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resolute

Functional Resonance Analysis Method based-Decision Support tool for Urban Transport System Resilience Management

E. Bellini, P. Nesi, G. Pantaleo, A. Venturi

Distributed Systems and Internet Technology, DISIT Lab, Univ. of Florence, Italy

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

paolo.nesi@unifi.it

Problem and issues

- **Cities include critical infrastructures strongly related / depended each other:**

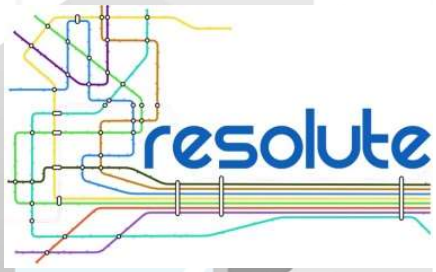
  Transport, energy, communication, cyber, health...

- **Risks for these Critical Infrastructure (**safety and security) may be due to natural and/or human made events.
- **UTS, Urban Transport System**, is one of the most challenging since UTS is the via by which many problems may propagate but also the path used by solutions and the recovery actions.

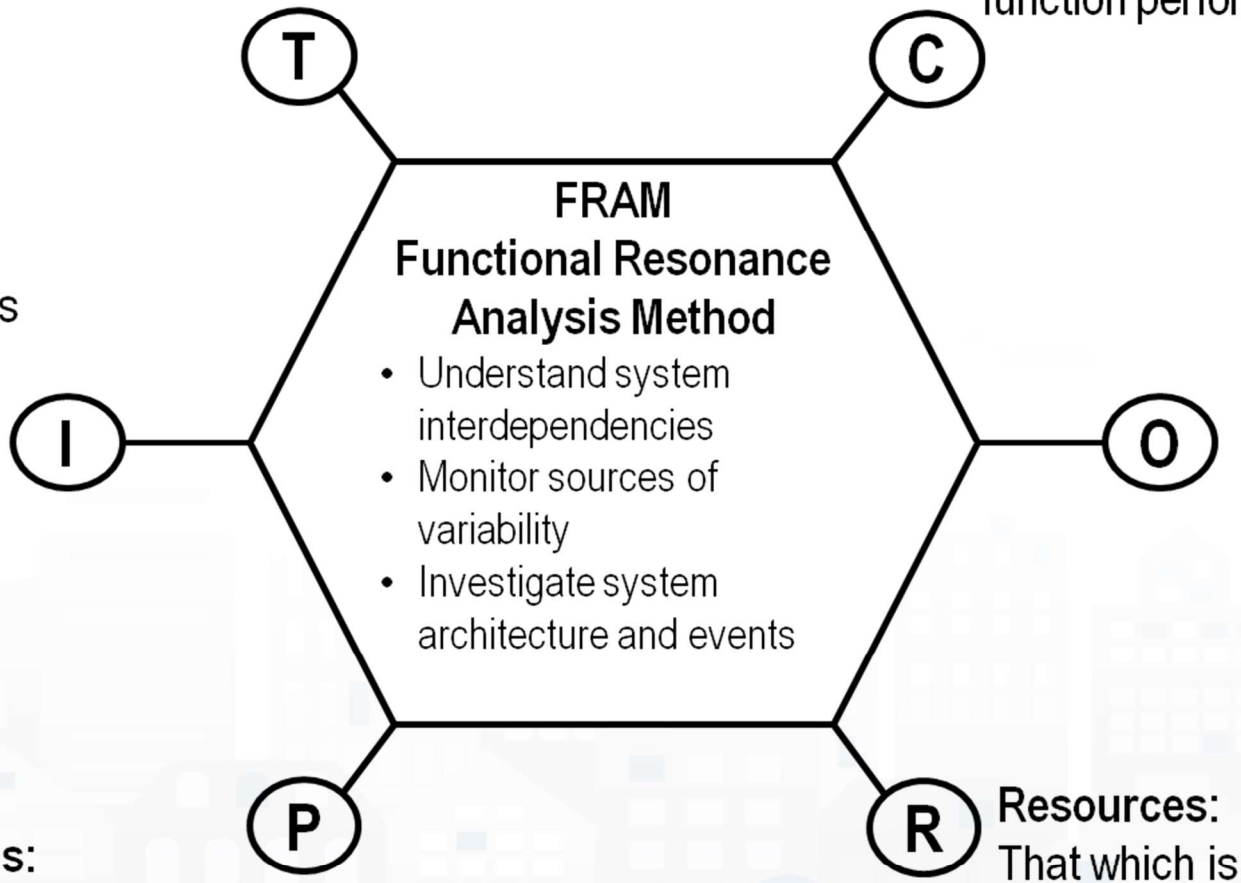
Main Approach

- **Three main layers**

1. **Complex System modeling**: function, processes, resources, time, events, etc..
   - Functional Resonance Analysis Method, FRAM
   - Resilience Analysis Grid, RAG
2. **Decision Support System**, DSS
   - E.g.: System Thinking, Goal Models
3. **Data, big data access and** exploitation
   - Data Analytics
   - Internet of Things, sensors, flows



Functional Resonance Analysis Method



Time:
This is simultaneously a resource and a constraint

Controls:
That which supervises or adjust function performance

Input:
That which engages function operation and is used to produce the function output

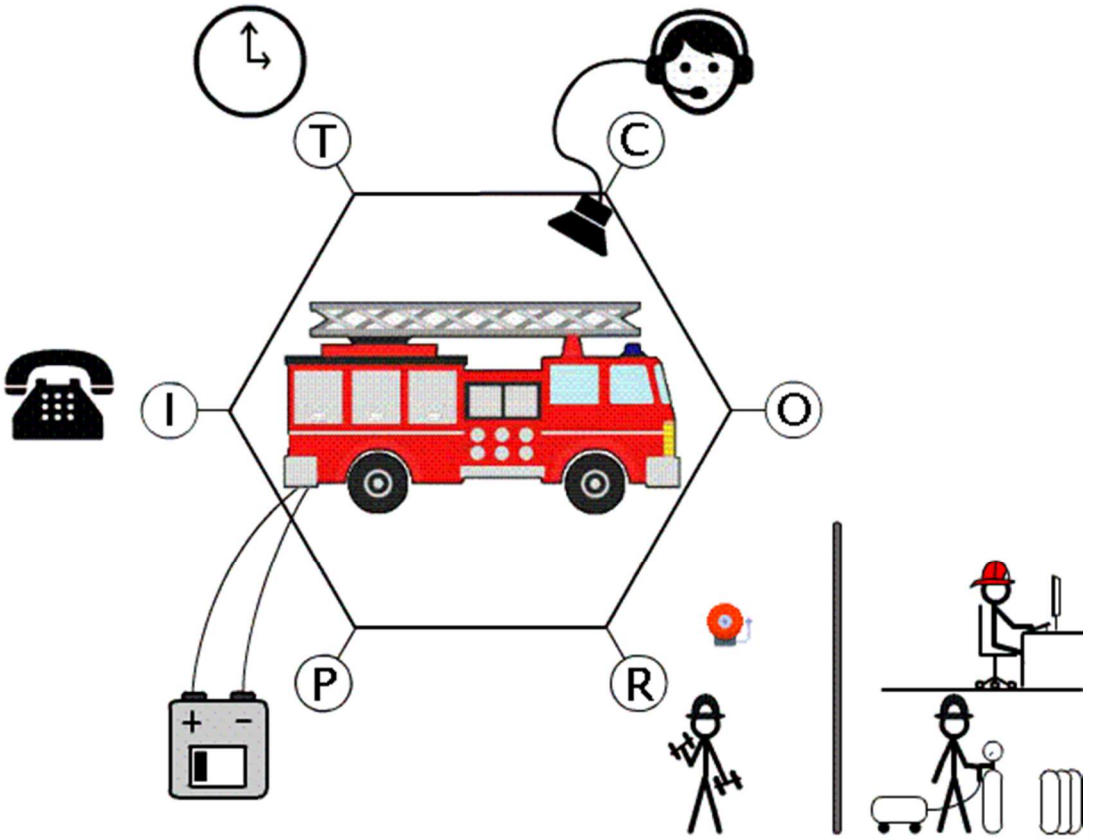
Output:
That which is produced by the function and becomes the input for other functions

Preconditions:
System conditions that must be met before function can be carried out

Resources:
That which is needed and/or consumed by the function to process the input

Functional Resonance Analysis Method

- **Success and failure are equivalent** in the sense that they both emerge from performance variability.
- **Variability**, intended as a way for people to adjust tools and procedures to match operating conditions.
- Emergence of either **success or failure** is due to unexpected combination of variability from multiple functions.
- The unexpected "amplified" effects of interactions between different sources of variability are at the origin of the phenomenon described by functional resonance.



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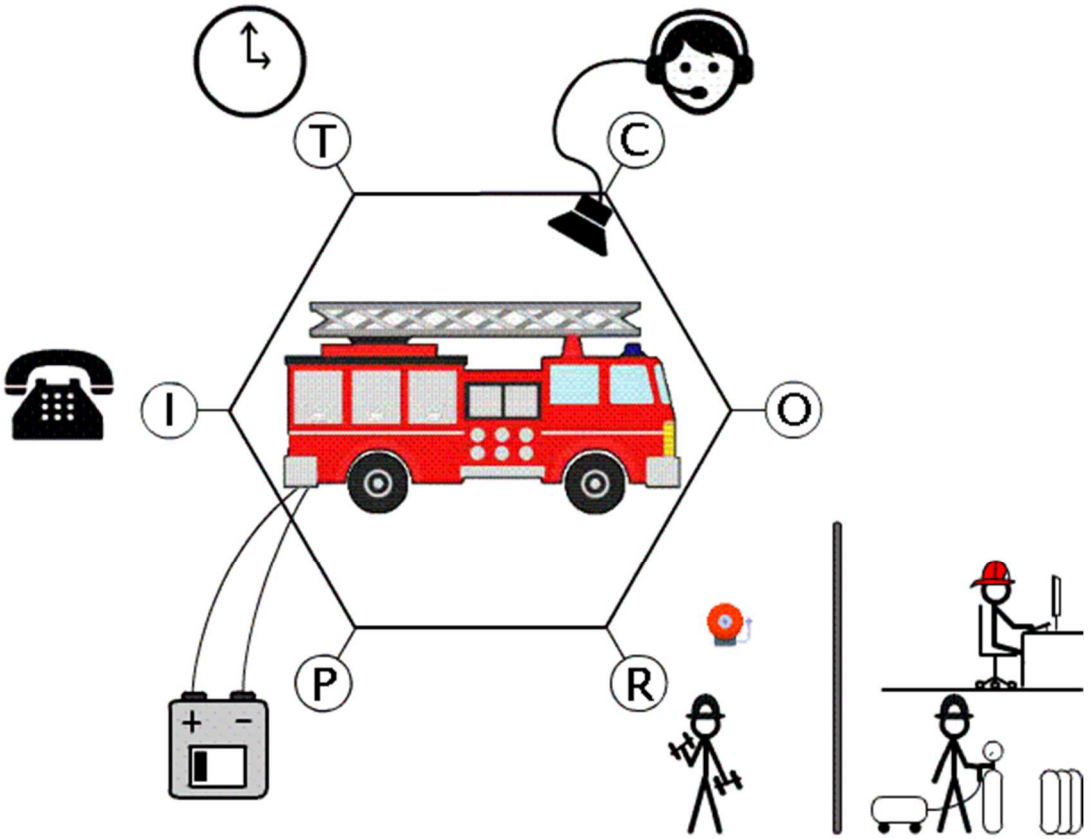

RESOLUTE Outcomes

- **European Resilience Management Guidelines** – (guidelines) – consensus driven approach improve guidelines acceptability at EU level
  - general version, and UTS version
  - http://www.resolute-eu.org/index.php/deliverables
- **CRAMSS** – (tools and algorithms) – ontology based static and dynamic CI data integration, processing and analysing platform
- **Mobile Emergency app** – (tools and procedures) – supporting users in their local decision before (early warnings), during and after an event
- **Game based training app** – (tools and procedures) – improving the current preparedness of the citizen in order to increase the community self-resilience

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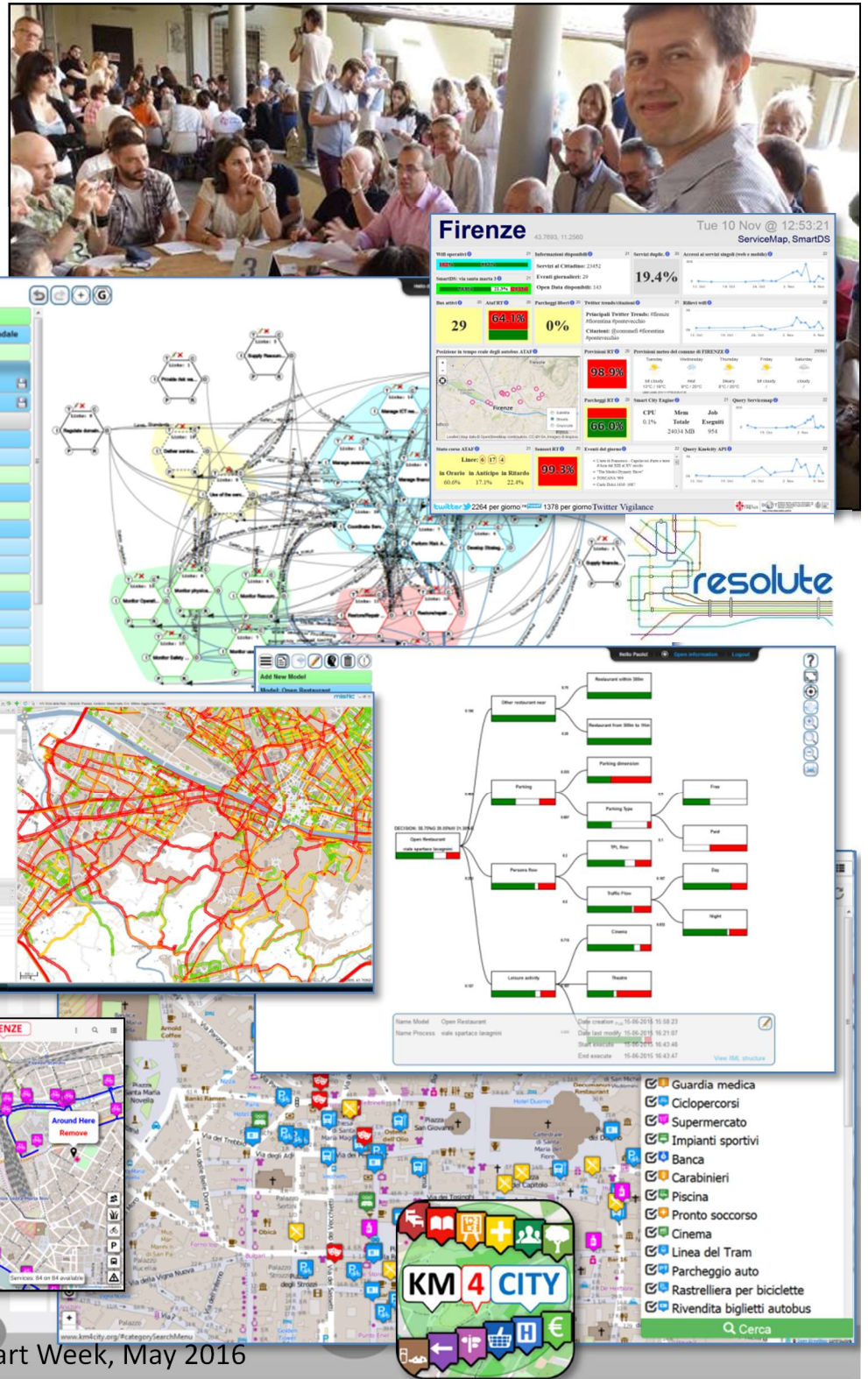
Improve city resilience, reducing risks and decision support

- **assessing city resilience** level
  - Resilience Decision Support, http://resilienceds.km4city.org
  - Smart decision support system, http://smartds.km4city.org
- **improving city users awareness** with personal city assistants and participatory tools
  - Dashboard: http://dashboard.km4city.org
  - Km4City Web App http://www.km4city.org
  - Km4City Mobile App: http://www.km4city.org/app



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European Union Funding for Research & Innovation

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Dashboarding city resilience

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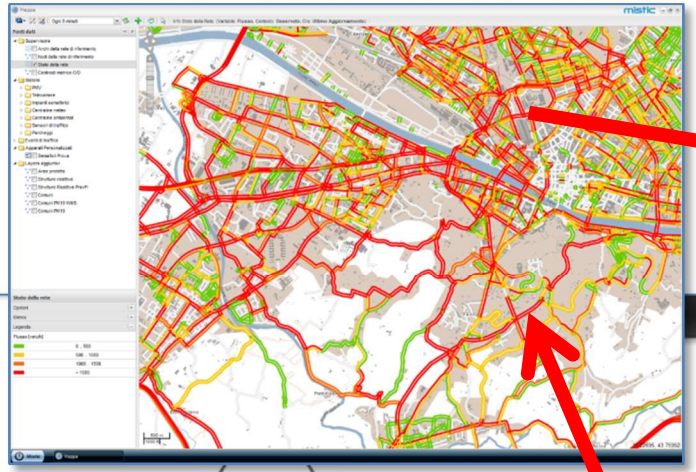

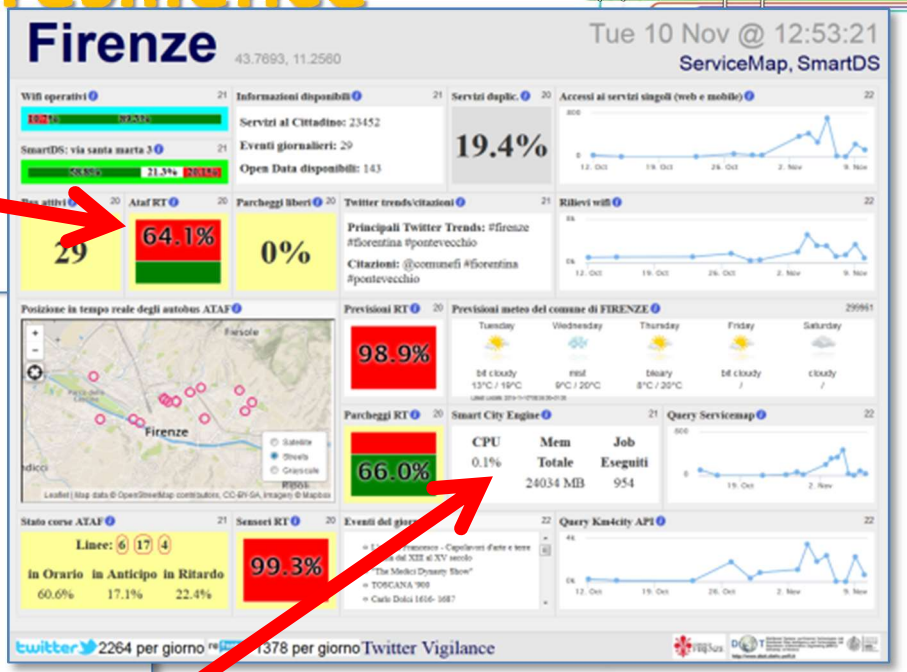

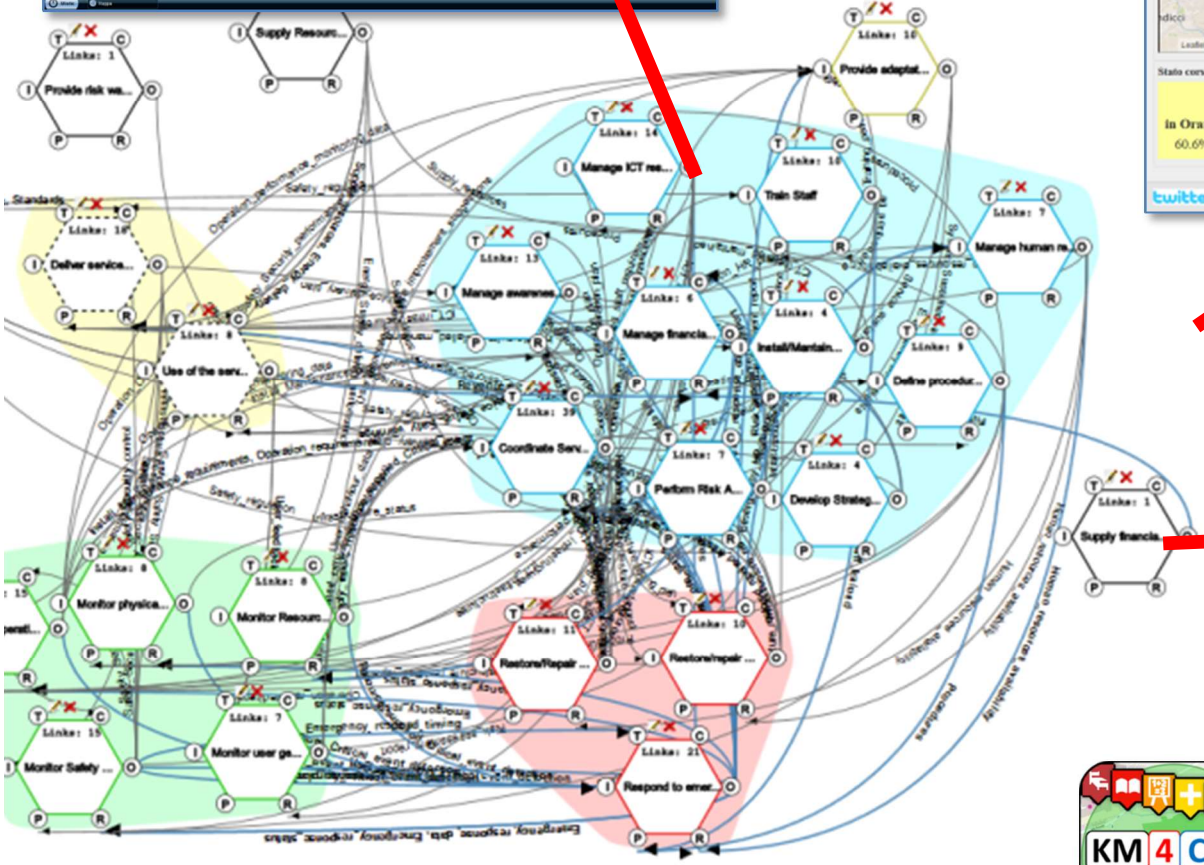

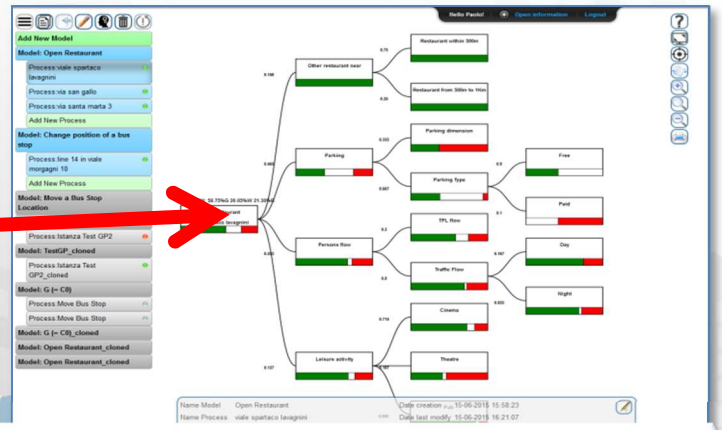

The Resilient City, C

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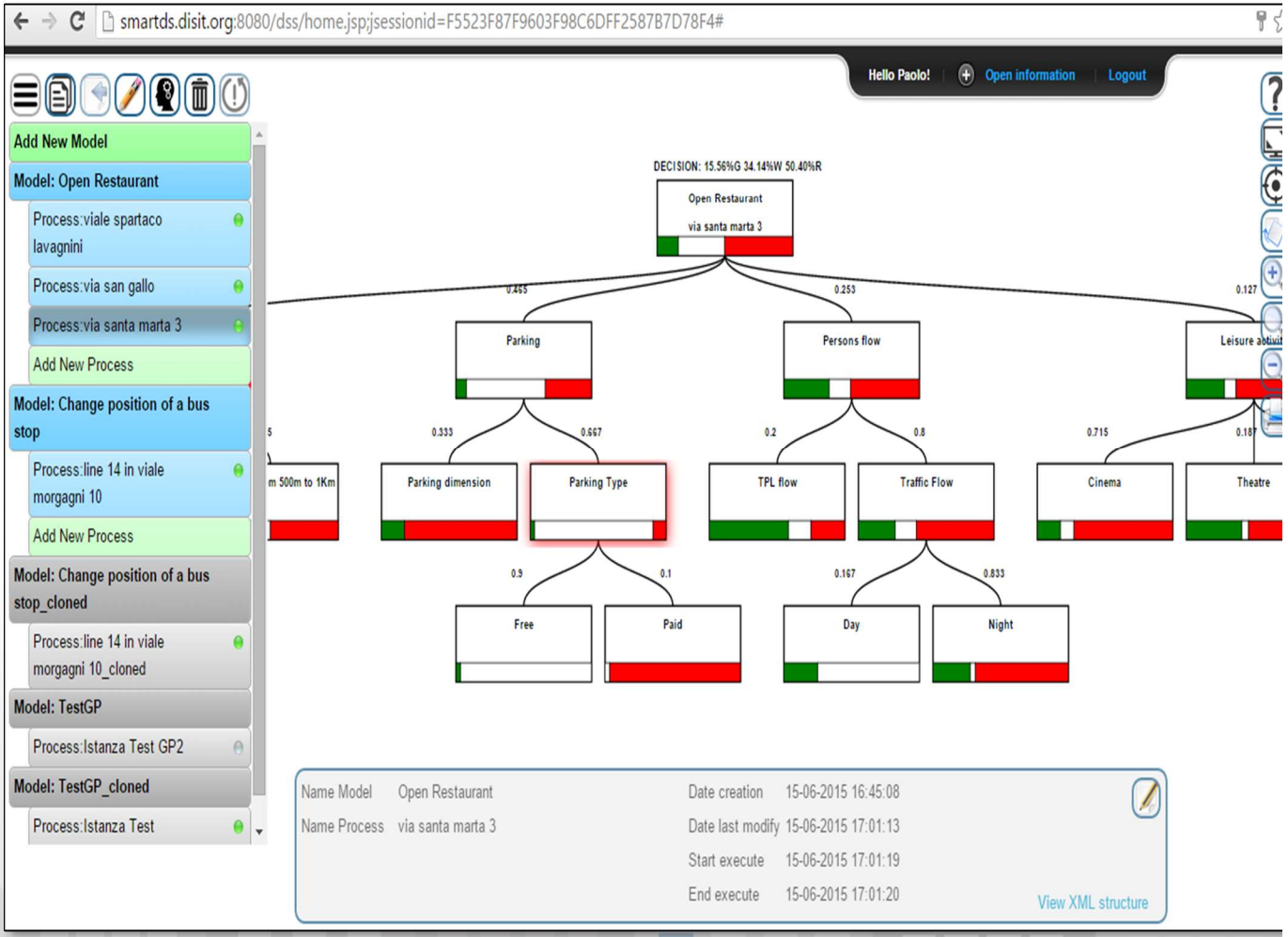
Smart Decision Support

- ***Smart Decision Support System*** *based on System Thinking plus*
- Actions to city reaction, resilience, smartness..

Enforcing

- Mathematical model for propagation of decision confidence..
- Collaborative work…,
- Processes connected to city data: DB, RDF Store, Twitter, etc.
- Production of alerts/alarms
- Data analytics process
- Twitter Processes
- reuse, copy past, …



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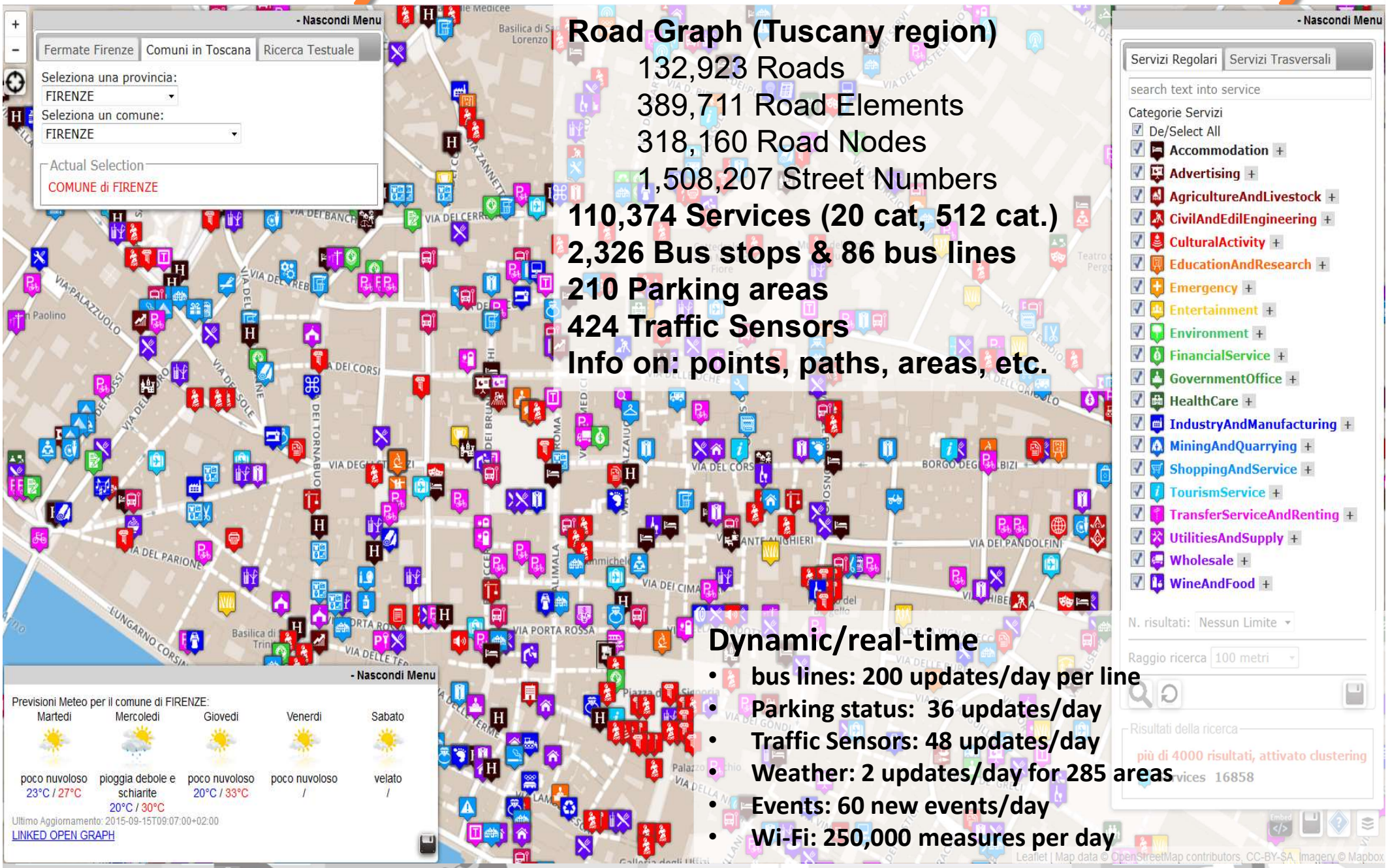
Km4City on Firenze & Tuscany



Road Graph (Tuscany region)

- 132,923 Roads
- 389,711 Road Elements
- 318,160 Road Nodes
- 1,508,207 Street Numbers

110,374 Services (20 cat, 512 cat.)

2,326 Bus stops & 86 bus lines

210 Parking areas

424 Traffic Sensors

Info on: points, paths, areas, etc.

Dynamic/real-time

- **bus lines: 200 updates/day per line**
- **Parking status: 36 updates/day**
- **Traffic Sensors: 48 updates/day**
- **Weather: 2 updates/day for 285 areas**
- **Events: 60 new events/day**
- **Wi-Fi: 250,000 measures per day**

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User Behavior Analyzer

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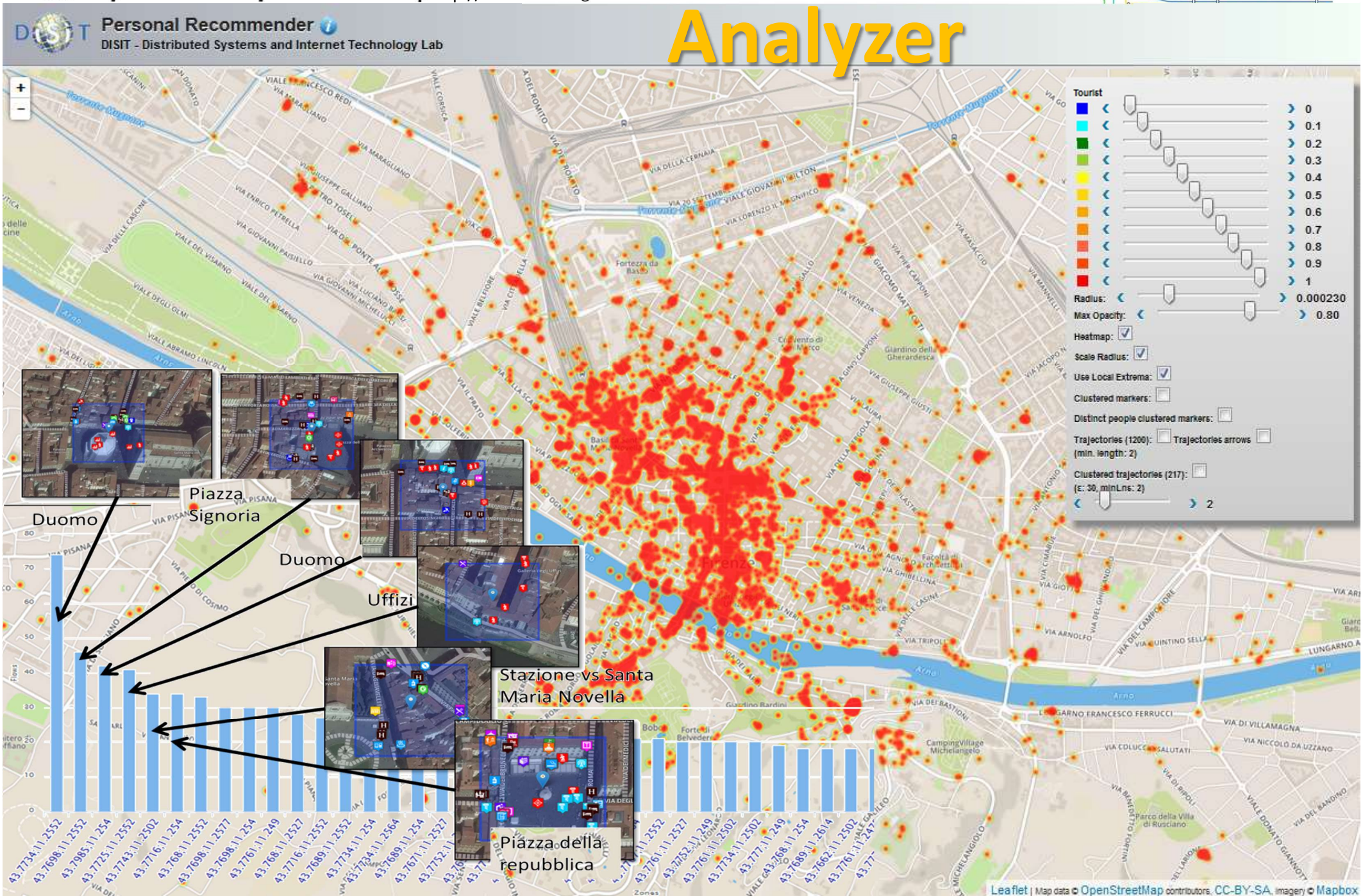

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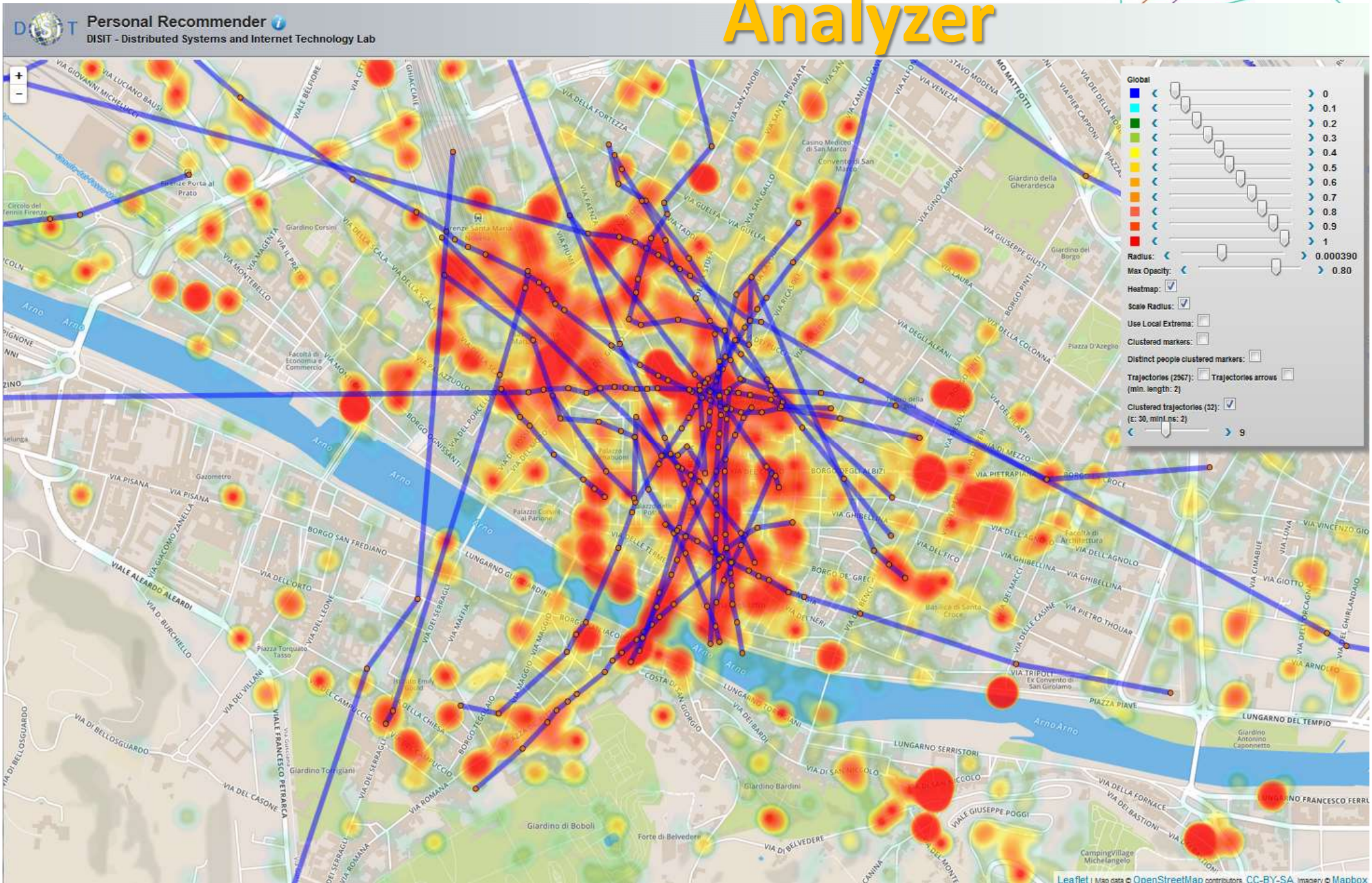


Twitter Vigilance, Sentiment Analysis, Monitoring and prediction

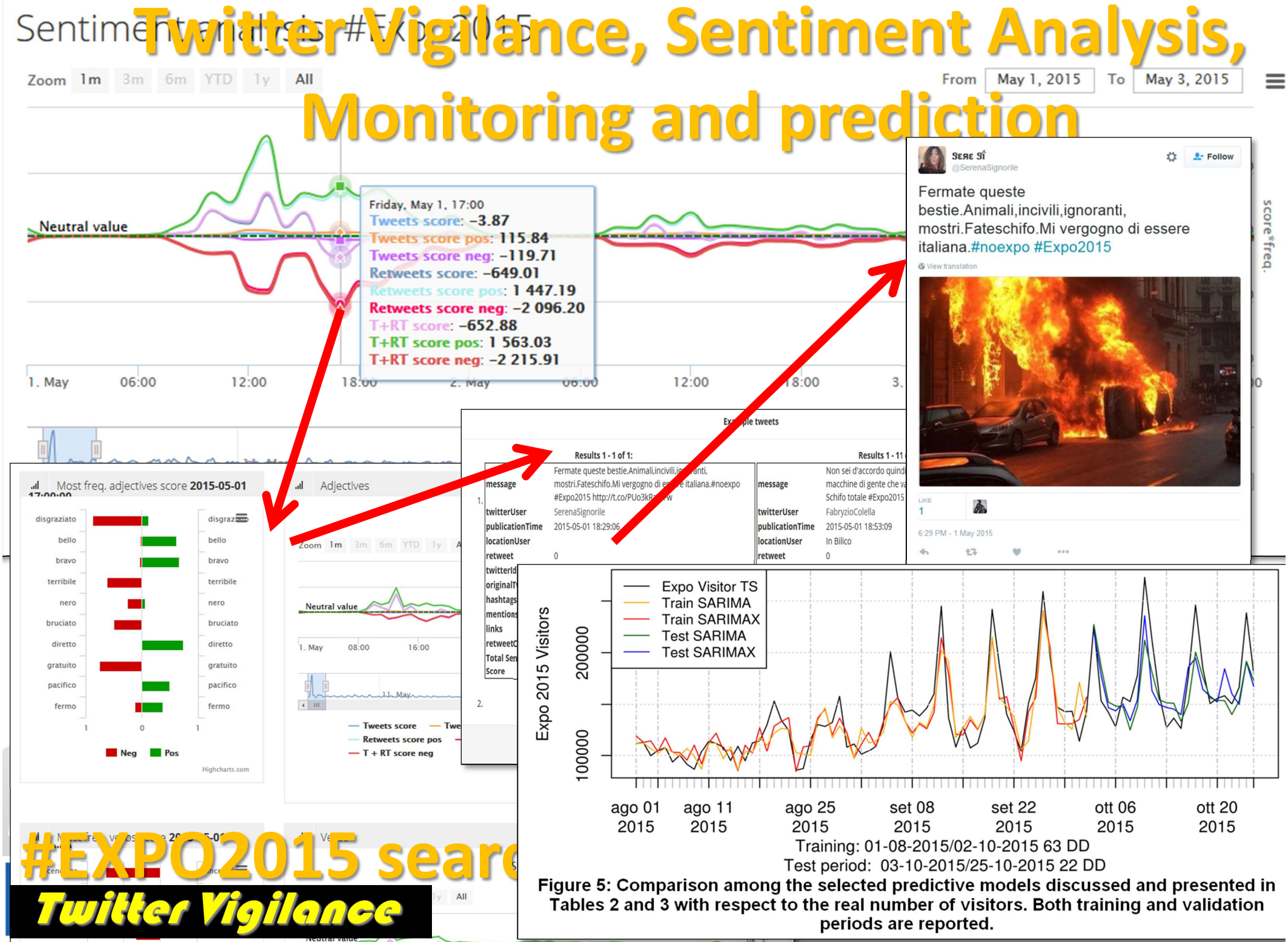


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.

#EXPO2015 searc

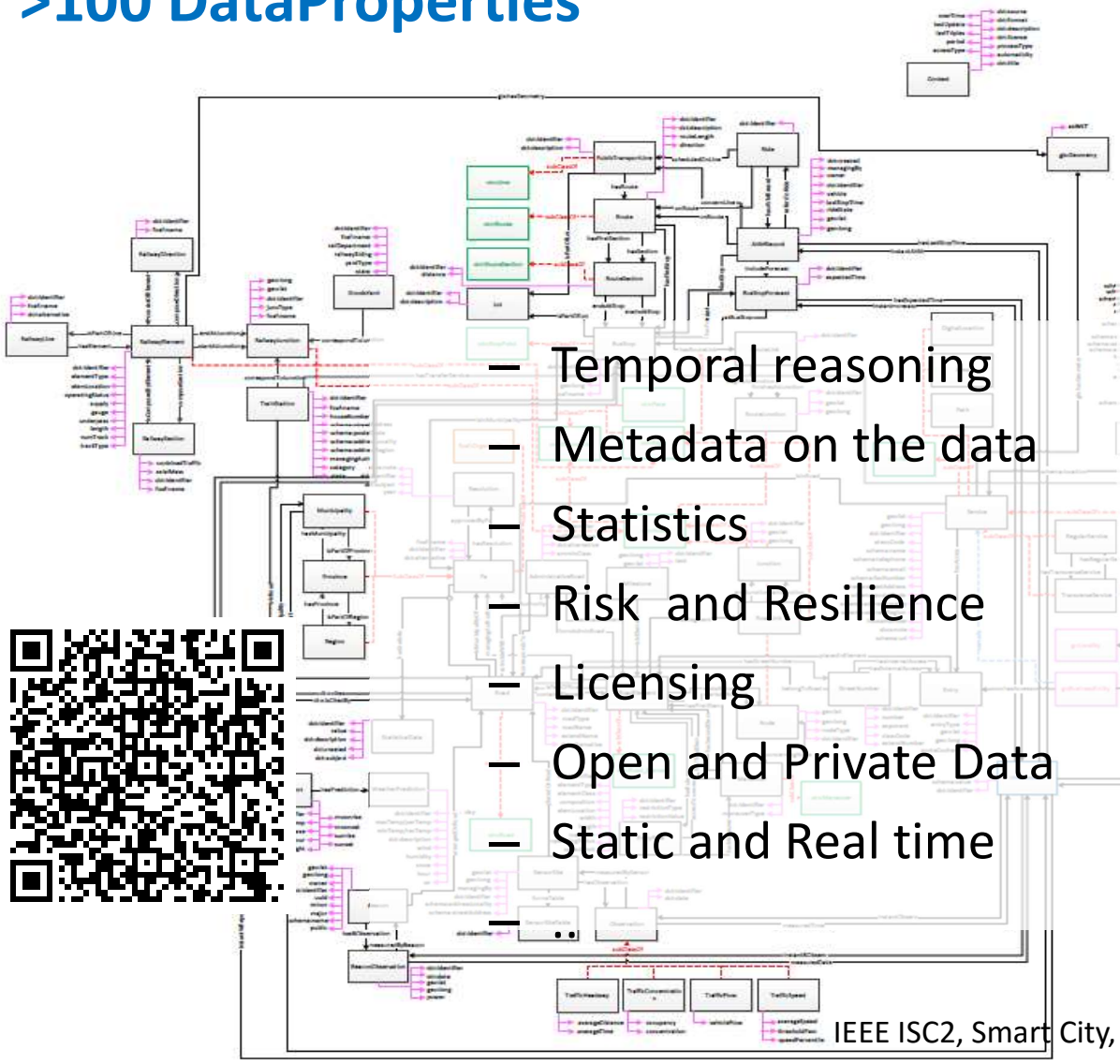
Twitter Vigilance

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

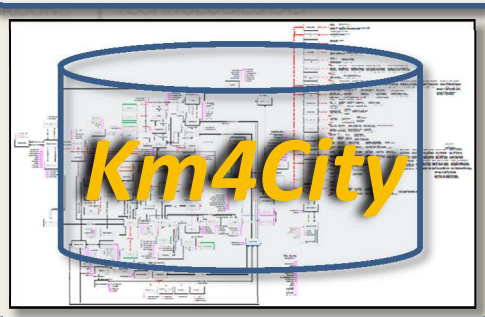
Shops, services,
operators

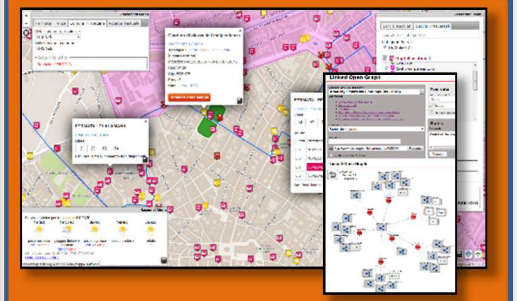
Social Media
WiFi, network

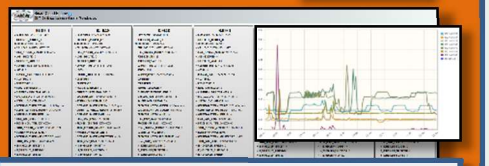
Static, Slow and Real Time data flows

DISCES -- Distributed and parallel architecture on Cloud

Km4City Smart City Engine

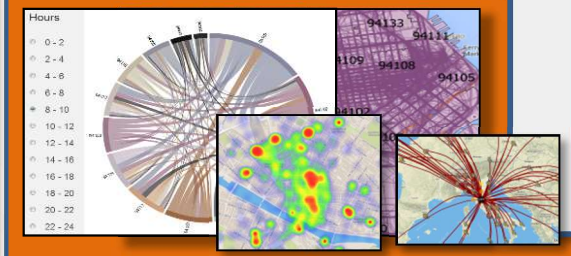






User Profiling and Suggestion Engine

Flow and Origin Destination Matrix
Http://www.disit.org/odsf

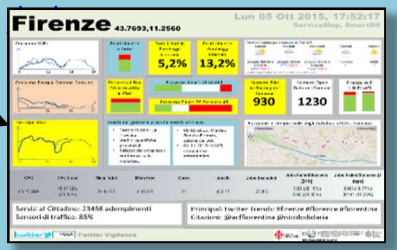


Km4City Tools for Developers

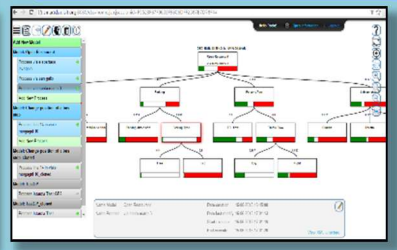
Km4City Smart City API

Tools for City Operators and Decision Makers

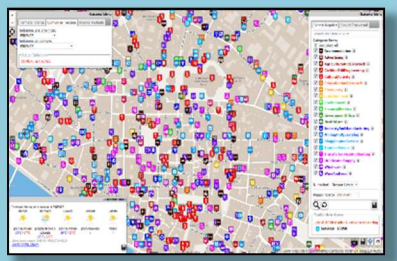
Smart City Dashboard
Http://dashboard.km4city.org/



Smart Decision Support
Http://Smartds.km4city.org

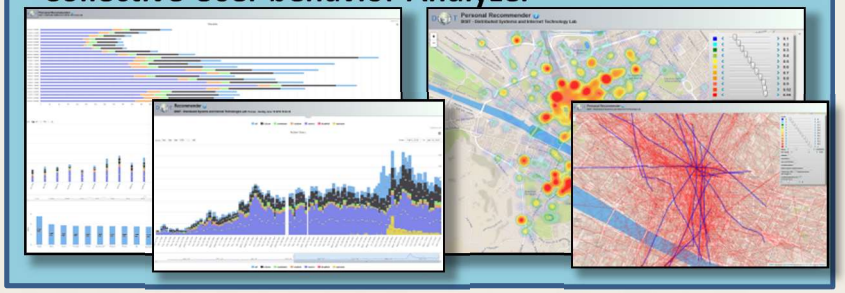


Service map browser
Http://servicemap.km4city.org



Twitter Vigilance
Http://www.disit.org/tv

Collective User behavior Analyzer

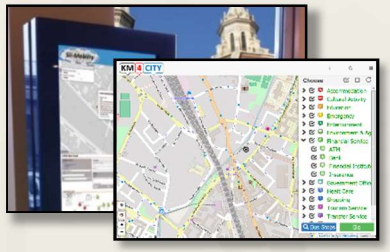


Tools for Final Users

Mobile e Web Apps

Http://www.km4city.org/app

Http://www.km4city.org



www.km4city.org

Projects based on KM4City

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

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

RESilience management guidelines and Operationalization appLied to Urban Transport Environment

Horizon 2020 European Union Funding for Research & Innovation

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

REPLICATE
REnaissance of PLaces with Innovative Citizenship And TEchnology

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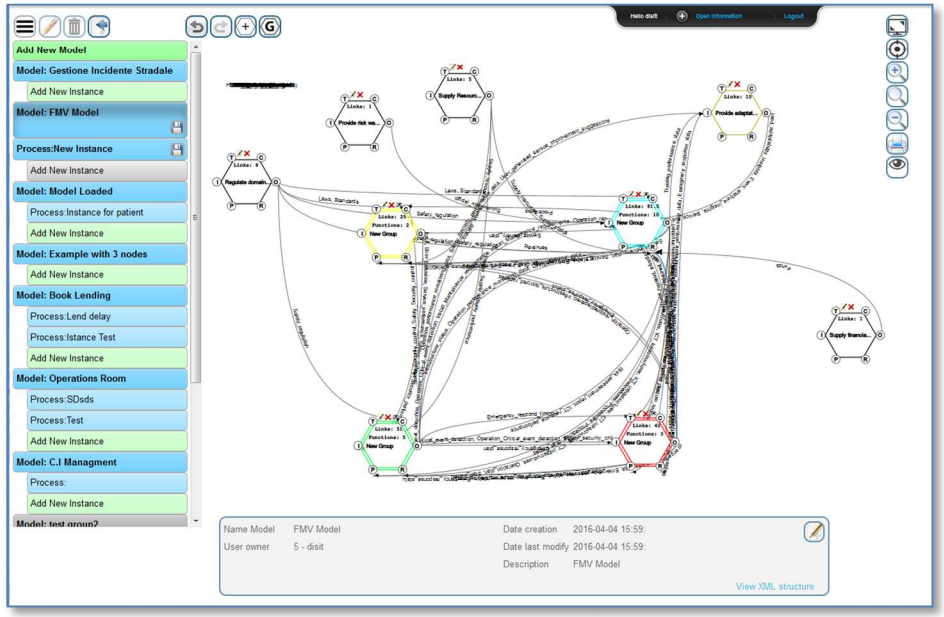
www.km4city.org

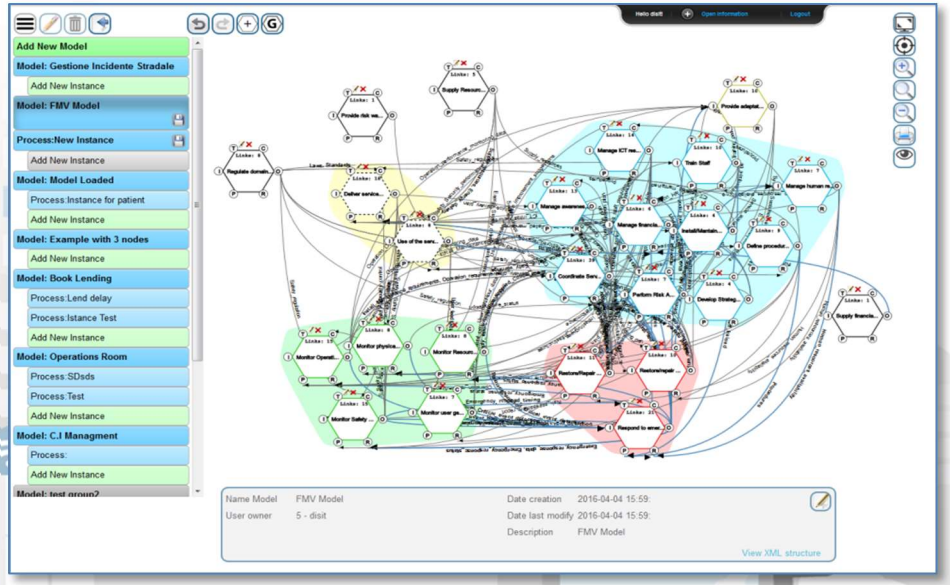
Technical info on: http://www.disit.org/km4city

Conclusions

ResilienceDS tool

- FRAM Model
  - Macro FRAM processes
  - Metrics for Process complexity assessment
  - Operational Semantic for executing FRAM model
  - Connection with SmartDS
  - Connection with BigData open to multiple sources of data and workgroup results, Km4City
- Collaborative work
- Open for all
- Validated on ERMG
- Web Tool





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Km4City

Smart City Ecosystem

http://www.disit.org/km4city

Http://www.km4city.org

http://www.disit.org/km4city

Paolo Nesi, paolo.nesi@unifi.it

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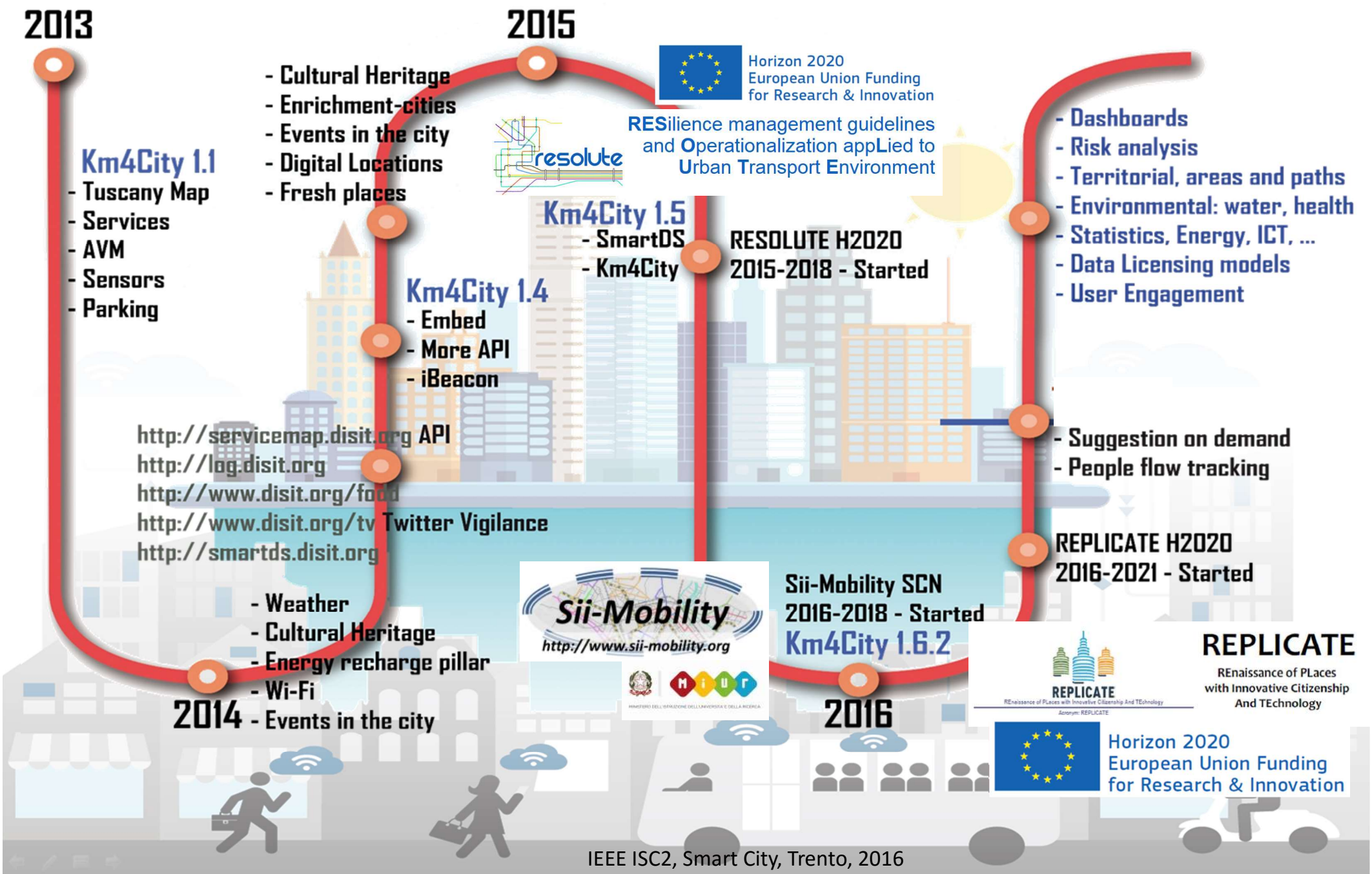
km4City Roadmap



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**