

Paolo Nesi
paolo.nesi@unifi.it
 Emanuele Bellini
emanuele.bellini@ieee.org

University of Florence
 Information Engineering Dept.
 DISIT lab

CERIS 2021

Project Contacts
 Prof. Paolo Nesi, Dr. Emanuele Bellini
 DISIT Lab, Department of Information Engineering
 University of Florence, Italy
 Tel. +39-055-275-8105 / 8117 - Fax +39-055-275-8100
 Email: info@resolute-eu.org





Resilience Management Guidelines and Operationalization applied to Urban Transport System

- **Started:** 1st May 2015, **duration** 36 months
- **Pilots:** Florence and Athens
 - End Users: City of Florence, Attiko Metro



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Motivations

Enhancing resilience in Urban Transport Systems is considered imperative for two main reasons:

- 1) Such systems provide critical support **to every socio-economic activity** and are currently themselves one of the most important economic sectors in Europe.
- 2) The **paths that convey people, goods and information, are the same through which risks are propagated.** Transport systems have thus developed a prominent safety and business critical nature, in view of which current management practices have shown evidence of important limitations

Project Objectives

- **Obj1- Conducting a systematic review and assessment** of the state of the art of the Resilience assessment and Management concepts, national guidelines and their implementation strategies in order to develop a conceptual framework for resilience within Urban Transport Systems
- **Obj2 - Development of European Resilience Management Guidelines (ERMG)**
- **Obj3 - Operationalize and validate the ERMG by implementing the RESOLUTE Collaborative Resilience Assessment and Management Support System (CRAMSS) for Urban Transport System (UTS) addressing Roads and Rails Infrastructures**
- **Obj4 – Enhancing resilience through improved support to human decision making processes**, particularly through increased focus on the training of final users
- **Obj5 – ERMG wide dissemination, acceptance and adoption** at EU and Associated Countries level

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 Critical Infrastructure (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

Impact – End users perspective

Increased system resilience through implementing resilience guidelines

- Increase resilience cost- and time-efficiently
- Make the resilience management process easier and effective
- Establish **coordination** among all stakeholders (including first responders) involved in UTS resilience management
- Enable co-creation, re-design, and enhancement of resilience oriented services
- Easily integrate new public services

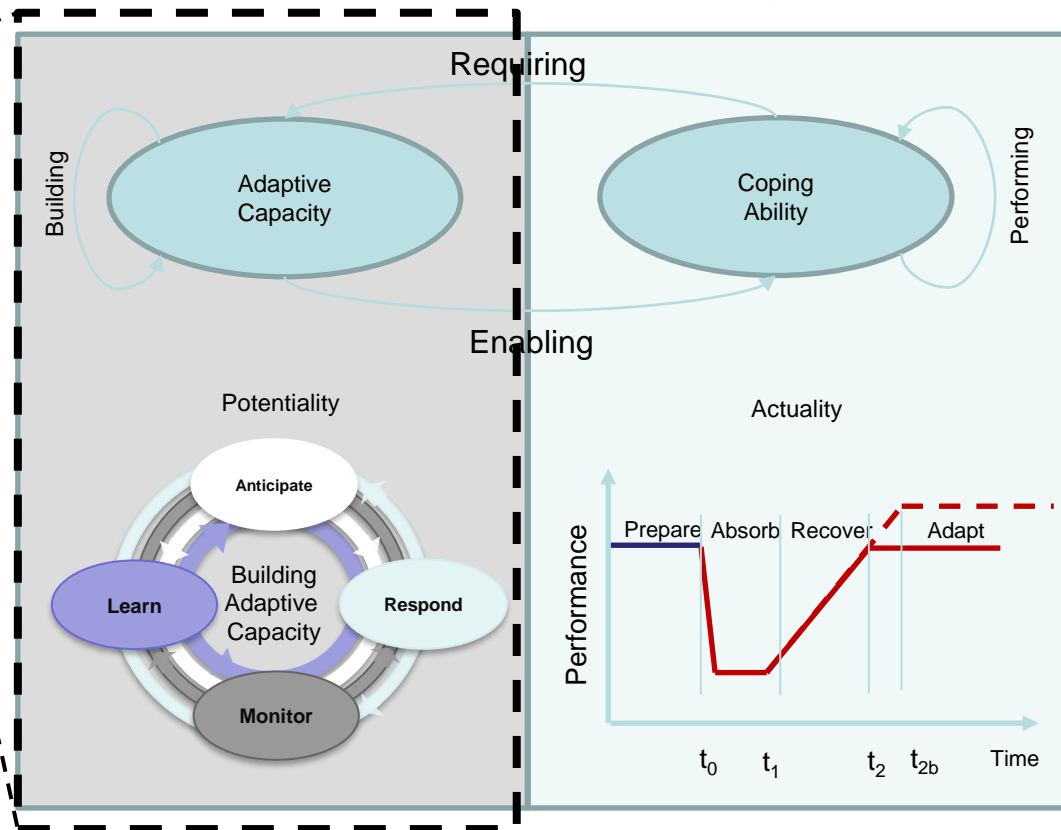
Increased efficiency of action in emergency situations

- Reduce the time for taking informed decisions
- Allocate resources efficiently to cope with emergency
- Reduce knowledge gap monitoring system (city) status
- Improve communication with citizens and authority
- Make emergency services more user-friendly and widely accessible

RESOLUTE resilience perspective

Resilience as an emergent property of a synergistic dual system

Resolute focus



Bellini, E.; Bellini, P.; Cenni, D.; Nesi, P.; Pantaleo, G.; Paoli, I.; Paolucci, M. An IoE and Big Multimedia Data Approach for Urban Transport System Resilience Management in Smart Cities. *Sensors* **2021**, *21*, 435. <https://doi.org/10.3390/s21020435>

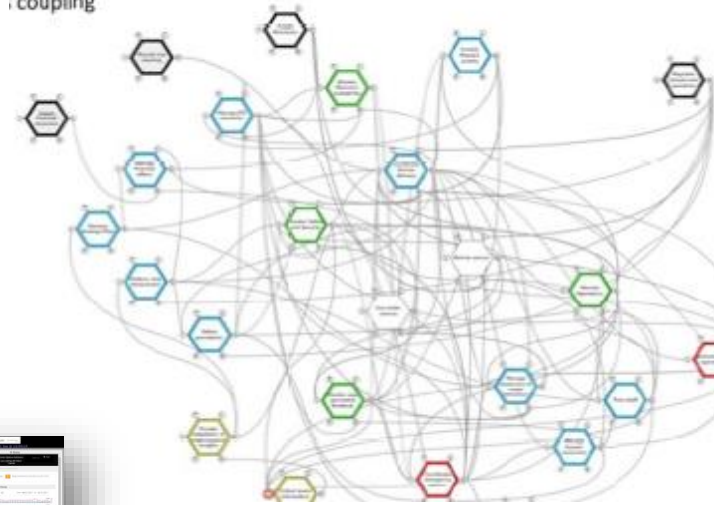
RESOLUTE Workflow



1. UTS Reference Model



coupling



3a. Big Data driven CRAMSS



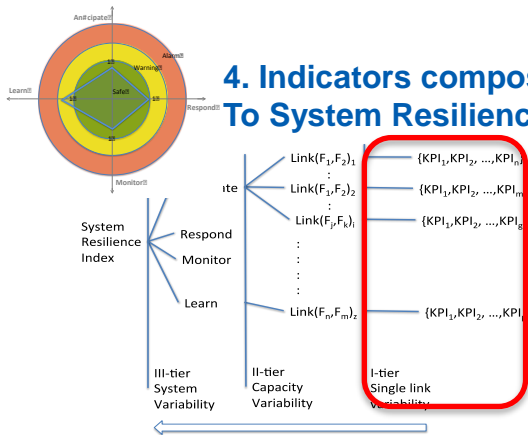
2. European Resilience Management Guidelines



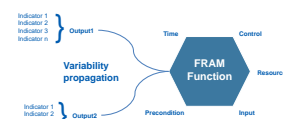
5. Assessment



4. Indicators composition To System Resilience Index



3b. Function variability indicators definition



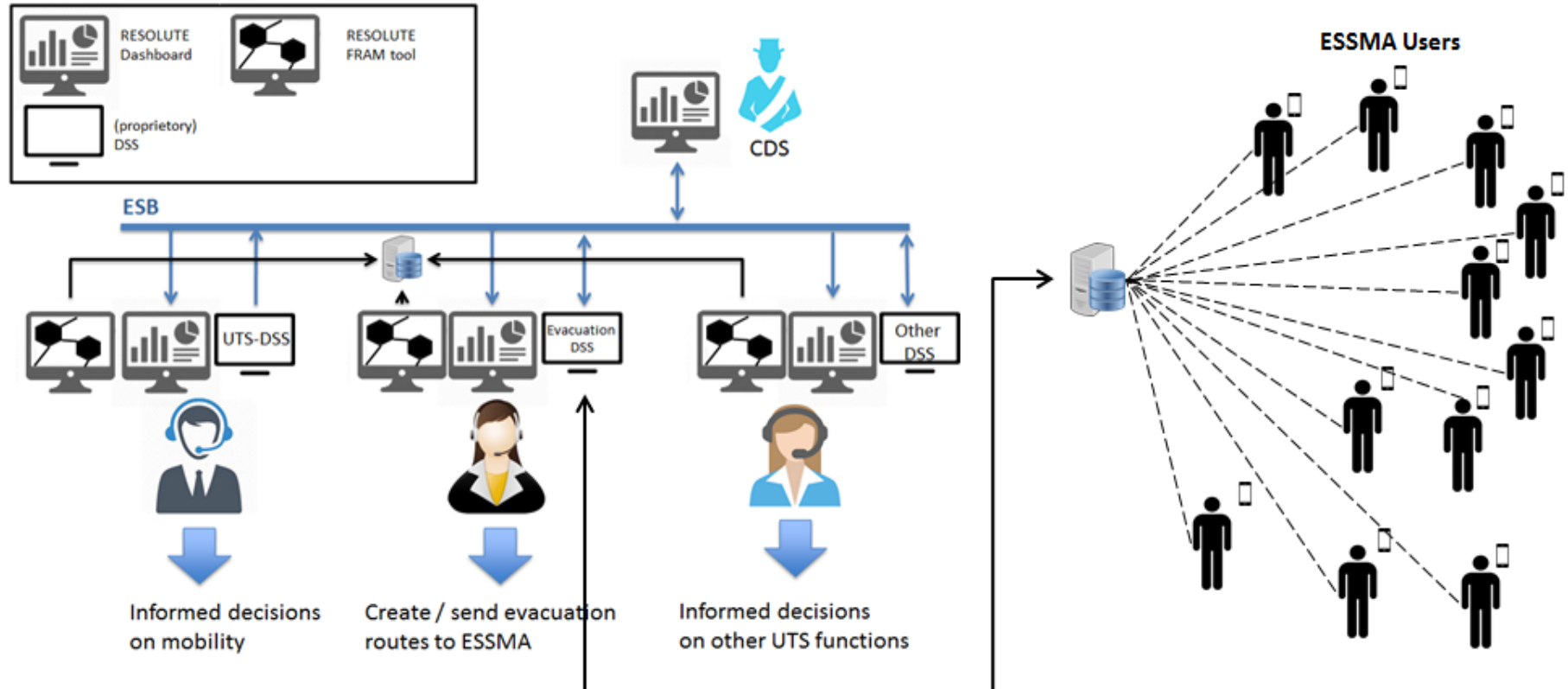
Manage Financial Affairs			
Anticipate	Monitor	Respond	Learn
<p>General Recommendations</p> <ul style="list-style-type: none"> Assess potential disaster impacts and manage insurances & Governmental disaster risk financing tools. Plan financial needs, cost-sharing & control including all involved entities & ensure an efficient deployment of funds. Manage eventual over-payment situations, wait real use after crisis. Analyze financial capacity & resources needs of each involved stakeholder including private companies, governments, public companies. Plan budget reserve & how to unlock it in case of emergency needs. Review it regularly. Manage call with knowledge of financial resources. <p>Custom Conditions Recommendations</p>	<p>Availability of resources</p> <p>Financial project cost management, cooperation side.</p> <p>Quality of communication</p> <p>Communication to both of involved stakeholders.</p> <p>ICT & operational support</p> <p>Software tools to analyze financial data, plan & monitor budget and resources, communicate with all functions.</p> <p>Availability of procedures and plans</p> <p>Emergency & team work, ability to define priorities.</p> <p>Number of goals and conflict resolution</p> <p>Manage conflicting objectives during strategic plan phase, define priorities, have a general agreement, communicate to other parties.</p> <p>Available time and time pressure</p> <p>Team collaboration quality.</p> <p>Team collaboration quality</p> <p>Collaborative financial planning through mutual/benefit relations, define mutual financial responsibilities.</p> <p>Quality and support of the organization</p> <p>Clear decision making process, align decision with available resources and defined priorities, measure performance, interpret financial results.</p>	<p>Background</p> <p>All financial resources assume a critical role for the system operation, provision of resources and assets, financial affairs function is one of the prerequisites for any system - current functions and/or recovery as funds will be needed to manage all system recovery. This function is activated during normal operation as well as for emergency cases.</p> <p>Example</p> <p>Infrastructure Business Unit Transport Strategy from Federal government of Austria.</p> <p>A Pre-Crisis Recovery Planning Guide for Transportation, TRRS report.</p> <p>Limitations</p> <ul style="list-style-type: none"> Provides limited financial resources of involved parties. Provides assistance of involved parties to plan a budget reserve in advance. Provides capacity of involved parties to produce a strategic plan. 	<p>Anticipate</p> <p>The function aims at forecasting, assessing operational, maintenance and emergency and recovery requirements. It assumes a critical role for all stages of system life cycle design, operation and decommissioning.</p>



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Collabrative Resilience Assessment and management support system (CRAMSS) -

Collaboration among operators + empowering citizens to self resilient behaviors



UTS and Big Data approach

Huge amount of data are produced from: Open Data, Linked Data, Real Time sensors, Twitter, WiFi, etc.
(**Big Data: velocity, variety, volume, veracity, ...**)



Data available and collected through km4cty platform
<http://www.disit.org/km4city>

- Traffic data flows
- Public mobility services real time positions (e.g. bus, metro)
- Open Data (close to 1K available datasets including Hidrogeological risk maps)
- City free Wifi covers the 80% of the city (tracking people flows and movement)
- Social networks (twitters)
- IoT (real time data from environmental sensors e.g. level of the river)
- Real time Parking availability
- City services (business,
- Real time status of the city hospitals-beds availability
- Meteo data
- Cadastre data
-**but more data are needed.**

ISSUES

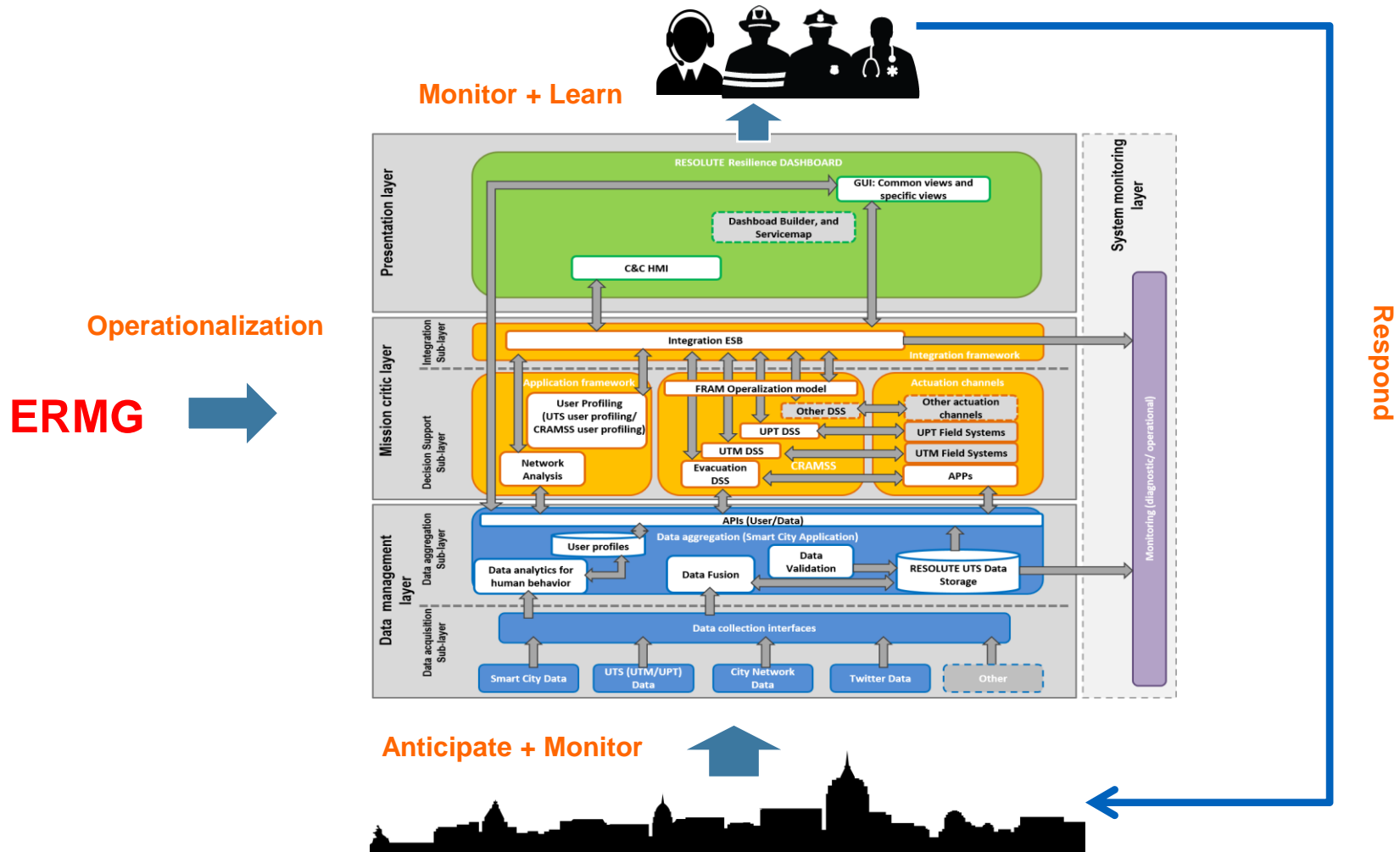
**Multiple data owners-producers,
Different delivery rate,
Different formats,
Different data quality,
Different licence for data reuse,
etc...**

New datasets

- **Wi-Fi Data (provided by City of Florence)** collection and
 - analysis (provided by DISIT lab), and corresponding data analytics for heat maps, trajectories, origin destination map, clustering of human behaviour, etc.; An extension of the Wifi network is also foreseen provided from the CMfirenze and Thales on the tramline of Florence.
- **Social media data in real time as Twitter Vigilance** real time (Extension of the DISIT Twitter Vigilance tool developed by DISIT lab) with corresponding data analytics: NLP and SA;
- **Real time number of available beds** in the emergency room data (provided by the hospitals in Florence), implemented by DISIT lab.
- **Specific sensors data**, as e.g., underpasses, not yet implemented as data ingestion process;
- **Specific areas of the city as:** Standing areas for population, recovery buildings, meeting points of rescuers and resources, assistance areas for population with the capability of extracting POI and other issues in the area as transport system facilities, etc.
 - [Aree di Assistenza della Popolazione](http://opendata.comune.fi.it/statistica_territorio/dataset_0373.html) http://opendata.comune.fi.it/statistica_territorio/dataset_0373.html
 - [Strutture di Ricovero della Popolazione](http://opendata.comune.fi.it/statistica_territorio/dataset_0306.html) http://opendata.comune.fi.it/statistica_territorio/dataset_0306.html
 - [Aree di Ammassamento Soccorritori e Risorse](http://opendata.comune.fi.it/statistica_territorio/dataset_0308.html) http://opendata.comune.fi.it/statistica_territorio/dataset_0308.html
 - [Aree di attesa della popolazione](http://opendata.comune.fi.it/statistica_territorio/dataset_0307.html) http://opendata.comune.fi.it/statistica_territorio/dataset_0307.html
- **Flooding susceptibility areas**
- **Generic weather database**
- **Twitter base dataset for EvacuationDSS**



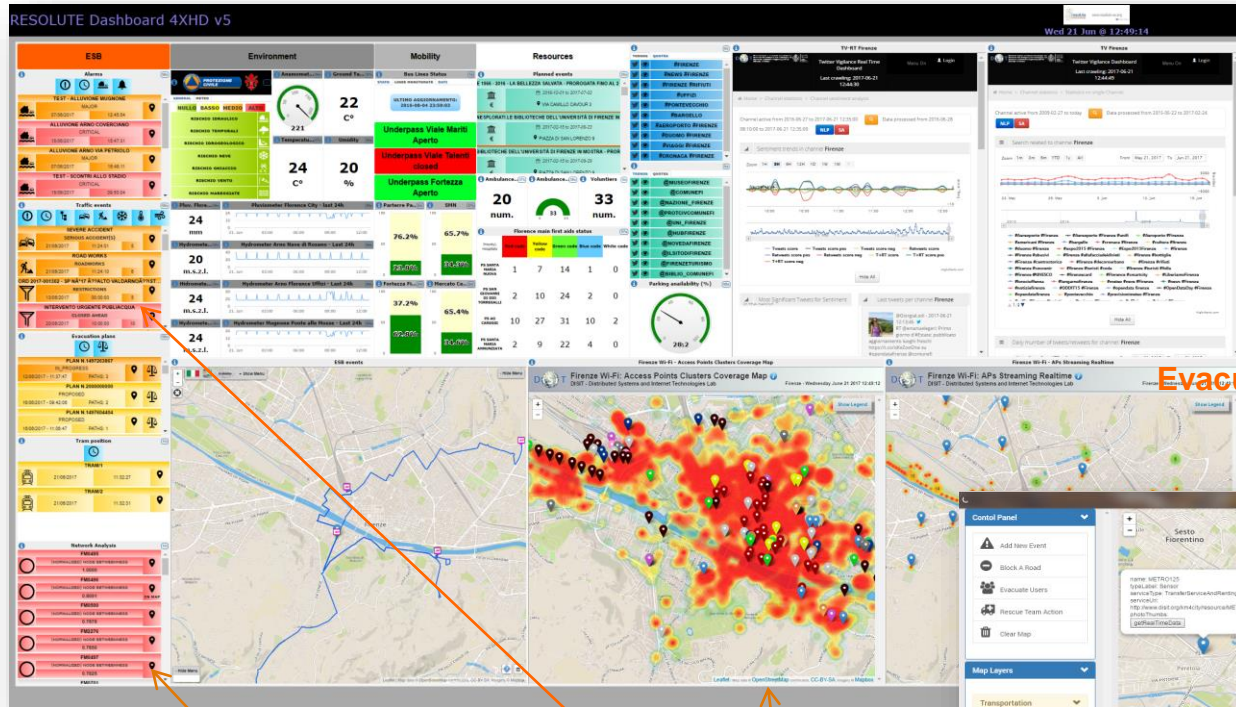
RESOLUTE platform



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RESOLUTE outcomes



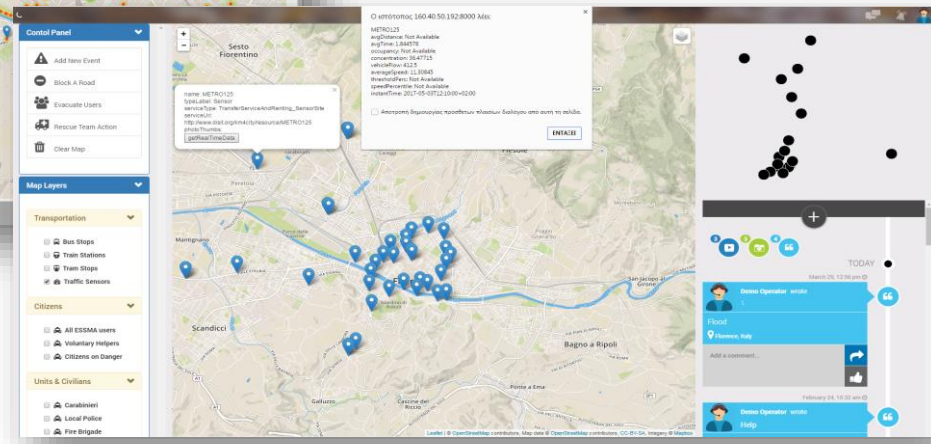
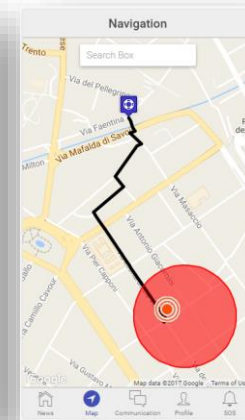
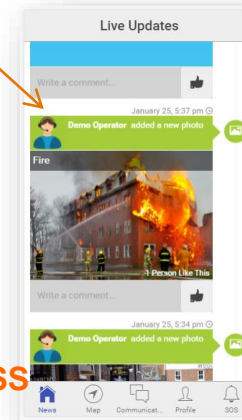
Bus routes Network analysis

UTS events

Resilience dashboard

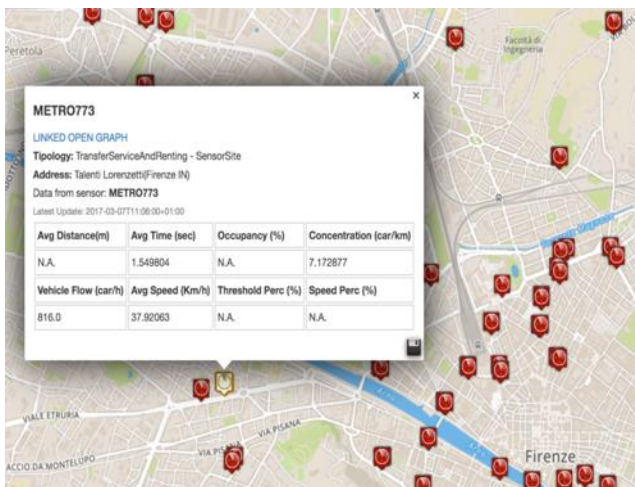
ESSMA

EvacuationDSS



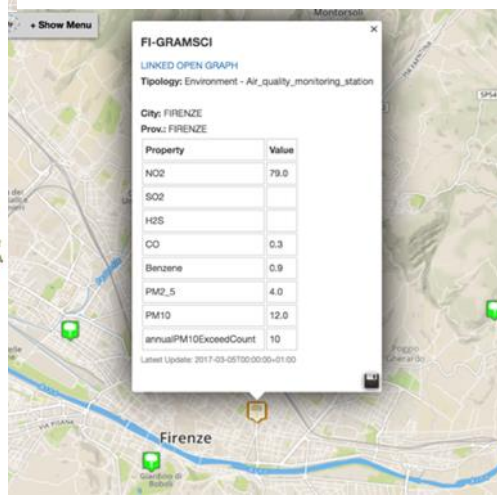
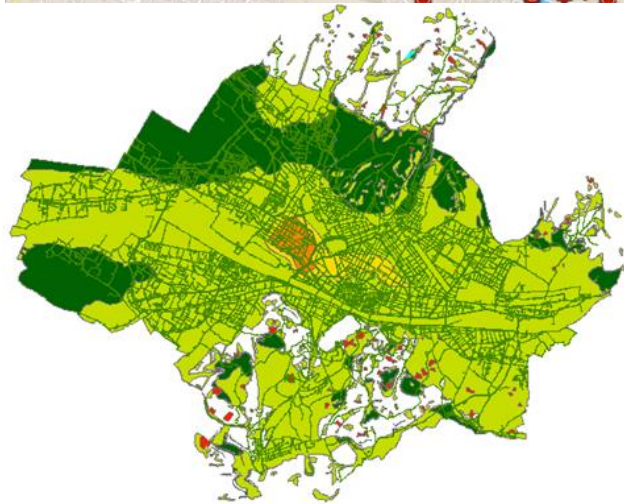
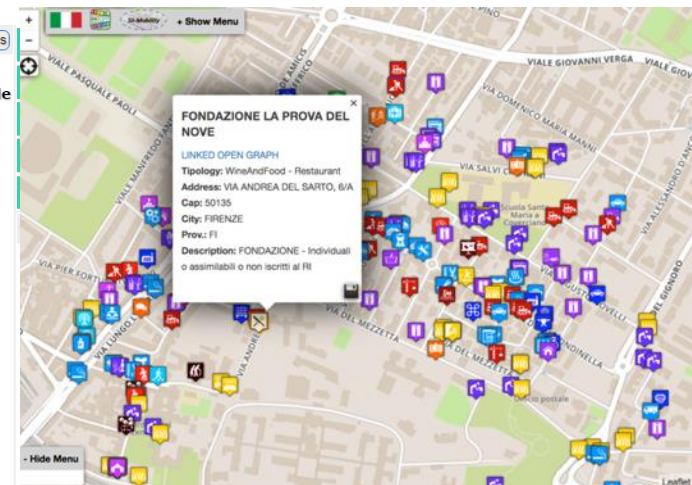
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Some data examples



Florence main first aids status

Priority\ Hospitals	Red code	Yellow code	Green code	Blue code	White code
PS SANTA MARIA NUOVA	1	7	14	1	0
PS SAN GIOVANNI DI DIO TORREGALLI	2	10	24	2	0
PS AO CAREGGI	10	27	31	10	2
PS SANTA MARIA ANNUNZIATA	2	9	22	4	0

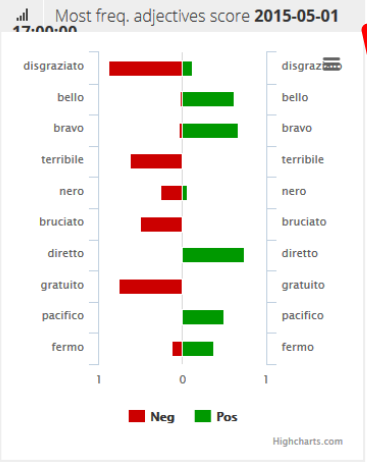
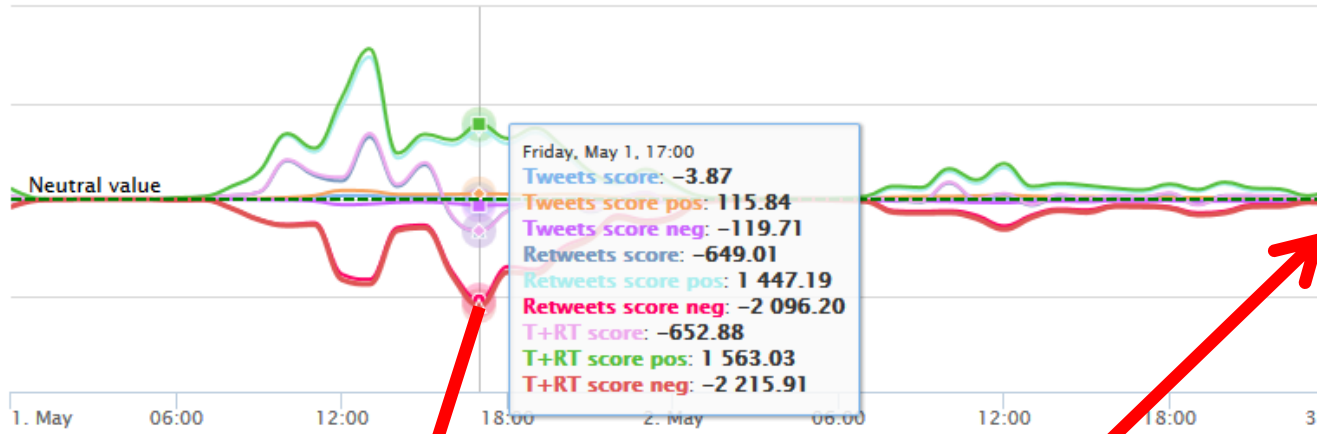


Sentiment analysis: #Expo2015

Twitter vigilance, Sentiment analysis

Zoom 1m 3m 6m YTD 1y All

From May 1, 2015 To May 3, 2015



Example tweets

Results 1 - 1 of 1:

message: Fermate queste bestie. Animali, incivili, ignoranti, mostri. Fateschifo. Mi vergogno di essere italiana. #noexpo #Expo2015 http://t.co/PUo3kR...
 twitterUser: SerenaSignorie
 publicationTime: 2015-05-01 18:29:06
 locationUser: [empty]
 retweet: 0

Results 1 - 11:

message: Non sei d'accordo quindi macchine di gente che v... Schifo totale #Expo2015
 twitterUser: FabrizioColella
 publicationTime: 2015-05-01 18:53:09
 locationUser: In Billico
 retweet: 0

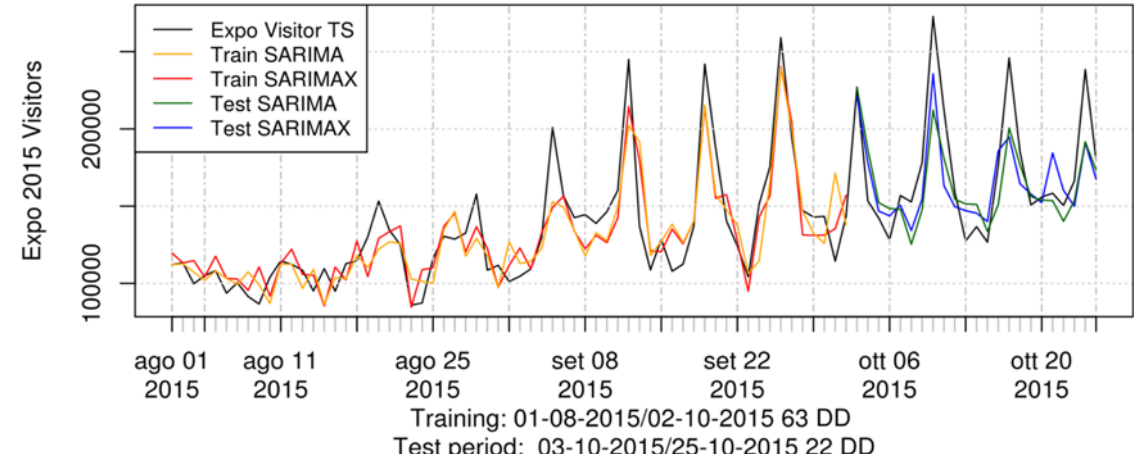
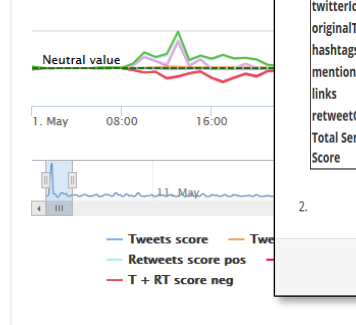


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.

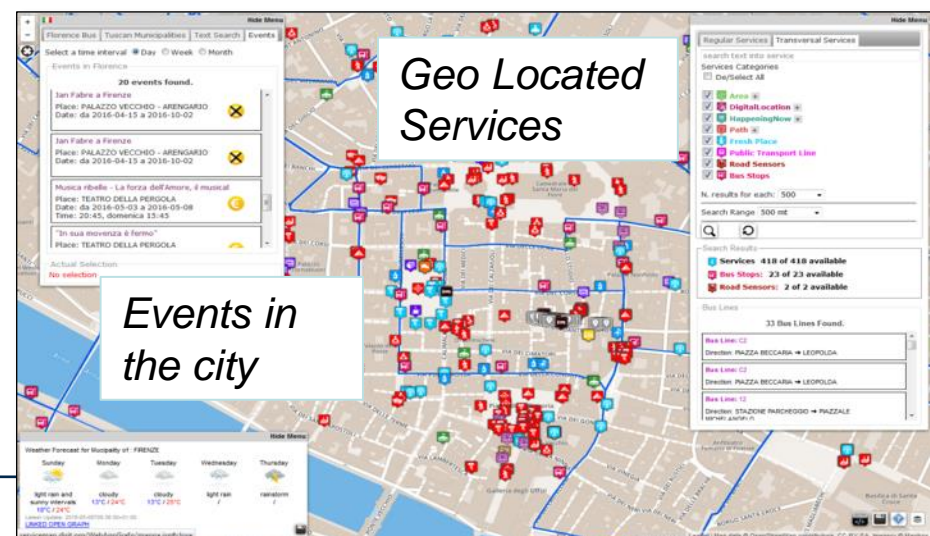
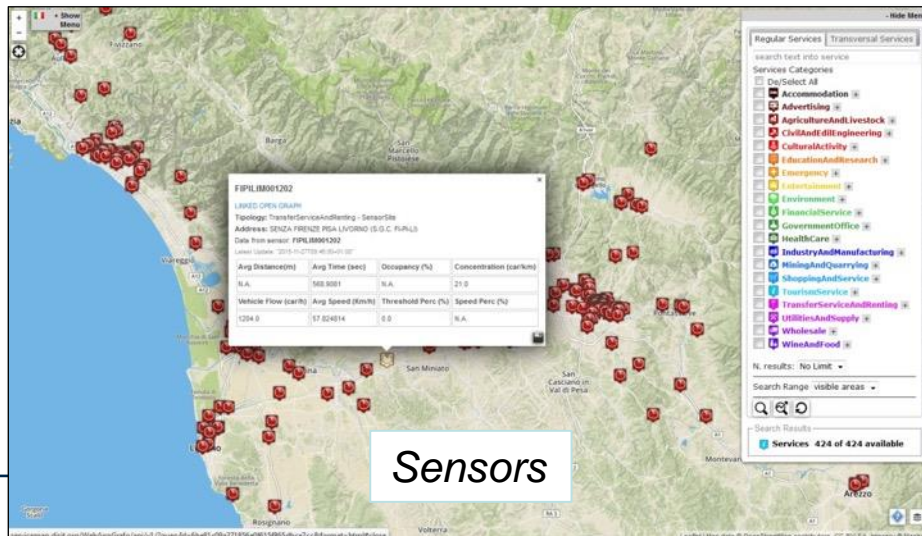
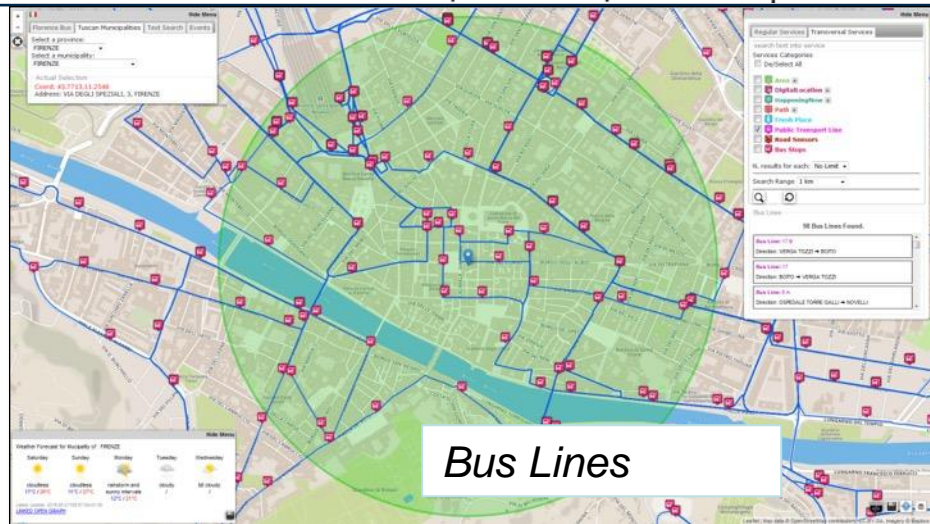
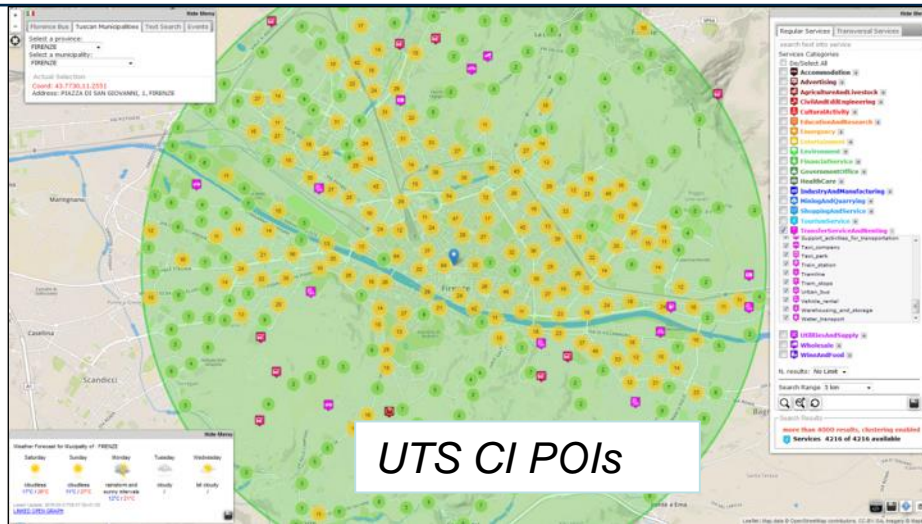


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Firenze Smart City: UTS +



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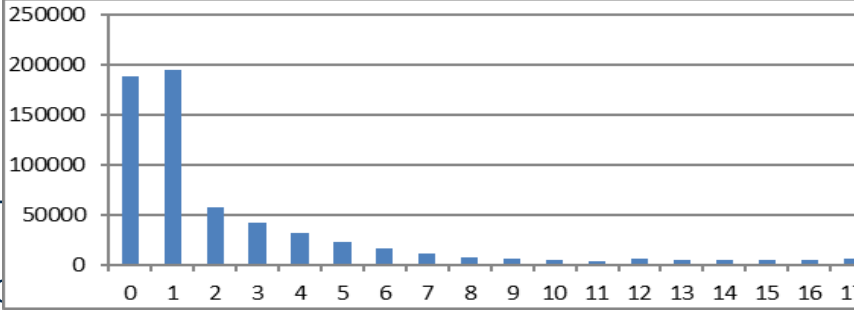
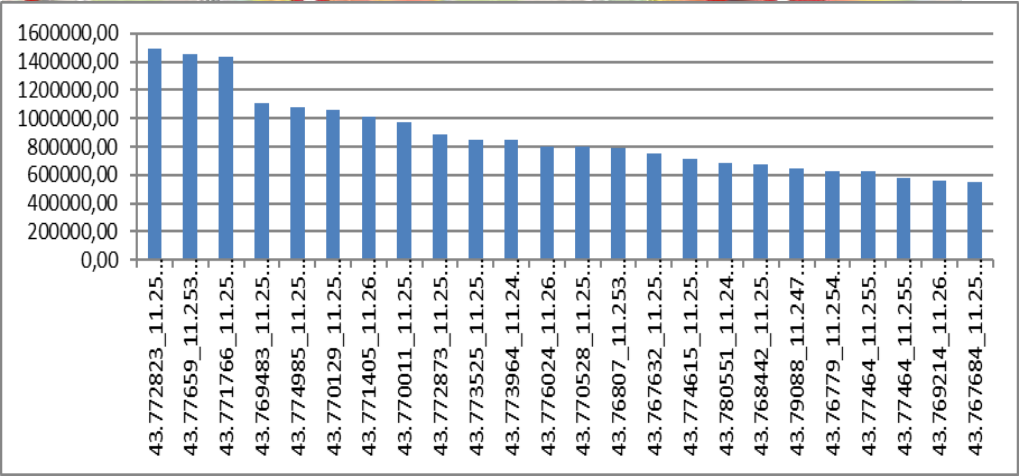
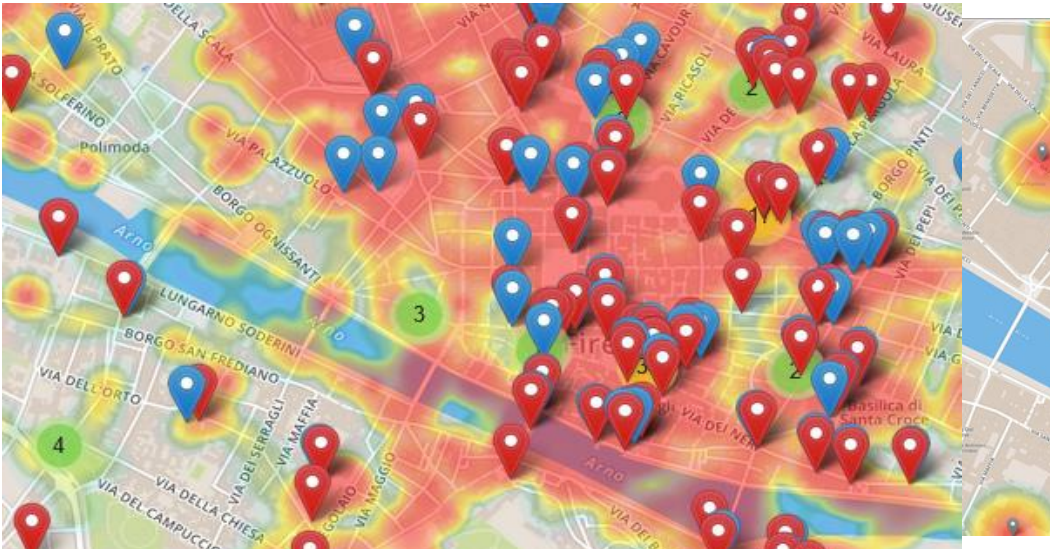
User Behaviour Analysis



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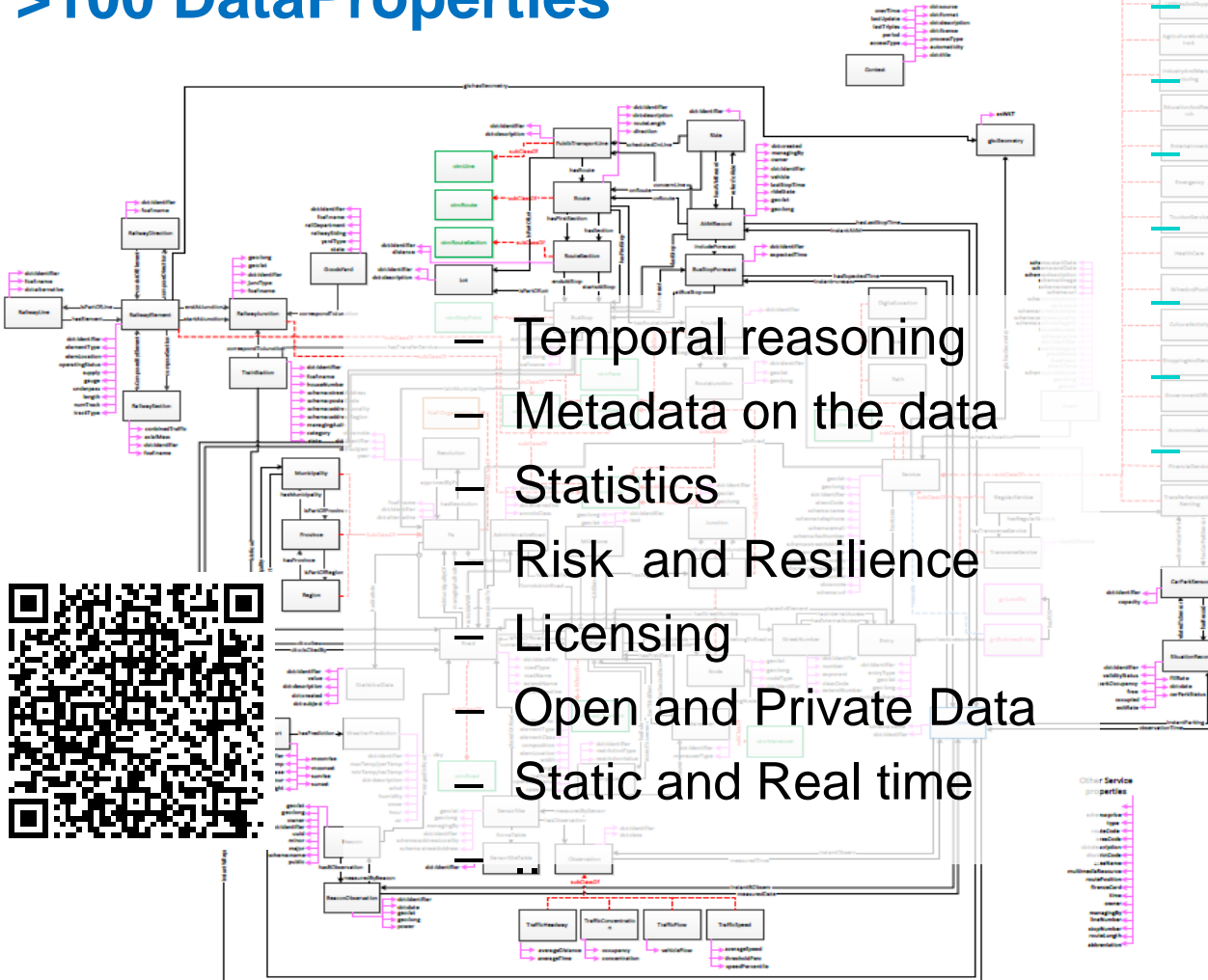
Km4City Ontology

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



- to cover different aspects:

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



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

Ontology Documentatio

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

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

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

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



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Snap4City Functional Architecture

Transport systems
Mobility, parking



Public Services,
Govern. events



Sensors, IOT Cameras,
Wi-Fi



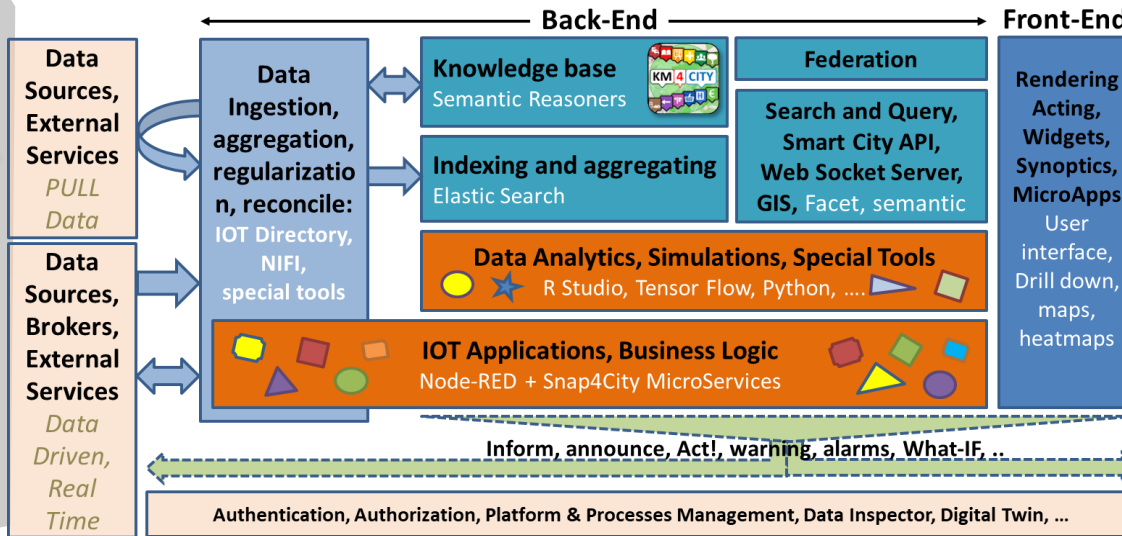
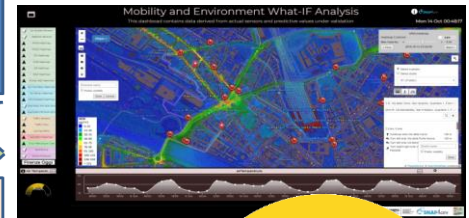
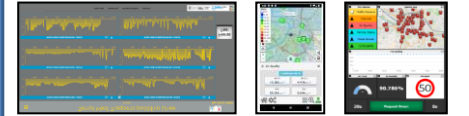
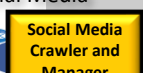
Environment, Water,
energy



Shops, services,
operators



Social Media



SNAP4
Appliances and Dockers
Installations



PEN Test Passed



EU GDPR COMPLIANT



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DASHBOARDS AND APPS - CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS

Powered by **FIWARE**

SNAP4
Appliances and Dockers
Installations

FREE TRIAL

PEN Test Passed

EU GDPR COMPLIANT

100% OPEN SOURCE



**EXPERT SYSTEM
KNOWLEDGE BASE
STORAGE**



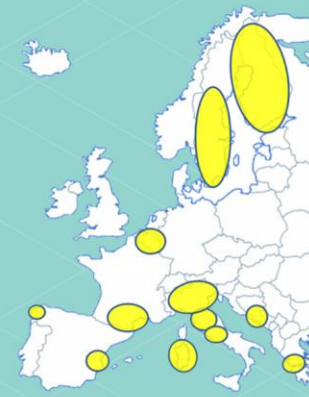
**BIG DATA ANALYTICS
ARTIFICIAL INTELLIGENCE
BUSINESS INTELLIGENCE
MACHINE LEARNING**



**DATA FLOWS, WORKFLOWS
MICROSERVICES
MANAGEMENT**



**METHODOLOGIES
COURSES AND COMMUNITY
LIVING LABS
DEVELOPMENT TOOLS**



What-IF analysis



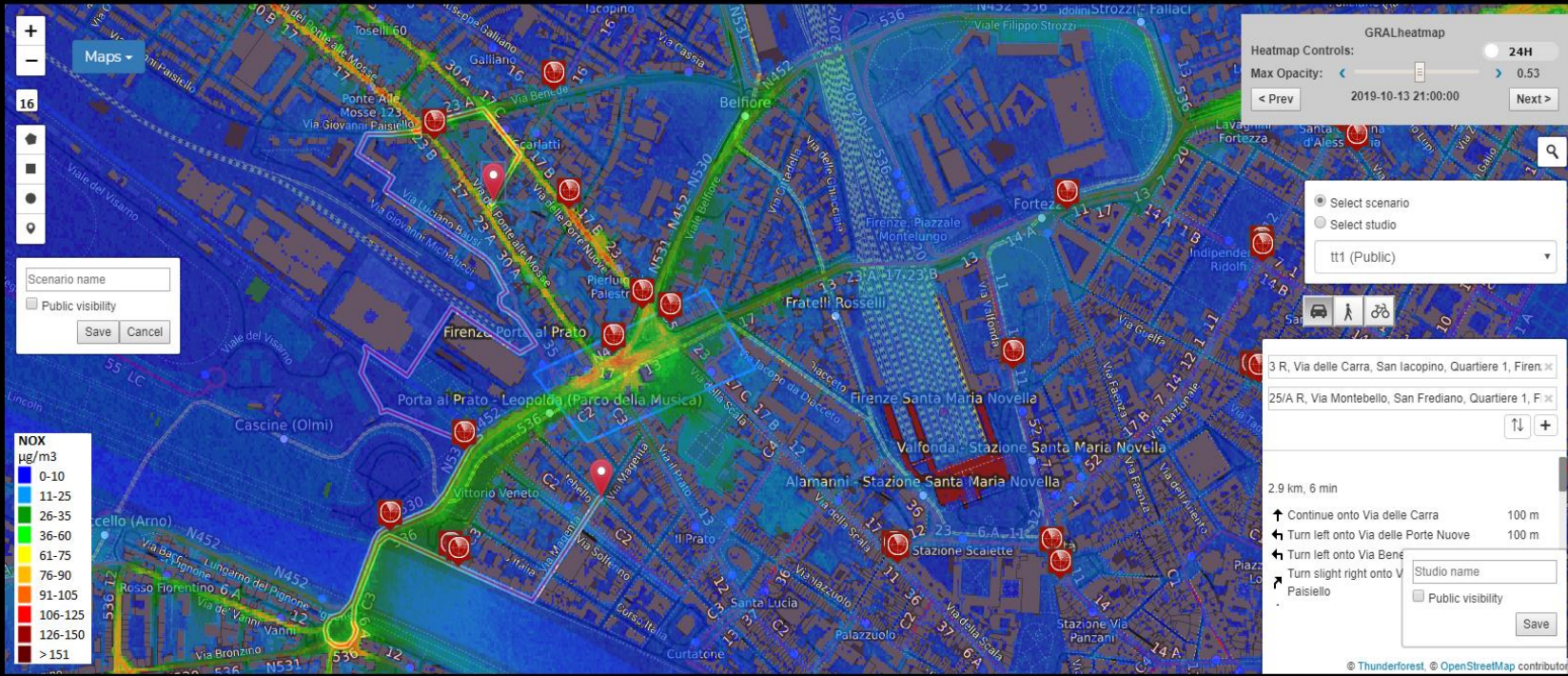
Co-funded by the European Union under H2020 DRS' 07-2014

Mobility and Environment What-IF Analysis

This dashboard contains data derived from actual sensors and predictive values under validation

Mon 14 Oct 00:48:17

- ✓ Air Quality Sensors
- ✓ Weather Sensors
- ▲ PM10 Heatmap
- ▲ PM25 Heatmap
- ▲ CO Heatmap
- ▲ CO2 Heatmap
- ▲ O3 Heatmap
- ▲ NO2 Heatmap
- ▲ Europ. AQI Heatmap
- ▲ Air Humidity Heatmap
- ▲ Air Temp. Heatmap
- ▲ Wind Speed Heatmap
- ▲ Gral Pred. HM NOx (3m)
- ▲ Gral Pred. HM NOx (6m)
- ▲ Traffic Sensors
- ▲ Traffic Flow
- ▲ Cycling Paths
- ▲ Accident Heatmap
- ▲ Only HRes Anym. Gral
- ▲ Scenarious
- ▲ What-if analysis



<https://www.snap4city.org/dashboardSmartCity/view/index.php?idashboard=MjE5MA==>



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Alert Registration



☰

Alerting Generation

This dashboard contains data derived from actual sensors and predictive values under validation

Sat 16 Jan 01:03:27

- ▲ Air Quality Sensors
- ▲ Weather Sensors
- ▲ PM10 Heatmap
- ▲ PM2.5 Heatmap
- ▲ CO Heatmap
- ▲ CO2 Heatmap
- ▲ NO2 Heatmap
- ▲ Europ. AQI Heatmap
- ▲ Air Humidity Heatmap
- ▲ Air Temp. Heatmap
- ▲ Gral. Pred. HM NOx (5m)
- ▲ Traffic Sensors
- ▲ Traffic Flow
- ▲ Traffic Bubble
- ▲ Cycling Paths
- ▲ Accident Heatmap
- ▲ Scenarios
- ▲ What-if analysis
- ! Area Alerts

RED

15/01/2021 - 14:27:27

TICKET NUMBER: 1610717247691

OPERATOR: PAOLO DISIT

Incident Kind

RIVER FLOODING

Severity

RELEVANT

People Involved

<=10

Short Term Impact

PEOPLE DISEASE

Long Term Impact

POLLUTANT

Alarm Description (7m)

Kind: River Flooding

Severity: Relevant

#People: 10

Impact 1: People Disease

Impact 2: Pollutant

GPS: 43.776114;11.210861

City: FIRENZE

Adr: VIA ADRIANO CECIONI N.undefined

Registered:Green:1610755283309

🔌

Clean

🔌

Register Alert

Firenze Oggi

Air Temperat... (7m)

tusc_wathe... (7m)

airTemperature (7m)

Alert Events (7m)

TICKET	OPERATOR
1610755283309	PAOLO DISIT
15/01/2021 14:30:28	
TICKET	OPERATOR
1610717428876	PAOLO DISIT
15/01/2021 14:27:27	
TICKET	OPERATOR
1610717247691	PAOLO DISIT
15/01/2021 14:23:22	
TICKET	OPERATOR
1610717002089	PAOLO DISIT
15/01/2021 14:06:37	
TICKET	OPERATOR

Closest WebCAM



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Dashboards



Co-funded by the European Union under H2020 DRS' 07-2014

Alerting Generation

This dashboard contains data derived from actual sensors and predictive values under validation

Sat 16 Jan 01:03:27

Incident Kind: RIVER FLOODING

Severity: RELEVANT

People Involved: 10

Short Term Impact: Impact 1: People Disease

Long Term Impact: Impact 2: Pollutant

POLLUTANT

City: FIRENZE

Adr: VIA ADRIANO CECIONI Nundefind

Registered: Green1610755283309

Alert Events

Ticket	Operator
1610755283309	PAOLO DISIT
1610755283309	PAOLO DISIT
1610755283309	PAOLO DISIT
1610755283309	PAOLO DISIT
1610755283309	PAOLO DISIT
1610755283309	PAOLO DISIT
1610755283309	PAOLO DISIT
1610755283309	PAOLO DISIT
1610755283309	PAOLO DISIT
1610755283309	PAOLO DISIT

Snap4Home 5G Demo

Thu 11 Jun 16:07:32

Gio 11 Giu
Prato

Pioggia e schiarite
18°C / 22°C
Powered by LaMMA

Preseza Associata sulla Pesa 1 e 2

Light Detect. OFF

LUCE

Ultrasonic

lampada No alarm

Privacy Policy | Cookies Policy | Terms and Conditions | Contact us

Data Analyzer: DevDash

User: root@localhost:root, Org: DISIT

Number of Sensors: 4

Latitude: 43.7789628161738

Longitude: 11.2736862864471

Time	organization	device_name	value	unit	label	value_name	value_type	data_type	sensor_id	sensor_unit
1 October 19h 20:01, 13:53:02:790	root@localhost	iot	0.215		iot	production_line	temperature	Real	1610755283309	°C
1 October 19h 20:01, 13:53:02:790	root@localhost	iot	24		iot	temperature	temperature	Real	1610755283309	°C
1 October 19h 20:01, 13:53:02:790	root@localhost	iot	43.7925111		iot	production_line	latitude	Real	1610755283309	°
1 October 19h 20:01, 13:53:02:492	root@localhost	iot	1.60041488		iot	production_line	longitude	Real	1610755283309	°

3D Map beta Testing

Sat 16 Jan 17:28:38

METRO20

SETTILE	DESCRIPTION	AT DATA
Value	Value	Value
avgTime	12.105	1.247
concentration	2.805484	1.247
vehicleFlow	145.6475	1.247








































48.6 num. of vehicles



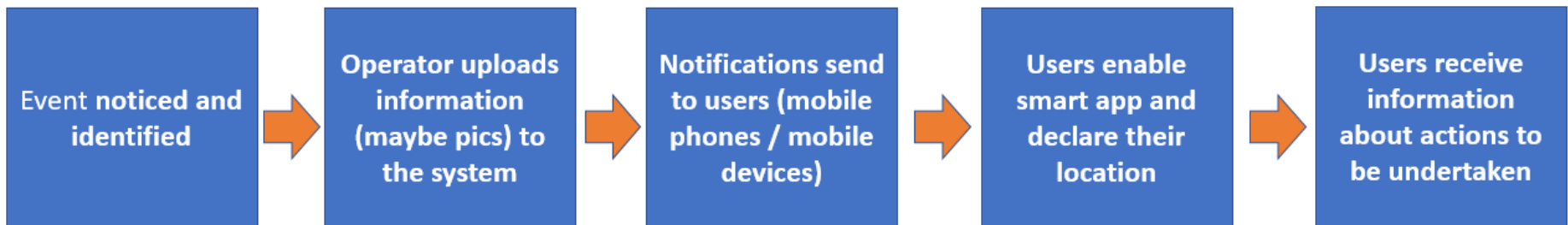
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<https://www.snap4city.org/577>

On Line Training Material (free of charge)

	1st part (*)	2nd part (*)	3rd part (*)	4th part (*)	5th part (*)	6th part (*)	7th part (*)
what	General	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App
PDF							
Inter active							
Video1							
Video2							
Video3							
Video4				none		none	none
duration	2:55	3:16	3:41	2:00	2:48	2:35	1:47

UTS Pilot execution *Florence Scenarios*



Scenario 1 – Evacuation optimization:

- 2 groups of people **suffering from partial / holistic disability** to be evacuated to the closest Safe point with higher priority
- 8 groups people to be evacuated Normal route already blocked due to public works
- DSS to view this route as blocked and offer alternative
- DSS sends to the APPs the information

Scenario 2 – User in need: collaborative assistance & rescue

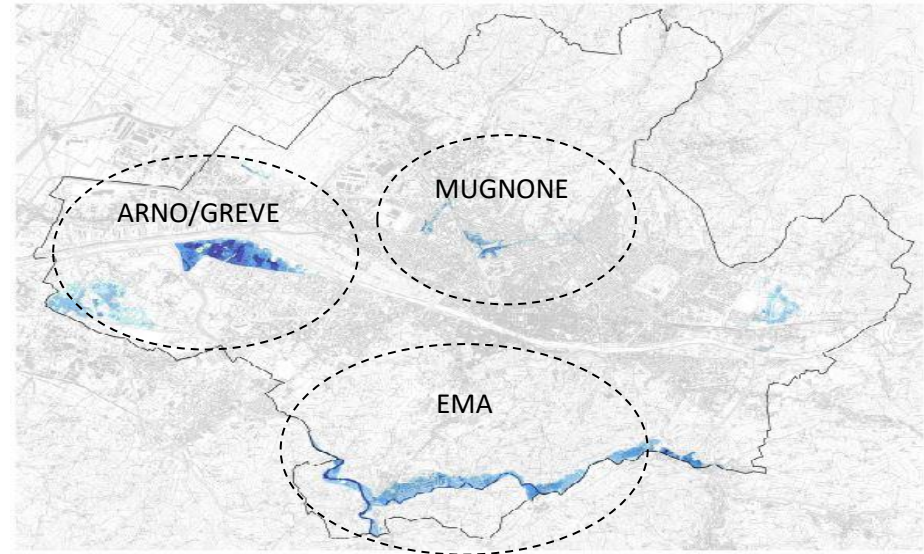
- Citizens (one Safe Point) declares injury / need / inability to evacuate on their own
- System identifies voluntary rescuers based on declared availability System identifies proximity of potential rescuers to citizen / user in need based on the location of user in need
- System informs **selected** rescuer to attend to user in need

Scenario 3: Parametric analysis

- Operator examines systems ability to respond effectively for a range of virtual scenarios
- Operator to check ability to collaborate with first responders
- **NO physical participation of volunteers**

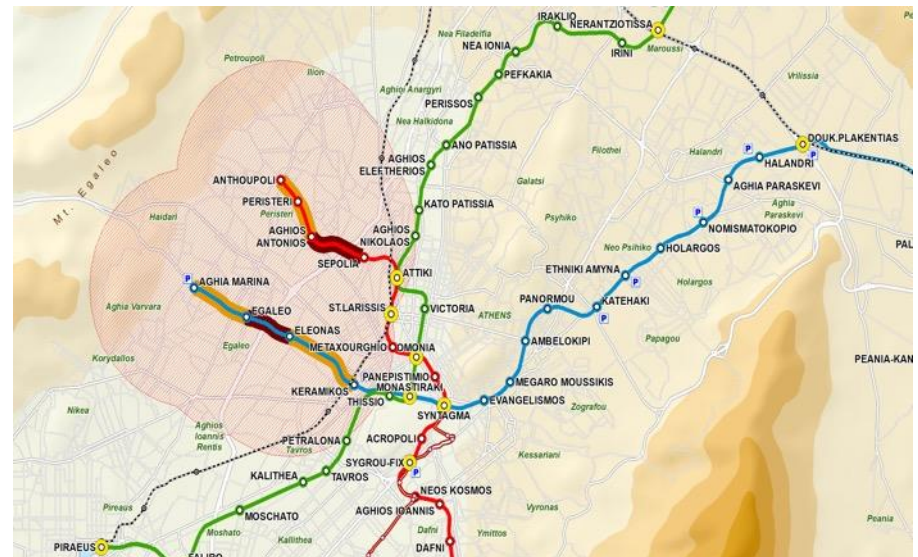
Florence pilot

- Florence pilot scenario identified:
 - river flooding
 - water bomb
- 4 use-case defined: 3 for river flooding, 1 for water bomb.
- All CRAMSS component used to validate the scenarios
- River Flooding use-case:
 - Arno/Greve
 - Mugnone
 - Ema



Athens pilot

- Athens pilot scenario identified:
 - Bomb attack
- Based on modelling/simulations and stated choice questionnaires on risk cost perception.
- Extension: testing eDSS and ESSMA





RESOLUTE team in Florence

IT Dept
 Responsible for the Municipality
 Data (Open, GIS)
 Dashboard w Unifi
 Dissemination on technical contents

City Manager Dept
EuroProjects Office
 Coordination with H2020 REPLICATE (SCC1)
 Dissemination & monitoring

Local Police
 Data/incidents/street events
 Dashboard evaluation



Mobility & Metropolitan City
 Mobility Scenarios Analysis
 Mobility Manager
 Traffic re-adaptation
 Traffic Supervisor



Office of the Mayor
Civil Protection (16 association activated)
 Processes & procedures
 Mapping communication channels



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Not only digital technologies....

Goose in the Riskland Game for kids

+1.200 kids, students, teachers, families meeting RESOLUTE



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RESOLUTE and Community of User

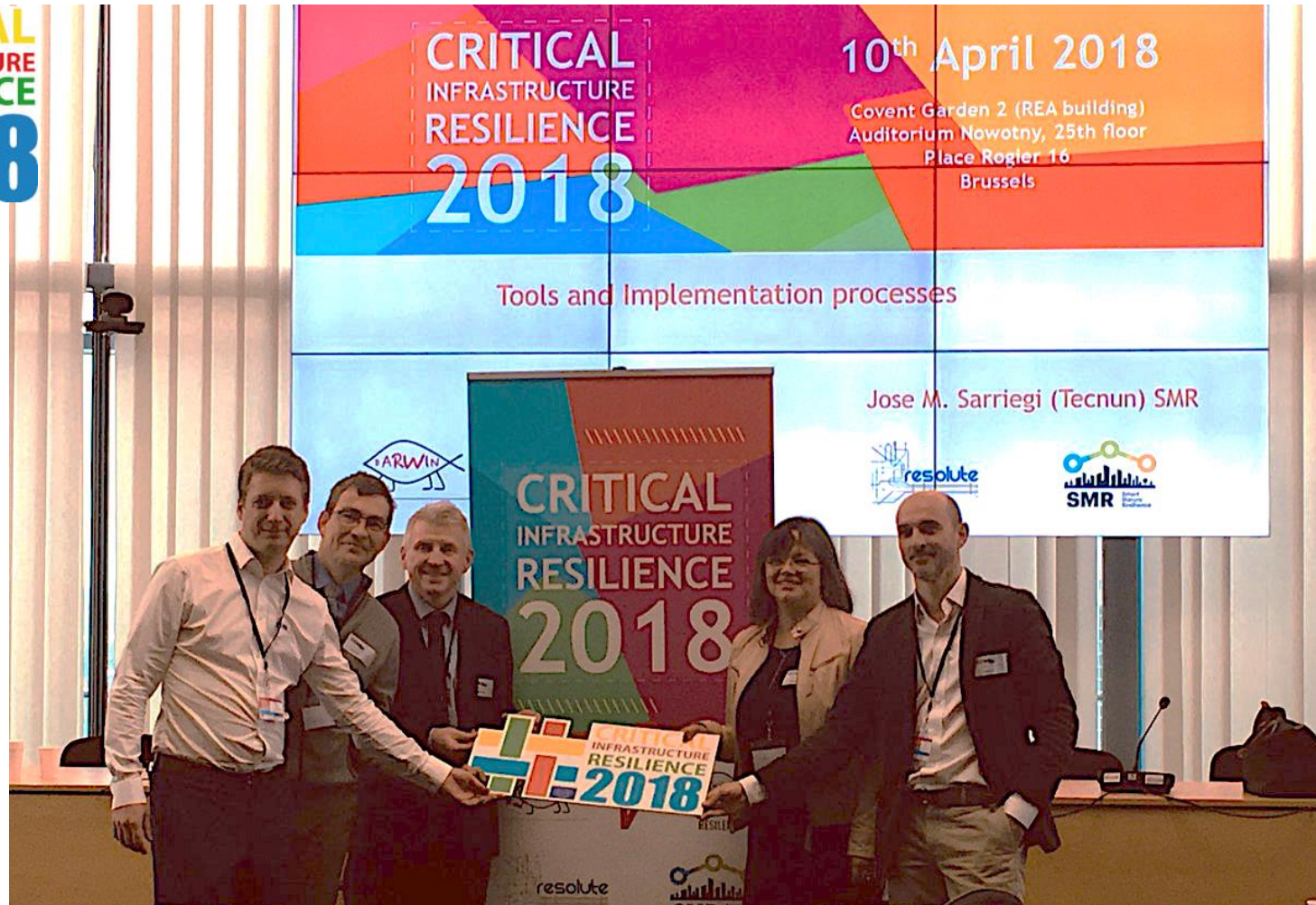
- **CoU** event in Brussels on 13 & 14 September 2017.
https://youtu.be/BC1_d2Z_RUo
- Aligning the resilience-related research efforts in the EU-DRS projects 12 September 2017, Brussels, Belgium
- In conjunction with **CoU** event & with DRS projects
 - Presenting new approaches to the resilience assessment and management methods, new guidelines and new tools are being developed in many current EU projects.

Aleksandar Jovanovic,
Emanuele Bellini (Eds.)
ISBN 978-3-95663-143-6
2017





Critical Infrastructure Resilience 2018 (DRS-7 joint conference)

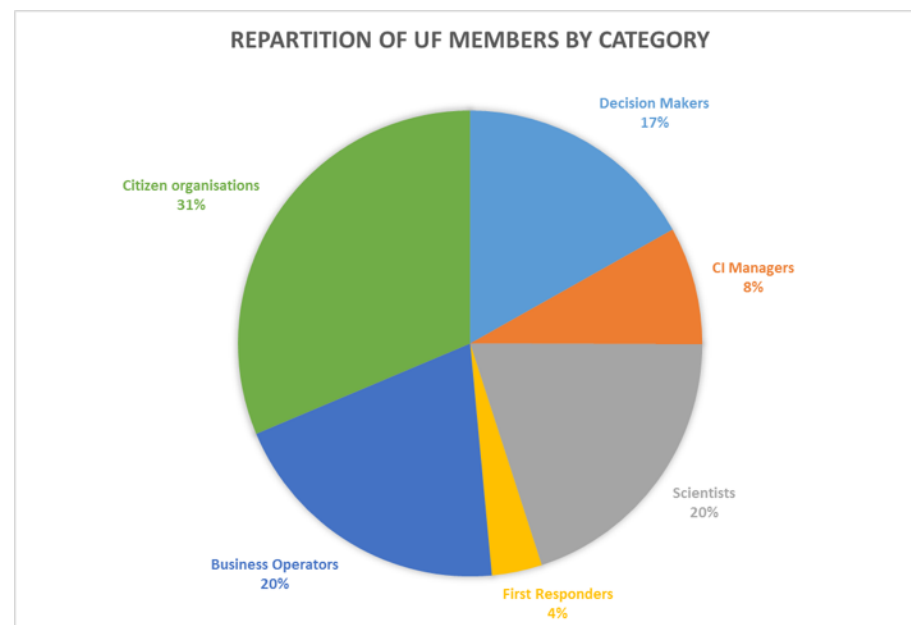


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RESOLUTE End User engagement results

Decision Makers	169
CI Managers	82
Scientists	200
First Responders	35
Business Operators	202
Citizen organisations	314
	1002





Thank you



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