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TECHNOLOGIES LAB
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Km4City Smart City API: an integrated support for mobility services

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2nd IEEE International Conference on Smart Computing (SMARTCOMP 2016)

St. Louis, Missouri, US | May 18-20, 2016

SMARTCOMP 2016

"Smart Living through Computing"

KM4City Ontology and APIs

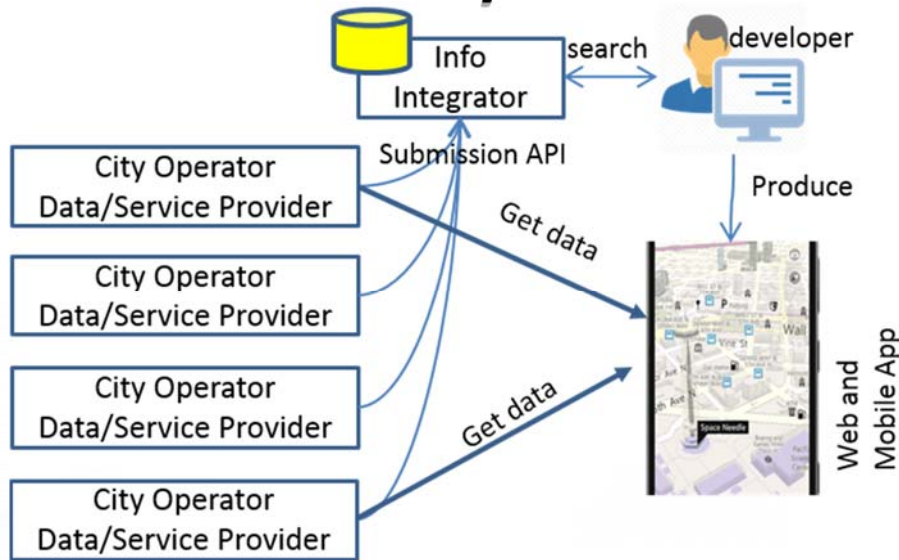
- The effective deploy of smart services is viable by exploiting the semantic integration of Open/Private data, Static/Real Time data
- The semantic aggregation of data is unfeasible without a common ontology, data are produced:
 - by different institutions
 - by using different formats and aims,
 - by using different references to geographical elements, different standards in different moments
- Aggregated data can be exploited to implement a large number of **services** and **applications** by structuring the **Smart City Architecture** and the corresponding **Smart City APIs**

Smart City API Architectures

- Different kinds of Smart City APIs can be set up with the aim of enabling Smart City Services and Applications, and their corresponding Architectural solutions
- Three main approaches can be presented:
 - **Info Integrator**
 - **Data and Metadata Aggregator**
 - **Semantic Aggregator and Reasoner**

CASE A)

Smart City API Architectures: Info Integrator



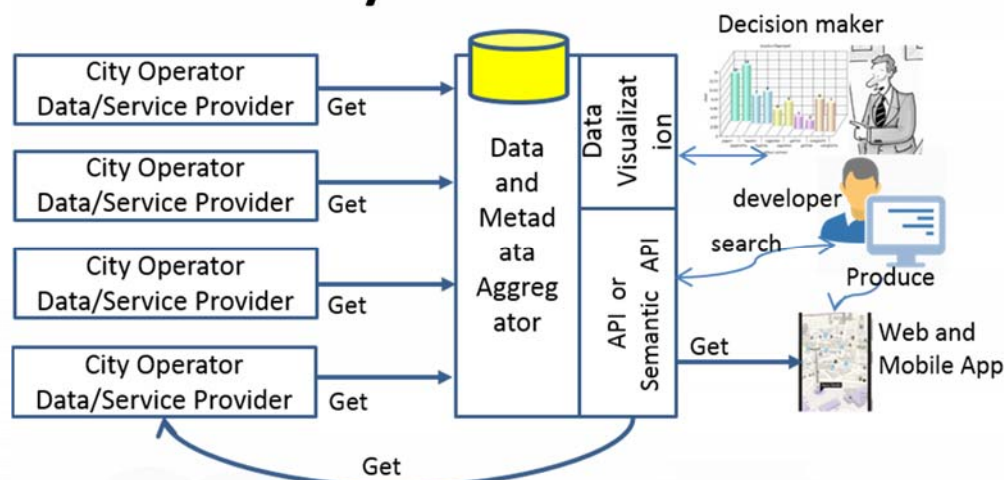
- Collects information about APIs provided by different data and/or service providers (including authentication and licensing)
- Provides a common place to access at the exposed API services and data

- Data & Services are NOT integrated each other
- APIs and data are not semantically interoperable
- The problems in managing the semantic integration of data and services are left in the hands of developers

Example:
EO15 Digital Ecosystem

CASE B)

Smart City API Architectures: Data & Metadata Aggregator



- Collects data and metadata information to index & aggregate them in a **common model**
- The aggregated data are made accessible to web and mobile App via some automatically generated APIs
- In some cases, graphic rendering is provided via data visualization tools

- The **common model** produced does not lead to a satisfactory semantic interoperable data service
- The data are not re-conciliated each other, and maintain the same quality of the original
- The resulting database is typically a set of tables with traditional MySQL capabilities. Thus, the provided APIs are not supported by a domain-oriented ontology

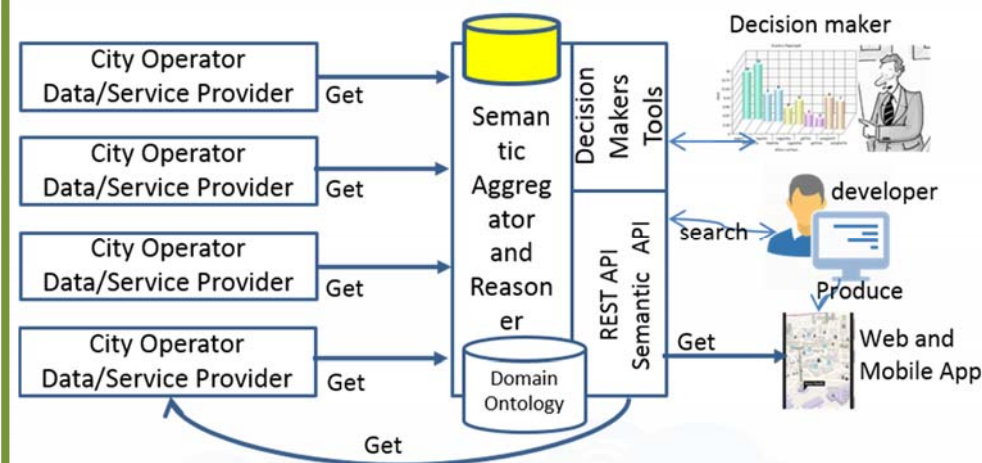
Example:
CKAN, ArcGIS OpenData, etc.

CASE C)



Smart City API Architectures: Semantic Aggregator & Reasoner

- Collects data and services to aggregate and integrate them in a unified and semantically interoperable model based on a multi-domain ontology
- Allows data re-conciliation
- The model defines semantics relationships enabling the inferential processes in the RDF Graph Database
- The obtained KB can be used for: creating strategies, data quality improvement, setting up algorithms and reasoning about the several aspects and services



Examples: CitySDK (with some limitations), KM4City (covering all features)

Smart City API Architectures: Comparison

	Case A) Info Integrator	Case B) Data and Metadata Aggregator	Case C) Semantic Aggregator and Reasoner
Addressing Open Data	Y	Y	Y
Addressing Private Data	Y	Y	Y
Addressing Real Time Data	Y	Y	Y
Addressing Services	Y	N	Y
Providing Data Search	N	Y	Y
Providing Metadata Search	Y	Y	Y
Providing Space Reasoning	N	(partially)	Y
Providing Time Reasoning	N	(partially)	Y
Providing Integrated Authenticated Access to data	Only metadata	Y	Y
Providing Syntactic Interoperable Data/Services	N	Y	Y
Providing Semantic Interoperable data/Services	N	N	Y
Independent from the Data model changes	N	N	Y
Providing REST API on data	N	Y	Y
Providing SPARQL API on data	N	(partially)	Y
Providing inference support on Data	N	N	Y
Providing Data Visualization	N	Y	Y
Providing Decision Maker Support	N	(partially)	Y

- Case C) mainly differ from Case B) for the presence of a real ontological model
- Case C) has to cope with Graph Database collecting huge amount of data (Big Data)
- Main difference perceived by City Users and Decision Makers in case C):
 - Number of smart and cross domain services

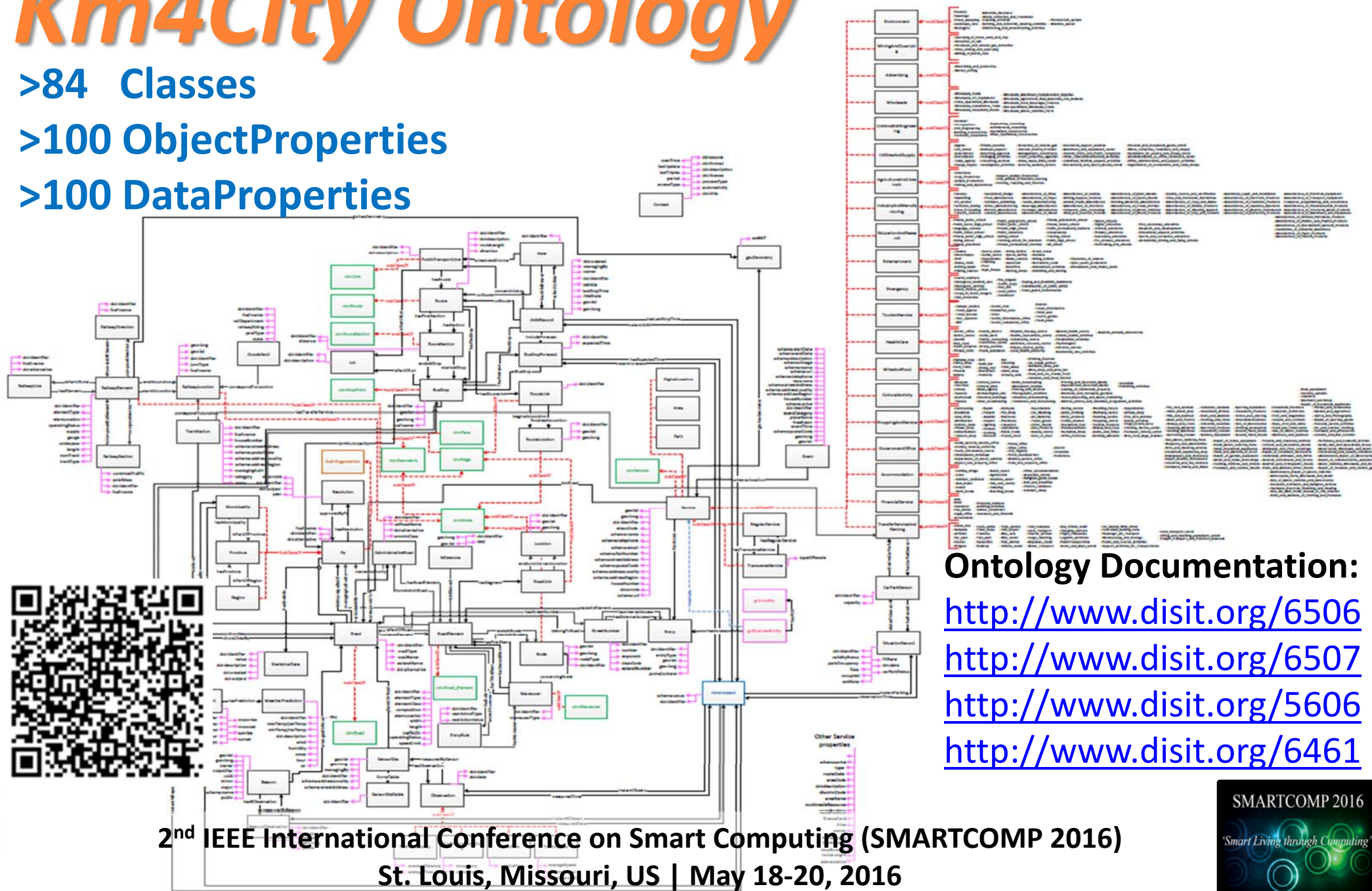


Km4City *Ontology*

>84 Classes

>100 ObjectProperties

>100 DataProperties



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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'Smart Living through Computing'



KM4 City APIs & other API of case C)

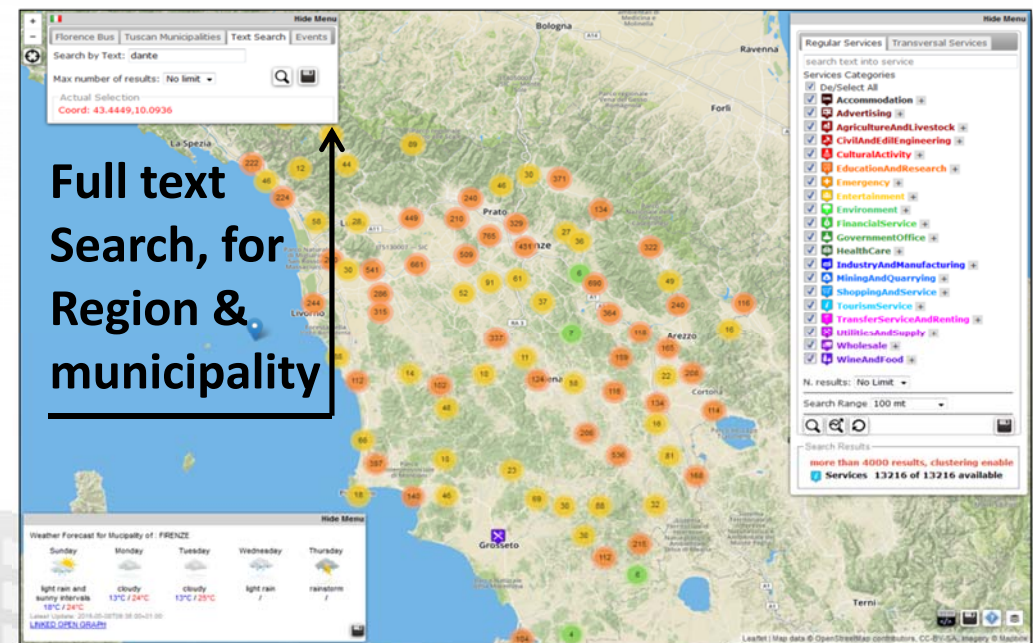
- Comparison in terms of:
 - Service Search,
 - Mobility
 - Environment, Sensors and Actuators
 - User Participation and Awareness
 - Personal Assistant
 - Smart City Interoperability and Dashboard
 - Domains of Geo Located Services
 - API Kind of Call

APIs: Service Search & Mobility

Front end Smart City API domains to provide services to management smart city applications, and to web and mobile applications.	CitySDK	ECIM	Transport.A.P.I	Navitia.io	Km4City
API: Service Search					
Search Full Text	x2	x2		X	X
Search around a GPS point	X	X	X	X	X
Search along a line, polyline	X				X
Search in an area, set of points	X			X	X
Search for region, municipality, etc.				X	X
API: Mobility					
Get Real time delay of Public Busses	X		X	X	X
Get Traffic Flows Status	X	X	X	X	X
Get Parking Status	X	X		X	X
Get a Routing (multi stop planning)	X	X	X		(x)
Get an Intermodal Routing	X	X	X	X	
Get an Integrated Ticketing		X	X	X	(x)
Get a Routing for Good Delivering	X		X		
API: Environment, Sensors and Actuators					
Get Weather Forecast	X			X	X
Get Sensor/Actuator Value/Status	X	X		X	X

ServiceMap

<http://servicemap.disit.org>



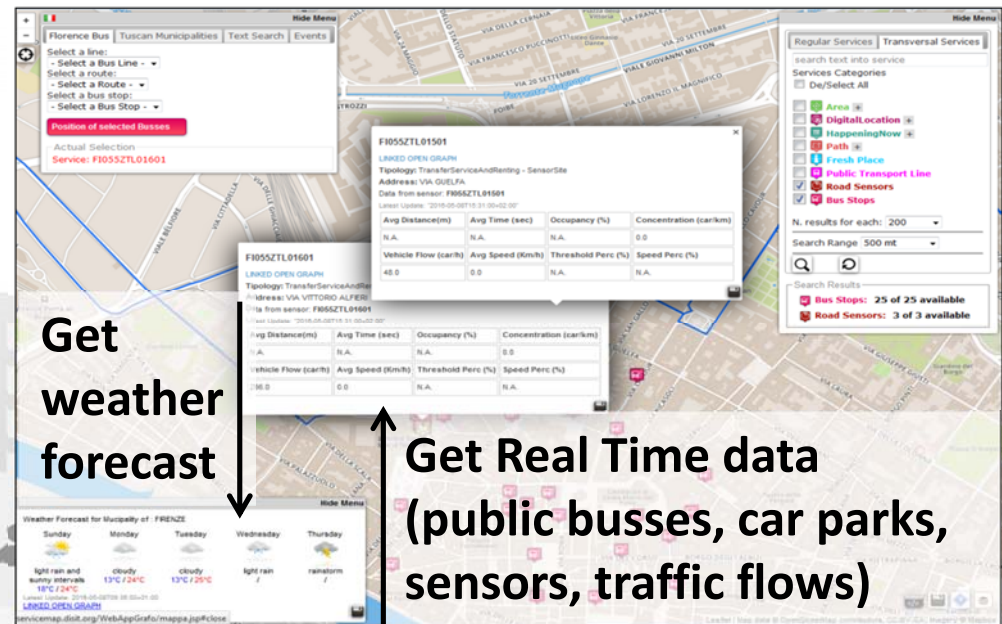
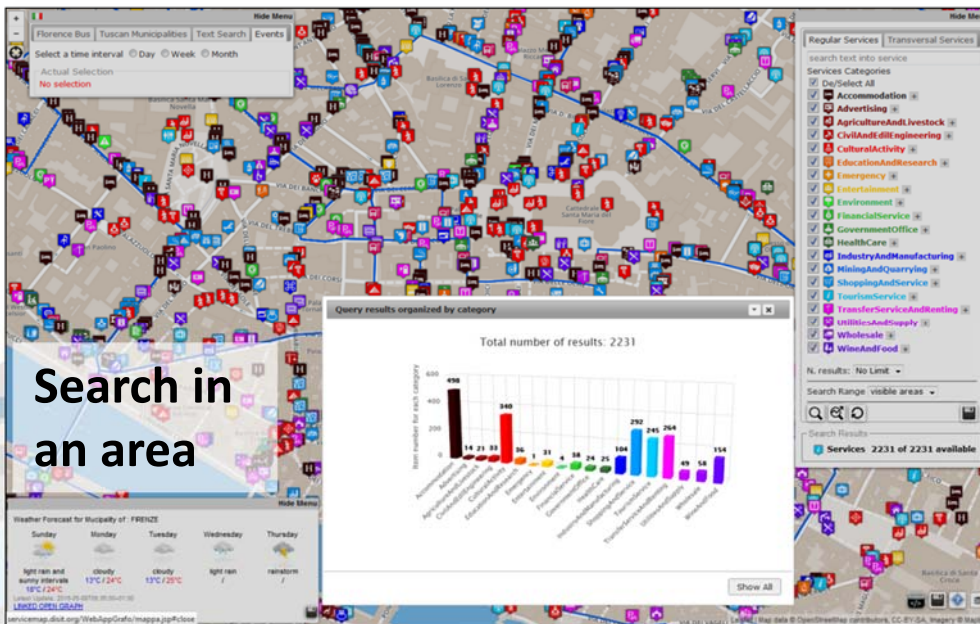
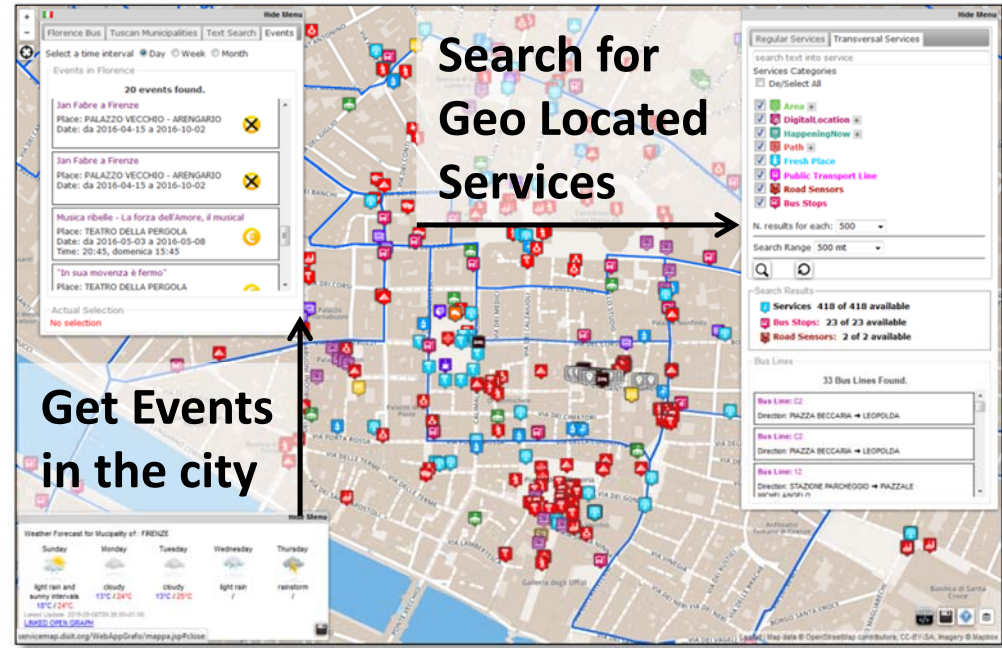
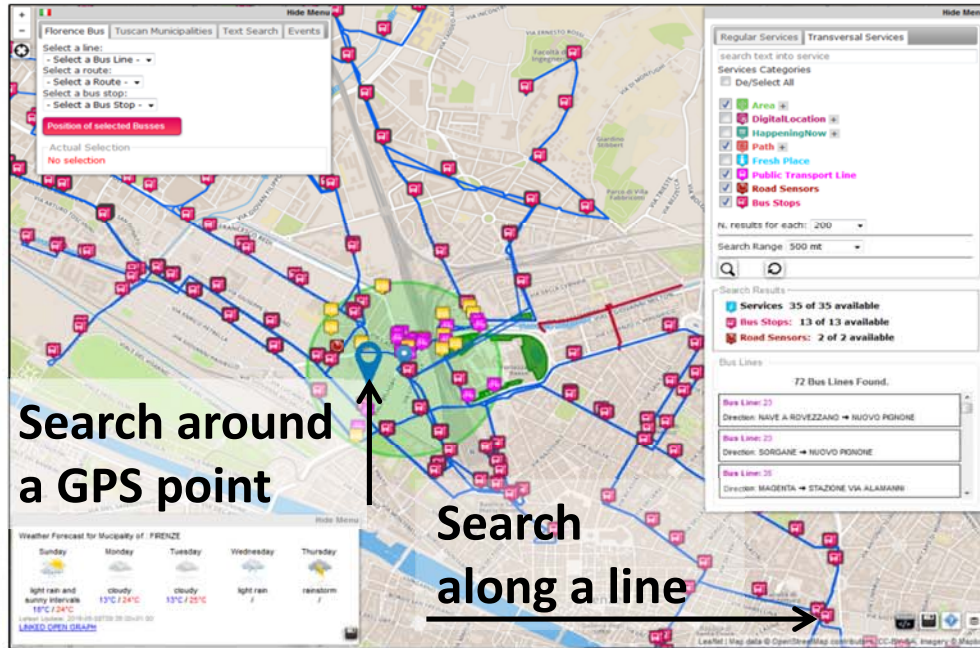


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ServiceMap



Km4city ServiceMap Km4City API

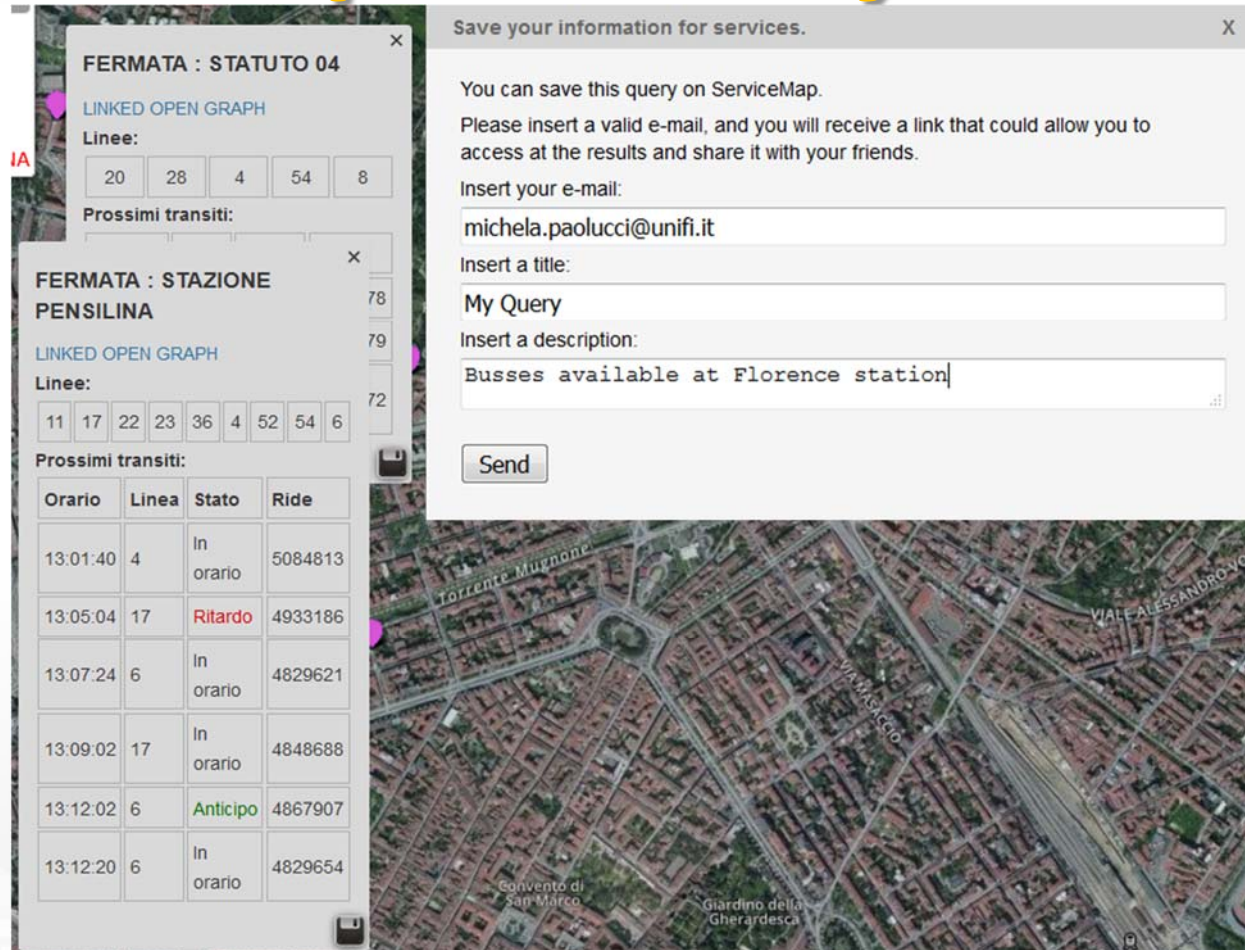
- <http://www.disit.org/6597>

- REST API: serviceURI or Selection or GPS
- REST API: Query ID
- Receive an email
- Get a JSON, HTML, ...

- EMBED facility in third party web pages

- Developers may use the ServiceMap tool to:

- compose geographical and textual queries
- THEN request an e-mail containing the calls (same results in JSON and/or in HTML)



FERMATA : STATUTO 04

LINKED OPEN GRAPH

Linee: 20 28 4 54 8

Prossimi transiti:

FERMATA : STAZIONE PENSILINA

LINKED OPEN GRAPH

Linee: 11 17 22 23 36 4 52 54 6

Prossimi transiti:

Orario	Linea	Stato	Ride
13:01:40	4	In orario	5084813
13:05:04	17	Ritardo	4933186
13:07:24	6	In orario	4829621
13:09:02	17	In orario	4848688
13:12:02	6	Anticipo	4867907
13:12:20	6	In orario	4829654

Save your information for services.

You can save this query on ServiceMap.

Please insert a valid e-mail, and you will receive a link that could allow you to access at the results and share it with your friends.

Insert your e-mail:

Insert a title:

Insert a description:

APIs: User Participation, Awareness Personal Assistant, Geo Located Services

Front end Smart City API domains to provide services to management smart city applications, and to web and mobile applications.	CitySDK	ECIM	Transport.API	Navitia.io	Km4City
API: User Participation and Awareness					
Get Social Media Monitoring Info			X		X
Save Crowd Sourcing Comments	x1		X		X
Save Crowd Sourcing Votes	X	X	X		X
Save Crowd Sourcing Media	X	X	X		X
Get Events in the city/area	X				X
API: Personal Assistant					
Save User Profile	(x)	(x)		(x)	X
Get Suggestions on Demand					X
Get Civil Protection in Push					X
Save Mobile Sensors Status	X	X		X	X
API: Domains of Geo Located Services					
Culture and Tourism	X	X			X
Point of Interest	X	X	X	X	X
Mobility and transport, parking, flow	X	X	X	X	X
Education and training	X	X			X
Government and Pub Services	X	X			X
Commerce and Industry	X	X			X
Health and personal	X	X			X
Public Energy, Energy and home	X	X			X
Energy and Mobility	X	X	X		X

Km4CityMobile App



Florence where, what. Km4City



Mobile APPLICATION

Geo Located Services

Get Suggestions on demand

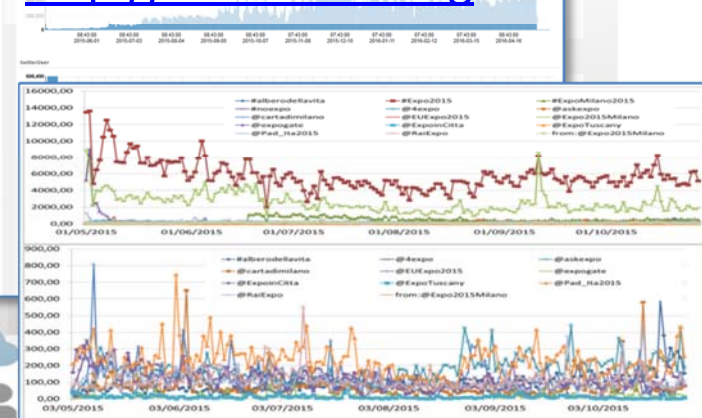
WEB APPLICATION

<http://www.km4city.org>

Twitter Vigilance

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

<http://tvsolr.disit.org>



Get Social Media Monitoring Info

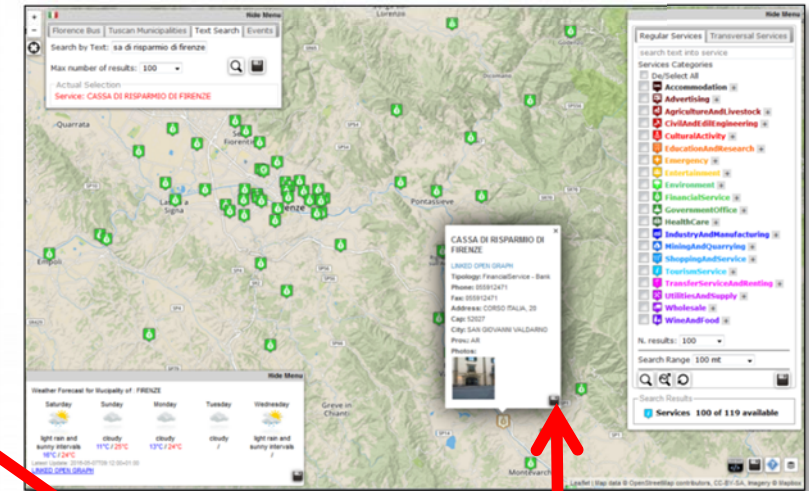
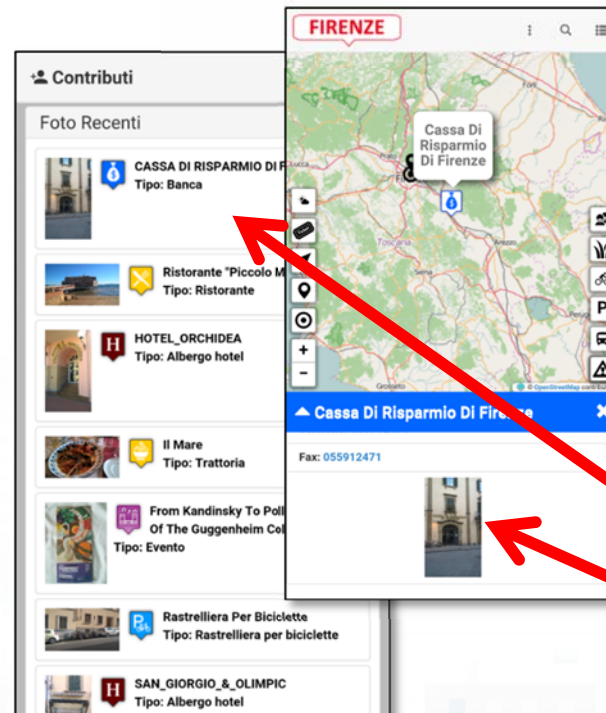
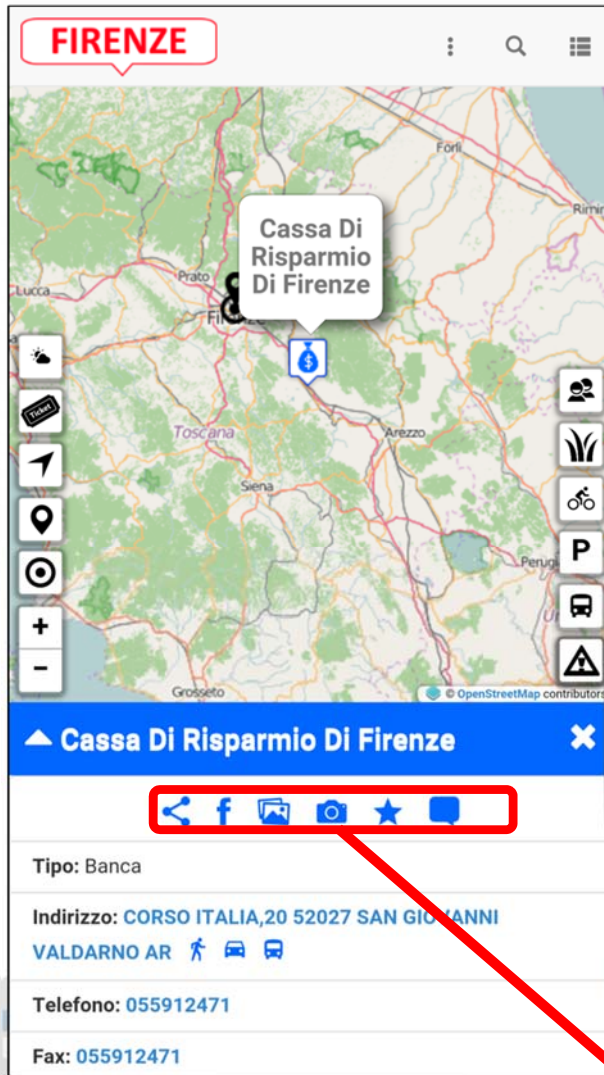


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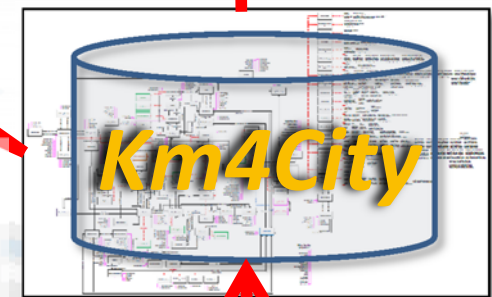
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Collecting contributions from city users



Save Crowd Sourcing Media,
votes, comments, status, ...



Save User Profiles

Photos uploaded from users

date submitted	service	photo	status
2016-04-26 18:55:08.0	CASSA DI RISPARMIO DI FIRENZE		validated
2016-04-25 18:21:06.0	Ristorante "Piccolo Mondo"		validated

APIs: Smart City Interoperability & Dashboard

Front end Smart City API domains to provide services to management smart city applications, and to web and mobile applications.	CitySDK	ECIM	Transport.API	Navitia.io	Km4City
API: Smart City Interoperability and Dash Board					
Save Indicator Values (GPS, CompanyID)					X
Get Indicator Values (Company, ID)					X



Shops,
services,
operators

Transport
systems,
Mobility, Parking



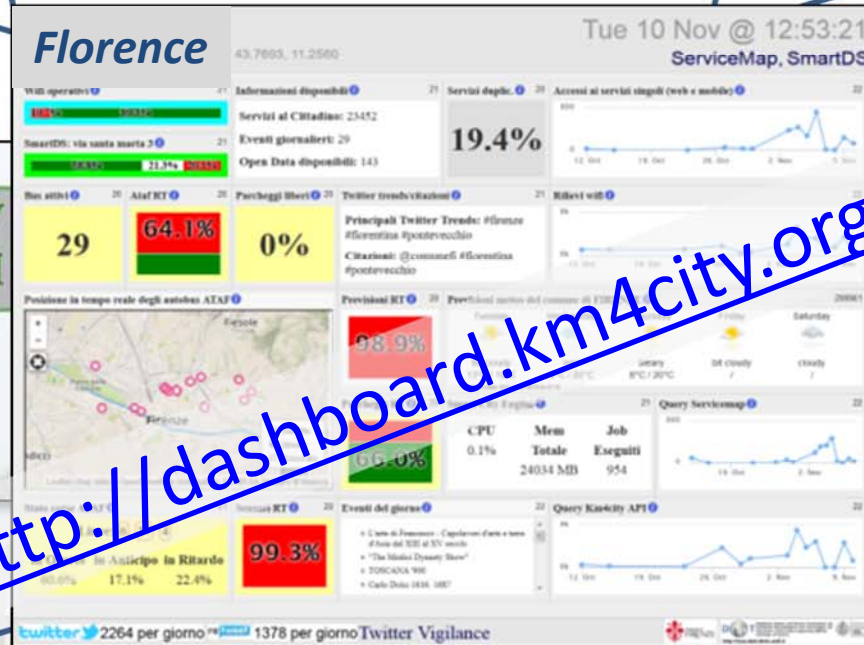
Sensors, IOT
Cameras, ..



Public services,
Govern, Events



Environment, Water, energy



<http://dashboard.km4city.org>



Social Media,
WiFi, Network



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APIs: Kind of Call, Non functional

Front end Smart City API domains to provide services to management smart city applications, and to web and mobile applications.	CitySDK	ECIM	Transport.API	Navitia.io	Km4City
API kind of Call					
SPARQL Query					X
SPARQL Query with Inference					X
REST	X	X	X	X	X
Query ID					X
Non Functional					
Direct API Authentication	X	X	X	X	X
API Authentication via Social Media		X			
Data Licensing Control	X		X	X	X

<http://servicemap.disit.org/WebAppGrafo/api/v1/?queryId=9e5662a352d90ad4bc77690277a371ab&format=html>



← Query ID

SPARQL on
Virtuoso

Virtuoso SPARQL Query Editor

Default Data Set Name (Graph IRI)

Query Text

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX voard: <http://www.w3.org/2006/voard/ns#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX dcm: <http://purl.org/dc/terms/>
PREFIX opengis: <http://www.opengis.net/ont/geosparql#>
SELECT DISTINCT ?via ?numero ?comune ?uriComune WHERE {
  ?entry rdf:type km4c:Entry.
  ?no km4c:hasExternalAccess ?entry.
  ?no km4c:extendNumber ?numero.
  ?no km4c:belongsToRoad ?road.
  ?road km4c:extendName ?via.
  ?entry geolatt ?lat.
  ?entry geolong ?long.
  ?road km4c:inMunicipalityOf ?uriComune.
  ?uriComune foaf:name ?comune.
  ?entry geo:geometry ?geo. filter(bif:st_intersects(?geo, bif:st_point(11.254806518554688, 43.77282920852046), 0.1))
  BIND( bif:st_distance(?geo, bif:st_point(11.254806518554688, 43.77282920852046)) AS ?dist)
}
```

(Security restrictions of this server do not allow you to retrieve remote RDF data, see [details](#))

Results Format:

Execution timeout: milliseconds (values less than 1000 are ignored)

Options: ☒ Strict checking of void variables

(The result can only be sent back to browser, not saved on the server, see [details](#))

Run Query Reset

SPARQL

<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

Query 1

```
1 PREFIX km4c: <http://www.disit.org/km4city/schema#>
2 PREFIX foaf: <http://xmlns.com/foaf/0.1/>
3 SELECT DISTINCT * WHERE {
4   ?s a km4c:BusStop;
5     foaf:name ?l;
6     geo:geometry ?geo.
7   BIND(bif:st_distance
8         [?geo, bif:st_point(11.2484, 43.7765)]
9         AS ?dist)
10  FILTER(?dist <= 0.1)
11 } ORDER BY ?dist
```

Submit

Samples SPARQL Properties Classes Prefixes

Select all municipalities names.

```
PREFIX km4c: <http://www.disit.org/km4city/schema#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT DISTINCT * WHERE {
  ?s a km4c:Municipality;
  foaf:name ?l.
} ORDER BY ?l LIMIT 100
```

Bus stops near the Florence SMN train station

The bus stops within 100m of the Florence SMN

```
PREFIX km4c: <http://www.disit.org/km4city/schema#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT DISTINCT * WHERE {
  ?s a km4c:BusStop;
  foaf:name ?l.
}
```

Line: 8; Position: 7; Query is valid

Query Results

#	s	l	geo	dist
1	http://www.disit.org/km4city/resource/FM0022	STAZIONE PENSILINA	POINT(11.2491 43.7765)	0.0544402
2	http://www.disit.org/km4city/resource/FM2143	STAZIONE GALLERIA	POINT(11.2482 43.7759)	0.0648533
3	http://www.disit.org/km4city/resource/FM1898	STAZIONE VALFONDA	POINT(11.2484 43.7772)	0.0768214
4	http://www.disit.org/km4city/resource/FM0452	STAZIONE LARGO ALINARI	POINT(11.2495 43.7765)	0.0898297
5	http://www.disit.org/km4city/resource/FM0313	STAZIONE PARCHEGGIO	POINT(11.2493 43.776)	0.0923469

<http://servicemap.disit.org/WebAppGrafo/sparql?query=...>

s	l	geo	dist
http://www.disit.org/km4city/resource/FM0022	"STAZIONE PENSILINA"	"POINT(11.249077 43.776466)"^^<http://www.openlinksw.com/schemas/virtrdf#Geometry>	0.0544402
http://www.disit.org/km4city/resource/FM2143	"STAZIONE GALLERIA"	"POINT(11.248156 43.775944)"^^<http://www.openlinksw.com/schemas/virtrdf#Geometry>	0.0648533
http://www.disit.org/km4city/resource/FM1898	"STAZIONE VALFONDA"	"POINT(11.248416 43.777191)"^^<http://www.openlinksw.com/schemas/virtrdf#Geometry>	0.0768214
http://www.disit.org/km4city/resource/FM0452	"STAZIONE LARGO ALINARI"	"POINT(11.249519 43.776512)"^^<http://www.openlinksw.com/schemas/virtrdf#Geometry>	0.0898297
http://www.disit.org/km4city/resource/FM0313	"STAZIONE PARCHEGGIO"	"POINT(11.249316 43.775997)"^^<http://www.openlinksw.com/schemas/virtrdf#Geometry>	0.0923469

<http://servicemap.disit.org/WebAppGrafo/sparql?query=...&format=JSON>

```
"head": {
  "results": {
    "distinct": false,
    "ordered": true,
    "bindings": [
      {
        "s": {
          "type": "uri",
          "value": "http://www.disit.org/km4city/resource/FM0022"
        },
        "l": {
          "type": "literal",
          "value": "STAZIONE PENSILINA"
        },
        "geo": {
          "type": "literal",
          "value": "POINT(11.249077 43.776466)"
        },
        "dist": {
          "type": "literal",
          "value": "0.0544402"
        }
      }
    ]
  }
}
```




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Km4City Engine



Transport systems
Mobility, parking



Public Services
Govern, events,



Sensors, IOT
Cameras, ..



Environment,
Water, energy



Shops, services,
operators



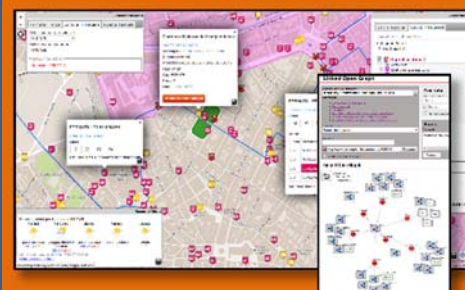
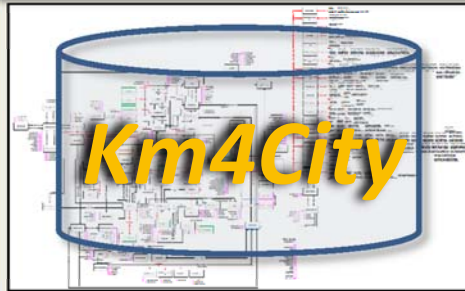
Social Media
WiFi, network



Static, Slow and Real Time data flows

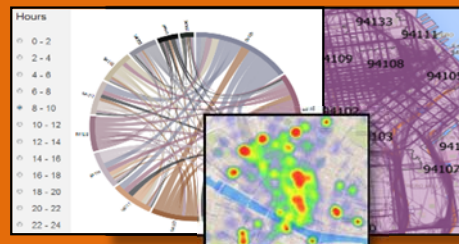
DISCES -- Distributed and parallel architecture on Cloud

Km4City Smart City Engine



User Profiling and Suggestions on Demand

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



Km4City Tools for Developers

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>

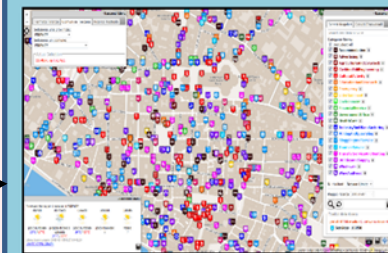


Service map browser

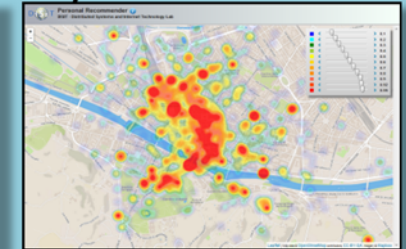
<http://servicemap.km4city.org>

Twitter Vigilance

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



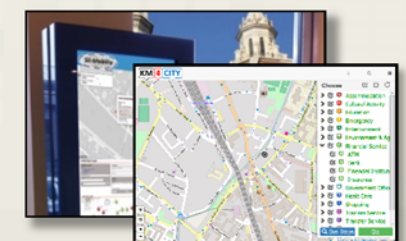
Collective User behavior Analyzer



Tools for Final Users

Mobile e Web Apps

<http://www.km4city.org>

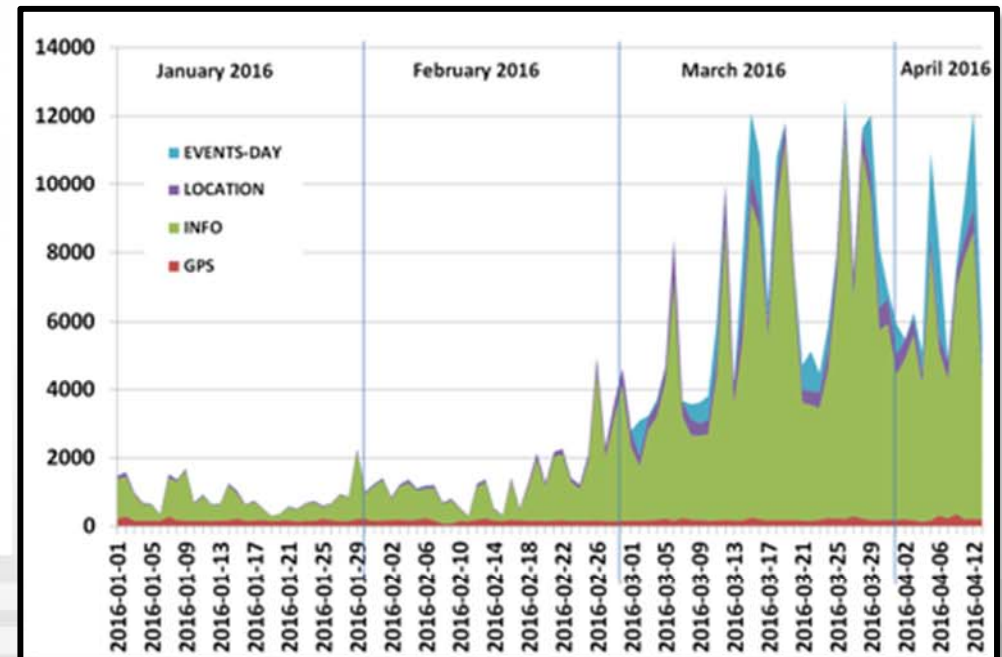


<http://www.km4city.org/app>

Data Results about KM4City

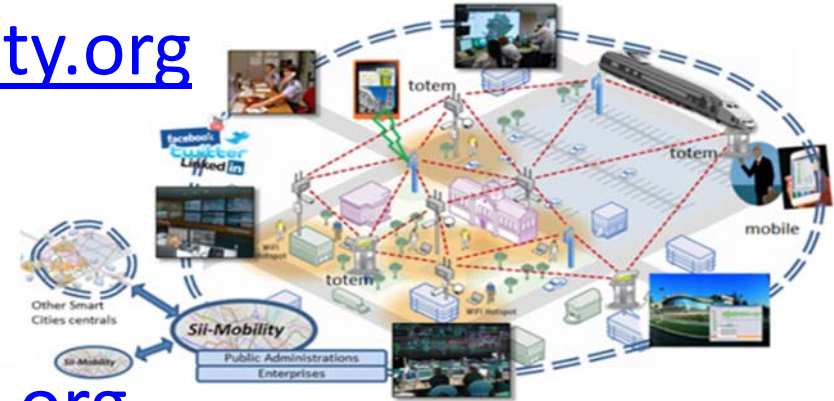
Received calls from applications to KM4City APIs

API mode	Jan.	Feb.	Mar.
<i>api-service-info</i>	21.118	36.826	173.303
<i>api-services-by-gps</i>	5.573	4.789	5.997
<i>api-location</i>	1.418	3.738	18.444
<i>api-events-day</i>	263	267	17,678
<i>api-text-search</i>	533	440	729
<i>api-services</i>	157	131	401
<i>api-events-week</i>	21	26	36
<i>api-events-month</i>	20	25	25
<i>api-services-by-queryid</i>	13	20	15
<i>api-service-photo</i>	10	5	11
<i>api-services-by-municipality</i>	2	13	3
<i>api-service-stars</i>	1	-	5
<i>api-service-comment</i>	1	-	4
total	29.130	46.280	216.651
format	Jan.	Feb.	Mar.
HTML (calls on servicesmap interface for developers)	179	157	444
JSON	28.939	46.118	216.187
total	29.118	46.275	216.651



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
Urbain **T**ransport **E**nvironment

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



REPLICATE

REnaissance of **PL**aces
with **I**nnovative **C**itizenship
And **T**echnology

2nd IEEE International Conference on Smart Computing (SMARTCOMP 2016)

St. Louis, Missouri, US | May 18-20, 2016

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Km4City Smart City API: an integrated support for mobility services

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