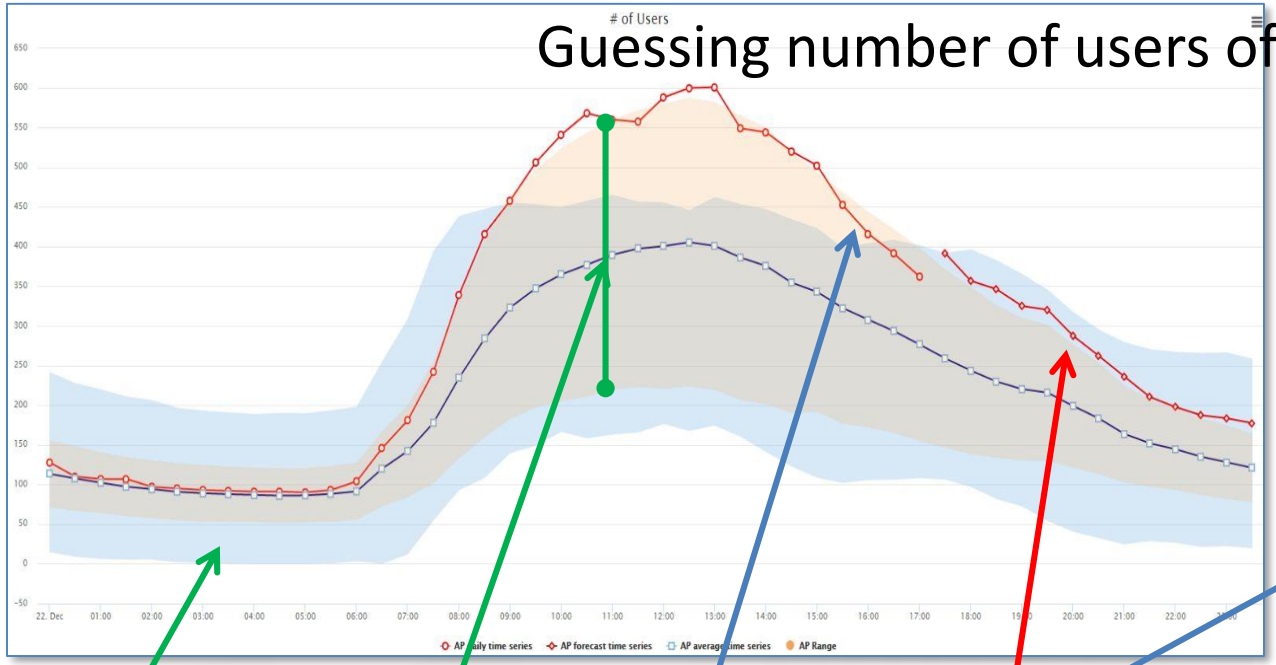
Wi-Fi based

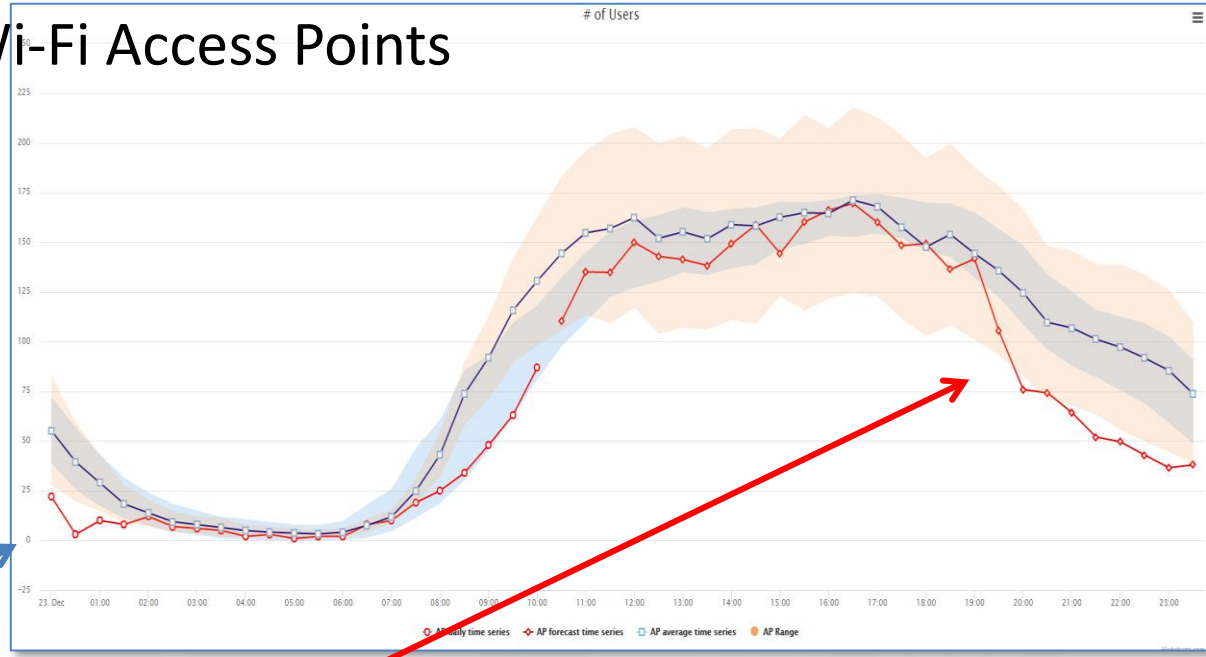
Predicting City Areas Crowd level characterizing Users' Behaviors



Prediction and identification of anomalies

Guessing number of users of Wi-Fi Access Points



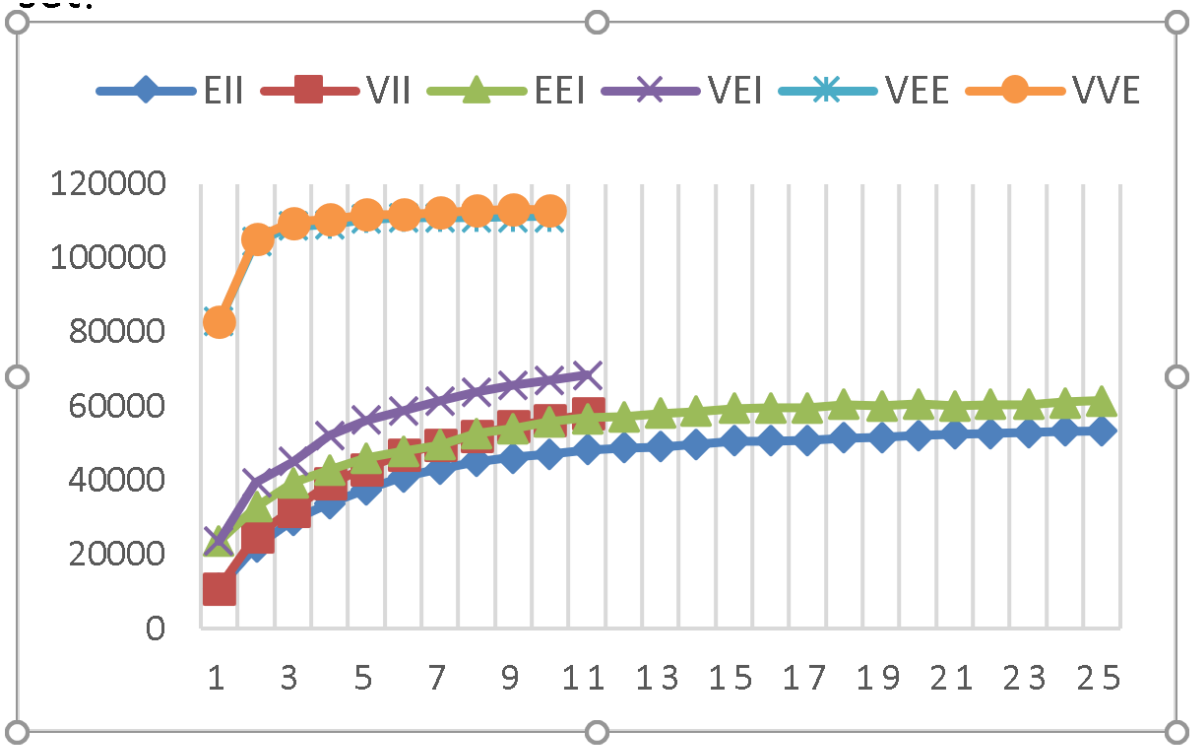


Cluster confidence

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



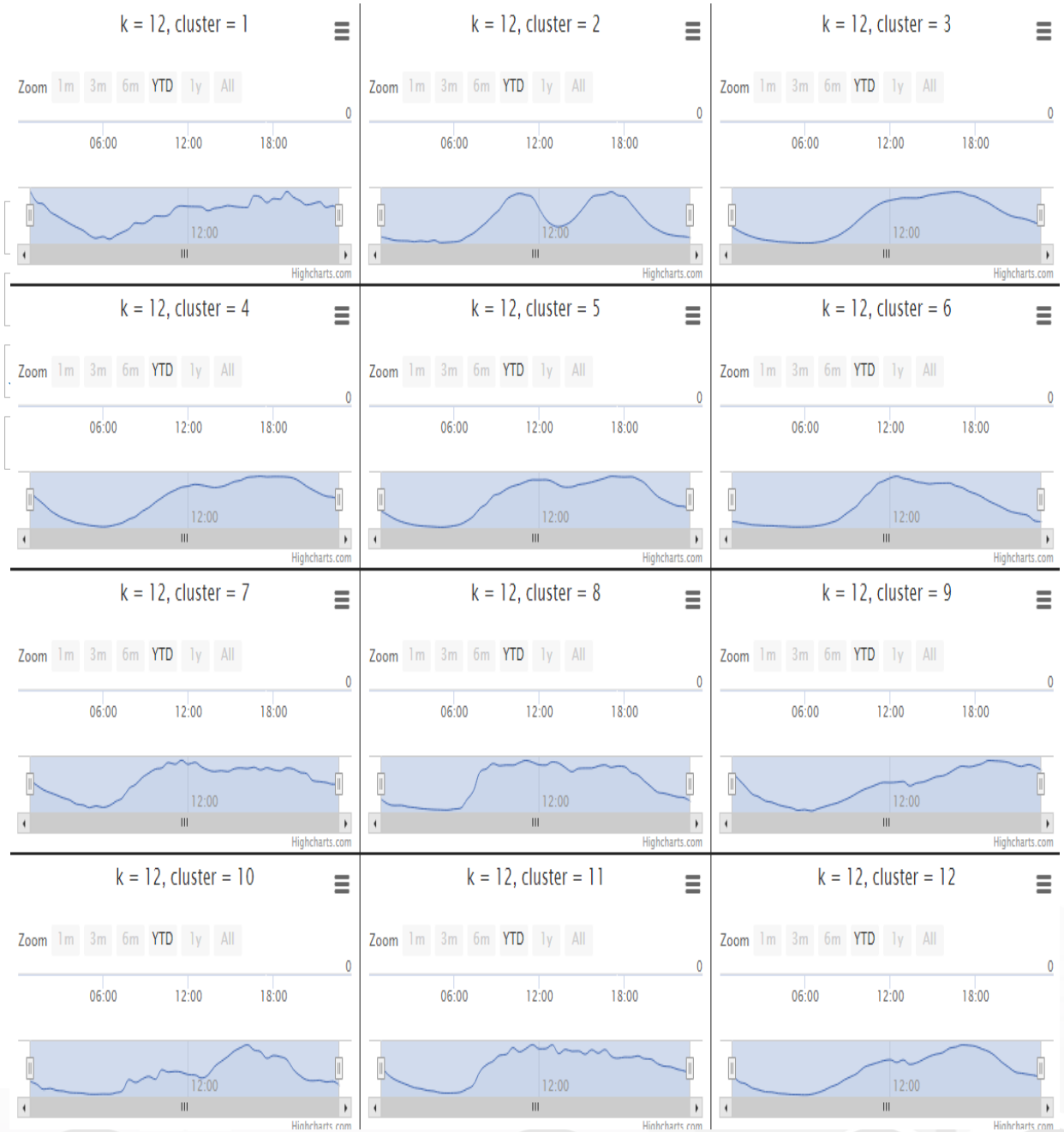
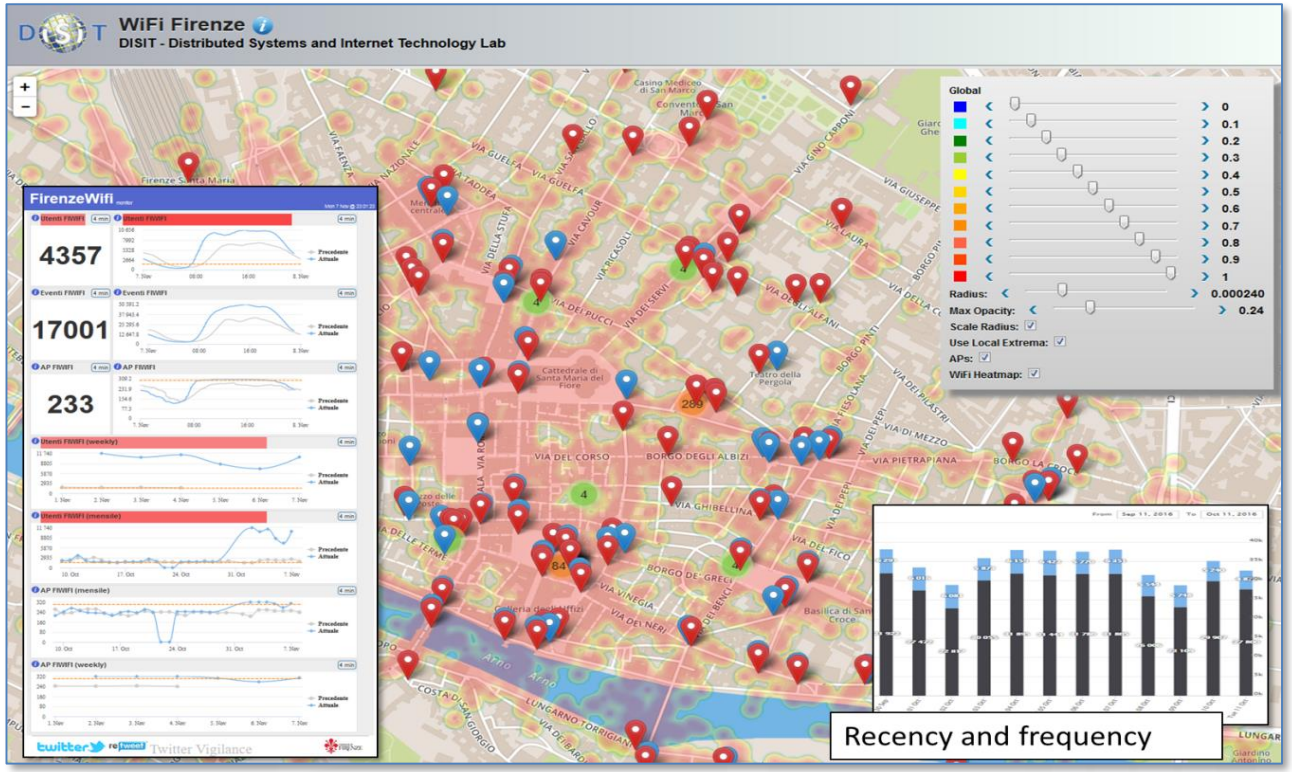
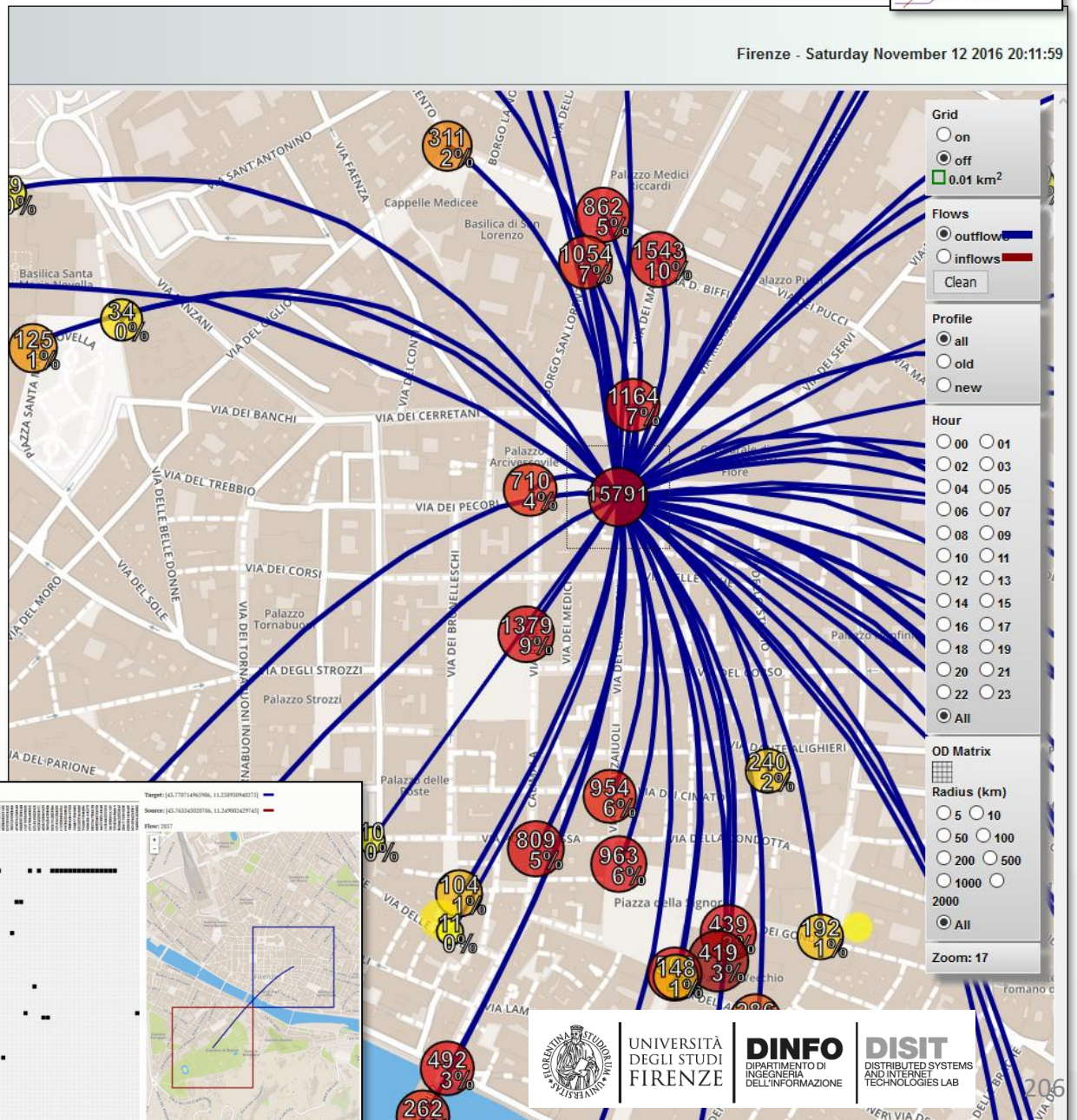
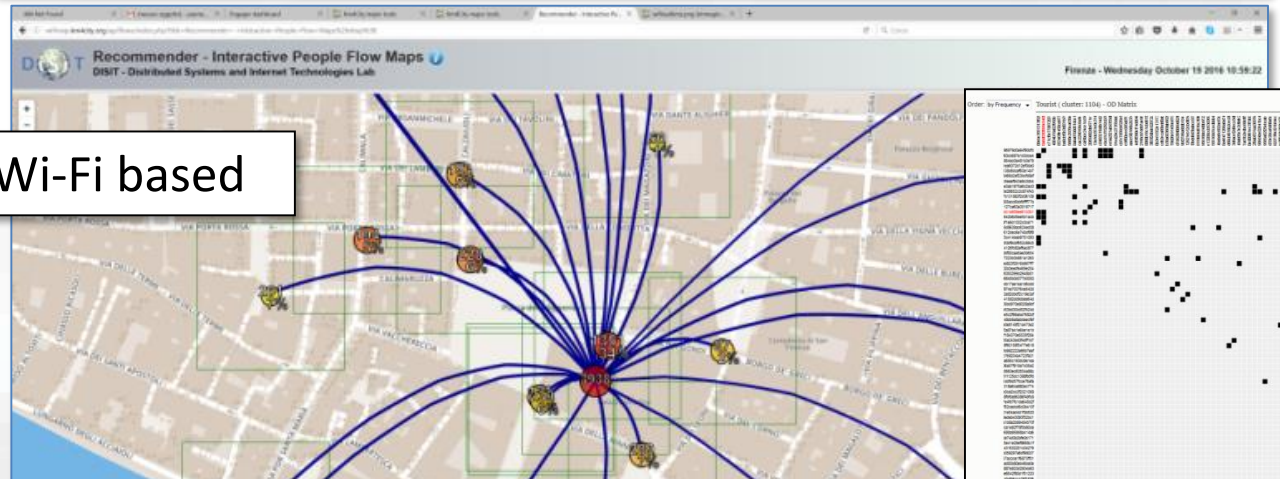


Figure 14 – Average BIC for mixture models vs K number of cluster, higher values are better, the curves are truncated at the best value for K they found.

Origin Destination Matrix Estimation







Wi-Fi based

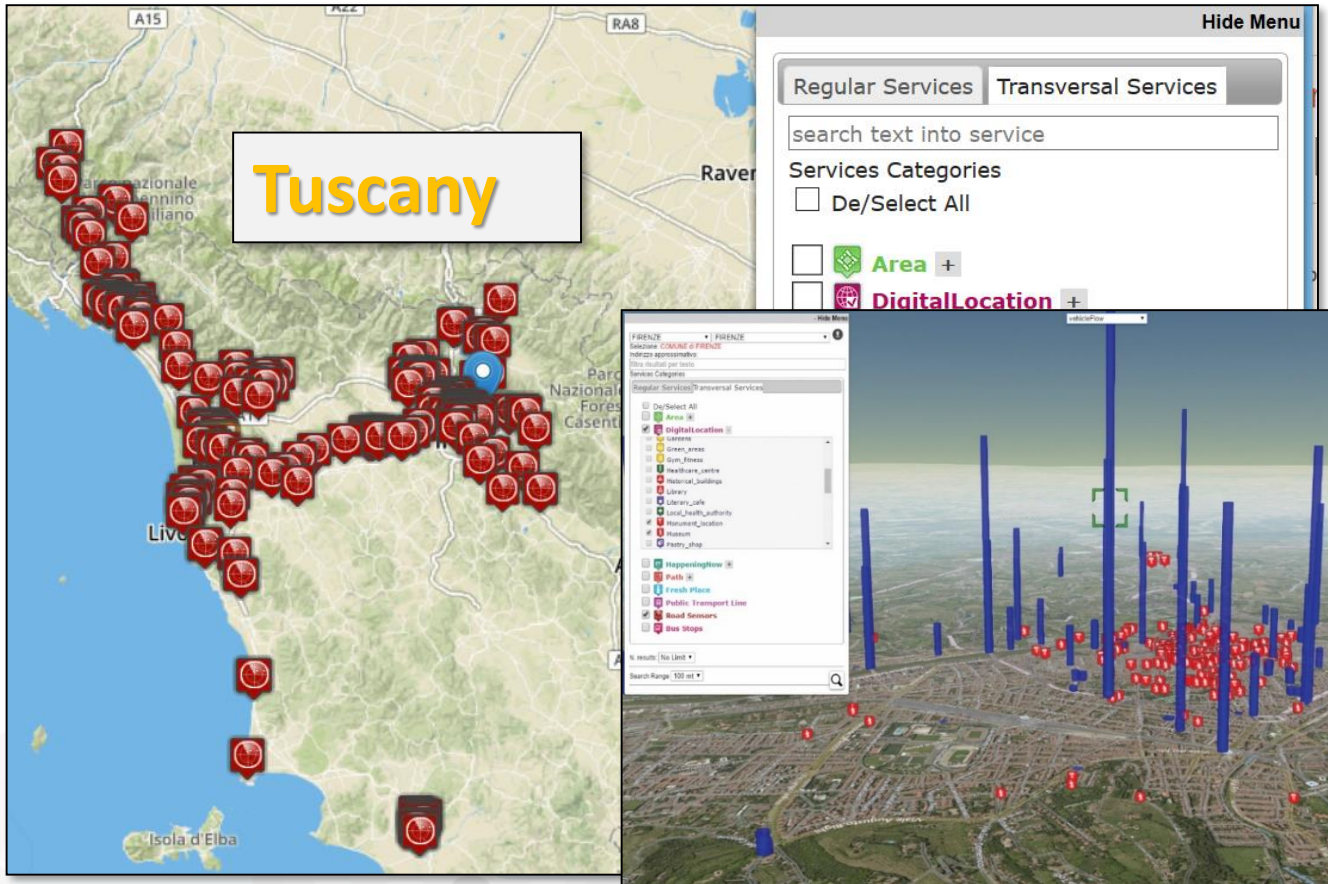
UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

Traffic Flows



Traffic Flow Tools

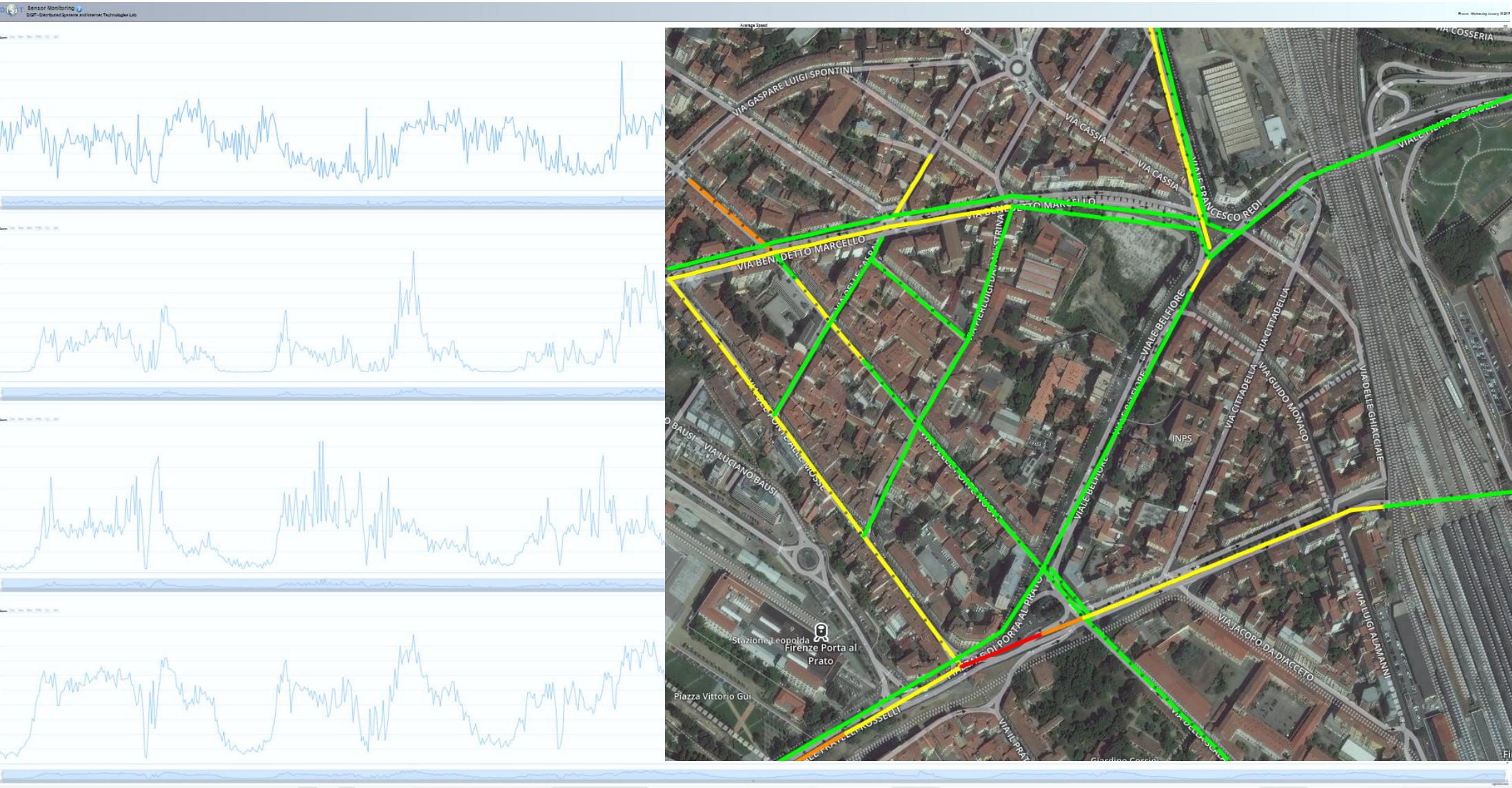
- Spire and Virtual Spires (cameras), Bluetooth, ..
- Specifically located: along, around, ..

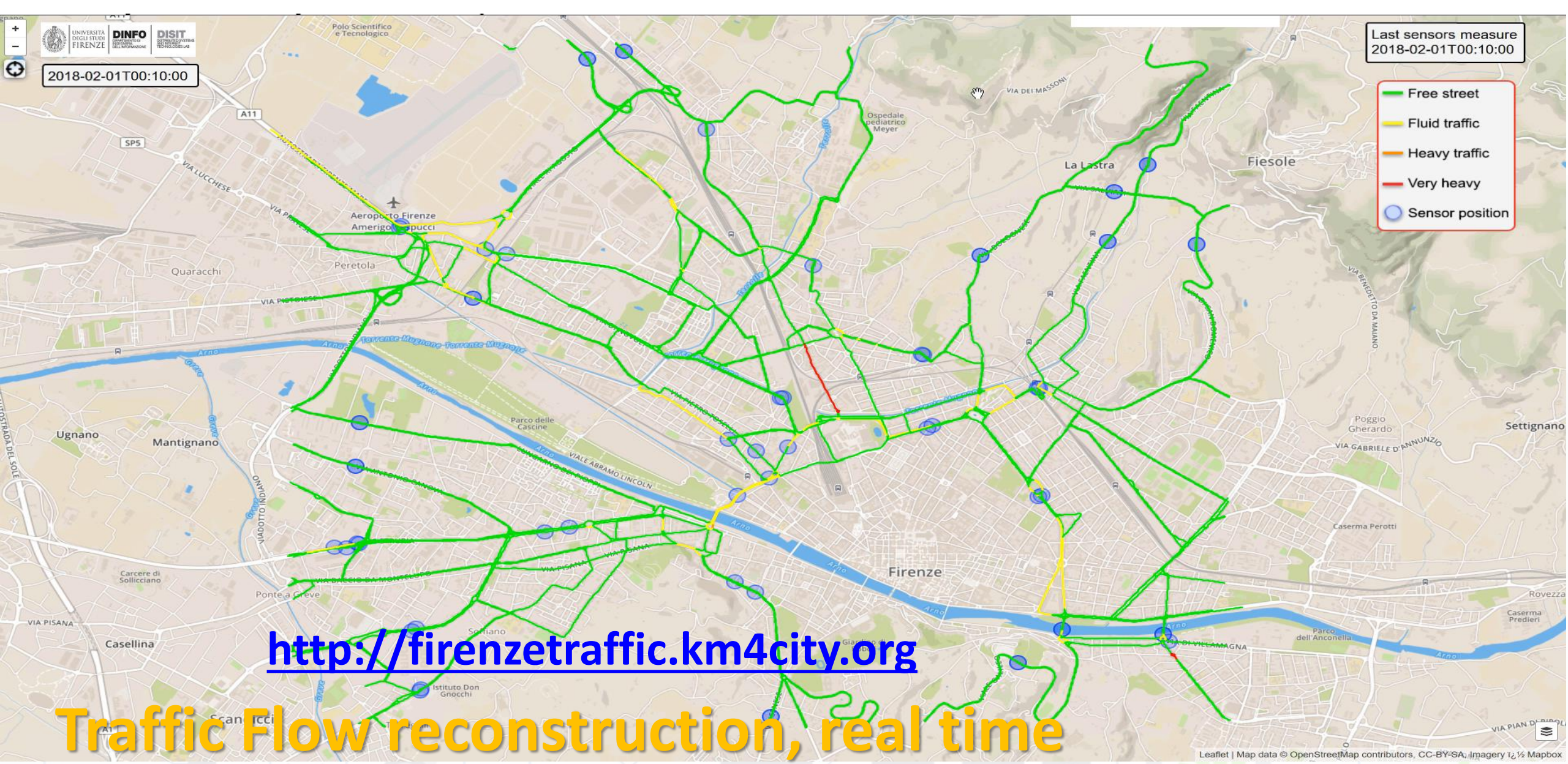






Traffic Flow data





http://firenzetraffic.km4city.org

Traffic Flow reconstruction, real time

https://www.km4city.org/traffic

Traffic Flow reconstruction, real time

Mathematical model

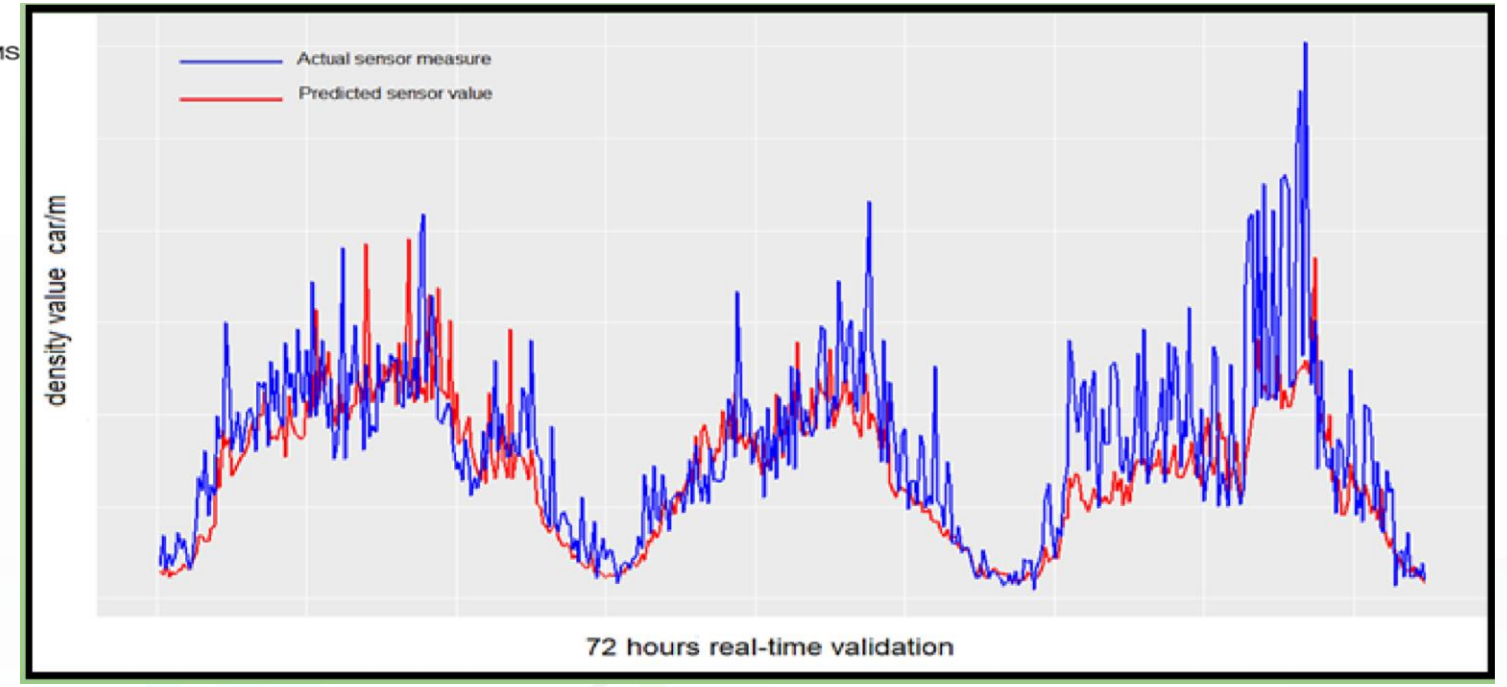
The vehicular traffic flow is propagated in the city graph according to a fluid dynamics model which is based on the conservation law of the vehicles. In a single road, it is described by the following partial differential equation:

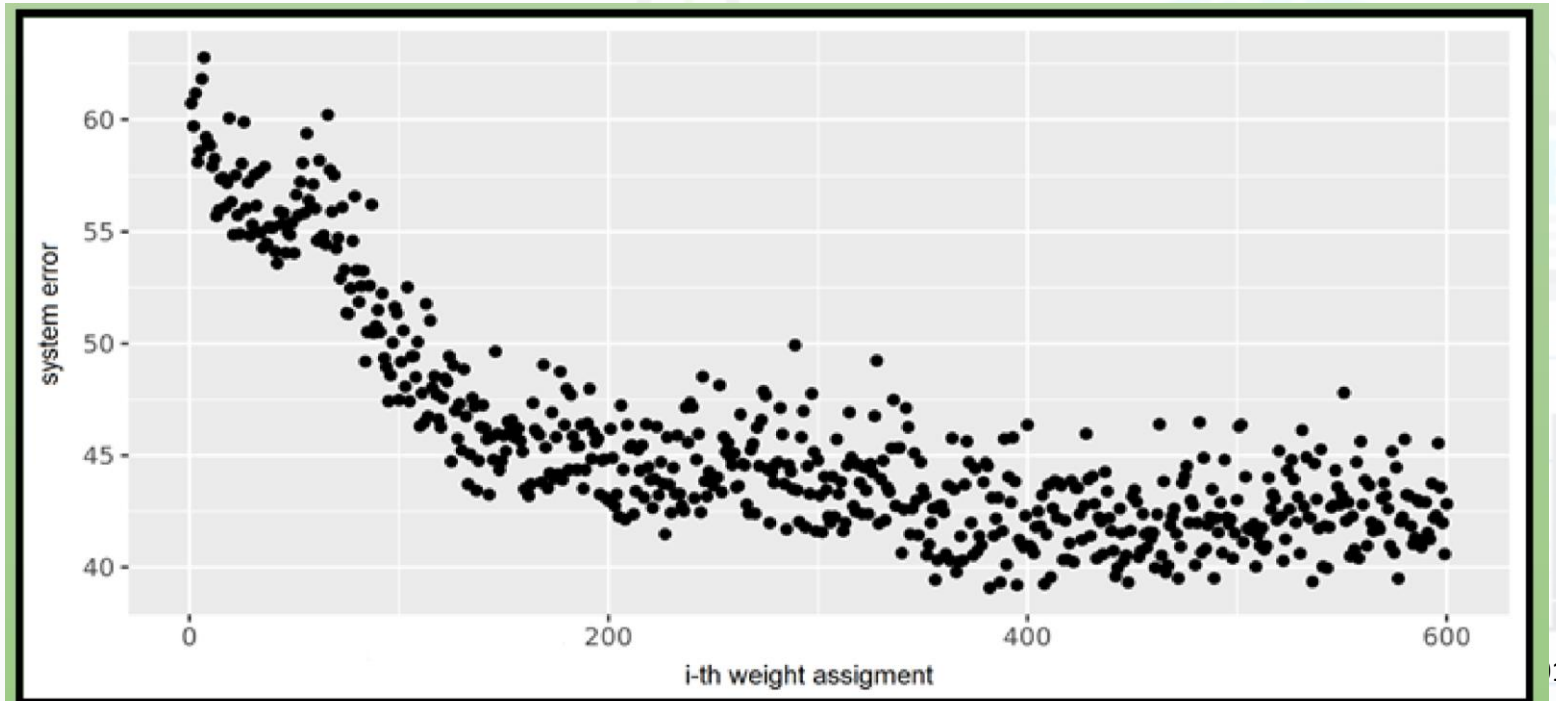
$$\frac{\partial \rho(t,x)}{\partial t} + \frac{\partial f\left(\rho(t,x)\right)}{\partial x} = 0$$

where $\rho(t,x)$ denotes the vehicular density and the function $f(\rho(t,x))$ is the vehicular flux which is defined as the product $\rho(t,x)v(t,x)$, being $v(t,x)$ the local speed of the vehicles.

A discretization scheme in terms of *finite differences* is considered to obtain a numerical solution of the above equation. The traffic flow is then distributed through the junctions in the city.

Convergence of learning phase

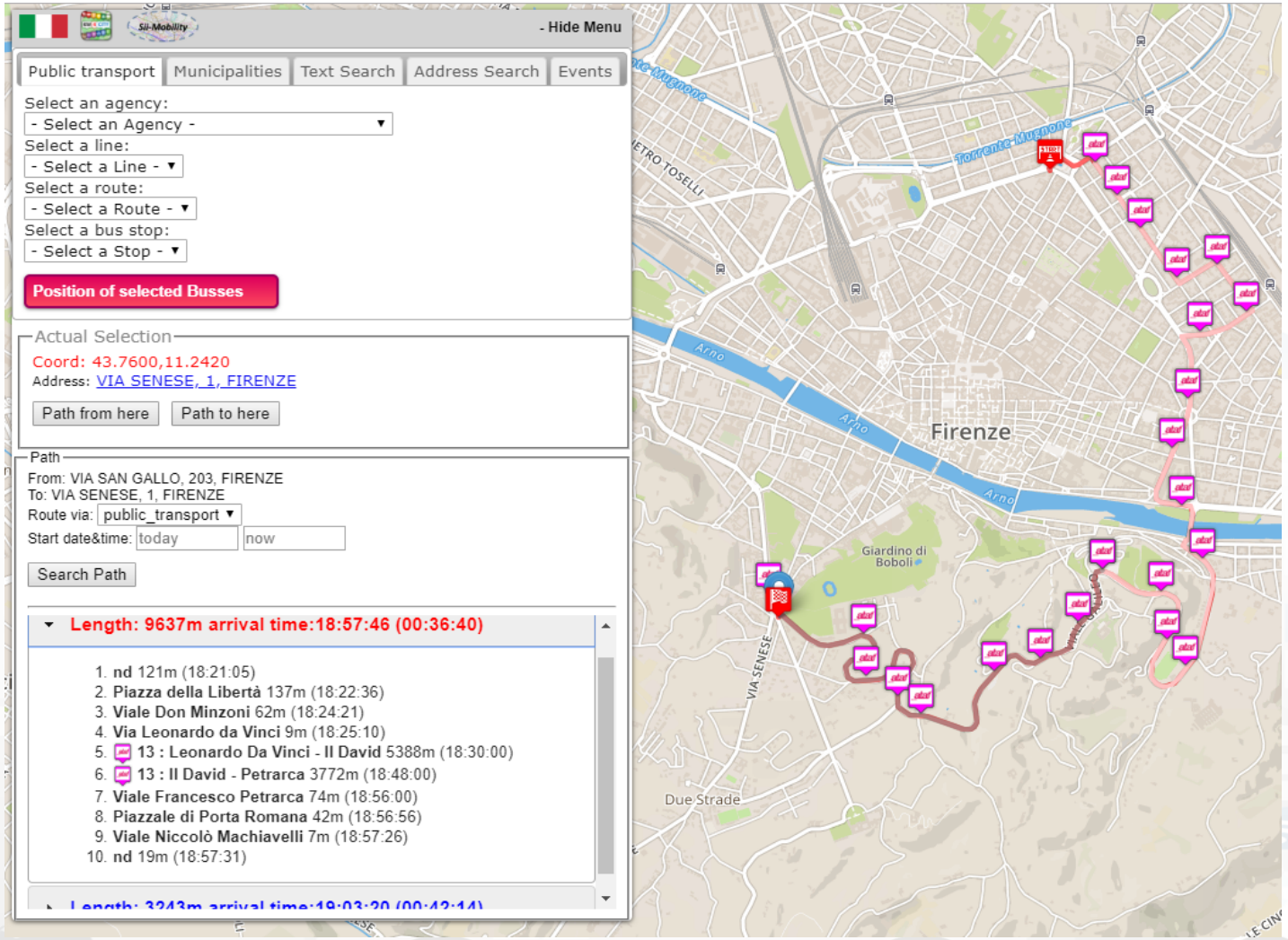




Traffic Flow reconstruction, real time

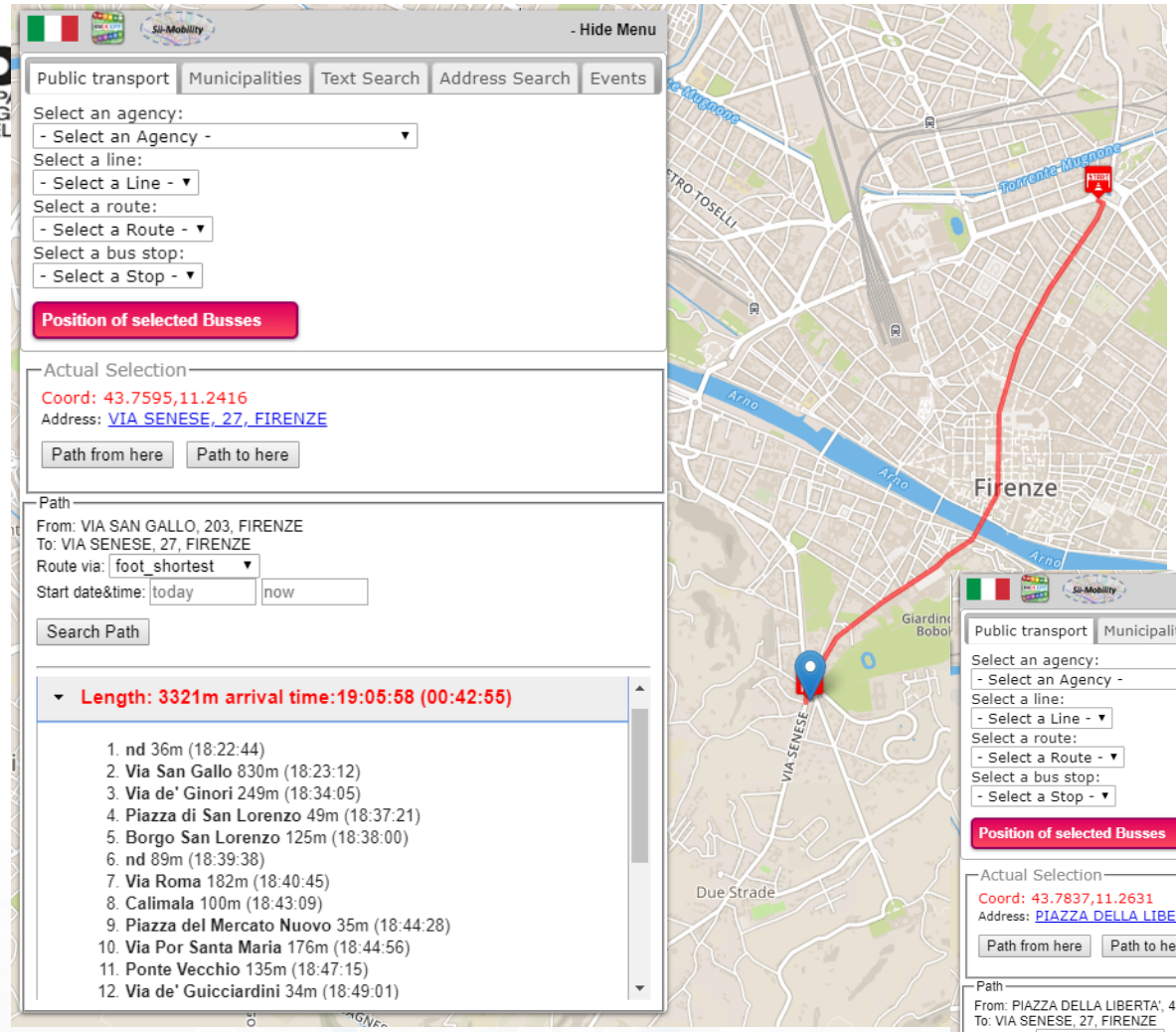
Routing and Multimodal Routing

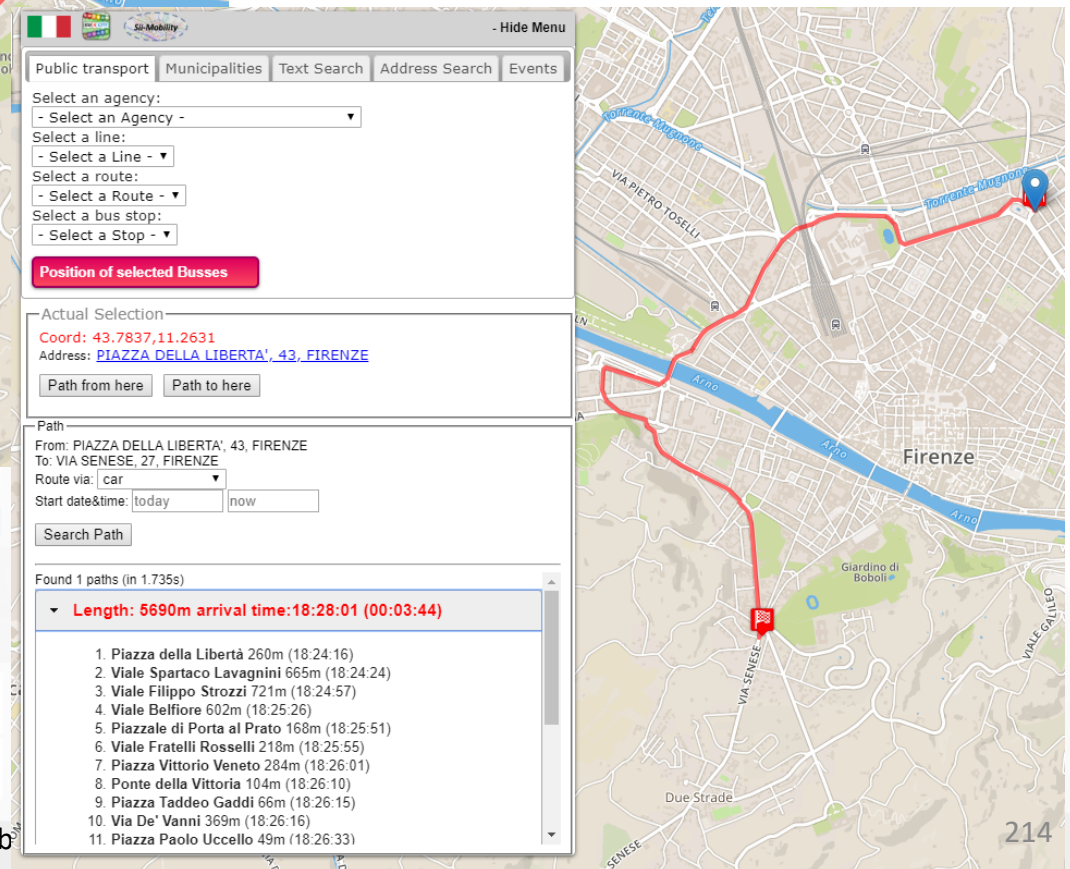
- Pedonal
- Veichles
- Public Multimodal
- Delivering



Routing

- Pedonal
  - Normal
  - Quite





Developing Data Analytics in R Studio

Snap4City

roottooladmin1
RootAdmin | ldap

- Dashboards
- My Dashboards
- Notificator
- IOT Applications
- My Personal Data
- IOT Directory and Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
  - R Studio Development
  - ETL Development
  - Knowledge Base Graphs
  - Knowledge Base Queries
  - Smart City API Docs: Swagger
  - Internal API Docs: Swagger
  - Testing API by Postman
  - Source Code Access
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles

R Studio Development

File Edit Code View Plots Session Build Debug Profile Tools Help

snap4city

Project: (None)

Console Terminal

~/Snap4City/Snap4CityStatistics/

```
> source('~/Snap4City/Snap4CityStatistics/RunRestApi.R')
Starting server to listen on port 8080
Running the swagger UI at http://127.0.0.1:8080/__swagger__/

> setwd("~/Snap4City/Snap4CityStatistics")
> source('~/Snap4City/Snap4CityStatistics/Stat4CityFunctions.R')
> api <- plumber::plumb("Stat4CityFunctions.R")
> api$run(host = "0.0.0.0", port=8080)
Starting server to listen on port 8080
Running the swagger UI at http://127.0.0.1:8080/__swagger__/
```

RunRestApi.R | 00Index.html | INDEX

Source on Save | Run | Source

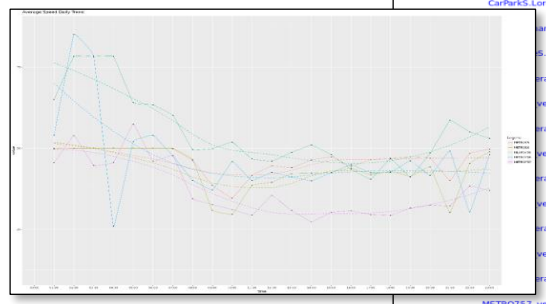
```
1 setwd("~/Snap4City/Snap4CityStatistics")
2 source('~/Snap4City/Snap4CityStatistics/Stat4CityFunctions.R')
3 api <- plumber::plumb("Stat4CityFunctions.R")
4 api$run(host = "0.0.0.0", port=8080)
```

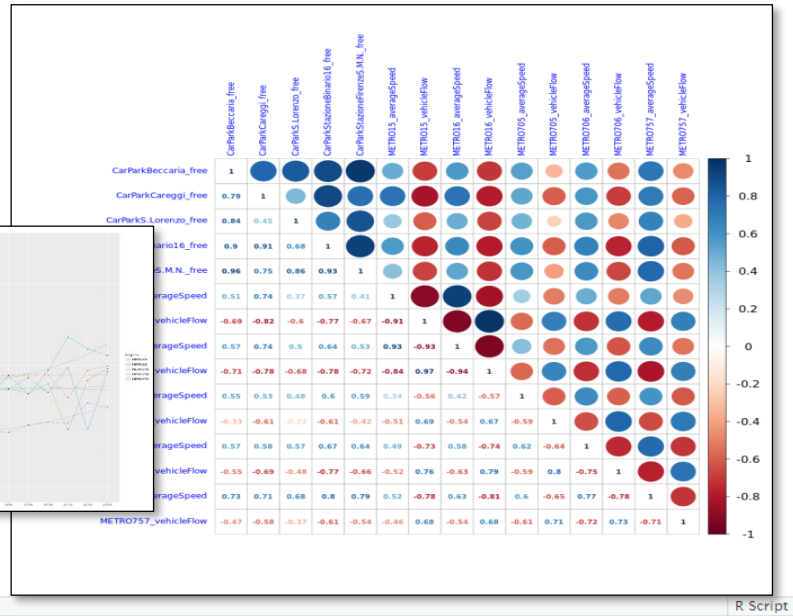
Files | Plots | Packages | Help | Viewer

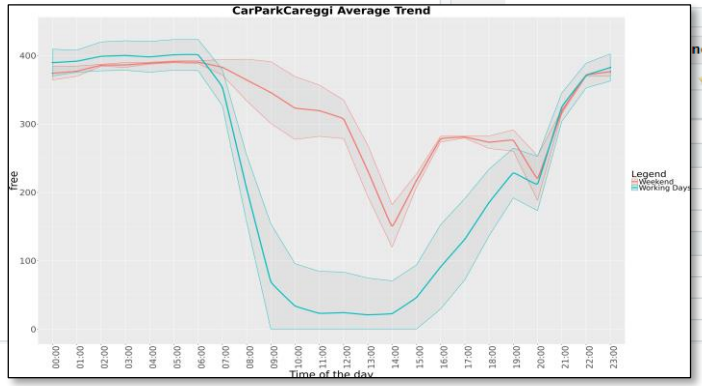
New Folder | Upload | Delete | Rename | More

Home

Name	Size	Modified
nohup.out	72 B	Mar 30, 2018, 9:47 AM
R		
Snap4City		
Snap4CityDEMO		
Snap4CityOld		







R Script

List

```
1500 obs. of 2 variables
<Object containing active binding>
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"http://192.168.0.206:8890/sparql?default-graph-uri=&query=SELECT+DISTINCT+%3Fdate+%3Ffre…
function (sensorTypeList, anomalyDate)
function (anomalyDate
function (sensorTyp
function (Sens
```
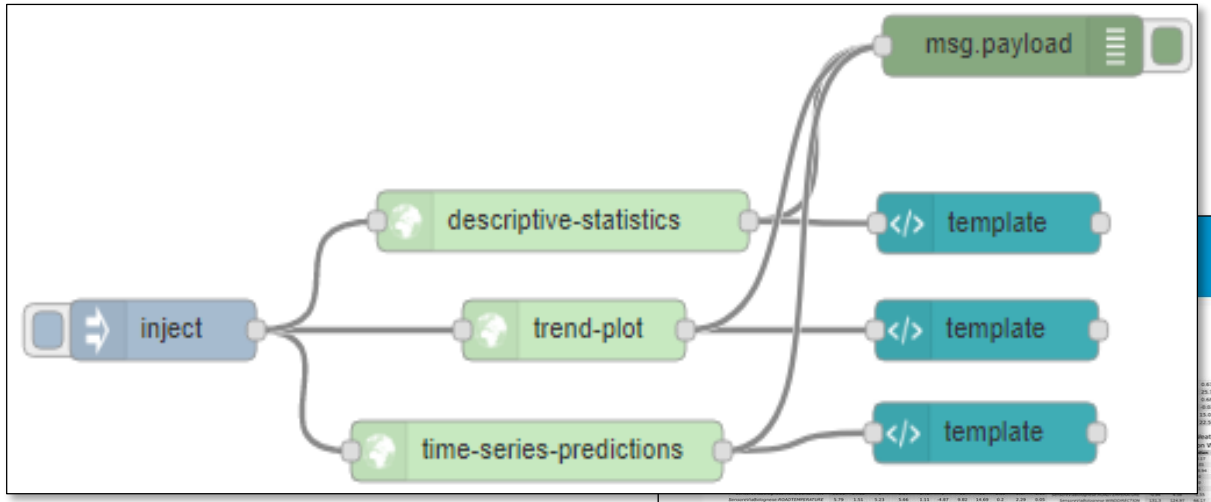
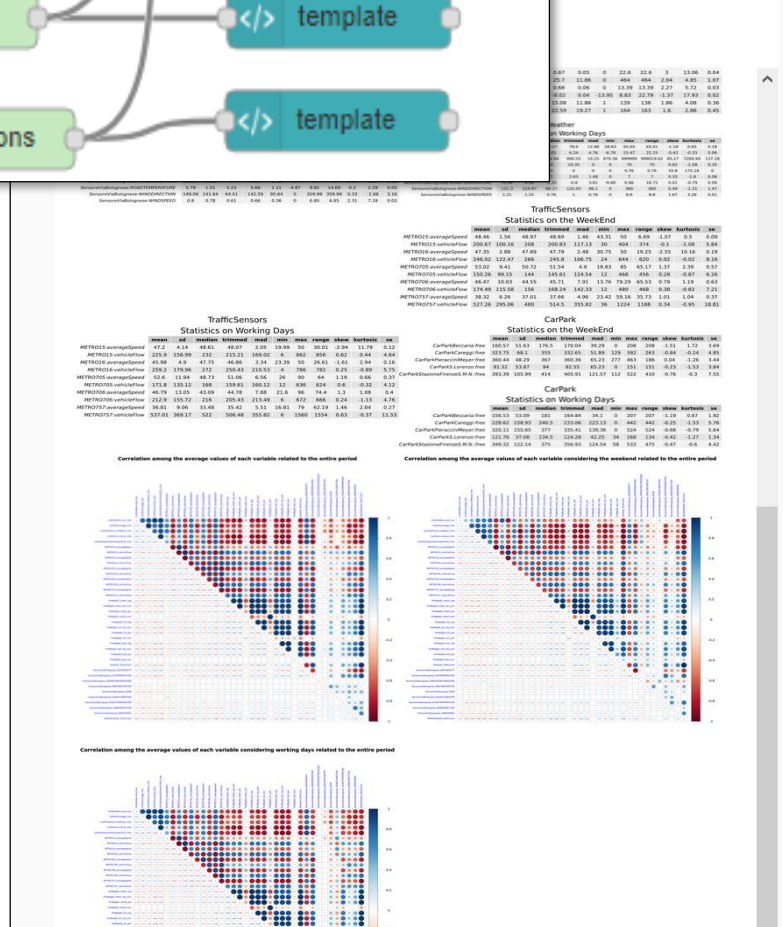
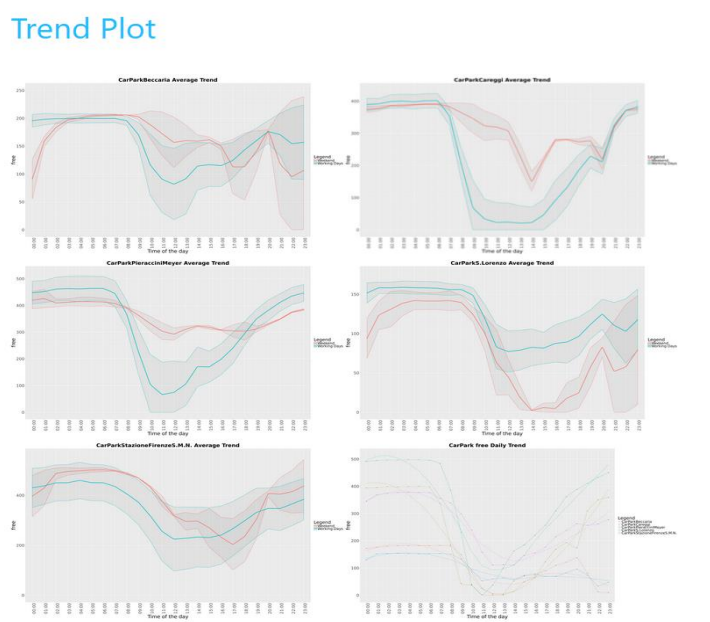
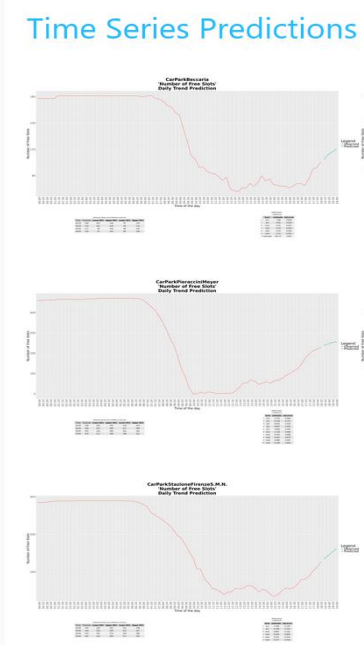

Developing Data Analytics in R Studio



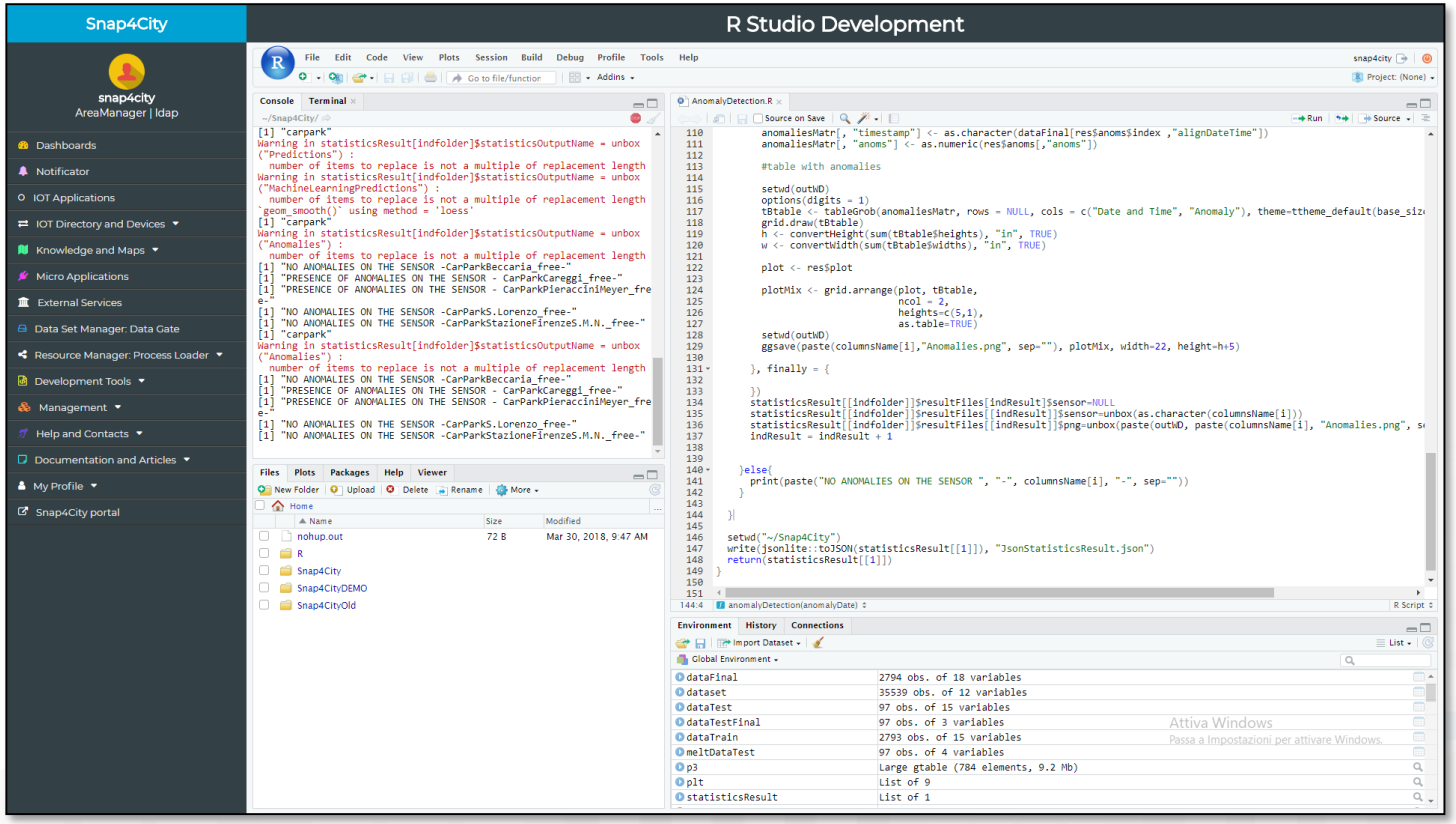
R Studio algorithms are automatically transformed into MicroServices for your IOT Applications

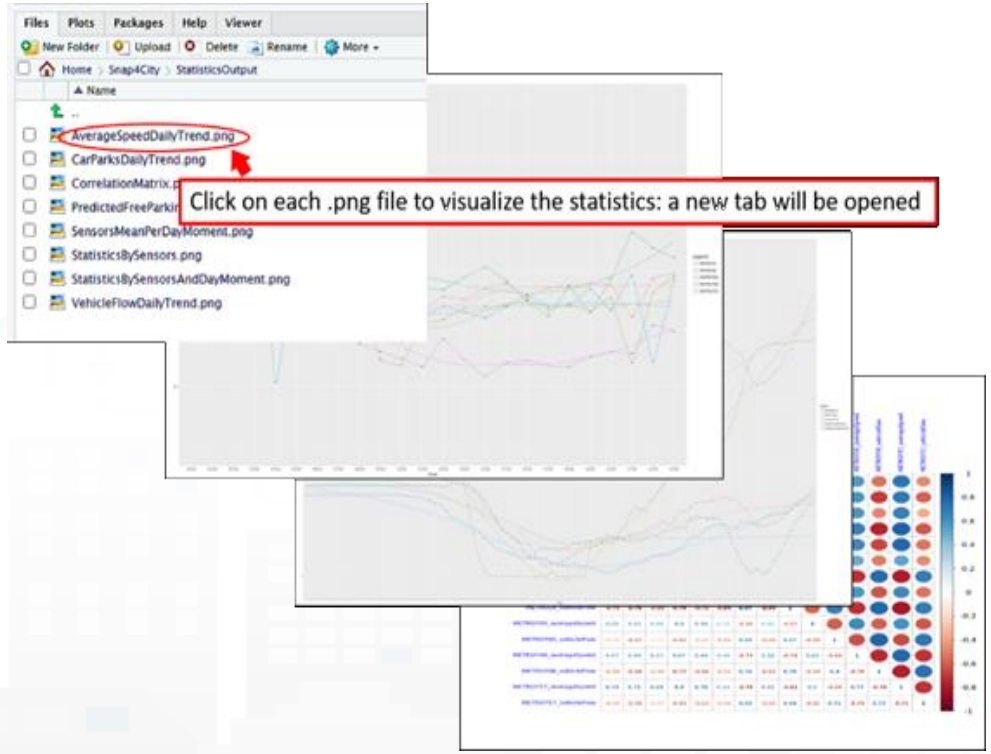


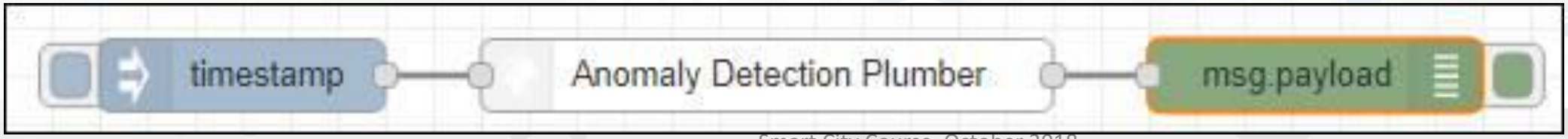




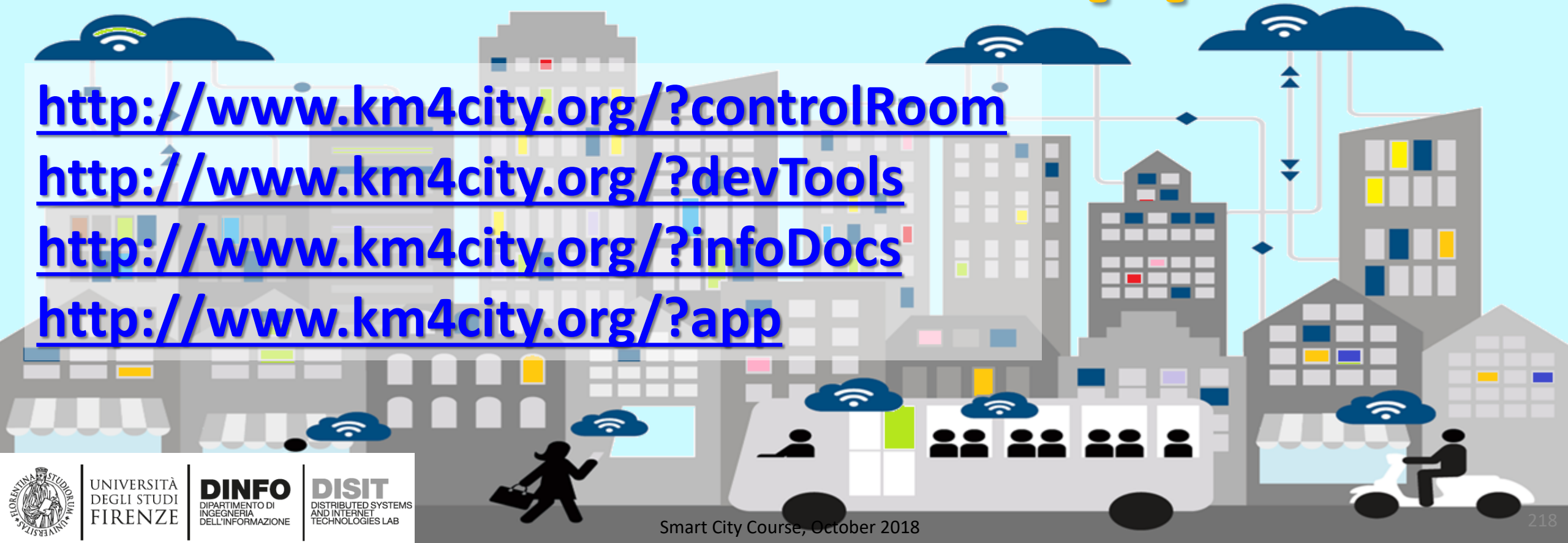
Developing in R Studio + Tensor Flow







Engaging Users via Mobile App



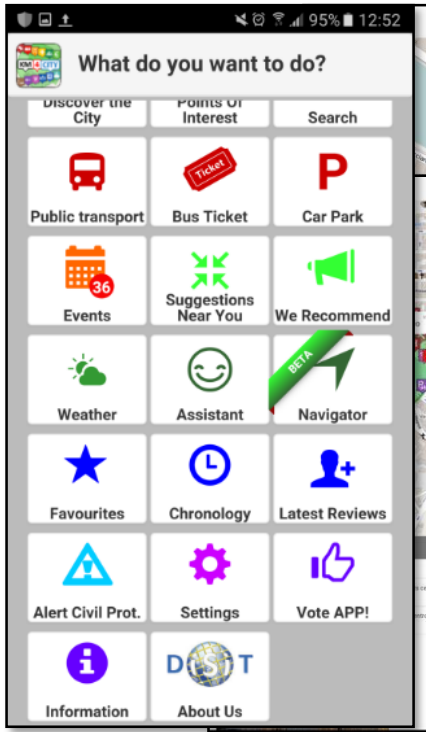
http://www.km4city.org/?controlRoom
http://www.km4city.org/?devTools
http://www.km4city.org/?infoDocs
http://www.km4city.org/?app

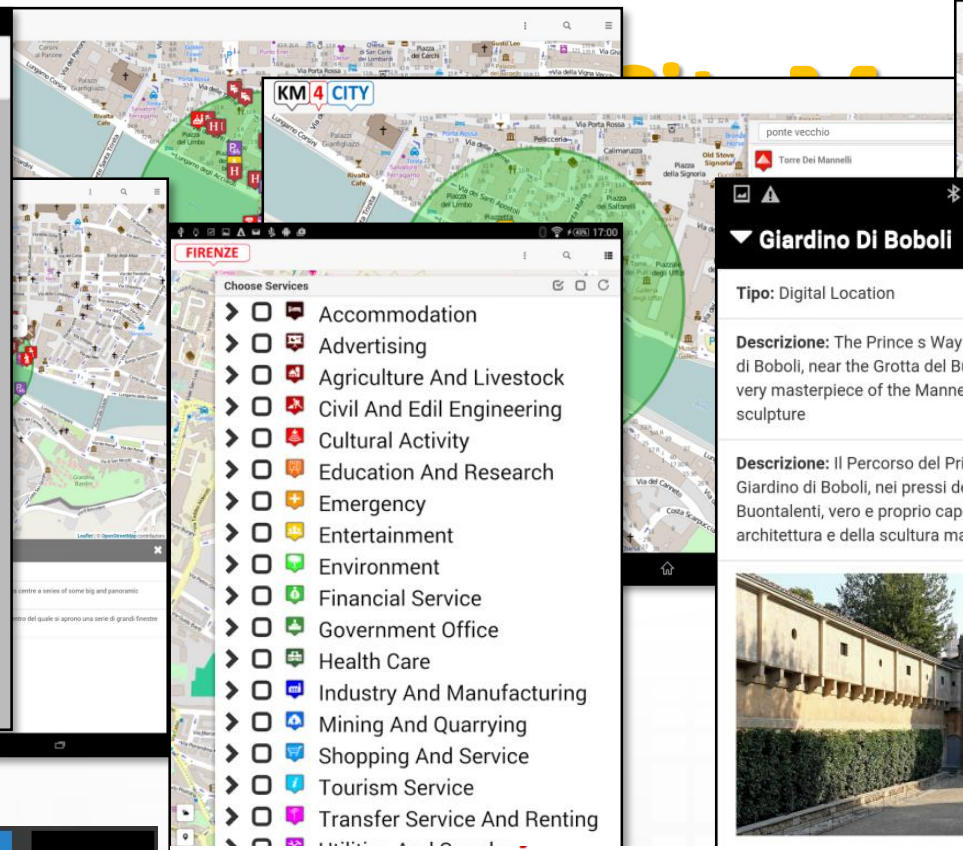
KM 4 CITY

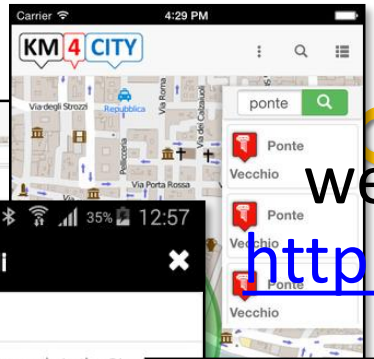
Sii-Mobility

web application

http://www.km4city.org



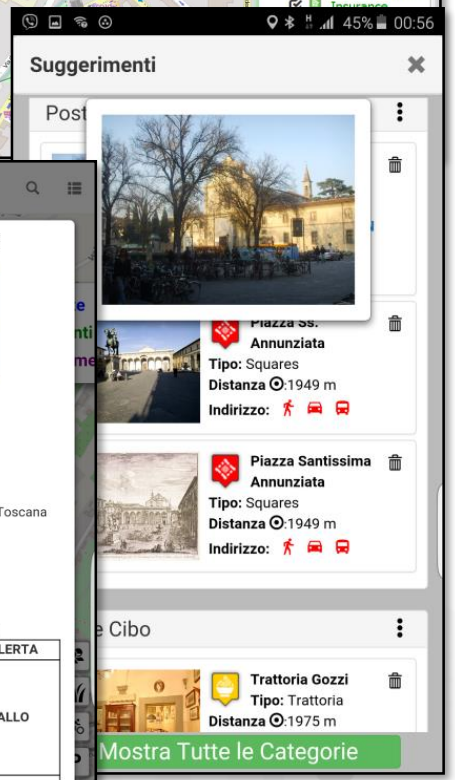














DISPONIBILE SU Google play

Scarica da App Store

Scarica da Windows Store

Km4City APP, features 1/3

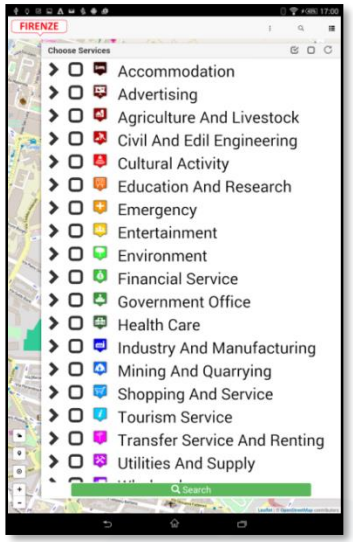
- **5 languages:** IT, EN, SP, DE, FR
- **Profiles** city users: Citizens, commuter, student, tourist, operator, etc..
- **Profiled Menu** per POI
  - adaptive
- **Main Menu: dynamic, and personalized**
- **Search Text**
- Search per POI
  - Near to you, near to a point, line...
- Other search
  - Close to you, events green areas, public transport, tickets , Cycling, parking, ….
  - Etc.
- POI
  - Preferred, Social icon
  - Ranking, Comments, images

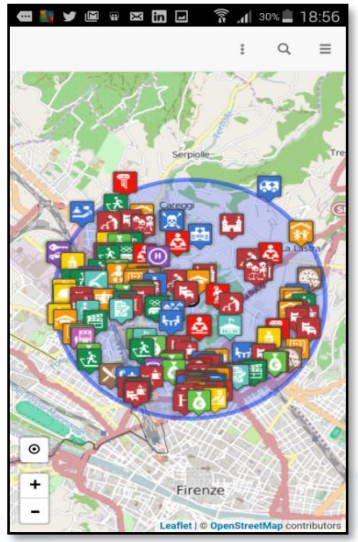
Available on the App Store

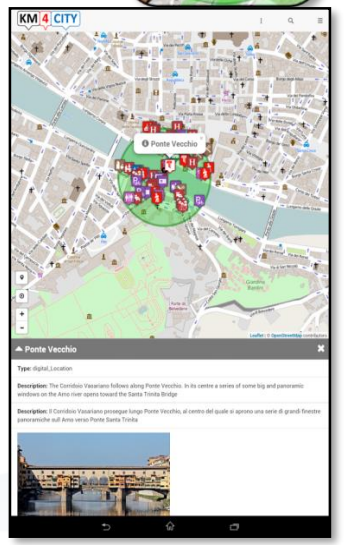
ANDROID APP ON Google play

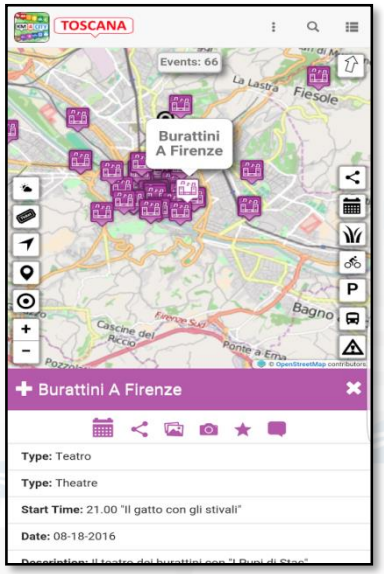
Download from Windows Phone Store

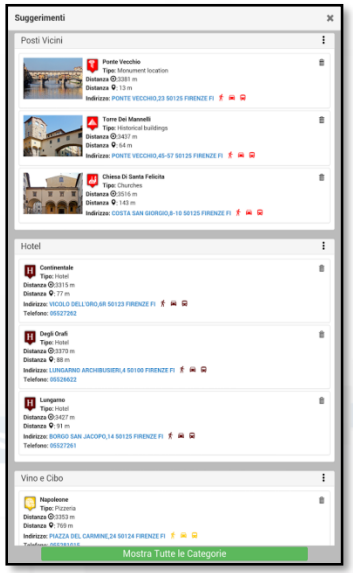


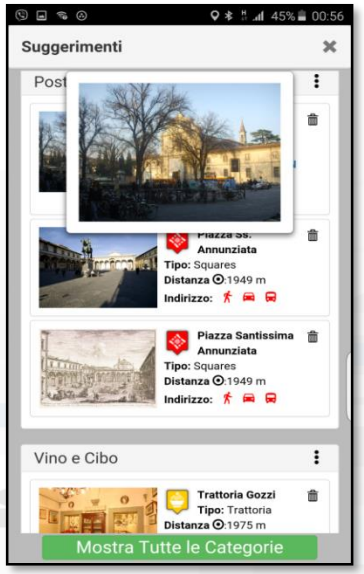


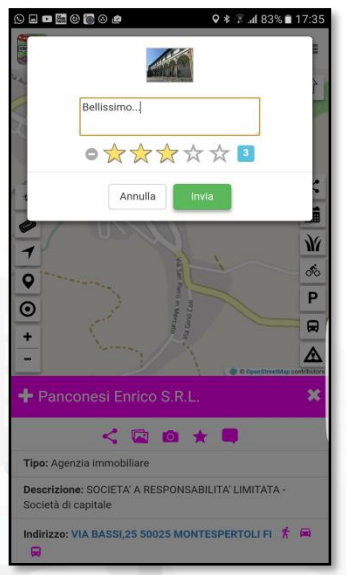






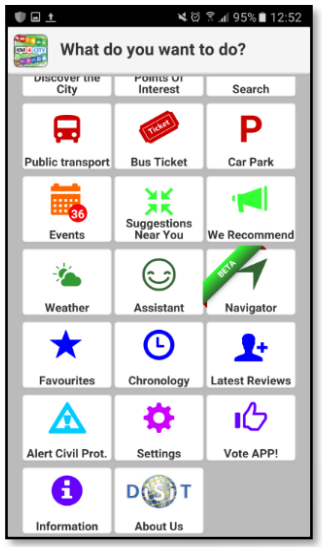


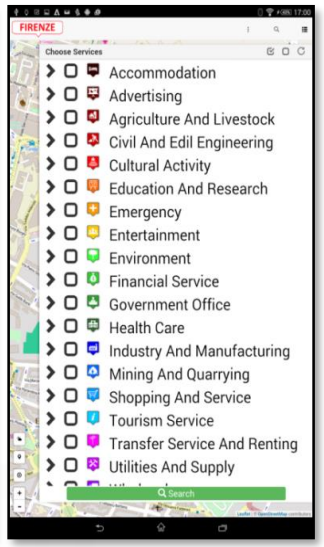




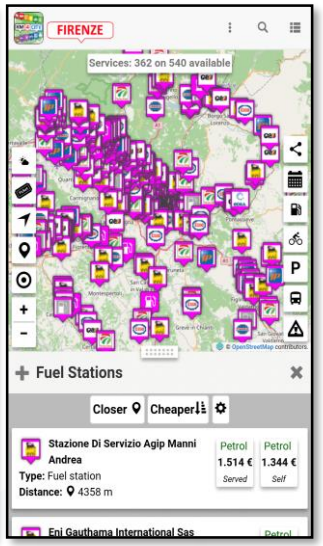
Km4City APP

- Smart Parking, in Tuscany
- Smart First Aid in Tuscany
- Smart Public Transportation in Tuscany
- Smart Fuel pricing in Tuscany
- Bike Sharing in Pisa
- Weather condition in Tuscany
- Pollution and Pollination in Tuscany
- Traffic Sensors in Tuscany
- Smart Routing in Tuscany
- Smart Transportation in Florence
  - Events, traffic, …
- Entertainment Events in Florence

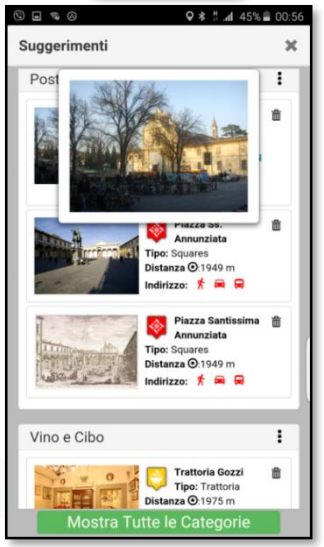


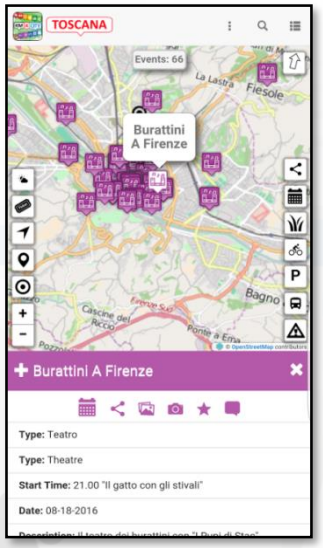




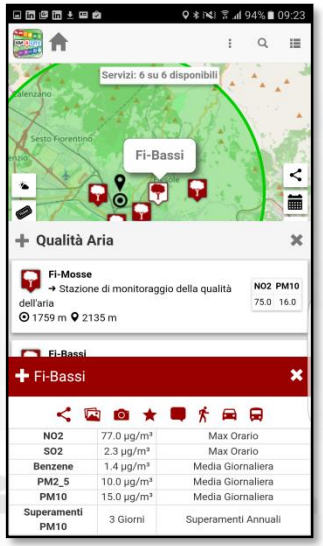


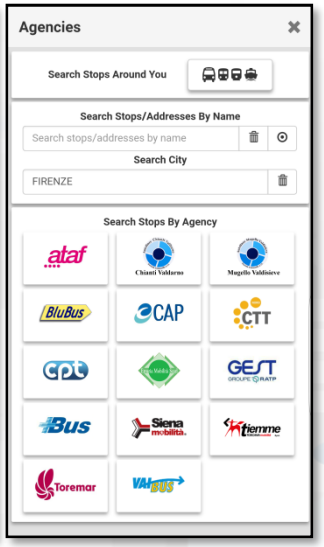














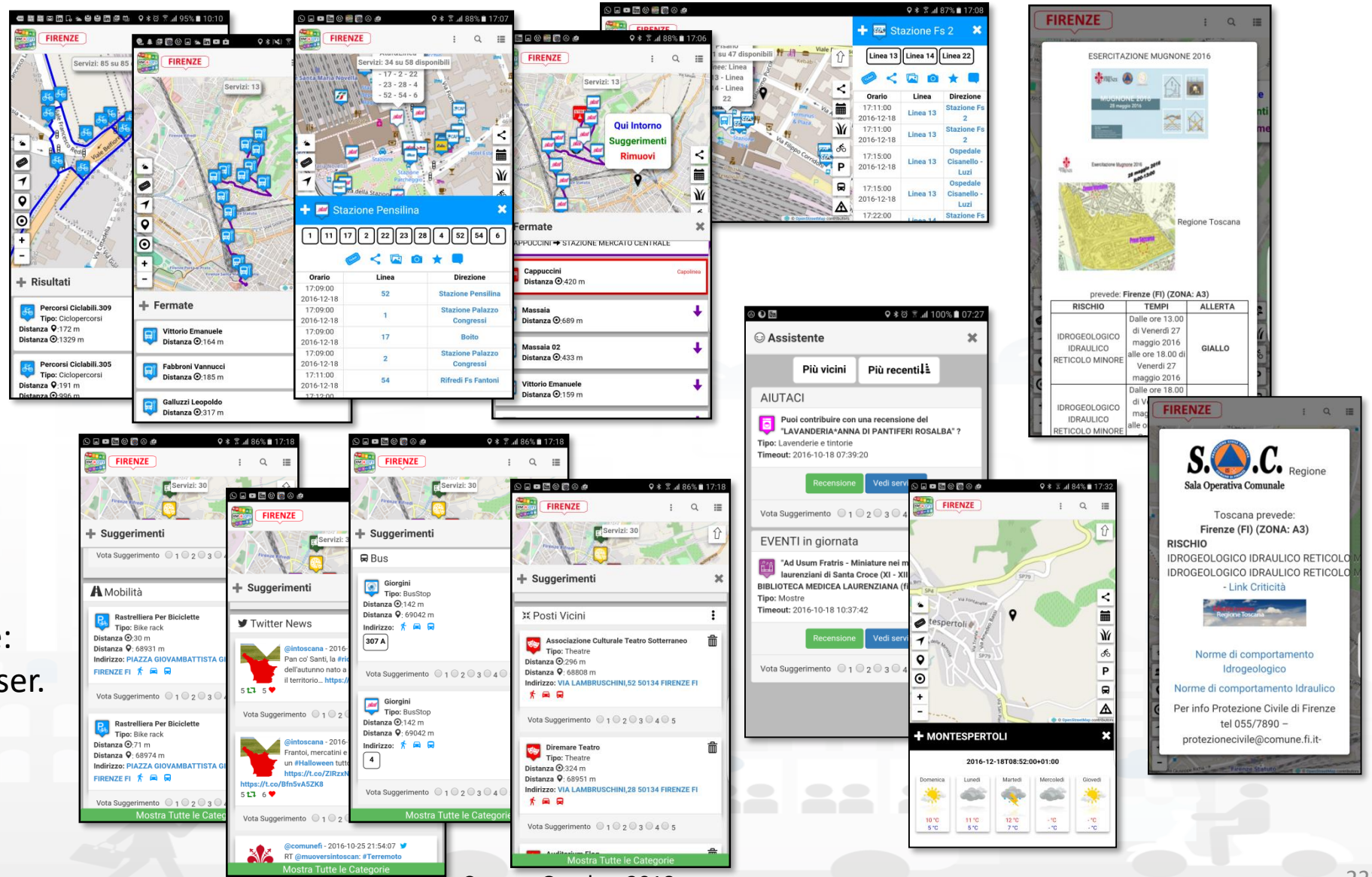
Available on the App Store

ANDROID APP ON Google play

Download from Windows Phone Store

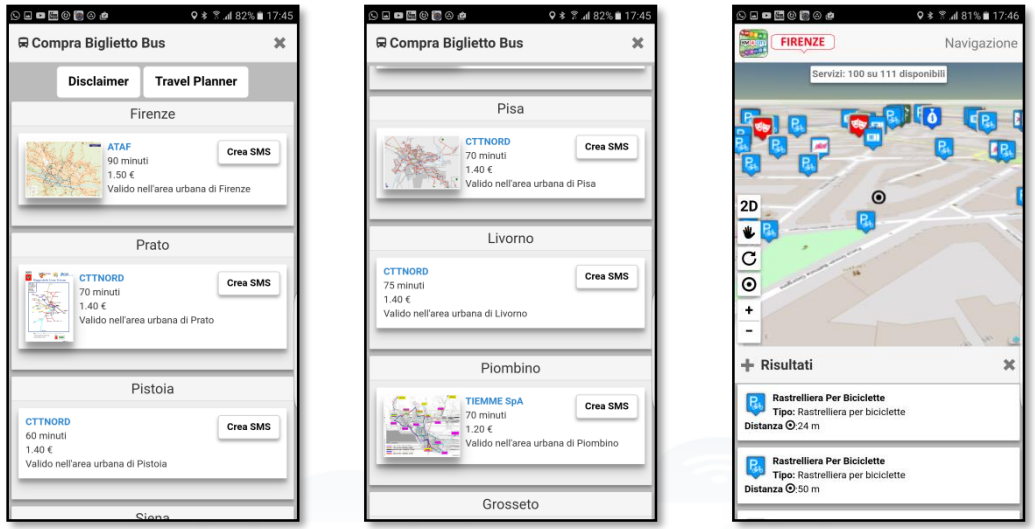
Km4City APP

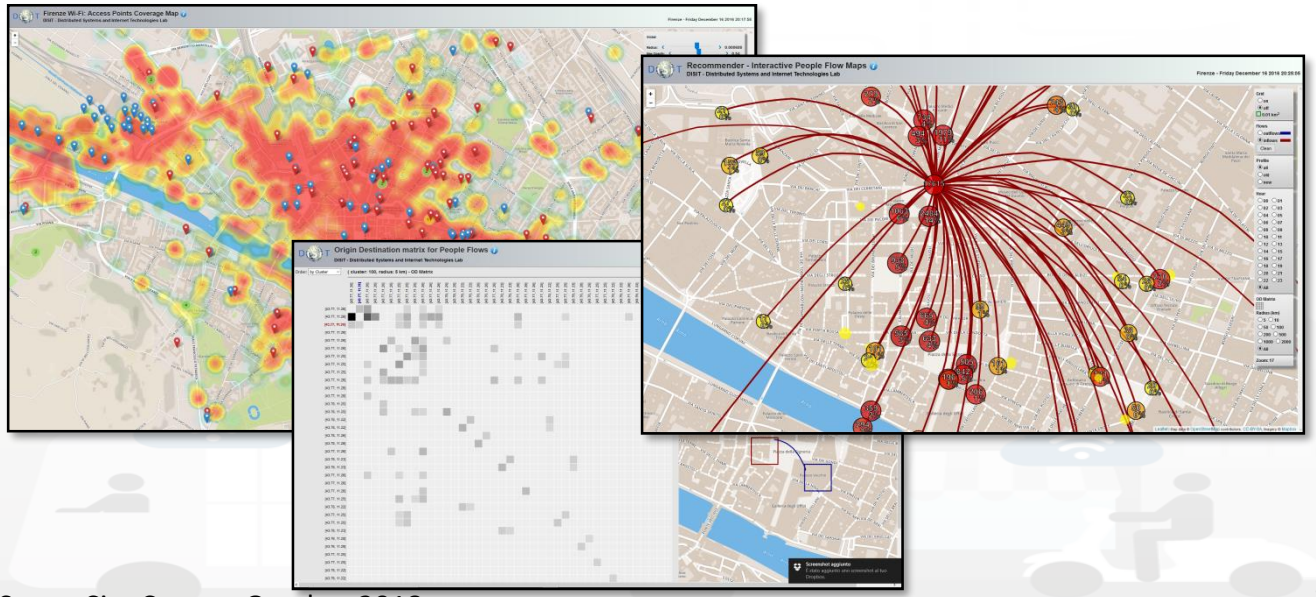
- **Mobility**
  - Paths and stops, time
  - Parching + prediction
  - Ticketing
  - Flow + prediction
  - Navigation
  - Connection with devices
  - XXX Sharing
- **Personal Assistant**
  - Info, Engagement
  - Help, Civil protection
- **Suggestions:**
  - Personalized and adaptive: banned e typed per city user.
  - POI, Twitter, Events,
  - Weather forecast,
  - Civil Protection
  - …



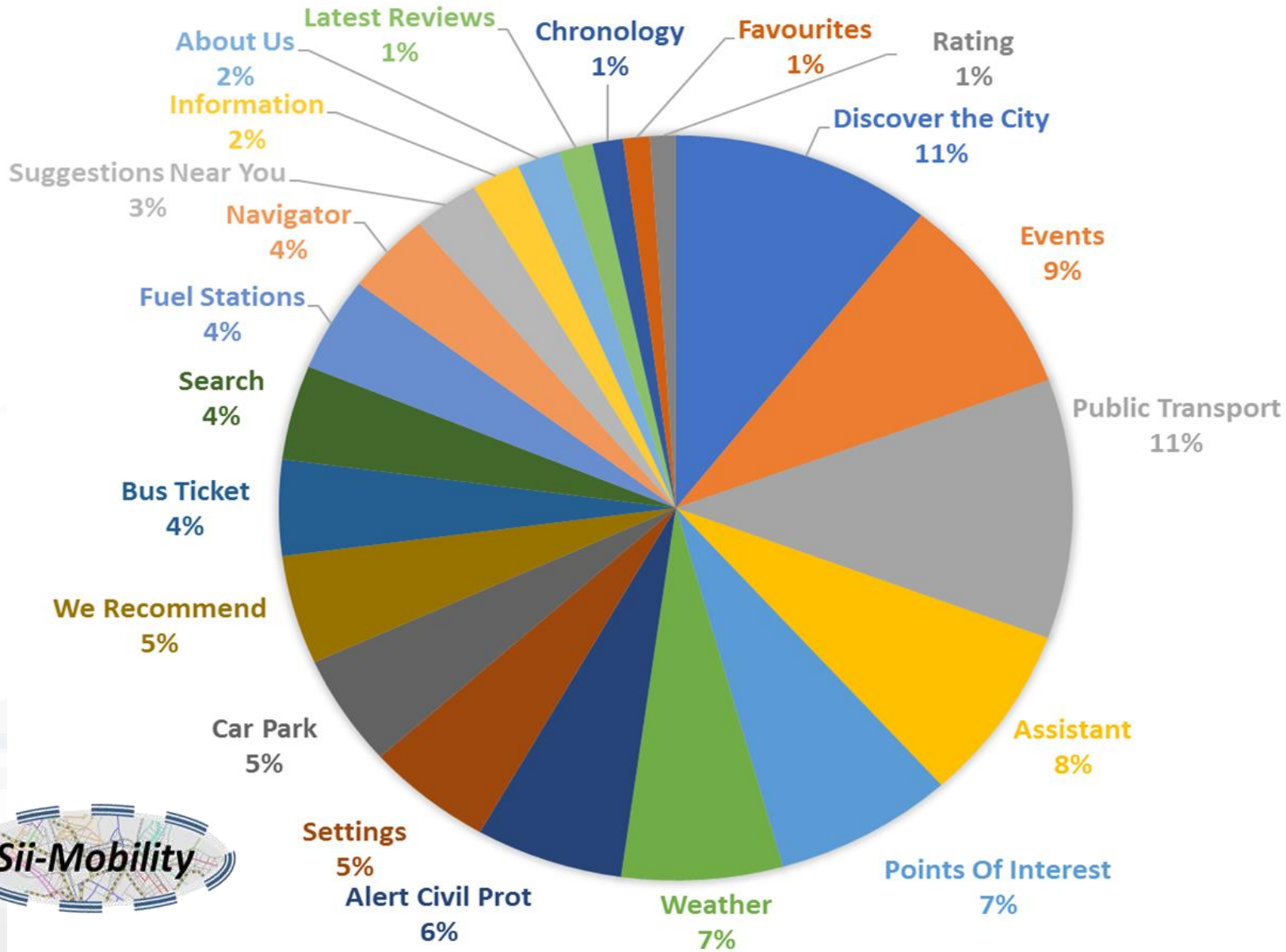
Km4City APP, features 3/3

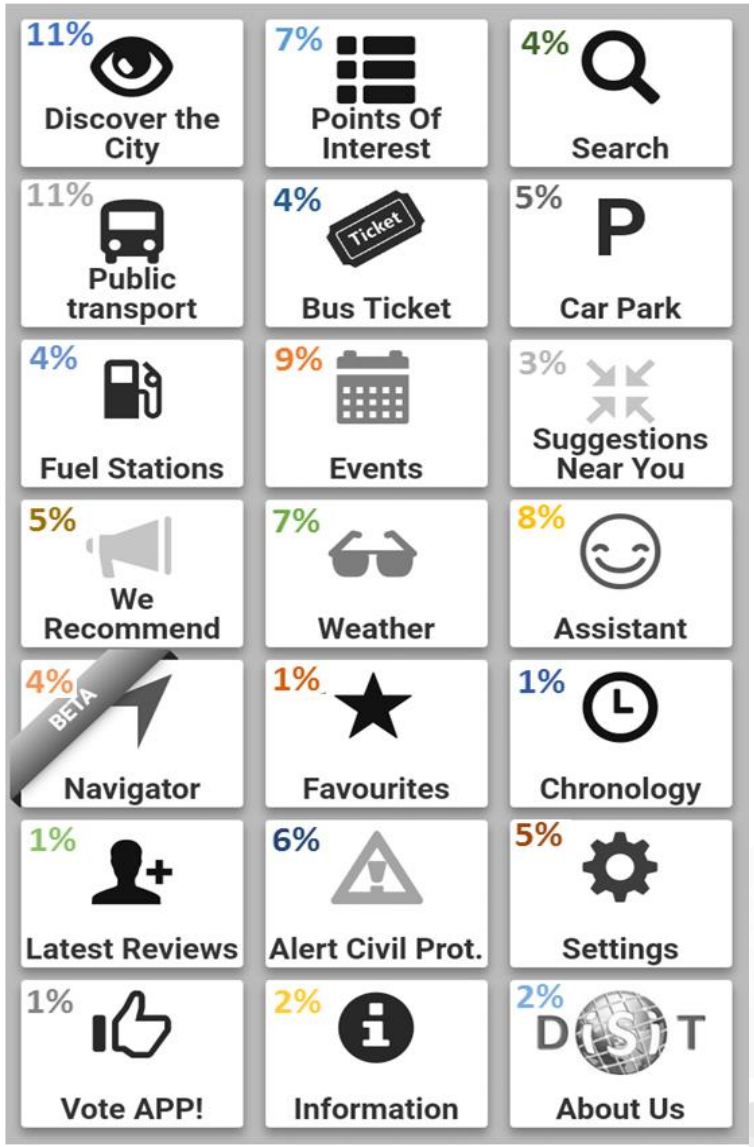
- **Navigation 3D**
- **Ticketing for busses**
- **App used are tool for city assessment**
  - Wifi status
  - iBeacon status
  - User behavior analysis
    - GPS movements kinds
    - OD matrix
    - International flows



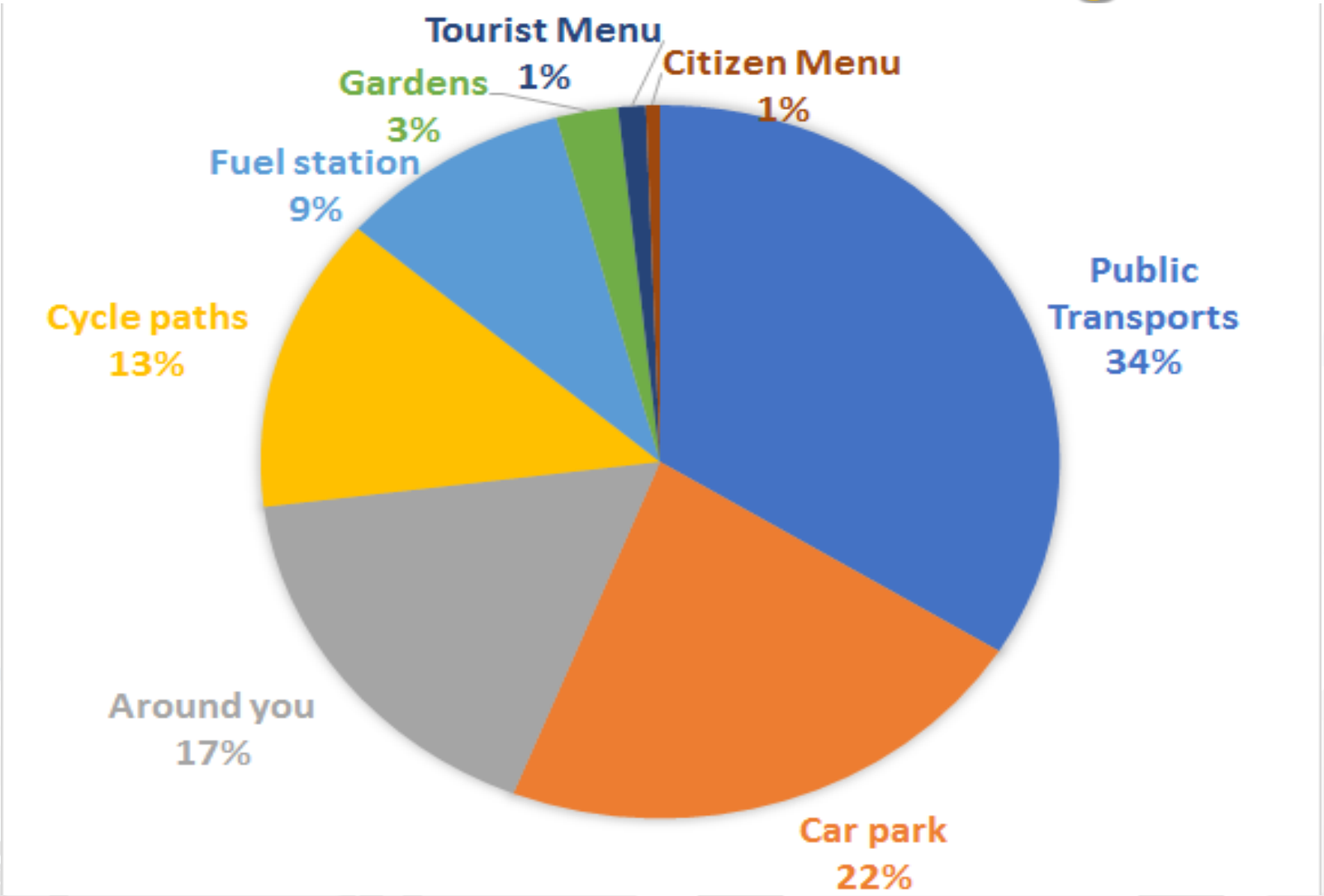


Usage of the main Menu

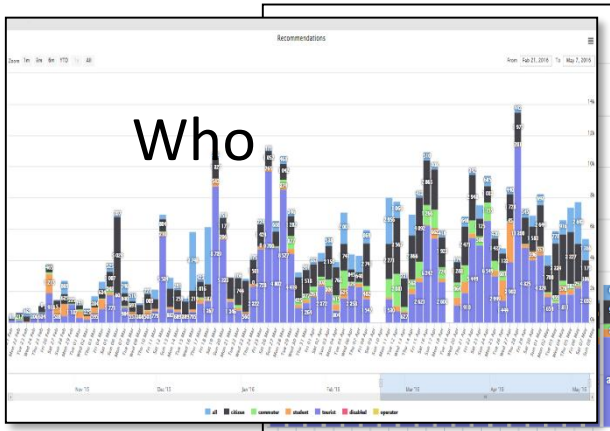


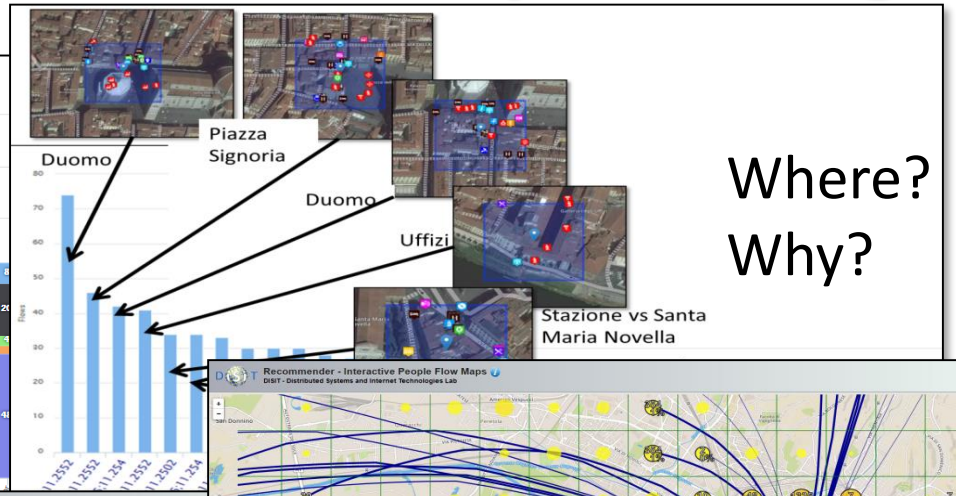


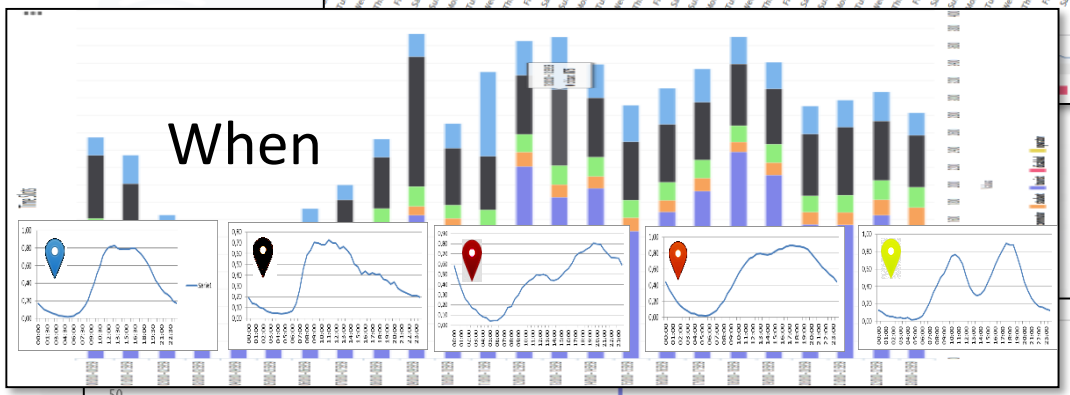
The most searches cathegories

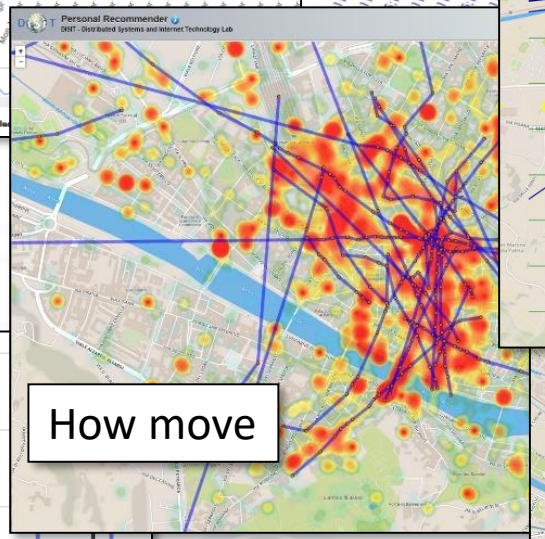


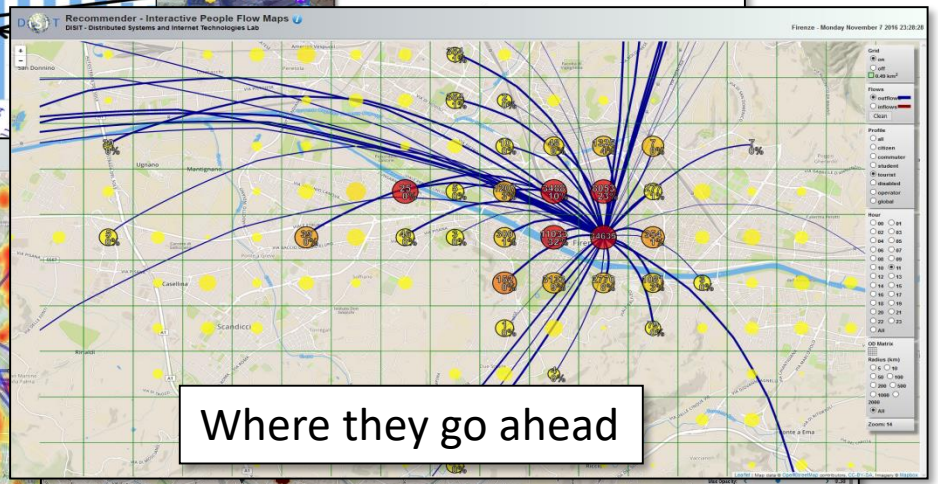
User Behavior Analyzer for Collective profiling

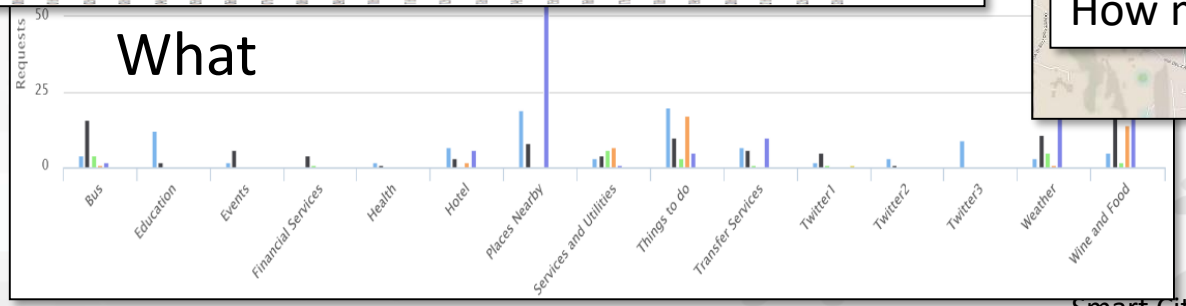


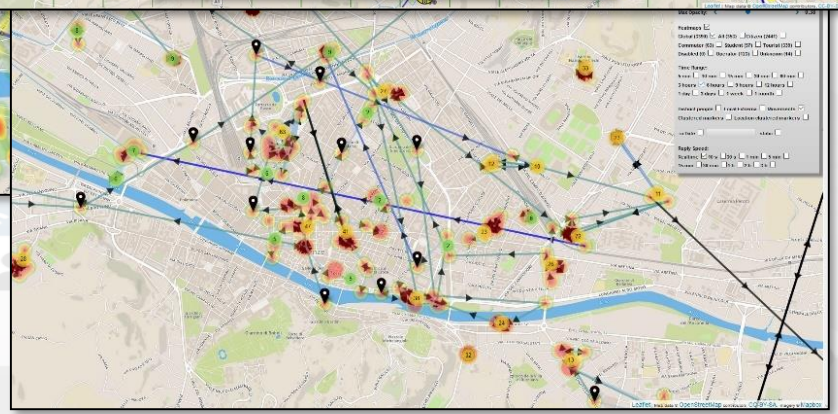




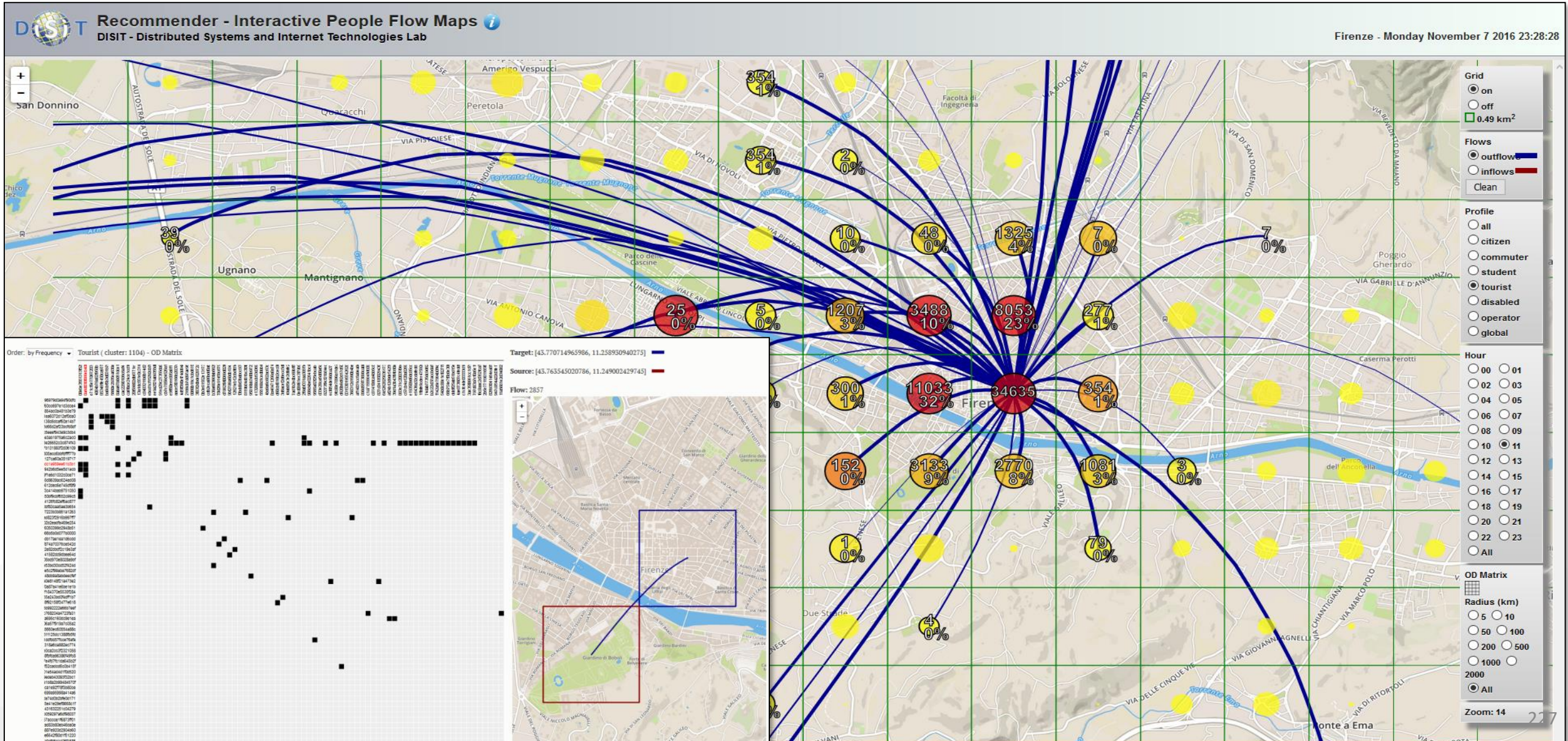






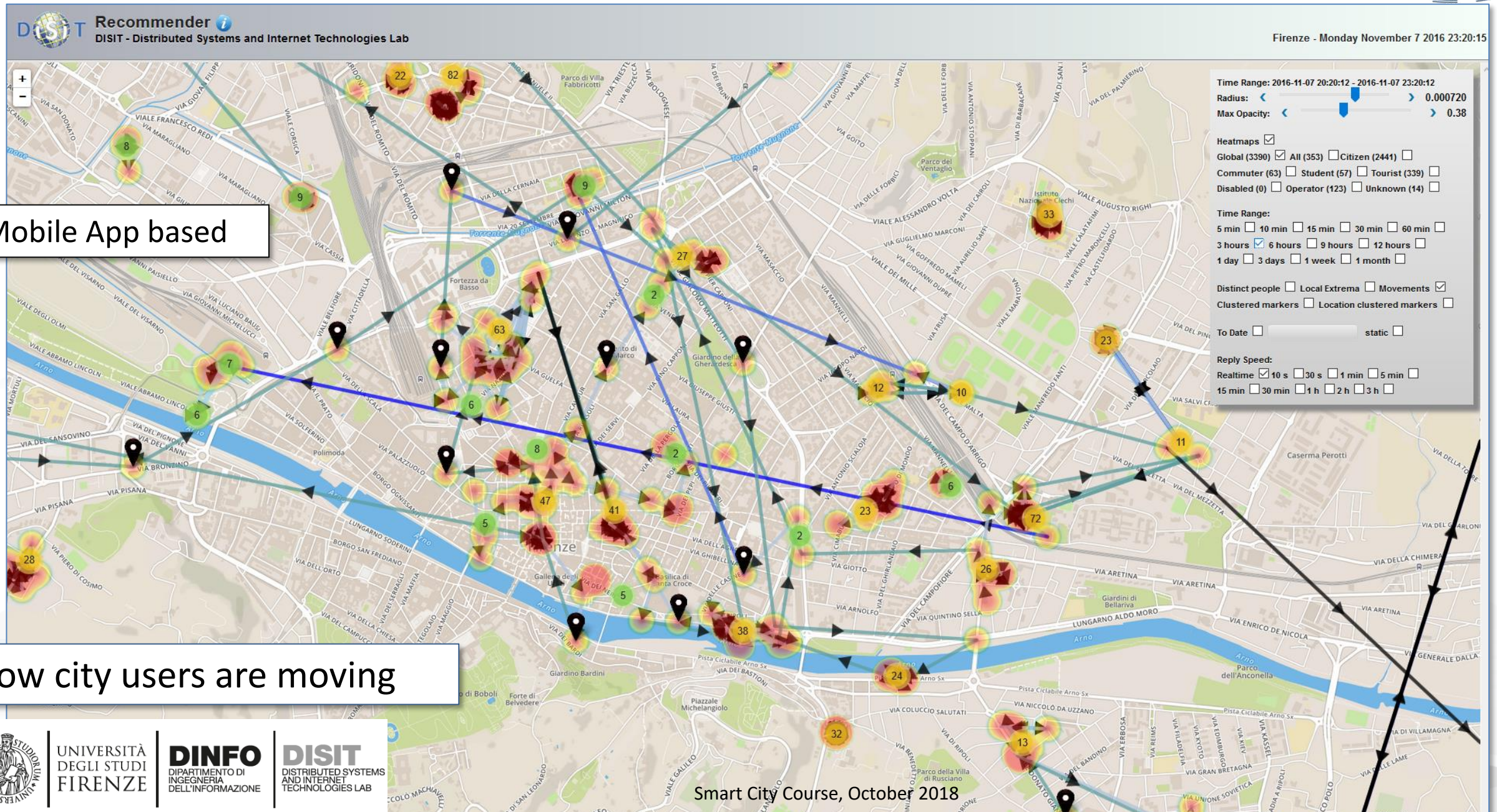


OD Matrix scalabile



Anonymous User Behavior Analysis

Sii-Mobility



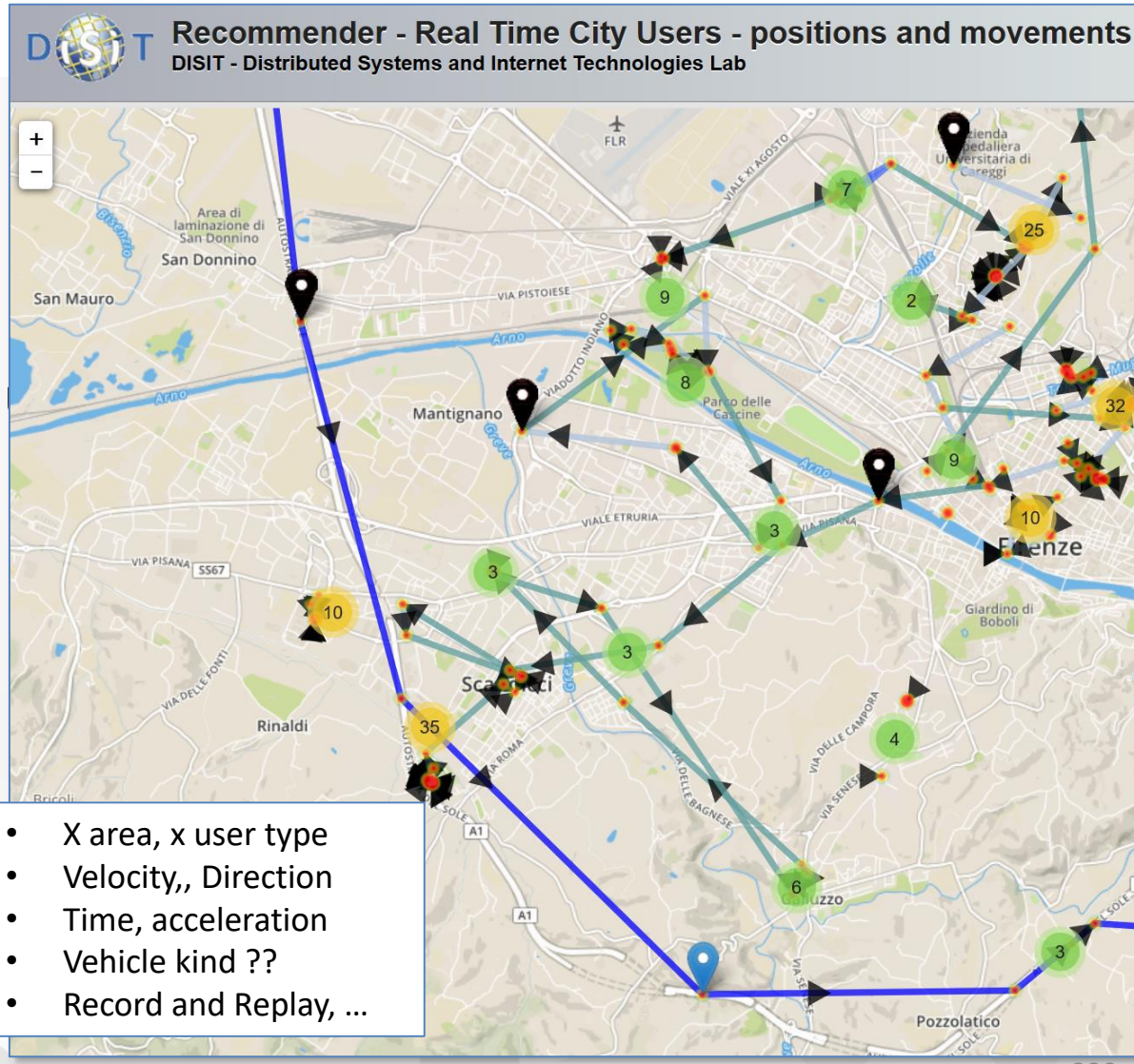
Mobile App based

How city users are moving

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

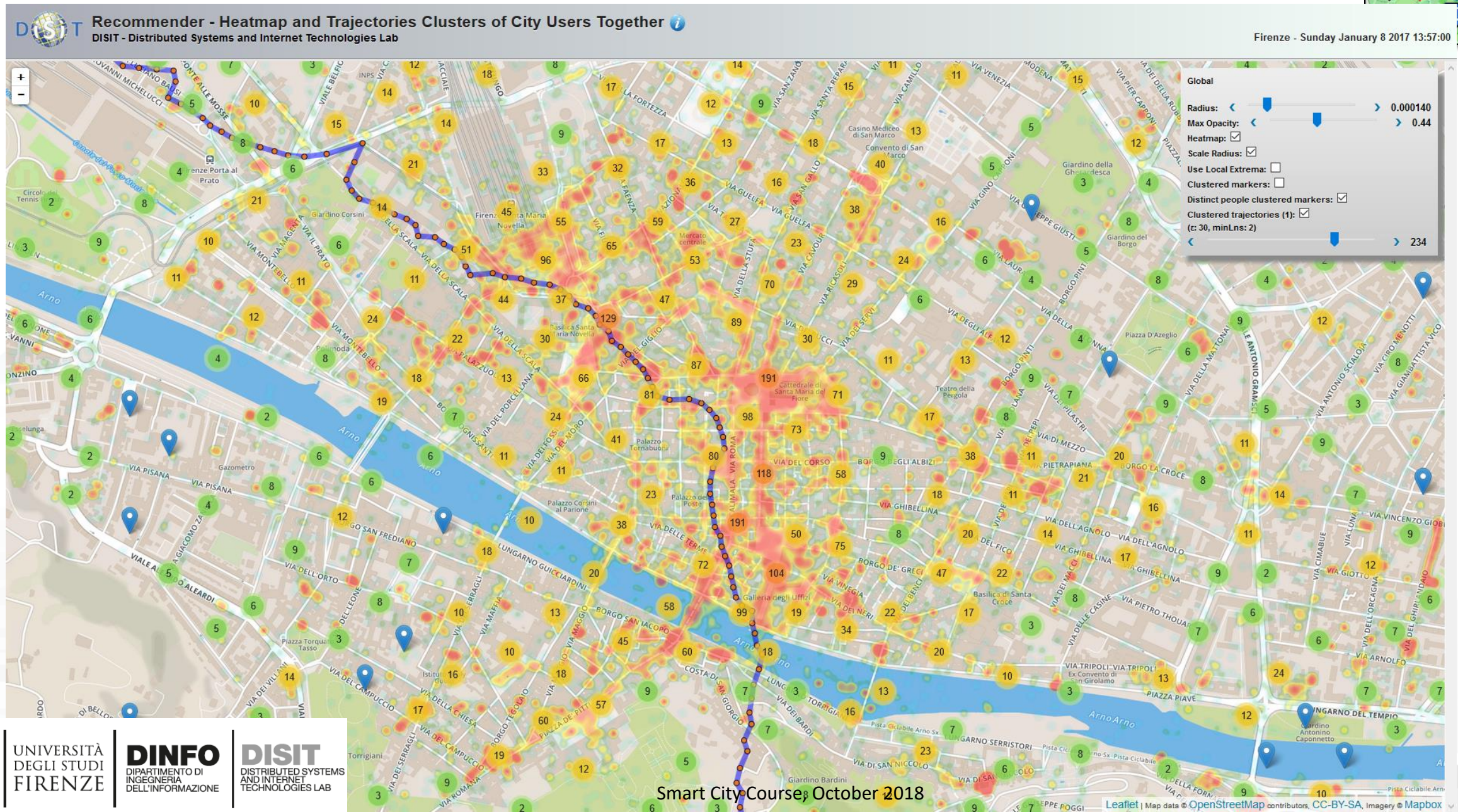
Problems of Trajectories from Apps

- **From mobile app:**
  - Resolving GPS location: GPS, cells, wifi-network, ..mixt
  - Noisy, different kind of devices, ..
  - Smart algorithm on devices for location acq
  - Anonymized data, terms of use on mobile
- **Issues and 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.

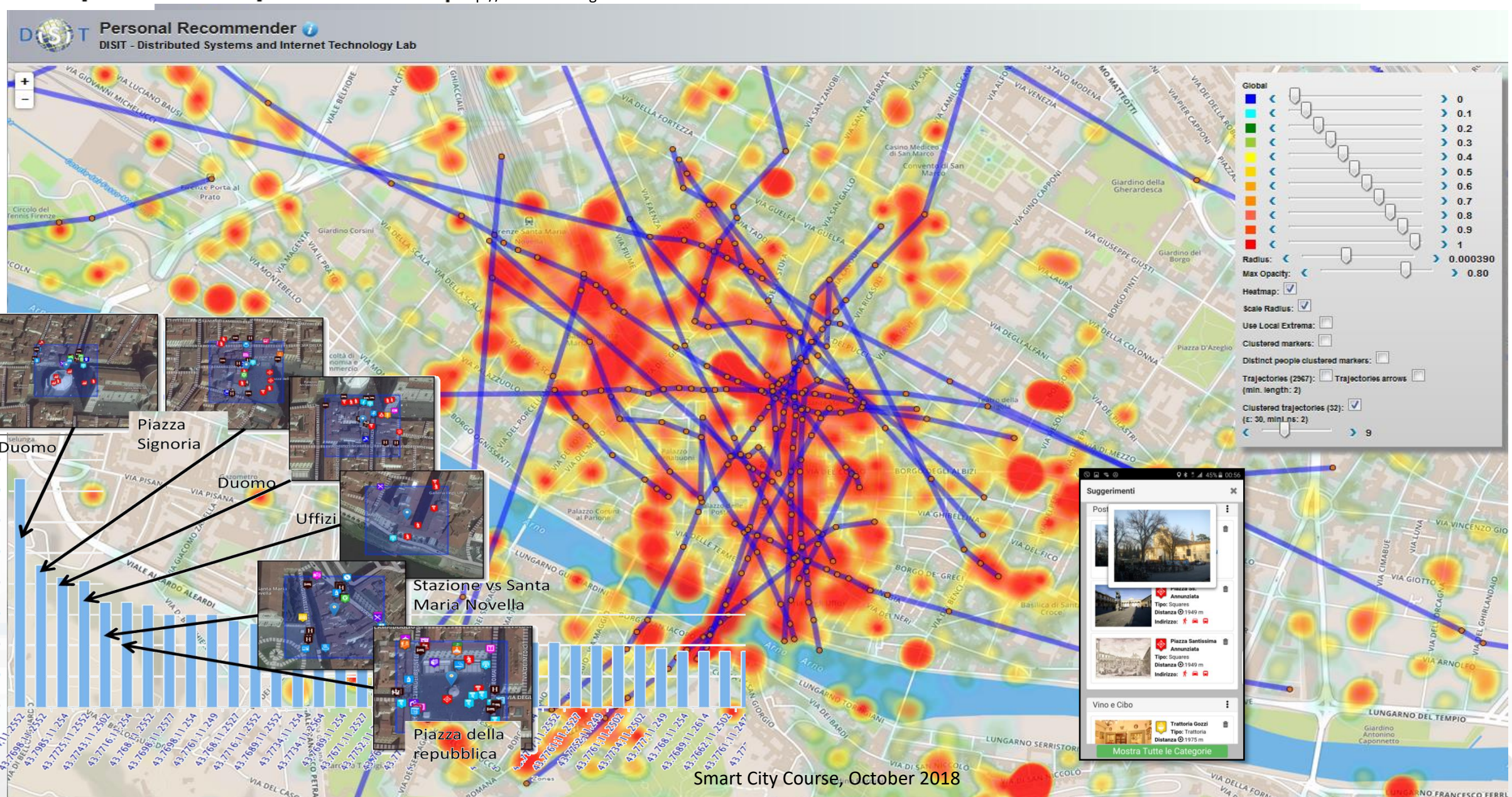


- X area, x user type
- Velocity,, Direction
- Time, acceleration
- Vehicle kind ??
- Record and Replay, …

Heat Map from Mobile: users as sensors



User Behavior Analyzer



Strategies Implementation via Engagement

- **Produce value from data enabling** to
  - ***Stimulate virtuous behavior,***
  - ***influence engage City Users!***
  - Increase efficiency in energy consumption
  - Reduce pollution and traffic congestion
  - Improve quality of service, quality of life
- **Create an ecosystem for innovation** and put in action any smart city solutions and services.



User influencing, engaging, monitoring & . Follow Up

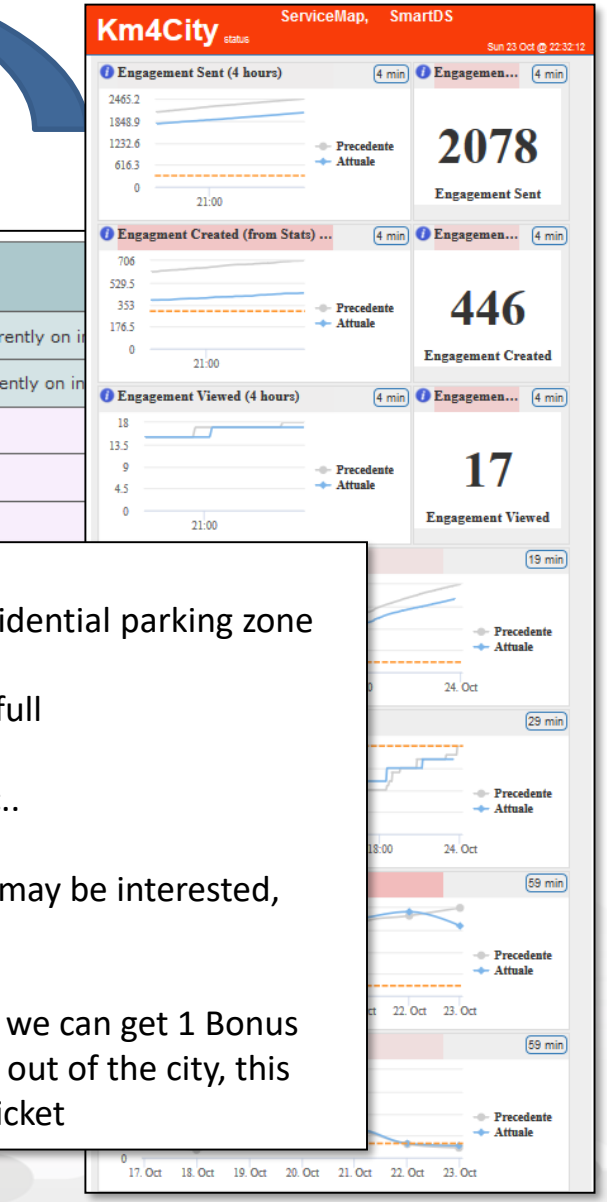
City & City Operators Strategy Editor





Any Mobile and Web App

Rule name	Type	#sent	#viewed	#viewed on #sent	Description
daily_event_de	ENGAGEMENT	1 (0%)	0 (0%)	0%	Suggest (in german) an event currently on i
daily_event_en	ENGAGEMENT	1720 (2.12%)	70 (7.1%)	4.07%	Suggest (in english) an event currently on in
	- commuter	5 (0.29%)	0 (0%)	0 (0%)	
	- student	14 (0.81%)	0 (0%)	0 (0%)	
	- tourist	1462 (85%)	25 (35.71%)	25 (1.71%)	
	- citizen	113 (6.57%)			
	- operator	0 (0%)			
	- disabled	0 (0%)			
	- all	119 (6.92%)			
daily_event_es	ENGAGEMENT	6 (0.01%)			
daily_event_fr	ENGAGEMENT	6 (0.01%)			
daily_event_it	ENGAGEMENT	5459 (6.73%)			
parking_en	ASSISTANCE	141 (0.17%)			
parking_es	ASSISTANCE	3 (0%)			
parking_it	ASSISTANCE	187 (0.23%)			
shoot_a_photo_de	ENGAGEMENT	68 (0.08%)			



Inform

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 your may be interested, etc..

Provide Bonus

Since you have parked here you we can get 1 Bonus
We suggest you to leave the car out of the city, this bonus can be used to by a bus ticket

Sii smart.
Sii-Mobility!

In palio per te

Carnet multicorsa Cap e voucher per:

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

cpt

MIUR

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In palio per te

Carnet multicorsa Cpt e voucher per:

FARMACIE COMUNALI PISA
Ci Prendiamo cura del tuo benessere

ZONE CITY

MULTISALA ODEON

TEATRO DI PISA

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



Dal 15 aprile al 15 luglio scegliere il trasporto pubblico ti premia!
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ataf | BUSITALIA NORD GRUPPO FERROVIE DELLO STATO ITALIANE | MIUR | UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO | DISIT

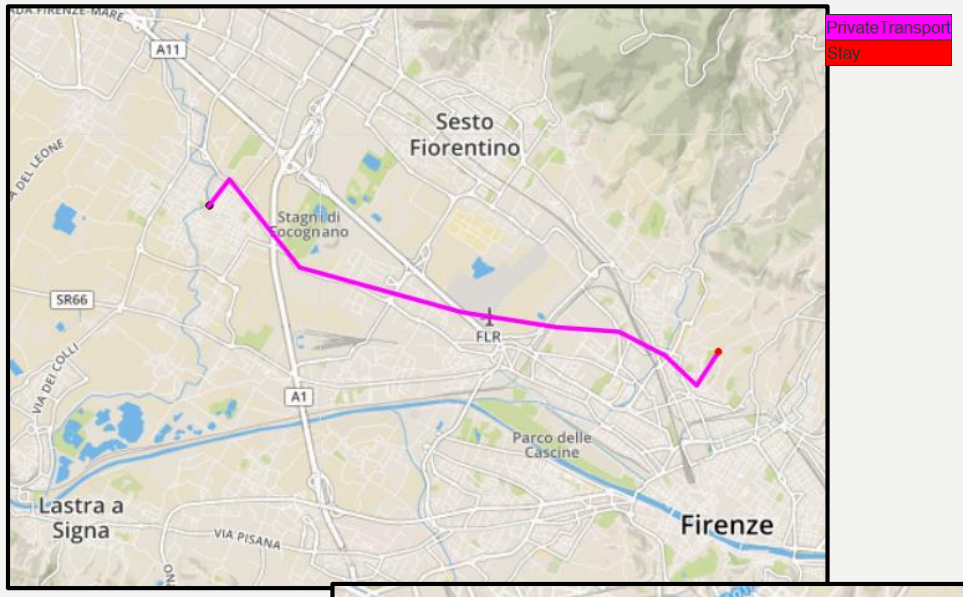
REWARDING'S RULES

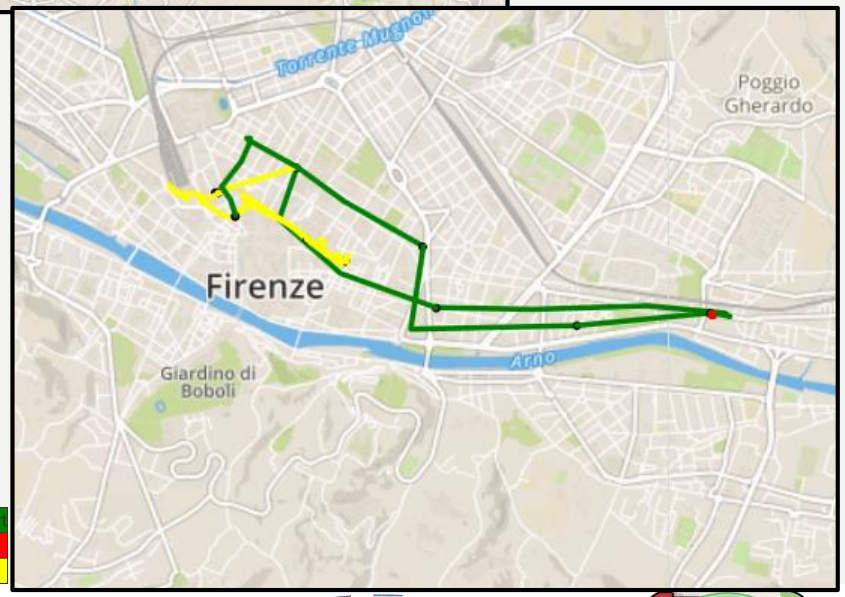
- **ASSISTANCE**
- If public transport is detected after bus line suggestion on trajectory usually made on private transport → 10points
  - Why don't you take the bus line 4 in Piazza Marconi to reach your workplace? You save money, you respect the environment and you will be stress free for not worry about parking!
- Once a day, if public transport is detected after suggestion on an alternative bus line availability →3points
  - Why don't you take the bus line 4 that stop just 50 meters far from you? You save money, you respect the environment and you will be stress free for the traffic jam!
- If public transport is detected for at least 30(?) minutes a day → 1point
- ?parking

- **ENGAGEMENT**
- Survey on commuter and their preferred way of mobility → 1point
  - How many minutes you usually commute to go to work? How do you rate the service?
- Feedback on public transport →1point
  - Which current public transport are you using? Are the service in line with your expectation?
- Comments/Photo/Rate or survey on POI (public transport) →1point
- Survey on use of the App after N days or for tourist coming home → 1point
- Feedback on PPOI or mobility → 1point
- ?events

WALLET / PROFILE

- On homepage
  - How many points have been distributed?
  - How many rewards has been already delivered?
  - How many rewards are still available?
  - How many CO2 has been saved?
  - How many km our users made this week?





CURRENT NUMBERS

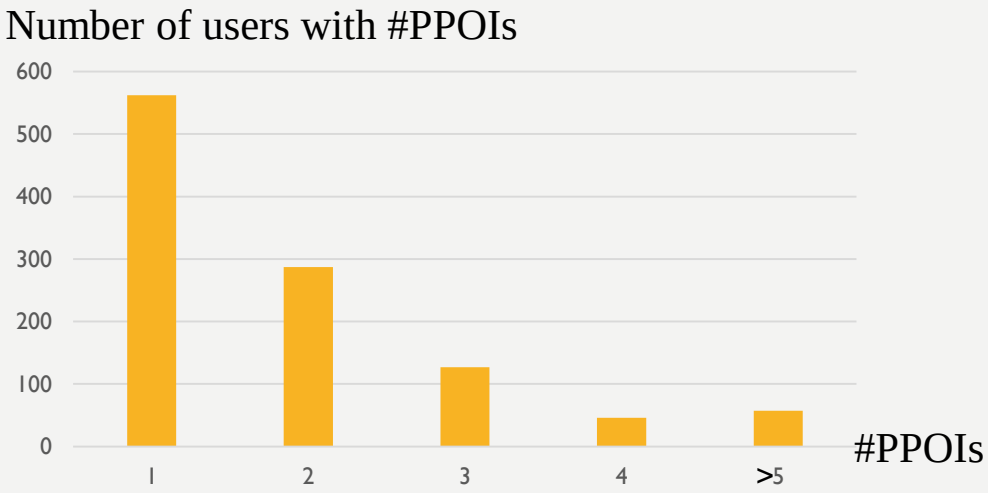
- 50 engagement's rules in 5 languages
  - (surveys, feedbacks, suggestions, assistances)
- From1° September 2016
  - Produced 322.900 engagements on 4270 users
- From 1° July 2017
  - 233 registered users with email (154 via social)

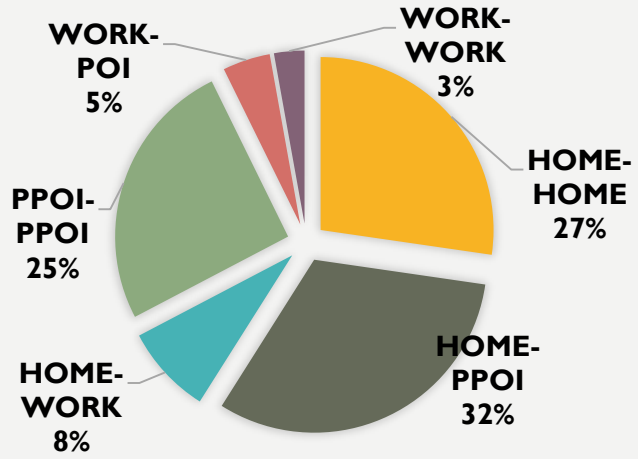
From: 2016-08-01 00:00:00
To: 2017-05-26 11:19:52
Refresh

Rule name	Type	#sent	#viewed	#viewed on #sent	#executed	#executed on #viewed	Description
confirm_ppoi_home_de	ENGAGEMENT	4 (0%)	1 (0.03%)	25%	0 (0%)	0%	Ask (in german) a confirmation of the position of user's HOME
confirm_ppoi_home_en	ENGAGEMENT	90 (0.03%)	0 (0%)	0%	0 (0%)	0%	Ask (in english) a confirmation of the position of user's HOME
confirm_ppoi_home_es	ENGAGEMENT	13 (0.01%)	1 (0.03%)	7.69%	1 (1.04%)	100%	Ask (in spanish) a confirmation of the position of user's HOME
confirm_ppoi_home_fr	ENGAGEMENT	1 (0%)	0 (0%)	0%	0 (0%)	0%	Ask (in french) a confirmation of the position of user's HOME
confirm_ppoi_home_it	ENGAGEMENT	1794 (0.69%)	97 (2.97%)	5.41%	16 (16.67%)	16.49%	Ask (in italian) a confirmation of the position of user's HOME
confirm_ppoi_school_it	ENGAGEMENT	45 (0.02%)	1 (0.03%)	2.22%	1 (1.04%)	100%	Ask (in italian) a confirmation of the position of user's SCHOOL
confirm_ppoi_work_en	ENGAGEMENT	15 (0.01%)	0 (0%)	0%	0 (0%)	0%	Ask (in english) a confirmation of the position of user's WORK
confirm_ppoi_work_it	ENGAGEMENT	368 (0.14%)	37 (1.13%)	10.05%	7 (7.29%)	18.92%	Ask (in italian) a confirmation of the position of user's WORK
daily_event_de	ENGAGEMENT	105 (0.04%)	19 (0.58%)	18.1%	0 (0%)	0%	Suggest (in german) an event currently on in Florence
daily_event_en	ENGAGEMENT	2115 (0.81%)	66 (2.02%)	3.12%	0 (0%)	0%	Suggest (in english) an event currently on in Florence
parking_it	ASSISTANCE	659 (0.25%)	75 (2.3%)	11.38%	0 (0%)	0%	Alert (in italian) if the user parked in a residential parking zone
shoot_a_photo_de	ENGAGEMENT	604 (0.23%)	4 (0.12%)	0.66%	0 (0%)	0%	Ask (in german) a contribution for a nearby point-of-interest
shoot_a_photo_en	ENGAGEMENT	11159 (4.29%)	37 (1.13%)	0.33%	0 (0%)	0%	Ask (in english) a contribution for a nearby point-of-interest
shoot_a_photo_es	ENGAGEMENT	2140 (0.82%)	11 (0.34%)	0.51%	1 (1.04%)	9.09%	Ask (in spanish) a contribution for a nearby point-of-interest
shoot_a_photo_fr	ENGAGEMENT	2880 (1.11%)	4 (0.12%)	0.14%	0 (0%)	0%	Ask (in french) a contribution for a nearby point-of-interest
shoot_a_photo_it	ENGAGEMENT	216479 (83.29%)	976 (29.88%)	0.45%	14 (14.58%)	1.43%	Ask (in italian) a contribution for a nearby point-of-interest
spent_time_en	ENGAGEMENT	53 (0.02%)	14 (0.43%)	26.42%	0 (0%)	0%	Ask (in english) a confirmation of the position of user's POI
spent_time_it	ENGAGEMENT	1192 (0.46%)	175 (5.36%)	14.68%	15 (15.63%)	8.57%	Ask (in italian) a confirmation of the position of user's POI
	- commuter	24 (2.01%)	2 (1.14%)	8.33%	0 (0%)	0%	
	- student	131 (10.99%)	11 (6.29%)	8.4%	2 (13.33%)	18.18%	
	- tourist	238 (19.97%)	59 (33.71%)	24.79%	0 (0%)	0%	
	- citizen	665 (55.79%)	122 (69.71%)	18.35%	10 (66.67%)	8.2%	
	- operator	26 (2.18%)	5 (2.86%)	19.23%	1 (6.67%)	20%	
	- all	155 (13%)	23 (13.14%)	14.84%	2 (13.33%)	8.7%	
survey_turist_de	ENGAGEMENT	179 (0.07%)	15 (0.46%)	8.38%	1 (1.04%)	6.67%	Propose (in german) a survey to turist after they left Florence
survey_turist_en	ENGAGEMENT	966 (0.37%)	13 (0.4%)	1.35%	2 (2.08%)	15.38%	Propose (in english) a survey to turist after they left Florence
survey_turist_es	ENGAGEMENT	115 (0.04%)	2 (0.06%)	1.74%	0 (0%)	0%	Propose (in spanish) a survey to turist after they left Florence
survey_turist_fr	ENGAGEMENT	51 (0.02%)	2 (0.06%)	3.92%	0 (0%)	0%	Propose (in french) a survey to turist after they left Florence
survey_turist_it	ENGAGEMENT	1006 (0.39%)	42 (1.29%)	4.17%	6 (6.25%)	14.29%	Propose (in italian) a survey to turist after they left Florence

CURRENT NUMBERS

- From 1° September 2016
  - Detected 2108 PPOIs on 1080 users
    - 437 HOME
    - 285 WORK
    - 34 SCHOOL
    - 1350 EXTRA
  - 130 PPOIs are feedbacked
  - 460 survey responses
- From 1° August 2017
  - Built 524 Markov Networks about user's trajectories





Social Media Analysis

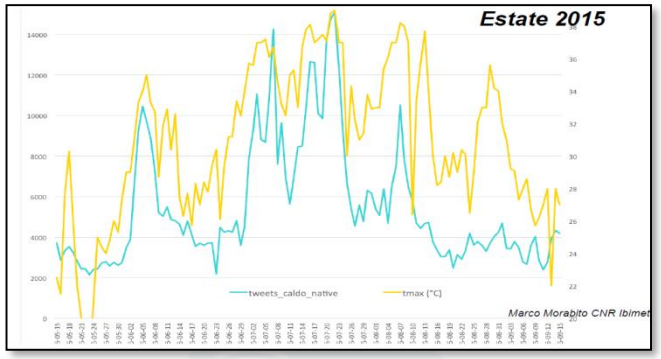


Course Segments

- **Cloud-based Infrastructures for Supporting the Analysis of Smart City Data**
  - Computational Requirements for Smart City
  - IOT Applications VS Data Analytics: MicroServices, External Services, legacy integration, etc.
  - Managing Data Analytics tools: processes vs Containers
  - IOT Applications on cloud and MicroServices
  - Data Analytics: predictions and anomaly detection
    - Examples of Data Analytics: predicting parking
    - Traffic flow reconstruction
  - Social Media Analysis. 

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



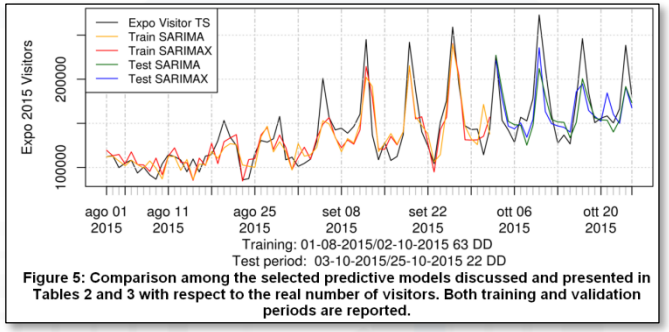
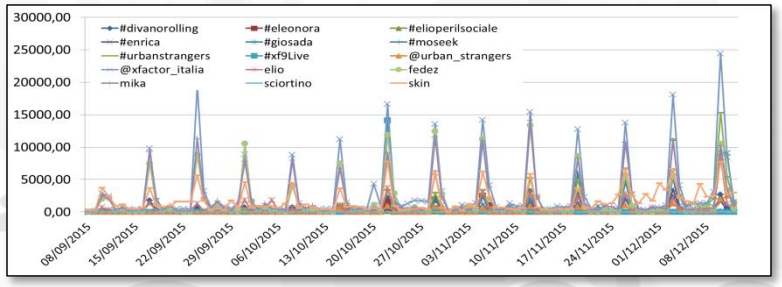
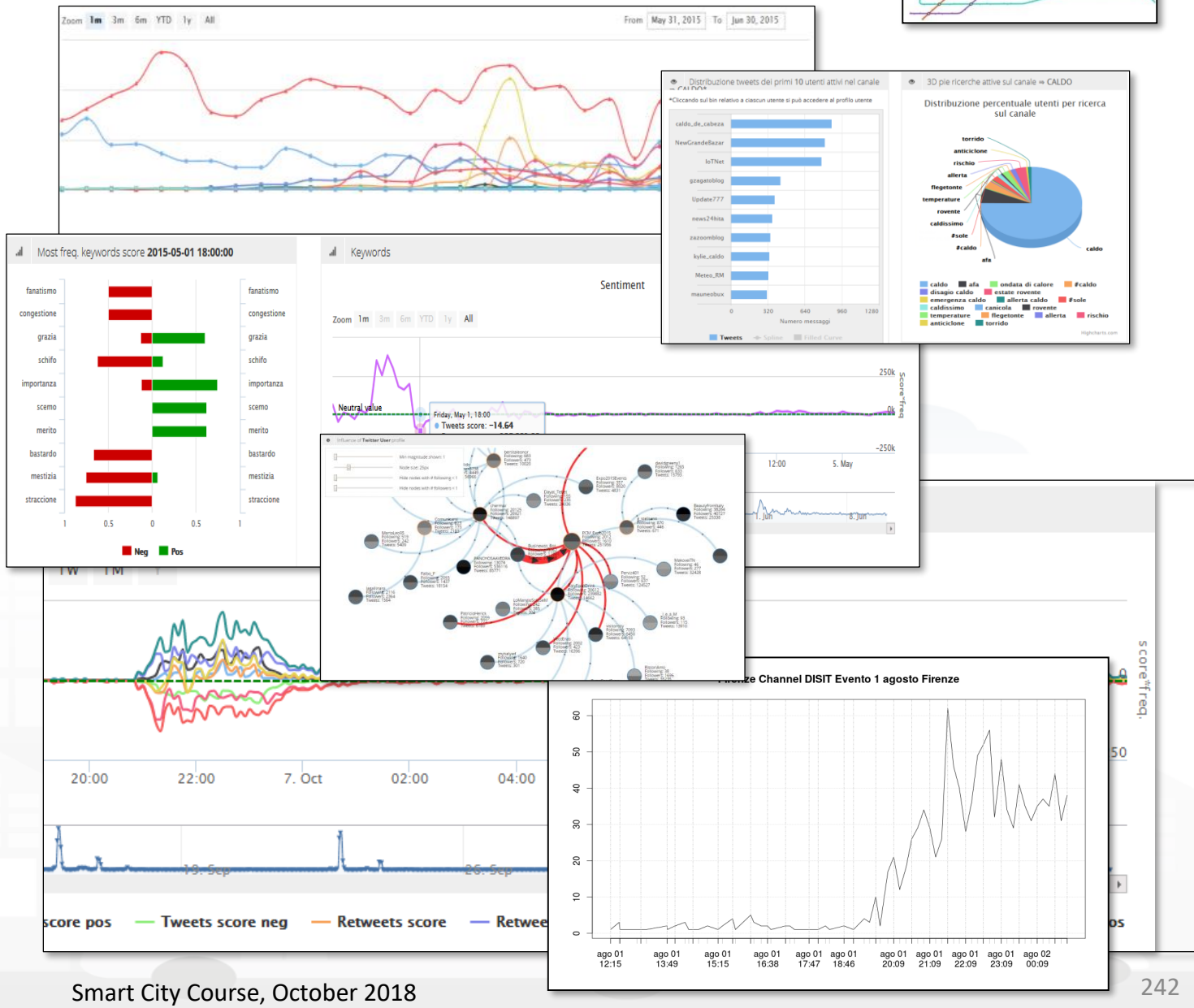


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.



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



Twitter Vigilance

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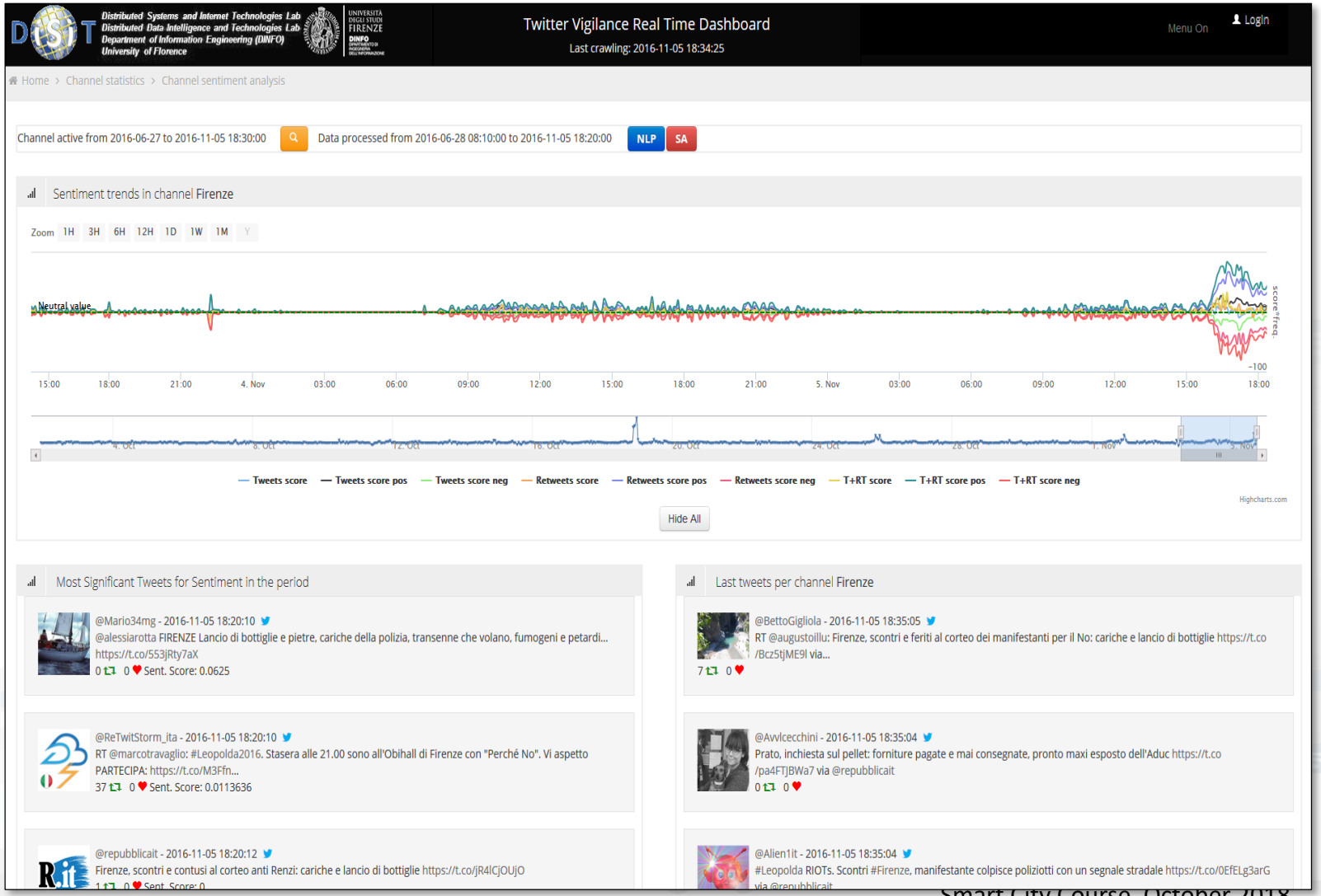
http://www.disit.org

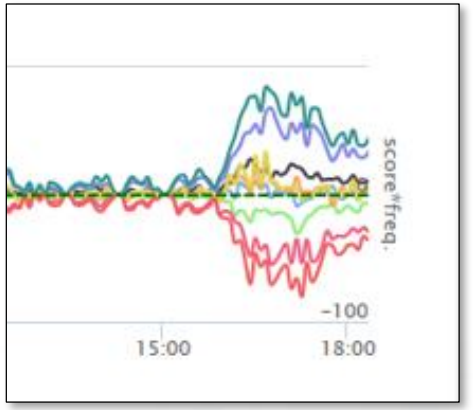
Twitter Vigilance

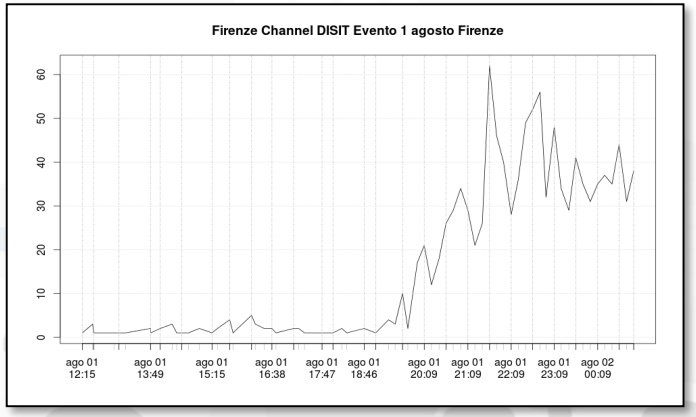
resolute

Real Time Twitter Vigilance, Early Warning



Sentiment Analysis





Twitter Vigilance su Firenze
(sperimentale)

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Sat 24 Dec @ 10:37:57

Twitter: Volume di Tweet tramite Twitter Vigilance

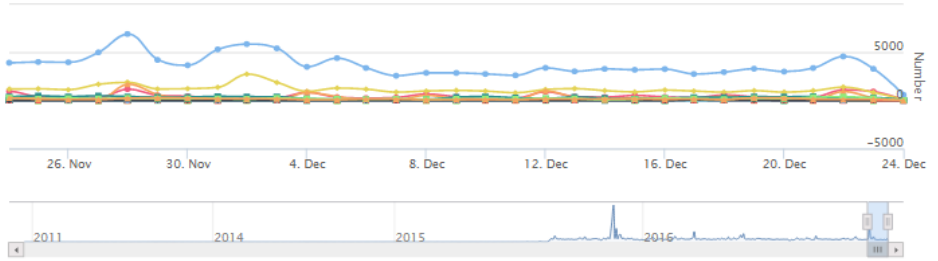
Twitter Vigilance Dashboard
Last crawling: 2016-12-24 12:34:51
Menu On | Login

Home > Channel statistics > Statistics on single Channel

Channel active from 2009-02-27 to today | Data processed from 2015-05-22 to 2016-12-02 | NLP | SA

Search related to channel **Firenze**

Zoom 1m 3m 6m YTD 1y All | From Nov 24, 2016 To Dec 24, 2016



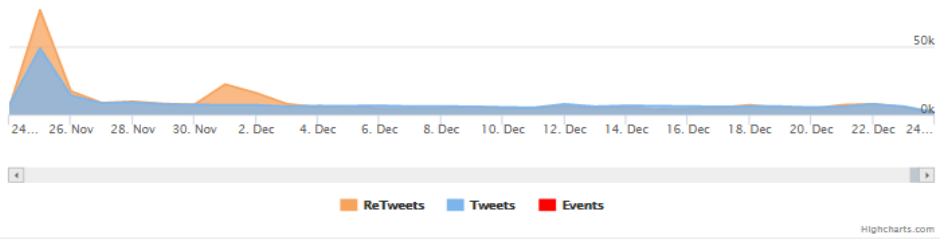
#Accademia #Aereoporto #Firenze #Aeroporto #Firenze #bargello #expo2015 #Firenze #fiorentina
#firenze #Florence #smartcity #fodd #ODDIT15 #Firenze #opendata firenze #pontevecchio
#uffizi @acffiorentina @BandieraiUffizi @Biblio_ComuneFi @bncfirenze @comunefi
@DarioNardella aereoporto @DiscoverTuscany @emergency_fi @firenzedigitale @firenzesulweb
@FirenzeTNews @museofirenze @museonovecento @Nazione_Firenze @NicolodiDaria @novedafirenze
@opentoscana @Pitti_Immagine @PoloMusealeFi @ProtCivComuneFi @prov_Fi_PC @santacroceopera
@STEEPproject @storianaturale @UNI_FIRENZE aereoporto firenze aeroporto firenze Firenze
firenze terremoto firenzesulweb Florence from:@UNI_FIRENZE lungarno medicea palazzopitti
palazzostrozzi ProtCivComuneFi smartcity firenze torrigiani uffizi voragine Events

Highcharts.com

Hide All

Daily mumber of tweets/retweets for channel: **Firenze**

Zoom 1m 3m 6m YTD 1y All | From Nov 24, 2016 To Dec 24, 2016



Highcharts.com

Sentiment Analysis in Tempo Reale su Firenze

Twitter Vigilance Real Time Dashboard
Last crawling: 2016-12-24 10:32:33
Menu On | Login

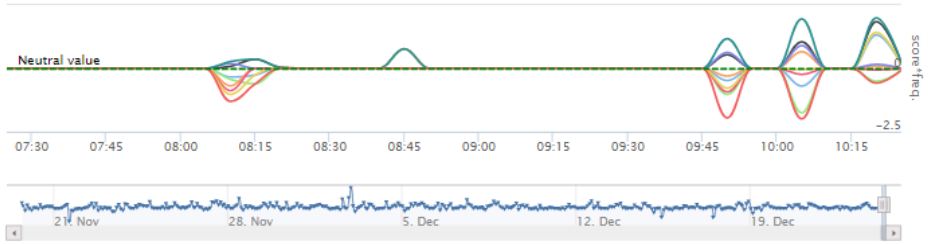
Home > Channel statistics > Channel sentiment analysis

Channel active from 2016-06-27 to 2016-12-24 10:30:00 | Data processed from 2016-06-28 08:10:00 to 2016-12-24 10:25:00

NLP | SA

Sentiment trends in channel **Firenze**

Zoom 1H 3H 6H 12H 1D 1W 1M Y



Tweets score | Tweets score pos | Tweets score neg | Retweets score | Retweets score pos
Retweets score neg | T+RT score | T+RT score pos | T+RT score neg

Highcharts.com

Hide All

Most Significant Tweets for Sentiment in the period



@forealziesdayle - 2016-12-24 10:25:39
@Ahno_its_arno meh, I've only had average curry there
0 0 Sent. Score: 0.166667

@esercizistorici - 2016-12-24 10:30:01
Stanotte Concerto di Natale di Peter Guth @ORT_Toscana in collaborazione con Conservatorio 'L.Cherubini' di Firenze... https://t.co/uFeTp4wG1y
0 0 Sent. Score: 0



@infoitinterno - 2016-12-24 10:30:05
Firenze, un piano per un Natale sicuro (055firenze) https://t.co/vpqDAsEspi https://t.co/2Bn5k3zoyv

Last tweets per channel **Firenze**



@FormulaLatina - 2016-12-24 10:30:26
★ ★ ★ CAPODANNO LATINO Woodstock Club Firenze ★ ★ ★ H. 21:00 > > GRAN BUFFET DI SAN SILVESTRO CON BRINDISI E... https://t.co/cM84Gw65sO
0 0



@MORINEMMANUELL2 - 2016-12-24 10:30:14
RT @Navymat: Francesco #Salviati Carità,1543 #Manierisme Galleria degli Uffizi, Firenze @ChevernyM @mariaireneali @pieroBENEDETTO @Giusepp...
6 0

@infoitinterno - 2016-12-24 10:30:12

Twitter Citazioni

TRENDS | QUOTES

@NICOLODIDARIA
@COMUNEFI
@ACFFIORENTINA
@NAZIONE_FIRENZE
@SANTACROCEOPERA
@MUSEONOVECENTO
@FIRENZEDIGITALE

Twitter Hashtag trend

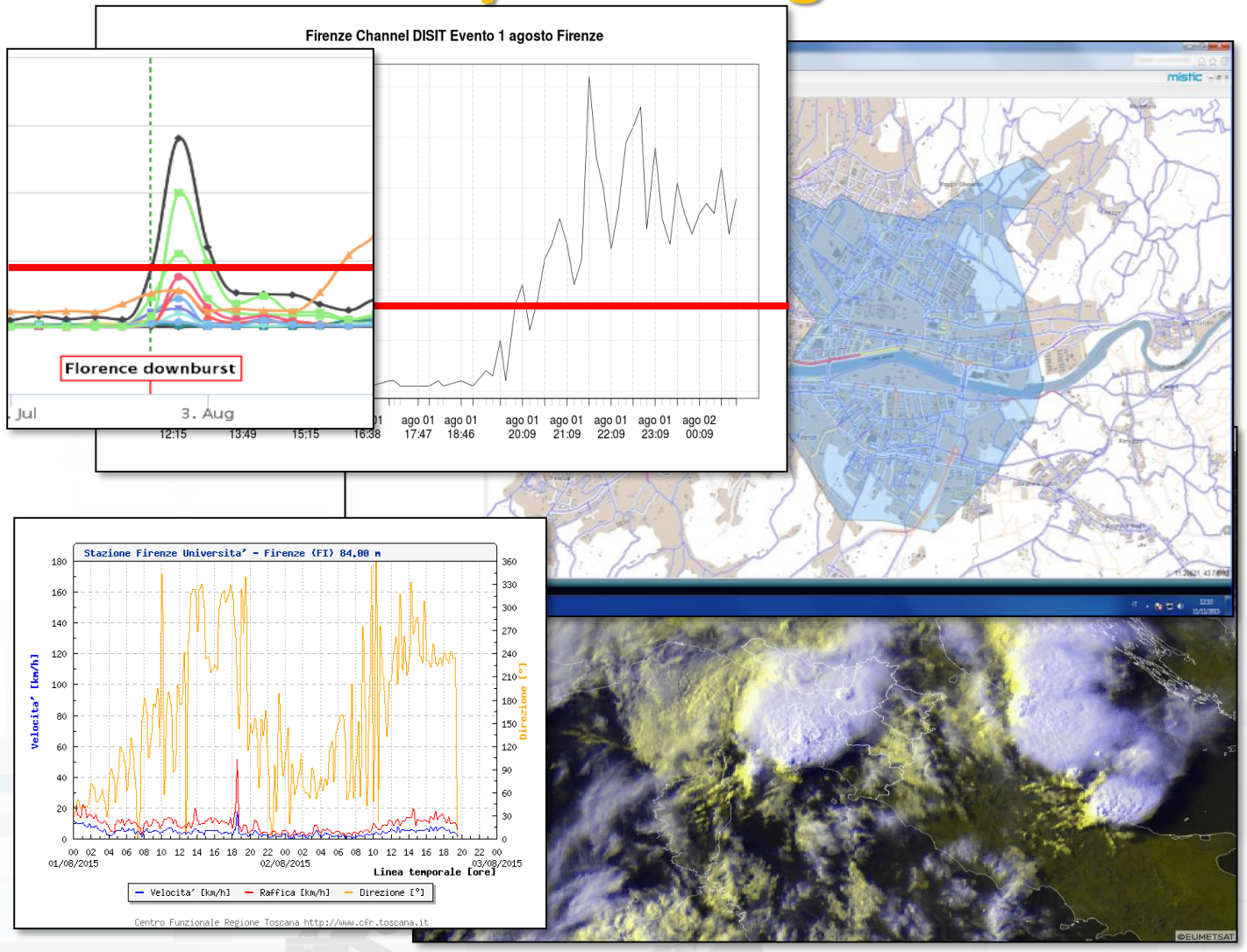
TRENDS | QUOTES

#FIRENZE
#FIORENTINA
#UFFIZI
#PONTEVECCHIO

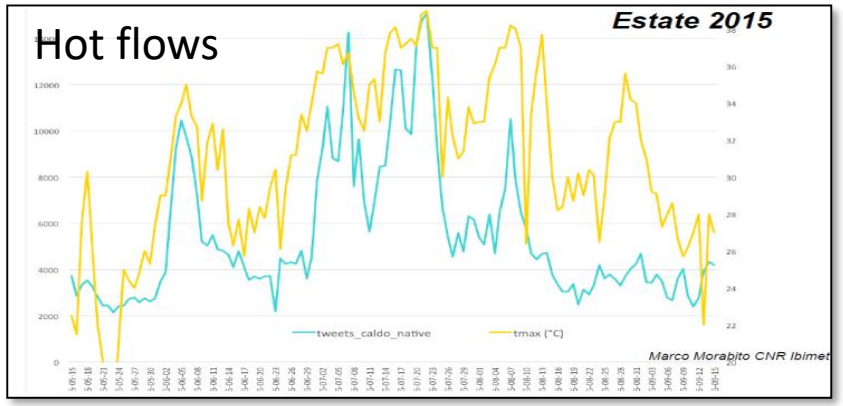
We suggest to use Chrome browser for better experience

Twitter Vigilance

Early Warning



Predictive models



Attendance at long lasting events: EXPO2015

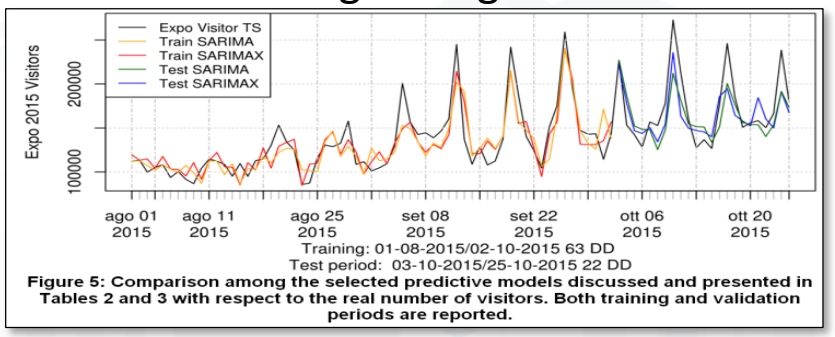
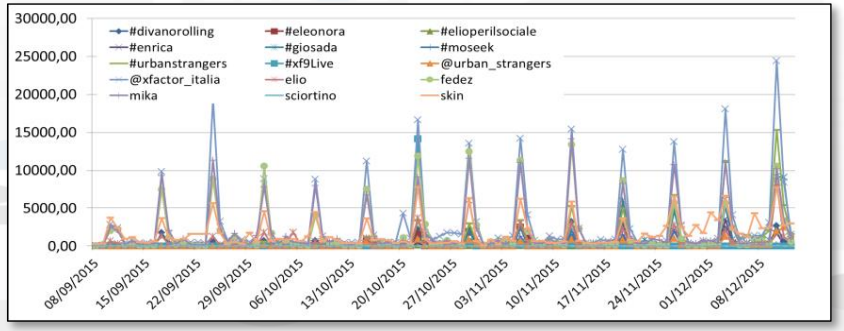
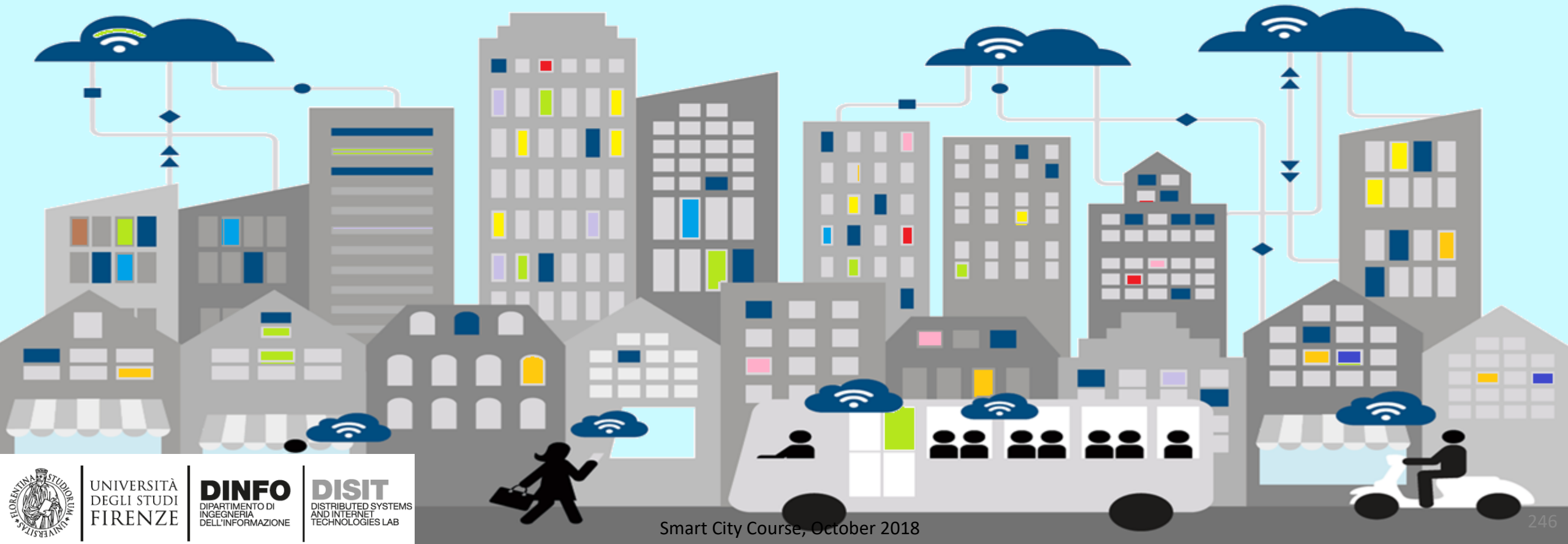


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.

Attendance at recurrent events: TV, footbal



From Data to Applications and Dashboards



Course Segments

- Qualification of the speaker
- Cloud-based Infrastructures for Smart Cities
- IOT Registration and Management
- Supporting the Analysis of Smart City Data
- From Data to Applications and Dashboards



Course Segments

- **From Data to Applications and Dashboards**
  - Requirements on dashboards and security/privacy for smart city
  - Dashboards: types and meaning
  - Protocols from Dashboards
  - Dashboards vs mobile app User Interface
  - End-to-end security on IOT infrastructures
  - Data Protection, Personal Data vs GDPR
  - Living Lab Approaches

Requirements on dashboards and security/privacy for smart city



Security/Privacy Requirements

- Managing private data together with public data
- Keep secure private data
- Manage private data according to GDPR
  - ….. Browsing, downloading, controlling rights, delegating access, revoking accesses, etc.
- 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.

Dashboards: types and meaning



Course Segments

- **From Data to Applications and Dashboards**
  - Requirements on dashboards and security/privacy for smart city
  - Dashboards: types and meaning
  - Protocols from Dashboards
  - Dashboards vs mobile app User Interface
  - End-to-end security on IOT infrastructures
  - Data Protection, Personal Data vs GDPR
  - Living Lab Approaches

Level 0 users



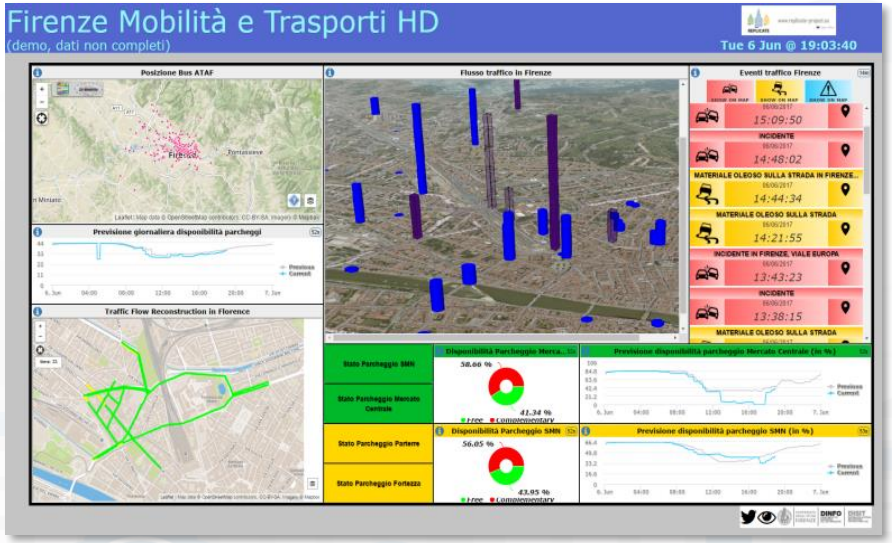
Level 0 user: Observer (public or invited)

- Access to the Portal, view Dashboards with public data

IOT and City data World

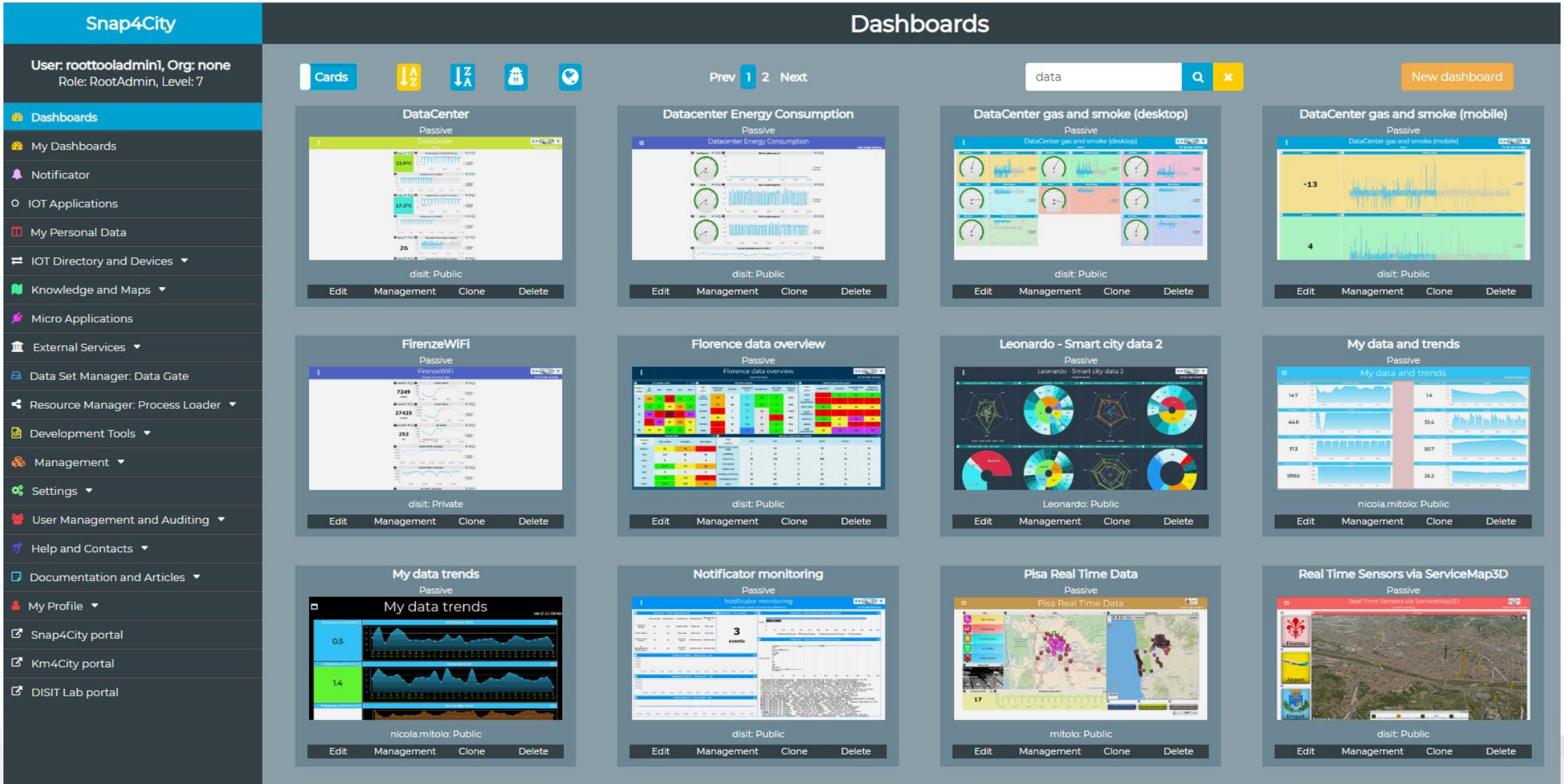


City Dashboard



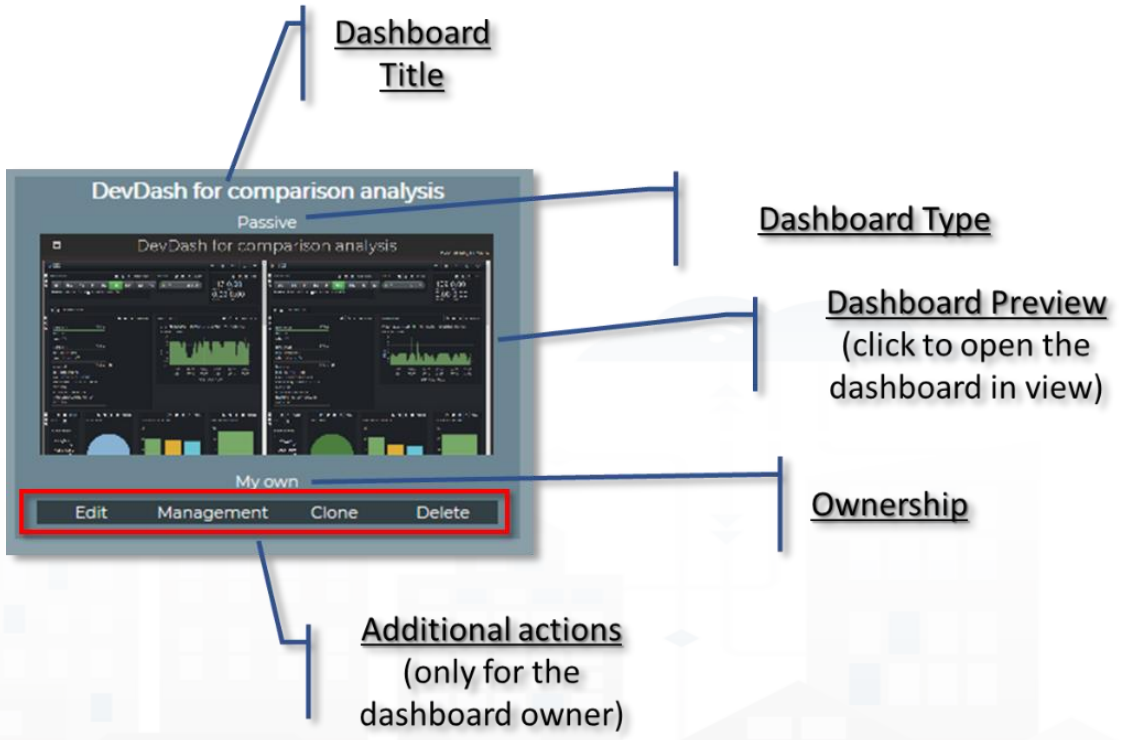


Dashboard List and Editor



Dashboard Management






Energy Dash
Pilot dashboard
Sun 8 Jul 11:59:06
Selector - Click the icon
Fast recharging stations
Florence WiFi POI
Normal recharging stations
Smart Benches
Smart waste
ZTL gate
Map
© OpenStreetMap contributors
Real time ac... 6m
< 70
87.5%
Accumulato... 6m
< 60
61.5%
Accumulato... 6m
< 60
57.4%
N. of App Users 6m
40
users
Energy consumption vi... 6m
122770
kWh
Avg heat consumption per buildi... 6m
40
Avg heat consumption per user 6m
44.7
Avg gas consumption 6m
<= 140
39.4
Smart Grid Data 6m
< 22
> 22
> 35
9
Web site status 6m
SNAP4CITY
TOKEN FOUND
2018-07-08 11:51:37

Real Time Sensors via ServiceMap3D

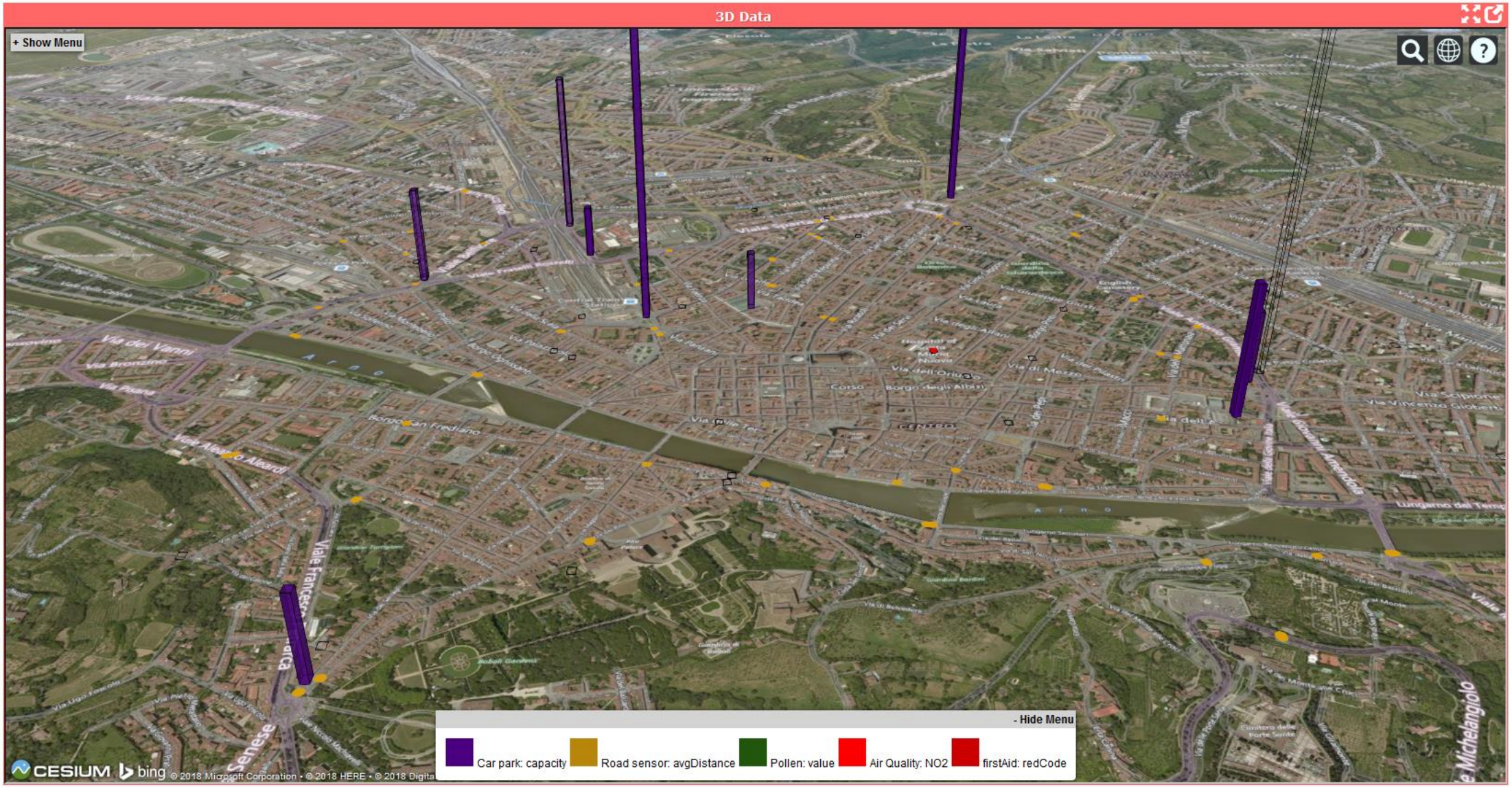
3D data rendering

Fri 26 Jan 00:23:19

Firenze

Airport

Empoli



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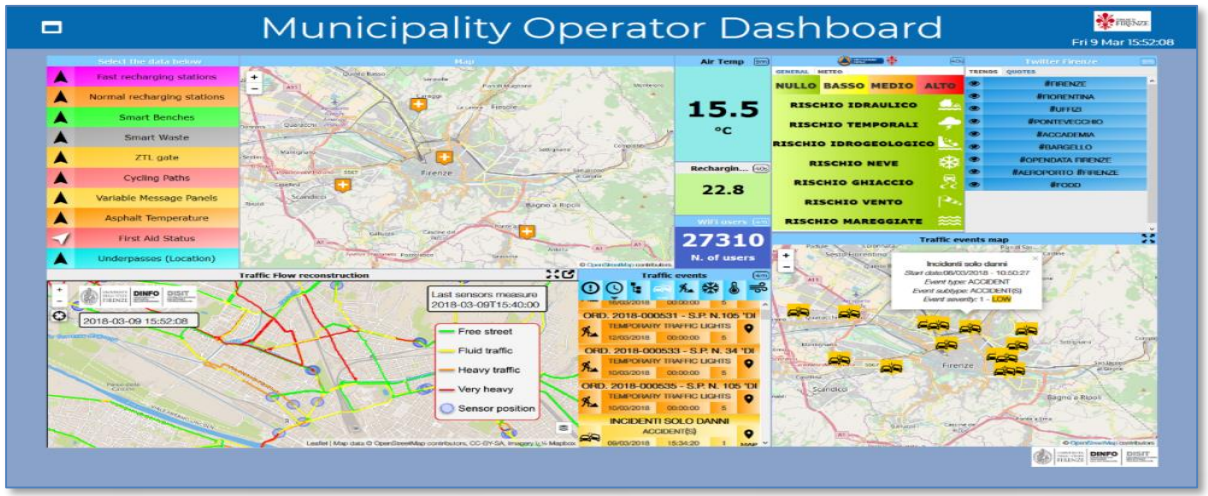
http://www.disit.org

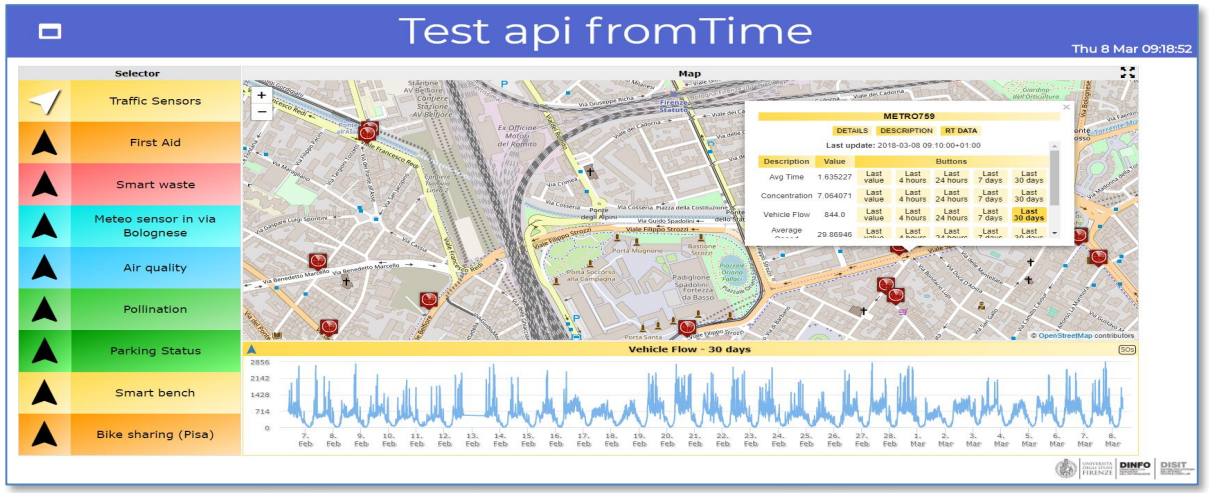
SNAP4CITY

KM4CITY

https://dashboard.km4city.org/view/index.php?iddasboard=MjY1



https://www.disit.org/dashboardSmartCity/view/index.php?iddasboard=MjI5



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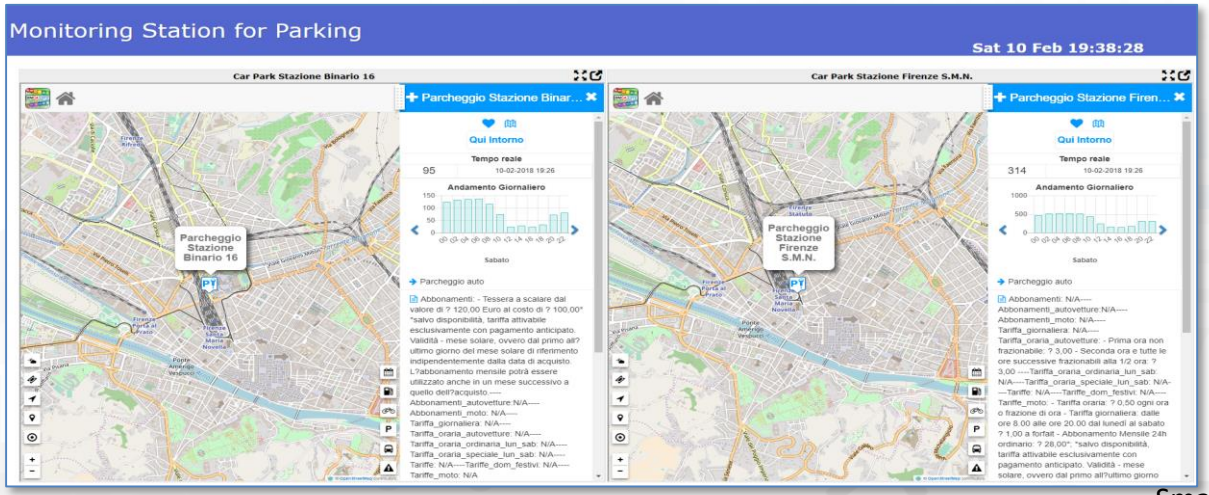

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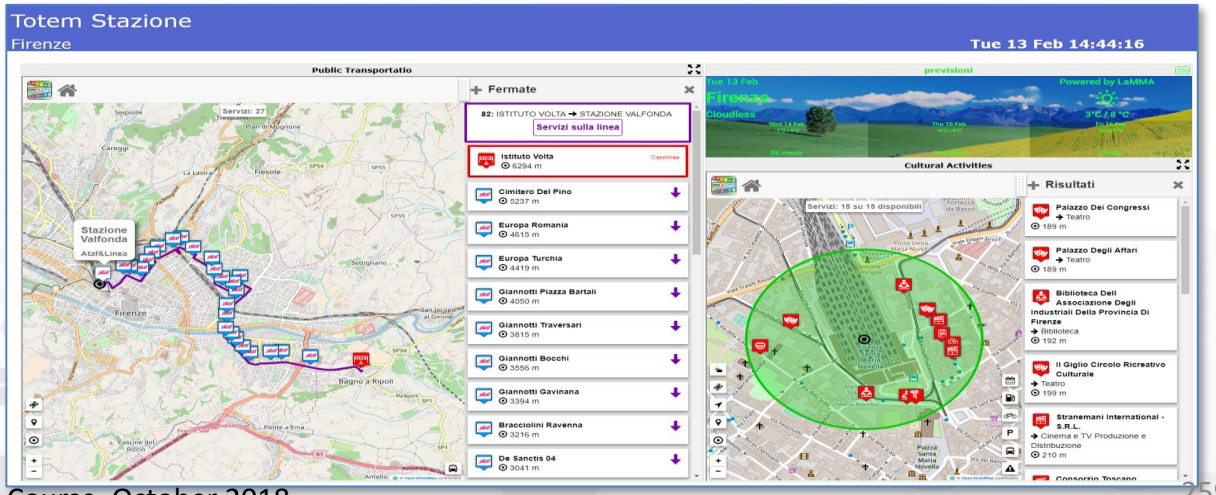


Servizi agli Utenti

Firenze (sperimentale)

Tue 17 Jan @ 19:52:49

Recenti #hashtag più utilizzati 2m

TRENDS | QUOTES

- #FIRENZE
- #NEWS #FIRENZE
- #UFFIZI

Citazioni di Firenze frequenti... 2m

TRENDS | QUOTES

- @NAZIONE_FIRENZE
- @UNI_FIRENZE
- @NOVEDAFIRENZE
- @FIRENZEDIGITALE
- @FIRENZETURISMO

Eventi a Firenze oggi 37s

- **ERWIN WURM - GURKEN**
  2016-09-23 to 2017-01-20
  PIAZZA DI SANTA MARIA NOVELLA 10
- **LA DIVINA COMMEDIA DI VENTURINO VENTURI**
  2016-09-29 to 2017-02-26
  COSTA SAN GIORGIO 2
- **IN COLLEZIONE - UN PERCORSO D'ARTE DAL XIII AL XX SECOLO**
  2016-10-01 to 2017-02-26
  VIA MAURIZIO BUFALINI
- **ARNO: FONTE DI PROSPERIT€ E FONTE DI DISTRUZIONE.** FREE
  2016-10-09 to 2017-02-04
  VIALE DELLA GIOVINE ITALIA
- **ARNO: FONTE DI PROSPERITÀ E FONTE DI DISTRUZIONE.**

PROTEZIONE CIVILE 37s

GENERAL | METEO

NULLO | BASSO | MEDIO | ALTO

- RISCHIO IDRAULICO
- RISCHIO TEMPORALI
- RISCHIO IDROGEOLOGICO
- RISCHIO NEVE
- RISCHIO GHIACCIO
- RISCHIO VENTO
- RISCHIO MAREGGIATE

Stato servizio BUS a Firenze 16m

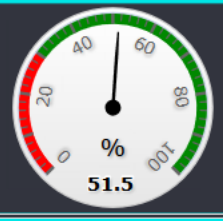
STATO | LINEE MONITORATE | DATI

46%	5%	49%
IN ORARIO	IN ANTICIPO	IN RITARDO

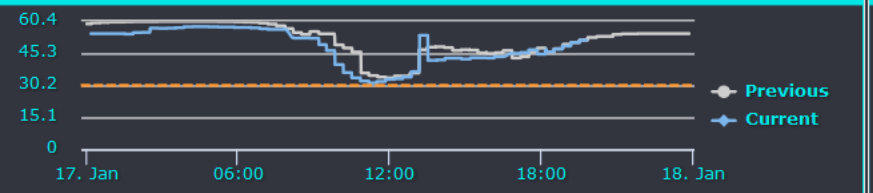
Previsioni del tempo a Firenze 59m

Tuesday	Wednesday	Thursday	Friday	Saturday
light snow	overcast	cloudy	bit cloudy	cloudy
3°C / 4°C	2°C / 5°C	2°C / 7°C	/	/

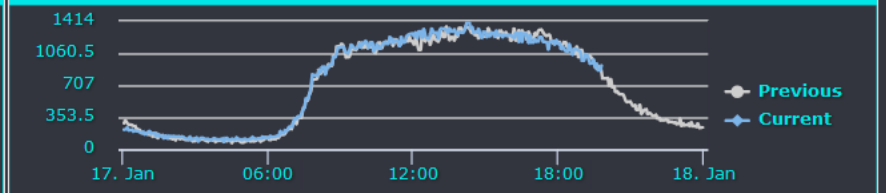
Posti Liberi 37s



Posti Liberi in Parcheggi Interrati a Firenze 2m

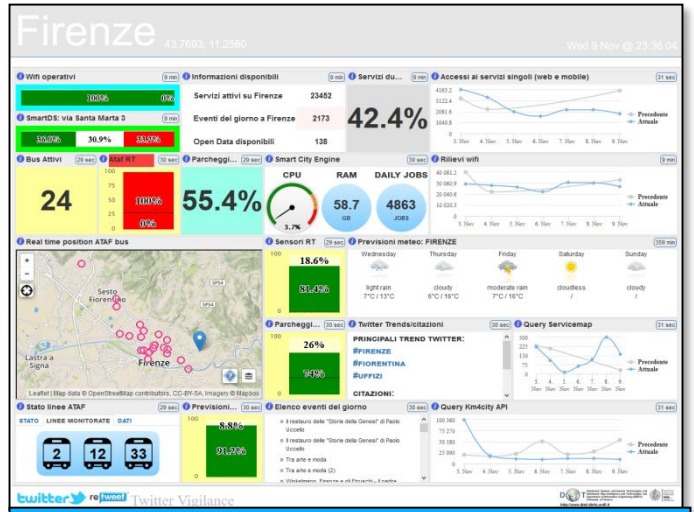


Utenti FirenzeWiFi negli ultimi 5 minuti 2m



REPLICATE

Horizon 2020
European Union Funding
for Research & Innovation





Florence data overview

A table based overview over city main data

Wed 18 Jan @ 19:19:10

Air Quality Index

Substances / Quarters	OZN	PM2	PM10	C02	NO2
Q1	120	41	165	36	4
Q2	33	25	66	123	45
Q3	225	153	342	193	217
Q4	174	221	87	122	93
Q5	79	87	23	27	65

Weather stations

Data / Station	Wind speed (km/h)	Direction	Temperature (°C)	Humidity (%)	Rain today (mm)	Pressure (mbar)
Sesto Fiorentino	50	N		32	0	922
Livorno	65	NE		37	0	876
Grosseto	78	E	4	22	0	1022
Vada	42	S	6	0	34	895
Follonica	102	N	7.2	23	0	913
Giglio	97	O	3	19	0	957

0 --> 4
4 --> 10
10 --> 20
20 --> 25
25 --> 30
30 --> 50

Citizens satisfaction index

Criteria / Services	Quality (%)	Cost (%)	Availability time (%)	Emergency handling (%)
Water	92	67	95	42
Public transportation	36	29	27	31
Public safety	77	64	58	62
Roads management	28	42	27	25
Healthcare	72	64	23	56
Welfare	43	51	38	36
Public administration	58	16	18	22

Tourists flow

Categories / Vehicle	Total arrivals	Overnights	Day trippers
Airplane	56	36	20
Train	122	81	41
Car	215	133	82
Bus	157	110	47
Cruise	0	0	0
Boat	0	0	0
Total	550	360	190

Florence events 2017 overview

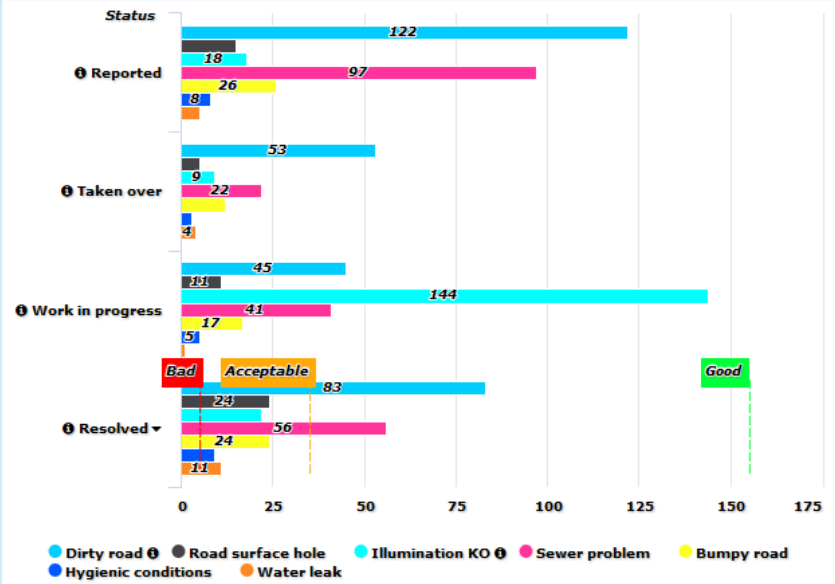
Fields / Categories	Free	Paid	Winter	Spring	Summer	Autumn
Classical music, opera, ballet	7	23	6	10	4	10
Exhibitions	4	16	3	7	6	4
Guided tours	60	140	15	100	50	35
Film festival	0	0	0	0	0	0
Markets, fairs	7	7	2	6	2	4
Readings, conferences	35	15	10	22	9	9
Contemporary music	30	42	8	25	30	9
Sport	20	192	55	104	27	26

Smart City Data Overview

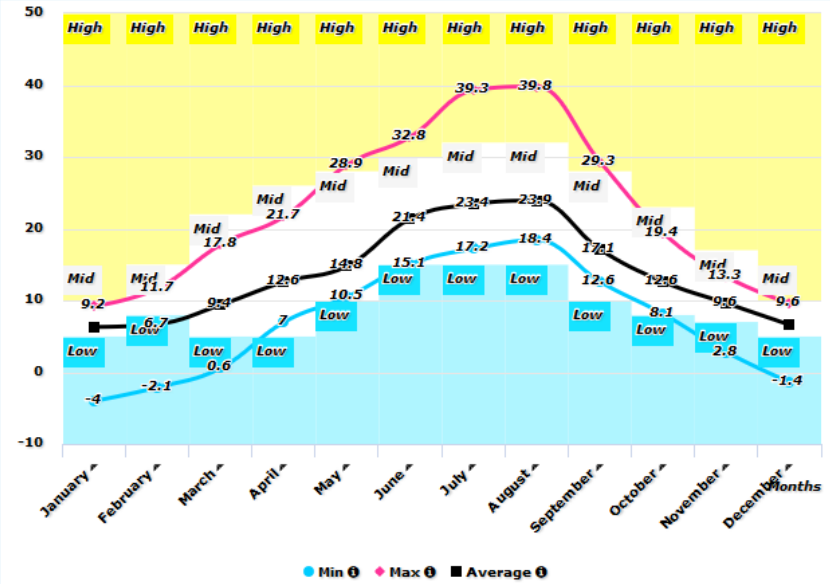
Sperimentale

Thu 16 Mar @ 02:23:38

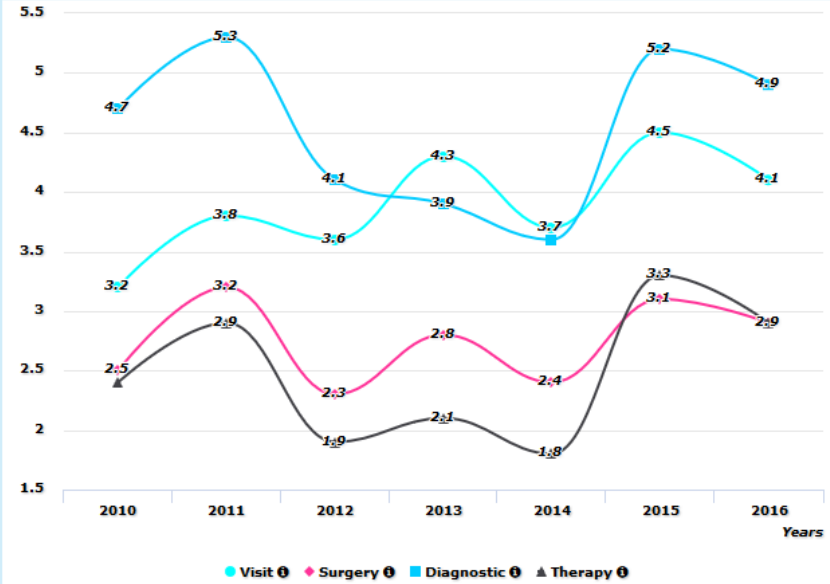
Urban faults - Horizontal bar series



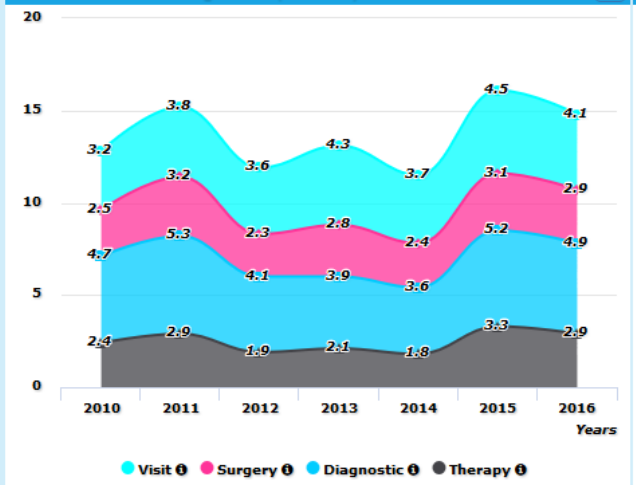
2016 Temperature statistics - Curved line series



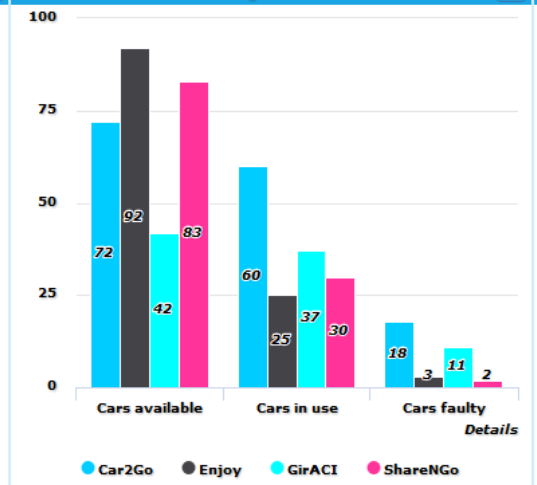
Healthcare waiting times (months) - Curved lines



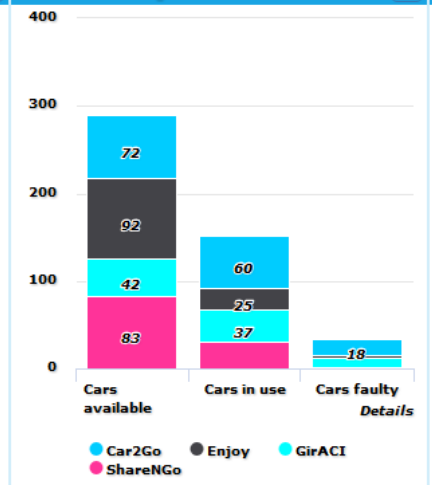
Healthcare waiting times (months) - Stacked curved area ...



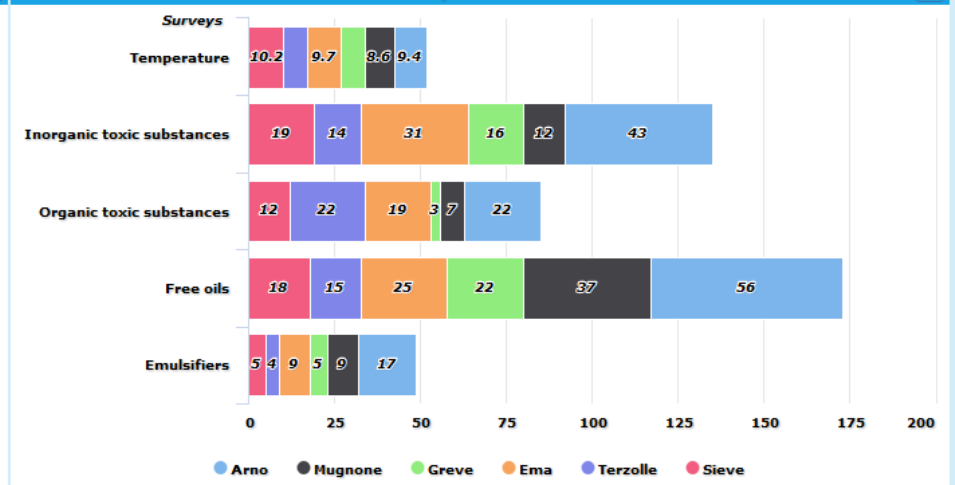
Car sharing - Vertical bars



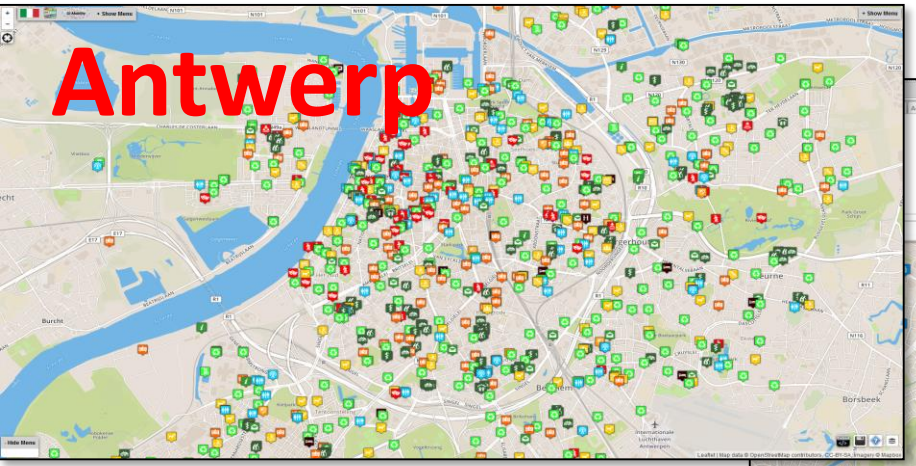
Car sharing - Vertical stacked bars

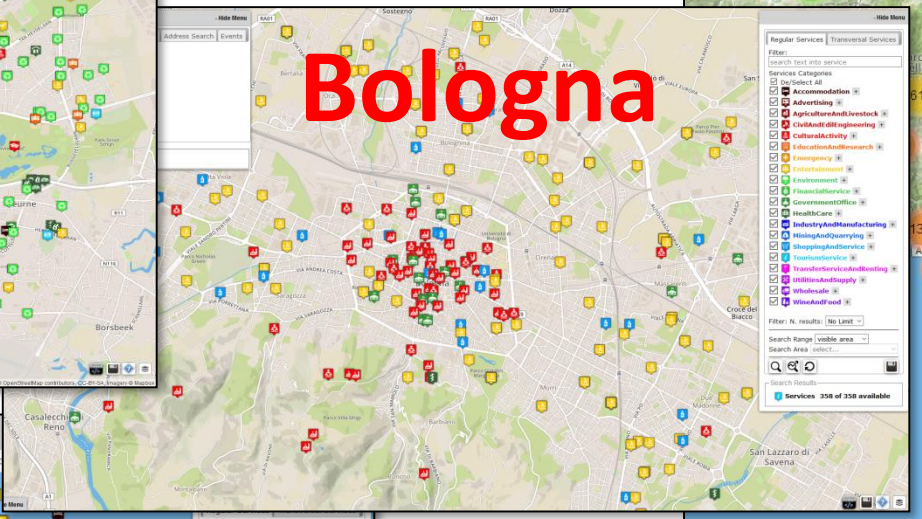


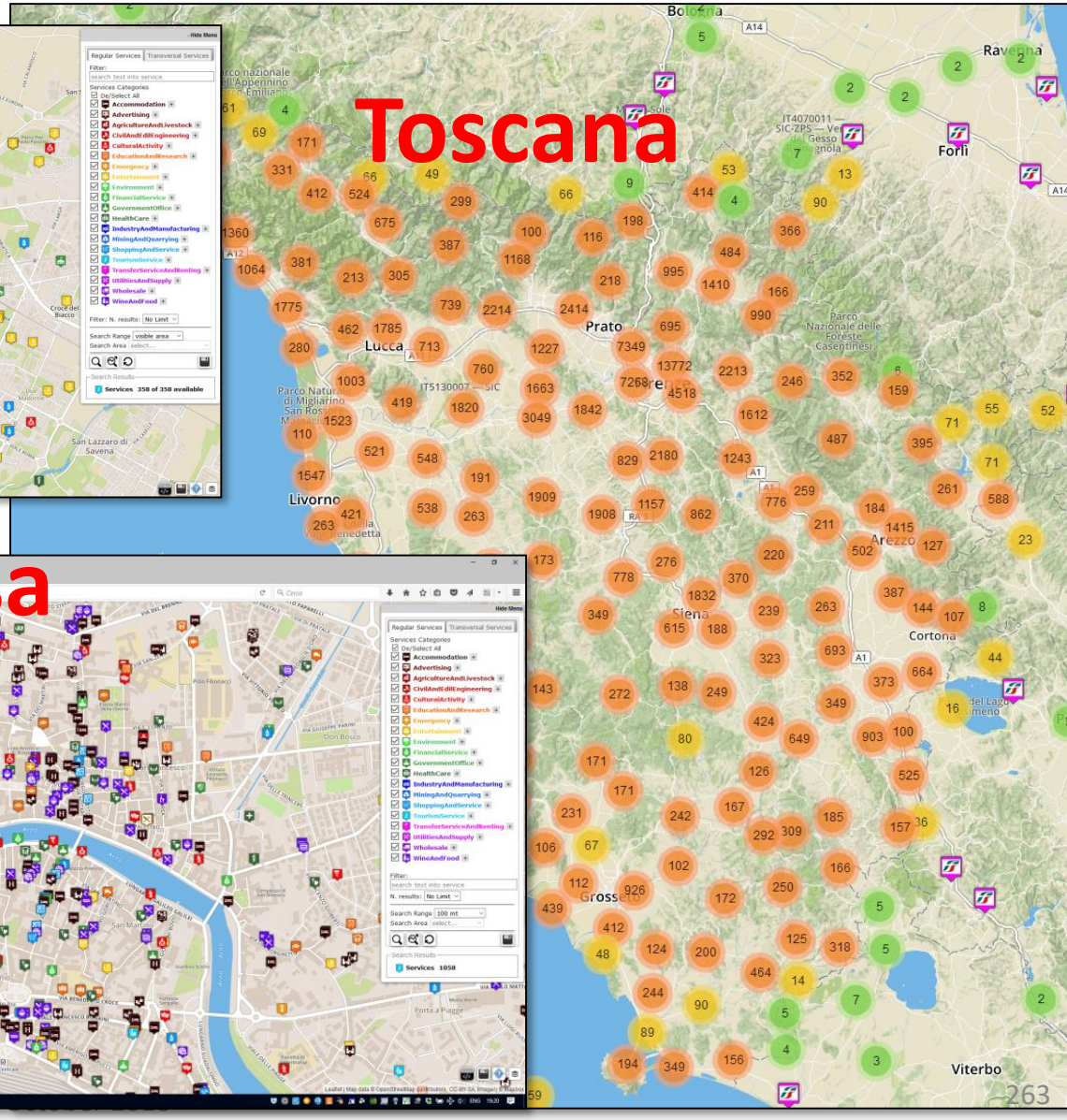
Rivers water analisys - Horizontal stacked bars

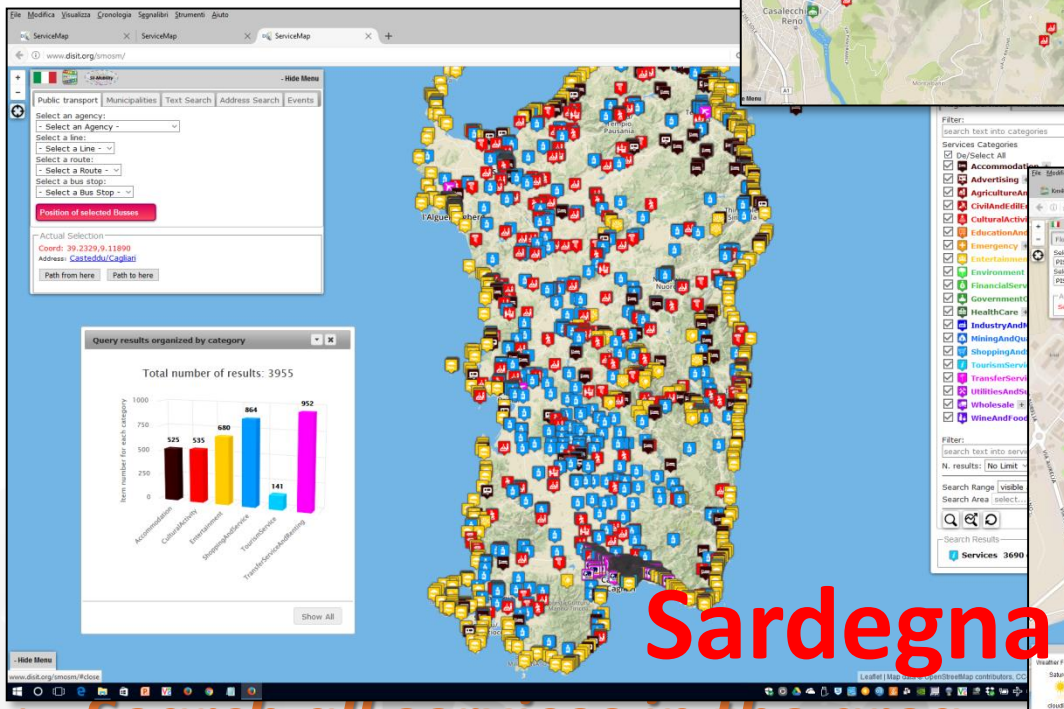


Coverage: examples

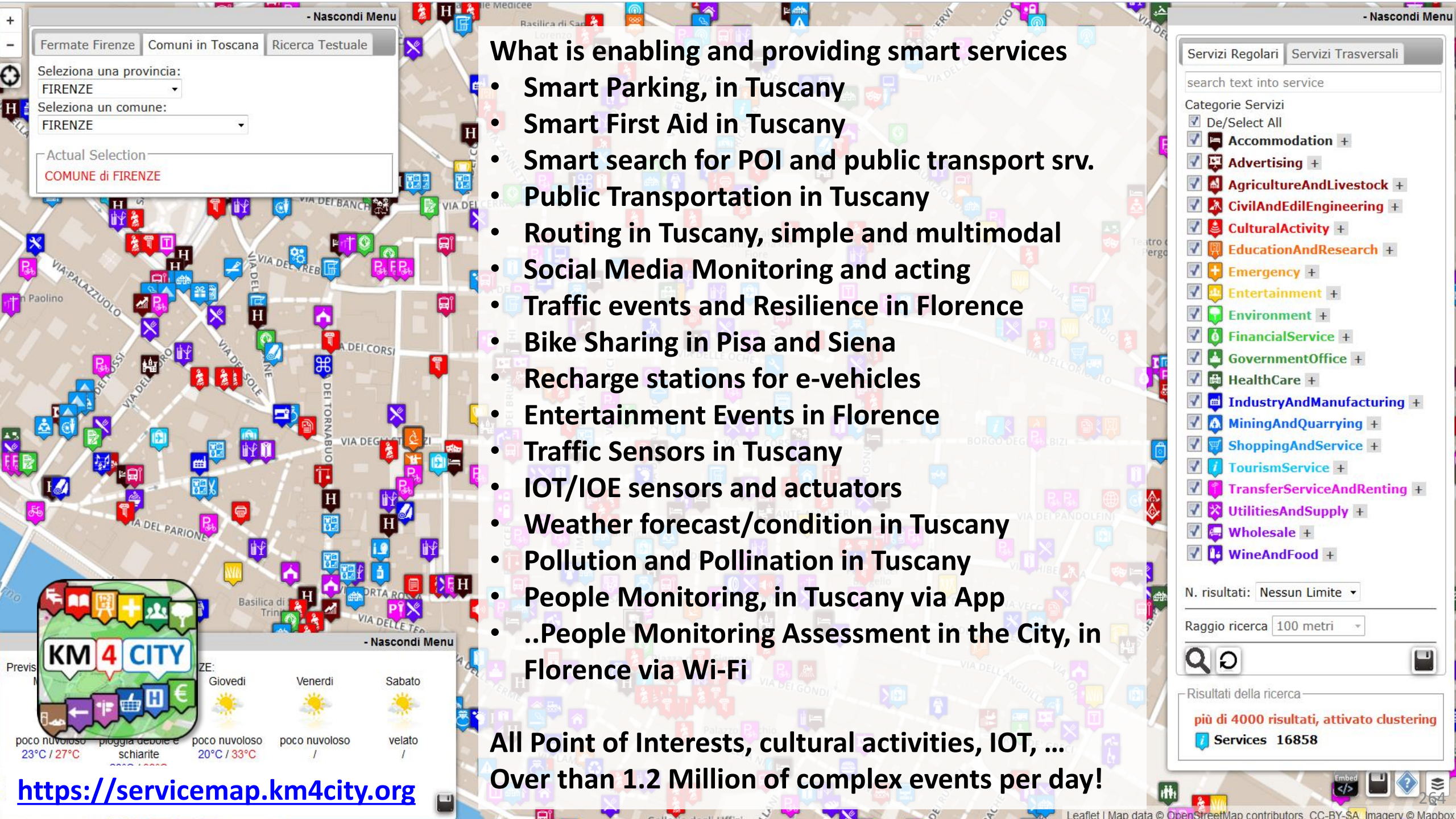








- Search all services in the area



What is enabling and providing smart services

- Smart Parking, in Tuscany
- Smart First Aid in Tuscany
- Smart search for POI and public transport srv.
- Public Transportation in Tuscany
- Routing in Tuscany, simple and multimodal
- Social Media Monitoring and acting
- Traffic events and Resilience in Florence
- Bike Sharing in Pisa and Siena
- Recharge stations for e-vehicles
- Entertainment Events in Florence
- Traffic Sensors in Tuscany
- IOT/IOE sensors and actuators
- Weather forecast/condition in Tuscany
- Pollution and Pollination in Tuscany
- People Monitoring, in Tuscany via App
- ..People Monitoring Assessment in the City, in Florence via Wi-Fi

All Point of Interests, cultural activities, IOT, …

Over than 1.2 Million of complex events per day!

Sentient City Control Room



REPLICATE

Services

- **Dashboard and Notifications for Decision Makers**
  - Control Room Dashboard, Notifications, personalized
  - Widgets in third party web pages
- **Development Tools for Applications**
  - Development of Web and Mobile App, HTML5, Open
  - Development of IOT Application for all
  - **Smart City API to access and exploit the city knowledge Km4City**
  - **Easy upload of Data Set and Data Analytics/Processing Processes**
  - **Development Environment for Data Analytics**
    - **Sand Box, VM for developers: ETL, Phython, C/C++, Java, etc.**

FIRENZE

Tue 16 Oct 16:18:39

INDICI DI CRITICITA' DELLA QUALITA' DELL'ARIA (ICQA)	
2	inviata comunicazione alla cittadinanza

OZONO	
200 µ/m³	superata la soglia di informazione

39492 Utenti WiFi

STATI DI ALLERTA 9m

GENERAL | METEO

MINIMO	BASSO	MEDIO	ALTO

RISCHIO IDRAULICO

RISCHIO TEMPORALI

RISCHIO IDROGEOLOGICO

RISCHIO NEVE

RISCHIO GHIACCIO

Mar 16 Ott
Firenze
Nuvoloso
19°C / 24 °C
Powered by LaMMA

Mer 17 Ott 16°C / 24°C	Nuvoloso
Gio 18 Ott 15°C / 26°C	Nuvoloso
Ven 19 Ott Temp N/A	Sereno
Sab 20 Ott Temp N/A	Sereno

TPL

N	14	57	21
Attesa	3'	8'	5'
Ritardo	2'	0'	2'

COLONNINE RICARICA 9m

180 INSTALLATE

81.1 % ATTIVE

8.9 % IN USO

REPLICATE

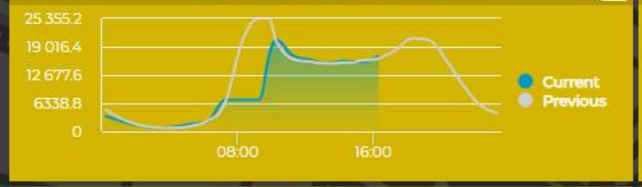
DISIT

FLORENCE DASHBOARD

This dashboard is the main entry point to access dashbaords realised in the REPLICATE H2020 EC project.

REPLICATE has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 691735.

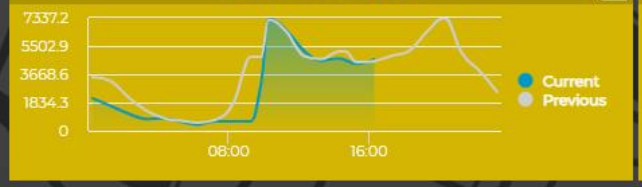
FLUSSI INGRESSO CITTA 9m



TOTALE 9m

141608 VEICOLI

FLUSSI INGRESSO ZTL 9m



TOTALE ZTL 9m

41146 VEICOLI

SITUAZIONE VIABILITA 54s

4 INCIDENTI

0 CHIUSURE AL TRAFFICO (TOT)	
0 CHIUSURE PER CANTIERI	
0 PROGR.	0 NON PROG.
0 LIMITAZIONI AL TRAFFICO (TOT)	
0 LIMITAZIONI PER CANTIERI	
0 NON PROG.	0 PROGR.

4 TOT. EVENTI SULLA RETE

SMN 9m	BINARIO16 9m	FORTEZZA 9m
63.4 % occupati su 901 posti	83 % occupati su 165 posti	17.9 % occupati su 521 posti
LEOPOLDA 9m	**CALZA 9m**	**S.AMBROGIO 9m**
36.3 % occupati su 300 posti	69.3 % occupati su 218	67 % occupati su 379 posti
PARTERRE 9m	**CAREGGI 9m**	**BECCARIA 9m**
64.9 % occupati su 106 posti	90.4 % occupati su 406 posti	78.6 % occupati su 210 posti

STATO TRIAGE CAREGGI 9m

Red code	Yellow code	Green code	Blue code	White code
3	12	83	37	9

MAPPA

Energy | Environment | Mobility | Social | Resilience

PM10	Riciclo rifiuto	Rifiuto per abitante	PIL residenti	Tasso di disoccupazione	Piste Ciclabili
26 superamenti/anno	56%	0,629 t/pers/anno	23.606 euro/pers	6,8%	19.7% km ciclabili/km totali

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

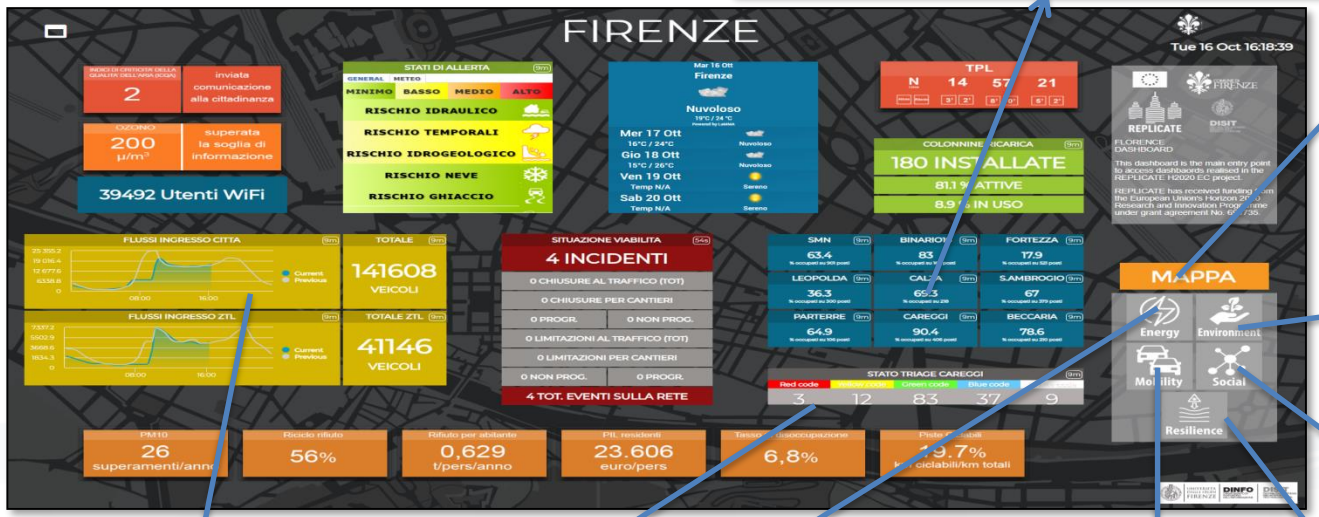
http://www.disit.org

REPLICATE

KM4CITY

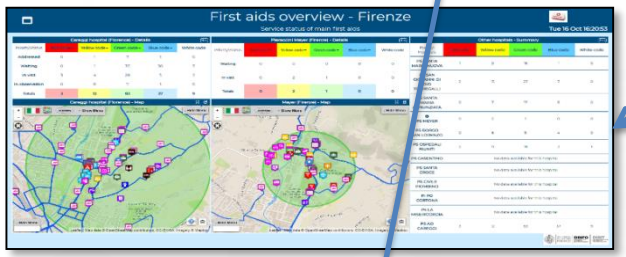




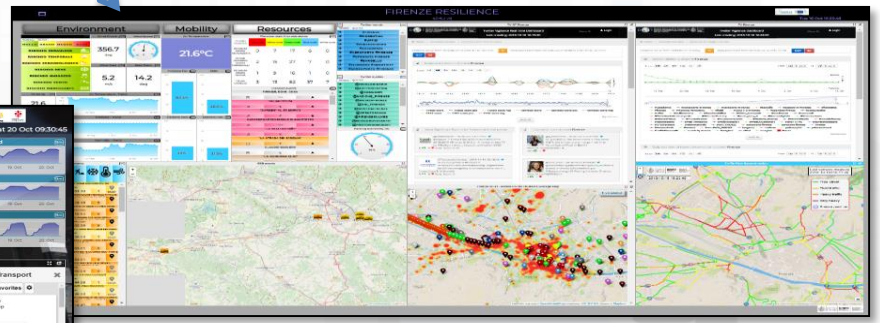


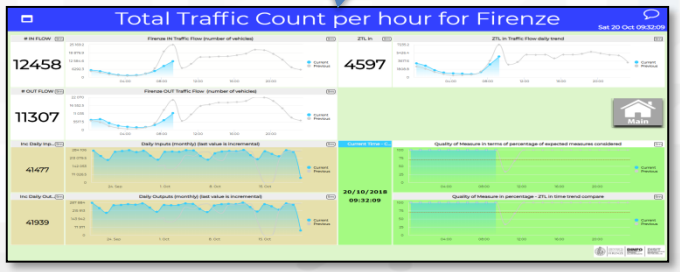








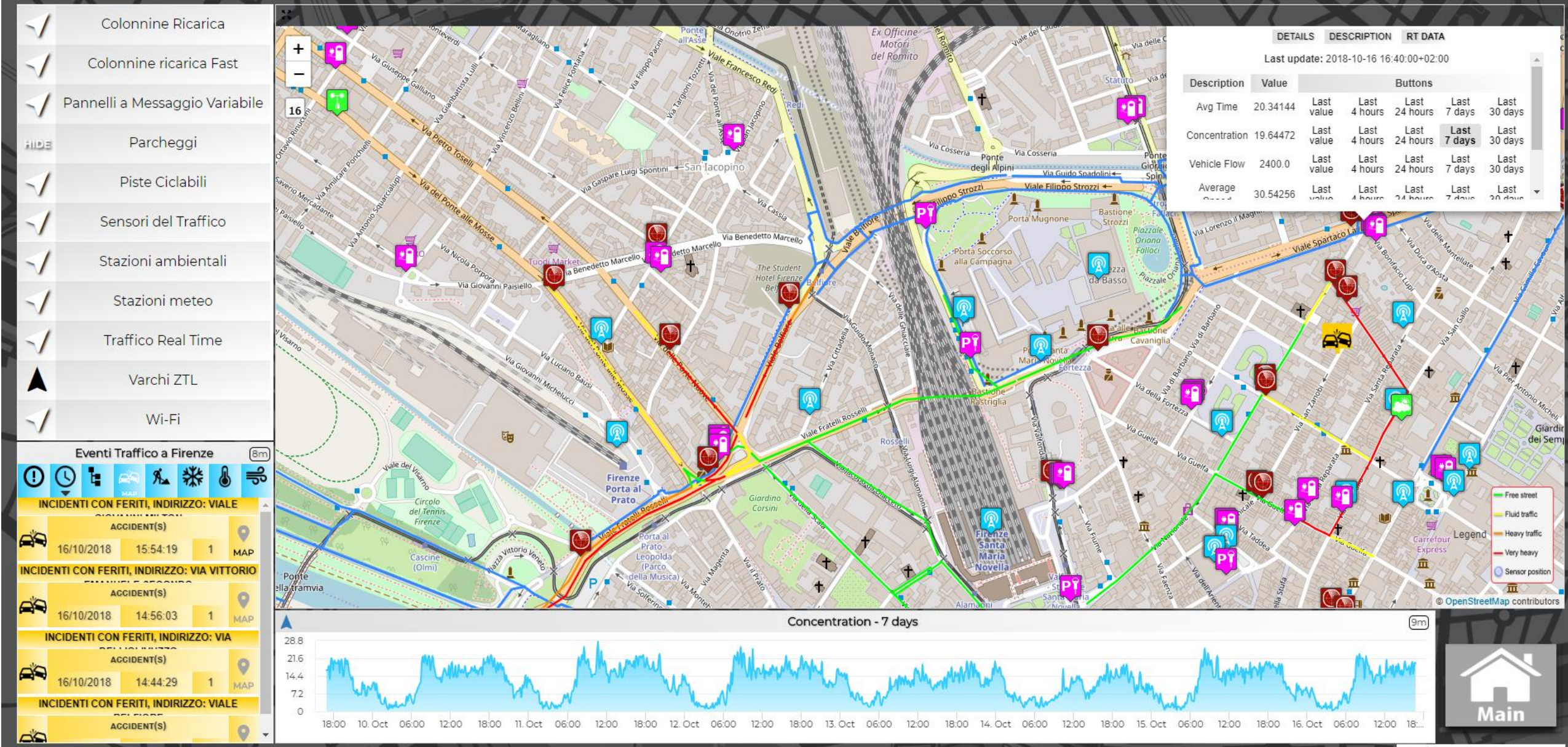






MAPPA FIRENZE

Tue 16 Oct 16:46:17

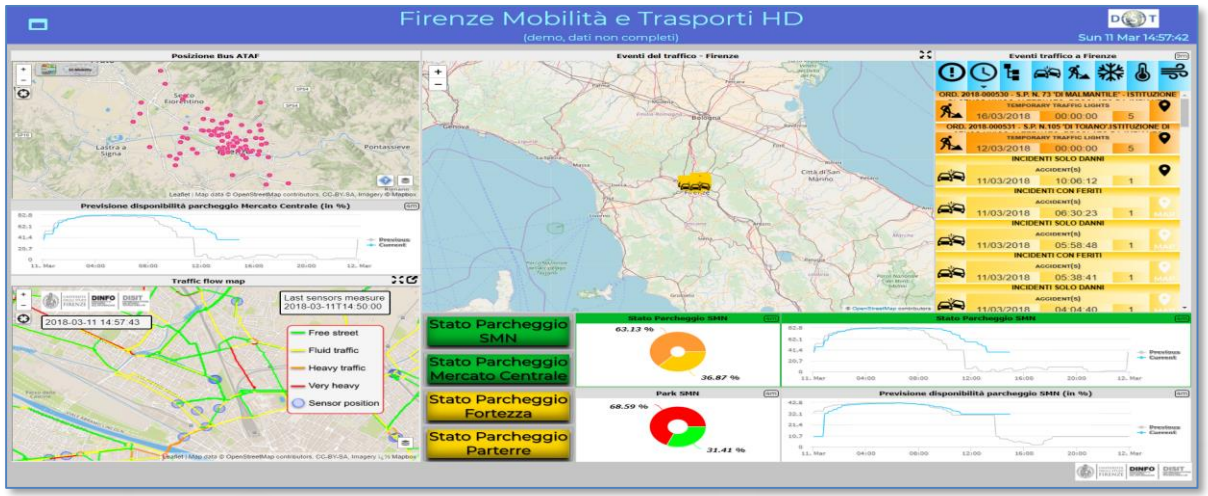


UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
http://www.disit.org

SNAP4CITY

KM4CITY

https://dashboard.km4city.org/dashboardSmartCity/view/index.php?iddasboard=MTE5



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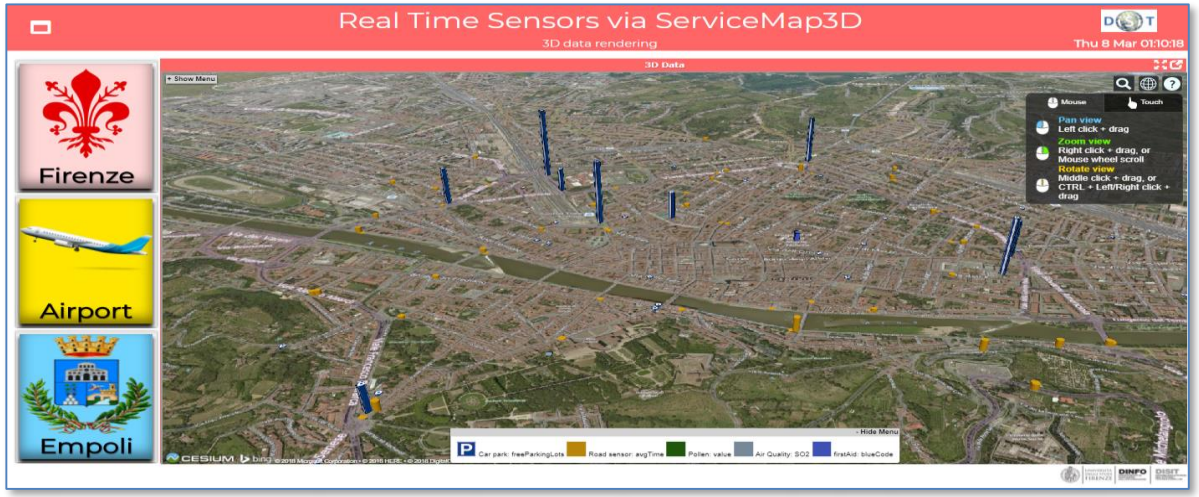

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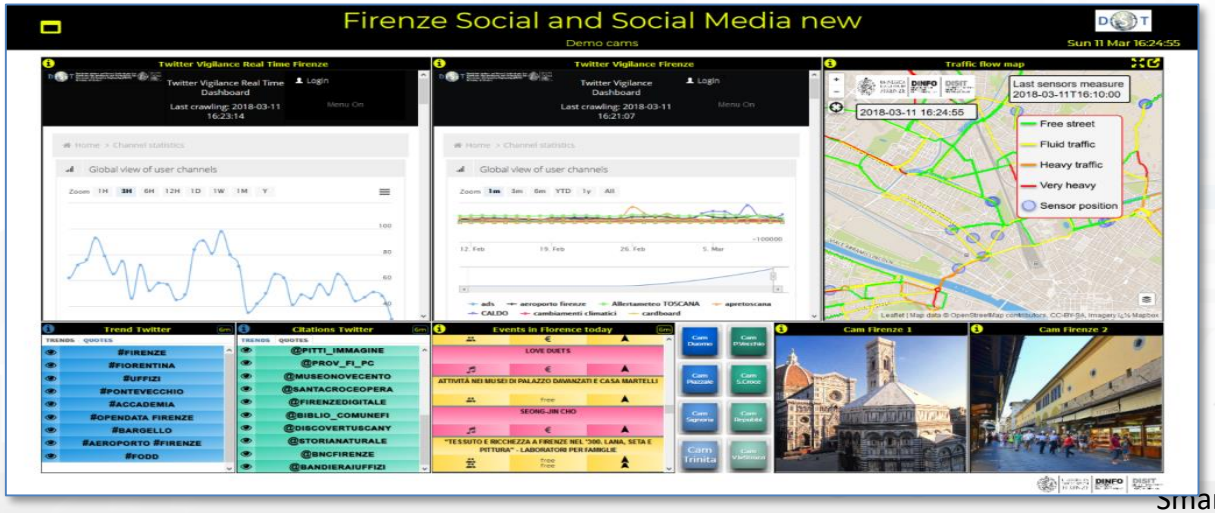

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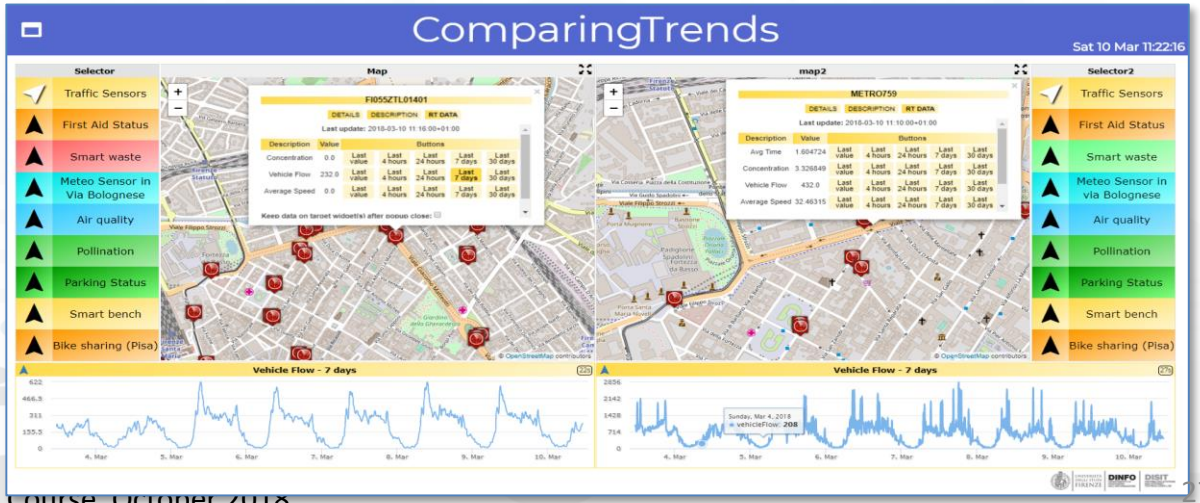


UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
http://www.disit.org

SNAP4CITY

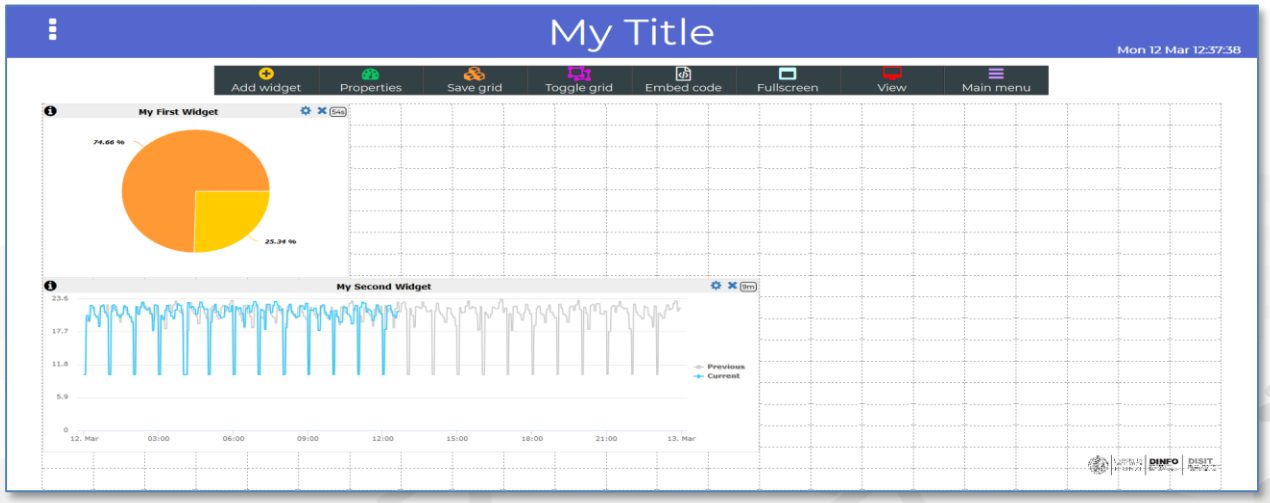
KM4CITY

https://dashboard.km4city.org/view/index.php?iddasboard=MTU1

https://dashboard.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjY2





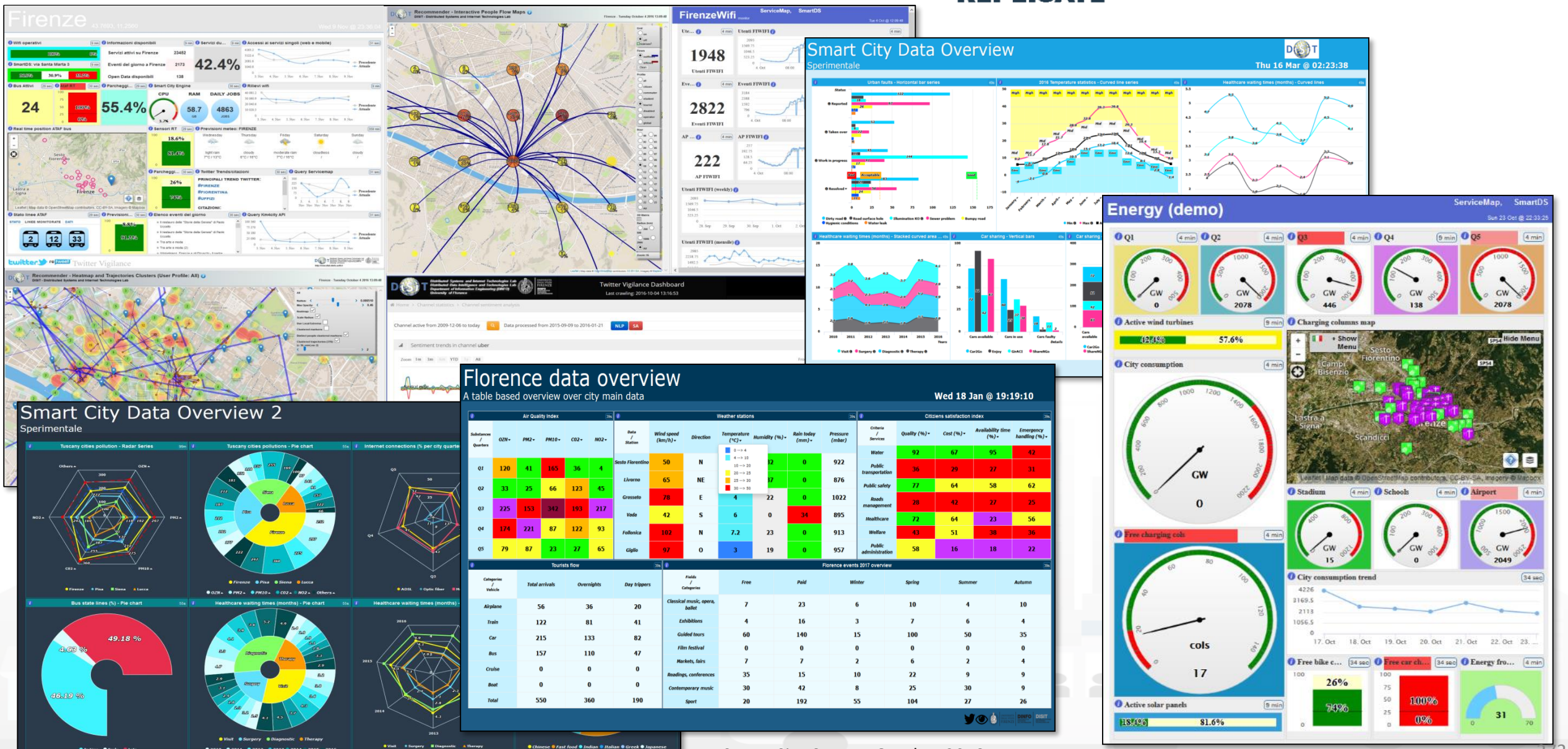


- Grid on the frame to simplify the sizing of dash and widgets
- Spaces among widgets to simplify the reading
- Full set of colour, which can be used more moderately than us ☺

Smart City Dashboard

REPLICATE

Horizon 2020
European Union Funding
for Research & Innovation



Cross widget interaction 1

Artistical events, traffic events, city cams

http://dashboard.km4city.org/dashboardSmartCity/view/index.php?iddasboard=MTI0

Artistical and recreative events 58m

PIAZZALE DEGLI UFFIZI 2

LA FABBRICA DELLA BELLEZZA. LA MANIFATTURA GINORI E IL SUO POPOLO DI STATUE
2017-05-18 to 2017-10-01
VIA DEL PROCONSOLO 4

"DANTE INFERNO"
2017-05-22 to 2017-06-30
VIA RICASOLI

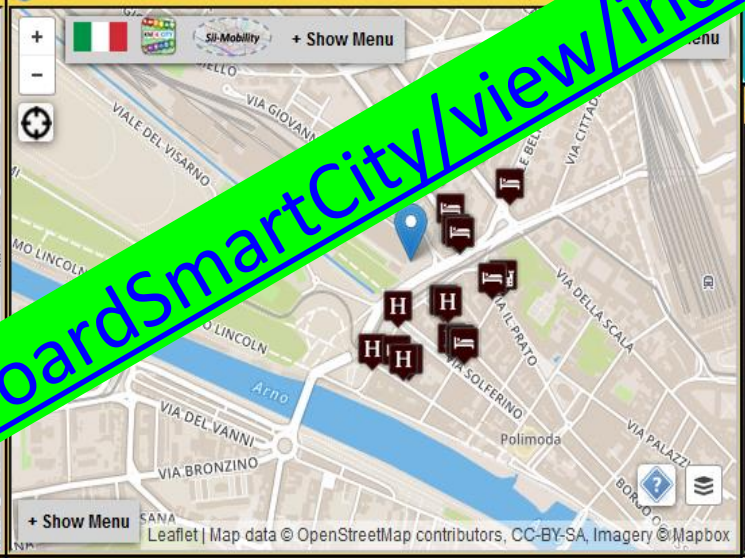
UN FRAGILE CAPOLAVORO
2017-05-24 to 2017-09-24
VIA DEGLI ALFANI 78

ESTATE FIORENTINA DEL GIARDINO DELL'ARTECULTURA

Artistical and recreative events - Exhibitions



Artistical and recreative events - Others



Cam Duomo | Cam Piazzale | Cam Signoria | Cam Trinita

City webcams - 1



Traffic events 3m

ALL ON MAP | ALL ON MAP | SHOW ON MAP

06/06/2017 14:21:55 ON MAP

INCIDENTE IN FIRENZE, VIALE EUROPA
06/06/2017 13:43:23 ON MAP

INCIDENTE
06/06/2017 13:38:

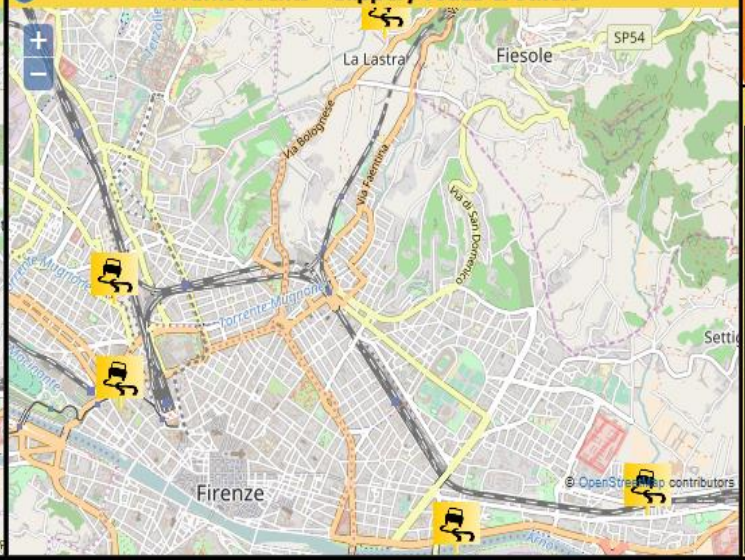
MATERIALE OLE
06/06 13:20

INCIDENTE IN FIRENZE, VI ALA
06/06/2017

Traffic ev



Traffic events - Slippery roads & others



Cam P.Vecchio | Cam S.Croce | Cam Repubbl. | Cam Fortezza

City webcams - 2



First aids overview - Tuscany

Service status of main first aids

...day @ 11:00:34

Careggi hospital (Florence) - Details

Priority\Status	Red code	Yellow code	Green code	Blue code	White code
Addressed	1	4	3	0	0
Waiting	0	2	9	2	0
In visit	1	9	18	3	0
In observation	4	19	2	0	0
Totals	6	34	32	5	0

Santa Chiara hospital (Pisa) - Details

Priority\Status	Red code	Yellow code	Green code	Blue code	White code
Waiting	0	1	7	9	3
In visit	0	7	1	1	
Totals	0	8	8		9

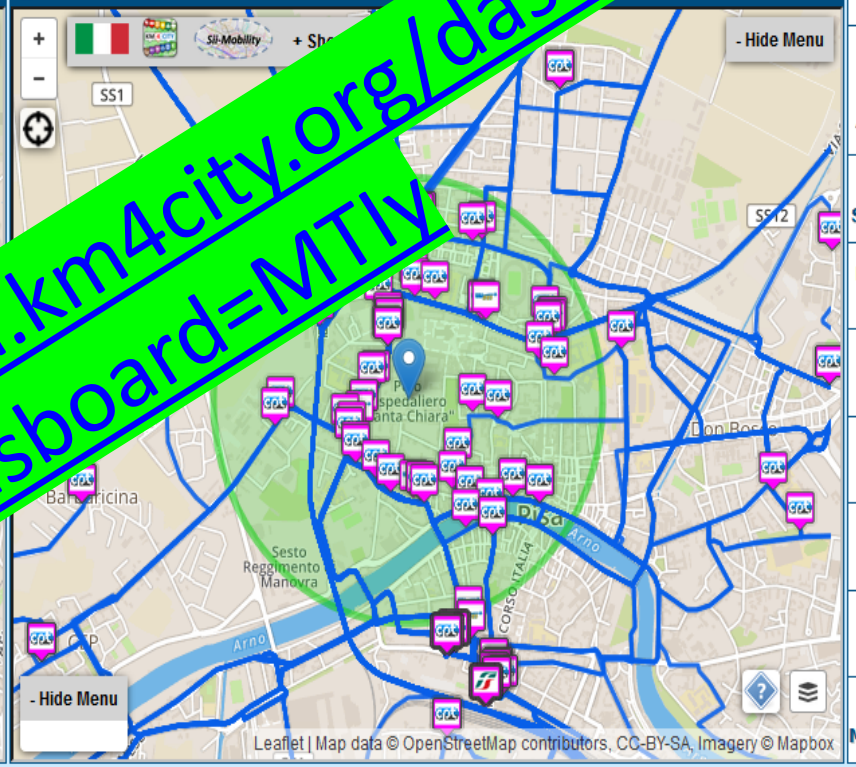
...spitals - Summary

Priority\Ho...	...ellow code	Green code	Blue code	White code
...EGALLI	1	16	20	1	0
PS SANTA MARIA NUOVA	1	14	12	3	0
PS AO CAREGGI	6	34	32	5	0
PS SANTA MARIA ANNUNZIATA	1	8	11	1	0
PS BORGO SAN LORENZO	0				0
PS OSPEDALI RIUNITI	3				1
PS CASENTINO					
PS SANTA CROCE					
PI PO CORTONA					
PS CIVILE PIOMBINO					
PS LA MISERICORDIA					

Careggi hospital (Florence) - Map



Santa Chiara ho...





http://dashboard.km4city.org/dashboardSmartCity/view/index.php?iddasboard=MTIy

Mobility and Transport

REPLICATE

Tue 6 Feb 00:01:34

Click POI of interest below

- Fast recharging stations
- Normal recharging stations
- Cycle paths
- Public transport paths (F)
- Restricted traffic areas
- **Parking status**
- Variable Message Signs

Traffic events 17m

05/02/2018	07:44:07	1	MAP

ORD. 2018-000257 - S.P. N. 56 'DEL BROLLO E POGGIO ALLA

TEMPORARY TRAFFIC LIGHTS | 05/02/2018 | 00:00:00 | 5

ORD. 2018-000222 - S.P. 503 'DEL PASSO DEL GIOGO'.ISTITUZIONE

TEMPORARY TRAFFIC LIGHTS | 04/02/2018 | 00:00:00 | 5

ORD. 2018-000252 - S.P. 10 'VAL D'ELSA'.CHIUSURA TOTALE AL

BLOCKED AHEAD

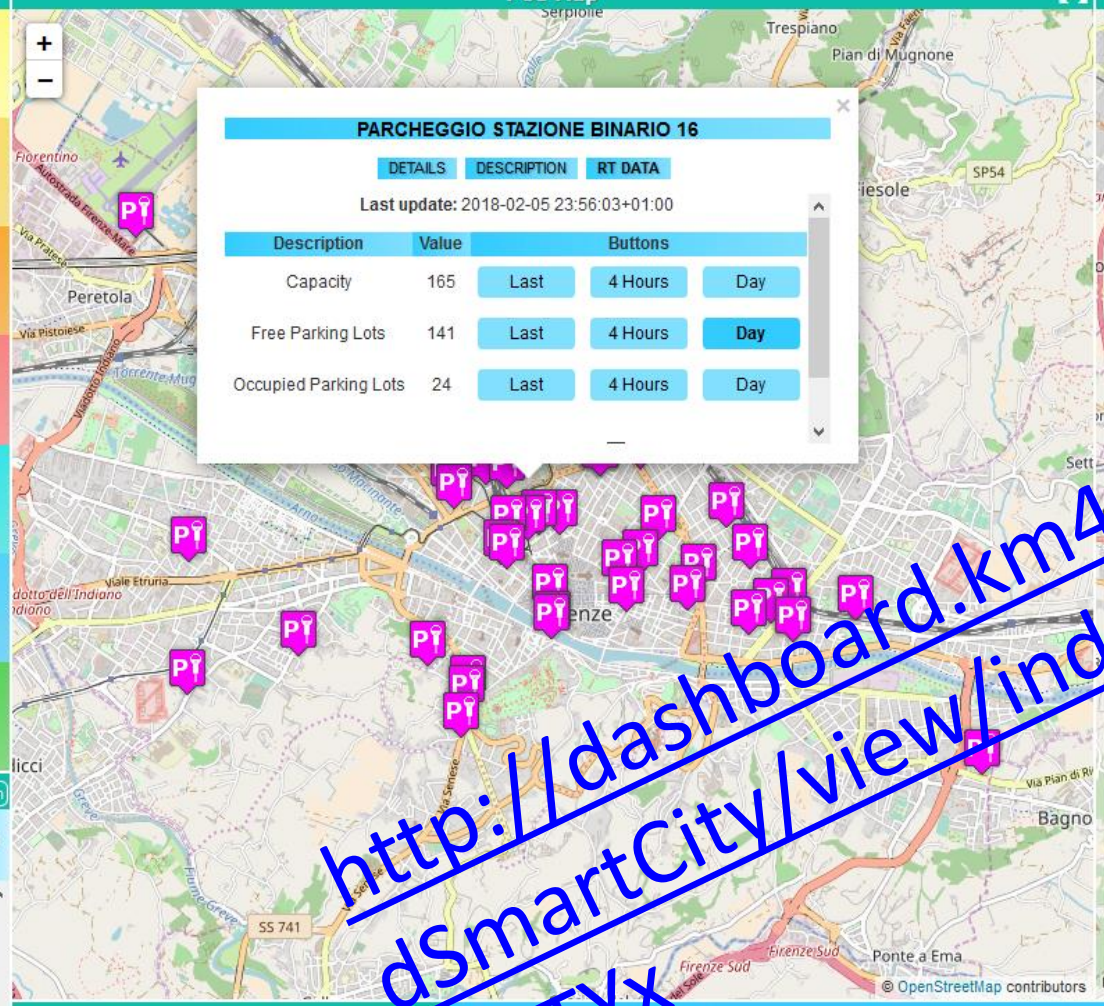
POI Map

PARCHEGGIO STAZIONE BINARIO 16

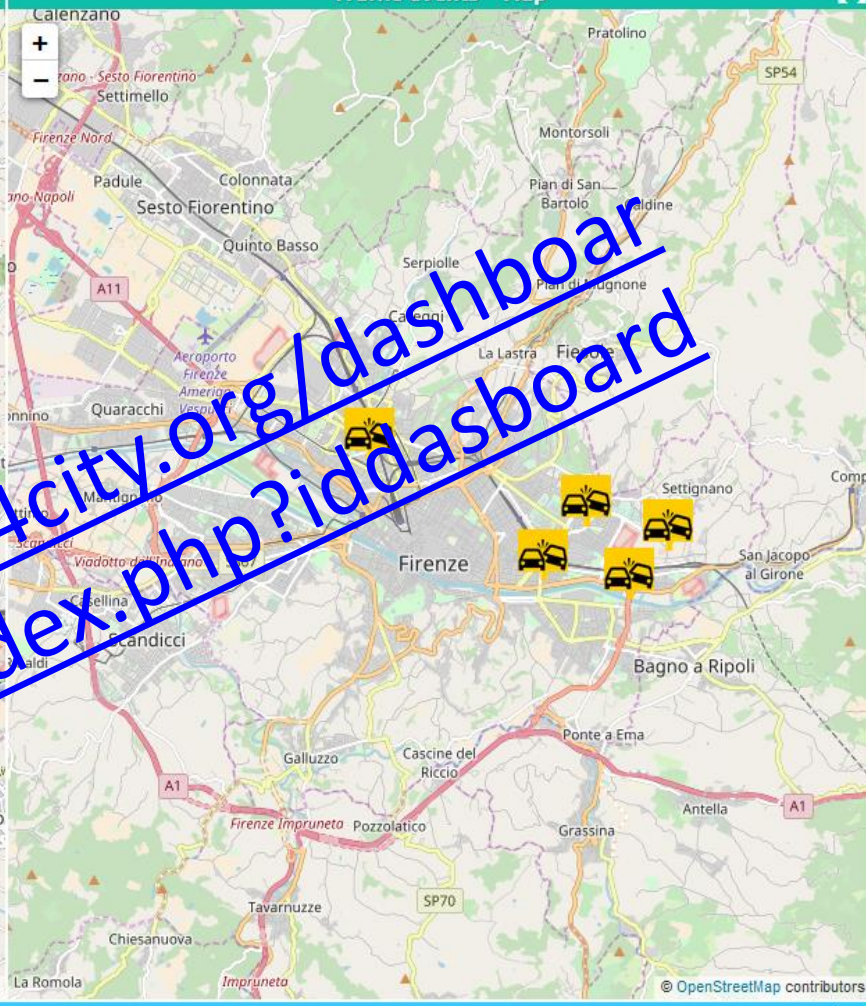
DETAILS | DESCRIPTION | RT DATA

Last update: 2018-02-05 23:56:03+01:00

Description	Value	Buttons		
Capacity	165	Last	4 Hours	Day
Free Parking Lots	141	Last	4 Hours	Day
Occupied Parking Lots	24	Last	4 Hours	Day



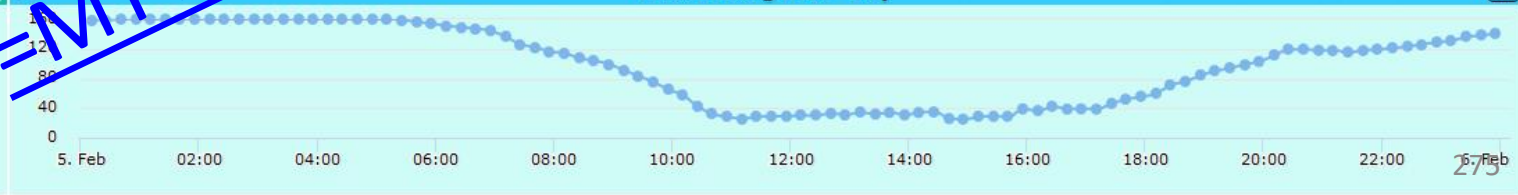
Traffic events - Map



Real time data 30s

10

Free Parking Lots - Day 3m



http://dashboard.km4city.org/dashboar
dSmartCity/view/index.php?iddasboard
=MTYx

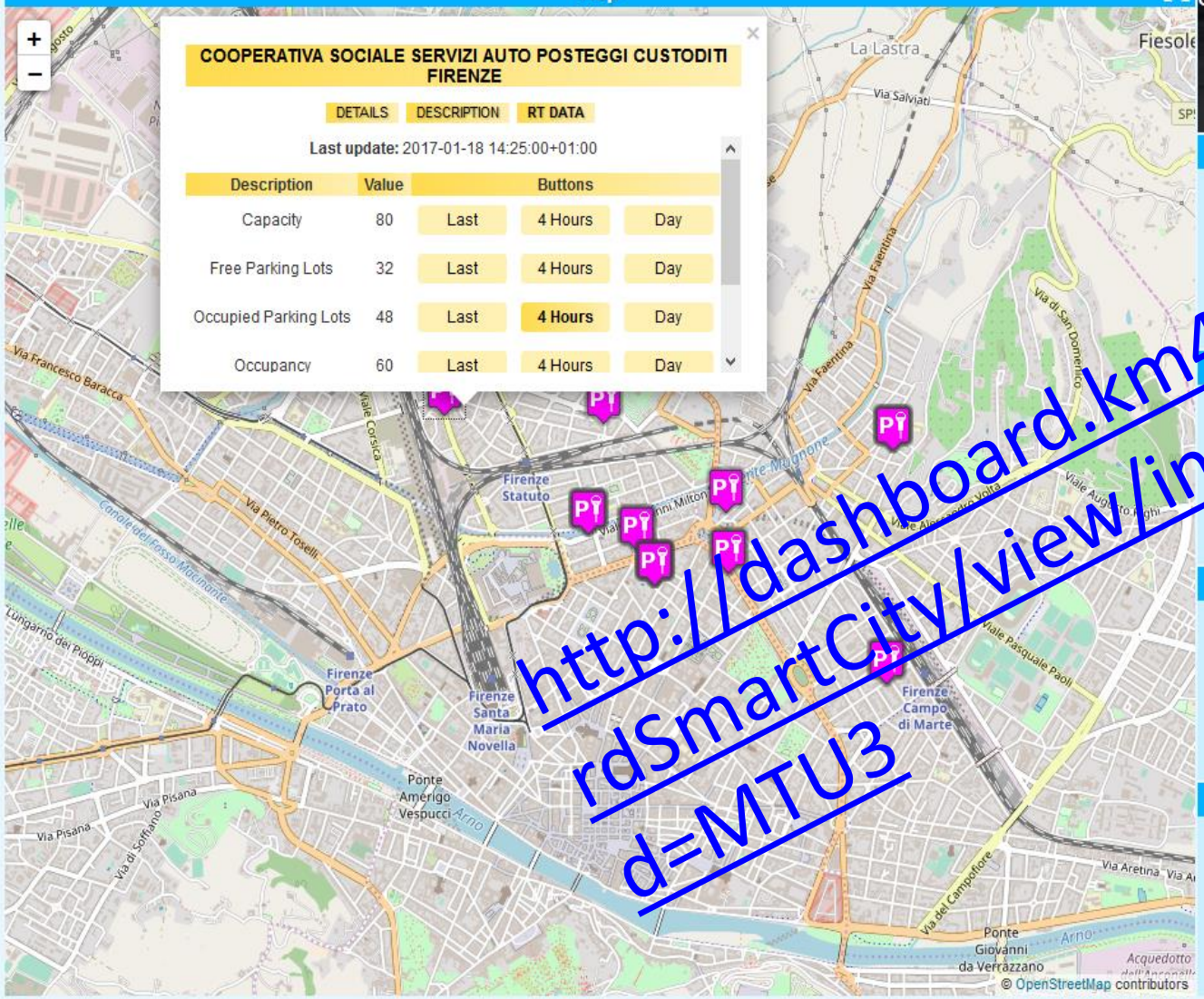
Environment and Weather

REPLICATE

Tue 6 Feb 00:03:58

Map Rivers	Map minor reticulum	Map Meteo stations
Rivers sensors (F)	Minor reticulum sensors (F)	Meteo stations (F)

Map



Weather forecast - Florence



N. of App users

42

N. of users

River sensor value

42

m.s.z.l.

River sensor values trend



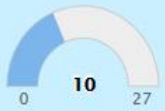
Public buildings ener...



Occupied Parking Lots - 4 Hours



Annual Energy consu...



Annual Energy consumption trend - Florence



Public Photovoltaic p...



Public Photovoltaic plants trend



http://dashboard.km4city.org/dashboard/rdSmartCity/view/index.php?iddasboard=MTU3

Energy Pilot

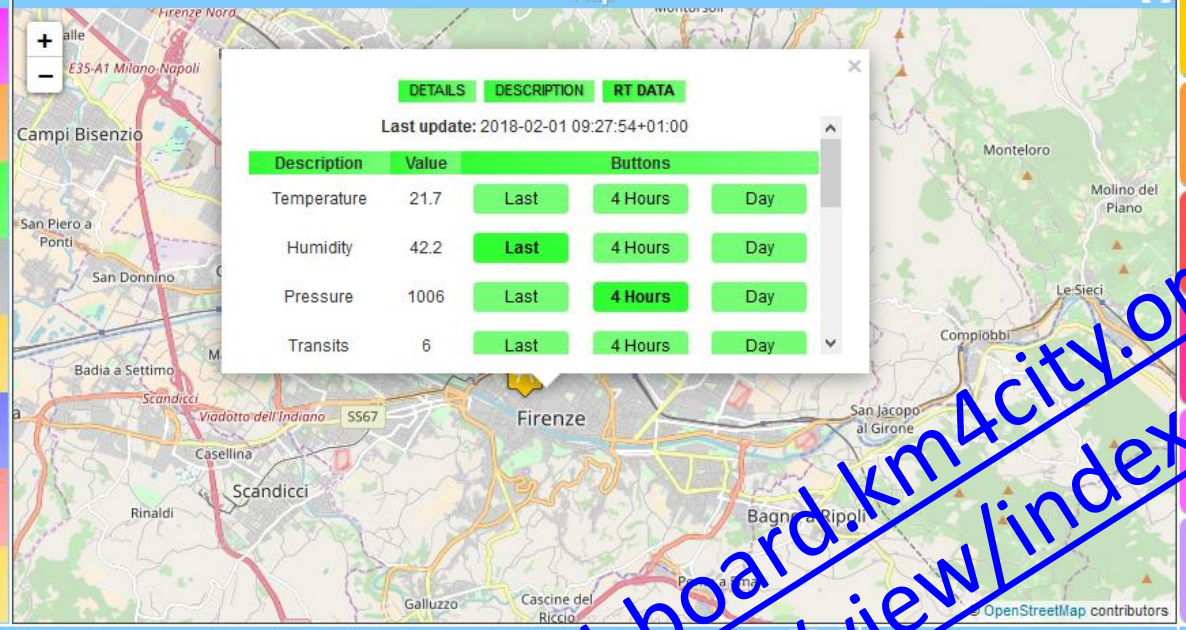
Pilot dashboard

Tue 6 Feb 00:09:39

Select the data below

- Fast recharging stations
- Normal recharging stations
- Smart Benches
- Smart Lights (F)
- Smart Irrigation (F)
- ZTL gate
- Smart waste
- Florence WiFi POI

Map

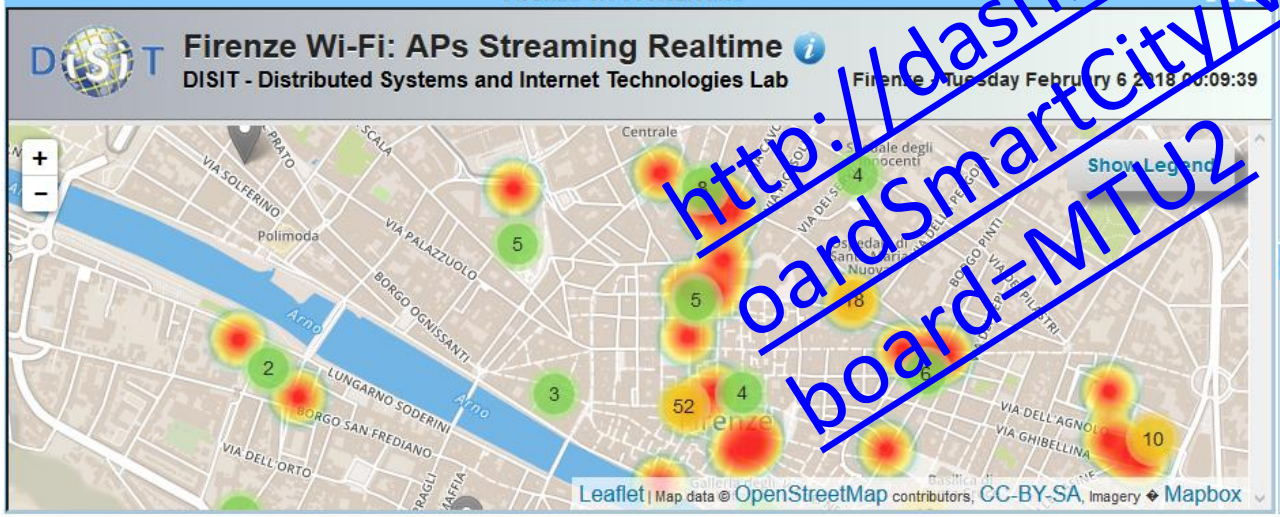




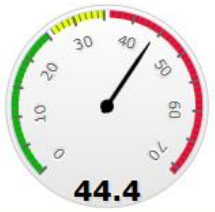
Firenze Cam



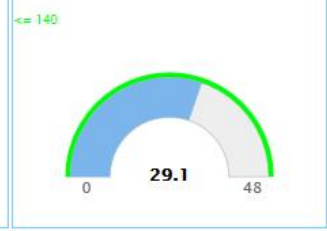
Firenze Wi-Fi RealTime



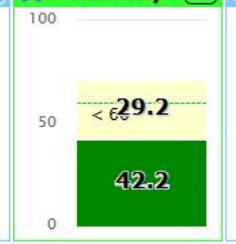
Avg heat consumpti... 8m



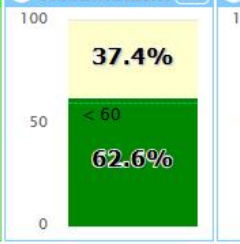
Avg gas consumption 8m



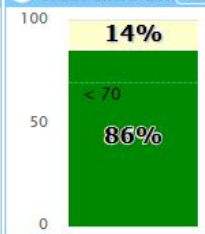
Humidity 9m



Accumulat... 8m



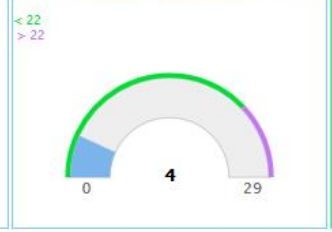
Real time a... 8m



Avg heat consumpti... 8m



Smart Grid Data 8m



Web porta... 8m

Ok

N. of App ... 8m

40 users

Energy co... 8m

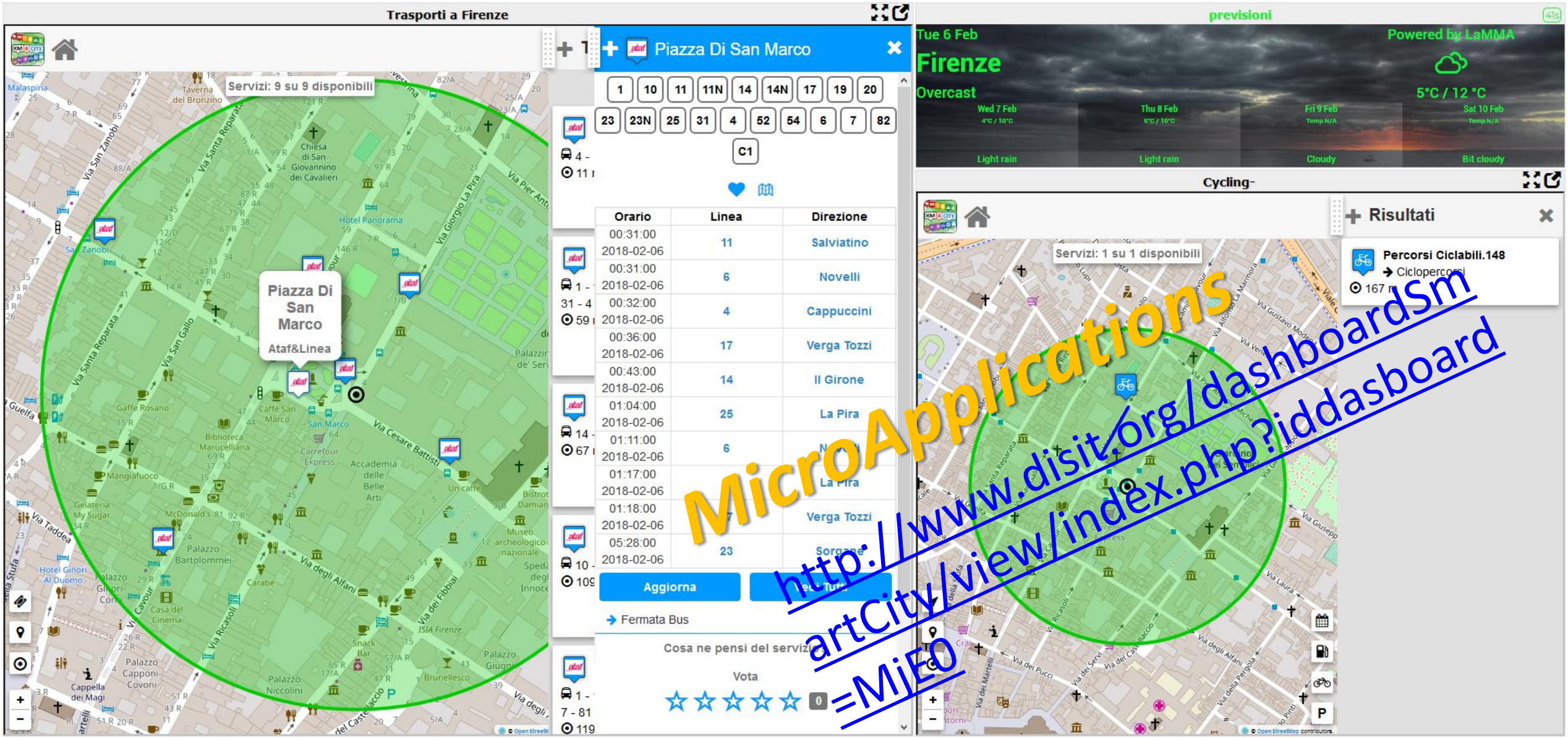
56108 kWh

http://dashboard.km4city.org/dashboardSmartCity/view/index.php?iddasboard=MTU2

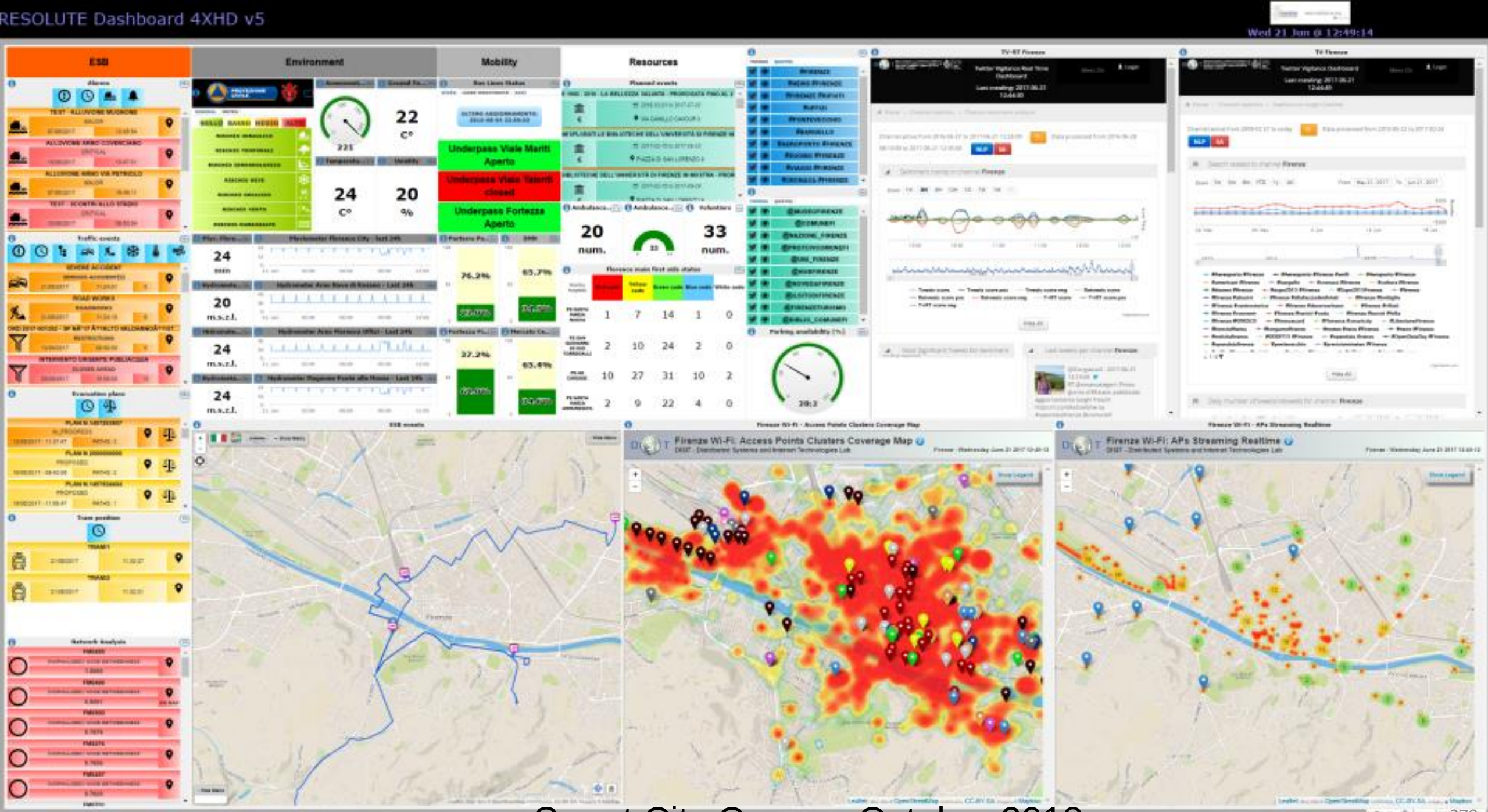
Totem for InfoMobiliy

Firenze

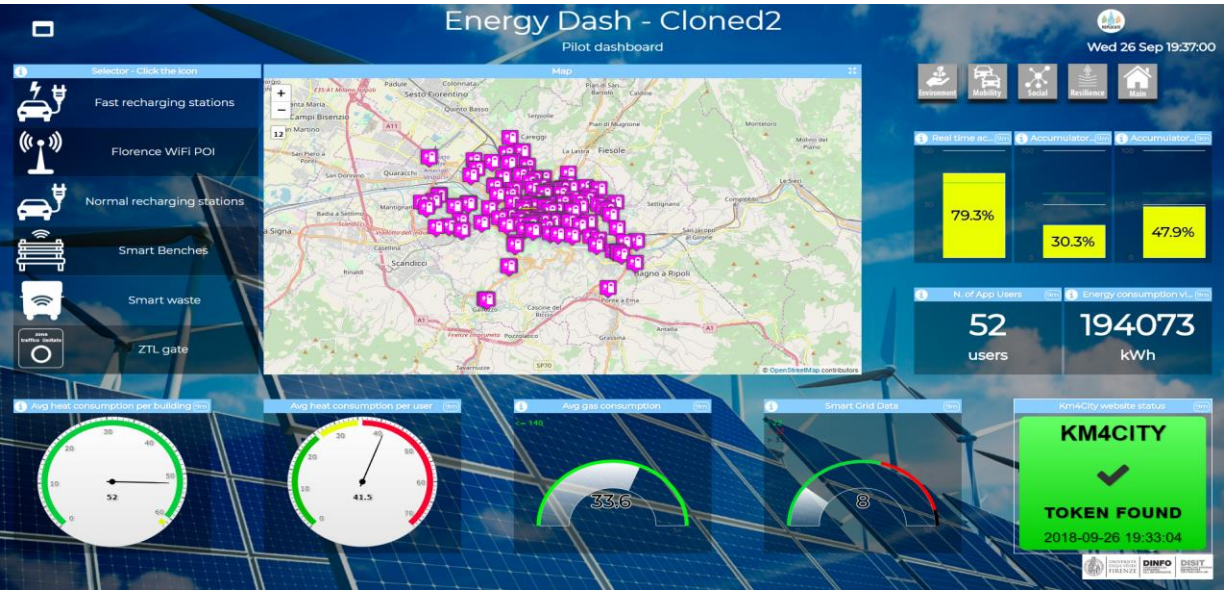
Tue 6 Feb 00:28:36

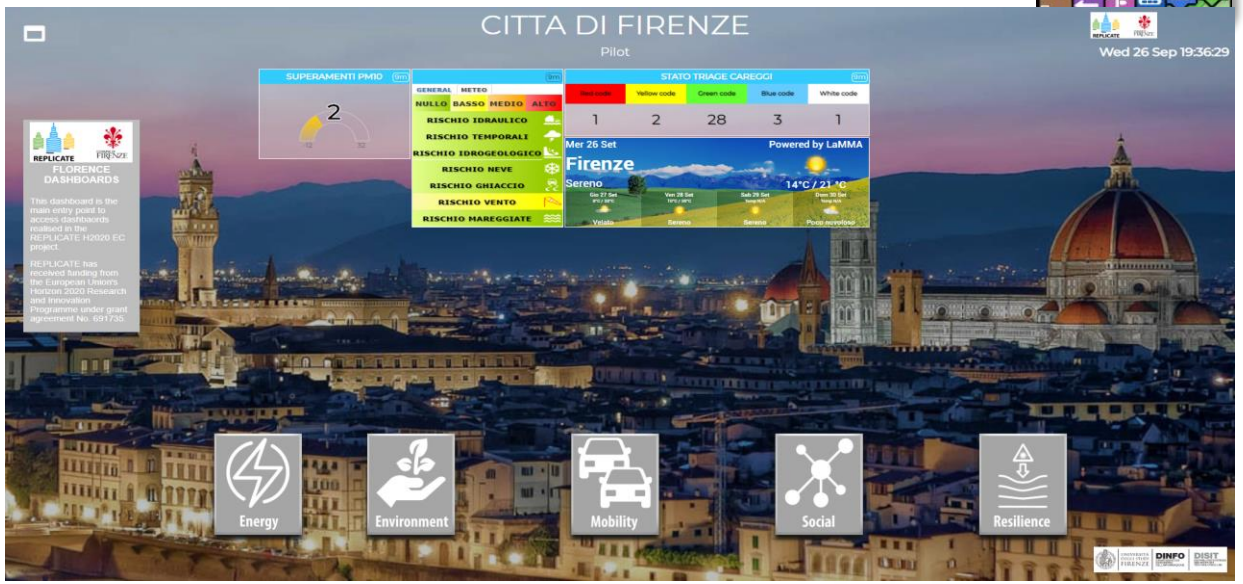


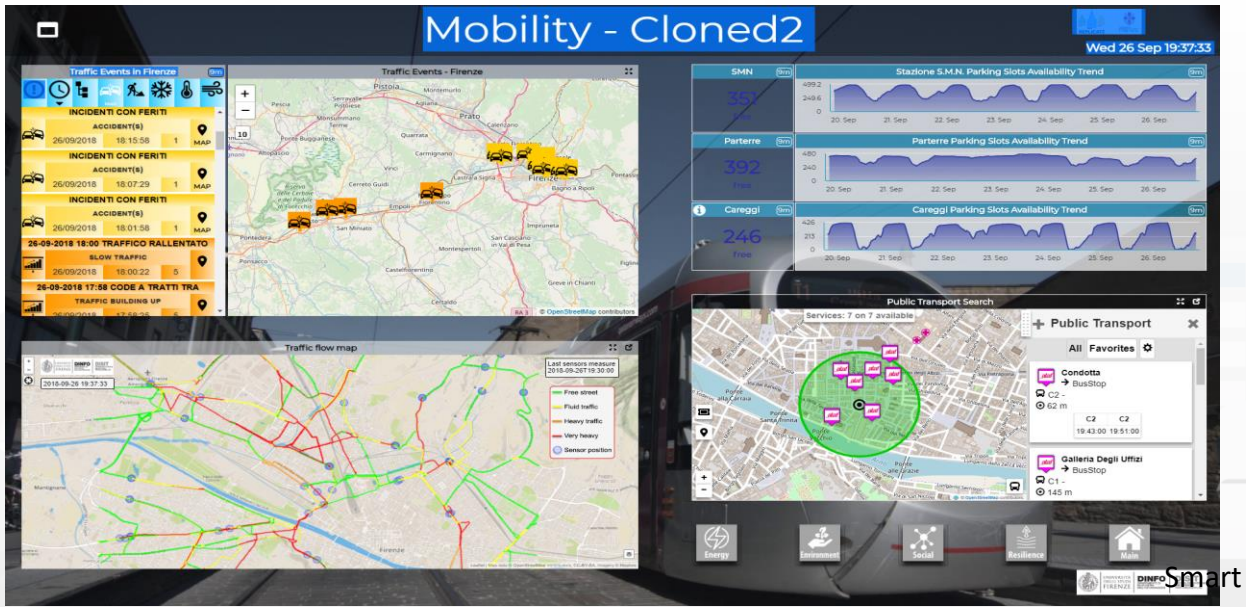
MicroApplications
http://www.disit.org/dashboardSm
artCity/view/index.php?iddasboard
=MiEO


RESOLUTE Dashboard 4XHD v5
Wed 21 Jun @ 12:49:14
ESB
Environment
Mobility
Resources
Underpass Viale Mariti Aperto
Underpass Viale Talenti closed
Underpass Fortezza Aperto
Firenze Wi-Fi: Access Points Clusters Coverage Map
Firenze Wi-Fi: APs Streaming Realtime

Smart City Dashboard







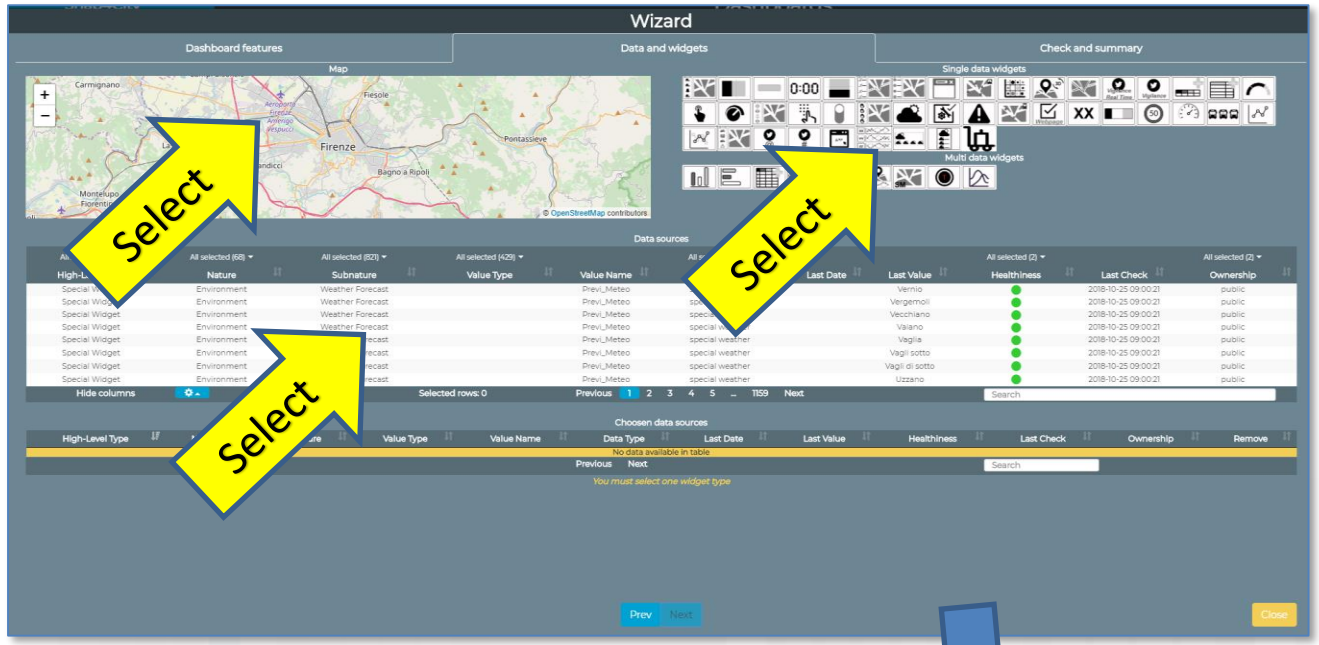


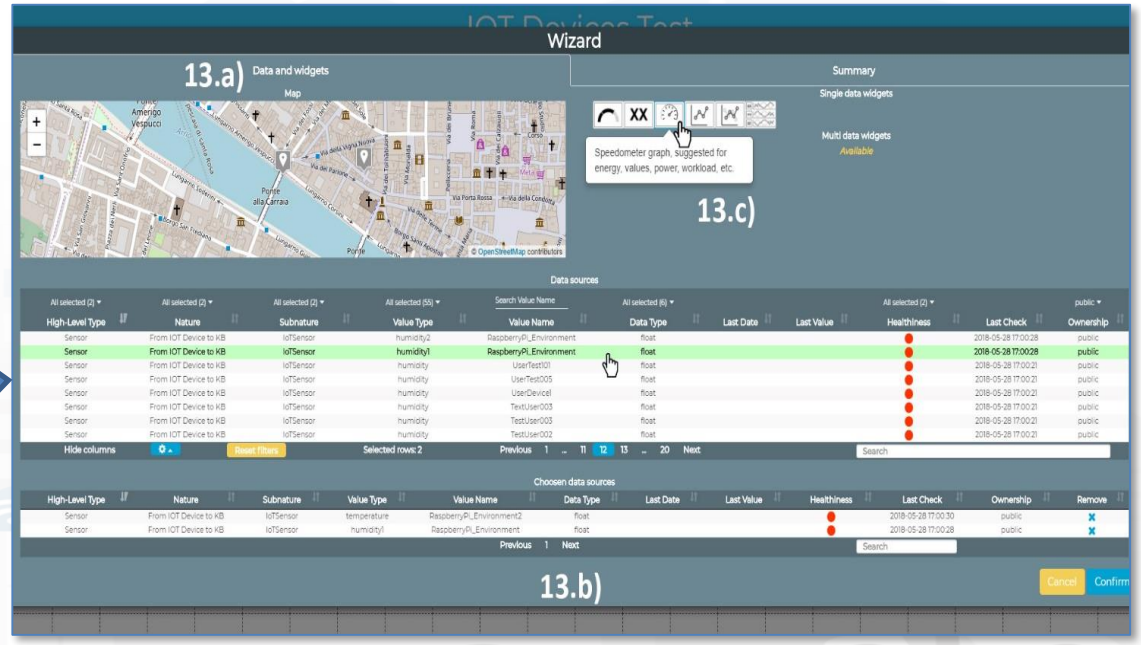
Smart City Dashboard

Multi-Widget Map



Dashboard Wizard





Editing Dahsboard

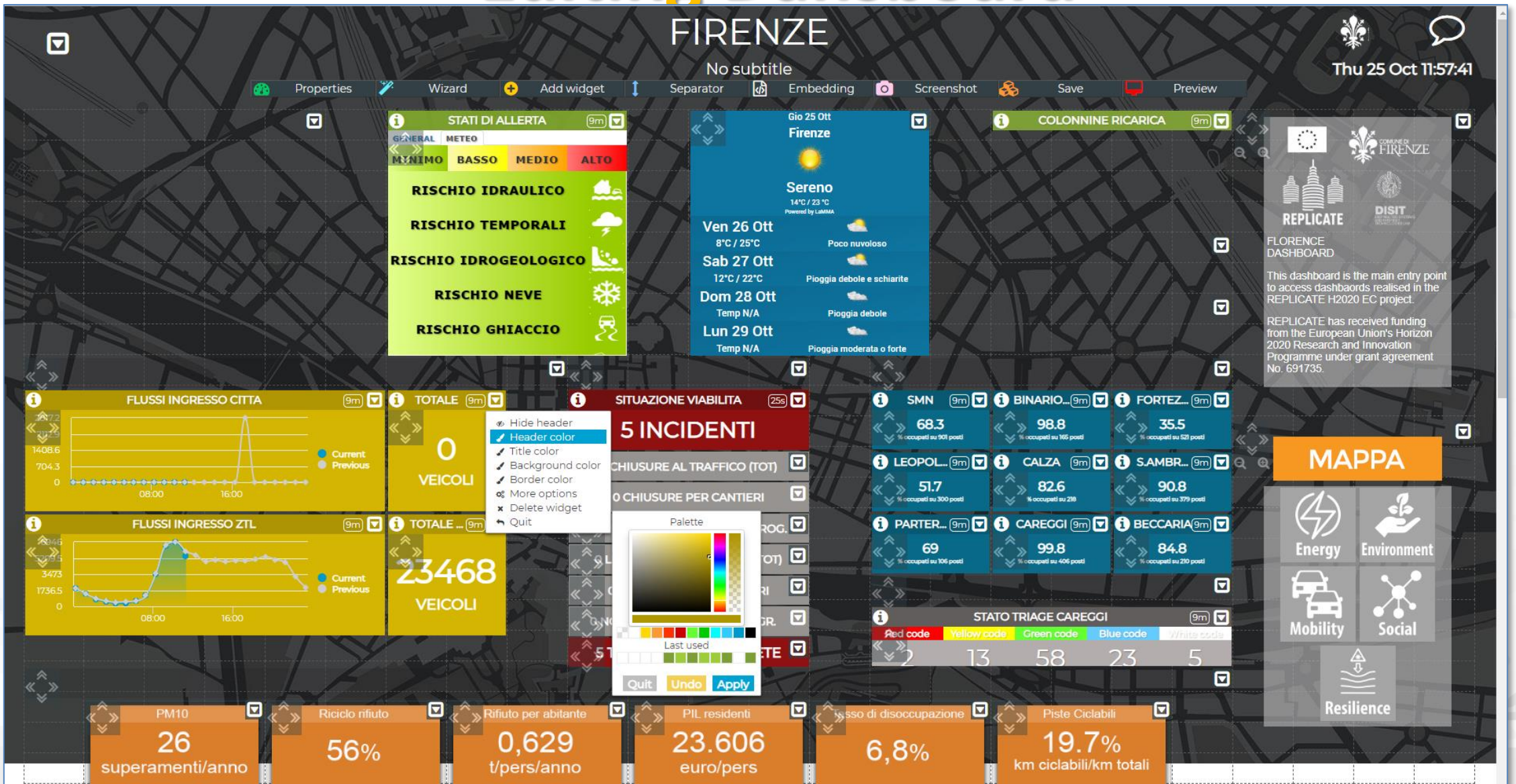
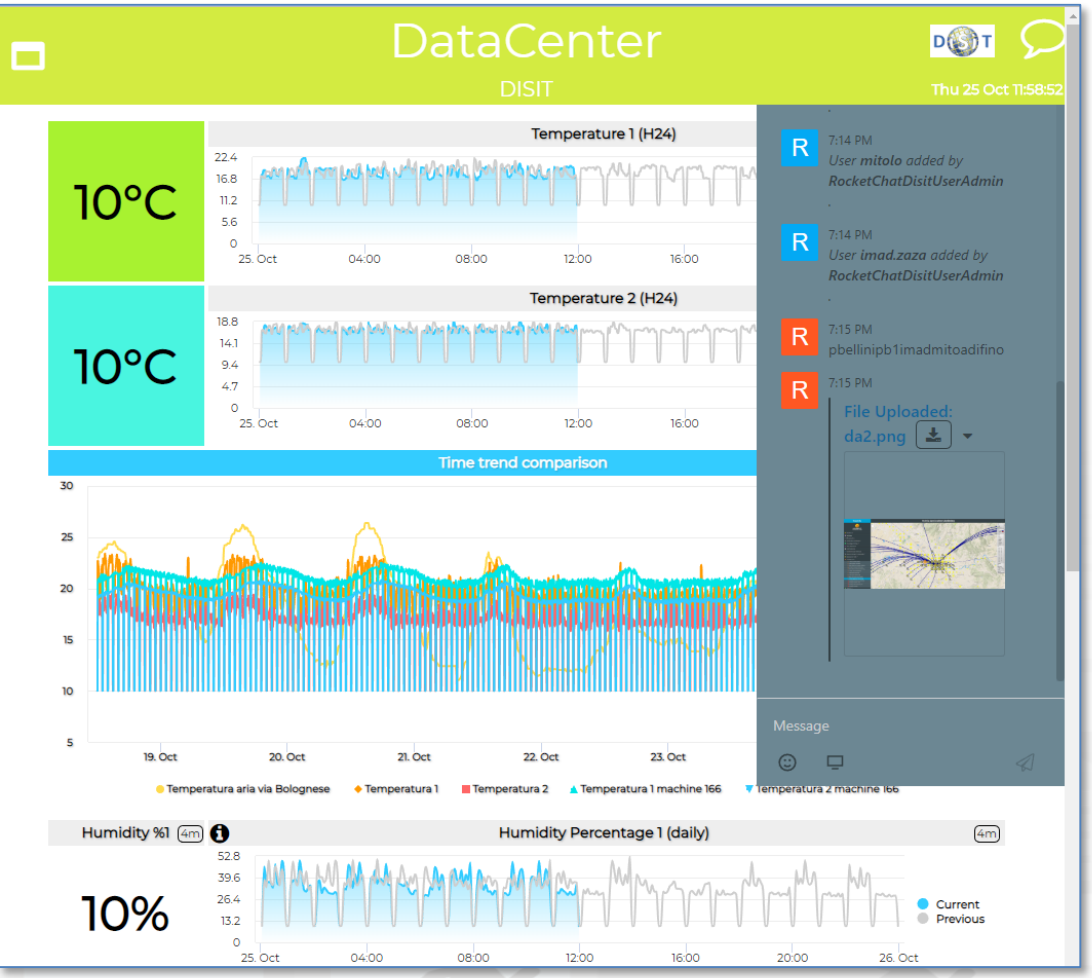
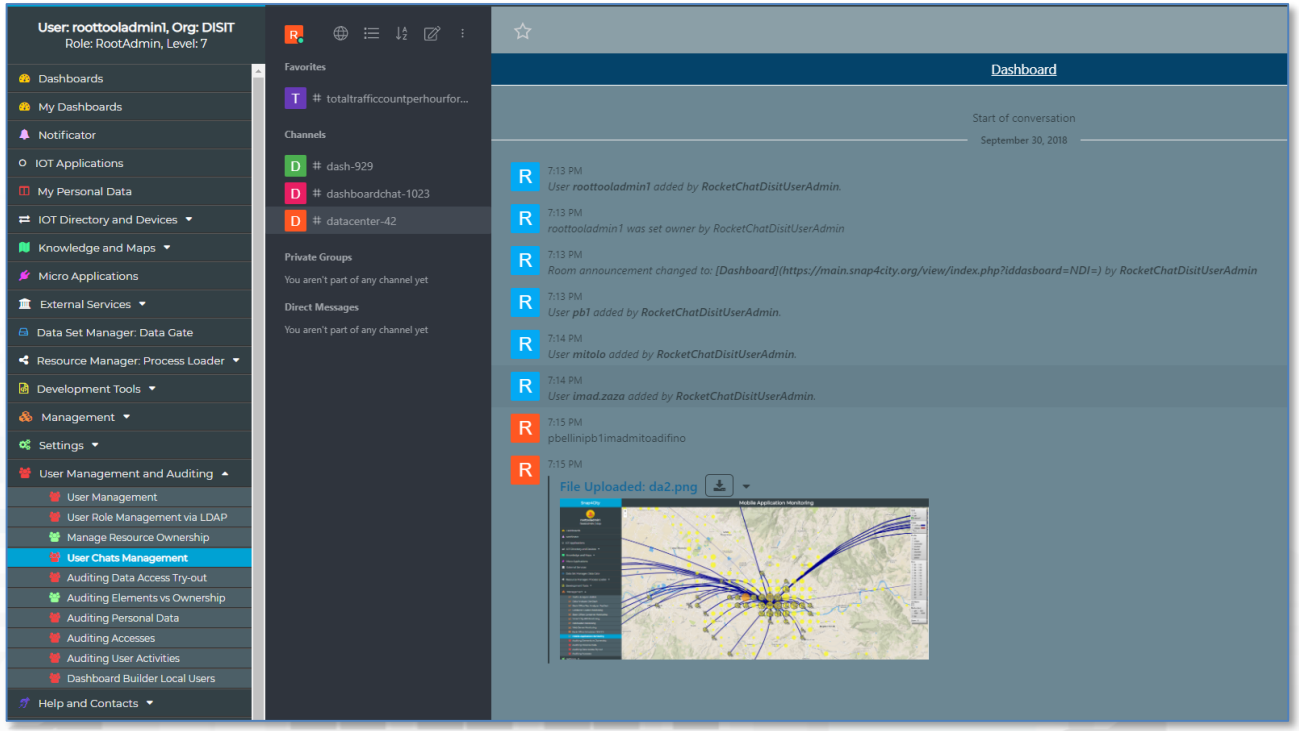


Chart Room Per Dashboard

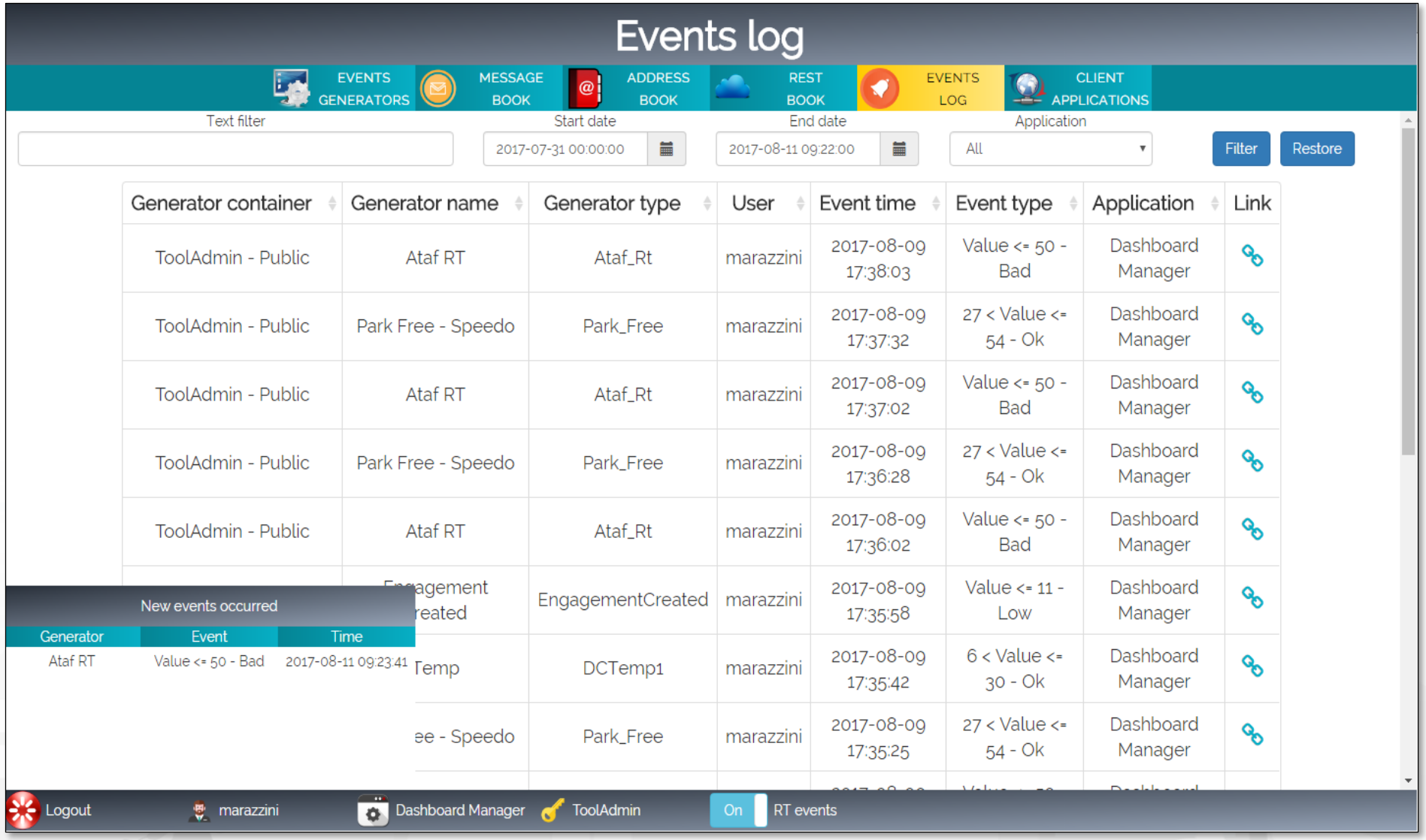


Using and managing

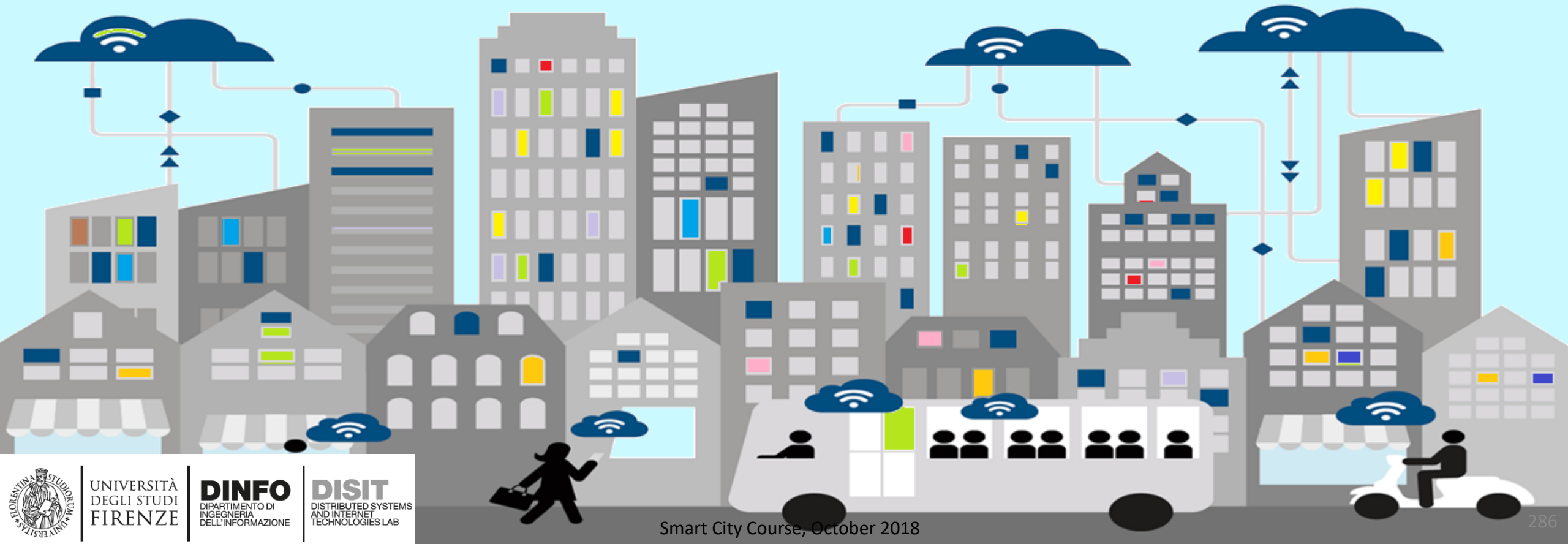


Smart City Monitoring: Notificator

Notifications may arrive via Facebook, Telegram, SMS, email, etc., by exploiting IOT App behind the dashboard



Level 2 users



Level 2 users: Create their own Dashboards

- With smart city data, and
- Sensor/actuator: info/IOT/IOE, if any provided by infrastruct. (e.g., Meter)
- → create events/notifications from them

IOT and City data World

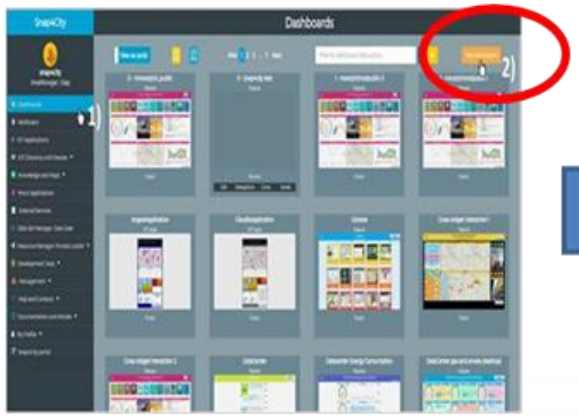


City Dashboard





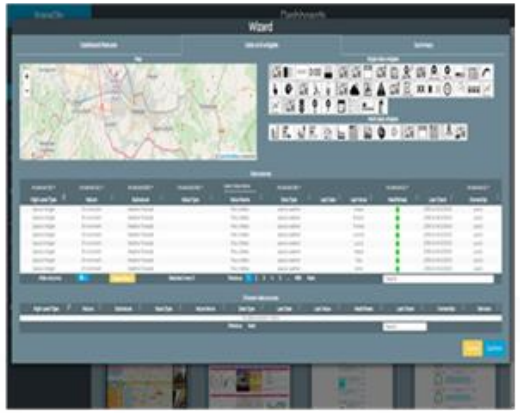
From Data to Dashboards by Wizard



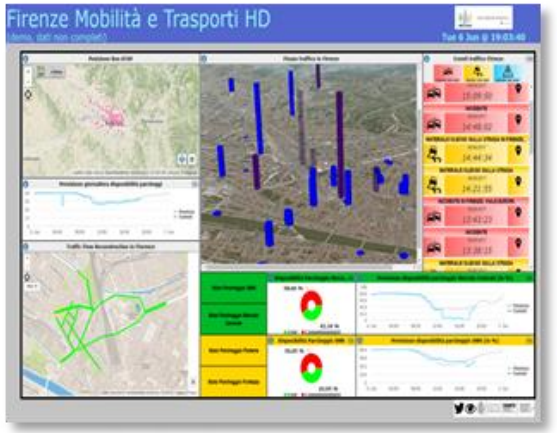
Dashboard List



Dashboard Model Selection



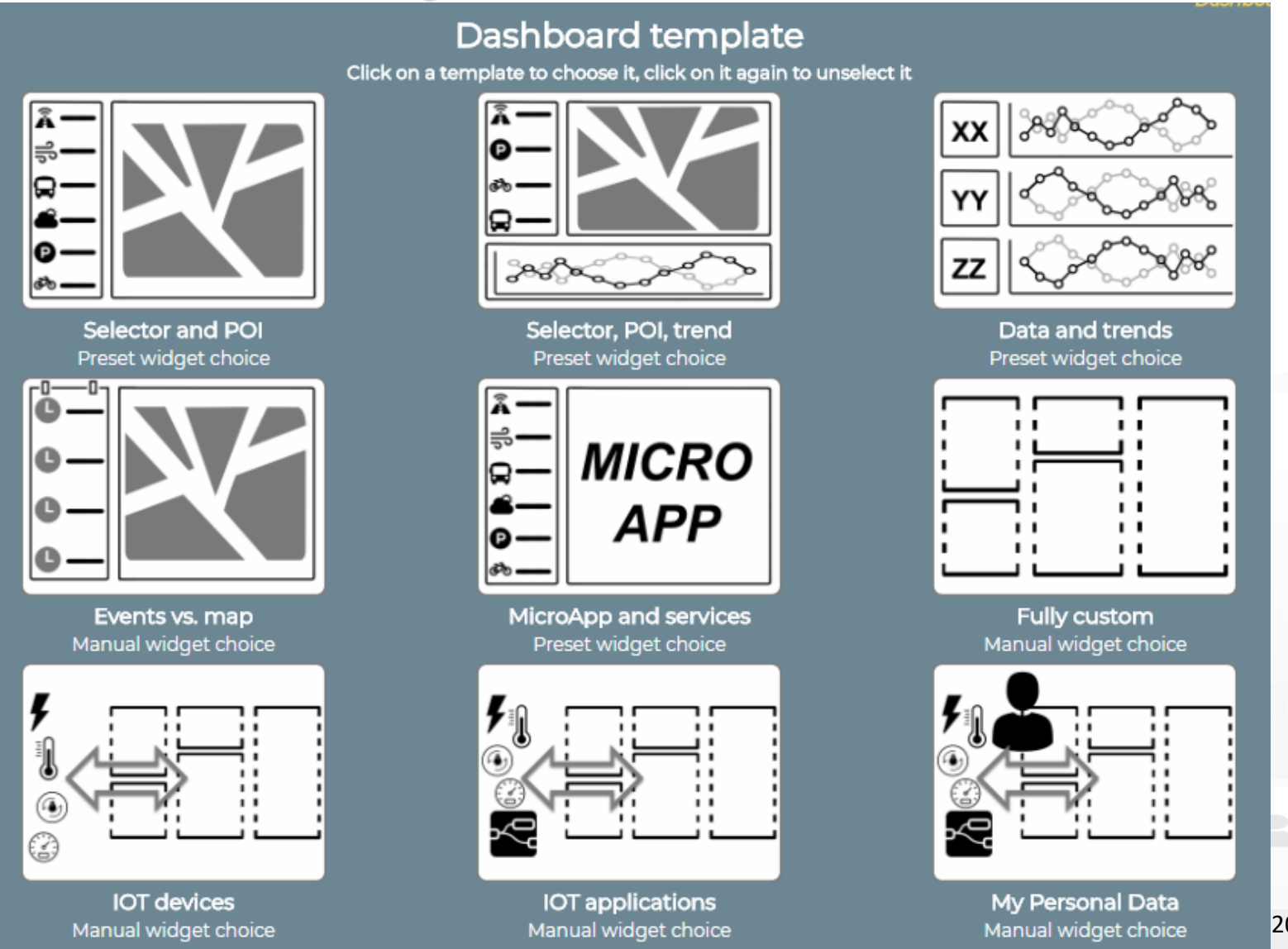
Wizard



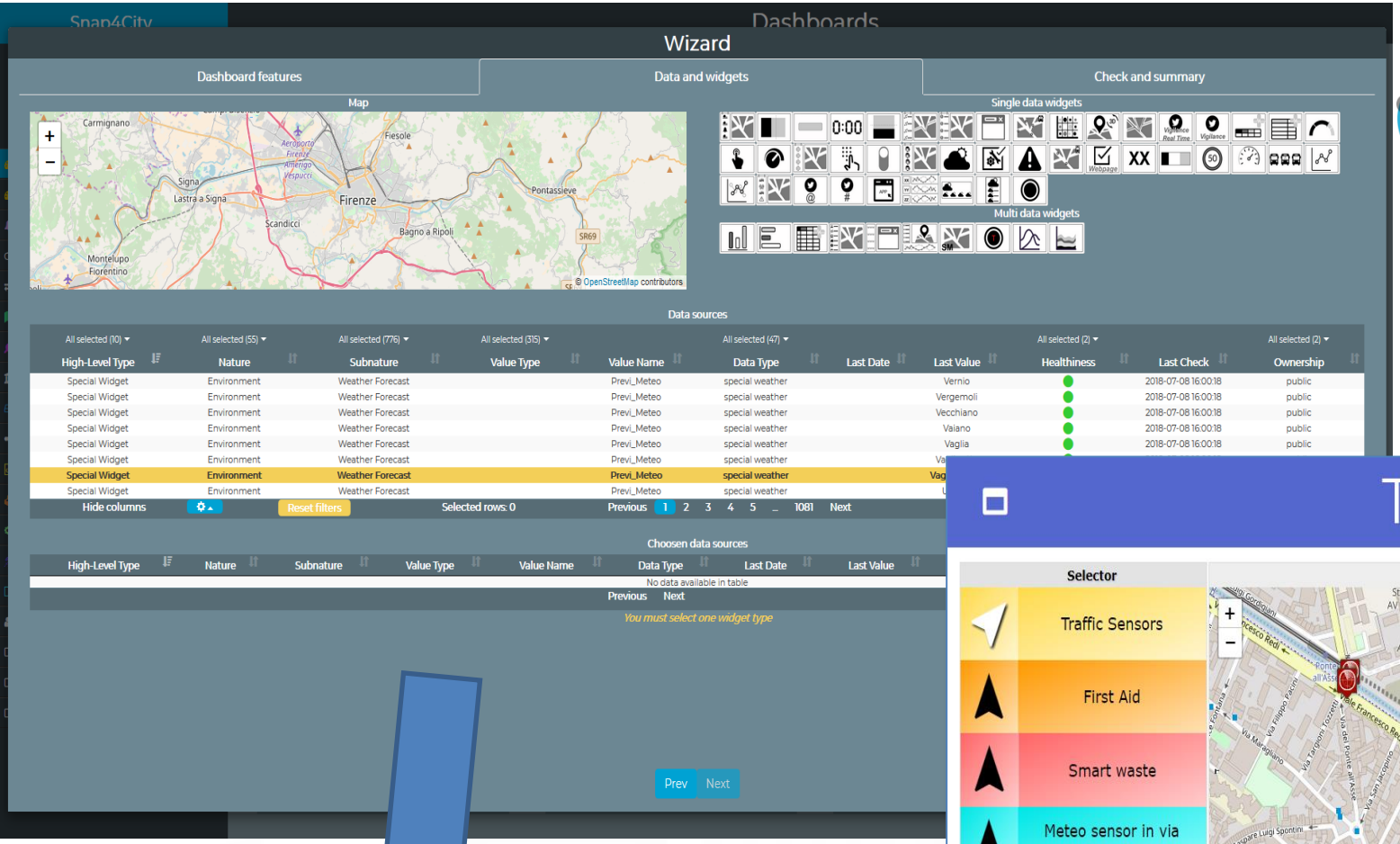
Examples:

- Official environmental data compared with temperature of the house
- Weather actual/forecast vs the consumption of energy in the company
- Number invoices and revenues vs energy

From Templates to Wizard and Dashboards

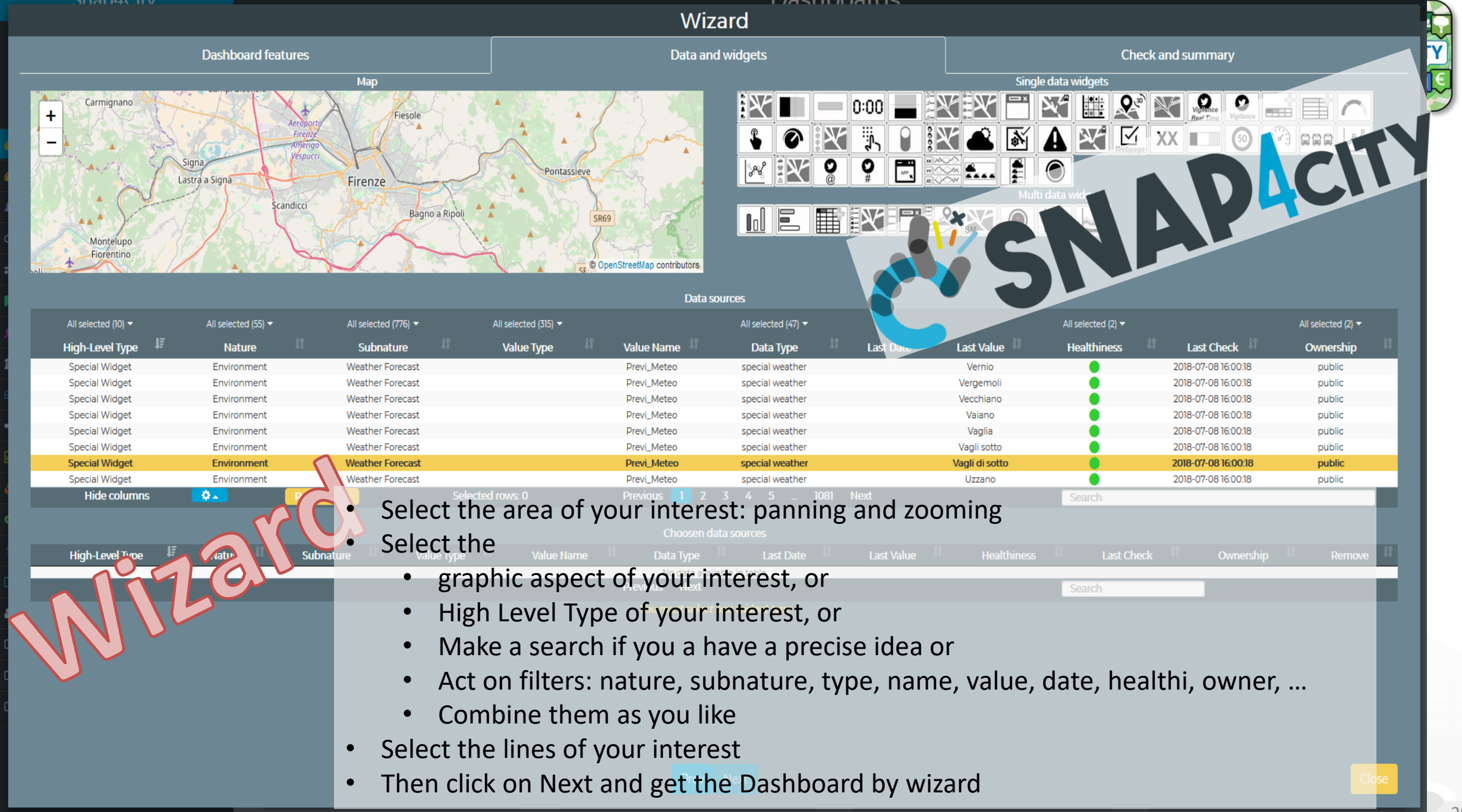


- From the scratch to create a new Dashboad
- From a Dashboard to Add widgets and groups of them


Snap4City
Dashboards
Wizard
Dashboard features
Data and widgets
Check and summary
Map
Single data widgets
Multi data widgets
Data sources
High-Level Type
Nature
Subnature
Value Type
Value Name
Data Type
Last Date
Last Value
Healthiness
Last Check
Ownership
Hide columns
Reset filters
Selected rows: 0
Previous
Next
Choosen data sources
No data available in table
You must select one widget type
Prev
Next




Test api fromTime
Thu 8 Mar 09:18:52
Selector
Traffic Sensors
First Aid
Smart waste
Meteo sensor in via Bolognese
Air quality
Pollination
Parking Status
Smart bench
Bike sharing (Pisa)
Map
METRO759
DETAILS
DESCRIPTION
RT DATA
Last update: 2018-03-08 09:10:00+01:00
Description
Value
Buttons
Avg Time 1.635227
Concentration 7.064071
Vehicle Flow 844.0
Average 29.86946
Last value
Last 4 hours
Last 24 hours
Last 7 days
Last 30 days
Vehicle Flow - 30 days
2856
2142
1428
714
0
© OpenStreetMap contributors



- 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 a have a precise idea or
  - Act on filters: nature, subnature, type, name, value, date, healthi, owner, …
  - Combine them as you like
- Select the lines of your interest
- Then click on Next and get the Dashboard by wizard

Filtering data to reach selection

- **High Level Types**: sensors, special, KPI, POI, etc.
- **Nature**: accommodation, mobility, financial, wine, health, etc.
  - Dashboard ←→ IOT APP, IOT Device to system
- **SubNature**: a subclassification of the nature
- **ValueType**: temperature, humidity, memory, pressure, glucose, etc…
- **ValueName**: name of variable of the: IOT sensor, data, etc.
- **DataType**: integer, text, Boolean, float, webpage
- **LastDate**: last date and time of data acquisition
- **LastValue**: the last value, an example; in some case a parameter
- **Healthiness**: green or red according to the data quality criteria defined
- **LastCheck**: date and time of the last valid data
- **Ownership**: Public or Private; it may be: private, private (Delegated), private (MyOwn)

Data Kinds vs Widgets: Complex events

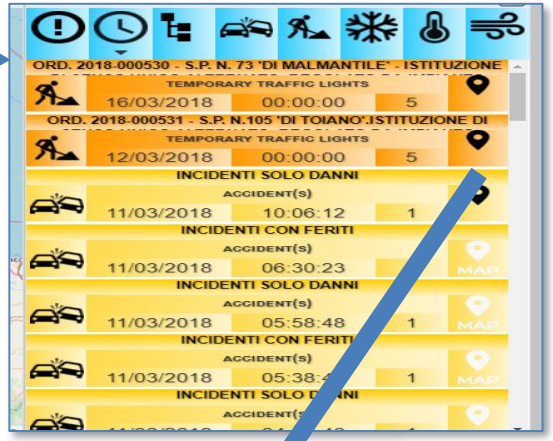
High Level Types

- **Complex Event**
- External Service
- MicroApplication
- Special Widget
- POI, Point of Interest
- KPI, Key Performance Indicator
- Sensor
- Sensor-Actuator
- My Personal Data
- Dashboard-IOT App

Traffic Events

Entertainment Events

Selector



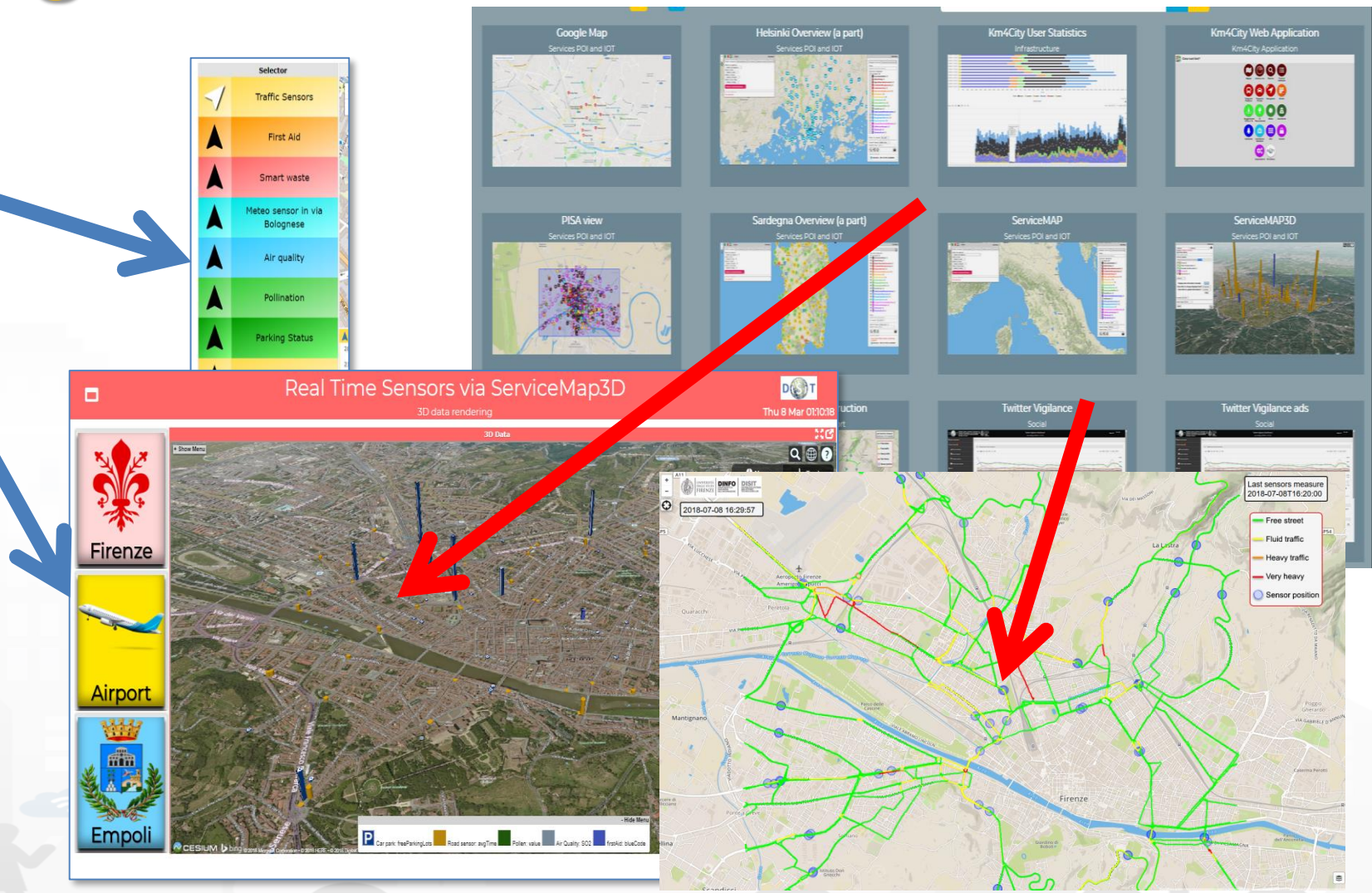




Data Kinds vs Widgets: external services

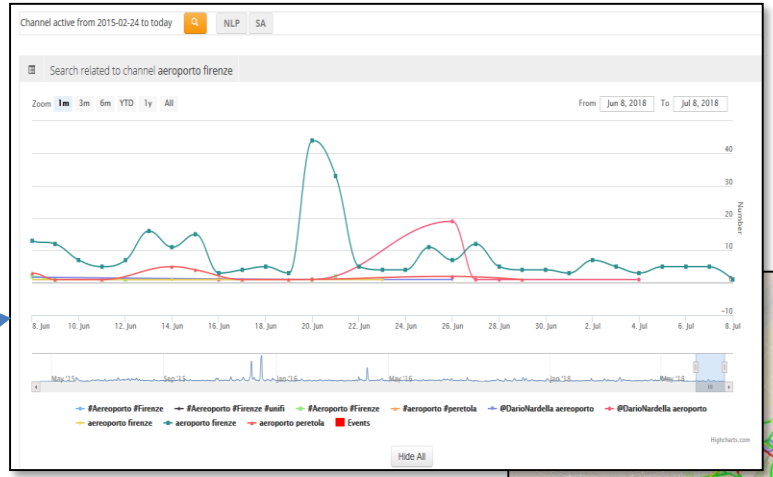
High Level Types

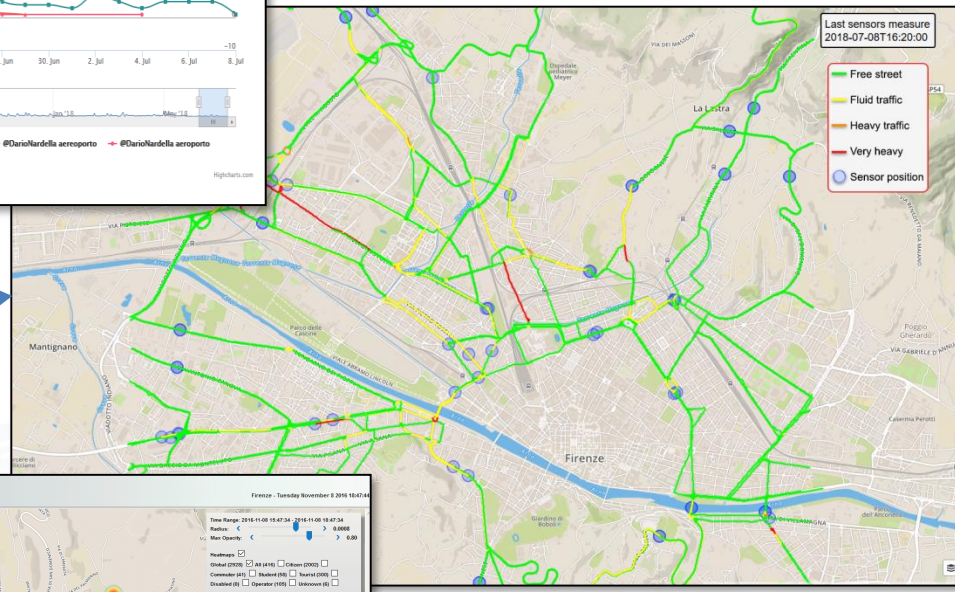
- Complex Event
- **External Service**
- MicroApplication
- Special Widget
- POI, Point of Interest
- KPI, Key Performance Indicator
- Sensor
- Sensor-Actuator
- My Personal Data
- Dashboard-IOT App

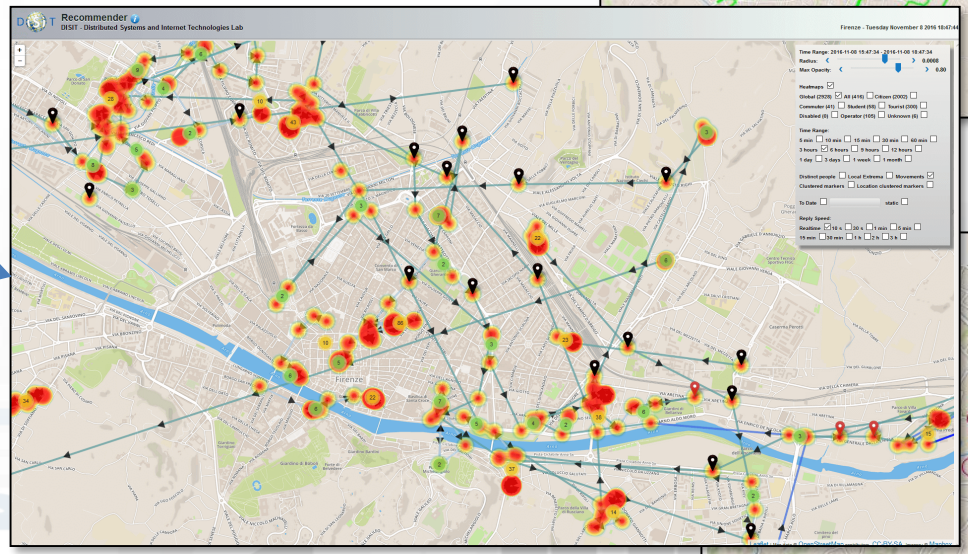


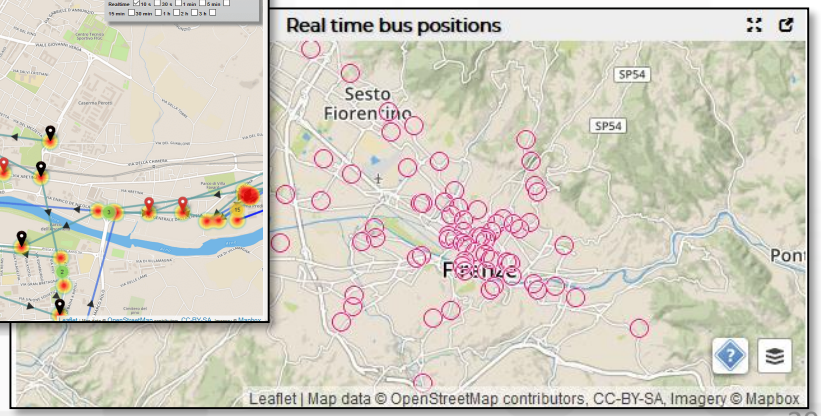
External Services

- Twitter Vigilance:
  - daily and real time
  - Volume and sentiment analysis
- Traffic Flow
- Services on Maps
- Tracking vehicles
- Real time sensors on 3D
- Web HTML5 Applications
- User behaviour monitoring



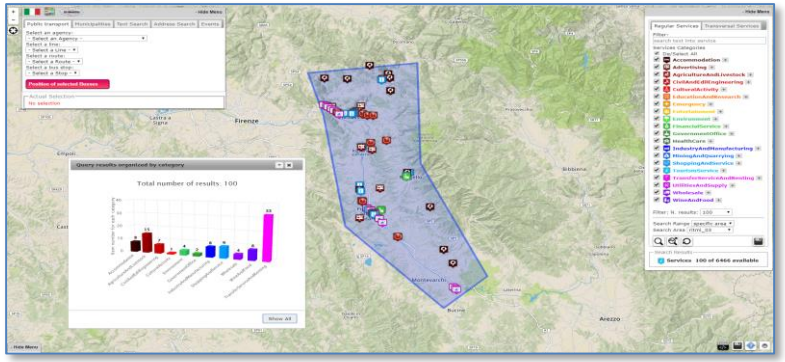


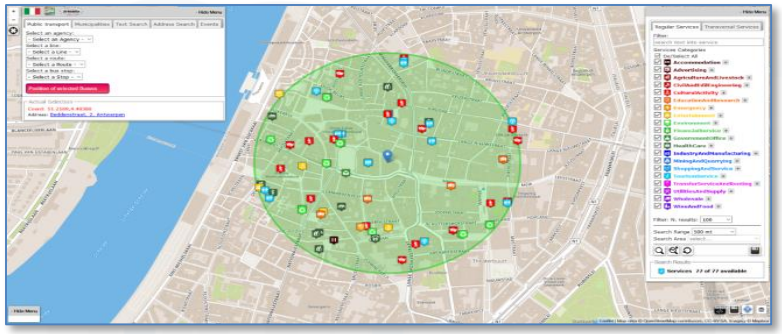
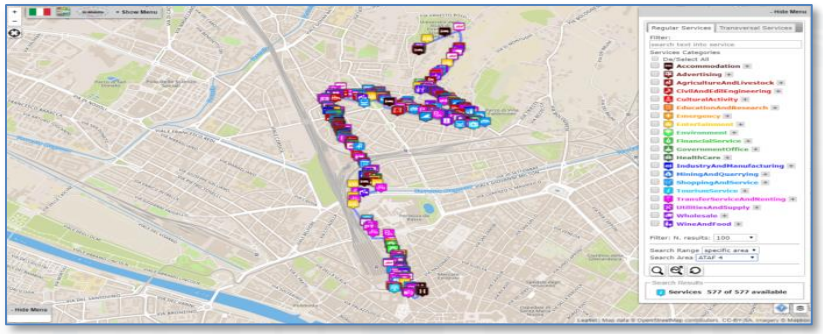
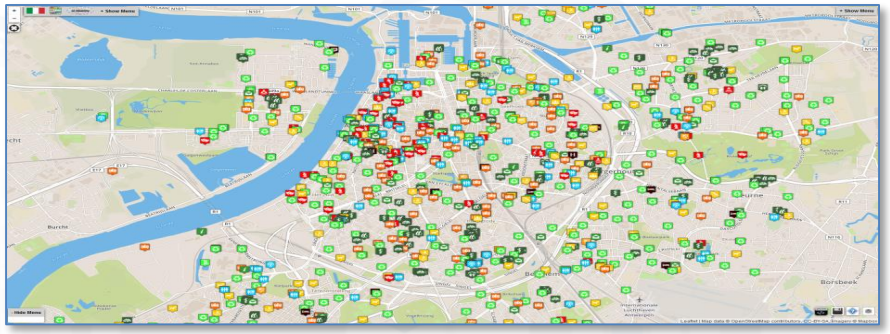
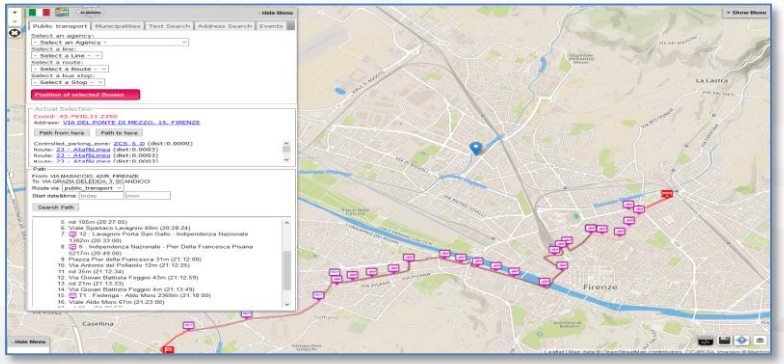
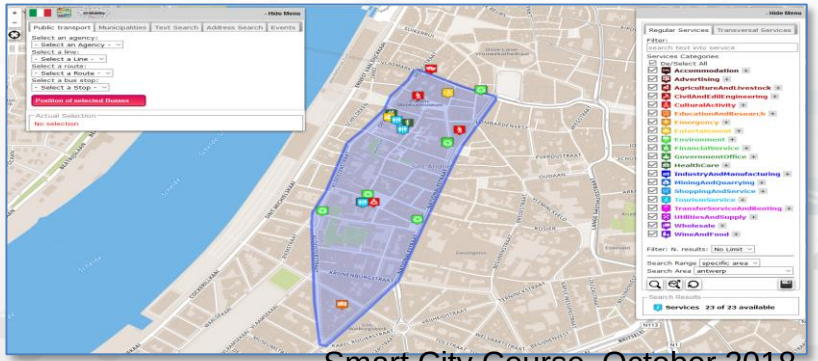
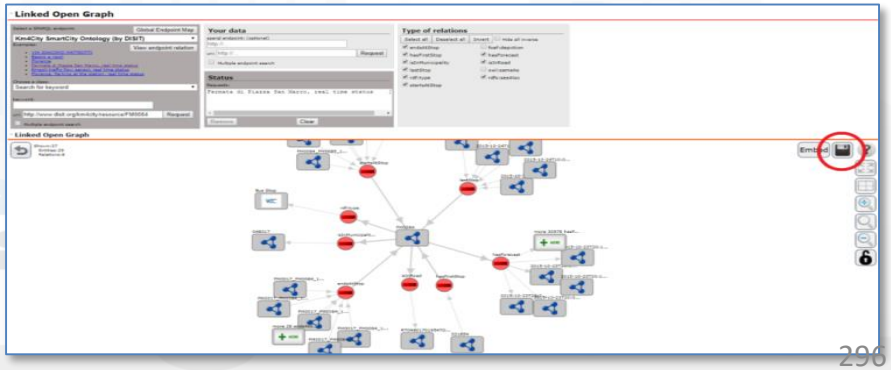




Knowledge base per Data Analytics

http://servicemap.km4city.org



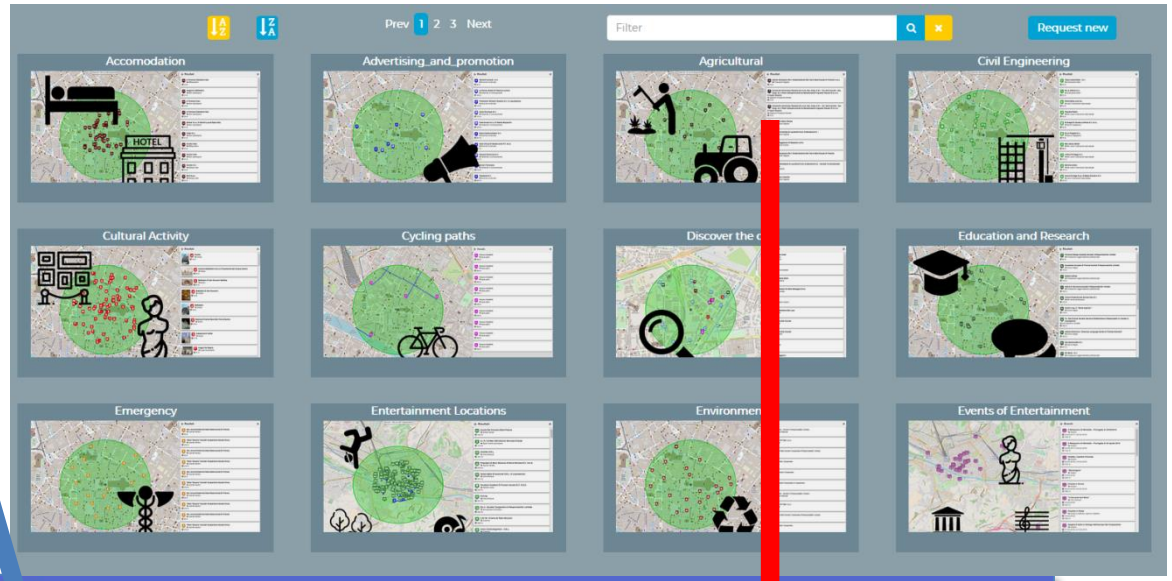








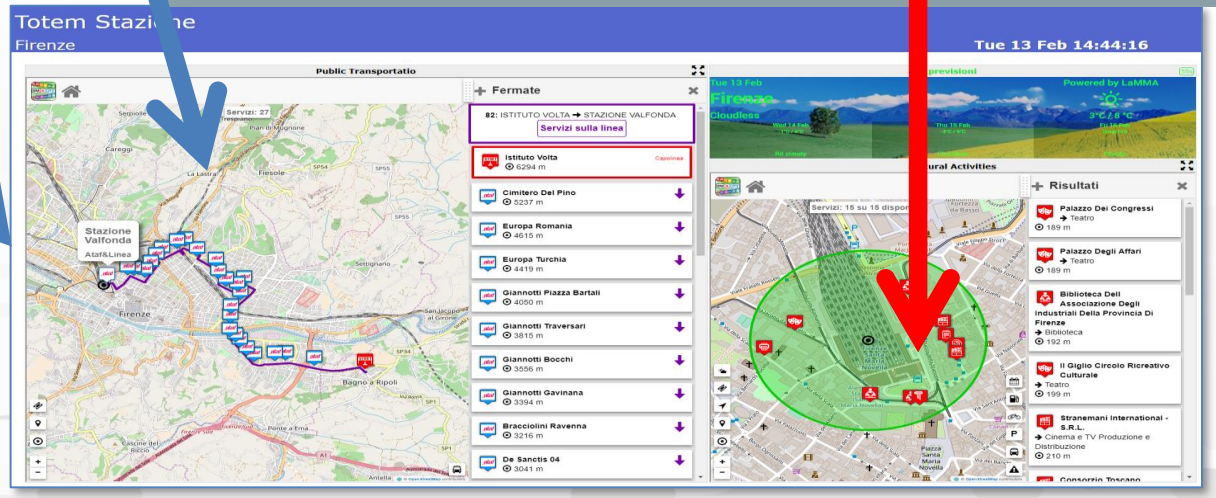
Data Kinds vs Widgets: MicroApplications

High Level Types

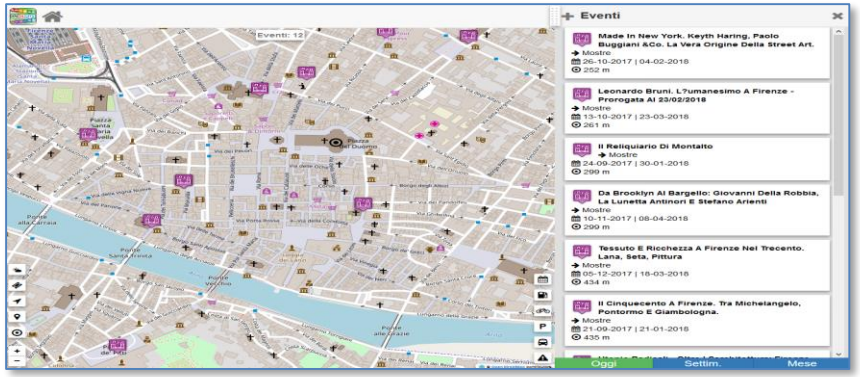
- Complex Event
- External Service
- **MicroApplication**
- Special Widget
- POI, Point of Interest
- KPI, Key Performance Indicator
- Sensor
- Sensor-Actuator
- My Personal Data
- Dashboard-IOT App

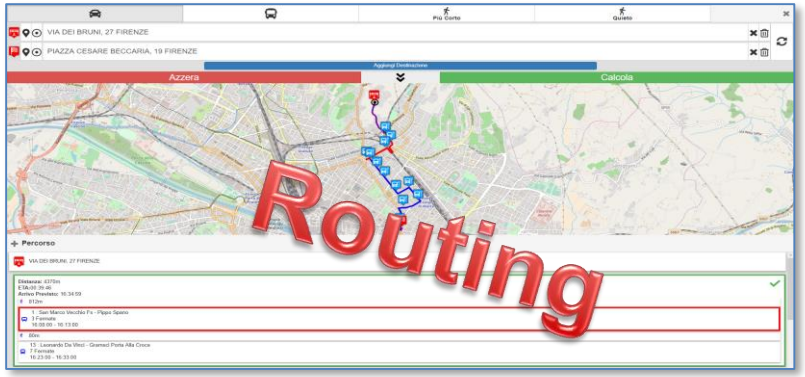


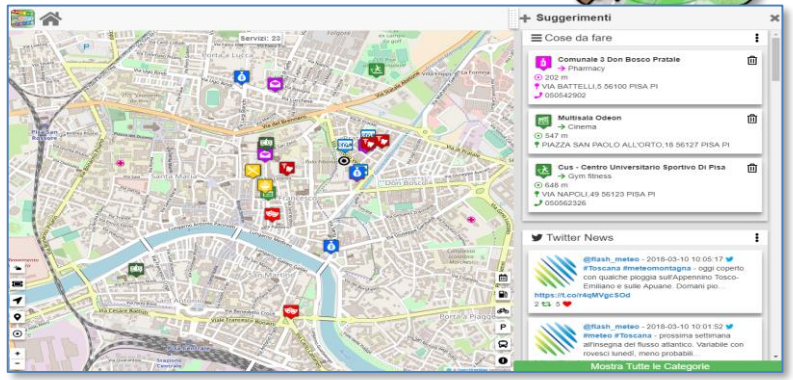


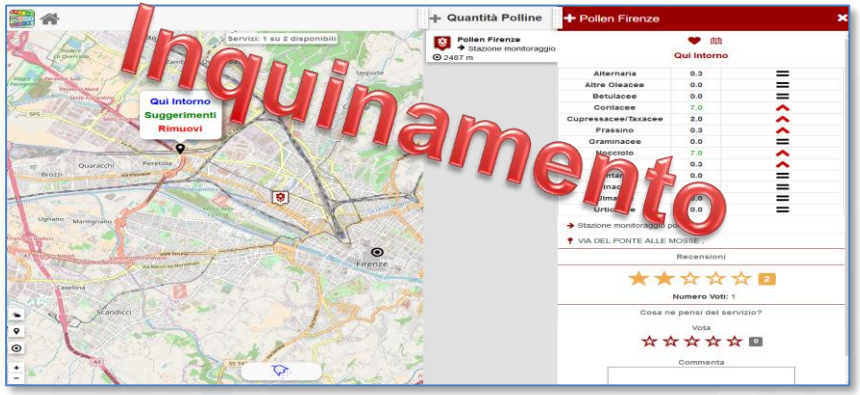


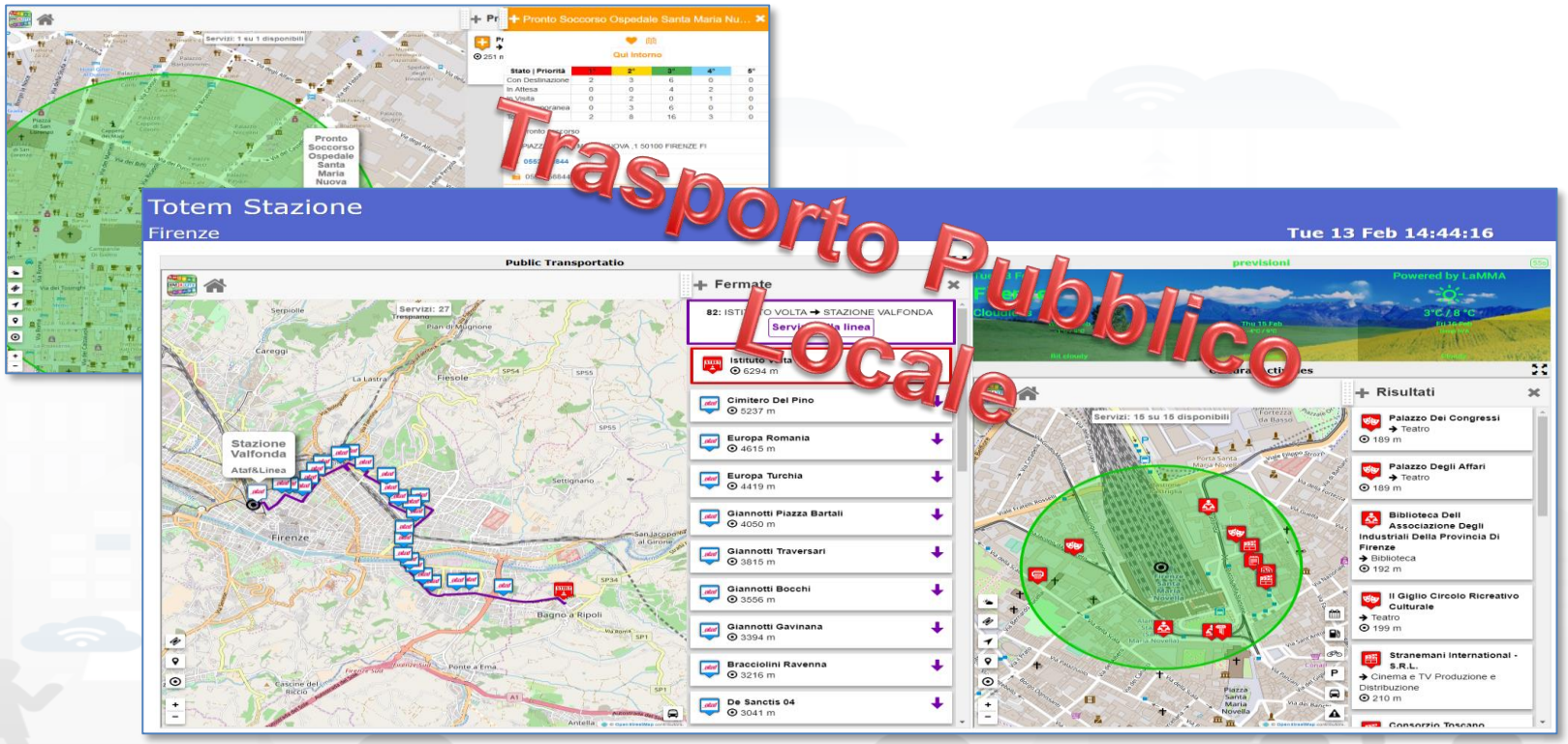
HTML5 MicroApplications

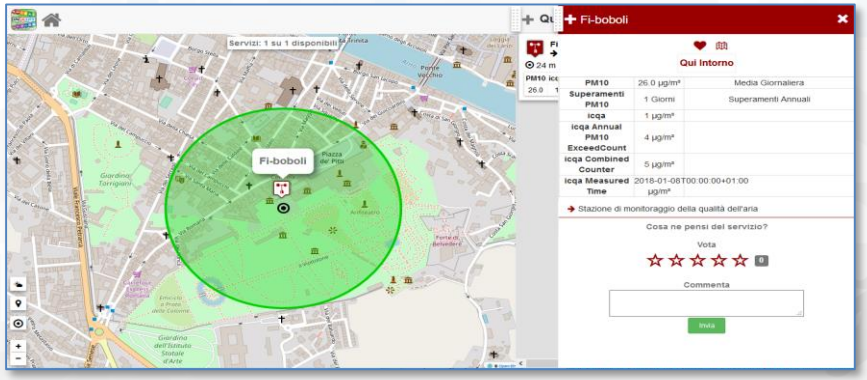












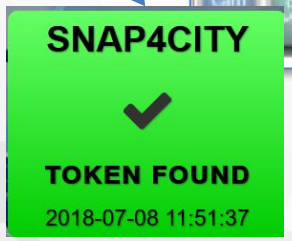
Data Kinds vs Widgets: Special Widgets

High Level Types

- Complex Event
- External Service
- MicroApplication
- **Special Widget**
- POI, Point of Interest
- KPI, Key Performance Indicator
- Sensor
- Sensor-Actuator
- My Personal Data
- Dashboard-IOT App

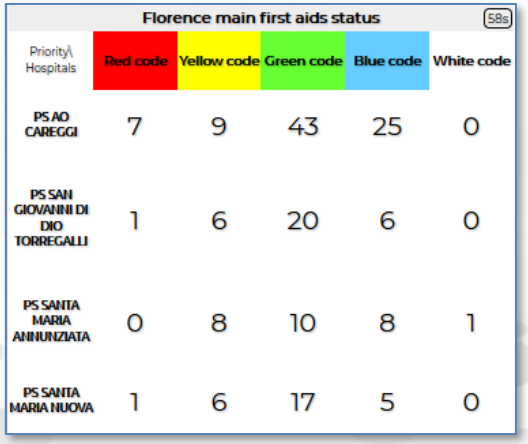








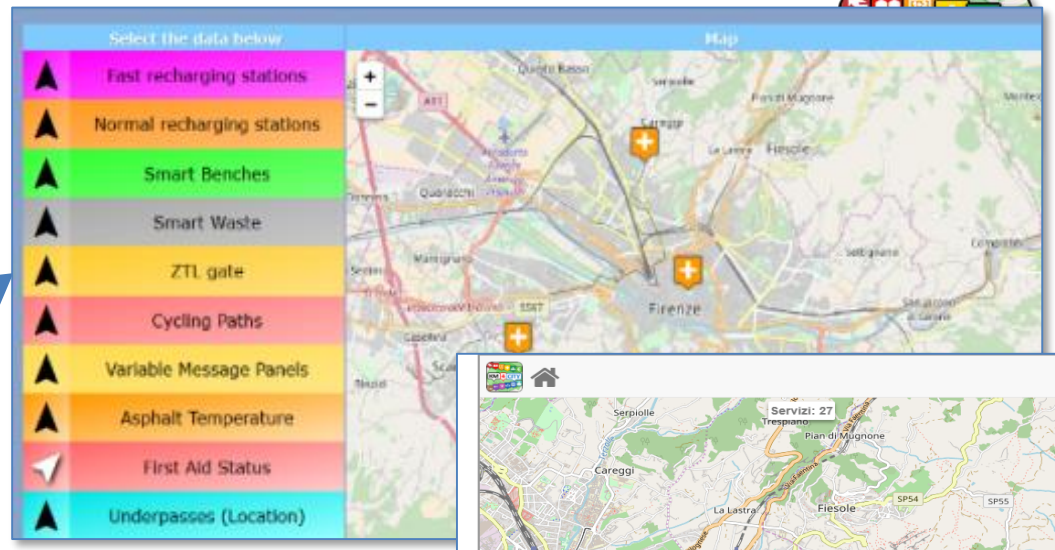


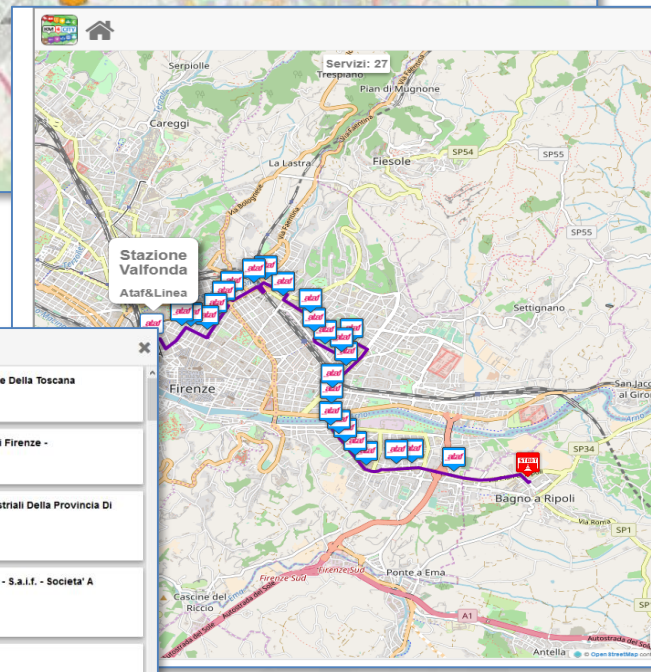


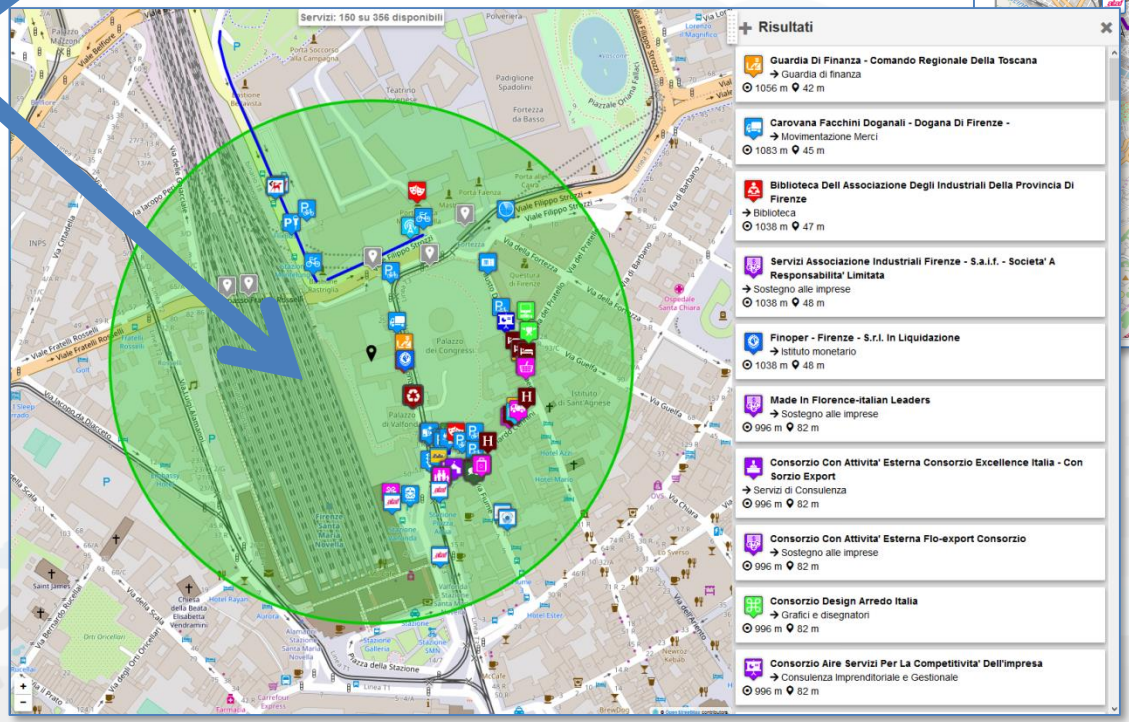
Data Kinds vs Widgets: POI

High Level Types

- Complex Event
- External Service
- MicroApplication
- Special Widget
- **POI, Point of Interest**
- KPI, Key Performance Indicator
- Sensor
- Sensor-Actuator
- My Personal Data
- Dashboard-IOT App



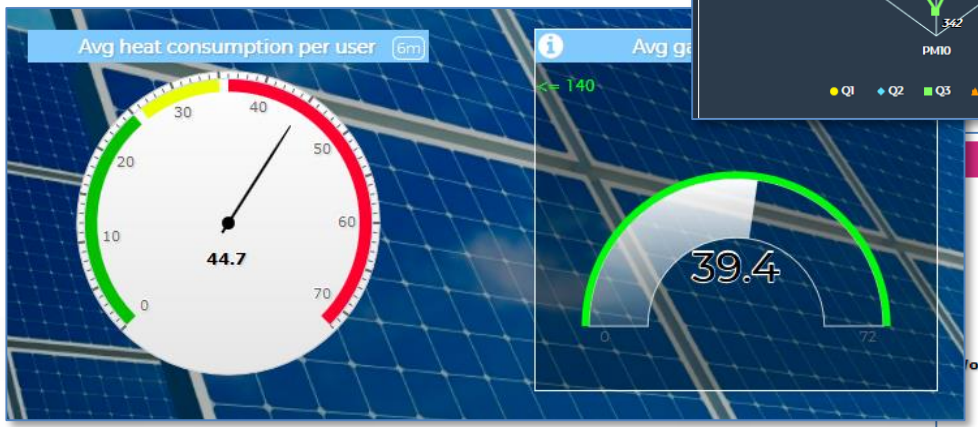


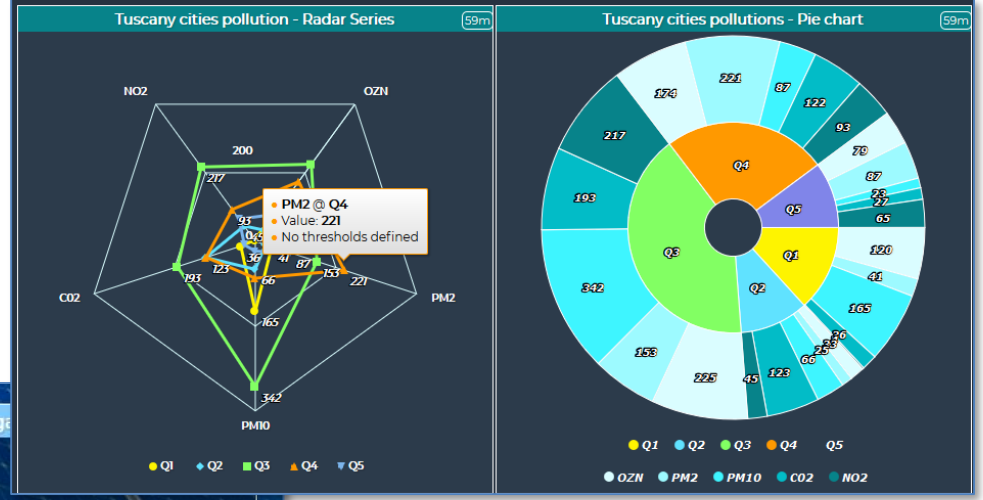


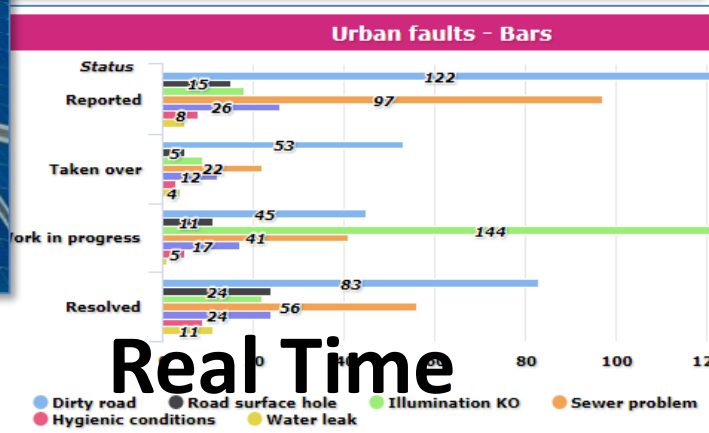
Data Kinds vs Widgets: KPI

High Level Types

- Complex Event
- External Service
- MicroApplication
- Special Widget
- POI, Point of Interest
- **KPI, Key Performance Indicator**
- Sensor
- Sensor-Actuator
- My Personal Data
- Dashboard-IOT App

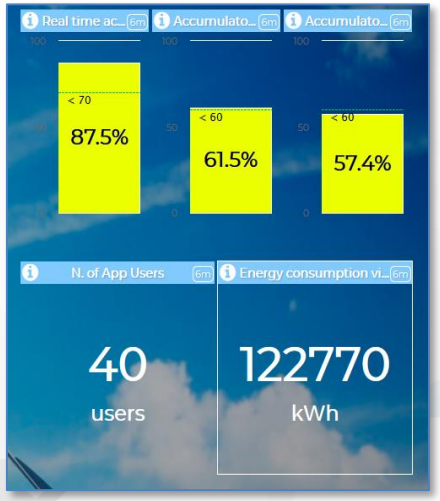






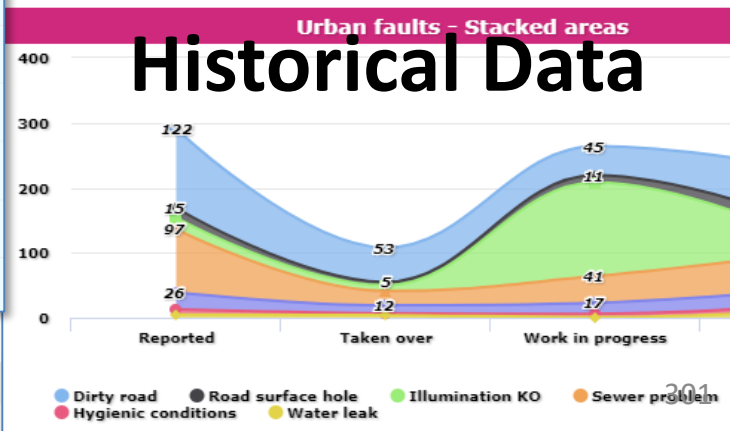
Real Time

Event Driven





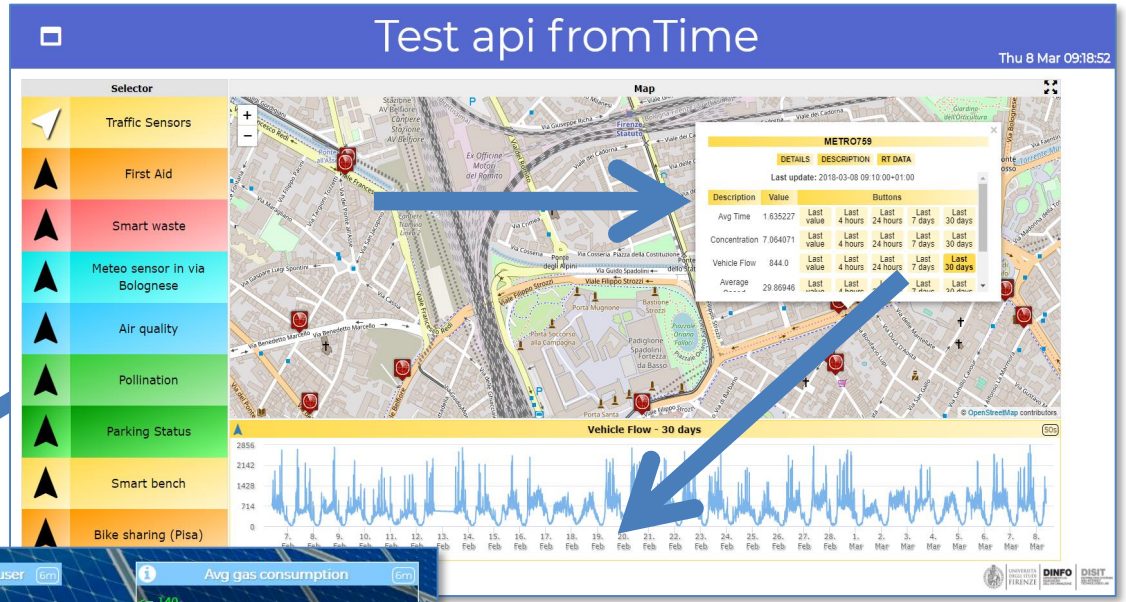
Historical Data



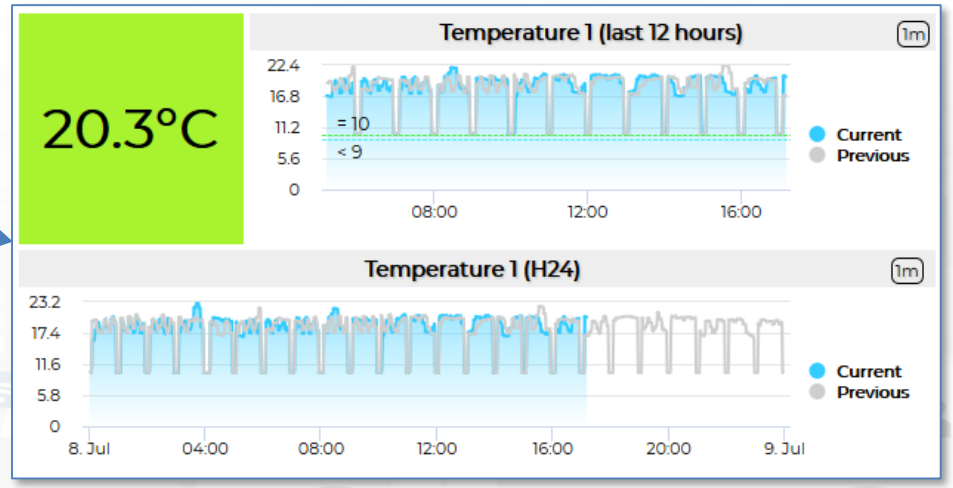
Data Kinds vs Widgets: Sensors

High Level Types

- Complex Event
- External Service
- MicroApplication
- Special Widget
- POI, Point of Interest
- KPI, Key Performance Indicator
- **Sensor**
- Sensor-Actuator
- My Personal Data
- Dashboard-IOT App







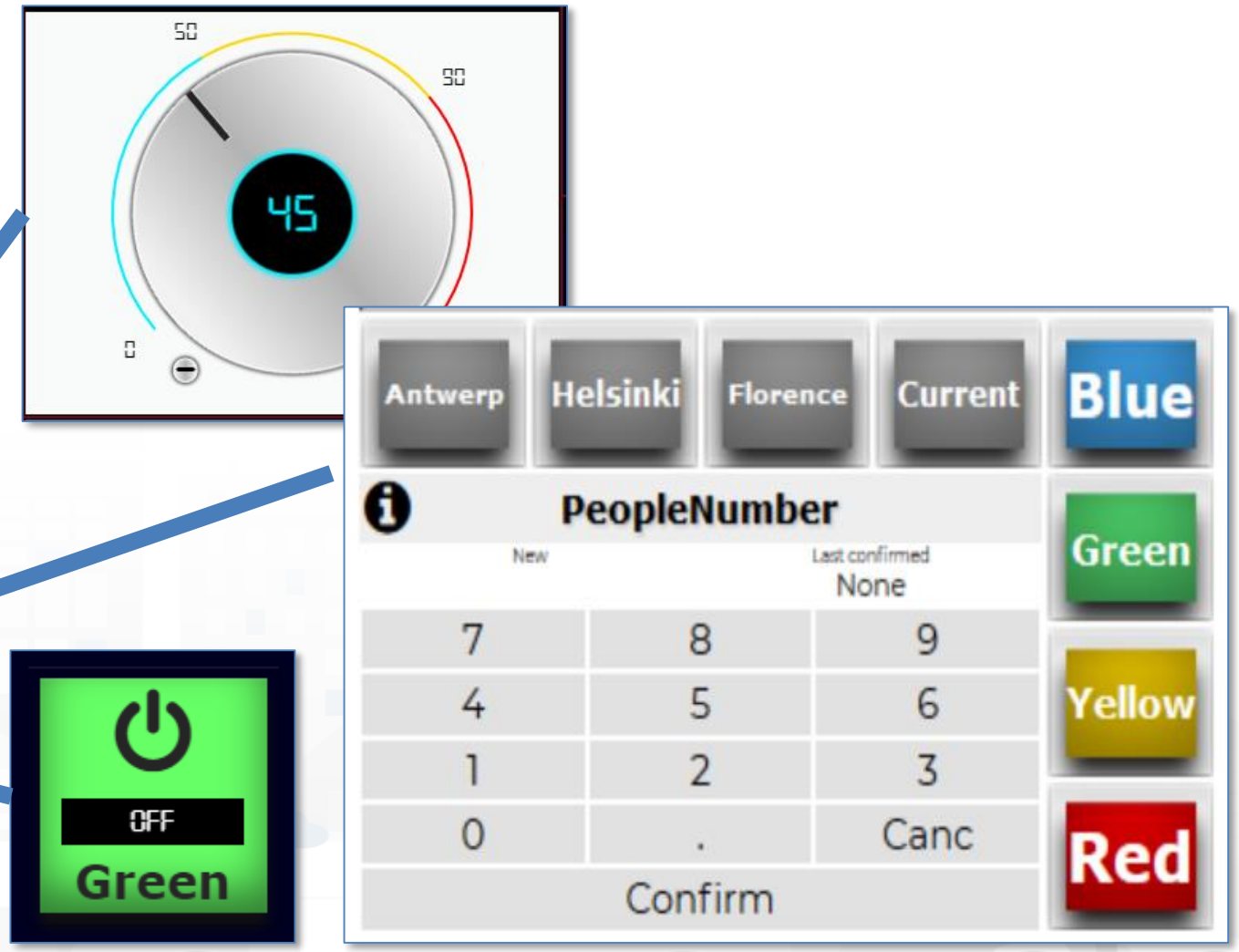
Real Time
Event Driven
Historical Data

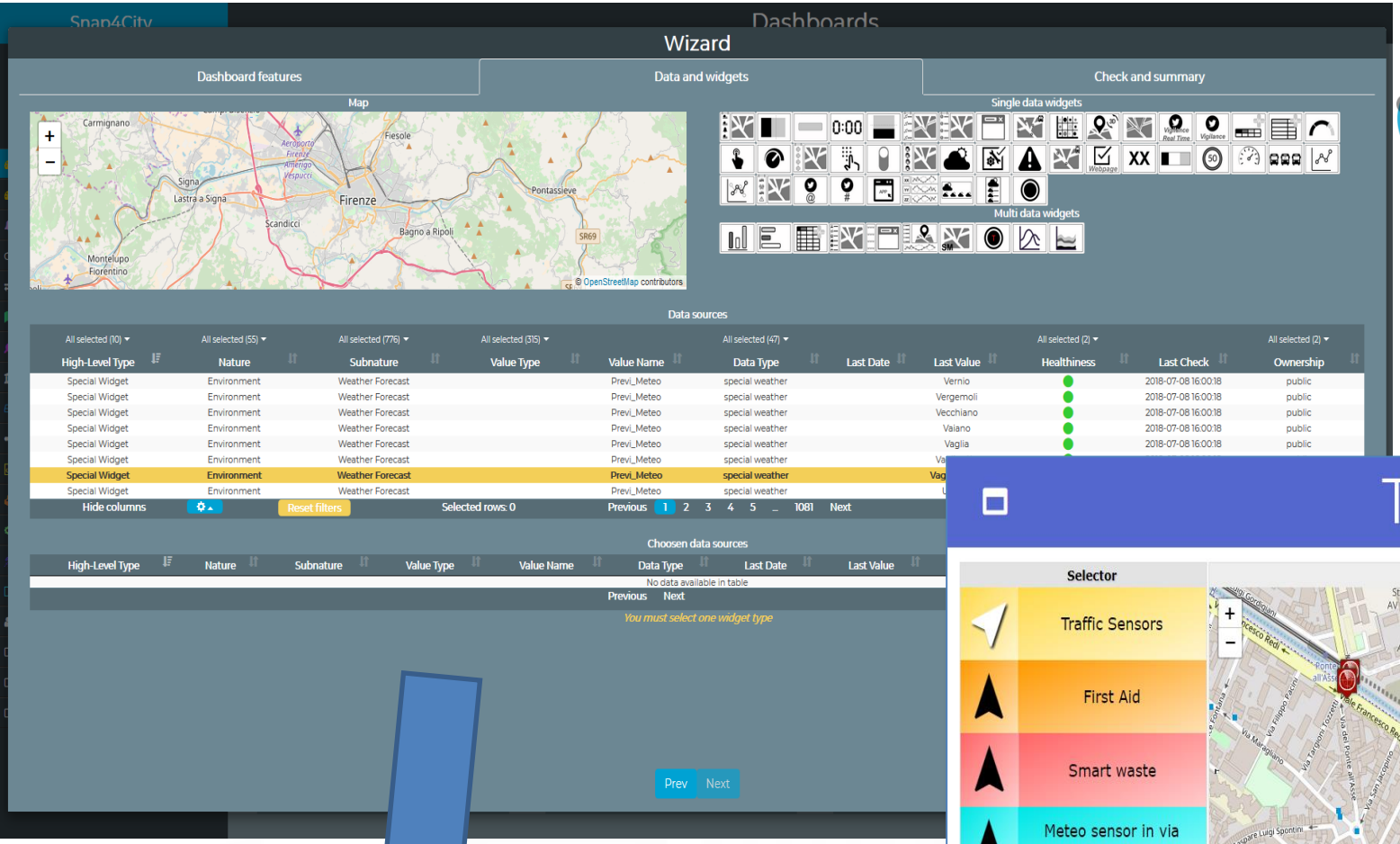
SNAP4CITY

Data Kinds vs Widgets: Sensors - Actutors

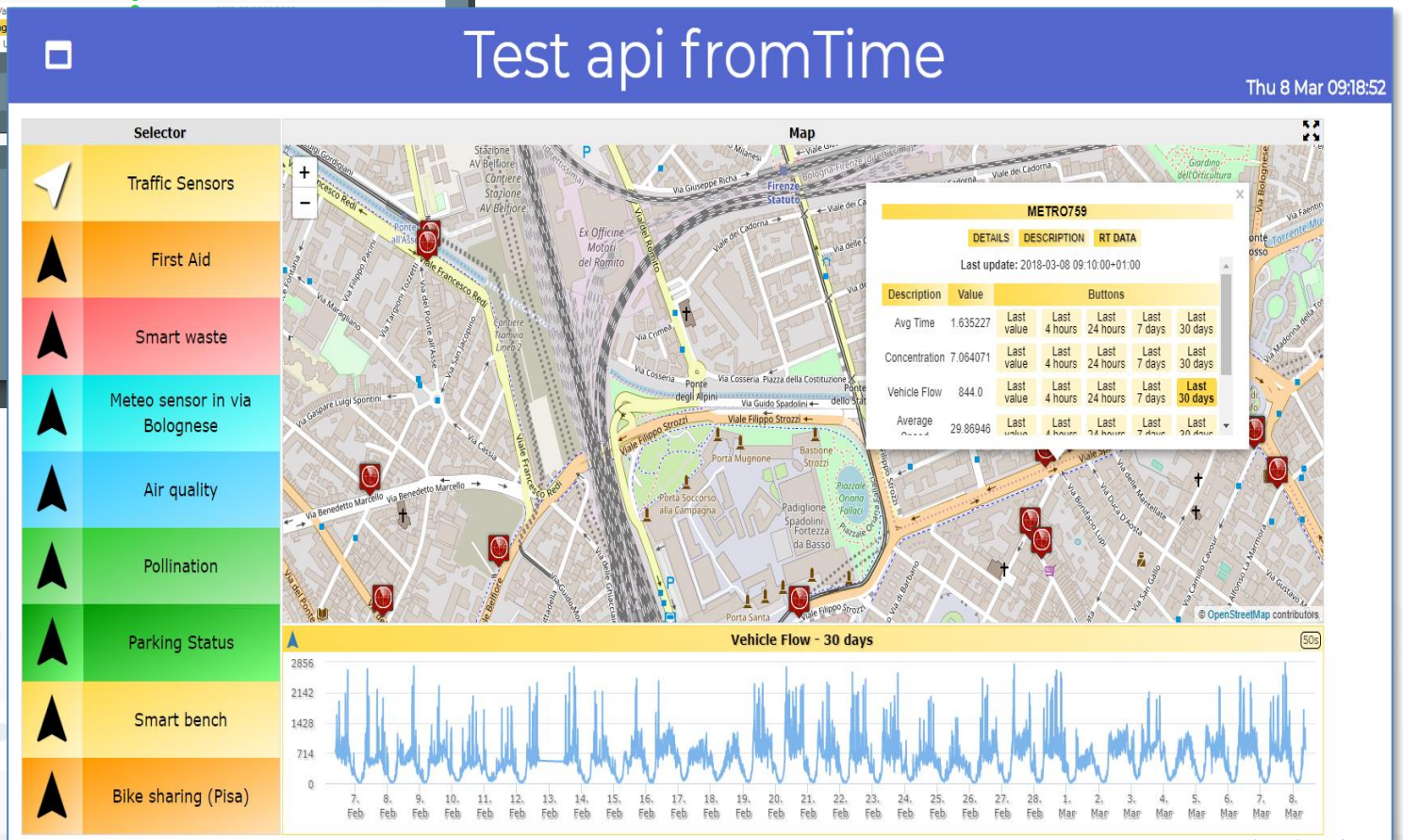
High Level Types

- Complex Event
- External Service
- MicroApplication
- Special Widget
- POI, Point of Interest
- KPI, Key Performance Indicator
- Sensor
- **Sensor-Actuator**
- My Personal Data
- Dashboard-IOT App

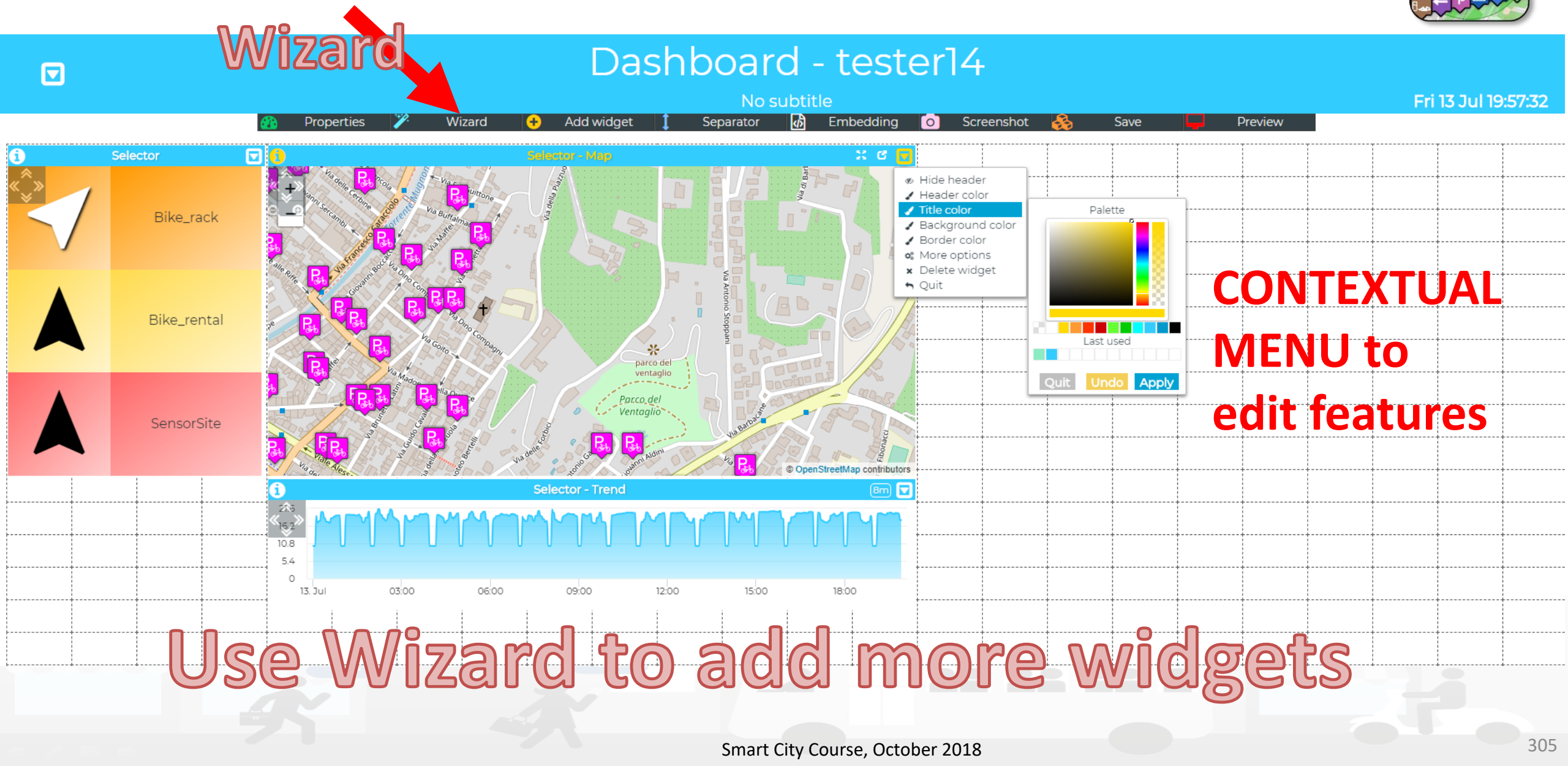



Snap4City
Dashboards
Wizard
Dashboard features
Data and widgets
Check and summary
Map
Single data widgets
Multi data widgets
Data sources
High-Level Type
Nature
Subnature
Value Type
Value Name
Data Type
Last Date
Last Value
Healthiness
Last Check
Ownership
Hide columns
Reset filters
Selected rows: 0
Previous
Next
Choosen data sources
No data available in table
You must select one widget type
Prev
Next




Test api fromTime
Thu 8 Mar 09:18:52
Selector
Traffic Sensors
First Aid
Smart waste
Meteo sensor in via Bolognese
Air quality
Pollination
Parking Status
Smart bench
Bike sharing (Pisa)
Map
METRO759
DETAILS
DESCRIPTION
RT DATA
Last update: 2018-03-08 09:10:00+01:00
Description
Value
Buttons
Avg Time 1.635227
Concentration 7.064071
Vehicle Flow 844.0
Average 29.86946
Last value
Last 4 hours
Last 24 hours
Last 7 days
Last 30 days
Vehicle Flow - 30 days
2856
2142
1428
714
0
© OpenStreetMap contributors

Wizard



CONTEXTUAL MENU to edit features

Use Wizard to add more widgets

Protocols vs Dashboards



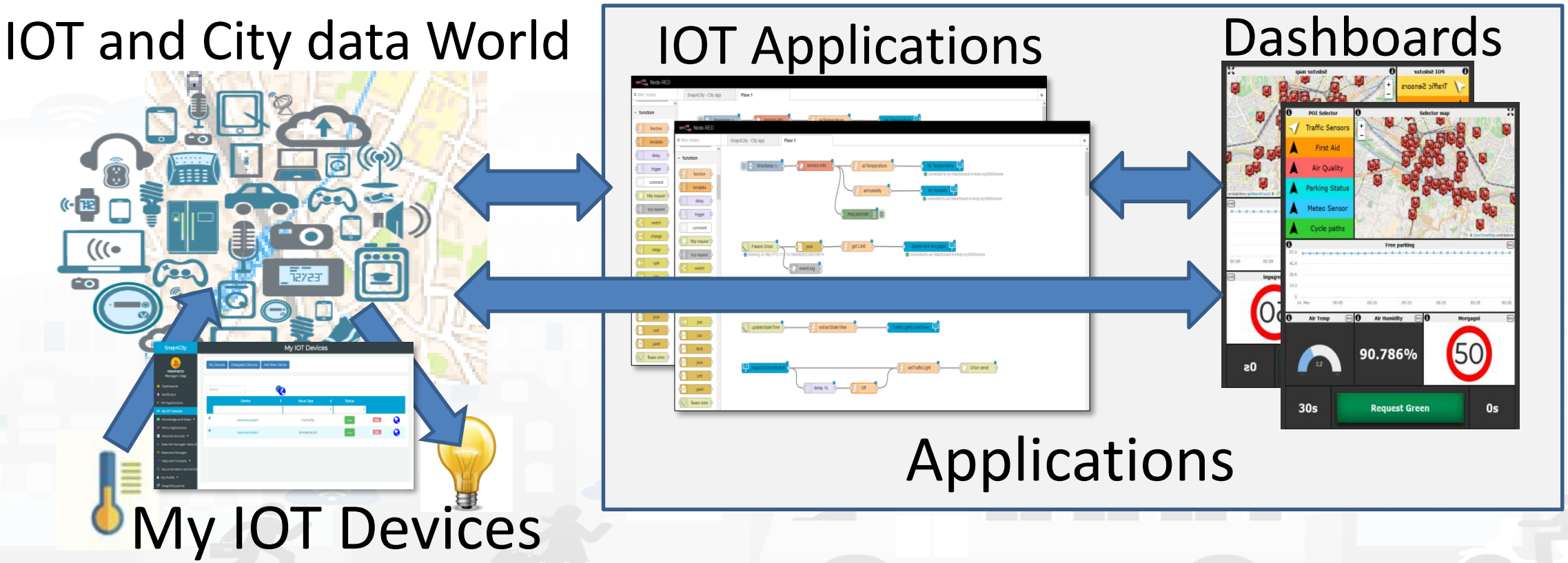
Course Segments

- **From Data to Applications and Dashboards**
  - Requirements on dashboards and security/privacy for smart city
  - Dashboards: types and meaning
  - Protocols from Dashboards
  - Dashboards vs mobile app User Interface
  - End-to-end security on IOT infrastructures
  - Data Protection, Personal Data vs GDPR
  - Living Lab Approaches

Level 4 users: dashboard with intelligence App

- Dashboards with IOT Applications for enforcing smart and intelligence into them.

Dashboard-IOT App

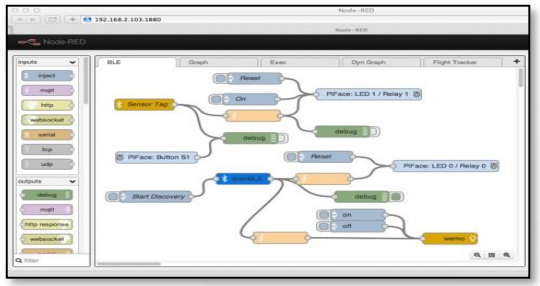


Dashboards and connections

HTTPS, ODBC, SQL, SPARQL,… NGSI

Dashboard Server

HTTPS



WSs

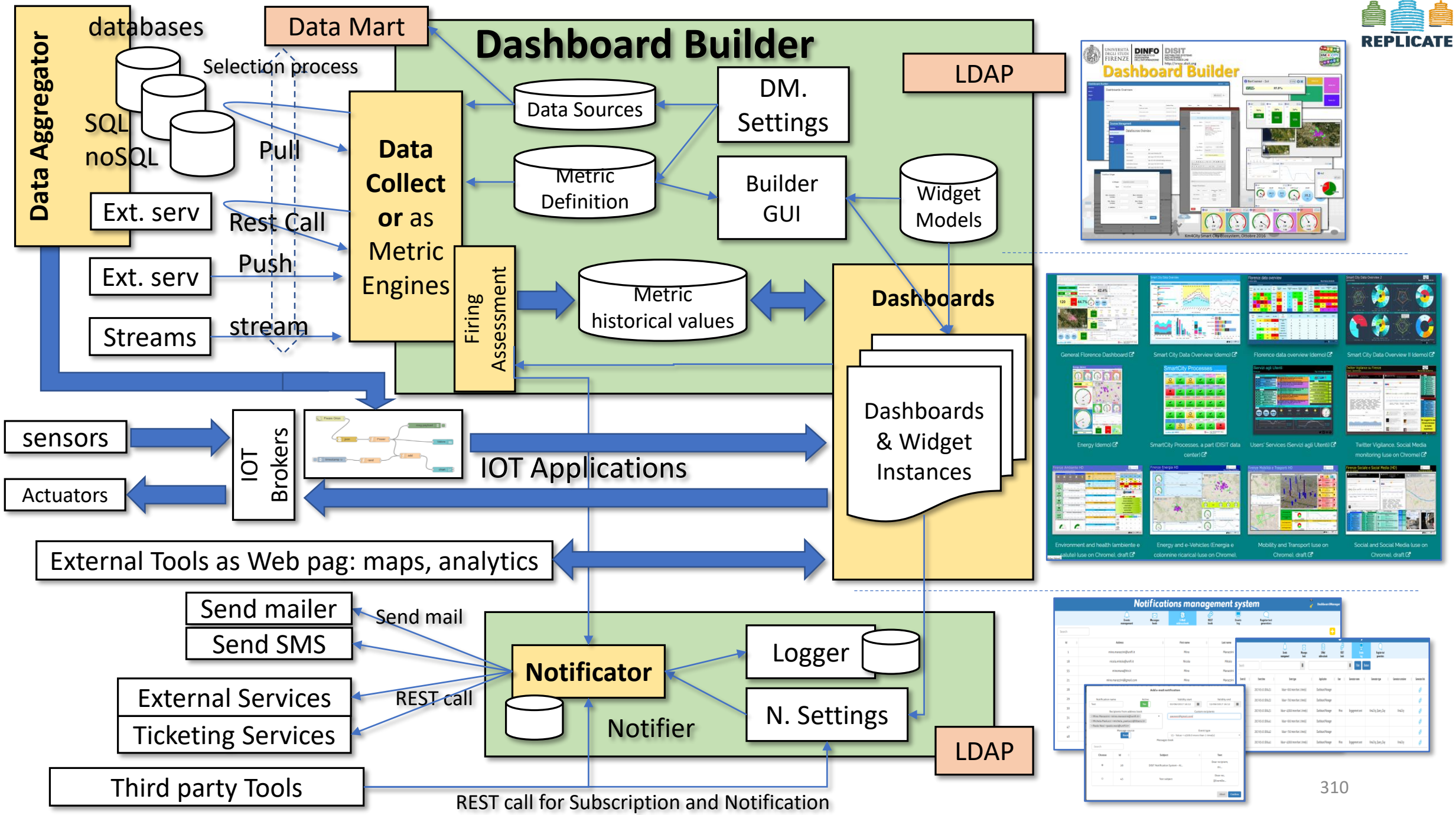


WSs

IOT BROKER

NGSI

WSs Server


Data Aggregator
databases
Selection process
SQL
noSQL
Pull
Ext. serv
Rest Call
Ext. serv
Push
Streams
stream
Data Mart
Dashboard Builder
Data Collect or as Metric Engines
Data Sources
Metric Definition
DM. Settings
Builder GUI
LDAP
Widget Models
Firing Assessment
Metric historical values
Dashboards
Dashboards & Widget Instances
sensors
Actuators
IOT Brokers
IOT Applications
External Tools as Web pag: maps, analytics
Send mailer
Send SMS
Send mail
External Services
Ticketing Services
REST call
Notificator
Notifier
Logger
N. Settings
LDAP
Third party Tools
REST call for Subscription and Notification

Dashboards vs mobile app User Interface



Course Segments

- **From Data to Applications and Dashboards**
  - Requirements on dashboards and security/privacy for smart city
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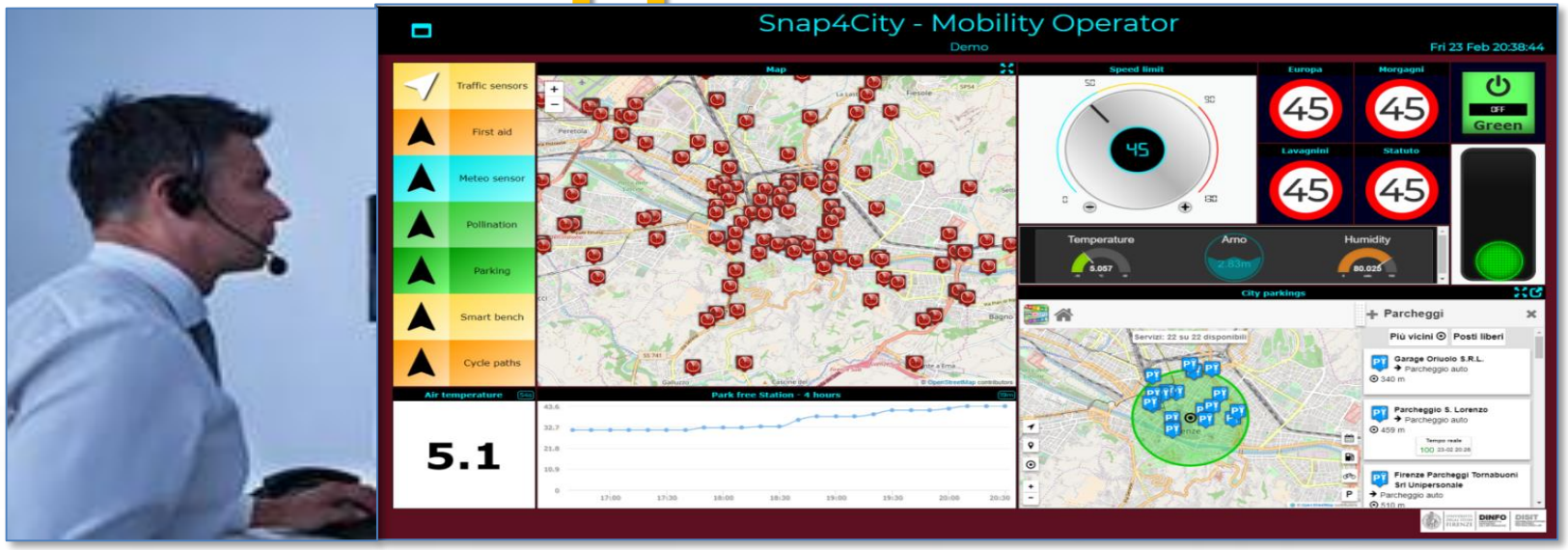
  - Living Lab Approaches

City Dashboard + IOT App

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

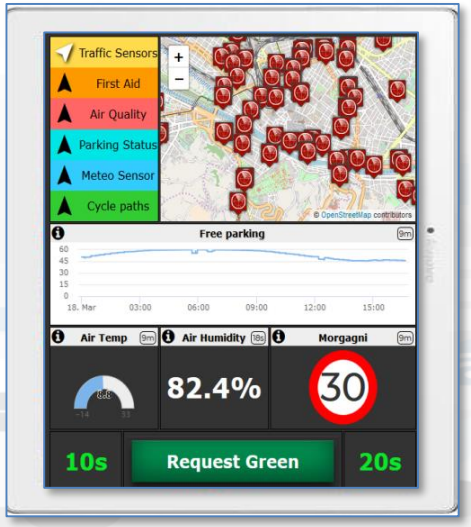


Driver, Policeman

Would like to:

- Monitor traffic, Parking, env., speed limit, …
- **Act and** monitor red lights





End-to-end security on IOT infrastructures



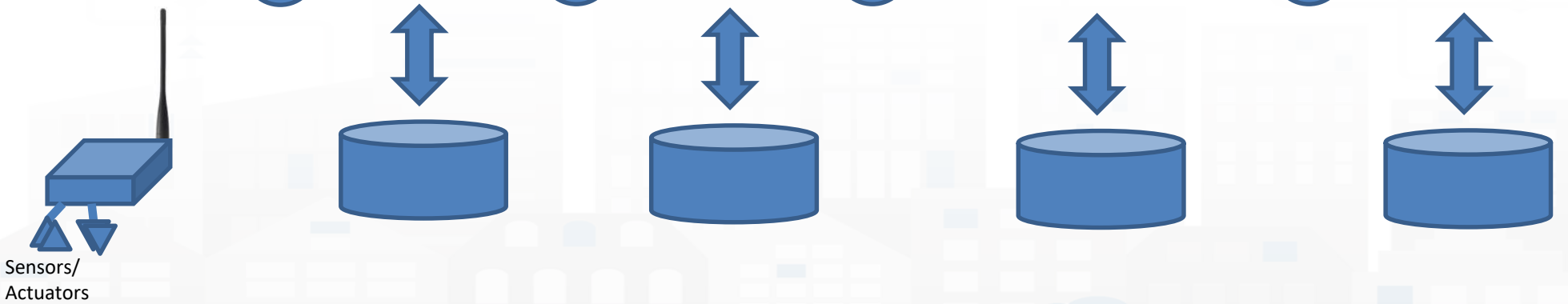
Course Segments

- **From Data to Applications and Dashboards**
  - Requirements on dashboards and security/privacy for smart city
  - Dashboards: types and meaning
  - Protocols from Dashboards
  - Dashboards vs mobile app User Interface
  - End-to-end security on IOT infrastructures
  - Data Protection, Personal Data vs GDPR
  - Living Lab Approaches

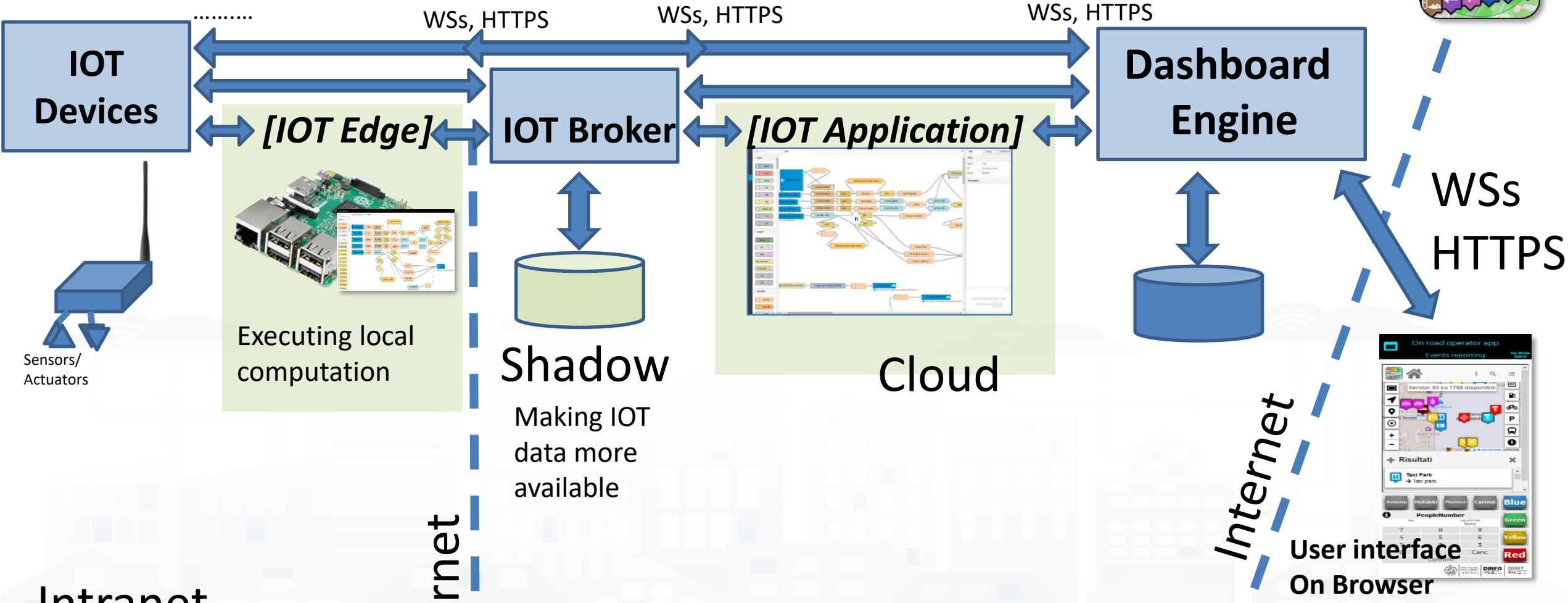
Complexity in Smart City IOT Platforms

- End to End security
  - From IOT Devices to Dashboard (user interface)
  - That means many critical points in the architecture:

IOT Device → *[IOT Edge]* → IOT Broker → *[IOT Application]* → Dashboard (User interface)






.....
WSs, HTTPS
WSs, HTTPS
WSs, HTTPS
IOT Devices
[IOT Edge]
IOT Broker
[IOT Application]
Dashboard Engine
WSs
HTTPS
Sensors/
Actuators
Executing local computation
Shadow
Making IOT data more available
Cloud
Internet
Internet
Intranet
User interface
On Browser

IOT Devices

.....

WSs, HTTPS

WSs, HTTPS

WSs, HTTPS

Dashboard Engine

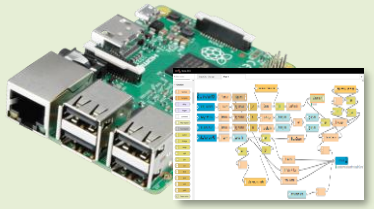
[IOT Edge]

IOT Broker

[IOT Application]

WSs HTTPS

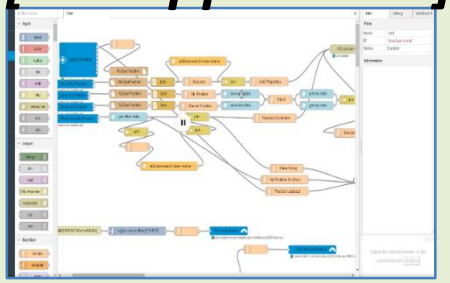
Sensors/ Actuators



Executing local computation

Shadow

Making IOT data more available



MicroServices
Ext-Services
.....

Executing permanent computation

Internet

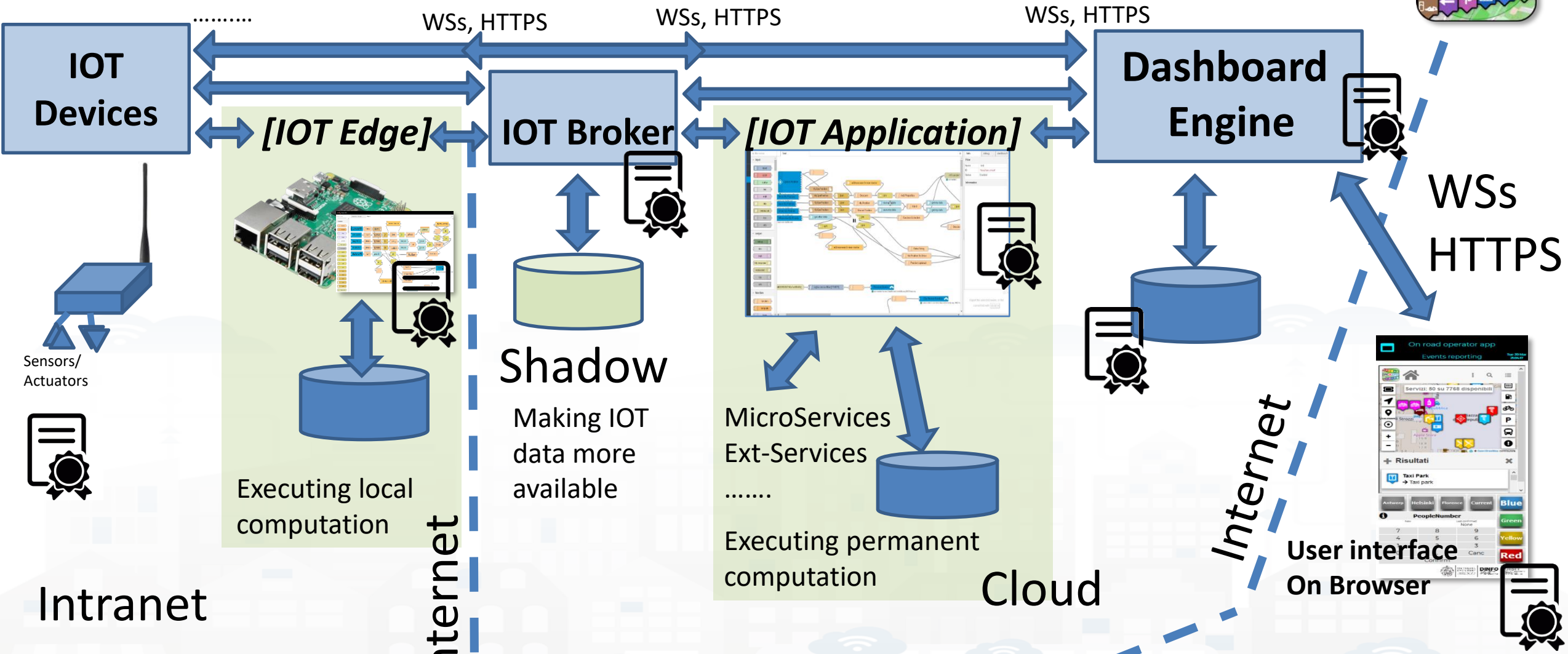
Internet



User interface On Browser

Intranet

Cloud


.....
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MicroServices
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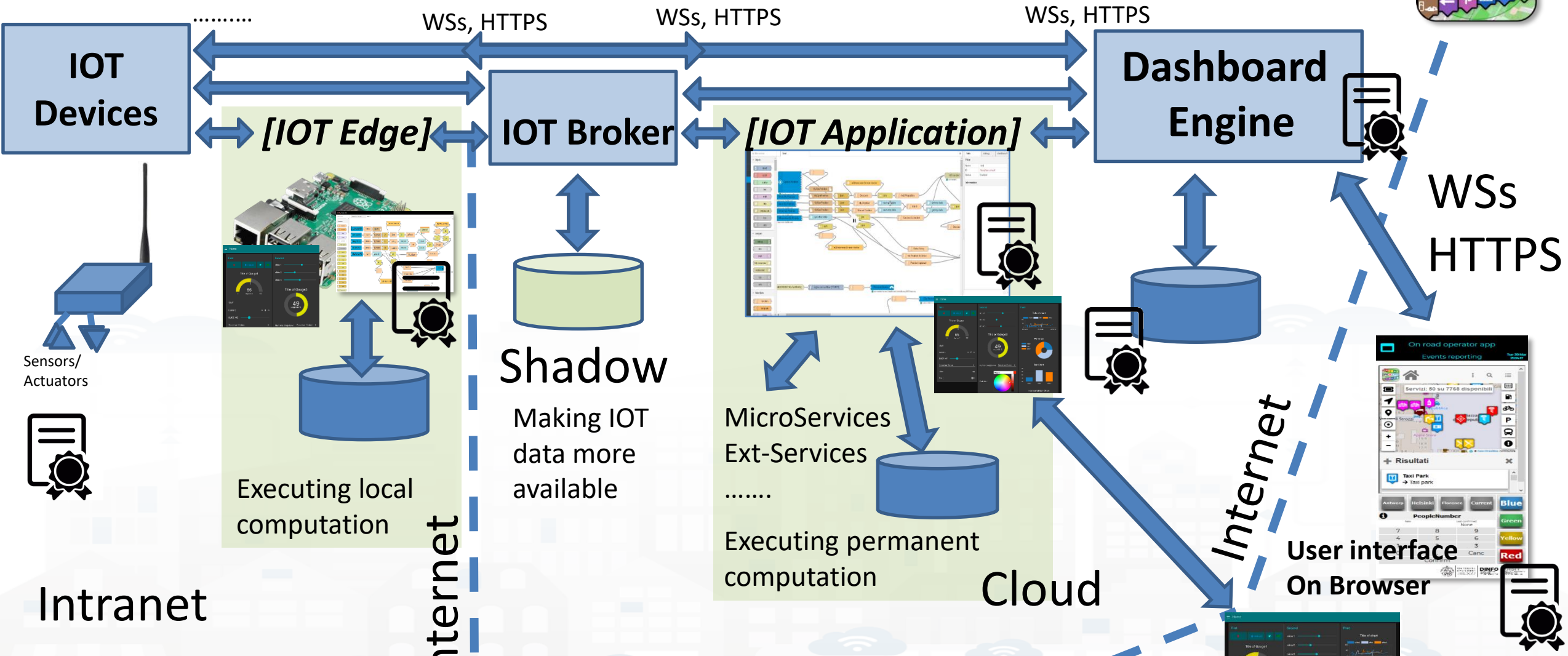
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[IOT Edge]
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WSs HTTPS
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.....
Executing permanent computation
Internet
Internet
Intranet
Cloud
User interface On Browser

IOT Devices

.....

WSs, HTTPS

WSs, HTTPS

WSs, HTTPS

[IOT Edge]

IOT Broker

[IOT Application]

Dashboard Engine

WSs HTTPS

Sensors/ Actuators

Executing local computation

Shadow

Making IOT data more available

MicroServices
Ext-Services
.....

Executing permanent computation

Smart City Knowledge Base and RT data

Internet

Internet

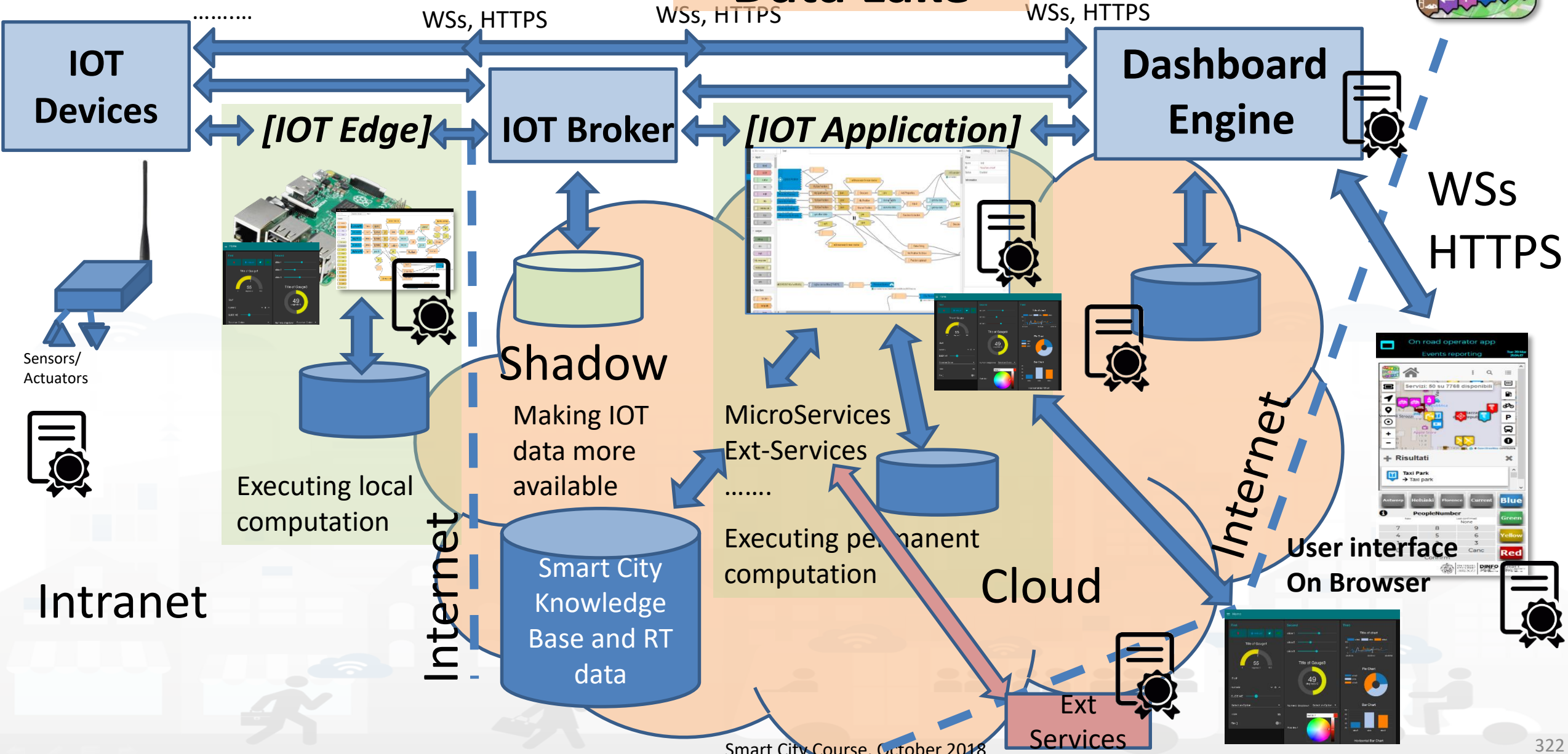
Intranet

Cloud

Ext Services

User interface On Browser

Grouping on Data Lake



Grouping on Data Lake

IOT Devices

WSs, HTTPS

WSs, HTTPS

WSs, HTTPS

Dashboard Engine

[IOT Edge]

IOT Broker

[IOT Application]

Data Analytics

WSs HTTPS

Sensors/ Actuators

Executing local computation

Shadow

Making IOT data more available

MicroServices
Ext-Services
.....

Executing permanent computation

Intranet

Internet

Smart City Knowledge Base and RT data

Parallel Computing

Cloud

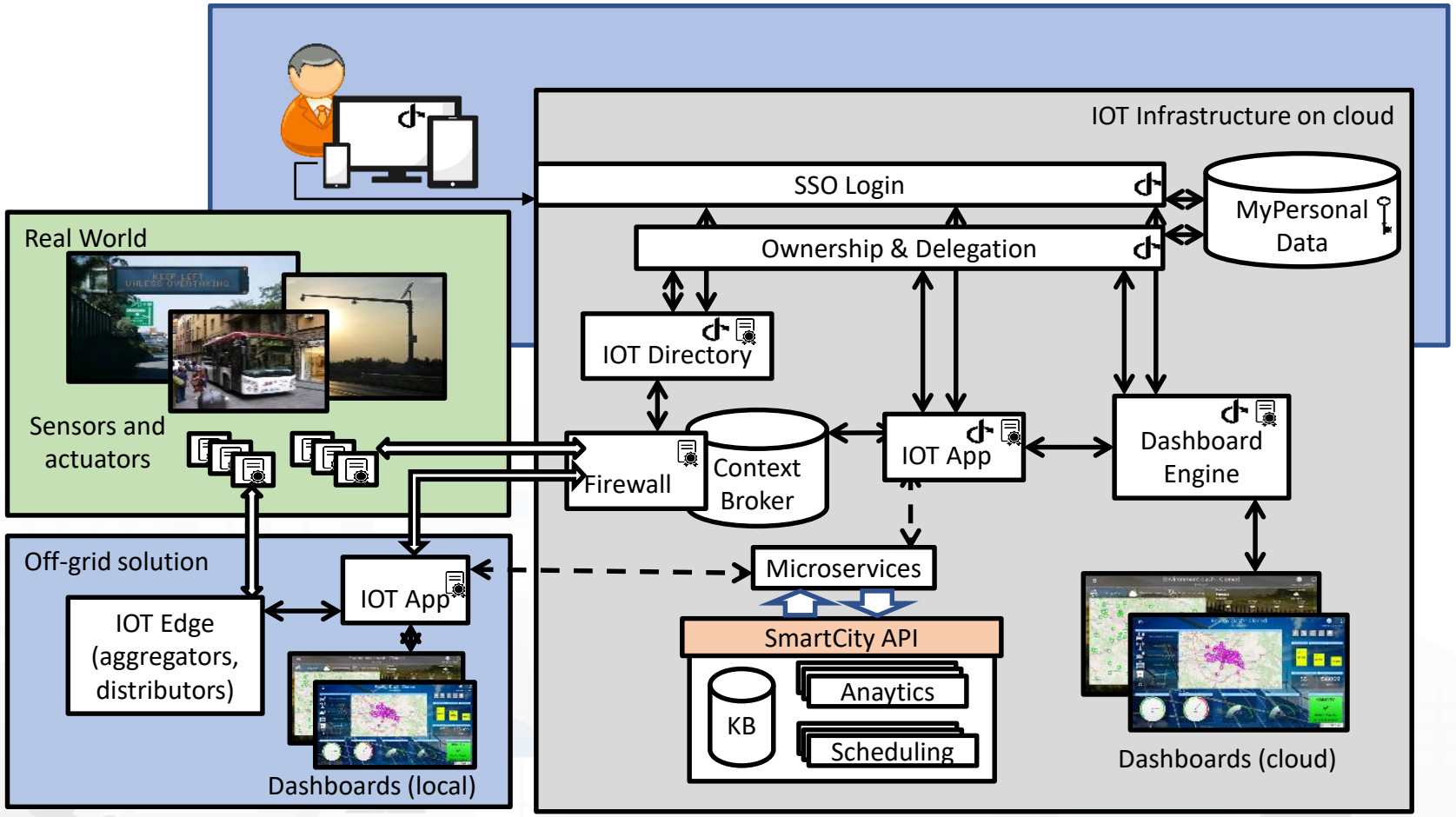
Ext Services

Internet

User interface On Browser

Snap4City Solution (User-Data)

- User data protection (by design)
  - Encryption on ***_any_*** personal data and storing in an isolated environment
    - Ownership and delegation (user access control and consent management)
    - Accessible remotely via APIS with authentication and authorization (LDAP and OpenIDconnect)
      - Description of user credentials Roles / Groups / Organization
      - In an encrypted way (TSL/SSL)
- Elapsing time (by default)
  - Deleting by temporally marking (investigative authorities audits)
- Tracking any activities → monitoring and auditing



Establishing Protected connections

- For example:
  - From IOT Broker to IOT Applications: sending data
  - From IOT Applications to
    - IOT Brokers: registering, subscribing, sending, etc.
    - MyPersonalData: save and reload (key + personal data + personal KPI)
    - Dashboards
- etc.

Data Protection, Personal Data vs GDPR



Course Segments

- **From Data to Applications and Dashboards**
  - Requirements on dashboards and security/privacy for smart city
  - Dashboards: types and meaning
  - Protocols from Dashboards
  - Dashboards vs mobile app User Interface
  - End-to-end security on IOT infrastructures
  - Data Protection, Personal Data vs GDPR
  - Living Lab Approaches

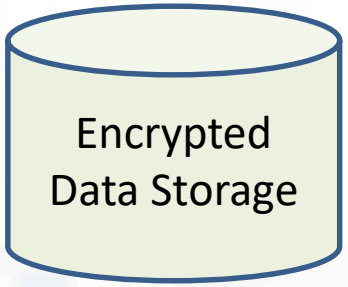
GDPR: General Data Protection Regulation

- **Users are** going to decide to:
  - provide access to who, for do what, until we consent
  - accept terms of use by **signed** consent **for each** data management **service**, *before was a simple informed consent*
- **from each service, the user has** to be capable to
  - **See** what the provider collect in terms of its Data Type: traces, logs, paths, profiles, accesses, IOT devices, sensors, maps, etc.
  - **Download**, **delete**, **inspect** each single Data Type
  - **Auditing** and **Revoke access** or **grant** access right to **each single Data Type**
  - **Delete all Data Types in single shot** or singularly (**forget all about me**)

- Correctness
- Transparency
- Security
- Integrity
- Privacy
- Auditing
- ….

GDPR: General Data Protection Regulation

- If personal data are **published by the owner**
  - the data have to be **released anonymously**,
    → also in this case they can be **revoked at any time**:
  - **Complexity reside** on: *distributed vs centralized control, revoke of Votes/scores, comments, …. If they are saved singularly or they already exploited in processing*
- GDPR also imposes **Technical Constraints** such 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
- **Relevant taxation** is foreseen when rules are violated, % of turnover



Grouping on Data Lake

IOT Devices

.....

WSs, HTTPS

WSs, HTTPS

WSs, HTTPS

Dashboard Engine

[IOT Edge]

IOT Broker

[IOT Application]

Data Analytics

WSs HTTPS

Sensors/ Actuators

Executing local computation

Shadow

Making IOT data more available

MicroServices
Ext-Services
.....

Executing permanent computation

Internet

Smart City Knowledge Base and RT data

Parallel Computing

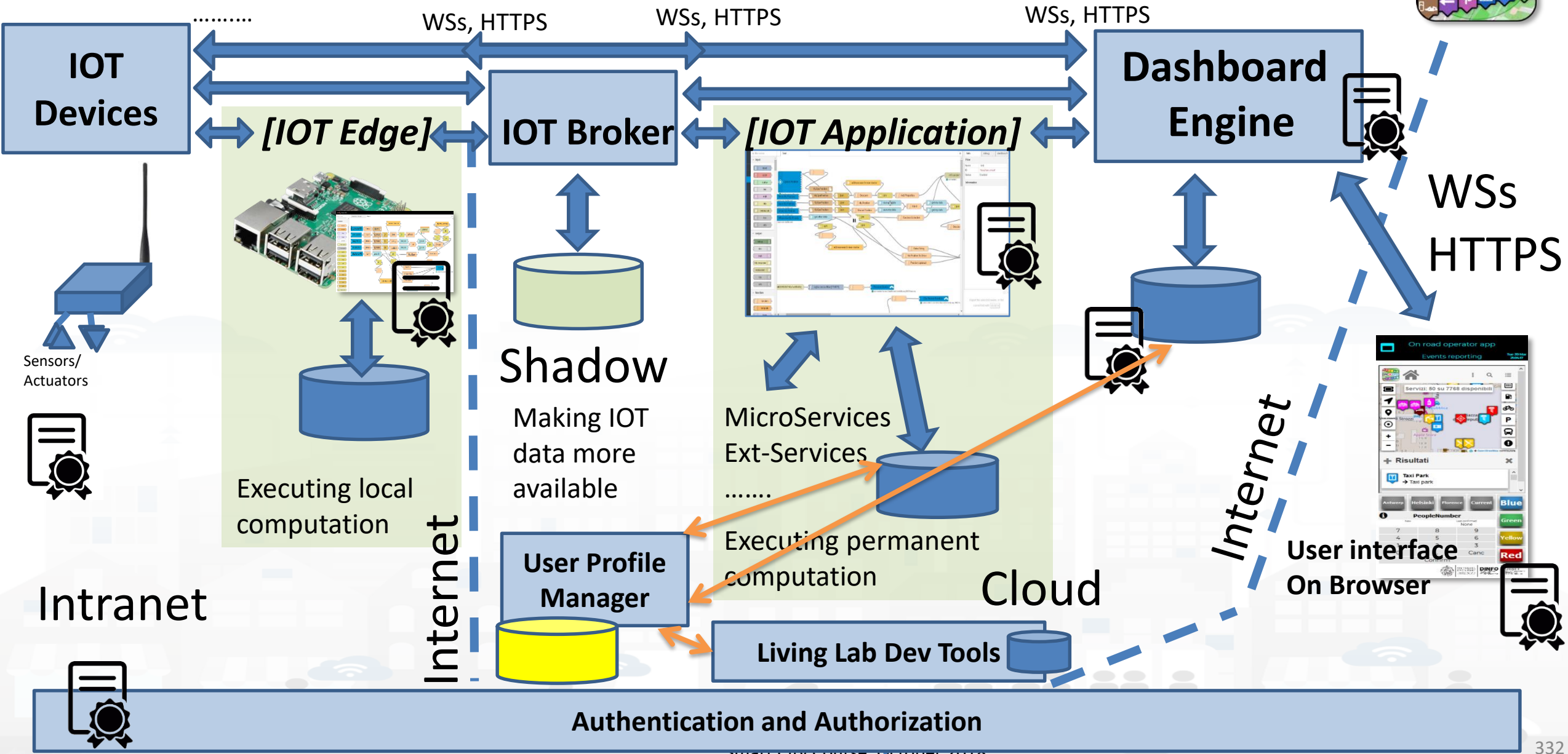
Ext Services

Cloud

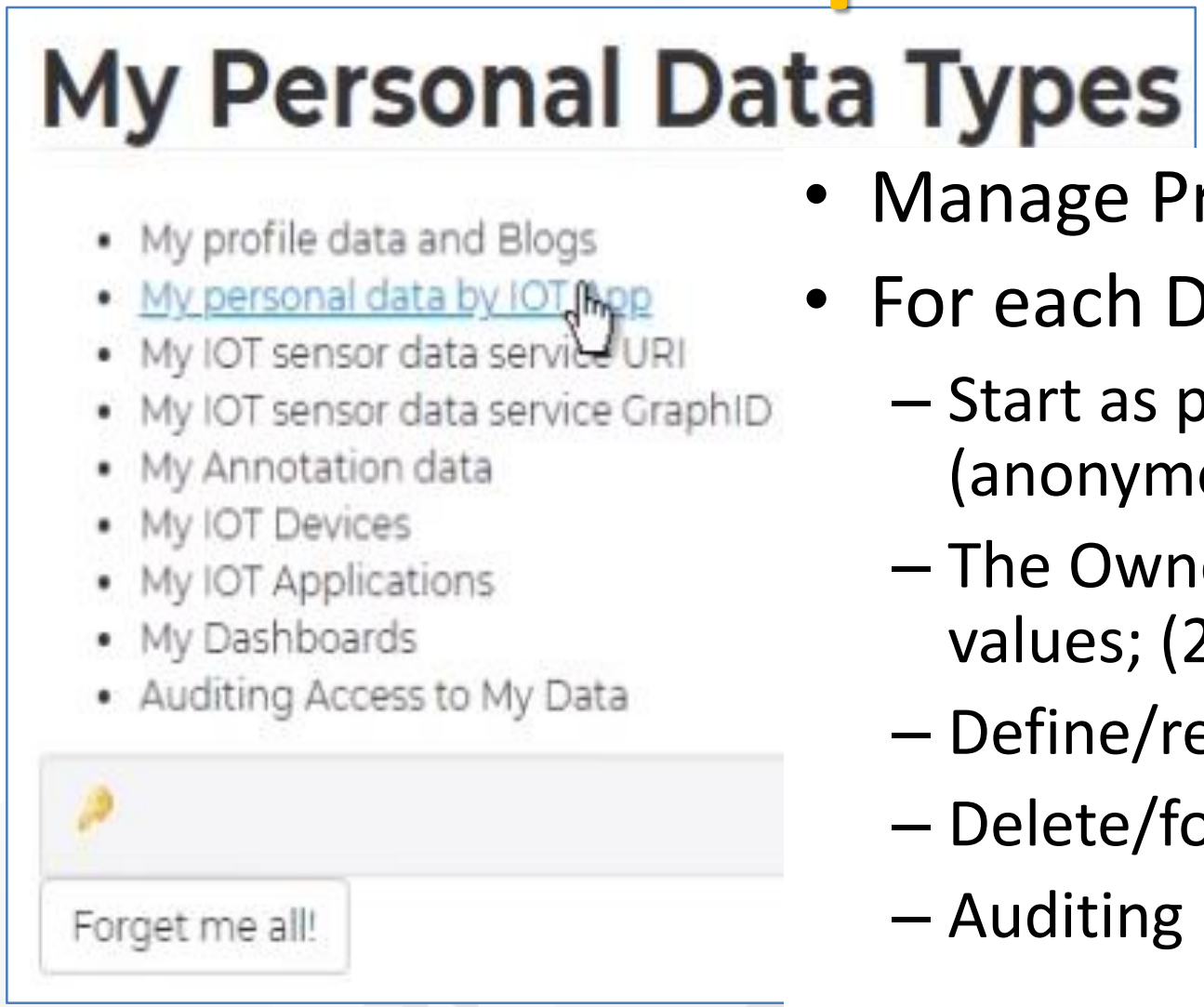
Internet

User interface On Browser

Intranet


.....
WSs, HTTPS
WSs, HTTPS
WSs, HTTPS
IOT Devices
[IOT Edge]
IOT Broker
[IOT Application]
Dashboard Engine
WSs
HTTPS
Sensors/
Actuators
Executing local computation
Shadow
Making IOT data more available
MicroServices
Ext-Services
.....
Executing permanent computation
Internet
User Profile Manager
Living Lab Dev Tools
Cloud
Internet
User interface On Browser
Intranet
Authentication and Authorization

GDPR Compliant



- Manage Profile and MyPersonalData
- For each Data Type:
  - Start as private → making them public (anonymous) and revoke
  - The Owner is the only one that can: (1) modify values; (2) change the ownership
  - Define/revoke Delegation to Access
  - Delete/forget per Data Type and "me all!".
  - Auditing

Managing MyPersonalData in secure manner

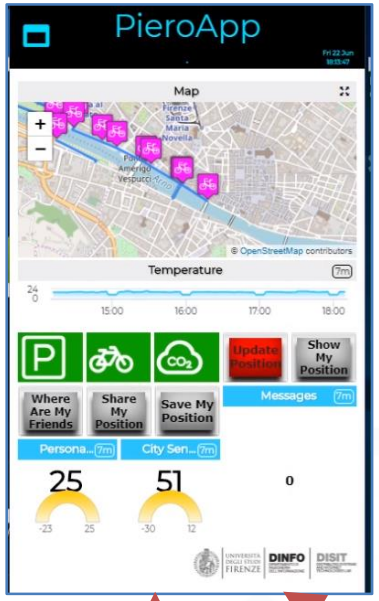


Examples:

- 1) Social IOT: A group of friends share some data with other according to GDPR: GPS position, Medical parameters as Glucose, etc.
- 2) saving and retrieve personal sensitive information.

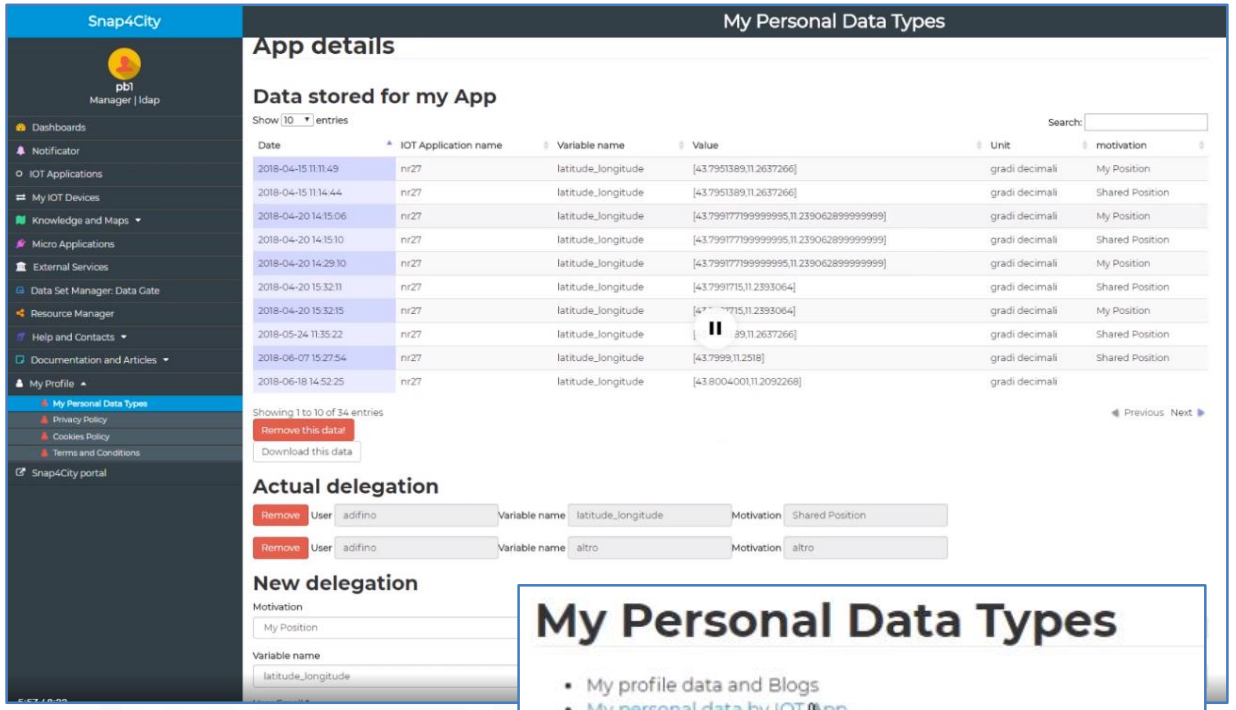
The users manage their Personal data via personal mobile Dash and IOT App, and configuration on the portal and/or Mobile App

Managing MyPersonalData in secure manner

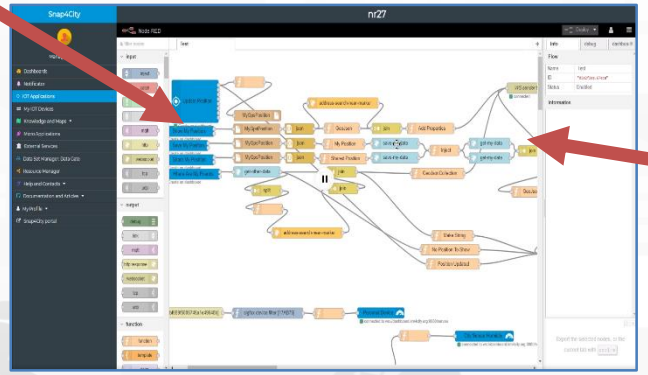


Example:

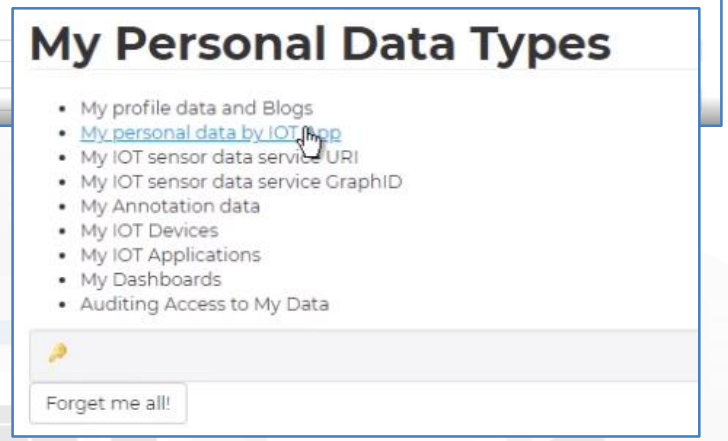
- Piero shares some data with selected friends according to GDPR: GPS position
- He managed the data via personal mobile Dashboard and IOT Application



Smart City Services and IOT/IOE



Encrypted Data Storage



Some Consideration on GDPR

- **Complexity of GDPR with end-to-end secure connections**
  - IOT Platforms as AWS, Microsoft Azure, Google IOT, etc. are not compliant yet.
  - Smart city GIS platforms as ESRI ArcGIS are not compliant yet.
  - Many Smart City platforms are not compliant yet.
- **Limitations are usually applied to simplify the solutions**
  - Limiting the number of supported protocols
  - Selling proprietary devices that may be attached on that secure chain
- **Snap4City is resulting platform developed for Helsinki and Antwerp to satisfy the above described requirements in** Open Source

Living Lab Approach



Course Segments

- **From Data to Applications and Dashboards**
  - Requirements on dashboards and security/privacy for smart city
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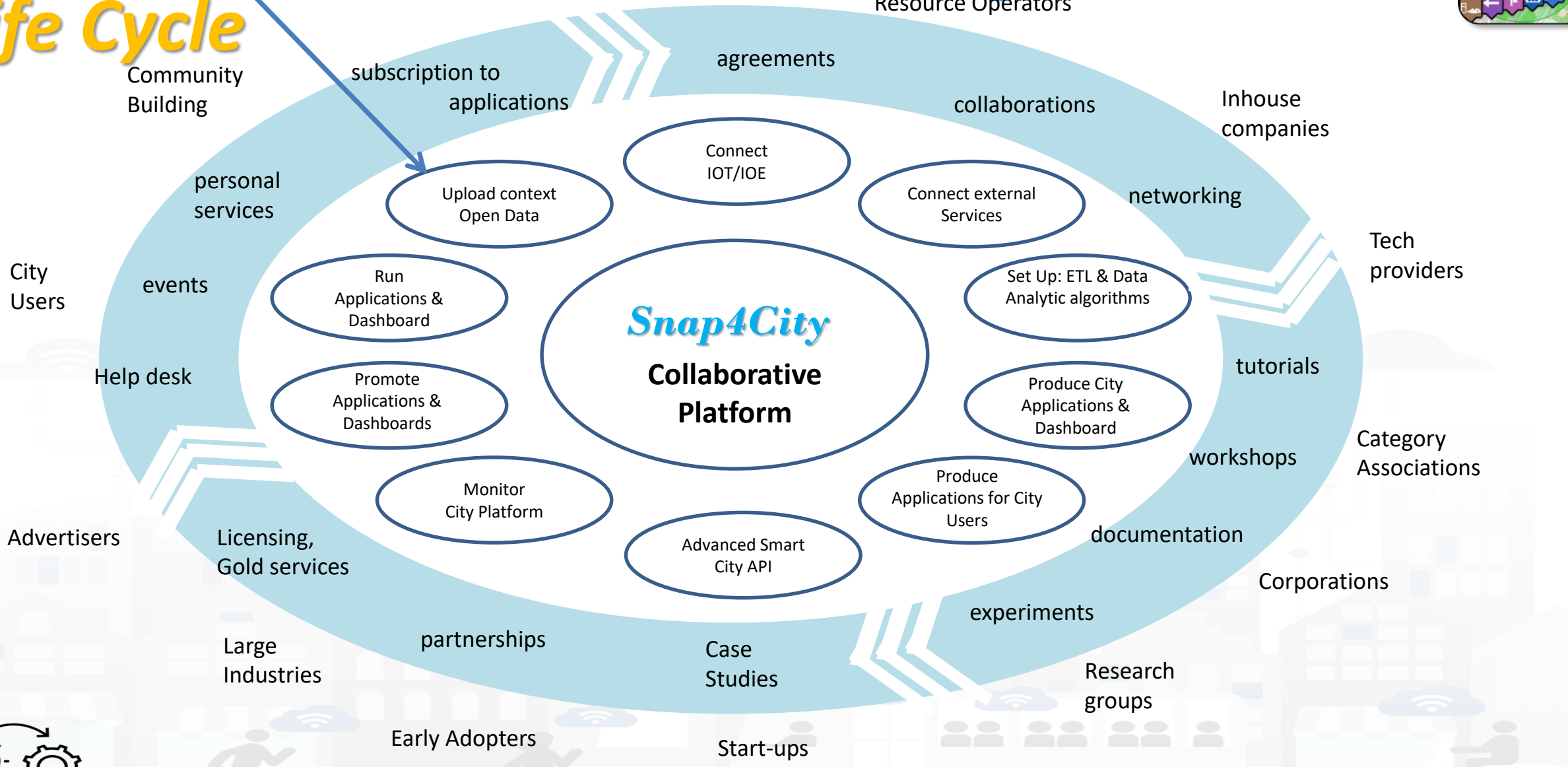
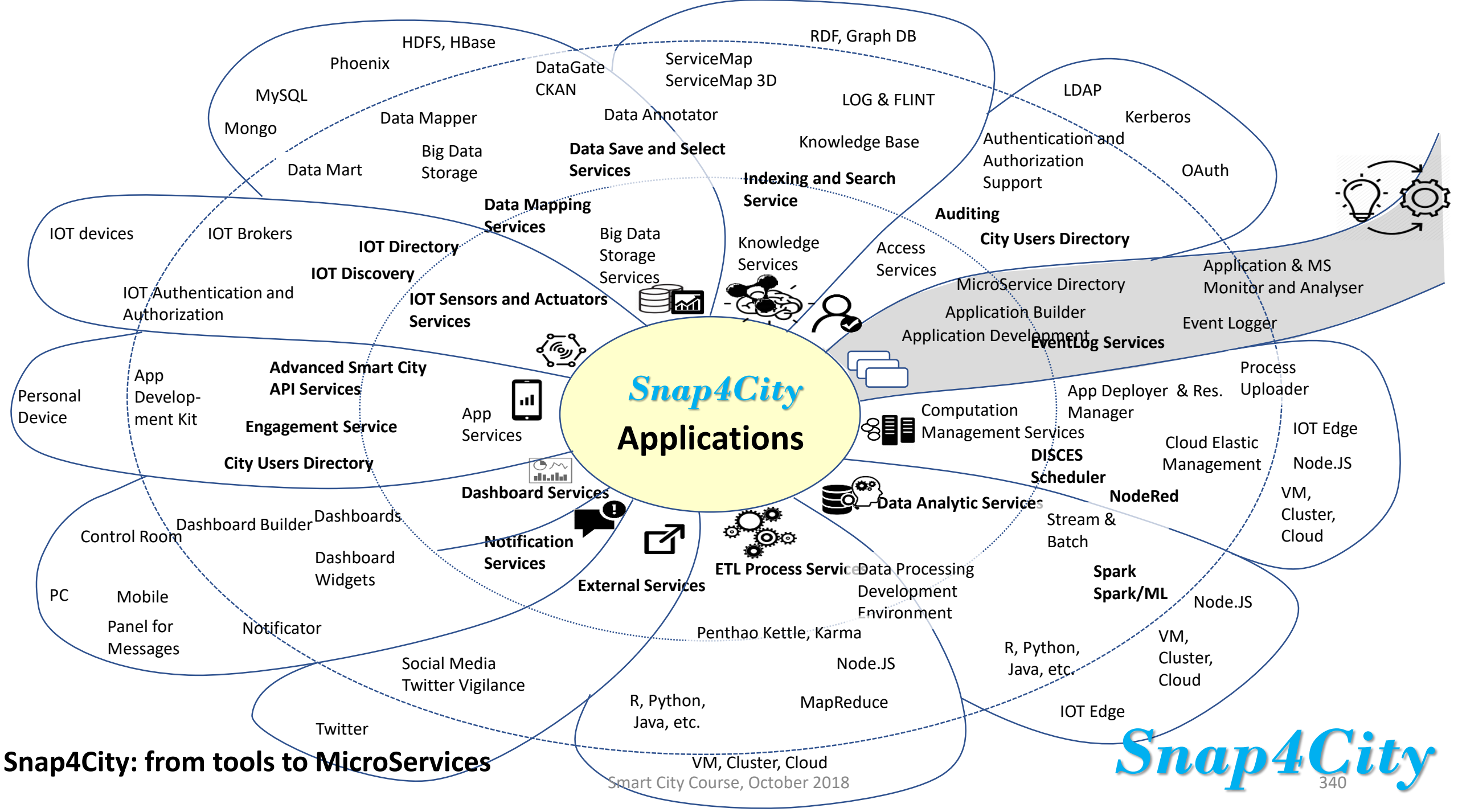
Life Cycle


City Operators
Resource Operators
Community Building
subscription to applications
agreements
collaborations
Inhouse companies
personal services
networking
Tech providers
City Users
events
tutorials
Help desk
workshops
Category Associations
documentation
Advertisers
Licensing, Gold services
Corporations
experiments
partnerships
Large Industries
Case Studies
Research groups
Early Adopters
Start-ups
Connect IOT/IOE
Upload context Open Data
Connect external Services
Run Applications & Dashboard
Set Up: ETL & Data Analytic algorithms
Promote Applications & Dashboards
Produce City Applications & Dashboard
Monitor City Platform
Produce Applications for City Users
Advanced Smart City API
Snap4City
Collaborative Platform

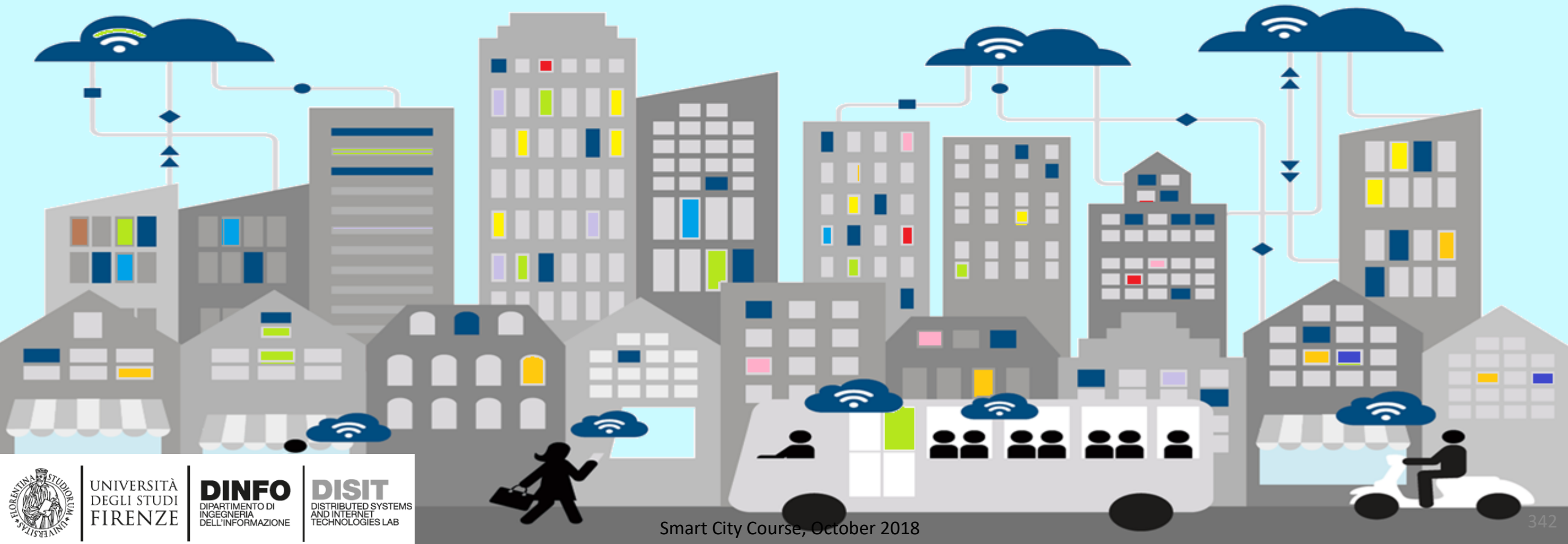


Snap4City: from tools to MicroServices

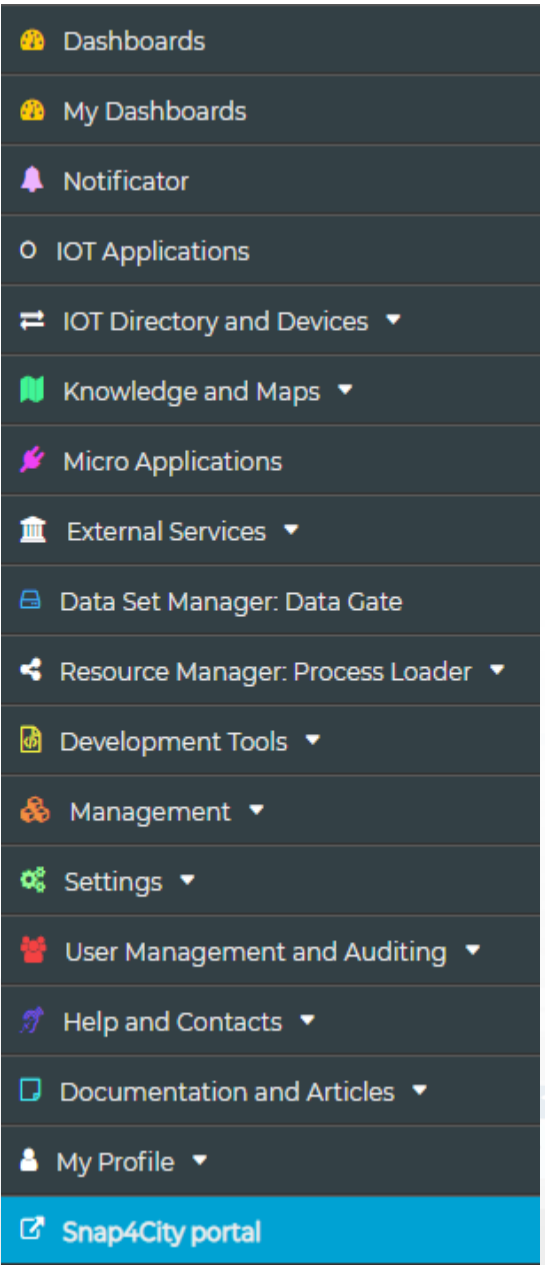
For the user: different levels of engagement

- **Observer:**
  - Level 0: observers of data with private access
- **Manager: Final Users**
  - Level 1: create Dashboards and IOT Applications
  - Level 2: create Dashboards that get and produce data, act on city
  - Level 3: add your own IOT Device, create Dashboards with them and city data
  - Level 4: create IOT Applications to make smarter your Dashboards, services, notifications, exploiting MicroServices
- **Area Manager: Developers, Researchers, Operators**
  - Level 5: Developer of complex services: R, ETL, External Srv, MicroApp, web and mobile application exploiting Smart City API…

Level 5 users and above



AreaManager: Level 5, the developers



- Creation of External Services
- Management of IOT Devices, IOT edges
- Development tools, for example:
  - Creation of Data Analytic, Machine Learning in: R, Tensor Flow
  - Creation of massive ingestion, data transformation processes in ETL Penthao kettle
  - Creation of MicroServices for IOT Applications, from REST Call or from Data Analytics
  - Management of resources and their sharing
  - Open Source with many examples
  - Smart City API with Swagger & Postman documentation/test
- Many tools for monitoring and control

Transport systems
Mobility, parking



Public Services
Govern, events, …



Sensors, IOT
Cameras, ..



Environment,
Water, energy



Shops, services,
operators



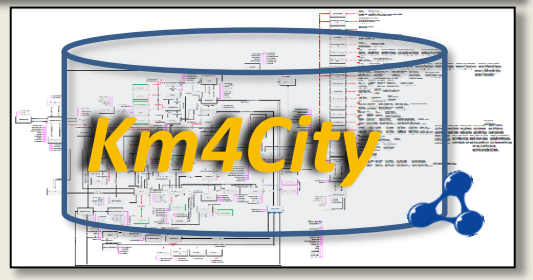
Social Media
WiFi, network



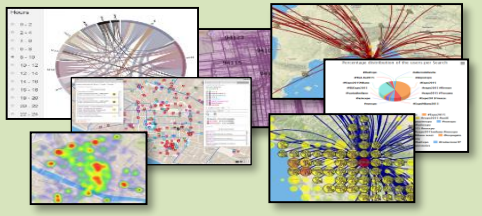
Static, Slow and Real Time data flows

DISCES -- Distributed and parallel architecture on Cloud

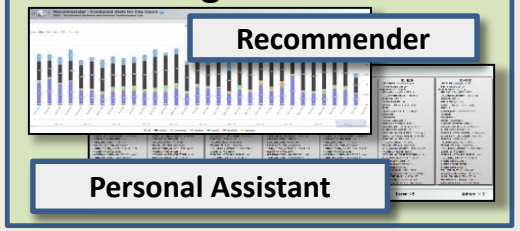
Km4City Smart City Engine



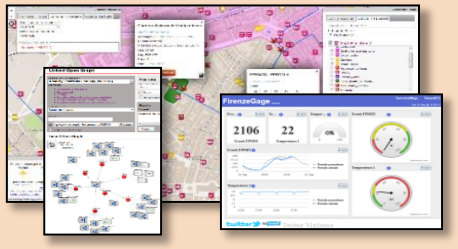
Big Data Analytics



Smartening Tools



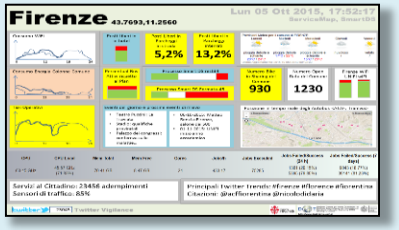
Development Tools



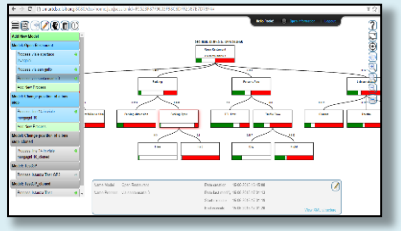
Km4City Smart City API

City Operators and Decision Makers

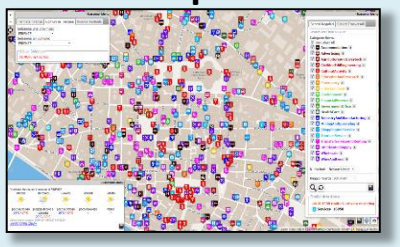
Dashboards



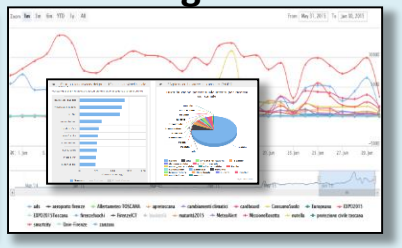
Smart Decision Support



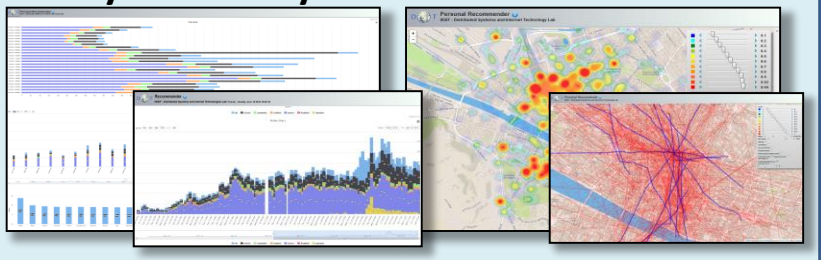
ServiceMap browser



Twitter Vigilance



Analyzers of City User Behavior

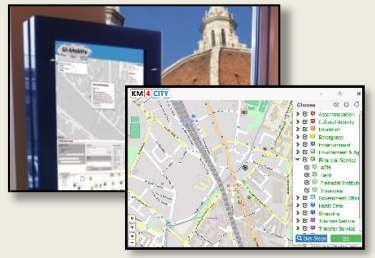


Tools for Final Users

Mobile e Web Apps







KM4CITY

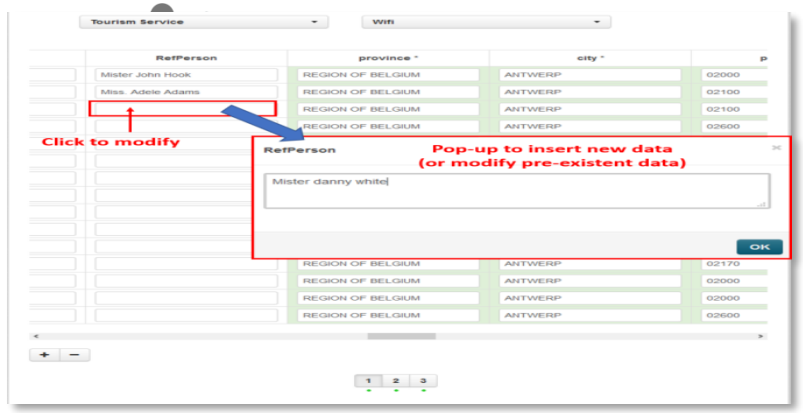
Sii-Mobility

Http://www.km4city.org

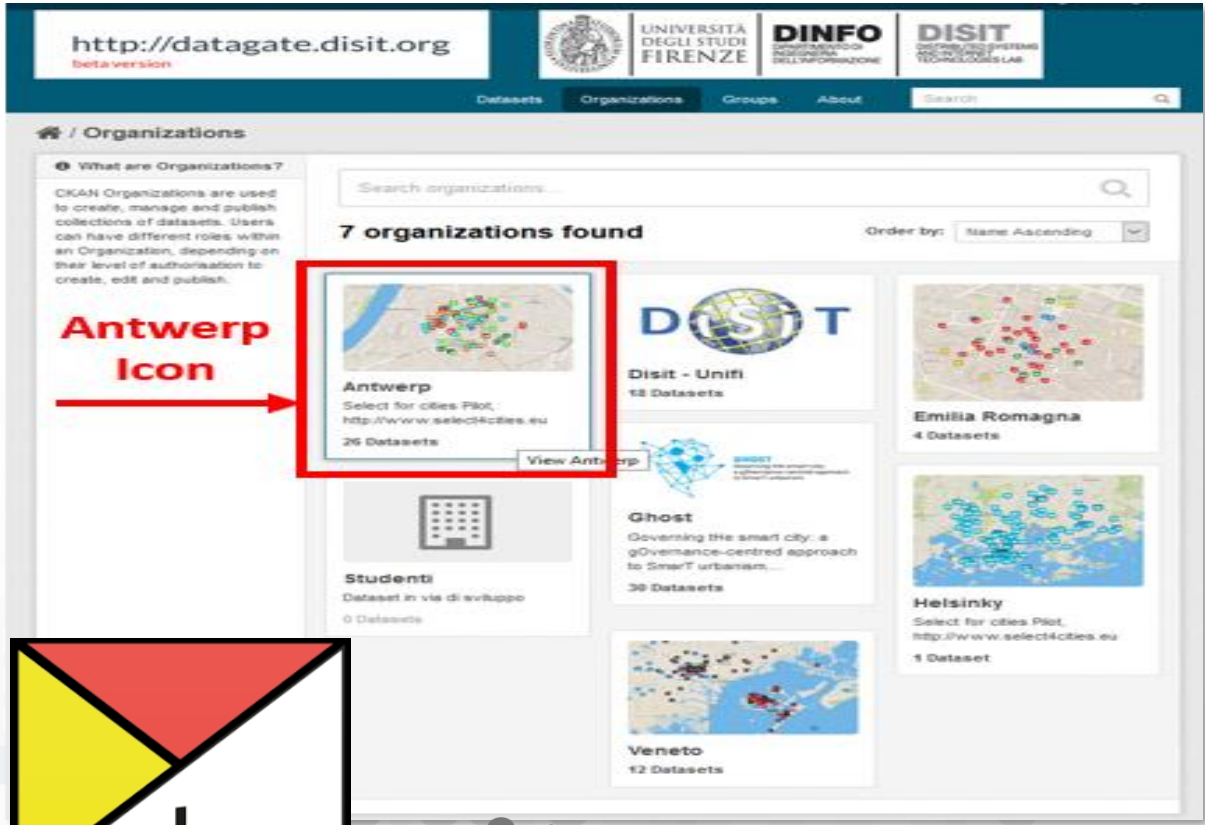
UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
http://www.disit.org

DataGate/CKAN

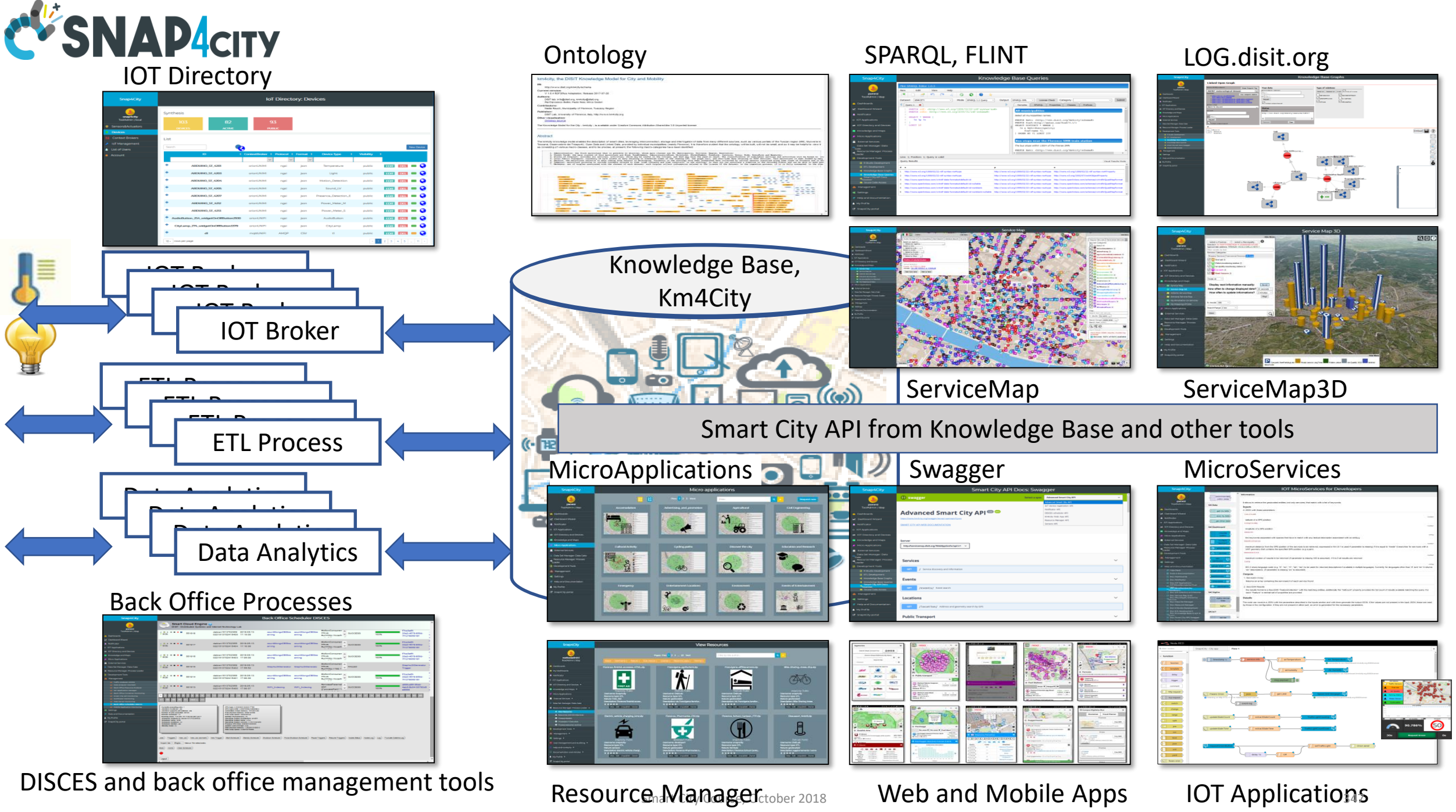
http://datagate.km4city.org



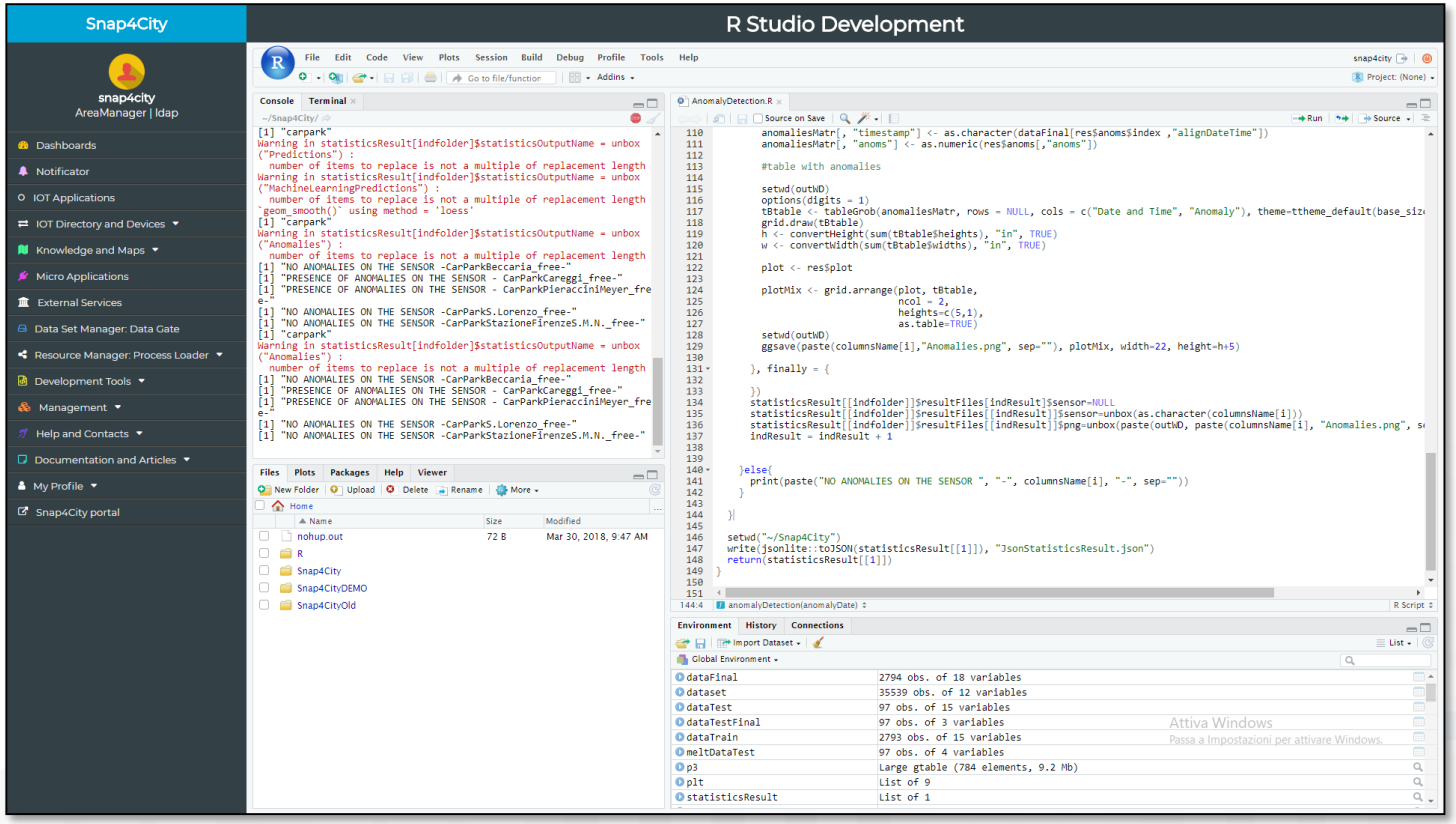


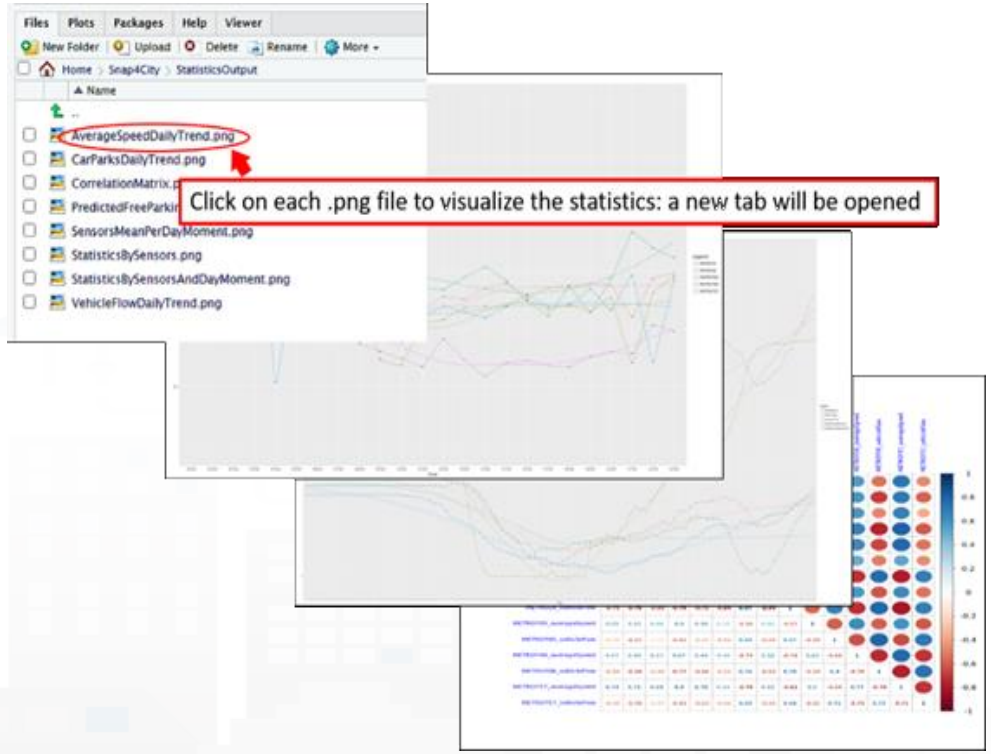


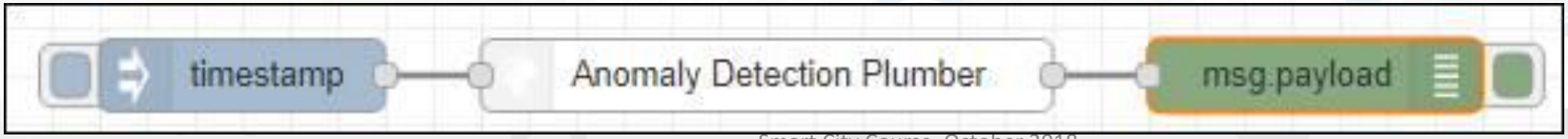



SNAP4CITY
IOT Directory
Ontology
SPARQL, FLINT
LOG.disit.org
IOT Broker
Knowledge Base, Km4City
ServiceMap
ServiceMap3D
ETL Process
Smart City API from Knowledge Base and other tools
MicroApplications
Swagger
MicroServices
Data Analytics
Back Office Processes
DISCES and back office management tools
Resource Manager
Web and Mobile Apps
IOT Applications

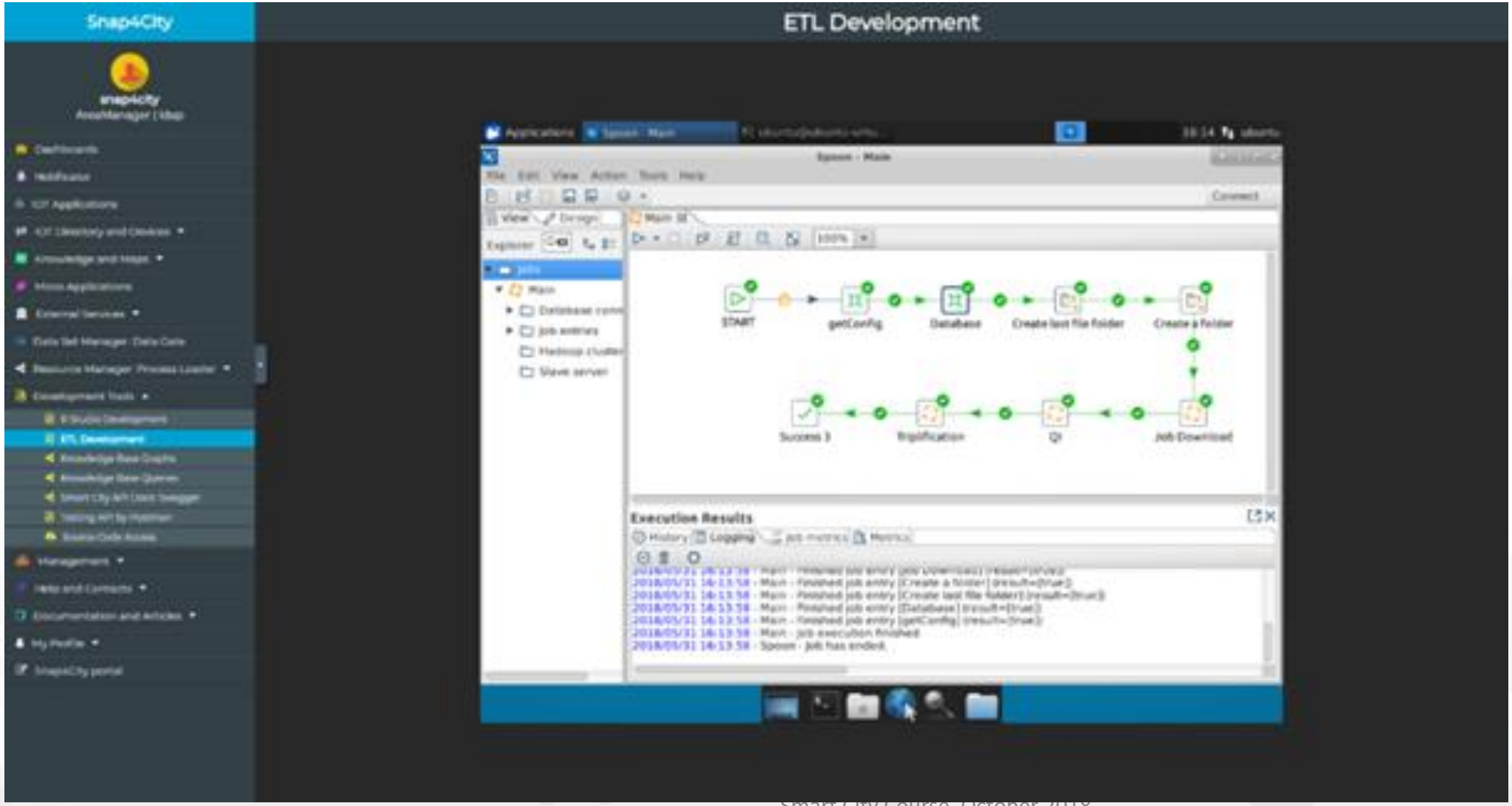
Developer in R Studio + Tensor Flow





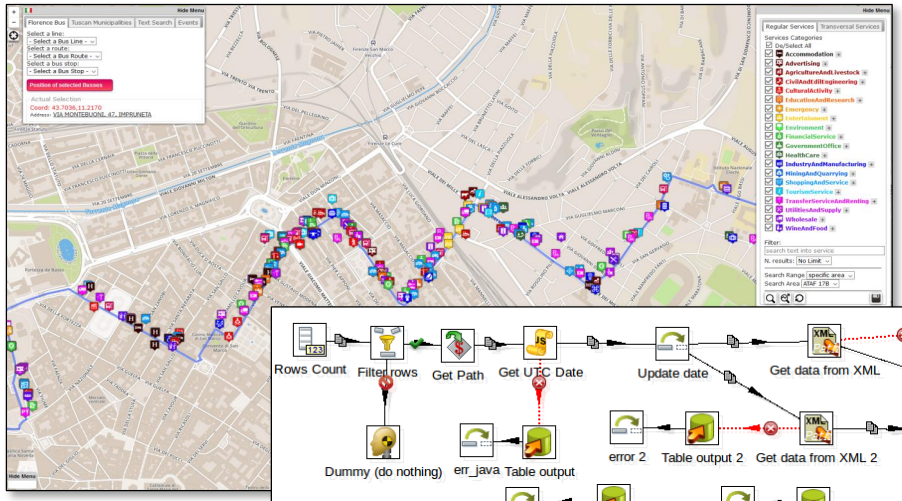


Developer in ETL: Penthao Kettle

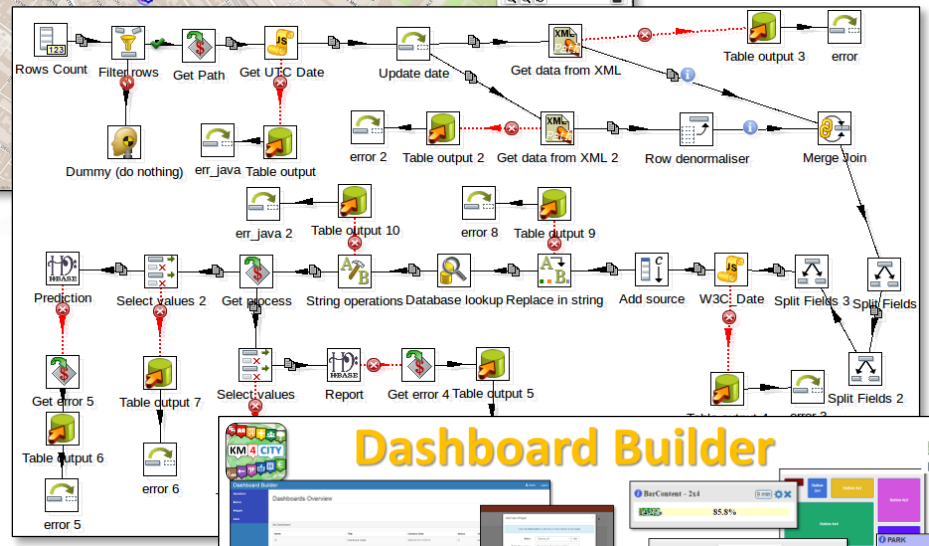


Development Tools

- **Smart City API:**
  - Several kind of APIs
- **Generator "ServiceMap", http://servicemap.km4city.org**
  - Call per web and mobile App
  - Embedding in web pages
  - ***Collaborative work***
- **Load new data: manual and automatic**
  - POI, IOT, etc.
  - Load of Shape & Paths
  - ***Collaborative work***
- **Dashboard builder**
  - Production of dashboard per control room
  - Embedding view of any other analytics of Km4City or of third party: wifi, 3D, flow, recommend, engager, etc.
  - ***Collaborative work***

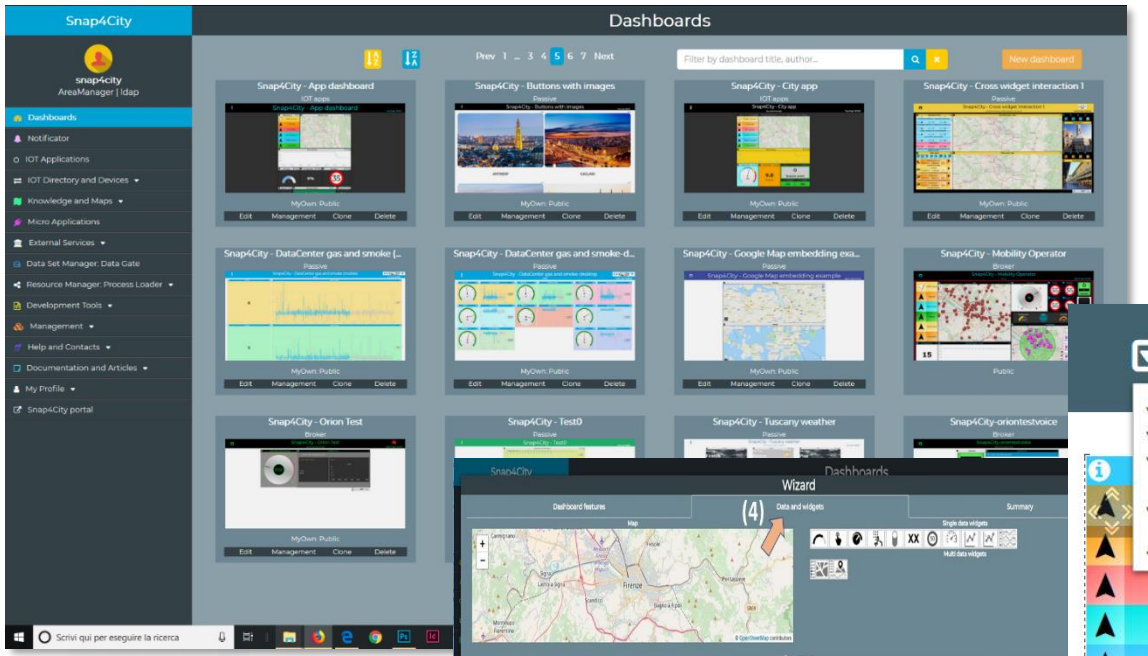


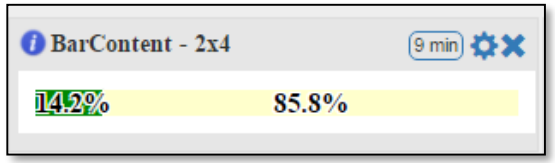
Sii-Mobility

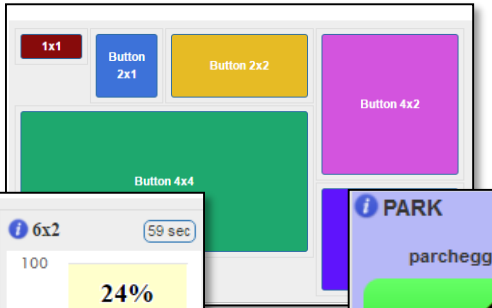


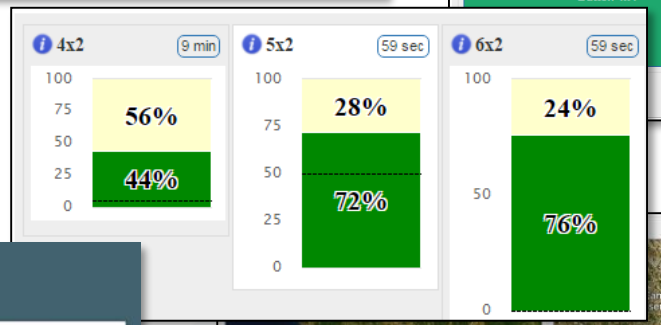


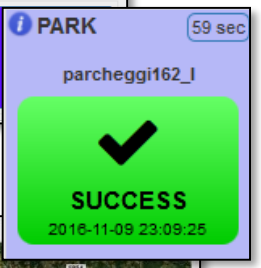
Dashboard Builder

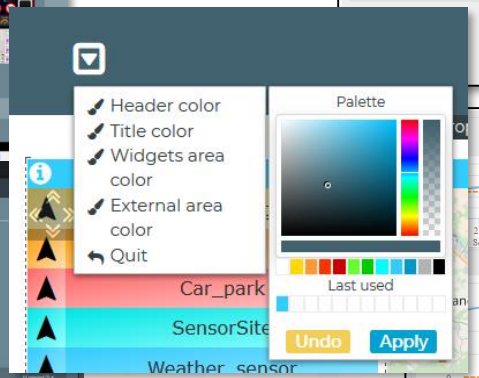




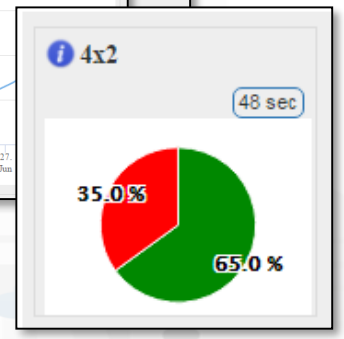


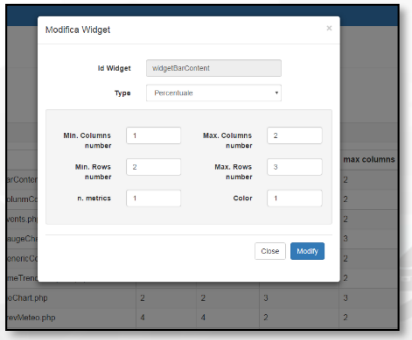


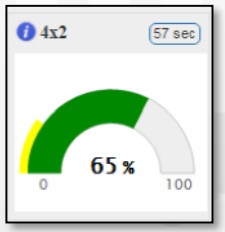


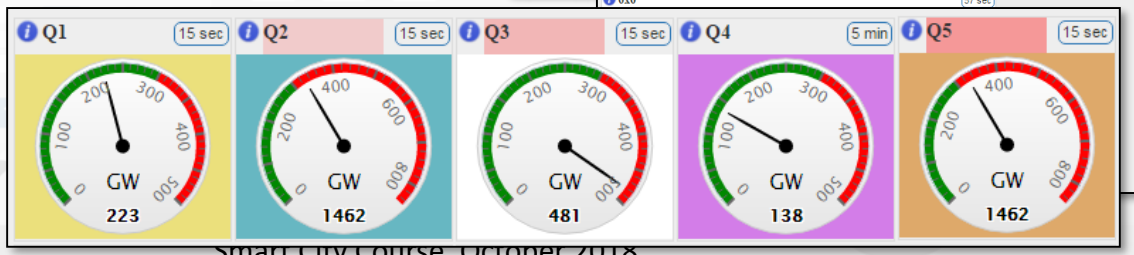




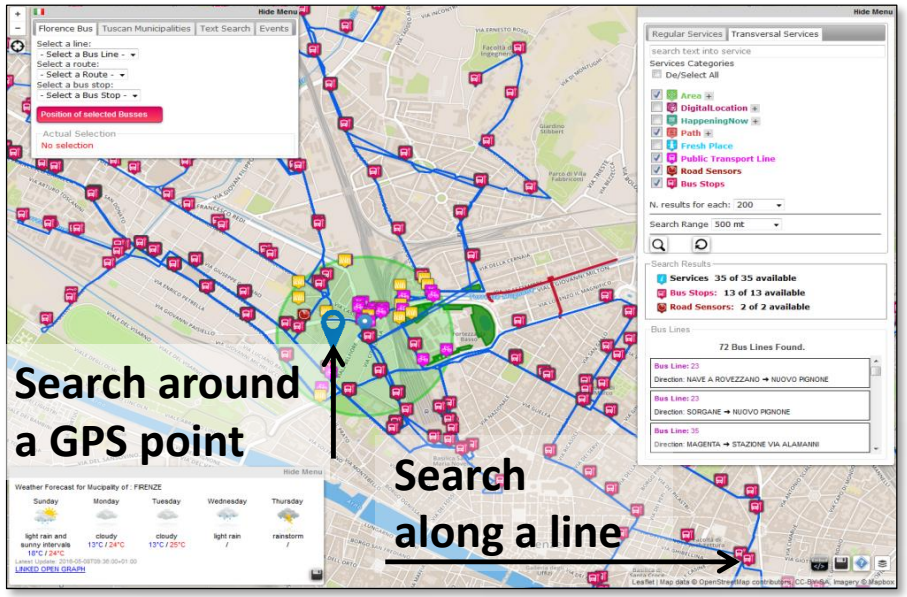


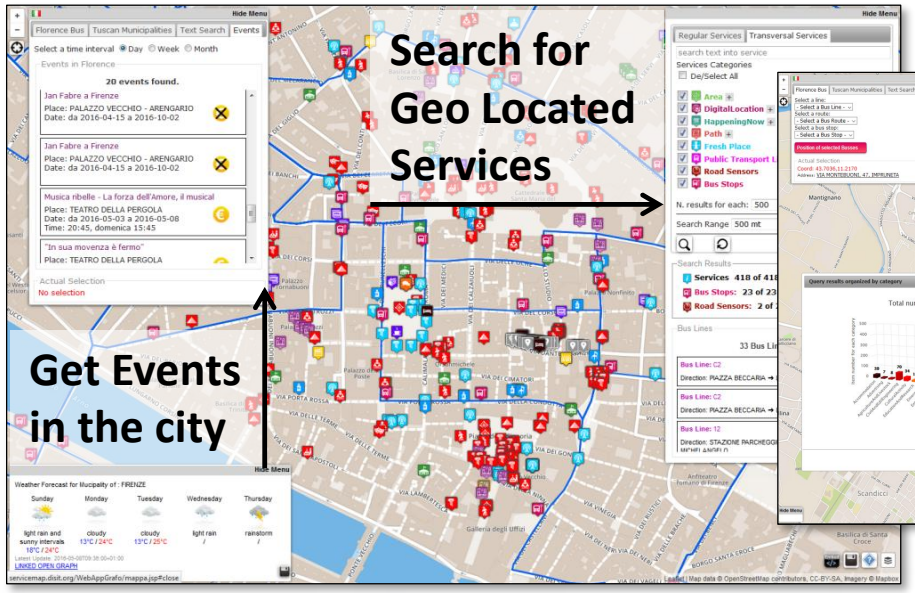




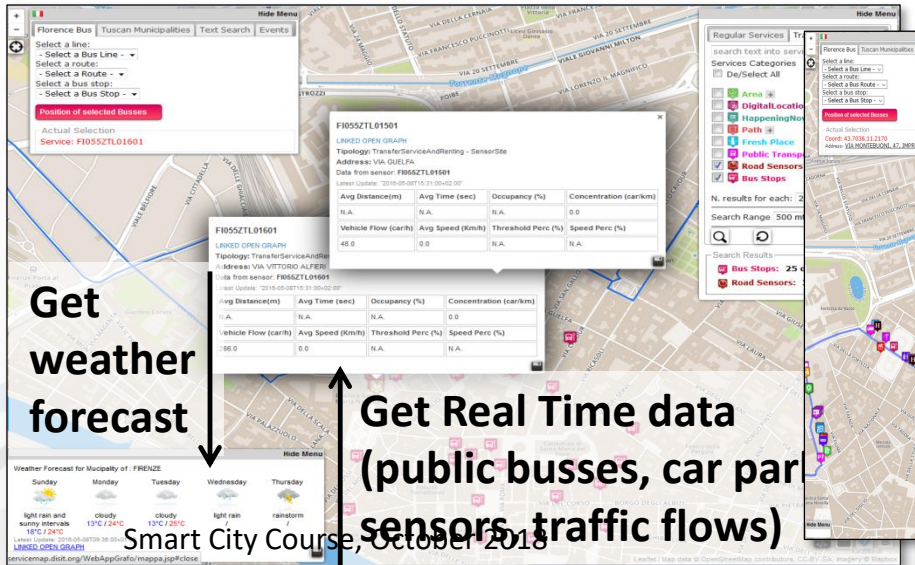


ServiceMap Development Tool

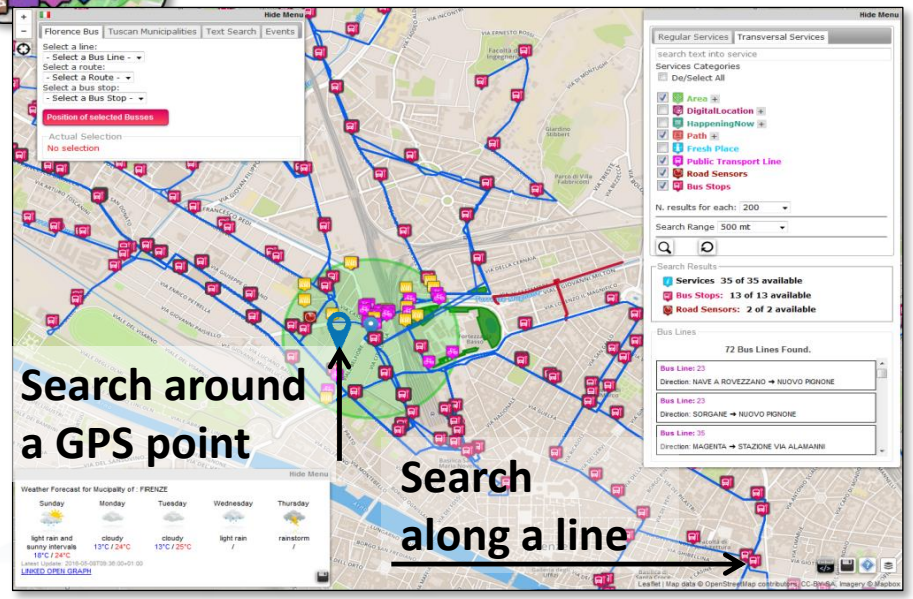


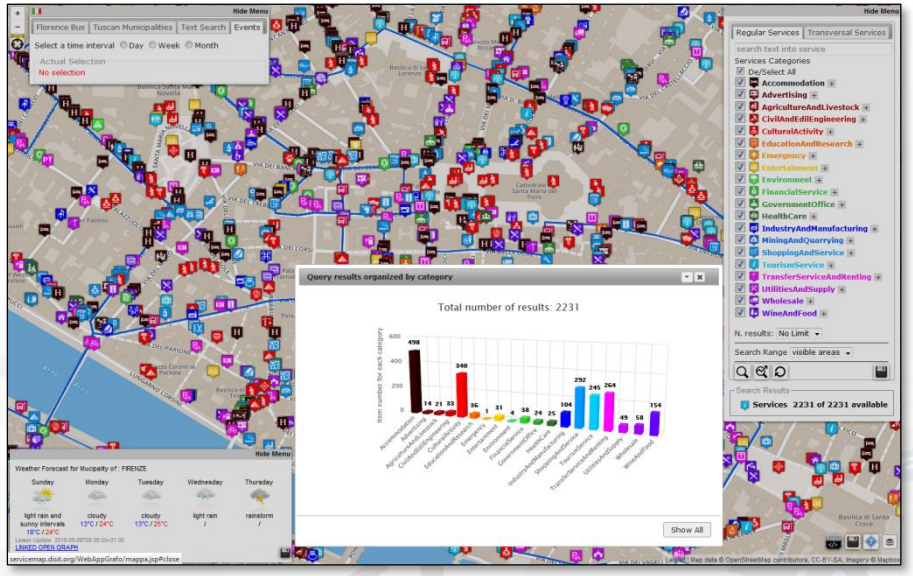






ServiceMap Dev Tool



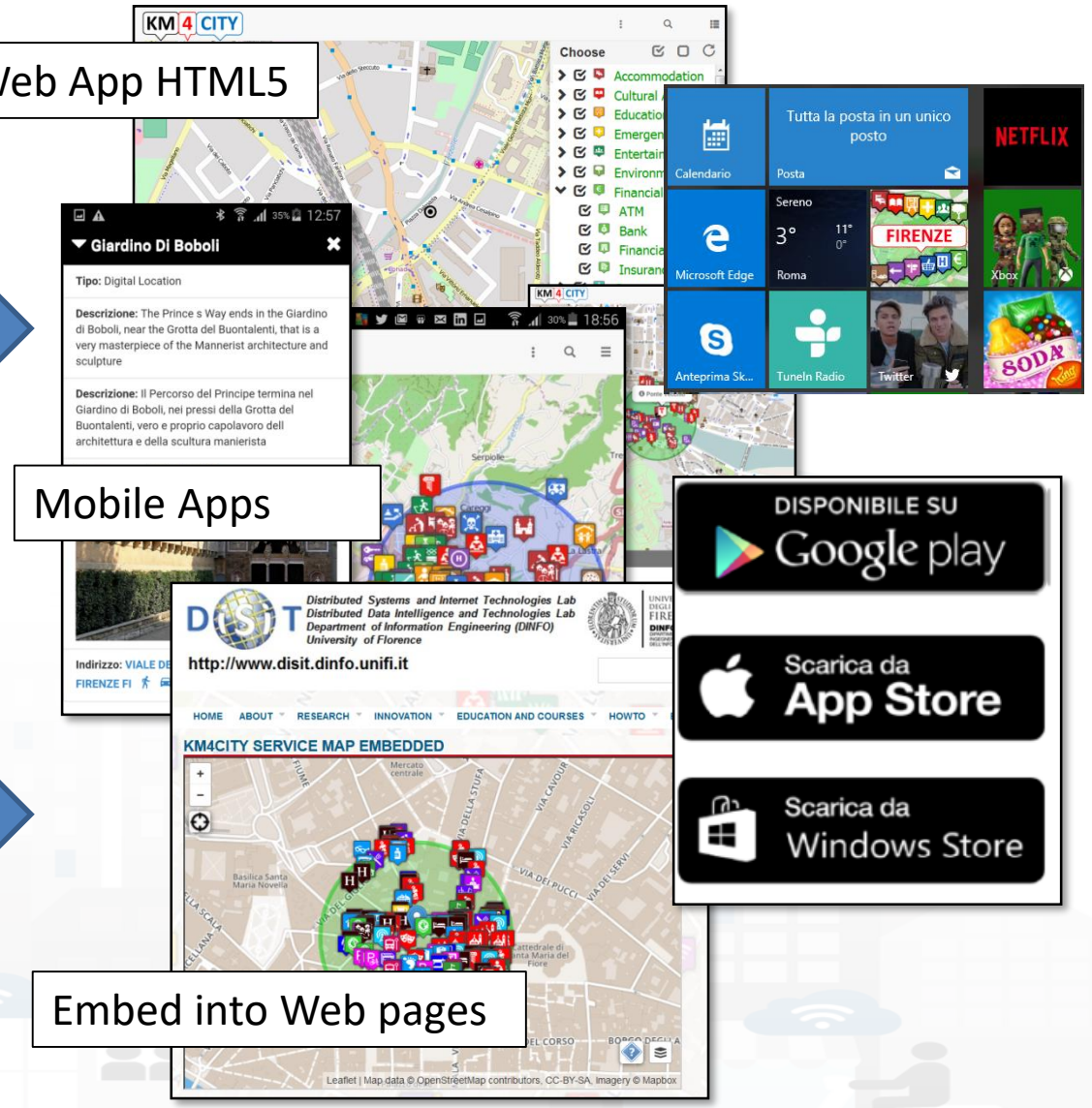


Smart City API call generation

Web App HTML5

Mobile Apps

Embed into Web pages



http://www.disit.org/6873

Comparison with State of the Art



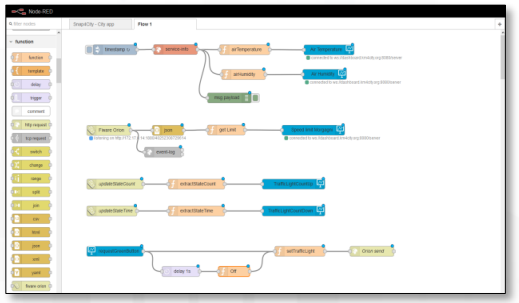
State of the Art Comparison

	Open Source end-to-end	Scalability IOT	Execution scalability	Visual Programming end-to-end applications	Advanced Smart City API, MicroServices	Multi Domain Semantic Platform	External sevices via API	Standard based Modules and IOT, Open Devices	Integrated Community manmagement	Resoruce Sharing	Referral data management	Security end-2-end	Dashboard H24/7	Falxible and easy dashboard creation	Multi-protocol on IOT
Snap4City	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
KAA	Y	Y	Y[1]	N	Y	N	Y	N/Y	Y	N	--	Y	Y	N	Y
AWS	N	Y	Y	N	N	N	Y	Y	N	Y	Y	Y	Y	(Y)	Limited
Azure IOT	N	Y	Y	(Y)	N	N	Y	Y	(Y)	Y	Y	Y	Y	(Y)	Limited
IOT IGNITE	Y	Y[2]	N	Y	N	N	Y	N	N	N	--	N	Y	(Y)	MQTT
PTC ThingWorkx	N	Y	(Y)	Y	N	N	Y	Y	N	N	--	Y	Y	(Y)	Y
BEZIRK	Y	N	N	N	N	Y	--	Y	N	N	--	N	N	N	Y
Bosch IoT Suite	N	Y	(Y)	Y	Y	N	Y	Y	N	N	Y	Y	Y	(Y)	Y
FIWARE	Y	(Y)	N	N	Y	N	N	Y	N	N	N	N	Y	N	Y
CISCO Jasper	N	Y	N	N	N	N	Y	N	--	--	Y	--	Y	--	N[3]
IBM Watson IoT	(N)	Y	(Y)	Y	Y	Y	Y	Y	N	Y	(y)	Y	Y	Y	Y
Siemens MindSphere	N	Y	--	Y	N	N	N	Y	N	N	Y	N	Y	N	Y
Carriots	N	Y	--	N	N	N	Y	--	N	N	--	N	Y	Y	MQTT
Thingsboard	Y	Y[4]	N	N	N	N	N	N	N	N	--	Y	Y	Y	(MQTT, CoAP, http)
IOT eclipse.org	Y	Y	N	N	N	N	Y	Y	N	N	N	N	N	N	Y
Google IOT	N	Y	Y	N	N	N	Y	N	N	N	N	Y	N	N	MQTT, HTTTP

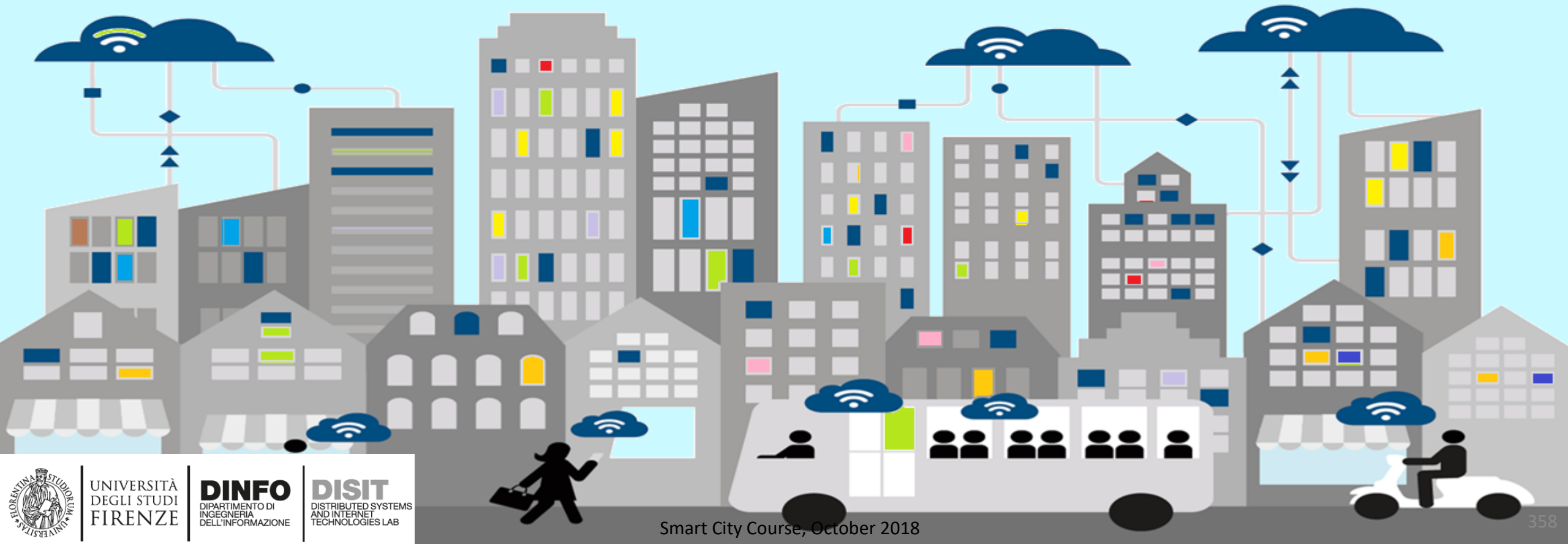
unique about our platform vs competitors?

- providing tools for **managing the Living Lab** community;
  - flexible and IOT **smartcity-oriented dashboards**, **visual editor** and **wizard** for creating dashboards, large collection of widgets, (addressing: sensors and actuators, selectors, maps, etc.);
  - **Visual tool for developing IOT Applications** (not rule based, largely avoiding coding), large number of MicroServices, easy to expand;
  - **Coworking** for: IOT applications, dashboards, back office processes, microservices, external services, etc.;
  - management of **any kind of data and resources (High Level Types)** by using Km4City Expert system and semantic indexing;
- **end-2-end encryption and security/privacy with GDPR**: several data types: My Personal Data, My Annotations, etc.;
- **integrated management** of referral data, historical data, traffic analyzer;





Further Reading



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references

- Https://www.snap4city.org
  - It contains about 30 articles, 20 video and 150 Tutorials about the platforms
- Https://www.km4city.org
  - If contains about video and a number of technical manuals



Home / Snap4City - scalable Smart aNalytic APplication builder for sentient Cities

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 capabilities. To this end, the Snap4City solution provides a flexible method and solution to quickly create a large range of smart city applications exploiting heterogeneous data and stakeholder services also enabled by IOT/IOE technologies and big data analytic. In that context, smart city applications need to support multiple paradigms as data driven, stream and batch processing, reporting in the hands of: Smart Living Lab users, a set of solutions to develop applications without vendor lock-in, for final users personalized tools and mobile Apps, and to decision makers and developers specialized dashboards. CLICK for NEWS



Snap4City improves city services, security and safety by offering a sustainable solution for smart city and **Living Lab**, thus attracting industries and stakeholders. Snap4City is capable to keep under control the real time city evolution: reading sensors; computing and controlling key performance indicators, KPI; detecting unexpected evolutions; performing analytics; taking actions on strategies and alarms. Snap4City supports the city in the process of continuous innovation on services, infrastructures, with control and supervision, tools for business intelligence, predictions, anomaly detection, early warning, risk assessment, also setting up strategies for increasing city resilience with respect to unexpected unknown events. Thanks to knowledge base Snap4City provides flexible solutions to get immediate insights and deductions of the city status and evolution, exploiting ultimate artificial intelligence, data analytics 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, streams, certified and personal). CLICK on Image TO ACCESS AT THE TOOLS please apply for a free registration.



We expect you at Stand 120, Hall P2 , Level 0, Street A
Smart City Expo World Congress 2018
13-15 Novembre 2018, Barcelona, Gran Via Venue
SMARTCITY EXPO WORLD CONGRESS

We expect you at Stand 8 of INNOVATION&STARTUPS village
ICT 2018
IMAGINE DIGITAL CONNECT EUROPE
ICT 2018: Imagine Digital - Connect Europe, of the European Commission
AUSTRIA CENTER VIENNA, BRUNO-KREISKY-PLATZ 1, 1220, WIEN
4-6 December 2018
VIENNA 4-6 DECEMBER

Snap4City is 100% open source, secure encrypted, scalable, modular and flexible; it can be used to set up **Living Lab and smart city solutions** satisfying a large range of requir
city officers, citizens, and tourists to developers, companies and researchers. It can be easily integrated with in place solutions to provide from data, factors and causes, p

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Registration

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SNAP4CITY

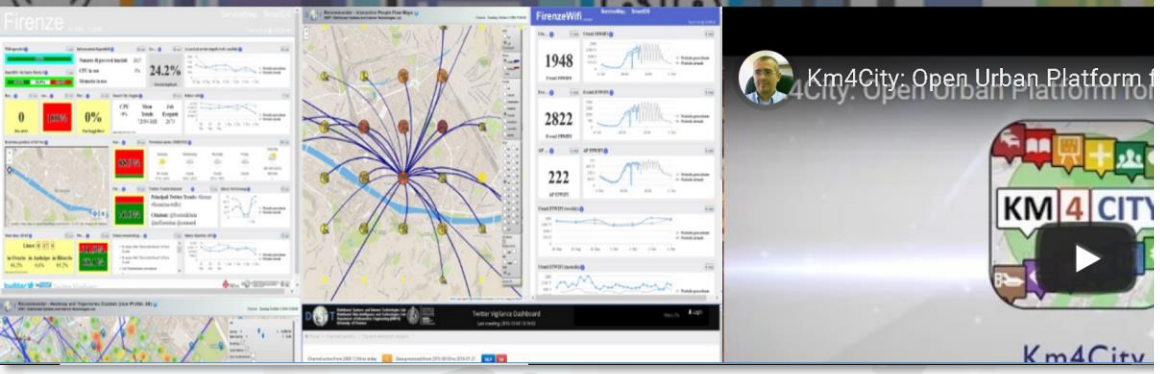


KM4CITY

Open Urban Platform for a Sentient Smart City

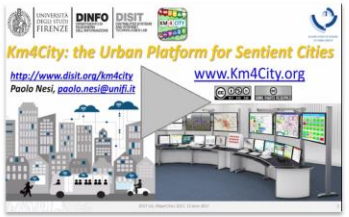
Km4City platform is a Smart City tools for implementing the city vision, monitoring the city evolution, diffusely providing new services for improving quality of life of city users, for the city economic grow; stimulating city users; since an attractive city is a `city that produces` in which users are happy and proud.





SENTIENT CITY DASHBOARDS BACK OFFICE AND DEV TOOLS APP WEBAPP INFO AND DOCS

Real Time Monitoring Tools for Control Room Dashboards



Km4City the Urban Platform for Sentient Cities, MajorCities Zagreb



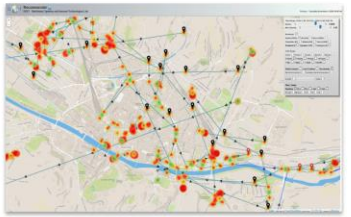
Overview of Smart City dashboards (REPLICATE, RESOLUTE H2020, Km4City based)



Overview of Km4Cityorg website www.km4city.org







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