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DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB

Rights Enforcement and Licensing Understanding for RDF Stores Aggregating Open and Private Data Sets

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<http://www.disit.org/>, <http://www.km4city.org>

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IEEE
Second International
Smart Cities Conference
(ISC2 2016)

Improving the citizens quality of life
12-15 September 2016 | Trento - Italy



UNIVERSITY
OF TRENTO - Italy





Problem Addressed

- **RDF stores are noSQL (suitable for bigdata) store and are**
 - Used for building knowledge base, KB: by using ontologies and data/triples, making reasoning via SPARQL
 - used to aggregate static and real time data sets; open and/or with many different kinds of licenses
 - based on triples/quadruple, where the 4th element is typically used for identifying the data set
 - used for Cloud, Smart City, Railways, etc.
 - **unsuitable to cope with multiple data sets having multiple licenses with different constraints: location, time, roles..**
- **Developers need powerful tools for realizing applications:**
 - Getting Calls from visual environments
 - Discovering suitable query to obtain desired data
 - At the end, the RDF store has to be to perform actions on data ONLY to who has the right to do that,
 - but not always in development phases, e.g., rights depends on data sets provider, locations, roles, etc.



In the context of Smart City

- **RDF stores are used** for realizing knowledge base RDF endpoints, connected to Smart City API, via REST Call of different kinds ...
 - See IEEE SMARTCOMP paper
- **Accessing data read/write**, exploiting inference, etc..
 - City operators/users having different rights, roles, etc. in different contexts
 - Data with different licenses for different operator and GPS coordinates, and time..
 - ...



Licenses and More..

- **Licenses:** MPEG-21, ODRL, XACML, Xrml, etc..
 - Suitable for media, Unsuitable for data
- **Data Licenses:** CC, ODC, OGL, IODL
 - Mainly open data and declinations
 - **Permissions:** derivative, commercialize, derivative...
 - **Restrictions/duties:** attribution, notice, ...
- **Getting Composing Data Set → Licences Composition is needed**
 - See www.disit.org/6877 extension
- Formal models to grant rights
- Techniques for **right enforcement/verification**
 - Almost missing on RDF stores



DISIT extension

First License	Second License												
	CC0	CC-PDM	CC-BY-ND	CC-BY-NC-ND	CC-BY	CC-BY-SA	CC-BY-NC	CC-BY-NC-SA	ODC-PDDL	ODC-BY	ODC-ODbL	OGL 2.0	OS OpenData
CC0	No restrictions	No restrictions	-	-	CC-BY	CC-BY-SA	CC-BY-NC	CC-BY-NC-SA	No restrictions	ODC-BY	ODC-ODbL	OGL 2.0	OS OpenData
CC-PDM	No restrictions	No restrictions	-	-	CC-BY	CC-BY-SA	CC-BY-NC	CC-BY-NC-SA	No restrictions	ODC-BY	ODC-ODbL	OGL 2.0	OS OpenData
CC-BY-ND	-	-	-	-	-	-	-	-	-	-	-	-	-
CC-BY-NC-ND	-	-	-	-	-	-	-	-	-	-	-	-	-
CC-BY	CC-BY	CC-BY	-	-	CC-BY	CC-BY-SA	CC-BY-NC	CC-BY-NC-SA	CC-BY	CC-BY	ODC-ODbL	CC-BY	OS OpenData
CC-BY-SA	CC-BY-SA	CC-BY-SA	-	-	CC-BY-SA	CC-BY-SA	-	-	CC-BY-SA	CC-BY-SA	ODC-ODbL	CC-BY-SA	CC-BY-SA
CC-BY-NC	CC-BY-NC	CC-BY-NC	-	-	CC-BY-NC	-	CC-BY-NC	CC-BY-NC-SA	CC-BY-NC	CC-BY-NC	-	CC-BY-NC	-
CC-BY-NC-SA	CC-BY-NC-SA	CC-BY-NC-SA	-	-	CC-BY-NC-SA	-	CC-BY-NC-SA	CC-BY-NC-SA	CC-BY-NC-SA	CC-BY-NC-SA	-	CC-BY-NC-SA	-
ODC-PDDL	No restrictions	No restrictions	-	-	CC-BY	CC-BY-SA	CC-BY-NC	CC-BY-NC-SA	No restrictions	ODC-BY	ODC-ODbL	OGL 2.0	OS OpenData
ODC-BY	ODC-BY	ODC-BY	-	-	ODC-BY	CC-BY-SA	CC-BY-NC	CC-BY-NC-SA	ODC-BY	ODC-BY	ODC-ODbL	ODC-BY	OS OpenData
ODC-ODbL	ODC-ODbL	ODC-ODbL	-	-	ODC-ODbL	ODC-ODbL	-	-	ODC-ODbL	ODC-ODbL	ODC-ODbL	ODC-ODbL	ODC-ODbL
OGL 2.0	OGL 2.0	OGL 2.0	-	-	CC-BY	CC-BY-SA	CC-BY-NC	CC-BY-NC-SA	OGL 2.0	ODC-BY	ODC-ODbL	OGL 2.0	OS OpenData
OS OpenData	OS OpenData	OS OpenData	-	-	OS OpenData	CC-BY-SA	-	-	OS OpenData	OS OpenData	ODC-ODbL	OS OpenData	OS OpenData



RDF state of the art

- **Fuseky-Jena, GraphDB** support access control to the whole repository, not at level of data set/graph.
 - **Jena** provides API to write JAVA processes for filtering triples.
- **ORACLE** support access control to users at level of triple and model, not on graphs
- **Virtuoso and Stardog** allow to formalize simple licenses (as read/write permissions) at level of data set (RDF graph), and associate them to users.
 - an user performing a SPARQL query get back only triples for which is authorized **without any explanation** about filtered triples, and thus about potentially accessible data set with a different user profiles and licenses.

- **SPARQL analyzer**

- Read SPARQL query and rewrite to ask at the RDF store the Union of all the Graphs involved in the query
- Several different constructs are addressed

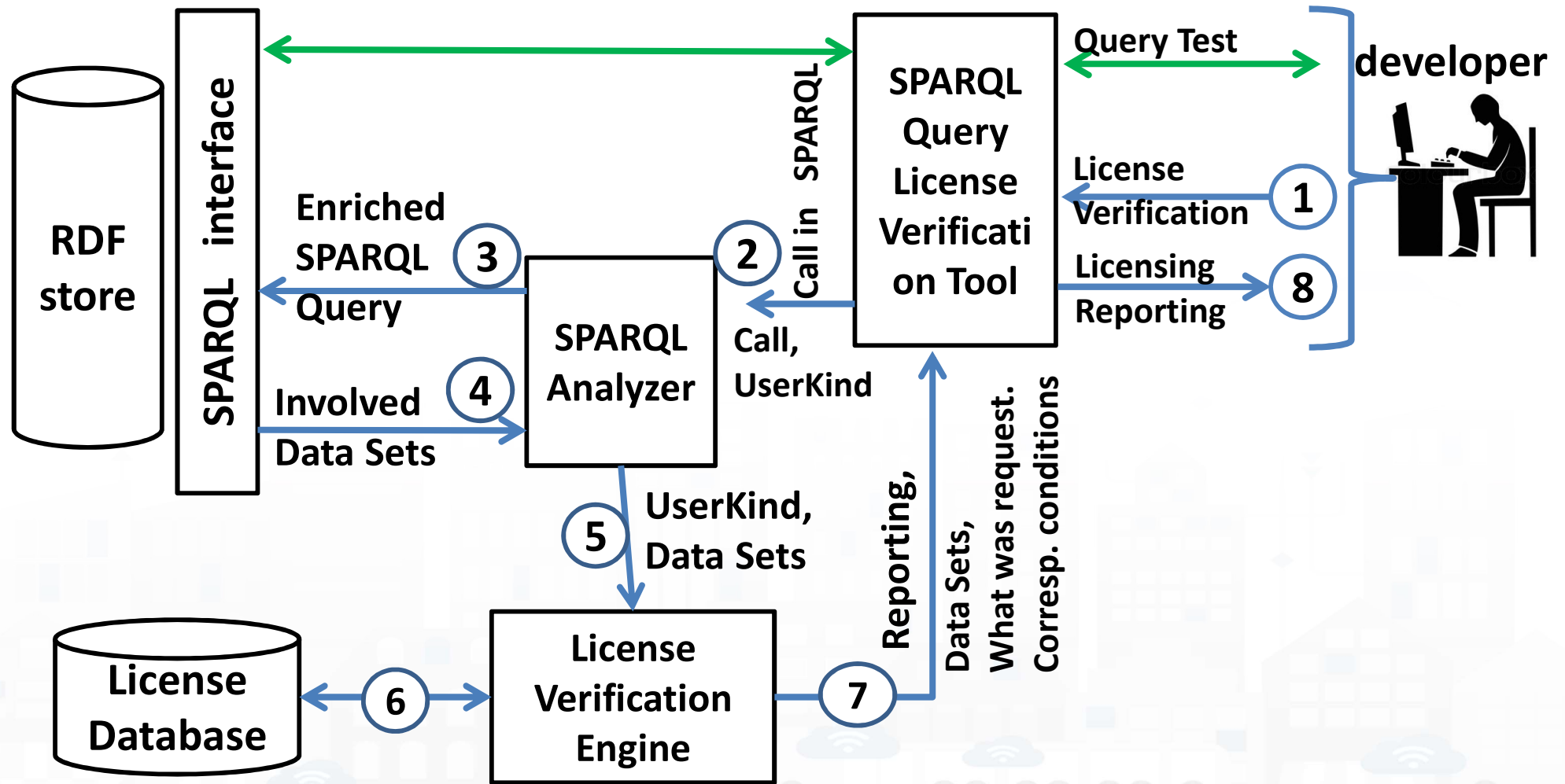
$$Graphs(Q) = \bigcup_{i=1}^n Graphs(Q.subQ_i) \cup G(Q)$$

- **License Verification Engine**

- To compute the Duties and Permissions according to the category for which the query has been requested.

$$\begin{aligned} allow(Q, c, p) &= \bigwedge_{g \in ResultGraphs(Q)} allow(g, c, p) \\ require(Q, c, d) &= \bigvee_{g \in ResultGraphs(Q)} require(g, c, d) \end{aligned}$$

SPARQL Query License Verification Tool



License Combination example

dataset/graph description	license	SD	Duties			permissions			user categories				
		sharelike	attribution	notice	derivative	commercialize	redistribute	reproduce	Citizen	Tourist	Police	Civil protection	Firefighters
DigitalLocation	CC-By-NC-SA	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
Energy Cabins	protected	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✓	✓
Commercial firms	CC-By	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Graph street	CC-By	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Services on the city	CC-By-NC	✗	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
Renting bikes	CC-By	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Taxi	CC-By	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Enogastronomy	CC-By	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

The solution allows:

- Developers to test and validate queries
- Cope with all kinds of RDF Stores

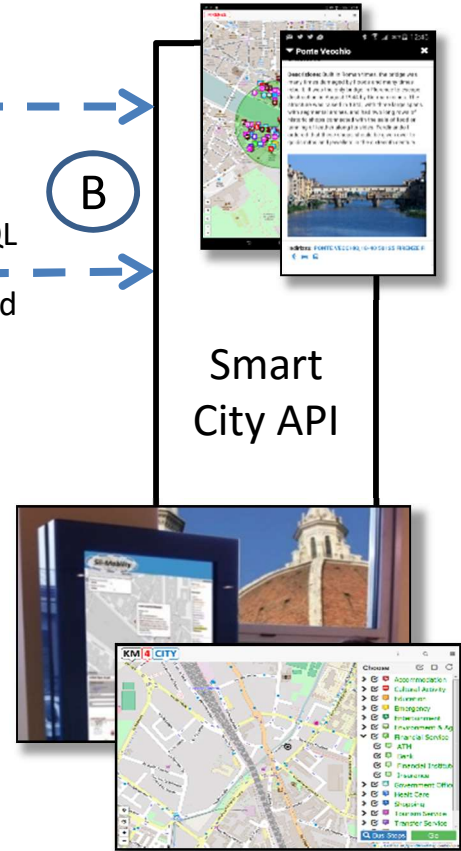
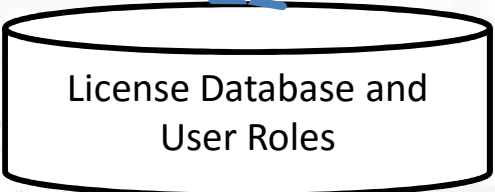
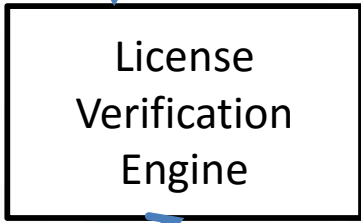
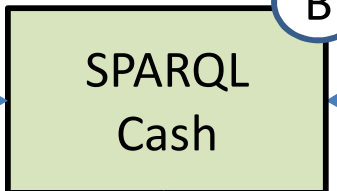
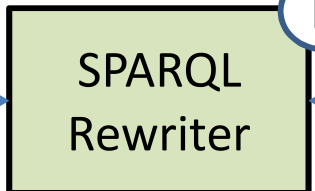
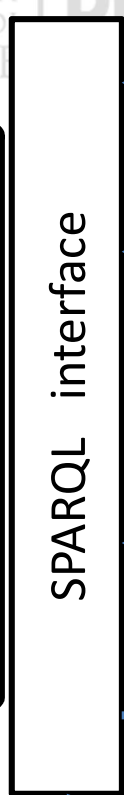
RDF Stores can be classified in two cases, those:

A. provide Triple filtering according to rights

- Set up the correct rights into the RDF store via the **License Rights Coder**

B. does not provide triple filtering support,

- provide support for **rights enforcement via query rewriting avoiding triple filtering**



Setting Rights per users

Reporting, Data Sets,
What was request.
Corresp. conditions

A

A

5

4

3

2

1

6

B

B

B

A

Call in SPARQL

Call in SPARQL

Call, UserKind

SPARQL Rewriter

SPARQL Cash

SPARQL Analyzer

SPARQL interface

RDF store

Enriched SPARQL Query

Involved Data Sets

UserKind, Data Sets

License Verification Engine

License Rights Coder

License Database and User Roles

Smart City API

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

Flint SPARQL Editor 1.0.3

New Edit View Help

Dataset KM4CITY Mode SPARQL 1.1 Query Output SPARQL-XML Submit

Query 1

```

1 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
2 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
3
4 SELECT * WHERE {
5     ?s ?p ?o
6 }
7 LIMIT 10

```

Samples SPARQL Properties Classes Prefixes

All municipalities

Select all municipalities names.

```

PREFIX km4cr: <http://www.disit.org/km4city/schema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT * WHERE {
    ?s a km4cr:Municipality;
    rdfs:label ?l.
} ORDER BY ?l

```

Bus stops near the Florence SMN train station

The bus stops within 100m of the Firenze SMN

```

PREFIX km4cr: <http://www.disit.org/km4city/schema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>

```

Line: 1; Position: 1; Query is valid

Query Results Visual Results Mode

#	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



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KM4CITY
FROM DATA TO SERVICES
FOR SENTIENT CITIES

TRANSFORMING DATA IN VALUE FOR THE CITY

- aggregating data and services for SMEs and city operators
- suggesting new services for SMEs and city operators
- enabling a wide range of commercial and business applications
- accelerating and simplifying the implementation of business and service oriented apps
- enabling integrated city services and third party web portals for all
- keeping city services under constant and automatic
- accessing and improving city resources



- | | | | | | | | |
|-------------------|-----------------------------|--------------------------|------------------------------|-----------------------------|---------------------------|-------------------|------------------------|
| 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>

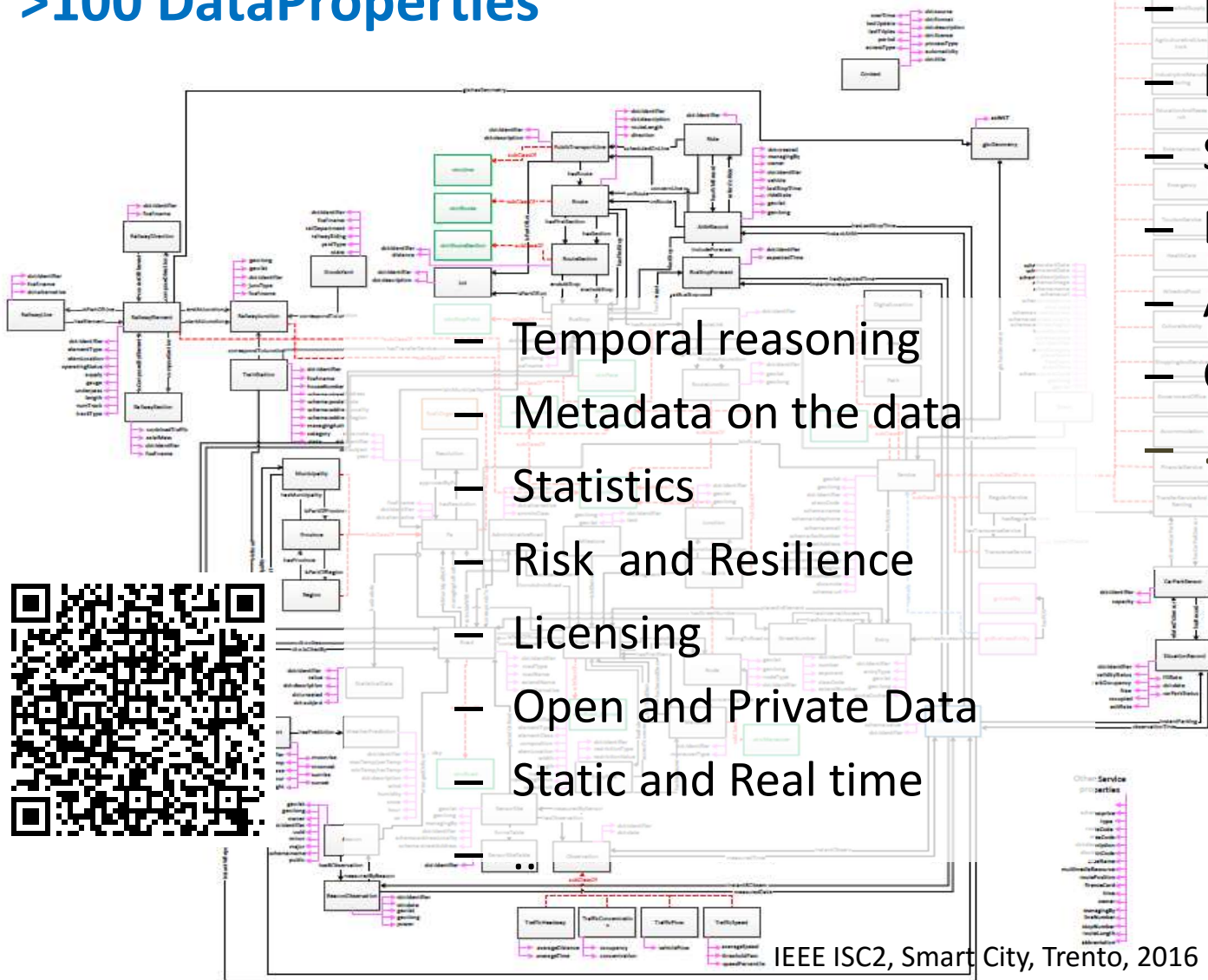


Km4City Ontology

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

- to cover different aspects:

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



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



Ontology Documentation:

<http://www.disit.org/6506>

<http://www.disit.org/6507>

<http://www.disit.org/5606>

<http://www.disit.org/6461>

Transport systems
Mobility, parking



Public Services
Govern, events,



Sensors, IOT
Cameras, ..



Environment,
Water, energy



Shops, services,
operators



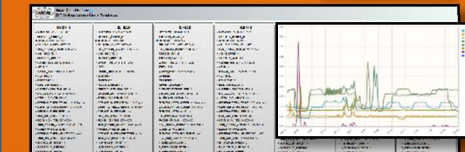
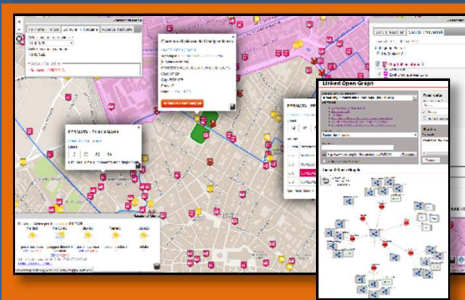
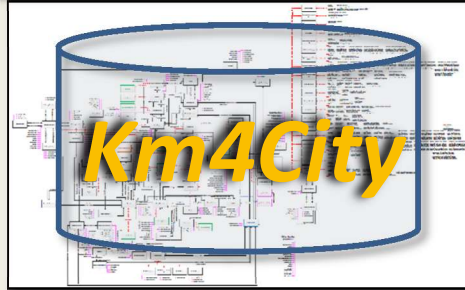
Social Media
WiFi, network



Static, Slow and Real Time data flows

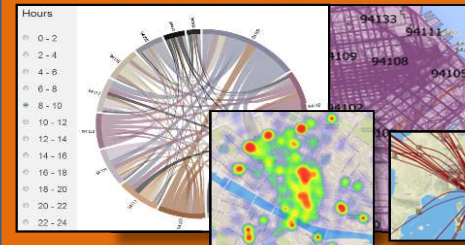
DISCES -- Distributed and parallel architecture on Cloud

Km4City Smart City Engine



User Profiling and Suggestion Engine

Flow and Origin Destination Matrix
<http://www.disit.org/ods>



Km4City Tools for Developers



www.km4city.org

Km4City Smart City API

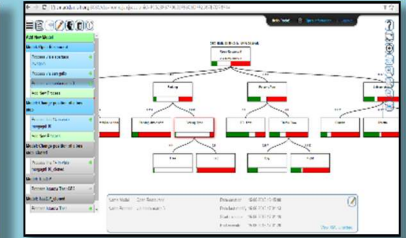
Tools for City Operators and Decision Makers

Smart City Dashboard

<http://dashboard.km4city.org/>

Smart Decision Support

<http://Smartds.km4city.org>

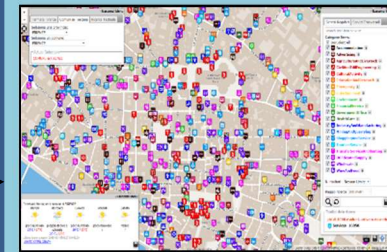


Service map browser

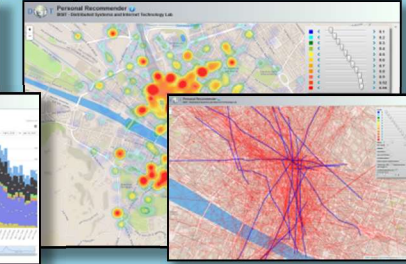
<http://servicemap.km4city.org>

Twitter Vigilance

<http://www.disit.org/tv>



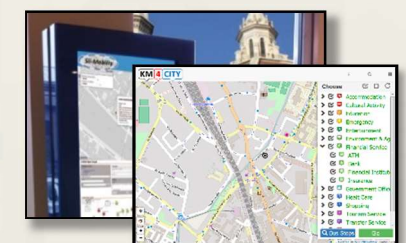
Collective User behavior Analyzer



Tools for Final Users

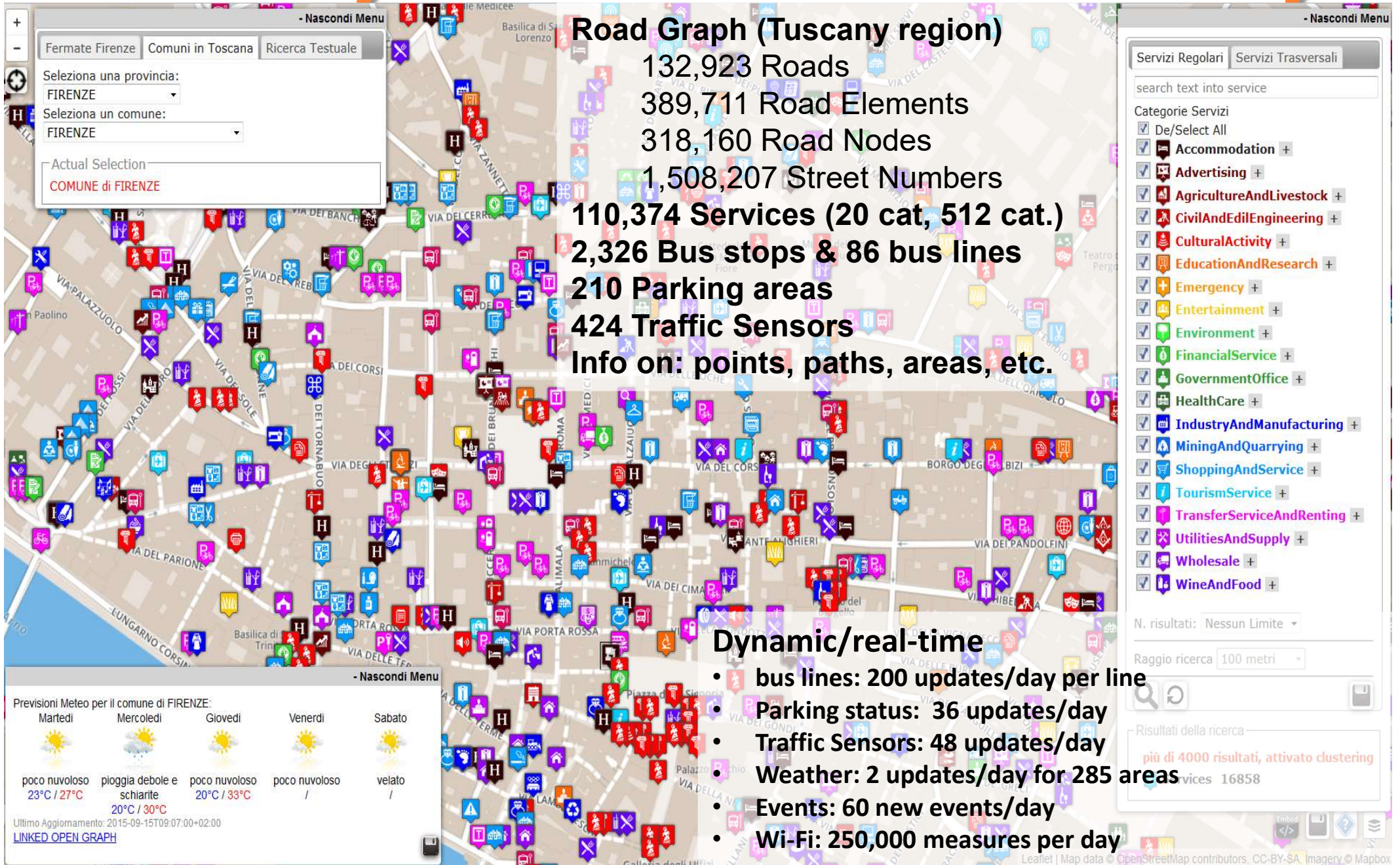
Mobile e Web Apps

<http://www.km4city.org>



<http://www.km4city.org/app>

Km4City on Firenze & Tuscany



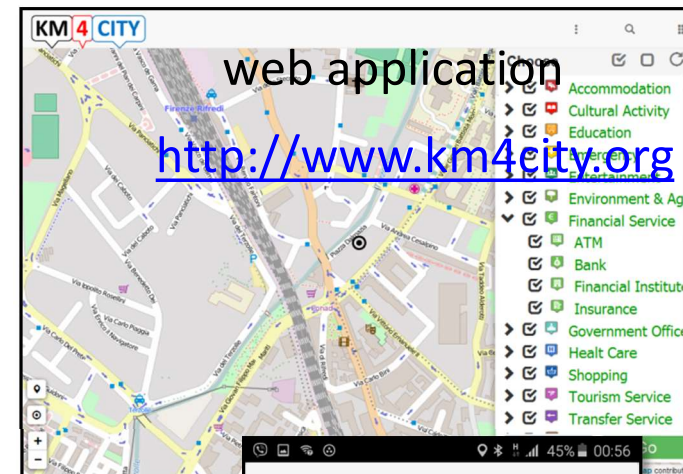
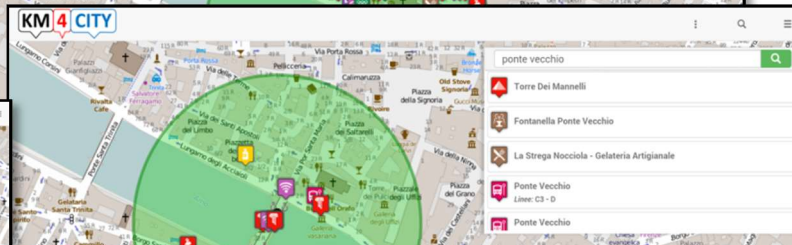


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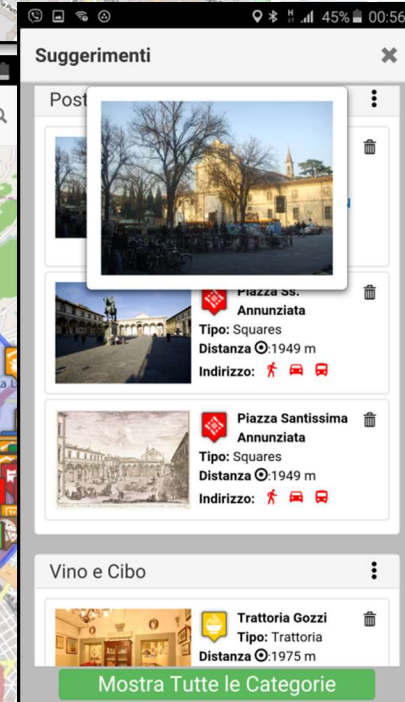
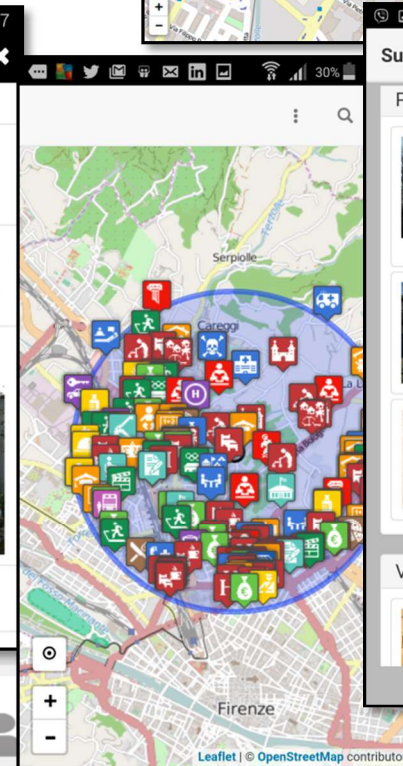
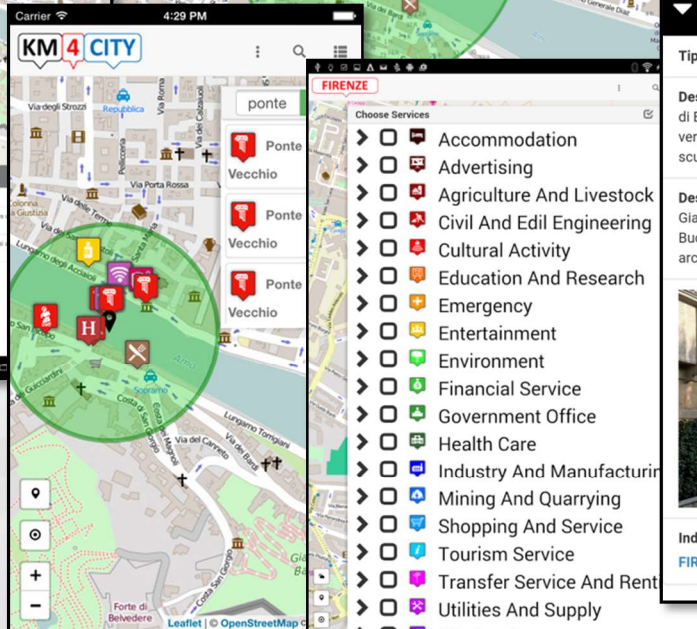
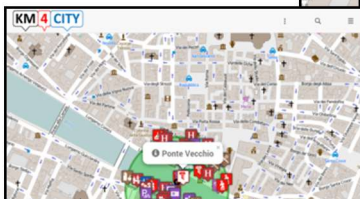
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Km4CityMobile App



web application

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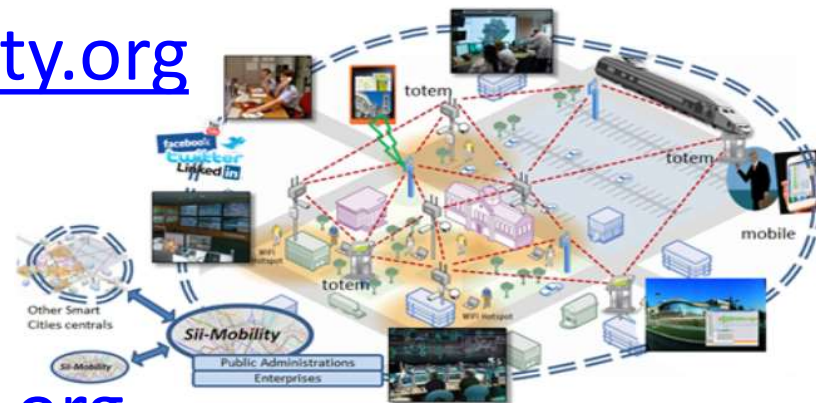
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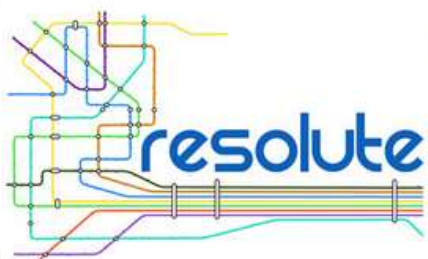


Projects based on KM4City

- 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



Horizon 2020
European Union Funding
for Research & Innovation

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



Horizon 2020
European Union Funding
for Research & Innovation



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

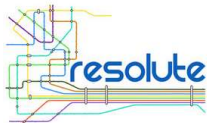
- Weather
- Cultural Heritage
- Energy recharge pillar
- Wi-Fi
- Events in the city

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

2016

Sii-Mobility SCN
2016-2018 - Started
Km4City 1.6.2



- 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
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Km4City

Smart City Ecosystem

<http://www.disit.org/km4city>

Paolo Nesi, paolo.nesi@unifi.it



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>