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# Km4City Smart City API: an integrated support for mobility services

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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**

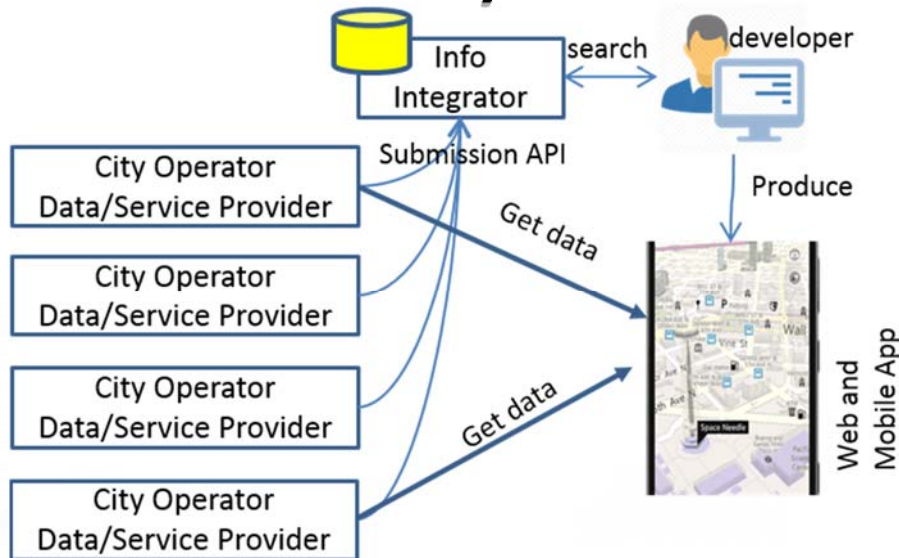


# Smart City API Architectures

- 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



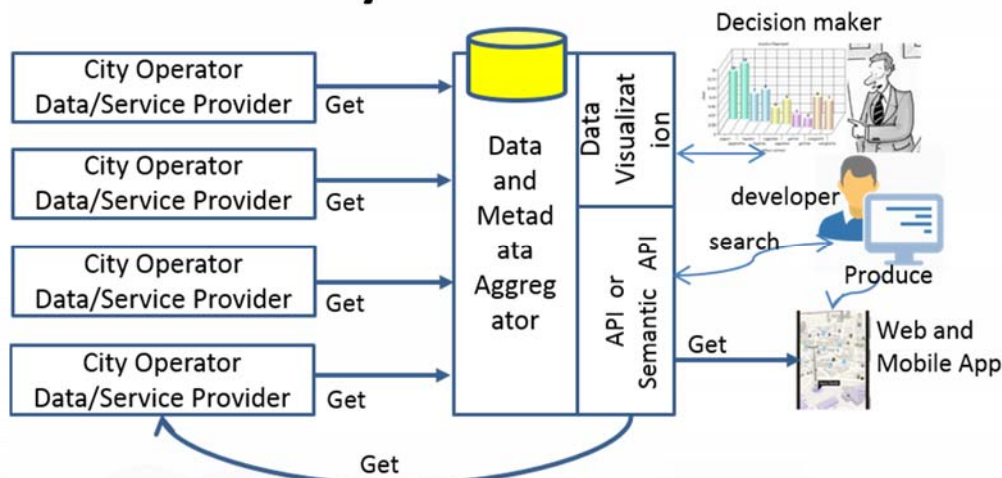
- Collects information about APIs provided by different data and/or service providers (including authentication and licensing)
- Provides a common place to access at the exposed API services and data

- 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

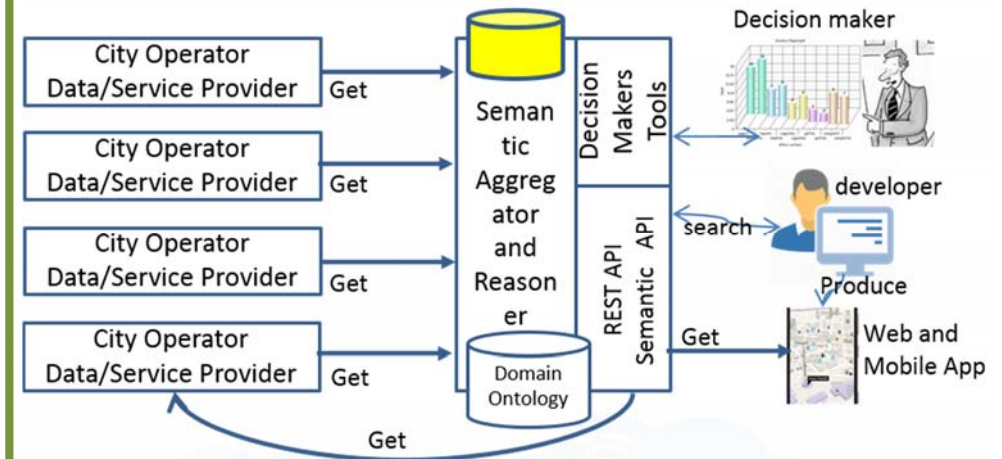
Example:  
CKAN, ArcGIS OpenData, etc.

## 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

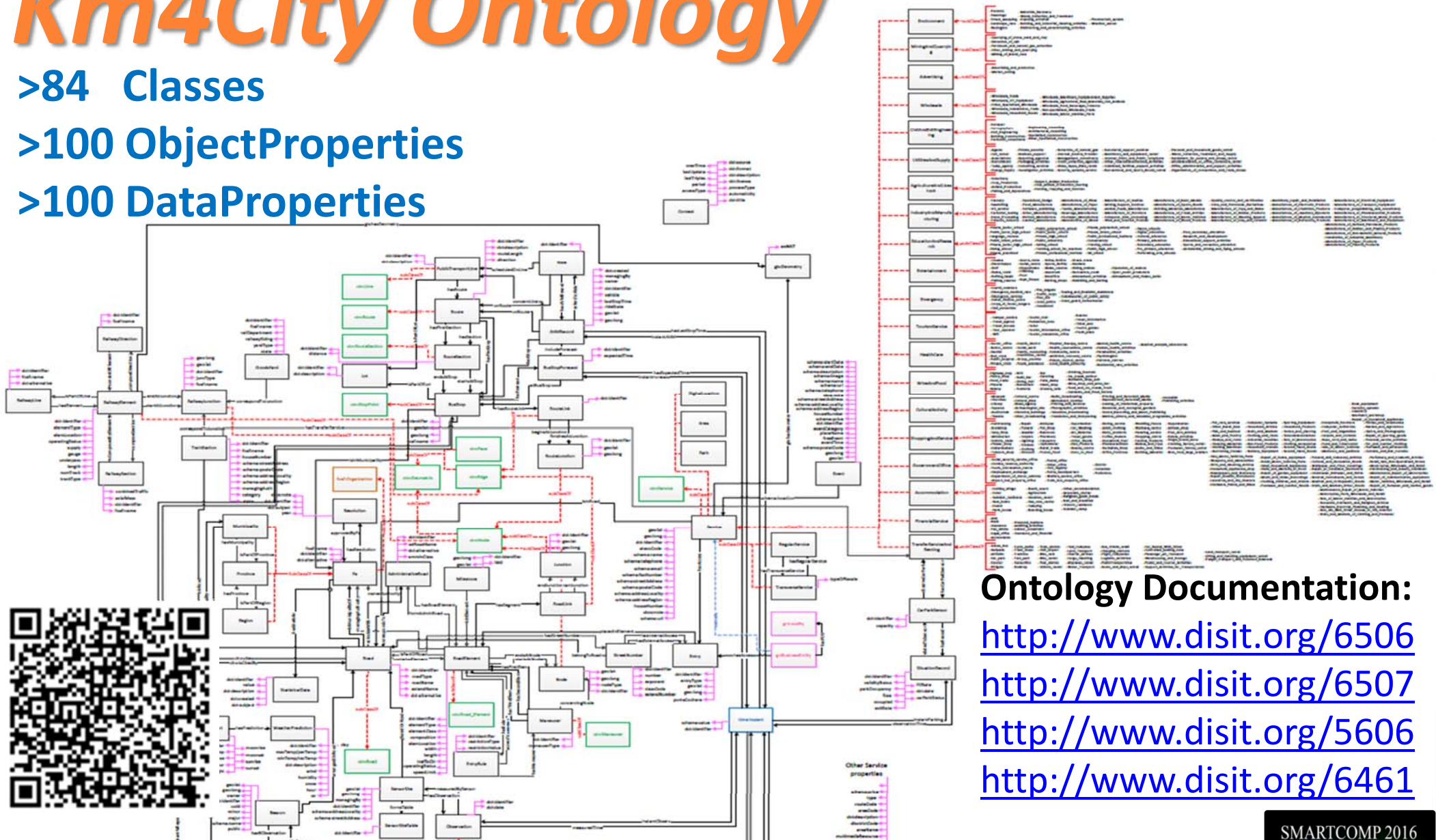


# Km4City Ontology

>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>







# KM4 City APIs & other API of case C)

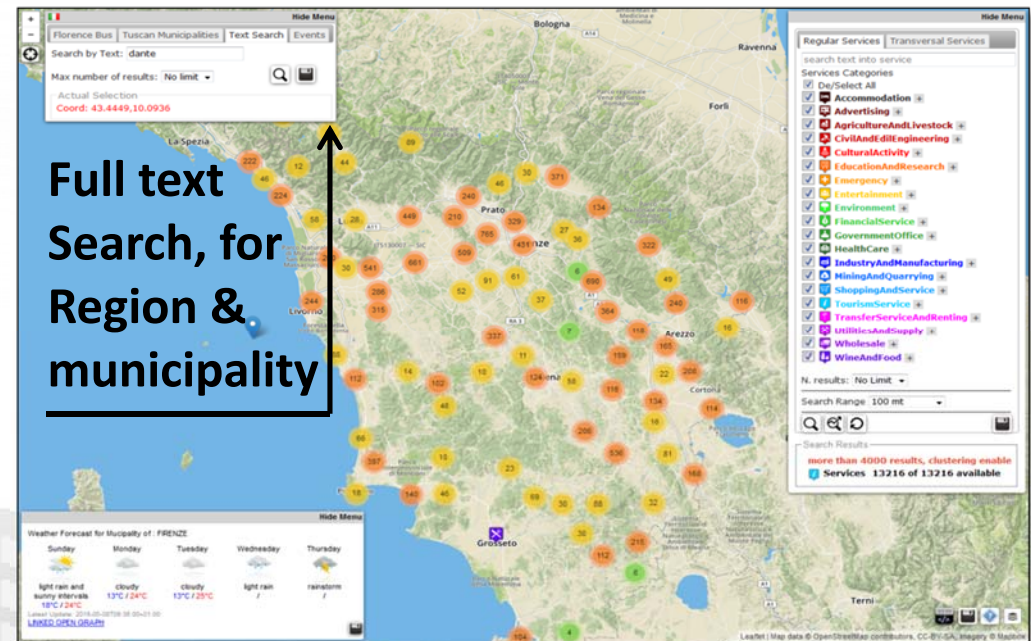
- Comparison in terms of:
  - Service Search,
  - Mobility
  - Environment, Sensors and Actuators
  - User Participation and Awareness
  - Personal Assistant
  - Smart City Interoperability and Dashboard
  - Domains of Geo Located Services
  - API Kind of Call

# 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.API	Navitia.io	Km4City
<b>API: Service Search</b>					
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
<b>API: Mobility</b>					
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		
<b>API: Environment, Sensors and Actuators</b>					
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



**Search around a GPS point**

**Search along a line**

Regular Services: 35 of 35 available  
 Bus Stops: 13 of 13 available  
 Road Sensors: 2 of 2 available

72 Bus Lines Found.

Bus Line: 23  
 Direzione: NAVE A ROVEZZANO → NUOVO PINONE

Bus Line: 23  
 Direzione: BORGANE → NUOVO PINONE

Bus Line: 35  
 Direzione: MAGENTA → STAZIONE VIA ALAMANNI

**Search for Geo Located Services**

**Get Events in the city**

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

Services: 418 of 418 available  
 Bus Stops: 23 of 23 available  
 Road Sensors: 2 of 2 available

33 Bus Lines Found.

Bus Line: C2  
 Direzione: PIAZZA BECCARIA → LEOPOLDA

Bus Line: C2  
 Direzione: PIAZZA BECCARIA → LEOPOLDA

Bus Line: L2  
 Direzione: STAZIONE PIACCHEDI → PIAZZALE servizi autostrada

**Search in an area**

Query results organized by category

Total number of results: 2231

Category	Number of Results
Accommodation	18
Advertising	21
AgricultureAndLivestock	31
CivilAndITditiEngineering	11
CulturalActivity	11
EducationAndResearch	11
Emergency	11
Environment	11
FinancialService	11
GovernmentOffice	11
HealthCare	11
IndustryAndManufacturing	11
MiningAndQuarrying	11
ShoppingAndService	11
TourismService	11
TransportServiceAndRenting	11
UtilitiesAndSupply	11
Wholesale	11
WineAndFood	11

Services: 2231 of 2231 available

**Get weather forecast**

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

Service: F1055ZTL01601

Parameter	Value
Avg Distance(m)	N.A.
Avg Time (sec)	N.A.
Occupancy (%)	N.A.
Concentration (car/km)	0.0
Vehicle Flow (car/h)	N.A.
Avg Speed (km/h)	N.A.
Threshold Perc (%)	N.A.
Speed Perc (%)	N.A.

Bus Stops: 25 of 25 available  
 Road Sensors: 3 of 3 available

# 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)

The screenshot shows the ServiceMap tool interface. It features two query windows and a 'Save your information for services' form.

**Query Window 1: FERMATA : STATUTO 04**

LINKED OPEN GRAPH

Linee: 20 28 4 54 8

Prossimi transiti:

**Query Window 2: 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:



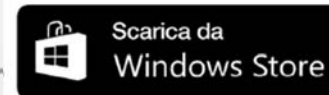
# APIs: User Participation, Awareness Personal Assistant, Geo Located Services

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
<b>API: User Participation and Awareness</b>					
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
<b>API: Personal Assistant</b>					
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
<b>API: Domains of Geo Located Services</b>					
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



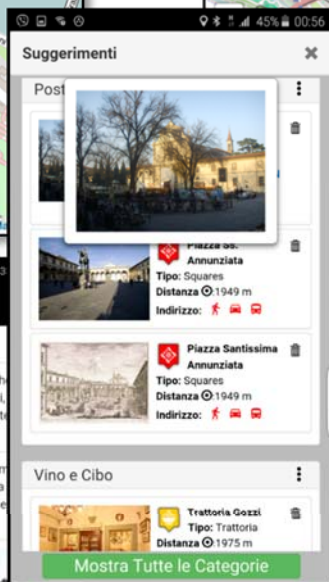
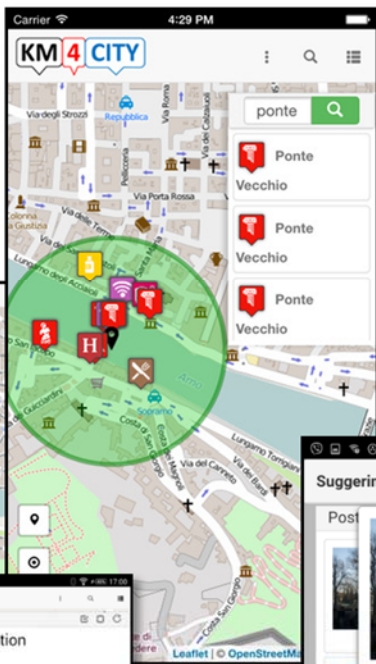


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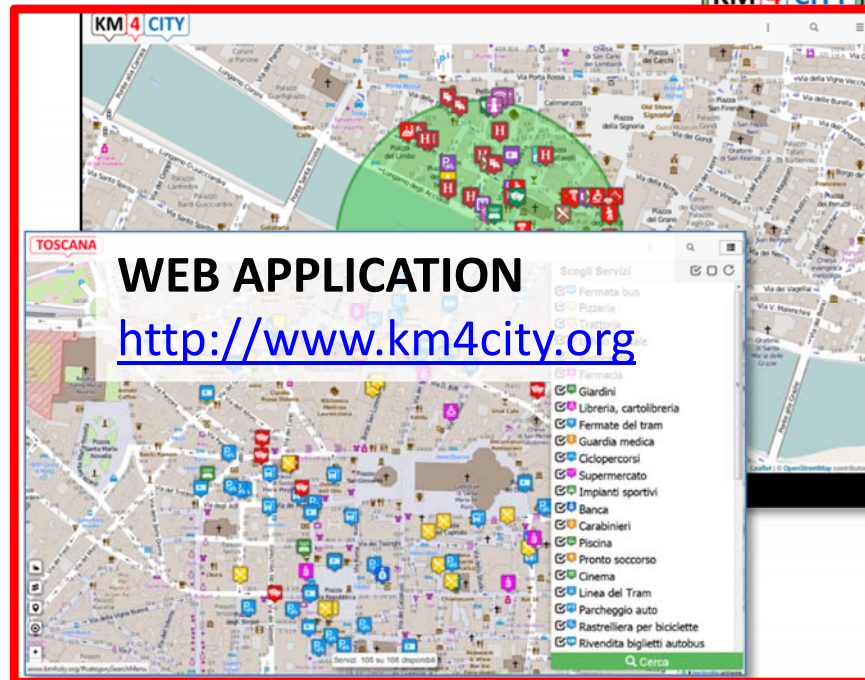
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# Mobile APPLICATION



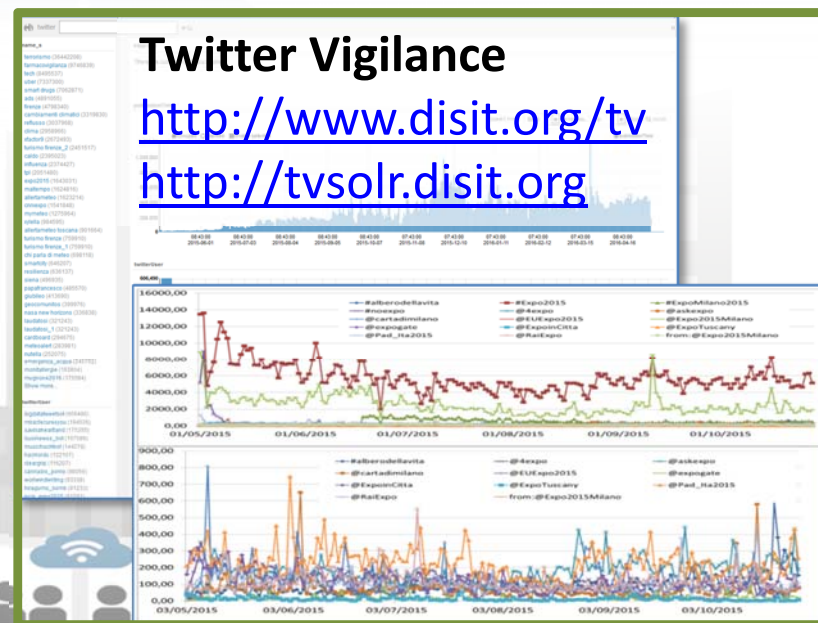
Geo Located  
Services

Get  
Suggestions  
on demand



WEB APPLICATION

<http://www.km4city.org>



Twitter Vigilance

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

<http://tvslr.disit.org>

Get Social Media Monitoring Info



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# Collecting contributions from city users



**FIRENZE**

Cassa Di Risparmio Di Firenze

**Cassa Di Risparmio Di Firenze**

Tipo: Banca

Indirizzo: CORSO ITALIA,20 52027 SAN GIOVANNI VALDARNO AR

Telefono: 055912471

Fax: 055912471

Share icons: back, share, photo, video, star, comment

**FIRENZE**

Contributi

Foto Recenti

- CASSA DI RISPARMIO DI FIRENZE  
Tipo: Banca
- Ristorante "Piccolo Mondo"  
Tipo: Ristorante
- HOTEL\_ORCHIDEA  
Tipo: Albergo hotel
- Il Mare  
Tipo: Trattoria
- From Kandinsky To Pollack  
Tipo: Evento
- Rastrelliera Per Biciclette  
Tipo: Rastrelliera per biciclette
- SAN\_GIORGIO\_ & OLIMPIC  
Tipo: Albergo hotel

Search by Text: sa di risparmio di firenze

Max number of results: 100

Actual Selection: Service: CASSA DI RISPARMIO DI FIRENZE

Weather Forecast for Municipality of FIRENZE

Regular Services | Transversal Services

search text into service

Services Categories

- Accommodation
- Advertising
- AgricultureAndLivestock
- CallCenterEngineering
- CulturalActivity
- EducationAndResearch
- Emergency
- Entertainment
- Environment
- FinancialService
- GovernmentOffice
- HealthCare
- IndustryAndManufacturing
- InformationAndCommunication
- ShoppingAndService
- TourismService
- TransportAndInfrastructure
- UtilitiesAndSupply
- Wholesale
- WholesaleAndRetail

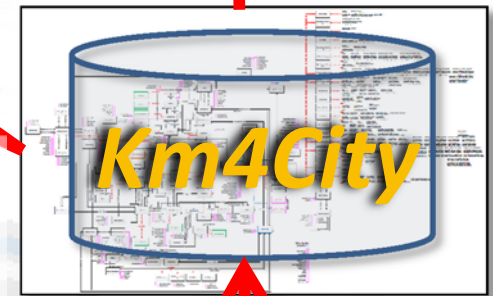
N. results: 100

Search Range: 100 mt

Search Results

Services: 100 of 119 available

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



## Photos uploaded from users

date submitted	service	photo	status
2016-04-26 18:55:08.0	<a href="#">CASSA DI RISPARMIO DI FIRENZE</a>		validated
2016-04-25 18:21:06.0	<a href="#">Ristorante "Piccolo Mondo"</a>		validated

Save User Profiles



# 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



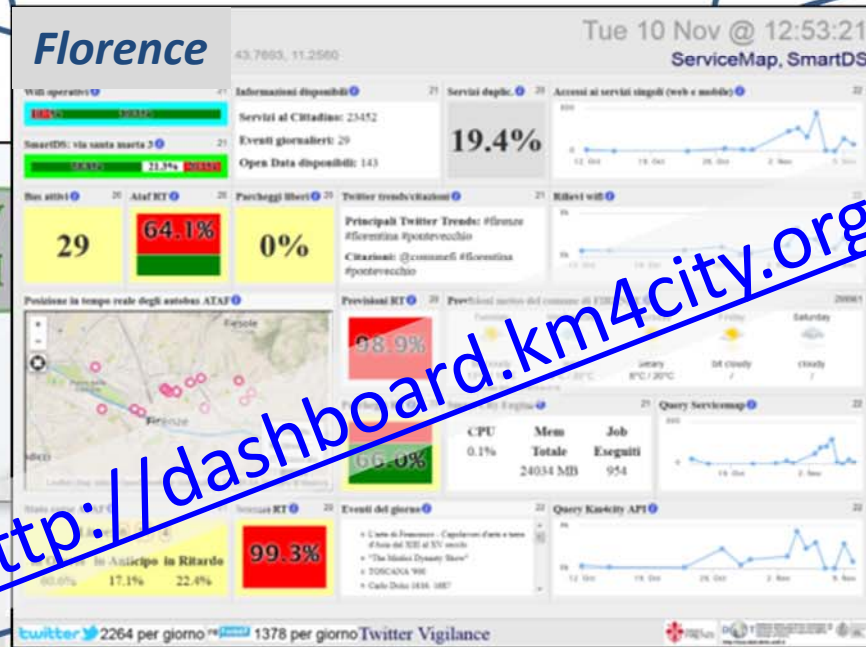
Sensors, IOT  
Cameras, ..



Public services,  
Govern, Events



Environment, Water, energy



<http://dashboard.km4city.org>



Social Media,  
WiFi, Network





# APIs: Kind of Call, Non functional

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

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



← Query ID

SPARQL on ↓

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 doctms:<http://purl.org/doctms/>
PREFIX opengis:<http://www.opengis.net/ont/geosparql#>
SELECT DISTINCT ?via ?numero ?comune ?uriComune WHERE (
?entry rdf:type km4:Entry.
?no km4:hasExternalAccess ?entry.
?no km4:extendNumber ?numero.
?no km4:belongToRoad ?road.
?road km4:extendName ?via.
?entry geo:lat ?elat.
?entry geo:long ?elong.
?road km4: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)
```

Results Format: HTML

Execution timeout: 0 milliseconds

Options:  Strict checking of void variables

Run Query Reset

SPARQL ↓

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

Flint SPARQL Editor 1.0.3

Dataset: KM4CITY Mode: SPARQL 1.1 Query

```
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
```

Output: SPARQL-XML

Bus stops near the Florence SMN train station

The bus stops within 100m of the Florence SMN

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

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

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

```



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# Km4City Engine



Transport systems  
Mobility, parking



Public Services  
Govern, events,



Sensors, IOT  
Cameras, ..



Environment,  
Water, energy



Shops, services,  
operators



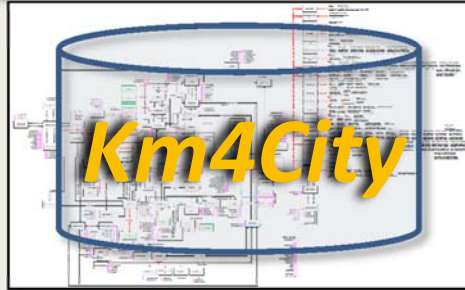
Social Media  
WiFi, network



Static, Slow and Real Time data flows

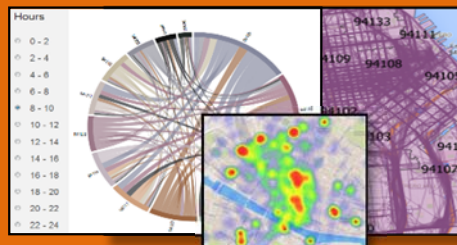
DISCES -- Distributed and parallel architecture on Cloud

## Km4City Smart City Engine



User Profiling and  
Suggestions on Demand

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



Km4City Tools for Developers

Km4City Smart City API

Tools for City Operators and Decision Makers  
Smart City Dashboard      Smart Decision Support

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

<http://Smartds.km4city.org>

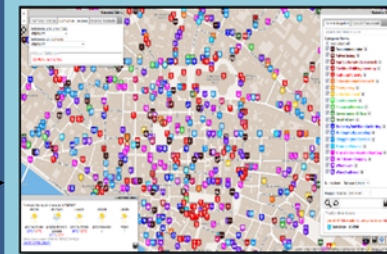


Service map browser

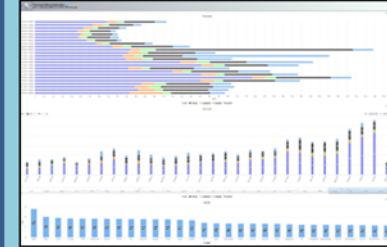
<http://servicemap.km4city.org>

Twitter Vigilance

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



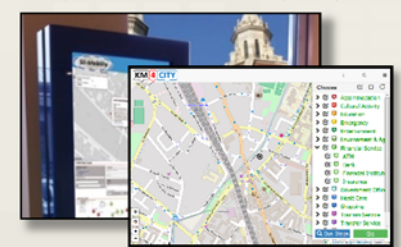
Collective User behavior Analyzer



Tools for Final Users

Mobile e Web Apps

<http://www.km4city.org>



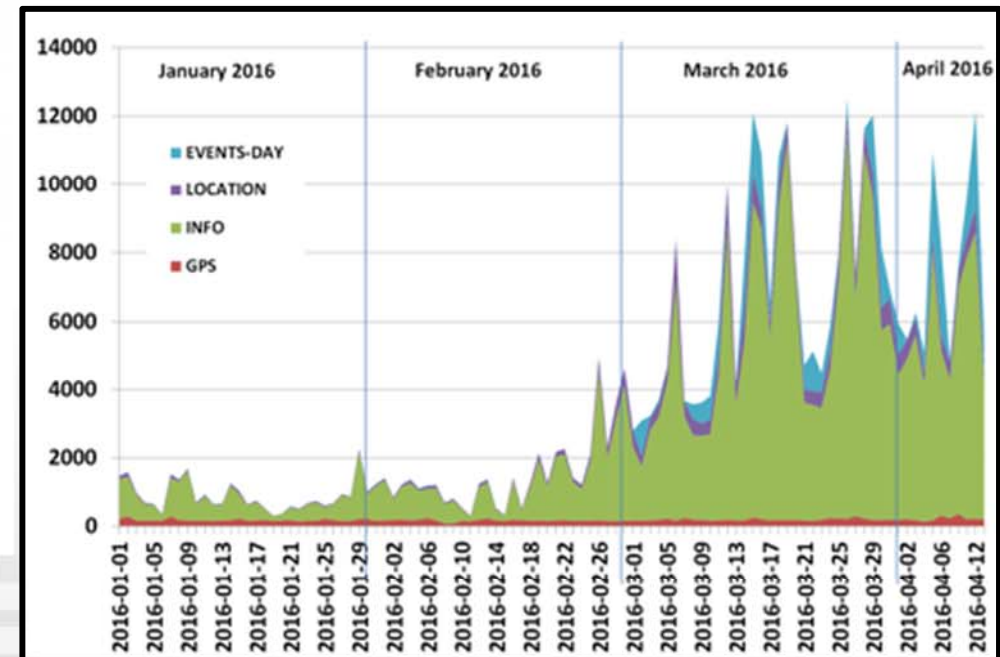
<http://www.km4city.org/app>



# 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
<b>total</b>	<b>29.130</b>	<b>46.280</b>	<b>216.651</b>
format	Jan.	Feb.	Mar.
HTML (calls on servicesmap interface for developers)	179	157	444
JSON	28.939	46.118	216.187
<b>total</b>	<b>29.118</b>	<b>46.275</b>	<b>216.651</b>





# Projects based on KM4City

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



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



**RES**ilience management guidelines  
and **O**perationalization appLied to  
**U**rbain **T**ransport **E**nvironment

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



## REPLICATE

REnaissance of PLACES  
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# Km4City Smart City API: an integrated support for mobility services

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