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

SNAP4CITY Powered by KM4CITY

Federation of Smart City Services via APIs

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https://www.disit.org, Https://www.snap4city.org

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https://www.Km4City.org
https://www.disit.org

100% OPEN SOURCE

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SNAP4CITY | KM4CITY

Smart City Functional Architecture

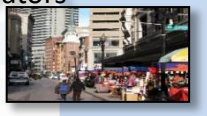
Transport systems Mobility, parking

Public Services, Govern, events, …

Sensors, IOT Cameras, Wi-Fi

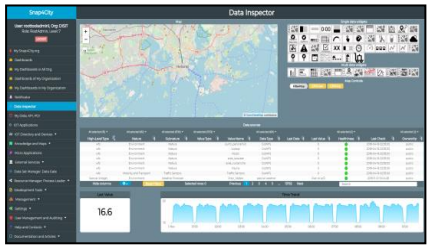
Environment, Water, energy

Shops, services, operators



Social Media

Social Media Crawler and Manager



Back-End ← → Front-End

Data Sources, External Services *PULL Data*

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

Data Ingestion, aggregation, regularization, reconcile: NIFI, IOT App

Knowledge base Semantic reasoners

Indexing and aggregating Elastic search

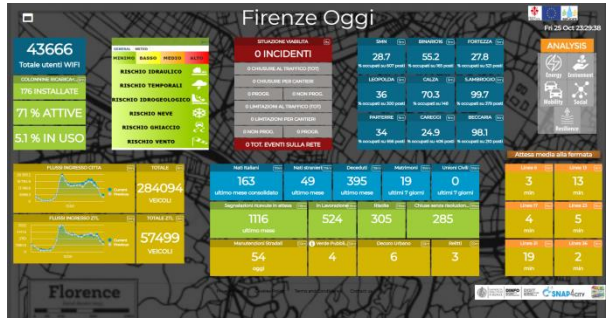
Search and Query, Smart City API Facet, semantic search

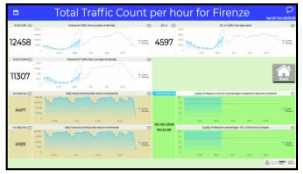
Data Analytics, Simulations R, Tensor Flow, Python, ….

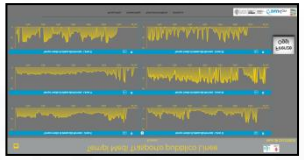
IOT Applications, Business Logic Node-RED + Snap4City MicroServices

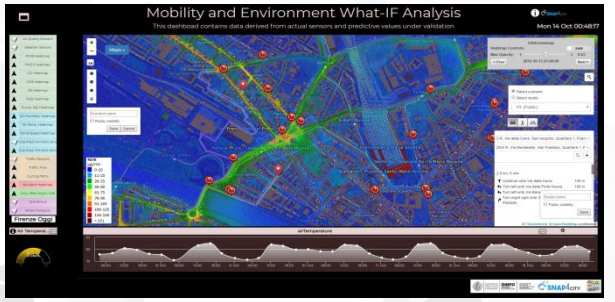
Rendering Acting, Widgets, MicroApps User interface, Interactive Dashboard, Drill down, maps, heatmaps

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







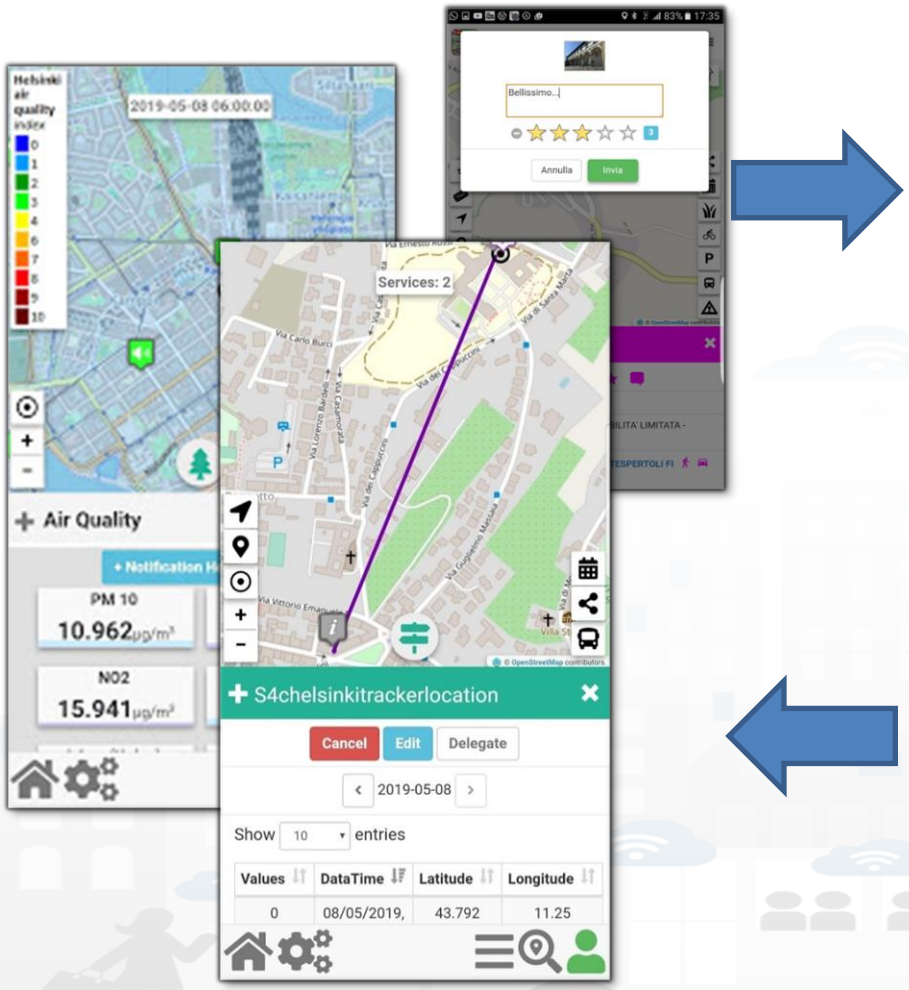


The App is a Bidirectional Device

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

Produced information

- Accepted ?
- Performed ?
- …



Derived information

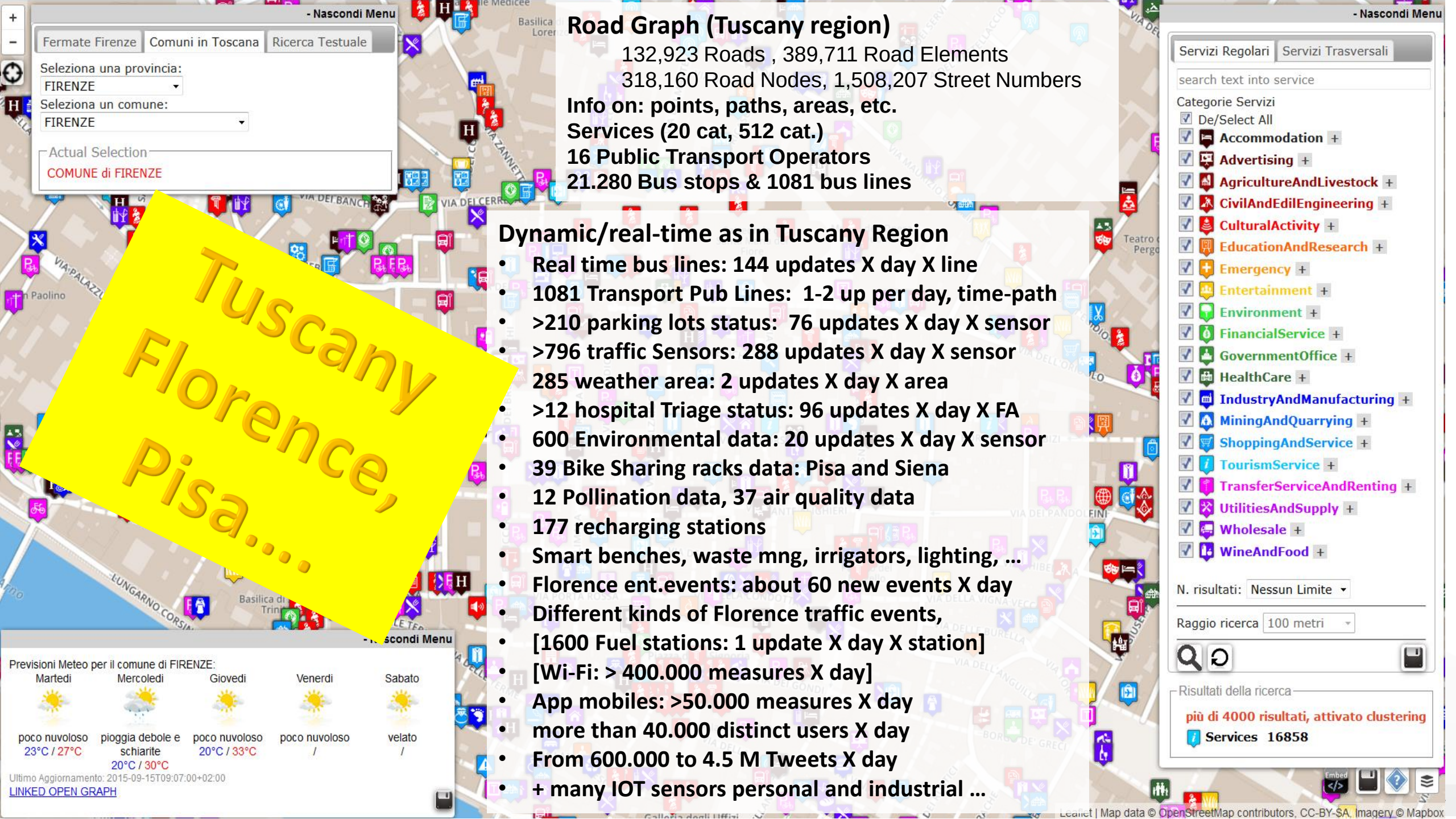
- Trajectories
- Hot Places by click and by move
- Origin destination matrices
- Most interested topics
- Most interested POI
- Delegation and relationships
- Accesses to Dashboards
- **Cumulated Scores from Actions**
- Requested information
- Routing performed
- …..

Produced information

- Suggestions
- Engagements
- Notifications
- …

Users

System


- 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
Tuscany Florence, Pisa....
Dynamic/real-time as 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
• 600 Environmental data: 20 updates X day X sensor
• 39 Bike Sharing racks data: Pisa and Siena
• 12 Pollination data, 37 air quality data
• 177 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 personal and industrial …
- Nascondi Menu
Previsioni Meteo per il comune di FIRENZE:
Martedi
poco nuvoloso
23°C / 27°C
Mercoledi
pioggia debole e schiarite
20°C / 30°C
Giovedi
poco nuvoloso
20°C / 33°C
Venerdi
poco nuvoloso
/
Sabato
velato
/
Ultimo Aggiornamento: 2015-09-15T09:07:00+02:00
LINKED OPEN GRAPH
- 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
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

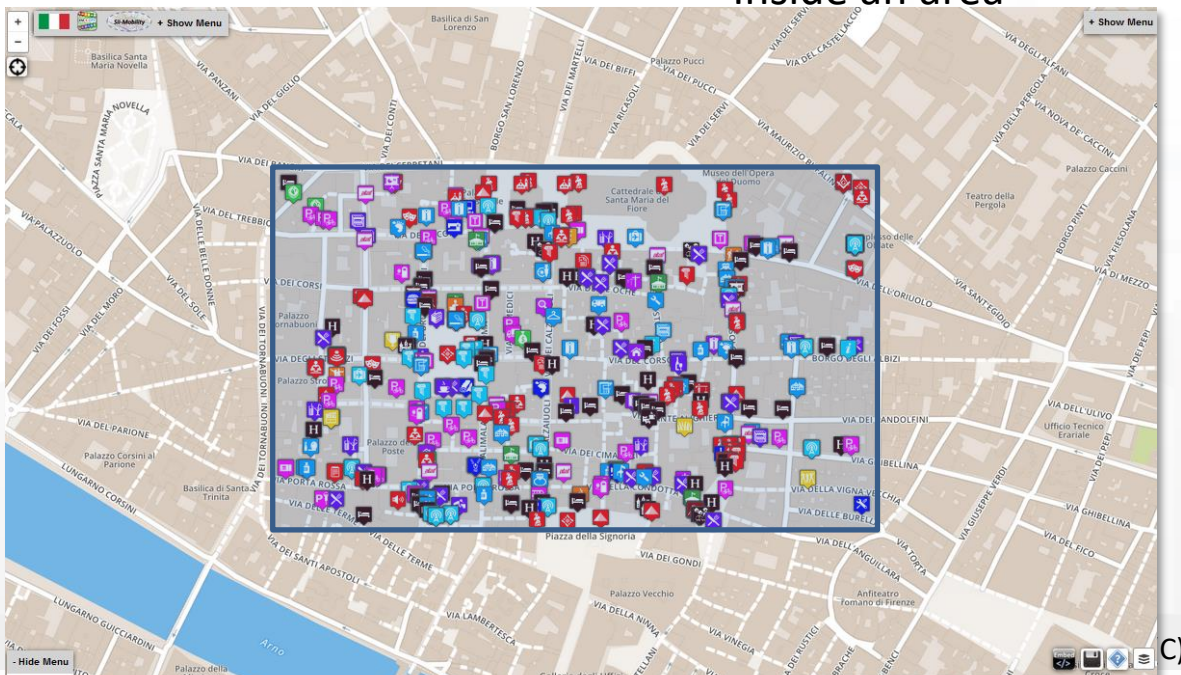
Discovery

Search by Shape and Distance

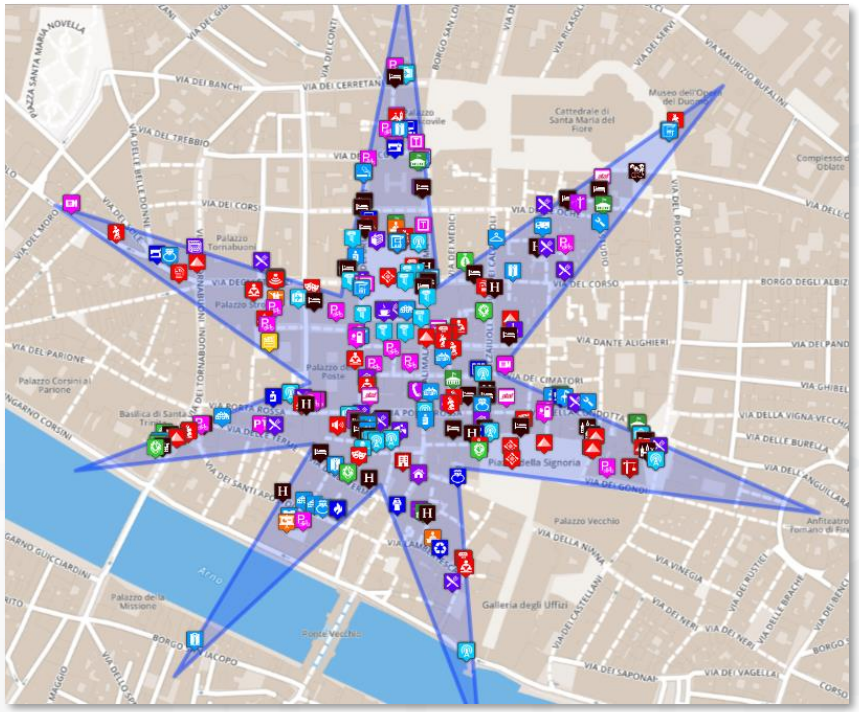
Around a point or POI

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

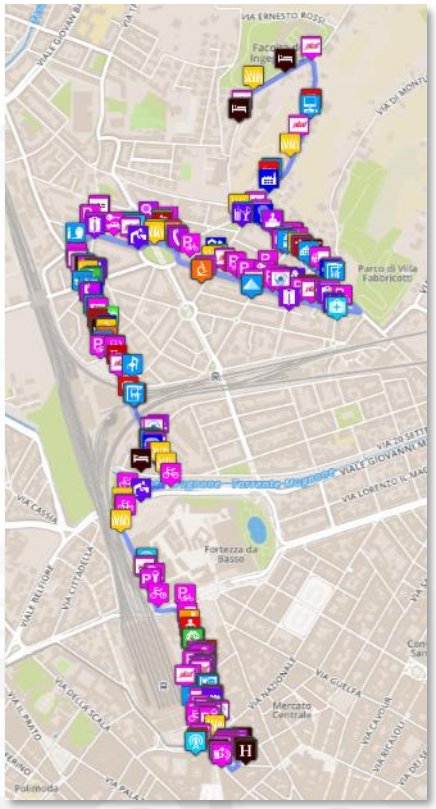
Inside an area



Inside a closed polyline



Along a polyline



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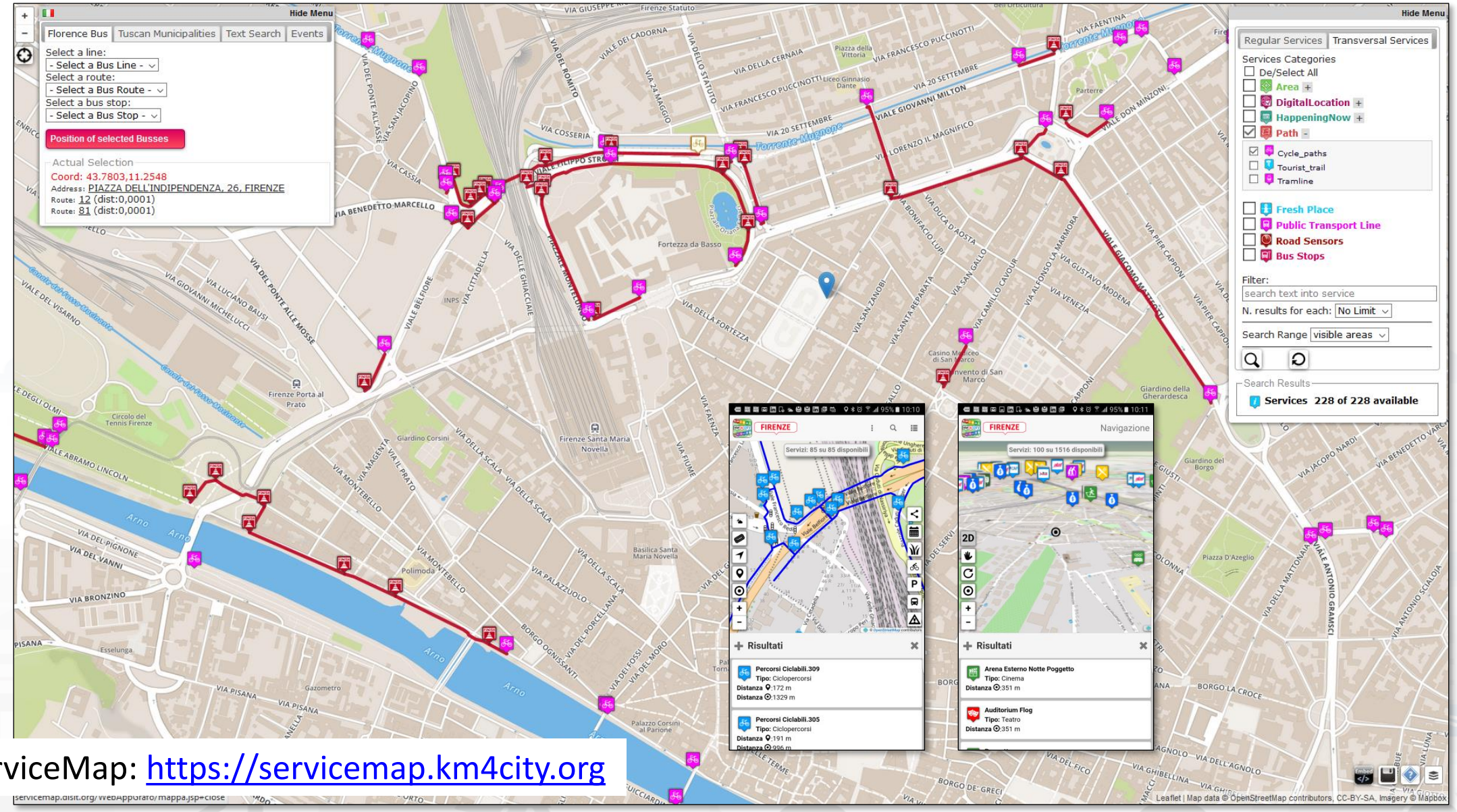
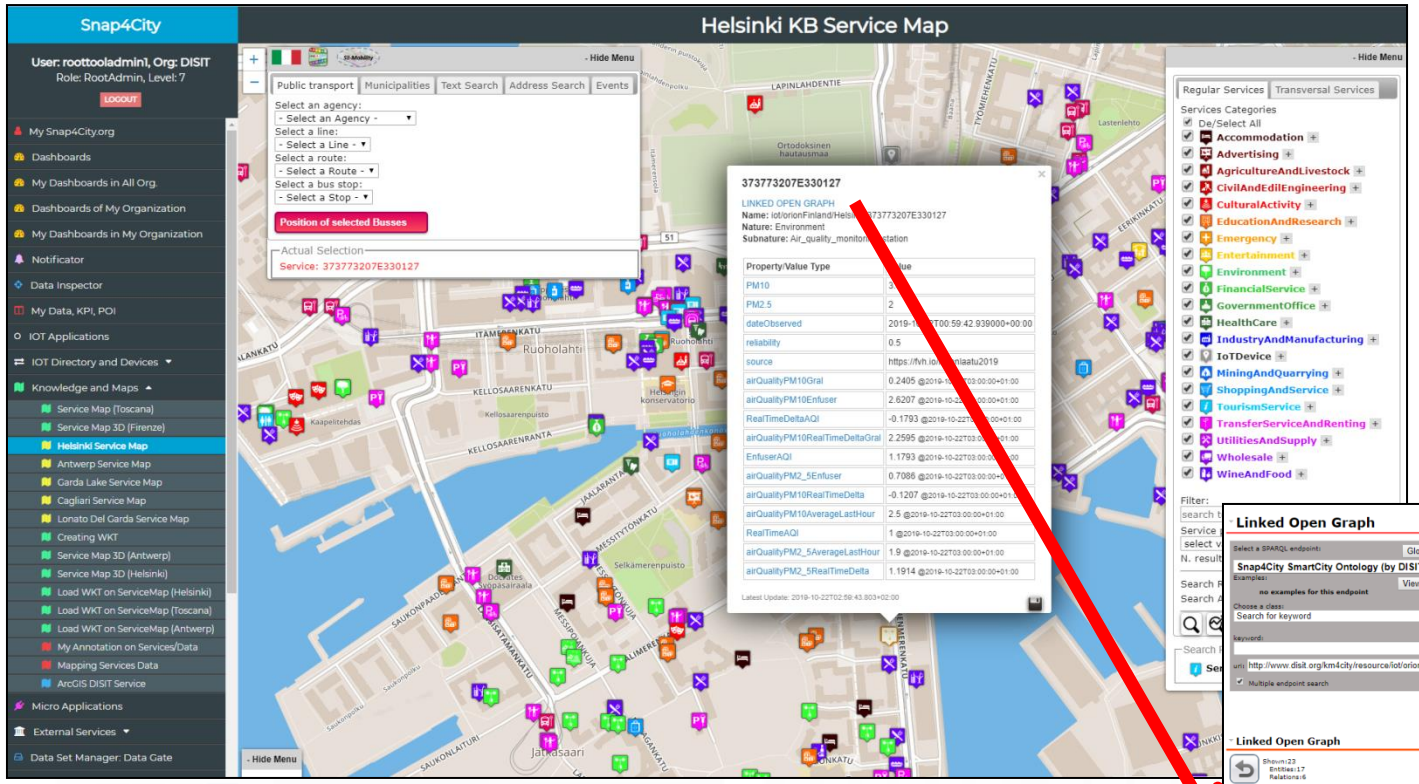
Cycling Paths

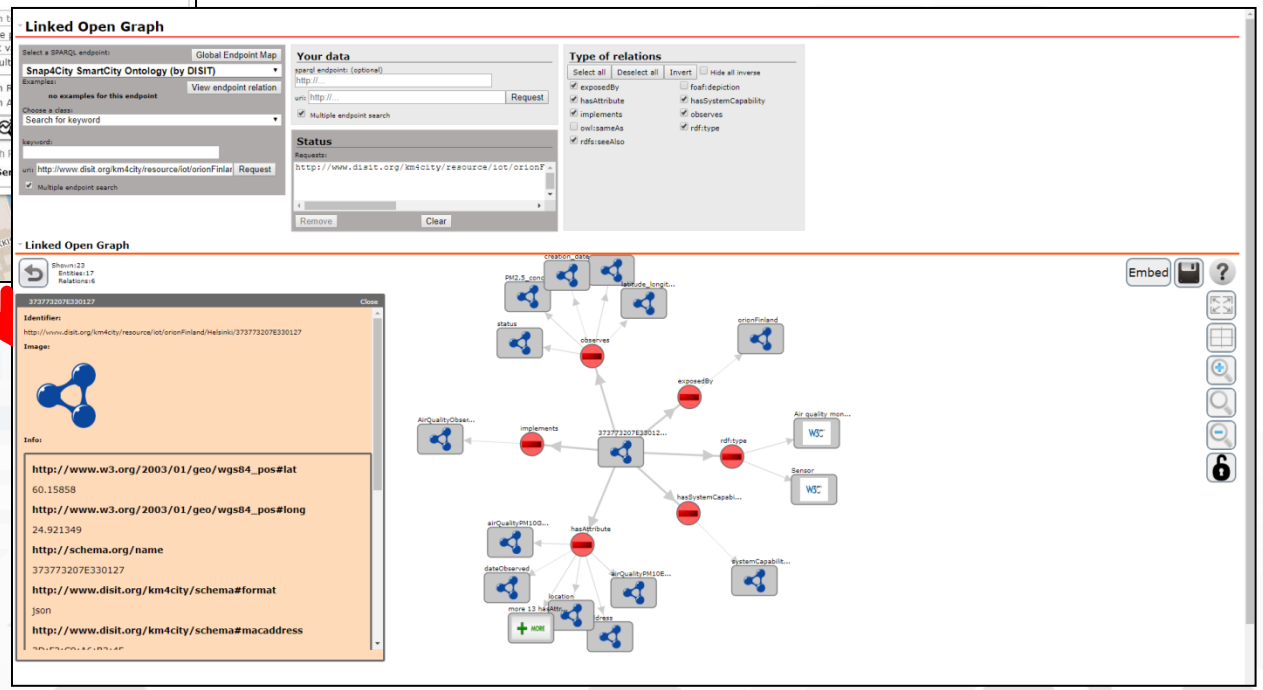


ServiceMap: https://servicemap.km4city.org

Views of the Knowledge Base

LOG: https://log.disit.org





- How pass from ServiceMap to Linked Open Graph, Linket Data view tool

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SNAP4CITY

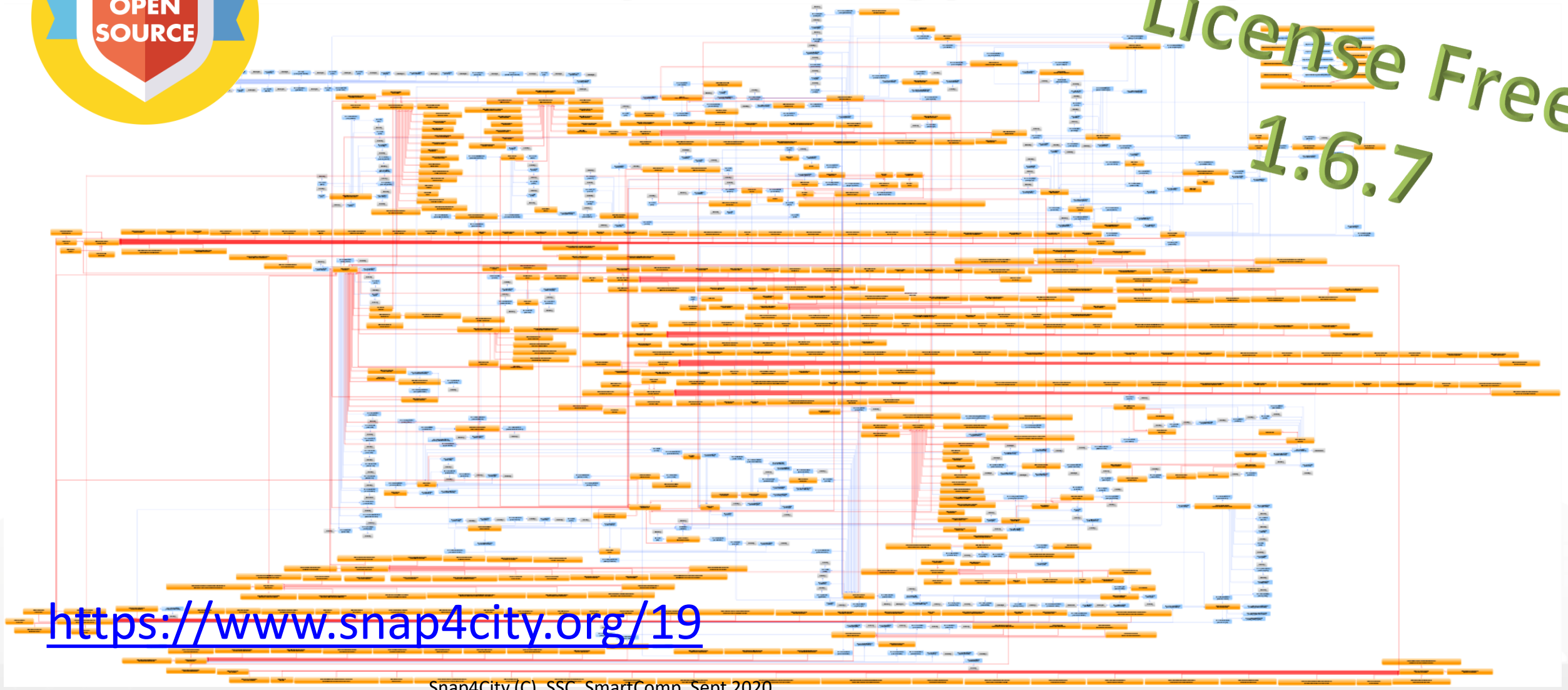
KM4CITY

100% OPEN SOURCE

Smart-city Ontology km4city

License Free

1.6.7

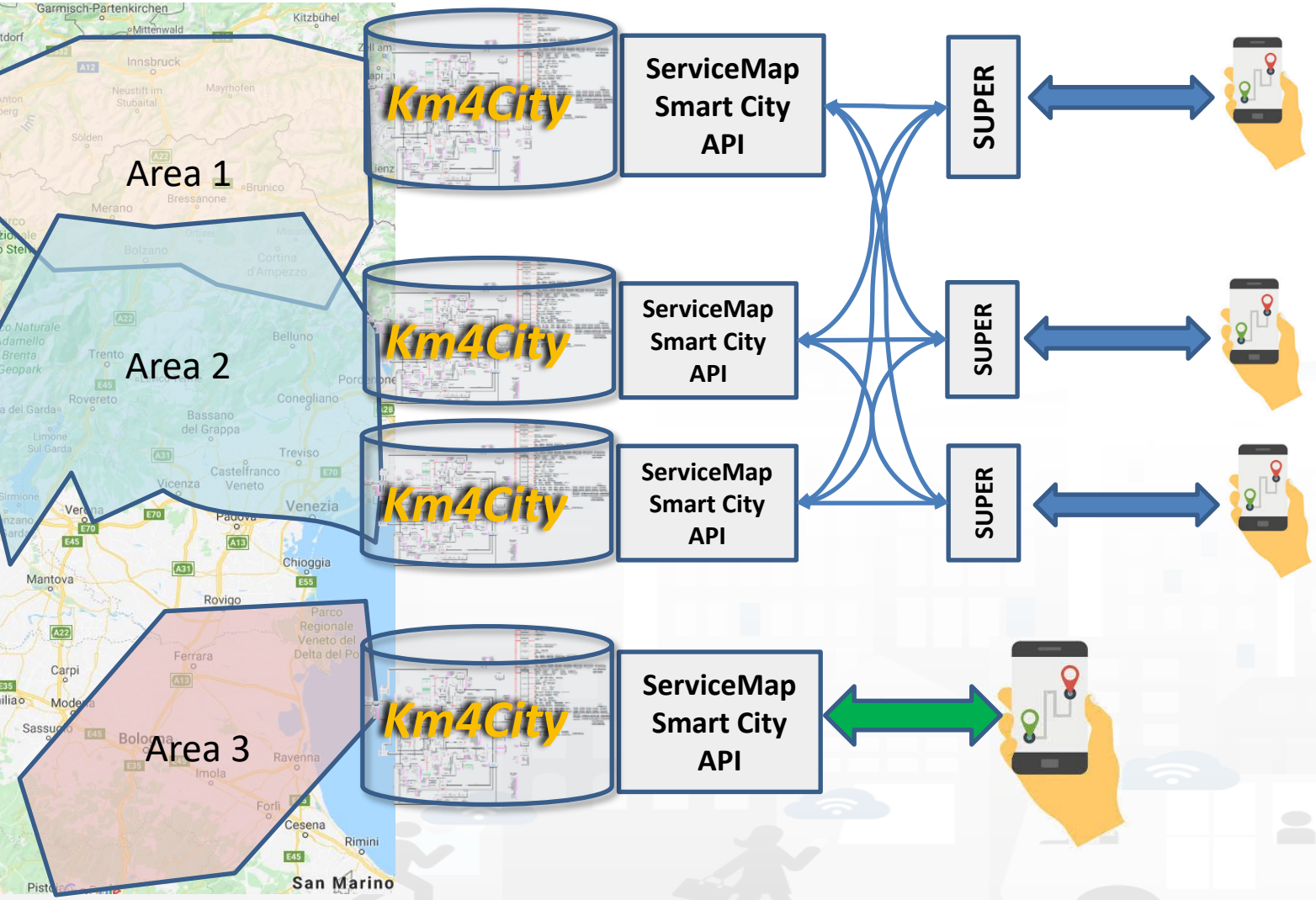


https://www.snap4city.org/19

Smart City API, SCAPI

1) guaranteed that **nodes do not need to permanently share data** as in P2P solutions or as in federated databases. This requirement must be satisfied to assure that the data are located only in the nodes authorized to manage them;
2) support **distributed search** on the federated **SCAPI** network;
3) support **nodes of any size** in terms of number and volume of data sets providing services of the nodes. In addition, the geospatial size and shape of each node may be: (i) not regular (nor a circle but a shape), and multiple connected (so called multi-polygon), (ii) partially overlapped with other nodes, (iii) totally included into those of other nodes, (iv) disjoined and even far each other (this means that the union of all the areas can be disjoined with respect to the global map of the earth);
4) Support nodes with a **different number of services available**. This implies that not all kinds of services and data may be necessarily available in all nodes;
5) Support nodes with **georeferenced services or not.** This means that are general for the area addressed and not specifically related to the GPS position;
6) respond to API calls in terms of services in **transparent manner passing from one node to another** or when the service needs to provide results coming from more nodes;
7) support access control to **prevent access to data and services by not authorised users**. Since the passage of a user from one SCAPI node to another of the federated SCAPI network may imply the sending of requests which may try to access at private data/services;
8) support the **addition/removal of nodes in the network** without the need of fully restructuring of the network and modifications have an immediate effect without any service reloading or disruption;
9) provide **results in real time also when a large number of nodes/areas are involved**. The implementation should also provide support for creating redundant solutions with high resilience;
10) provide the **response in the coherent format** with the expected response of the single services. Thus, the results of the federation may need to be merged to produce the response in any format: JSON, XML or HTML.

Multiple Knowledge Bases Km4City/ServiceMap

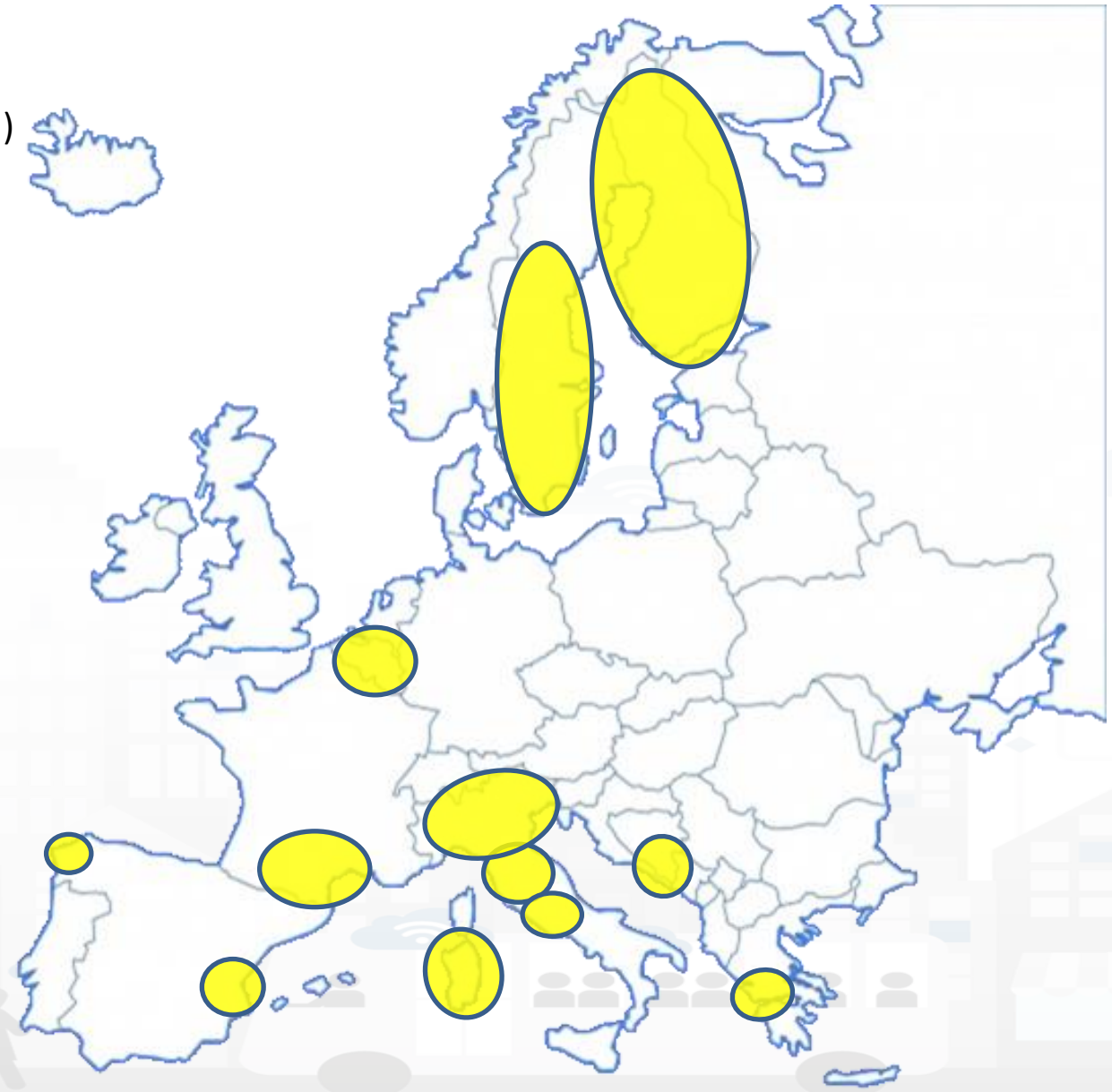


- A Mobile App may refer to one Smart City API Server (for Area 1) via SUPER and receive data from the Federated SUPERS (Area 2) if navigation, queries, etc. are leading to discover out of the addressed KB.
  - SUPER can be used for creating redundant and/or balanced distributed solutions for Federated KB. See Area 2, the two KB in the front.
  - Federated SUPER ServiceMap can have overlapped KB even totally.
  - A Mobile App can be developed to support multiple Smart City API servers, for balancing and
- The usage of Super (ServiceMap) is not mandatory so that separate services can be produced as well
- SuperServiceMap and ServiceMap presents the same Smart City APIs.

Coverage 2020

Main Organizations/areas

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



Federated ServiceMap and Smart City API

To improve scalability, fault tolerance and federation among cities:

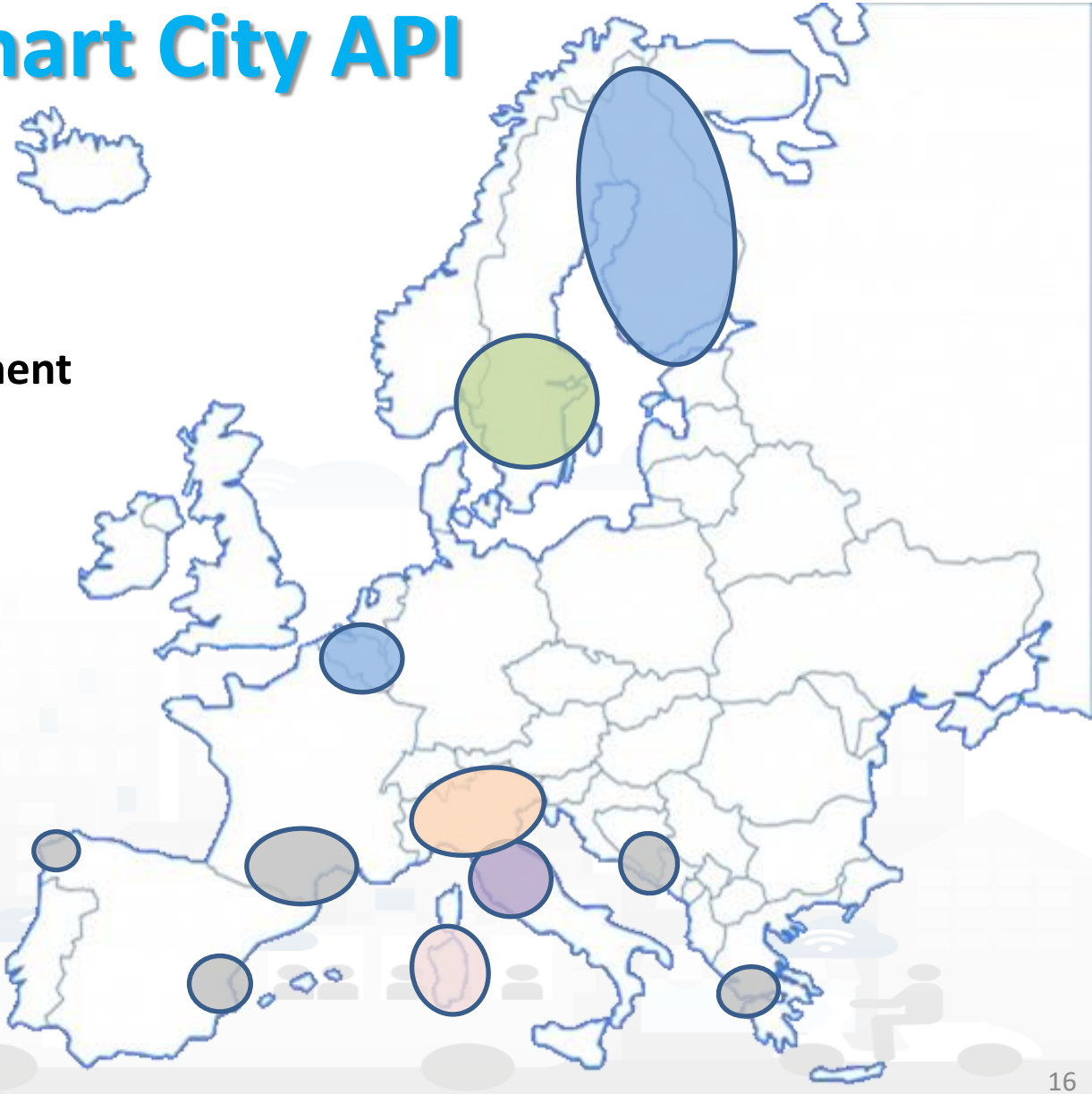
- **One entry point Smart City API for all zones**
- **Multiple Knowledge base See performance assessment**

At different levels:

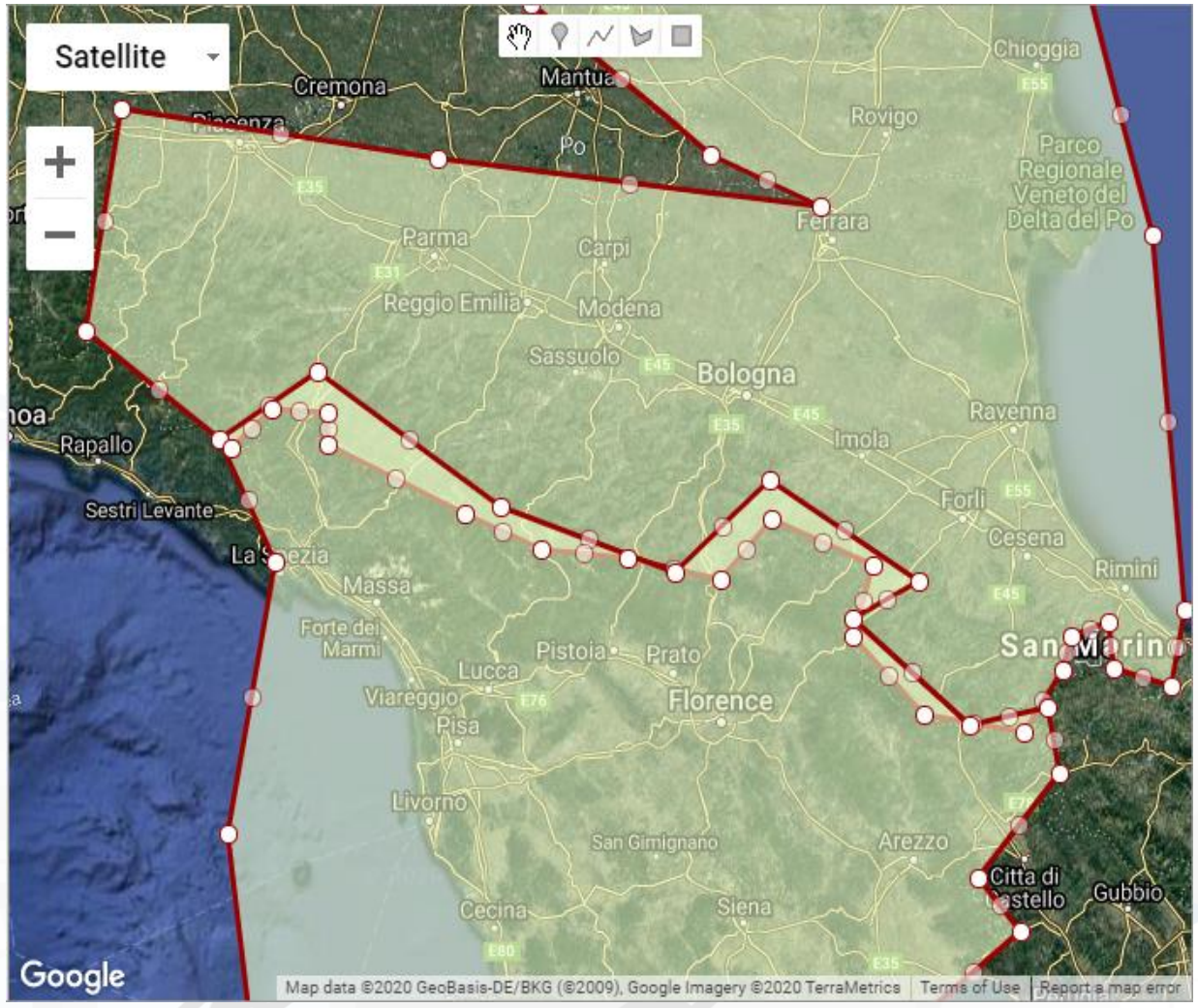
- Among cities/regions
- Among data providers, Operators

By Means of:

- Smart City API → Apps
- Smart City Ontology
- Dashboards/data analytics
- Organization independent



Some cases in graphs



Validation

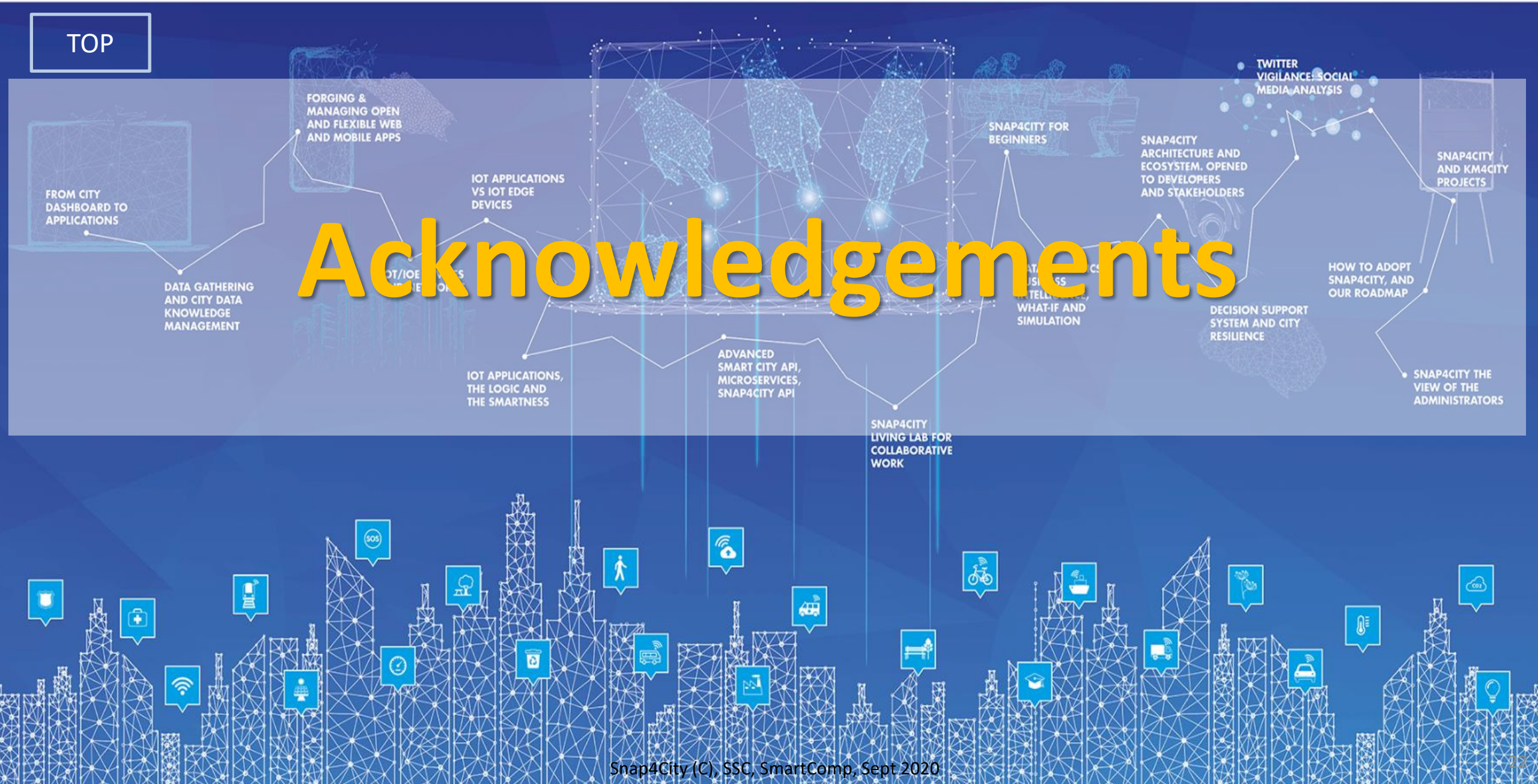
- **FSSM**: the **SuperServiceMap is forced to forward requests to all ServiceMaps** (three ServiceMap VMs each of which with 16 GByte of RAM and 12 cores) any query is receiving from clients and merges the results;
- **PSSM**: the **SuperServiceMap performs a selection** of the most suitable ServiceMaps (among the three ServiceMap VM each of which with 16 GByte of RAM and 12 cores) to be involved on the basis of the geoinfo included in the query, and merges the received results;
- **ASM**: the **client is sending the query directly to the ServiceMap of its referred area** (a ServiceMap with 16 GByte of RAM and 12 cores);
- **GSM**: the **client queries a ServiceMap in which all the data (triples) of the three areas have been stored** (a VM with 16 GByte of RAM and 12 cores);
  - **PGSM**: as GSM but with a **ServiceMap VM with 48 GByte of RAM** and 36 cores.

Validation Performance

Query/Kind		Times of Response (ms)			
		FSSM	***PSSM***	***ASM***	***GSM*** ***PGSM***
Get all **services** in a radius of 500 m from the center of Florence	A	5076	4670	4033	139329 132306
Get all **events** in a radius of 20 km from the center of Antwerp this month	B	1124	531	478	696 697
Get all events in a radius of 20 km from the center of Helsinki this month	B	656	525	404	179 131
Locate a given bar in the Municipality of Florence	C	2051	1572	1456	3259 761
Get **full details** about a given bar in Florence	D	535	314	196	1257 120
Locate all bars in a radius of 1 km from a given bar in Florence	E	4755	4671	3976	6725 5745
Locate all cinemas in Florence or in its immediate nearby	F	307	242	185	275 202
Locate restaurants in the district of Katajanokka, in Helsinki	H	539	351	266	919 365
Locate public transport stops in the small district of Borgerhout, in Antwerp	H	1118	1000	961	363071 342253
Get public transport **routes** that traverse the district of Rifredi (Florence)	J	1948	907	878	* *
Get the **full address** of the center of Antwerp	K	775	769	668	641 656
Get the **full address** of the center of Helsinki	K	799	757	588	778 768
Get **public transport agencies** that operate within 5 km from the center of Florence	L	141	121	70	319 206
Get public transport agencies that operate within 5 km from the center of Antwerp	L	183	149	149	54 35
Find the **shortest path** from the center to the airport in Florence	M	2040	1983	1916	2746 1977
Get **all kind of services** on a Linestring crossing the border on Tuscany and Emilia Romagna	N	2117	1919	-	NA 2004

Conclusions

- **The solution solves the requirements** that presently cannot be solved by traditional GIS solutions
  - avoid migrating data,
  - provides federation at level of APIs,
  - involving nodes of any size,
  - combining them autonomously, leaving the possibility of having different kind of services,
  - enabling the movements from among federate areas,
  - prevent the access and respect GDPR and data security, combining services, etc.
- **Validation** of the solution we have used and enhanced the 1.6.7 Km4City API and ontology.
  - SuperServiceMap, 100% open source
  - 4 large areas and smart city services, now they are much more….
  - the solution performs better than single centralized services in most cases, except for the cases in which simple direct queries are performed.
  - implements a number of strategies to improve the service performance in specific cases.



Acknowledgements

DISIT lab roadmap vs model and tools' usage

2013
Km4City Ontology 1.1

- Tuscany, Road Graph
- Mobility
- culture, tourism
- Events
- Parking
- Services
- Linked open graph

2014
- Weather Forecast
- Real Time Wi-Fi
- Entertainment
- LOD

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015
Km4City 1.5

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

ckan, resolute

H2020 (2015-18)

2016
(2016-21) H2020 REPLICATE

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

Sii-Mobility (2016-21) MIUR

SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

FIWARE

2017
Km4City 1.6.4

Sii-Mobility

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

E0l5 digital ecosystem (Powered by EXPO MILANO 2015)

(2016-19) MIUR

GHOST SIR

- Sardinia Region Smart City Strategies and plan

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

GREEN IMPACT
POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

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

life weee (2017-20)

- Smart Waste

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

- Mobility Demand / Offer Analytics and Strategy

Sii-Mobility

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

IOT/IOE

Km4City 1.6.6

Node-RED

SNAP4CITY

SELECT for Cities H2020 (2017-19)

2019
5G (2018-21)

- 5G tech
- Energy
- Industry 4.0
- Synoptics

TRAFAIR

CEF (2018-21)

- Traffic and Mobility Impact on Pollution
- NOX predictions

EUROPEAN OPEN SCIENCE CLOUD

SIRIUS

LAID Smart Bed

- Smart Health

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

- Industry 4.0

bee smart city

- Smart Lonato

Reverberi Enetec Gruppo MPES

- PCP Award

2020
…2022

2021
- CAPELON
- Sweden

smartGARDAlake

Interreg MARITTIMO-IT FR-MARITIME MOBI MART

- Smart Mobility
- PISA, PUMS
- Living lab

Interreg Mediterranean HERIT-DATA

- Smart Tourism
- 6 Pilots
- Data Analytics
- Extended platform

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Main running projects

- Sii-Mobility → mobility and transport, sustainability
- REPLICATE → ICT, smart City Control room, Energy, IOT
- RESOLUTE → Resilience, ICT, Big Data
- GHOST → Strategies, smart city
- TRAFAIR → Environment & transport
- MOSAIC → mobility and transport
- WEEE Life → Smart waste, environment
- Smart Garda Lake → Castelnuovo del Garda
- 5G → Industry 4.0 vs SmartCity
- Green Impact → Industry 4.0, Chemical Plant
- SmartBed (laid → smart health
- Green Field Peas (soda) → Industry 4.0, Chemical plant
- PISA MobiMart and Agreement → data aggregation, Living Lab
- Lonato del Garda → smart parking, environment
- Herit Data → tourism, culture and management
- MobiMart → mobility and transport
- ISPRA JRC → site management and services