



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB



La Citta' Senziante: Modelli e Strumenti

Paolo Nesi

DISIT Lab, Distributed [Systems and internet | Data Intelligence and]
Technologies Lab

Dep. of Information Engineering (DINFO), University of Florence, Italy,
Fax: 0039-055-2758570, tel: 0039-3355668674

<http://www.disit.dinfo.unifi.it>, <http://www.km4city.org> , paolo.nesi@unifi.it

Città Dinamica
Politiche e strumenti per governare
il futuro di città e territori

Giornate di Studio - Alghero 12 ottobre e Cagliari 14 ottobre 2016



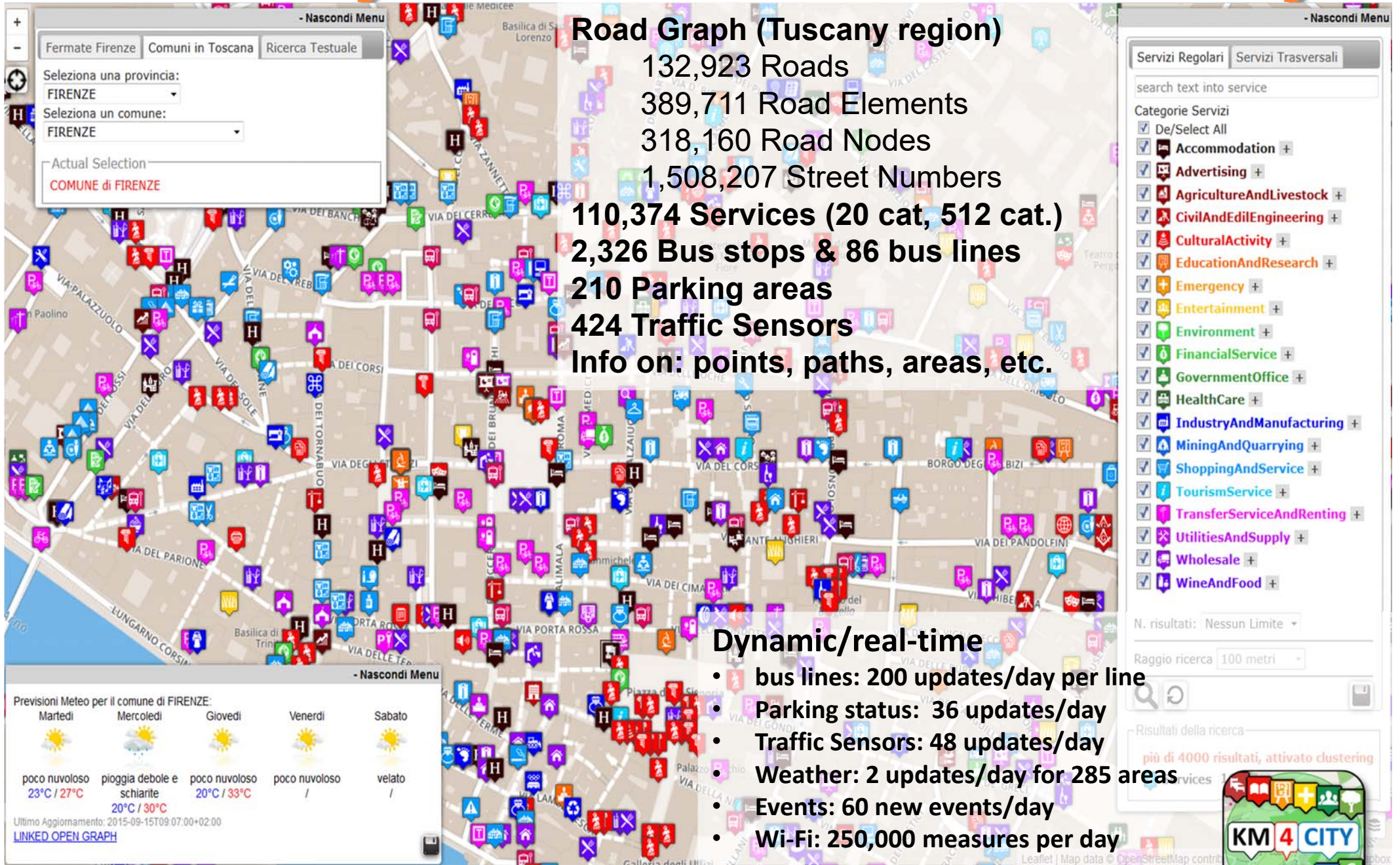


Le Urban Platform

- **architettura che integra dati e flussi di dati tra e fra sistemi urbani:**
 - sfrutta open data e le moderne tecnologie (sensori sul territorio: internet of everything, servizi cloud, dispositivi mobili, analisi, social media, ecc);
- **permette di andare verso una gestione integrata dei dati:**
 - permettere operazioni di predizione, ragionamento coinvolgendo e a servizio degli operatori della città;
- **elabora i dati in modo tangibile** andando a produrre risultati a livello locale.
 - aumentare l'efficienza energetica, ridurre la congestione del traffico e le emissioni, creare ecosistemi digitali di innovazione, efficientizzare le operazioni della città per le amministrazioni e i servizi.



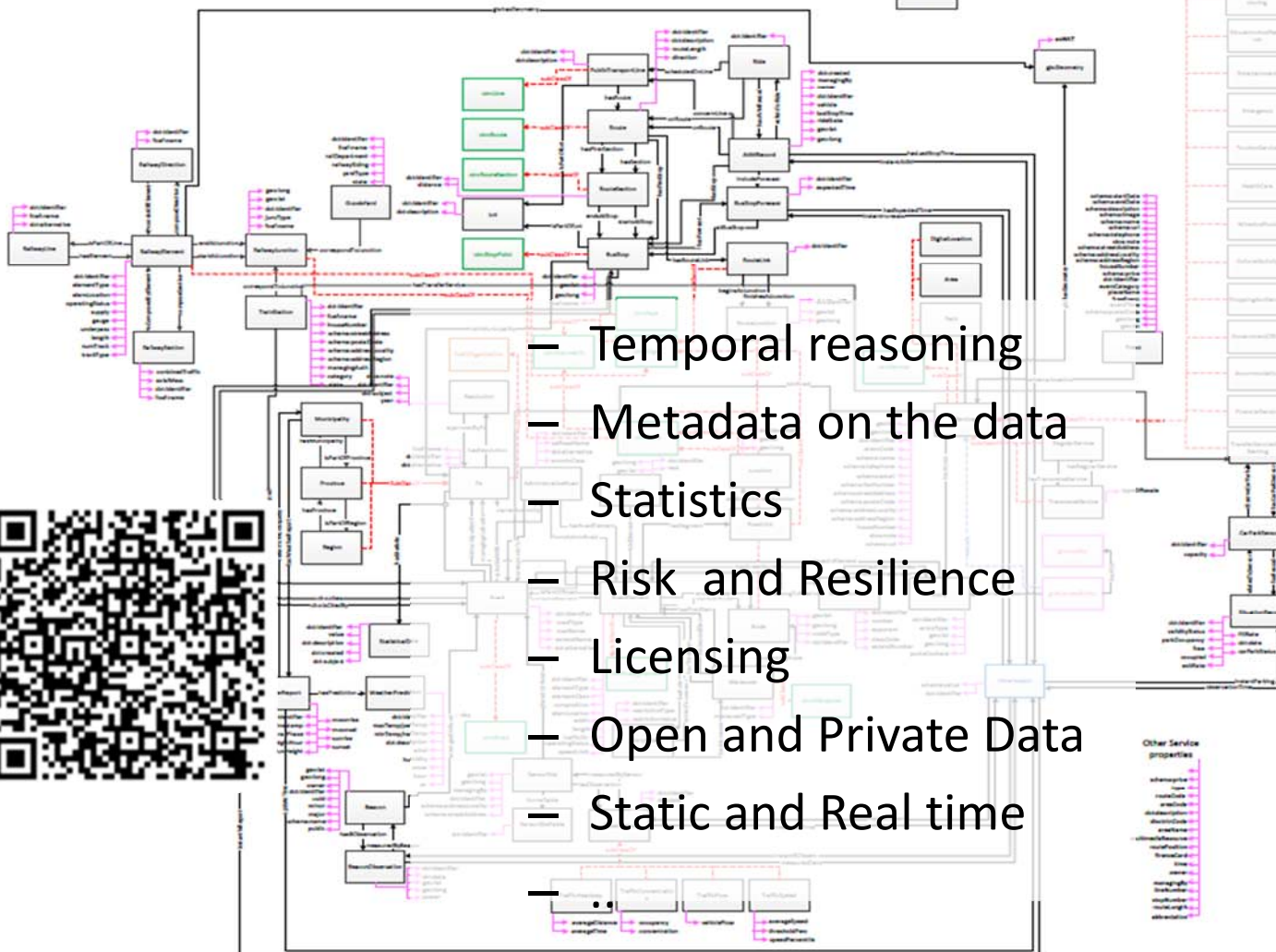
Km4City on Firenze & Tuscany



Km4City Ontology



- >84 Classes
- >100 ObjectProperties
- >100 DataProperties



- Temporal reasoning
- Metadata on the data
- Statistics
- Risk and Resilience
- Licensing
- Open and Private Data
- Static and Real time

- different aspects:
 - 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>



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ServiceMap



Search around a GPS point

Search along a line

Regular Services Transversal Services

search text into service

Services Categories

De/Select All

- Area
- DigitalLocation
- HappeningNow
- Fresh Place
- Path
- Public Transport Line
- Road Sensors
- Bus Stops

N. results for each: 200

Search Range: 500 mt

Search Results

Services: 35 of 35 available

Bus Stops: 13 of 13 available

Road Sensors: 2 of 2 available

Bus Lines

72 Bus Lines Found.

Bus Line: 23
Direction: NAVÈ A ROVEZZANO → NUOVO PINONE

Bus Line: 23
Direction: BORGANE → NUOVO PINONE

Bus Line: 35
Direction: MADENTA → STAZIONE VIA ALAMANNI

Weather Forecast for Municipality of FIRENZE

Sunday: light rain and sunny intervals 18°C / 24°C

Monday: cloudy 13°C / 24°C

Tuesday: cloudy 13°C / 25°C

Wednesday: light rain

Thursday: rainstorm

Search for Geo Located Services

Get Events in the city

Regular Services Transversal Services

search text into service

Services Categories

De/Select All

- Area
- DigitalLocation
- HappeningNow
- Fresh Place
- Path
- Public Transport Line
- Road Sensors
- Bus Stops

N. results for each: 500

Search Range: 500 mt

Search Results

Services: 418 of 418 available

Bus Stops: 23 of 23 available

Road Sensors: 2 of 2 available

Bus Lines

33 Bus Lines Found.

Bus Line: C2
Direction: PIAZZA BECCARIA → LEOPOLDA

Bus Line: C2
Direction: PIAZZA BECCARIA → LEOPOLDA

Bus Line: I2
Direction: STAZIONE PIACCHEDI → PIAZZALE servizi asstn 1

Events in Florence

20 events found.

Jan Fabre a Firenze
Place: PALAZZO VECCHIO - ARENGARDO
Date: da 2016-04-15 a 2016-10-02

Jan Fabre a Firenze
Place: PALAZZO VECCHIO - ARENGARDO
Date: da 2016-04-15 a 2016-10-02

Musica ribelle - La forza dell'Amore, il musical
Place: TEATRO DELLA PERGOLA
Date: da 2016-05-03 a 2016-05-08
Time: 20:45, domenica 19:45

"In sua movenza è fermo"
Place: TEATRO DELLA PERGOLA

Weather Forecast for Municipality of FIRENZE

Sunday: light rain and sunny intervals 18°C / 24°C

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Tuesday: cloudy 13°C / 25°C

Wednesday: light rain

Thursday: rainstorm

Search in an area

Get weather forecast

Regular Services Transversal Services

search text into service

Services Categories

De/Select All

- Accommodation
- Advertising
- AgricultureAndLivestock
- CivilAndITEngineering
- CulturalActivity
- EducationAndResearch
- Emergency
- Environment
- FinancialService
- GovernmentOffice
- HealthCare
- IndustryAndManufacturing
- MiningAndQuarrying
- ShoppingAndService
- TourismService
- TransportServiceAndRenting
- UtilityAndSupply
- Wholesale
- WineAndFood

N. results: No Limit

Search Range: visible areas

Search Results

Services: 2231 of 2231 available

Query results organized by category

Total number of results: 2231

Bar chart showing results by category:

Category	Results
Accommodation	18
Advertising	21
AgricultureAndLivestock	31
CivilAndITEngineering	14
CulturalActivity	11
EducationAndResearch	14
Emergency	24
Environment	21
FinancialService	262
GovernmentOffice	241
HealthCare	264
IndustryAndManufacturing	114
MiningAndQuarrying	114
ShoppingAndService	114
TourismService	114
TransportServiceAndRenting	114
UtilityAndSupply	114
Wholesale	114
WineAndFood	114

Weather Forecast for Municipality of FIRENZE

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Monday: cloudy 12°C / 24°C

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Wednesday: light rain

Thursday: rainstorm

Get Real Time data (public busses, car parks, sensors, traffic flows)

Regular Services Transversal Services

search text into service

Services Categories

De/Select All

- Area
- DigitalLocation
- HappeningNow
- Path
- Fresh Place
- Public Transport Line
- Road Sensors
- Bus Stops

N. results for each: 200

Search Range: 500 mt

Search Results

Bus Stops: 25 of 25 available

Road Sensors: 3 of 3 available

Service: FI055ZTL01601

Avg Distance(m)	Avg Time (sec)	Occupancy (%)	Concentration (car/km)
N.A.	N.A.	N.A.	0.0
N.A.	N.A.	N.A.	0.0
48.0	0.0	N.A.	N.A.

Service: FI055ZTL01501

Avg Distance(m)	Avg Time (sec)	Occupancy (%)	Concentration (car/km)
N.A.	N.A.	N.A.	0.0
N.A.	N.A.	N.A.	0.0
48.0	0.0	N.A.	N.A.

Weather Forecast for Municipality of FIRENZE

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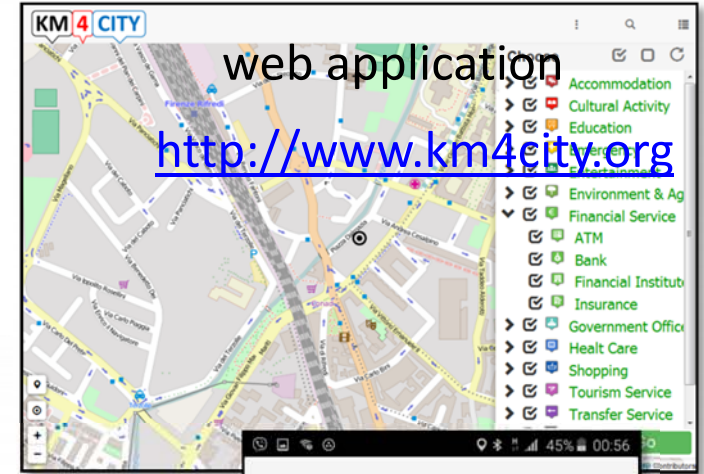
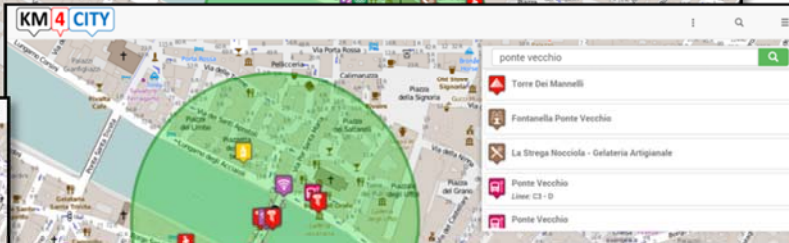


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Km4CityMobile App

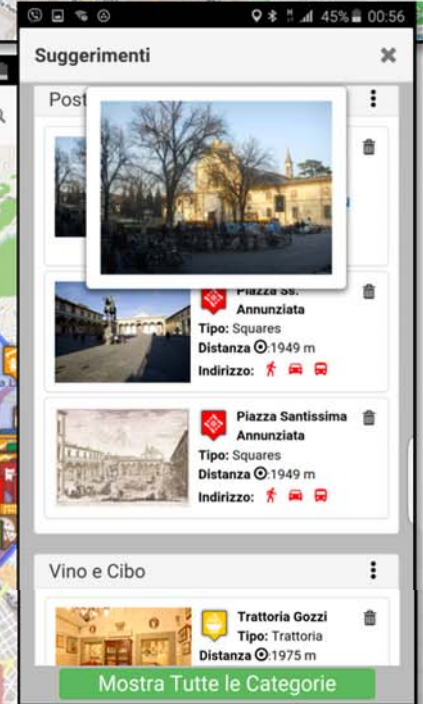


web application

<http://www.km4city.org>



- Choose Services
- > Accommodation
 - > Advertising
 - > Agriculture And Livestock
 - > Civil And Edil Engineering
 - > Cultural Activity
 - > Education And Research
 - > Emergency
 - > Entertainment
 - > Environment
 - > Financial Service
 - > Government Office







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Sii-Mobility



- Experimentations and validation in Tuscany ■ <http://www.Sii-Mobility.org>
- Integration with present central station and subsystems 
- DISIT lab, Università di Firenze, is the tech-scientific coordinator 



ataf

tiemme
TOSCANA MOBILE

BUSITALIA
GRUPPO FERROVIE DELLO STATO ITALIANE

atam

CTT
CORRISPONDENZA TELEGRAFICA ITALIANA

— Autostrade
— SS Fi-Pi-Li
— SS Fi-Si
— Ferrovie (primarie)
- - Aree

 Comune di Perugia

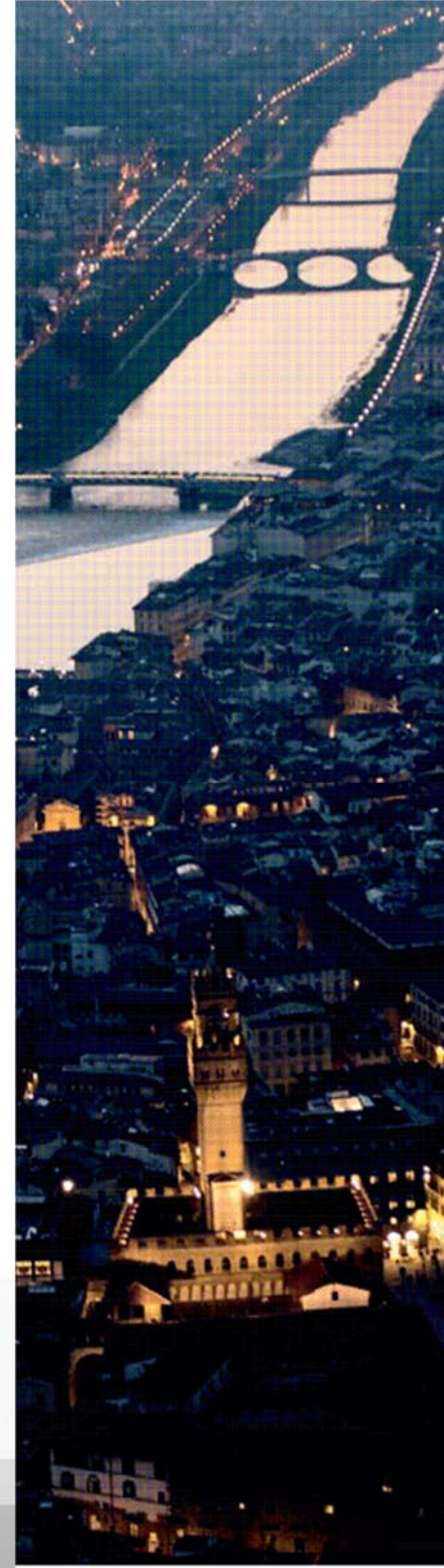
 COMUNE DI NAPOLI

*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*



Le Citta' Senzienti

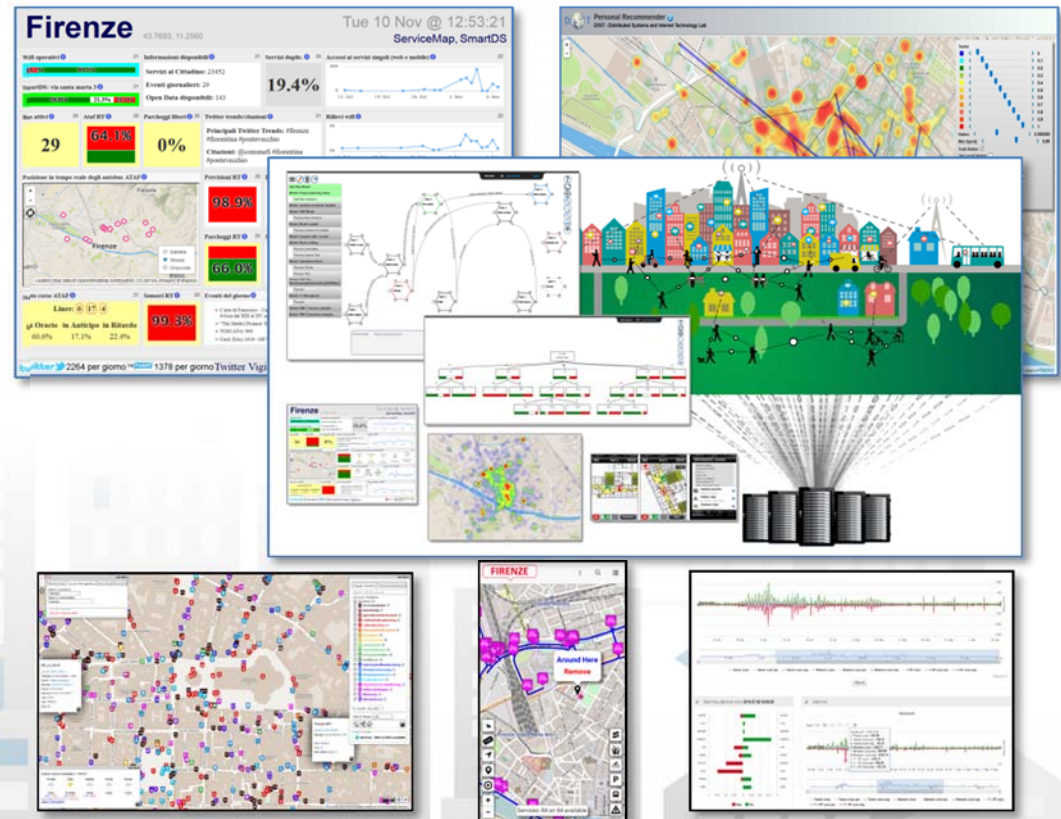
- **aggregare ed integrare dati** provenienti dalle varie sorgenti
- **tenere sotto controllo lo stato della città** e dei suoi servizi nei vari domini
- **comprendere il comportamento dei suoi utenti** e delle imprese per poter apprendere gli andamenti tipici, identificare le disfunzioni, definire e stimolare aggiustamenti.
- **assistere gli utenti della città** nell'uso dei servizi e stimolarli verso comportamenti "virtuosi" che possono portare beneficio alla qualità della vita secondo le linee strategiche della città.
- fornire **supporto alle decisioni** (sia per gli amministratori che per le attività economiche), per la riduzione dei costi, il miglioramento dei servizi, l'incremento della sicurezza e della resilienza
- migliorare la **capacità di reazione ed adattamento della città rispetto all'occorrenza di situazioni critiche**
- produrre **servizi innovativi, smart e senzienti per le imprese** sulla base di dati aggregati ed integrati del territorio.



Dai dati ai servizi per Sentient Cities

Open Source and inter-operable tools to

- 1. keep city under control via personalized dashboards**
- 2. improve city resilience, reducing risks and decision support**
- 3. transform data in value for the city**



Km4City Data and Service Aggregator





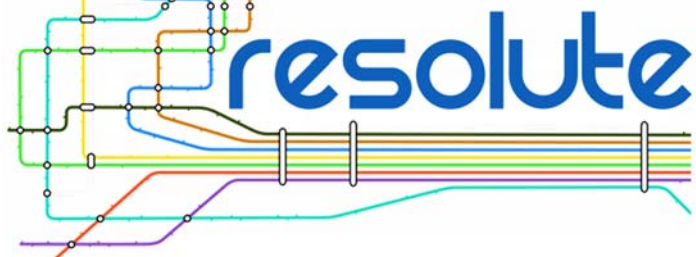
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Horizon 2020
European Union Funding
for Research & Innovation



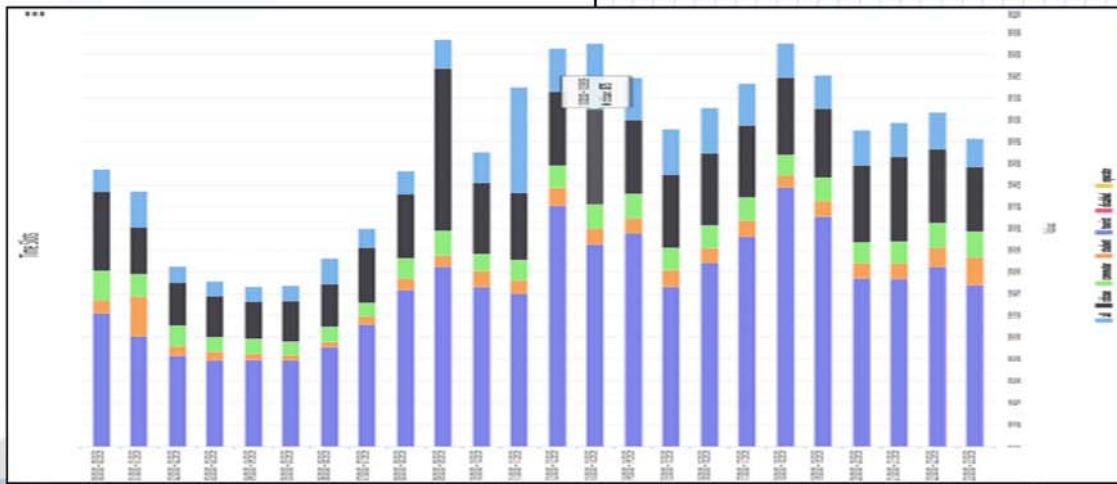
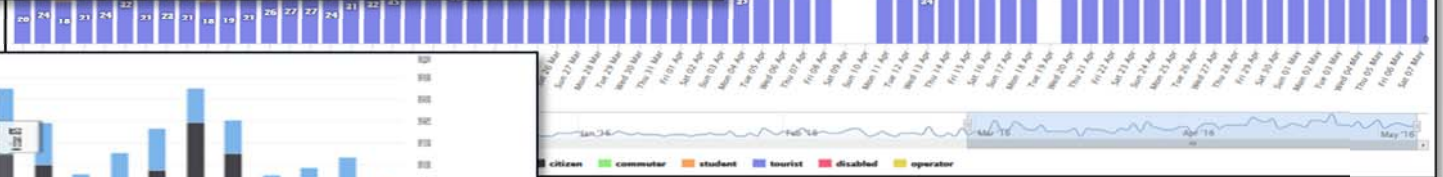
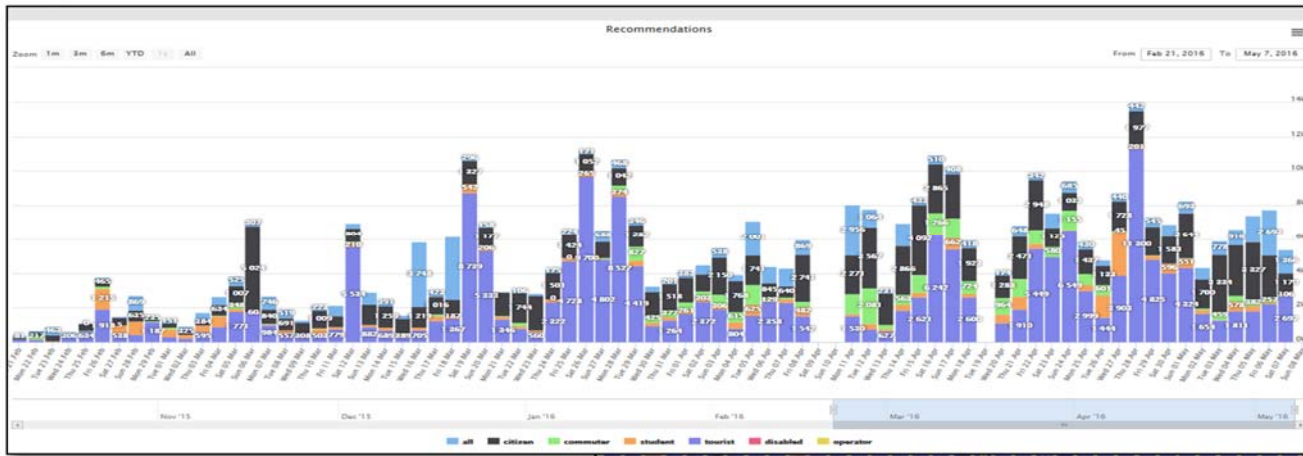
<http://www.resolute-eu.org>

- **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	HUMANIS T	FR
SWARCO Mizar	SWMIZ	IT
Associação para o Desenvolvimento da Investigação no Instituto Superior de Gestão	ADI-ISG	PT
<i>Consorzio Milano Ricerche</i>	CMR	IT



Recommender and User Behavior Analyzer





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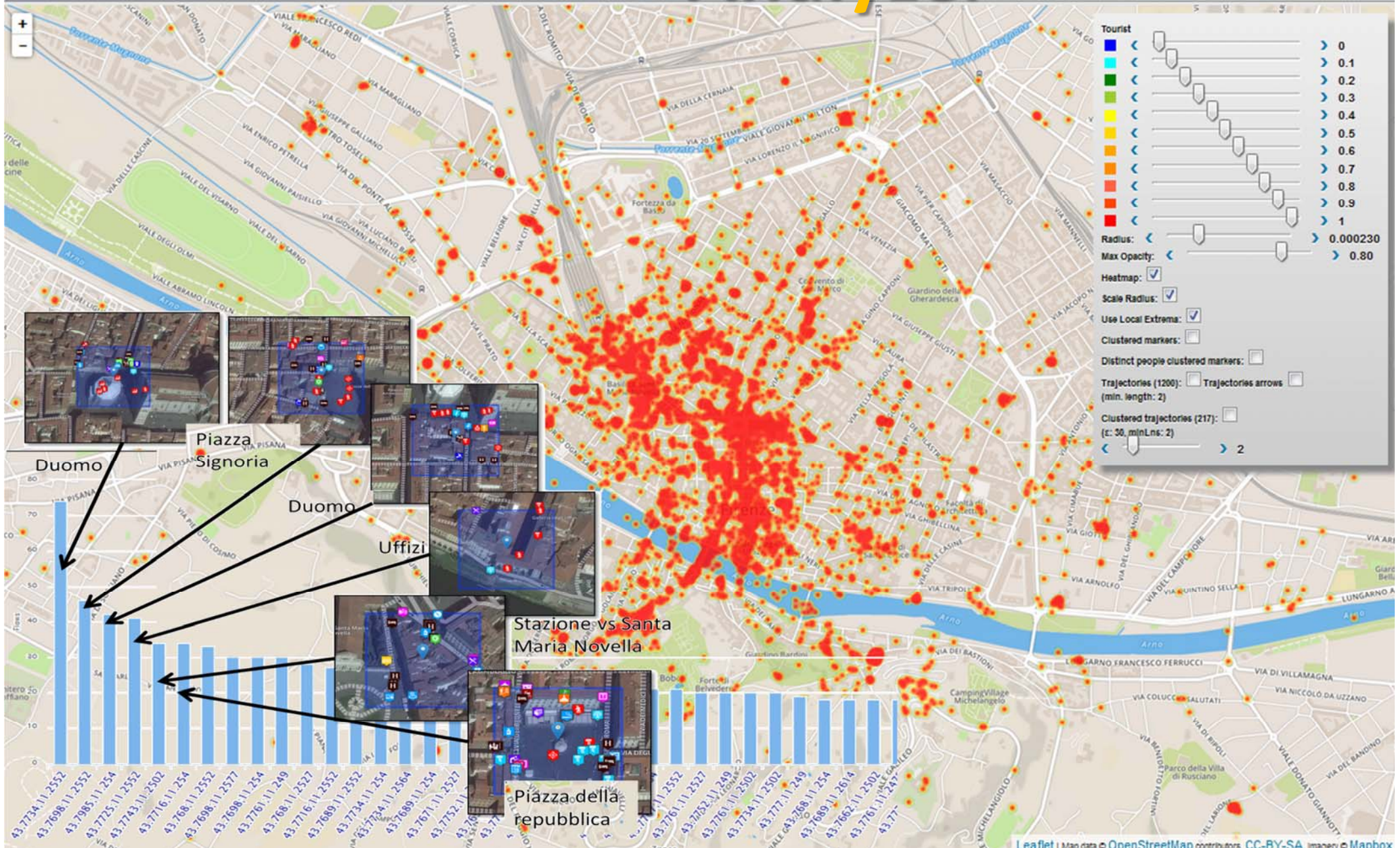
User Behavior



Personal Recommender

DISIT - Distributed Systems and Internet Technology Lab

Analyzer





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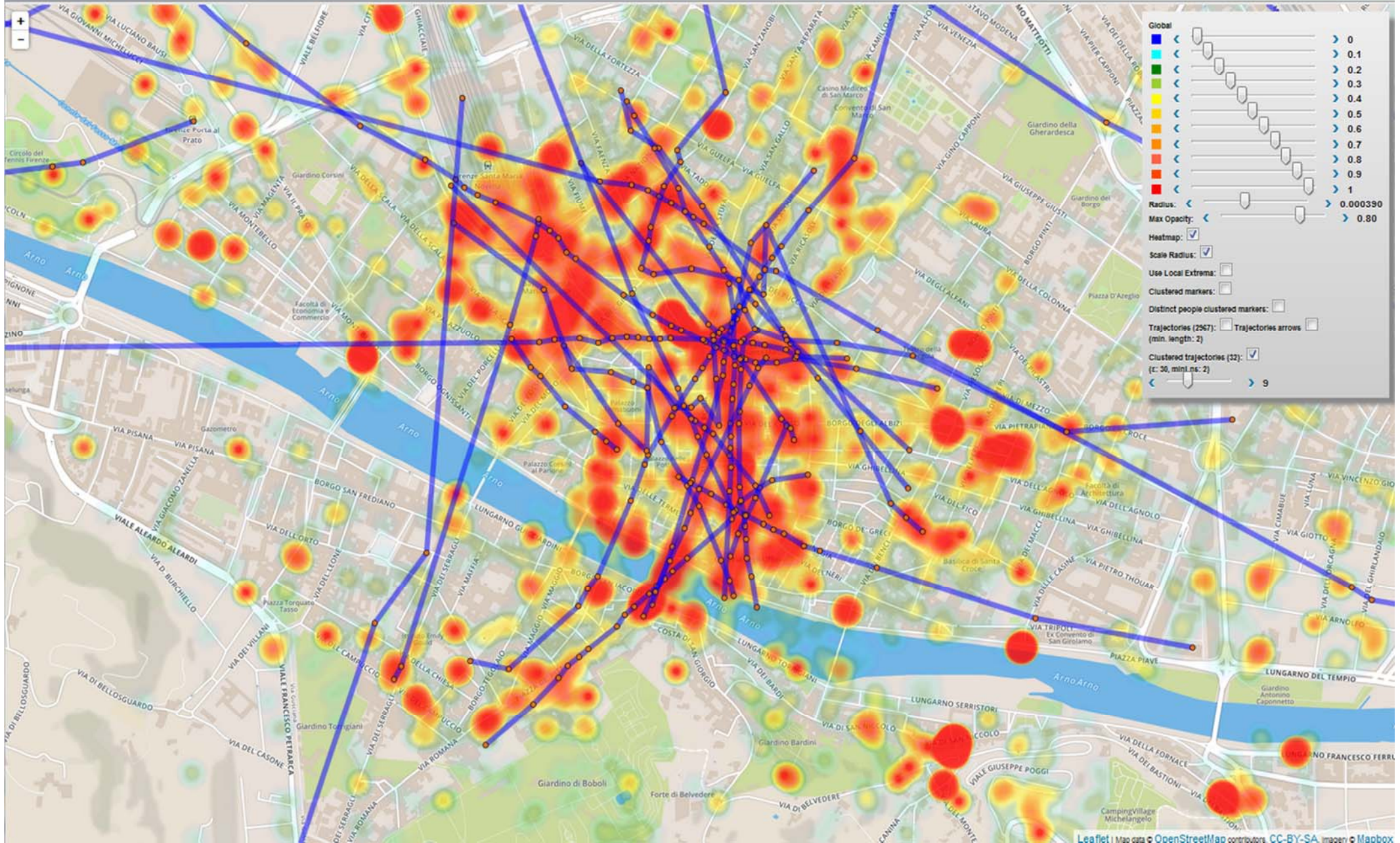
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User Behavior Analyzer

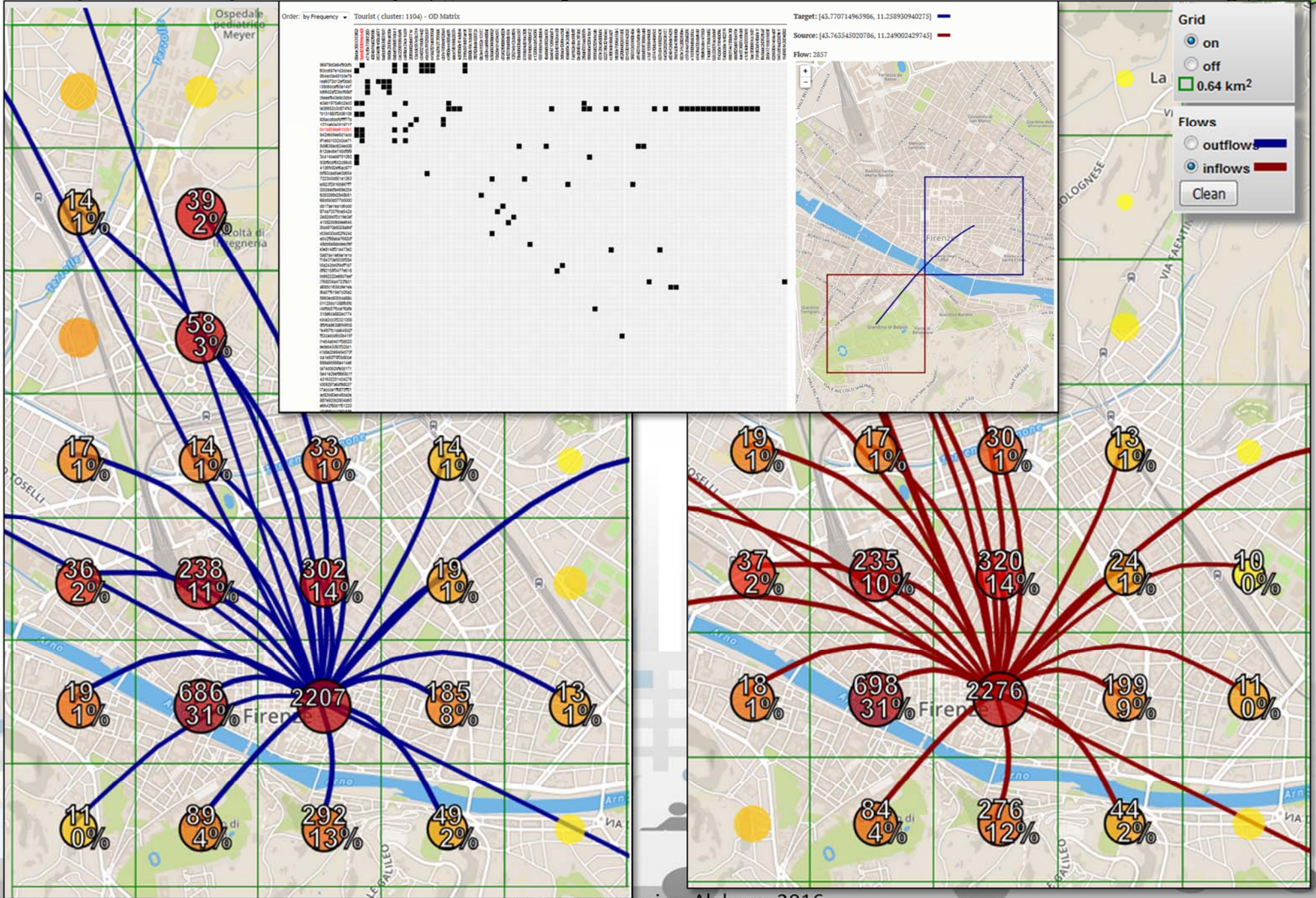


DISIT Personal Recommender
DISIT - Distributed Systems and Internet Technology Lab





OD Matrix scalabile



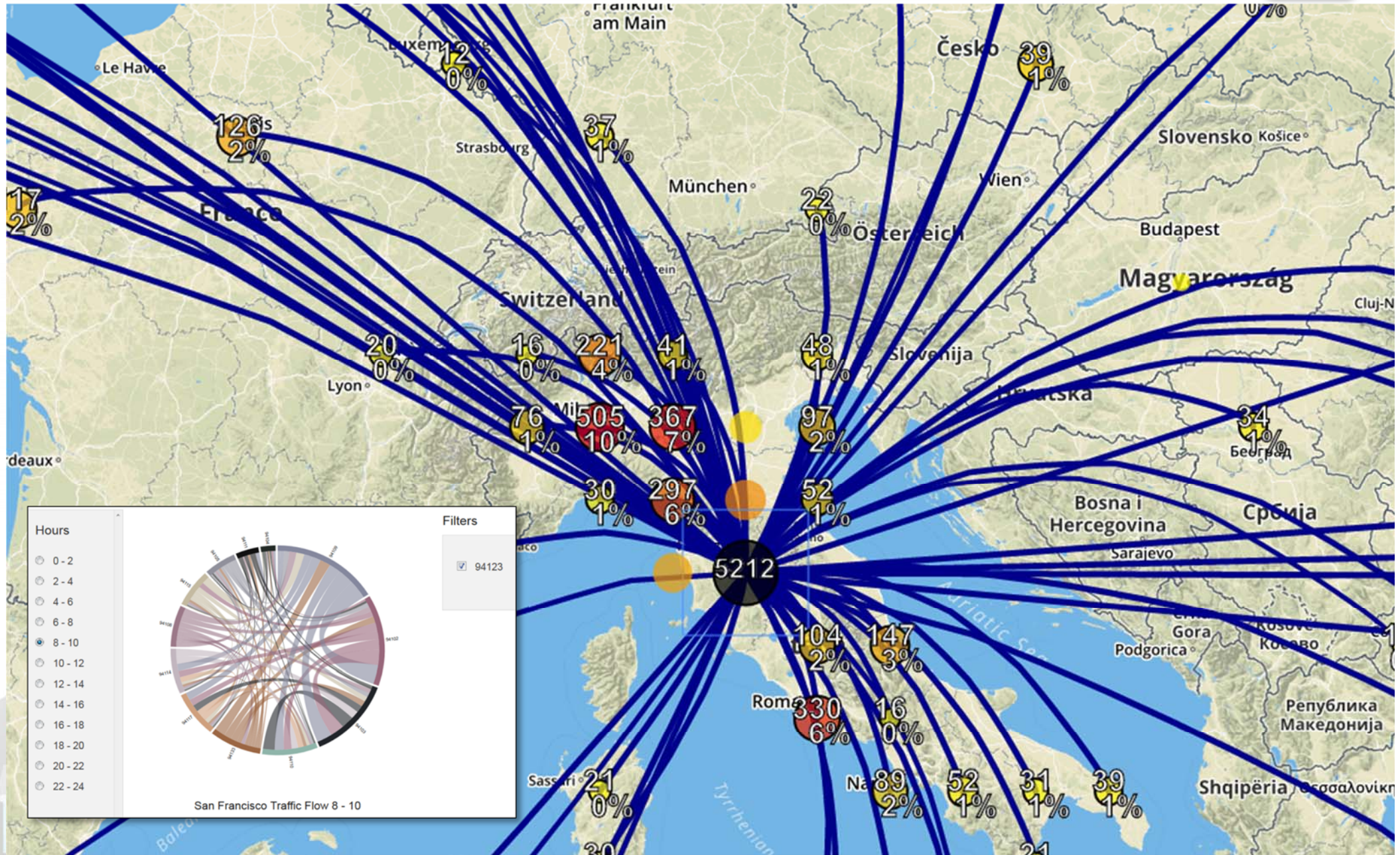


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Outbounds





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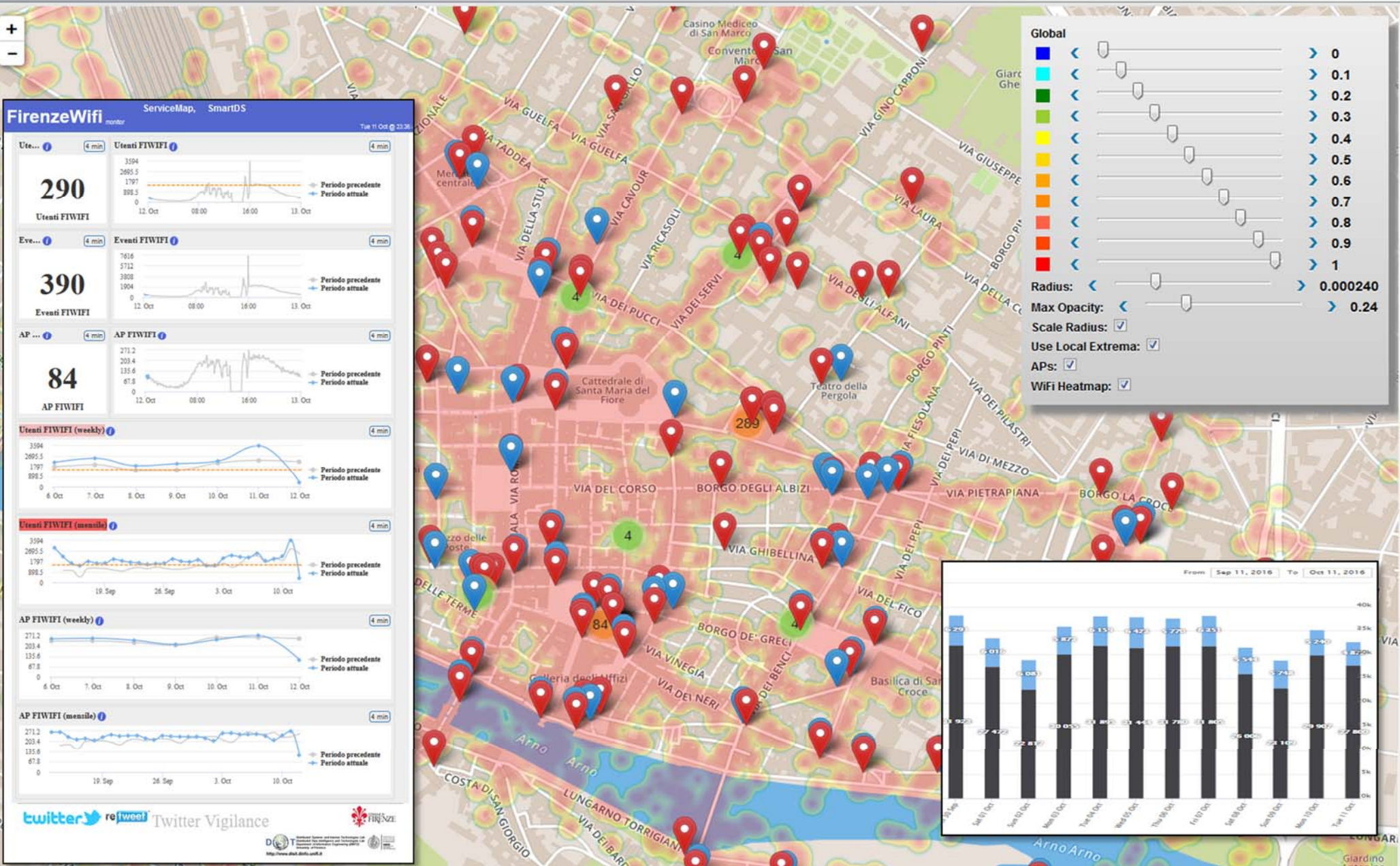
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WiFi Monitor tool



WiFi Firenze

DISIT - Distributed Systems and Internet Technology Lab



FirenzeWiFi monitor

Ute... **290** Utenti FIWIFI

Eve... **390** Eventi FIWIFI

AP... **84** AP FIWIFI

Utenti FIWIFI (weekly)

Utenti FIWIFI (mensile)

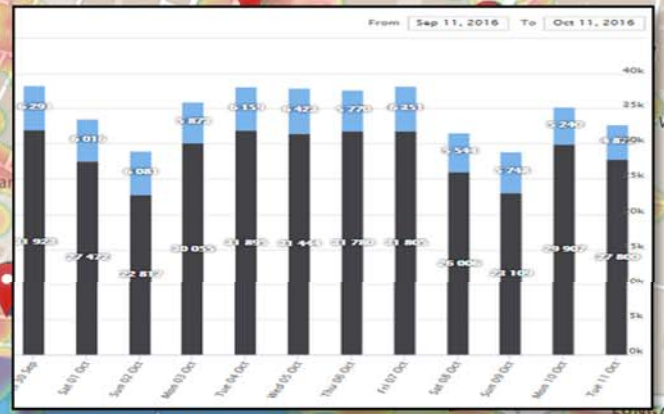
AP FIWIFI (weekly)

AP FIWIFI (mensile)

twitter re:tweet Twitter Vigilance

Global

- Color scale: 0 (blue) to 1 (red)
- Radius: 0.000240
- Max Opacity: 0.24
- Scale Radius:
- Use Local Extrema:
- APs:
- WiFi Heatmap:



Traffic Flow data



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

Tuscany

Regular Services | Tra

search text into service

Services Categories

De/Select All

- Area +
- DigitalLocation
- HappeningNow
- Path +
- Fresh Place
- Public Transport Line
- Road Sensors
- Bus Stops

N. results for each: No Limit

Search Range: visible areas

Search Results

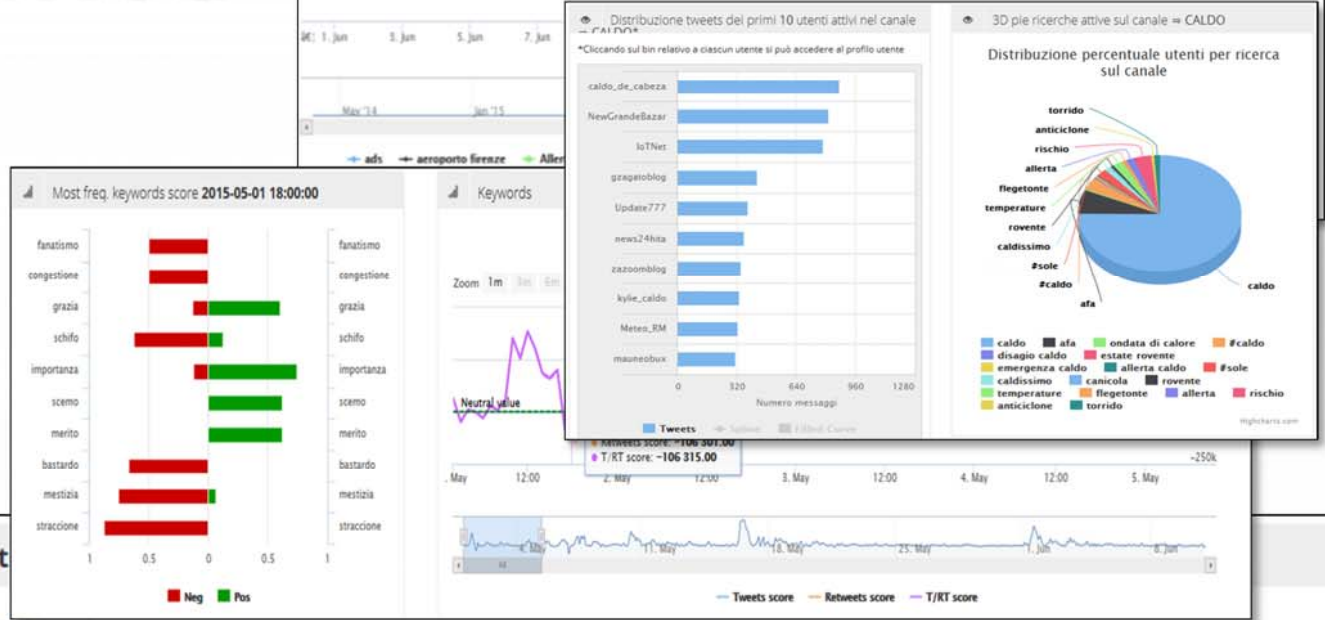
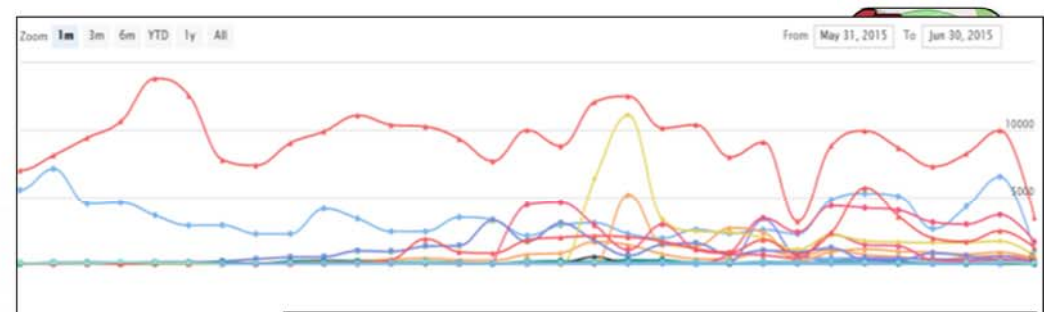
Road Sensors: 424 of 424 available

Pisa

La Citta' dinamica, Alghero, 2016

Twitter Vigilance

- <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**





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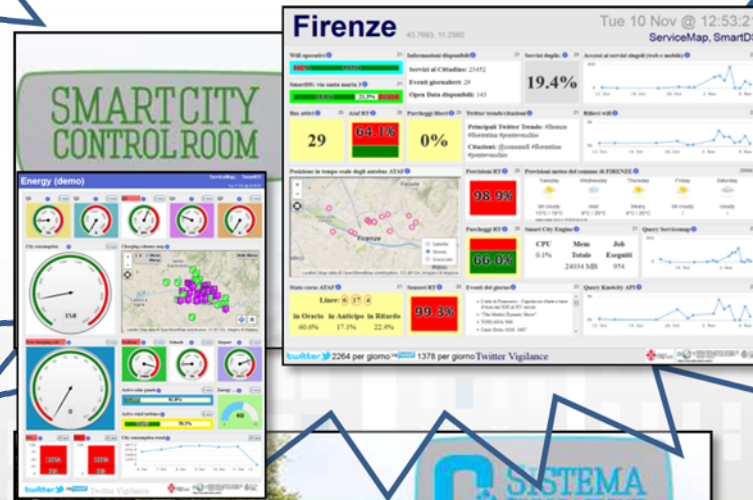
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Horizon 2020
European Union Funding
for Research & Innovation

REPLICATE a Firenze: Energia, ICT e Mobilità





Horizon 2020
European Union Funding
for Research & Innovation

**REnaissance of PLaces
with Innovative Citizenship
And Technology**



- **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, DIF**
- **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 SYSTEMS, 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**

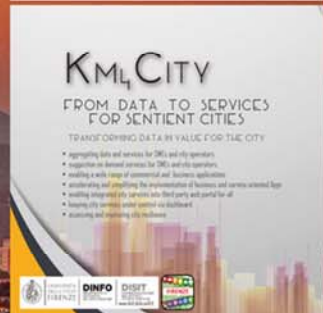
www.Km4City.org



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- | | | | | | | | |
|-------------------|-----------------------------|--------------------------|------------------------------|-----------------------------|---------------------------|-------------------|------------------------|
| Service Map | Bus Stops | Real Time Busses (Embed) | Traffic Sensors | Services in Tuscany | Services in Florence | Km4City App Video | Km4City Video 2015 |
| Services in Pisa | Green Areas | Bus Lines | Hotels | Florence Downtown | Events in Florence | DISIT Lab | Km4City Slides |
| Dashboard | Dashboard Mugnone2016 | Linked Open Graph, LOD | SPARQL & Data Licenses | Resilience Decision Support | Smart Decision Support | Km4City Info Page | Km4City Projects |
| Recommendations | Monitoring City Users | City Users Heat Map | Tourists Heat Map | Monitoring Wi-Fi Users | Monitoring Wi-Fi Coverage | Km4City Ontology | Km4City Smart City API |
| Twitter Vigilance | Real Time Twitter Vigilance | Twitter Search | Interactive People Flow Maps | OD Matrix for People Flow | | Km4City WebApp | PUBLIC |

Technical info on: <http://www.disit.org/km4city>

Transport systems
Mobility, parking



Public Services
Govern, events,



Sensors, IOT
Cameras, ..



Environment,
Water, energy



Shops, services,
operators



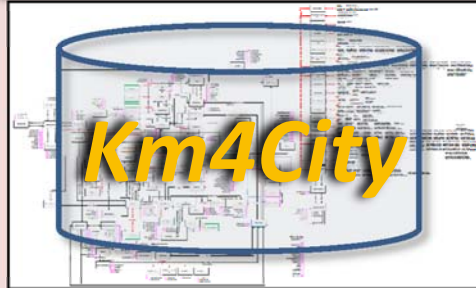
Social Media
WiFi, network



Static, Slow and Real Time data flows

DISCES -- Distributed and parallel architecture on Cloud

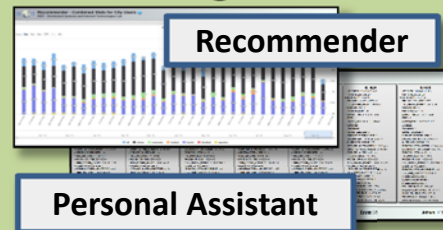
Km4City Smart City Engine



Big Data Analytics



Smartening Tools



Development Tools



Km4City Smart City API

Tools for City Operators and Decision Makers

Smart City Dashboard

[Http://dashboard.km4city.org/](http://dashboard.km4city.org/)

Smart Decision Support

[Http://Smartds.km4city.org](http://Smartds.km4city.org)

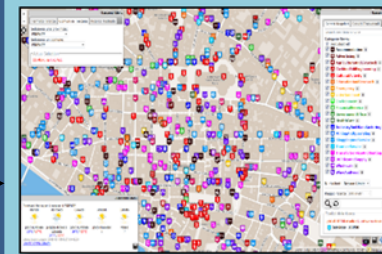


ServiceMap browser

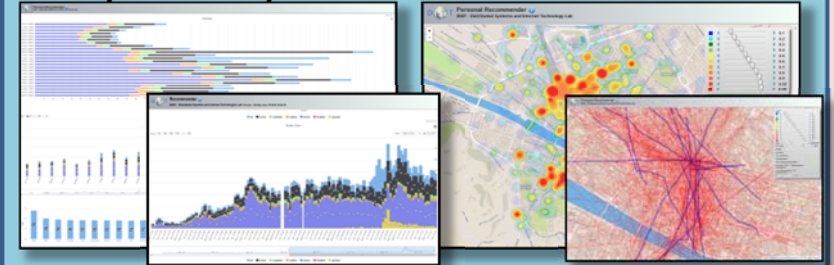
[Http://servicemap.km4city.org](http://servicemap.km4city.org)

Twitter Vigilance

[Http://www.disit.org/tv](http://www.disit.org/tv)



Analyzers of City User Behavior



Tools for Final Users

Mobile e Web Apps

[Http://www.km4city.org/webapp](http://www.km4city.org/webapp)



[Http://www.km4city.org](http://www.km4city.org)

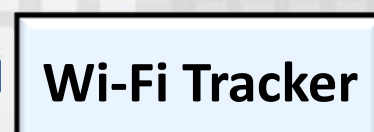
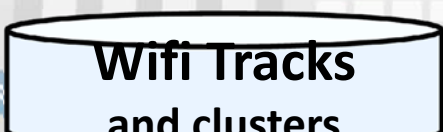
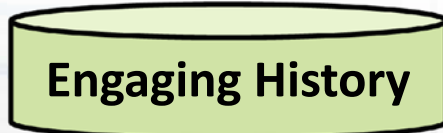
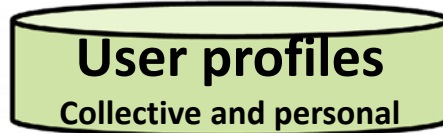
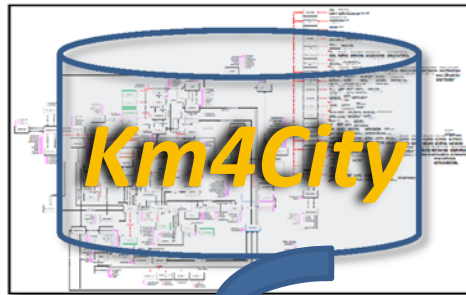
[Http://www.km4city.org/app](http://www.km4city.org/app)

User Supporting Apps



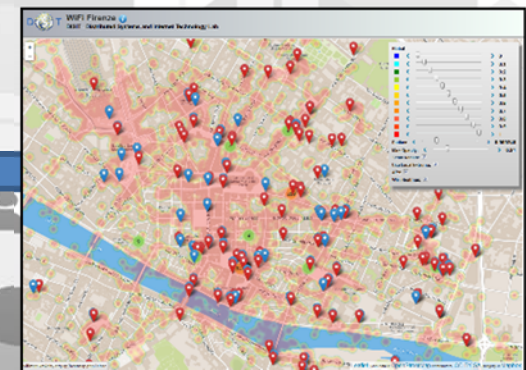
Real Time Data Analytics:

- filtering
- from track to OD
- clustering
- analyzing user behavior
- computing recommendation
- computing Engaging rules
- advertising
- managing bonus



[Http://www.km4city.org/app](http://www.km4city.org/app)

Mobile e Web Apps





km4City Roadmap



2013

Km4City 1.1

- Tuscany Map
- Services
- AVM
- Sensors
- Parking

<http://servicemap.disit.org> API
<http://log.disit.org>
<http://www.disit.org/food>
<http://www.disit.org/tv> Twitter Vigilance
<http://smartds.disit.org>

2014

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

2015

- Cultural Heritage
- Enrichment-cities
- Events in the city
- Digital Locations
- Fresh places

Km4City 1.4

- Embed
- More API
- iBeacon



RESilience management guidelines and Operationalization appLied to Urban Transport Environment



Horizon 2020
European Union Funding
for Research & Innovation

Km4City 1.5

- SmartDS
- Km4City

**RESOLUTE H2020
2015-2018 - Started**



**Sii-Mobility SCN
2016-2018 - Started
Km4City 1.6.2**

2016

- Dashboards
- Risk analysis
- Territorial, areas and paths
- Environmental: water, health
- Statistics, Energy, ICT, ...
- Data Licensing models
- User Engagement

- Suggestion on demand
- People flow tracking

**REPLICATE H2020
2016-2021 - Started**



REPLICATE
REnaissance of PLaces
with Innovative Citizenship
And TEchnology



Horizon 2020
European Union Funding
for Research & Innovation



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

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



Projects based on KM4City

- Sii-Mobility, <http://www.sii-mobility.org>



- Resolute, <http://www.resolute-eu.org>



RESilience management guidelines
and **O**perationalization app**L**ied to
Urban **T**ransport **E**nvironment



- Replicate, <http://www.disit.org/6778>



Smart City EcoSystem



<https://github.com/disit>

- **Decision Makers, Public administrator tools:**
 - ✓ Smart City Dashboards, <http://dashboard.km4city.org> → Dashboard Builder
 - ✓ Resilience Decision Support, <http://resilienceds.km4city.org>
 - ✓ Smart decision support system, <http://smartds.km4city.org>
 - ✓ Twitter Vigilance, <http://www.disit.org/tv>
 - ✓ Recommender and User Behavior Analyzer, <http://recommender.km4city.org>
 - ✓ WiFi monitor, <http://wifimap.km4city.org>
 - ✓ ServiceMap Server, <http://servicemap.km4city.org>
 - ✓ Traffic and People Flow Assessment <http://www.disit.org/6694>
- **Final Users tools:**
 - ✓ Km4City mobile applications, <http://www.km4city.org/app>
 - ✓ Km4City web application, <http://www.km4city.org>
 - Open Source Mobile Application, FODD <http://www.disit.org/6595>
- **Developers tools:** <http://www.disit.org/km4city>
 - ServiceMap Server, plus API, <http://servicemap.km4city.org>
 - ✓ Smart City API , <http://www.disit.org/6597>
 - ✓ Km4City Ontology, <http://www.disit.org/km4city>
 - SPARQL query tool and licenser, http://log.disit.org/sparql_query_frontend/
 - LOG LOD browser, <http://log.disit.org>
- **Back Office tools:**
 - Data Ingestion Manager, DIM, <http://www.disit.org/6732>
 - Distributed Smart City Engine, SCE, Scheduler, DISCES <http://www.disit.org/6515>
 - RDF Indexer Manager, RIM, <http://www.disit.org/6708>
 - RDF store enricher with dbPedia
- **Adopted on projects and real scenarios**
 - Sii-Mobility SCN MIUR, <http://www.sii-mobility.org>
 - RESOLUTE H2020, <http://www.resolute-eu.org>
 - REPLICATE H2020, <http://www.zabala.co.uk/en/projects/replicate>