UNIVERSITÀ DEGLI STUDI FIRENZE
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

https://www.disit.org/
Paolo Nesi, paolo.nesi@unifi.it

Big Data and Analytics

https://www.snap4City.org

Master di I° livello
INDUSTRY 4.0 DESIGN
Enterprise Digitalization and 4.0 Technologies
https://www.masterindustry40.it/

SNAP4INDUSTRY

SNAP4 Appliances and Dockers Installations

100% OPEN SOURCE



https://www.snap4city.org/700

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http://www.disit.dinfo.unifi.it

Distributed Systems and Internet Technologies Lab
Distributed Data Intelligence and Technologies Lab
Department of Information Engineering (DINFO)
University of Florence

http://www.disit.dinfo.unifi.it

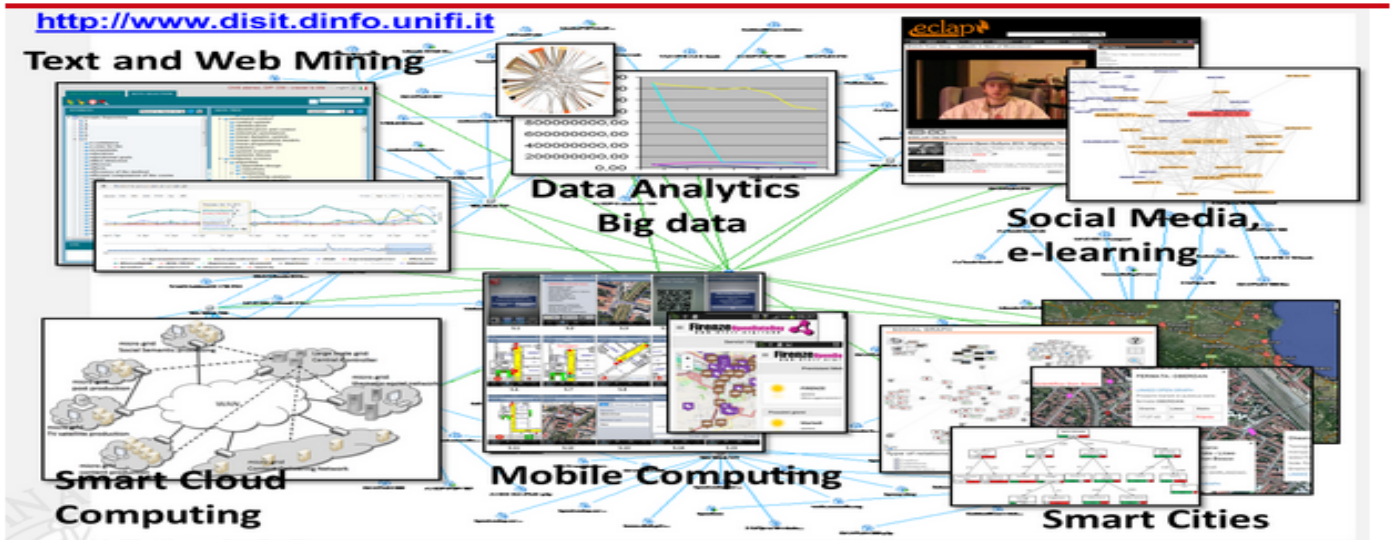
UNIVERSITÀ DEGLI STUDI FIRENZE — DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

qualsiasi tipo | deep search

HOME | ABOUT | RESEARCH | INNOVATION | CORSI E TESI | COME FARE | EVENTI | MIO PROFILO | root | Uscire

Mostra | Modifica | Log | Translate | Devel

DISIT LAB OVERVIEW



DISIT lab and research group is active since 1994. It is one of the most active ICT labs of the University of Florence, metropolitan Tuscany area. DISIT successfully developed a relevant number of International and National research, development and innovation projects. DISIT provides an infrastructure for cloud and distributed computing.
DISIT has coordinated a number of large EC projects, in many others has covered the role of partner, and also coordinating scientific and technical WP and performing activities of dissemination and assessment. DISIT has received a relevant number of awards and is currently involved in top level international [illegible] boards, and committees.



DISIT research areas: big data, artificial intelligence, natural language

CONTENUTI

- *Ultime Attività*
- *In primo piano*
- *Più visti*
- *Most Viewed (last 500)*
- *Most Viewed All (last 500)*
- *Ultimi caricati*
- *Più votati*
- *Mie collezioni pubblicate*
- *Miei contenuti*
- *Carica un nuovo contenuto*

ROOT

- Gruppi
- Cerca Utenti
- Contenuti ed attività non lette relative ai tuoi gruppi
- Crea la matrice di tassonomia
- Forum
- Invite a colleague
- Issues
- Keyword cloud
- Messaggi e Sottoscrizioni
- Mio MatchMaking
- My issues
- News Blog
- Salva informazioni del cluster
- Workflow summary

https://www.disit.org

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http://www.disit.org

Con chi lavoriamo

swarco First in Traffic Solutions. · var group · THALES · BUSITALIA NORD GRUPPO FERROVIE DELLO STATO ITALIANE · Hewlett Packard Enterprise · European Commission Joint Research Centre · WINDTRE

TIM · LEONARDO · ALSTOM · ataf · italmatic · ALTAIR CHIMICA

COMPUTER GROSS · PHILIPS · eutelsat · CTT NORD

tiscali: · e-distribuzione · Rai · estra · COSTRUZIONI NOVICROM · PerDormire DESIGN FOR WELLNESS

ENGINEERING · GIUNTI EDITORE · Reverberi Enetec Gruppo MPES · CONSORZIO LaMMA · Camera di Commercio Firenze · REGIONE TOSCANA

ECM · SIAE Società Italiana degli Autori ed Editori · EUROPEAN OPEN SCIENCE CLOUD

Fondazione per la ricerca e l'innovazione · liberologico · europeana think culture · BMG · Node-RED · anci toscana · COMUNE DI FIRENZE · CITTÀ METROPOLITANA DI FIRENZE

Consiglio Nazionale delle Ricerche · Fraunhofer · CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS · BBC · COMUNE DI CAGLIARI · CITTÀ METROPOLITANA DI CAGLIARI · REGIONE AUTÒNOMA DE SARDIGNA REGIONE AUTONOMA DELLA SARDEGNA

cini · cnit consorzio nazionale interuniversitario per le telecomunicazioni · ARPAT Agenzia regionale per la protezione ambientale della Toscana · ENTE CASSA DI RISPARMIO DI FIRENZE

National Technical University of Athens · EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE · UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA · UNIVERSITÀ DEGLI STUDI DI CAGLIARI · APRE TOSCANA AGENZIA PER LA PROMOZIONE DELLA RICERCA EUROPEA · ACCADEMIA NAZIONALE DI SANTA CECILIA · comune di PRATO · Comune di LIVORNO · Comune di Modena

Some DISIT Projects

MobiMart: mobility in the mediterraneous
Herit-Data: Tourism and Mng. https://herit-data.interreg-med.eu/
Snap4City: IOT/IOE smart city www.snap4city.org
Trafair: CEF project with several Cities http://trafair.eu/
Mosaic: Mobility and transport model
Km4City: http://www.km4city.org
REPLICATE H2020, SCC1, EC flagship
http://replicate-project.eu/
Sii-Mobility SCN MIUR: http://www.sii-mobility.org
Feedback: retail and GDO Big Data analytics
5G with 3G-Wind, Open Fiber, Estra
Coll@bora Social Innovation, MIUR:
http://www.disit.org/5479
RESOLUTE H2020, EC:
http://www.resolute-eu.org
TRACE-IT, RAISSS, TESYSRAIL, …
Mobile Emergency:
http://www.disit.org/5404



























Trace-IT



RAISSS









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Main running projects

- Sii-Mobility → mobility and transport, sustainability
- REPLICATE → ICT, smart City Control room, Energy, IOT
- RESOLUTE → Resilience, ICT, Big Data
- GHOST → Strategies, smart city
- TRAFAIR → Environment & transport
- MOSAIC → mobility and transport
- WEEE Life → Smart waste, environment
- Smart Garda Lake → Castelnuovo del Garda
- 5G → Industry 4.0 vs SmartCity
- Green Impact → Industry 4.0, Chemical Plant
- SmartBed (laid → smart health
- Green Field Peas (soda) → Industry 4.0, Chemical plant
- PISA MobiMart and Agreement → data aggregation, Living Lab
- Lonato del Garda → smart parking, environment
- Herit-Data → tourism, culture and management
- MobiMart → mobility and transport
- ISPRA JRC → site management and services
- Capelon Sweden → Smart Light and smart city

DISIT lab roadmap vs model and tools' usage

2013
Km4City Ontology 1.1

- Tuscany, Road Graph
- Mobility
- culture, tourism
- Events
- Parking
- Services
- Linked open graph

2014
- Weather Forecast
- Real Time Wi-Fi
- Entertainment
- LOD

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015
Km4City 1.5

- Resilience Decision Support
- Smart First Aid
- User Behaviour Analysis, predictions
- Risk Analysis

ckan, resolute

H2020 (2015-18)

2016
(2016-21) H2020 REPLICATE

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

Sii-Mobility (2016-21) MIUR

SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

FIWARE

2017
Km4City 1.6.4

Sii-Mobility

- Origin-Destination and trajectories
- Traffic Reconstruction
- Offer Analysis
- OBU, smart devices

E0l5 digital ecosystem (Powered by EXPO MILANO 2015)

(2016-19) MIUR GHOST SIR

- Sardinia Region Smart City Strategies and plan

GREEN IMPACT C.A.P.A.C.I.T.Y.

GREEN IMPACT
POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

- IOT/IOE, IOT App
- Living Lab
- Maker Support
- IOT Edge
- Smart City IOT
- GDPR,
- Privacy & Security

life weee (2017-20)

- Smart Waste

2018
MOSAiC MObility 4.0 for SmArt (i) CiTy (2018-20)

- Mobility Demand / Offer Analytics and Strategy

Sii-Mobility

- User engagement
- Bike Sharing
- Data Analytics ++
- Social Predictions
- OBD2

IOT/IOE

Km4City 1.6.6

Node-RED

SNAP4CITY SELECT for Cities H2020 (2017-19)

2019
5G (2018-21)

- 5G tech
- Energy
- Industry 4.0
- Synoptics

TRAFAIR CEF (2018-21)

- Traffic and Mobility Impact on Pollution
- NOX predictions

EUROPEAN OPEN SCIENCE CLOUD

SIRIUS

LAID Smart Bed

- Smart Health

GREEN FIELD PEAS Soda4.0 (Optimization and Automated Decision System 4.0)

- Industry 4.0

bee smart city

- Smart Lonato

Reverberi Enetec Gruppo MPES

- PCP Award

SELECT for Cities 1° place award to SNAP4CITY

2020
- Smart Tourism
- 6 Pilots
- Data Analytics
- Extended platform

2021
- CAPELON
- Sweden

smartGARDAlake

Interreg MARITTIMO-IT FR-MARITIME MOBI MART

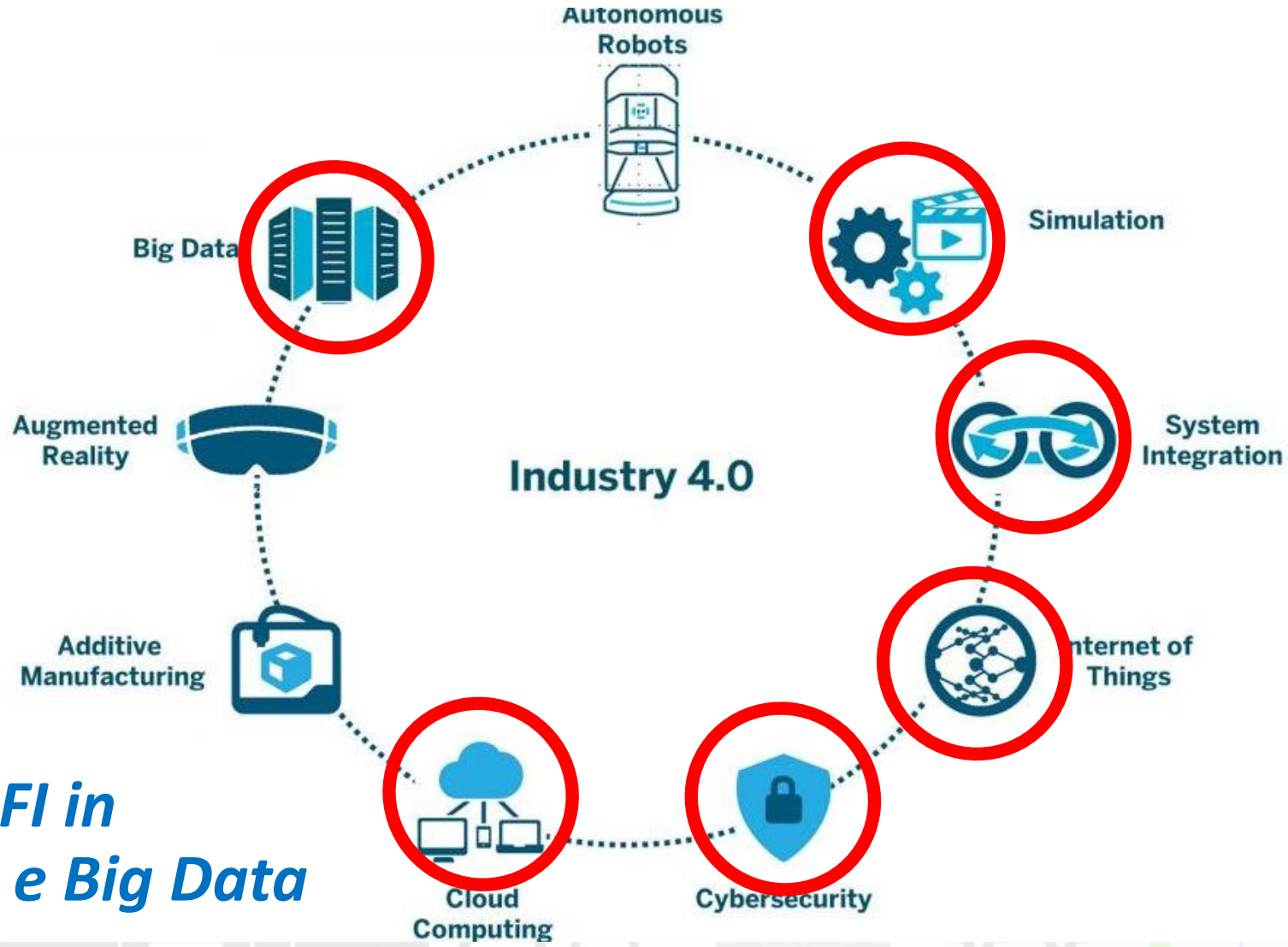
- Smart Mobility
- PISA, PUMS
- Living lab

Interreg Mediterranean HERIT-DATA

…2022

Industria 4.0 vs DISIT Lab

- Big Data
- Cloud Computing
- Cybersecurity
- IOT/IOE
- System Integration
- Simulation
- +
- Data Analytics
- ***P. Nesi è referente per UNIFI in RegioneToscana per Cloud e Big Data***



DISIT: Competences

- **Technologies**:
  - **Big Data and Analytics:** data management, user analysis, user engagement, prediction, predictive maintenance, early detection, anomaly detection, data intelligence, What-IF analysis, …
  - **Data Mining:** artificial intelligence, machine learning, natural language processing, semantic computing, semantic reasoner, expert systems, statistic analysis, ..
  - **IOT/IOE:** internet of things/everything, brokers, microservices, ..
  - **Cloud:** smart cloud, cloud simulation, optimization, containers, ..
  - **Mobile Computing:** mobile application, user behavior analysis, ..
  - **NLP and Sentiment Analysis:** response vigilance, interaction, answering, Personal Assistant, NLP, SA, ..
- **See projects on: http://www.disit.org/5501**

DISIT: Application Fields

Increasing investments in Big Data can lead to interesting discoveries in **science**, **medicine**, benefits and gains in the **ICT sector** and in **business** contexts, new services and opportunities for digital **citizens** and **web users**.

- **Big Data infrastructures with** real time management:
  - Control Room
  - Smart City: Mobility and transport, Environment, Tourism and culture, energy
  - Industry 4.0
  - Living Lab Solutions
  - Mobile Apps
- **Data Analytic: prediction, anomaly detection, optimization, early warning, classifications, recommendations, etc.**
  - **Traffic, parking, bike, pollutant, production, maintenance, marketing, people flow, etc.**
- **Semantic Reasoners: Km4City, Cloud, Eclap, ..**
- Virtual Assistant: PAVAL, OSIM
- Cloud management and simulation
- Security for IOT and Big Data
- Energy and Govern
- Healthcare and Medicine
- Social Network – Internet Service – Web Data

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							
Interactive							
Video1							
Video2							
Video3							
Video4				none		none	none
duration	2:55	3:16	3:41	2:00	2:48	2:35	1:47

CORSO: BIG DATA ARCHITECTURES (B028463, B028462), UNIVERSITÀ DEGLI STUDI DI FIRENZE

B028462 - B028463 - BIG DATA ARCHITECTURES
Corso di Studio: B070 - INGEGNERIA INFORMATICA,
Università degli Studi di Firenze.

Contenuti:
--Overview del costo e del Lab
--Big data architectures
--Cloud: virtualizzazione, HA, DRS, FT, architetture
--Container: Marathon, Mesos, Docker
--Hadoop, MapReduce, Spark
--Batch and Data Stream processing: NIFI, Kafka, ETL, …
--Indexing and Search: SOLR, SOLR Sharded, Elastic Search
--Big Data Store: Hbase, Mongo
--Big Data Analytics: prediction, early warning, anomaly detection
--Visual Analytics: Business intelligence, Dashboard
--IOT Architecture: AWS, Azure IOT, Google IOT, Snap4City IOT/IOE
--Tools: snap4city.org, Km4city.org, Twitter vigilance
--Big data computing, Performance analysis



Snap4City: IOT/IOE smart city https://www.snap4city.org Trafair: CEF project con varie Citta Mobility and transport model Smart City of Florence Metropolitan Area http://www.km4city.org REPLICATE H2020, SCC1, EC flagship http://www.replicate-project.eu/ Sii-Mobility SCN MIUR: http://www.sii-mobility.org Feedback: reail and GDO Big Data analytics 5G with 3-Wind Open Fiber Estra Coll@bora Social Innovation, MIUR: http://www.disit.org/5479 RESOLUTE H2020, EC: http://www.resolute-eu.org TRACE-IT, RAISSS, TESYSRAIL, ETC. ETC.

Video 2020: Lex1 (all'inizio vi sono svariati minuti di prove da saltare),

https://www.disit.org/7154

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- My issues
- News Blog
- Salva informazioni del cluster
- Workflow summary
- Crea contenuto

Agenda

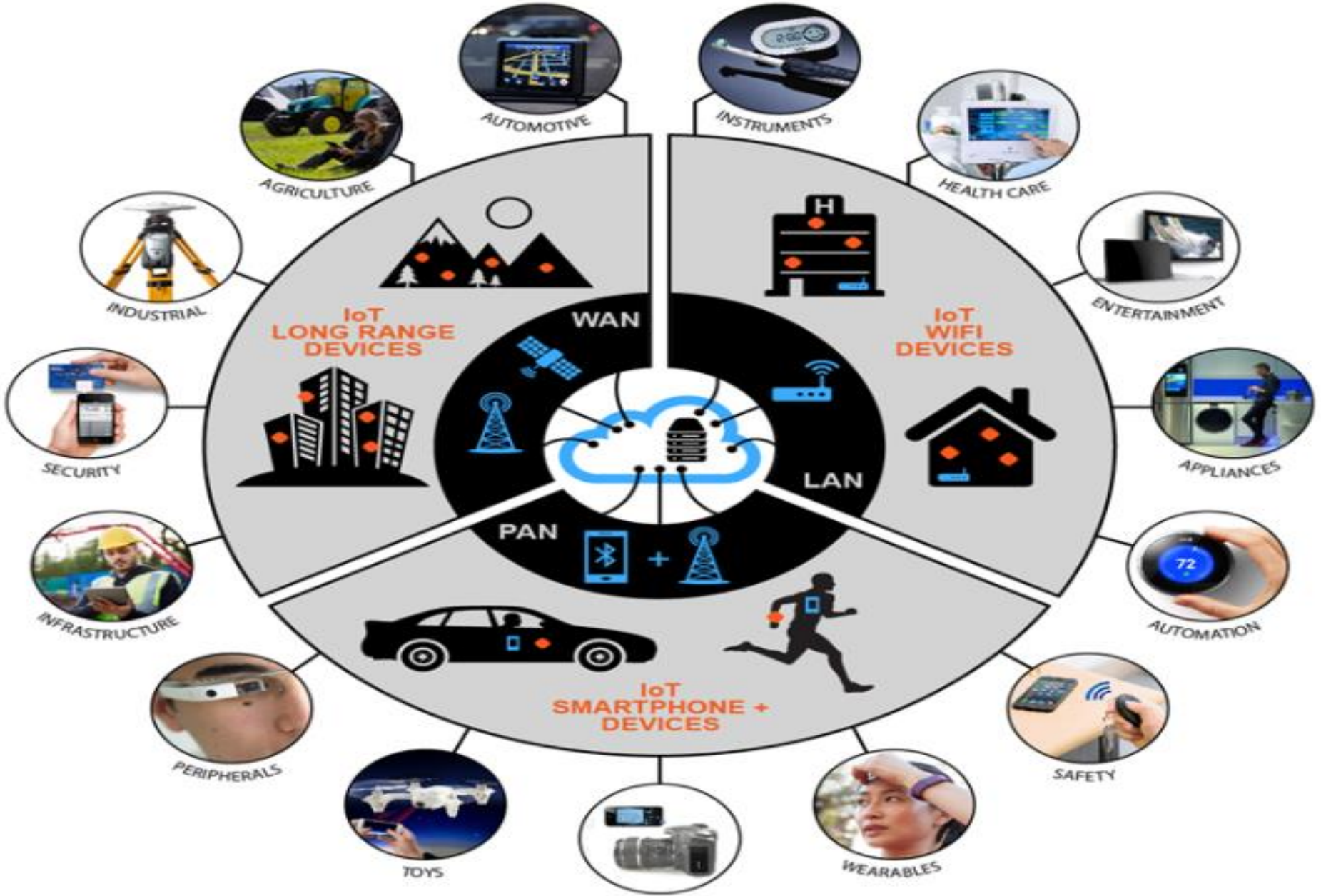
- Big Data Architecture
- Data Warehouse
- Data Storage
- Data Processing
- Data Analytics
- Visual Analytics
- Dashboards
- Living lab for Collaborative work
- Deploy and Install Snap4 .. Solutions
- Acknowledgment

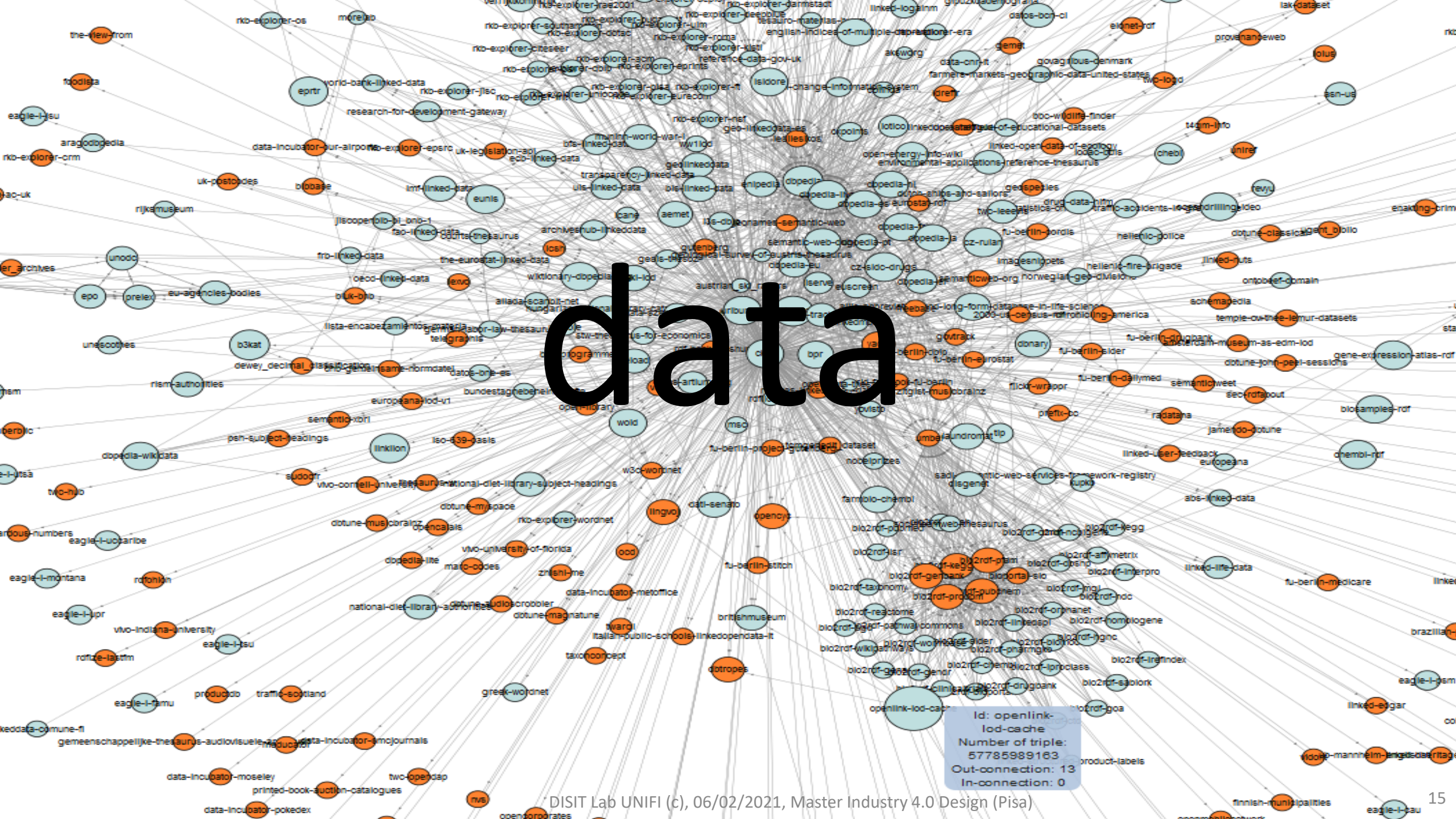
Big Data Architecture

http://www.snap4city.org/download/video/pisa/BigDataAndAnalytic-PISA-2020-v0-6.pdf

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Big Data & Analytics




data
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Number of triple: 57785989163
Out-connection: 13
In-connection: 0

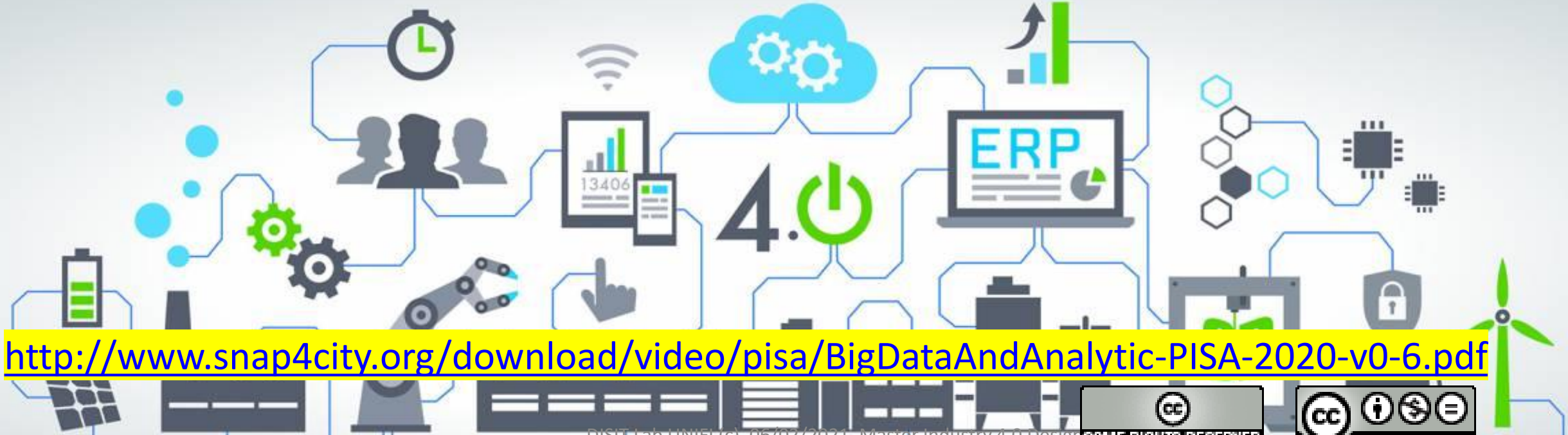
Complessità del Dato

- **Formati diversi, valori sparsi e discontinui** anche in stream
  - Data healthiness, integrity, etc.
- Tecniche: Data Lake per la normalizzazione del dato
  - → big data graveyards based on HDFS
- **Formati e dati non riferibili in modo preciso alla stessa semantica** delle entità in gioco: temperatur*e*, coordinat*e*, misure dei sensori in generale, … → molto dipendenti dal contesto
  - Modelli ontologici → ontologie → knowledge base → expert systems, per ricerche in chiave semantica, Riconciliazione semantica, completamento, contestualizzazione, …
  - Concetti come: value unit, value type, data type, etc…

Agenda

- **Big Data Architecture**
  - Classic Architectural Models
  - Snap4City/Snap4Industry Architecture
- Data Warehouse
- Data Storage
- Data Processing
- Data Analytics
- Visual Analytics
- Dashboards
- Living lab for Collaborative work
- Deploy and Install Snap4 .. Solutions
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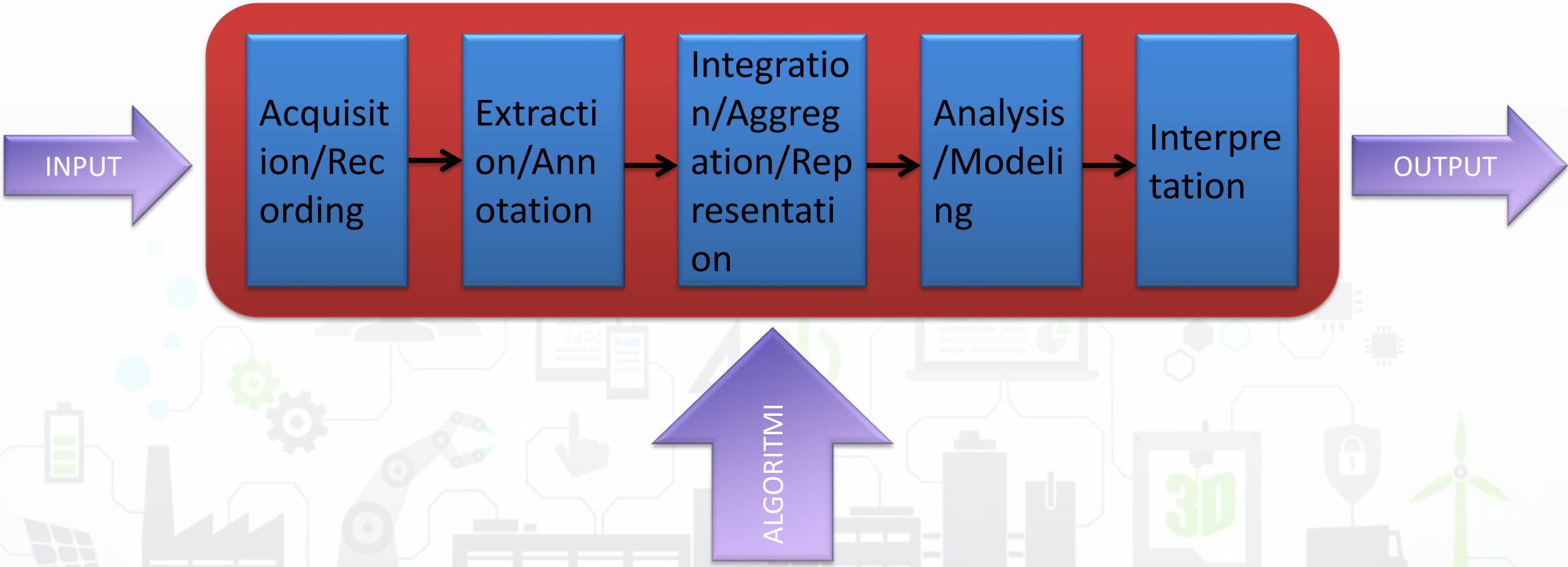
Classic Architectural Models



http://www.snap4city.org/download/video/pisa/BigDataAndAnalytic-PISA-2020-v0-6.pdf

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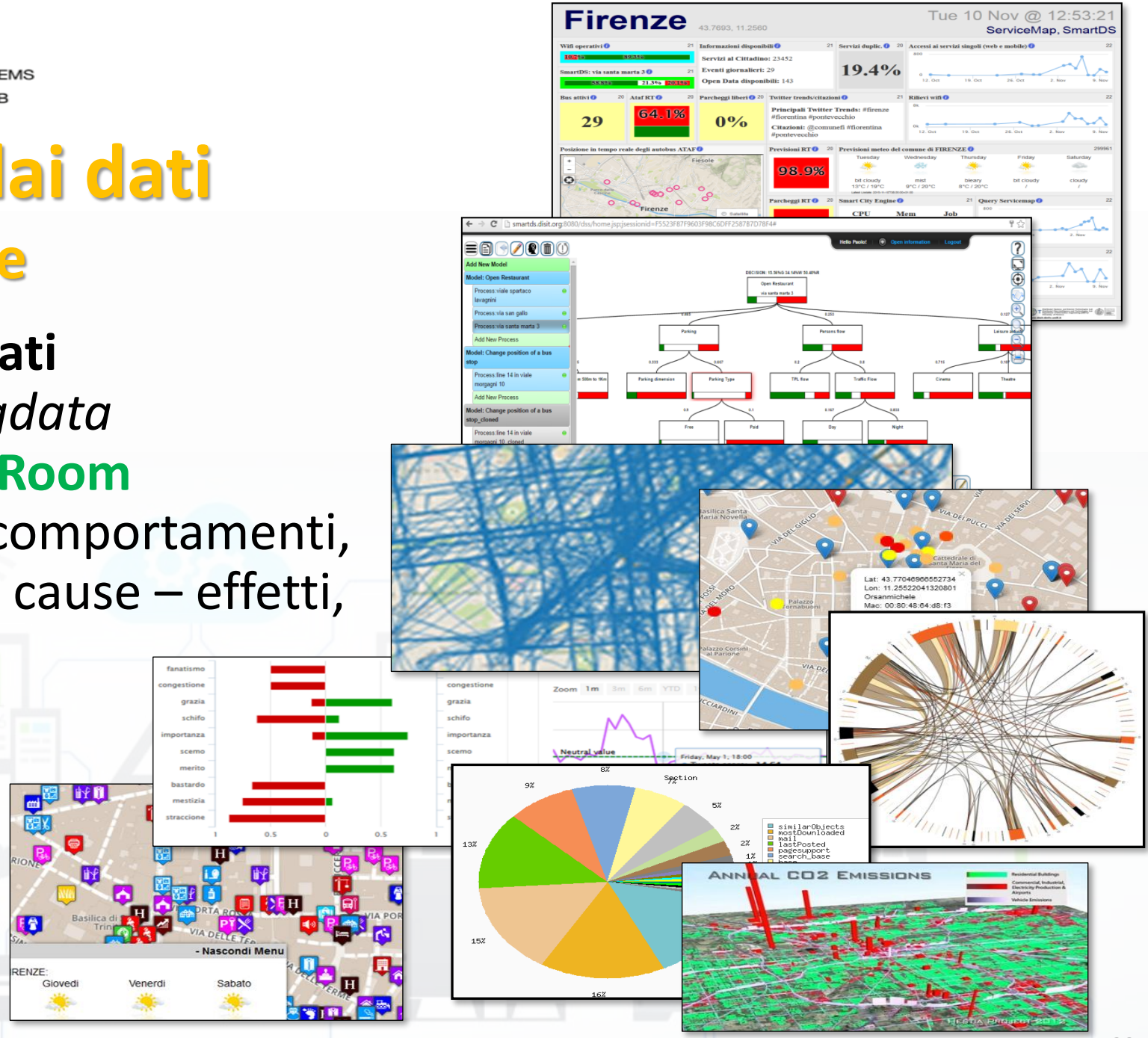
Pipeline


INPUT
Acquisition/Recording
Extraction/Annotation
Integration/Aggregation/Representation
Analysis/Modeling
Interpretation
OUTPUT
ALGORITMI

Decisioni supportate dai dati

periodiche ed in tempo reale

- **Condivisione e Integrazione Dati multidominio:** *semantica e bigdata*
- **Dati → processing → Control Room**
- **analisi**: monitoraggio, flussi e comportamenti, sondaggi, mining, correlazioni, cause – effetti, etc.
  - Per il miglioramento di servizi correnti
  - Per reagire ad eventi, incremento della resilienza,
  - Per la creazione servizi innovativi



Big Data visione di Sistema

non abbiamo il tempo di pulire i dati o regolarizzarli, il sistema deve lavorare con quello che arriva, ed inoltre deve essere:

- in grado di operare H24/7, in HA (high availability, 99.999% up time)?
- in grado di reggere il carico delle richieste? è scalabile?
- in grado di lavorare alla massima precisione in predizione?
- in grado di rispondere in tempo reale?
- resiliente: recupera stabilità a fronte di eventi inattesi?
- modulare, è flessibile, è replicabile, è open, è …..
- sicuro?
- In grado di rispettare la Privacy?

Architettura di base Big Data, IOT, Industry 4.0

Data Sources

Transatio ns sys, sensors Social media, ws, etc.

Data Stream analysis

Spark, Storm, Kafka

Big Data Cluster

HDFS, noSQL

Data Transformati on

ETL, NIFI

Indexing

SOLR, Elastic search

Data Analytics

R, TF, …

Search and Query

Facet, cluster

Visual Analytics

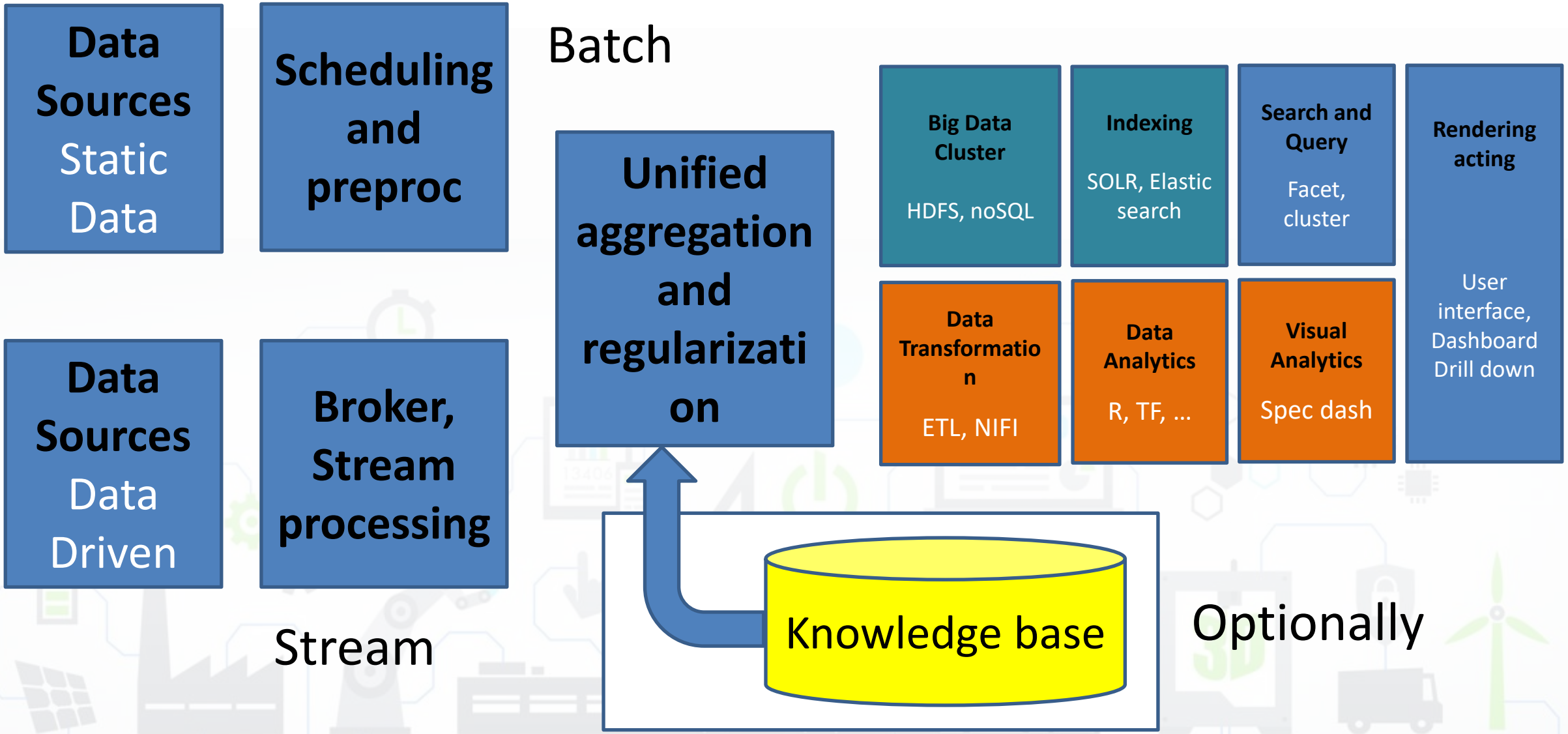
Spec Dash

Rendering acting

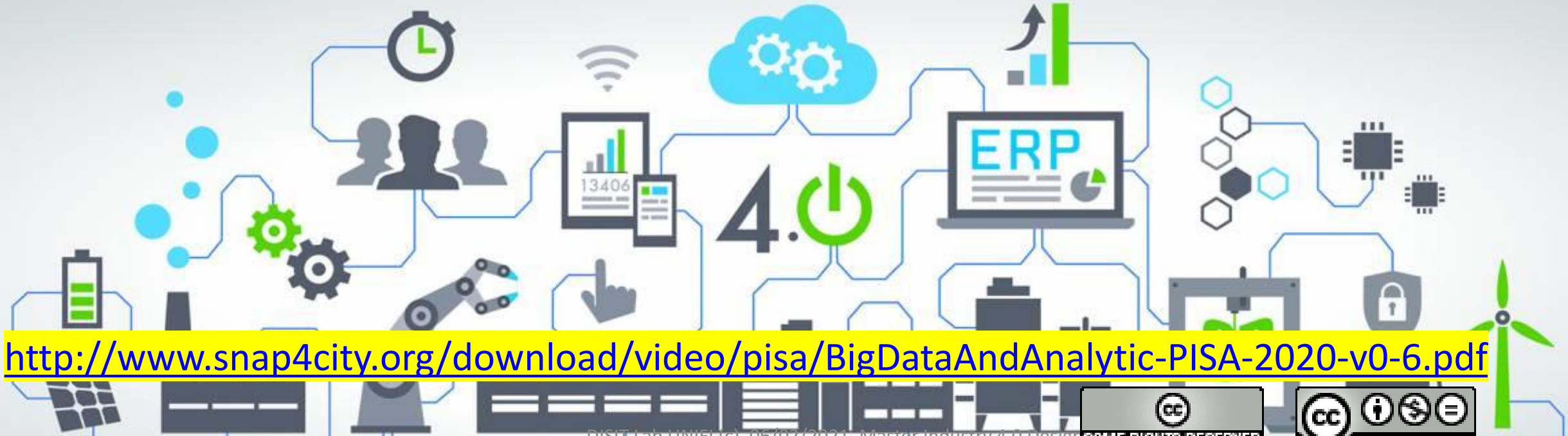
User interface, Dashboard Drill down

Data Management: security, privacy, licensing, etc.

Lambda Architecture



Snap4City/Snap4Industry Architecture



http://www.snap4city.org/download/video/pisa/BigDataAndAnalytic-PISA-2020-v0-6.pdf

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URBAN PLATFORM: SMART CITY IOT AS A SERVICE AND ON PREMISE

100% OPEN SOURCE

APPLIANCES CONTAINERS



- LOCAL GOVERN
- STAKEHOLDERS
- CITY USERS
- IN-HOUSE
- ENERGY OPERATORS
- MOBILITY OPERATORS
- COMMERCIAL OPERATORS
- SECURITY OPERATORS
- INDUSTRIES
- RESEARCHERS
- START-UPS
- ASSOCIATIONS

- GDPR
- SECURITY
- PRIVACY
- ASSESSMENT
- AUDITING
- PENTESTED

- OPEN IOT DEVICES
- IOT EDGE
- IOT GATEWAY
- PAX COUNTERS
- IOT BUTTONS

- TEST CASES, SCENARIOUS, VIDEOS, HACKATHONS
- OPEN SOURCES, COMMUNITY OF CITIES
- TRAINING TUTORIALS, COMMUNITY MANAGEMENT

IOT APPLICATIONS - INSTANT APPS



DATA DRIVEN APPLICATIONS • REAL TIME PROCESSING • BATCH PROCESSING • ANY PROTOCOL & FORMAT

DASHBOARDS & APPLICATIONS



CONTROL ROOM • SITUATION ROOM • OPERATOR DASHBORDS • BUSINESS INTELLIGENCE • WHAT-IF ANALYSIS • DECISION SUPPORT • SIMULATIONS • RISK ANALYSIS • RESILIENCE ANALYSIS

MOBILE & WEB APPLICATIONS



DEVELOPMENT KIT • SUGGESTIONS • MOBILE APPS • MONITORING PANELS • PLATFORM UTILITIES • READY TO USE SMART APPLICATIONS

MICROSERVICES & ADVANCED SMART CITY API

LIVING LAB - DEV TOOLS - COWORKING



IOT DIRECTORY • SERVICE MAP • RESOURCE MANAGER • DATA GATE • R STUDIO • ETL

BIG DATA - DATA ANALYTICS



DATA ANALYTICS TOOLS - MICRO-APPLICATIONS



PREDICTIONS • ANOMALY DETECTION • WHAT-IF ANALYSIS • TRAFFIC FLOW RECONSTRUCTION • ORIGIN-DESTINATION MATRICES • SOCIAL MEDIA ANALYSIS • OFFER VS DEMAND ANALYSIS • ENVIRONMENTAL DATA ANALYSIS AND PREDICTIONS • REAL TIME HEATMAPS • ROUTING • ALERTING • EARLY WARNING • PERSONAL AND VIRTUAL ASSISSTANTS • SMART SOLUTIONS • SMART SHARING • PARTECIPATORY

KM4CITY DATA AGGREGAT KNOWLEDGE BASE - EXPERT SYSTEM OF THE CITY – BIG DATA STORE

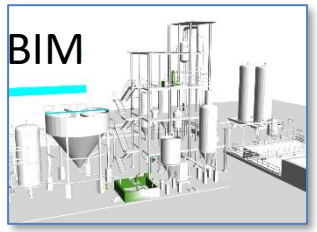
IOT MNG - DATA MNG - DATA INSPECTOR – PROCESS MNG – USER ENGAGEMENT – GDPR MNG ...

GIS	CITY UTILITIES	OPEN DATA	LEGACY & EXTERNAL SERVICES	PERSONAL DATA	IOT / IOE	BROKERS	KPI	INDUSTRY 4.0	SOCIAL MEDIA

https://www.snap4City.org

Concept

BIM

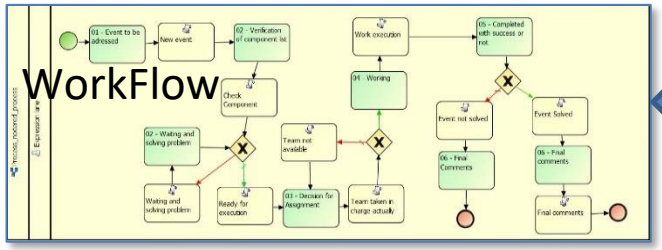


KPI, POI, MyKPI, …

API, External Services

Web Scraping

WorkFlow

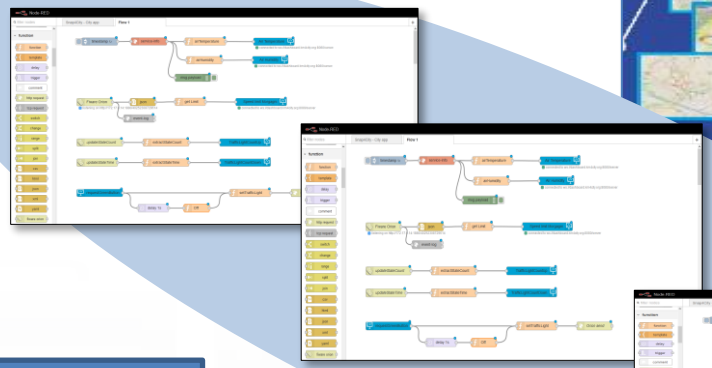






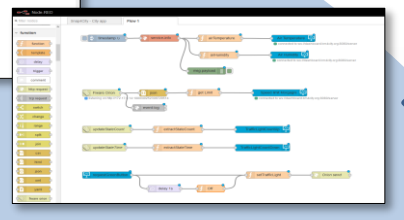


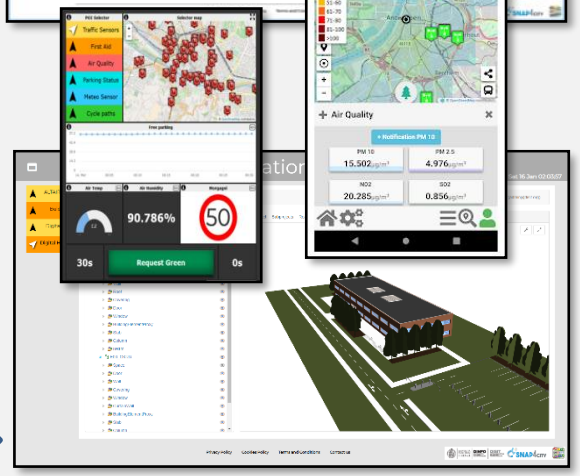




Data Analytics,
Artificial Intelligence

IOT Apps





IOT Broker



FIWARE

ckan

LD, LOD



GIS

Big Data

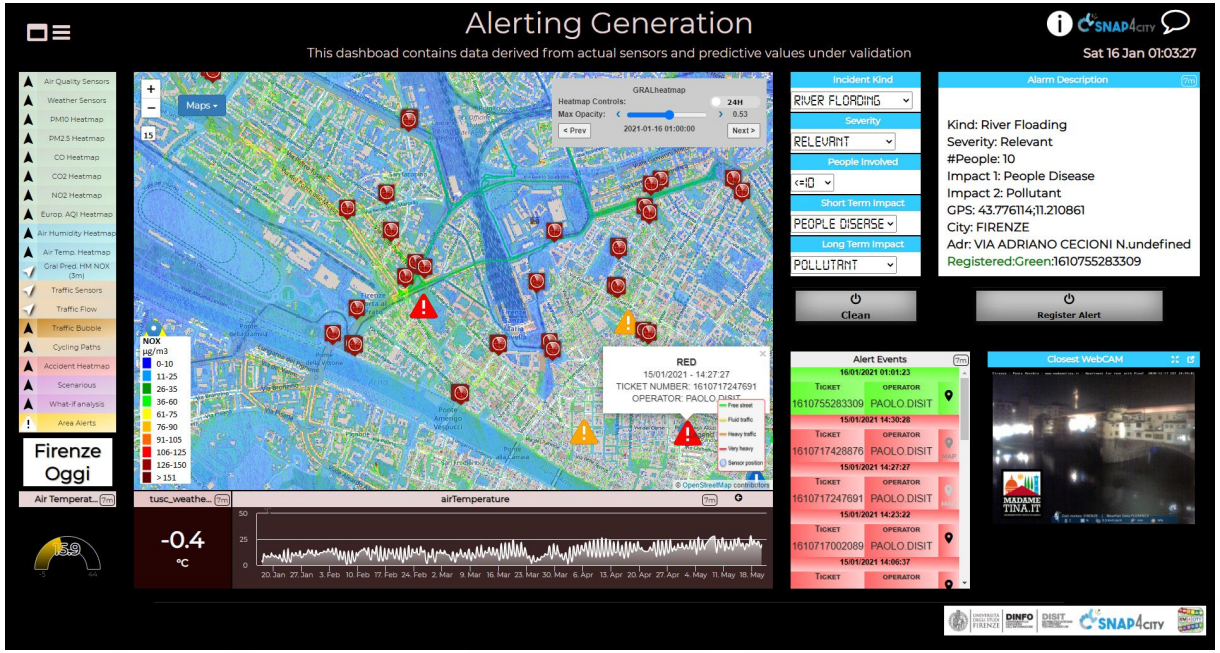
KB

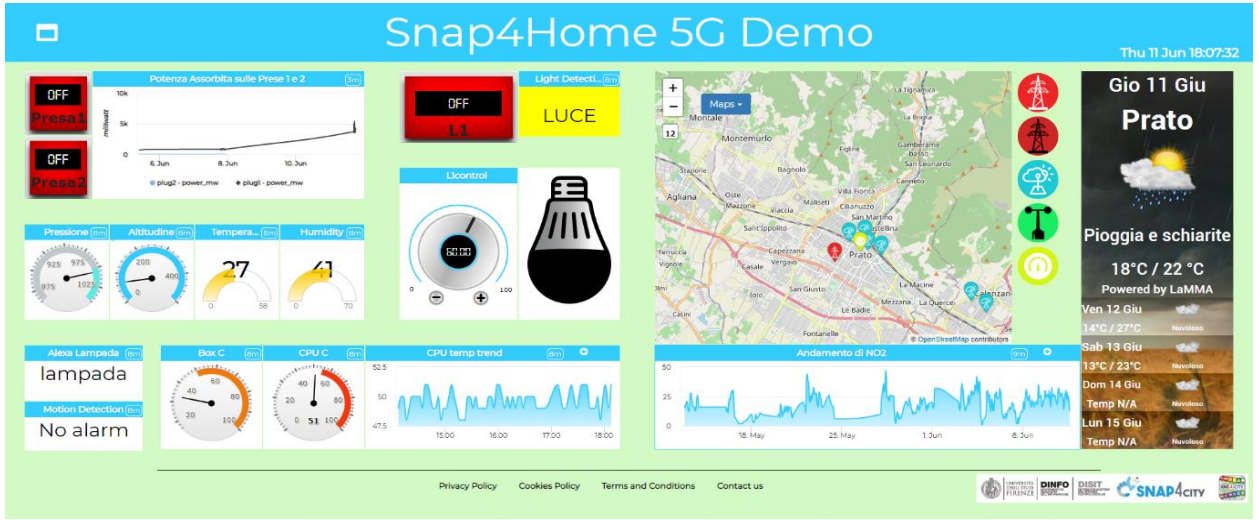
Dashboards and Apps

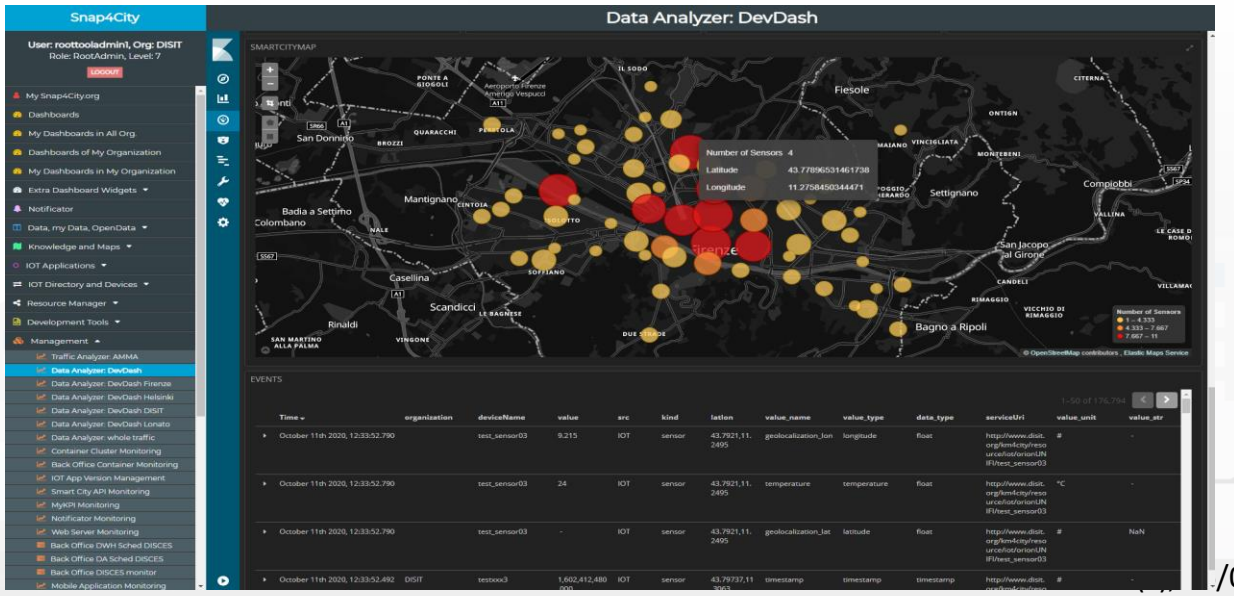
UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

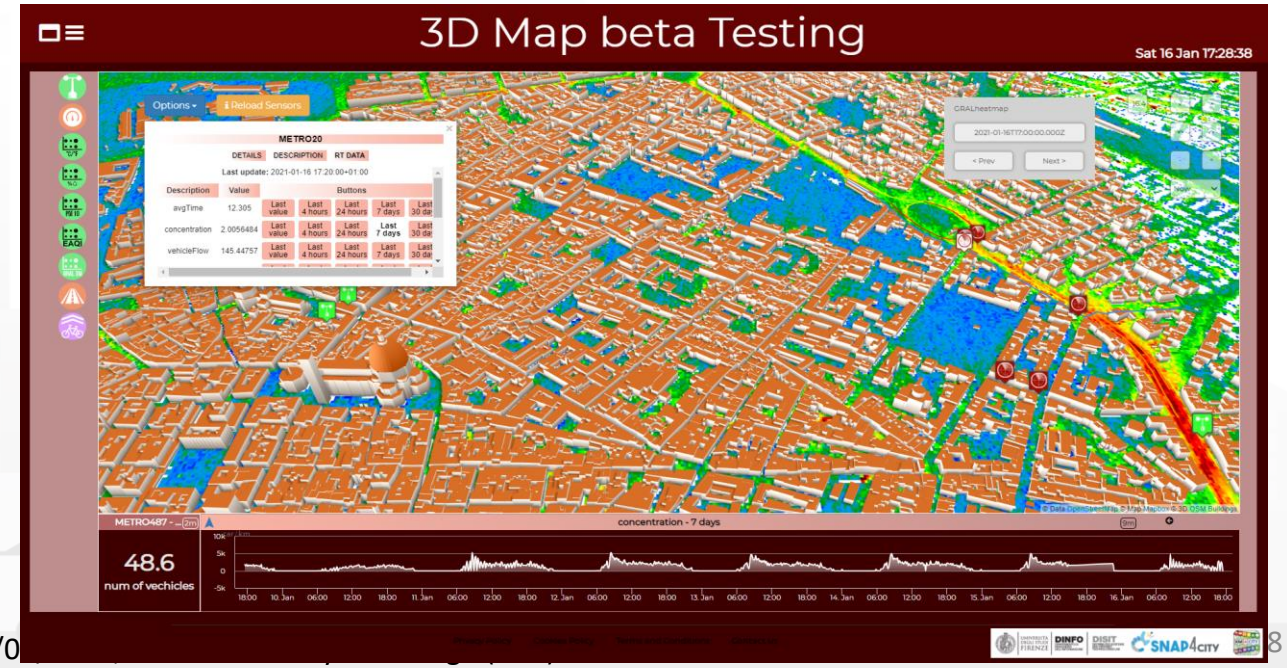
Dashboards

SNAP4CITY | KM4CITY

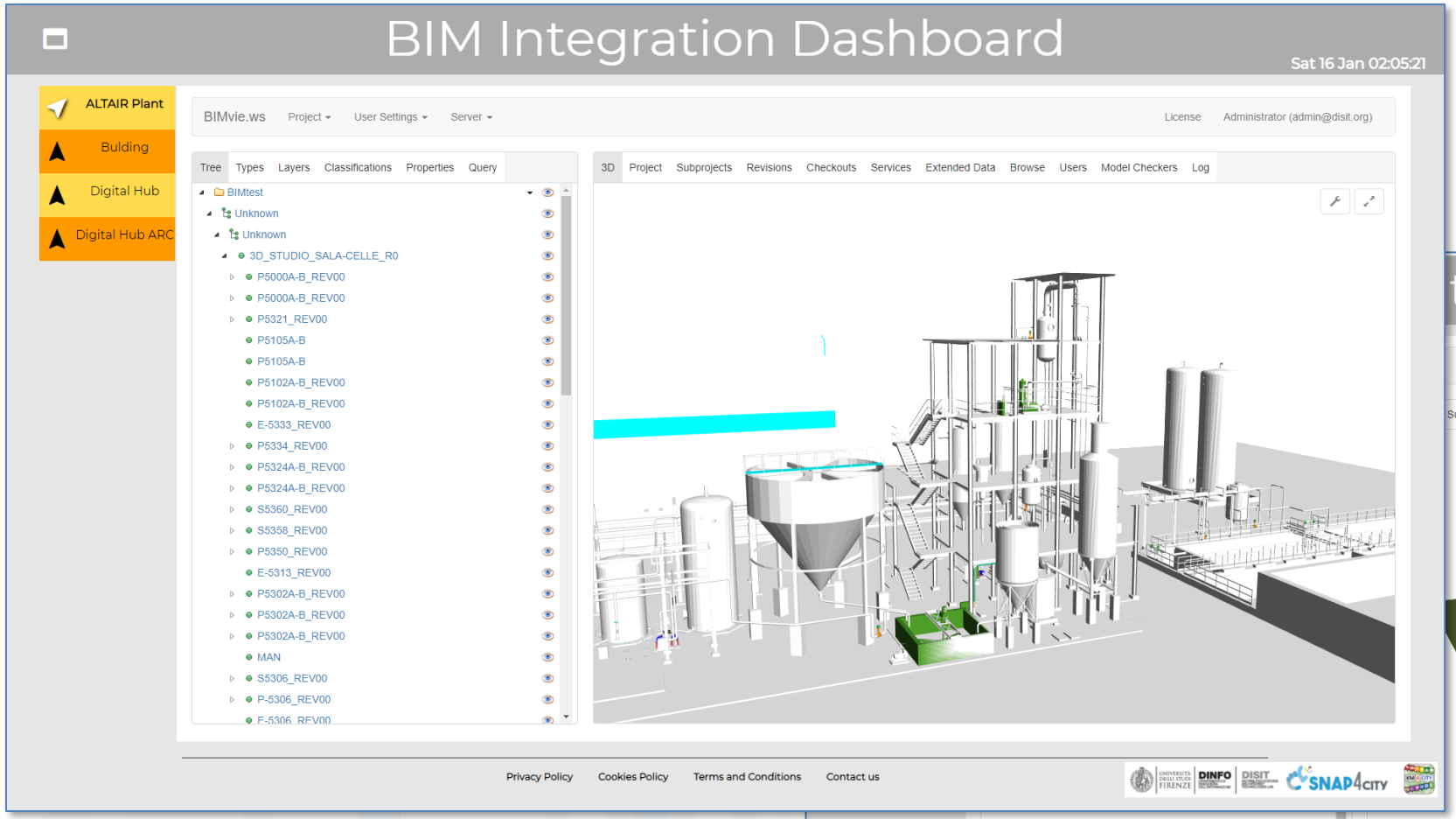


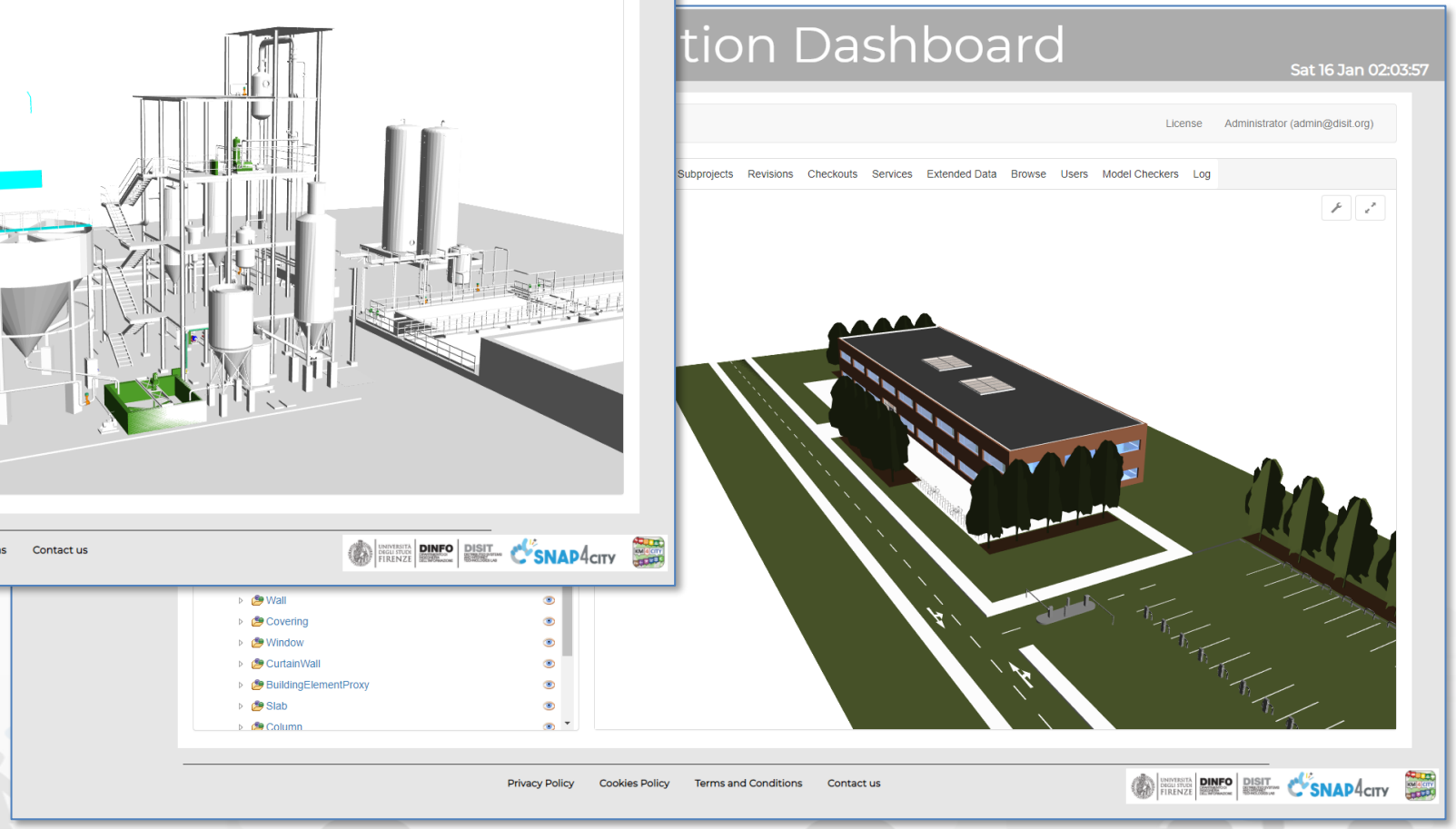






BIM Server





https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1NA==

Snap4Industry as a Lambda Architecture



Data Sources PULL Data



Data Sources, Brokers, External Services Data Driven, Real Time



Data Ingestion, aggregation, regularization, reconcile

ETL, NIFI, DISCES

Big Data Cluster
HDFS, Hbase, Phoenix

Knowledge base
Semantic reasoners

Indexing and aggregating
Elastic search

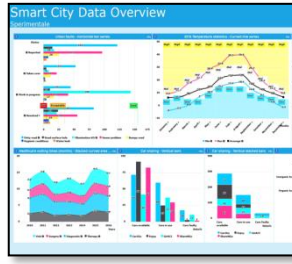
Data Analytics
R, Tensor Flow, Python, MapReduce, …

IOT Applications
Node-RED + Snap4City MicroSrvs

Search and Query, Smart API
Facet, semantic search

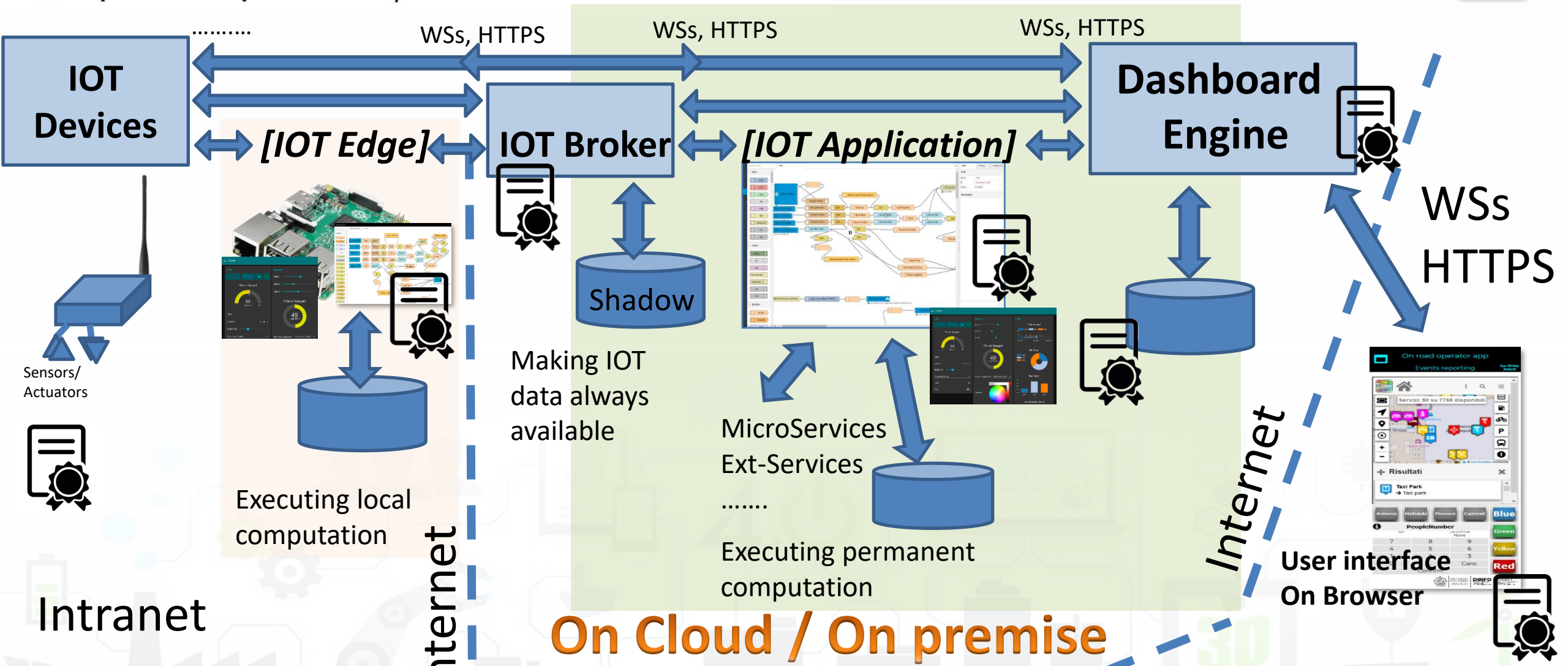
Visual Analytics
Special dash/ tools

Rendering Acting, Widgets, MicroApps
User interface, Interactive Dashboard, Drill down, maps, heatmaps





Inform, announce, Act!, warning, alarms, What-IF, ..



End 2 end security

Smart City Functional Architecture

Transport systems
Mobility, parking



Public Services,
Govern, events, …



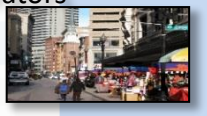
Sensors, IOT Cameras,
Wi-Fi



Environment, Water,
energy



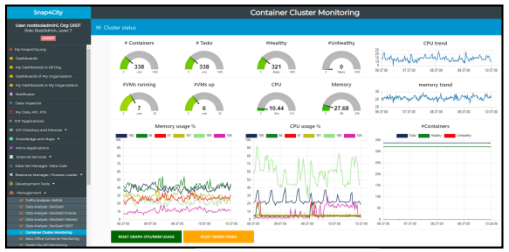
Shops, services,
operators

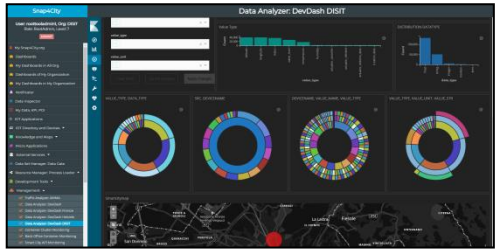


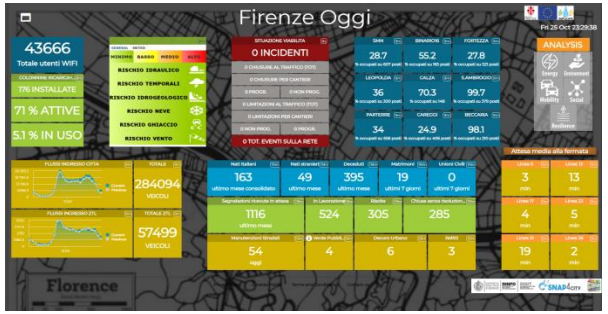
Social Media

Social Media Crawler and Manager









Back-End ⟵ ⟶ Front-End

Data Sources, External Services *PULL Data*

Data Sources, Brokers, External Services *Data Driven, Real Time*

Data Ingestion, aggregation, regularization, reconcile: IOT Directory, NIFI, special tools

Knowledge base Semantic Reasoners

Indexing and aggregating Elastic Search

Federation

Search and Query, Smart City API, Web Socket Server, GIS, Facet, semantic

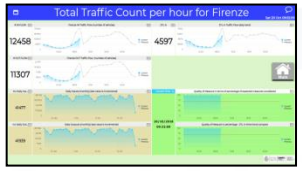
Data Analytics, Simulations, Special Tools R Studio, Tensor Flow, Python, ….

IOT Applications, Business Logic Node-RED + Snap4City MicroServices

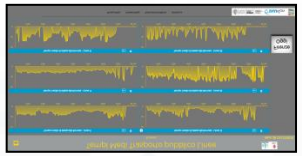
Rendering Acting, Widgets, Synoptics, MicroApps User interface, Drill down, maps, heatmaps

Inform, announce, Act!, warning, alarms, What-IF, ..

Authentication, Authorization, Platform & Processes Management, Data Inspector, Digital Twin, …

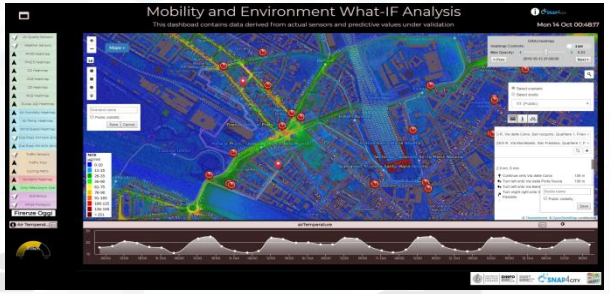




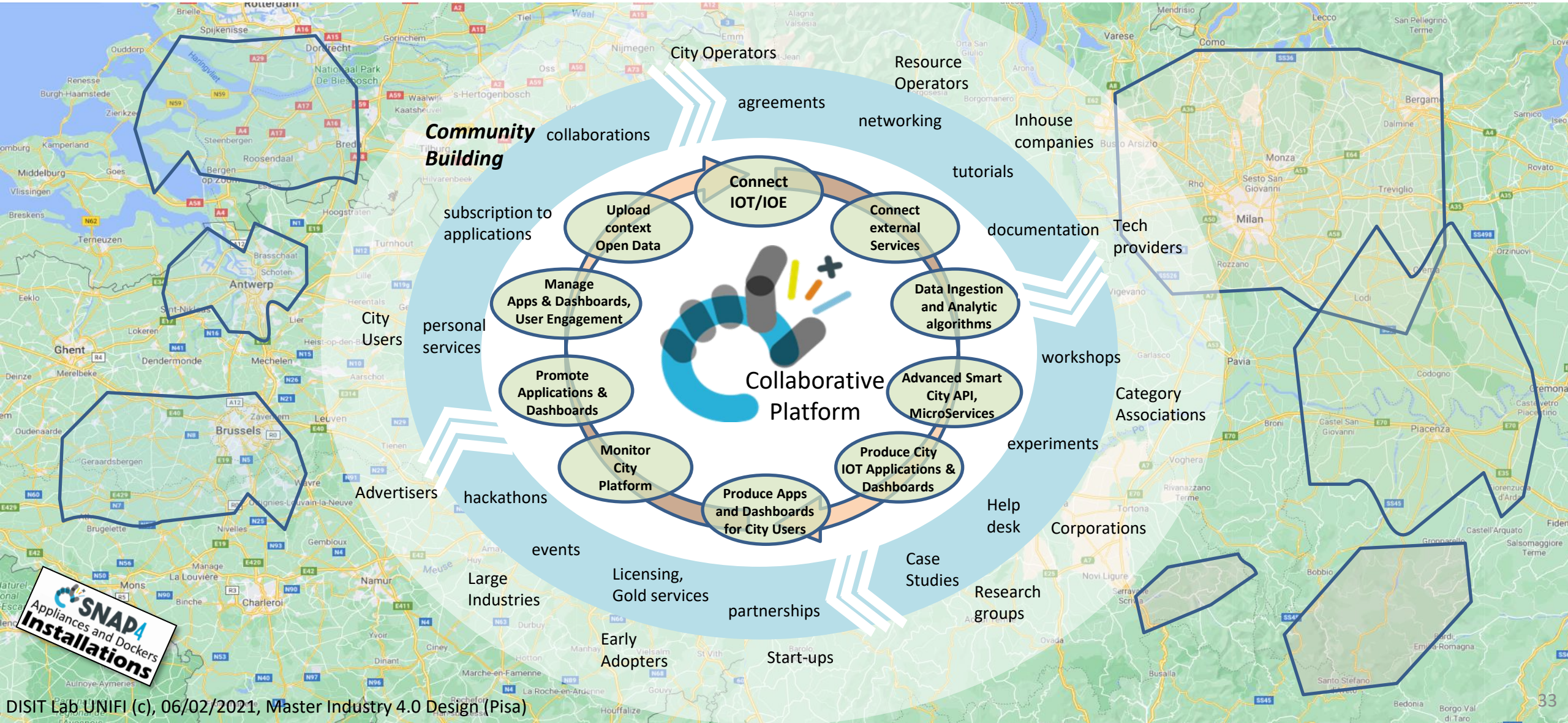




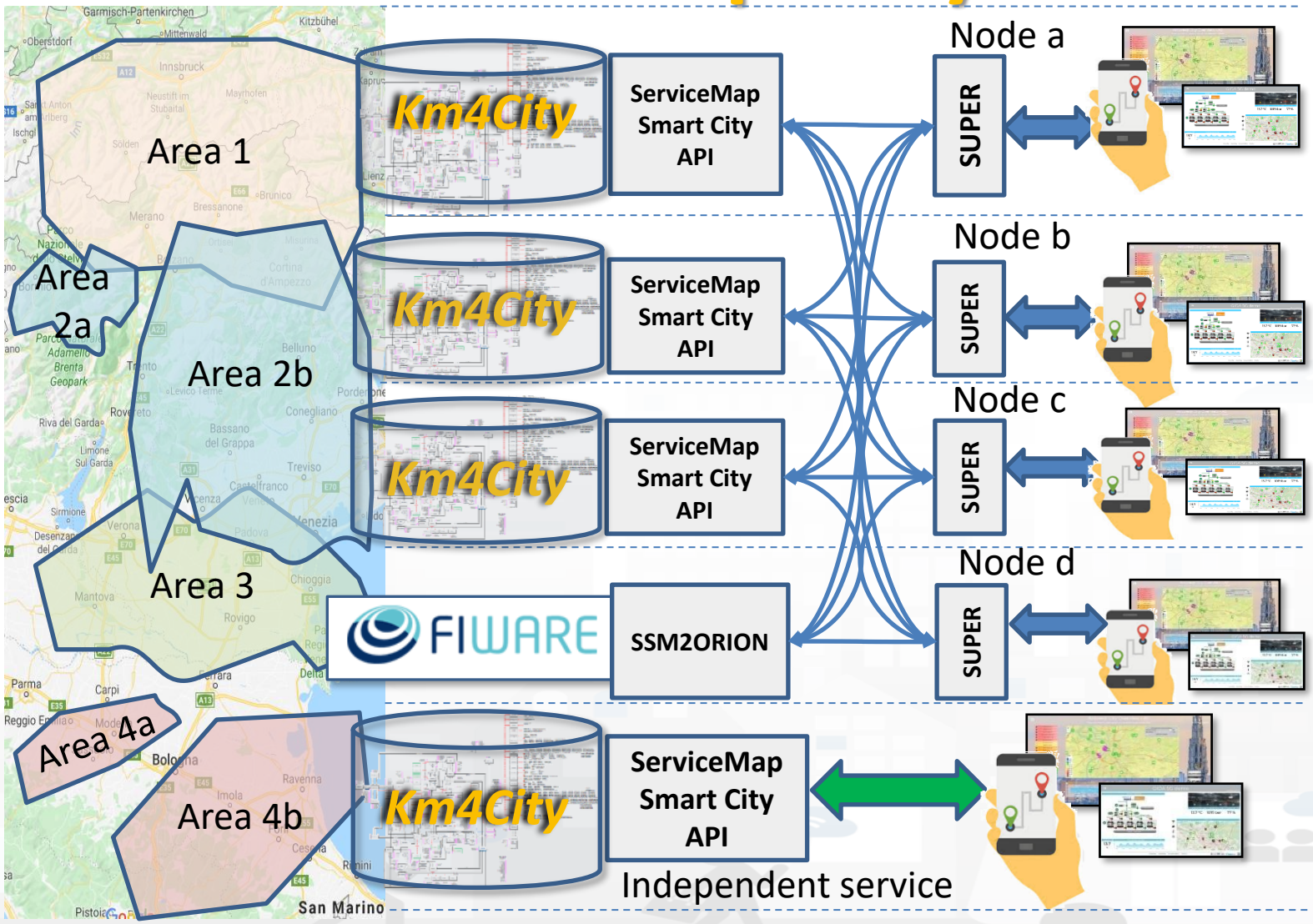




One Snap4City Platform may serve Multiple Cities

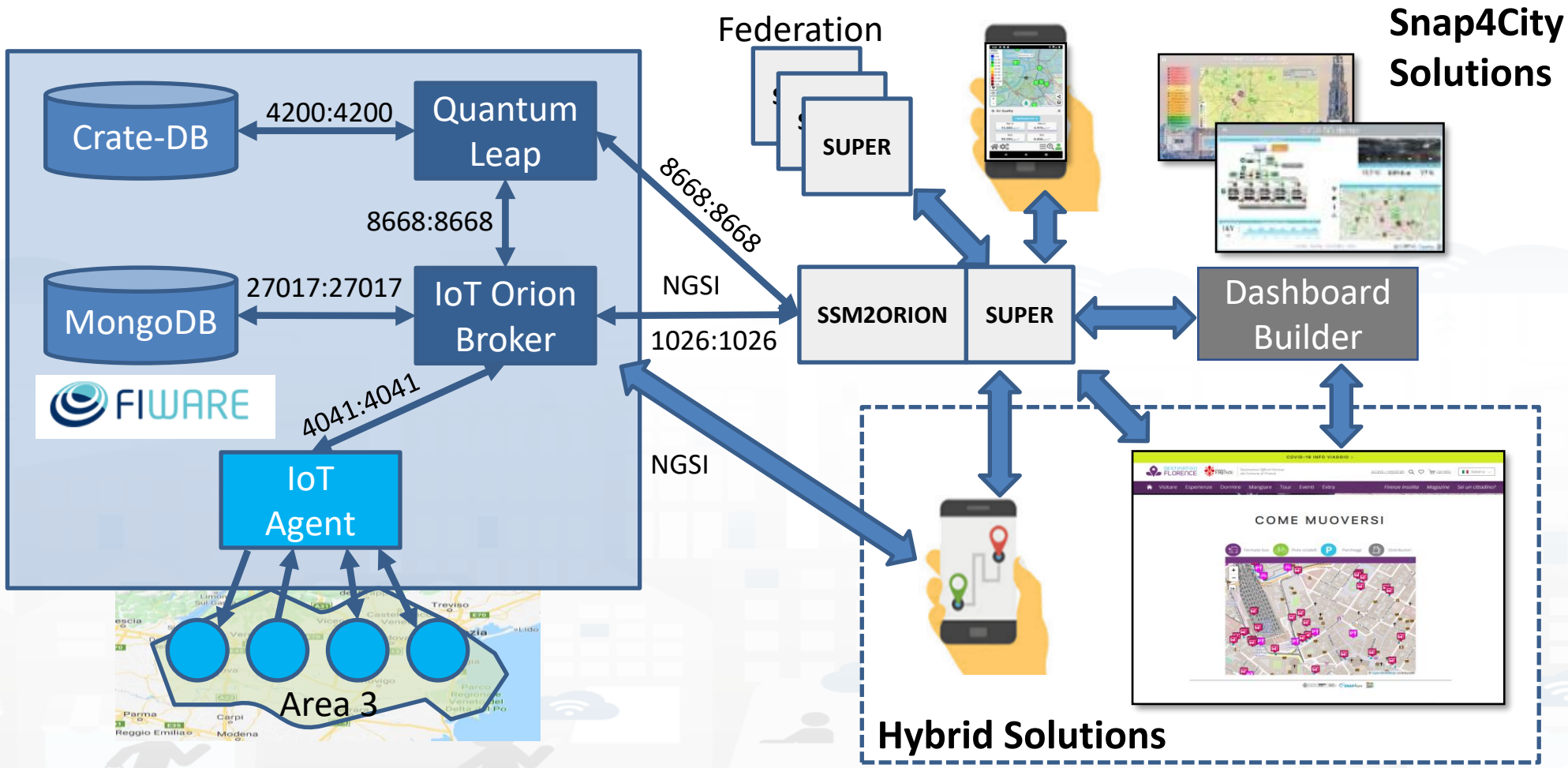


Federation of Snap4City Services



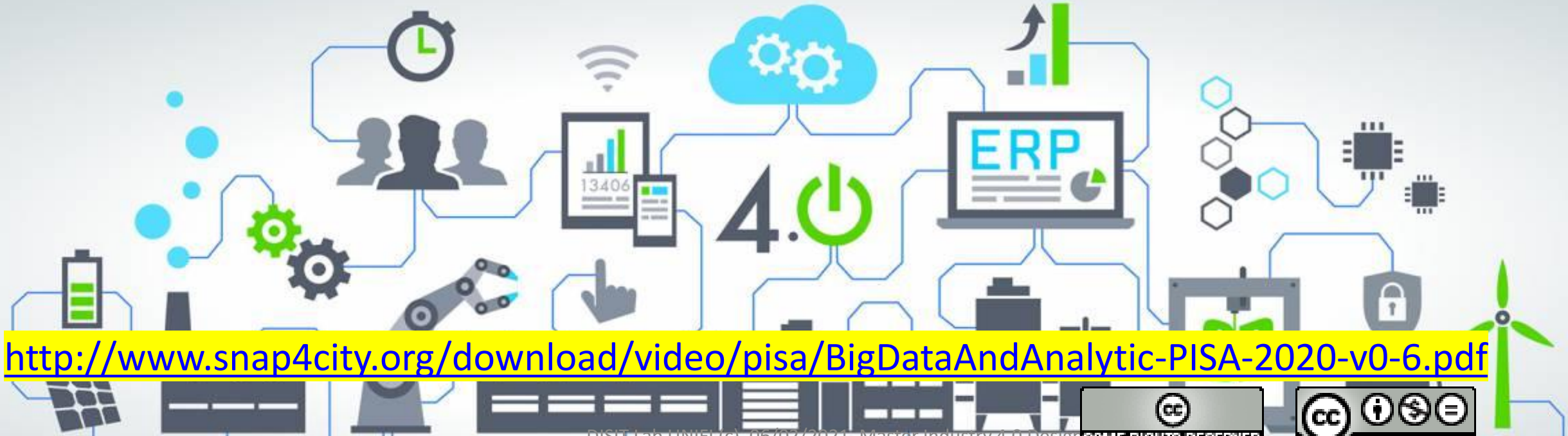
- A Mobile App may refer to one Smart City API Server (for Area 1) via SUPER and receive data from the Federated SUPERS (Area 2) if navigation, queries, etc. are leading to discover out of the addressed KB.
  - SUPER can be used for creating redundant and/or balanced distributed solutions for Federated KB. See Area 2, the two KB in the front.
  - Federated SUPER can have overlapped KB even totally.
  - A Mobile App can be developed to support multiple Smart City API servers, for balancing and
- The usage of Super is not mandatory so that separate services can be produced as well
- Super and Nodes presents the same Smart City APIs.

Federation of Snap4City vs IOT ORION Broker



•DEMO

Scenari



http://www.snap4city.org/download/video/pisa/BigDataAndAnalytic-PISA-2020-v0-6.pdf

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SNAP4CITY
www.snap4city.org

KM4CITY

Powered by FIWARE

SNAP4 Appliances and Dockers Installations

FREE TRIAL

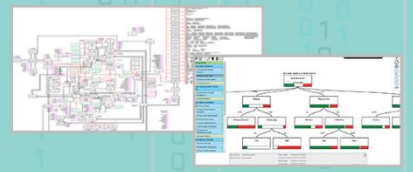
PEN Test Passed

EU GDPR COMPLIANT

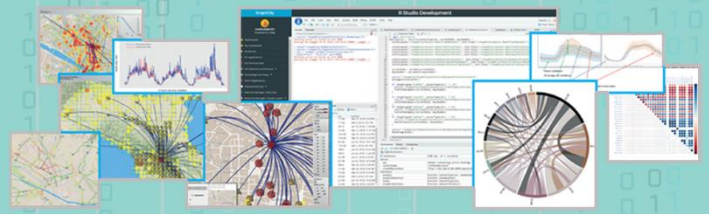
100% OPEN SOURCE



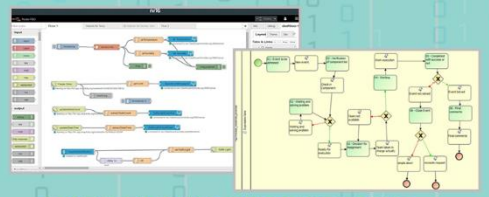
DASHBOARDS AND APPS - CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS



EXPERT SYSTEM
KNOWLEDGE BASE
STORAGE



BIG DATA ANALYTICS
ARTIFICIAL INTELLIGENCE
BUSINESS INTELLIGENCE
MACHINE LEARNING

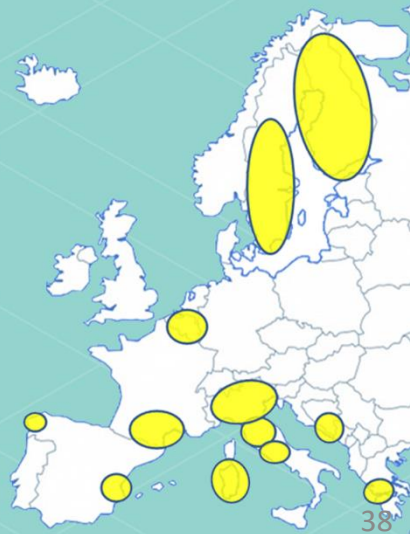


DATA FLOWS, WORKFLOWS
MICROSERVICES
MANAGEMENT



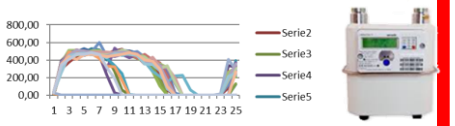
METHODOLOGIES
COURSES AND COMMUNITY
LIVING LABS
DEVELOPMENT TOOLS





https://www.snap4city.org/369

External Services



Fleet management



IoT Devices/Edge

IoT Broker



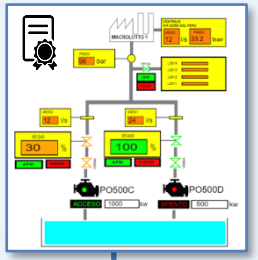
Internet

SECURE



Admin



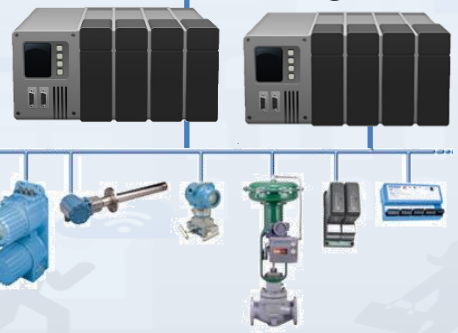


DCS



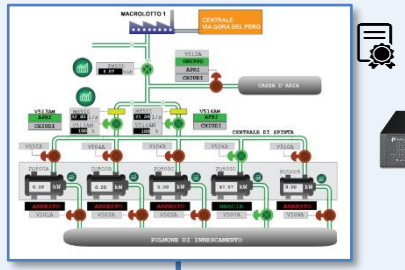
IoT Broker

PLC



IoT Devices/Edge

Industry Plant1.....



SCADA

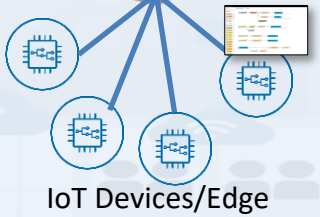




PLC/ RTU

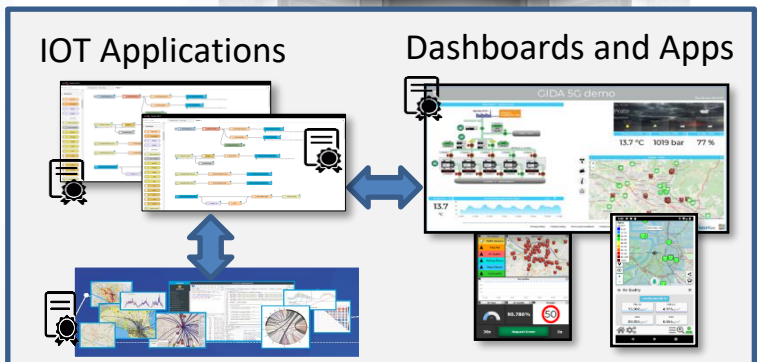
IoT Broker





IoT Devices/Edge

Industry Plant2.....



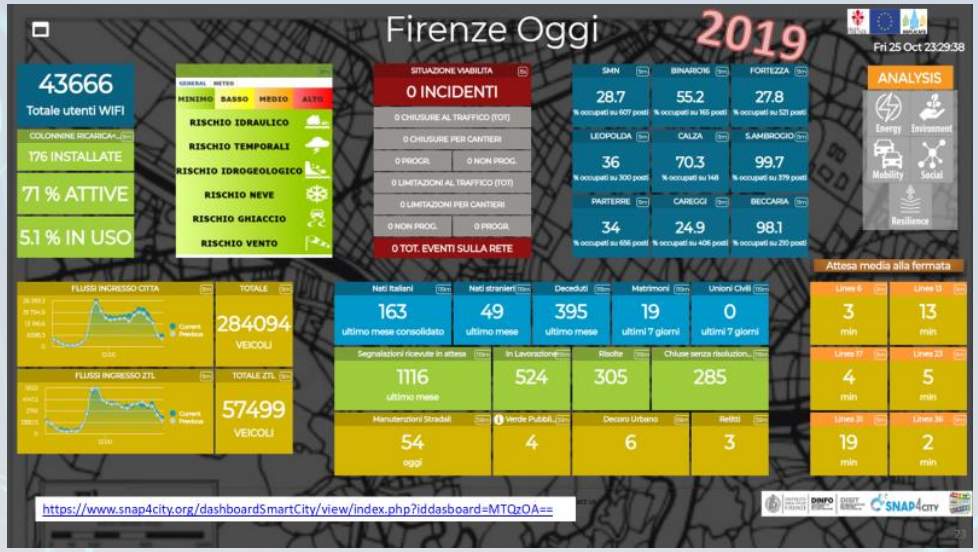
Control and Supervision on Multiple Supply Chains

Industry 4.0 as a Service

Smart City Control Room
Florence Metropolitan City

reference

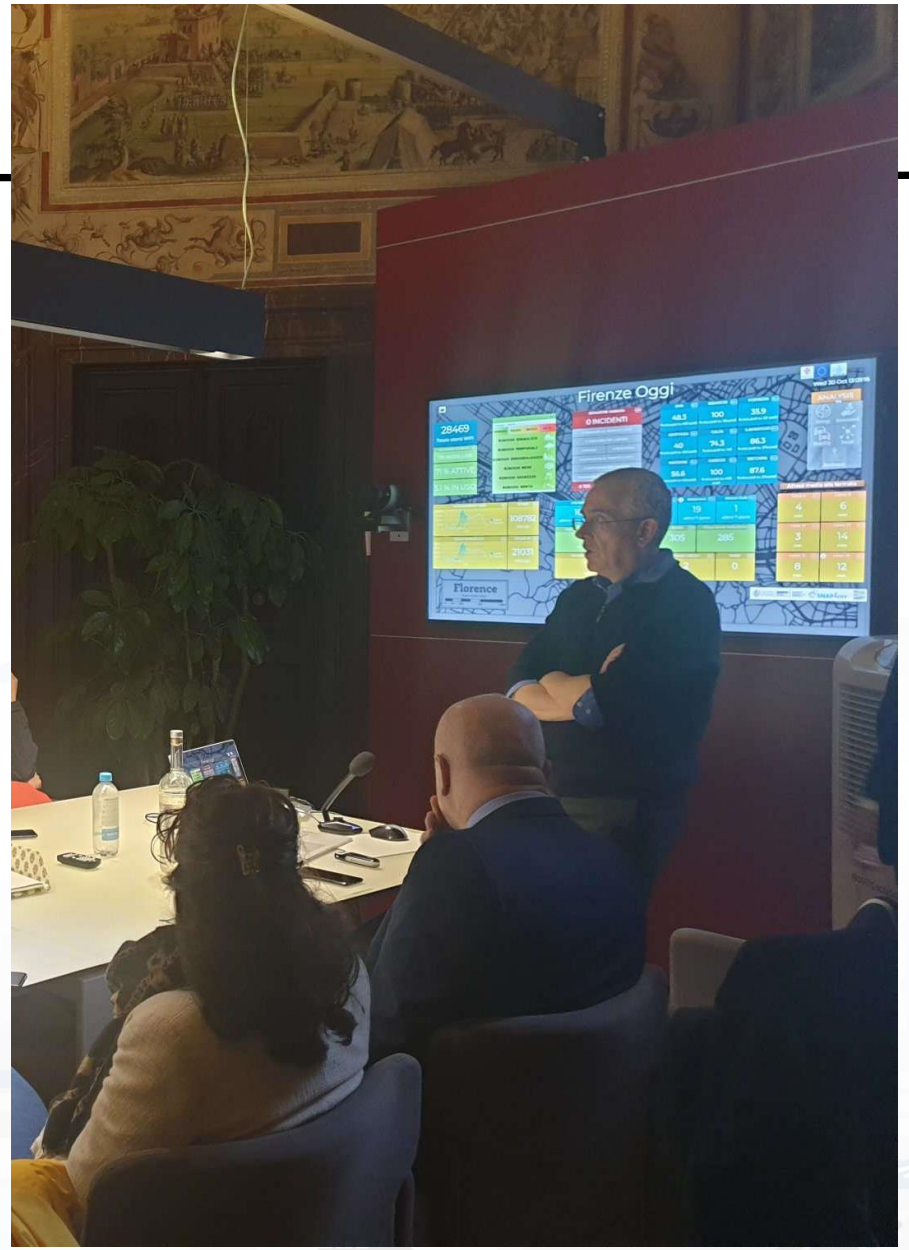
- **Multiple Domain Data**
  - mobility and transport, accidents, public transport, parking, traffic flow, Traffic Reconstruction, …
  - civil protection, gov data, covid-19, social & social media, people flow, tourism, energy, …
- **Multiple dash/tool Levels & Decision Makers**
- **Historical and Real Time data**
  - Billions of Data
  - Predictions, what-if analysis
- **Services Exploited on:**
  - Multiple Levels, Mobile Apps, API
- **Since 2017**













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FIRENZE
CITTÀ FARO

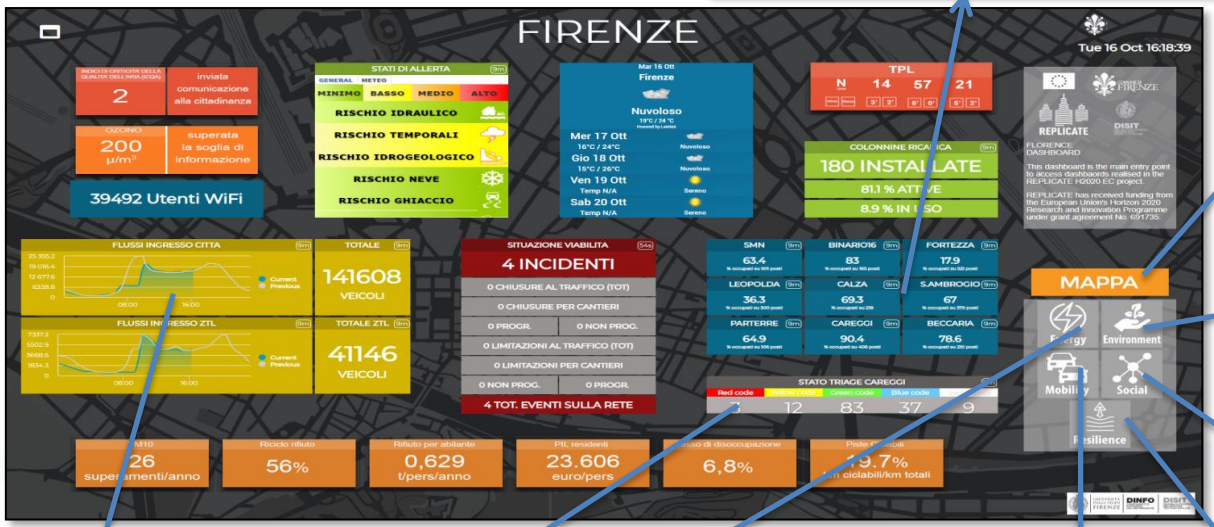


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REPLICATE

KM4CITY

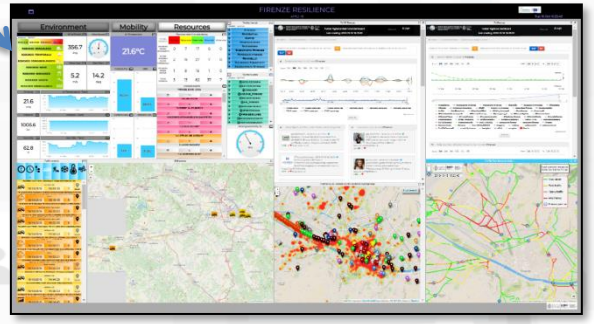


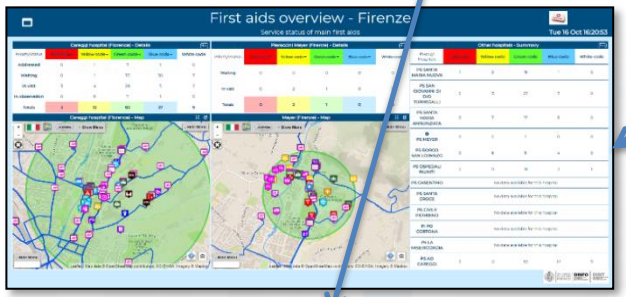


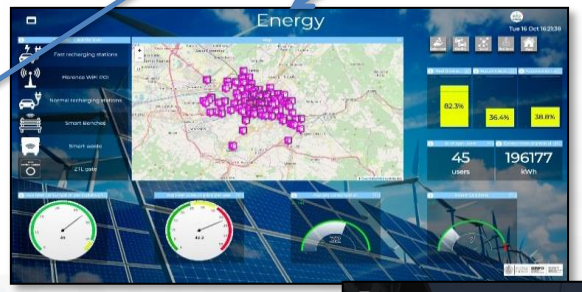


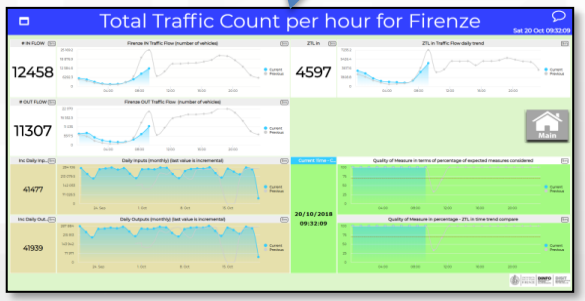










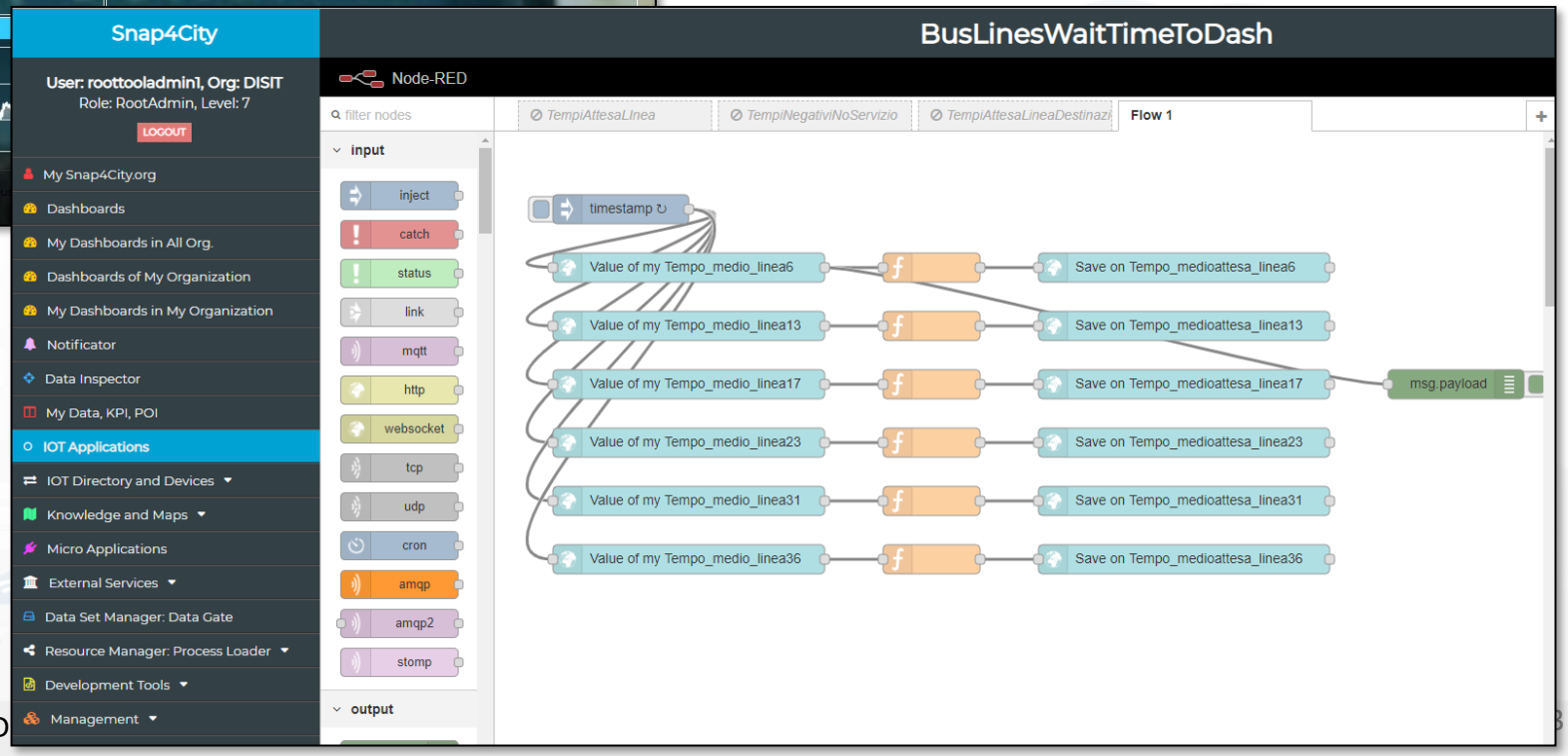




Estimation of the mean waiting time at bus stops







Mobility and Transport Traffic Flow Analysis

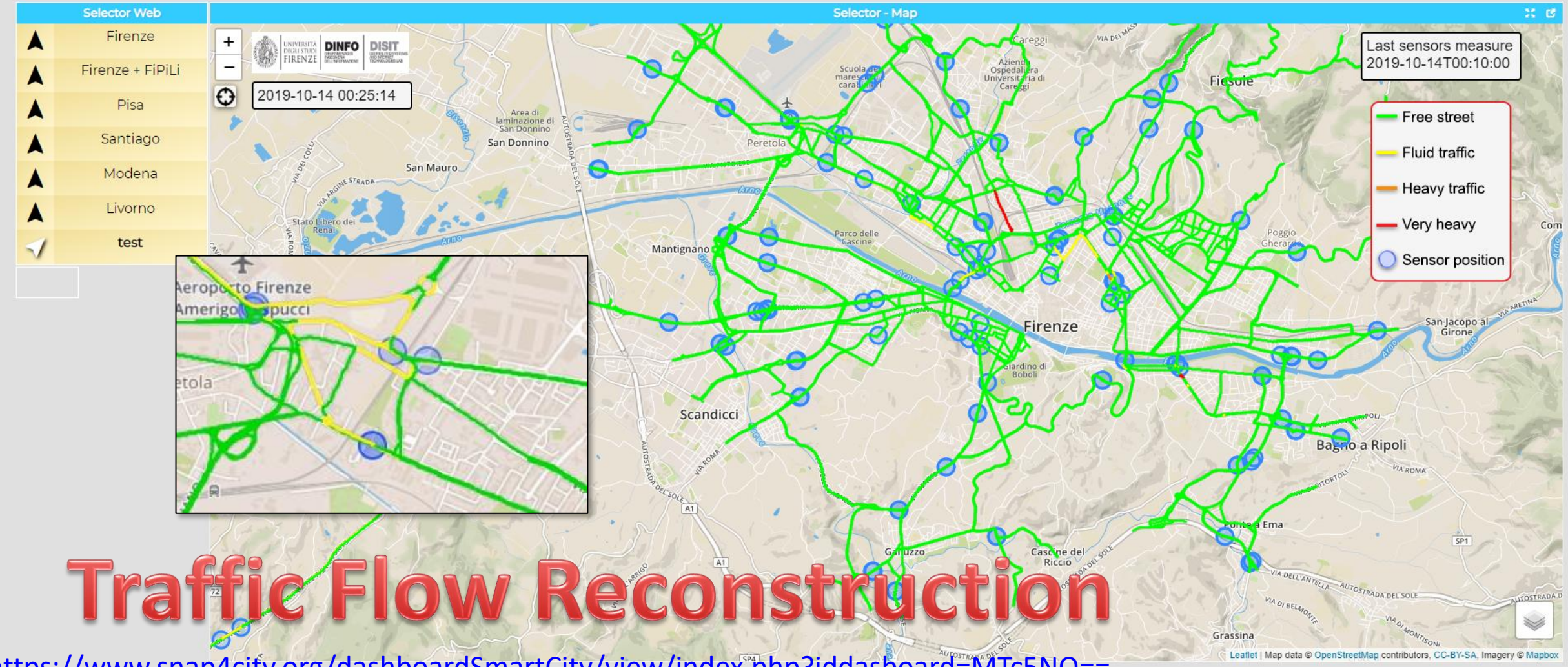
Cities: Firenze, Pisa, Livorno, Modena, Santiago di Compostela

reference

- **Multiple Domain Data**
  - Traffic Flow sensors, city structure, weather
- **Decision Makers Multiple Locations**
- **Historical and Real Time data**
  - Dashboards, What-IF analysis
  - Traffic Flow Predictions,
  - Reconstructions, routing
  - Mobile App, people flows
- **Services Exploited on:**
  - Dashboards, Mobile App
- **Since 2017, 2019**



Traffic Flow Reconstruction for the cities



Traffic Flow Reconstruction

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc5NQ==

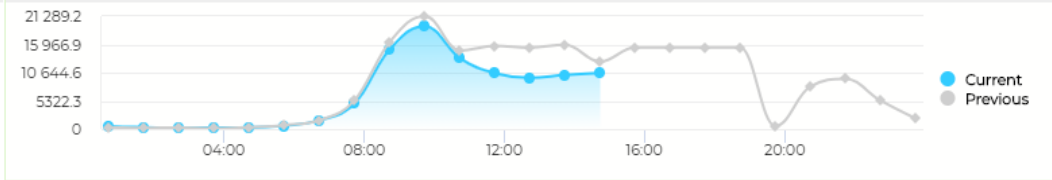
Traffic Flow Monitoring - Firenze - Cloned2

Wed 11 Nov 15:01:32

 # IN FLOW 9m

10549 #ofvehicles

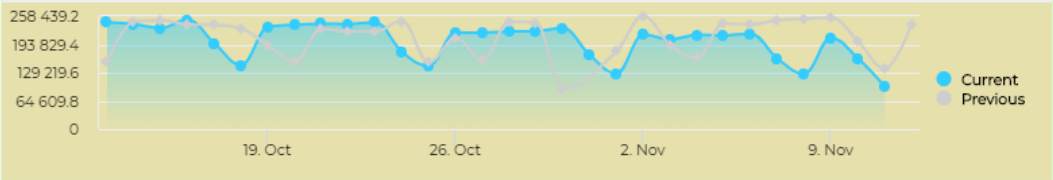
Firenze IN Traffic Flow (number of vehicles) 9m



Inc Daily Inp... 9m

97137 #ofvehicles

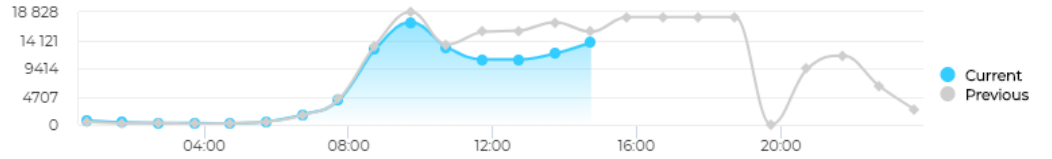
Daily Inputs (monthly) (last value is incremental, real time) 9m



 # OUT FLOW 9m

13720 #ofvehicles

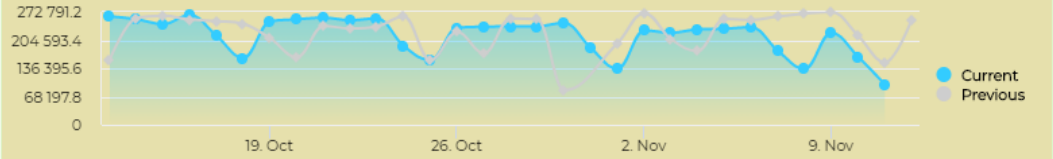
Firenze OUT Traffic Flow (number of vehicles) 9m



Inc Daily Out... 9m

97457 #ofvehicles

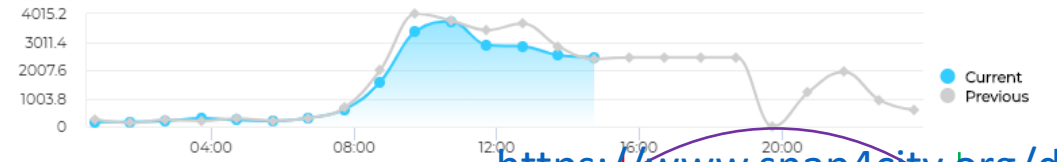
Daily Outputs (monthly) (last value is incremental real time) 9m



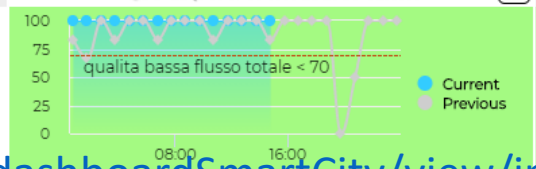
ZTL in 9m

2468 #ofvehicles

ZTL in Traffic Flow daily trend, entering in ZTL 9m



QoS as perc. of measures taken 9m



QoS as perc. of measures in ZTL 9m

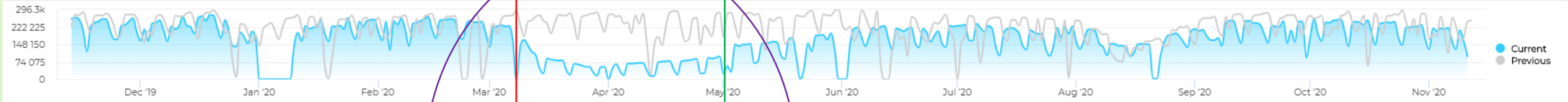


11/11/2020

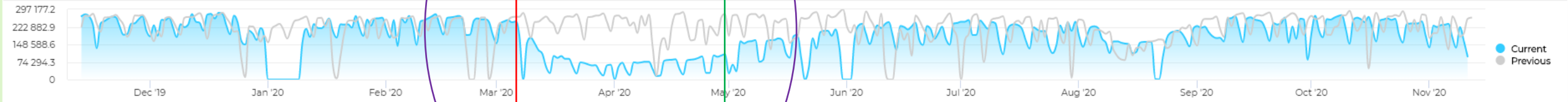
15:01:33

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjY1MQ==

inflow total of the day, yearly 9m



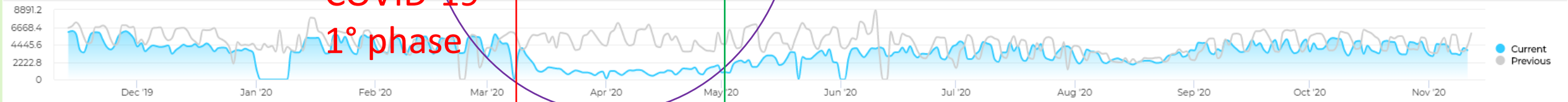
outflow total over the day Yearly 9m



COVID-19

1° phase

in ZTL yearly compare 9m



Mobility and Environment What-IF Analysis

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

Mon 14 Oct 00:48:17

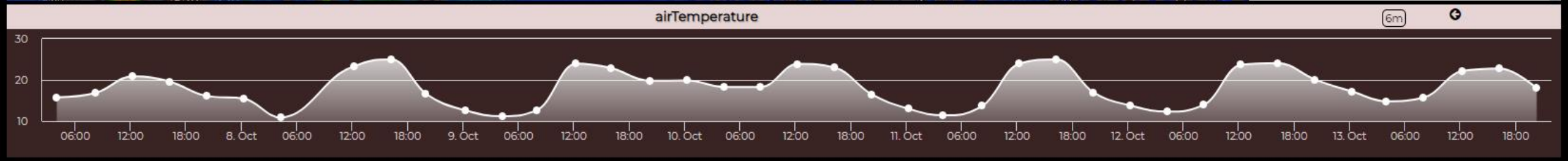
- Air Quality Sensors
- Weather Sensors
- PM10 Heatmap
- PM2.5 Heatmap
- CO Heatmap
- CO2 Heatmap
- O3 Heatmap
- NO2 Heatmap
- Europ. AQI Heatmap
- Air Humidity Heatmap
- Air Temp. Heatmap
- Wind Speed Heatmap
- Gral Pred. HM NOX (3m)
- Gral Pred. HM NOX (6m)
- Traffic Sensors
- Traffic Flow
- Cycling Paths
- Accident Heatmap
- Only HRes Anym. Gral
- Scenarious
- What-if analysis

Firenze Oggi

Air Temperat... 6m





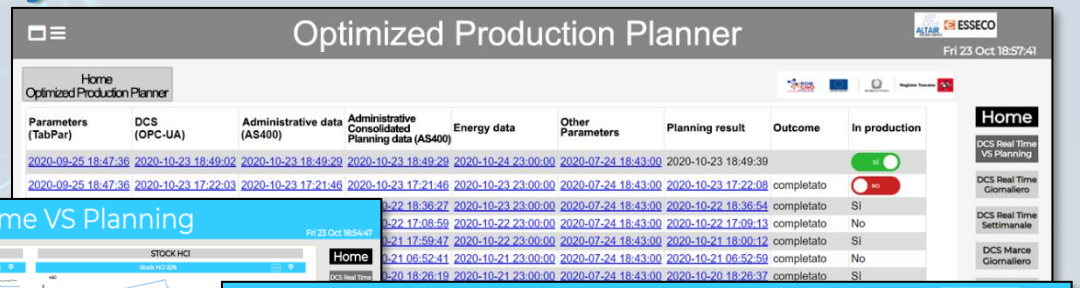


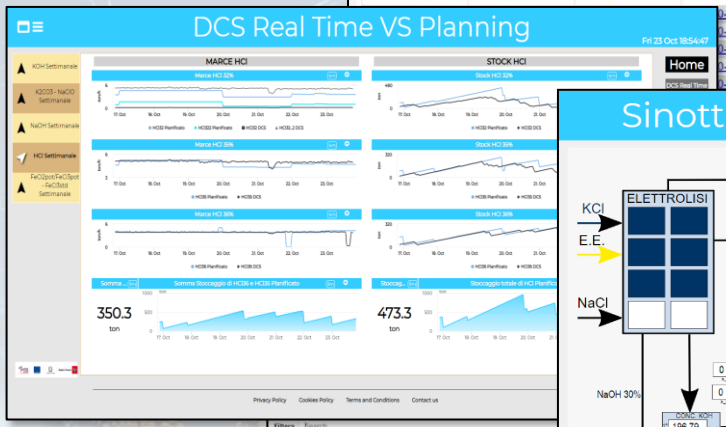
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==

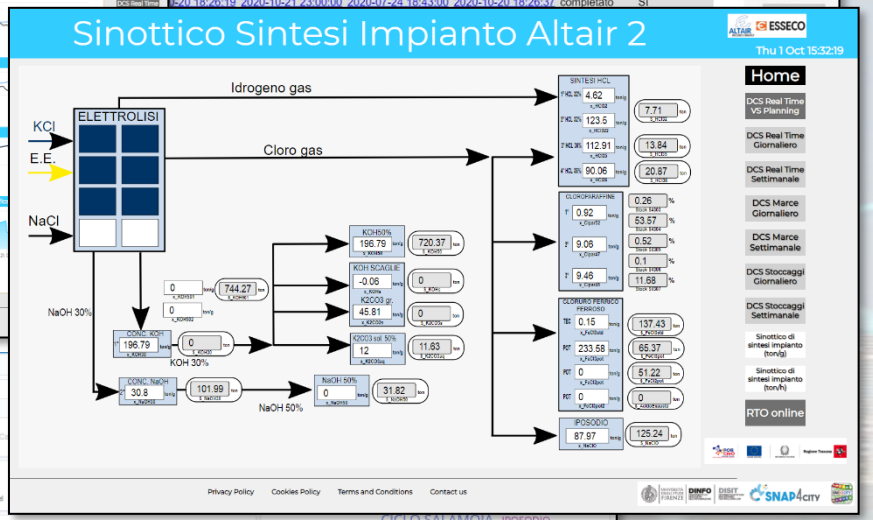
Snap4Altair Decision Support supervision and control, Industry 4.0

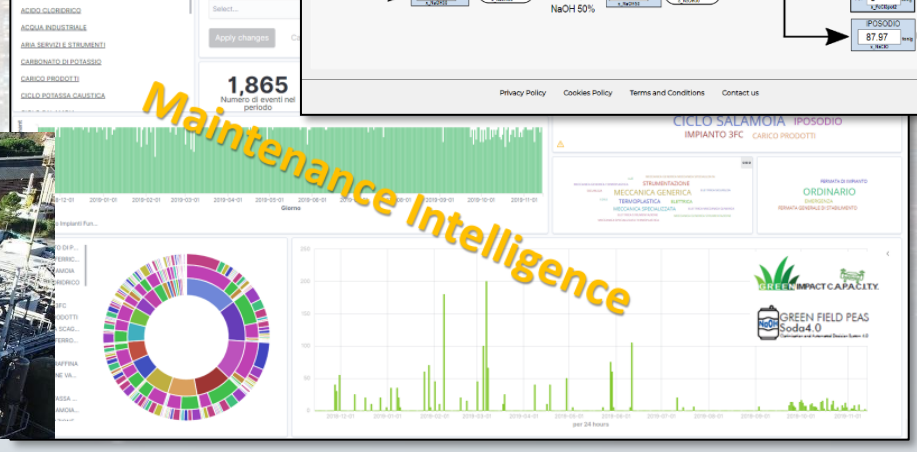
reference

- **Multiple Domain Data**
  - Distributed Control System: energy, flows, storage, chemical data, settings, ..
  - Cost of energy
  - Orders
  - Production Parameters
  - Maintenance data
- **Multiple Levels & Decision Makers**
- **Historical and Real Time data**
  - Billions of Data
  - Optimized planning on chemical model
  - Business Intelligence on Maintenance data
- **Services Exploited on:**
  - Multiple Levels, Mobile Apps, API
- **Since 2020**

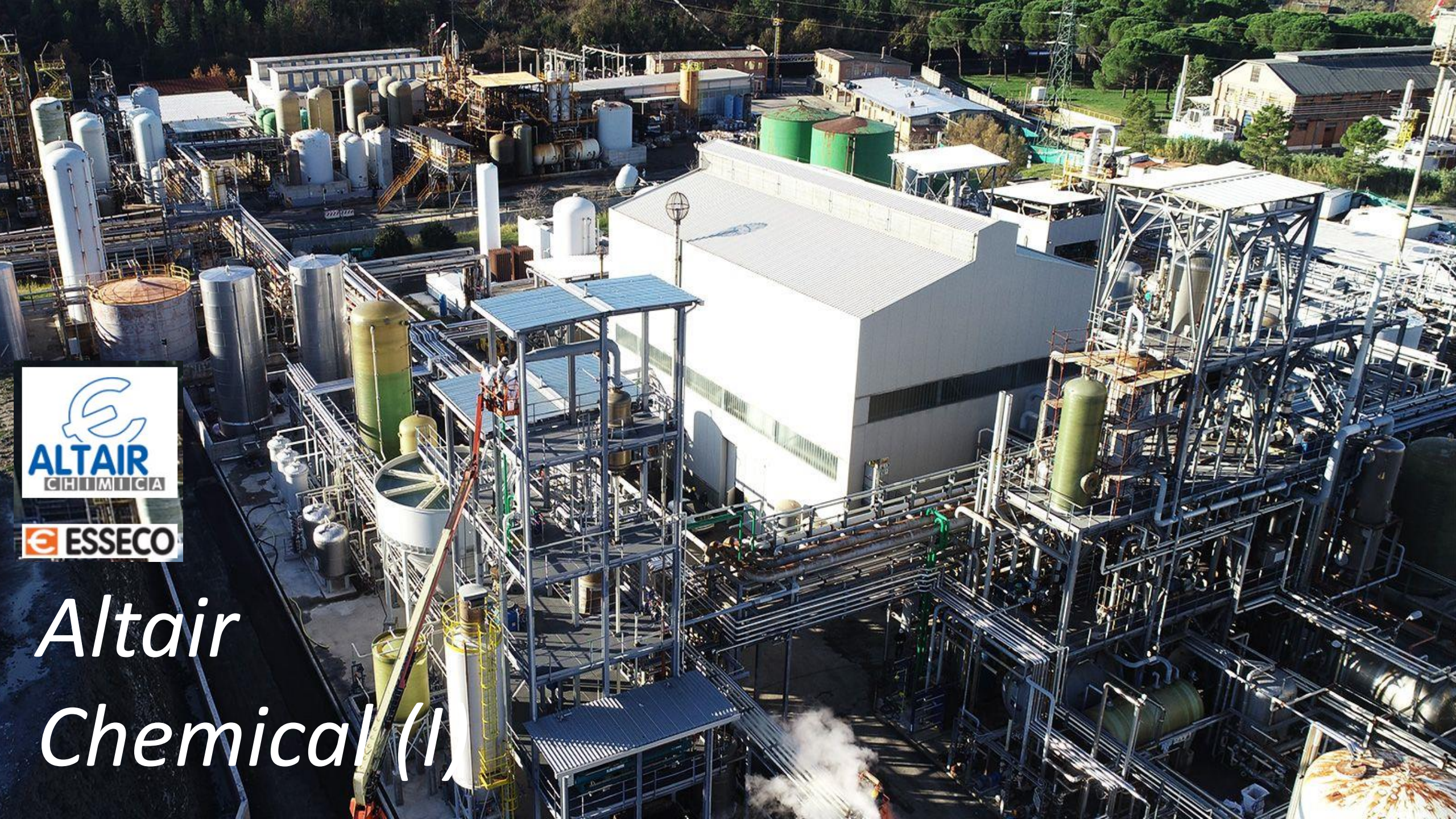




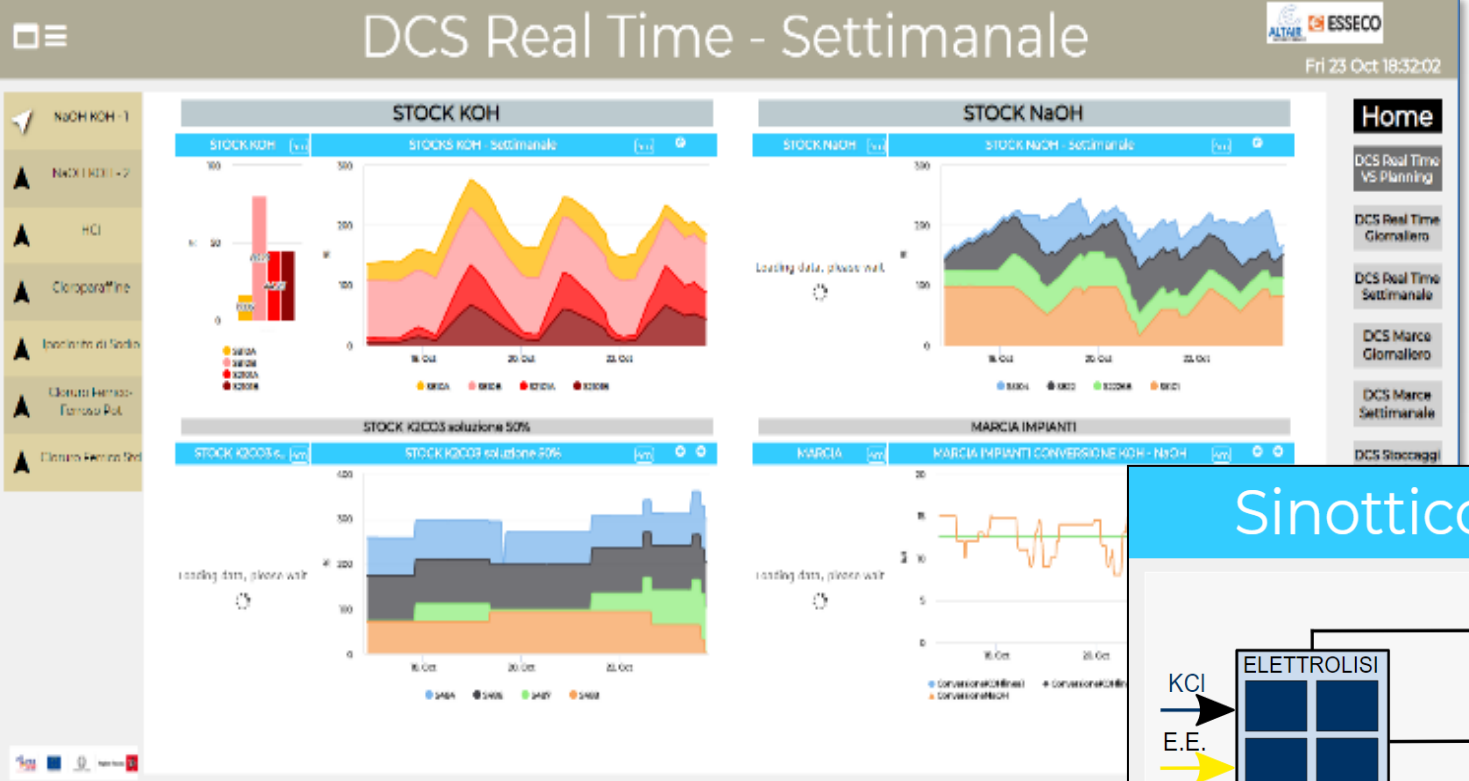


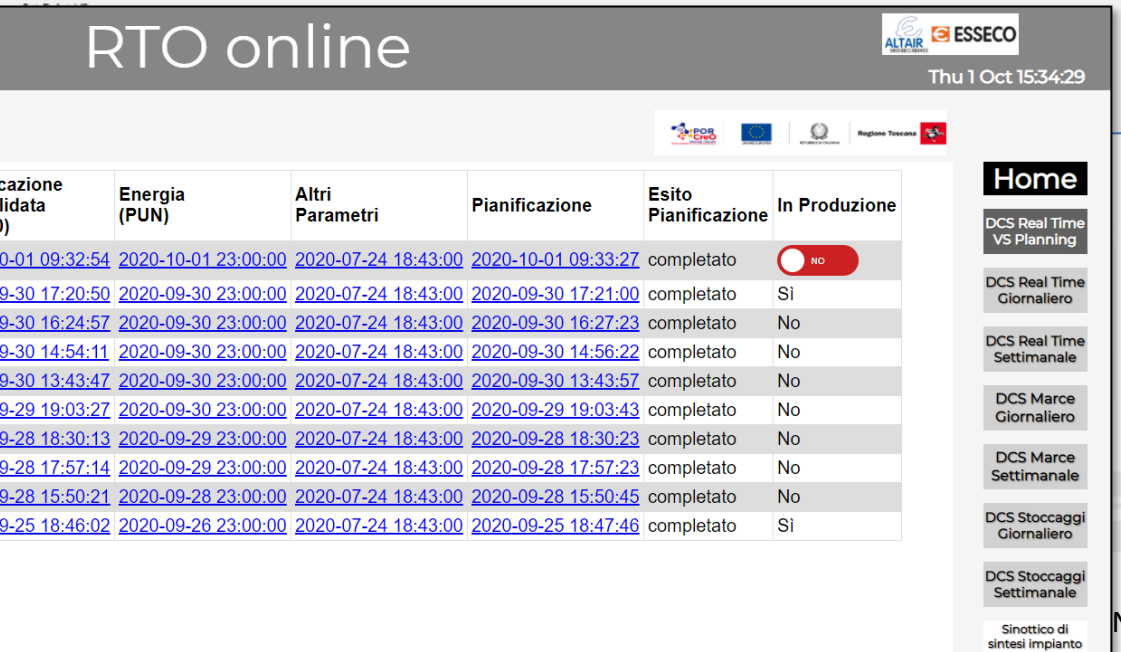




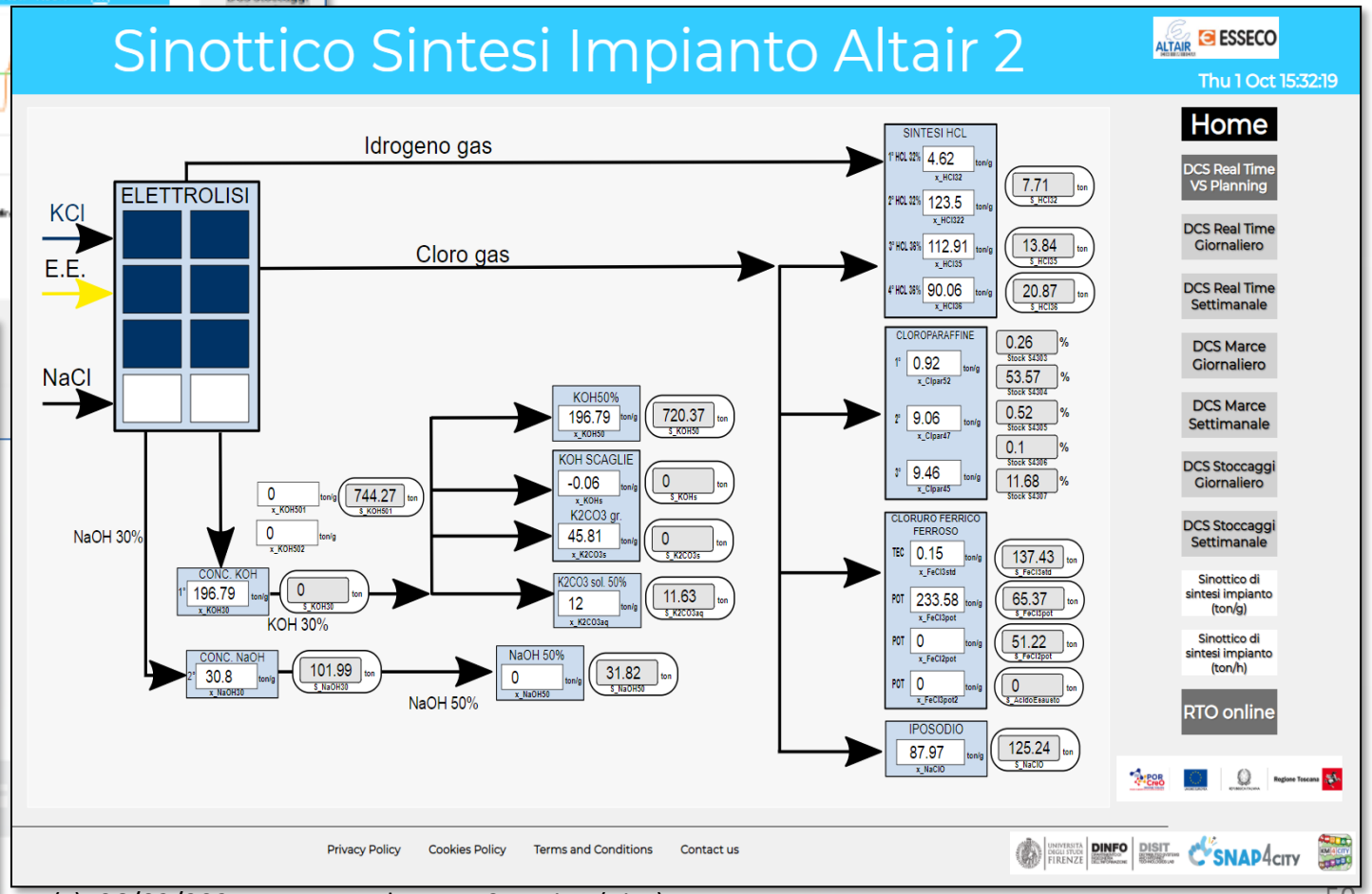


Altair Chemical (I)



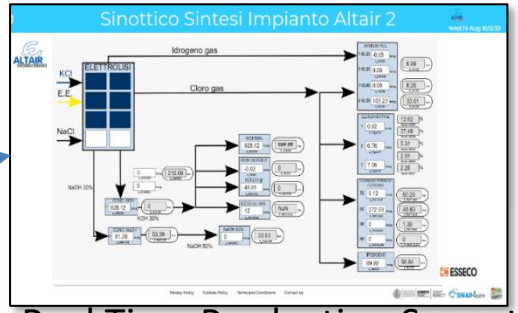


cazione lidata)	Energia (PUN)	Altri Parametri	Pianificazione	Esito Pianificazione	In Produzione
0-01 09:32:54	2020-10-01 23:00:00	2020-07-24 18:43:00	2020-10-01 09:33:27	completato	NO
9-30 17:20:50	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 17:21:00	completato	Sì
9-30 16:24:57	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 16:27:23	completato	No
9-30 14:54:11	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 14:56:22	completato	No
9-30 13:43:47	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 13:43:57	completato	No
9-29 19:03:27	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-29 19:03:43	completato	No
9-28 18:30:13	2020-09-29 23:00:00	2020-07-24 18:43:00	2020-09-28 18:30:23	completato	No
9-28 17:57:14	2020-09-29 23:00:00	2020-07-24 18:43:00	2020-09-28 17:57:23	completato	No
9-28 15:50:21	2020-09-28 23:00:00	2020-07-24 18:43:00	2020-09-28 15:50:45	completato	No
9-25 18:46:02	2020-09-26 23:00:00	2020-07-24 18:43:00	2020-09-25 18:47:46	completato	Sì





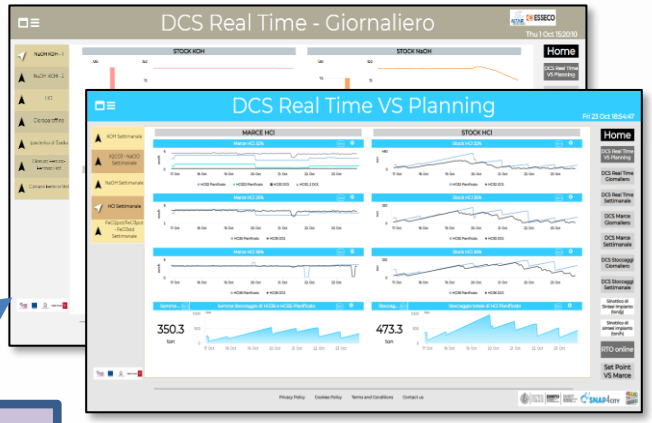
Plant Status



Real Time Production Synoptic

Production Plan

Production vs Planning





AS400

Orders

Energy Service

Transportation

Other Costs

Data Ingestion

Data Storage

Decision Support

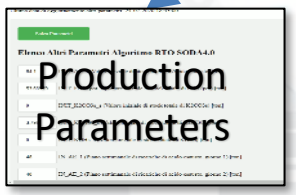
Production Plant Management

Optimized Production Planner

Possible Plan

Possible Plans

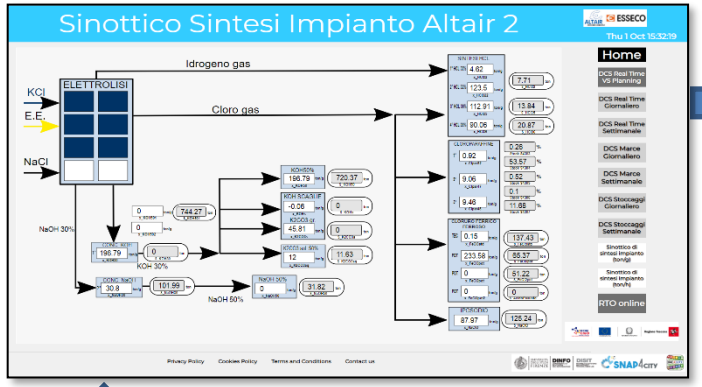




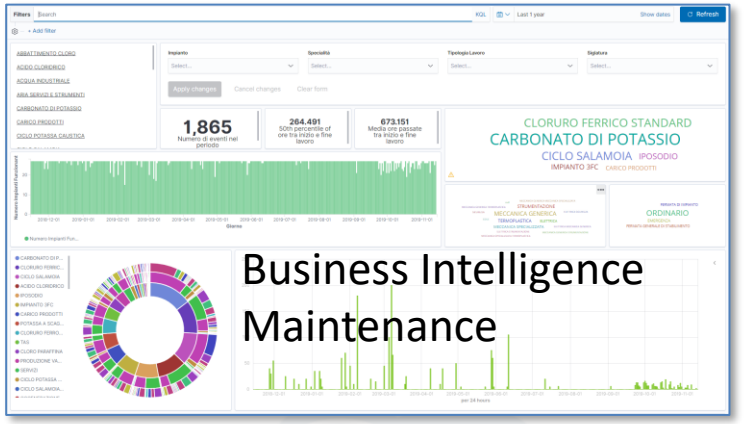


Plant Management

Workflow for Ticket management

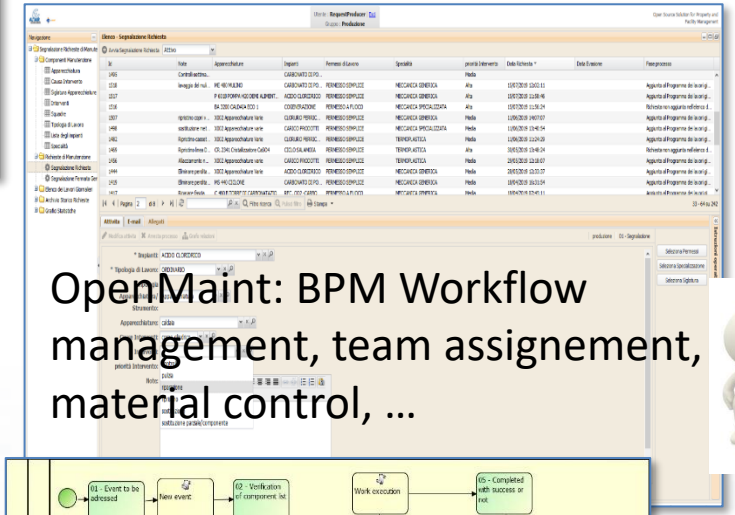


Consumptions/productions

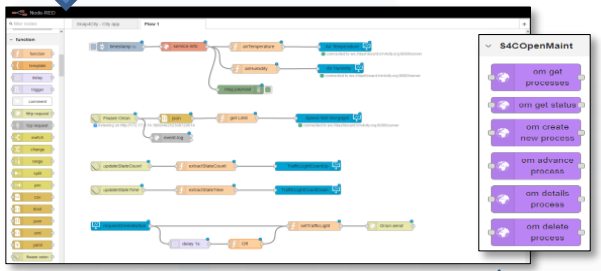


Dashboards and actions

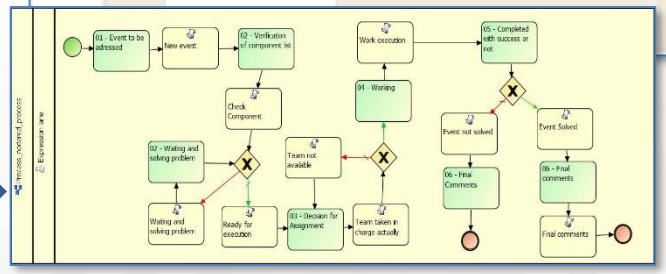
Events/actions

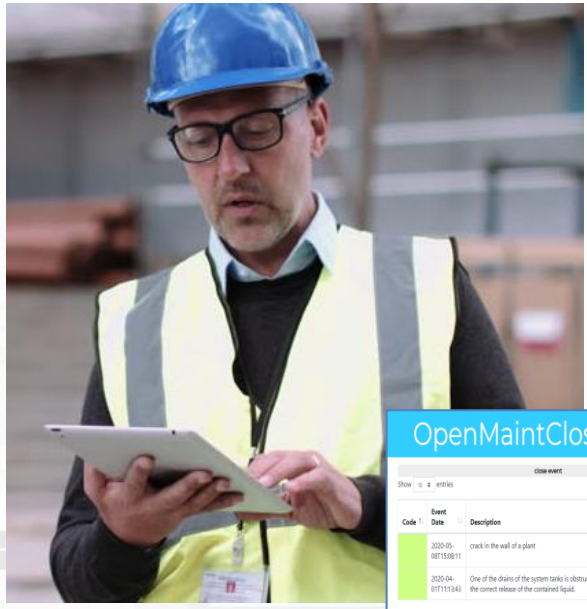


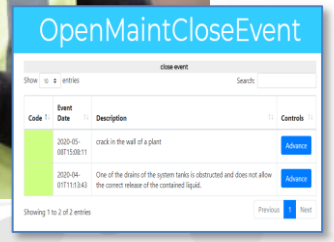
OpenMaint: BPM Workflow management, team assignement, material control, …











IOT App, Data event firing, event detection and firing Critical event management

Filters | Search | KQL | Last 1 year | Show dates | Refresh

+ Add filter

- ABBATTIMENTO CLORO
- ACIDO CLORIDRICO
- ACQUA INDUSTRIALE
- ARIA SERVIZI E STRUMENTI
- CARBONATO DI POTASSIO
- CARICO PRODOTTI
- CICLO POTASSA CAUSTICA

Impianto: Select...

Specialità: Select...

Tipologia Lavoro: Select...

Siglatura: Select...

Apply changes | Cancel changes | Clear form

1,865
Numero di eventi nel periodo

264.491
50th percentile of ore tra inizio e fine lavoro

673.151
Media ore passate tra inizio e fine lavoro

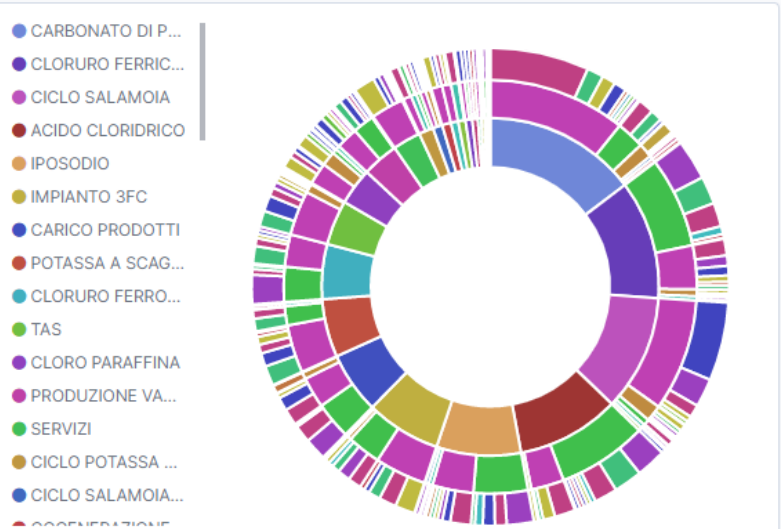
CLORURO FERRICO STANDARD
CARBONATO DI POTASSIO
CICLO SALAMOIA IPOSODIO
IMPIANTO 3FC CARICO PRODOTTI

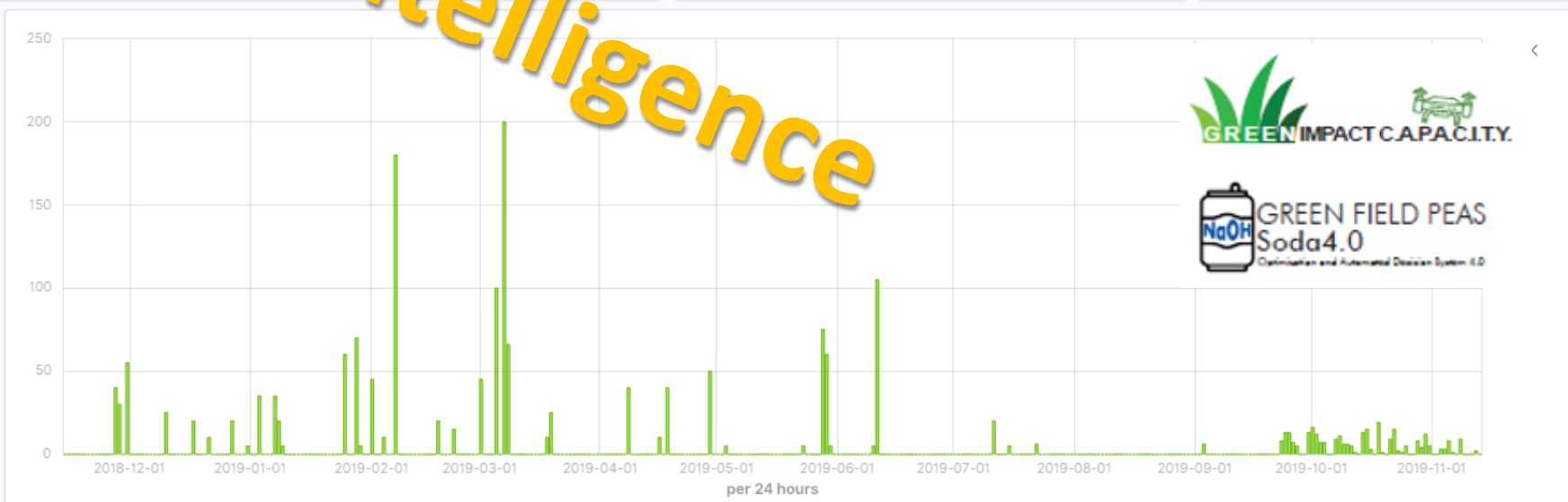
Maintenance Intelligence

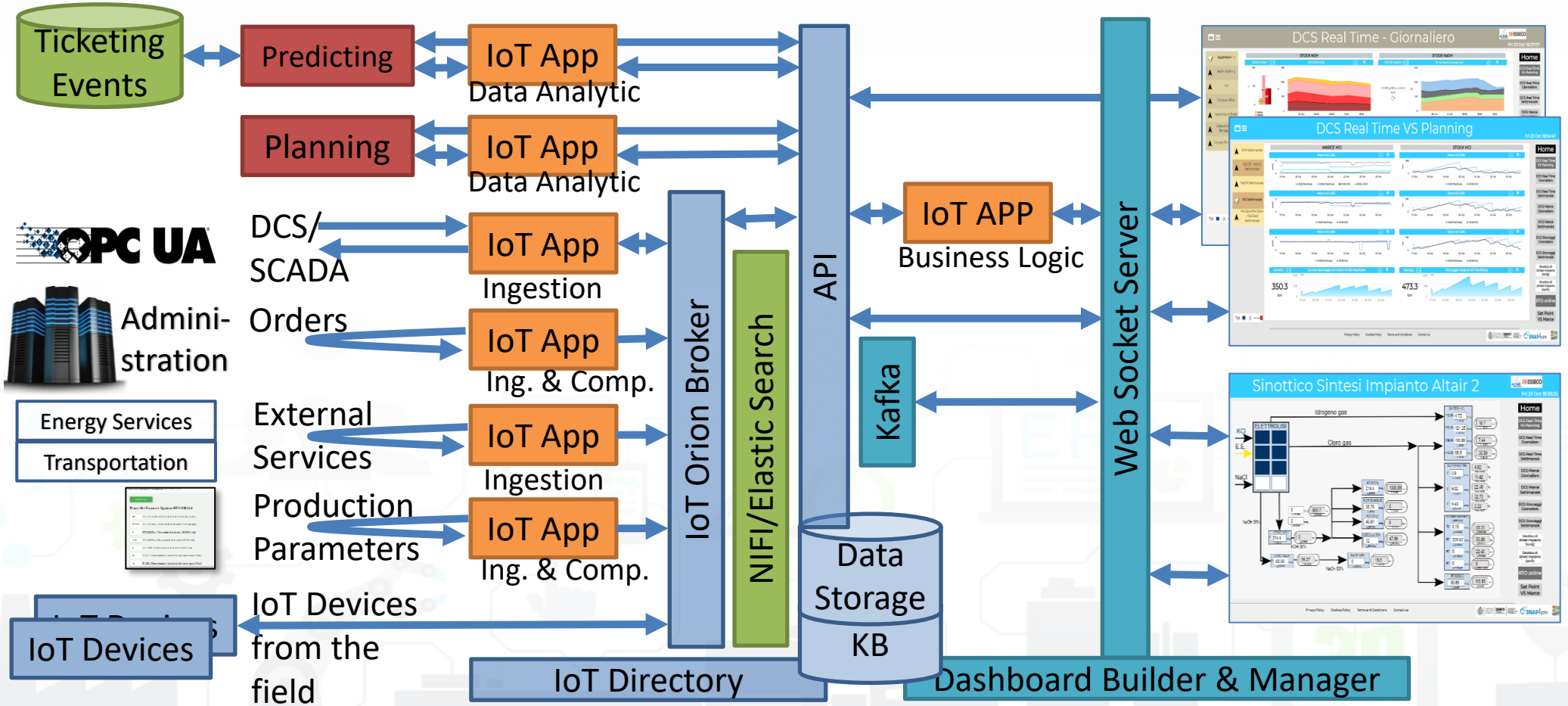




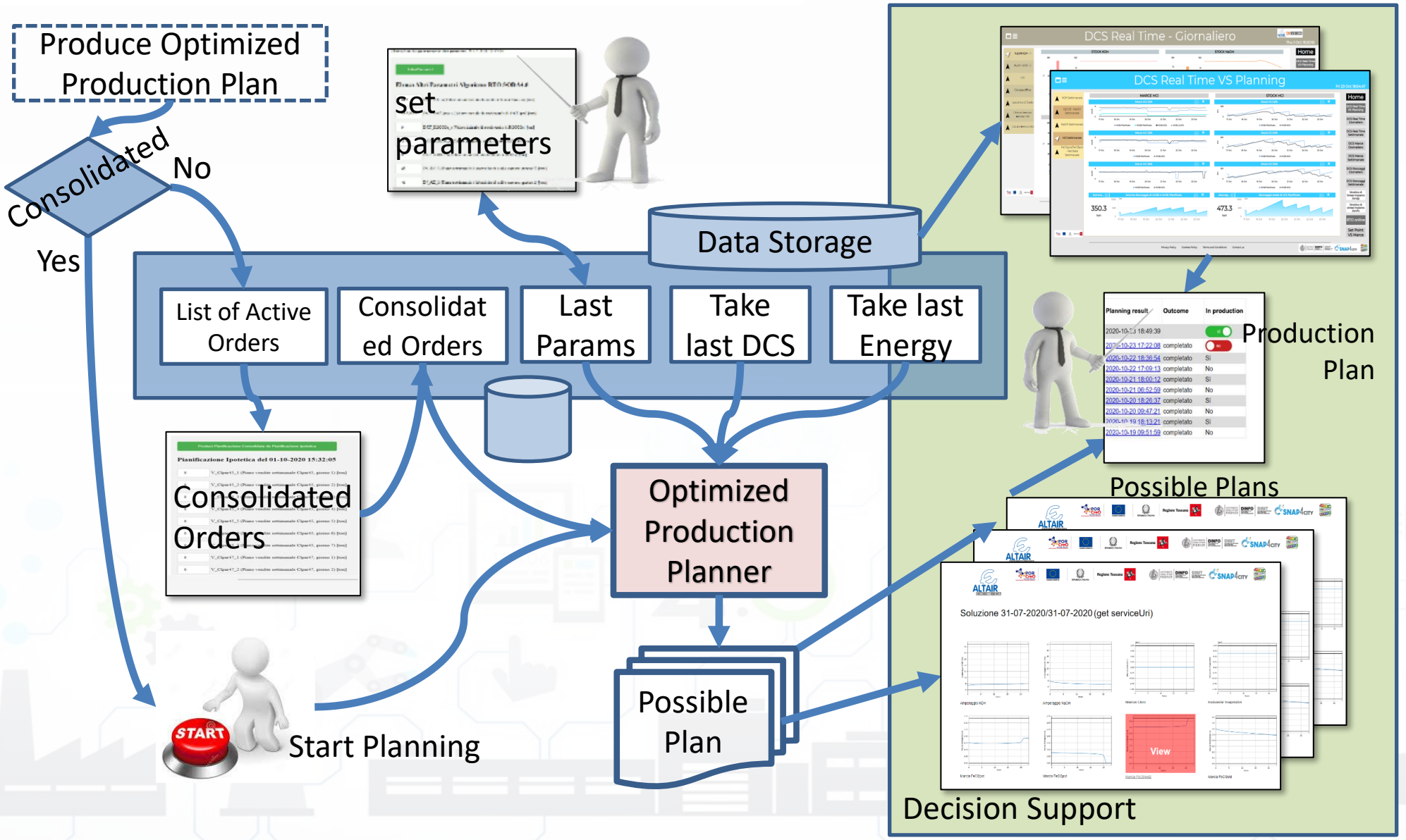







Ticketing Events
Predicting
IoT App
Data Analytic
Planning
IoT App
Data Analytic
OPC UA
DCS/ SCADA
IoT App
Ingestion
Admini-stration
Orders
IoT App
Ing. & Comp.
Energy Services
Transportation
External Services
IoT App
Ingestion
Production Parameters
IoT App
Ing. & Comp.
IoT Devices
IoT Devices from the field
IoT Orion Broker
NIFI/Elastic Search
API
IoT APP
Business Logic
Kafka
Data Storage
KB
IoT Directory
Web Socket Server
Dashboard Builder & Manager
DCS Real Time - Giornaliero
DCS Real Time VS Planning
Sinottico Sintesi Impianto Altair 2

Business Logic



Environment and Quality of Life
Air Quality Predictions

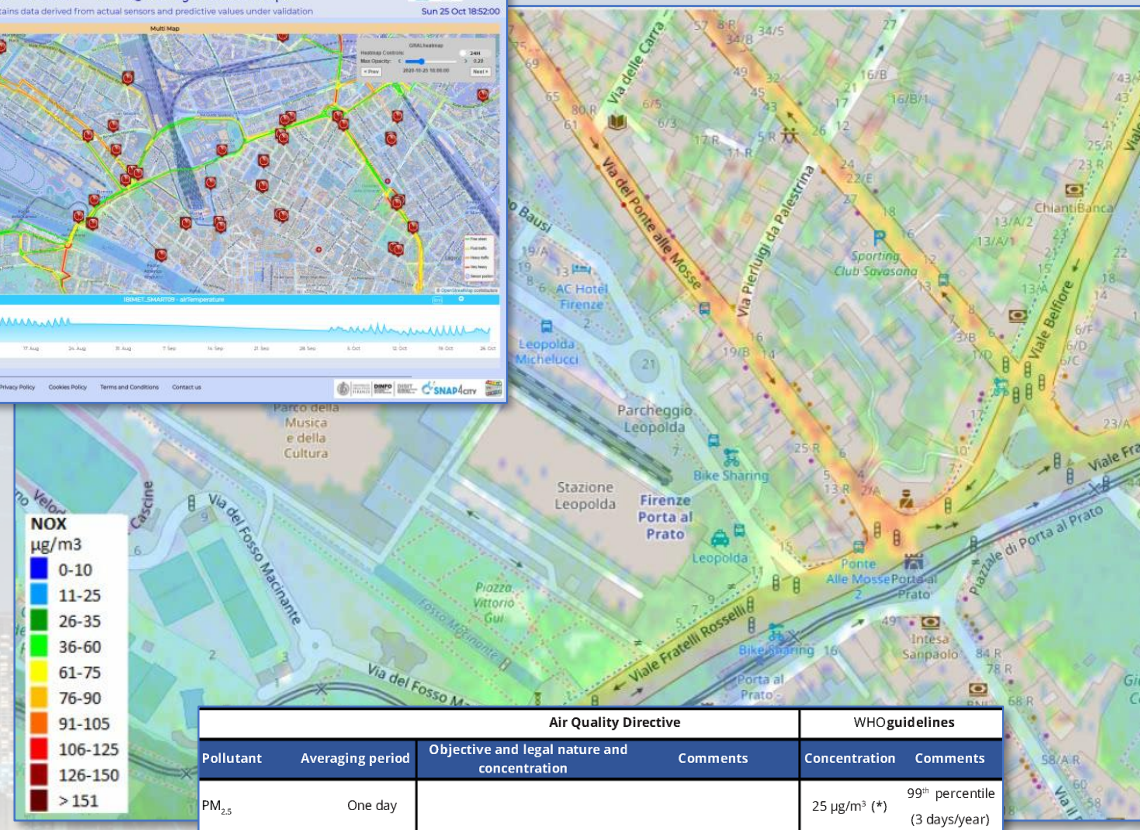
reference

Cities of: Firenze, Pisa, Livorno

- **Multiple Domain Data**
  - Traffic Flow data, Pollutant, 3D City structure, weather, …
- **Multiple Decision Makers**
  - City officers, energy industries
- **Historical and Real Time data**
  - Dashboards, What-IF analysis
  - Pollutant Predictions,
  - Traffic Flow Reconstruction
- **Services Exploited on:**
  - Dashboards, Mobile App
- **Since 2020**



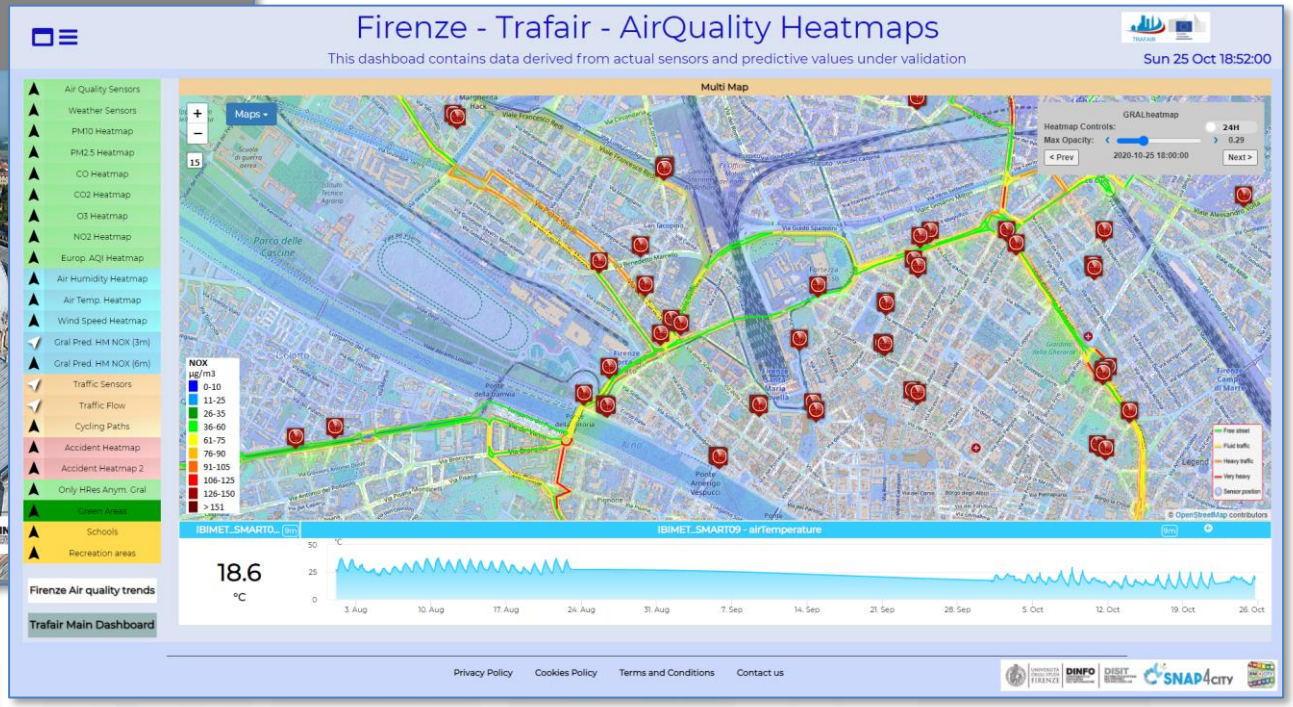




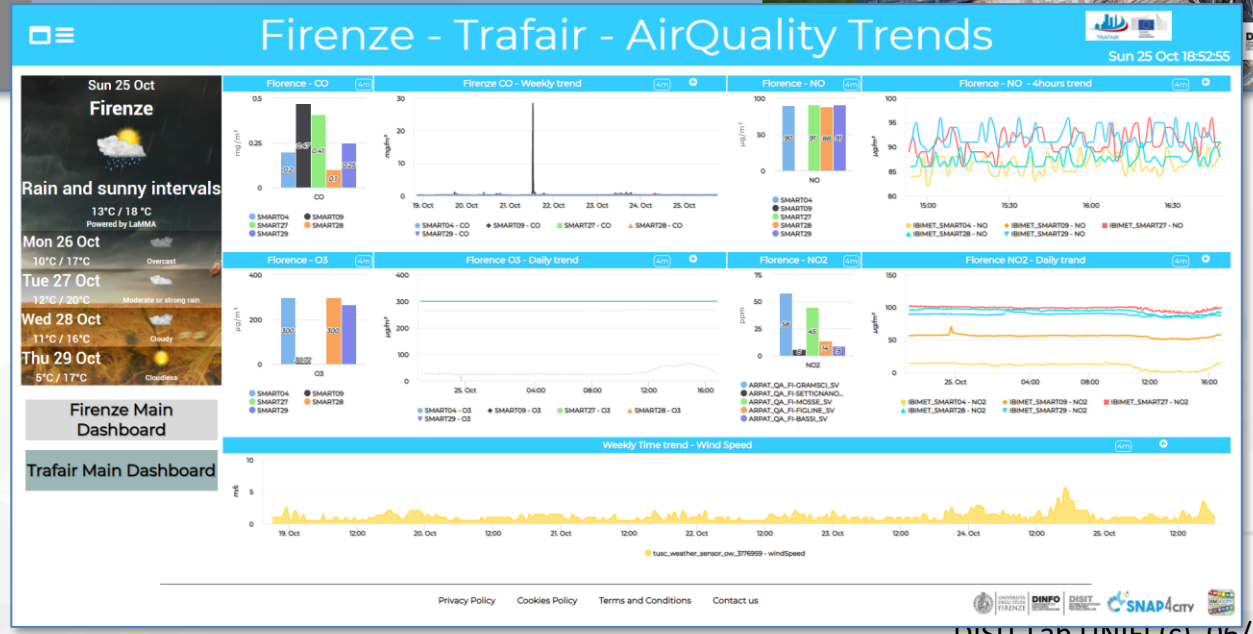
	Air Quality Directive			WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	One day			25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The target value has become a limit value since 1 January 2015	10 µg/m³	
PM_{10}	One day	Limit value, 50 µg/m³	Not to be exceeded on more than 35 days per year.	50 µg/m³ (*)	99th percentile (3 days/year)
PM_{10}	Calendar year	Limit value, 40 µg/m³ (*)		20 µg/m³	
O_3	Maximum daily 8-hour mean	Target value, 120 µg/m³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m³	
NO_2	One hour	Limit value, 200 µg/m³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m³ (*)	
NO_2	Calendar year	Limit value, 40 µg/m³		40 µg/m³	

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjY4MQ==





https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTUzMg==

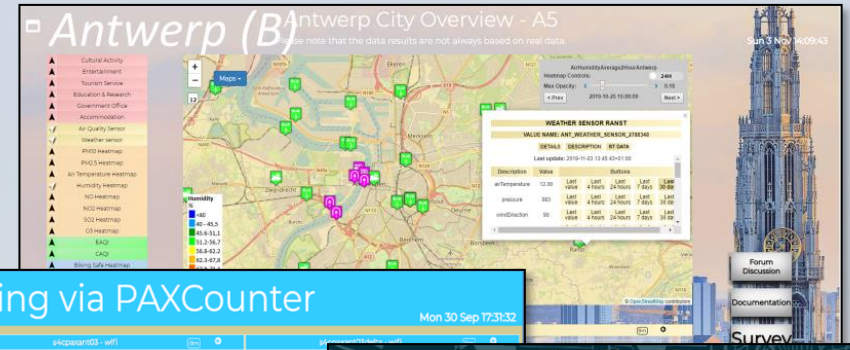


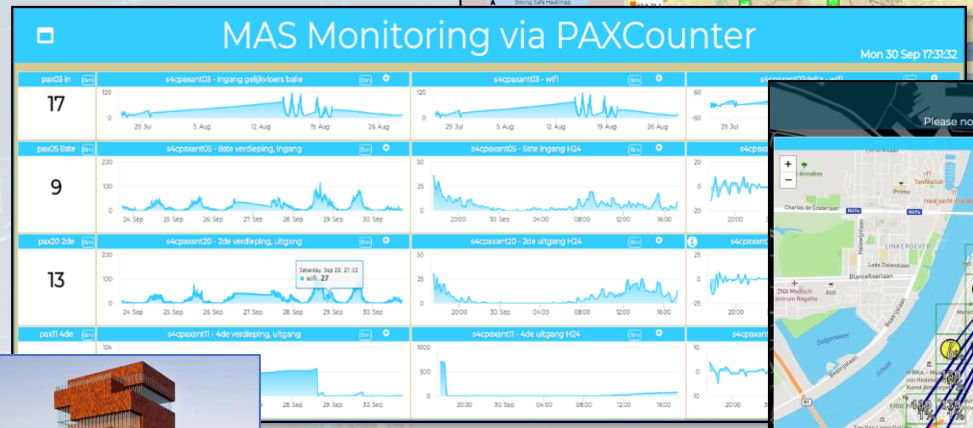
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjU0Mg==

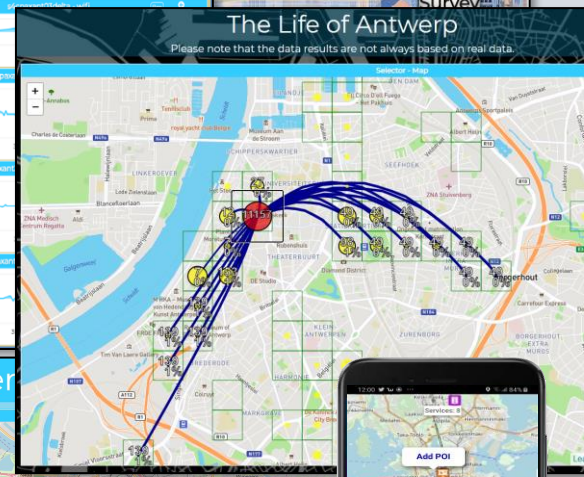
People Control on Pub Services DIGIPOLIS Antwerp

reference

- **Multiple Domain Data**
  - PAX Counters: museum, pub services, COVID-19
- **Multiple Levels & Decision Makers**
- **Historical and Real Time data**
  - 20 fixed PaxCounters
  - 2 Mobile PaxCounters
  - Business Intelligence Dashboards
- **Services Exploited on:**
  - Dashboards, Mobile Apps, API
  - Fully Controlled Devices by Digipolis
- **Since 2019**











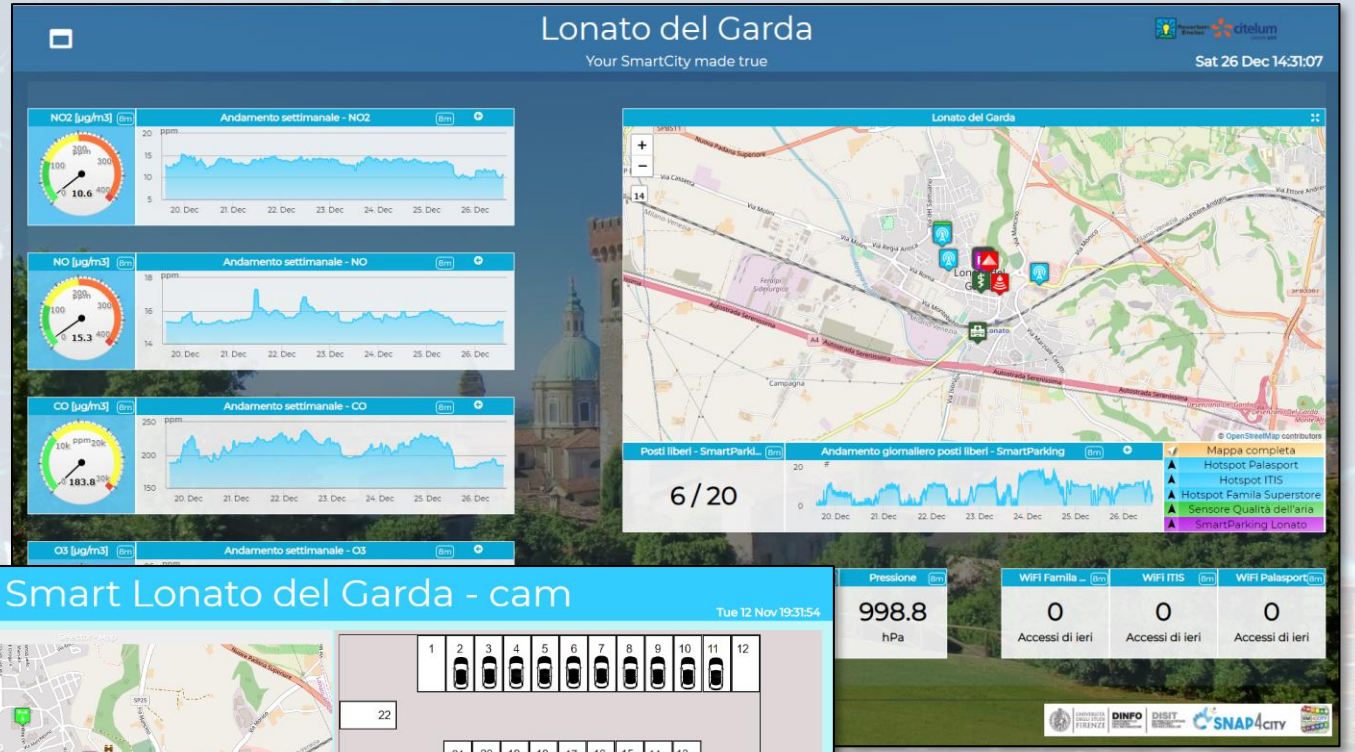


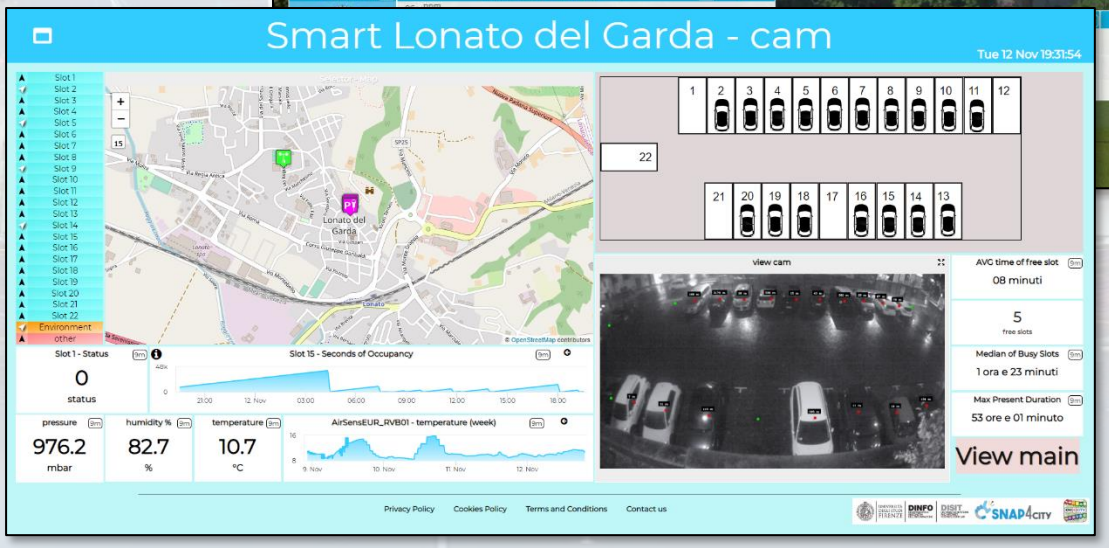


Smart City / Smart Parking + Environment
Reverberi, Lonato del Garda

reference

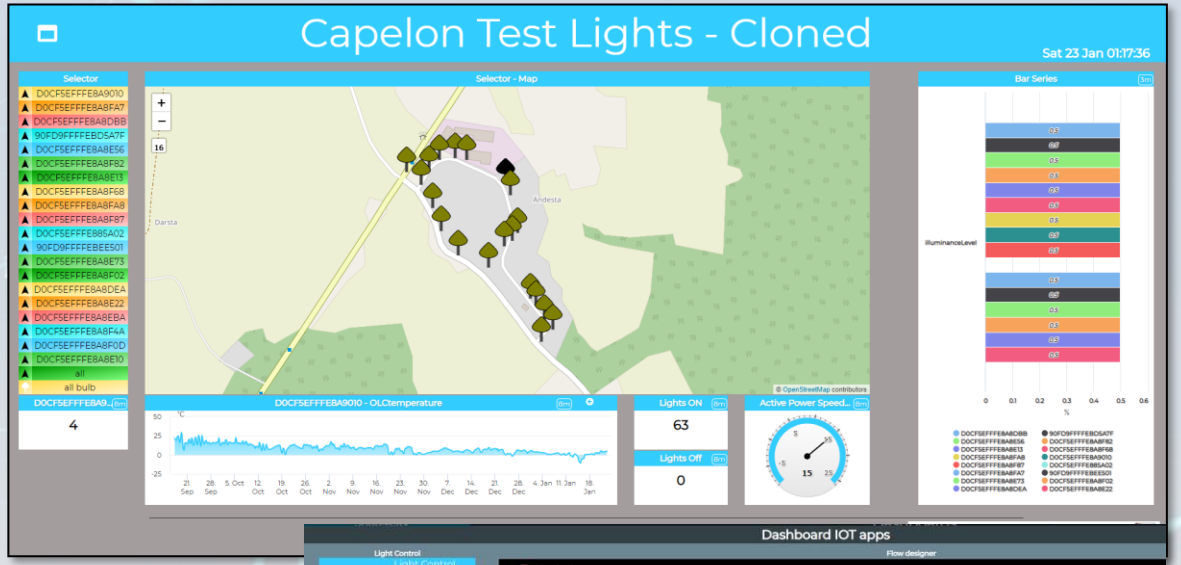
- **Multiple Domain Data**
  - Smart Parking, Environment, Wi-Fi
- **Multiple Decision Makers**
  - City Officer, operators
- **Historical and Real Time data**
  - Dashboards
- **Services Exploited on:**
  - Dashboards, API
- **Since 2019**

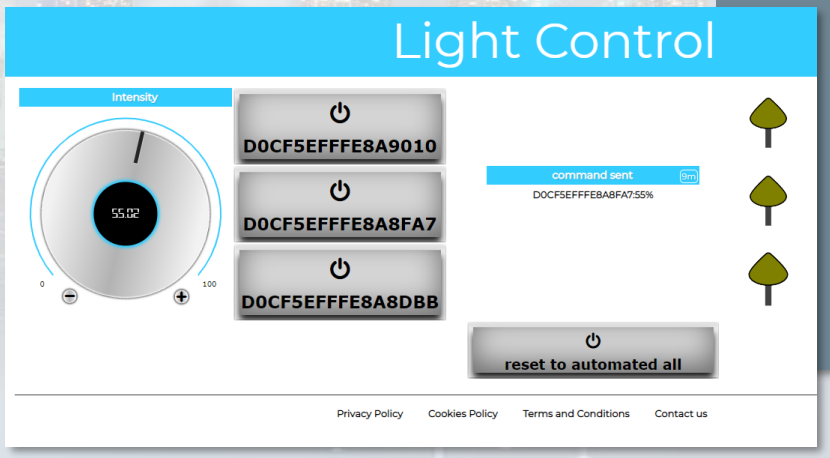




Smart Light Control of CAPELON *reference*

- **Energy Domain**
  - Smart Light
  - FiWare Orion Broker
- **Dashboards**
  - Map coverage on Sweden
  - Monitoring and real time control
- **Historical and Real Time data**
- **Services Exploited on:**
  - Multiple Levels, API
- **Since 2020**





https://www.snap4city.org/4



Scenarious

- Scenario: SnapBot: Real Time Smart City services via Telegram
- Scenario: Copernicus Satellite Data
- Scenario: SmartBed, Materasso Intelligente
- MicroServices Suite for Smart City Applications
- Scenario: MODBUS for Snap4Industry Snap4City Applications
- Scenario: MOBIMART Interreg: MOBilità Intelligente MARe Terra
- Scenario: City of Roma case, mobility and environmental data
- Scenario: Herit-Data video and aims
- Scenario: Control Room vs Video Wall
- Scenario: Snap4Home the case of: Alexa, Philips, Sonoff, TP-link, etc. (Italiano)
- Scenario: how to manage maintenance and accidents workflows
- Scenario: Snap4Home, how to exploit Snap4City solution on home automation
- Scenario: Energy Monitoring
- Scenario: Multipurpose User Engagement Tools
- Scenario: 5G Enabled Water Cleaning Control (smart city, industry 4.0)
- Scenario: High Level Control of Industrial Plant (industry 4.0)
- Scenario: Vehicle Monitoring via OBD2
- Scenario: Events and Museums Monitoring in Antwerp
- Scenario: High Resolution Prediction of Environmental Data
- Scenario: Mobility and Transport Analyses in multiple cities
- Scenario: People Flow Analysis via Wi-Fi
- Scenario: Antwerp Pilot on Environmental Data
- Scenario: Helsinki Pilot on Environmental Data
- Scenario: Firenze Smart City Control Room
- Scenario: Mobile & Web App: Toscana Where What … Km4City, Toscana in a Snap
- Scenario: Helsinki Pilot on User Behaviour
- Scenario: Antwerp Pilot on User Behaviour

- Data Analytic: Origin Destination Matrices, Algorithms and tools
- Data Analytic: Traffic Flow Reconstruction
- Data Analytic: in general, and the cases of Antwerp and Helsinki
- Data Analytic: Predicting Air Quality
- Data Analytic: Analyzing Public Transportation Offer wrt Mobility Demand

Data Warehouse





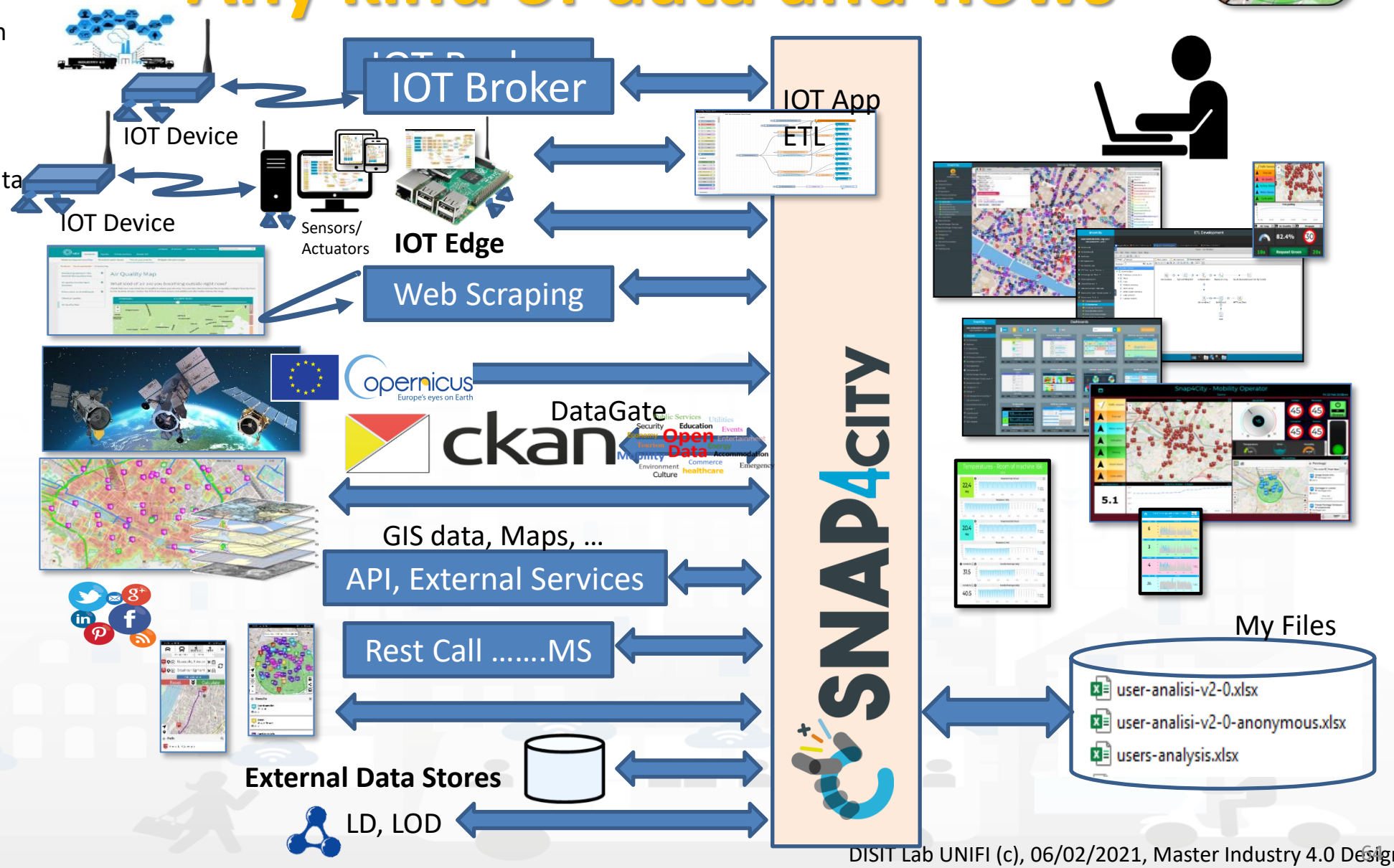
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Agenda

- Big Data Architecture
- **Data Warehouse**
  - IOT Data vs Protocols
  - Data Ingestion/Transformation Tools
  - Unified Semantic Data Model
- Data Storage
- Data Processing
- Data Analytics
- Visual Analytics
- Dashboards
- Living lab for Collaborative work
- Deploy and Install Snap4 .. Solutions
- Acknowledgment

Any kind of data and flows

- **Open Data:**
  - Data gate, federation of Open Data Portals
  - IOT App, ETL proc(PULL)
- **IOT Networks:**
  - IOT Application processes, data driven or PULL
  - IOT Brokers (Push) → IOT Shadow
- **Web Pages:**
  - Web scraping, crawling processes
- **Satellite data**
- **Social media: Twitter, Facebook,..**
  - Twitter Vigilance, IOT App
- **Mobile Apps**
  - Smart City API
- **Files upload: CSV, Excel, etc.**
  - IOT Applications, ETL
- **REST API, WS, FTP, LD, LOD, etc.**
  - IOT Applications, ETL
- **Data base accesses**
  - GIS: WFS, WMS
  - ETL, IOT Application



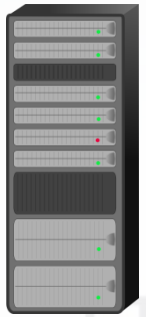
Standards and Interoperability

Compliant with: AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, NGSI, LoRa, LoRaWan, TheThingsNetwork, SigFOX, DATEX II, SOAP, WSDL, Twitter, FaceBook, Telegram, SMS, OLAP, MySQL, Mongo, HBASE, SOLR, SPARQL, EMAIL, FTP, FTPS, WebSocket, WebSocket Secure, ModBUS, OPC, GML, RS485, RS232, WFS, WMS, ODBC, JDBC, Elastic Search, Phoenix, XML, JSON, CSV, db, GeoJSON, Enfuser FMI, Android, Raspberry Pi, Local File System, ESP32, Libelium, IBIMET/IBE, OBD2, SVG, XLS, XLSX, TXT, HTML, CSS, KNX, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Copernicus, Protocol Buffer, IFC, XPDL, etc.

Node-RED | JS Foundation | FI-WARE | E015 digital ecosystem | bee smart city | sigfox partner network | ckan | GJL | LABGEO | esri Italia | EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

Snap4Industry as a Lambda Architecture







Data Sources PULL Data

Data Sources, Brokers, External Services Data Driven, Real Time

Data Ingestion, aggregation, regularization, reconcile ETL, NIFI, DISCES

ig Data Cluster DFS, Hbase, Phoenix

nowledge base emantic reasoners



ndexing and aggregating lastic search

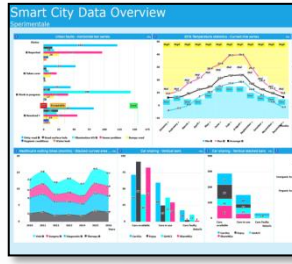
Search and Query, Smart API Facet, semanti search

Data Analytics R, Tensor Flow, Python, MapReduce, …

IOT Applications Node-RED + Snap4City MicroSrvs

Visual Analytics Special dash/ tools

Rendering Acting, Widgets, MicroApps User interface, Interactive Dashboard, Drill down, maps, heatmaps





Inform, announce, Act!, warning, alarms, What-IF, ..

Complessità del Dato

- **Formati diversi, valori sparsi e discontinui** anche in stream
  - Data healthiness, integrity, etc.
- Tecniche: Data Lake per la normalizzazione del dato
  - → big data graveyards based on HDFS
- **Formati e dati non riferibili in modo preciso alla stessa semantica** delle entità in gioco: temperatur*e*, coordinat*e*, misure dei sensori in generale, … → molto dipendenti dal contesto
  - Modelli ontologici → ontologie → knowledge base → expert systems, per ricerche in chiave semantica, Riconciliazione semantica, completamento, contestualizzazione, …

Main Purpose

- To store a large amount of data, **big data**, and they can be **structured and un-structured**, several different kind of data:
  - **Direct Data**: Time series, geolocated data, events, shapes, measures, social media posts, video, files, logs, etc.
    - Most of them may have multiple features, e.g.: geolocated events with shape
  - **Derived Data**: predictions, typical trends, trajectories, flows, heatmaps, 3D reconstructions, traffic reconstruction, planning, simulations, etc.
- for **exploiting them** for producing:
  - Deductions, hints, early warning, decision support systems
  - Derived Data as well, in real time, what if analysis

Main Functions (ETL-ELT)

- **Data Extraction:**
  - gathering, harvesting, ingestion, reception in push, ….
- **Data Transformation:**
  - Adaptation, mapping, formatting, conversion, enrich
  - If it is postponed: Cleaning or leaving as it is
- **Data Loading** and Refreshing: saving in the storage
  - As it is, converted and ready to use, etc.
- **Data Usage:**
  - As it is from Storage (faster, more rigid schema, higher volume in access)
  - Transformed on the fly (slower, more flexible, moderate volume in access), higher costs of CPU

Parameters	Data Lake	Data Warehouse
Storage	In the data lake, all data is kept irrespective of the source and its structure. Data is kept in its raw form. It is only transformed when it is ready to be used.	A data warehouse will consist of data that is extracted from transactional systems or data which consists of quantitative metrics with their attributes. The data is cleaned and transformed
History	Big data technologies used in data lakes is relatively new.	Data warehouse concept, unlike big data, had been used for decades.
Data Capturing	Captures all kinds of data and structures, semi-structured and unstructured in their original form from source systems.	Captures structured information and organizes them in schemas as defined for data warehouse purposes
Data Timeline	can retain all data. This includes not only the data that is in use but also data that it might use in the future. Also, data is kept for all time, to go back in time and do an analysis.	In the data warehouse development process, significant time is spent on analyzing various data sources.
Users	ideal for the users who indulge in deep analysis. Such users include data scientists who need advanced analytical tools with capabilities such as predictive modeling and statistical analysis.	The data warehouse is ideal for operational users because of being well structured, easy to use and understand.
Storage Costs	Data storing in big data technologies are relatively inexpensive then storing data in a data warehouse.	Storing data in Data warehouse is costlier and time-consuming.

https://www.guru99.com/data-lake-vs-data-warehouse.html

Parameters	Data Lake	Data Warehouse
Task	can contain all data and data types; it empowers users to access data prior the process of transformed, cleansed and structured.	Data warehouses can provide insights into pre-defined questions for pre-defined data types.
Processing time	empower users to access data before it has been transformed, cleansed and structured. Thus, it allows users to get to their result more quickly compares to the traditional data warehouse.	Data warehouses offer insights into pre-defined questions for pre-defined data types. So, any changes to the data warehouse needed more time.
Position of Schema	Typically, the schema is defined after data is stored. This offers high agility and ease of data capture but requires work at the end of the process	Typically schema is defined before data is stored. Requires work at the start of the process, but offers performance, security, and integration.
Data processing	use of the ELT (**Extract Load Transform**) process.	Data warehouse uses a traditional ETL (**Extract Transform Load**) process.
Complain	Data is kept in its raw form. It is only transformed when it is ready to be used.	The chief complaint against data warehouses is the inability, or the problem faced when trying to make change in in them.
Key Benefits	They integrate different types of data to come up with entirely new questions as these users not likely to use data warehouses because they may need to go beyond its capabilities.	Most users in an organization are operational. These type of users only care about reports and key performance metrics.

https://www.guru99.com/data-lake-vs-data-warehouse.html

Pros and Cons

- **Data Lake**
  - Original data preserved, structured and unstructured
  - Lower costs of ingestion
  - Lower performance in the usage
  - Security: possible control at source
  - More difficult to extend in usage, simpler in storage
  - More scientist oriented
    - Moderated results in access

- **Data Warehouse**
  - Original data transformed and prepared for mainly structured or semi-structured
  - Higher cost of ingestion
  - Higher performance in the usage
  - Security: Control on organized data
  - More difficult to extend in storage, simpler in usage
  - More Business and Purpose Oriented
    - Large volume of accesses

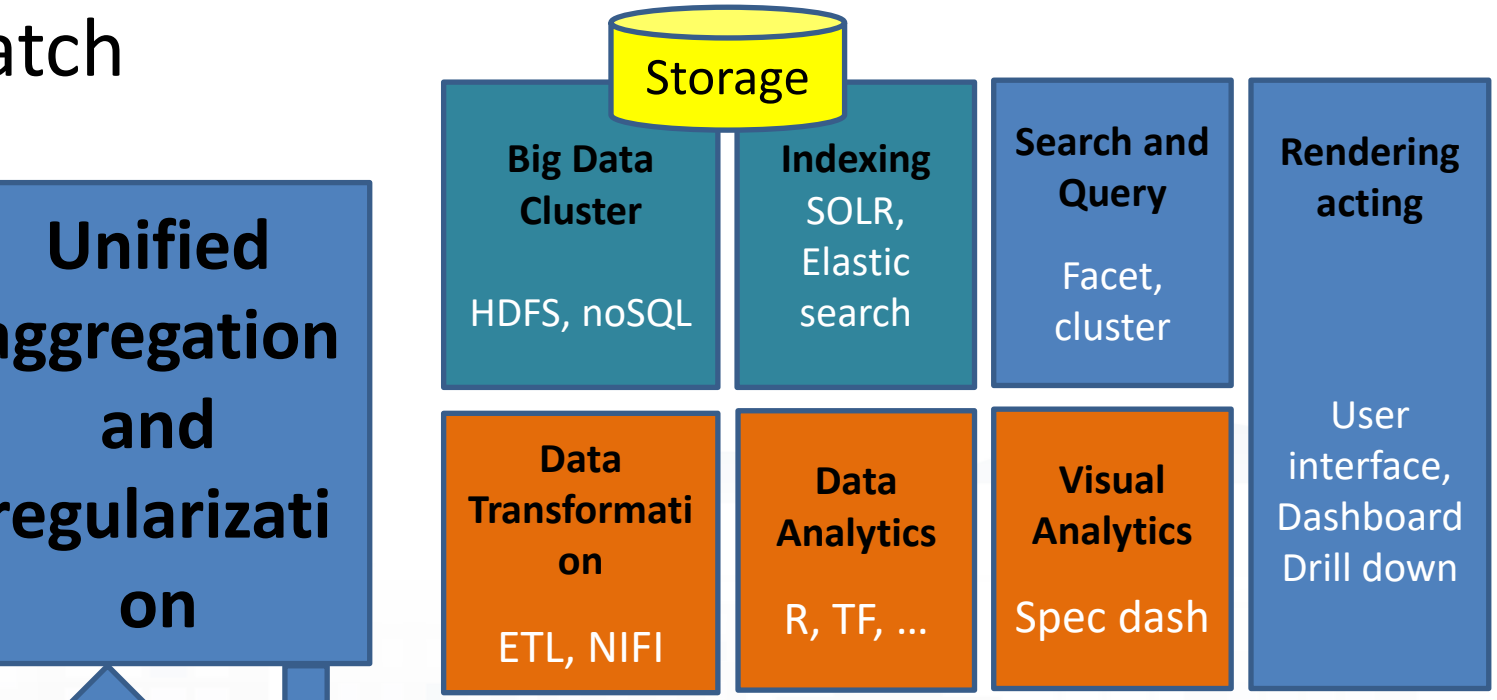
DWH

Data Sources Static Data

Scheduling and preproc

Batch

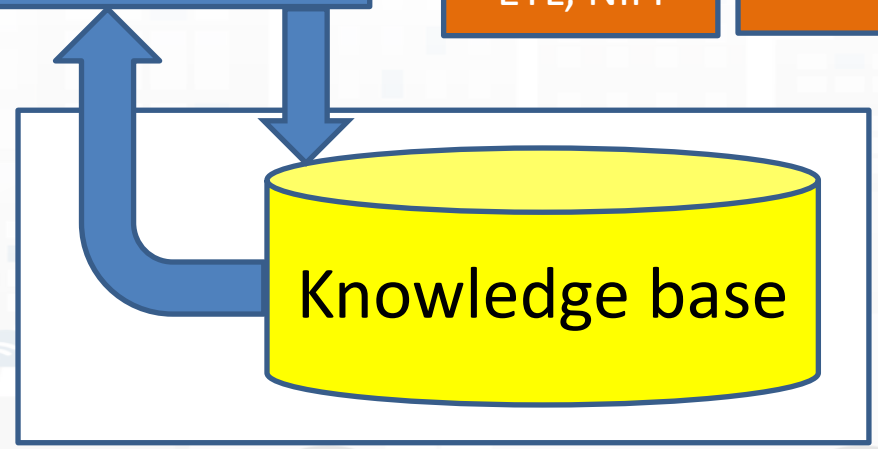
Unified aggregation and regularizati on



Data Sources Data Driven

Broker, Stream processing

Stream

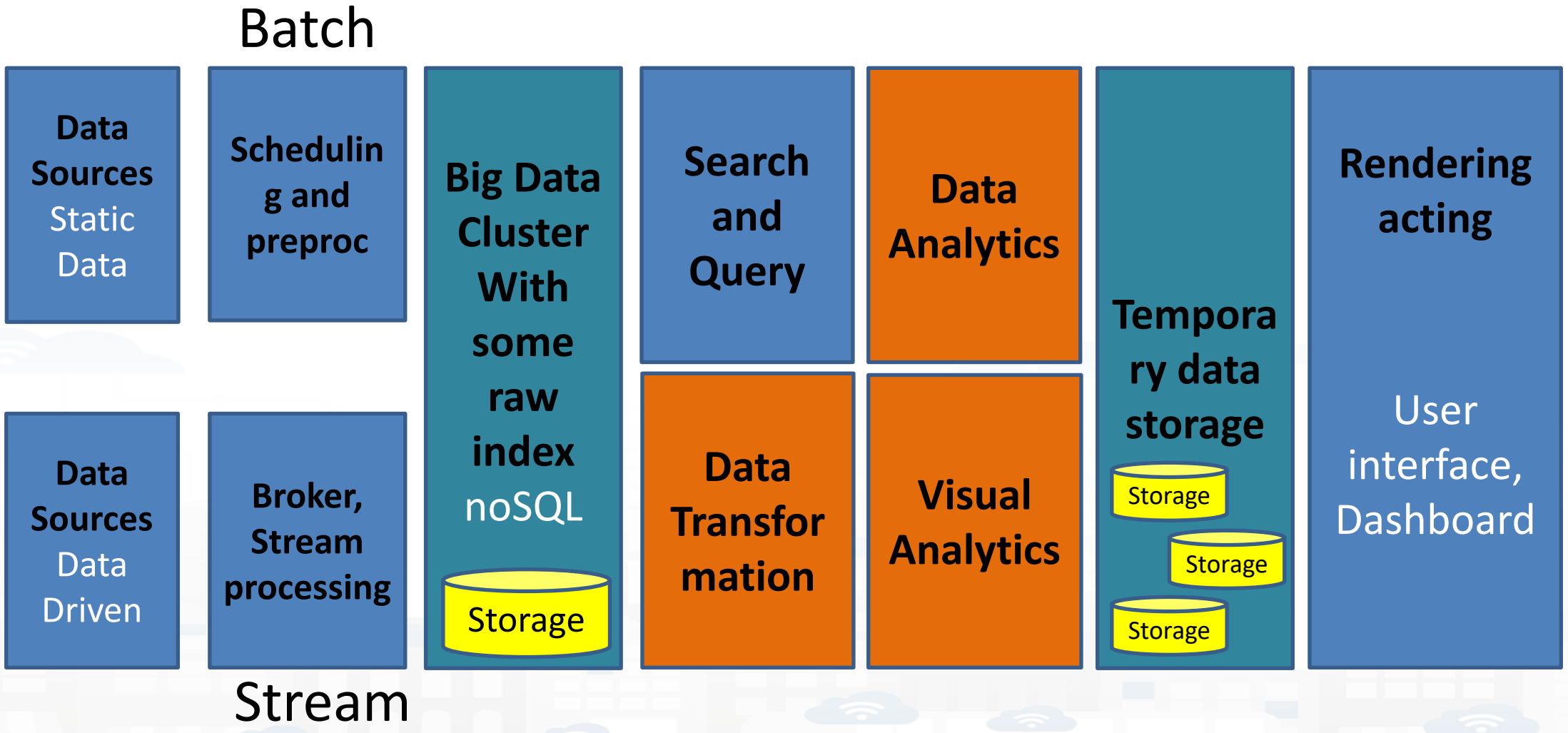


Optionally

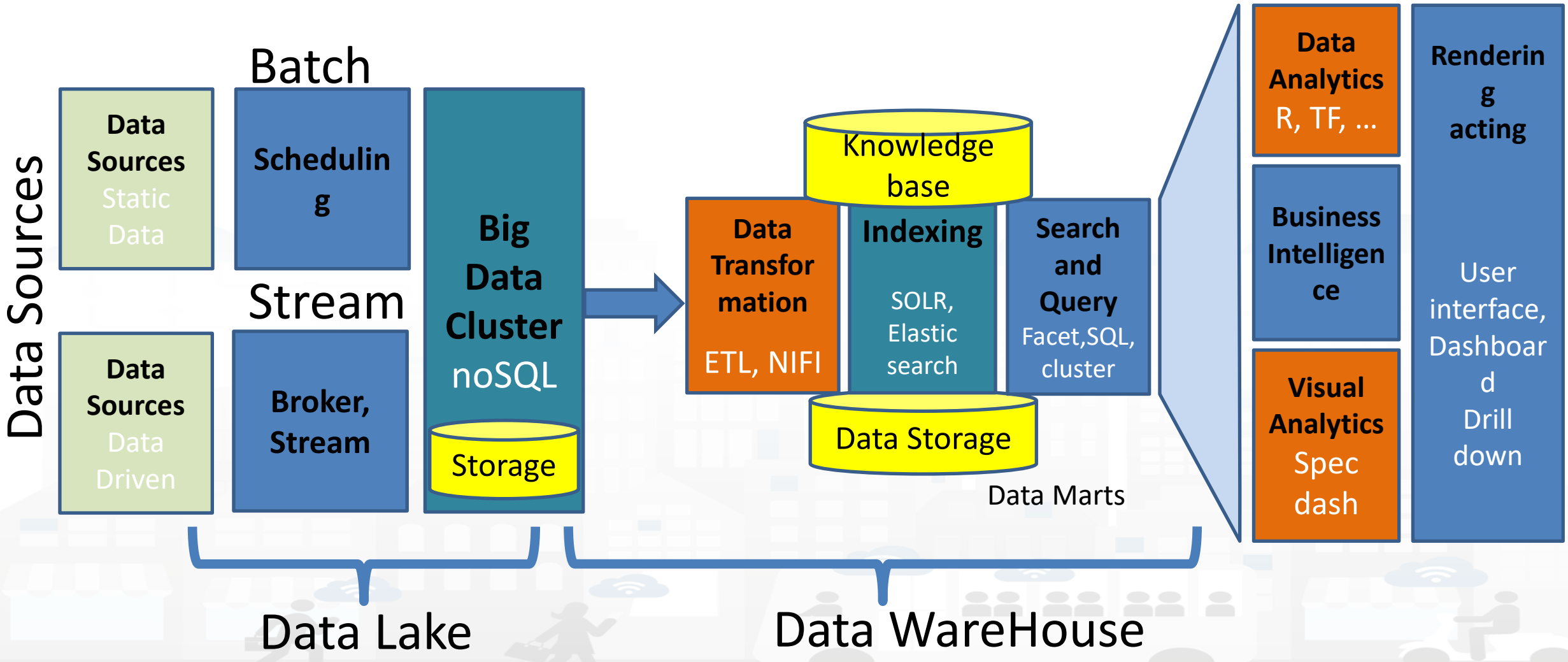
Top Cloud Data Warehouses at a Glance

	Amazon Redshift	Microsoft Azure Synapse	Google BigQuery	Snowflake Cloud Data Platform
Initial Release	2012	2016	2010	2014
Separates Storage and Compute	No	Yes	Yes	Yes
Multi-Cloud	No	No	No	Yes
Query Language	Amazon Redshift SQL	TSQL	Standard SQL 2011 & BigQuery SQL	Snowflake SQL
Elasticity	Yes - Manual	Yes – Manual and Automatic	Yes – Automatic	Yes – Automatic
MPP	Yes	Yes	Yes	Yes
Columnar	Yes	Yes	Yes	Yes
Foreign Keys	Yes	Yes	No	Yes
Transaction	ACID	ACID	ACID	ACID
Concurrency	Yes	Yes	Yes	Yes
Durability	Yes	Yes	Yes	Yes
Automation	No	No	No	No
Website	Link	Link	Link	Link
Free Trial	Yes	Yes	Yes	Yes

DL


Batch
Data Sources Static Data
Scheduling and preproc
Big Data Cluster With some raw index noSQL
Storage
Search and Query
Data Analytics
Temporary data storage
Storage
Storage
Storage
Rendering acting
User interface, Dashboard
Data Sources Data Driven
Broker, Stream processing
Data Transformation
Visual Analytics
Stream

Combined Solutions



Modalities and Strategies for data ingestion

- **Road Graphs**: from GIS, and/or OSM (see Snap4City tool for that), …
- **Data** of any format via any protocol
- **Structured and non-structured** data (tables and free text, mixt)
- **Static data** and metadata descriptions:
  - typically ingested with DataGate for automated ingestion and you find it on the menu on left of Snap4City environment.
    - DataGate is a module of CKAN, it can be installed on any CKAN also.
  - ingested producing a process visually: ETL, Node-RED, NIFI, etc.
- **Simple data and complex data as:** GIS data, heatmaps, tracks, etc.
- **Real Time data** can be ingested by using:
  - Node-RED, NIFI, ETL, WebScraping, etc.
- **Event Driven** → Node-RED, NodeJS

Snap4….. vs Formats

- Snap4City is capable to ingest and work with any format:
  - Data **exchange**: JSON, GeoJSON, XML, HTML, HTML5, DATEX, GTFS, binary, etc.
  - **GIS formats:** WMF, WFS, heatmaps, ….
  - **Table**: CSV, XLSX, XLS, database, …
  - **archive** file formats: zip, rar, 7z, tgz, …
  - **image** formats: png, gif, tiff, ico, jpg, …
  - **video** formats: mp4, avi, mov, …
- Search the format you need to cope on the search box of Snap4City portal!: **Snap4City Supported Protocols, adding new protocols**

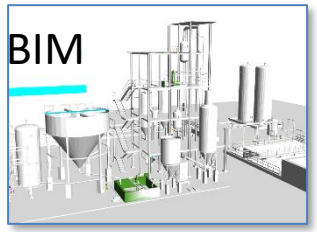
IOT Data vs Protocols



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Concept

BIM

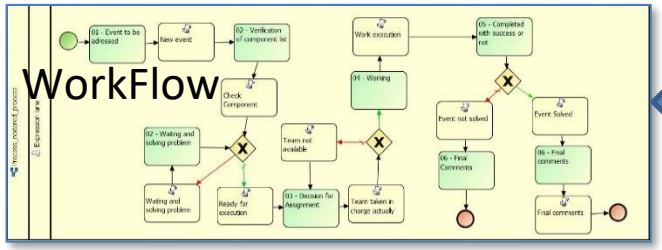


KPI, POI, MyKPI, …

API, External Services

Web Scraping

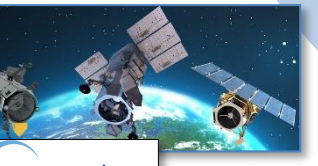
WorkFlow

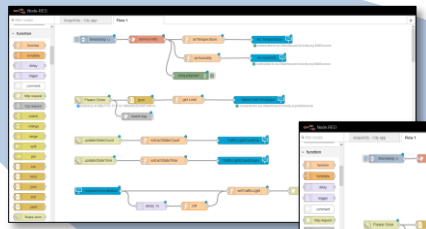


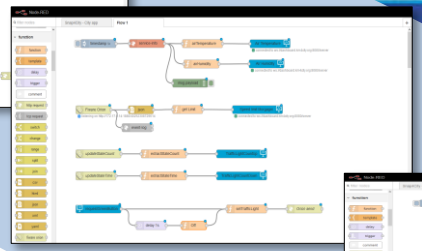


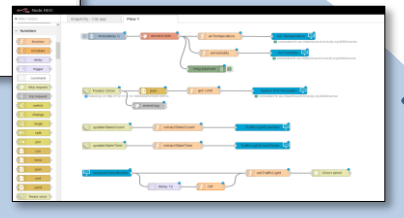












Data Analytics,
Artificial Intelligence

IOT Broker

IOT Apps

FIWARE



ckan

LD, LOD



GIS

Big Data

KB

Dashboards and Apps

Snap4Industry as a Lambda Architecture



Data Sources PULL Data

Data Sources, Brokers

Data Ingestion, aggregation, regularization, reconcile

ETL, NIFI, DISCES



External Services Data Driven, Real Time



Big Data Cluster HDFS, Hbase, Phoenix

Knowledge base Semantic reasoners

Indexing and aggregating Elastic search

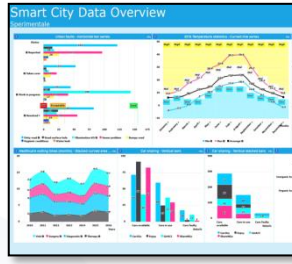
Data Analytics R, Tensor Flow, Python, MapReduce, …

IOT Applications Node-RED + Snap4City MicroSrvs

Search and Query, Smart API Facet, semantic search

Visual Analytics Special dash/ tools

Rendering Acting, Widgets, MicroApps User interface, Interactive Dashboard, Drill down, maps, heatmaps

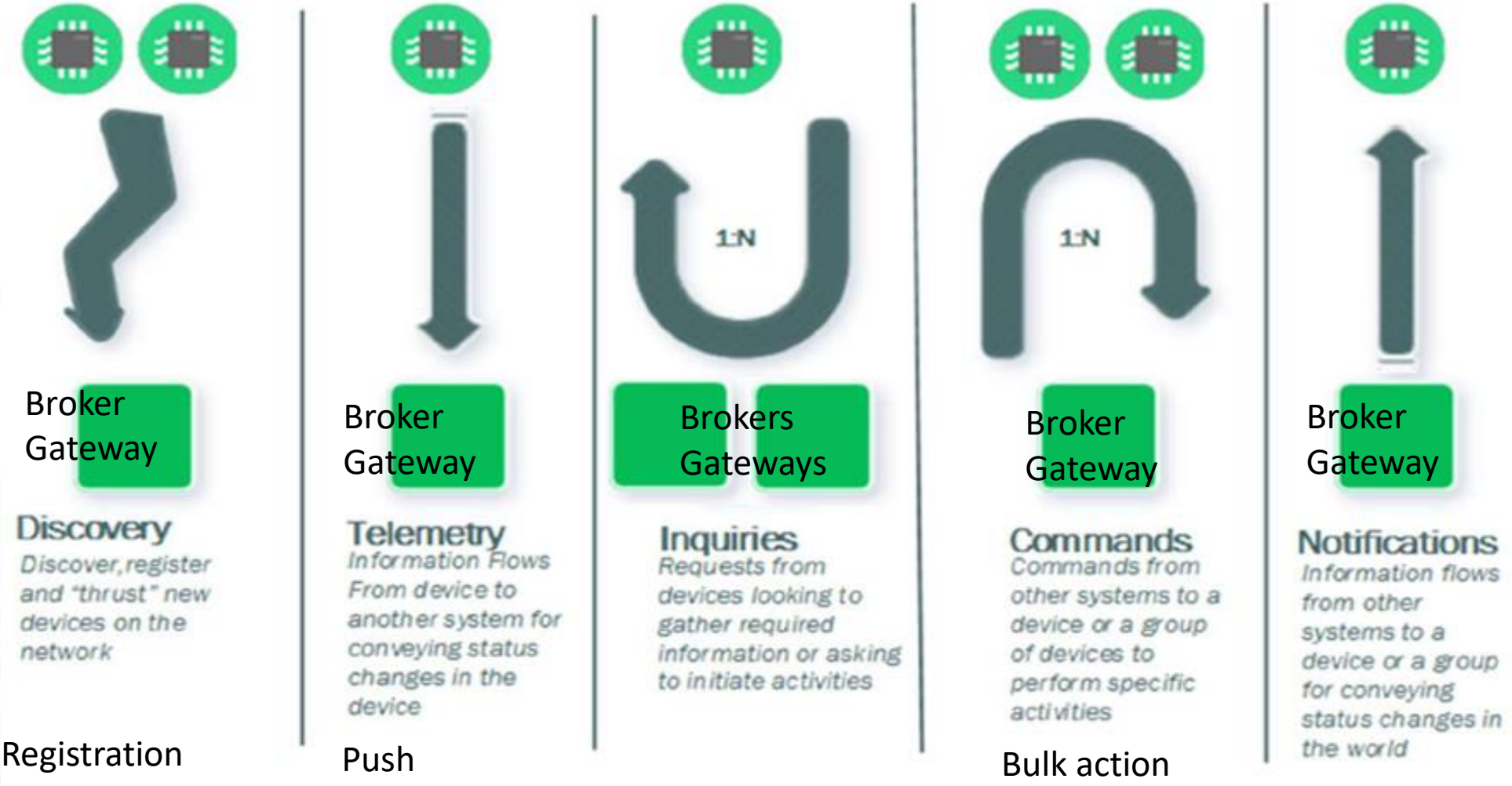




Inform, announce, Act!, warning, alarms, What-IF, ..

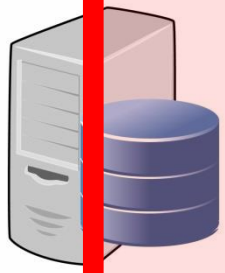
IOT/IOE Protocols

Communication Patterns

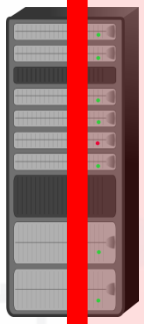


- MQTT
- HTTP(s)
- AMQP
- COAP
- NGSI
- OneM2M
- WebSockets
- ……..
- Etc.

Snap4Industry as a Lambda Architecture



Data Sources
PULL Data



Data Sources, Brokers, External Services
Data Driven, Real Time

Data Ingestion, aggregation, regularization, reconcile

ETL, NIFI, DISCES

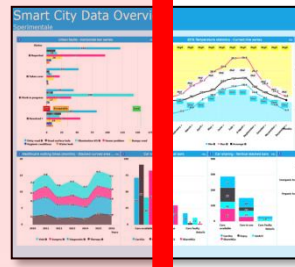
Big Data Cluster
HDFS, Hbase, Phoenix

Knowledge base
Semantic reasoners

Indexing and aggregating
Elastic search

Search and Query, Smart API
Facet, semantic search

Rendering Acting, Widgets, MicroApps
User interface, Interactive Dashboard, Drill down, maps, heatmaps





Data Analytics
R, Tensor Flow, Python, MapReduce, …

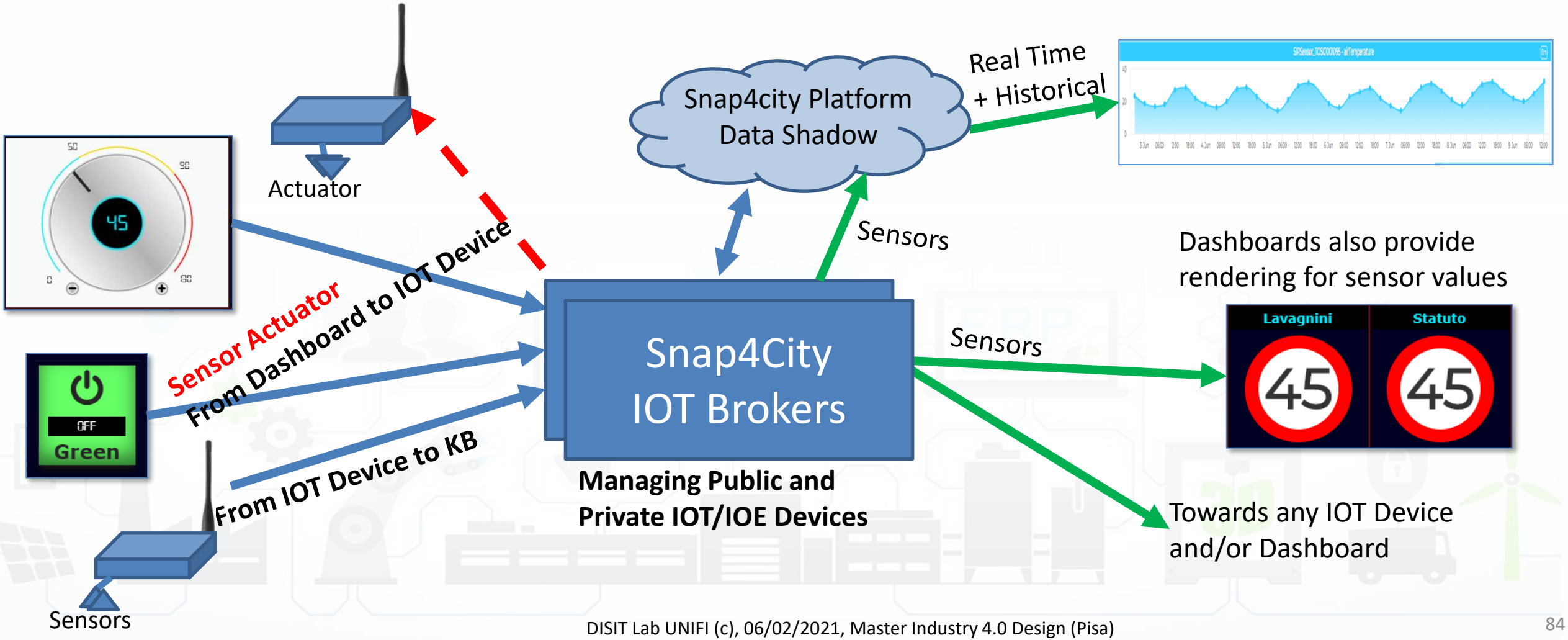
IOT Applications
Node-RED + Snap4City MicroSrvs

Visual Analytics
Special dash/ tools

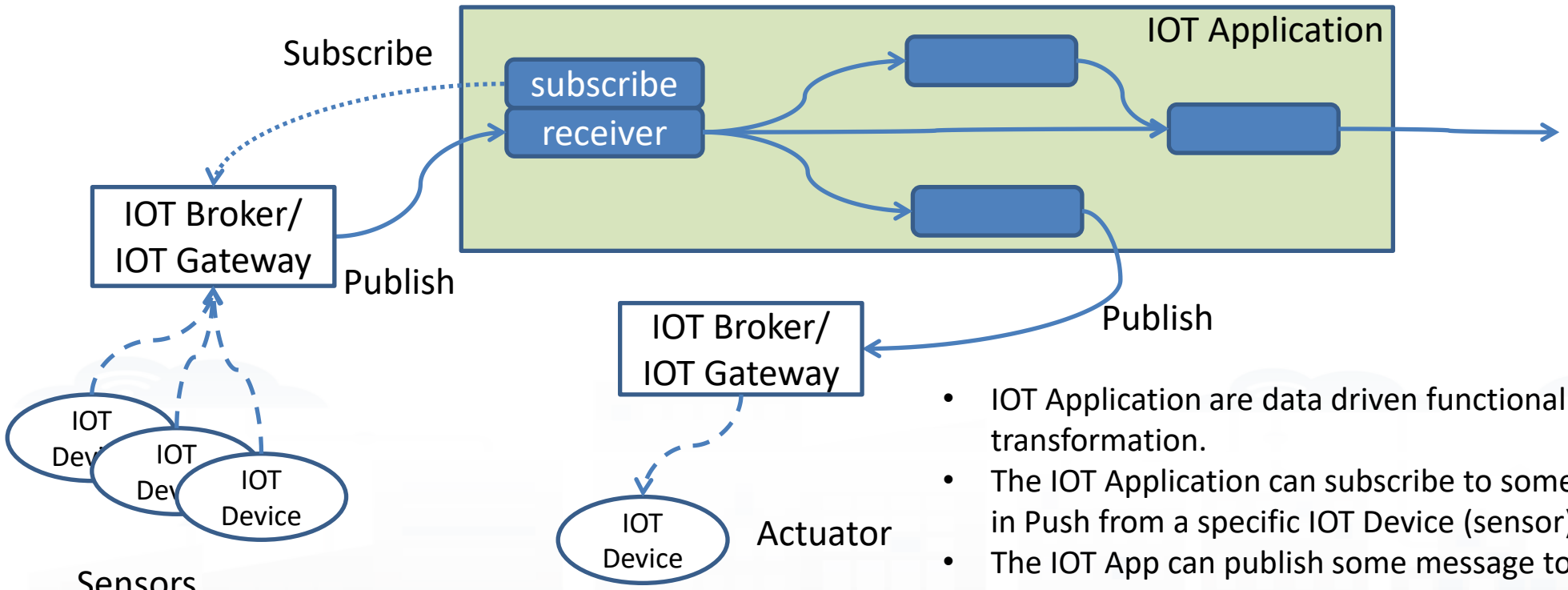


Inform, announce, Act!, warning, alarms, What-IF, ..

IOT Data Driven



IOT Basic

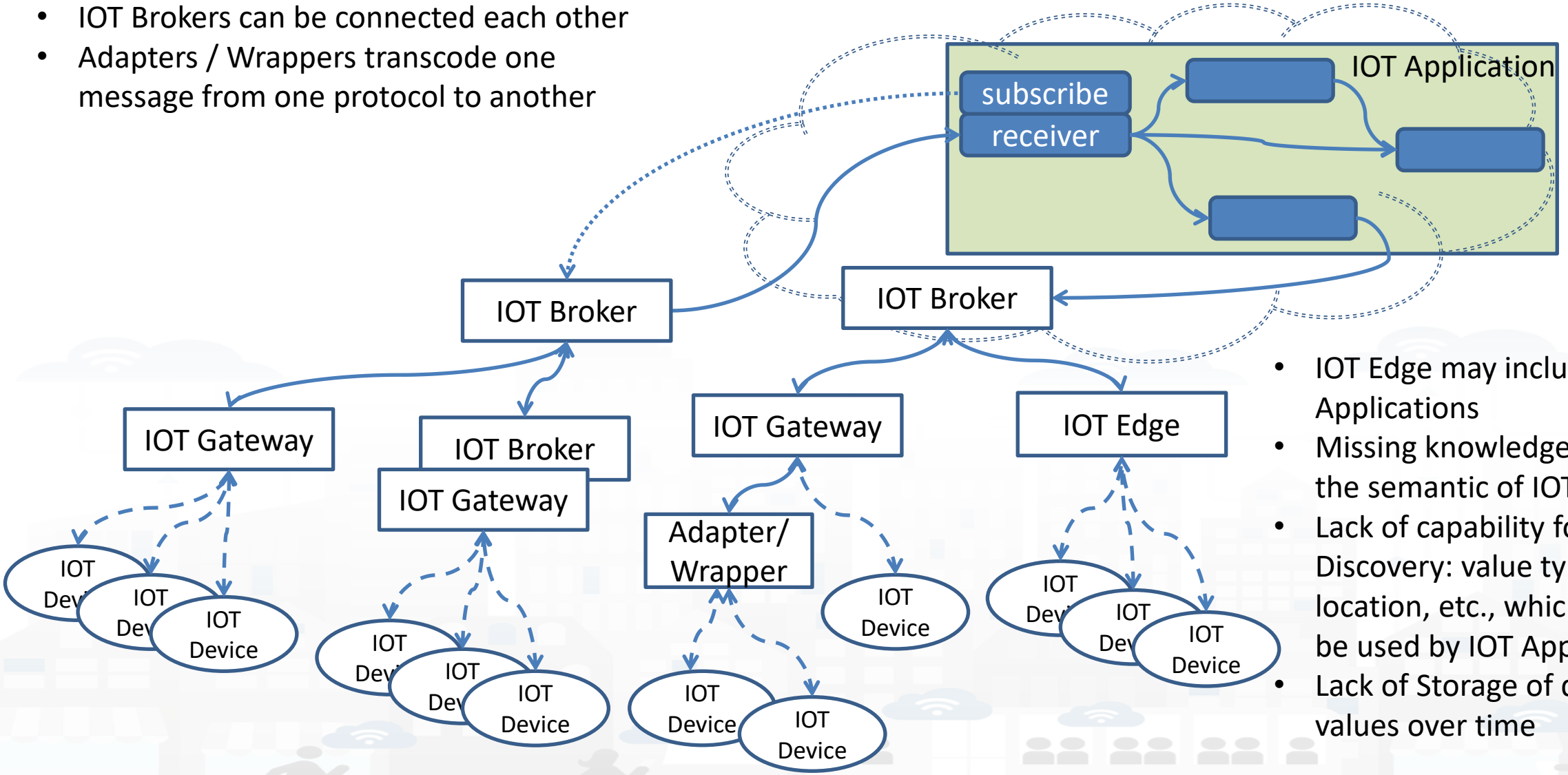


- Sensors are programmed to send data (i) periodically, or (ii) when a relevant change occurs in the sensor value, or (iii) when events occur (for example a change of status of something), etc.
- Actuator perform some action on the field: change of status, reset, turn on something, change setting value, etc.

- IOT Application are data driven functional programs for data transformation.
- The IOT Application can subscribe to some IOT Brokers to receive data in Push from a specific IOT Device (sensor)
- The IOT App can publish some message toward some IOT Device (Actuator), passing via an IOT Broker.
- Continuous lines are messages via TCP/IP
- Dashed lines are message via some radio channel (Lora, BT, Wi-Fi, …)
- IOT Brokers and IOT Gateway can be distinct servers
- IOT Brokers can be on cloud
- IOT Gateway performs the SW update, the business management, access in Push and Pull

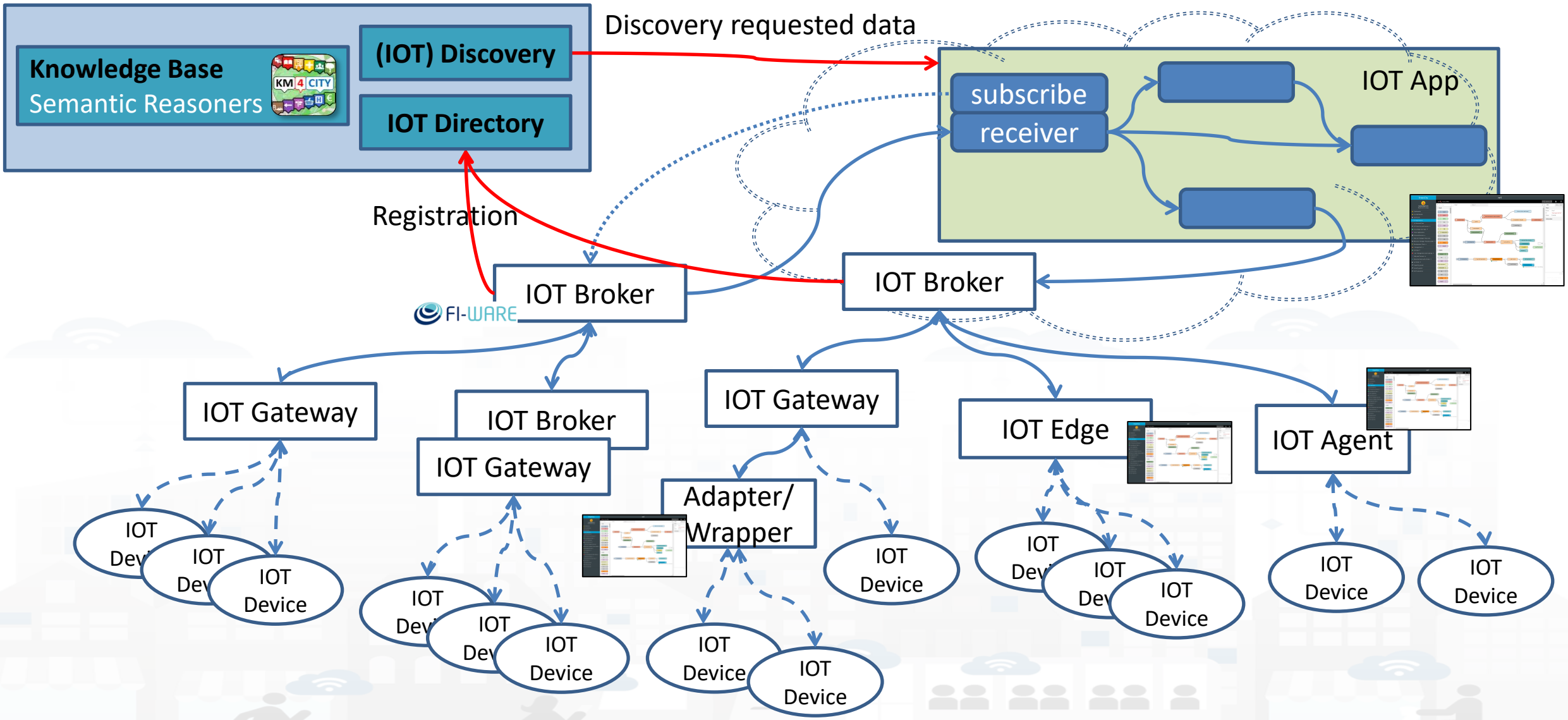
Definitions

- IOT Brokers can be connected each other
- Adapters / Wrappers transcode one message from one protocol to another



- IOT Edge may include IOT Applications
- Missing knowledge about the semantic of IOT devices
- Lack of capability for IOT Discovery: value type, location, etc., which could be used by IOT App
- Lack of Storage of data values over time

IoT Network

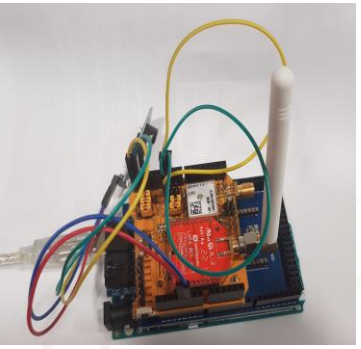

Knowledge Base
Semantic Reasoners
(IOT) Discovery
IOT Directory
Discovery requested data
Registration
subscribe
receiver
IOT App
FI-WARE
IOT Broker
IOT Broker
IOT Gateway
IOT Broker
IOT Gateway
IOT Gateway
Adapter/
Wrapper
IOT Edge
IOT Agent
IOT Device

IOT Devices

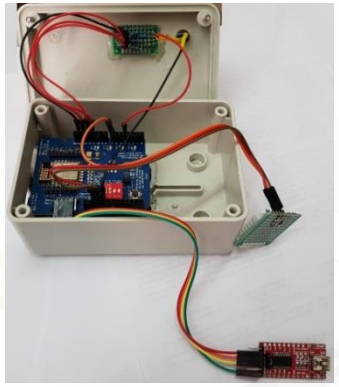
Sensors/
Actuators

IOT Edge Devices

LoraWAN +
Arduino +
I2C, NGSI



Arduino,
Wi-Fi, NGSI



Snap4All
IOT Button
ESP, NGSI,
Wi-FI, BT



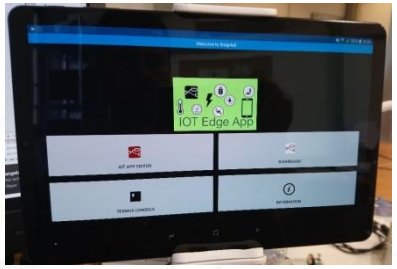
Snap4All PAX
Counter
LoraWAN
WIFI, NGSI,
GPS

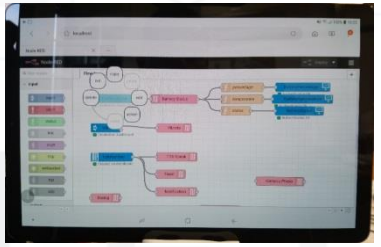


IOT Edge
NodeRED:
Raspberry Pi,
NGSI, WiFi,
RJ45,..



IOT Edge
NodeRED:
Android, LINUX,
Windows, …





LoraWan
Gateway:
IOT Edge, NGSI,
WIFI, RJ45, GPS



Any Sensor / Actuator
Open to other protocols

IOT Edge and computing



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Measuring any kind of sensors values

Controlling Energy Power

Measuring
Energy Consumption

Any kind of notification channel

IOT Edge:
Node-RED
+
Snap4City

Local Control

DCS

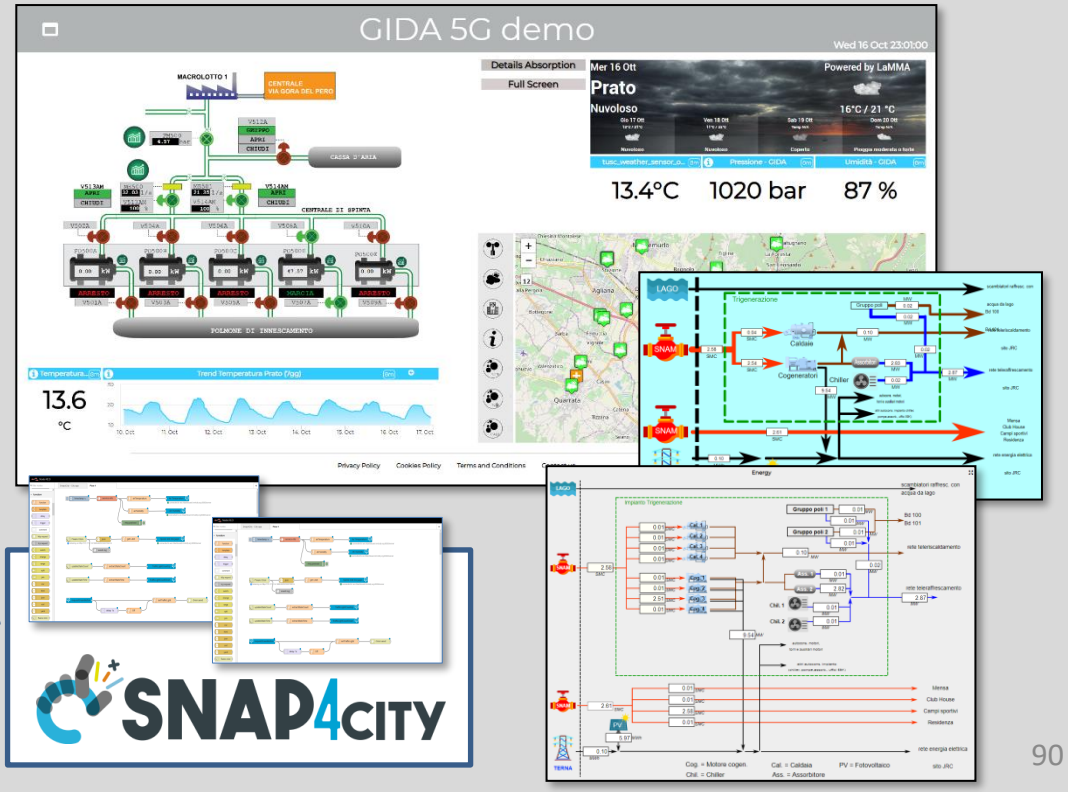
SCADA

Administrative Servers

ODBC

Alexa: Voice Commands

Contextual (smart city/home) data, Data Analytics
Historical Data, Remote Control, Mobile App



Snap4Home

Sonoff: Controlling Energy Power



Philips Hue: Controlling Lights





Hue: Motion Control / Alarm



Measuring
Energy Consumption



TP Link: Controlling / Measuring Energy Plugs

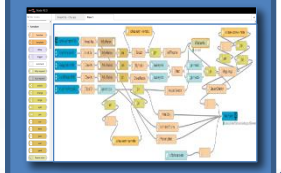


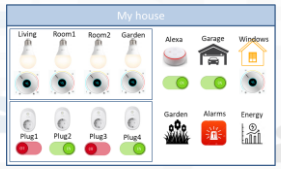
Alexa: Voice Control



IOT Edge:

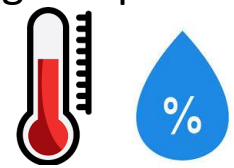
Raspberry pi: Node-RED + Snap4City





Local Control

Measuring Temperature and Humidity



Garage Door

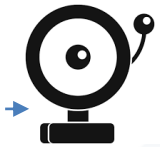


Window
Roller Shutters



Controlling Motors

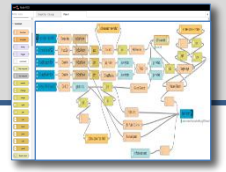




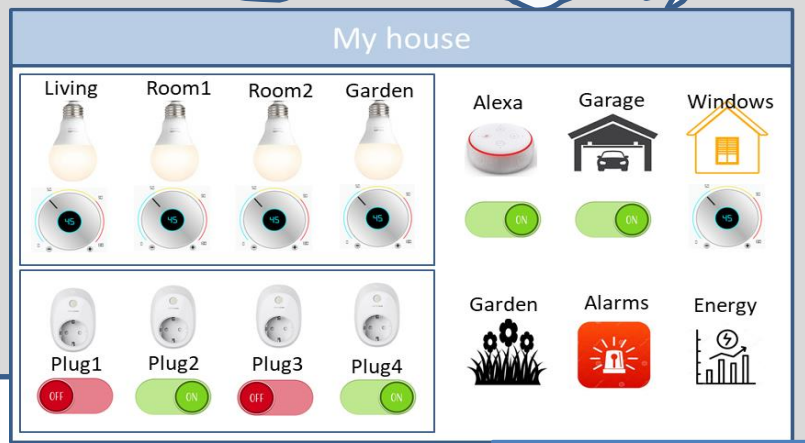
Alarm sound
and light

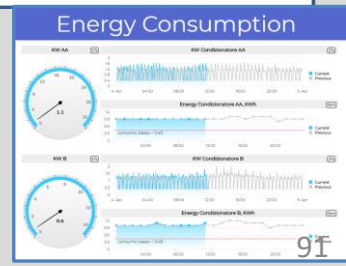
Controlling
Irrigators











Environmental Contextual data from the city
Historical Data, Remote Control, Mobile App

https://www.snap4city.org/620

IOT Edge Device

Other Local Connections

IOT Brokers

IOT Brokers

HTTPS

HTTPS

WiFi

Modbus

OPC UA

IOT Edge:
Node-RED + Snap4City

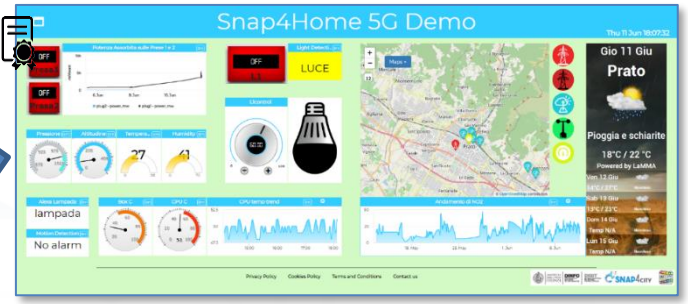
edge-tunnel-to-cloud

Search and Query, Smart City API
Facet, semantic search

Knowledge base
Semantic reasoners

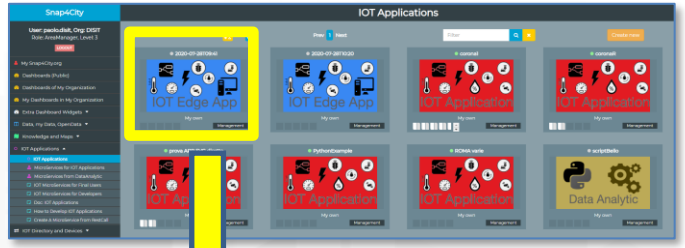
Indexing and aggregating
Elastic search

SNAP4CITY



WSs

Firewall
Gateway
Towards internet

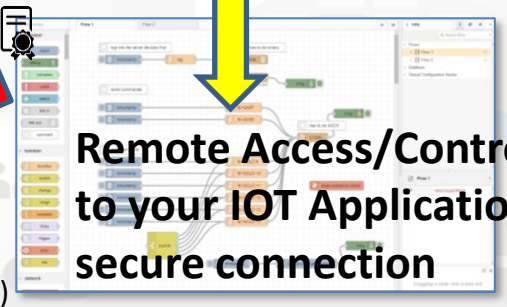


HTTPS



IOT Devices

Access to IoT Edge Maintenance



Remote Access/Control/program to your IOT Applications via secure connection

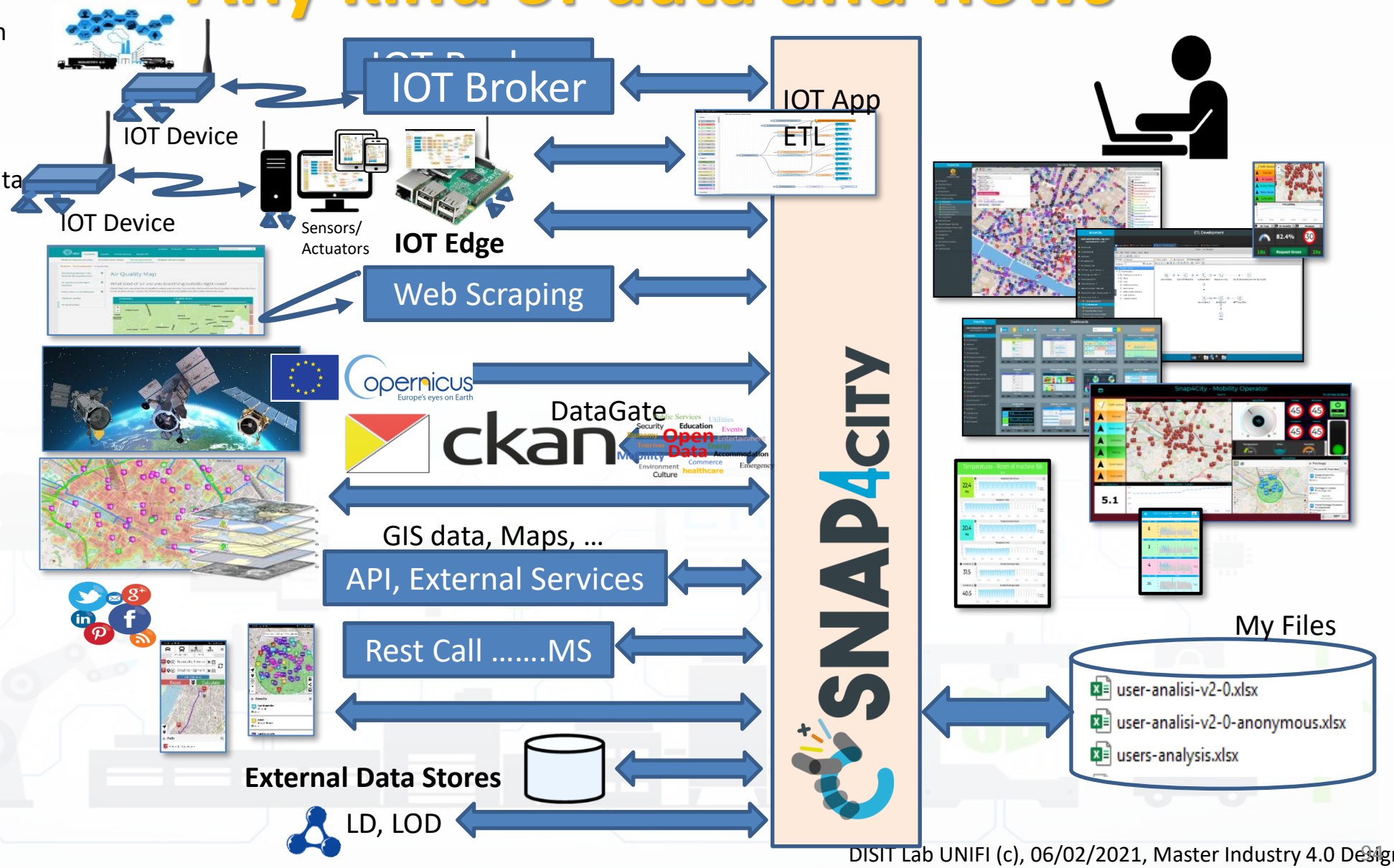
Data Ingestion/ Transformation Tools



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Any kind of data and flows

- **Open Data:**
  - Data gate, federation of Open Data Portals
  - IOT App, ETL proc(PULL)
- **IOT Networks:**
  - IOT Application processes, data driven or PULL
  - IOT Brokers (Push) → IOT Shadow
- **Web Pages:**
  - Web scraping, crawling processes
- **Satellite data**
- **Social media: Twitter, Facebook,..**
  - Twitter Vigilance, IOT App
- **Mobile Apps**
  - Smart City API
- **Files upload: CSV, Excel, etc.**
  - IOT Applications, ETL
- **REST API, WS, FTP, LD, LOD, etc.**
  - IOT Applications, ETL
- **Data base accesses**
  - GIS: WFS, WMS
  - ETL, IOT Application



To Start we are going to use Direct Dashboards

Dashboards accessing data available on Platform, including your own data coming from Mobile App, already registered!!!



My IOT/IOE Devices

IOT and data World

Dashboards Applications

IOT App vs ETL

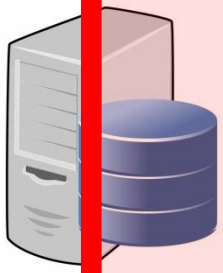
IOT Applications

- Created on browser
- A huge number of Protocols https://www.snap4city.org/65
- Scheduled internally and managed as Container
- Less diffused approach
- Large number of Snap4City MicroServices, well documented
- PUSH and PULL models
- Simple mechanism to add new Features
- Very diffused in IOT
- Static and Dynamic data models depending on IOT Broker capabilities

ETL processes

- Created with Spoon editor on VM (on premise or via remote access to VM)
- A Large number of protocols https://www.snap4city.org/65
- Scheduled by DISCES in the back office
- Well known data warehouse model
- Well documented for the process
- Only PUSH models
- Complex mechanism to add a new functionality
- Very diffused in Data transformation
- Static and Dynamic data models well linked ..

Snap4Industry as a Lambda Architecture



Data Sources PULL Data

Data Ingestion, aggregation, regularization, reconcile

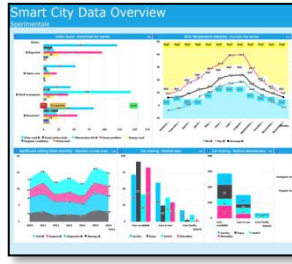
Big Data Cluster HDFS, Hbase, Phoenix

Knowledge base Semantic reasoners

Indexing and aggregating Elastic search

Search and Query, Smart API Facet, semantic search

Rendering Acting, Widgets, MicroApps User interface, Interactive Dashboard, Drill down, maps, heatmaps







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ETL, NIFI, DISCES

Data Analytics R, Tensor Flow, Python, MapReduce, …

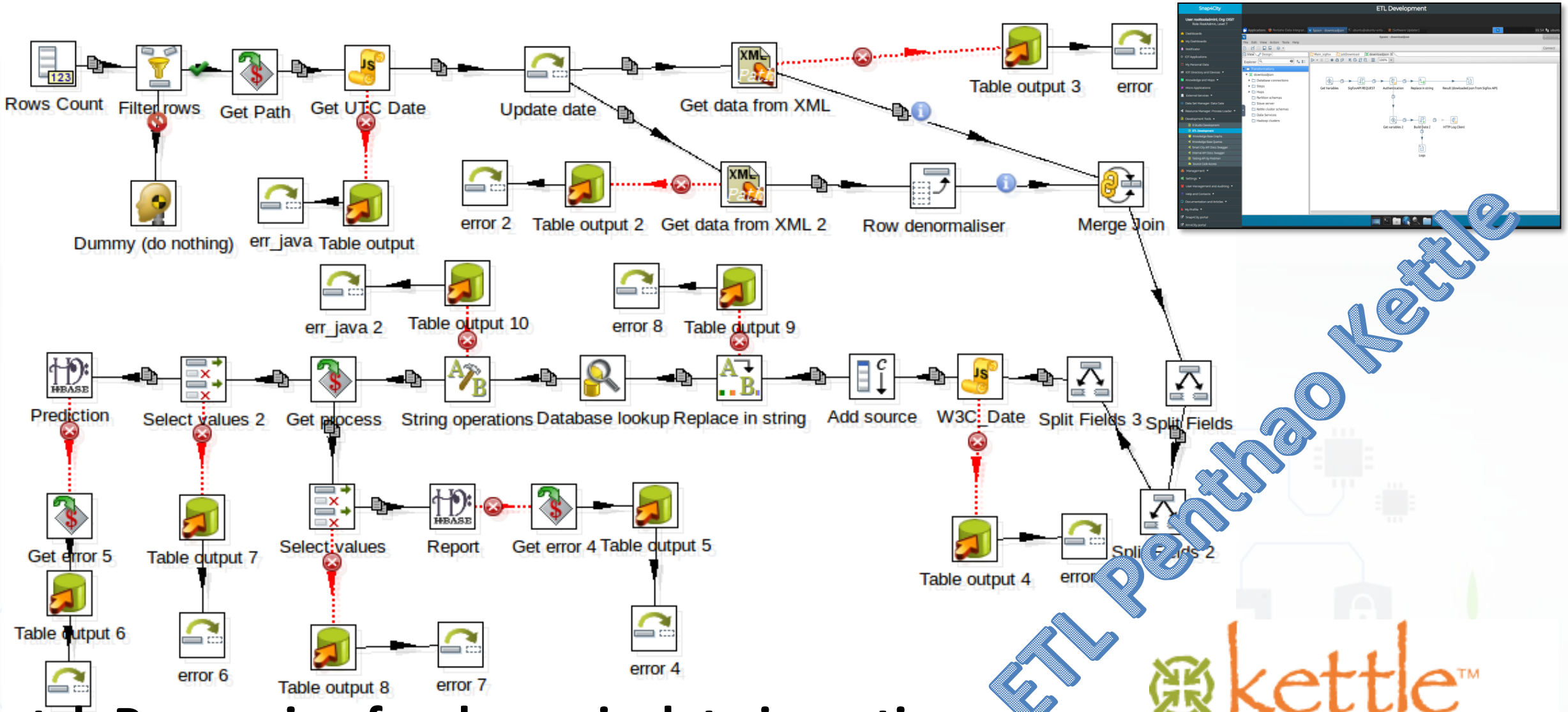
IOT Applications Node-RED + Snap4City MicroSrvs

Visual Analytics Special dash/ tools



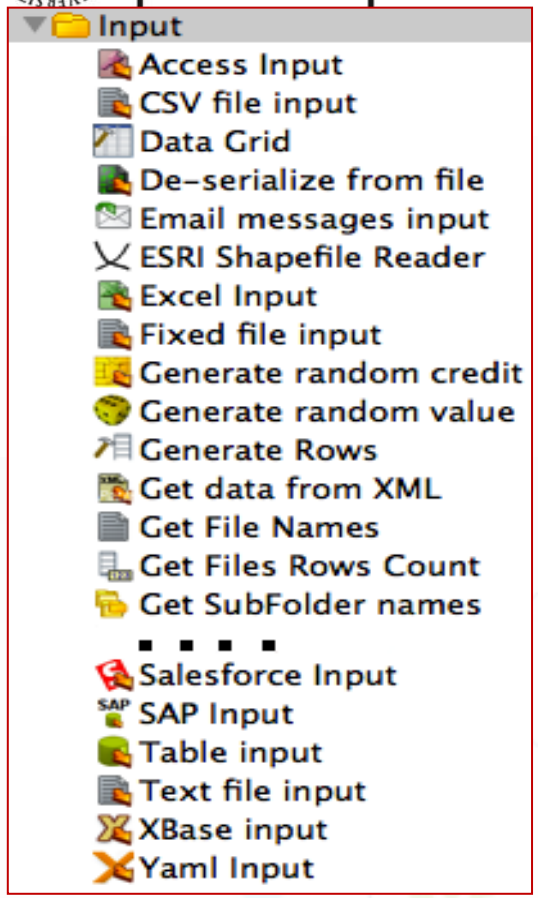
Inform, announce, Act!, warning, alarms, What-IF, ..

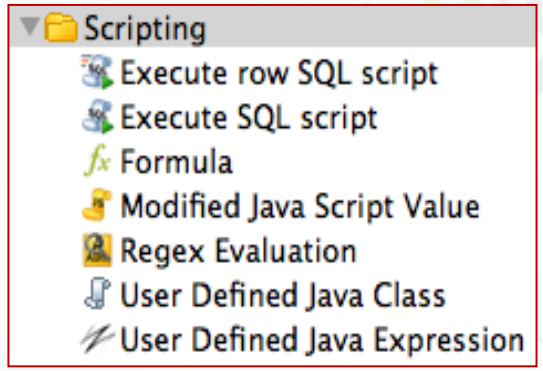
Integrated ETL development

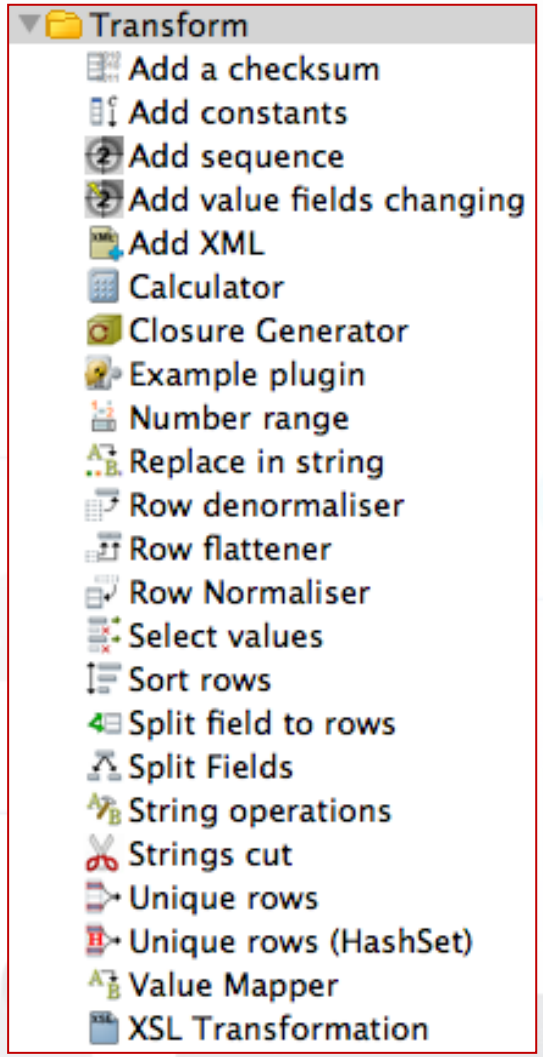


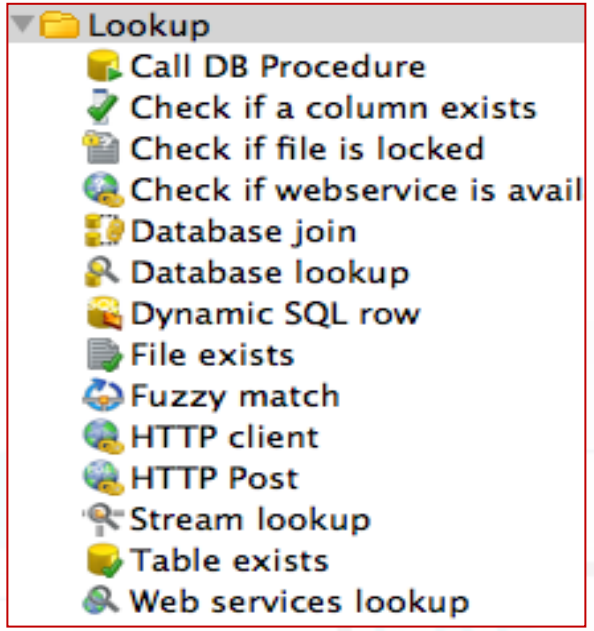
Batch Processing for dynamic data ingestion

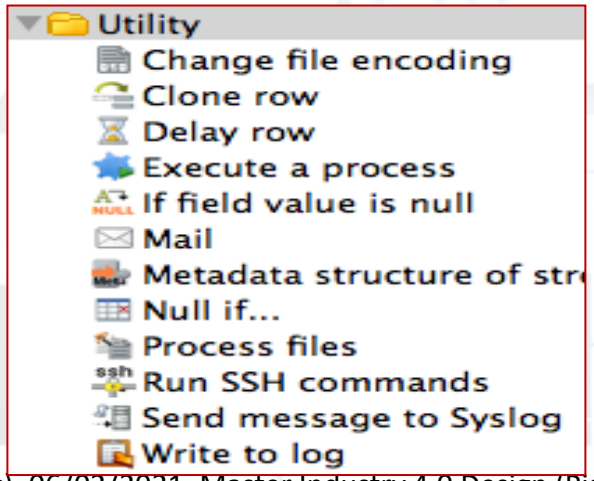
Type of Transformations in Spoon

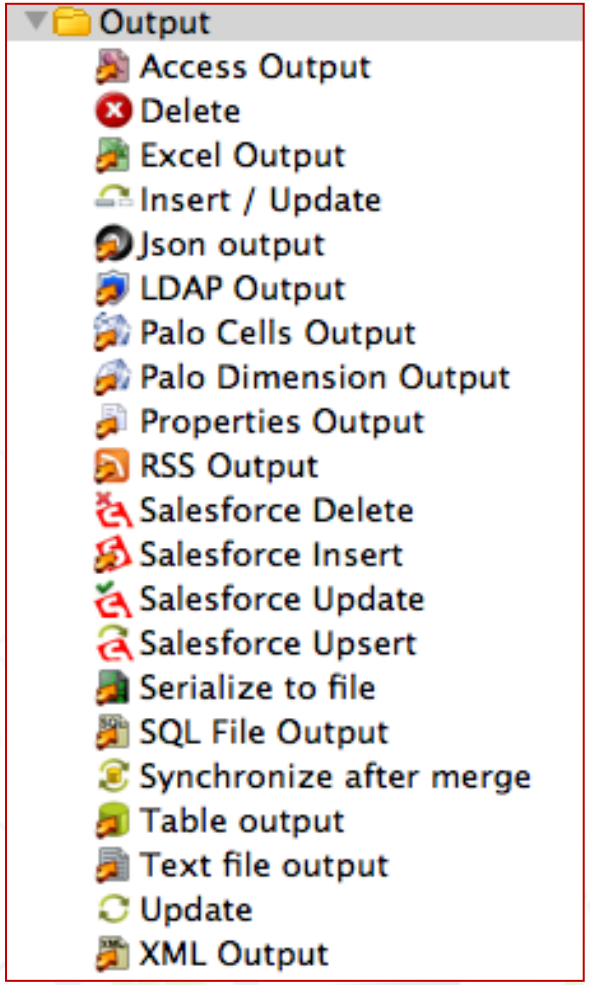












Snap4Industry as a Lambda Architecture



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Data Ingestion, aggregation, regularization, reconcile

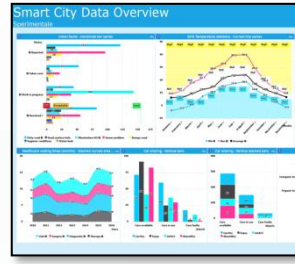
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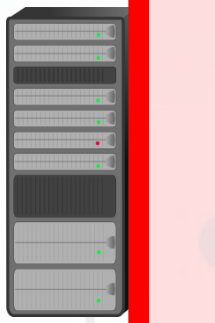
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ETL, NIFI, DISCES

Data Analytics R, Tensor Flow, Python, MapReduce, …

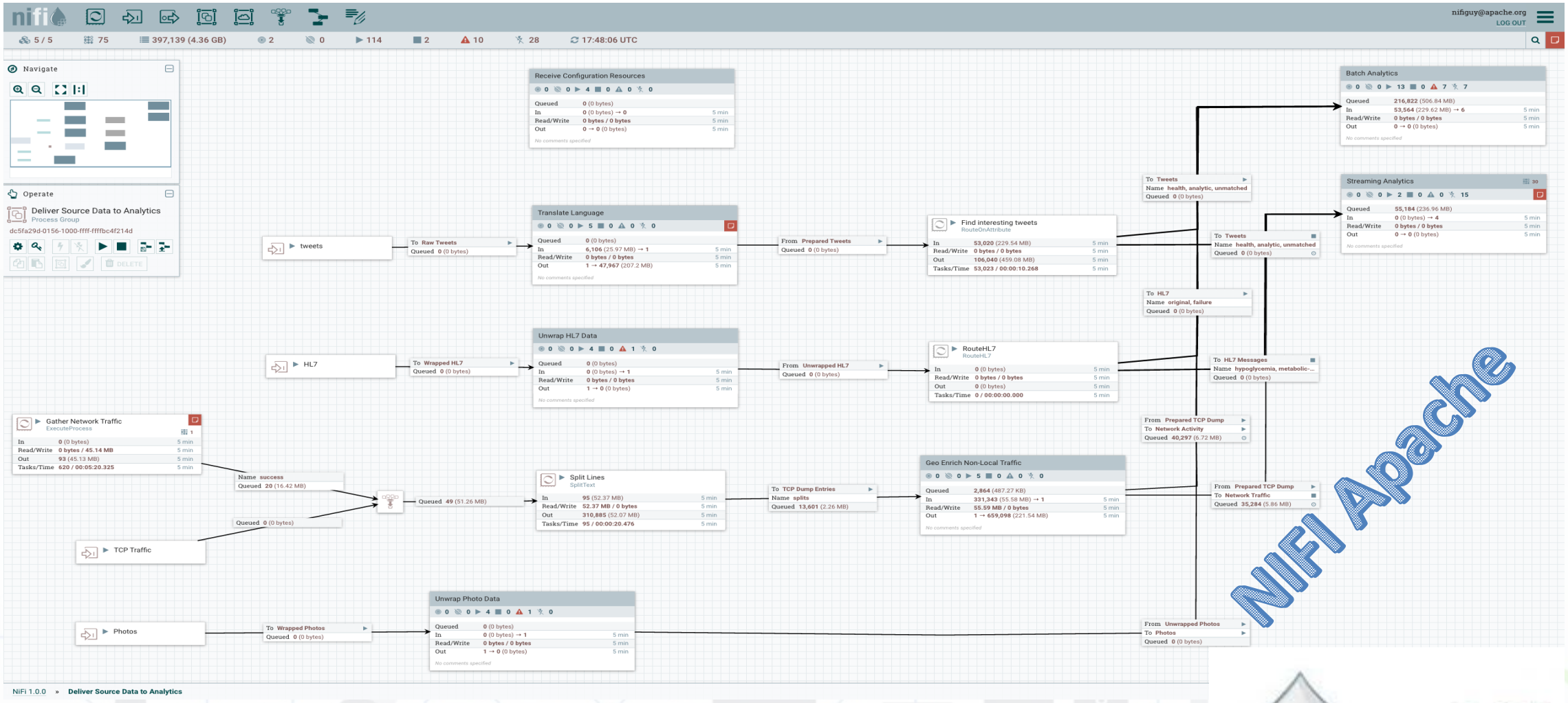
IOT Applications Node-RED + Snap4City MicroSrvs

Visual Analytics Special dash/ tools



Inform, announce, Act!, warning, alarms, What-IF, ..

Example of NIFI

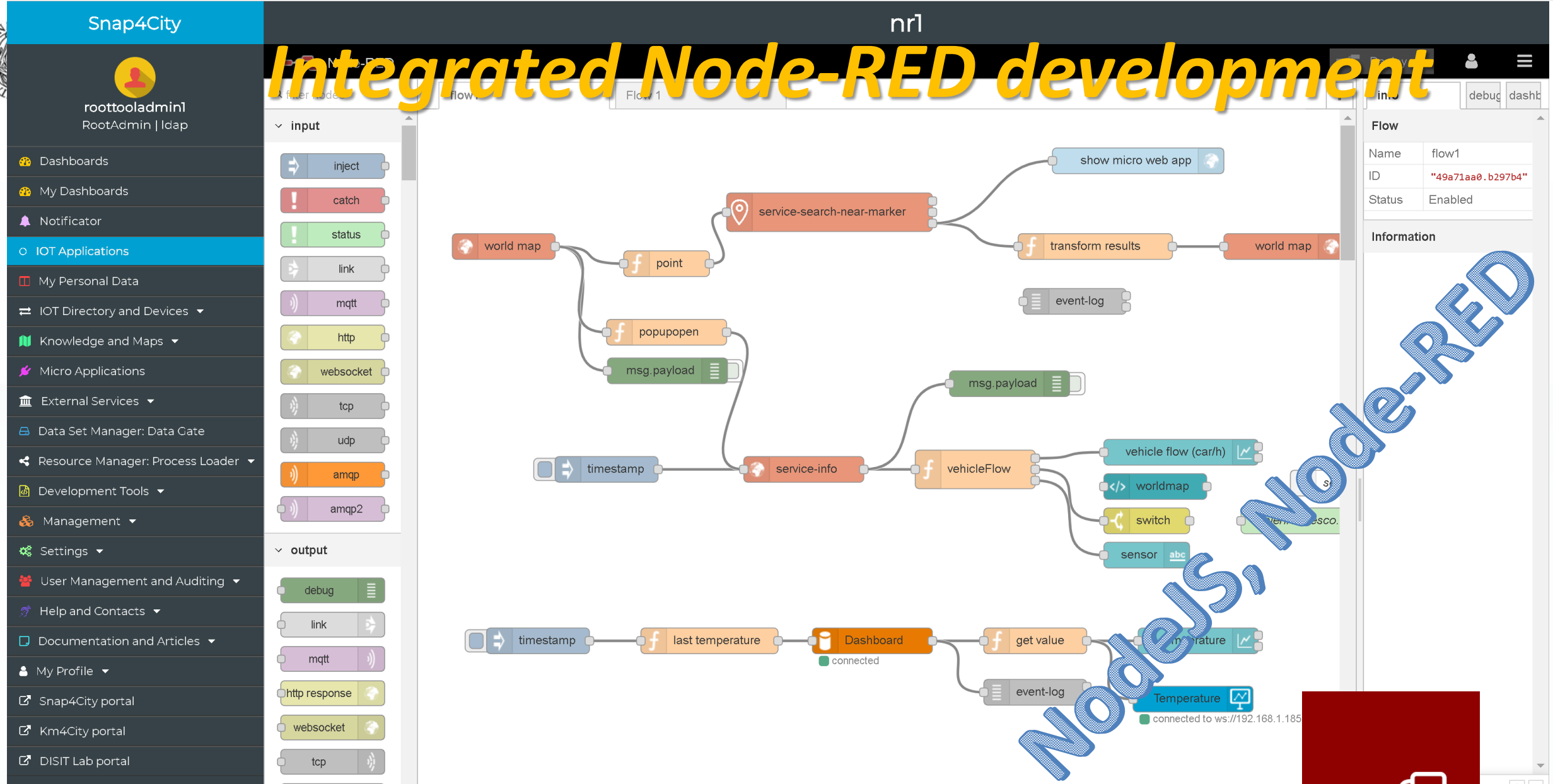


NIFI Apache

nifi

Batch and Data Driven Processing

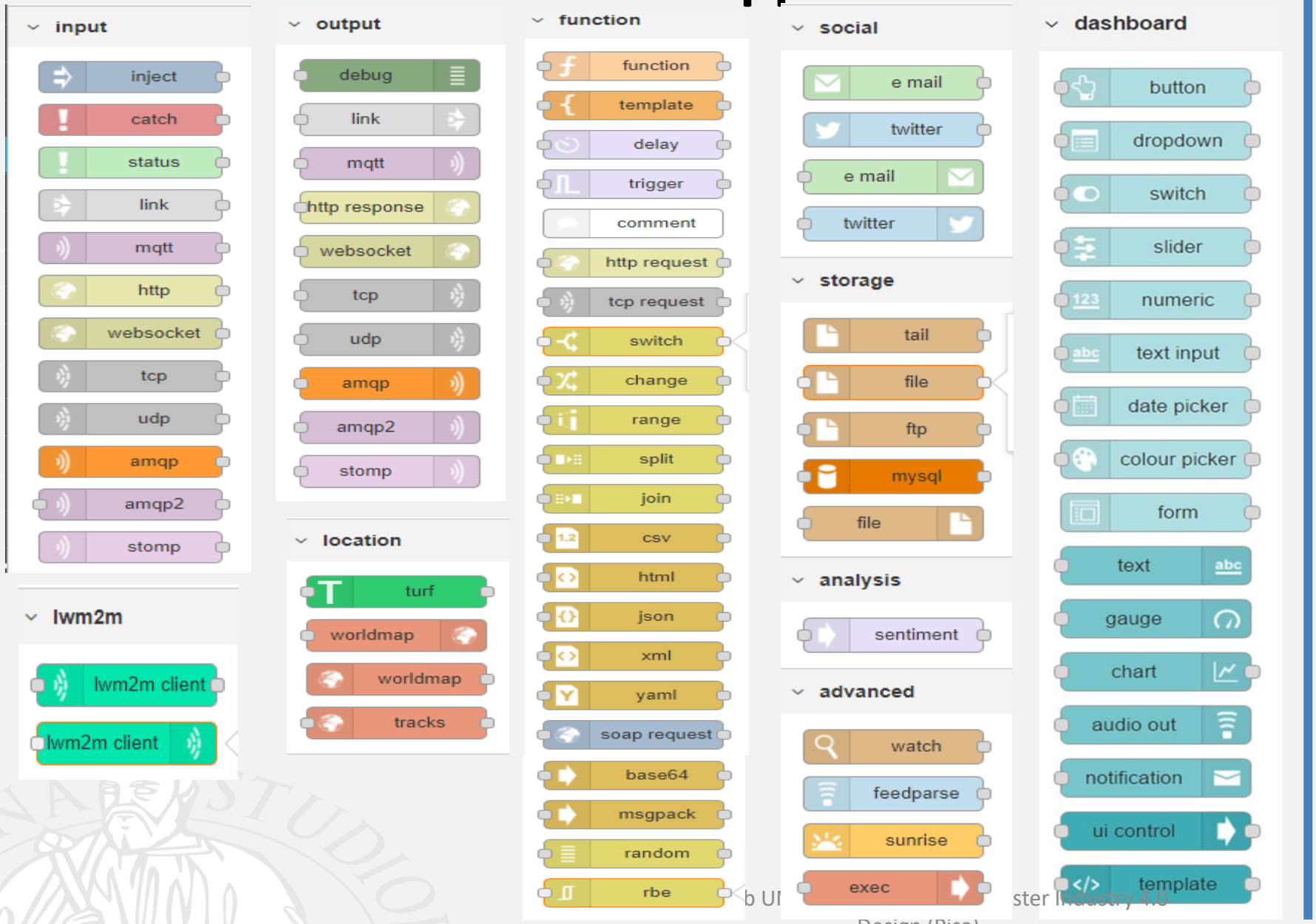
Integrated Node-RED development



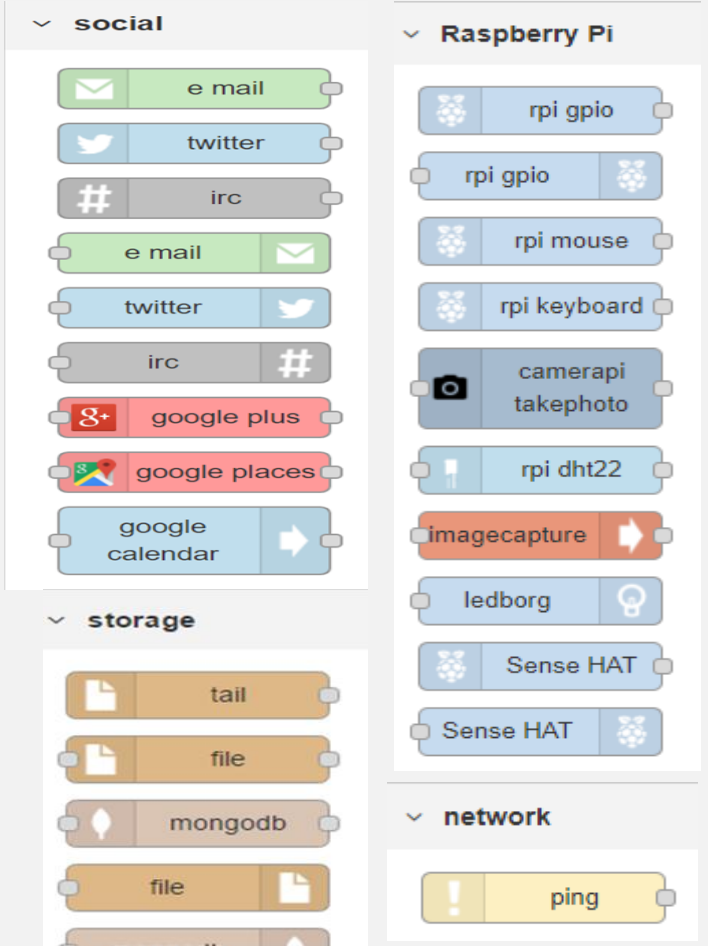
Event Driven, real time data ingestion

Basic Node.js Blocks on NodeRed on our Advanced IOT Apps



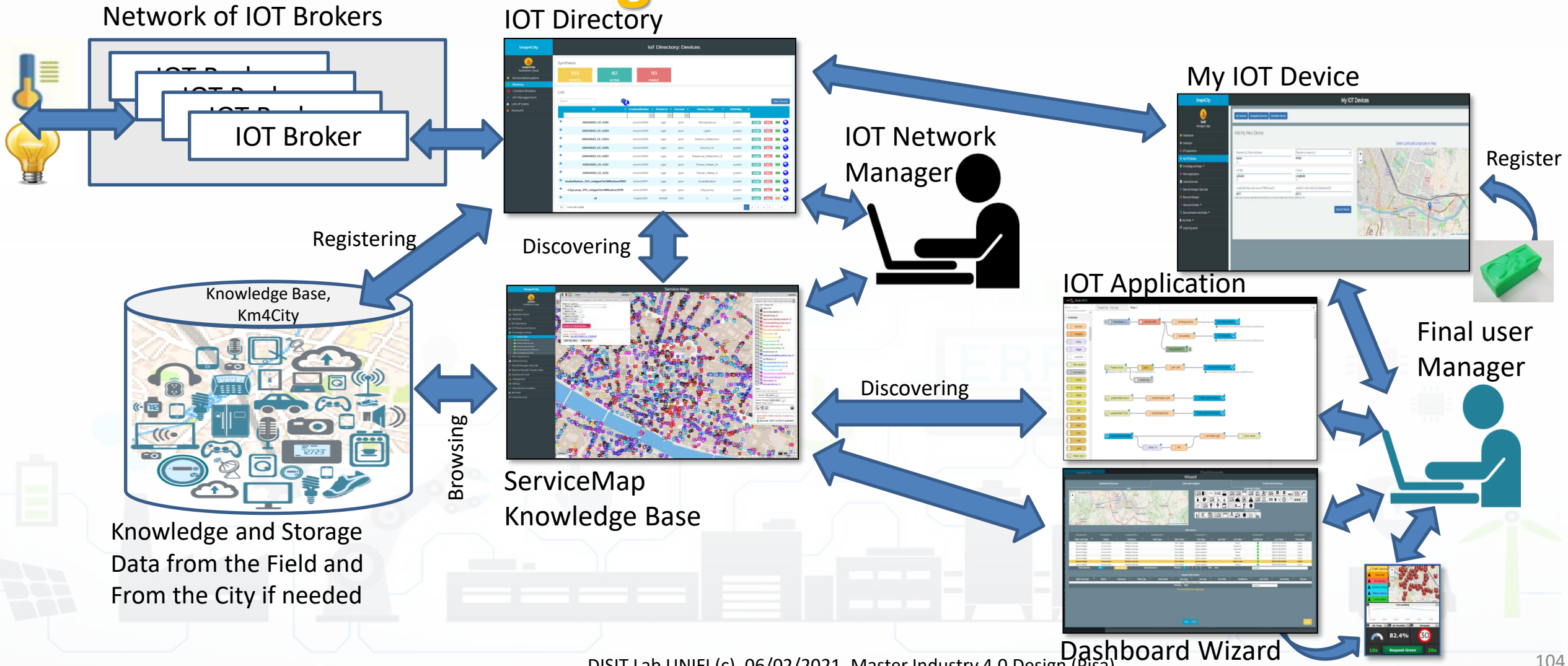


+ on IOT Edge Raspberry



IOT Directory

IOT Network Manager vs Final User



Protocols/formats

- Snap4City supports a large range of protocols for communicating with servers, services, IOT devices, legacy systems, GIS, etc., and format
- See also
  - Supported Protocols
  - High Levels IOT Protocols
  - TC9.2 - Managing heterogeneous File Ingestion, protocols, formats via IOT applications, and open standards
  - US9. Creating Snap4City IOT Applications, different formats, protocols, brokers, communications
  - TC2.14 - IOT Applications using multiple protocols, and formats for files Creating IOT Applications coping with heterogeneous data

Unified Semantic Data Model



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Snap4Industry as a Lambda Architecture



Data Sources PULL Data



Data Sources, Brokers, External Services Data Driven, Real Time

Data Ingestion aggregation, regularization, reconcile

ETL, NIFI, DISCES

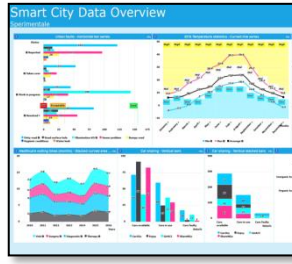
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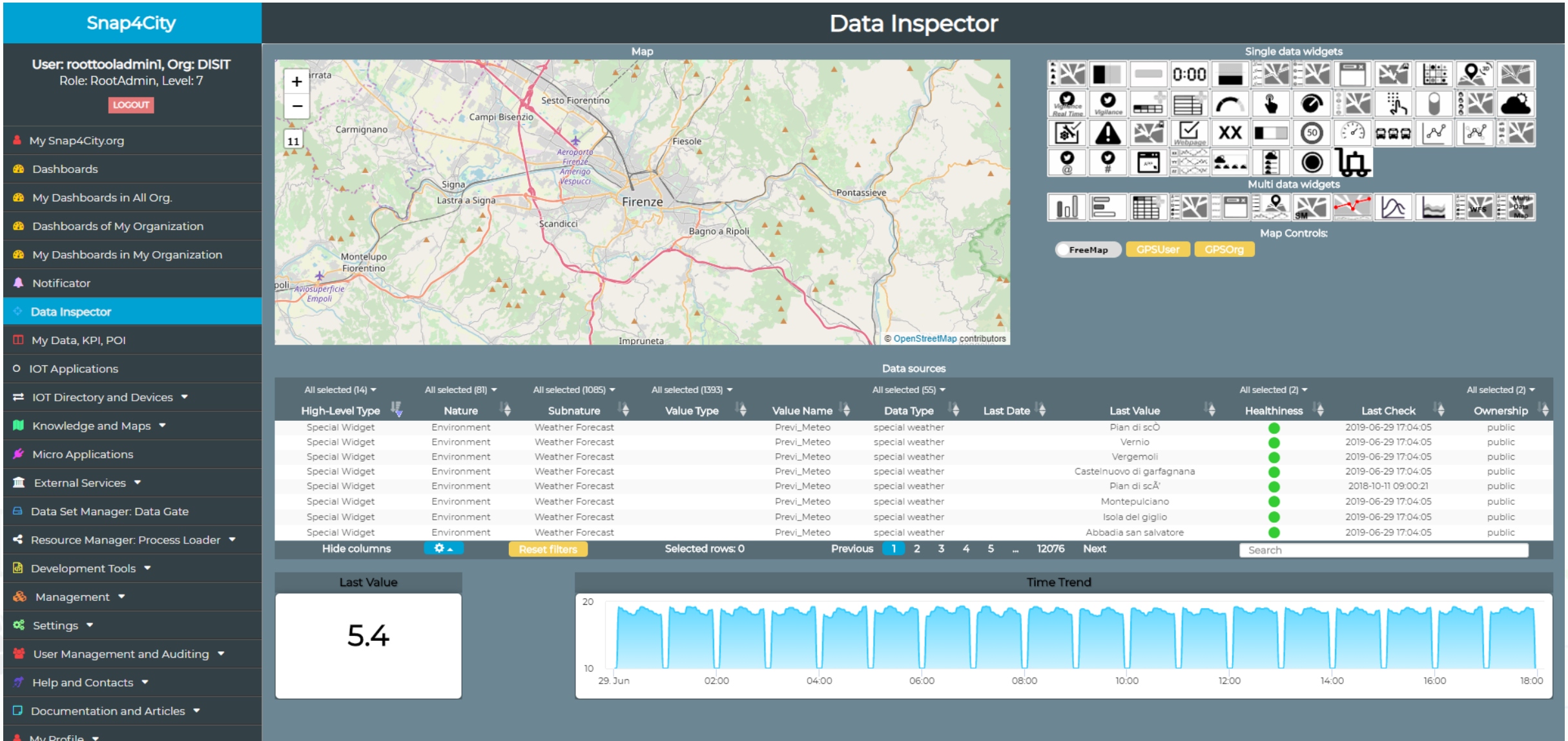
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IOT Applications Node-RED + Snap4City MicroSrvs



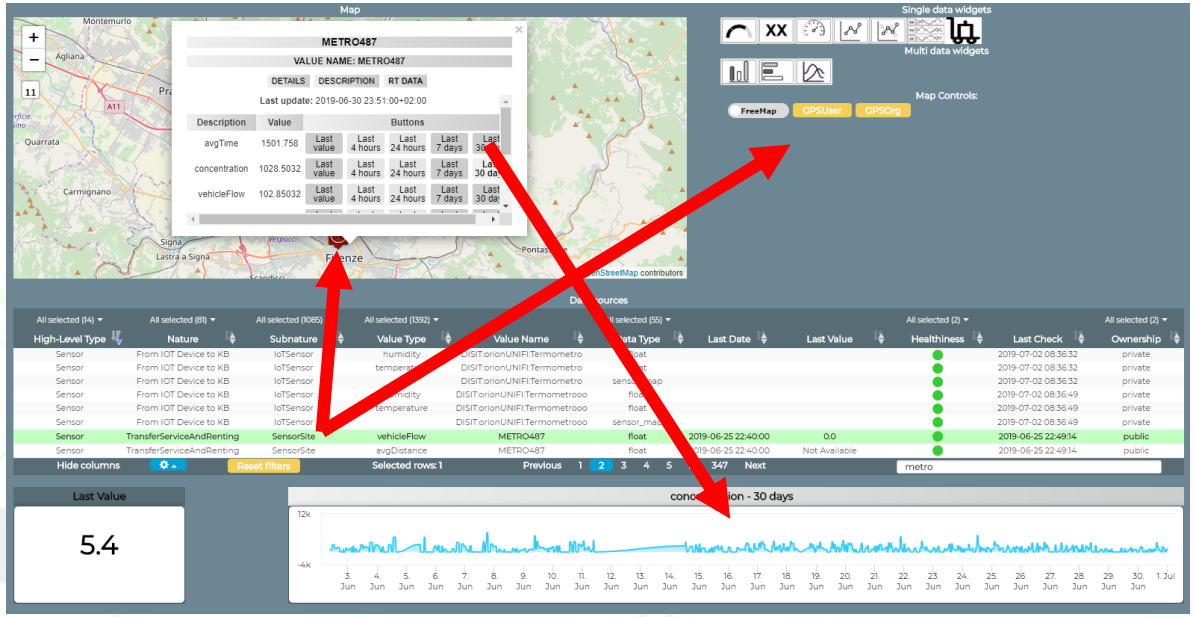
Inform, announce, Act!, warning, alarms, What-IF, ..

Data Inspector

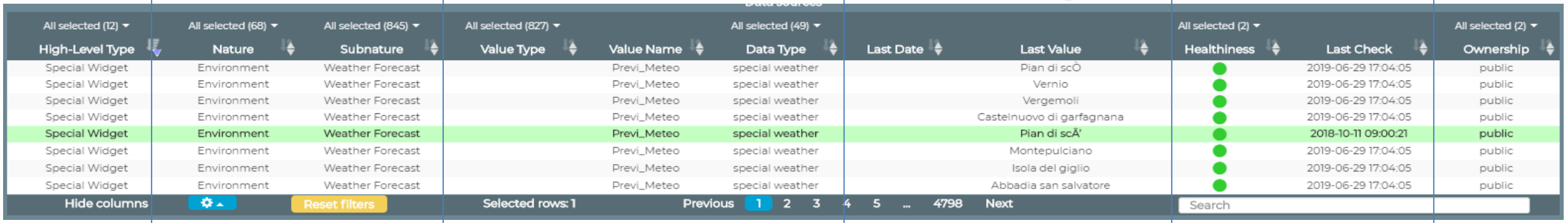


Data Inspector (open on your left side menu)

- **Cross Filtering on the basis of**:
  - MAP: pan and zoom → lock , center on GPS coordinates of the user
  - Data Source Classification:
    - faceted filtering
    - full text search
  - Click on data source to see it on map, and see the graphics representation, just to learn how widgeting it.
- **Selecting a Data Source on Map**: on its Pin you can see:
  - Real time data
  - Time trend: 4 hours, 12 hours, 1 day, 1 week, 30 days.
  - Full status and description (only for Administrators)



Unified Data and Services Model/Classification



High-Level Type	Nature	Subnature	Value Type	Value Name	Data Type	Last Date	Last Value	Healthiness	Last Check	Ownership
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Pian di scÒ		2019-06-29 17:04:05	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Vernio		2019-06-29 17:04:05	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Vergemoli		2019-06-29 17:04:05	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Castelnuovo di garfagnana		2019-06-29 17:04:05	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Pian di scÃ'		2018-10-11 09:00:21	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Montepulciano		2019-06-29 17:04:05	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Isola del giglio		2019-06-29 17:04:05	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Abbadia san salvatore		2019-06-29 17:04:05	public

Hide columns | Reset filters | Selected rows: 1 | Previous 1 2 3 4 5 ... 4798 Next | Search

High Level Types

Nature

SubNature

Value Type

Value Name

Data Type

Last Date/Time

Last Value

Healthiness

Last Check

Ownership

Semantic

Technical

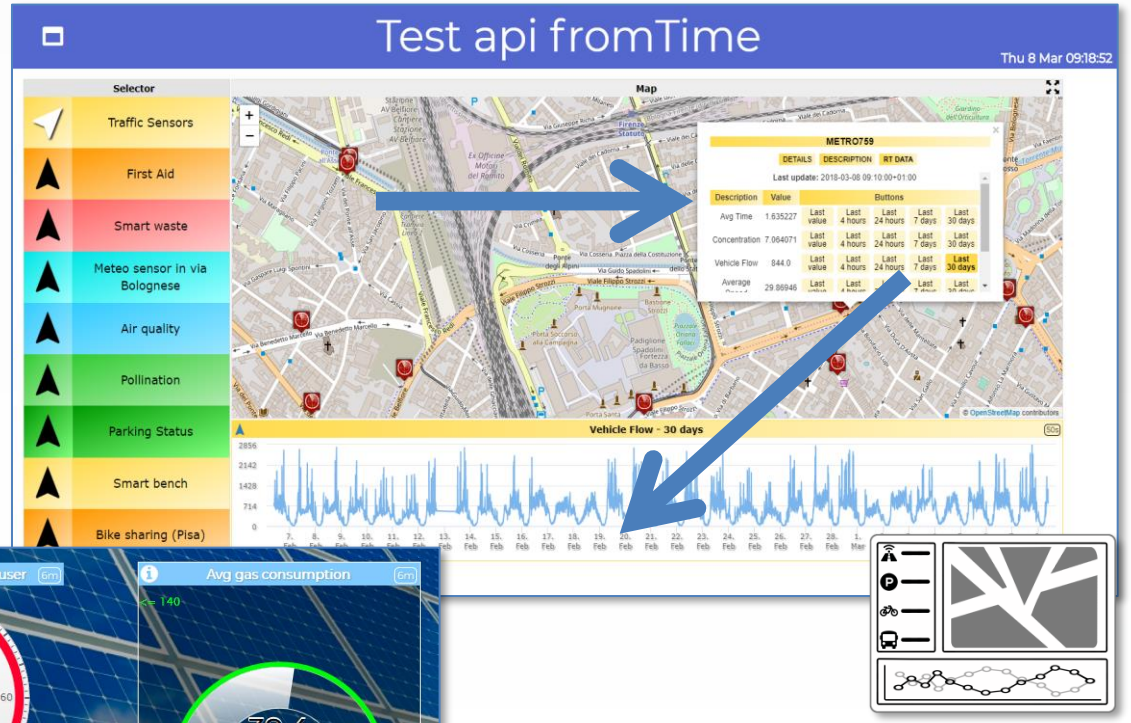
RealTime

Status

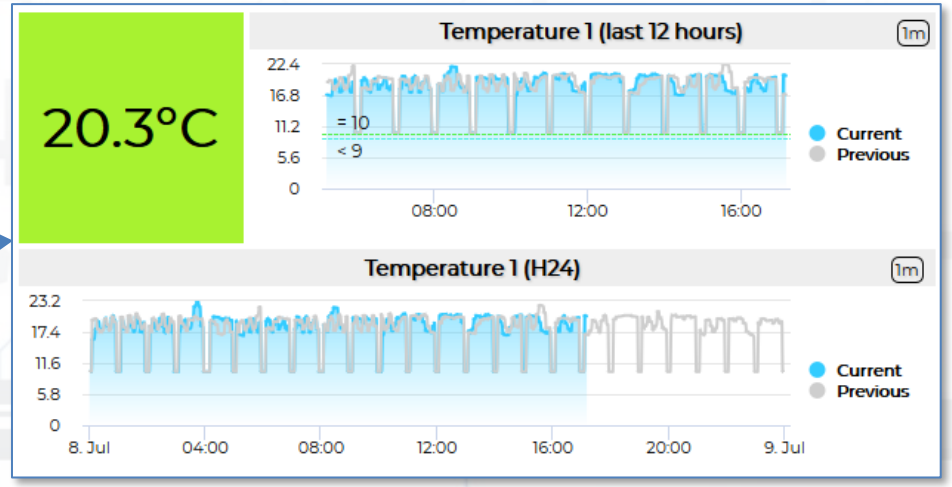
HLT: Sensors

High Level Types

- **Complex Event**
- Dashboard-IOT App
- **External Service**
- **Heatmap**
- **KPI (Key Performance Indicator)**
- **MicroApplication**
- My Personal Data
- MyKPI
- MyPOI
- **POI (Point of Interest)**
- **Sensor**
- **(Sensor Actuator)**
- **Special Widget**
- Wfs (GIS)



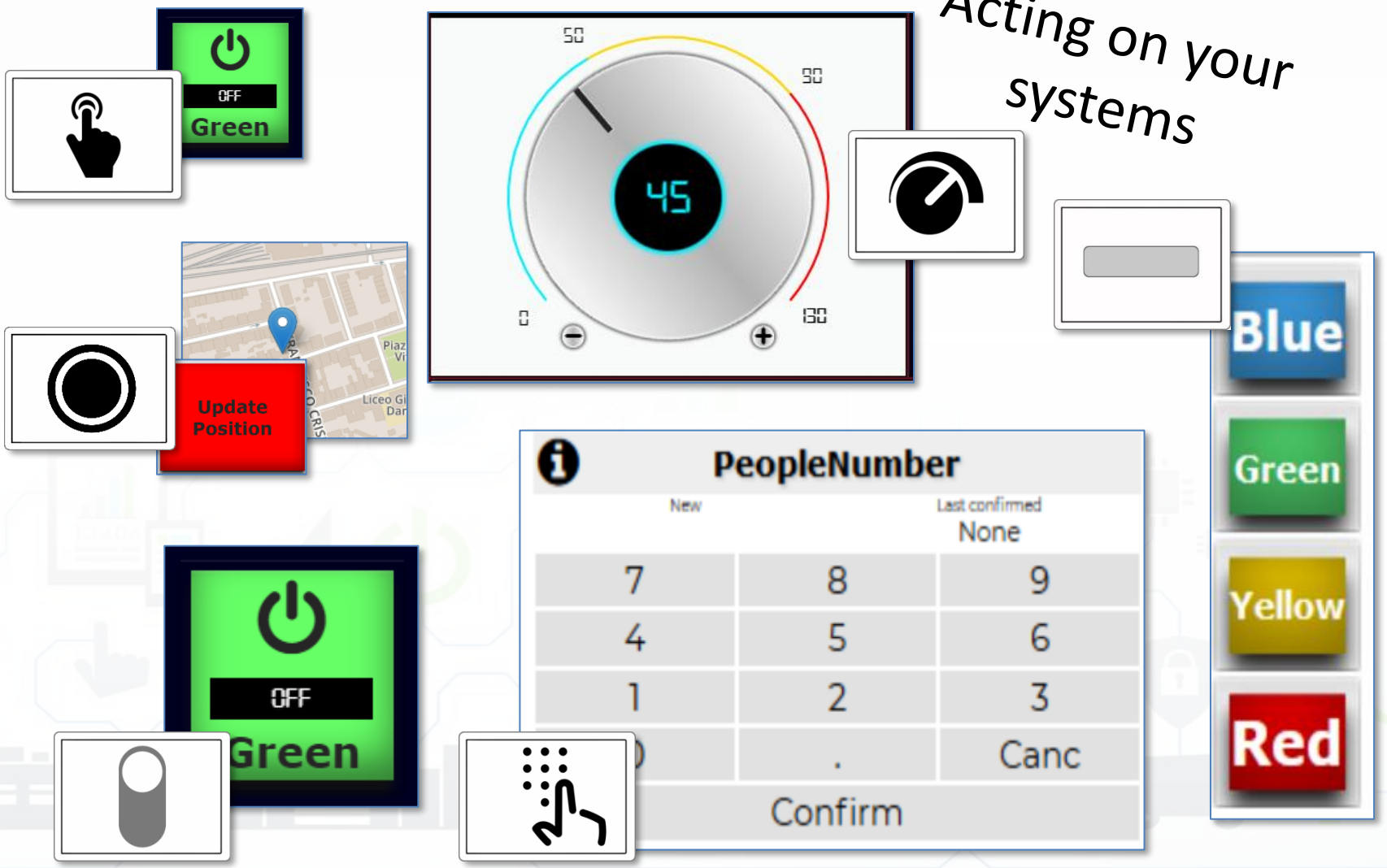




Real Time
Event Driven
Historical Data

From Dashboard to IOT Devices

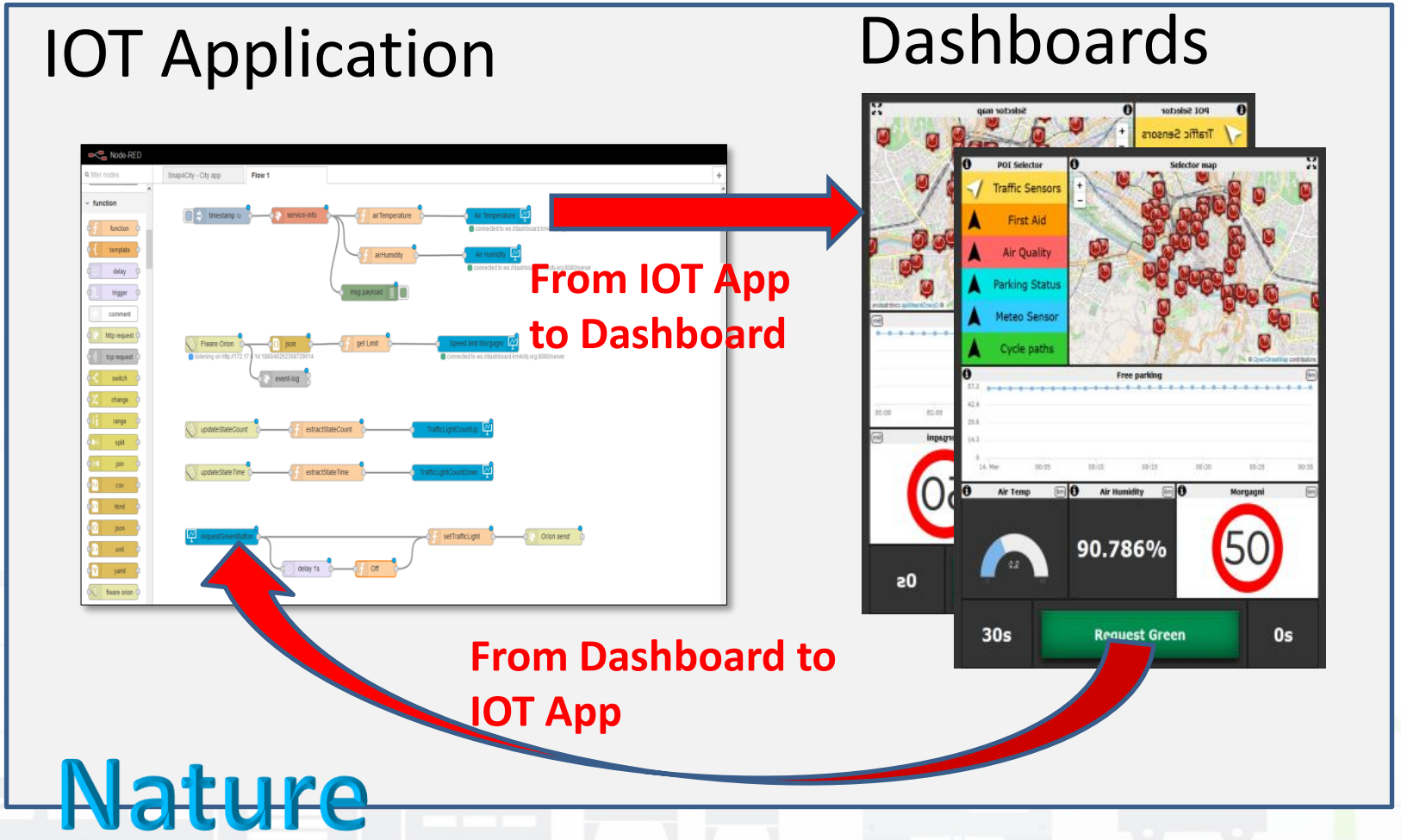
- **Widgets:**
  - Impulse Button
  - Button
  - Switch
  - Dimer/Knowb
  - KeyPad
  - geolocator
- **Registered** on some IOT brokers with NGSI mutual authentication



HLT: Sensors-Actuators

High Level Types

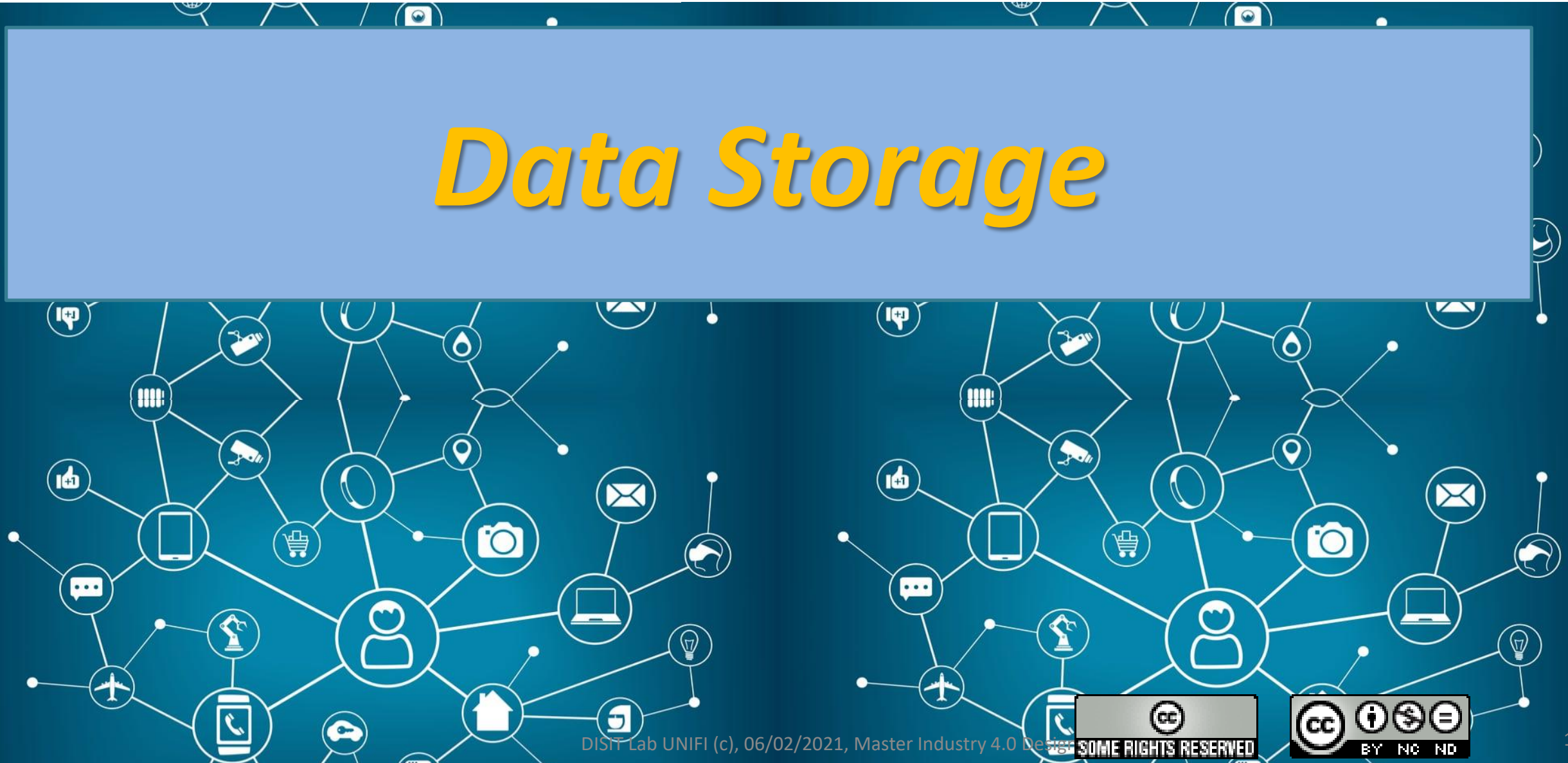
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- MyPOI
- **POI (Point of Interest)**
- **Sensor**
- **Sensor Actuator**
- **Special Widget**
- Wfs (GIS)



Data Gathering and Knowledge Management

- Data ingestion can be performed by using multiple tools:
  - ETL processes, IOT Applications, Data Gate, WebScraping. We suggest:
    - ETL for static / periodic data in PULL
    - IOT App for real time data and flow, from IOT Brokers/Devices
    - DataGate for Static Data, upload them as files, or collected from other CKAN
    - WebScraper for scraping data from Web Pages, when authorized!
- See how to test cases:
  - **HOW TO: add data sources to the Platform**
  - **HOW TO: define privacy rules for personal data, produced by the end-users own device**
  - **US6. Developing and using processes for data transformation**
  - **TC6.1 - Managing DataSets via DataGate: ingest, search, download, upload, annotate, share**
  - **TC6.3 - Creating ETL processes for automated data ingestion and data transformation**
  - **TC6.5 - Managing Heterogeneous File Ingestion via ETL processes**
  - **TC6.9 - ETL processes for multiprotocol and format data ingestion, see on GITHUB for library**
  - **TC9.2 - Managing heterogeneous File Ingestion, protocols, formats via IOT applications, and open standards**

Data Storage



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Agenda

- Big Data Architecture
- Data Warehouse
- **Data Storage**
  - HDFS, Hbase, Phoenix
  - Knowledge Representation
  - Elastic Search, Kibana
- Data Processing
- Data Analytics
- Visual Analytics
- Dashboards
- Living lab for Collaborative work
- Deploy and Install Snap4 .. Solutions
- Acknowledgment

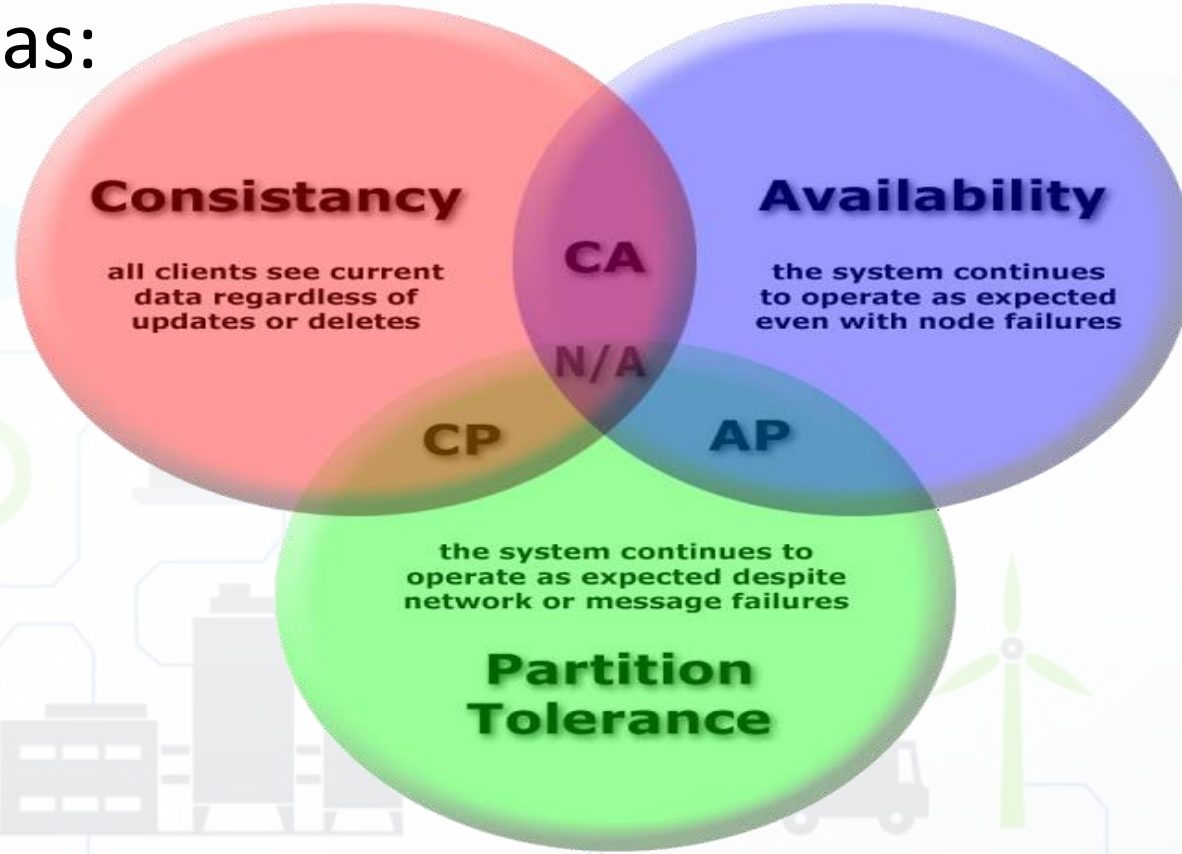
Types of NoSQL Database

- Key-Value DB
- Col- Family/Big Table DB
- Document DB
- XML DB
- Object DB
- Multivalue DB
- ACID NoSQL
- Graph DB

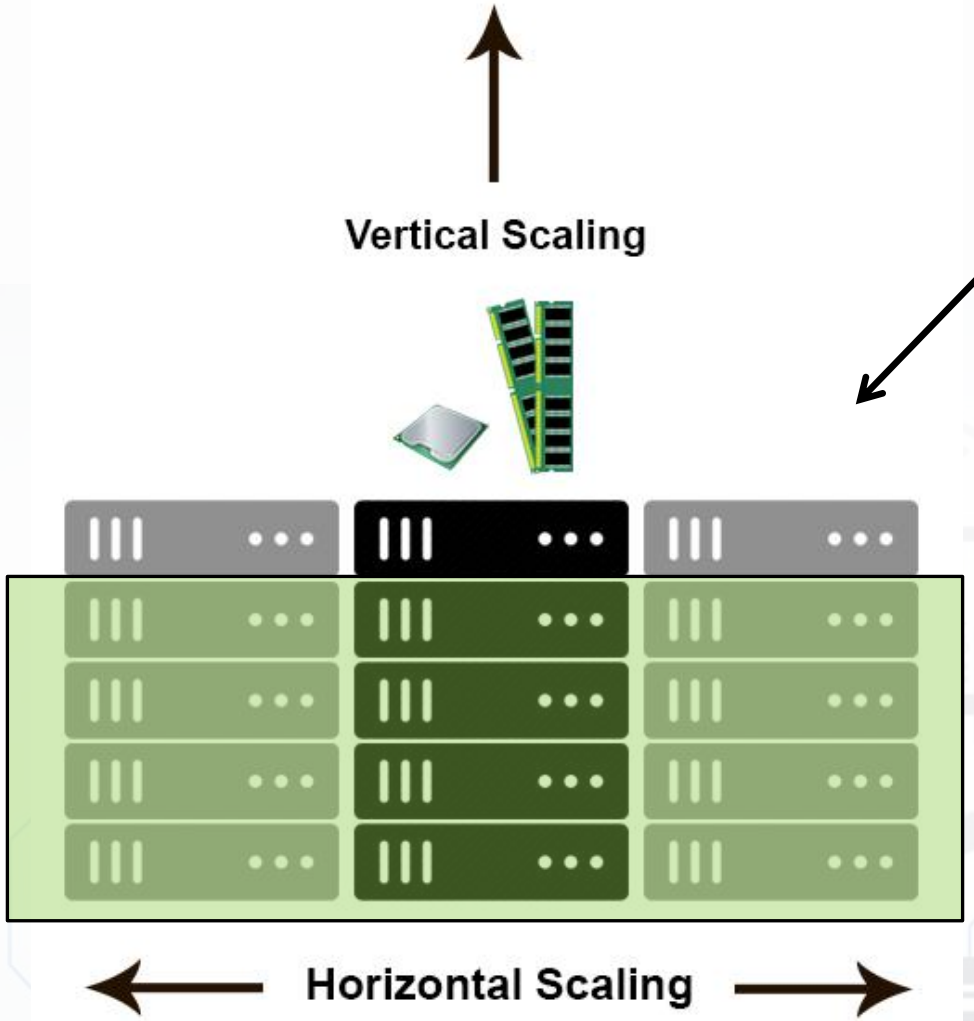


CAP theorem

- The **CAP theorem** (Consistency - Availability - Partition tolerance) is essential to **understand** the **behavior** of **distributed SW systems**, and **how** to **design** the **architecture** in order to meet stringent requirements, such as:
  - High **performance**.
  - Continued **availability**.
  - **Geographically distributed** systems.
- Working on billions and trillions of day, **scalability** became a key concept.



Horizontal vs Vertical Scalability



Single Computer or Resource Pool

- **Vertical Scalability**
  - More memory
  - More clock per second
  - More CPU into the server (cluster)
  - More storage
- **Horizontal Scalability**
  - More Servers into your resource pool/area
  - (More Clusters)

HDFS, Hbase, Phoenix



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Storage vs processing



Data Sources PULL Data



Data Sources, Brokers, External Services Data Driven, Real Time



Data Ingestion aggregation, regularization, reconcile

ETL, NIFI, DISCES

Big Data Cluster
HDFS, Hbase, Phoenix

Knowledge base
Semantic reasoners

Indexing and aggregating
Elastic search

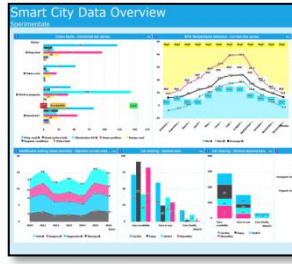
Search and Query, Smart API
Faceted, semantic search

Data Analytics
R, Tensor Flow, Python, MapReduce, …

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Node-RED + Snap4City MicroSrvs

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Special dash/ tools

Rendering Acting, Widgets, MicroApps
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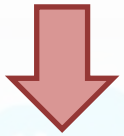




Inform, announce, Act!, warning, alarms, What-IF, ..

Processes vs Data

- Different processes operate on specific portions of data. The single process allocation depends on the position of such data portions to be accessed and processed.



Data locality

- Minimize data flow through the cluster nodes
- Avoid communications among nodes to serve computational nodes
- Hadoop is grounded on moving computation to the data
  And **not** data to computation !!!

Hadoop Scalability

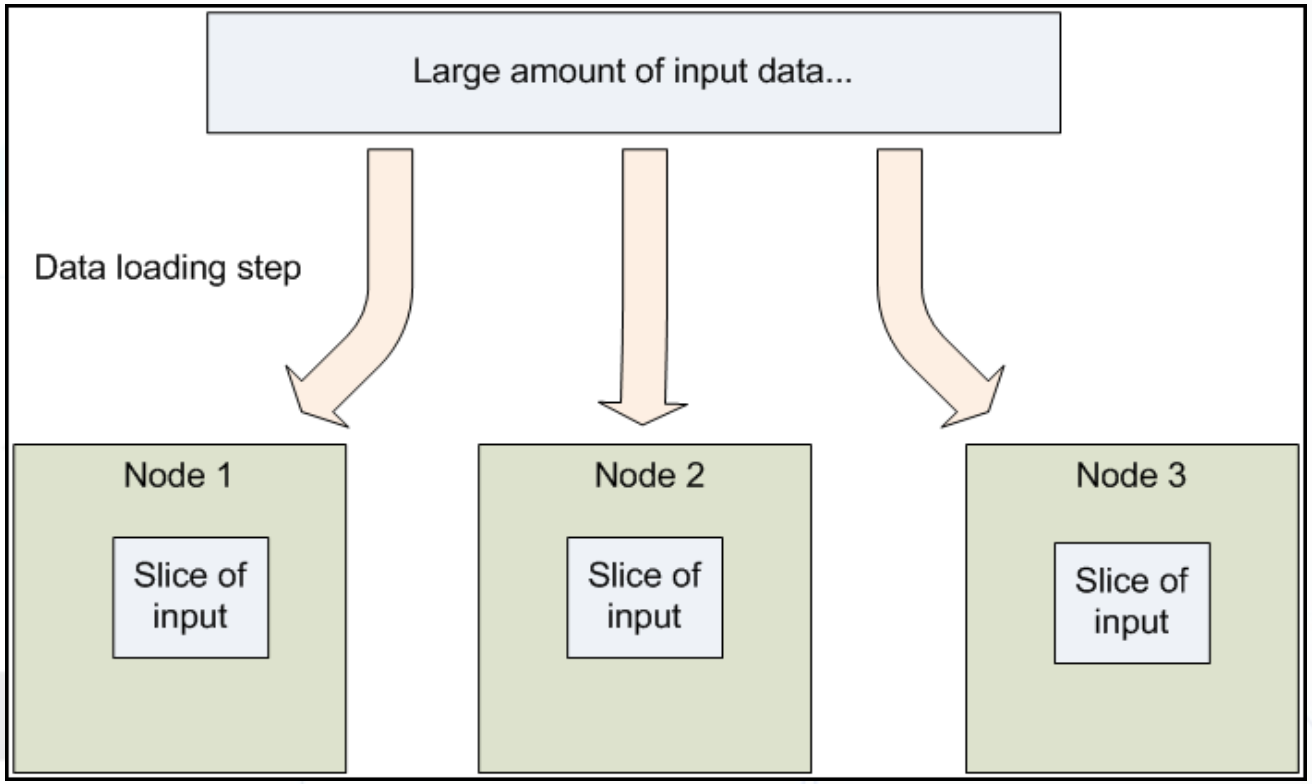
- A significative performance increase may be perceived only with a high number of nodes.
- Parallel computational paradigms, such as MPI (Message Passing Interface) may have better performance on a cluster composed by 2, 4, or up to 10 thousand nodes.
- Hadoop is specifically designed to have a linear scalability curve.
- If a process is running on (for example) 10 nodes, it can work efficiently as well on thousands of nodes without causing network congestion.

Hadoop Architecture

- The distributed Hadoop architecture is a *master-slave* architecture, composed by two main components:
  - **HDFS** Hadoop Distributed File System (HDFS) for data storage.
  - **MapReduce** as a parallel computational paradigm.

Hadoop data distribution

- Is based on the Hadoop Distributed File System (HDFS) that distribute data files on large chunks on the different nodes
- Each chunk is replicated across several nodes, thus supporting the failure of nodes.
  - An active process maintains the replications when failures occurs and when new data are stored.
  - Replicas are not instantly maintained aligned !!!

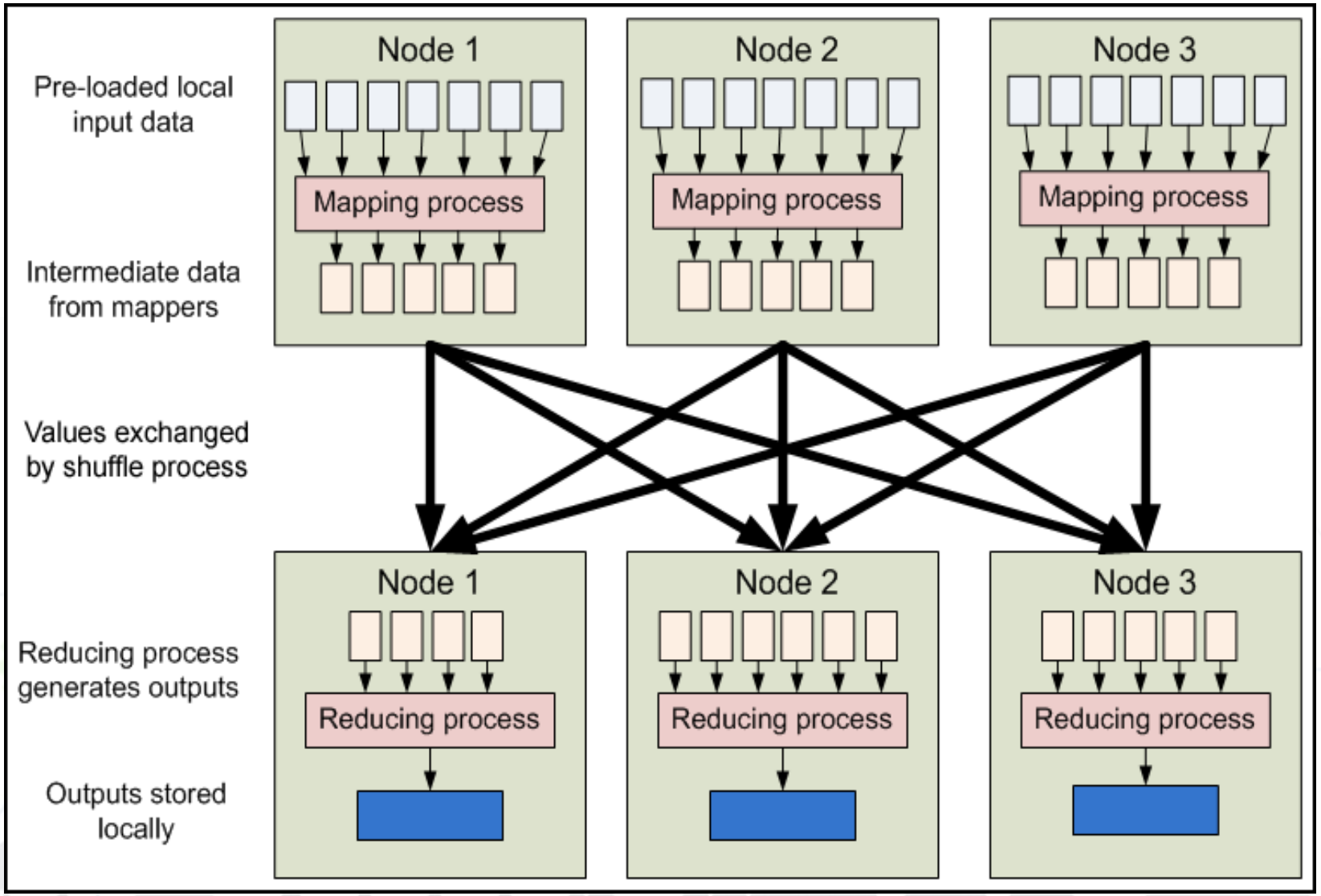


Processes vs Data

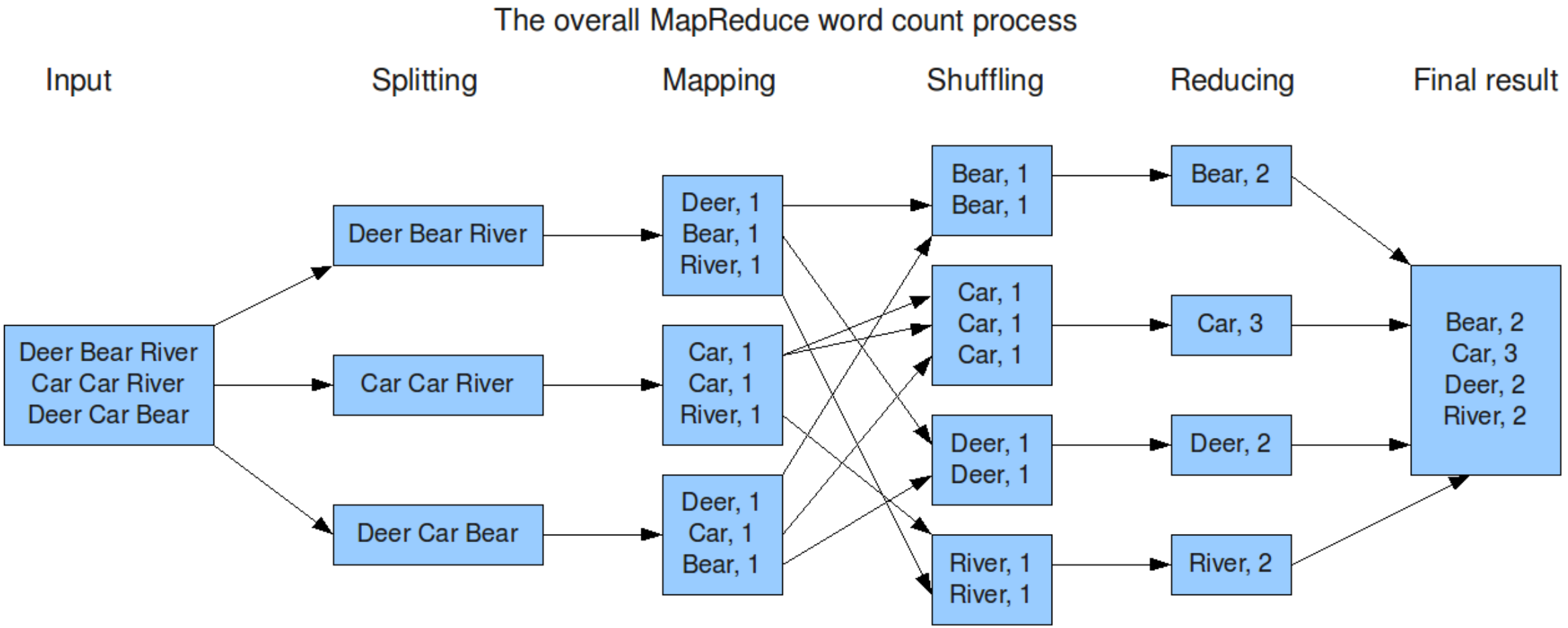
- Processes works on specific chunks of data. The allocations of processes depend on the position of the chunks they need to access,
- That is: data locality.
  - This reduces the data flow among nodes
  - Avoid communications among nodes to serve computational nodes
  - Hadoop is grounded on moving computation to the data !!!
    And **not** data to computation.

MapReduce: Isolated Processes

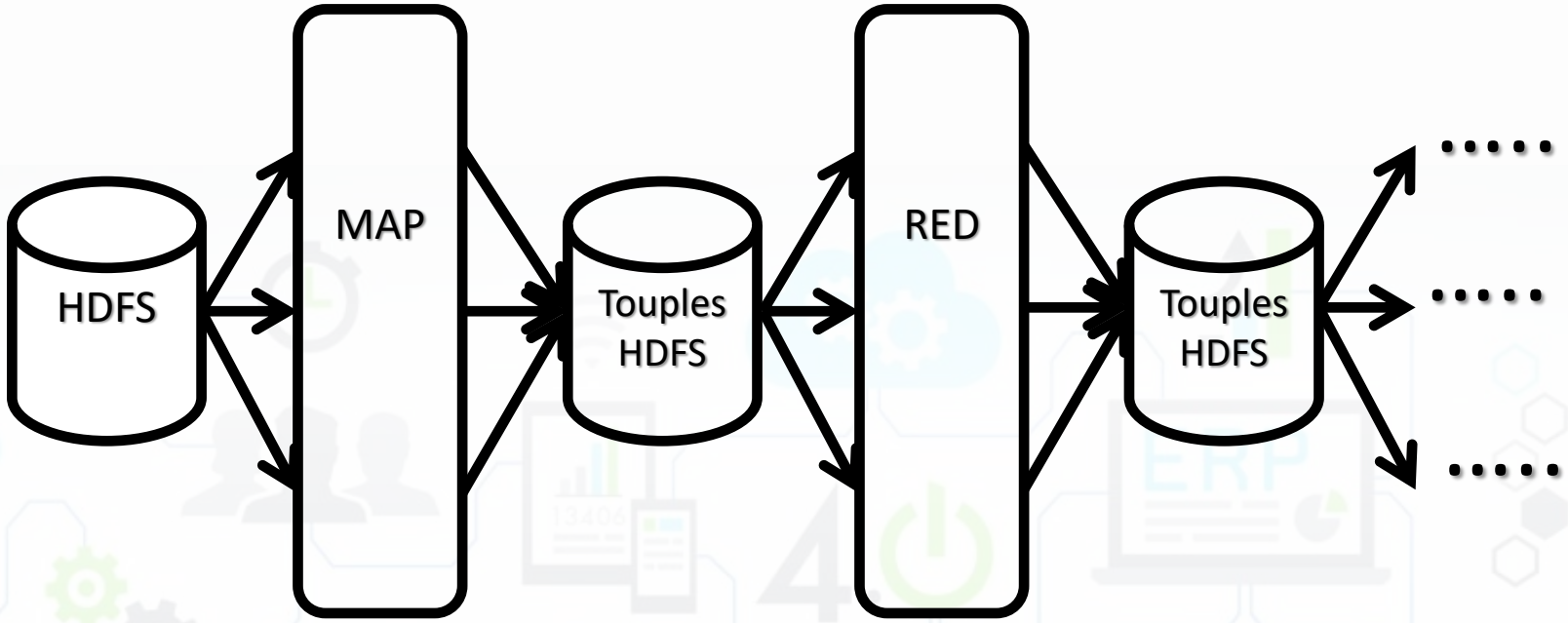
- The main idea:
  - Each individual record is processed by a task in isolation from one another.
    Replications allow to reduce communications for: contour conditions, data overlap, etc.
- This approach does not allow any program to be executed.
- Algorithms have to be converted into parallel implementations to be executed on cluster of nodes.
- This programming model is called MapReduce model


Pre-loaded local input data
Intermediate data from mappers
Values exchanged by shuffle process
Reducing process generates outputs
Outputs stored locally
Node 1
Node 2
Node 3
Mapping process
Mapping process
Mapping process
Node 1
Node 2
Node 3
Reducing process
Reducing process
Reducing process

MapReduce: Word count

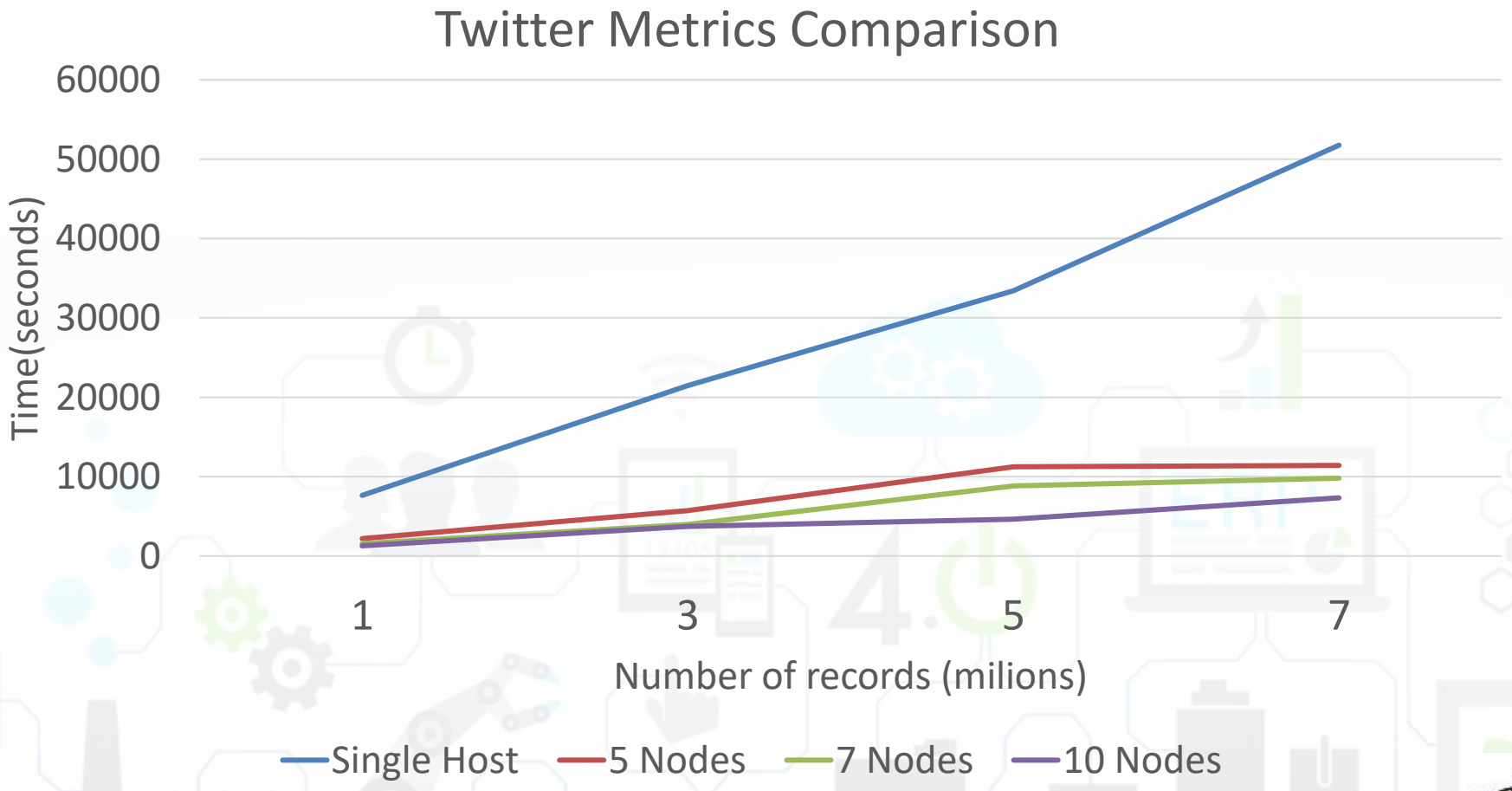


Classic MapReduce

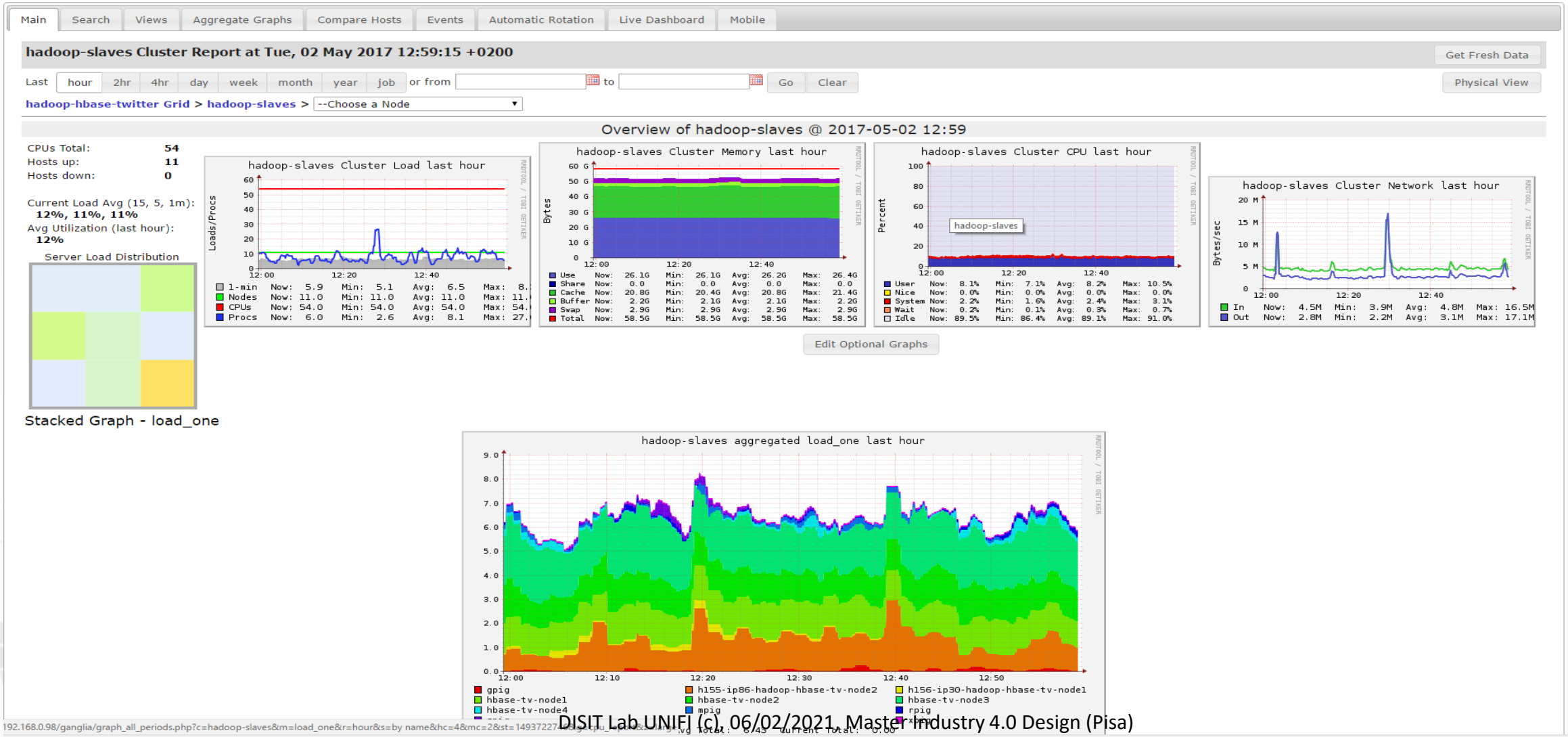


- In processes with several iterations the R/W cost may be too high even if performed in parallel

Single Host vs Hadoop



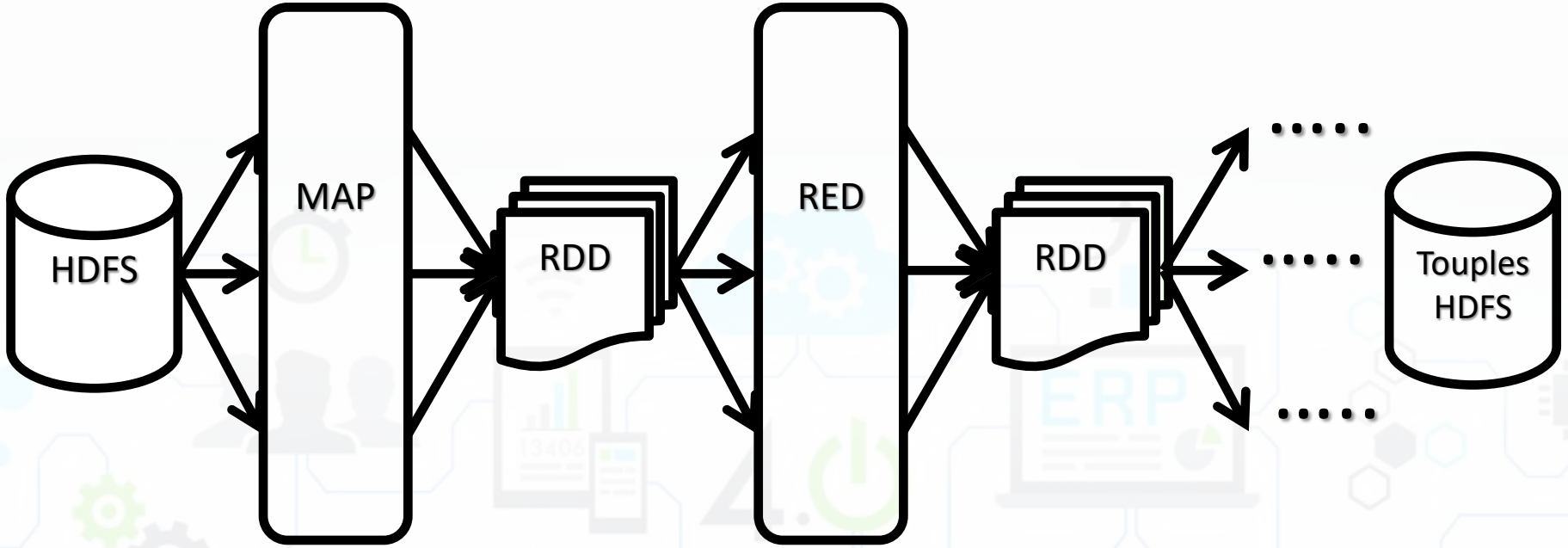
Ganglia: Monitoring MapReduce



Host level detail



Iterations with Spark



- In processes with several iterations the R/W is going to performed in memory and only finally on HDFS

HBASE on top of HDFS



- HBase is a NoSQL (schema-less), column-oriented database.
- It is open source, sparse, consistently distributed, sorted map modeled after Google's BigTable.
- Developed as part of Apache's Hadoop project and runs on top of Hadoop Distributed File System.
- Horizontaly, linearly scalable

Knowledge Representation



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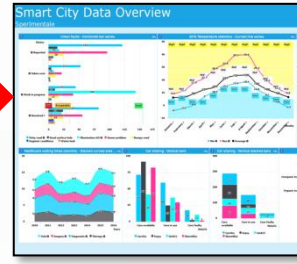
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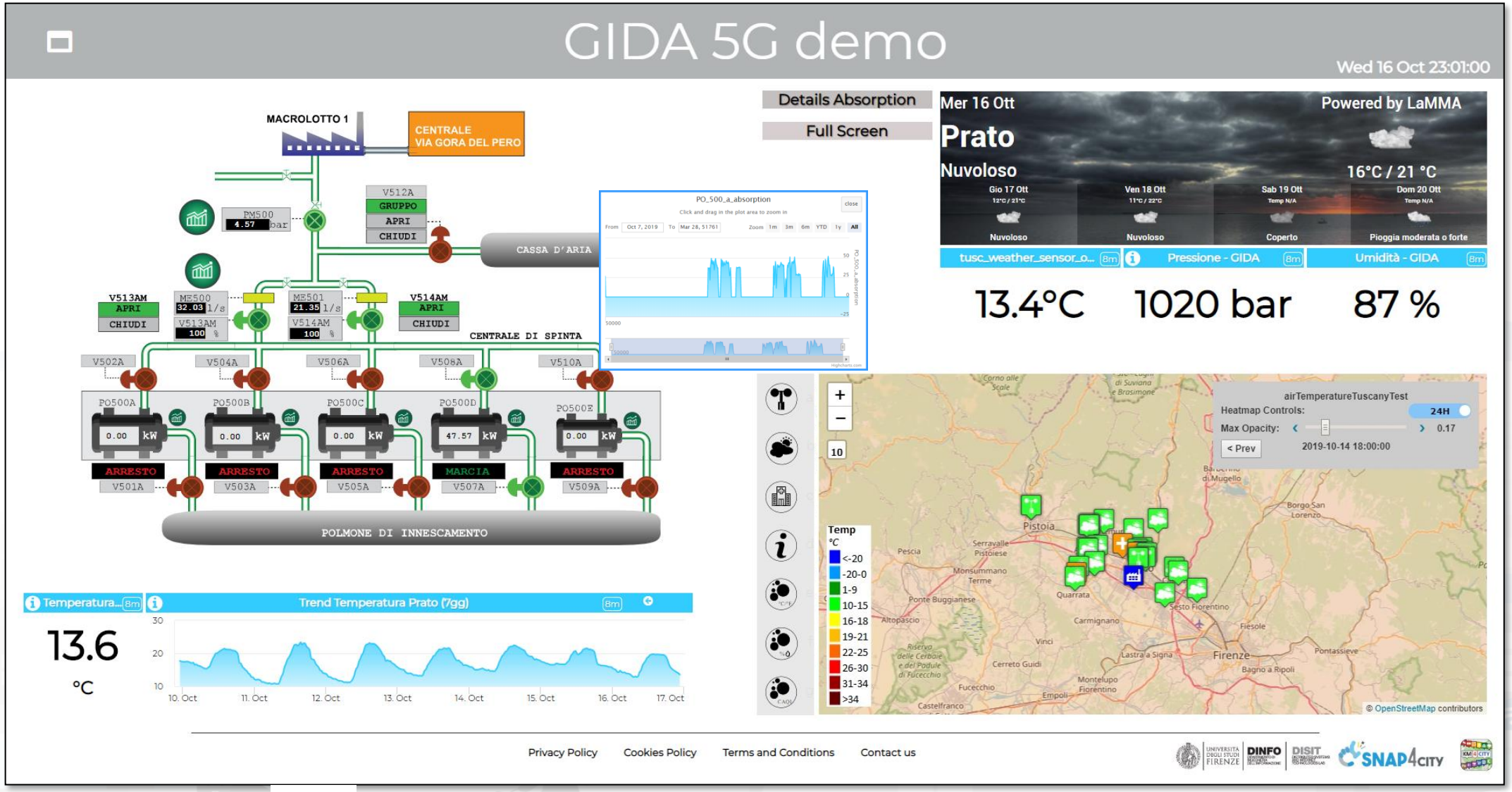
Rendering Acting, Widgets, MicroApps
User interface, Interactive Dashboard, Drill down, maps, heatmaps





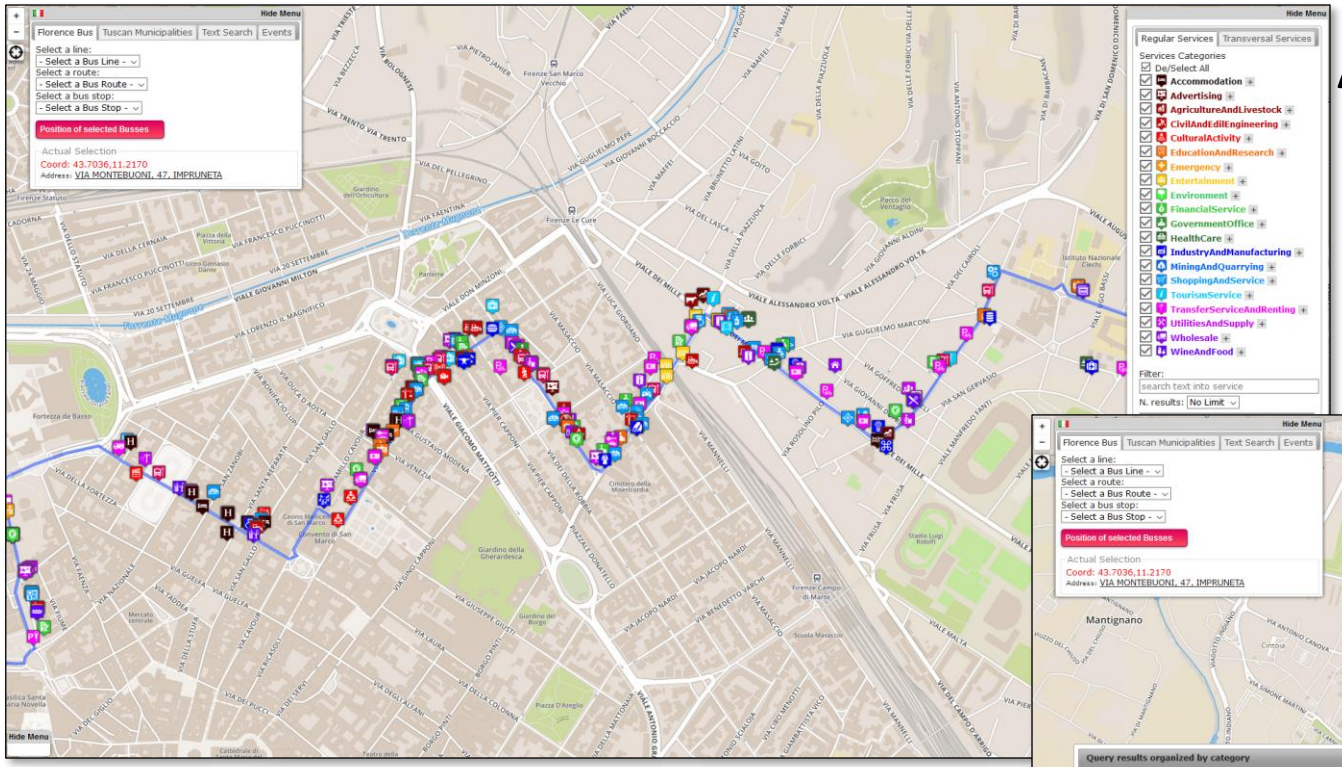
Inform, announce, Act!, warning, alarms, What-IF, ..

Demo UC5 GIDA



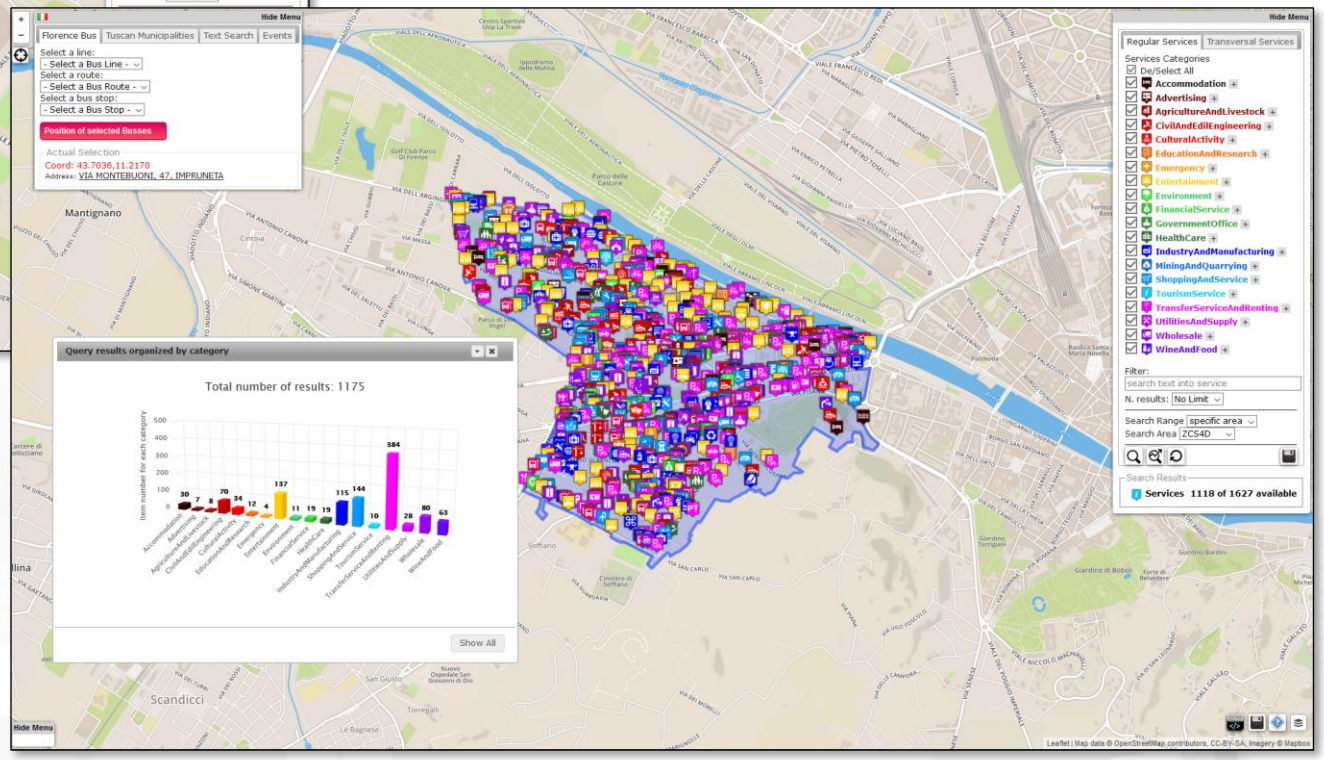
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjIyNg==

Along a path



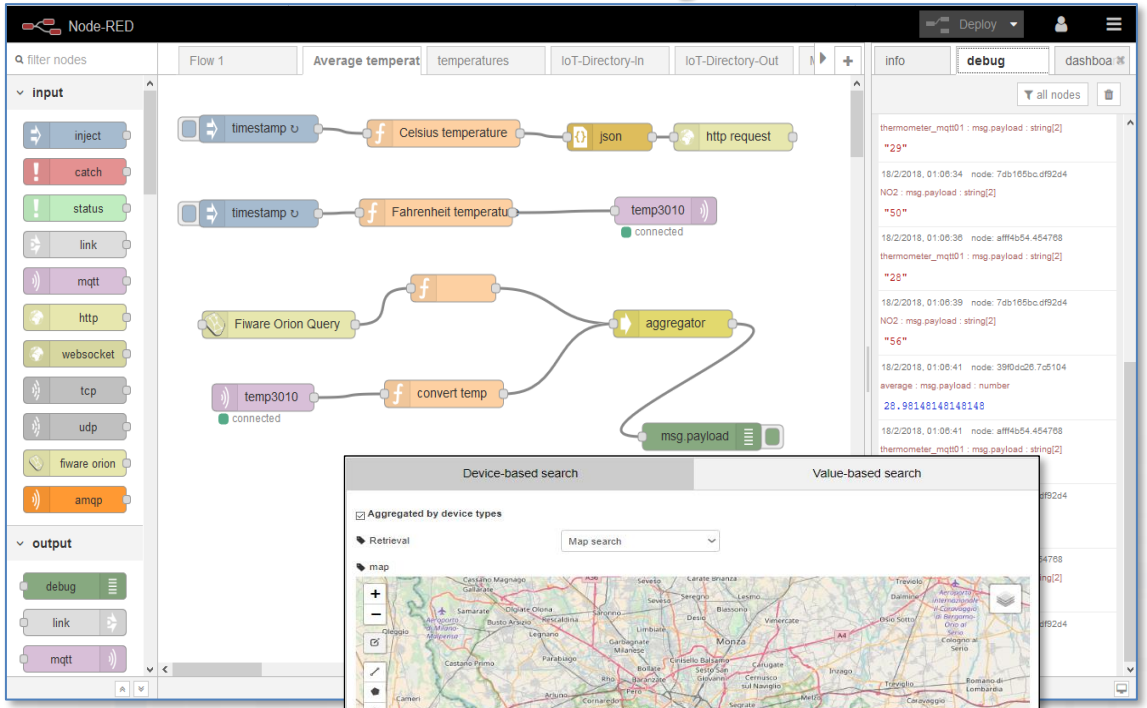
Sii-Mobility

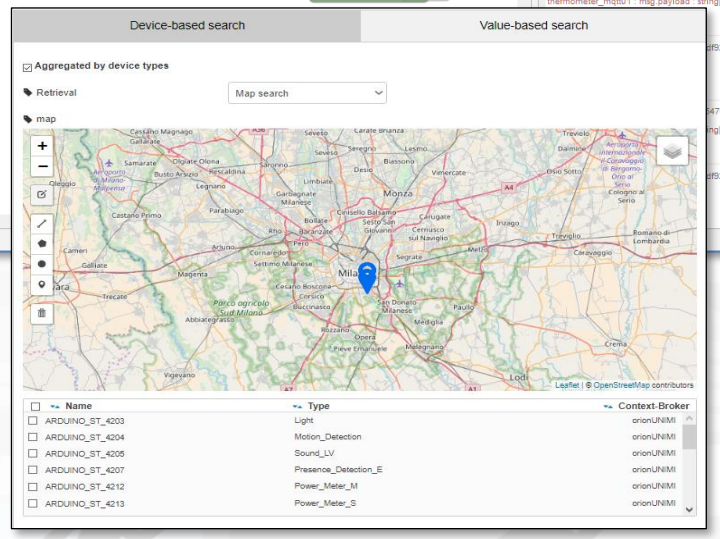
Inside an area

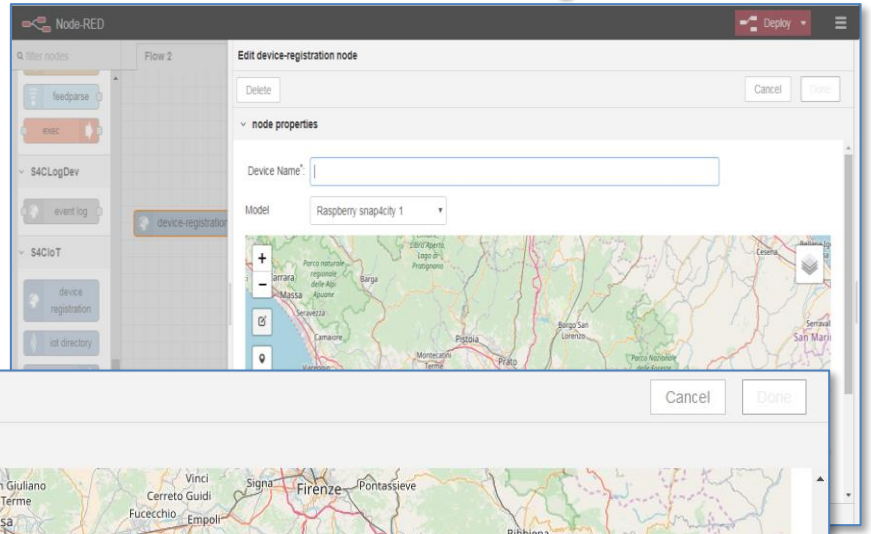


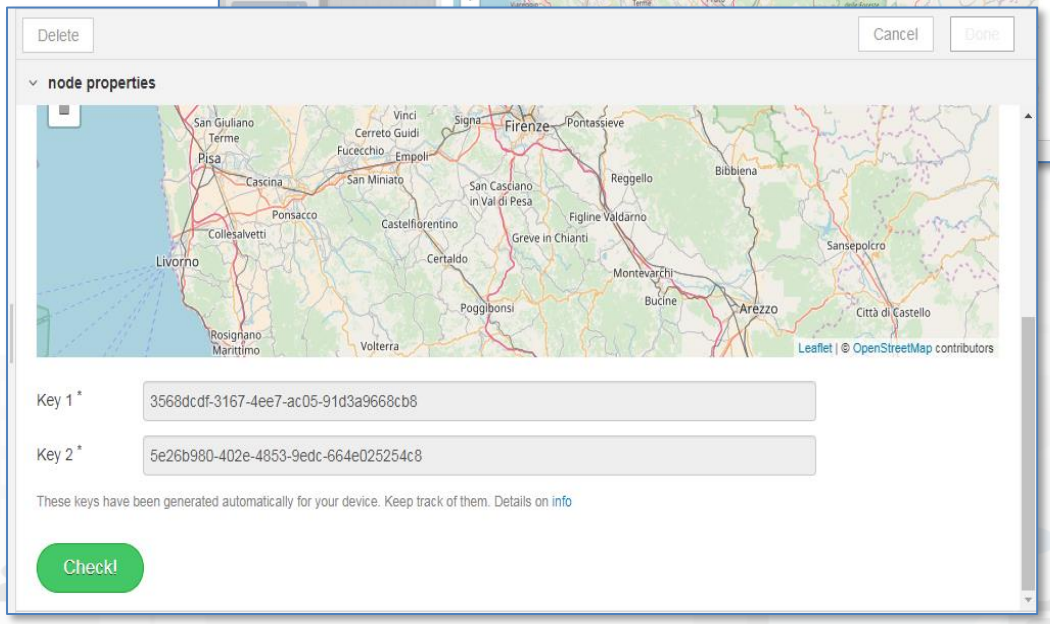
ServiceMap: https://servicemap.km4city.org

IOT Discovery on IOT Application Development



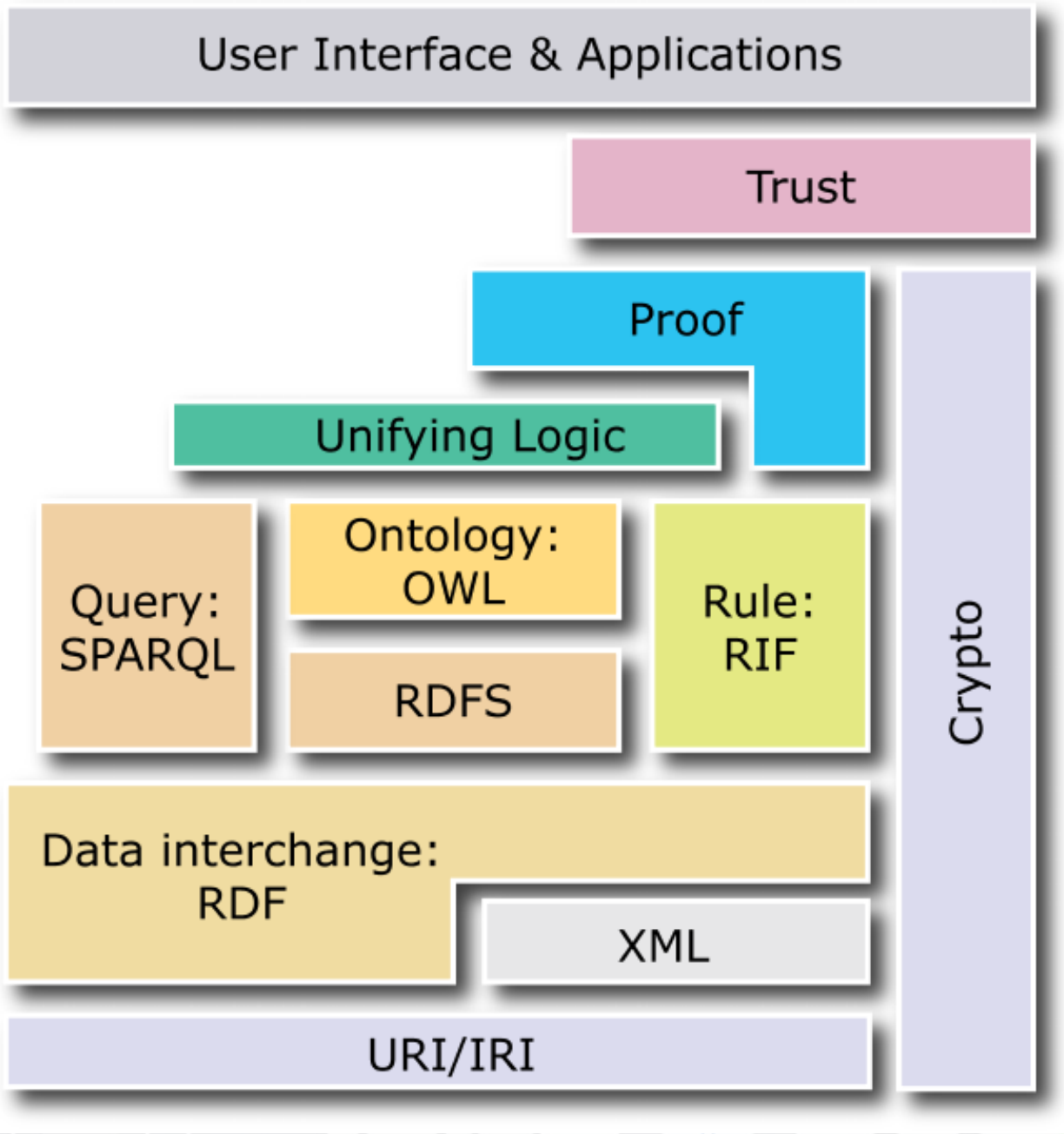






Semantic Web stack

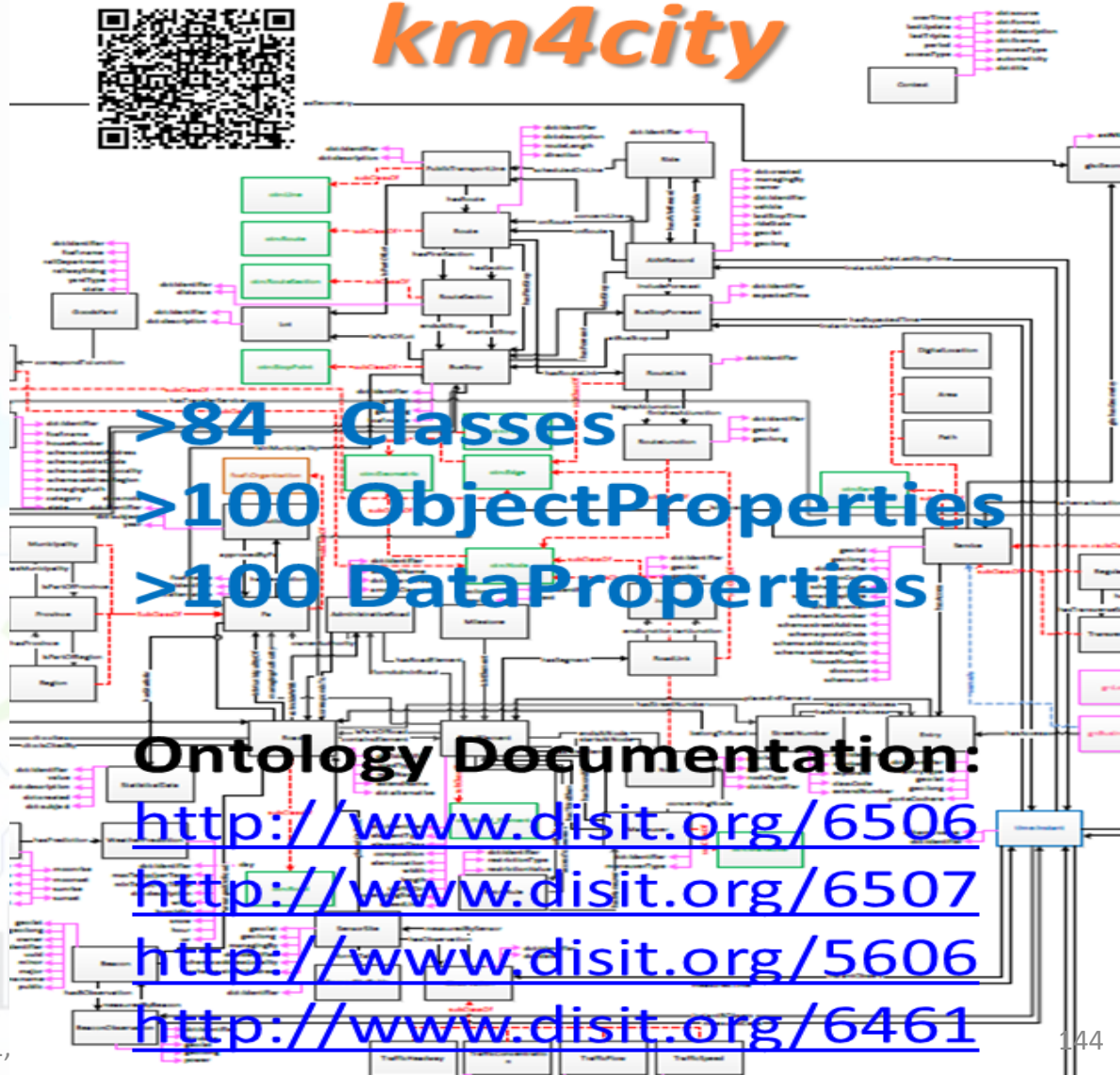
- Triples at the basis:
  - <o> <r> <s>
  - E.g.:
    - Carlo figliodi Bruno
- Relationships are also specialized and not only those of OOP
  - SKOS = Simple Knowledge Organization System



I Dati

- **Collezionamento dati** statici, quasi statici e real time, stream
  - **Dati open**: geo localizzati, servizi, statistiche, censimenti, etc.
  - **Dati privati degli operatori**: con licenze limitate per non permettere di fare profitto ad altri operatori sulla base dei loro dati
  - **Dati personali delle persone**: profili, comportamenti tramite APP, IOT, sensori, web, etc.
- **Integrazione dati per renderli *semanticamente interoperabili***, ed operare deduzioni (time, space…)
  - I tradizionali ***collettori di open data*** danno visioni statistiche ma **non sono adatti a produrre servizi integrati**
  - ***Integrazione con modelli semantici unificanti come Km4City***

Smart-city Ontology km4city



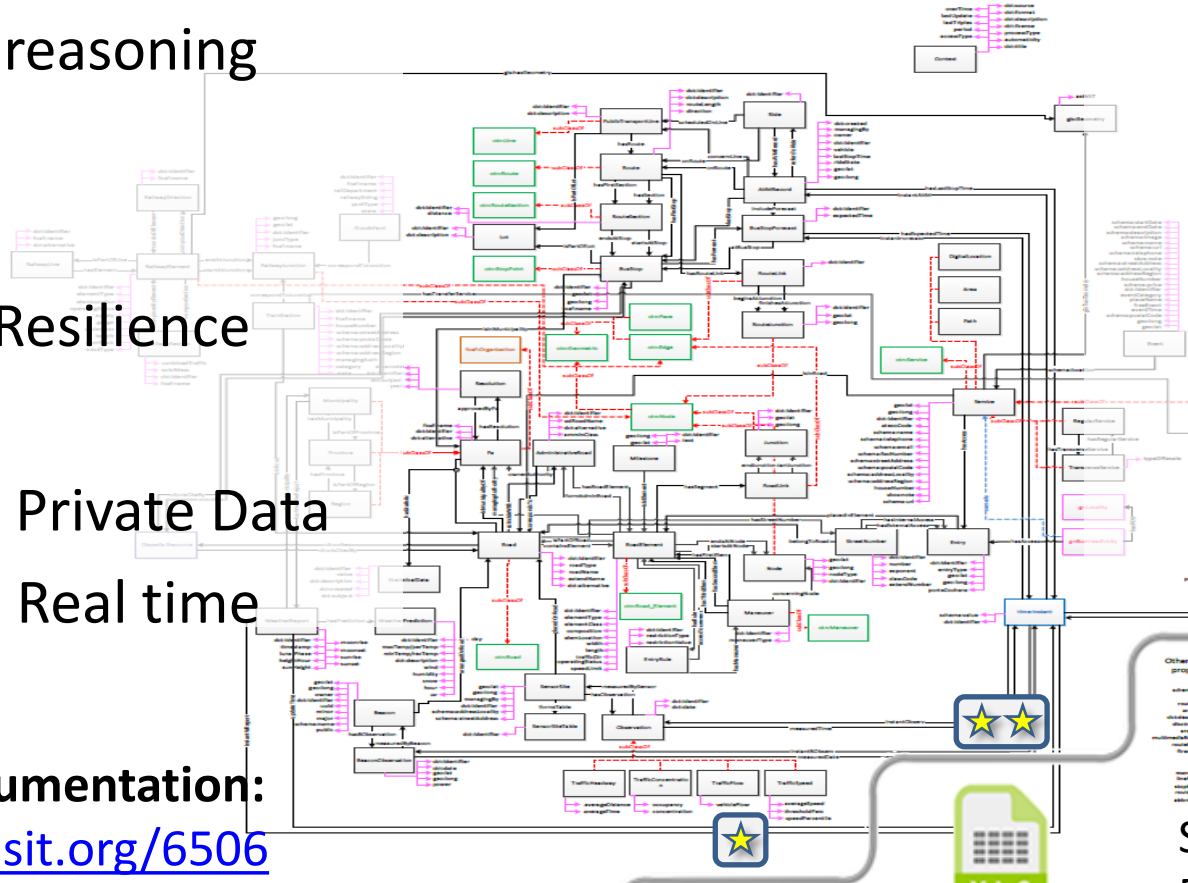
Why Knowledge base + Data (ES) is needed

- Ontological model
  - Modeling relationships and excluding those not modeled,
  - Posing semantic queries on what can be viable or what may exists
- Addition of Data allows to have reasoners on spatial, temporal, relational aspects exploiting
  - Defined Relationships (specialization, generalization)
  - Aggregation and semantic patterns

Km4City: Knowledge Base

- **Multiple DOMAINS**
- Geospatial reasoning
- Temporal reasoning
- Metadata
- Statistics
- Risk and Resilience
- Licensing
- Open and Private Data
- Static and Real time
- IOT/IOE

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



Big Data Tools

LOD and reasoners

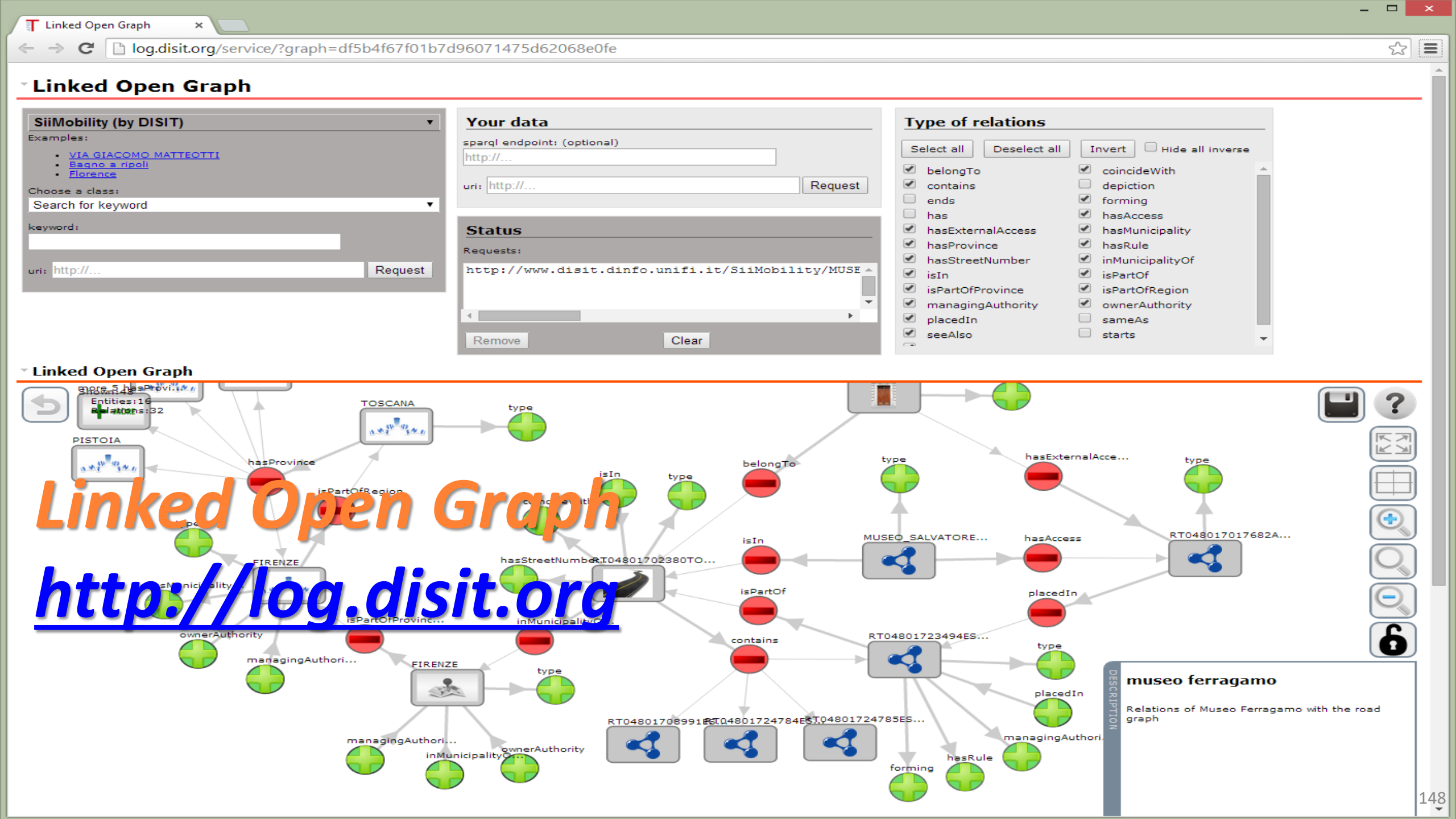
Ontology Documentation:

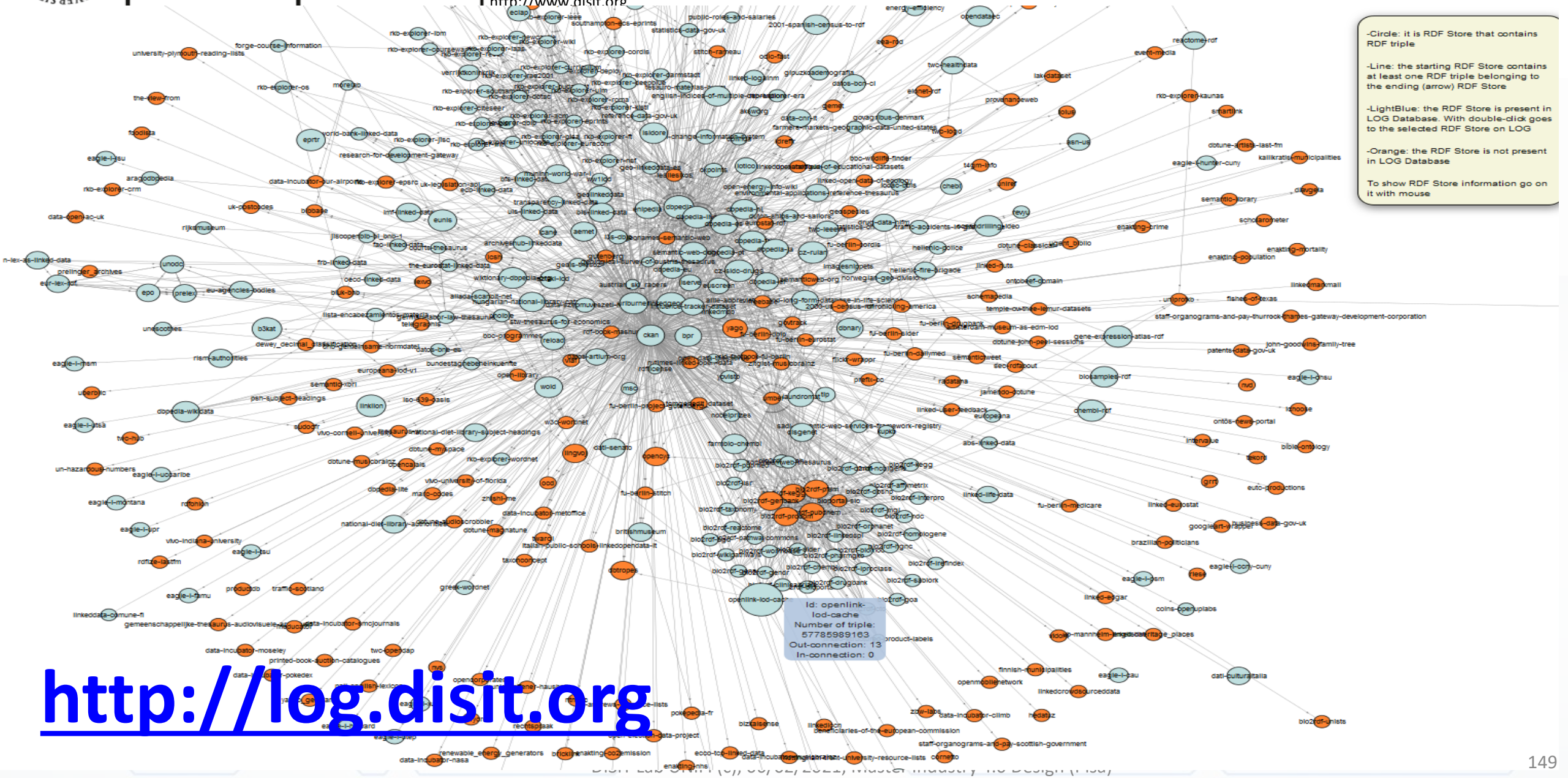
http://www.disit.org/6506
http://www.disit.org/6507
http://www.disit.org/5606
http://www.disit.org/6461

Schema: http://www.disit.org/km4city/schema
RDF version: http://www.disit.org/km4city.rdf

Semantic modeling

- **Km4City is the reference ontology for Snap4City,** It allows to:
  - keep connected city entities each other:
    - Semantic Index, reticular
    - Perform spatial, geo graphic, and temporal reasoning
  - Discover city entities and their relationships,
    - IOT devices, IOT sensors, city elements, etc.
  - Provide access via Advanced Smart City API
  - Federate other Km4City Knowledge Bases, the approach allows to scale geographically and create redundancies, improving performances
- Documentation
  - **TC5.15 - Snap4City Smart City API Collection and overview, real time**
  - **ServiceMap and ServiceMap3D, Knowledge Model, Km4City Ontology**
  - **Knowledge Base Graphs and Queries: browsing and queries into the KB**


Linked Open Graph
log.disit.org/service/?graph=df5b4f67f01b7d96071475d62068e0fe
Linked Open Graph
SiiMobility (by DISIT)
Examples:
VIA GIACOMO MATTEOTTI
Bagno a ripoli
Florence
Choose a class:
Search for keyword
keyword:
uri: http://...
Request
Your data
sparql endpoint: (optional)
http://...
uri: http://...
Request
Status
Requests:
http://www.disit.dinfo.unifi.it/SiiMobility/MUSE
Remove
Clear
Type of relations
Select all
Deselect all
Invert
Hide all inverse
belongTo
contains
ends
has
hasExternalAccess
hasProvince
hasStreetNumber
isIn
isPartOfProvince
managingAuthority
placedIn
seeAlso
coincideWith
depiction
forming
hasAccess
hasMunicipality
hasRule
inMunicipalityOf
isPartOf
isPartOfRegion
ownerAuthority
sameAs
starts
Linked Open Graph
Shown:48
Entities:16
Relations:32
TOSCANA
type
PISTOIA
hasProvince
isPartOfRegion
isIn
type
belongTo
type
hasExternalAcce...
type
FIRENZE
hasStreetNumber
RT048017023801O...
isIn
MUSEO_SALVATORE...
hasAccess
RT048017017682A...
isPartOf
placedIn
ownerAuthority
managingAuthori...
FIRENZE
contains
RT048017234945S...
type
placedIn
managingAuthori...
ownerAuthority
forming
hasRule
museo ferragamo
Relations of Museo Ferragamo with the road graph
DESCRIPTION
Linked Open Graph
http://log.disit.org



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Elastic Search, Kibana



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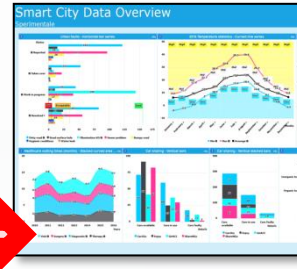
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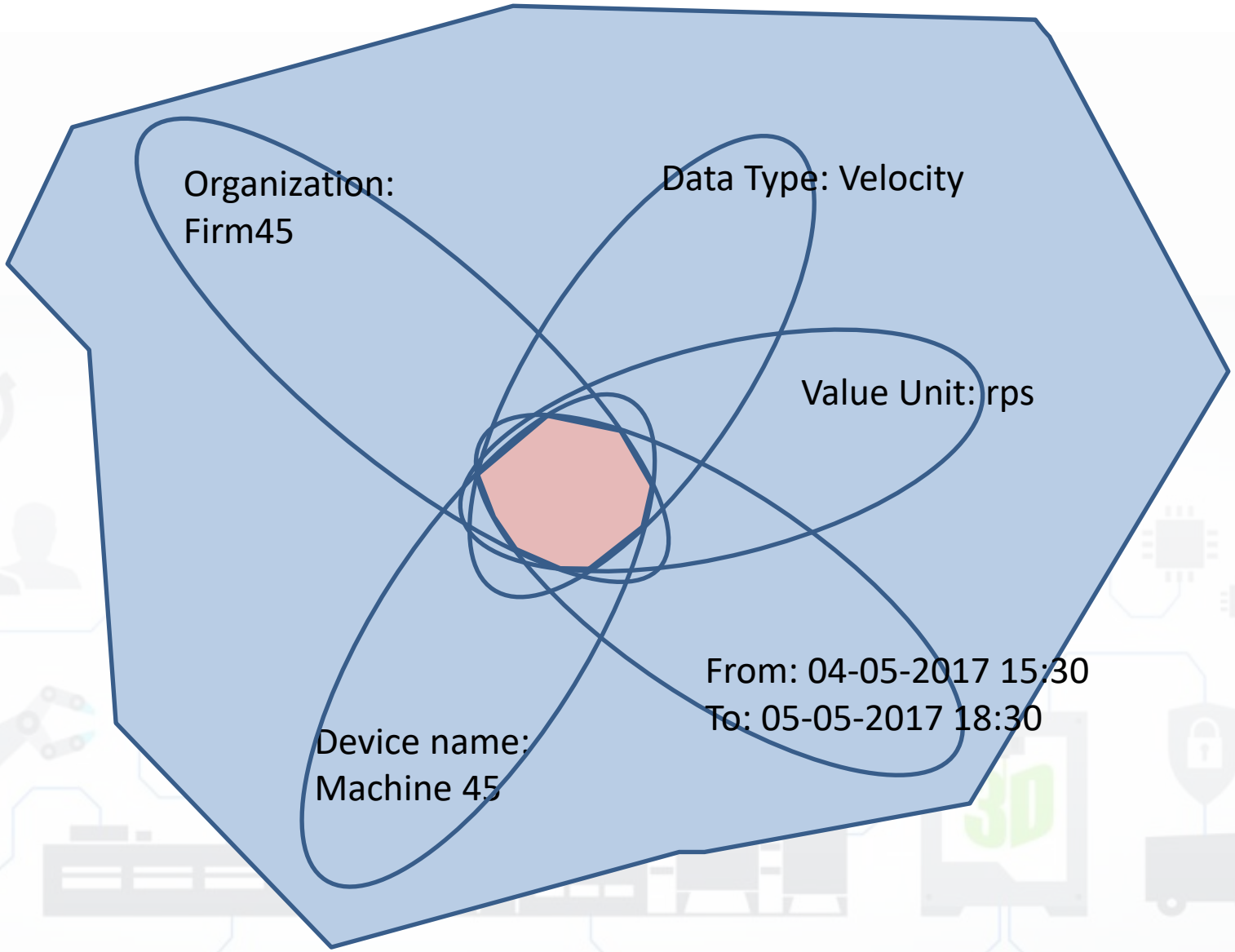
Elastic Search

- Similar to SOLR faceted, Including Full text search, etc.
- noSQL but RestFull API for each using JSON over HTTP
- Multiple Indexes
- Easy to scale
- Document Oriented database
- Authentication (not in the open source),

elasticsearch

Data Indexing: Multiple views





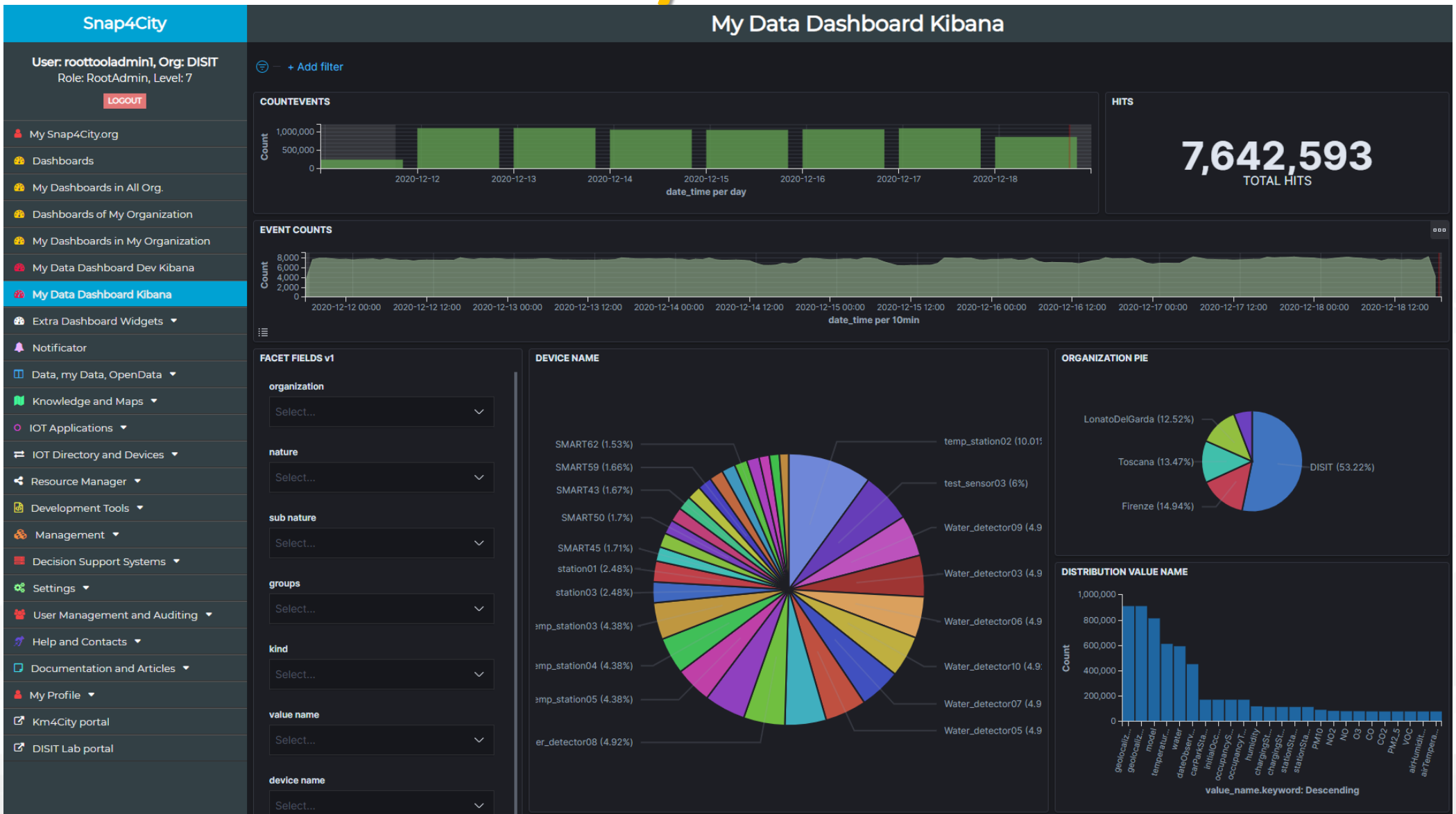
Two aspects of Elastic Search usage

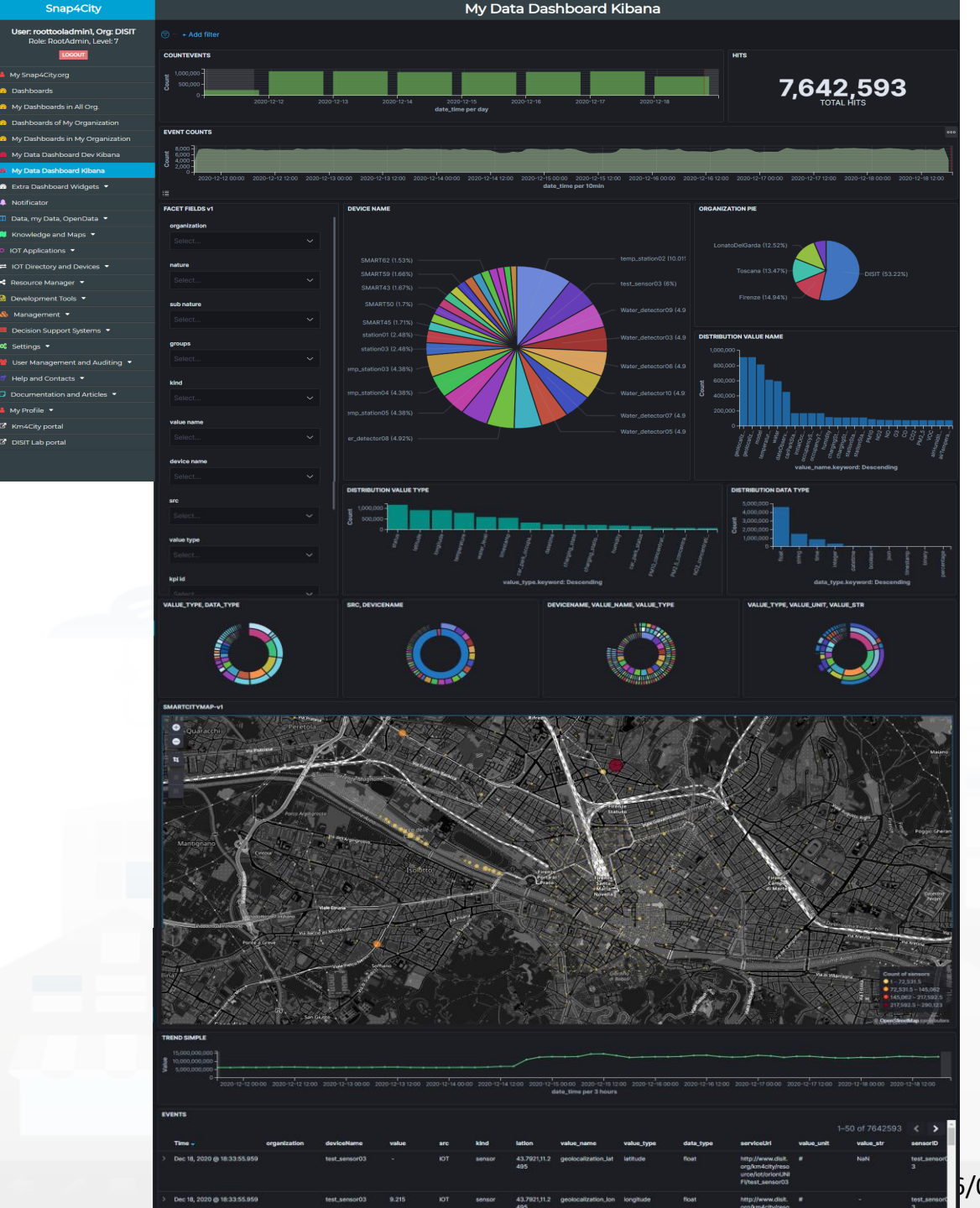
- Elastic Search is a scalable index and storage that can be used as a Data Lake in some sense.
- All «has» to the normalized to enable full filtering and faceting/grouping
- The user interface can be Kibana, Grafana. Open Source and paid versions
- In Snap4City/Snap4Industry two usage of ElasticSearch/Kibana:
  - **AMMA**: Application and MicroService Monitor and Analyzer
  - **DevDash**: Developers Dashboard





DevDash: My Data Dashboard Kibana



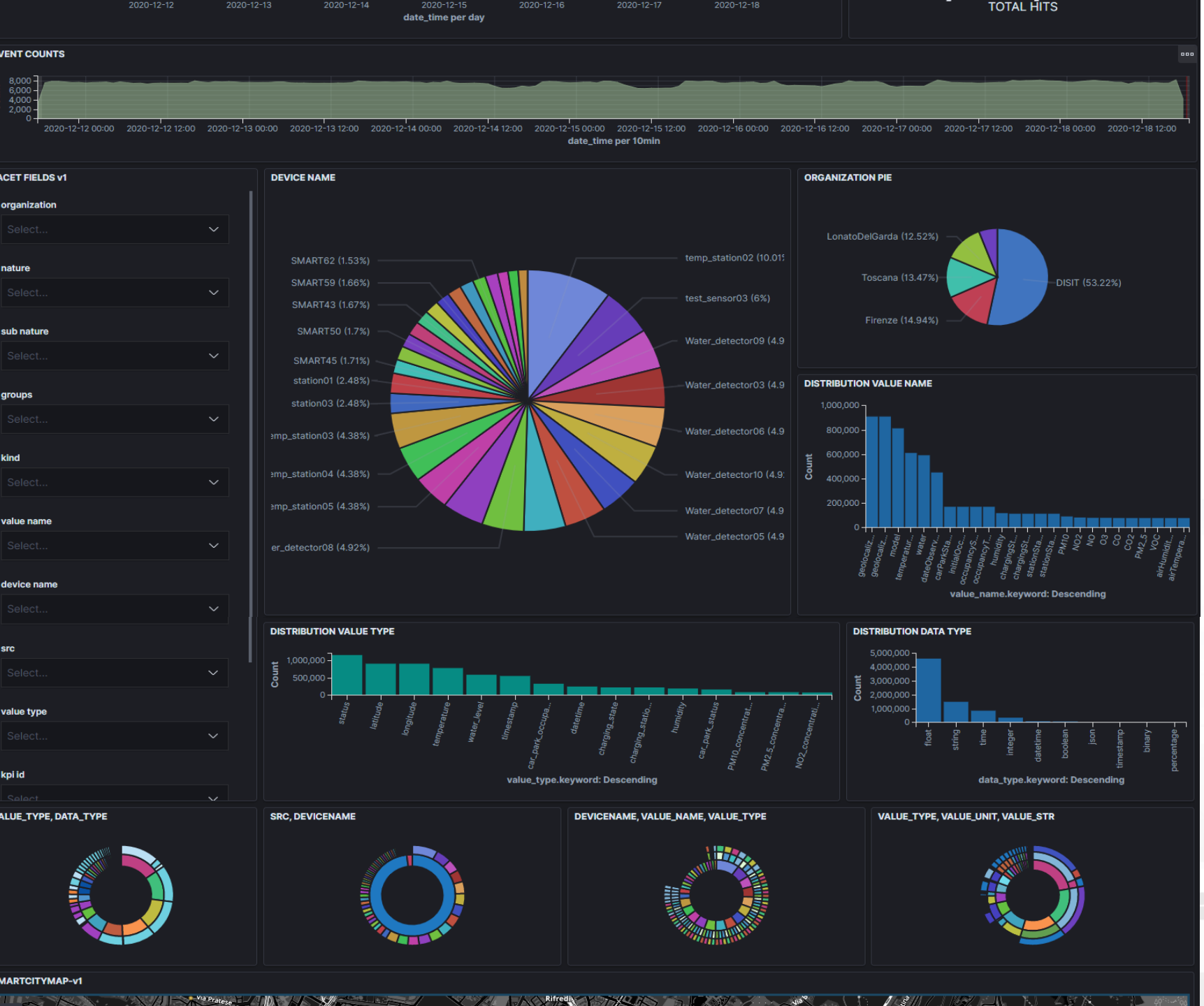


kibana

SNAP4CITY

Business Analysis Dashboards For all kind of users: DevDash

- Dynamic Filtering, Adaptable, …
- Full data details, drill down,…
- Synergic with **Data Inspector** which addresses data relationships, processing and information
- **Only Your Data for**
  - Manager and Area Managers
- **All Accessible Data for**
  - ToolAdmin and RootAdmin



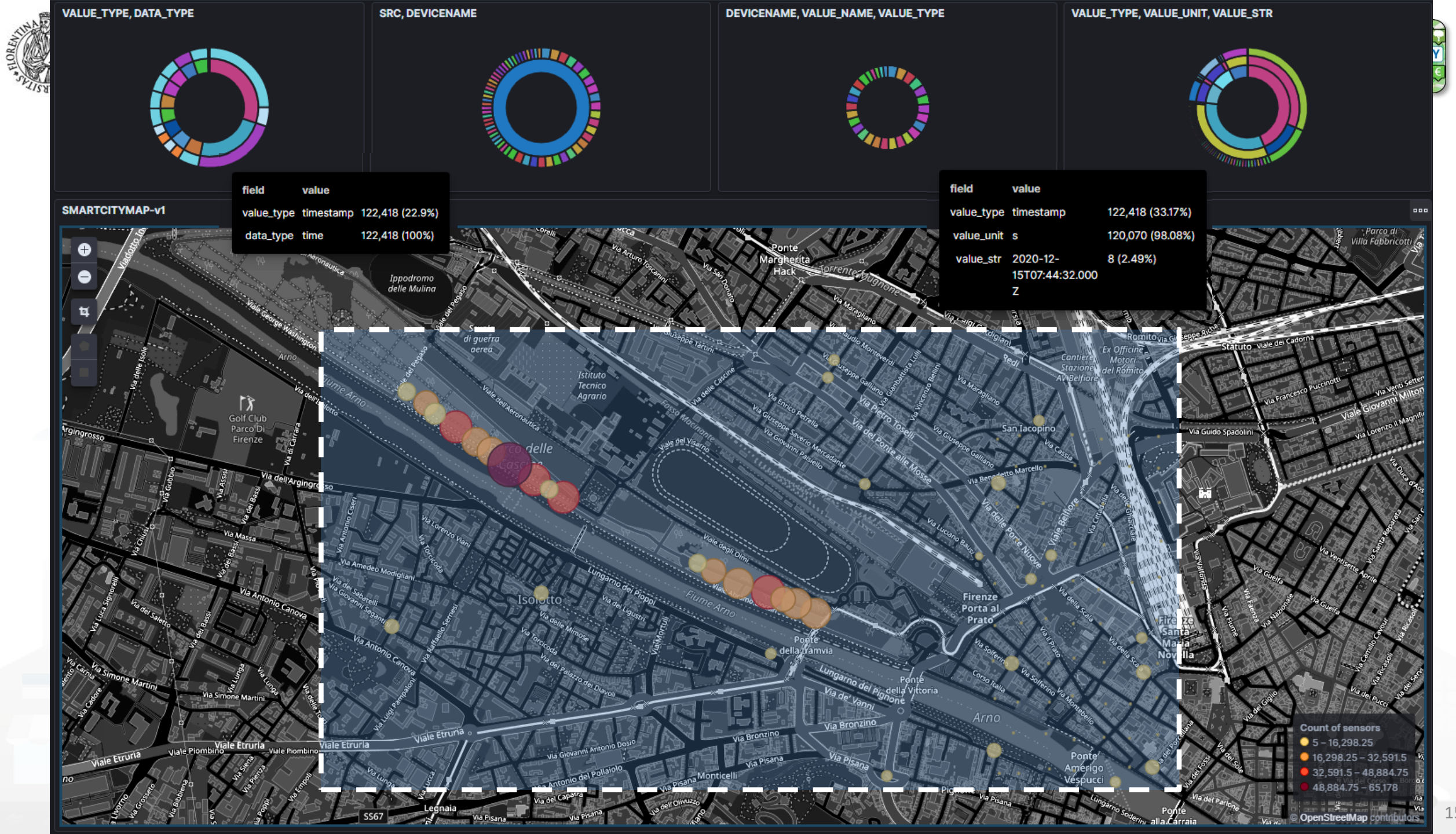
SNAP4CITY

KM4CITY

- Multi faceted Search by
  - Devices
  - Organization
  - Drill on Time
  - Drill on Map
  - Value Types
  - Data Type
  - Value name
  - Data table
  - Etc.

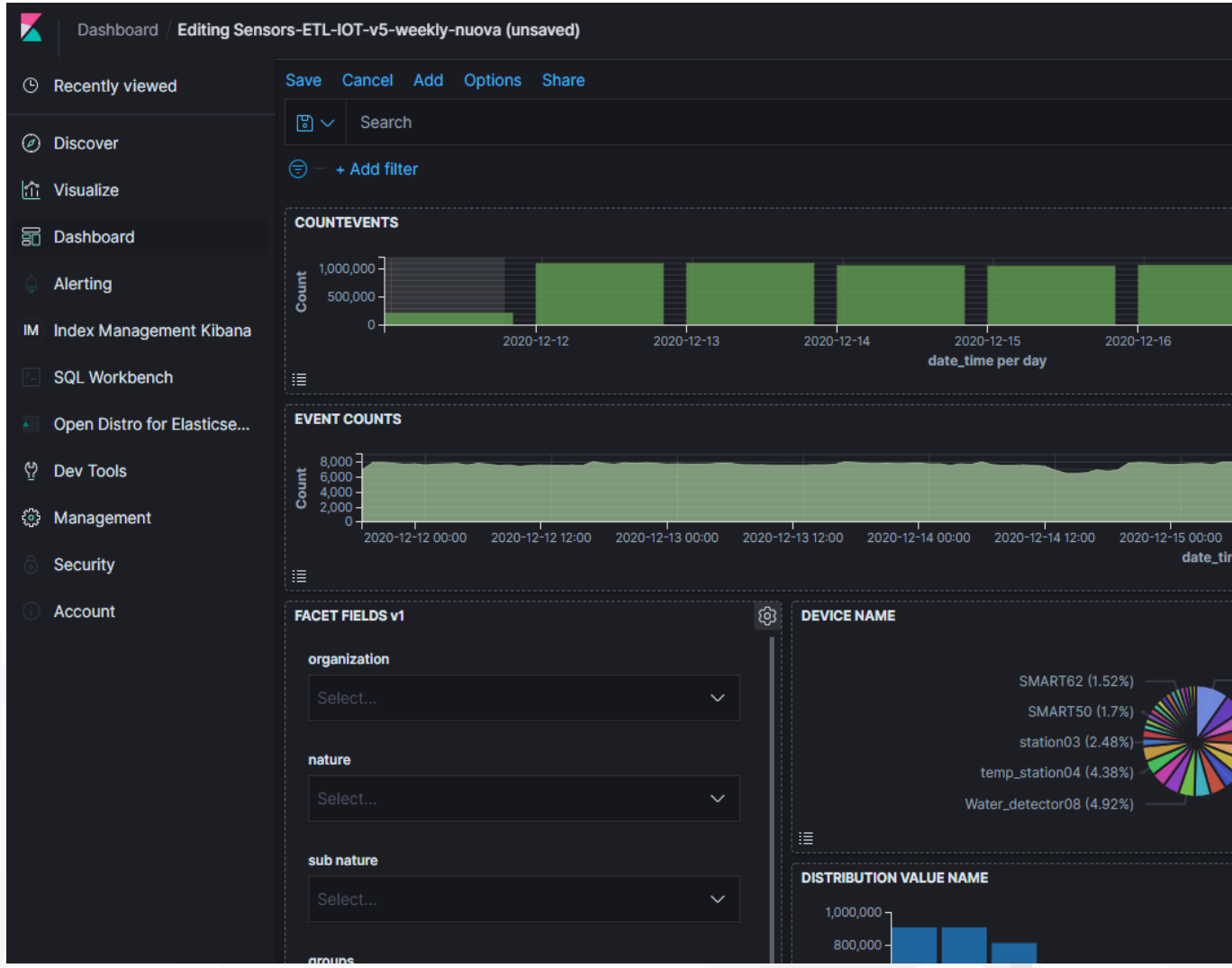
kibana

- Respect Privacy and GDPR

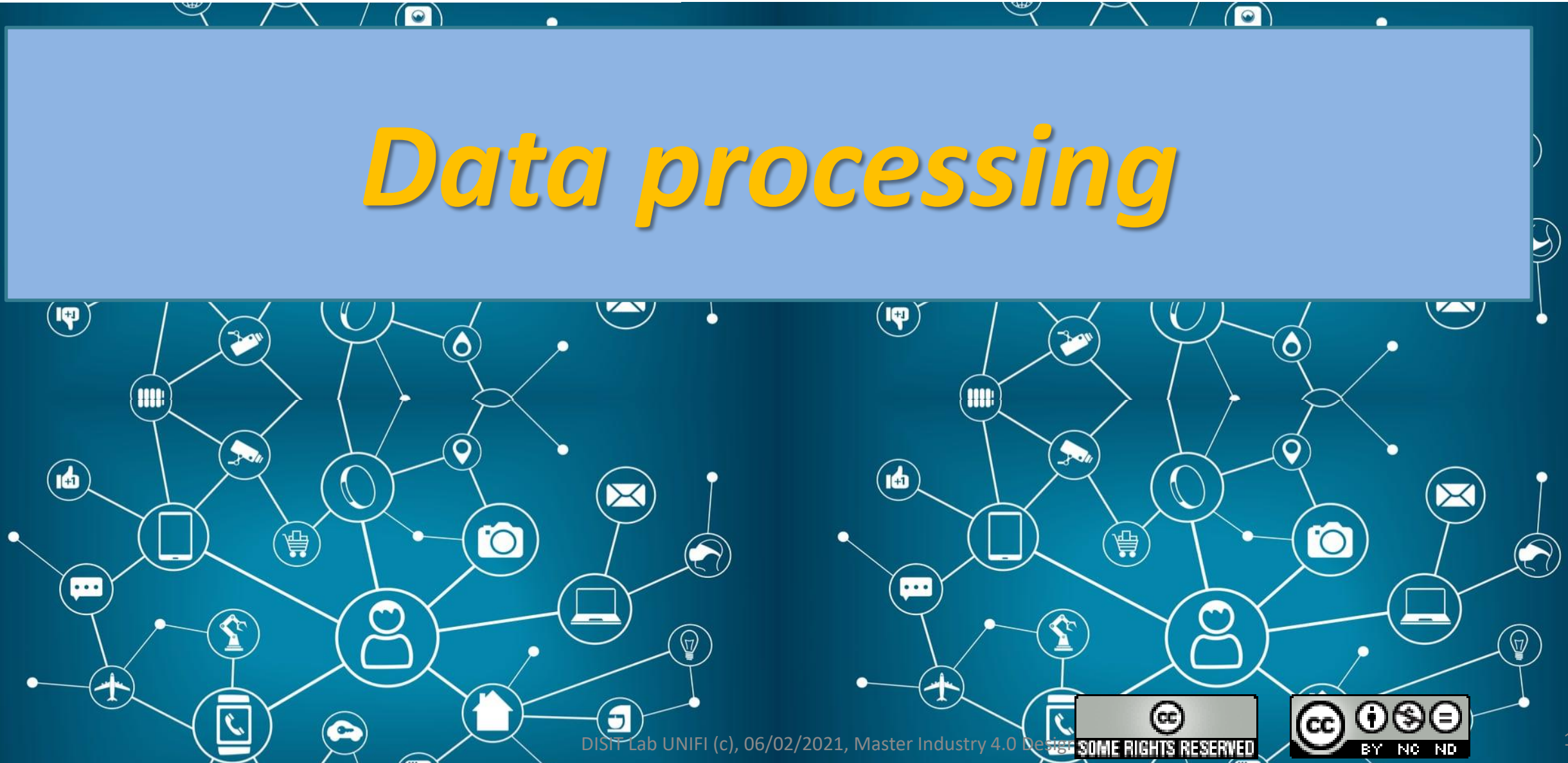

VALUE_TYPE, DATA_TYPE
SRC, DEVICENAME
DEVICENAME, VALUE_NAME, VALUE_TYPE
VALUE_TYPE, VALUE_UNIT, VALUE_STR
field value
value_type timestamp 122,418 (22.9%)
data_type time 122,418 (100%)
field value
value_type timestamp 122,418 (33.17%)
value_unit s 120,070 (98.08%)
value_str 2020-12-15T07:44:32.000Z 8 (2.49%)
SMARTCITYMAP-v1
Count of sensors
5 – 16,298.25
16,298.25 – 32,591.5
32,591.5 – 48,884.75
48,884.75 – 65,178
© OpenStreetMap contributors

My Data Dashboard Customization

- My Data Dashboards (for Developers and for Managers) can be customized by RootAdmin.
  - Authority for Customizzation can be also extended to other role on Premise solutions
- Customizations is based on Full editing Capabilities of Kibana Elastic Search 7, and with multiple indexes of Snap4City



Data processing



SOME RIGHTS RESERVED
BY NC ND

Agenda

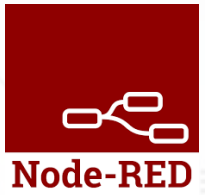
- Big Data Architecture
- Data Warehouse
- Data Storage
- **Data Processing**
  - IoT Applications, on IOT Edge and on Cloud
  - IoT Data from the move
  - IoT Security
- Data Analytics
- Visual Analytics
- Dashboards
- Living lab for Collaborative work
- Deploy and Install Snap4 .. Solutions
- Acknowledgment

Simpler Approaces

- **If Then That**: IF <condition> than <action>
  - Rule based solutions
- **ETL**: Extract Transform Load
  - Typically in PULL, batch processing
- **NIFI** Apache: (former Niagra files)
  - Push and Pull, not easy to program but scalable in federated cluster of processes
- **NodeRED**, based on concept of **MicroServices, … SOA**
  - Data driven, workflow, Push; also PULL
  - Easy to develop, custom libraries of Node, node.JS based, etc.







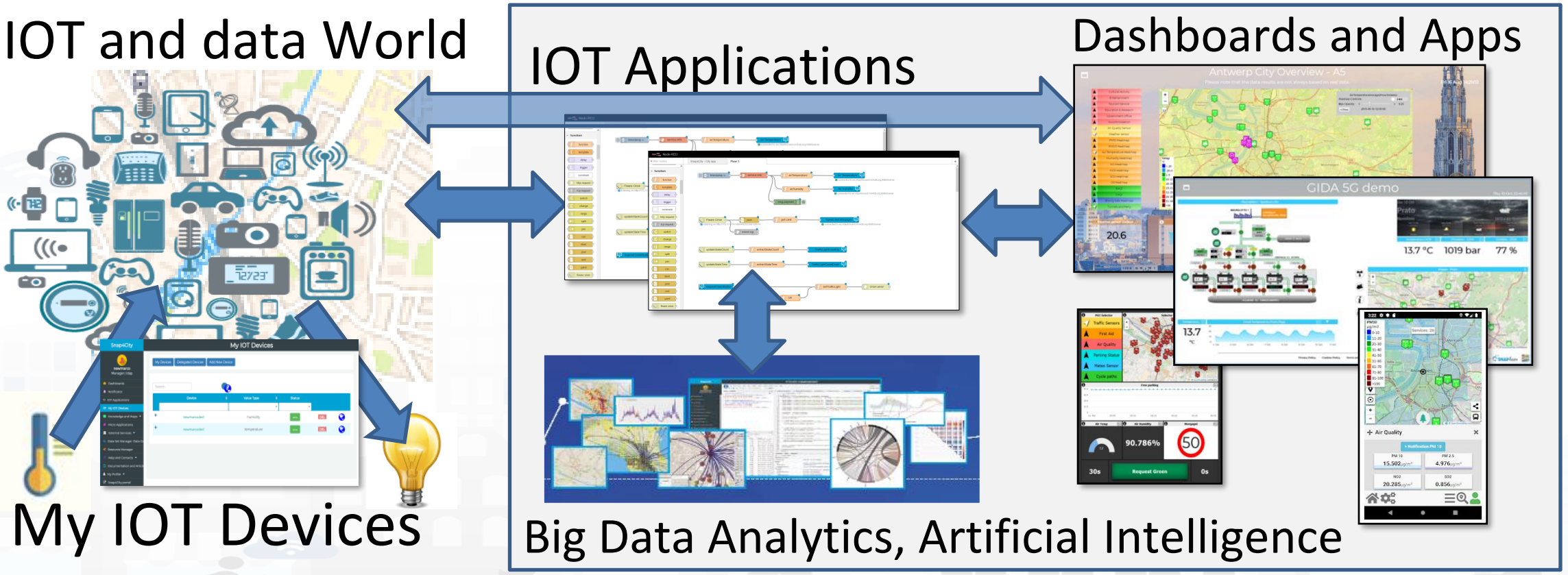
- **Push solutions** are in most cases implemented as PULL solution with high refresh rate.
- **Integration with Data Analytics** is a problematic aspects in most cases including the integration with Machine Learning and advanced Tensor Flow computing in real time and accessible to developers directly from the web.

IoT Applications, on IOT Edge and on Cloud

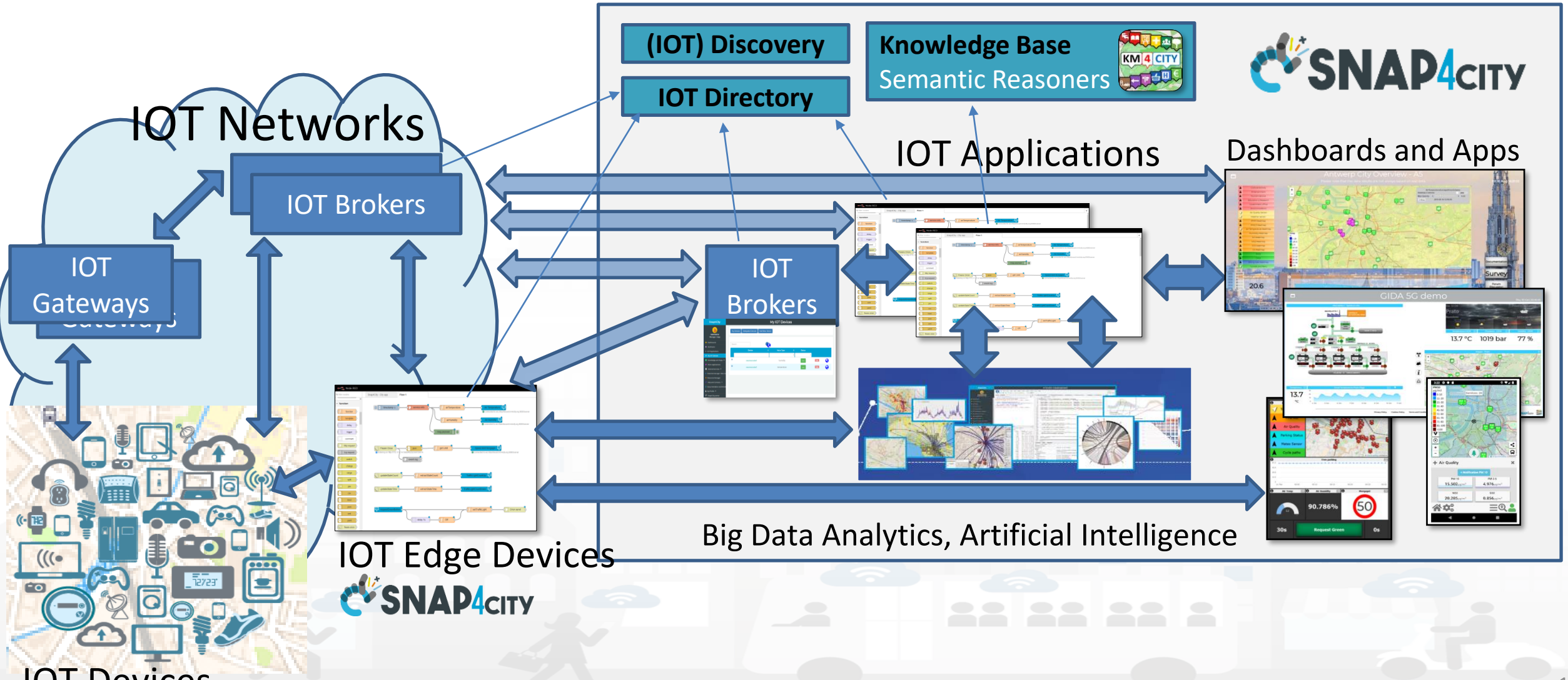


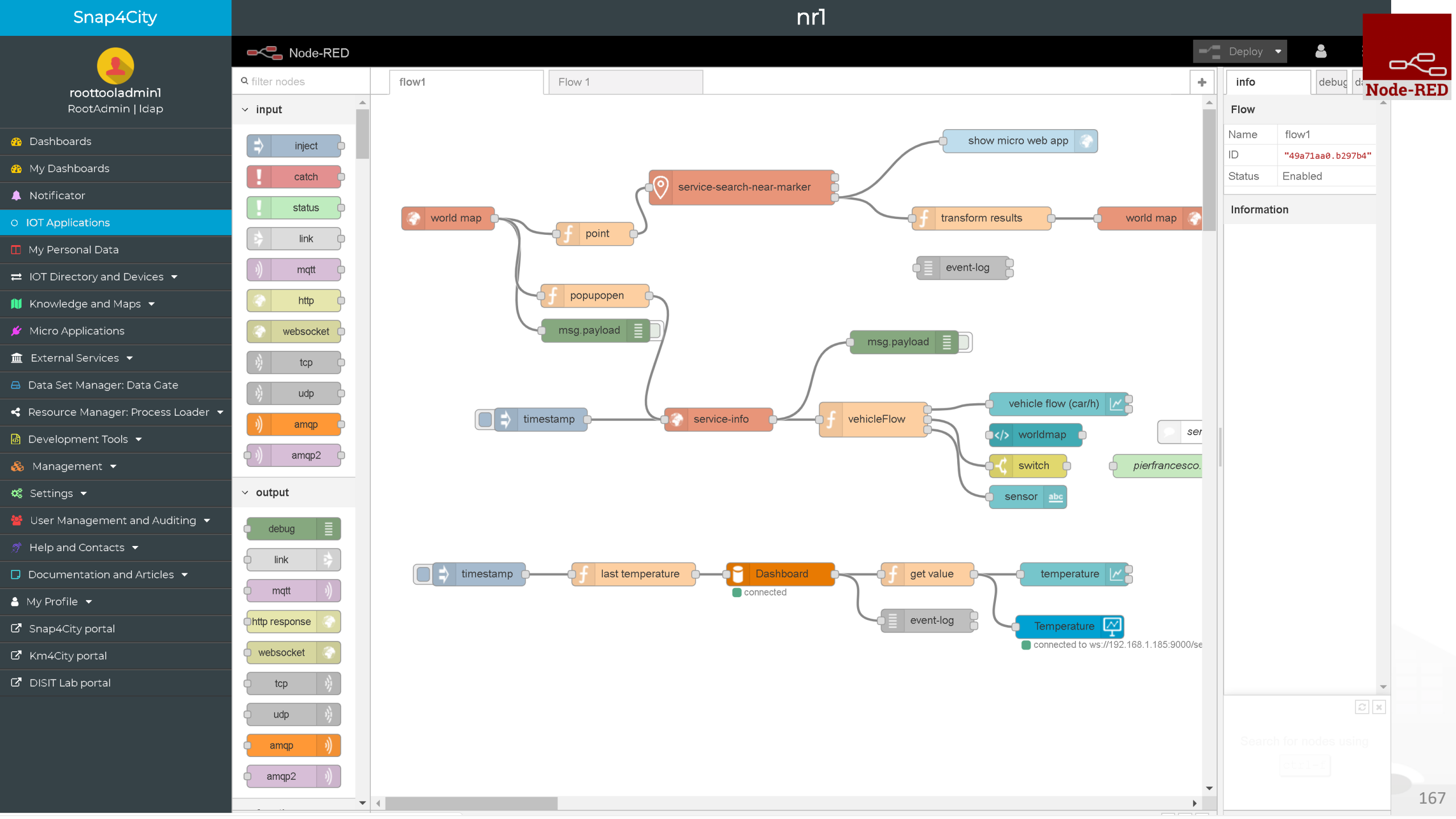
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Dashboards with data driven IOT Applications enforcing intelligence



Snap4City: IOT Directory and data/device Discovery

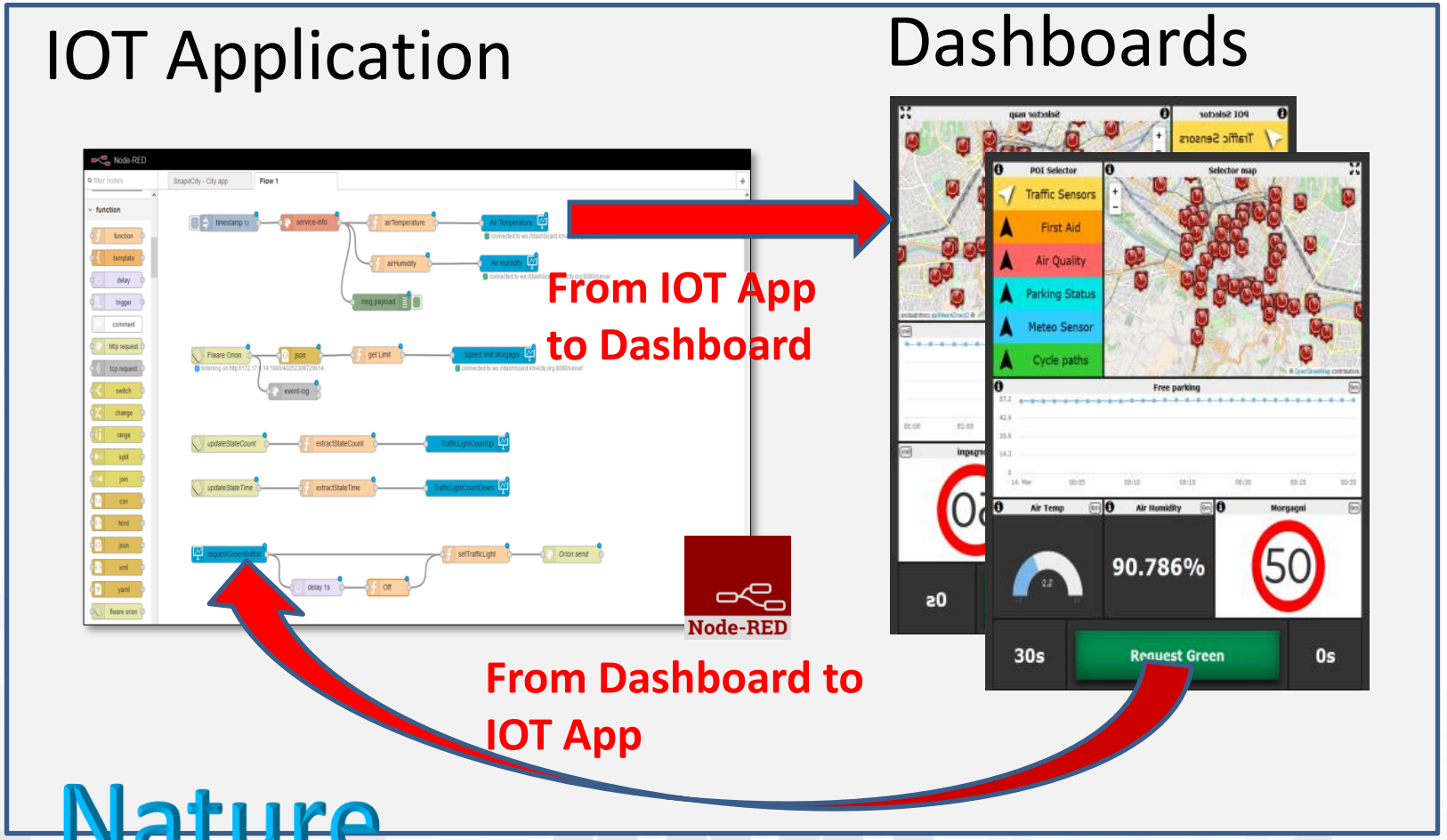



Snap4City
nr1
roottooladmin1
RootAdmin | ldap
Dashboards
My Dashboards
Notificator
IOT Applications
My Personal Data
IOT Directory and Devices
Knowledge and Maps
Micro Applications
External Services
Data Set Manager: Data Gate
Resource Manager: Process Loader
Development Tools
Management
Settings
User Management and Auditing
Help and Contacts
Documentation and Articles
My Profile
Snap4City portal
Km4City portal
DISIT Lab portal
Node-RED
Deploy
filter nodes
flow1
Flow 1
input
inject
catch
status
link
mqtt
http
websocket
tcp
udp
amqp
amqp2
output
debug
link
mqtt
http response
websocket
tcp
udp
amqp
amqp2
show micro web app
service-search-near-marker
world map
point
transform results
world map
event-log
popupopen
msg.payload
msg.payload
timestamp
service-info
vehicleFlow
vehicle flow (car/h)
worldmap
switch
sensor
timestamp
last temperature
Dashboard
connected
get value
temperature
event-log
Temperature
connected to ws://192.168.1.185:9000/se
info
debug
Flow
Name
flow1
ID
"49a71aa0.b297b4"
Status
Enabled
Information
Search for nodes using
Node-RED

HLT: Sensors-Actuators

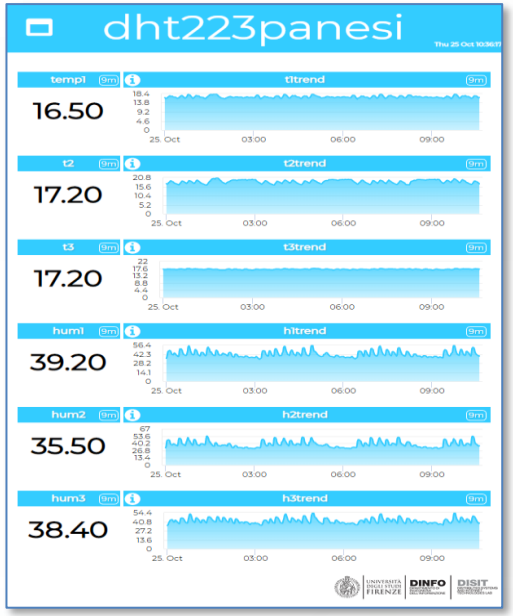
High Level Types

- **Complex Event**
- **Dashboard-IOT App**
- **External Service**
- **Heatmap**
- **KPI (Key Performance Indicator)**
- **MicroApplication**
- My Personal Data
- MyKPI
- MyPOI
- **POI (Point of Interest)**
- **Sensor**
- **Sensor Actuator**
- **Special Widget**
- Wfs (GIS)

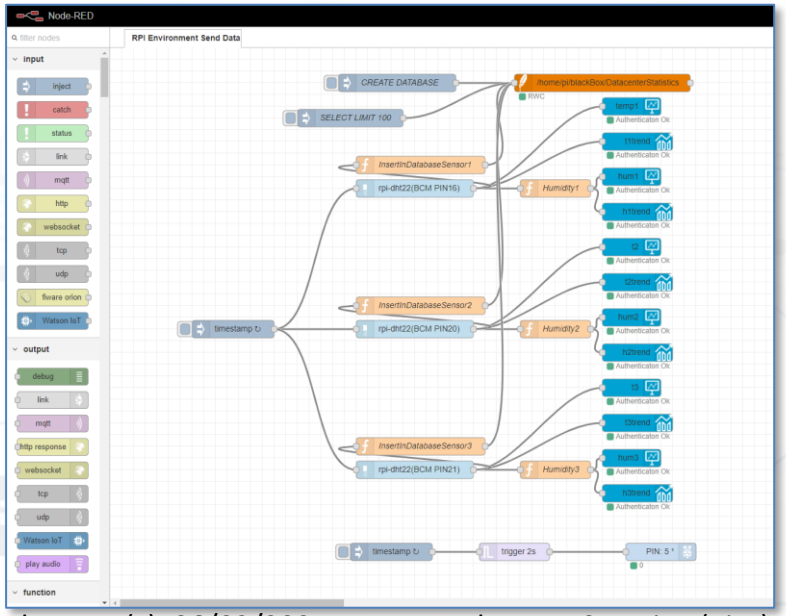


IOT Edge on Raspberry Pi

- Raspberry Pi
- Mutual Authentication with certificates
- Secure encrypted connection
- IOT Application inside
- Any sensor
- Any protocol from IOT devices
- NGSI or any other protocol
- Fully Customizable
- Local and Cloud Dashboard
- **Special MicroServices**





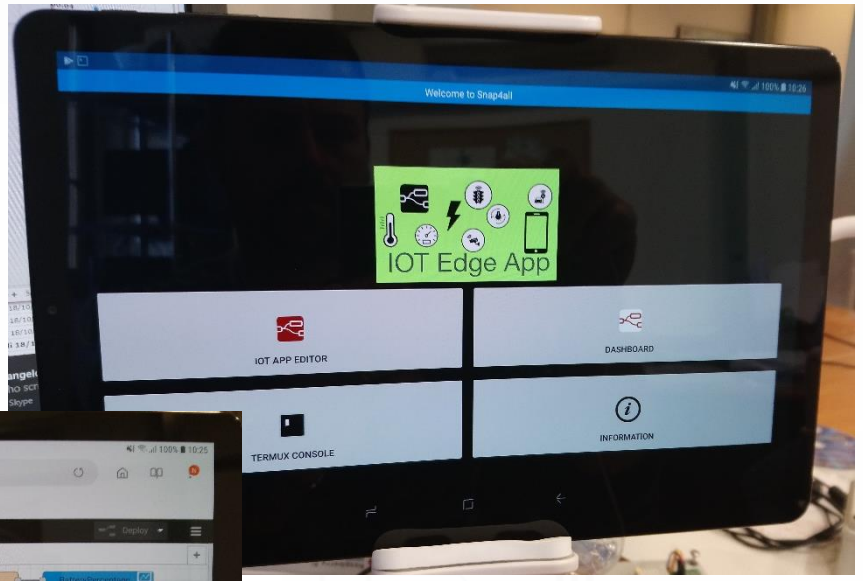


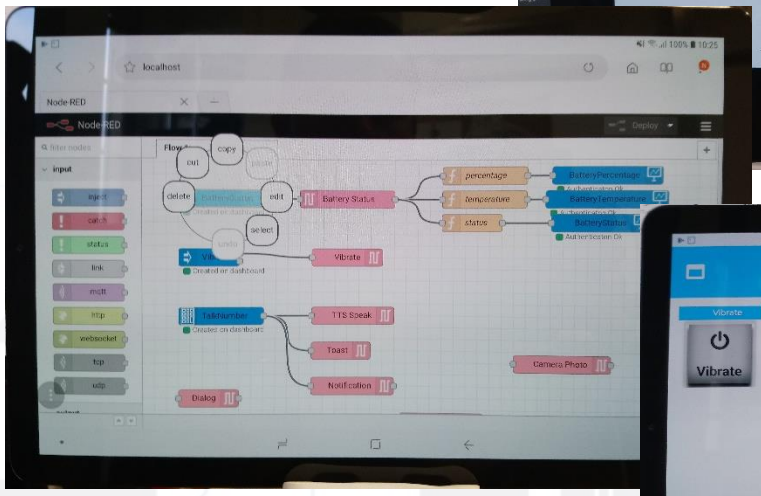


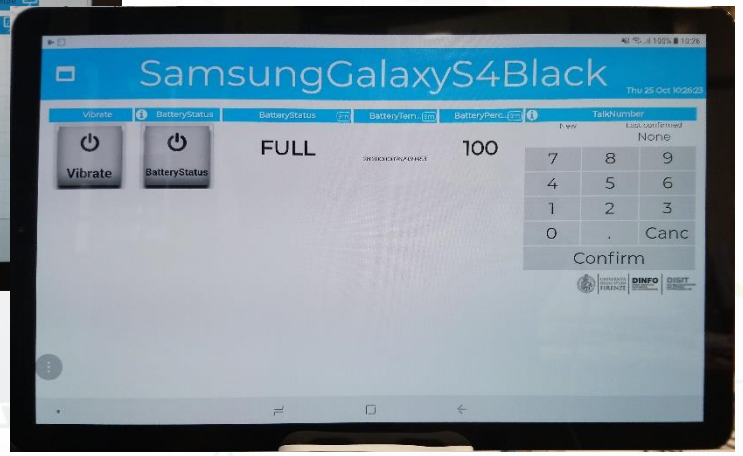
MicroServices:
- DHT
- ModBus
- any shield
- etc....

IOT Edge Snap4All App for Android

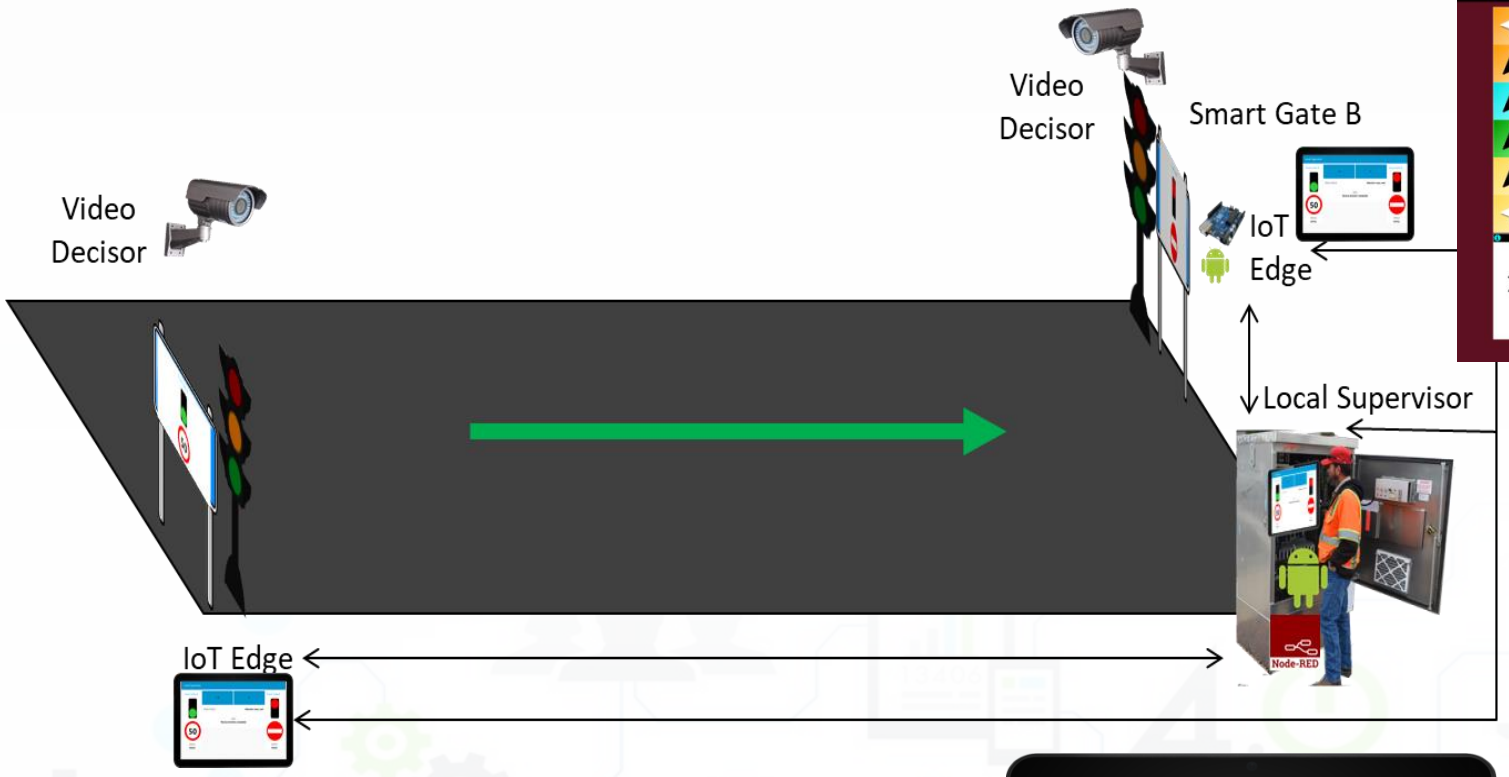
- **Android**, any version, App from: https://www.snap4city.org/download/video/Snap4All.apk
- **Mutual Authentication** with certificates
- *Secure encrypted connection*, NGSI
- **IOT Application inside**
- **Any sensor** + Local device sensors
- **Any protocol** from IOT devices
- **NGSI** or any other protocol
- **Fully Customizable**
- Local and Cloud Dashboard
- **Special MicroServices**

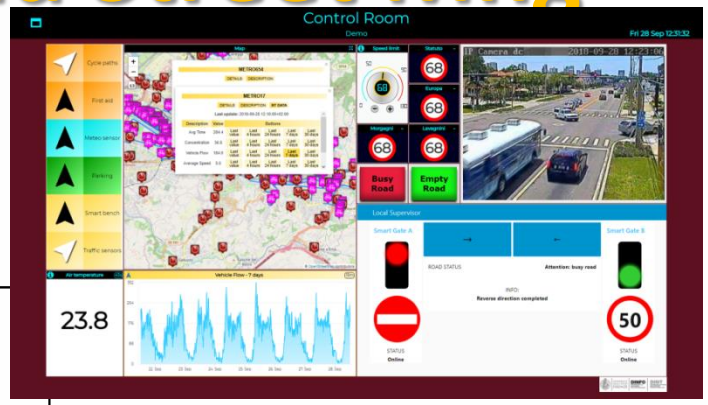






Sii-Mobility: Dynamic Signage and Street Mng

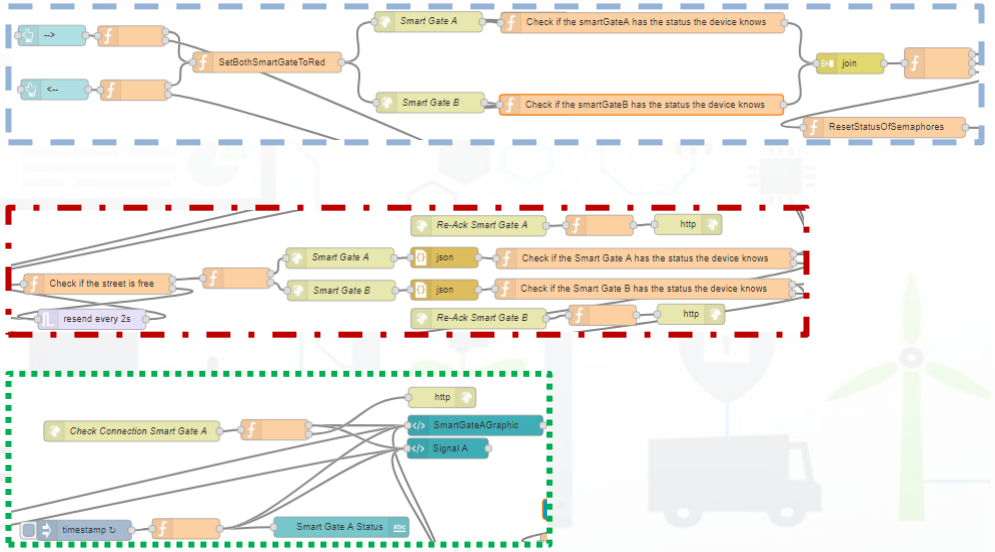




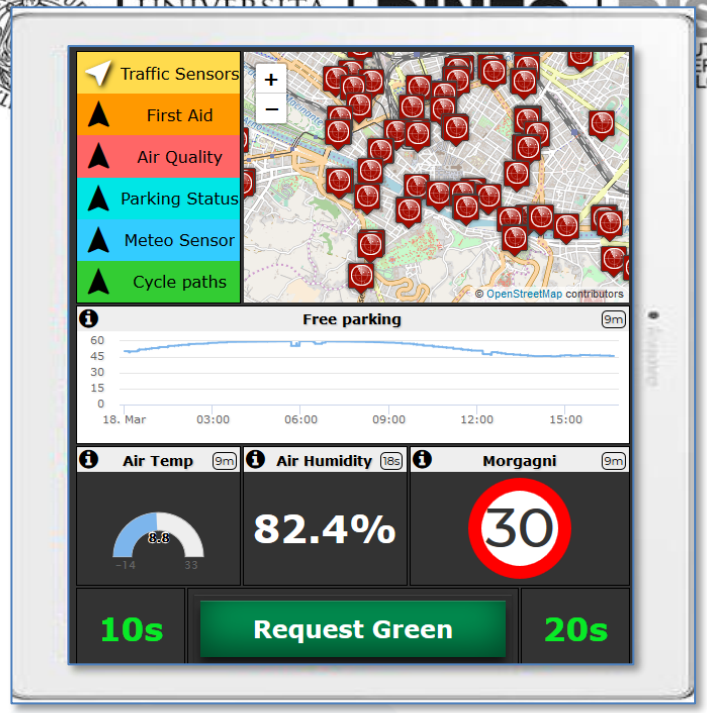
Control Room

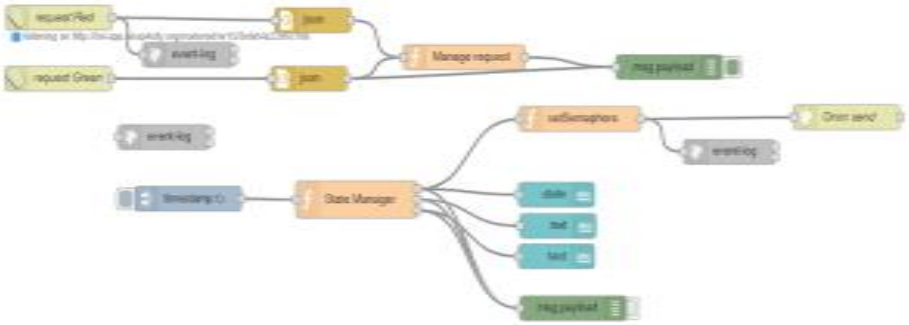
Local Control Dashboard





Safe and resilient solution manging Degradated conditions


Traffic Sensors
First Aid
Air Quality
Parking Status
Meteo Sensor
Cycle paths
© OpenStreetMap contributors
Free parking
9m
60
45
30
15
0
18. Mar
03:00
06:00
09:00
12:00
15:00
Air Temp
9m
Air Humidity
18s
82.4%
Morgagni
9m
30
10s
Request Green
20s







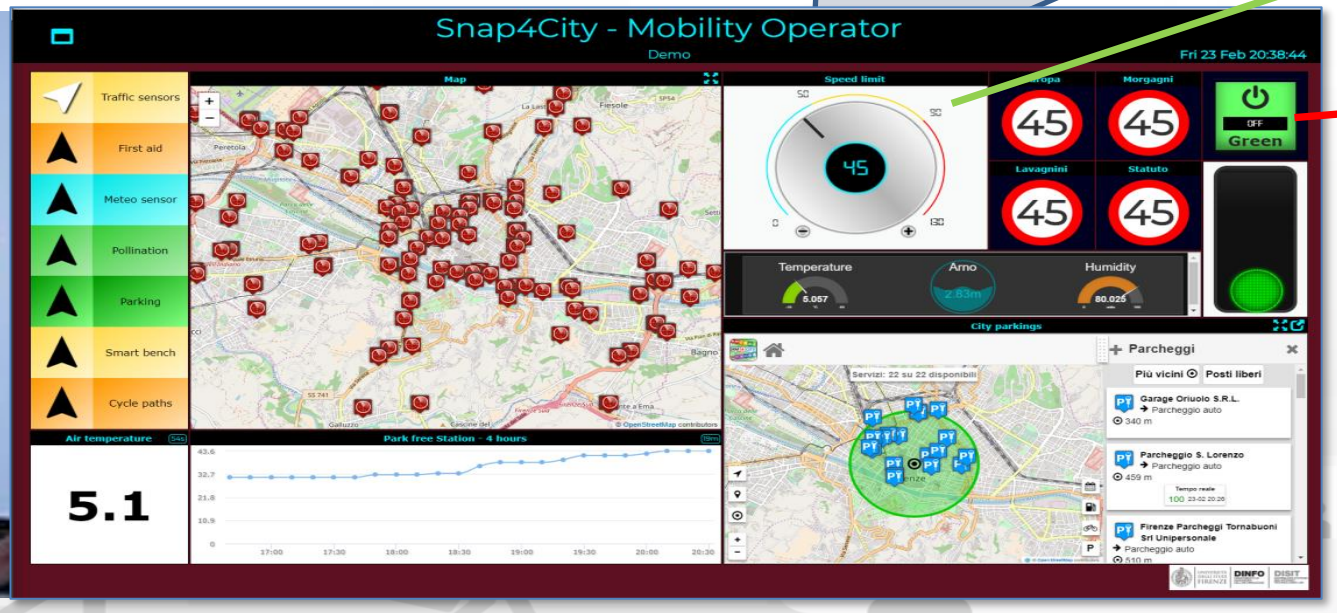

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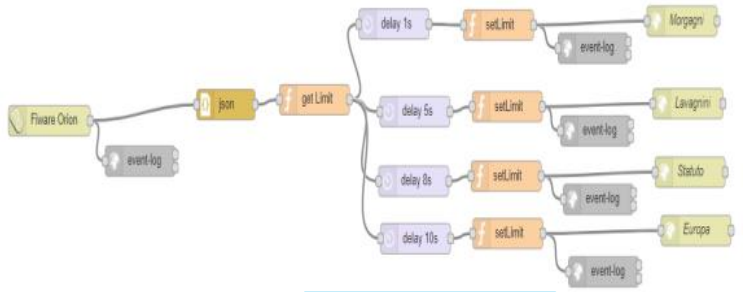

30


30


30




Snap4City - Mobility Operator
Demo
Fri 23 Feb 20:38:44
Traffic sensors
First aid
Meteo sensor
Pollination
Parking
Smart bench
Cycle paths
Map
Speed limit
45
Europa
45
Morgagni
45
Lavagnini
45
Statuto
45
OFF
Green
Temperature
6.057
Arno
Humidity
80.025
City parkings
Parcheggi
Più vicini
Posti liberi
Garage Oriuolo S.R.L.
Parcheggio S. Lorenzo
Firenze Parcheggi Tornabuoni Srl Unipersonale
Air temperature
5.1
Park free Station - 4 hours

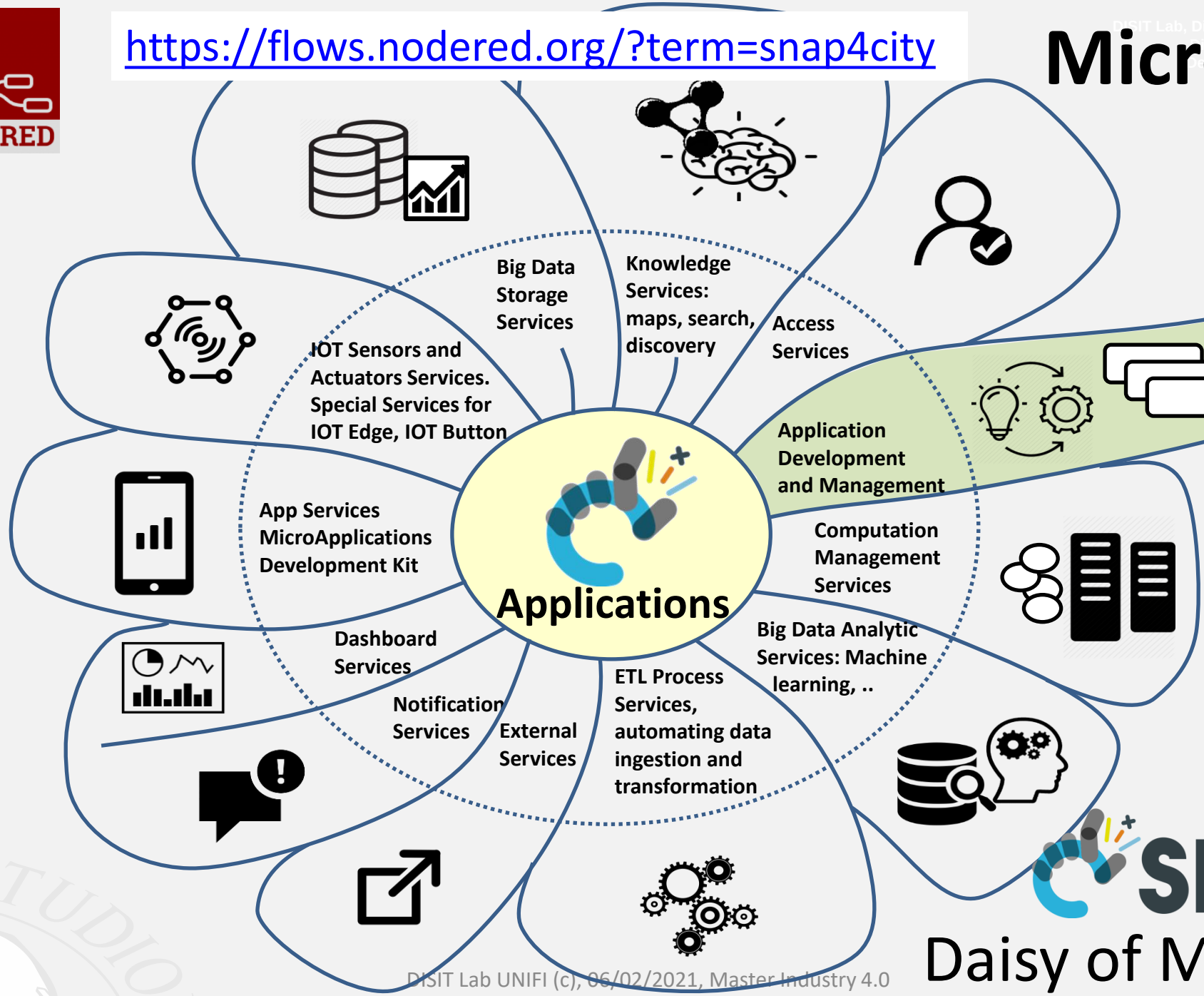

Fiware Orion
event-log
json
get Limit
delay 1s
delay 5s
delay 8s
delay 10s
setLimit
setLimit
setLimit
setLimit
event-log
event-log
event-log
event-log
Morgagni
Lavagnini
Statuto
Europa

- input
- output
- function
- social
- storage
- analysis
- advanced
- Iwm2m
- S4CSearchDev
- S4CMapping
- S4CManagement
- S4CDataAnalytic
- S4CBigData
- S4CSearch
- S4CData
- S4CDashboard
- S4CSigfox
- S4CIoT
- S4CLogDev
- S4CView
- S4CSocial
- location
- dashboard

Node-RED

https://flows.nodered.org/?term=snap4city

MicroServices Areas



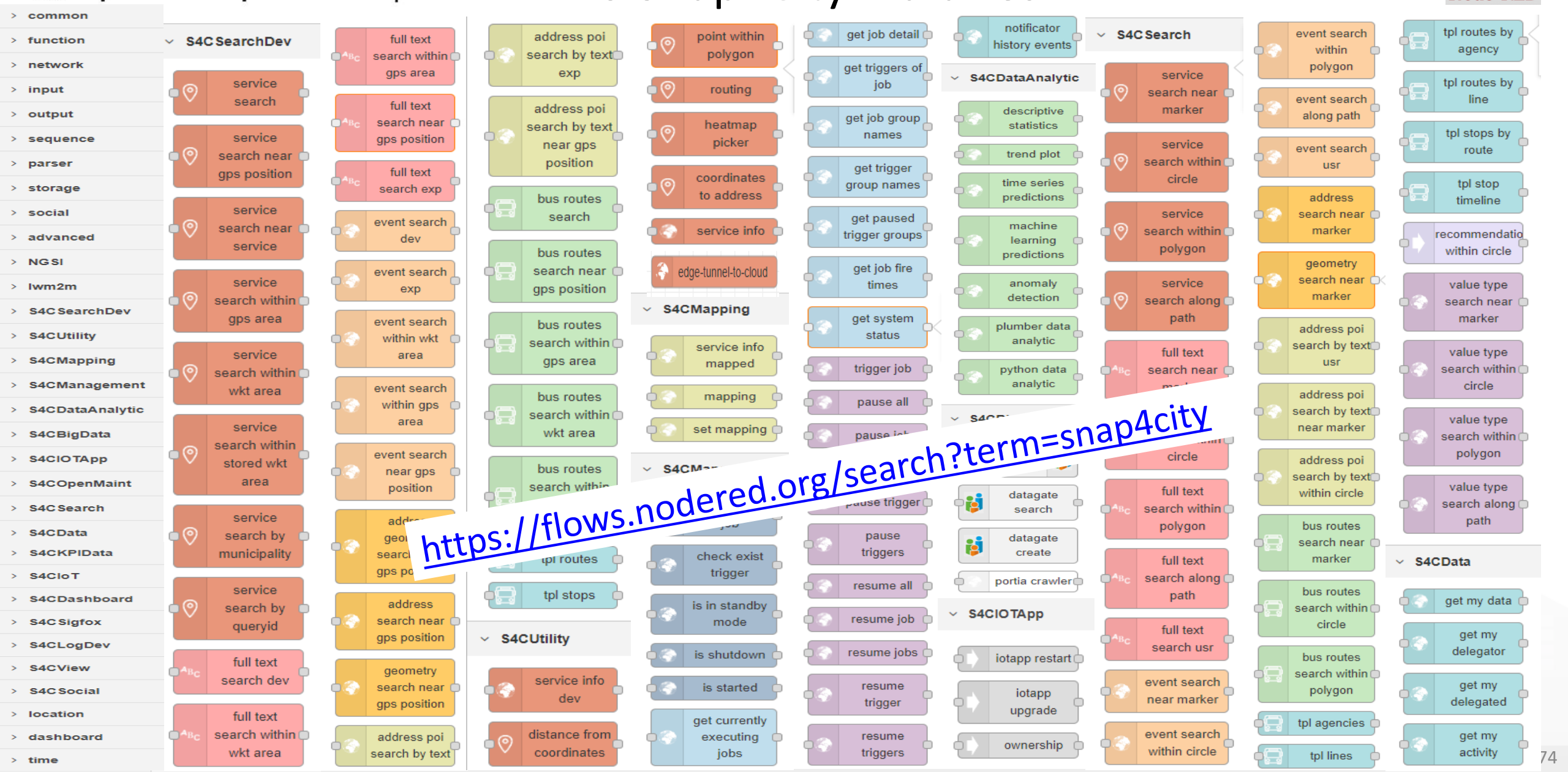
SNAP4CITY

Daisy of MicroServices

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

Nov. 2020 collection
Two Snap4City Libraries

SNAP4CITY | Node-RED

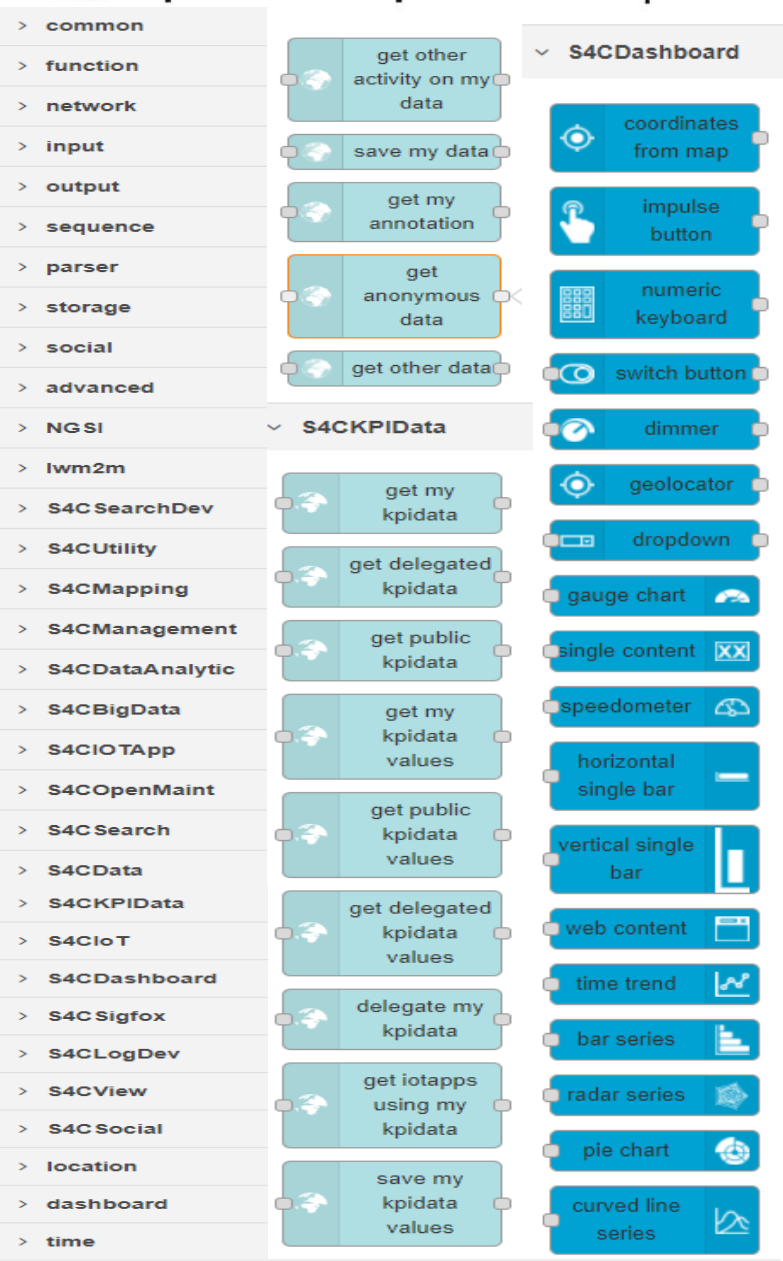


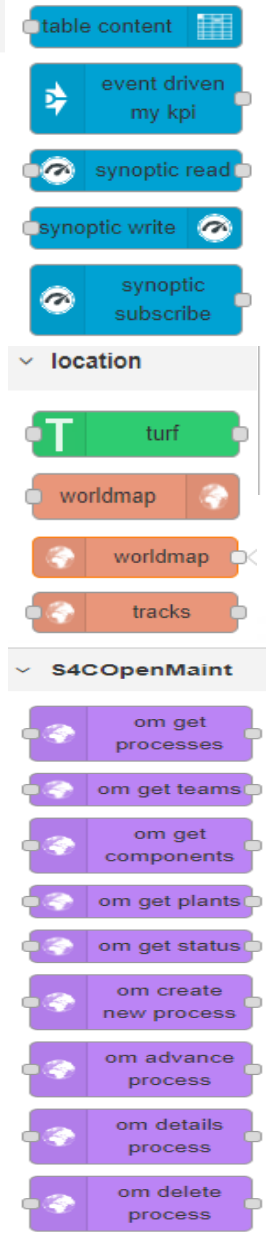
https://flows.nodered.org/search?term=snap4city

Nov. 2020 collection

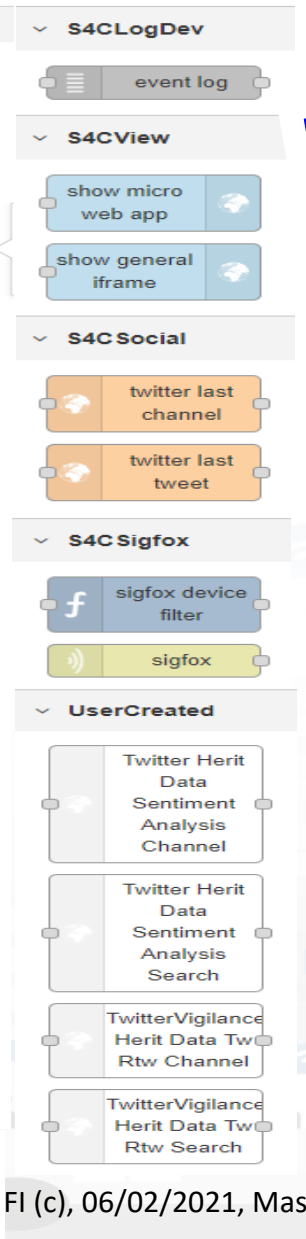
Two Snap4Citv Libraries

https://flows.nodered.org/search?term=snap4city

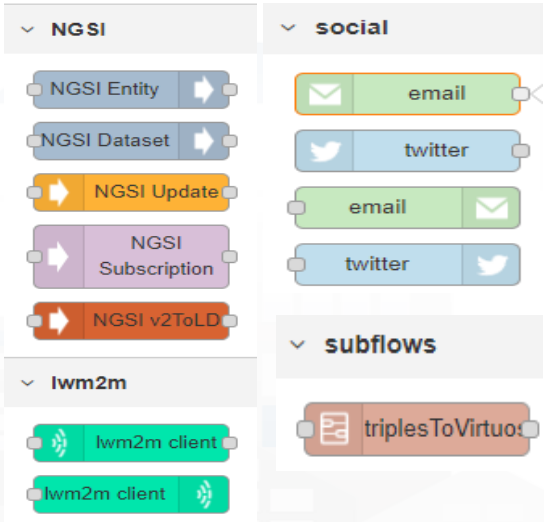






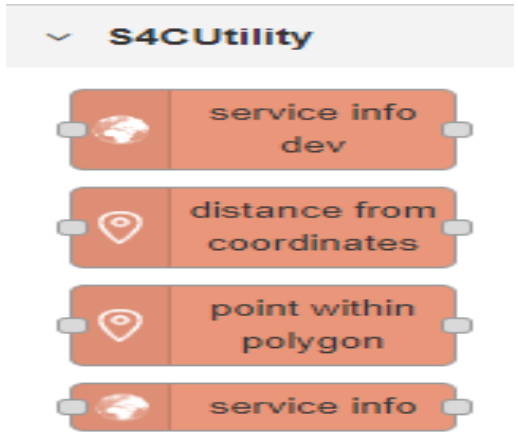


We suggest also to install:

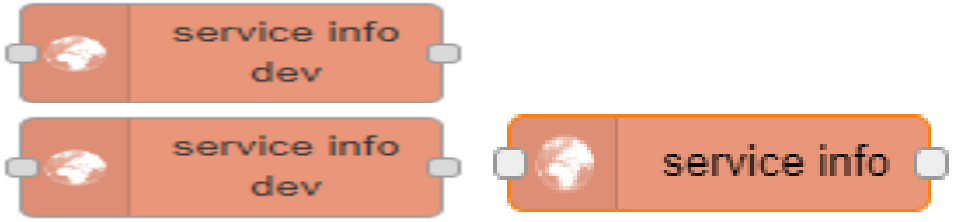


S4CSearch

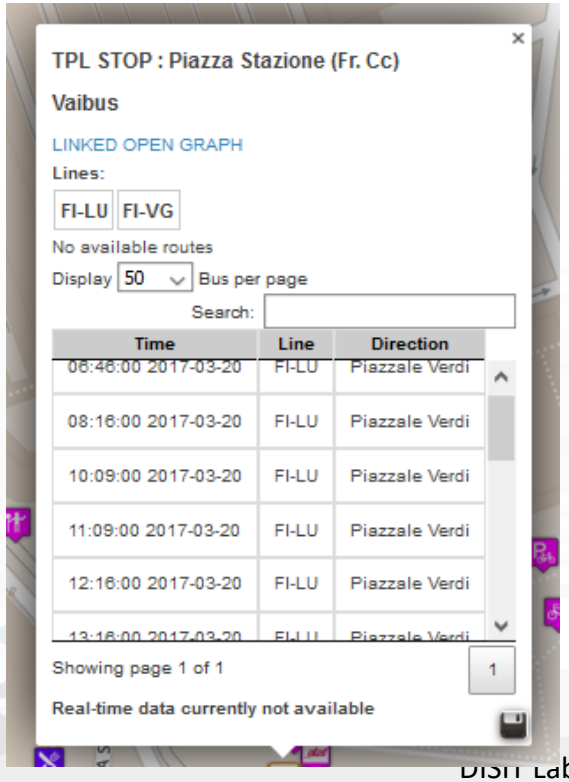
Node-RED

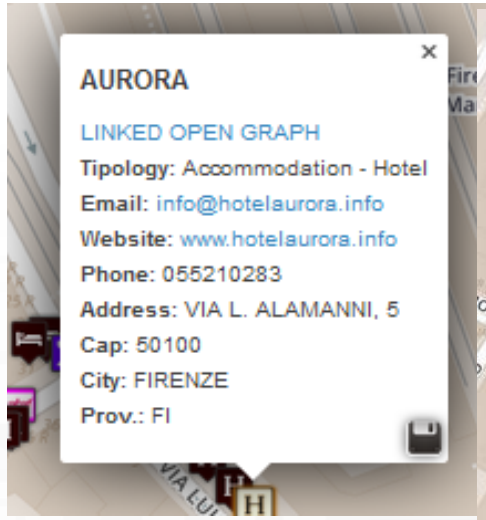


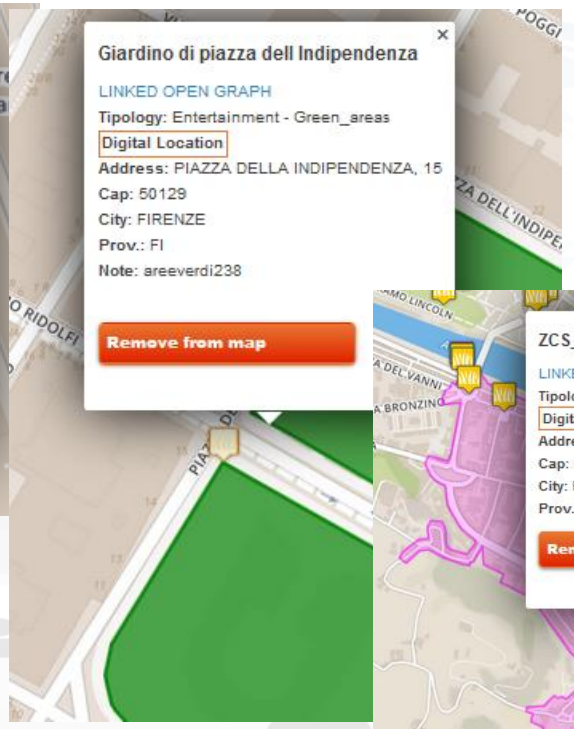
- ANY kind of sensors
- **To Get DATA of a Service / POI /sensor**
  - Historical and real time
  - Real Time

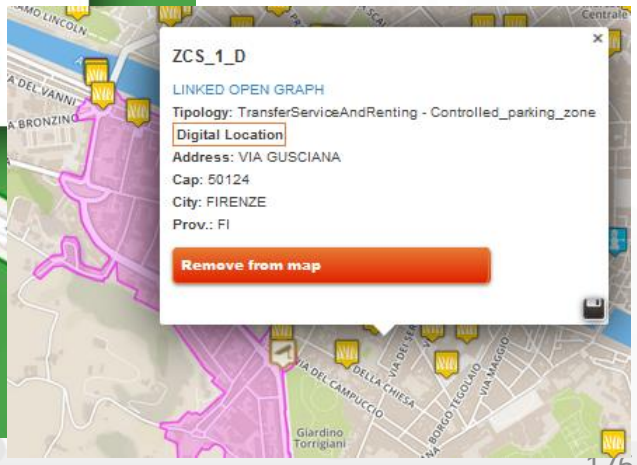


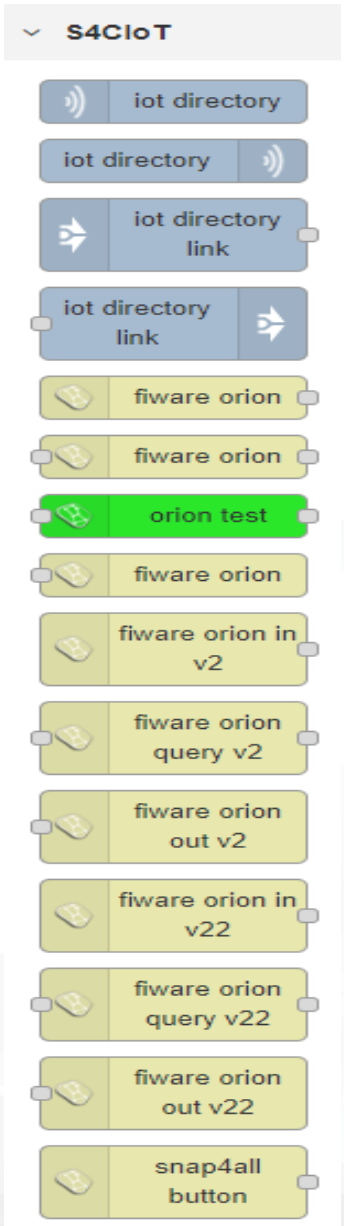






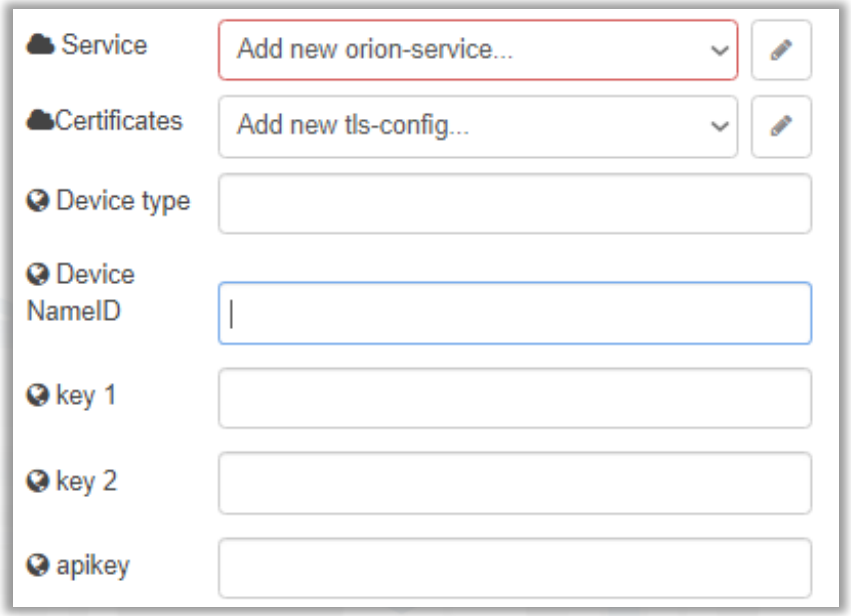






- **Search** for IOT Devices in a given area, or for kind (temperature, model, location, producer, Broker, …)
- **Subscribe** to one or more IOT Devices independently on their protocol, broker, owner, etc.
- **Send** data to IOT devices
- Establish with IOT Devices **Secure** certified Connections

Node-RED



- Please note that many other protocols can be also added, adding mode nodes, or registering IOT brokers to the Snap4City IOT Directory



IoT Data from the move



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BY NC ND

PaxCounter devices







- Fixed PaxCounter LoraWan
  - Based on Wi-Fi- Bluetooth
- Mobile PaxCounter LoraWan
  - Based on Wi-Fi- Bluetooth
- Fixed PaxCounter(LoraWan+Wifi out)
  - Based on Wi-Fi- Bluetooth

LoRa® Wi Fi Bluetooth™

https://www.snap4city.org/drupal/node/456

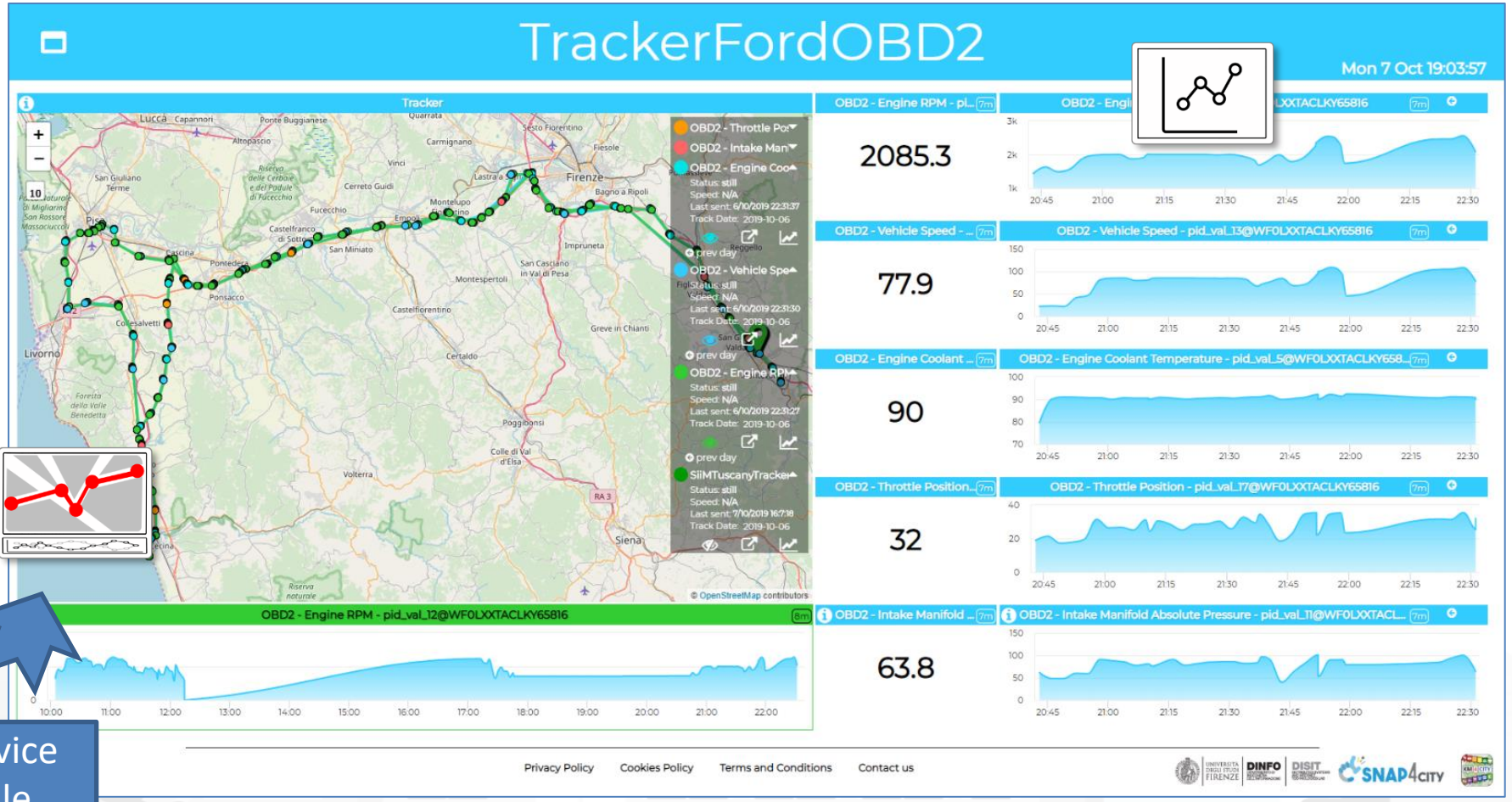
Programmable PAX counting



MyKPI: Tracking of Devices and Mobiles

- Real Time Trajectories for
  - Mobile Phone
  - Moving IOT Devices
  - OBU, Vehicular Kits
  - Multiple tracks
  - Day by day
- Micro Application





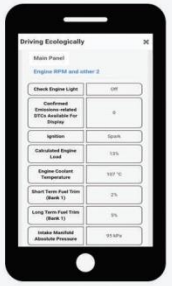
IOE – Vehicle Monitoring

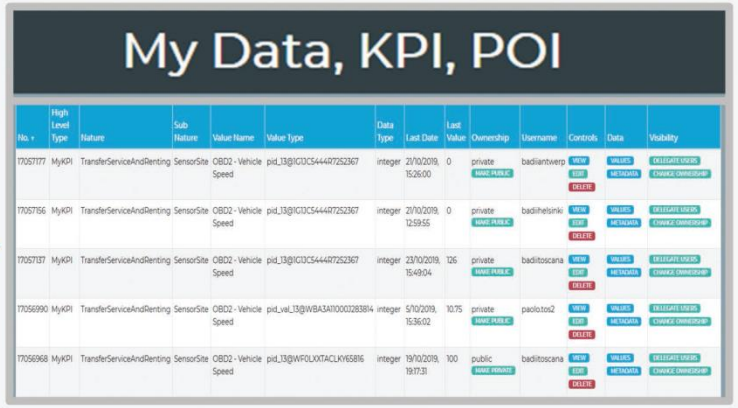


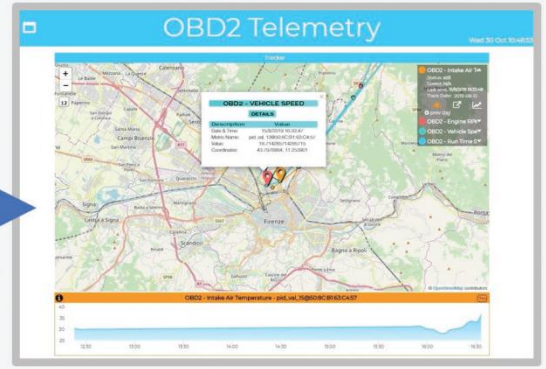
CANBUS sniffer



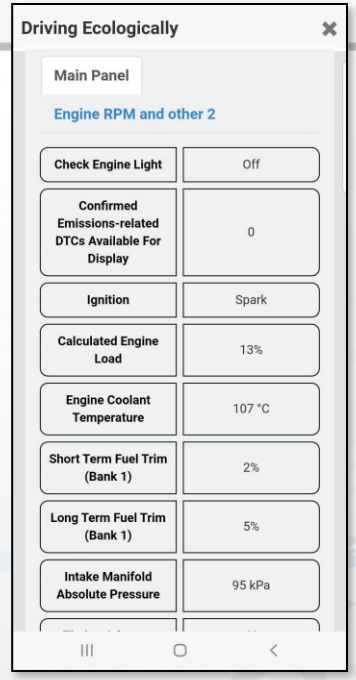
Bluetooth

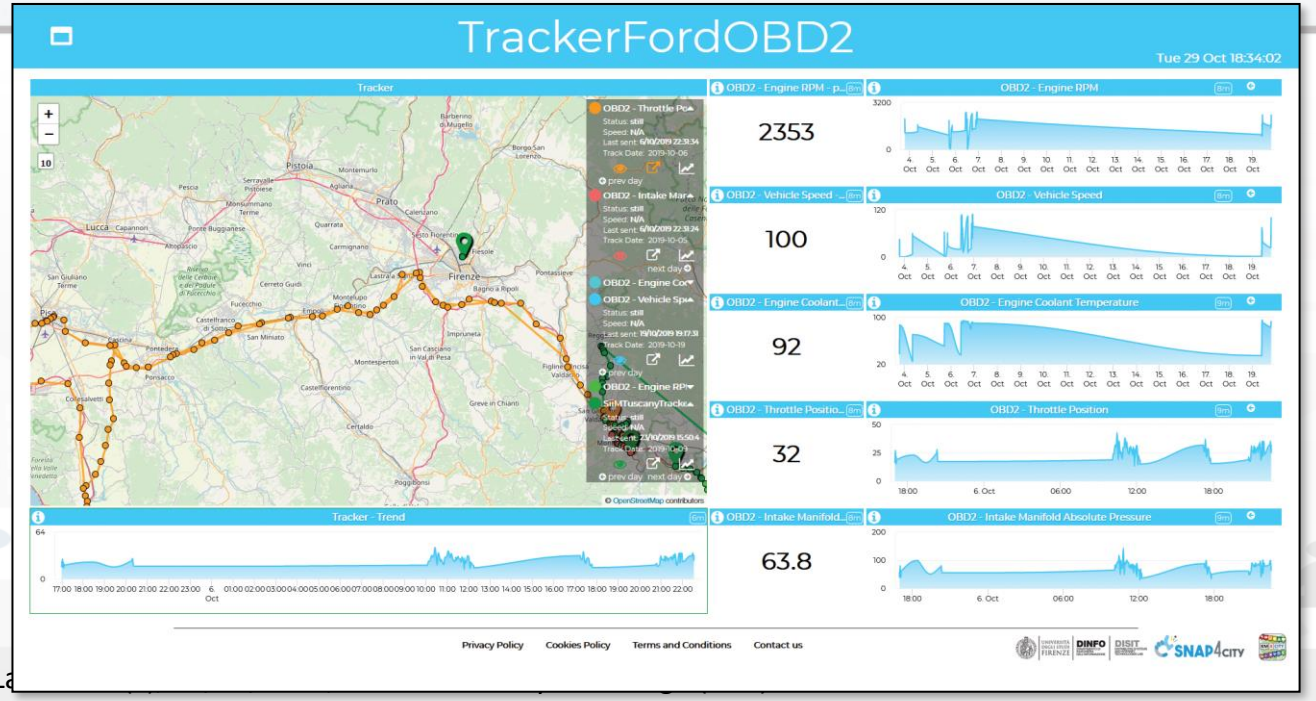






Tuscany in a Snap Mobile App on Android



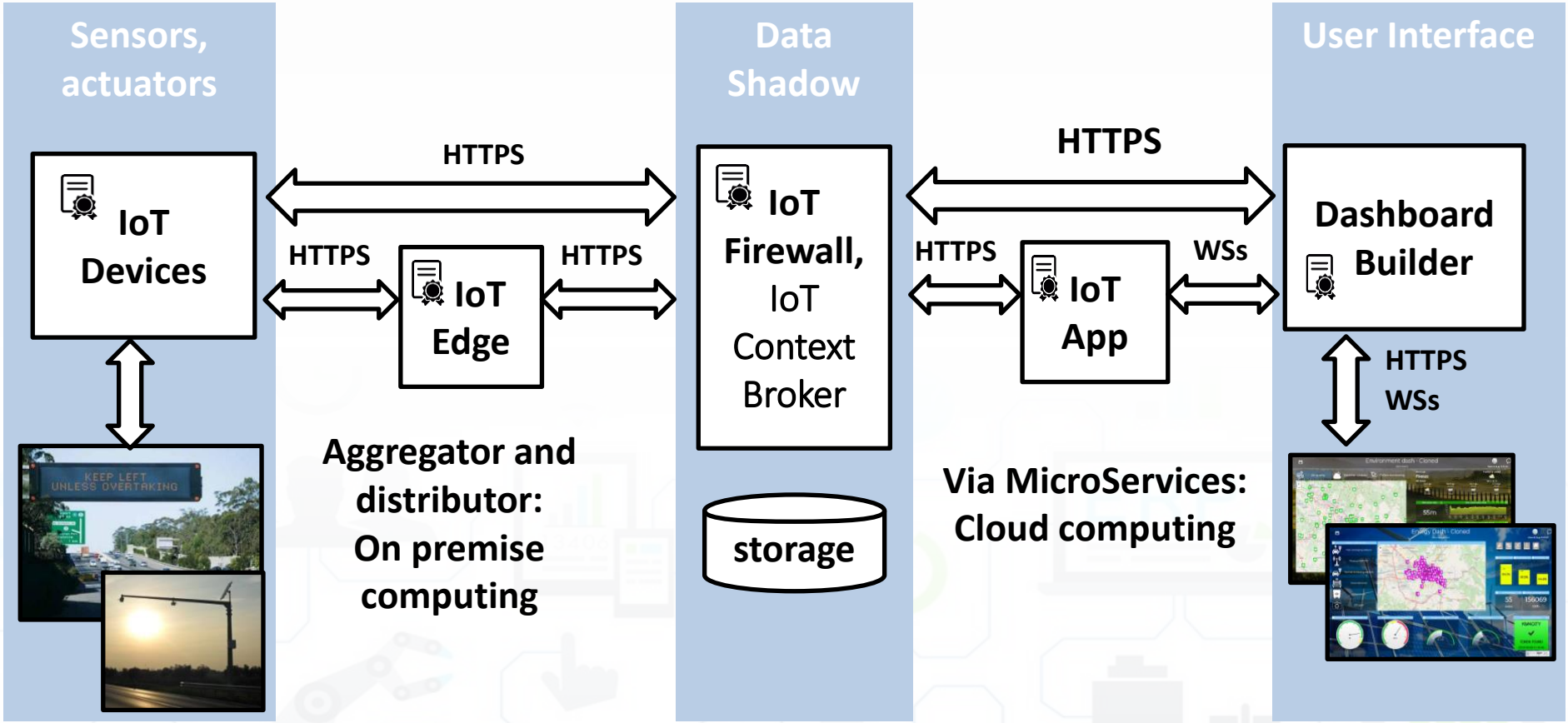


IoT Security

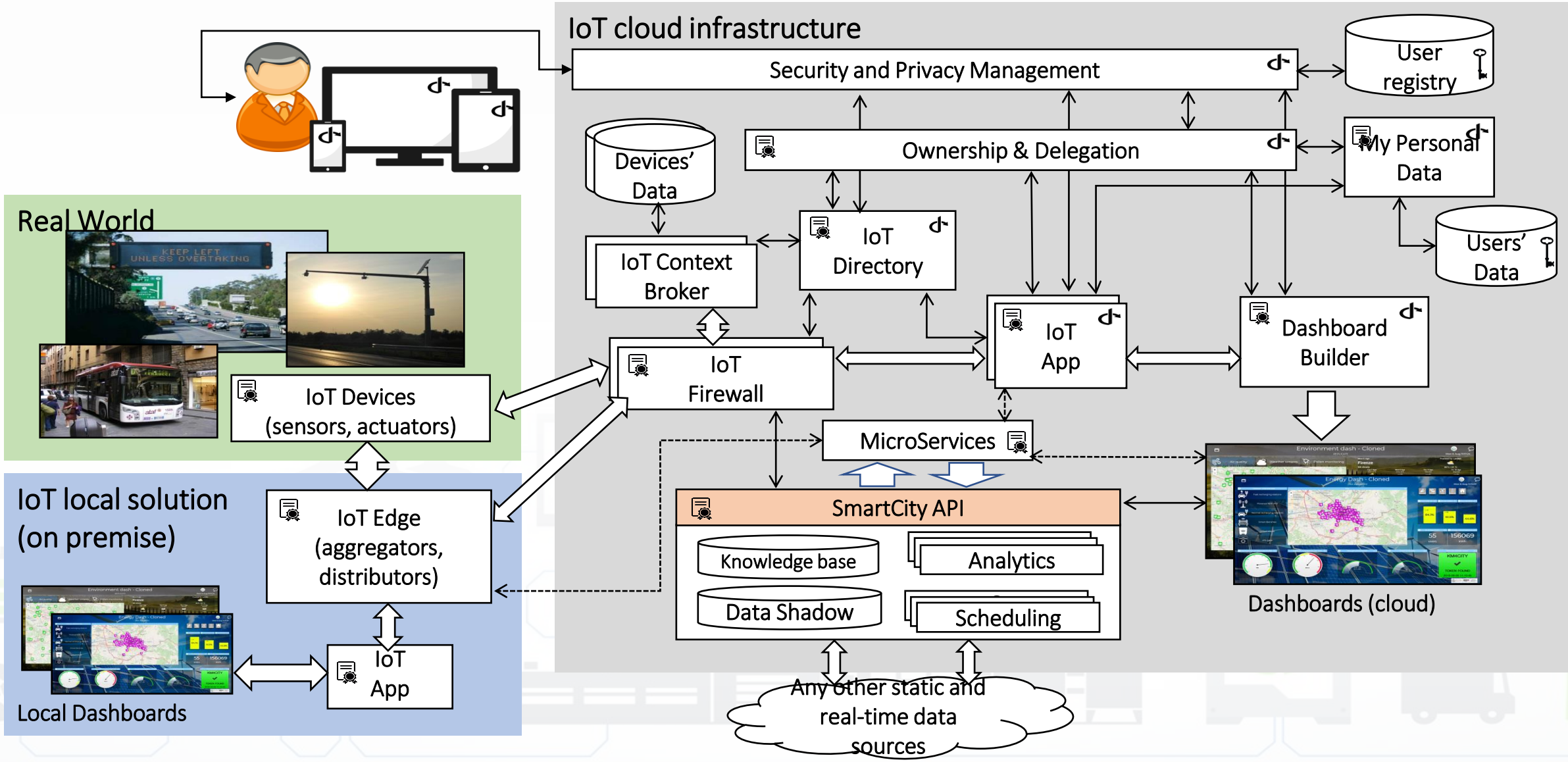


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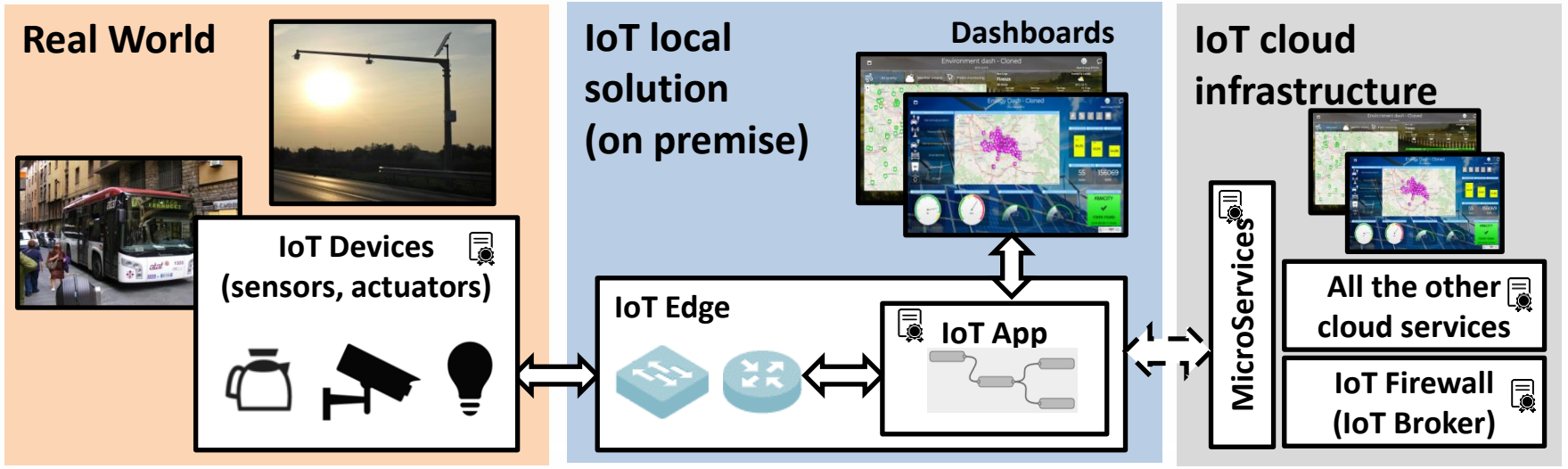
The secure stack

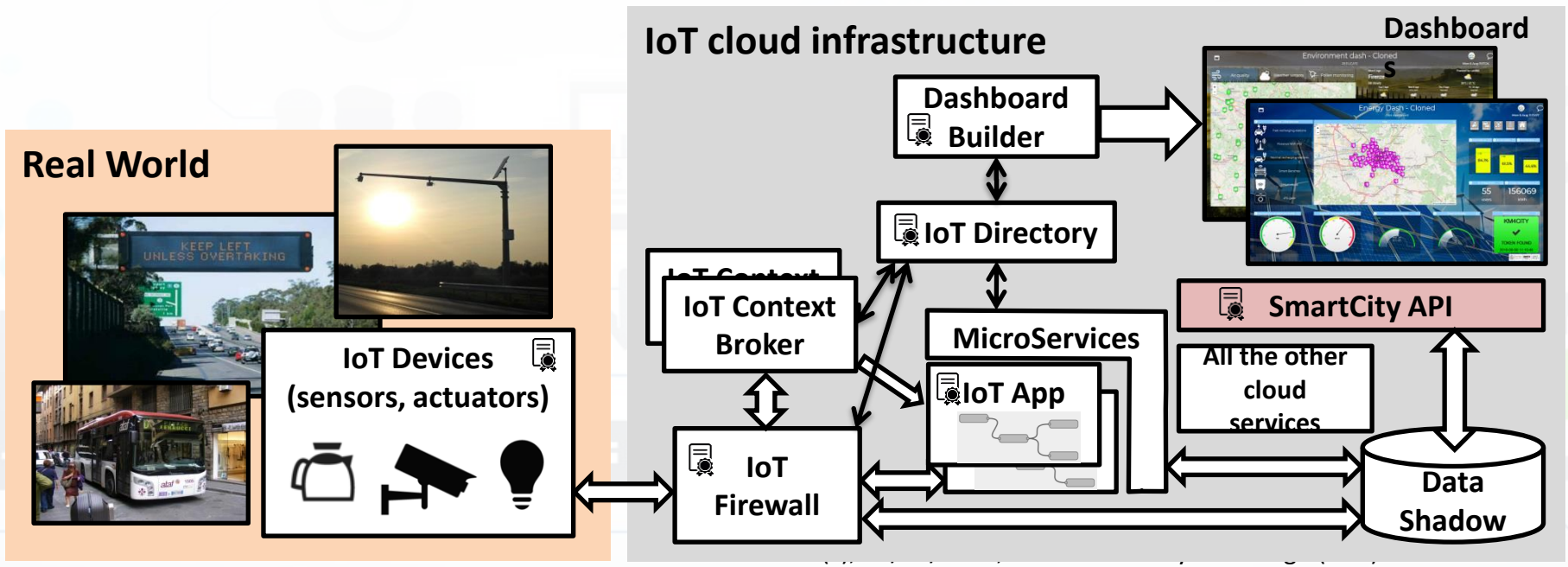


Secure Architecture



OnPremise vs Cloud

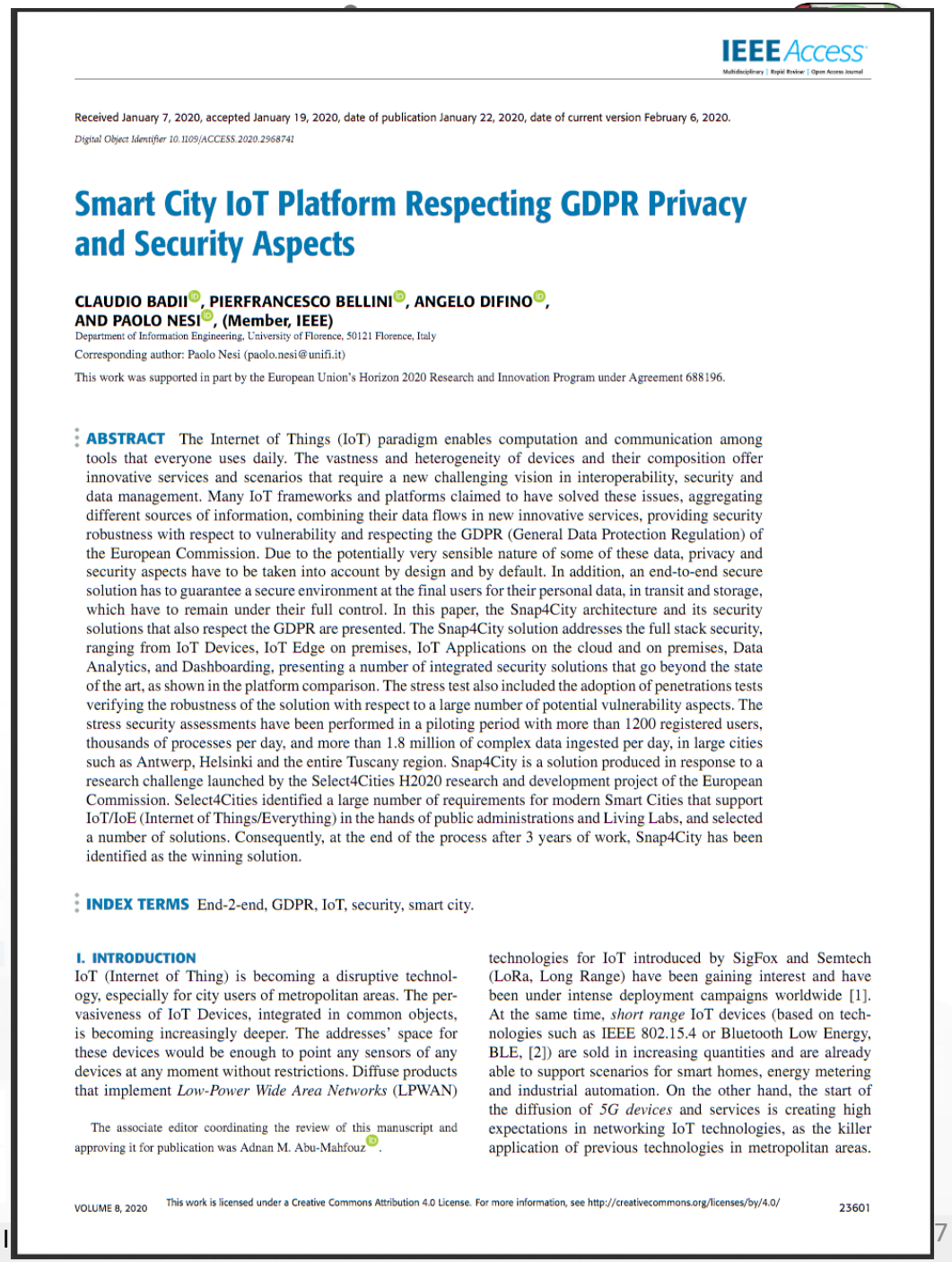




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IEEE Access

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Digital Object Identifier 10.1109/ACCESS.2020.2968741

Smart City IoT Platform Respecting GDPR Privacy and Security Aspects

CLAUDIO BADII, PIERFRANCESCO BELLINI, ANGELO DIFINO, AND PAOLO NESI, (Member, IEEE)

Department of Information Engineering, University of Florence, 50121 Florence, Italy

Corresponding author: Paolo Nesi (paolo.nesi@unifi.it)

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ABSTRACT The Internet of Things (IoT) paradigm enables computation and communication among tools that everyone uses daily. The vastness and heterogeneity of devices and their composition offer innovative services and scenarios that require a new challenging vision in interoperability, security and data management. Many IoT frameworks and platforms claimed to have solved these issues, aggregating different sources of information, combining their data flows in new innovative services, providing security robustness with respect to vulnerability and respecting the GDPR (General Data Protection Regulation) of the European Commission. Due to the potentially very sensible nature of some of these data, privacy and security aspects have to be taken into account by design and by default. In addition, an end-to-end secure solution has to guarantee a secure environment at the final users for their personal data, in transit and storage, which have to remain under their full control. In this paper, the Snap4City architecture and its security solutions that also respect the GDPR are presented. The Snap4City solution addresses the full stack security, ranging from IoT Devices, IoT Edge on premises, IoT Applications on the cloud and on premises, Data Analytics, and Dashboarding, presenting a number of integrated security solutions that go beyond the state of the art, as shown in the platform comparison. The stress test also included the adoption of penetrations tests verifying the robustness of the solution with respect to a large number of potential vulnerability aspects. The stress security assessments have been performed in a piloting period with more than 1200 registered users, thousands of processes per day, and more than 1.8 million of complex data ingested per day, in large cities such as Antwerp, Helsinki and the entire Tuscany region. Snap4City is a solution produced in response to a research challenge launched by the Select4Cities H2020 research and development project of the European Commission. Select4Cities identified a large number of requirements for modern Smart Cities that support IoT/IoE (Internet of Things/Everything) in the hands of public administrations and Living Labs, and selected a number of solutions. Consequently, at the end of the process after 3 years of work, Snap4City has been identified as the winning solution.

INDEX TERMS End-2-end, GDPR, IoT, security, smart city.

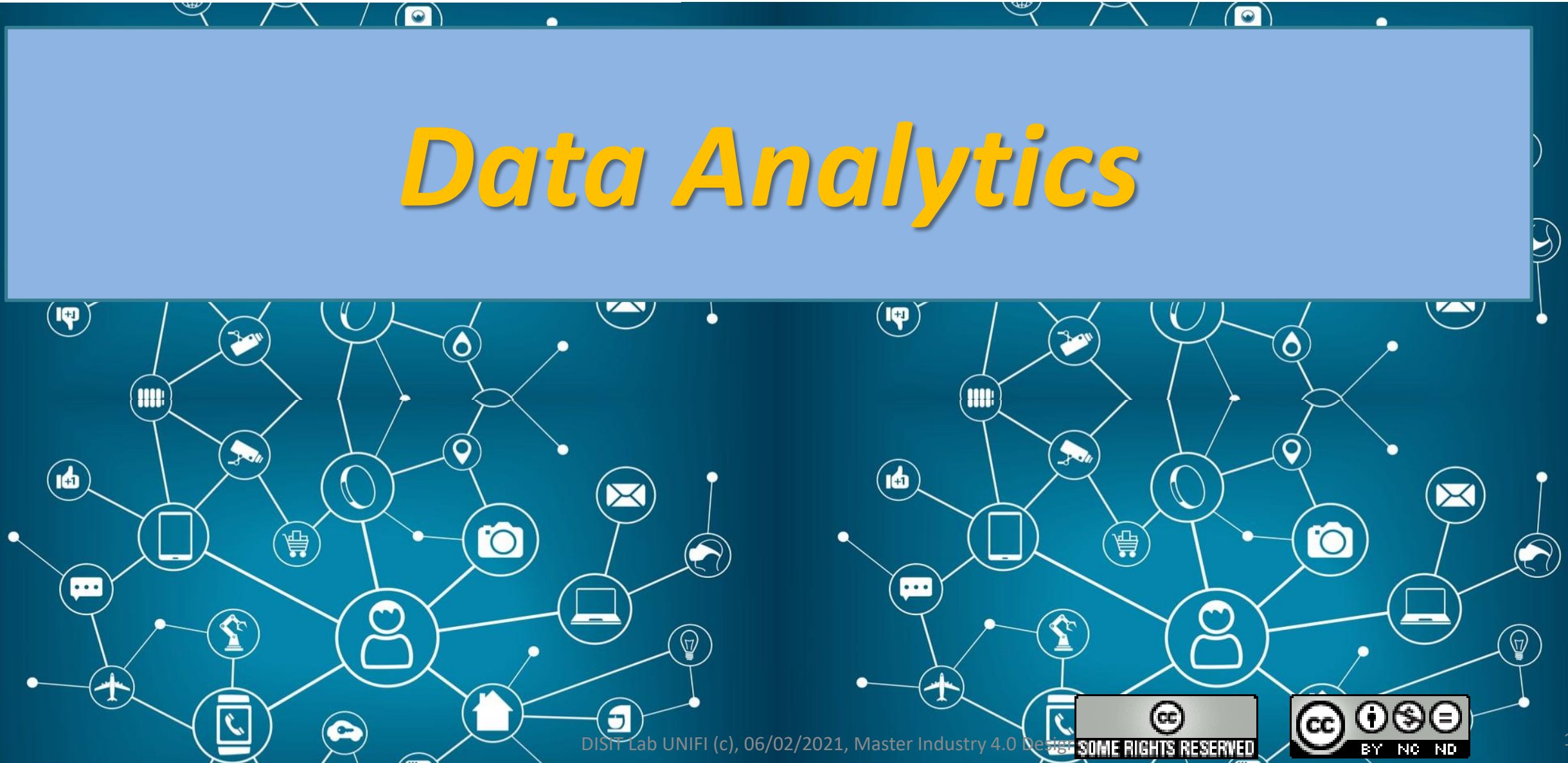
I. INTRODUCTION

IoT (Internet of Thing) is becoming a disruptive technology, especially for city users of metropolitan areas. The pervasiveness of IoT Devices, integrated in common objects, is becoming increasingly deeper. The addresses' space for these devices would be enough to point any sensors of any devices at any moment without restrictions. Diffuse products that implement *Low-Power Wide Area Networks* (LPWAN) technologies for IoT introduced by SigFox and Semtech (LoRa, Long Range) have been gaining interest and have been under intense deployment campaigns worldwide [1]. At the same time, *short range* IoT devices (based on technologies such as IEEE 802.15.4 or Bluetooth Low Energy, BLE, [2]) are sold in increasing quantities and are already able to support scenarios for smart homes, energy metering and industrial automation. On the other hand, the start of the diffusion of *5G devices* and services is creating high expectations in networking IoT technologies, as the killer application of previous technologies in metropolitan areas.

The associate editor coordinating the review of this manuscript and approving it for publication was Adnan M. Abu-Mahfouz.

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Data Analytics



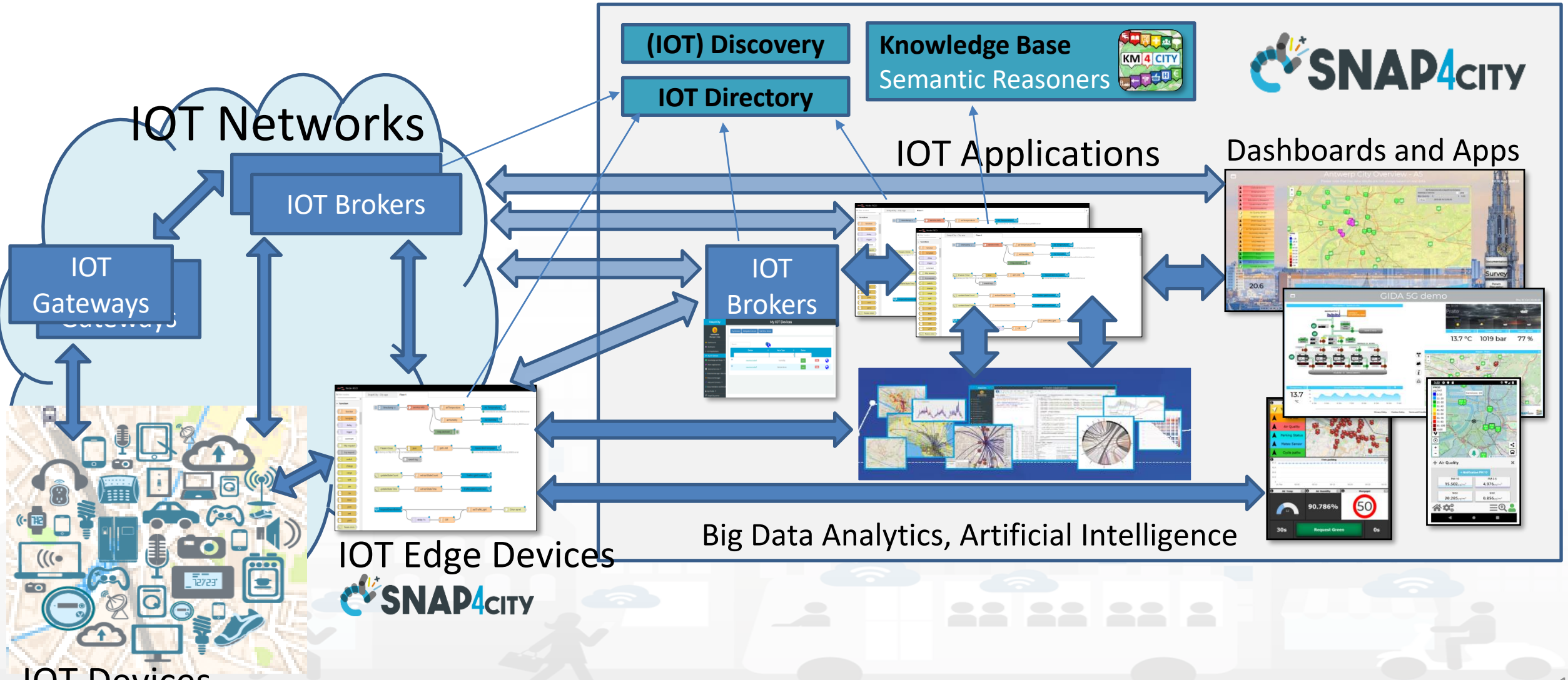
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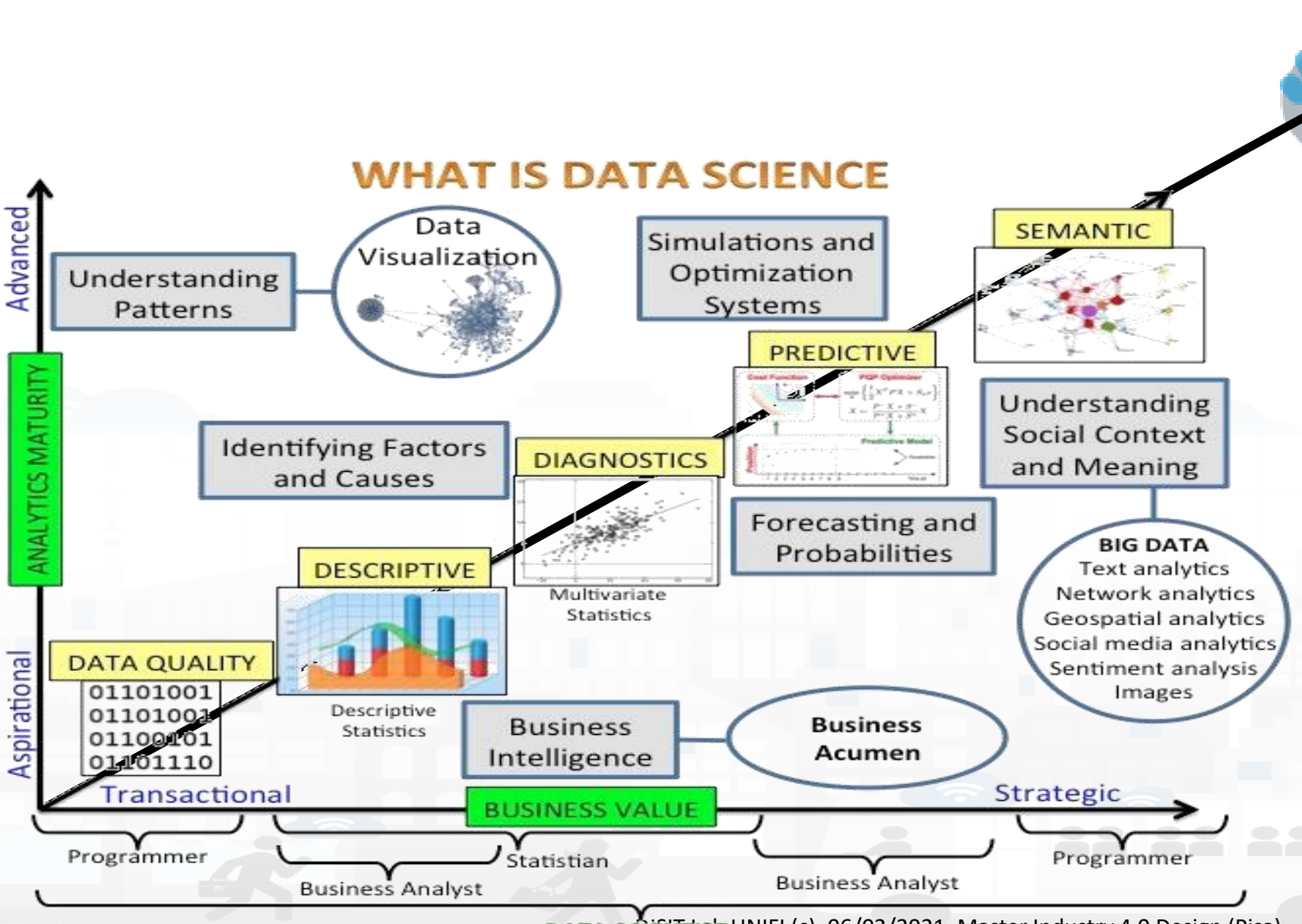
Agenda

- Big Data Architecture
- Data Warehouse
- Data Storage
- Data Processing
- **Data Analytics**
- Visual Analytics
- Dashboards
- Living lab for Collaborative work
- Deploy and Install Snap4 .. Solutions
- Acknowledgment

- Developing and Exploiting Data Analytics as MicroServices
- Smart Parking
- User Behaviour Analysis
- Traffic Flow Reconstruction
- Environmental Data: Predictions, Early Warning
- Anomaly Detection
- Intelligence on Maintenance Data
- Suggestions for Retail
- Predicting ReTweet Proneness

Snap4City: IOT Directory and data/device Discovery



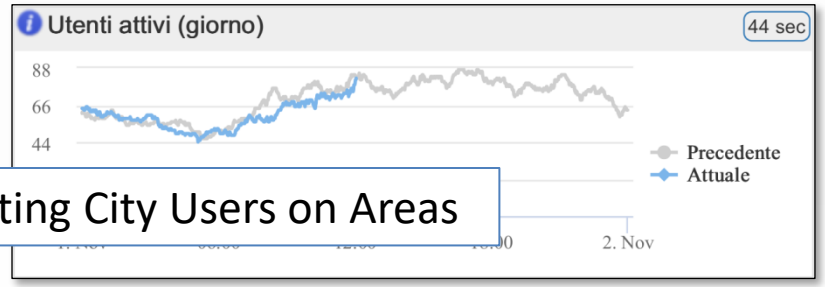


Sentient and active processes

- Big Data
- What If Analysis
- Semantic Computing
- Machine Learning
- Geo Spatial Reasoning
- Sentiment Analysis
- Text Analysis
- Simulations
- Visual Analytics
- Engagement Analysis
- Predictions
- Anomaly detections
- MicroServices
- Scalability
- ....

Predicting Models

- **Aiming at improving**
  - quality of service, distributing workload
  - early warning
- **Predictions**: **Short** (15 min, 30 Min) and mid Term (1 week)
- **Data Analytics**: ML, NLP/SA, Clust., …
  - Traffic Flows → multi-flow reconstruction
  - Parking Status → free slots
  - Environmental Alarms
  - Air Quality parameters and indexes
  - People Flows (Wi-Fi, Twitter) → crowd , #number of people



Predicting City Users on Areas

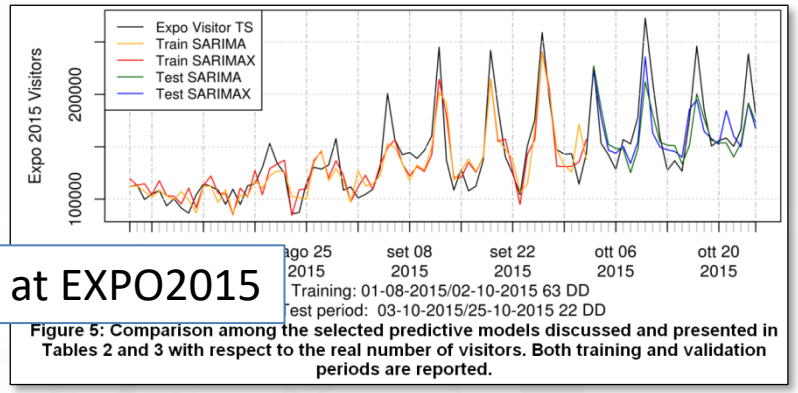
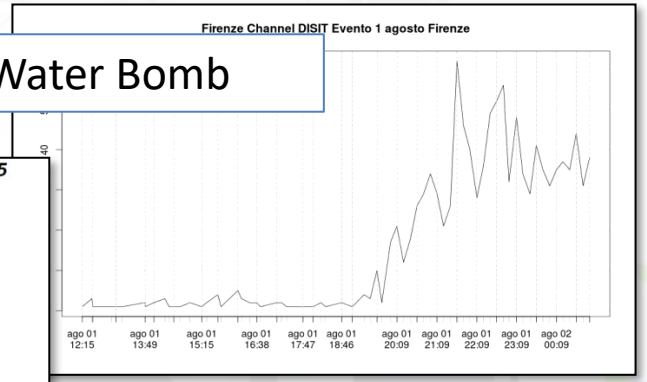
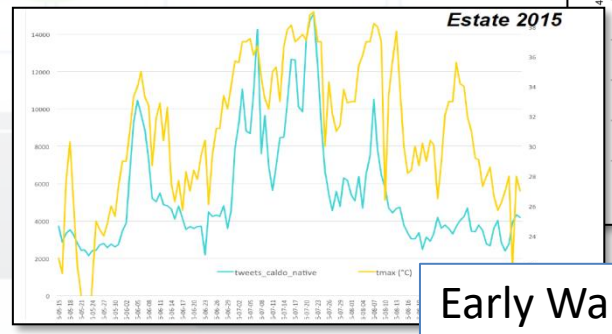


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.

Predicting at EXPO2015



Early Warning Water Bomb



Early Warning Hot in Tuscany

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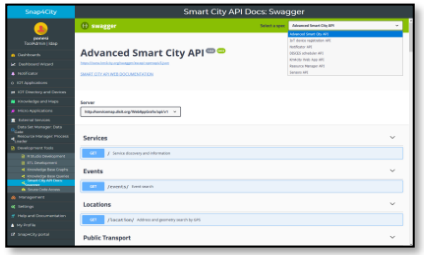
Developing and Exploiting Data Analytics as MicroServices



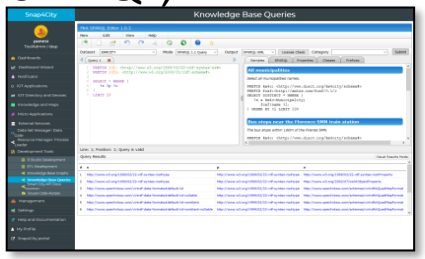
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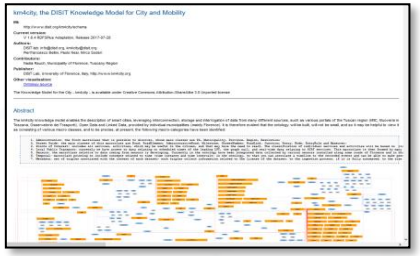
Data Analytics Dev. in R Studio and/or Tensor Flow

Swagger



SPARQL, FLINT





Ontology Schema



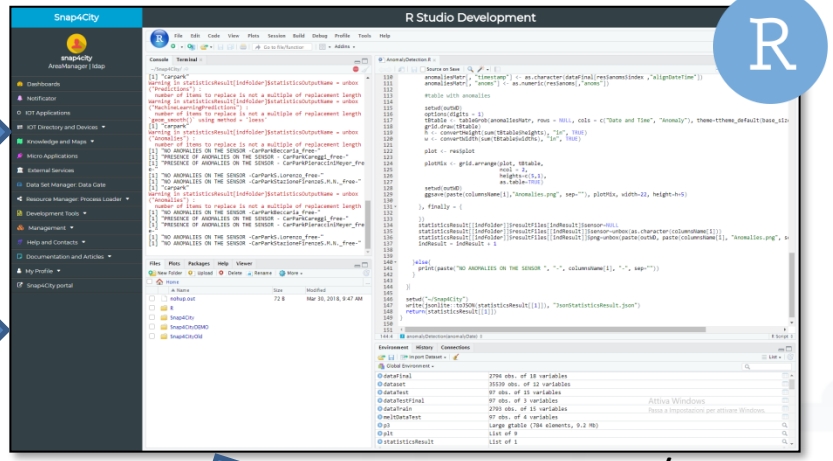
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Knowledge Base, Km4City



Big Data Store Facility

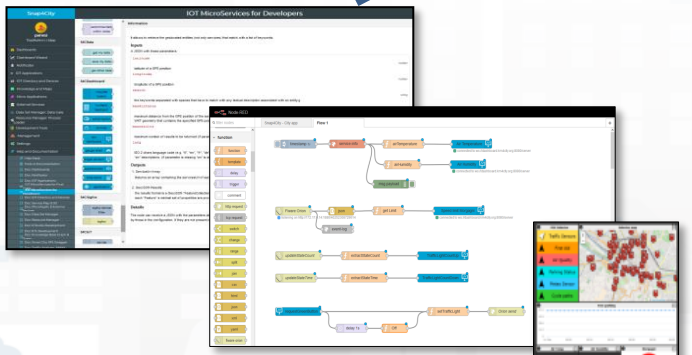
Smart City API from Knowledge Base and other tools



R Studio



Creating MicroServices



Using them into IOT Applications

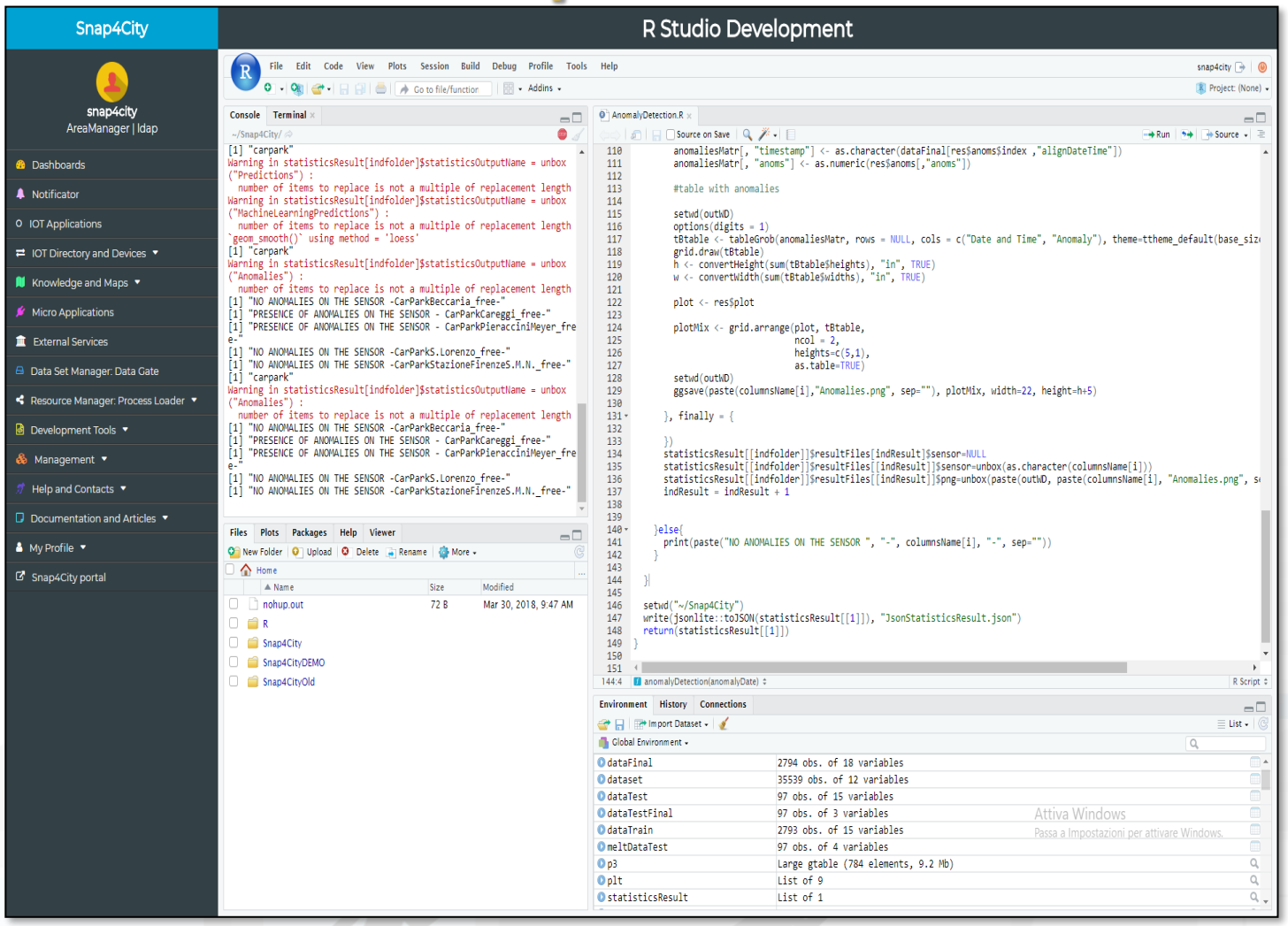
Saving / Sharing reusing



Resource Manager



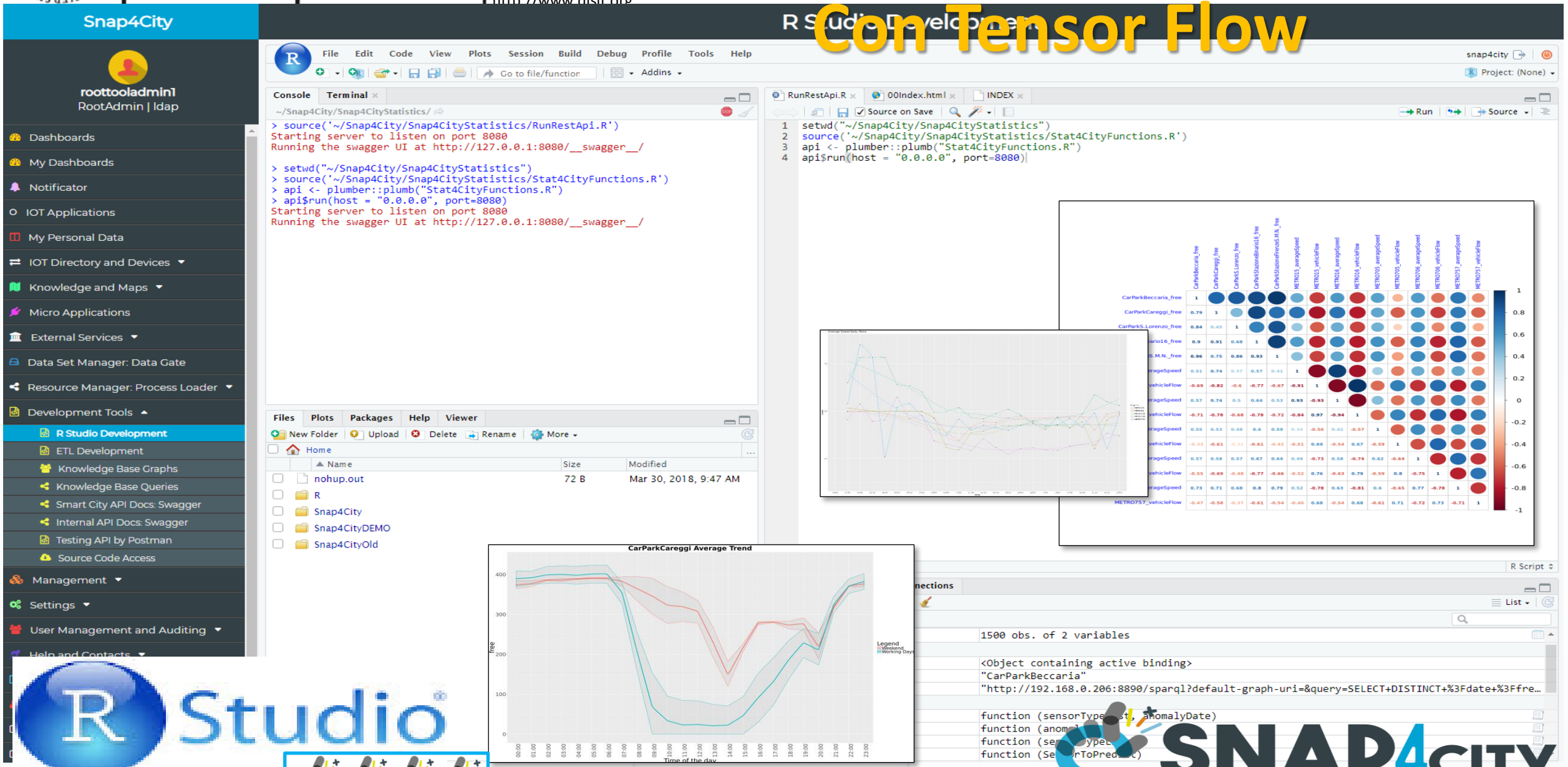
Developer in R Studio + Tensor Flow



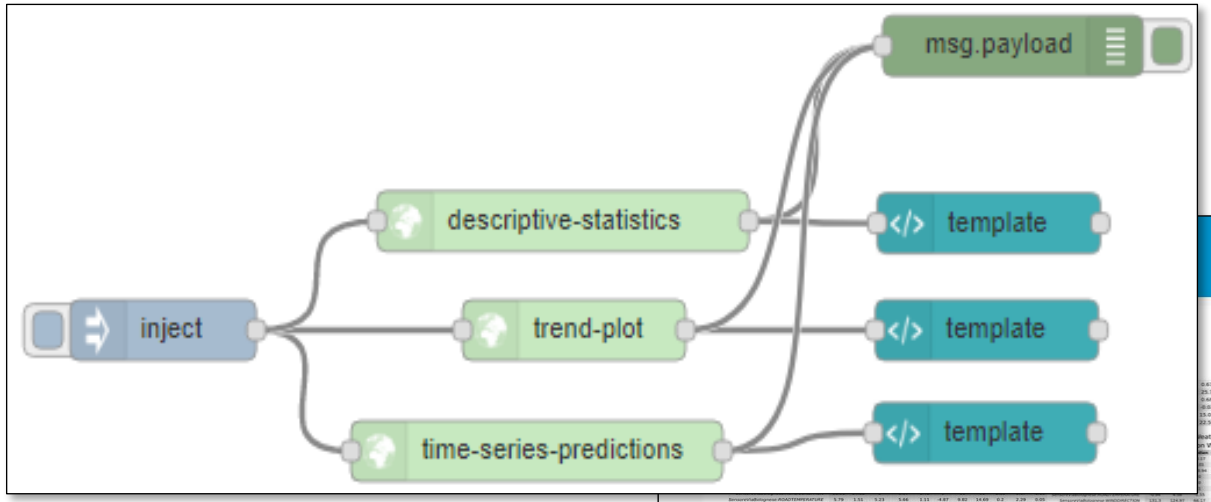


Data Analytics in R Studio Con Tensor Flow

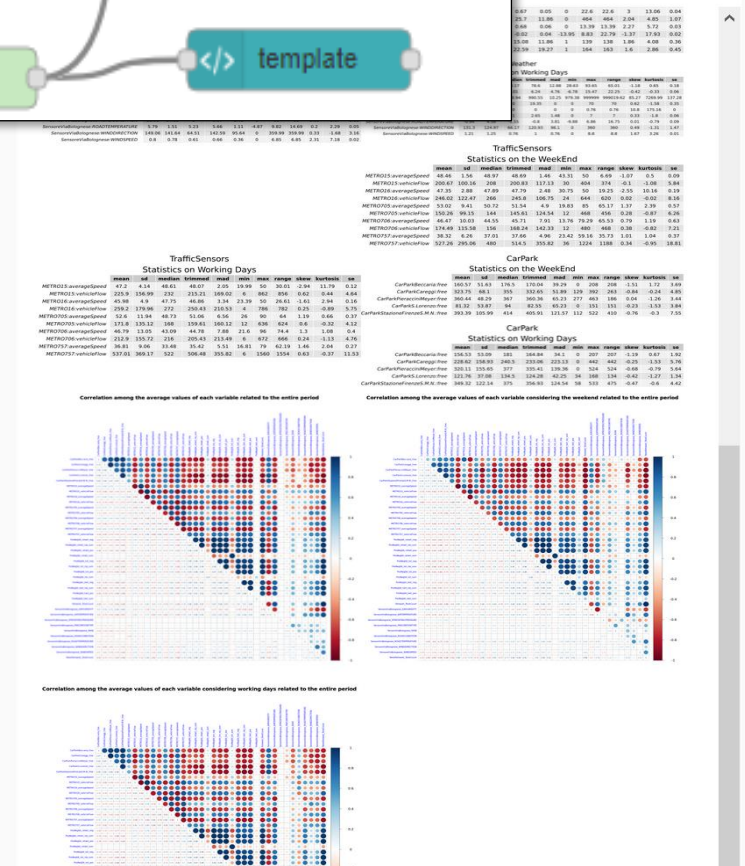
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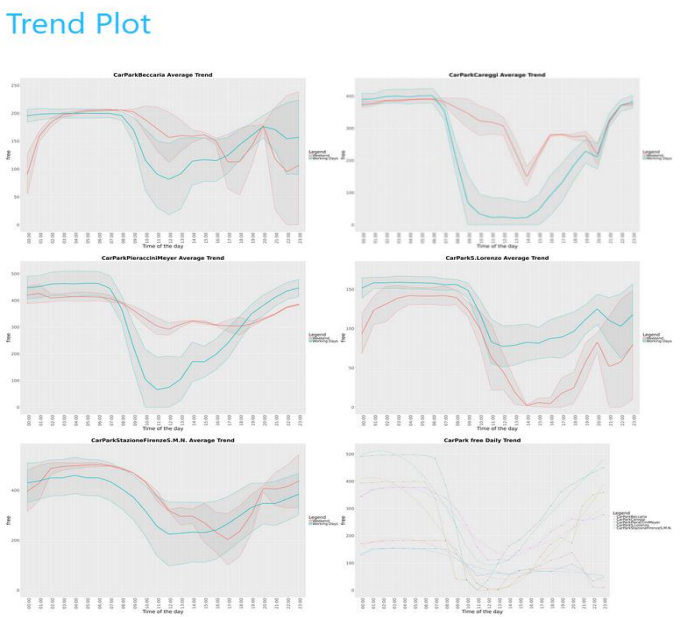


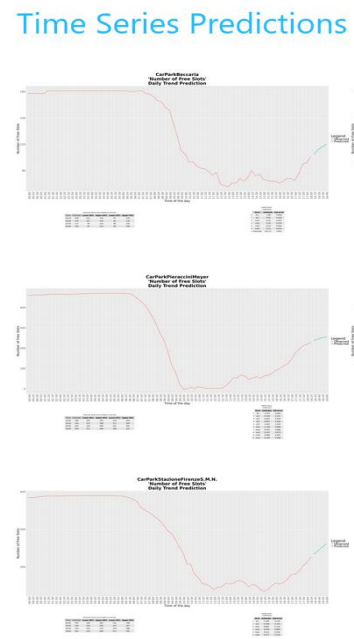
From R studio data analytics to MicroService



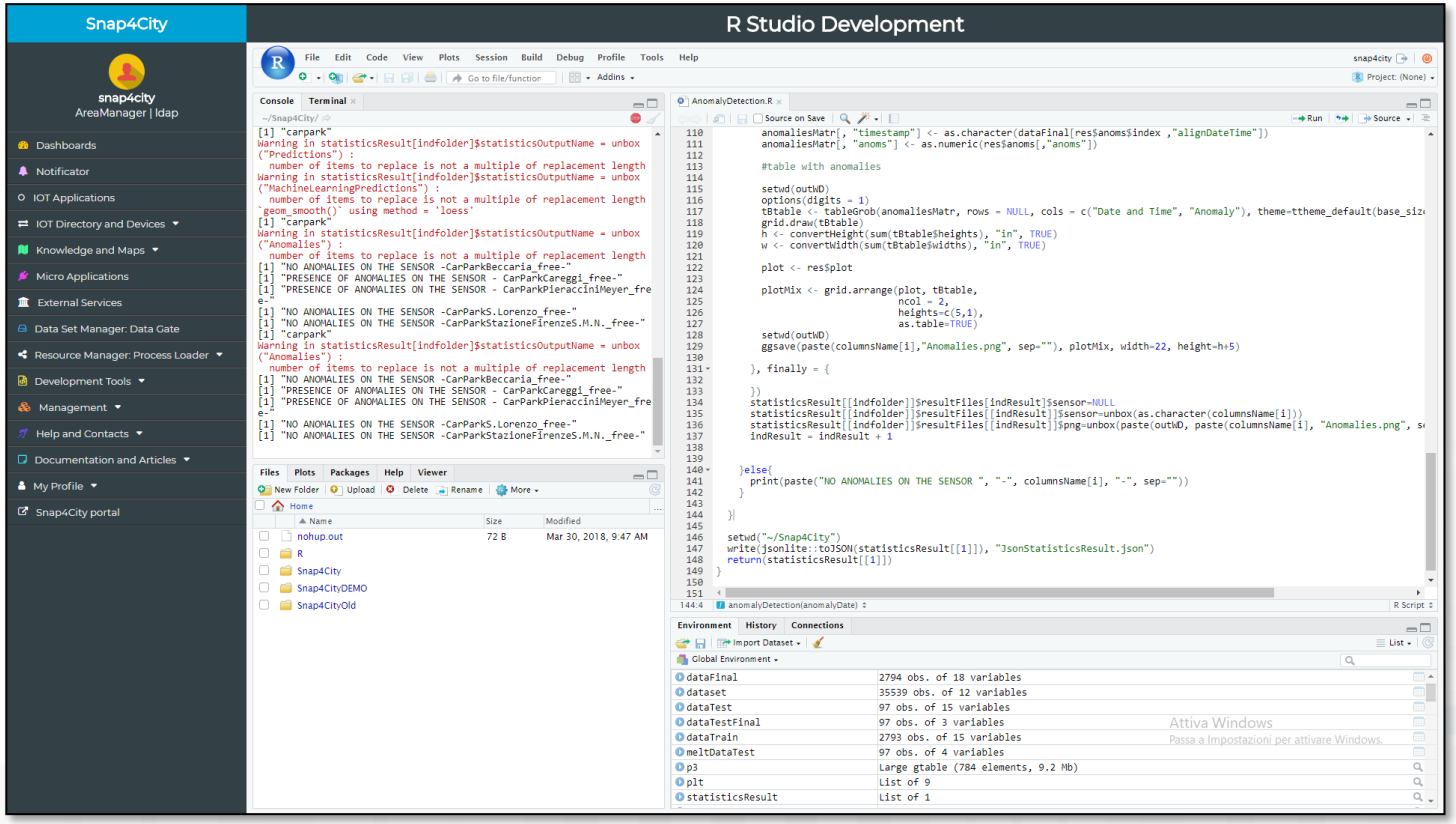
R Studio algorithms are automatically transformed into MicroServices for your IOT Applications

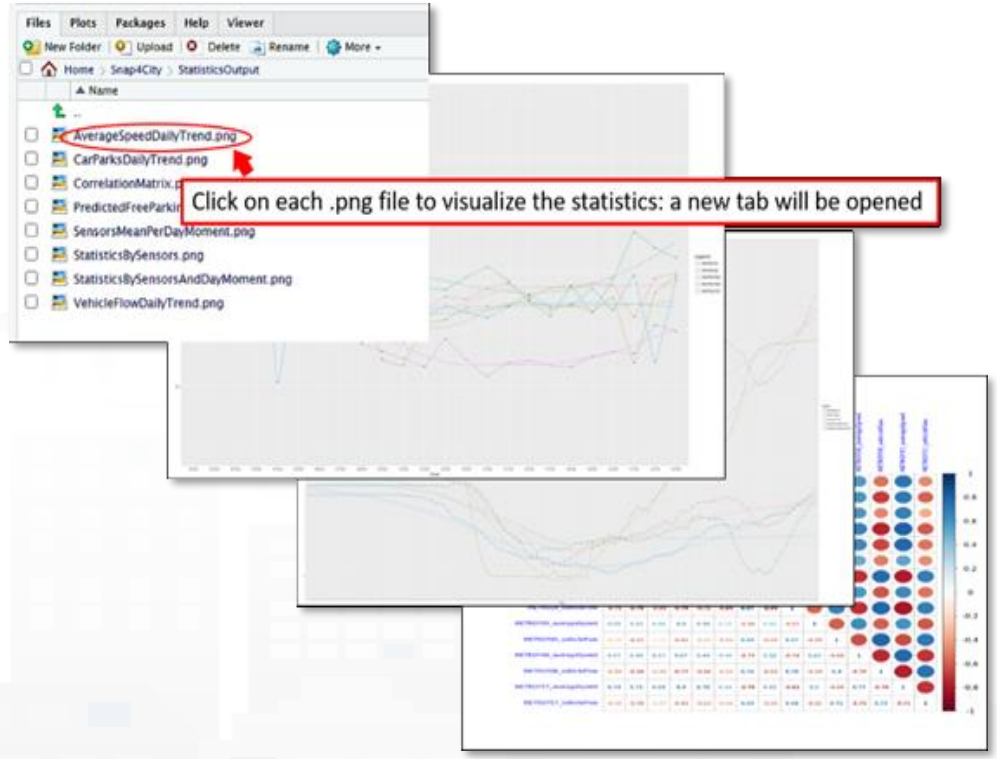


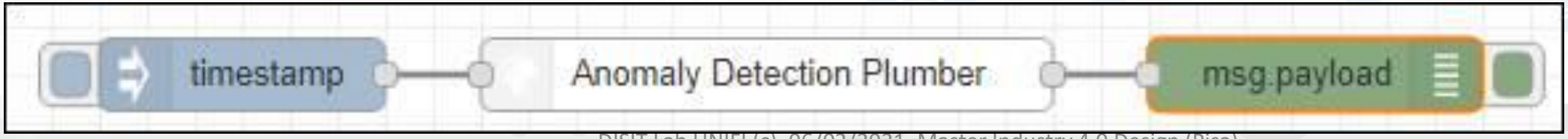




Developing in R Studio and/or Tensor Flow

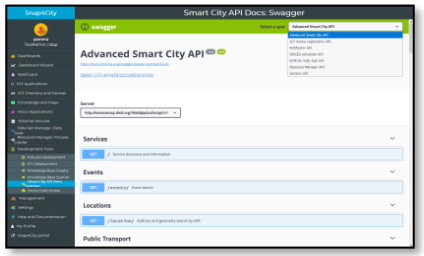




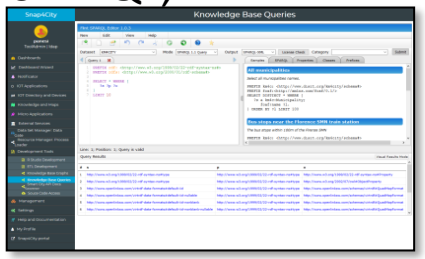


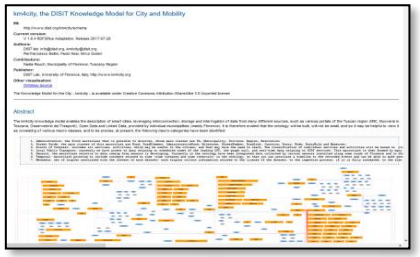
Data Analytics Dev. in Java, Python, ..

Swagger



SPARQL, FLINT





Ontology Schema



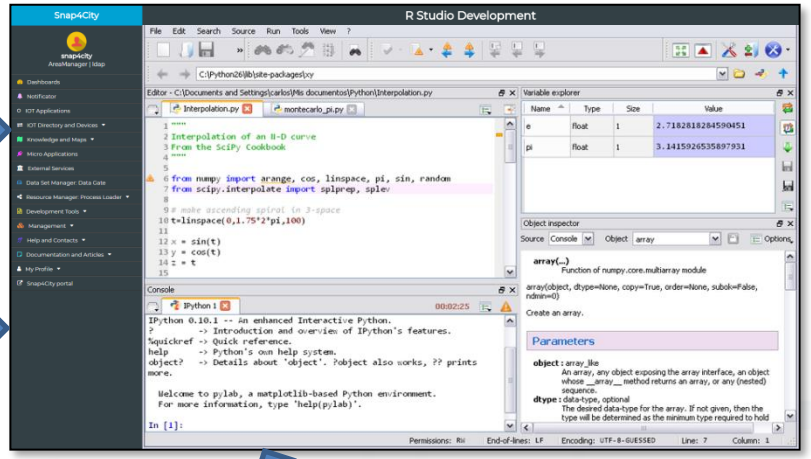
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Knowledge Base, Km4City



Big Data Store Facility

Smart City API from Knowledge Base and other tools

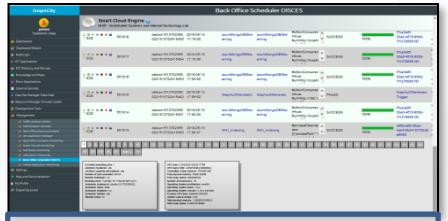


Coding
Testing



Saving /
Sharing
resusing

DISCES scheduler



Monitoring



Resource Manager

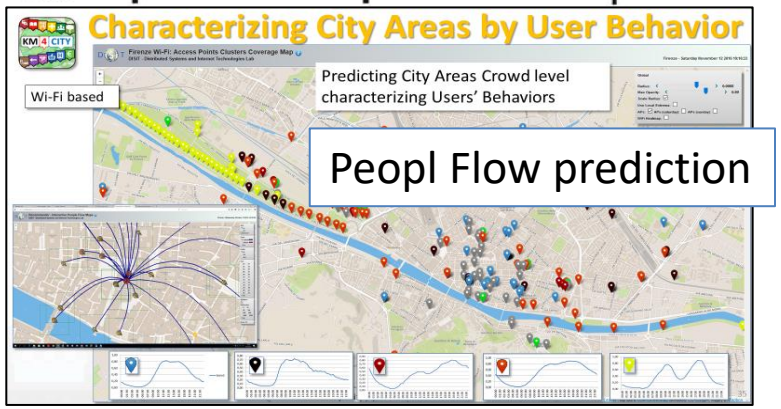


Process

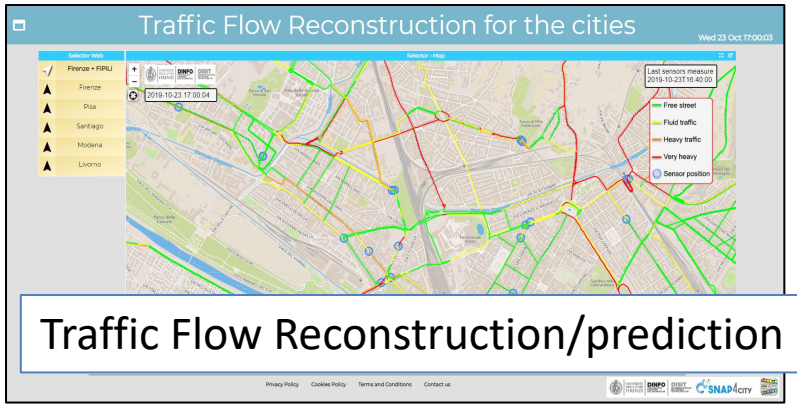
Data sources

Distributed Back Office

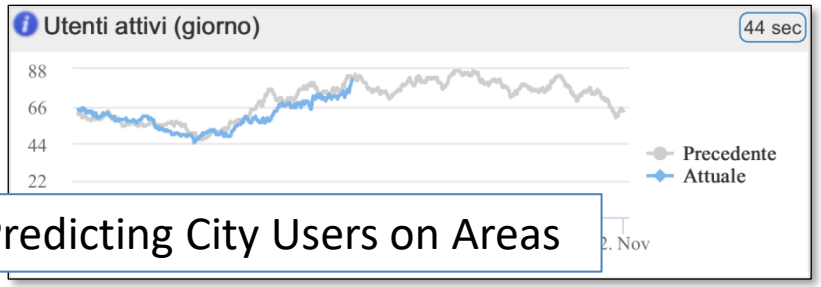
Data Analytics



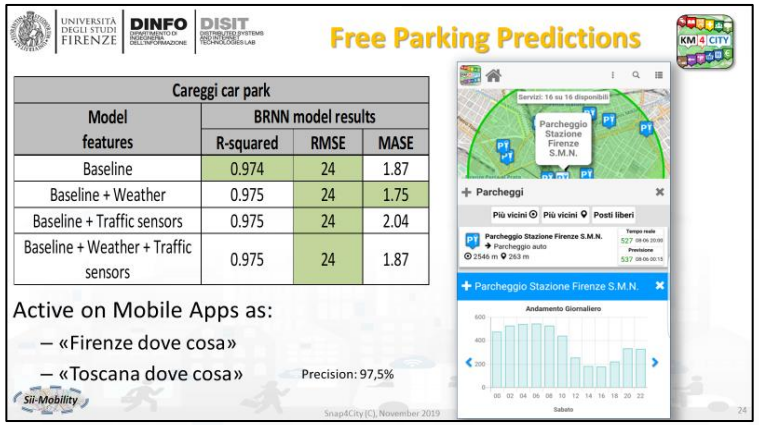
Peopl Flow prediction

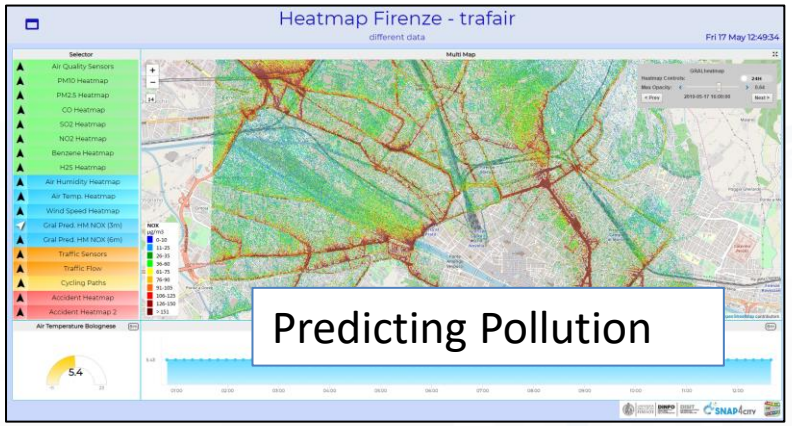


Traffic Flow Reconstruction/prediction

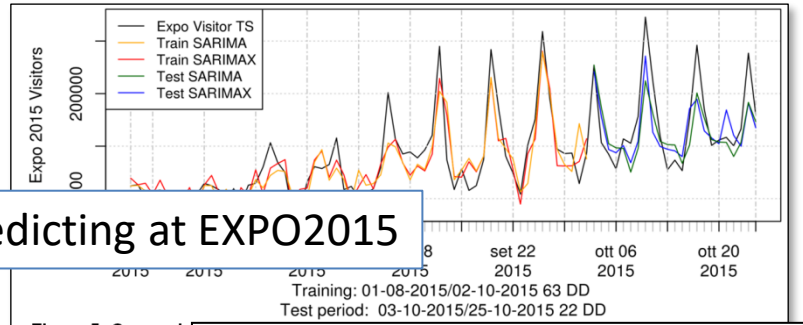


Predicting City Users on Areas

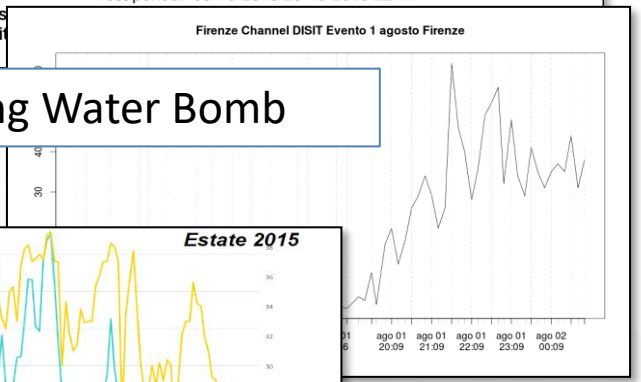




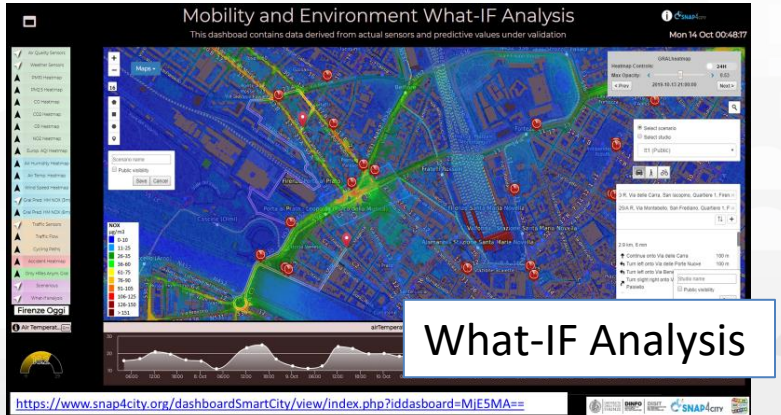
Predicting Pollution



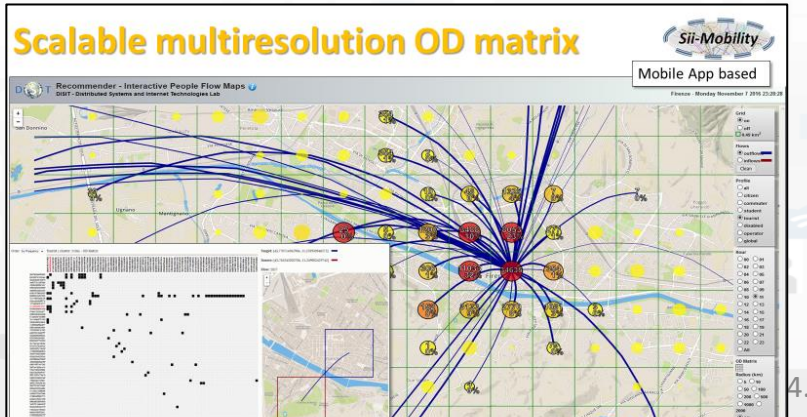
Predicting at EXPO2015

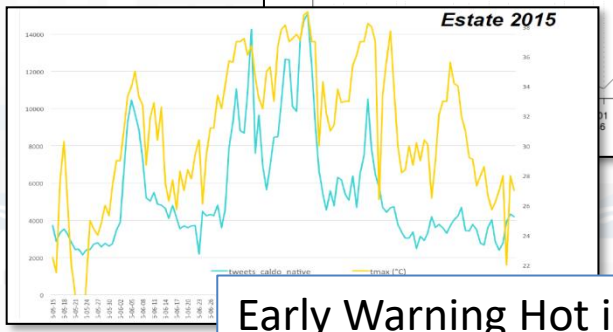


Early Warning Water Bomb



What-IF Analysis





Early Warning Hot in Tuscany

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Disappearing Data Analytics

SNAP4CITY | KM 4 CITY

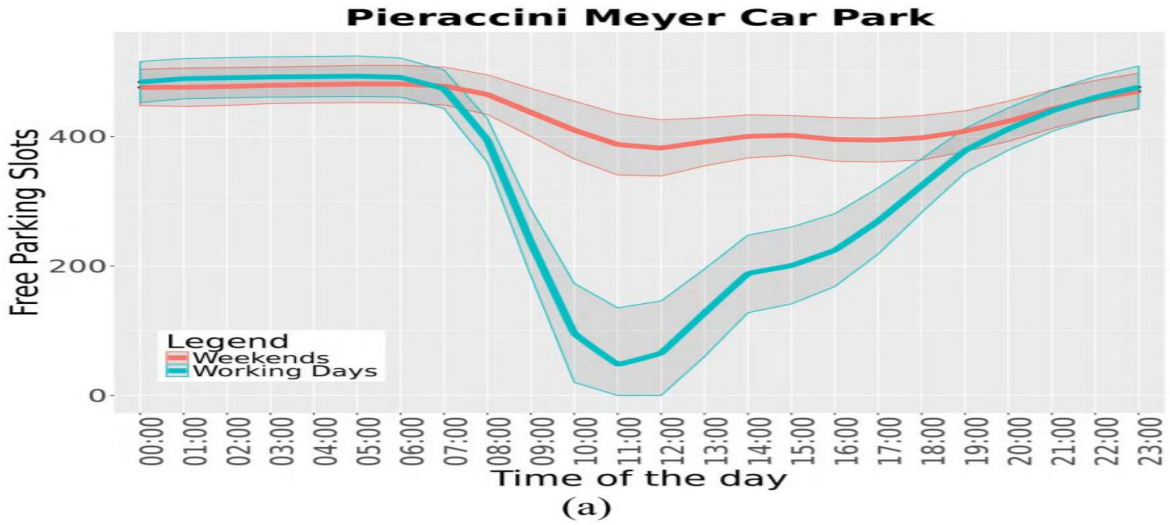
	Antwerp					Helsinki								Where				
SNAP4CITY	City official	ICT official	Developer	Citizen, tourist, visitor	Business owner	City officials	City officials Domain experts	City officials City developers	Third party developers	Citizen	Citizens with respiratory problems	Tourists	Business owners	Mobile	MicroApplication	Tool, via Portal (ICT Developers)	Dashboards	RULE OF THUMB Main Data Sources
Discovery near to me	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			POI, OSM
Discovery along a path	x	x	x	x		x		x	x	x	x	x		x	x			POI, OSM
Discovery in an area, shape	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x		POI, OSM
browsing Public Transport	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			OSM, GTFS
Full Text search	x	x	x	x	x	x		x	x	x	x	x	x	x		x		POI, OSM
Routing: pedestrian				x	x			x	x	x	x	x	x	x	x			OSM
Routing: pedestrian quite				x	x			x	x	x	x	x	x	x	x			OSM
Routing: private vehicles	x		x	x		x		x	x	x	x	x		x	x			OSM
Routing: Multimodal Public Transport				x					x	x	x	x		x	x	x		OSM, GTFS
heatmaps: weather (Temp, Humidity)	x	x		x	x	x	x		x	x	x	x	x	x			x	Sensors data, OSM
heatmaps: environmental variables, PM10, PM2.5, NO2, EAQI	x	x		x	x	x	x		x	x	x	x	x	x			x	Sensors data, OSM
heatmaps: environmental variables, Noise						x	x		x	x	x	x	x	x			x	Sensors data, OSM
heatmaps: safe on bike (Antwerp)	x	x		x	x									x			x	Spec. Portal
heatmaps: Enfuser prediction, PM10, PM2.5, AQI						x	x		x	x	x	x	x	x			x	Enfuser data
heatmaps piking values any place	x	x			x	x	x	x	x				x				x	Computed Heatmps
heatmaps: GRAL prediction, PM10						x	x		x	x	x	x	x	x			x	OSM, Traffic, Weather
Comparsison: Enfuser, Gral, Real Time						x	x										x	Enfuser, Sensors, GRAL
Sensors Data Time Trends, & drill down	x	x	x		x	x	x	x					x			x	x	Sensors data, OSM
Weather Forecast	x	x		x	x	x	x		x	x	x	x	x	x			x	Forecast Service
Origin Destination Matrices	x	x	x		x	x	x	x	x				x				x	Snap4City Mobile App
Typical trajectories	x	x	x	x	x	x	x	x	x				x			x	x	Snap4City Mobile App
Hot Area in the city	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	Snap4City Mobile App
Hot Places in Smart Zone	x	x	x	x	x									x		x	x	Snap4City PAXcounters
Services Suggestions on mobiles				x						x	x	x		x	x			Snap4City Mobile App
Alerts on critical cases: several variables	x			x	x	x	x			x	x		x	x				Sensors data, OSM
The most used services		x		x	x		x			x	x	x	x				x	Snap4City Mobile App
Twitter Trends Daily	x	x	x		x	x	x	x	x				x			x	x	Twitter Vigilance
The auditing of user and living lab		x				x		x								x		Snap4City Portal
Self assessment	x	x	x	x	x	x	x	x	x	x	x	x	x			x		Snap4City Portal
Trajectories reg from mobile PAX Counters	x	x	x			x	x	x							x		x	PAX Counters

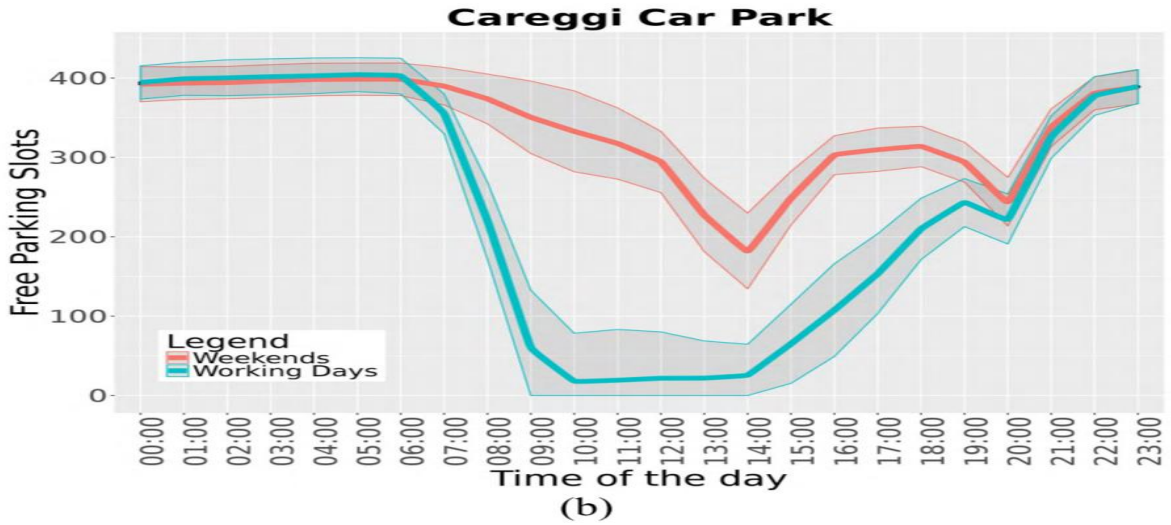
Smart Parking

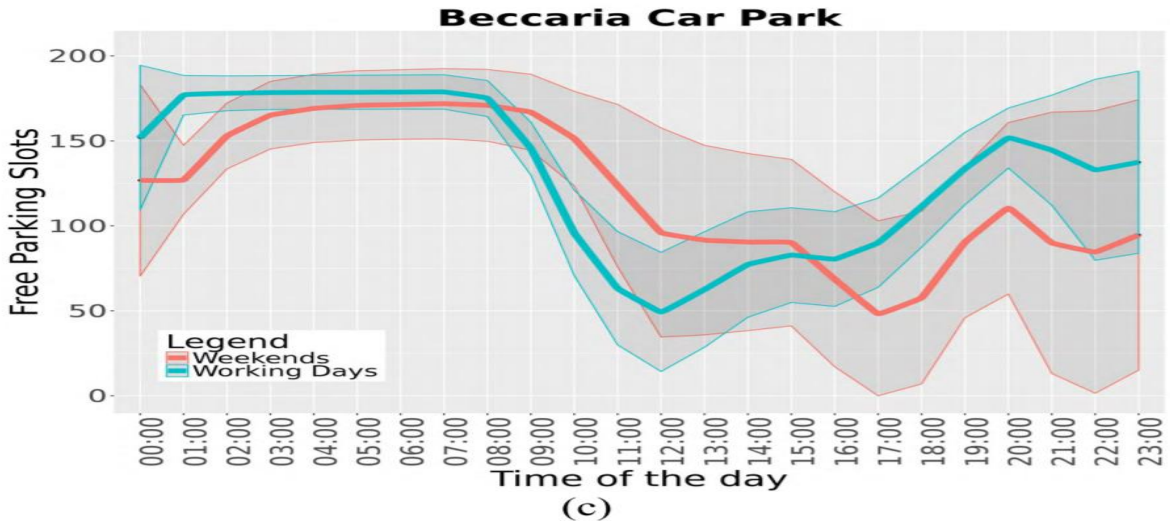


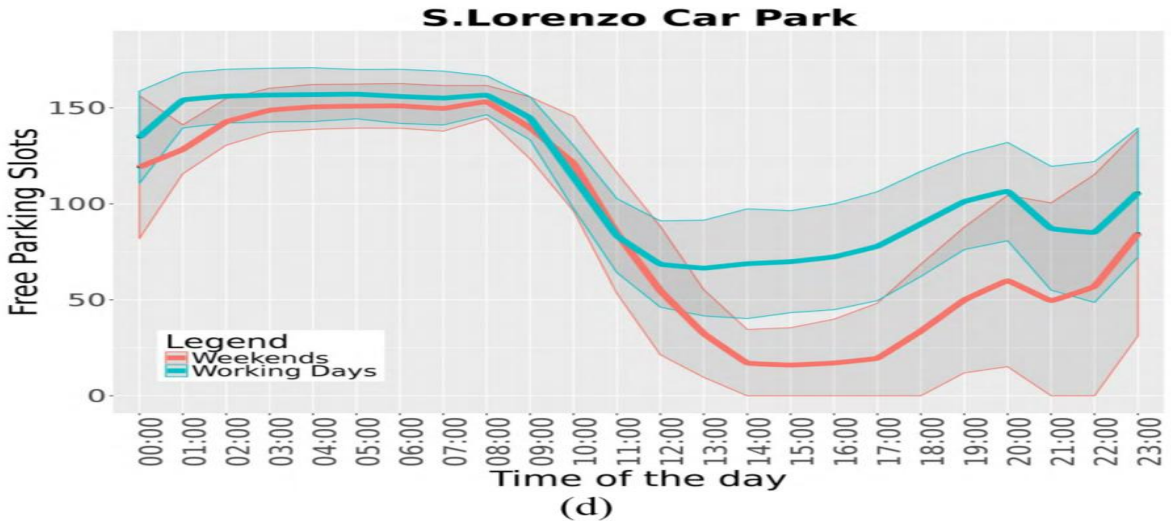
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Free Parking space trends







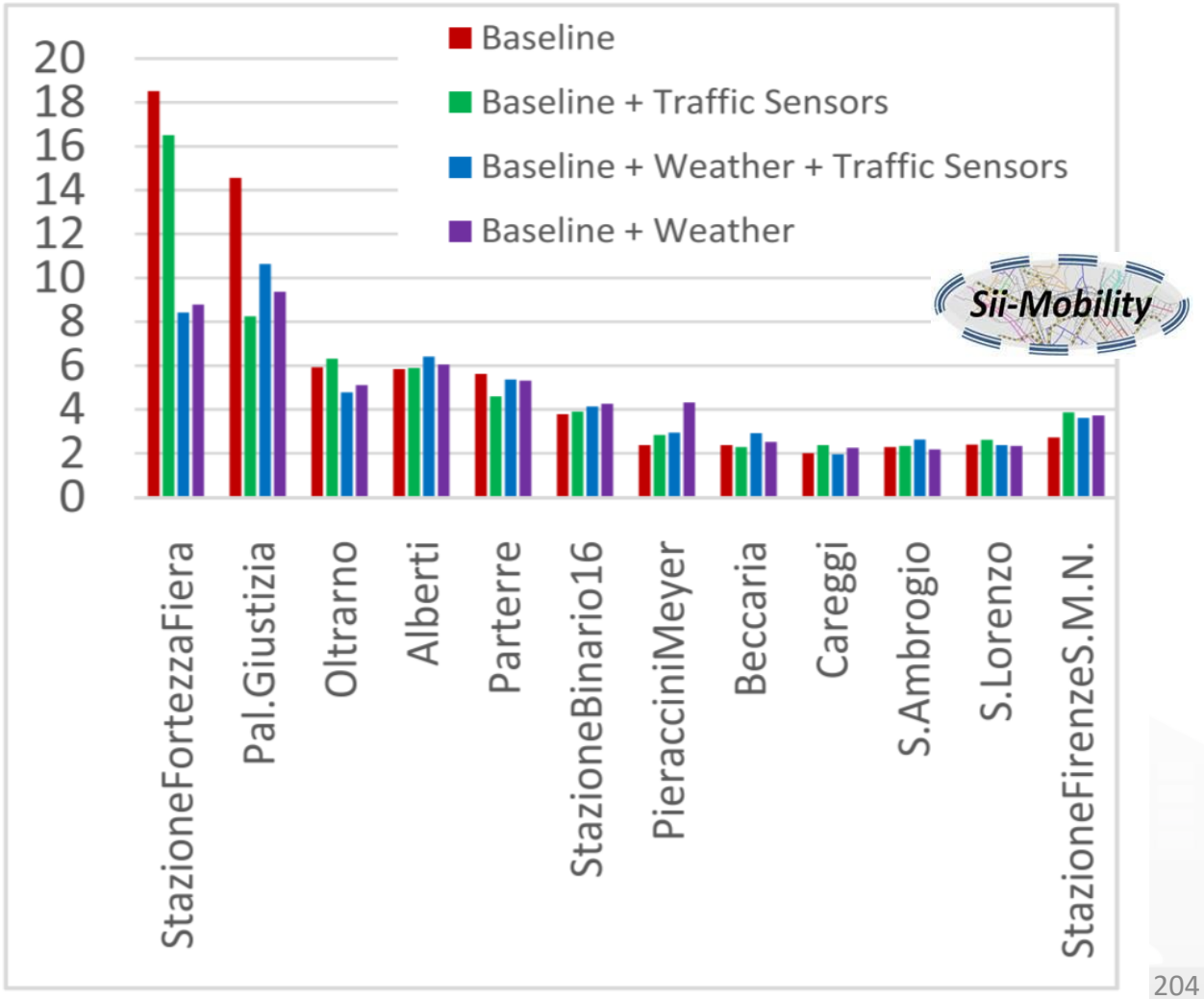


12 parking areas in Florence

Free Parking PREDICTIONS

C. Badii, P. Nesi, I. Paoli, "Predicting available parking slots on critical and regular services exploiting a range of open data", IEEE Access, preprint, 2018, https://ieeexplore.ieee.org/abstract/document/8430514/

Comparison Error	Forecasting Techniques		
	BRANN	SVR	RNN
Careggi car park			
MASE Night	34.85	16.29	20.01
MASE Morning	0.76	1.42	2.82
MASE Afternoon	1.89	4.34	3.66
MASE Evening	1.99	1.51	2.33
MASE	1.87	2.34	3.16
Pieraccini Meyer car park			
MASE Night	6.08	12.83	10.03
MASE Morning	0.86	1.27	4.90
MASE Afternoon	1.87	2.91	6.75
MASE Evening	1.36	1.57	10.23
MASE	1.37	2.06	6.67
S. Lorenzo car park			
MASE Night	10.33	11.81	18.34
MASE Morning	2.13	1.91	3.93
MASE Afternoon	2.70	3.15	2.37
MASE Evening	2.15	3.09	3.82
MASE	2.72	3.21	4.19
Beccaria car park			
MASE Night	9.32	7.80	12.47
MASE Morning	0.95	1.25	4.87
MASE Afternoon	2.49	2.14	2.45
MASE Evening	2.96	4.75	5.91
MASE	2.13	2.67	4.85

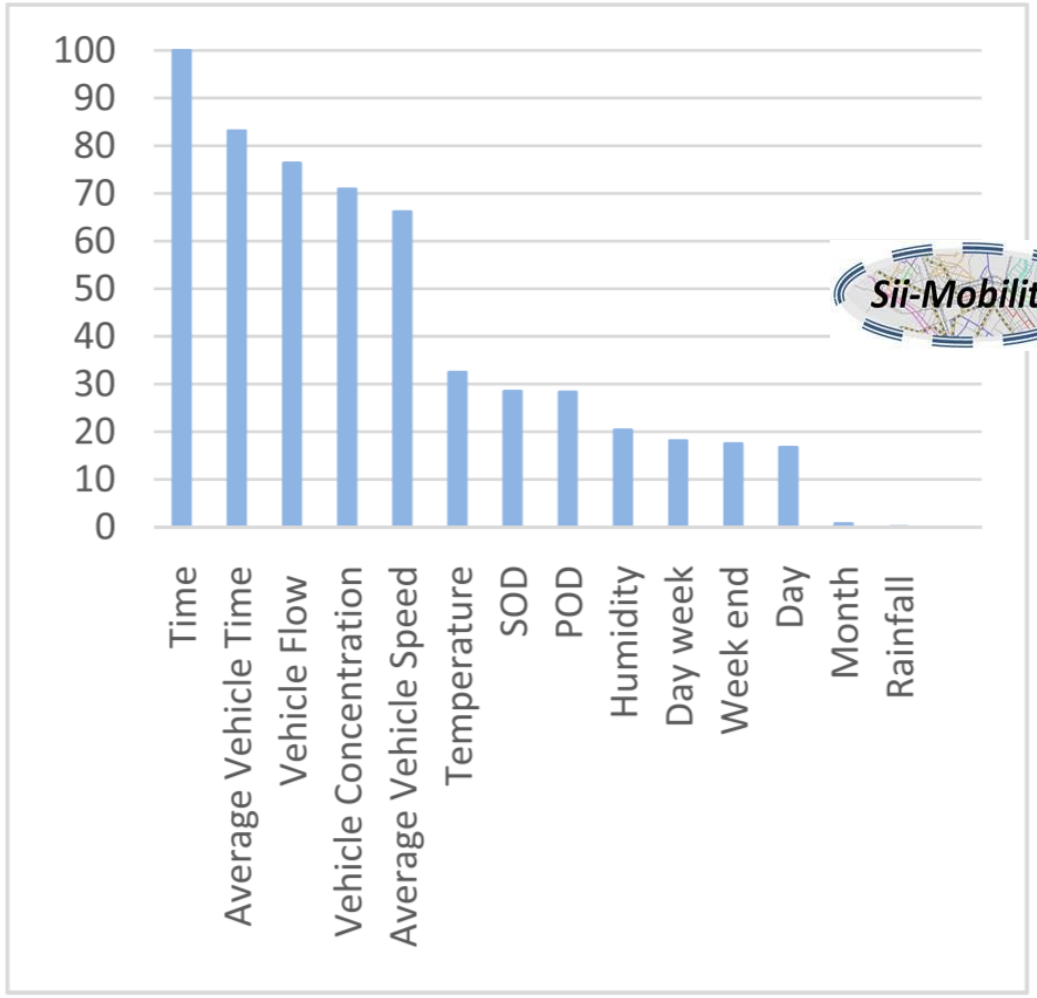


Free Parking PREDICTIONS

Performances

Training	Forecasting Techniques			
	BRANN	SVR	RNN	ARIMA
Average Training processing time (sec)	76.3	9.1	598.7	9.2
Re-Training frequency	Daily	Daily	Daily	Hourly
Training period	3 months	3 months	3 months	3 months
Estimation	**BRANN**	**SVR**	**RNN**	**ARIMA**
Average Estimation time (sec)	0.0031	0.0052	0.034	0.0015
Estimation frequency	Hourly	Hourly	Hourly	Hourly
Estimation predicted period	1 hour	1 hour	1 hour	1 hour

Relevance of Variable



Free Parking Predictions

Careggi car park			
Model features	BRNN model results		
	R-squared	RMSE	MASE
Baseline	0.974	24	1.87
Baseline + Weather	0.975	24	1.75
Baseline + Traffic sensors	0.975	24	2.04
Baseline + Weather + Traffic sensors	0.975	24	1.87



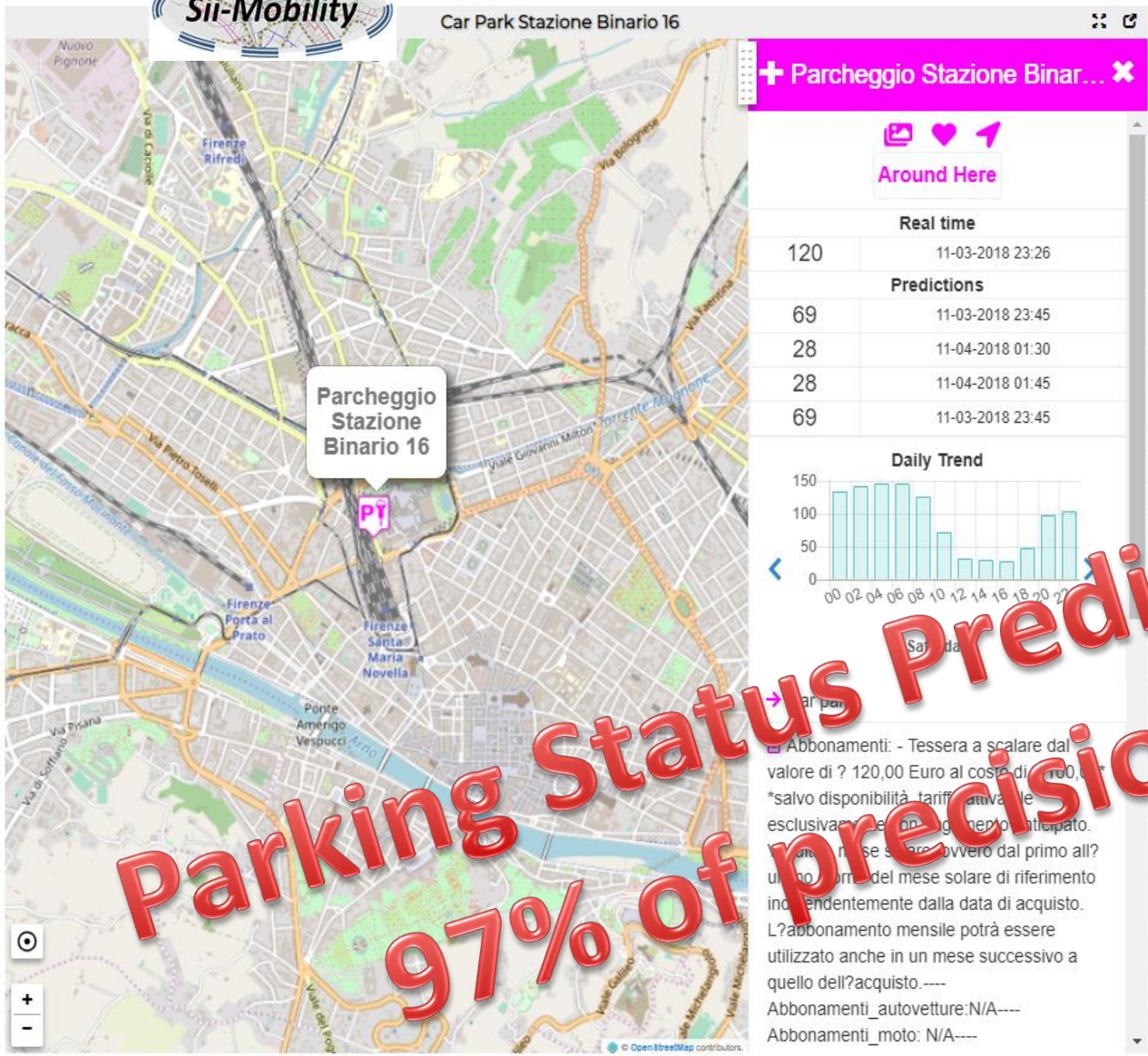
Active on Mobile Apps as:

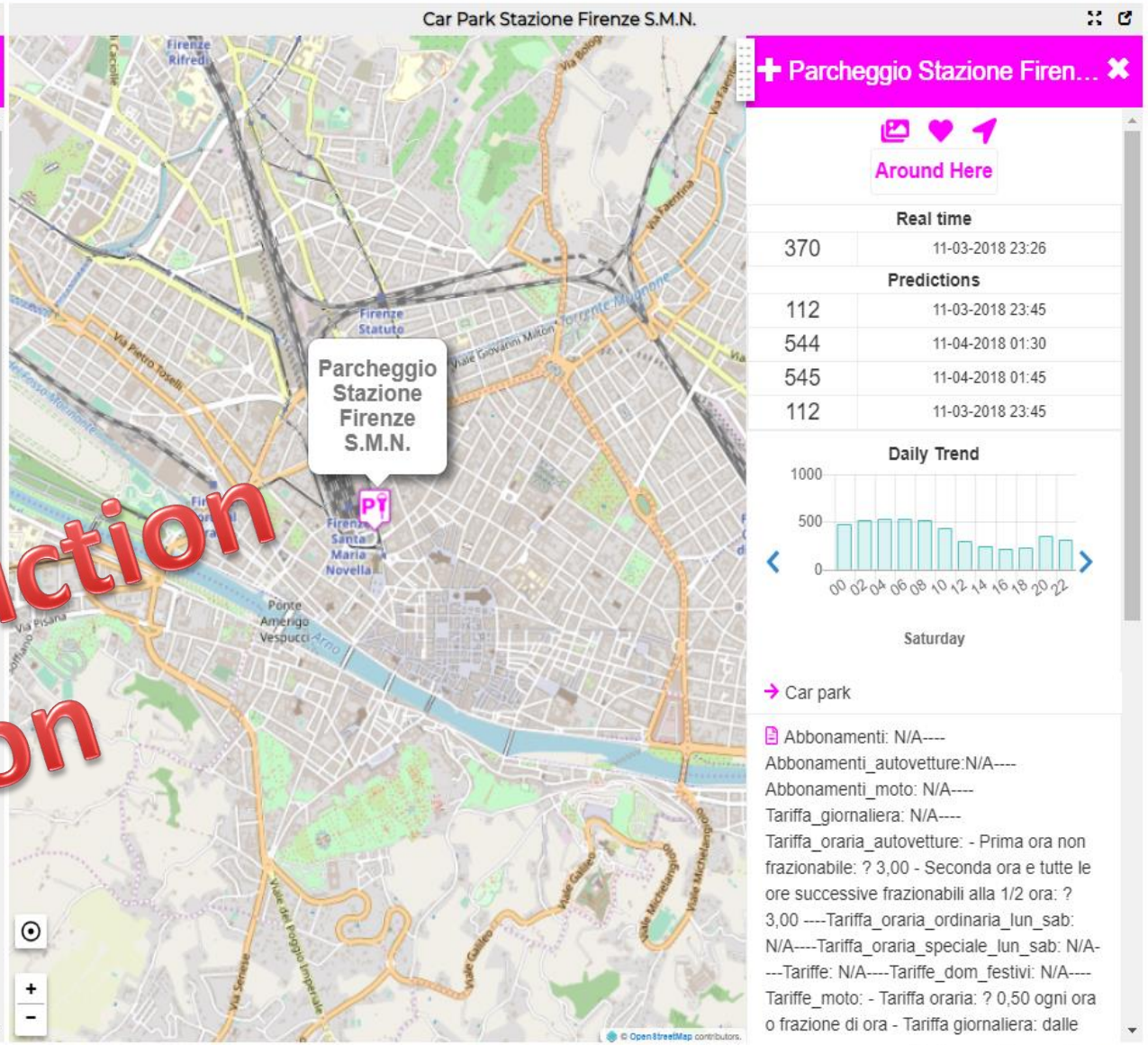
- «Firenze dove cosa»
- «Toscana dove cosa»

Precision: 97,5%

Monitoring Station for Parking

Sat 3 Nov 23:39:55





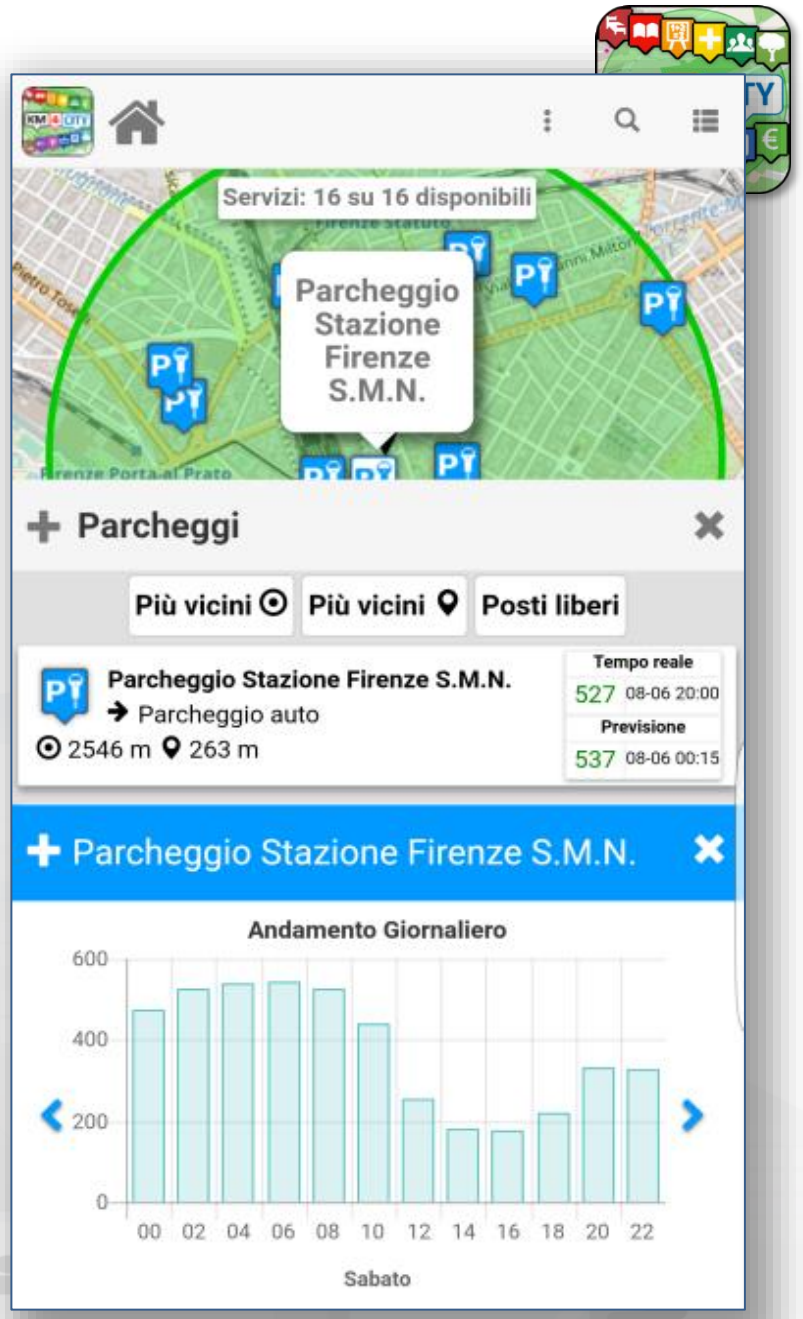
Parking Status Prediction 97% of precision

https://www.disit.org/dashboardSmartCity/view/index.php?iddasboard=MjQ2

Predictions on Parking

IEEE Access

- C. Badii, P. Nesi, I. Paoli, "Predicting available parking slots on critical and regular services exploiting a range of open data", IEEE Access, preprint, 2018, https://ieeexplore.ieee.org/abstract/document/8430514/



Sii-Mobility

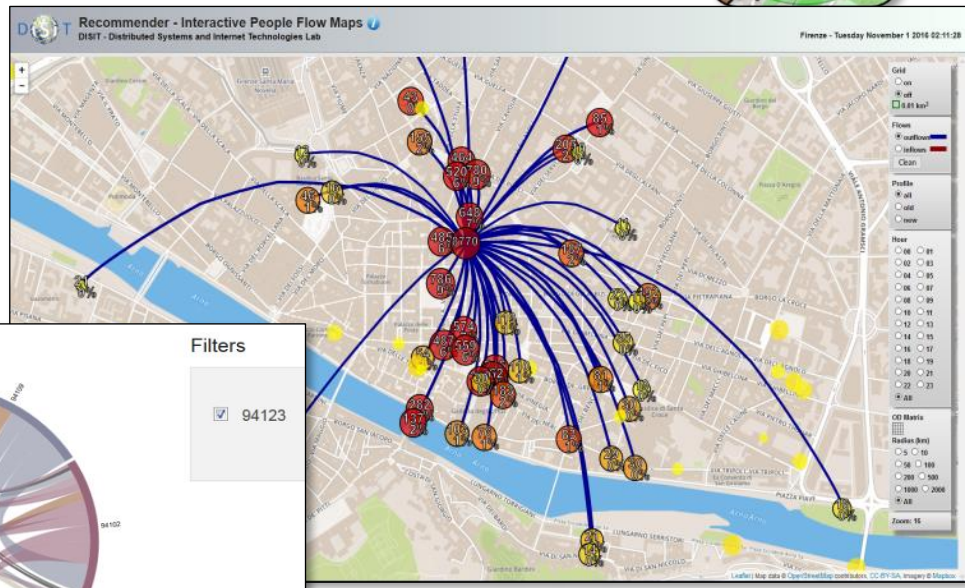
User Behavior Analysis

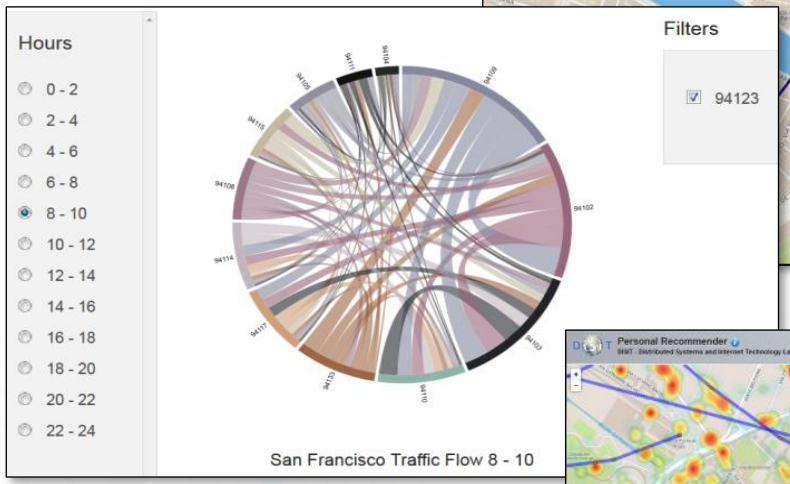


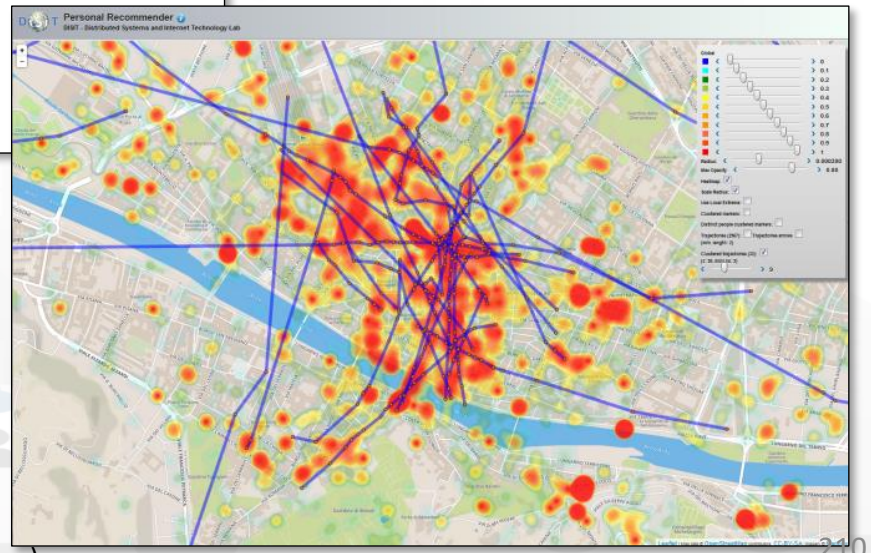
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User Behaviour Analysis

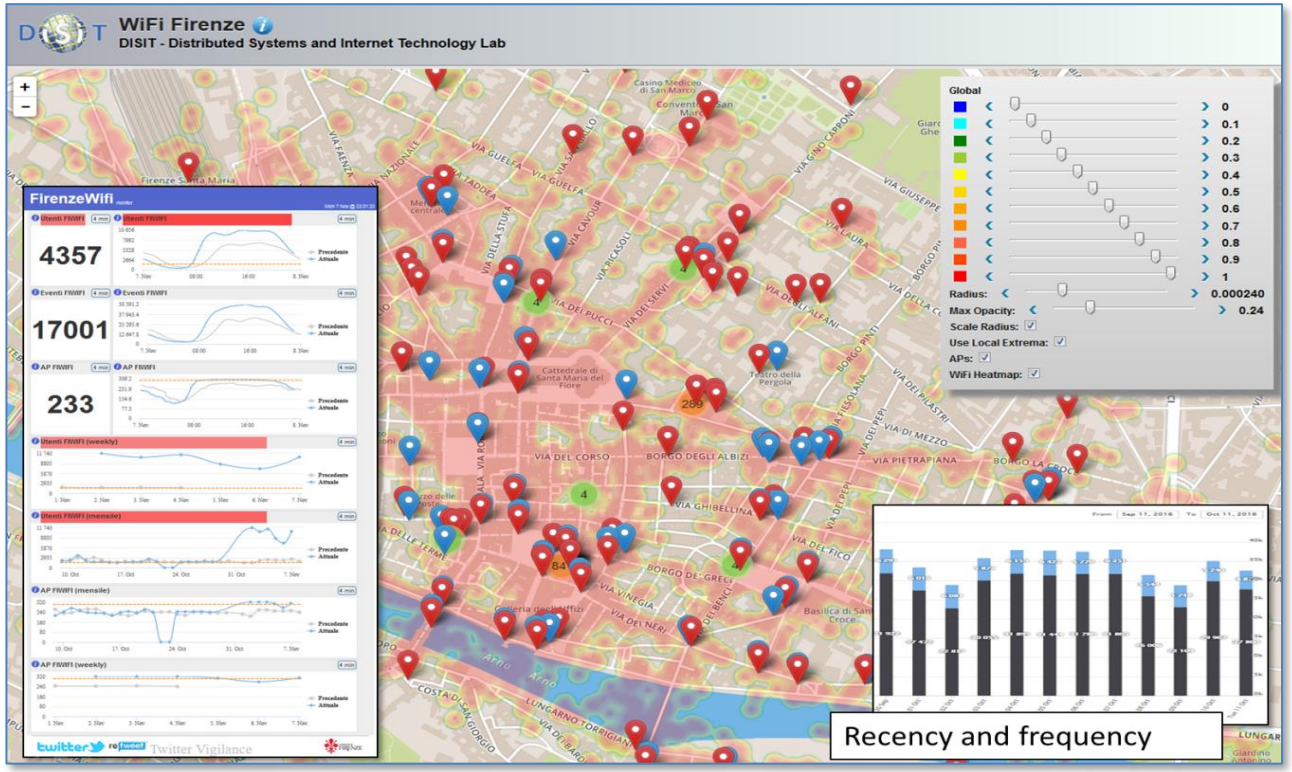
- **Monitoring movements by traffic flow sensors**
  - Spires and virtual spires
- **Monitoring movements from Mobile Cells**
  - Unsuitable for precise tracking and OD production
- **Monitoring movements from Wi-Fi**
- **Monitoring movements** and much more from mobile Apps

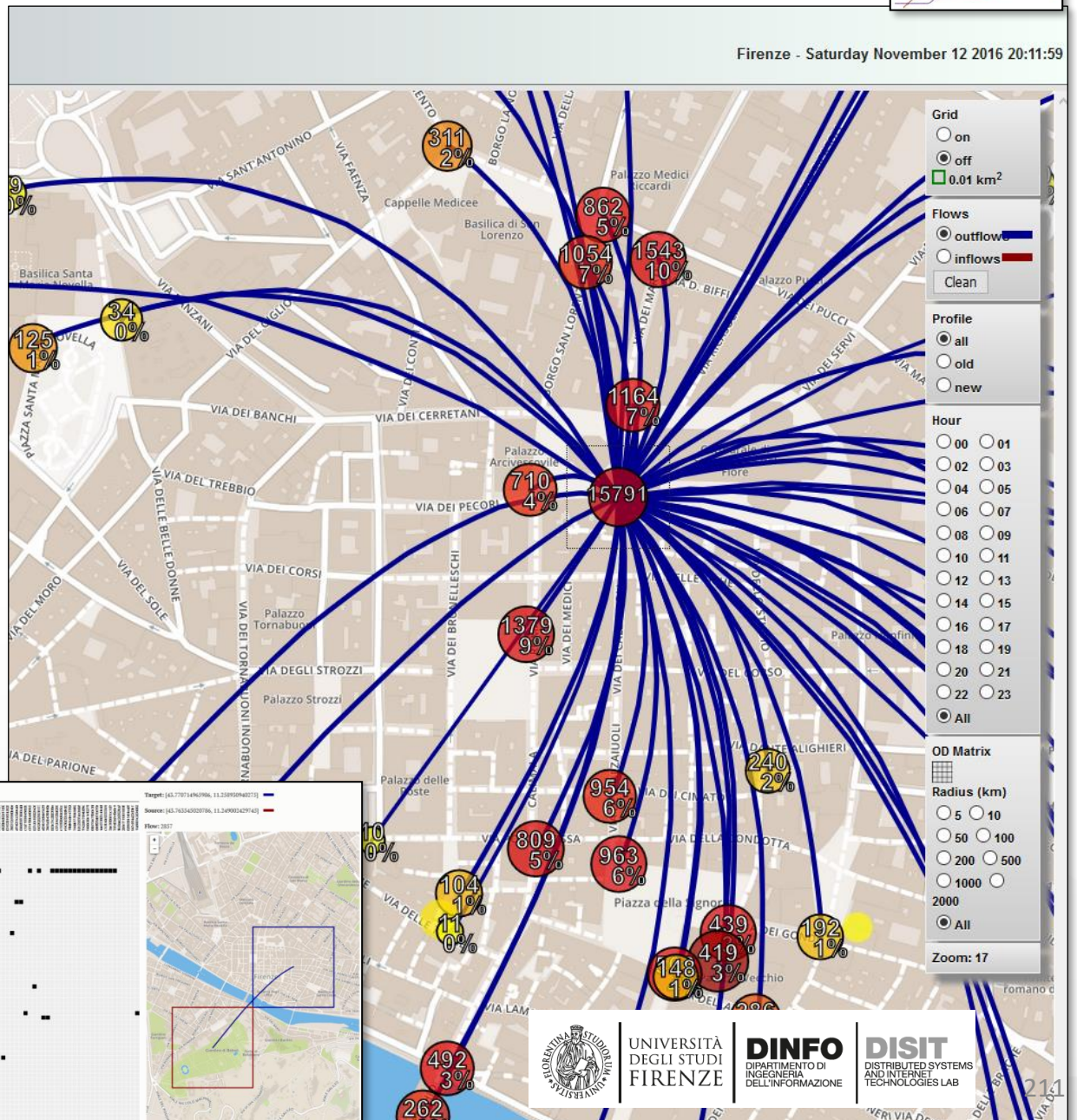


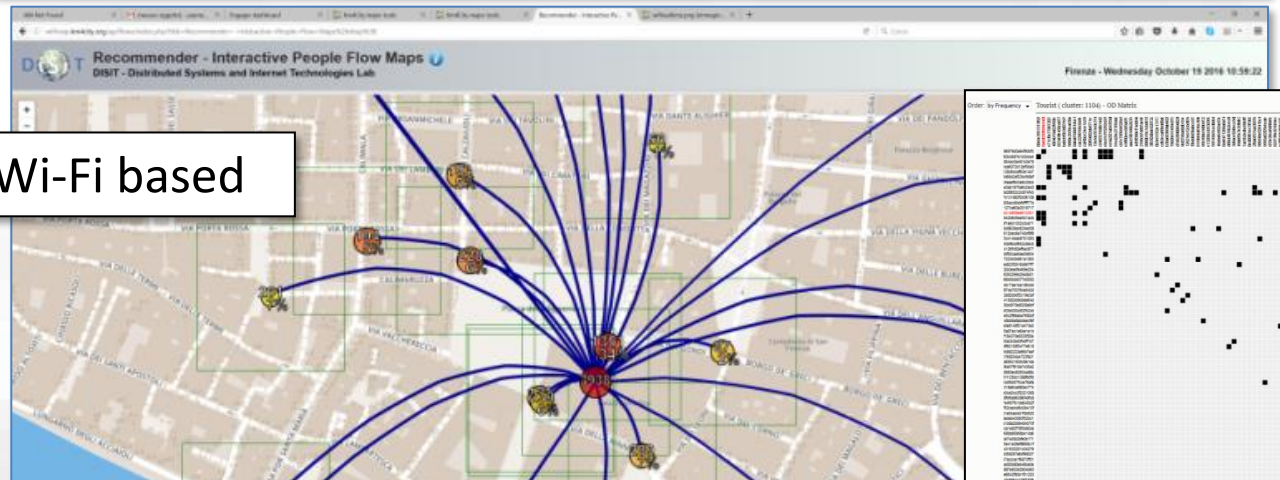




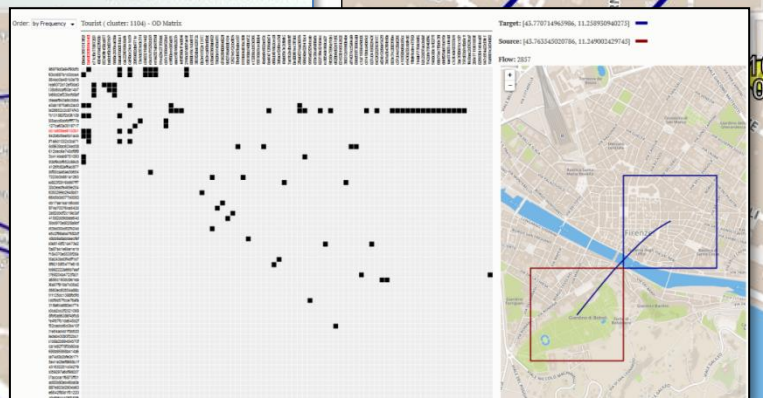
Origin Destination Matrix Estimation







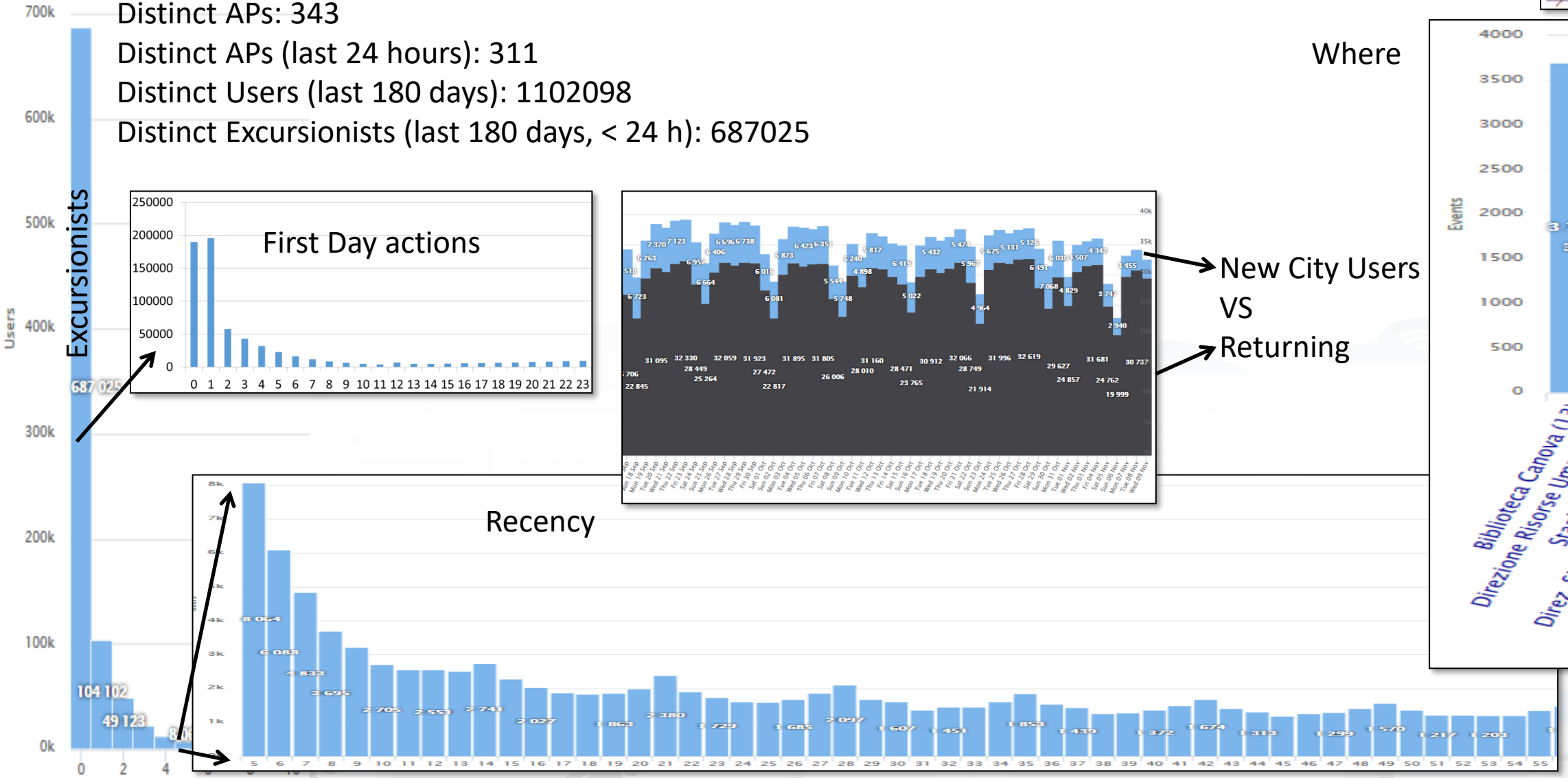
Wi-Fi based



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User Behaviour Analysis

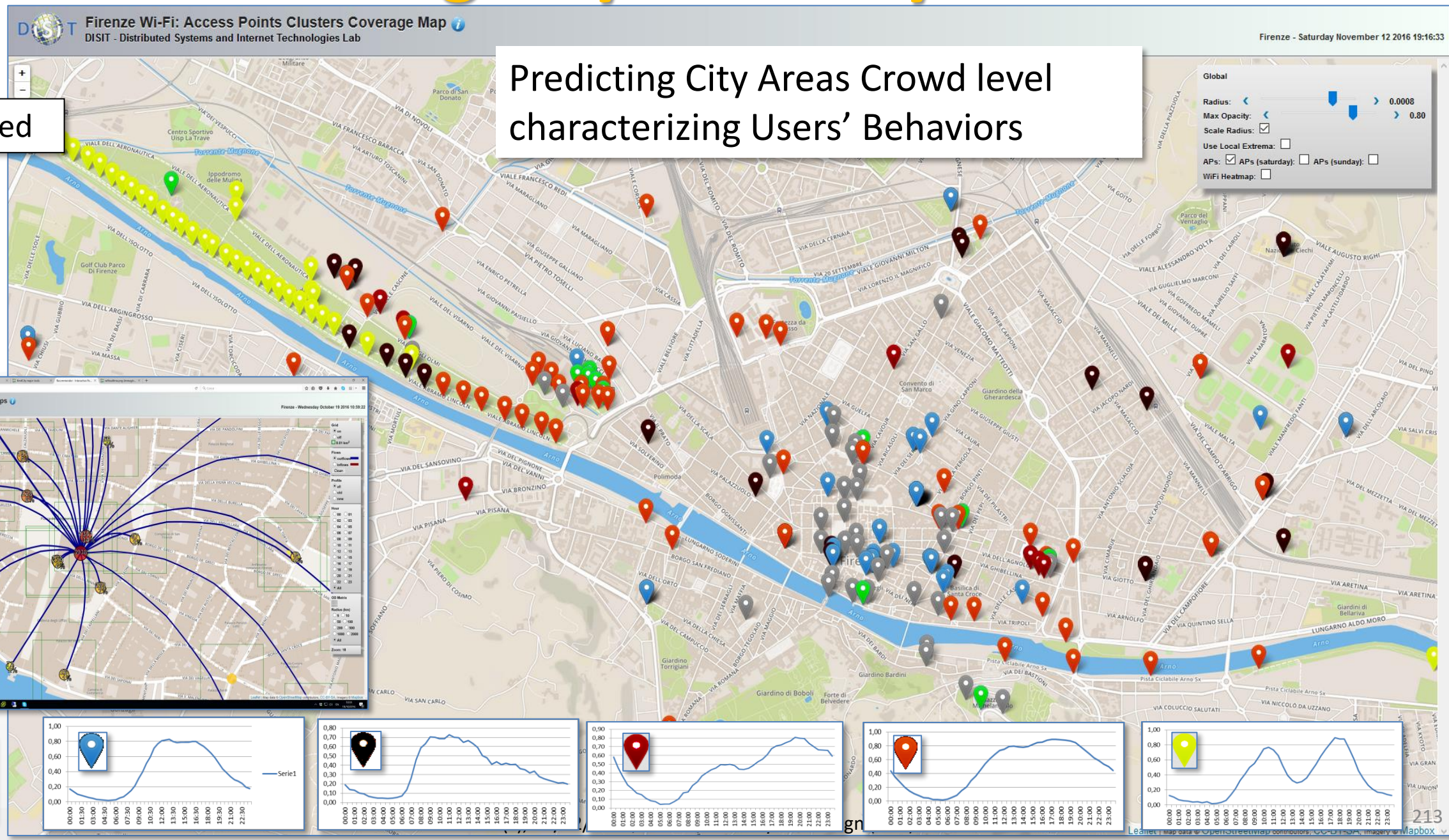
Distinct APs: 343
Distinct APs (last 24 hours): 311
Distinct Users (last 180 days): 1102098
Distinct Excursionists (last 180 days, < 24 h): 687025

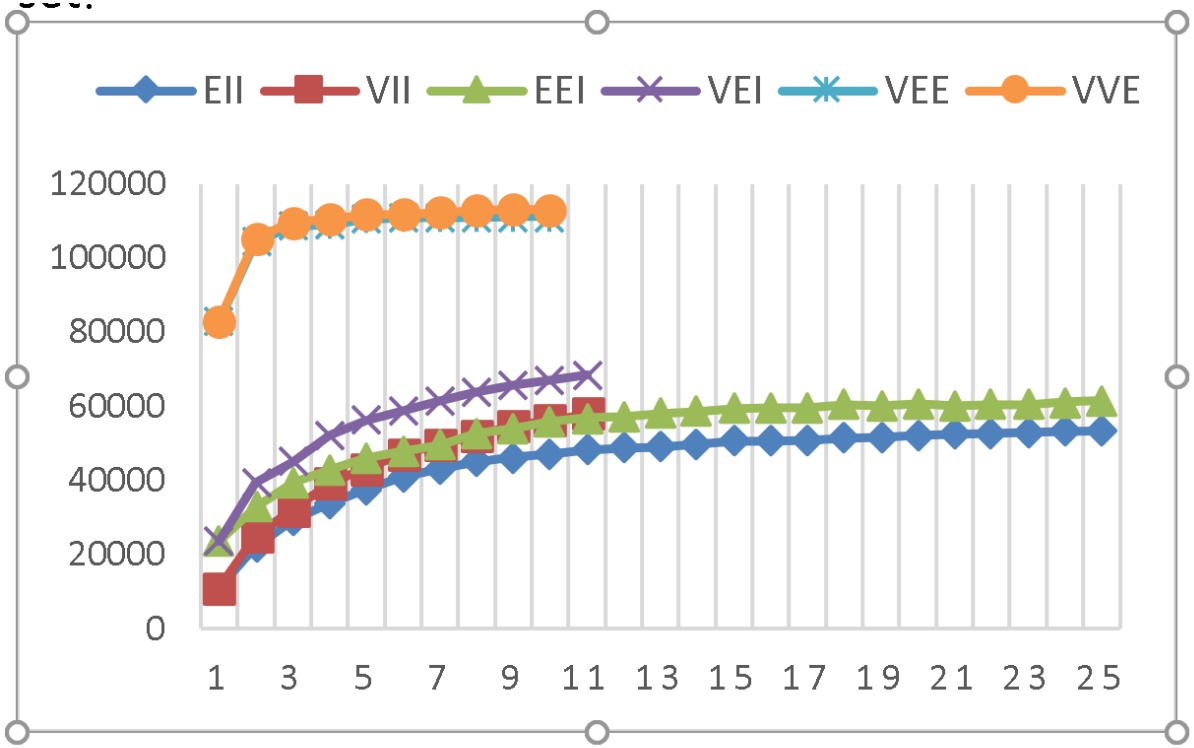


Characterizing City Areas by User Behavior

Wi-Fi based

Predicting City Areas Crowd level characterizing Users' Behaviors





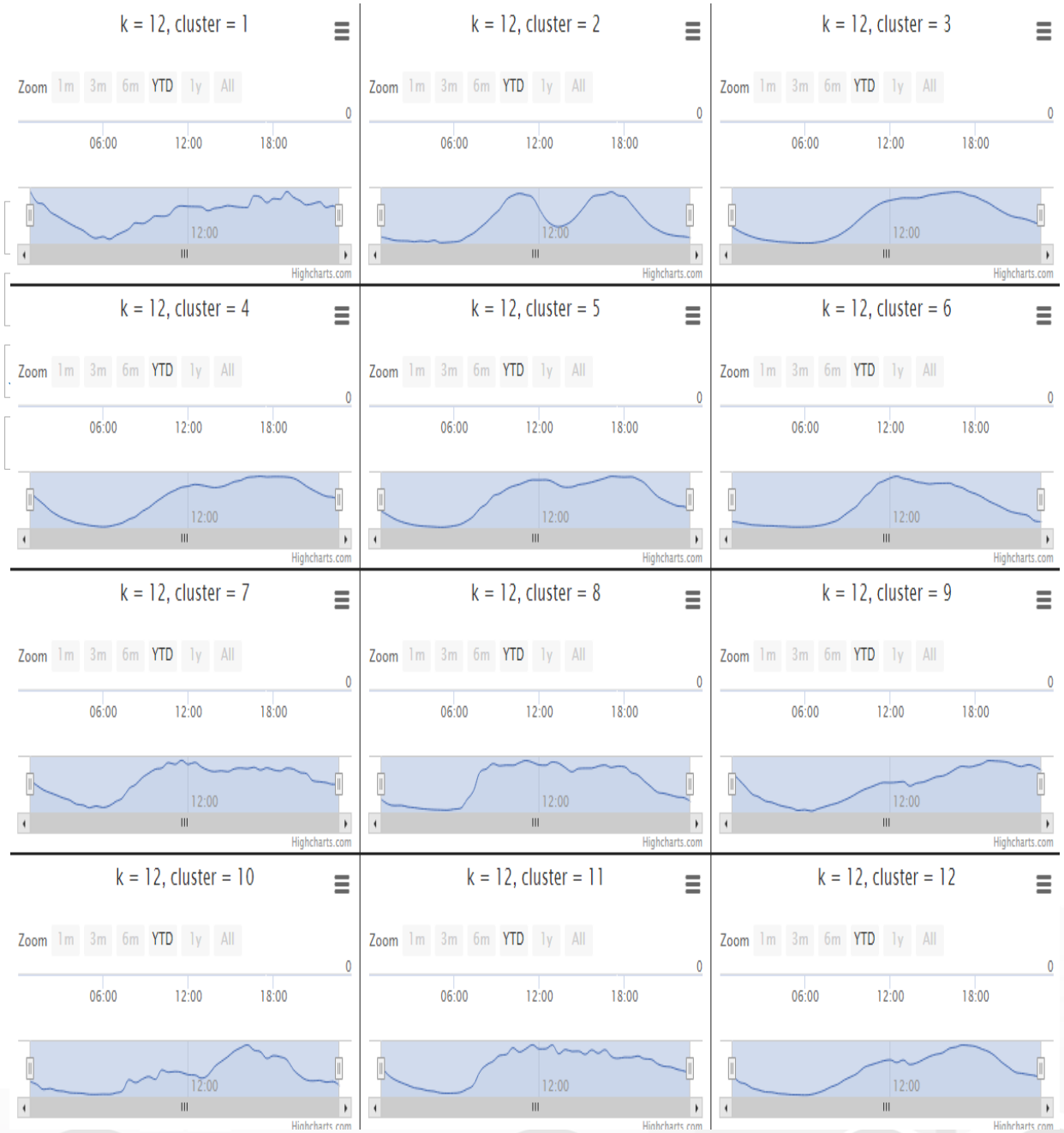
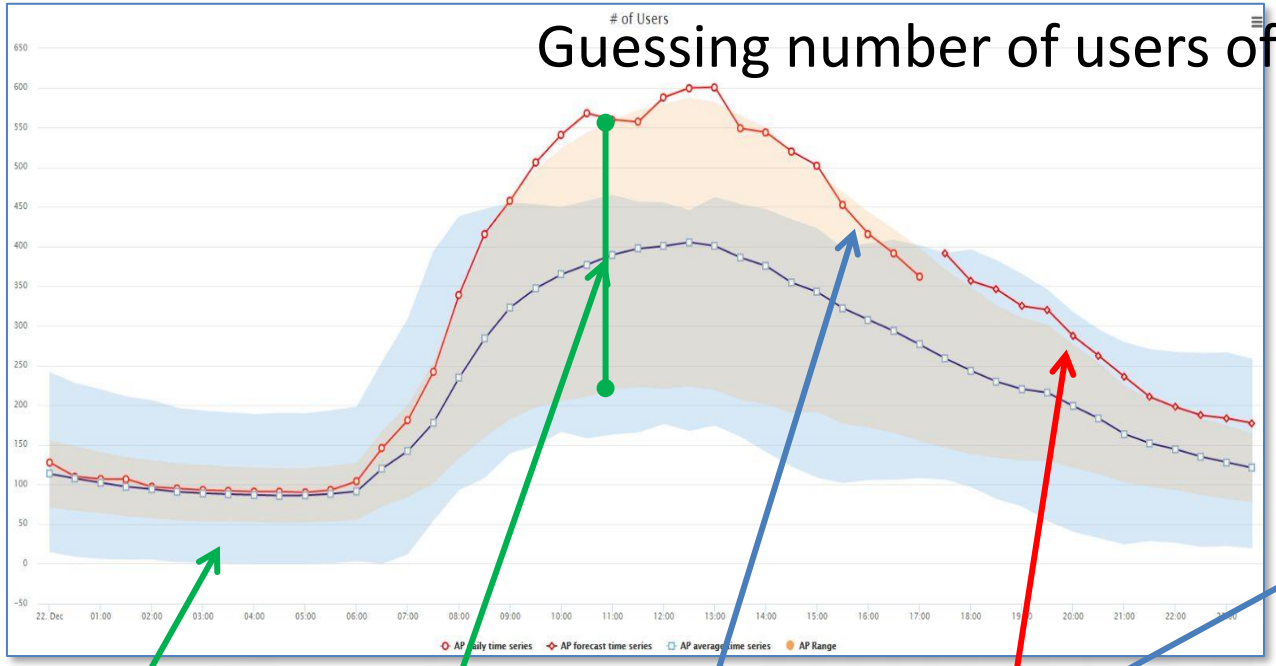
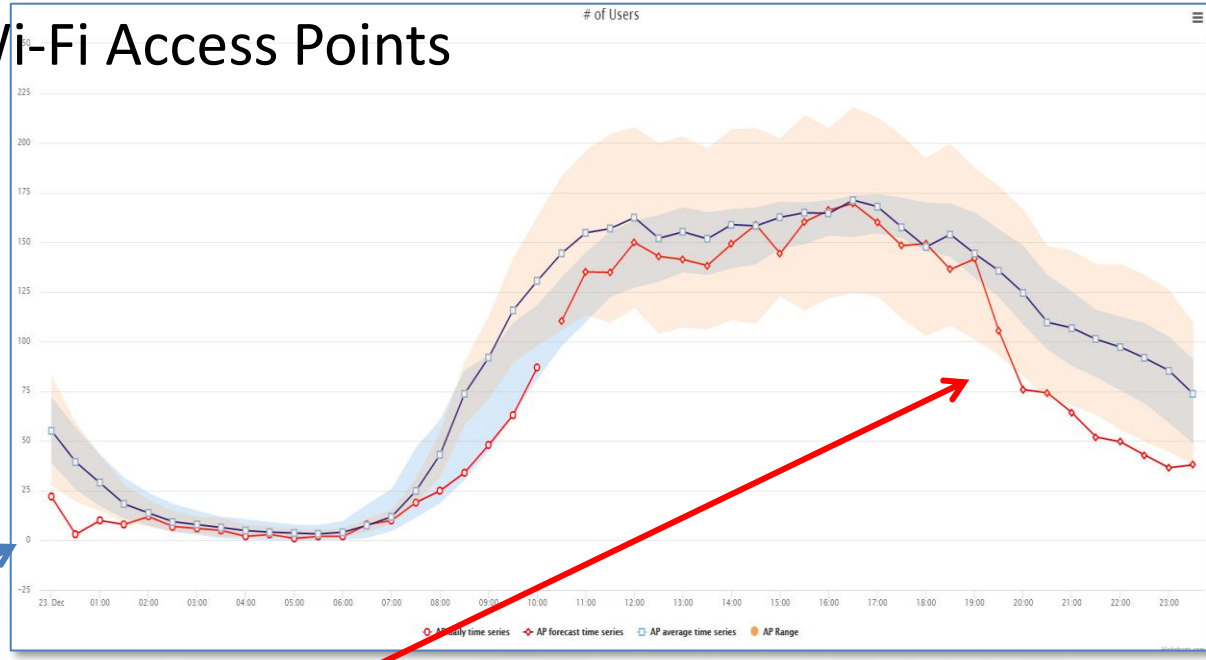


Figure 14 – Average BIC for mixture models vs K number of cluster, higher values are better, the curves are truncated at the best value for K they found.

Prediction and Identification of Anomalies

Guessing number of users of Wi-Fi Access Points





Cluster confidence

AP average and confidence

Actual AP trend for today

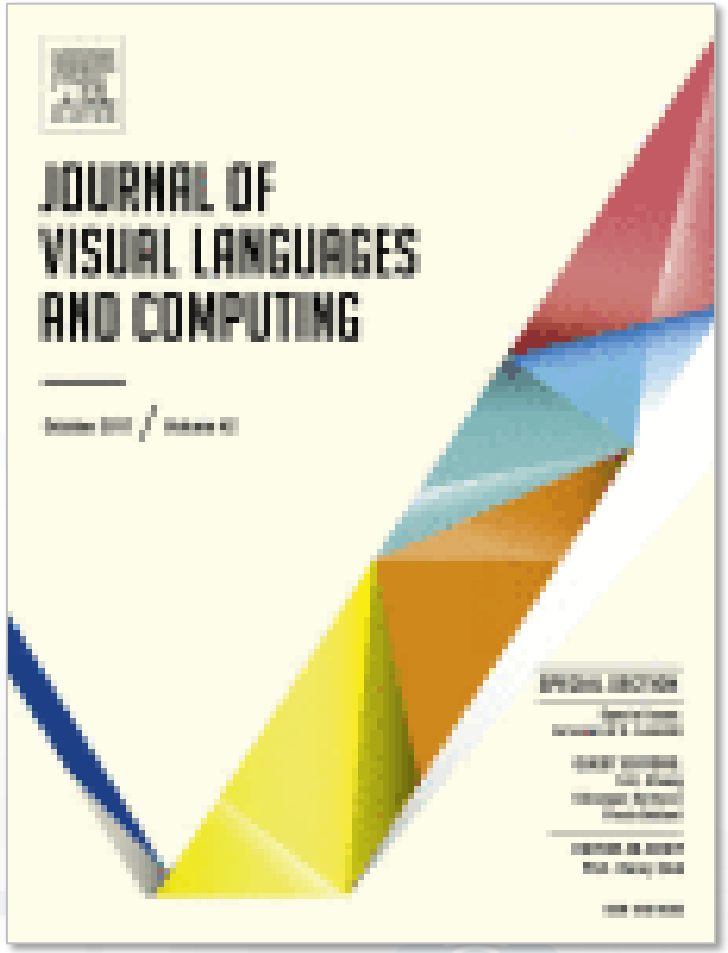
AP prediction for the next time slot in the day on the basis of past weeks

Predictive precision of the 95%

User Behaviour Analysis

- P. Bellini, D. Cenni, P. Nesi, I. Paoli, "Wi-Fi Based City Users' Behaviour Analysis for Smart City", Journal of Visual Language and Computing, Elsevier, 2017. http://www.sciencedirect.com/science/article/pii/S1045926X17300083

ELSEVIER



Traffic Flow Reconstruction

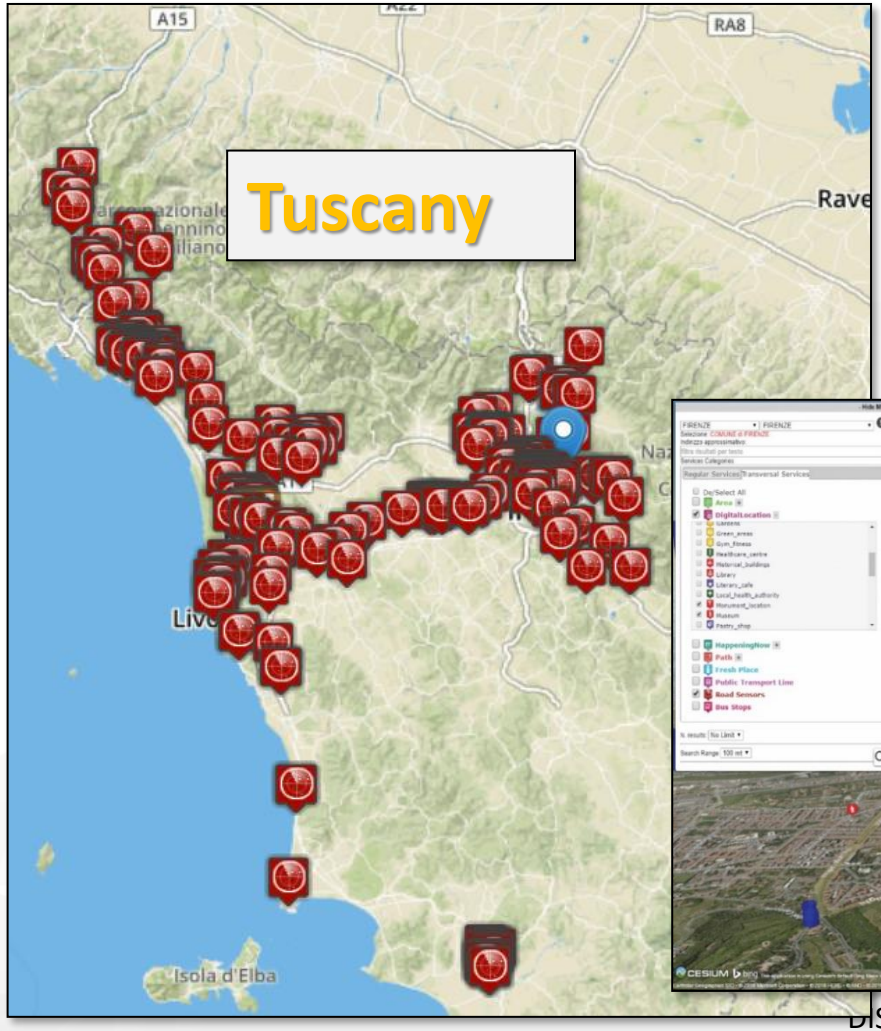


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Traffic Flow Tools

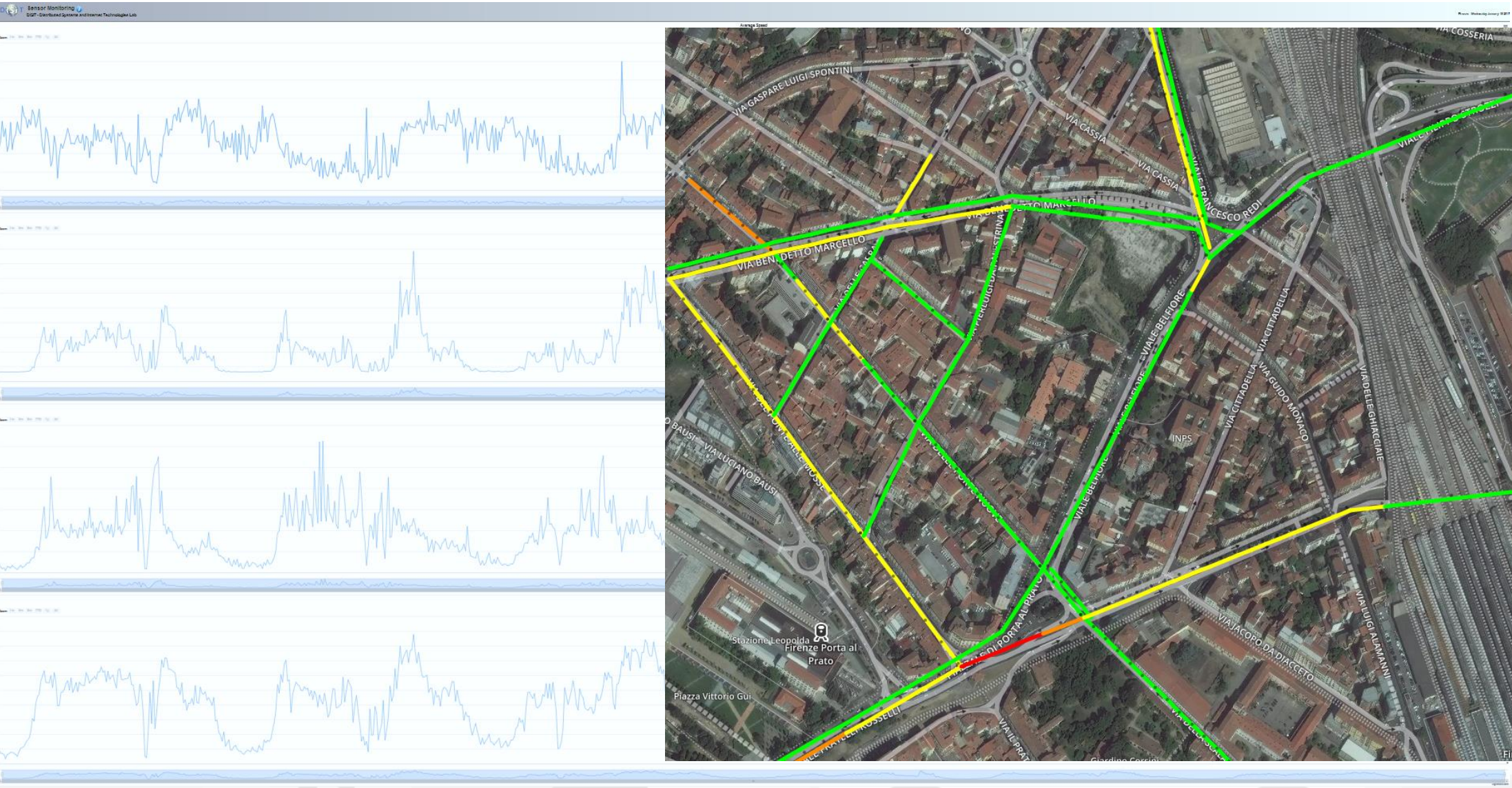
Spire and Virtual Spires (cameras), Bluetooth, ...

Specifically located: along, around, on gates, on x...





Traffic Flow data



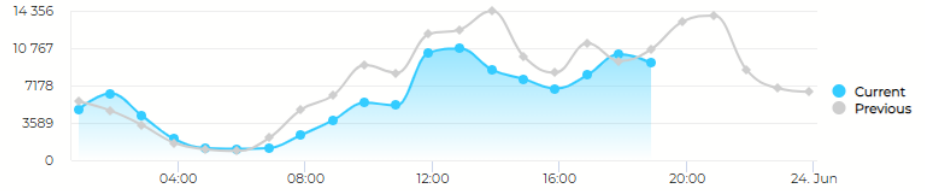
Traffic Flow Monitoring - Firenze - Cloned

Sun 23 Jun 19:38:15

 # IN FLOW 9m

9350

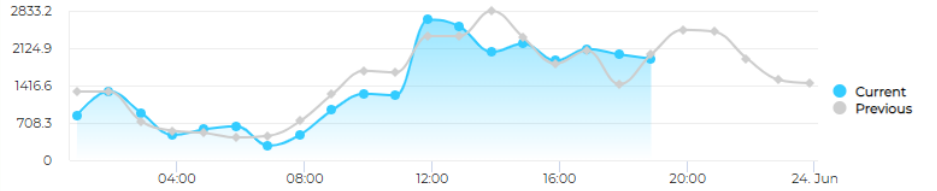
Firenze IN Traffic Flow (number of vehicles) 9m



ZTL in 9m

1925

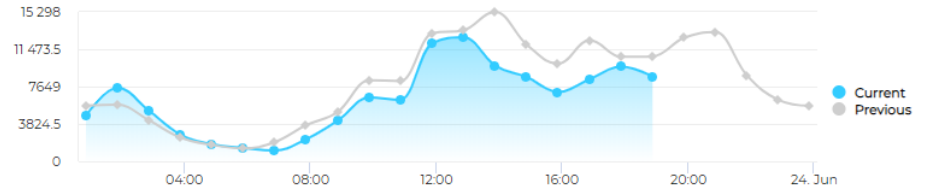
ZTL in Traffic Flow daily trend 9m



 # OUT FLOW 9m

8684

Firenze OUT Traffic Flow (number of vehicles) 9m



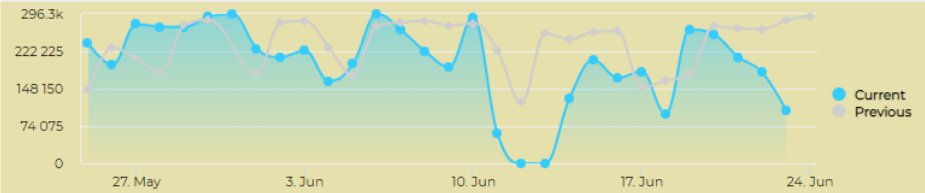
status comments 4m

All OK

Inc Daily Inp... 9m

105354

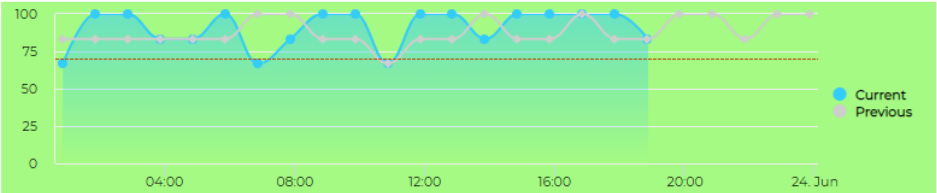
Daily Inputs (monthly) (last value is incremental) 9m



Current Time - C...

23/06/2019
19:38:15

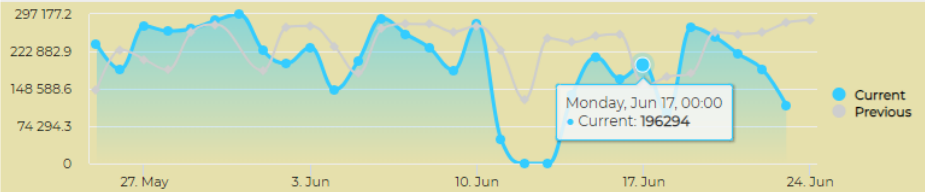
Quality of Measure in terms of percentage of expected measures considered 9m



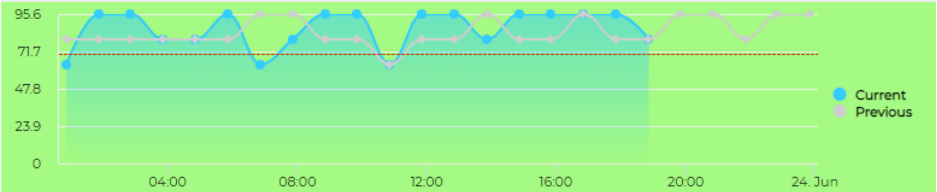
Inc Daily Out... 9m

116029

Daily Outputs (monthly) (last value is incremental) 9m



Quality of Measure in percentage - ZTL in time trend compare 9m



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc2MQ==



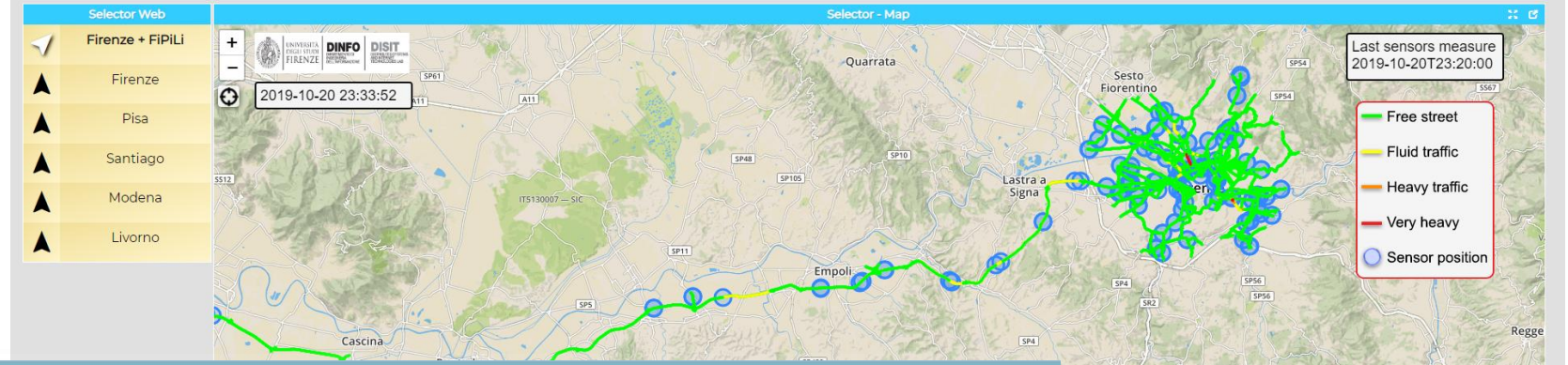
http://firenzetraffic.km4city.org

http://firenzetraffic.km4city.org/new.html

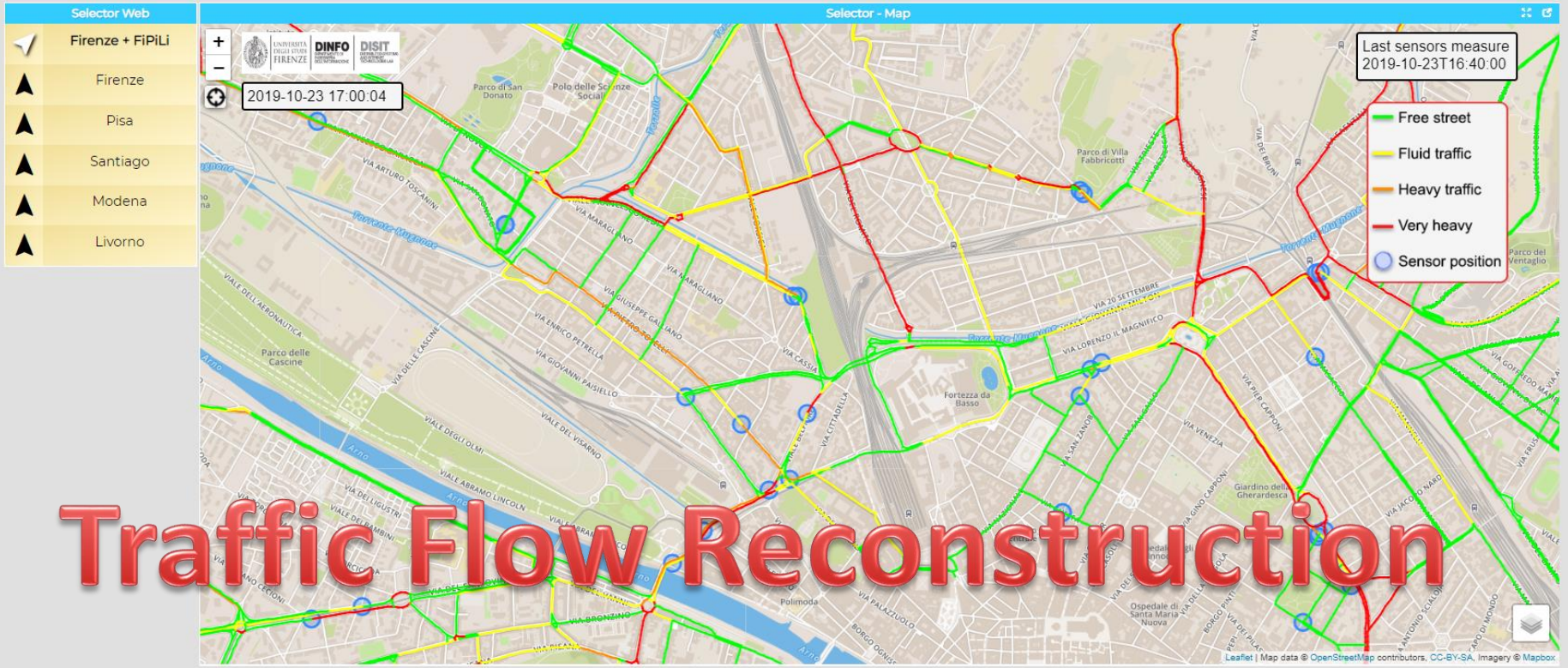
http://firenzetraffic.km4city.org/newSensors.html

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Traffic Flow Reconstruction for the cities



Traffic Flow Reconstruction for the cities



Traffic Flow Reconstruction

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc5NQ==

Traffic Flow reconstruction, real time

Mathematical model

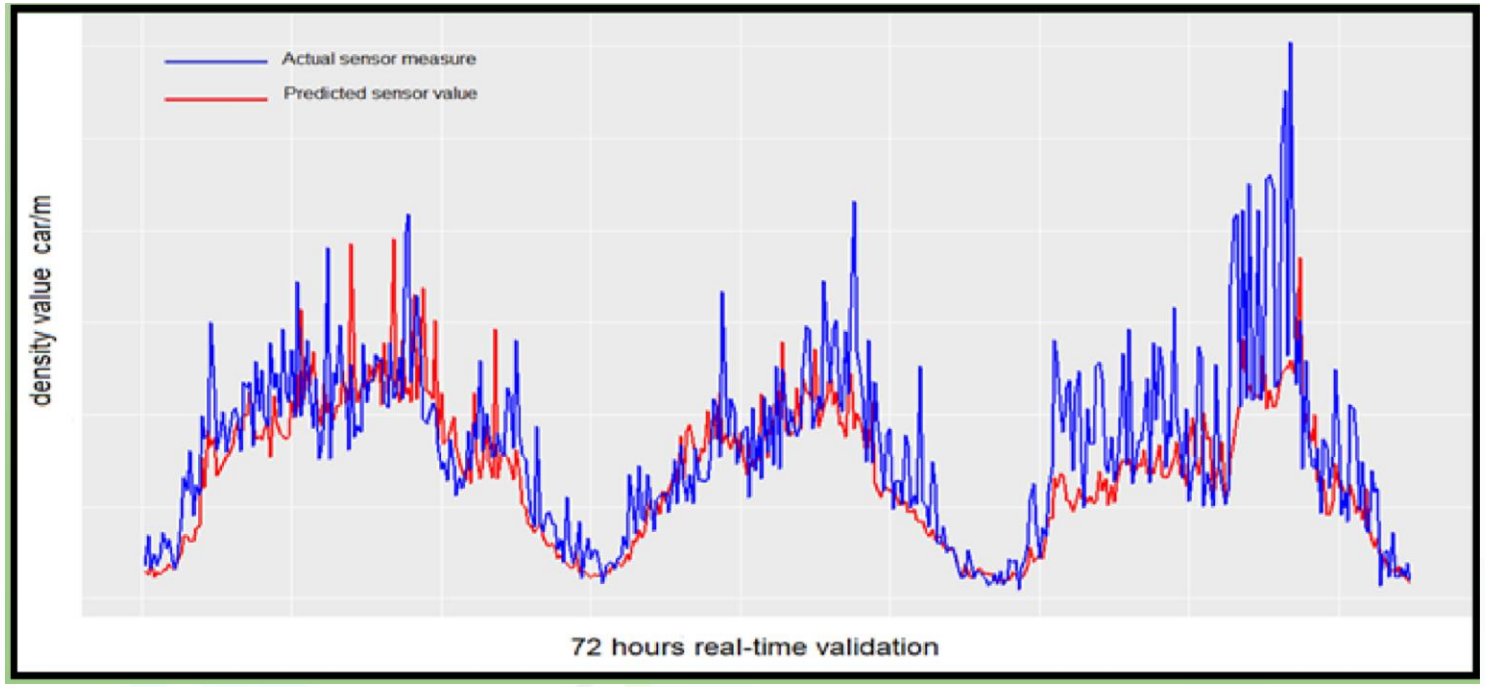
The vehicular traffic flow is propagated in the city graph according to a fluid dynamics model which is based on the conservation law of the vehicles. In a single road, it is described by the following partial differential equation:

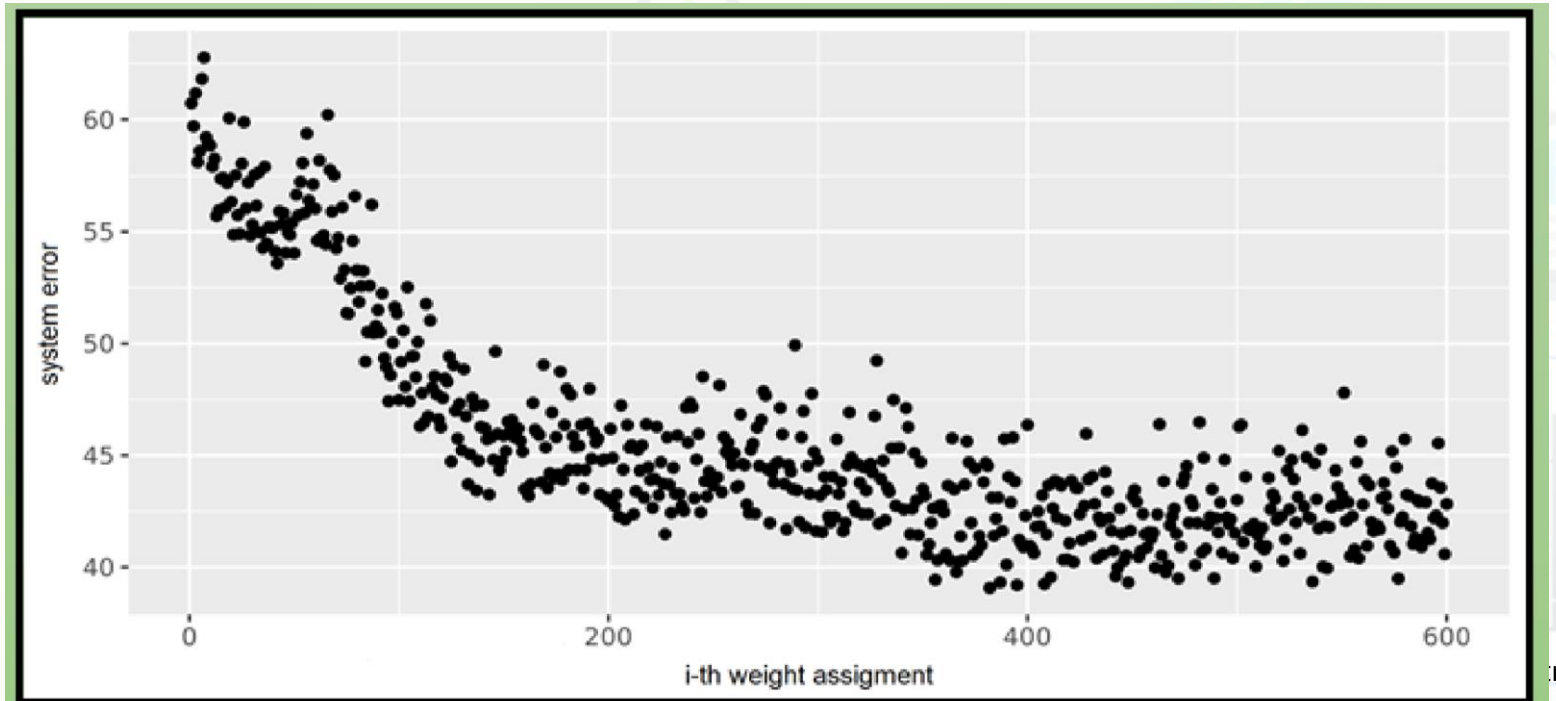
$$\frac{\partial \rho(t,x)}{\partial t} + \frac{\partial f\left(\rho(t,x)\right)}{\partial x} = 0$$

where $\rho(t,x)$ denotes the vehicular density and the function $f(\rho(t,x))$ is the vehicular flux which is defined as the product $\rho(t,x)v(t,x)$, being $v(t,x)$ the local speed of the vehicles.

A discretization scheme in terms of *finite differences* is considered to obtain a numerical solution of the above equation. The traffic flow is then distributed through the junctions in the city.

Convergence of learning phase





Traffic Flow reconstruction, real time

Traffic Flow Reconstruction (self training)

- P. Bellini, S. Bilotta, P. Nesi, M. Paolucci, M. Soderi, "Traffic Flow Reconstruction from Scattered Data", IEEE SMARTCOMP, IEEE international conference on smart computing, 18-20 June, Taormina, Sicily, Italy. 2018
- P. Bellini, S. Bilotta, P. Nesi, M. Paolucci, M. Soderi, "Real-Time Traffic Estimation of Unmonitored Roads", IEEE-DataCom'2018, Athens, 2018

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TRAFAIR

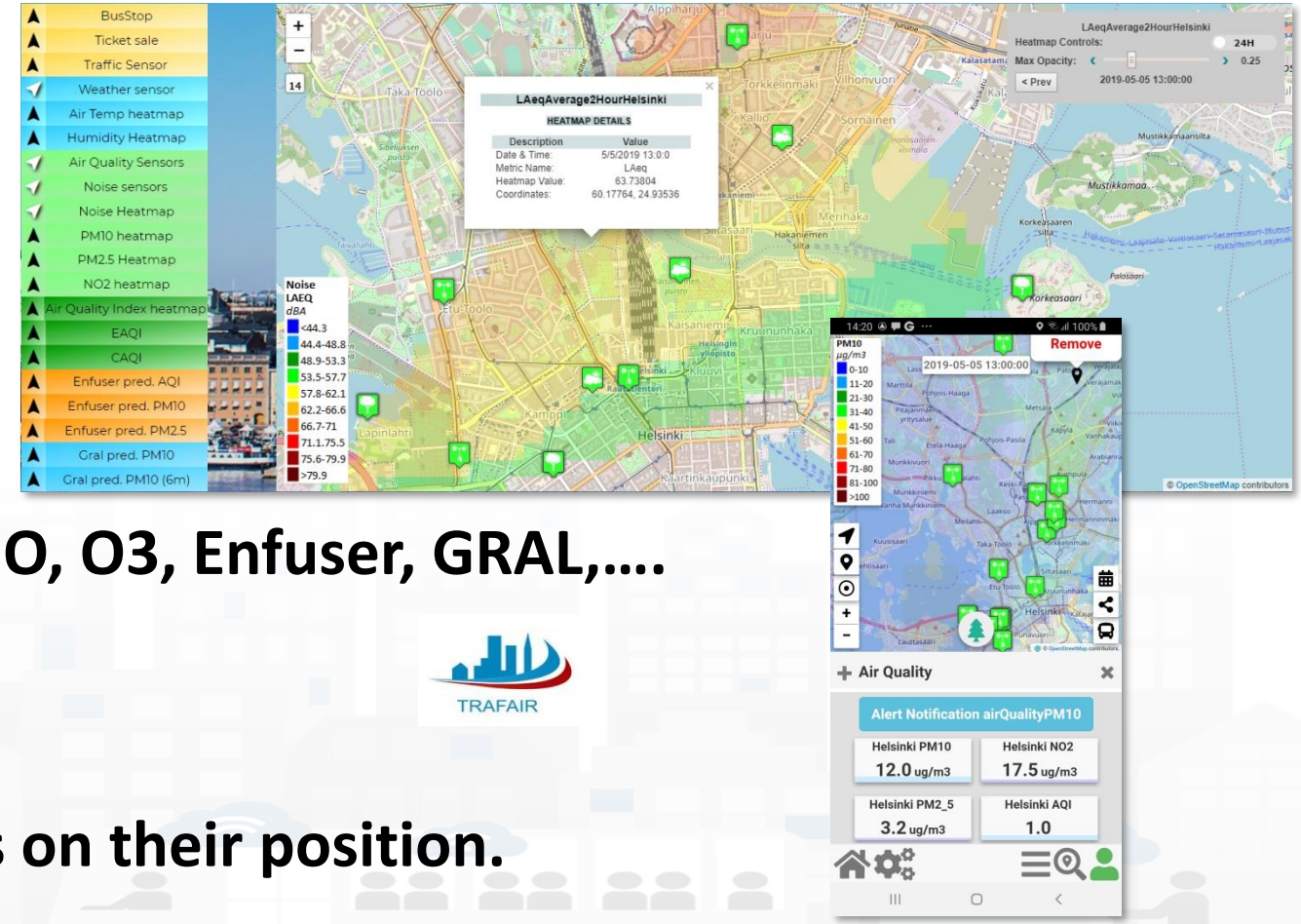
Environmental Data: Predictions, Early Warning



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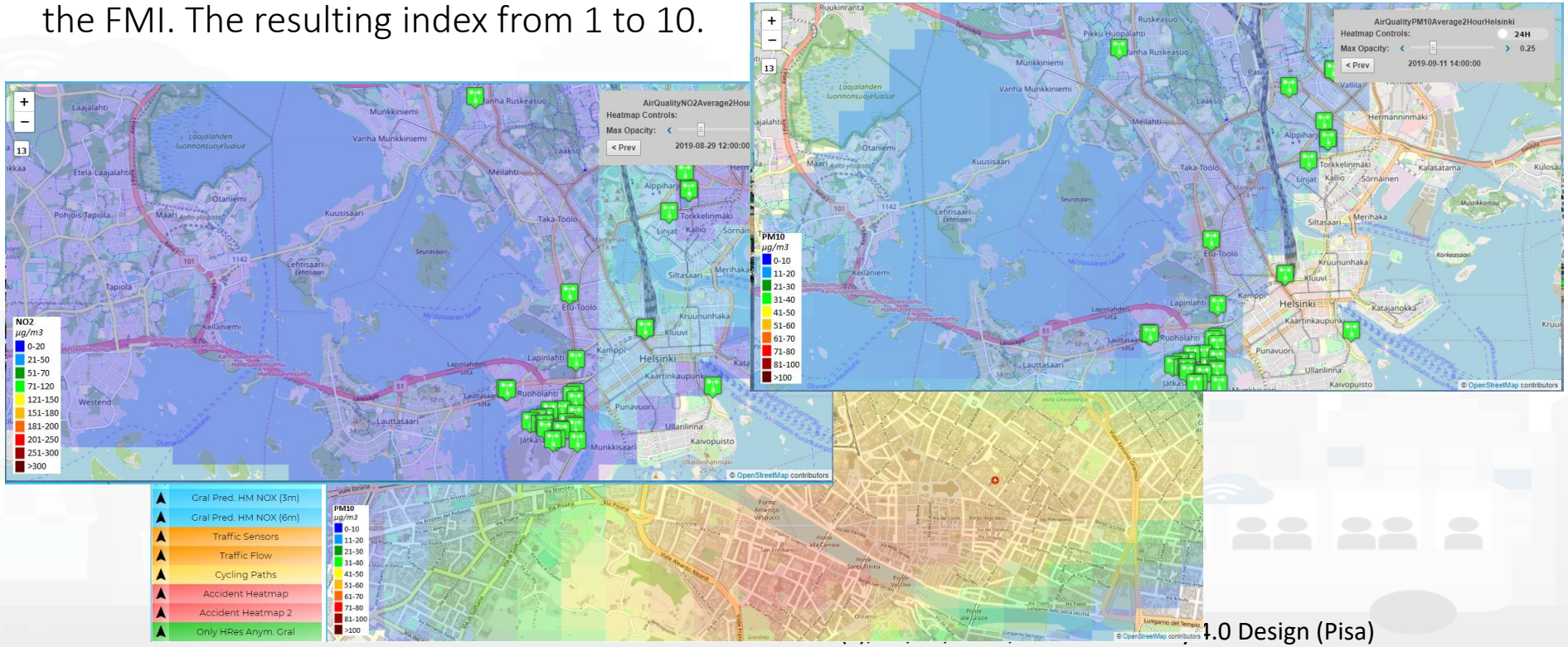
Data Analytics: Heatmaps

- Over the Gaussian Heatmaps
- Calibrated heatmaps on the basis of Interpolated data for:
  - From 200x200 to 4x4 mt
  - PM10, PM2.5, SO2, NO2, Noise, NO, O3, Enfuser, GRAL,….
  - Any programmed Color map
  - Animations over H24
  - Picking values in any place, values on their position.
  - On Web and Mobile App



Environmental Real Time Measures

- **Noise:** real time noise levels (measured in dBA).
- **PM_{10}:** real time pollutant levels in air in terms of PM_{10} (measured in $\mu g/m_3$) particles.
- **$PM_{2,5}$**: real time pollutant levels in air in terms of $PM_{2.5}$ (measured in $\mu g/m_3$) particles
- **NO_2**: real time pollutant levels in air in terms of nitrogen dioxide (measured in $\mu g/m_3$).
- **Air Quality Index (AQI):** real time air quality index of the Helsinki area, provided by the FMI. The resulting index from 1 to 10.



Environmental Data Predictions: GRAL

- **GRAL predictions: PM10, NOX, ….**
  - **Comparison wrt real time values in actual value of Sensors**
  - Graz Lagrangian Model.
- GRAL model takes into account:
  - pollution sources (for example the vehicles, their distribution on the streets, the about of pollution they produce according to their distribution over time and space, etc.),
  - structure of the city (streets and shape 3D of the buildings),
  - weather forecast (wind intensity and direction), etc.
- GRAL can be applied on NOX, PM10, PM2.5, … or any other particles



TRAFAIR

Traffic Flow Reconstruction for the cities

Sun 3 Nov 20:39:47

Selector Web

- Firenze + FiPiLi
- Firenze
- Pisa
- Santiago
- Modena
- Livorno

Selector - Map

2019-11-03 20:39:47

Last sensors measure
2019-11-03T20:30:00

- Free street
- Fluid traffic
- Heavy traffic
- Very heavy
- Sensor position

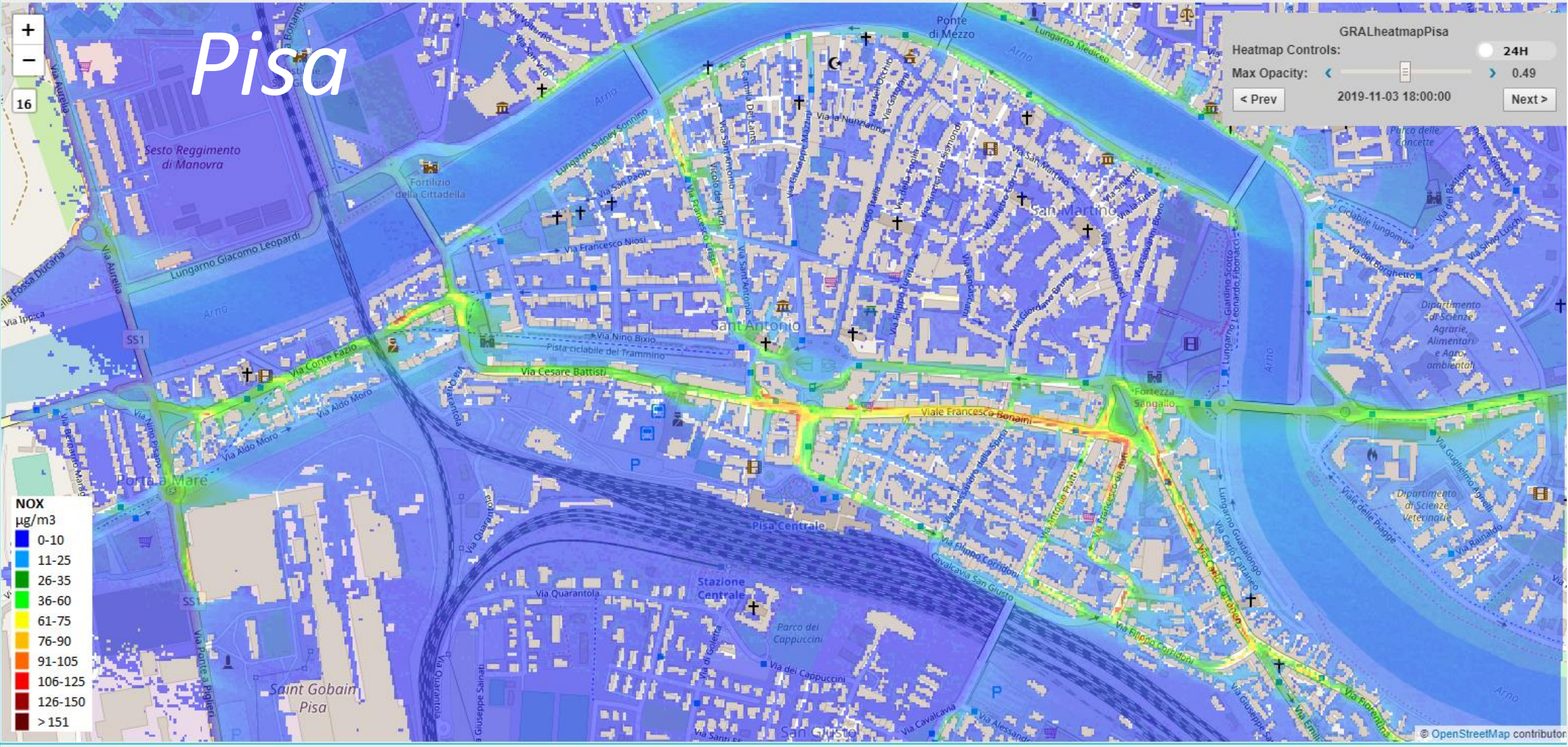


Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

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SNAP4CITY | KM4CITY

Multi Map



Selector - Map

2019-11-03 20:44:08



Multi Map

15

NOX
µg/m3
0-10
11-25
26-35
36-60
61-75
76-90
91-105
106-125
126-150
>151

DISIT Lab UNIFI (c),

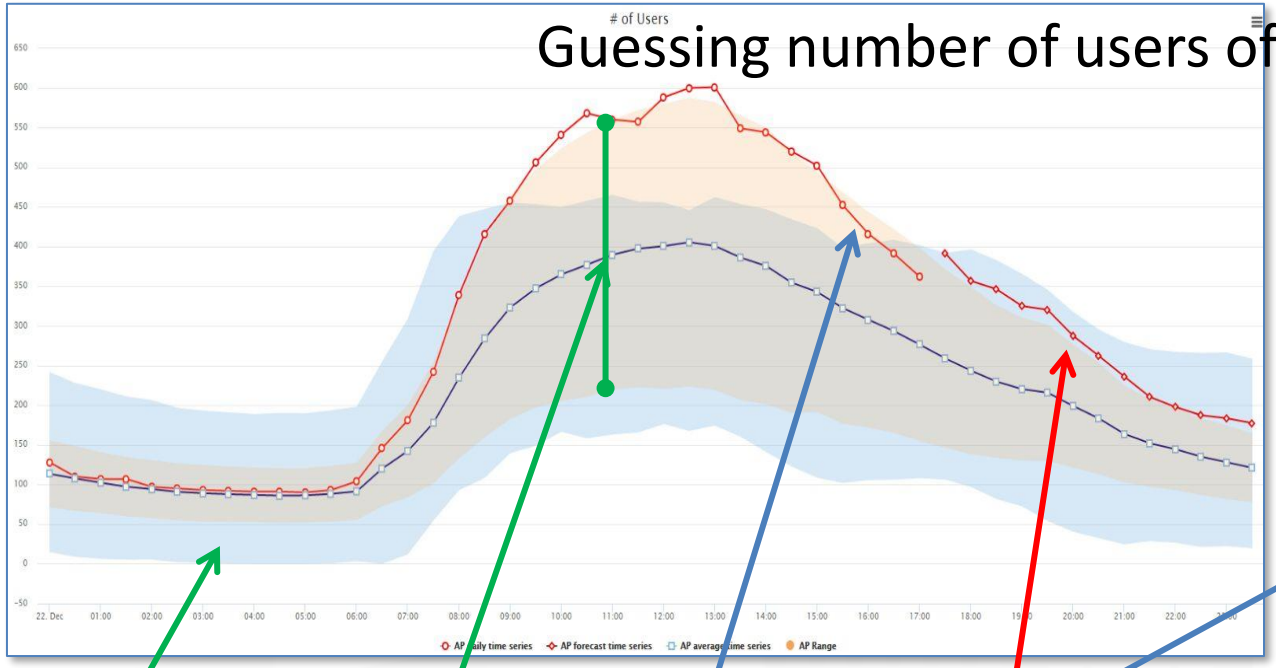
Anomaly Detection

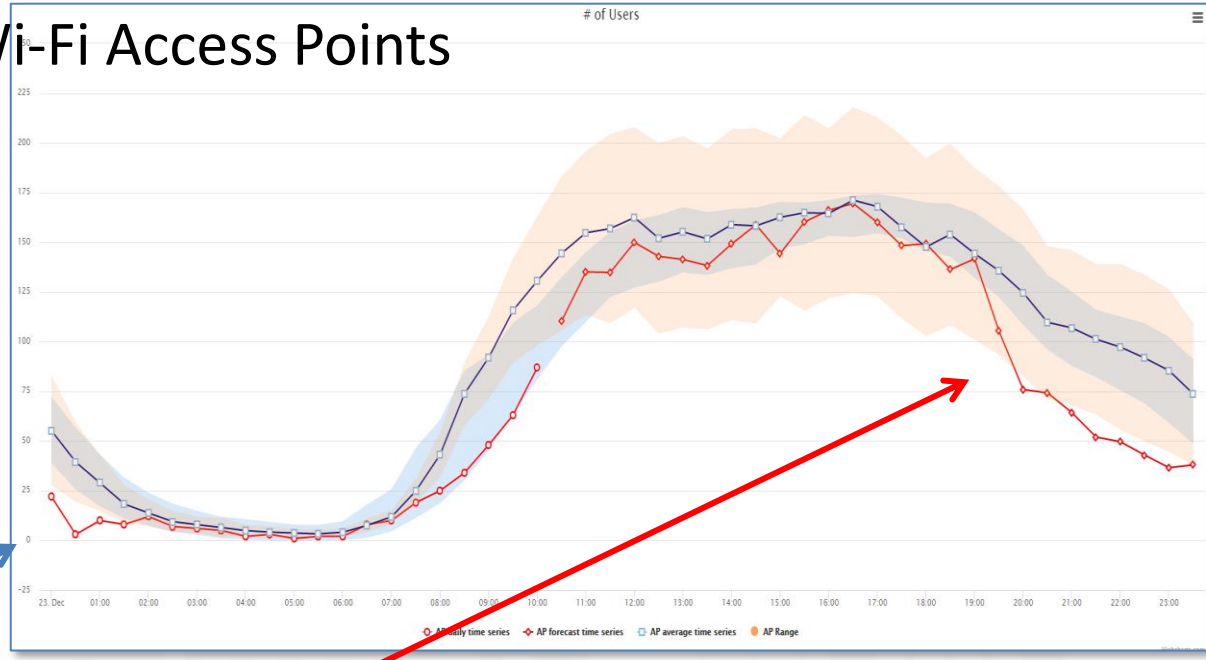


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Prediction and Identification of Anomalies

Guessing number of users of Wi-Fi Access Points





Cluster confidence

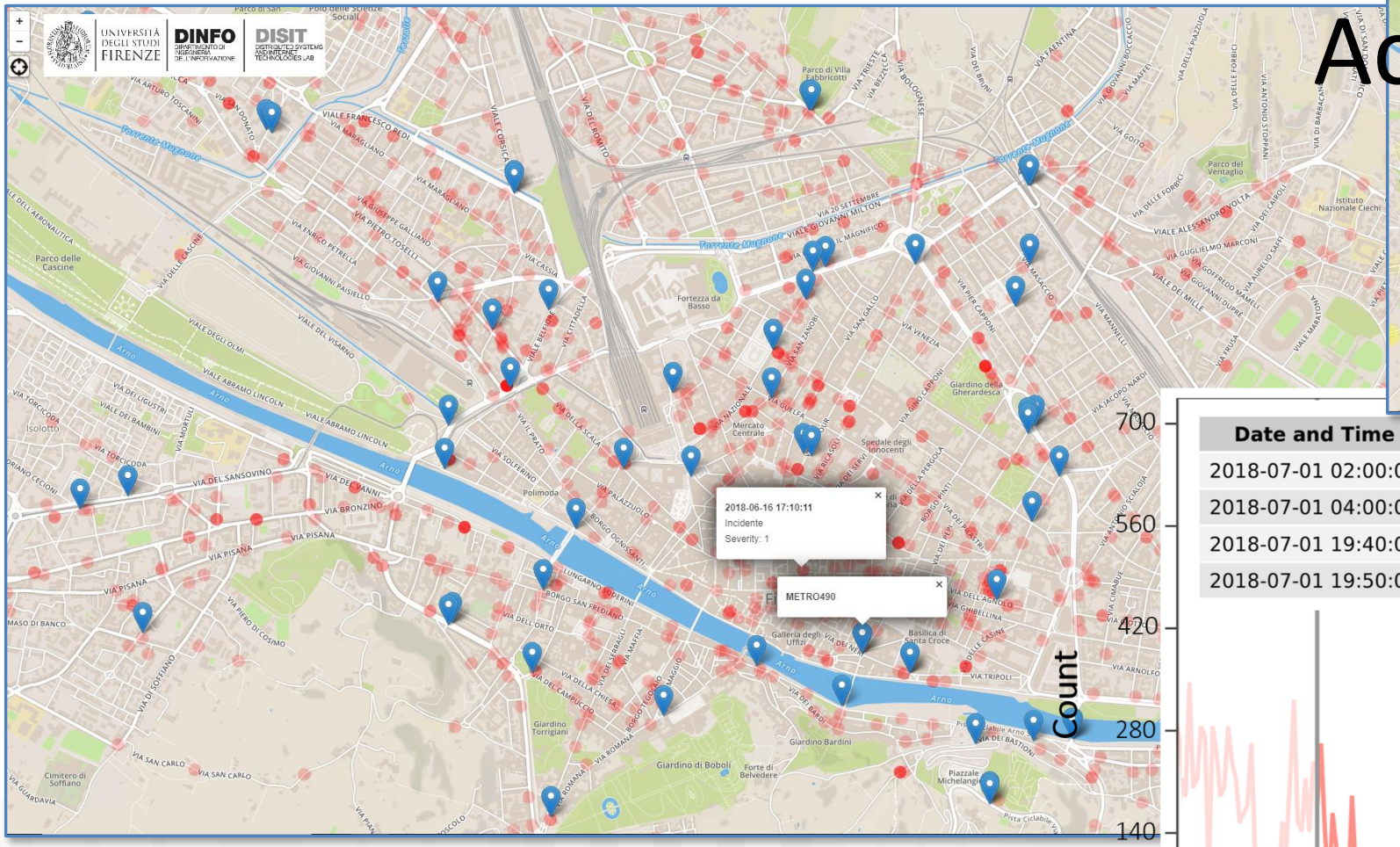
AP average and confidence

Actual AP trend for today

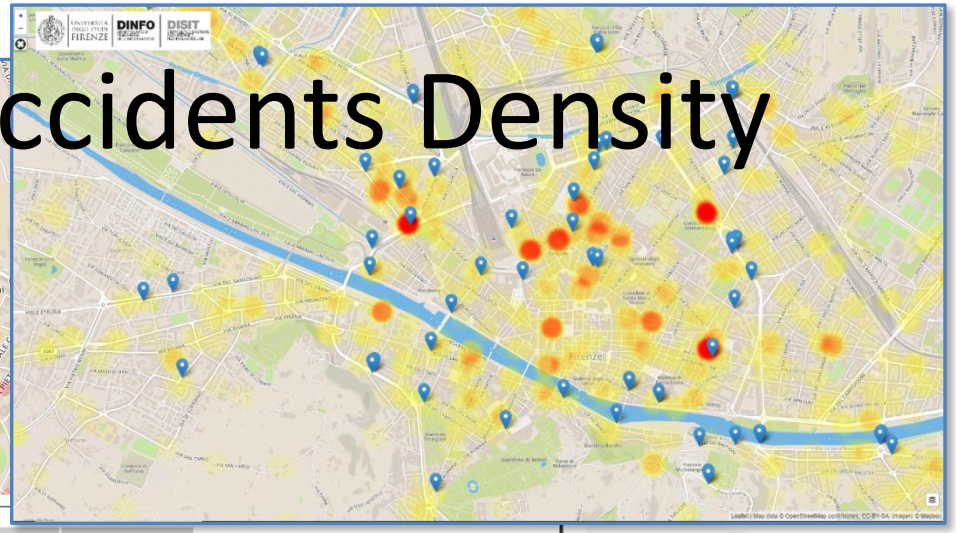
AP prediction for the next time slot in the day on the basis of past weeks

Predictive precision of the 95%

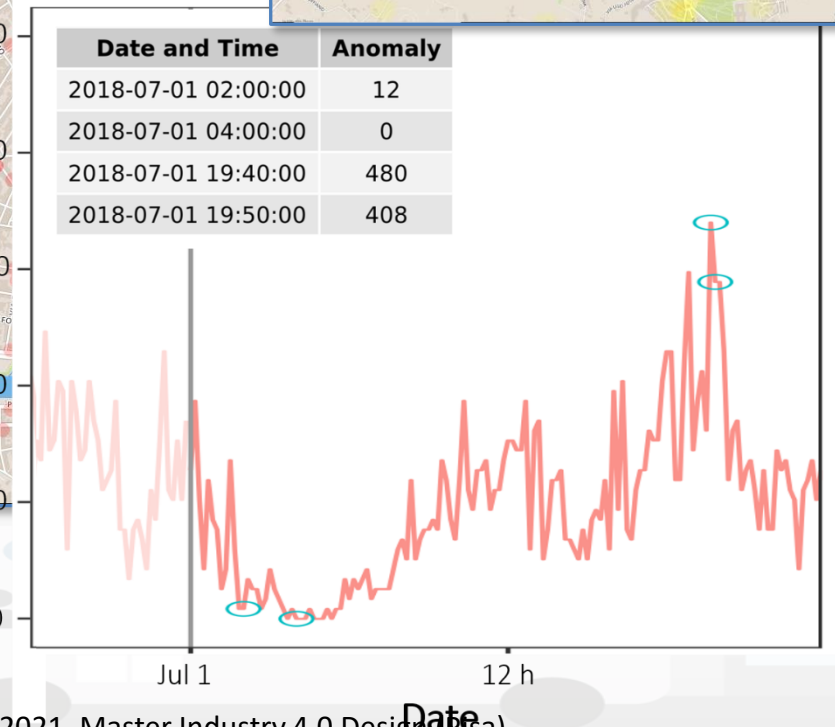
Anomaly Detection



Accidents Density



Accidents vs Traffic



Intelligence on Maintenance Data



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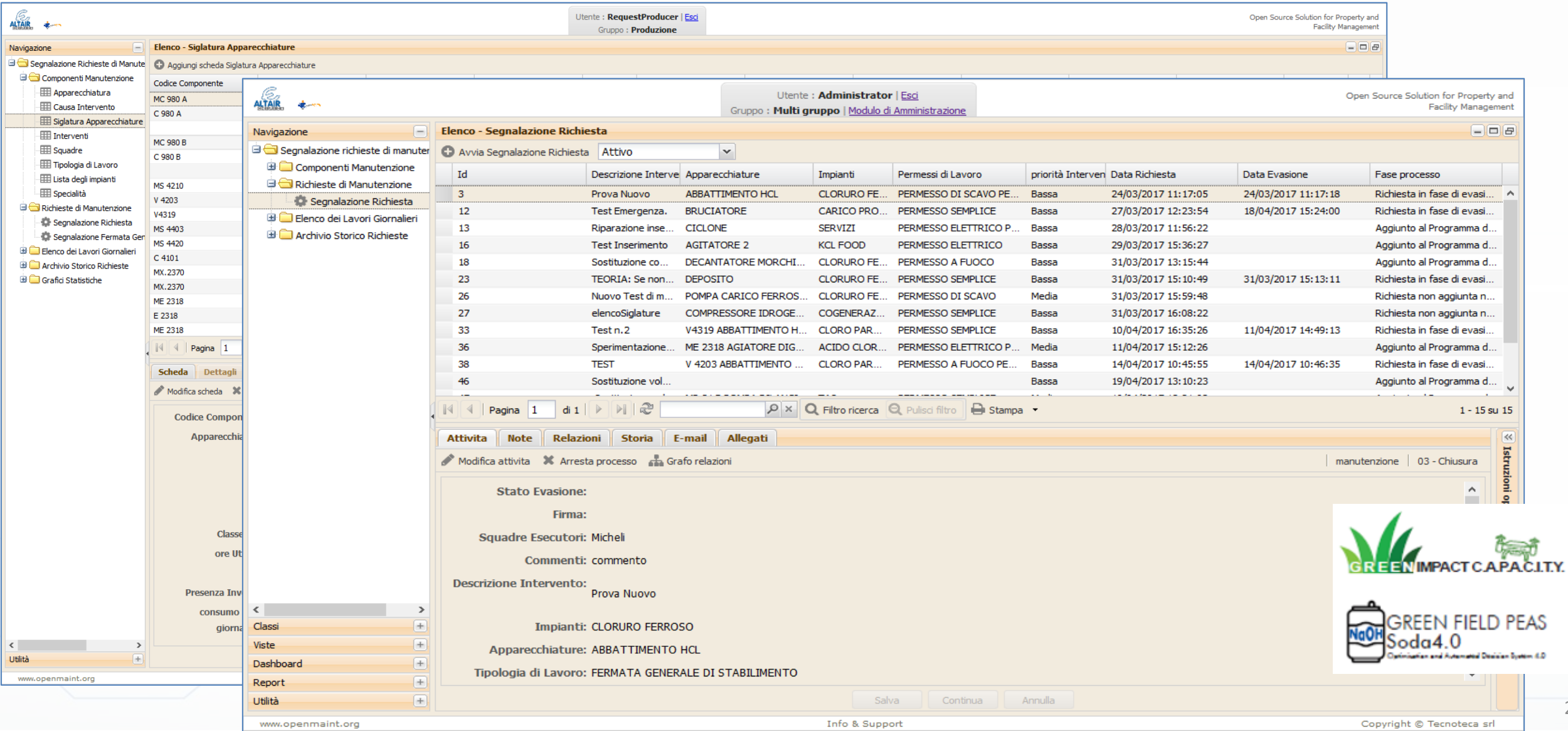
Solution for Asset Management and Maintenance

- Inventory of industry assets (movable, logistics, equipments, etc.)
- Tickets management for corrective maintenance
- Reports and Dashboards
- Predictive maintenance and Early Warning support via analytics
- Business Intelligence support
- User management with different levels of access

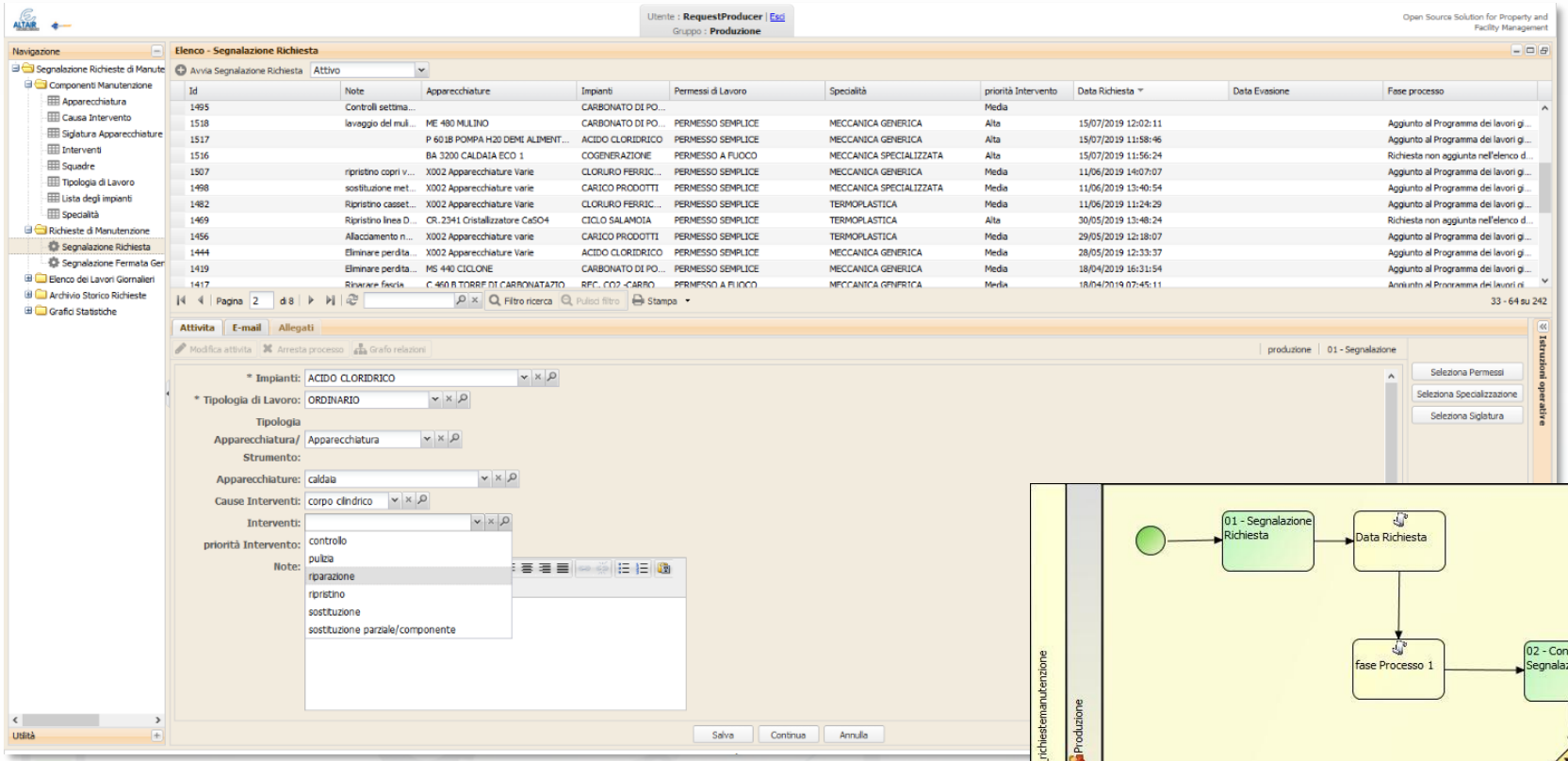
GREEN IMPACT C.A.P.A.C.I.T.Y.

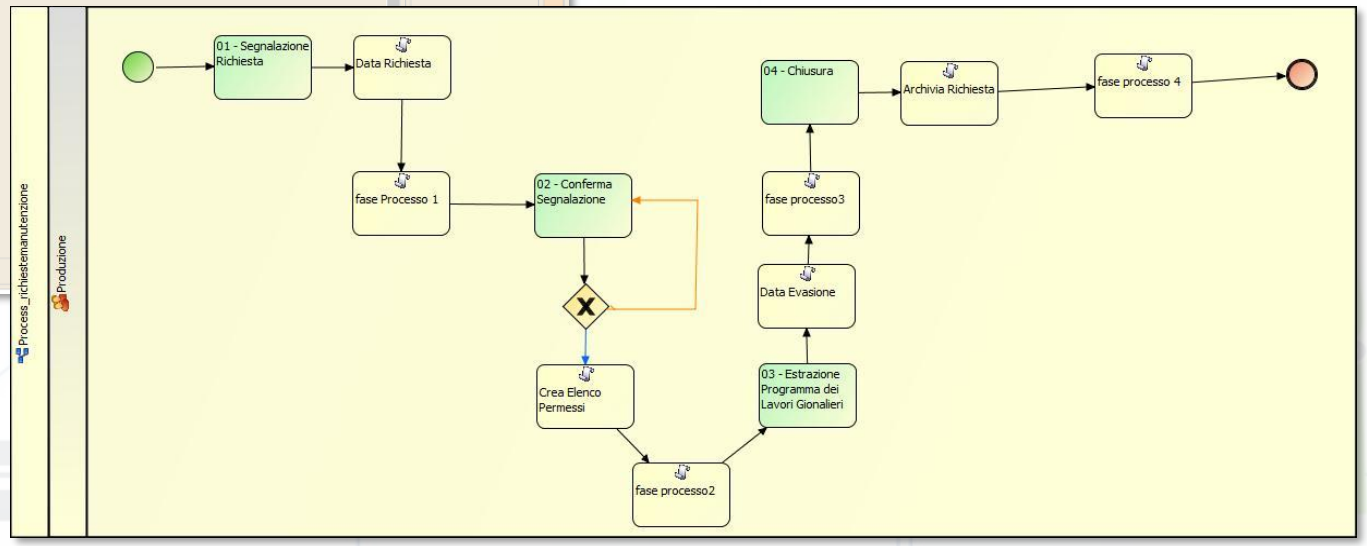
GREEN FIELD PEAS Soda4.0

Assets inventory and management



Maintenance: ticket management





Personalised Workflows

Filters | Search | KQL | Last 1 year | Show dates | Refresh

+ Add filter

- ABBATTIMENTO CLORO
- ACIDO CLORIDRICO
- ACQUA INDUSTRIALE
- ARIA SERVIZI E STRUMENTI
- CARBONATO DI POTASSIO
- CARICO PRODOTTI
- CICLO POTASSA CAUSTICA

Impianto: Select...

Specialità: Select...

Tipologia Lavoro: Select...

Siglatura: Select...

Apply changes | Cancel changes | Clear form

1,865
Numero di eventi nel periodo

264.491
50th percentile of ore tra inizio e fine lavoro

673.151
Media ore passate tra inizio e fine lavoro

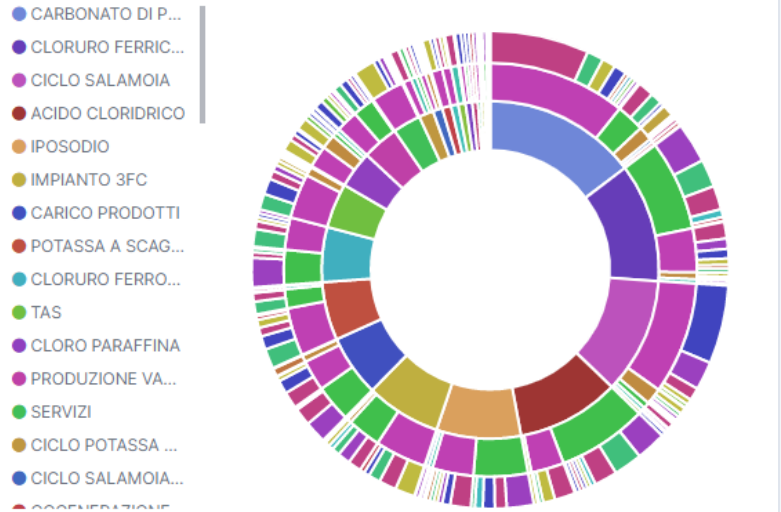
CLORURO FERRICO STANDARD
CARBONATO DI POTASSIO
CICLO SALAMOIA
IPOSODIO
IMPIANTO 3FC
CARICO PRODOTTI

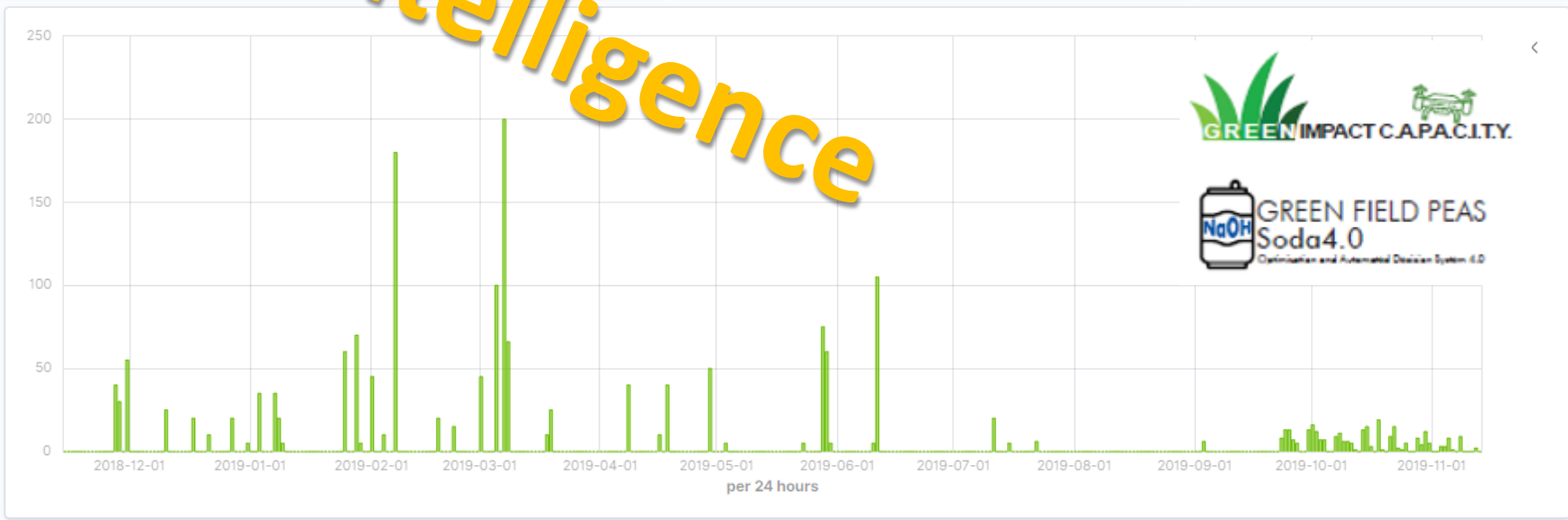






Maintenance Intelligence





Suggestions for Retail



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FEEDBACK: Customer Segmentation

Customer segmentation is the practice of dividing a customer base into groups of individuals that are similar in specific ways relevant to marketing



Demographic information
GENDER, AGE, FAMILY STATUS, ...

Geographical information
COUNTRY, DISTRICT, CITY, ZIP CODE, ...

Behavioral data
FIDELITY CARD, FIRST BUY, LAST BUY, PREFERRED POS, ...

Behavioral data
ONLINE (Days Frequency, Days Recency), Avg Amount, TRANSACTION(Days Recency, Days Frequency) ...

Behavioral data
CUSTOMER Presence in store (Days Frequency Days Recency), Interest Level PRODUCT (totem, cart, check out, tried in the dressing room), ...

Interest Product

Level of interest for cluster,
Number products buyed into cluster

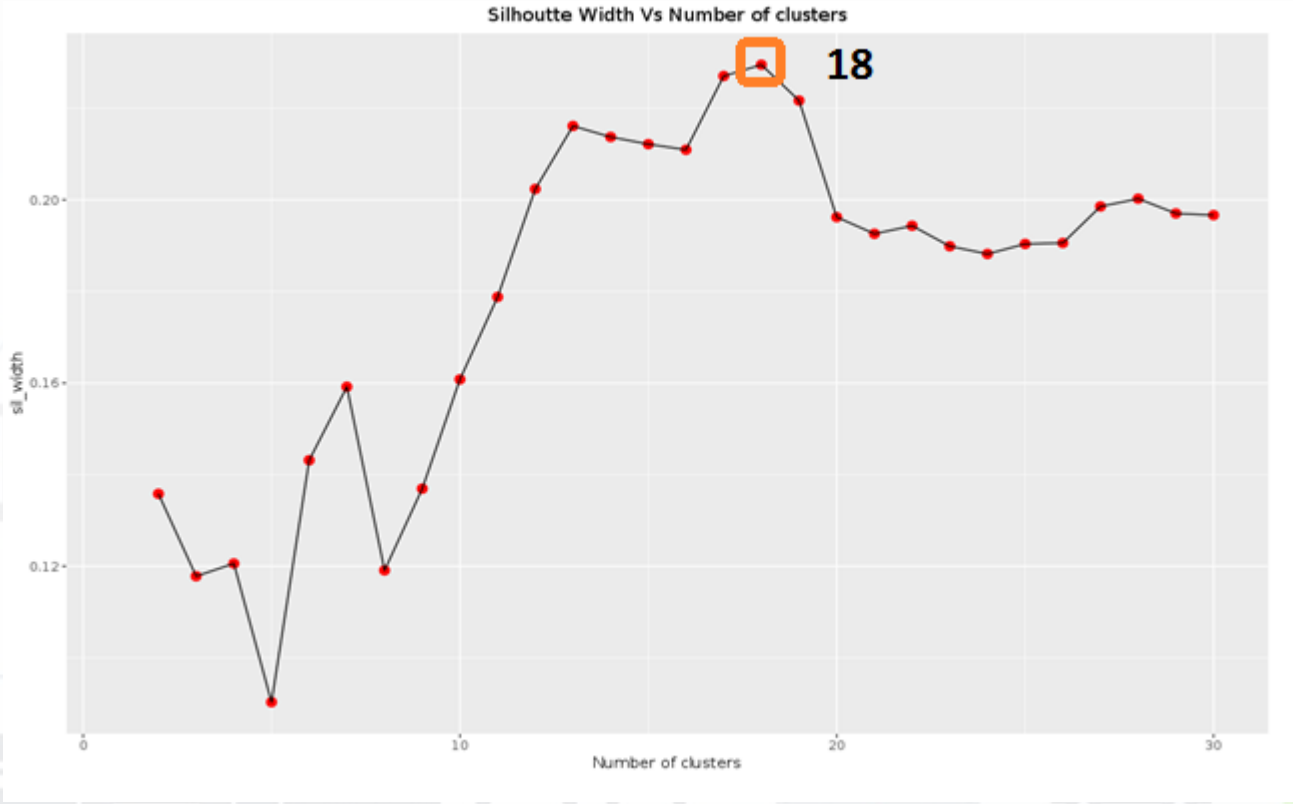
Dataset:
Customer retail fashion and large scale retail distribution

1: Products Segmentation

Qualitative data → Methods: K-Medoids

Table Product	
SKU_TYPE_CD	tipo articolo (codice modello)
SKU_CONFIGURATION_CD	codice parte
SKU_PATTERN_CD	codice colore
SKU_MODEL_CD	codice modello
SKU_PACKAGING_TYPE_CD	CodicePACCHETTO
PRODUCTION_CATEGORY_CD	ClassePRODUTTIVA
PRODUCTION_SUBCATEGORY	DescSottoClassePRODUTTIVA
MERCHANDISE_MCR_TYP_DS	DescClasseCOMMERCIALE
MERCHANDISE_TYPOLOGY_DS	DescSottoclasseCOMMERCIALE
MERCHANDISE_FAMILY_CD	SottoclasseBUDGET
MERCHANDISE_GROUP_DS	DescClasseMERCEOLOGICA
MERCHANDISE_SUBGROUP_DS	DescSottoclasseMERCEOLOGICA
SKU_MATERIAL_GROUP_DS	DescClasseTECNICA
SKU_MATERIAL_SUBGROUP_DS	DescSottoclasseTECNICA
SKU_GENDER_CD	CodiceDIVISIONE
SKU_LINE_CD	LineaDiVendita
SKU_BRAND_CD	CodiceSTILISTA
SKU_DIMENSION_GROUP_CD	(parte riferimento)
SKU_STYLE_GROUP_CD	(tipo modello)
SKU_BIRTH_SEASON_CD	Stagione
SKU_BIRTH_COLLECTION_CD	StagionePACCHETTO
SKU_PERIODICITY_CD	PeriodicitaModello
SKU_IS_CLOTHING_ITEM_FL	FlagCapoNonCapo
SKU_NRM_CAT_LVL_1_CD	cod Classificazione Business Normalizzata Livello 1
SKU_NRM_CAT_LVL_2_CD	cod Classificazione Business Normalizzata Livello 2
SKU_NRM_CAT_LVL_3_CD	cod Classificazione Business Normalizzata Livello 3

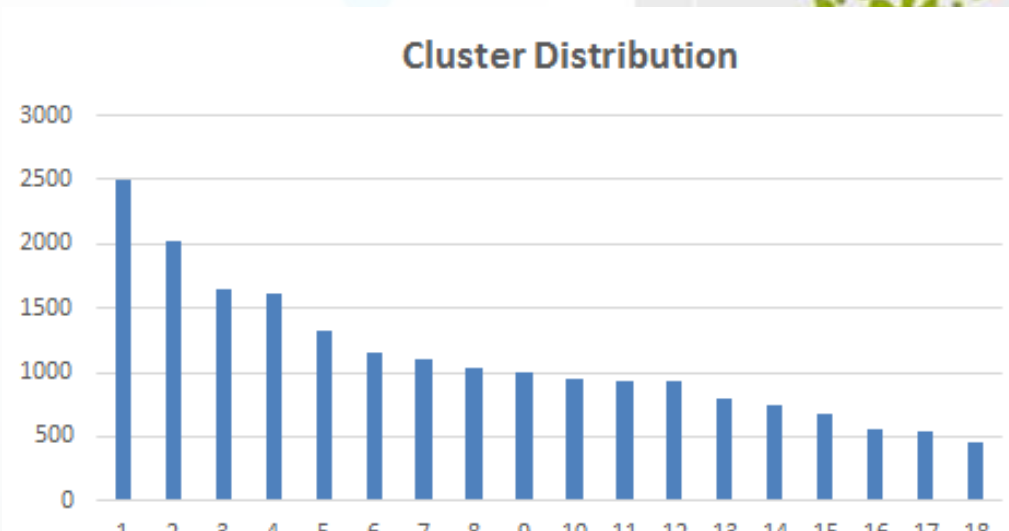
Calculate optimal number of clusters: **Silhoutte analysis**
(The location of the maximum is considered as the appropriate

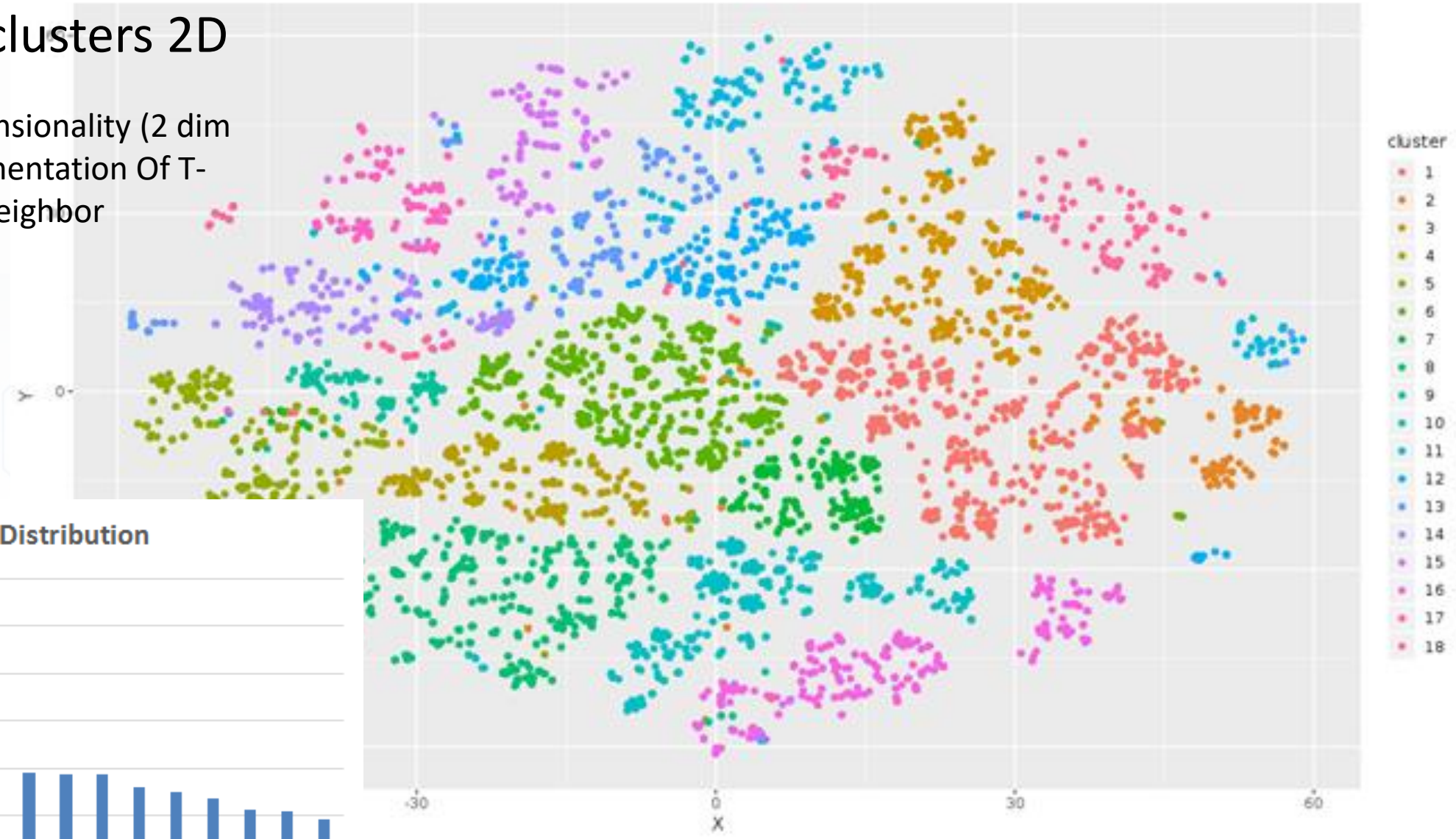


1: Products Segmentation

Visualizing the clusters 2D

Method reduction dimensionality (2 dim X/Y): Barnes-Hut Implementation Of T-Distributed Stochastic Neighbor Embedding.





2: Add Interest Customer for customer

CUSTOMER_TABLE	
CUS_GENDER_CD	sesso
CUS_AGE_NM	età
CUS_FAMILY_STATUS_DS	stato civile
CUS_FIDELITY_CARD_LEVEL_CD	codice attuale livello fidelity card
CUS_ACTUAL_SCORE_NM	Punteggio loyalty attualmente disponibile
CUS_ACTUAL_DISCOUNT_VL	importo totale buoni utilizzati
CUS_TOTAL_SCORE_NM	totale punteggio loyalty acquisito
CUS_STD_COUNTRY_CD	nazione cliente in ISO code
CUS_STD_CITY_DS	descrizione standard città
CUS_FIRST_BUY_DT	data primo acquisto
CUS_FIRST_BUY_POS_CD	pos primo acquisto
CUS_LAST_BUY_DT	data ultimo acquisto
CUS_LAST_BUY_POS_CD	pos ultimo acquisto
SurveyAvgScore	media punteggio survey
RFM_TRN_DaysFrequency	distanza media in giorni tra acquisti
RFM_TRN_DaysRecency	giorni da ultimo acquisto
RFM_TRN_AvgAmount	importo medio per acquisto
RFM_PRS_ONLINE_DaysFrequency	distanza media in giorni tra visite online
RFM_PRS_ONLINE_DaysRecency	giorni da ultima visita online
RFM_PRS_ONPREM_DaysFrequency	distanza media in giorni tra visite in negozio
RFM_PRS_ONPREM_DaysRecency	data ultima visita in negozio
Preferred_POS_ID	pos preferenziale in base a numero acquisti
PercFidelityUsage	percentuale redenzione punti fidelity rispetto ad accumulati



Interest Cluster1	Interest Cluster2	.....	Interest Cluster18	# buyed cluster1	# buyed cluster2	.....	# buyed cluster18

Max interest for product in the cluster

0: No interest

1: Observed (Totem, Online, ecc)

2: Tried

3: Buyed

Number products buyed in the cluster

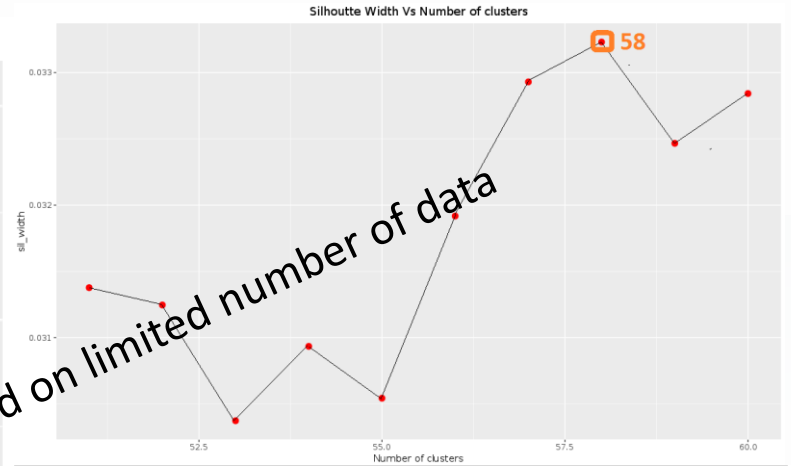
Early TEST on Interest Customer for customer

Mixed data Methods: K-Medoids

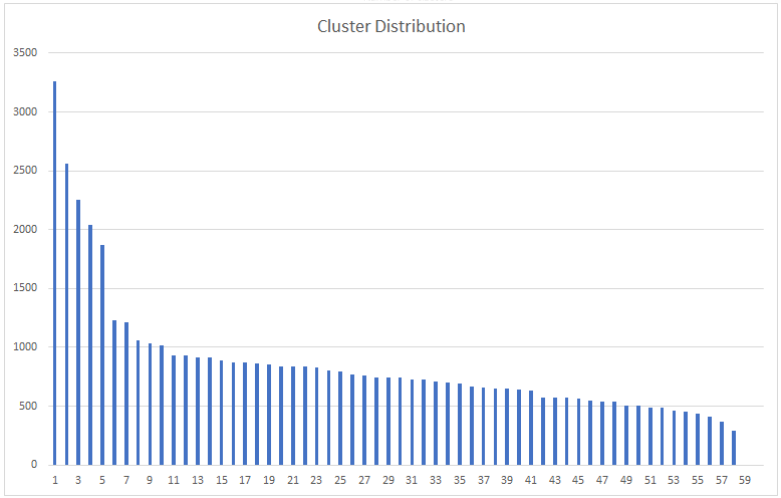
Calculate optimal number of clusters: **Silhoutte analysis** (The location of the maximum is considered as the appropriate number of clusters).

Visualizing the clusters 2D Method reduction dimensionality (2 dim X/Y): Barnes-Hut Implementation Of T-Distributed Stochastic Neighbor Embedding.





Not satisfactory results ..... and based on limited number of data



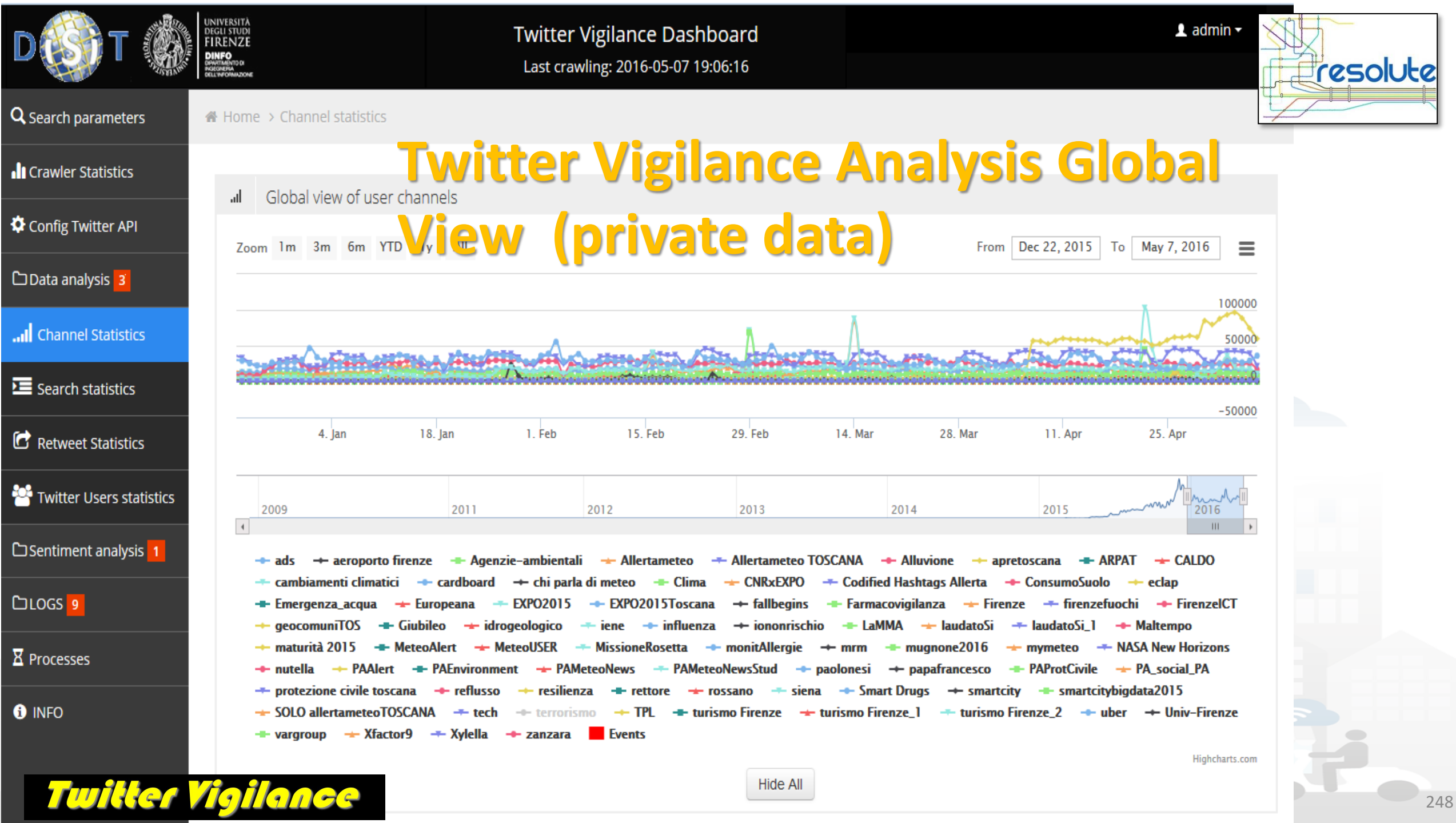
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Twitter Vigilance

Predicting ReTweet Proneness

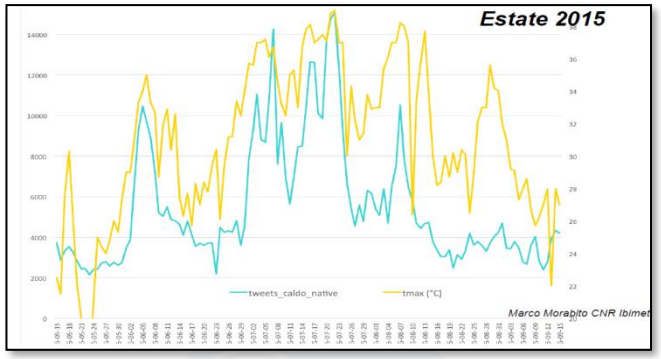


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Twitter Vigilance Dashboard
Last crawling: 2016-05-07 19:06:16
admin
resolute
Search parameters
Crawler Statistics
Config Twitter API
Data analysis 3
Channel Statistics
Search statistics
Retweet Statistics
Twitter Users statistics
Sentiment analysis 1
LOGS 9
Processes
INFO
Home › Channel statistics
Twitter Vigilance Analysis Global View (private data)
Global view of user channels
Zoom 1m 3m 6m YTD
From Dec 22, 2015 To May 7, 2016
100000
50000
0
-50000
4. Jan
18. Jan
1. Feb
15. Feb
29. Feb
14. Mar
28. Mar
11. Apr
25. Apr
2009
2011
2012
2013
2014
2015
2016
ads aeroporto firenze Agenzie-ambientali Allertameteo Allertameteo TOSCANA Alluvione apretoscana ARPAT CALDO
cambiamenti climatici cardboard chi parla di meteo Clima CNRxEXPO Codified Hashtags Allerta ConsumoSuolo eclap
Emergenza_acqua Europeana EXPO2015 EXPO2015Toscana fallbegins Farmacovigilanza Firenze firenzefuochi FirenzeICT
geocomuniTOS Giubileo idrogeologico iene influenza iononrischio LaMMA laudatoSi laudatoSi_1 Maltempo
maturità 2015 MeteoAlert MeteoUSER MissioneRosetta monitAllergie mrm mugnone2016 mymeteo NASA New Horizons
nutella PAAlert PAEnvironment PAMeteoNews PAMeteoNewsStud paolonesi papafrancesco PAProtCivile PA_social_PA
protezione civile toscana reflusso resilienza rettore rossano siena Smart Drugs smartcity smartcitybigdata2015
SOLO allertameteoTOSCANA tech terrorismo TPL turismo Firenze turismo Firenze_1 turismo Firenze_2 uber Univ-Firenze
vargroup Xfactor9 Xylella zanzara Events
Highcharts.com
Hide All
Twitter Vigilance

Prediction/Assessment

- Football game results as related to the volume of Tweets
- Number of votes on political elections, via sentiment analysis, SA
- Size and inception of contagious diseases
- marketability of consumer goods
- public health seasonal flu
- box-office revenues for movies
- places to be visited, most visited
- number of people in locations like airports
- audience of TV programmes, political TV shows
- weather forecast information
- Appreciation of services



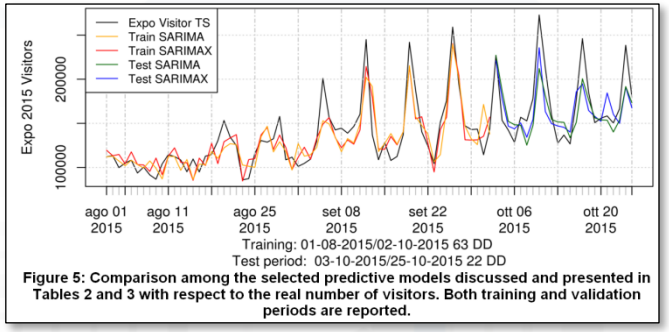
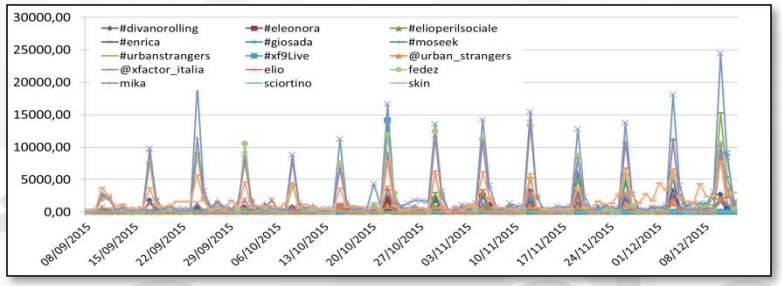
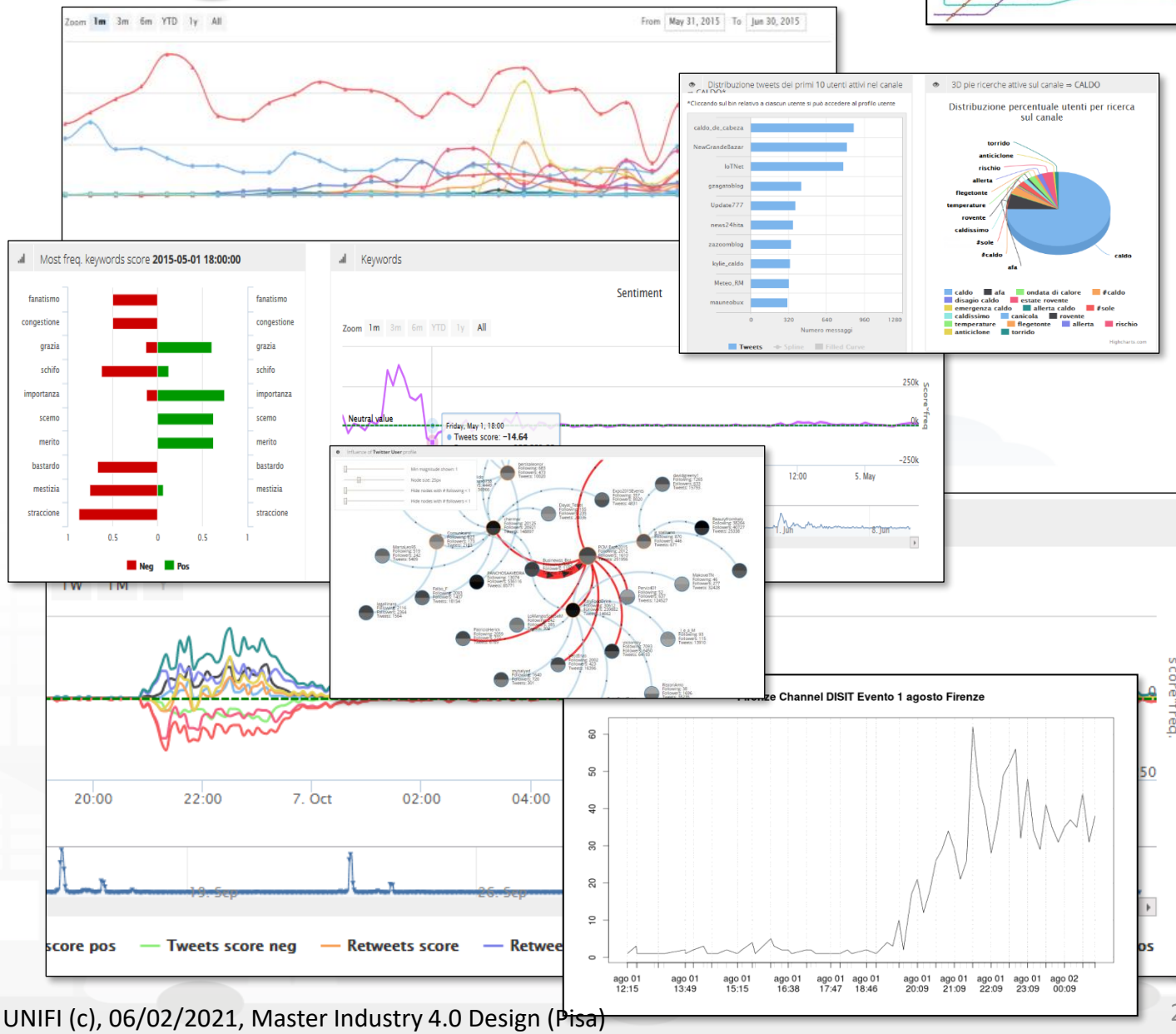


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.



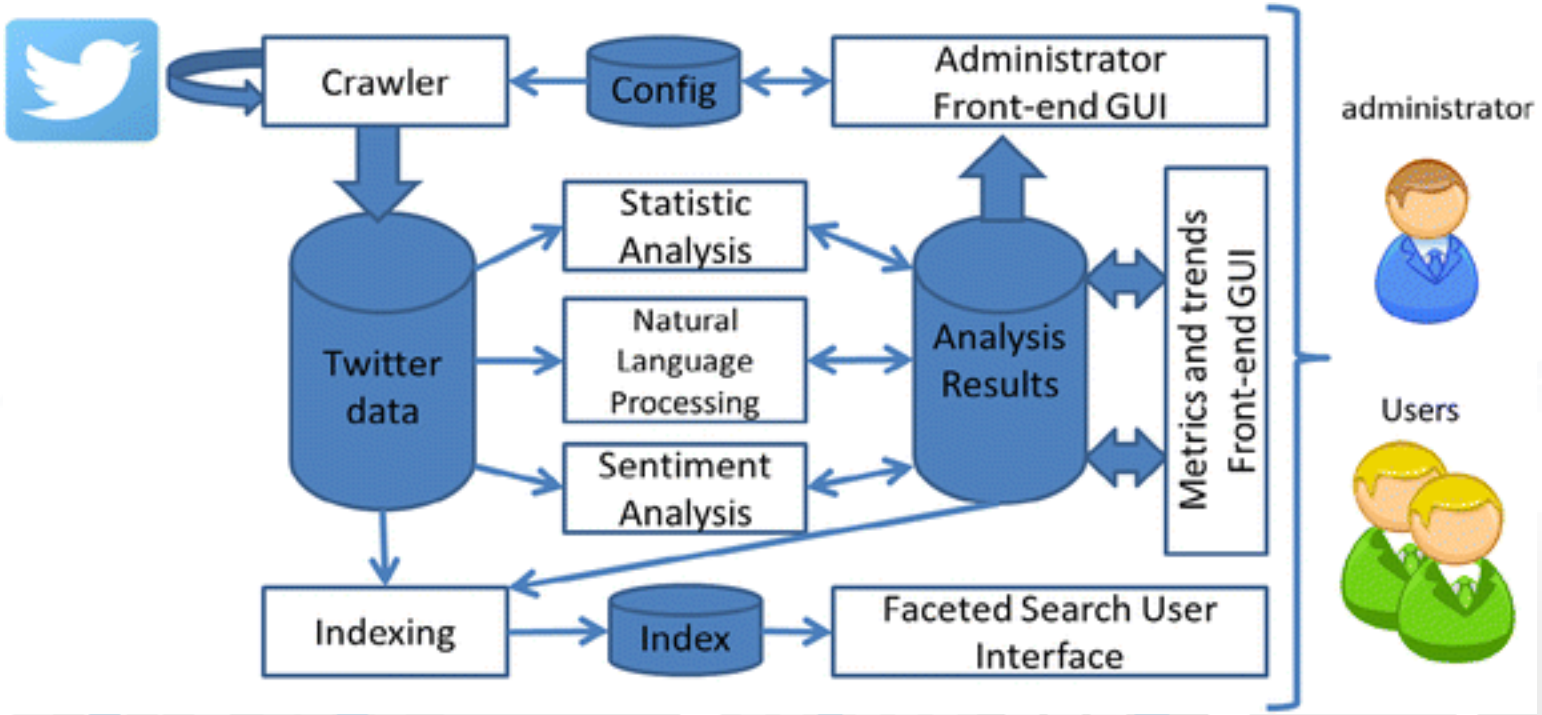
Twitter Vigilance

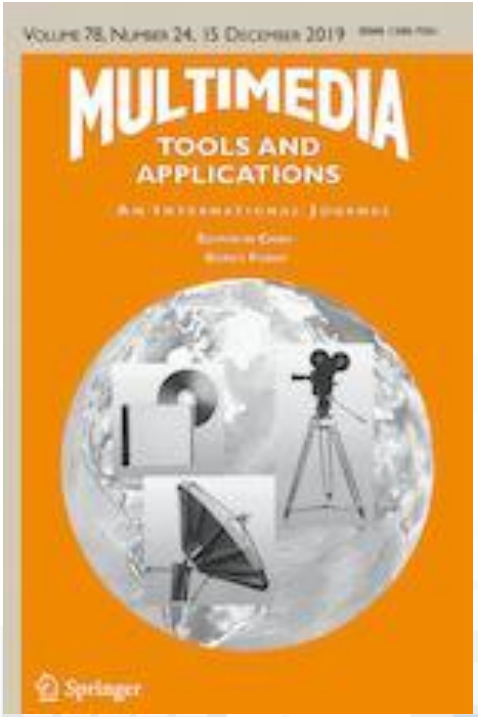
- http://www.disit.org/tv
- http://www.disit.org/rttv
- Citizens as sensors to
  - Assess sentiment on services, events, …
  - Response of consumers wrt…
  - Early detection of critical conditions
  - Information channel
  - Opinion leaders
  - Communities
  - Formation
  - Predicting volume of visitors for tuning the services



Twitter Vigilance

Architecture of Twitter Vigilance





https://link.springer.com/article/10.1007/s11042-018-5865-0

https://link.springer.com/article/10.1007/s11042-017-4880-x

Twitter Vigilance

Several Channels

Twitter Vigilance Dashboard

Last crawling: 2015-12-11 01:20:20

Login

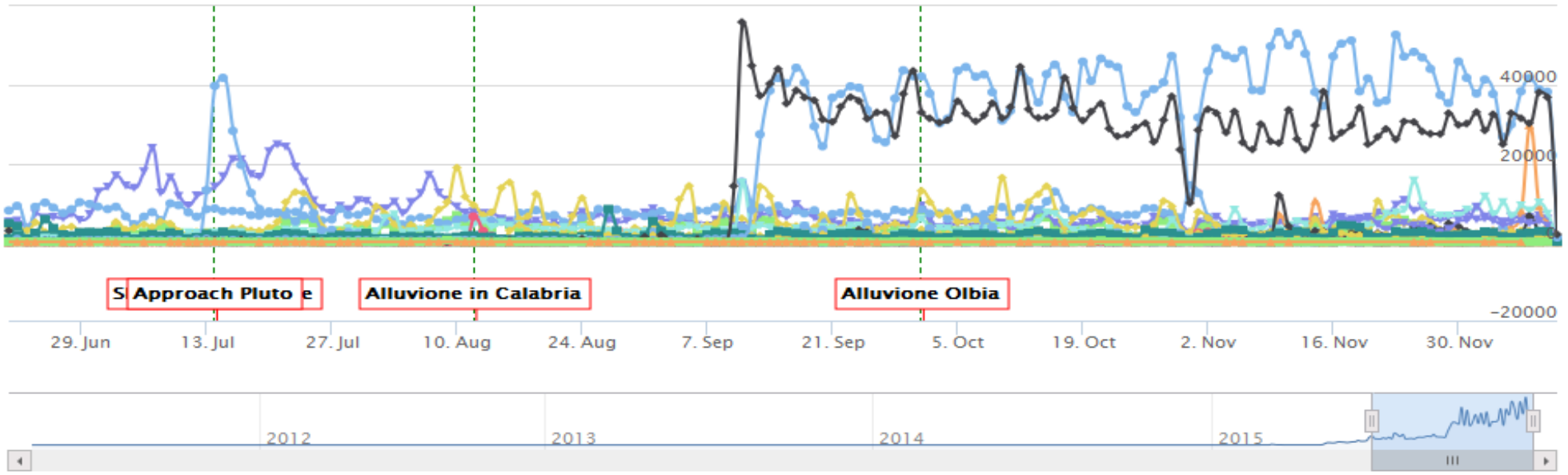
- Search parameters
- Data analysis 4
- Channel statistics
- Search statistics
- Retweet statistics
- Twitter Users statistics
- INFO

Home > Channel statistics

Global view of user channels

Zoom 1m 3m 6m YTD 1y All

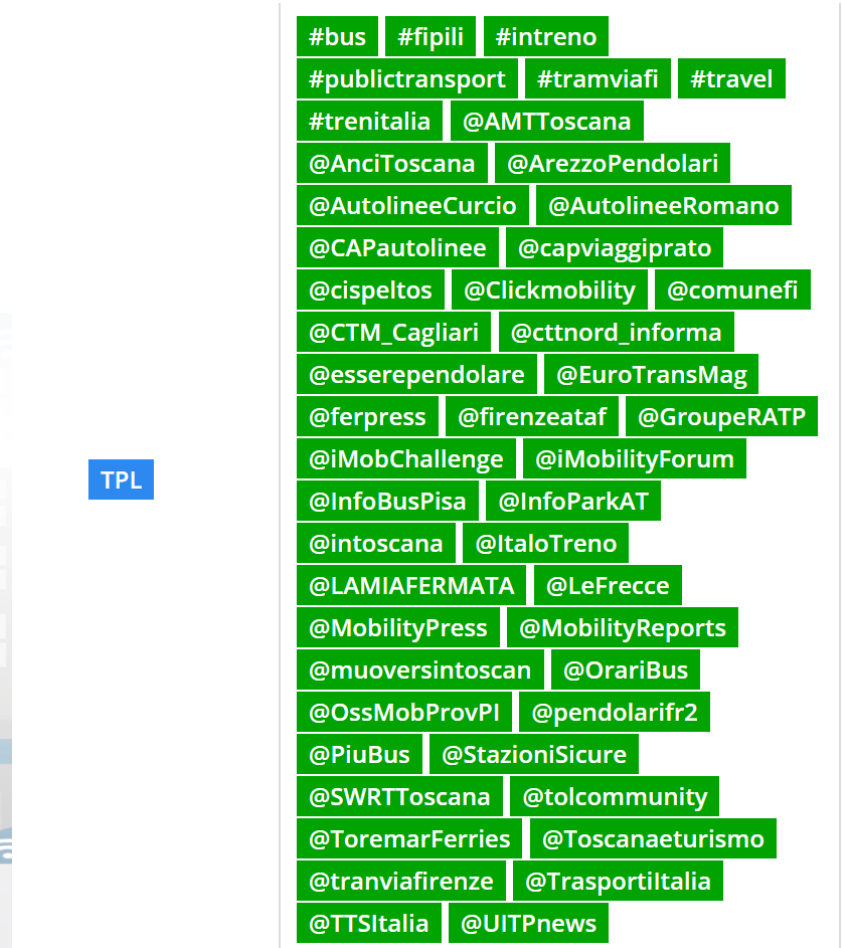
From Jun 20, 2015 To Dec 11, 2015



ads aeroporto firenze Allertameteo TOSCANA apretoscana CALDO cambiamenti climatici
Codified Hashtags Allerta ConsumoSuolo Emergenza_acqua Europeana EXPO2015 Firenze
FirenzeICT Giubileo iononrischio LaMMA Maltempo maturità 2015 MeteoUSER mymeteo
NASA New Horizons papafrancesco PA_social_PA protezione civile toscana resilienza rossano
siena smartcity smartcitybigdata2015 SOLO allertameteoTOSCANA tech uber Univ-Firenze
zanzara Events

Twitter Syntax for Searches

- String substring: Caldo
- Hashtag: #Caldo,
- Citations: @CivilProtection, @paolonesi
- From users: From:@paolonesi
- Etc.
- ….ANDed and ORed

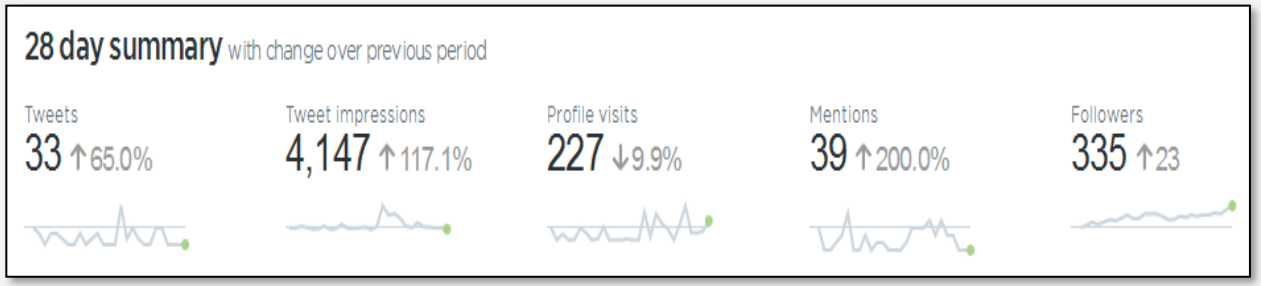


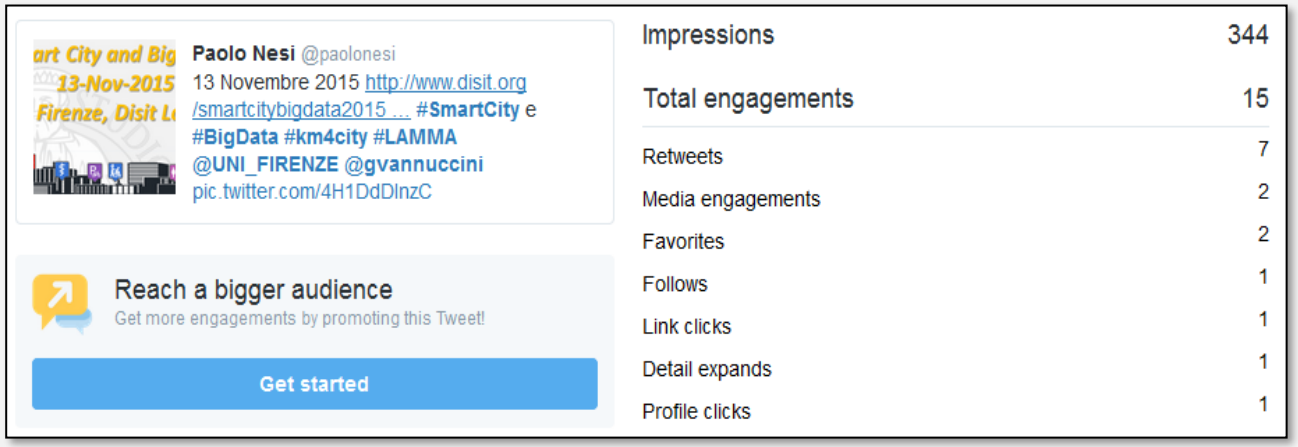
Twitter Vigilance

Predicting the reTweet Proneness

- **Issue:**
  - How to understand if a tweet has a good probability of being retweeted?
- **Impact:**
  - Advertising, promotion, training
- **Several metrics related to**
  - Structure of the tweet
  - Features of the tweetting author
  - Relationships ….

Twitter Analytics





Case Study C

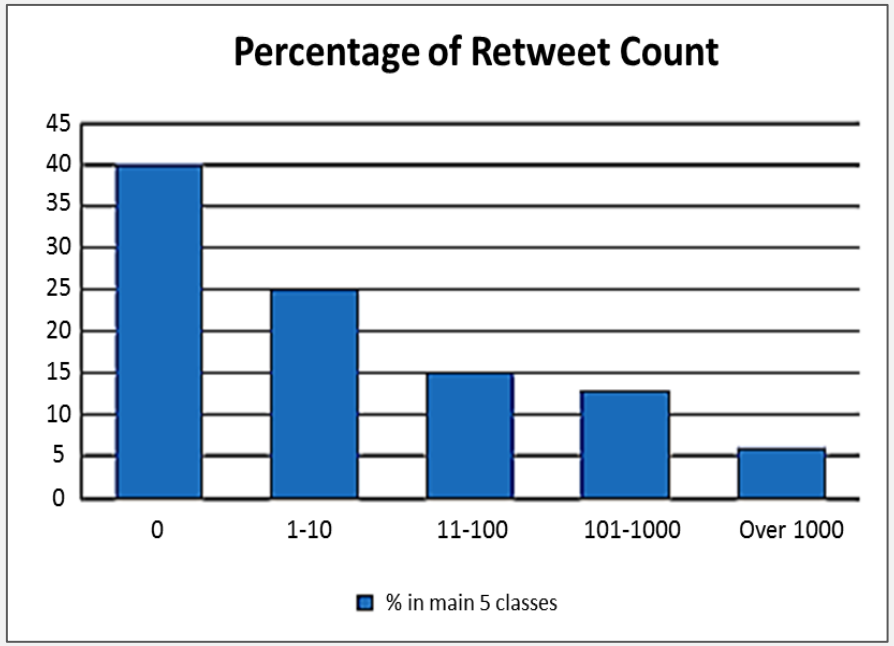
DISIT Lab, Distributed Data Intelligence and Technologies
Distributed Systems and Internet Technologies
Department of Information Engineering (DINFO)
http://www.disit.dinfo.unifi.it

Tweet proneness Metrics

Tweet metrics	
URLs Count	# of URLs in the tweet
Mentions Count	# of mentions/citation of Twitter users in the tweet
Hashtags Count	# of hashtags included in the tweet
Favorites Count	# of favorite obtained by the tweet
Publication Time	Local hour H24 in which the tweet has been published in the day according to the author' local time.
Author of Tweet metrics	
Days Count	# of days since the tweet's author created its Twitter account
Statuses Count	# of tweets made by the tweet's author since the creation of its own account
Author Network metrics	
Followers Count	# of followers the author of the tweet
Followees Count	# of friends the tweet's author is following
Listed Count	# of people added the tweet's author to a list

Data sets:

- 100 Million of Tweet
- 500 K
- 100 K

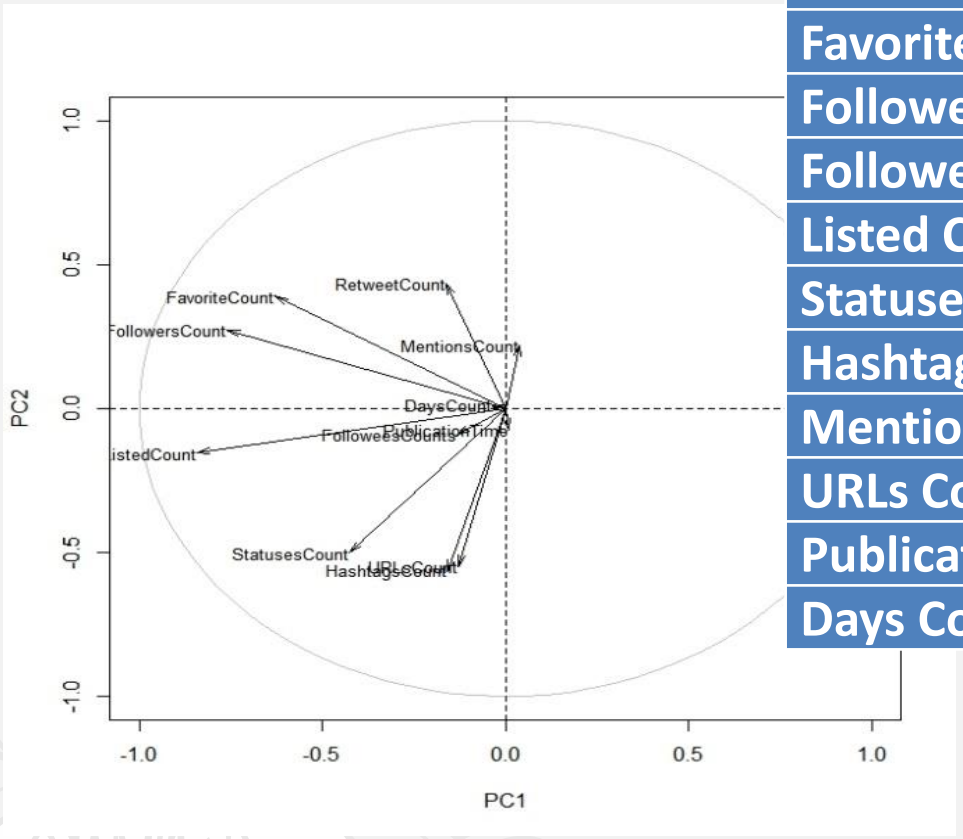


Case Study C

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Distributed Systems and Internet Technologies
Department of Information Engineering (DINFO)
http://www.disit.dinfo.unifi.it

reTweet proneness: assessment

- PCA



Metrics	PC1	PC2	PC3	PC4	PC5
Retweet Count	-0.1623	0.4346	0.1635	-0.0026	-0.1009
Favorites Count	**-0.6294**	0.3908	0.1922	-0.1128	-0.1880
Followers Count	**-0.7599**	0.2736	0.0522	-0.0983	-0.0857
Followees Count	-0.1336	-0.0907	**-0.4627**	-0.2494	0.1182
Listed Count	**-0.8431**	-0.1549	-0.0498	0.1500	0.1871
Statuses Count	-0.4256	**-0.5016**	-0.3781	0.2795	0.2410
Hashtags Count	-0.1585	**-0.5661**	0.4377	-0.0517	0.0309
Mentions Count	0.0394	0.2194	0.0786	-0.1607	**0.7697**
URLs Count	-0.1288	**-0.5483**	0.2539	-0.3388	-0.3248
Publication Time	0.0076	-0.0728	0.3639	**-0.5186**	0.3707
Days Count	-0.0370	0.0070	-0.**5072**	**-0.6604**	-0.1691

reTweet proneness: Classification methods

- Statistic classifications vs machine-learning methods
- 80% of training data set, 20% of testing data sets; 500K data set
- → Recursive partitioning procedure models (RPART), good compromise for Big data problems

Classifier Models	Accuracy	Precision	Recall	F_1 score	Processing Time in sec.
Recursive Partitioning (Stat)	0.6807	0.8512	0.7767	0.8122	180
Random Forests (ML)	0.6884	0.8601	0.7866	0.8217	198968
Gradient boosting (ML)	0.6796	0.8534	0.7731	0.8113	64448
Multinomial Model (Stat)	0.6411	0.8367	0.7245	0.7765	31576

Case Study C

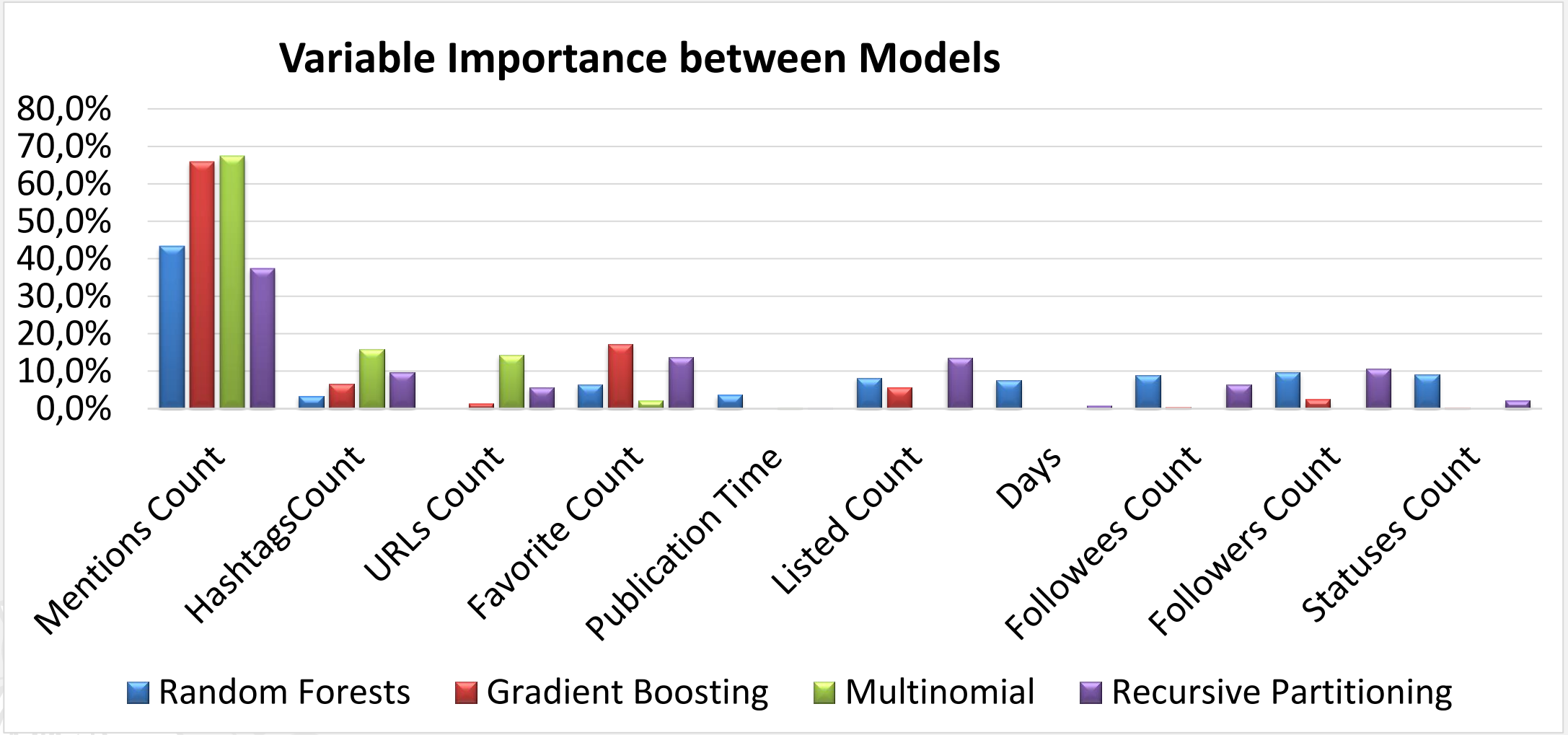
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Distributed Systems and Internet Technologies
Department of Information Engineering (DINFO)
http://www.disit.dinfo.unifi.it

reTweet proneness (RPART), 100M

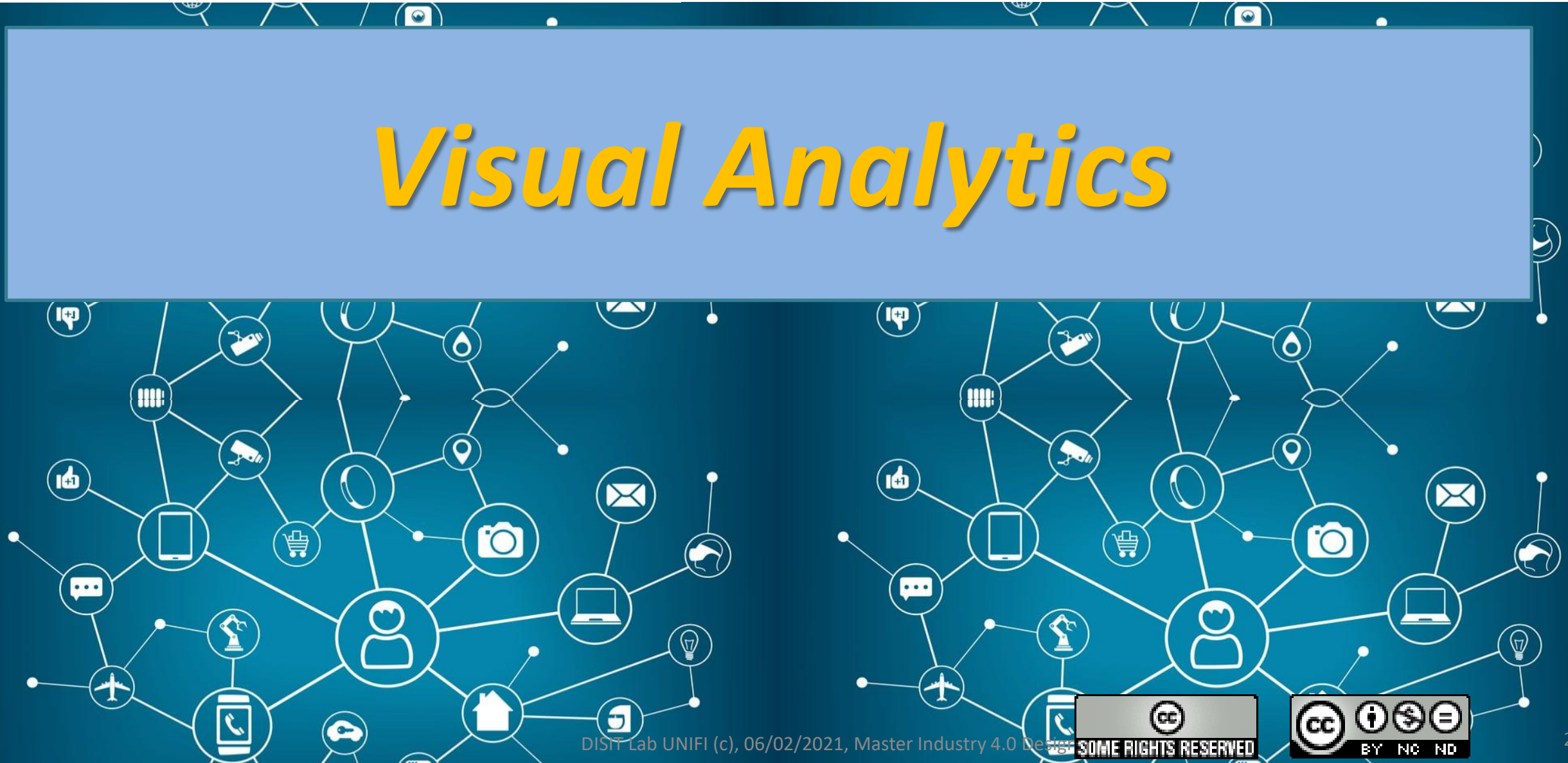
Assessment drivers	Degree of Retweeting Classes				
	0	1-100	101-1000	1001-10000	Over 10000
Sensitivity	0.7737	0.8105	0.3142	0.0208	0.0136
Specificity	0.9132	0.6694	0.9199	0.9996	1.0000
Positive Predictive Value	0.8564	0.6256	0.3752	0.7345	0.8488
Negative Predictive Value	0.8579	0.8382	0.8975	0.9485	0.9915
Prevalence	0.4007	0.4053	0.1328	0.0526	0.0086
Detection Rate	0.3100	0.3285	0.0417	0.0011	0.0001
Detection Prevalence	0.3620	0.5251	0.1112	0.0015	0.0001
Balanced Accuracy	**0.8435**	**0.7399**	**0.6170**	0.5102	0.5068

Accuracy	0.6815
Accuracy 95% Confidential Interval (min, max)	(0.6813, 0.6817)
Recall	0.7737
Precision	0.8564
Kappa	0.4922

Predictive models VS metrics relevance



Visual Analytics

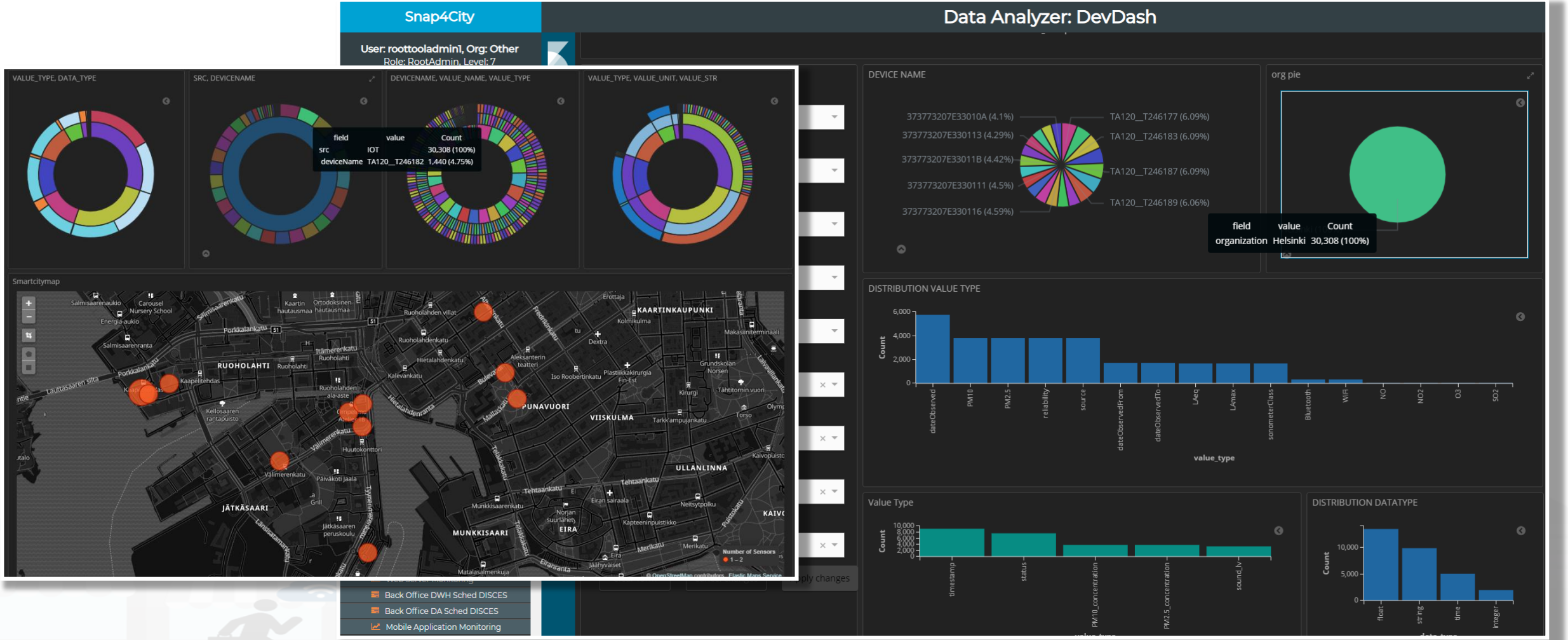


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Agenda

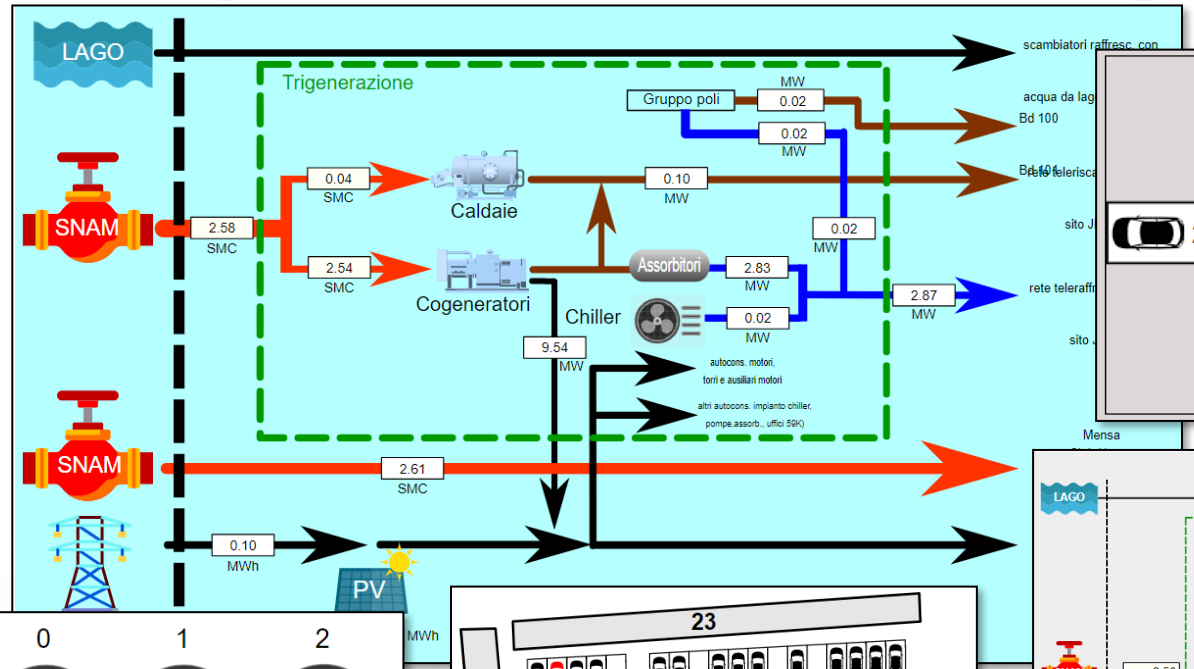
- Big Data Architecture
- Data Warehouse
- Data Storage
- Data Processing
- Data Analytics
- **Visual Analytics**
  - **What-if analysis**
  - **Mobile App Development, User Engagement**
- Dashboards
- Living lab for Collaborative work
- Deploy and Install Snap4 .. Solutions
- Acknowledgment

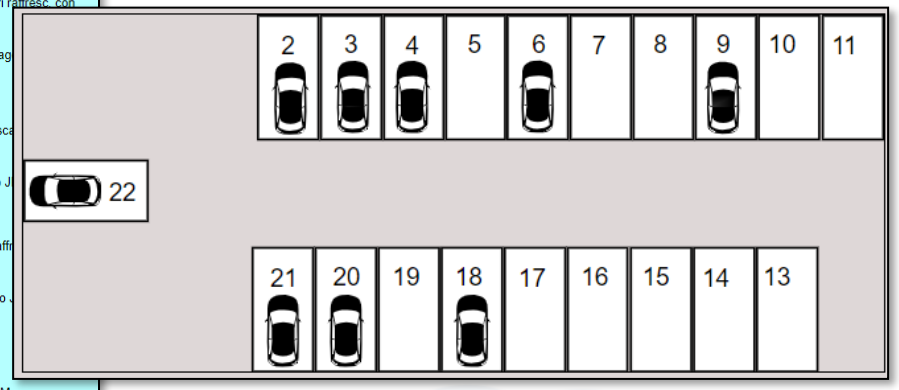
DevDash by Elastic Search + Kibana

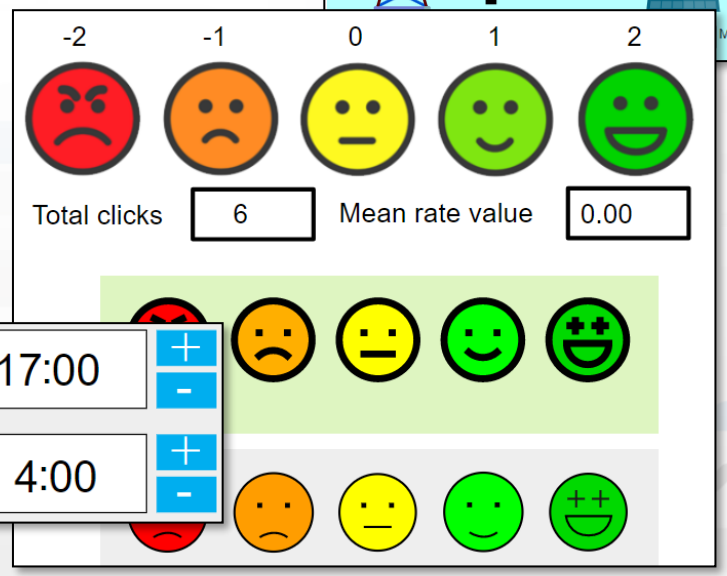


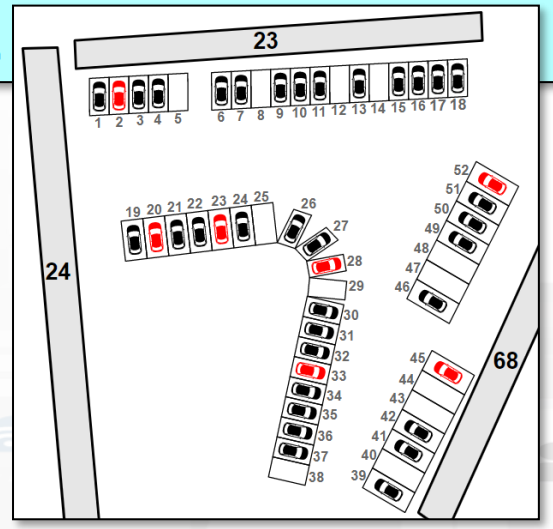
Special Custom Widgets

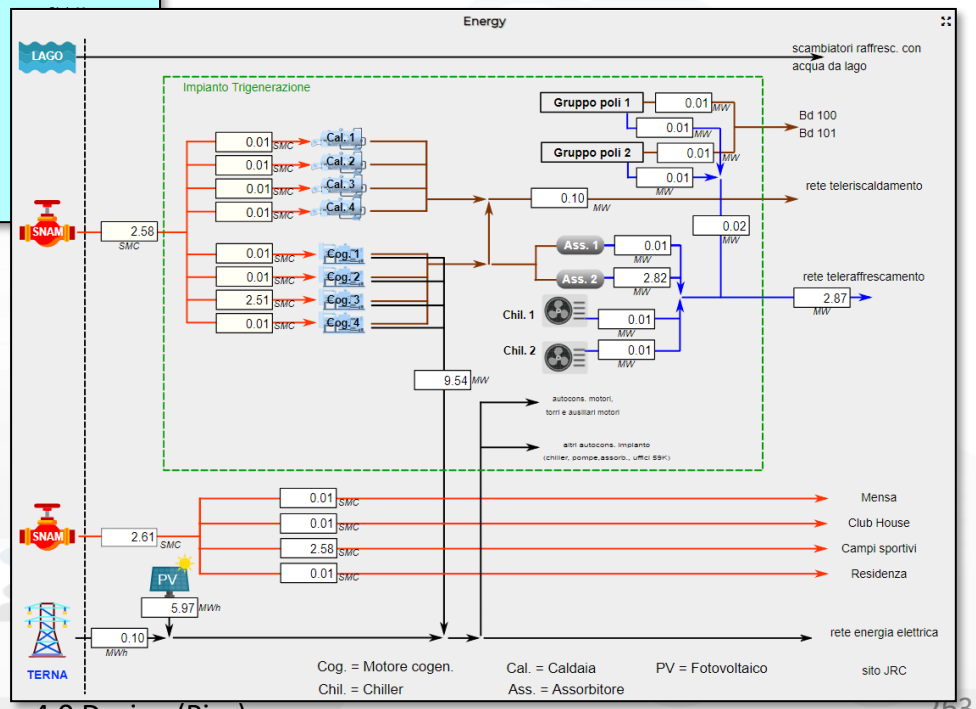
- Smart parking
- Smart Energy
- Smart Light
- Smart ….
- Energy View
- Custom Controls









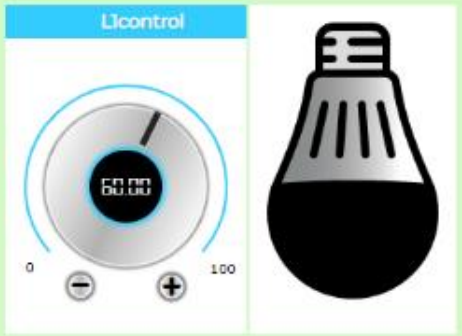


Snap4Home 5G Demo

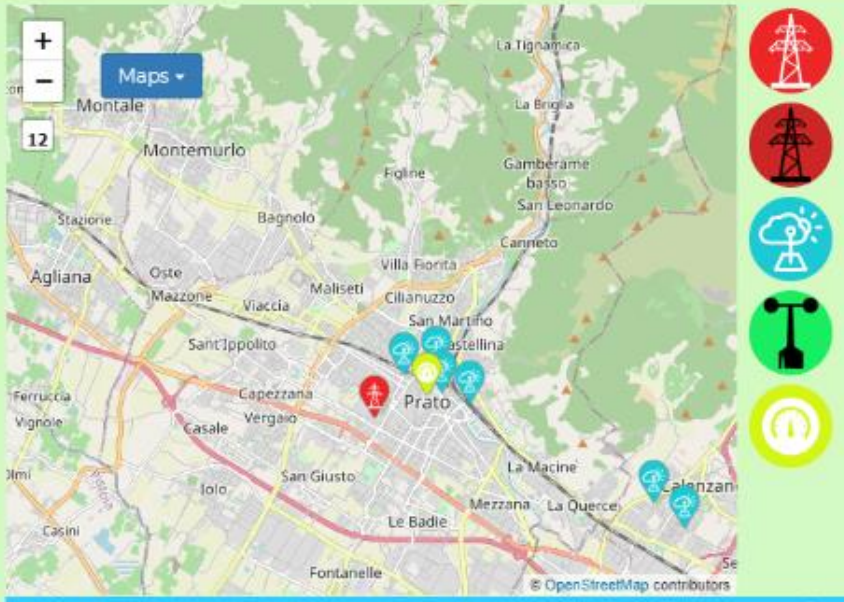
Thu 11 Jun 18:07:32





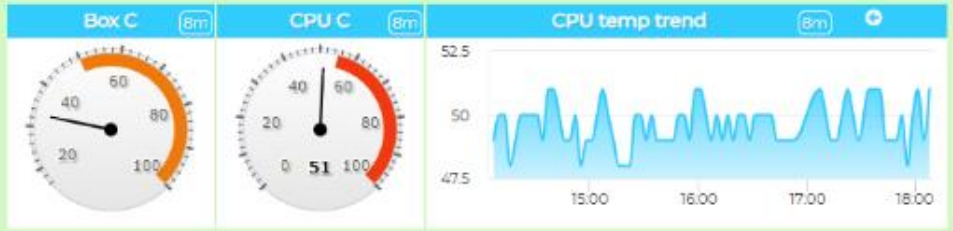






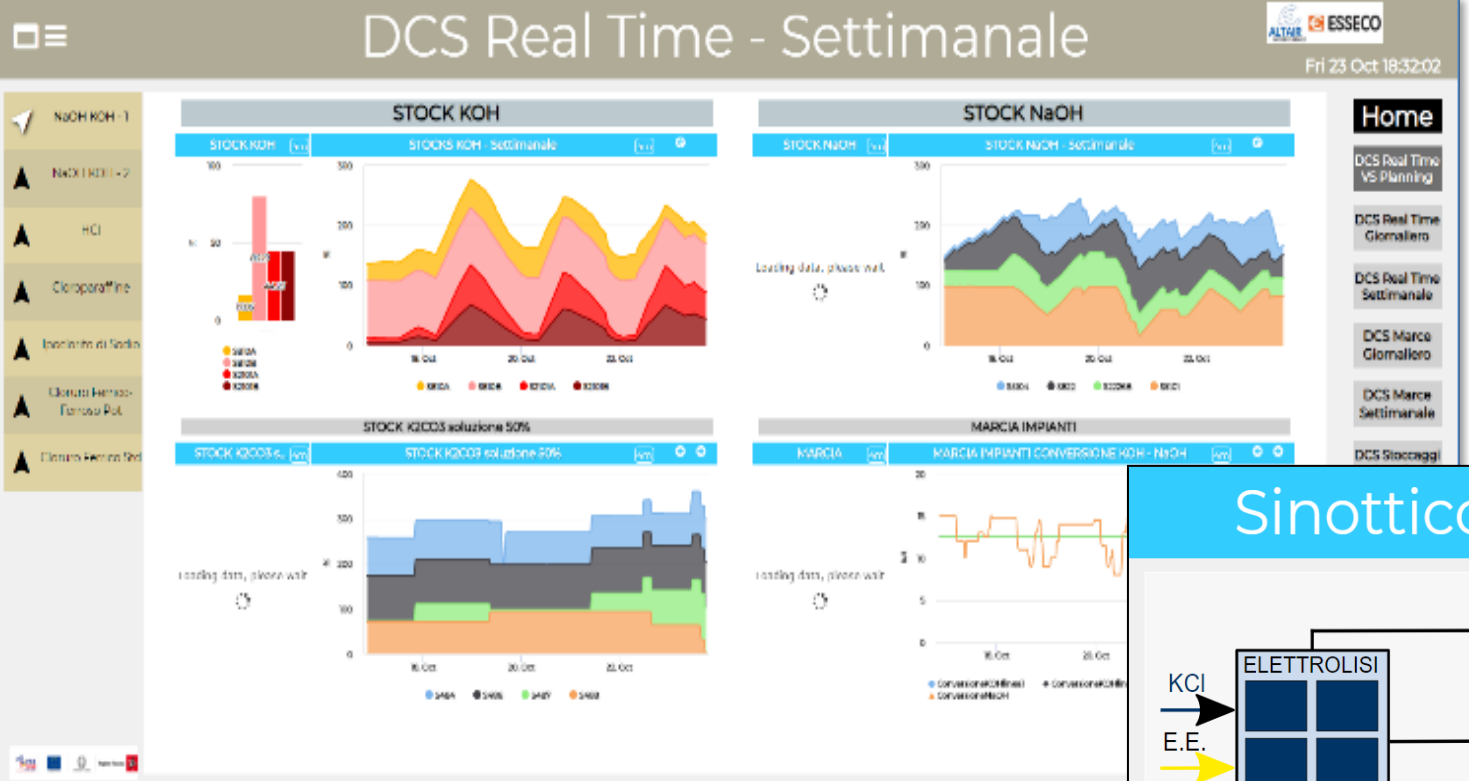


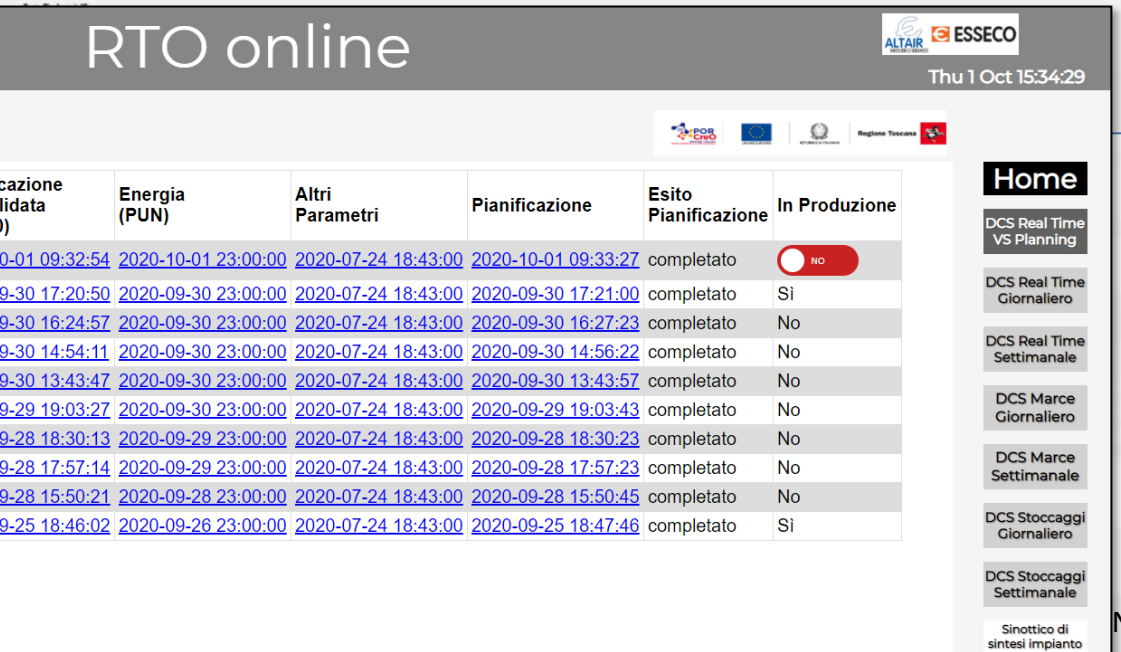




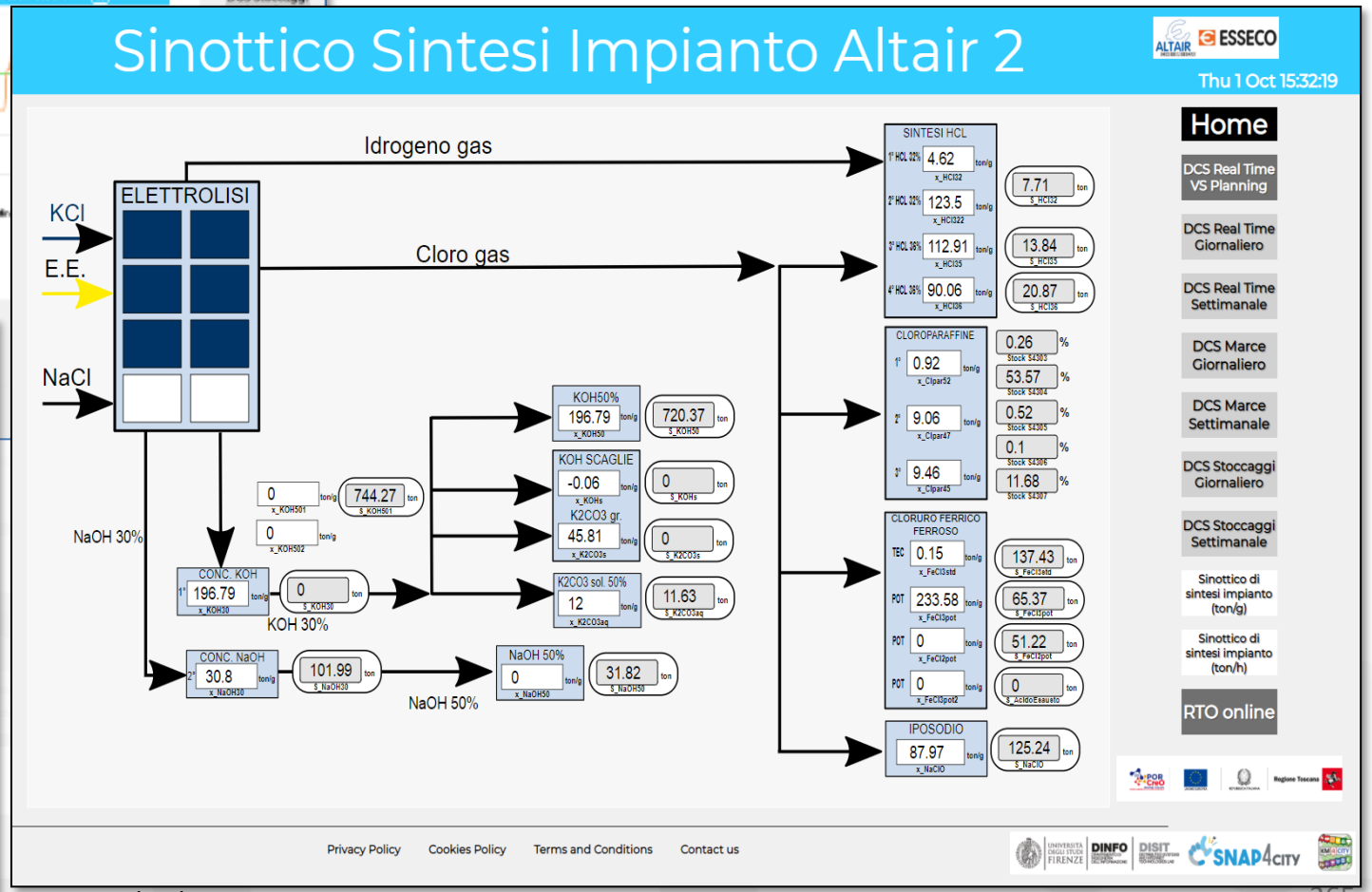


open fiber WIND 3 ZTE estra

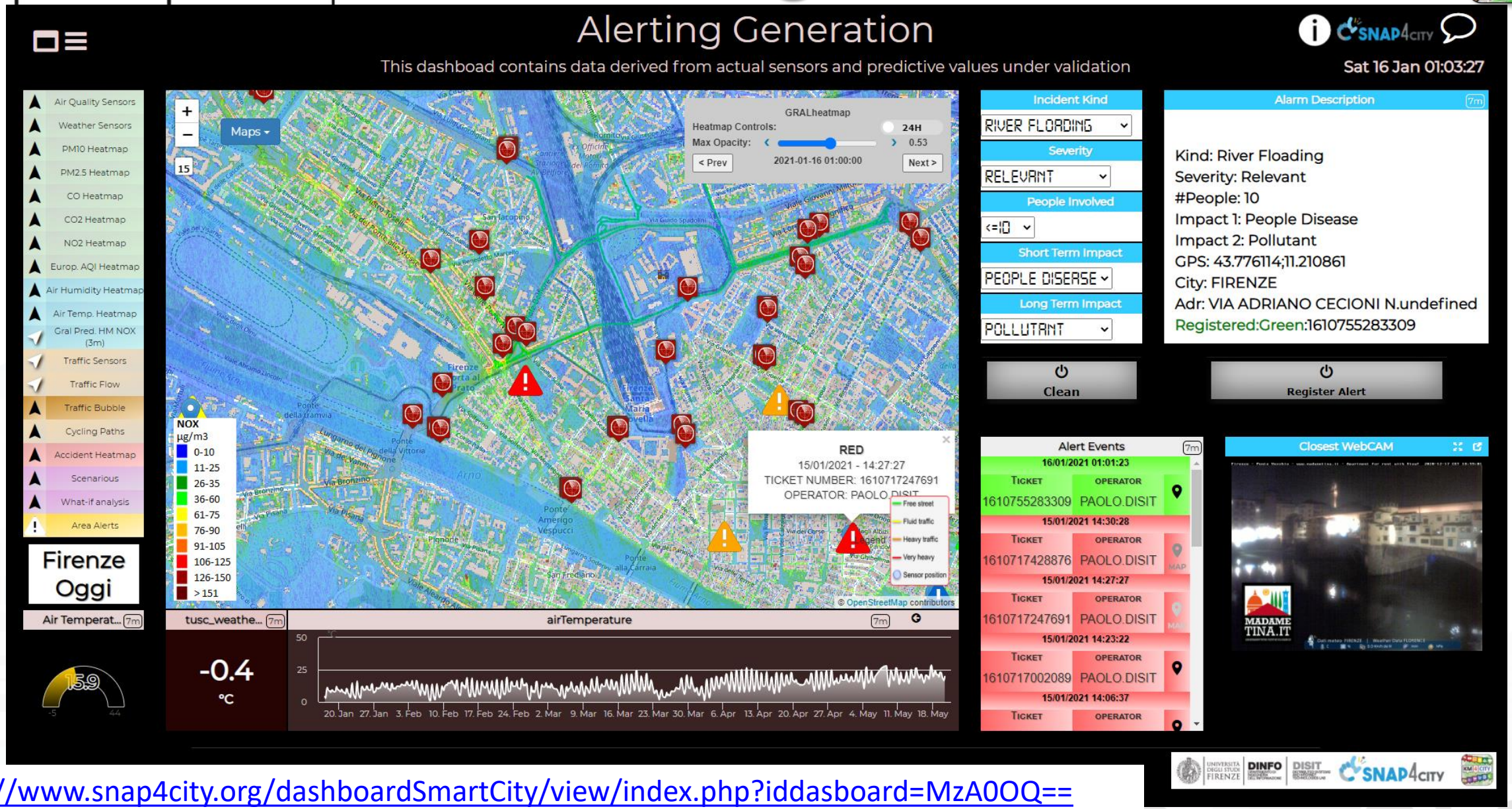




cazione lidata)	Energia (PUN)	Altri Parametri	Pianificazione	Esito Pianificazione	In Produzione
0-01 09:32:54	2020-10-01 23:00:00	2020-07-24 18:43:00	2020-10-01 09:33:27	completato	NO
9-30 17:20:50	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 17:21:00	completato	Sì
9-30 16:24:57	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 16:27:23	completato	No
9-30 14:54:11	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 14:56:22	completato	No
9-30 13:43:47	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-30 13:43:57	completato	No
9-29 19:03:27	2020-09-30 23:00:00	2020-07-24 18:43:00	2020-09-29 19:03:43	completato	No
9-28 18:30:13	2020-09-29 23:00:00	2020-07-24 18:43:00	2020-09-28 18:30:23	completato	No
9-28 17:57:14	2020-09-29 23:00:00	2020-07-24 18:43:00	2020-09-28 17:57:23	completato	No
9-28 15:50:21	2020-09-28 23:00:00	2020-07-24 18:43:00	2020-09-28 15:50:45	completato	No
9-25 18:46:02	2020-09-26 23:00:00	2020-07-24 18:43:00	2020-09-25 18:47:46	completato	Sì



Alert Registration



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA0OQ==

How the Dashboards exchange data

Snap4City BigData Storage and KB

IOT Broker Orion Quantum Leap

ServiceMap Super ServiceMap

- Req. ServiceURI

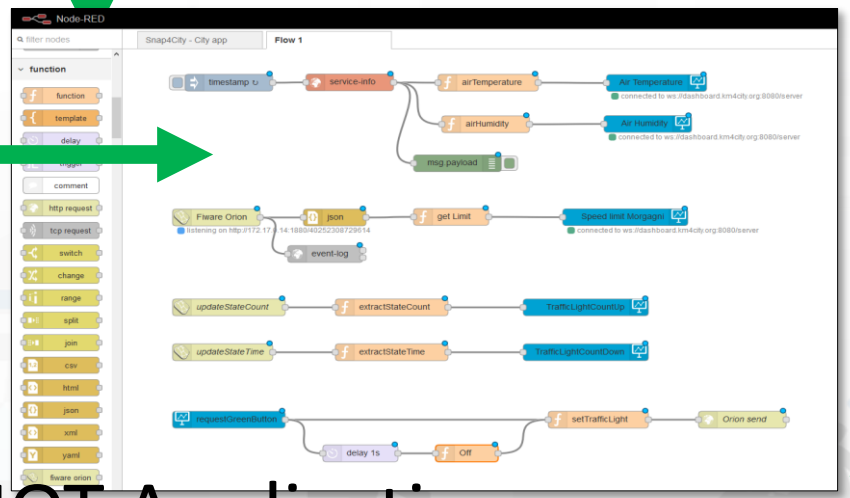
Metric, KPI

MyKPI, MyPOI, …

- Req. KPI, Metric ID
- Req. MyKPI ID

API, External Services, MicroApp

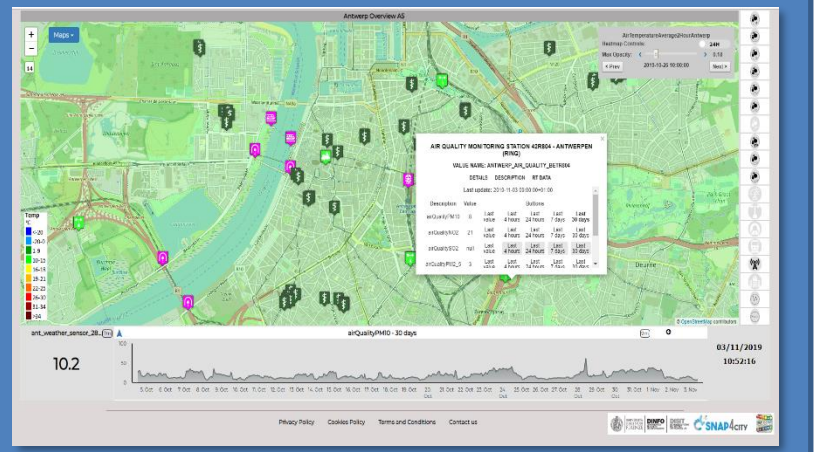
- Traffic Flow, MAPS, Heatmaps
- GIS, HTTPs URLs



- ServiceURI (ID)
- MyKPI, Metric (ID)
- Dynamic Data, computed into IOT Application

- Rx. Dynamic Data
- Event Driven Synoptics
- Actions, Show

Dashboards





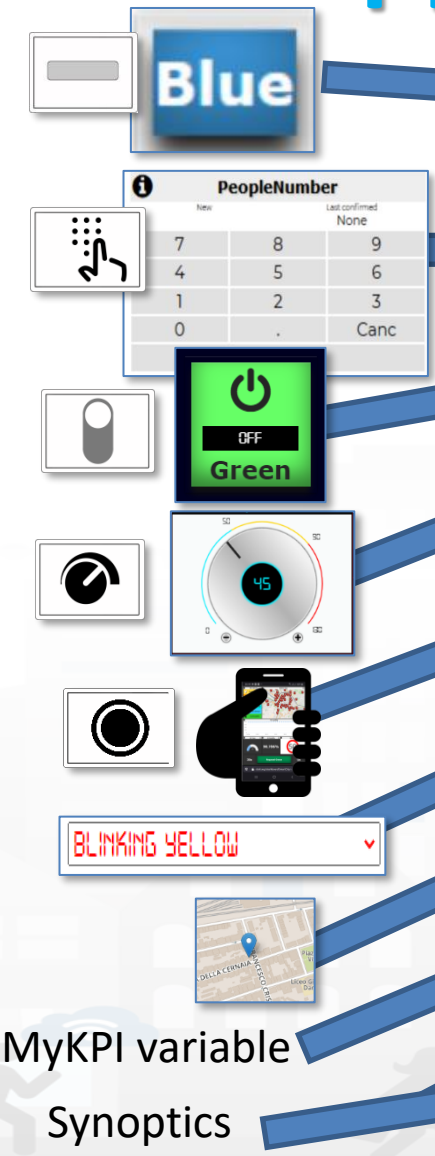
IOT Application

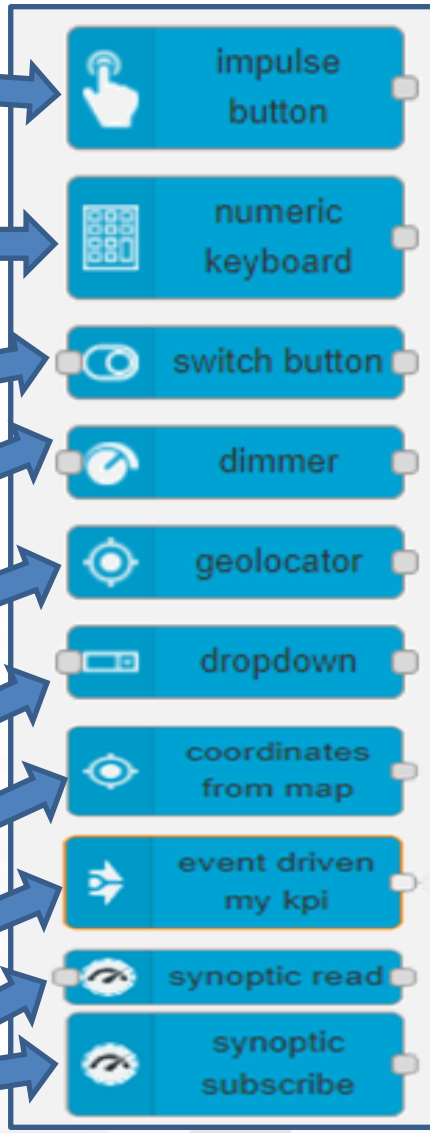
Nature

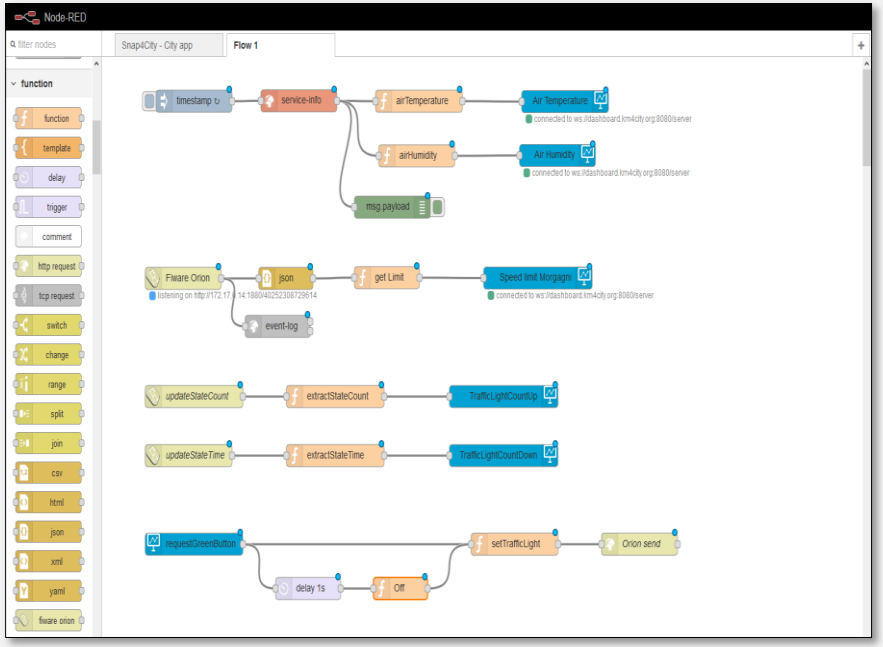
Dashboard-IOT App

From Dashboard to IOT App









MyKPI variable

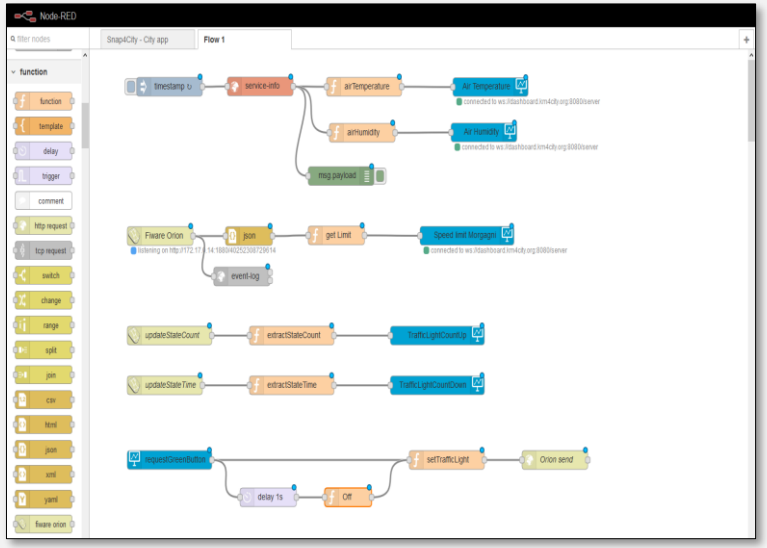
Synoptics

IOT Application

Nature

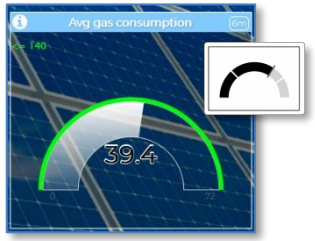
Dashboard-IOT App

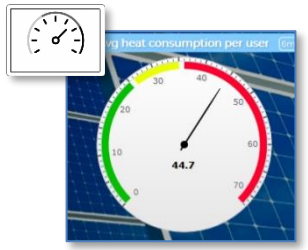
From IOT App to Dashboard



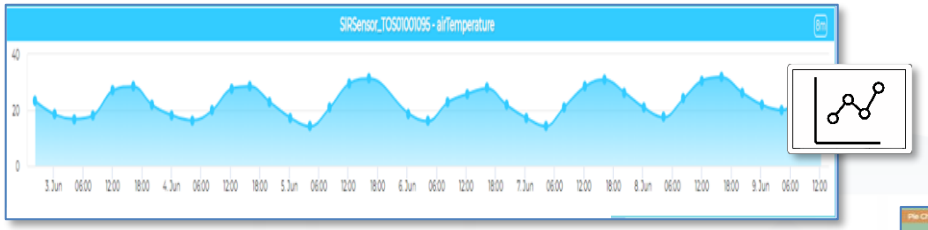
IOT Application

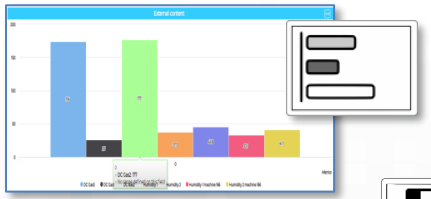
- gauge chart
- single content
- speedometer
- horizontal single bar
- vertical single bar
- web content
- time trend
- bar series
- radar series
- pie chart
- curved line series
- table content
- synoptic write

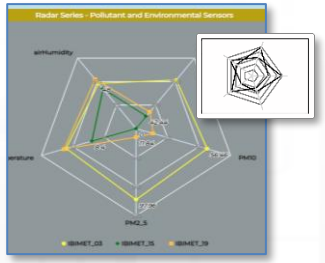


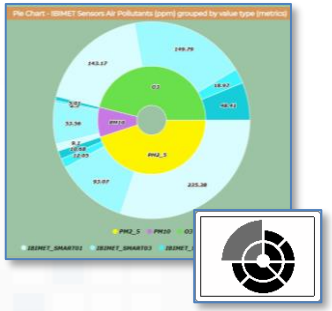


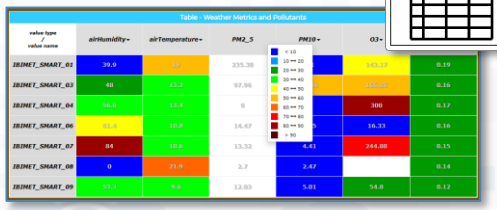


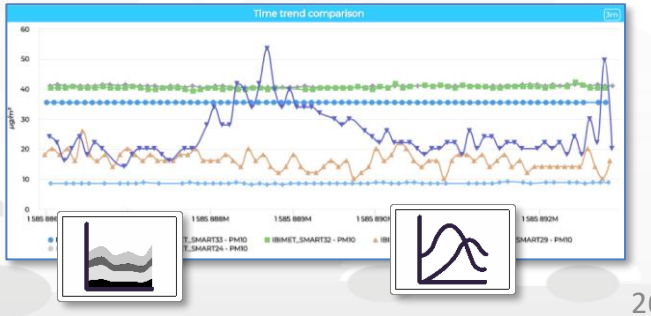


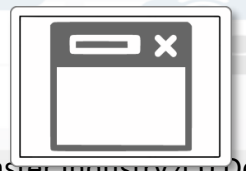












What If Analysis



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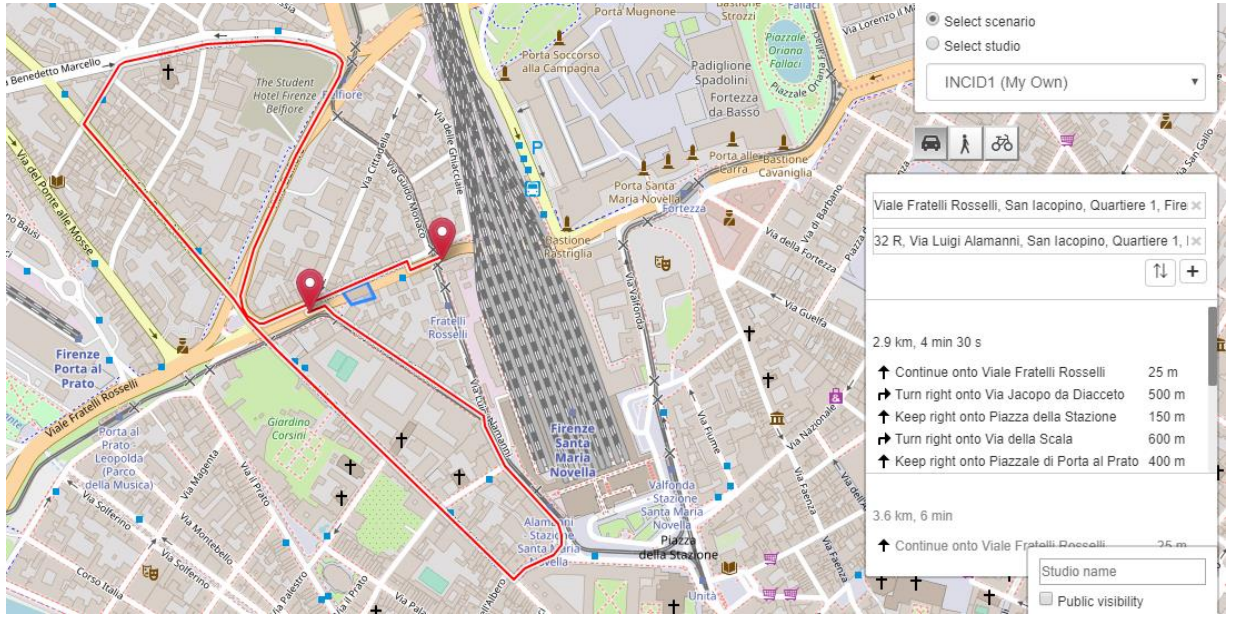
What-If Analysis

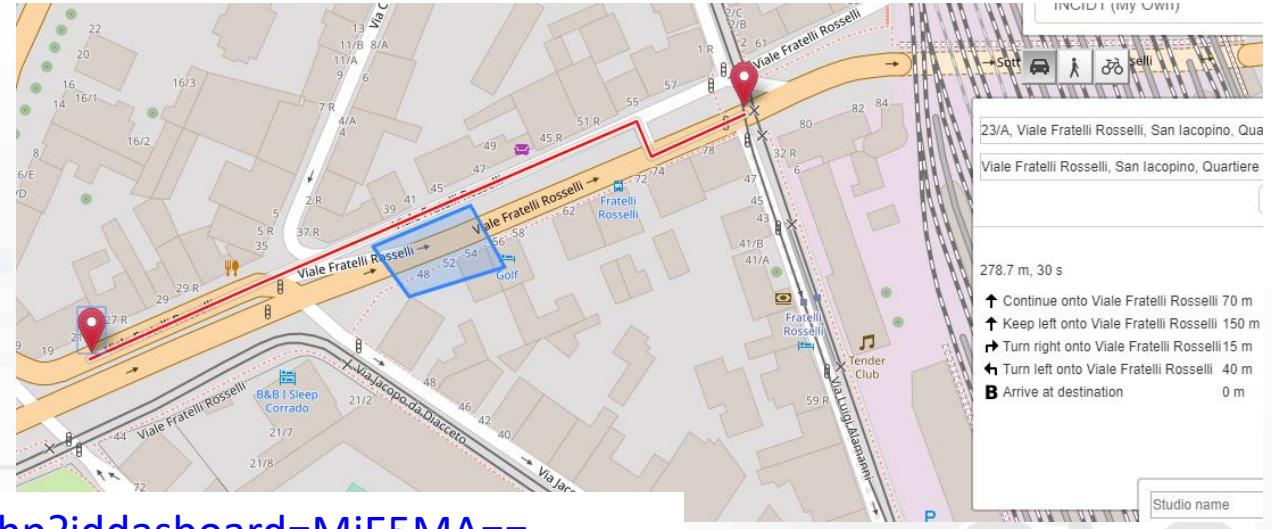
Accidents and elements blocking Points and Shapes taken into account for:

- Routing
- Traffic Flow reconstruction
- Evacuation paths
- Rescue team paths

Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment





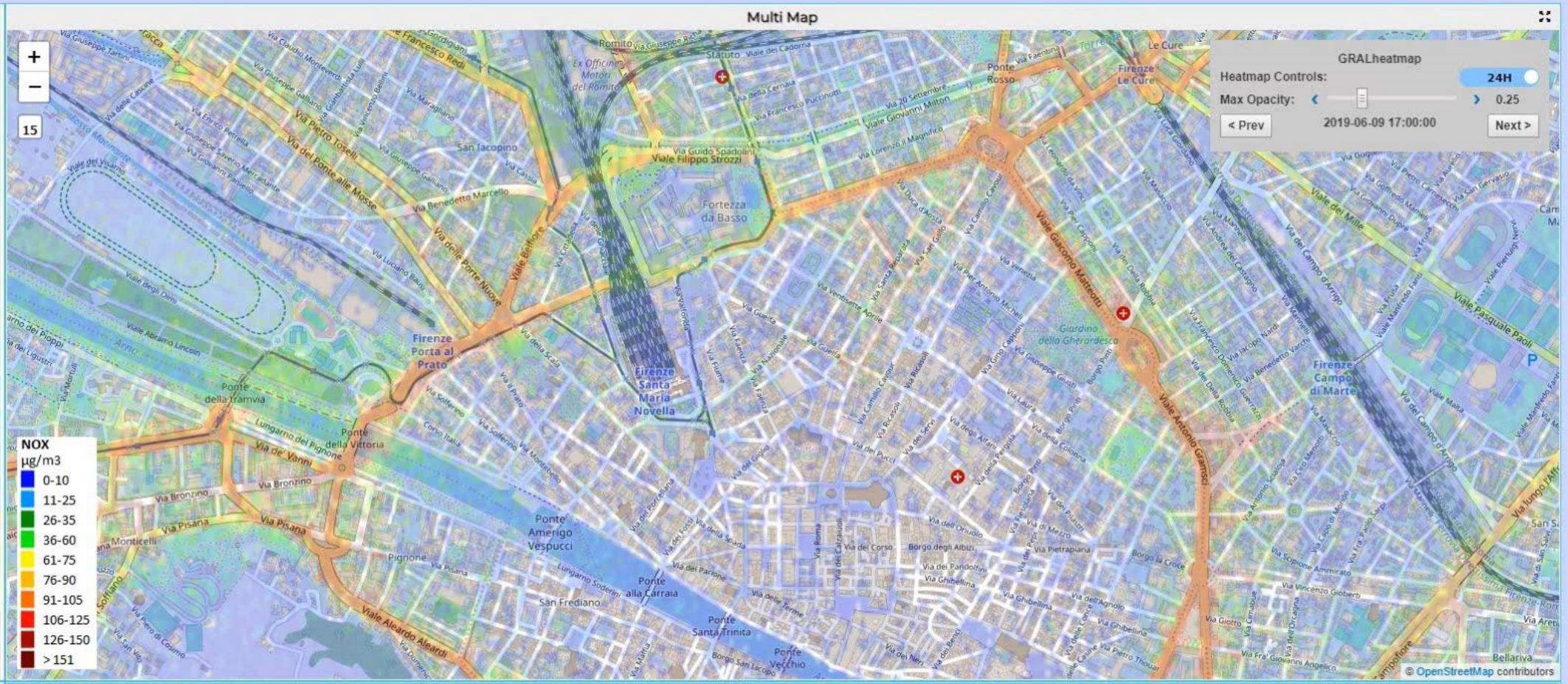
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==

Firenze - Trafair - AirQuality Heatmaps

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

Sun 9 Jun 17:41:58

- Air Quality Sensors
- PM10 Heatmap
- PM2.5 Heatmap
- CO Heatmap
- CO2 Heatmap
- SO2 Heatmap
- O3 Heatmap
- NO2 Heatmap
- Benzene Heatmap
- H2S 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
- Accident Heatmap 2



Air Temperature Bolognese 7m



SIRSensor_TOS01001095 - airTemperature 7m



What-If analysis



Mobility and Environment What-IF Analysis

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

Mon 14 Oct 00:48:17

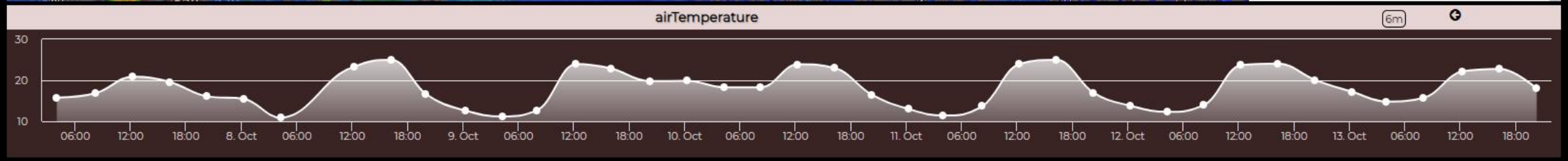
- Air Quality Sensors
- Weather Sensors
- PM10 Heatmap
- PM2.5 Heatmap
- CO Heatmap
- CO2 Heatmap
- O3 Heatmap
- NO2 Heatmap
- Europ. AQI Heatmap
- Air Humidity Heatmap
- Air Temp. Heatmap
- Wind Speed Heatmap
- Gral Pred. HM NOX (3m)
- Gral Pred. HM NOX (6m)
- Traffic Sensors
- Traffic Flow
- Cycling Paths
- Accident Heatmap
- Only HRes Anym. Gral
- Scenarious
- What-if analysis

Firenze Oggi

Air Temperat... 6m







https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==

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Mobile App Development, User Engagement



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Web and Mobile App working



Data Sources PULL Data



Data Sources, Brokers, External Services Data Driven, Real Time



Data Ingestion, aggregation, regularization, reconcile

ETL, NIFI, DISCES

Big Data Cluster
HDFS, Hbase, Phoenix

Knowledge base
Semantic reasoners

Indexing and aggregating
Elastic search

Search and Query, Smart API
Facet, semantic search

Data Analytics
R, Tensor Flow, Python, MapReduce, …

IOT Applications
Node-RED + Snap4City MicroSrvs

Visual Analytics
dash/ tools

Rendering Acting, Widgets, MicroApps
User interface, Interactive Dashboard, Drill down, maps,



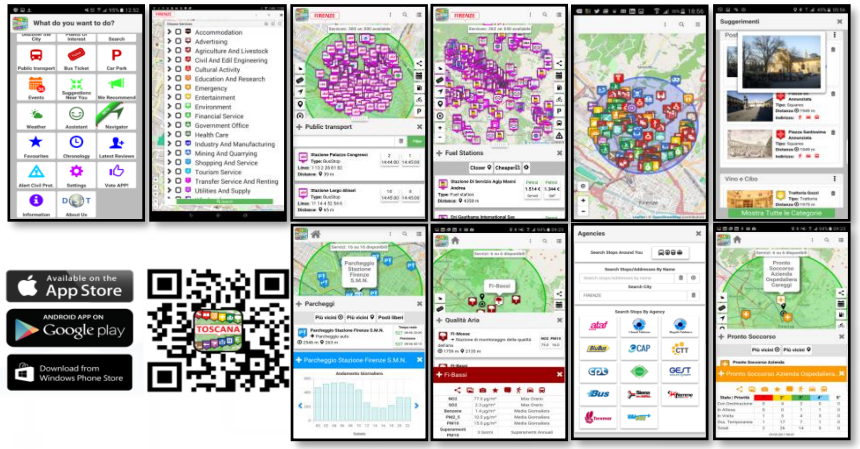




Inform, announce, Act!, warning, alarms, What-IF, ..

Web and Mobile App Developers, to generate

Mobile Apps



Web App HTML5



Embed into Web pages



City User



Advanced Smart City API



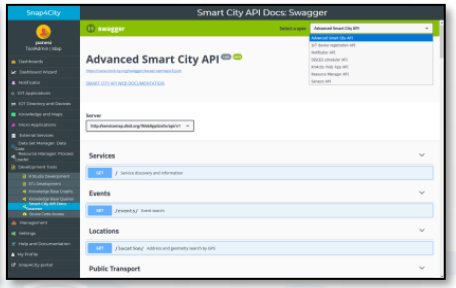
Mobile Application Monitoring Administrator



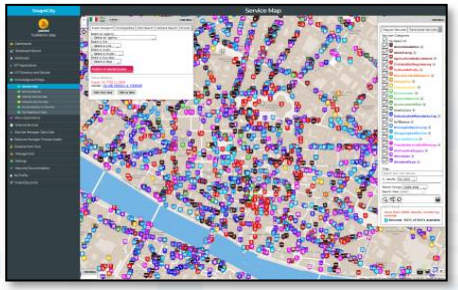
Knowledge Base, Km4City



Km4City Open Source examples dev. tool kit



Swagger

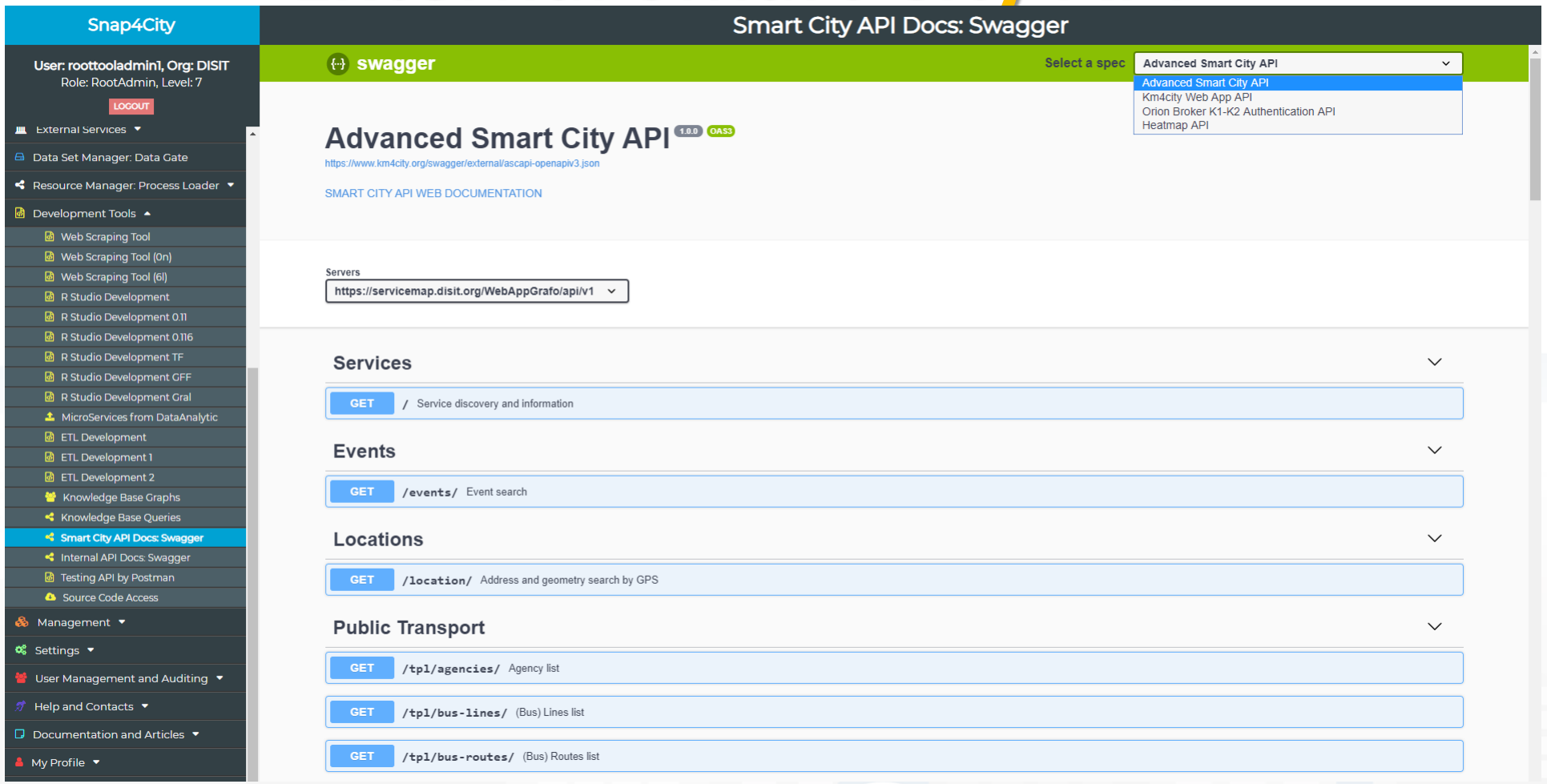


ServiceMap

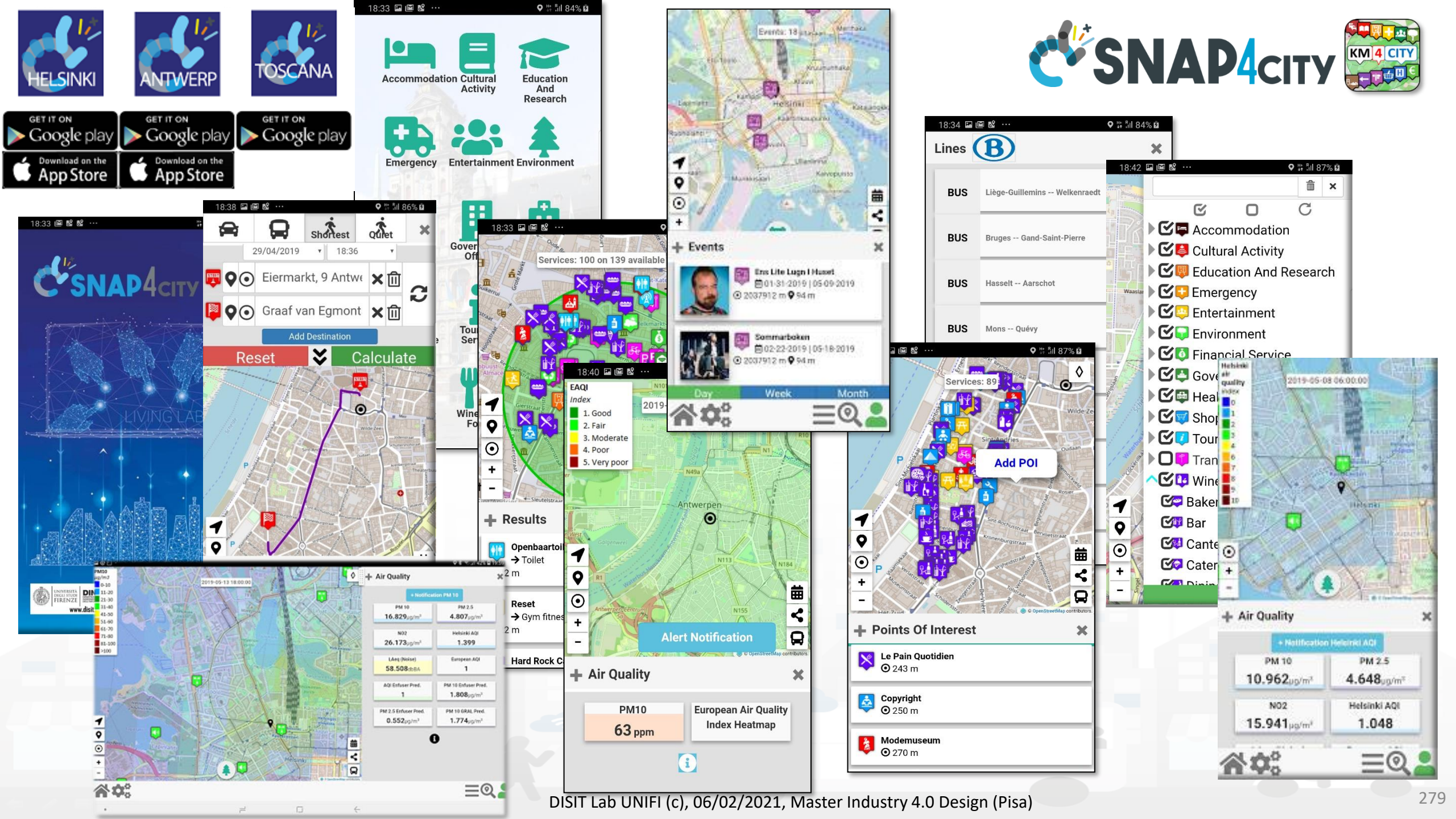
Developer



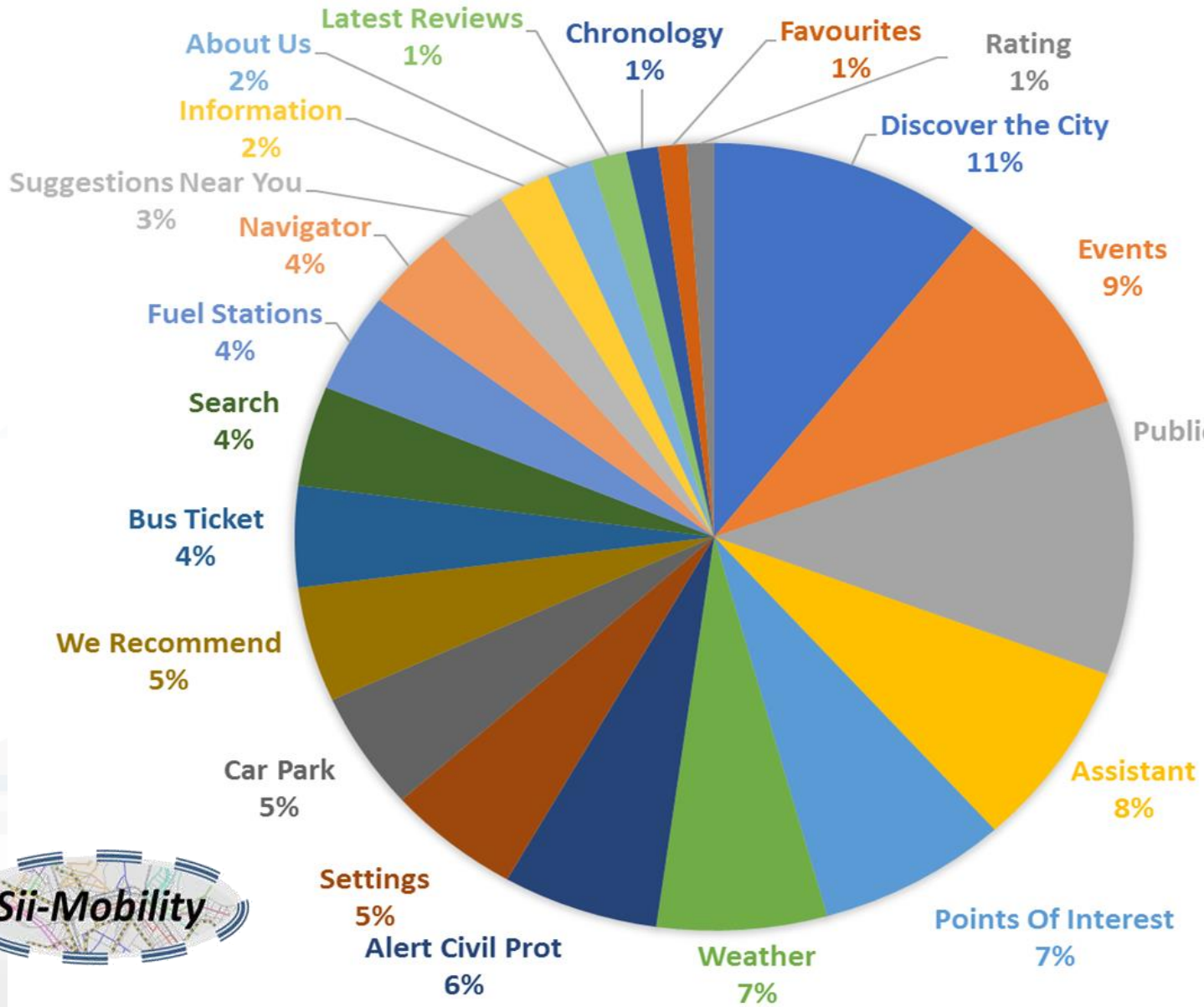
External Smart City API

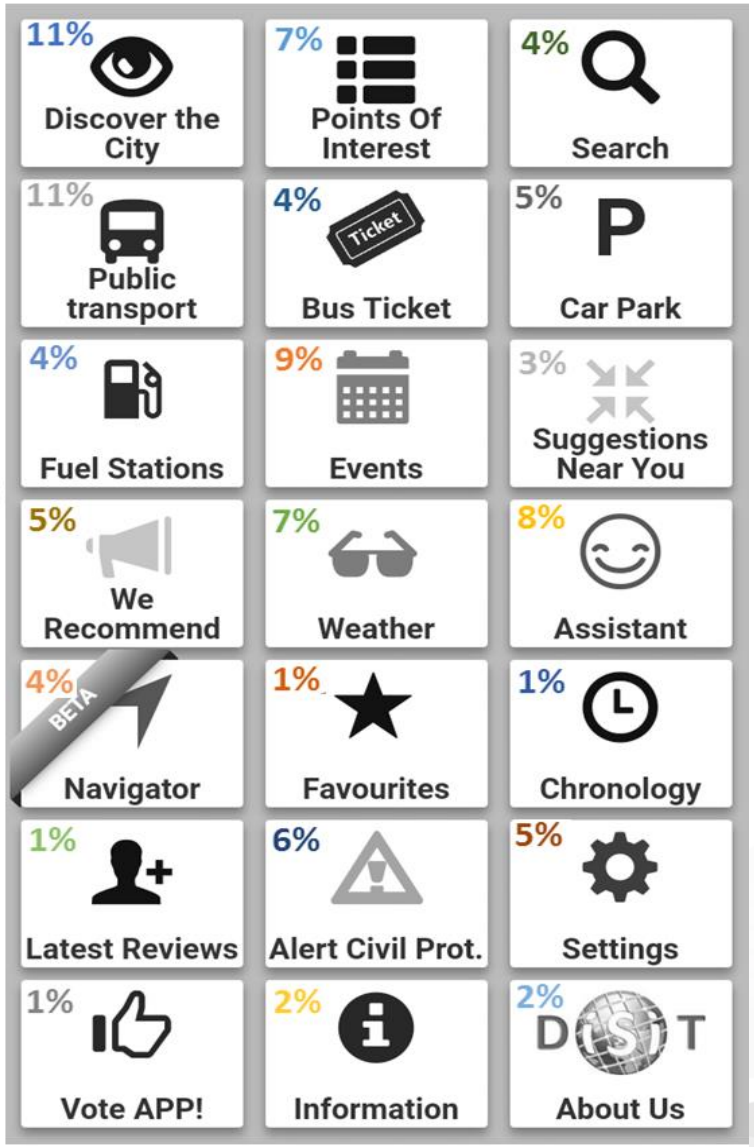


https://www.km4city.org/swagger/external/index.html


HELSINKI
ANTWERP
TOSCANA
GET IT ON Google play
Download on the App Store
SNAP4CITY
KM 4 CITY
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Shortest
Quiet
Add Destination
Reset
Calculate
Events
Day
Week
Month
Services: 100 on 139 available
EAQI Index
1. Good
2. Fair
3. Moderate
4. Poor
5. Very poor
Results
Antwerpen
Alert Notification
Air Quality
PM10
63 ppm
European Air Quality Index Heatmap
Lines
BUS
Liège-Guillemins -- Welkenraedt
Bruges -- Gand-Saint-Pierre
Hasselt -- Aarschot
Mons -- Quévy
Add POI
Points Of Interest
Le Pain Quotidien
243 m
Copyright
250 m
Modemuseum
270 m
Air Quality
PM 10
10.962
PM 2.5
4.648
NO2
15.941
Helsinki AQI
1.048

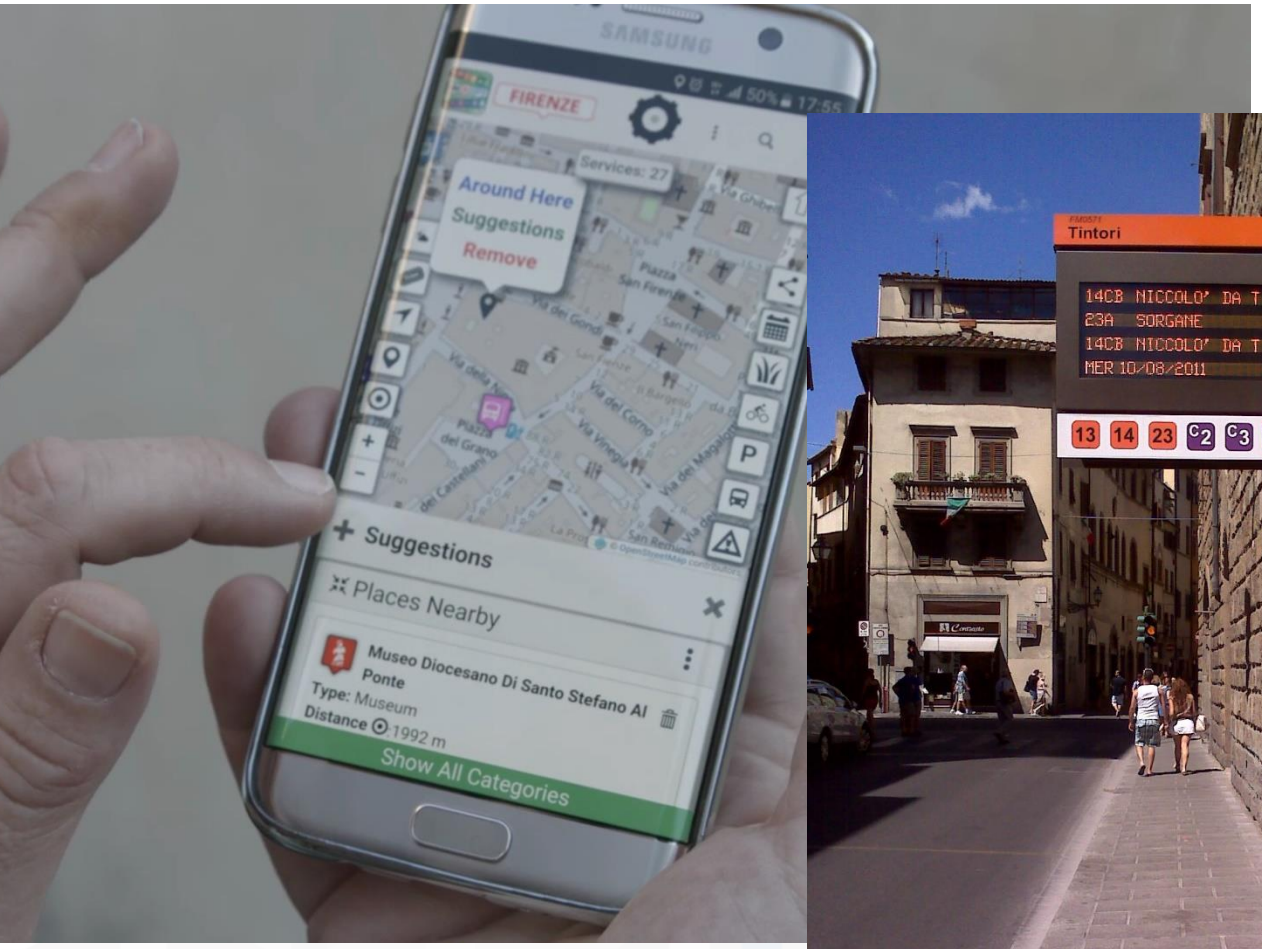
Users' preferences





Sii-Mobility

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Sii smart.
Sii-Mobility!
Scarica, viaggia, vinci!

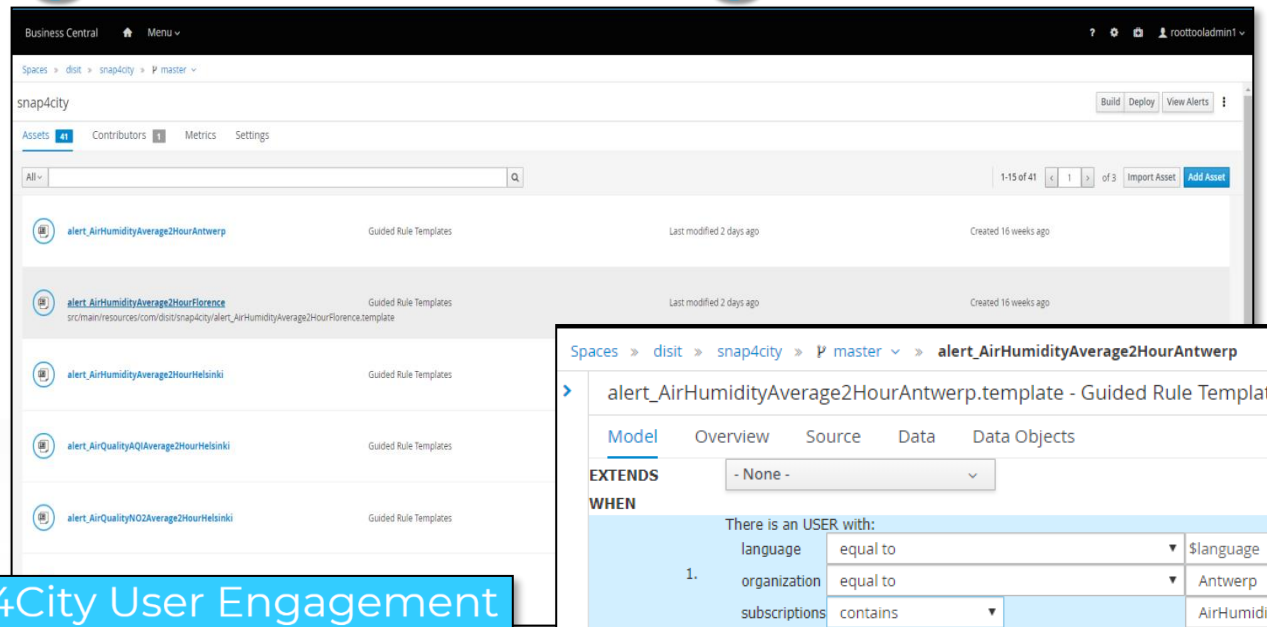


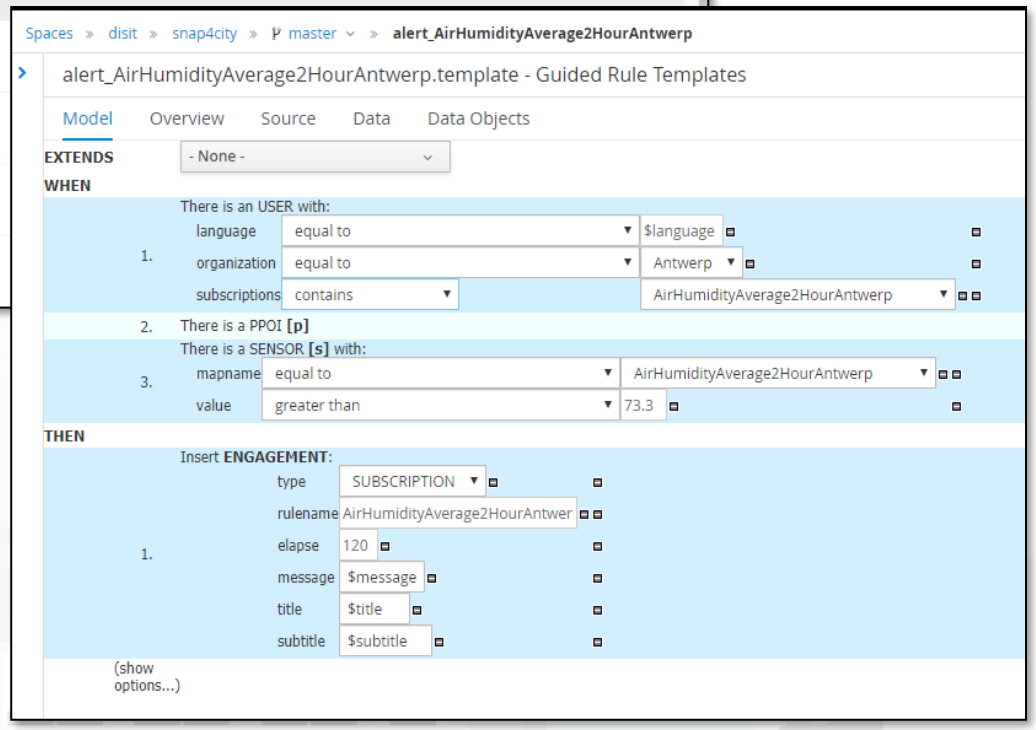
Dal 15 aprile al 15 luglio scegliere il trasporto pubblico ti premia!
Scarica l'app "*Toscana dove, cosa*", guadagna punti viaggiando in autobus e vinci tanti fantastici premi.
Per maggiori informazioni visita il sito info.sii-mobility.org

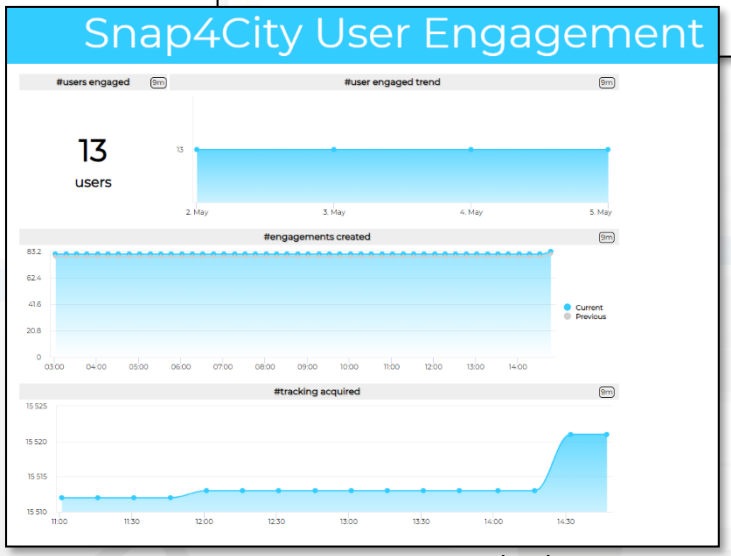
ataf | BUSITALIA NORD GRUPPO FERROVIE DELLO STATO ITALIANE | MIUR | UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO | DISIT

Engagement Manager

- Definition of Rules for campaigns
- Monitoring and follow-up for each City
- Segmented for user kind and interest

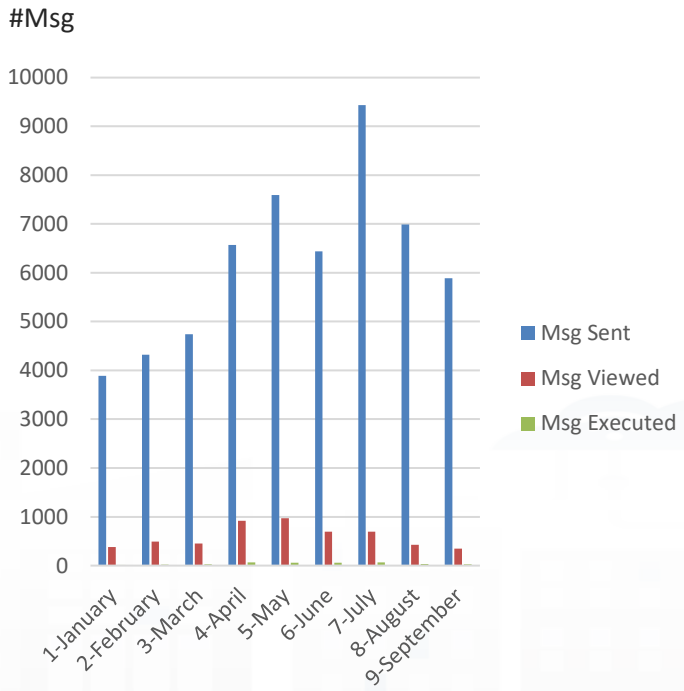


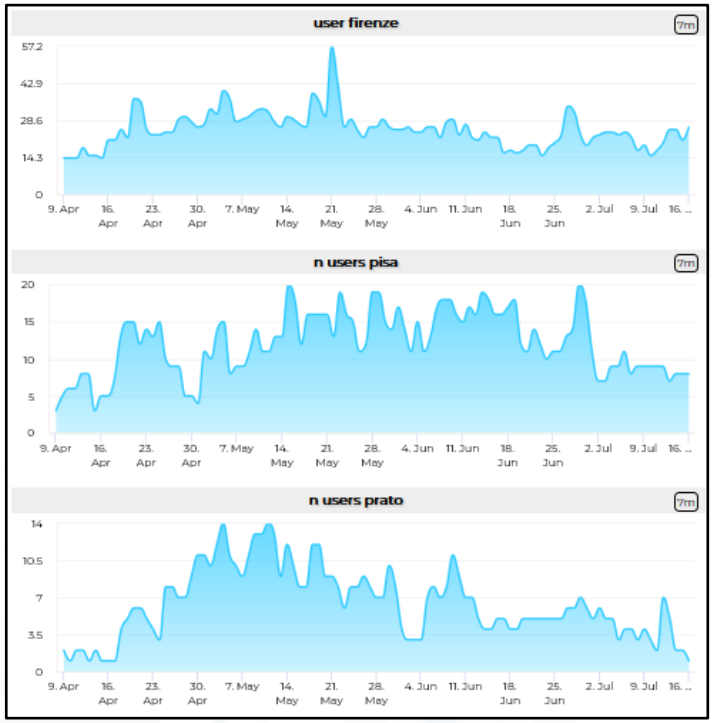


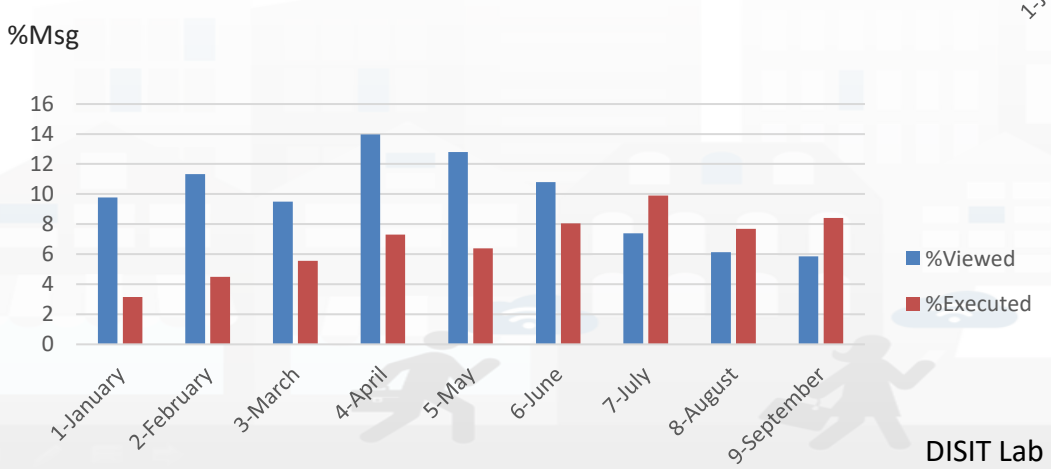


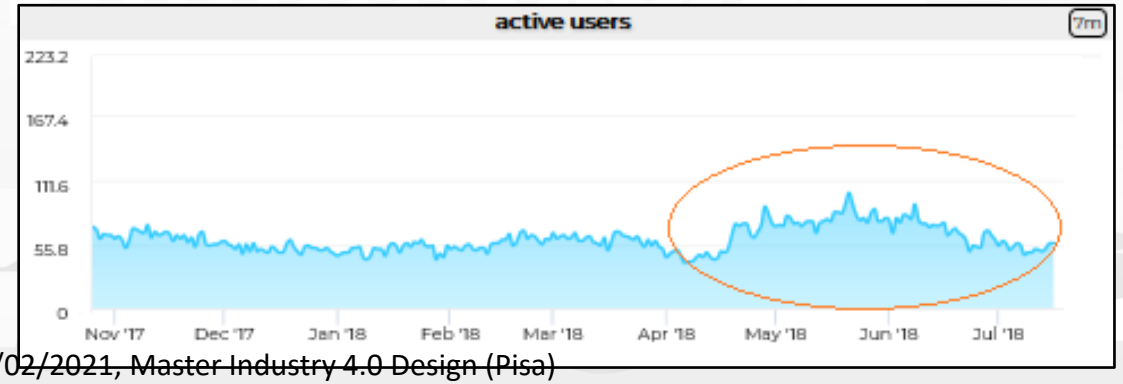
Validation of user Engagement

Months	Msg Sent	Msg Viewed	Msg Executed
1-January	3888	380	12
2-February	4319	489	22
3-March	4739	450	25
4-April	6567	918	67
5-May	7594	972	61
6-June	6437	695	55
7-July	9432	697	69
8-August	6988	429	73
9-September	5885	345	49
Total	55849	5375	433





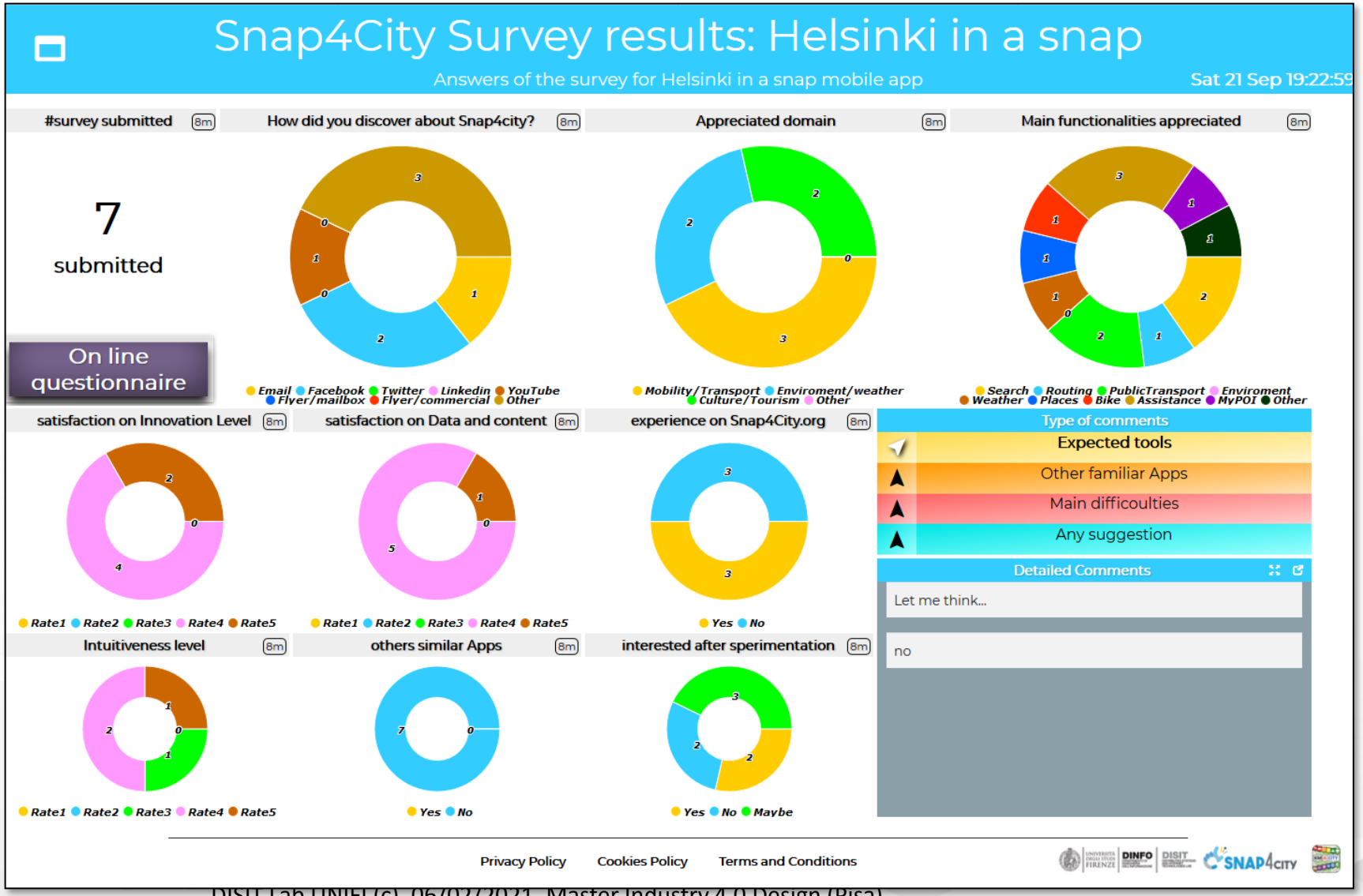




Helsinki

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc2OA==

Dashboard created to monitor in real time the answers to the survey provided on the Mobile App directly by the Engagement tool

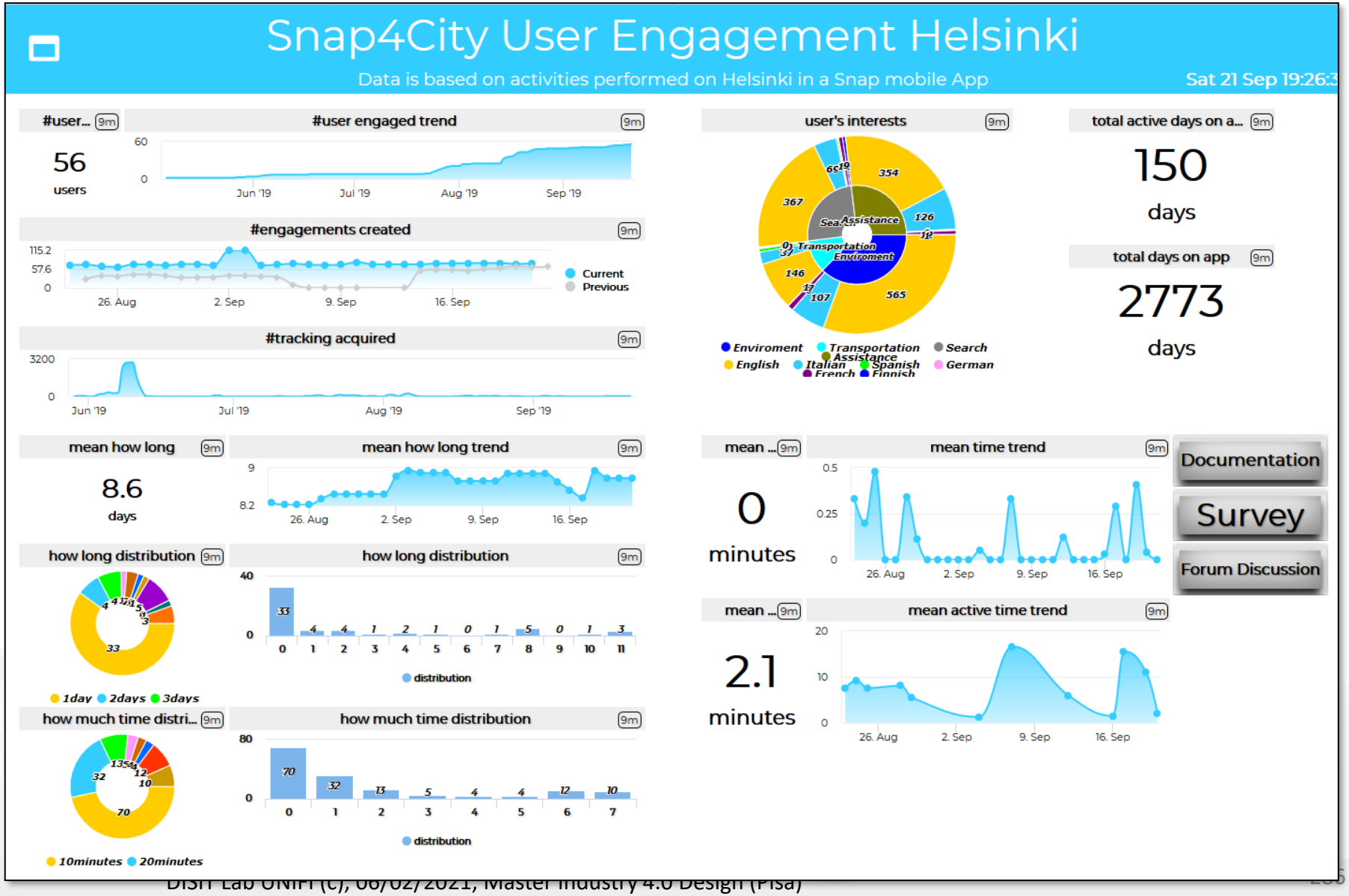


Helsinki

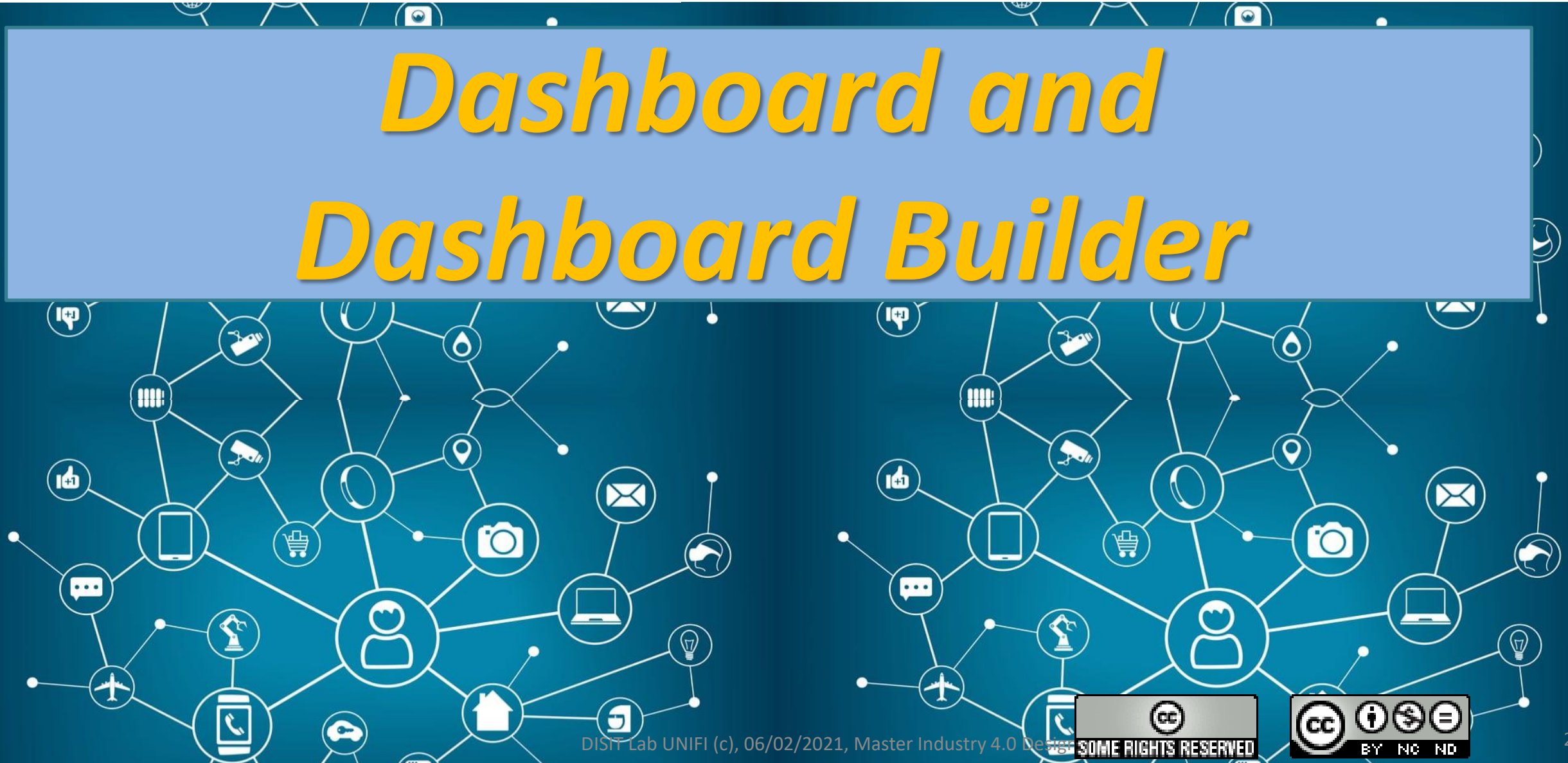
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc1OA==

Dashboard monitoring the Mobile App:

- Collecting the clicks
- Describing the community of users in terms of the profile aspects
- Measuring the time spend, and topics of interest of the users, etc.



Dashboard and Dashboard Builder



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Agenda

- Big Data Architecture
- Data Warehouse
- Data Storage
- Data Processing
- Data Analytics
- Visual Analytics
- **Dashboards**
- Living lab for Collaborative work
- Deploy and Install Snap4 .. Solutions
- Acknowledgment

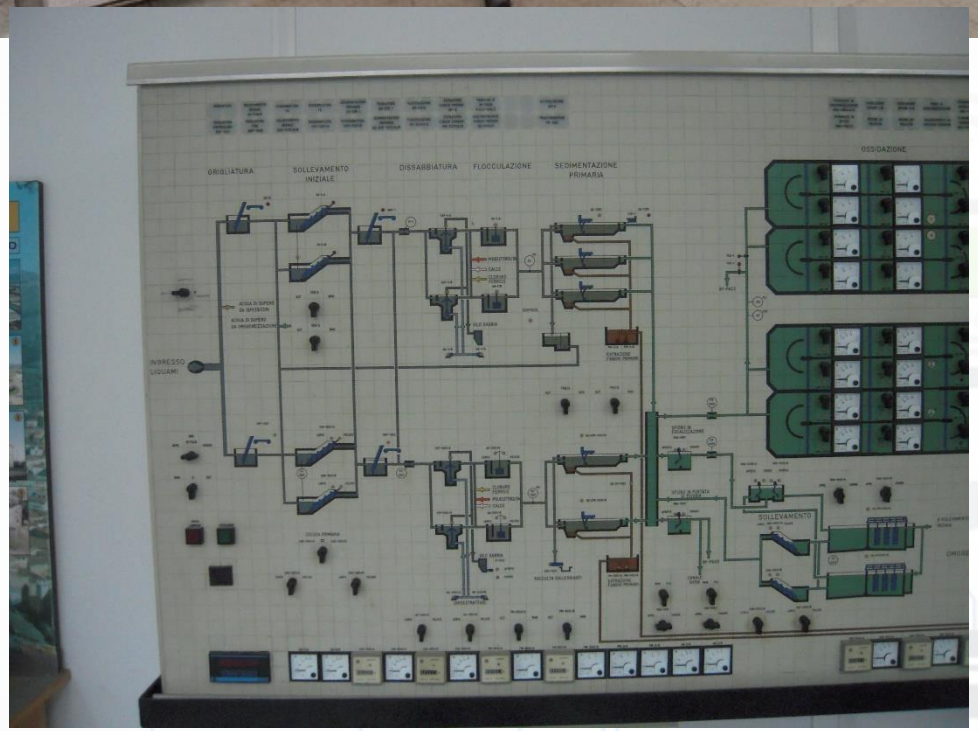
Control Room

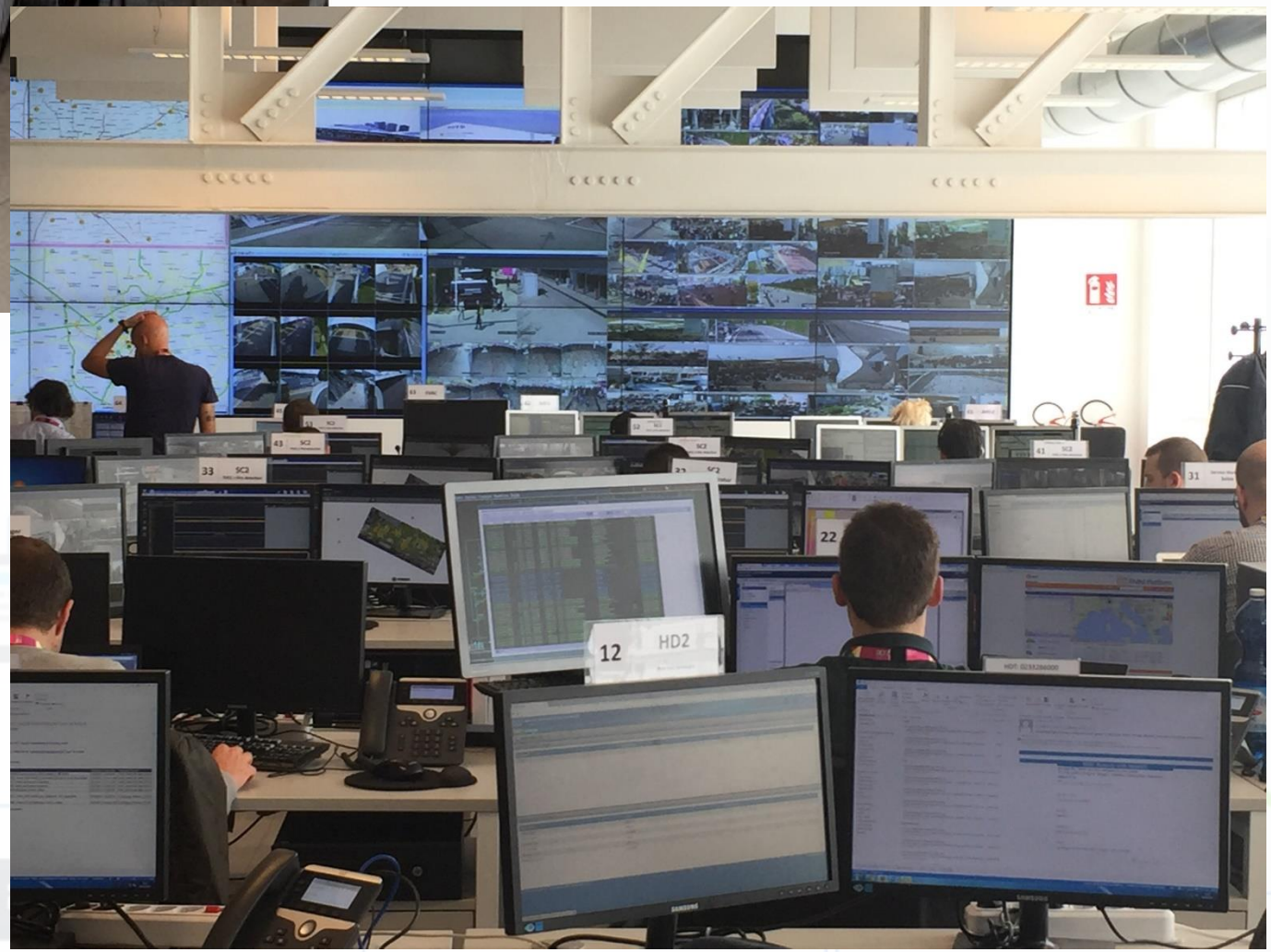




Control Room & Telecontrol








MAPPA FIRENZE
Fri 19 Oct 17:24:39
Colonnine Ricarica
Colonnine ricarica Fast
Pannelli a Messaggio Variabile
Parcheggi
Piste Ciclabili
Sensori del Traffico
Stazioni ambientali
Stazioni meteo
Traffico Real Time
Varchi ZTL
Wi-Fi
Eventi Traffico a Firenze
Concentration - 7 days
Main



https://www.snap4city.org/511

Firenze Oggi 2019

Fri 25 Oct 23:29:38

43666
Totale utenti WIFI

COLONNINE RICARICA<... 9m
176 INSTALLATE
71 % ATTIVE
5.1 % IN USO

GENERAL | METEO

MINIMO	BASSO	MEDIO	ALTO

RISCHIO IDRAULICO
RISCHIO TEMPORALI
RISCHIO IDROGEOLOGICO
RISCHIO NEVE
RISCHIO GHIACCIO
RISCHIO VENTO

SITUAZIONE VIABILITA 8s
0 INCIDENTI
0 CHIUSURE AL TRAFFICO (TOT)
0 CHIUSURE PER CANTIERI
0 PROGR. | 0 NON PROG.
0 LIMITAZIONI AL TRAFFICO (TOT)
0 LIMITAZIONI PER CANTIERI
0 NON PROG. | 0 PROGR.
0 TOT. EVENTI SULLA RETE

SMN 9m	BINARIO16 9m	FORTEZZA 9m
28.7 % occupati su 607 posti	55.2 % occupati su 165 posti	27.8 % occupati su 521 posti
LEOPOLDA 9m	**CALZA 9m**	**S.AMBROGIO 9m**
36 % occupati su 300 posti	70.3 % occupati su 148	99.7 % occupati su 379 posti
PARTERRE 9m	**CAREGGI 9m**	**BECCARIA 9m**
34 % occupati su 656 posti	24.9 % occupati su 406 posti	98.1 % occupati su 210 posti

ANALYSIS
Energy | Environment | Mobility | Social | Resilience

FLUSSI INGRESSO CITTA 9m
26 393.2 / 19 794.9 / 13 196.6 / 6598.3 / 0
12:00
Current / Previous

TOTALE 9m
284094
VEICOLI

FLUSSI INGRESSO ZTL 9m
5522 / 4141.5 / 2761 / 1380.5 / 0
12:00
Current / Previous

TOTALE ZTL 9m
57499
VEICOLI

Nati Italiani 119m	Nati stranieri 119m	Deceduti 119m	Matrimoni 119m	Unioni Civili 119m
163 ultimo mese consolidato	49 ultimo mese	395 ultimo mese	19 ultimi 7 giorni	0 ultimi 7 giorni

Segnalazioni ricevute in attesa 119m	In Lavorazione 119m	Risolte 119m	Chiuse senza risoluzion... 119m
1116 ultimo mese	524	305	285

Manutenzioni Stradali 59m	Verde Pubbli... 59m	Decoro Urbano 59m	Relitti 59m
54 oggi	4	6	3

Attesa media alla fermata

Linea 6 9m	Linea 13 9m
3 min	13 min
Linea 17 9m	**Linea 23 9m**
4 min	5 min
Linea 31 9m	**Linea 36 9m**
19 min	2 min

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTQzOA==

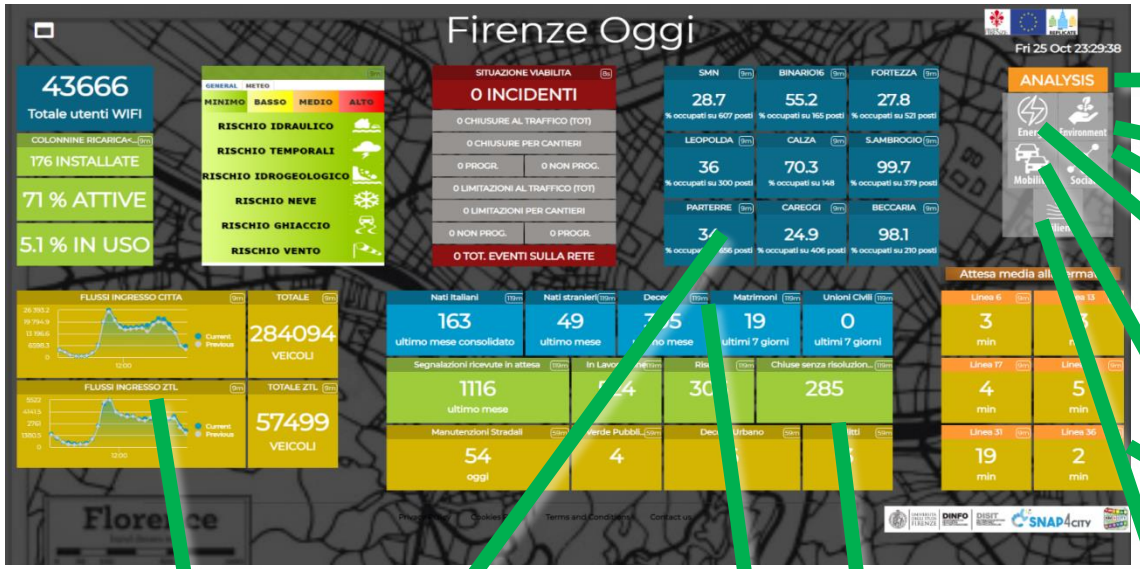
Smart City Control Room

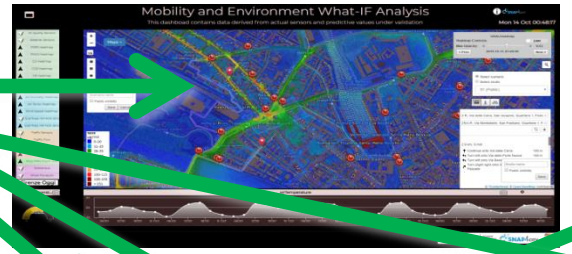
a set of dashboards and tools

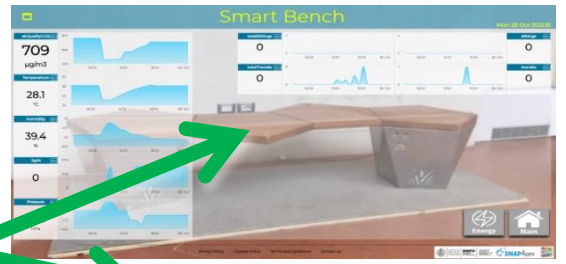
REPLICATE

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement Nº 691735

FIRENZE CITTÀ FARO



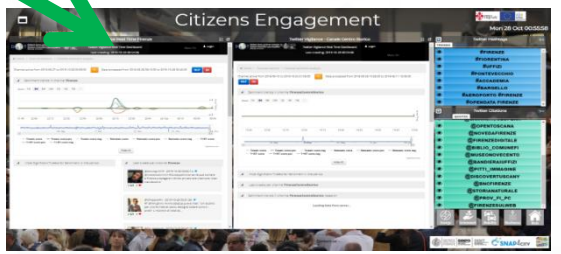


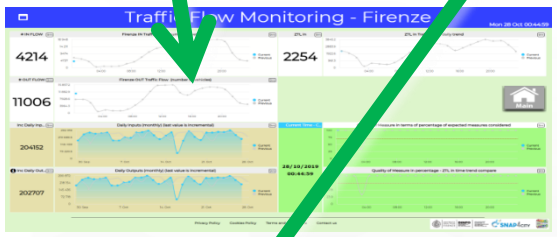








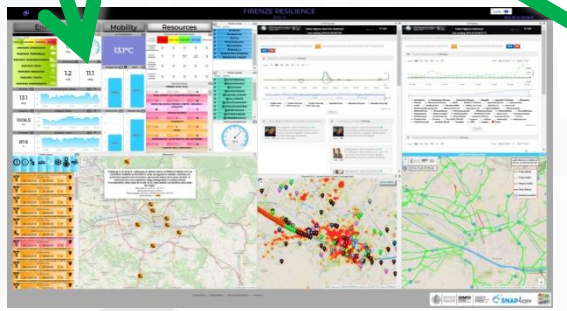


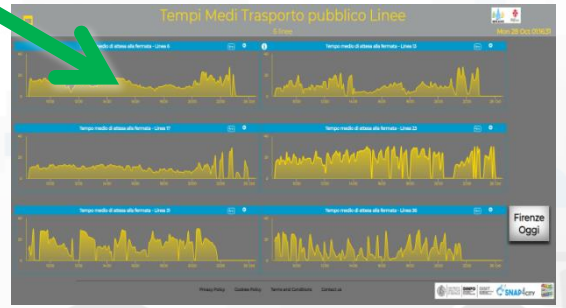












Storage vs processing



Data Sources PULL Data



Data Sources, Brokers, External Services Data Driven, Real Time



Data Ingestion, aggregation, regularization, reconcile

ETL, NIFI, DISCES

Big Data Cluster
HDFS, Hbase, Phoenix

Knowledge base
Semantic reasoners

Indexing and aggregating
Elastic search

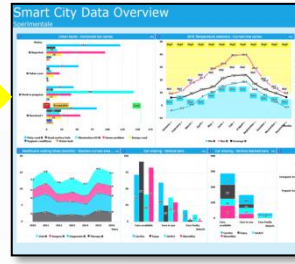
Data Analytics
R, Tensor Flow, Python, MapReduce, …

IOT Applications
Node-RED + Snap4City MicroSrvs

Search and Query, Smart API
Facet, semantic search

Visual Analytics
dash/ tools

Rendering Acting, MicroApps
User interface, Interactive Dashboard, Drill down, maps,







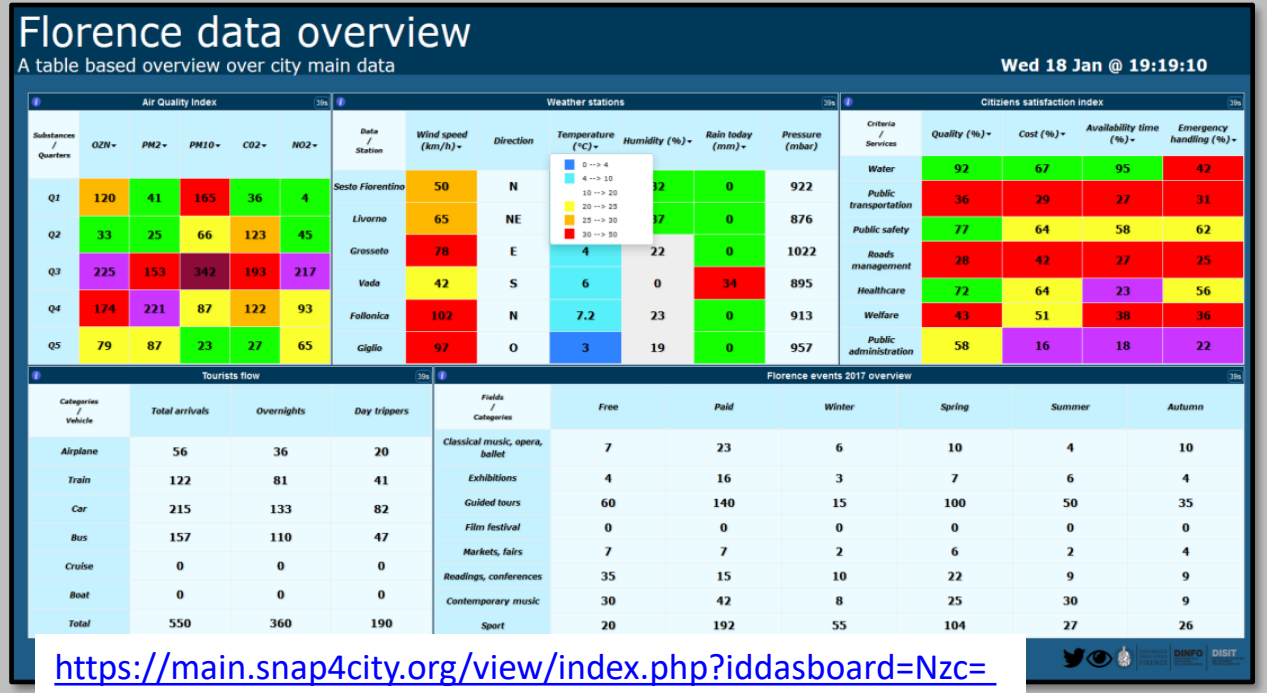
Inform, announce, Act!, warning, alarms, What-IF, ..

Different kind of Dashboards for Different User Kind

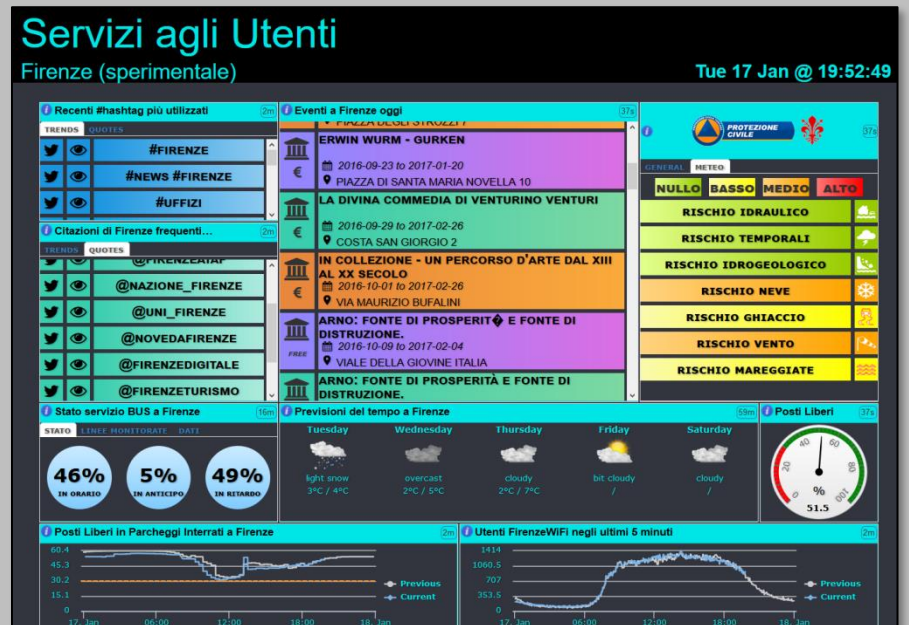


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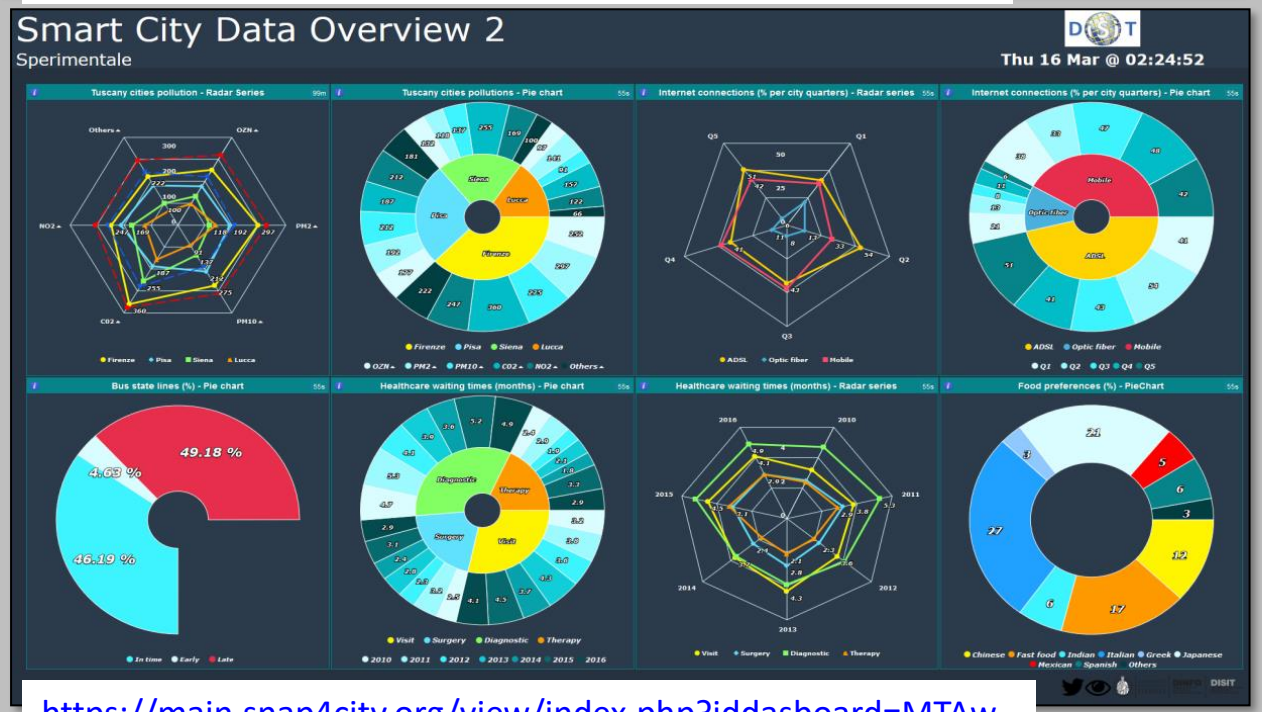

Datacenter Energy Consumption
DataCenter gas and smoke (mobile)
DISIT
Sat 22 Jun 09:40:02
Smoke1
6
Smoke1 (day)
Smoke2
3
Smoke2 (day)
Smoke3
4
Smoke3 (day)
Gas1
36
Current
Previous
Temperatures - Room of machine 166
DISIT
22.4
deg
Temperature 1 (last 12 hours)
Temperature 1 (H24)
20.4
deg
Temperature 2 (last 12 hours)
Temperature 2 (H24)
Humidity %1
31.5
Humidity Percentage 1 (daily)
Humidity %2
40.5
Humidity Percentage 2 (daily)
WebMonitoring major
Status of Web servers
Sat 22 Jun 09:43:50
DISIT_ORG
KM4CITY
SERVICEMAP
SERVICEMAPOSM
TWITTERVIGILANCE
LINKEDOPENGRAPH
NODERED_1
NODERED_2
NODERED_3
NODERED_4
NODERED_5
NODERED_6
NODERED_7
NODERED_8
TOKEN FOUND



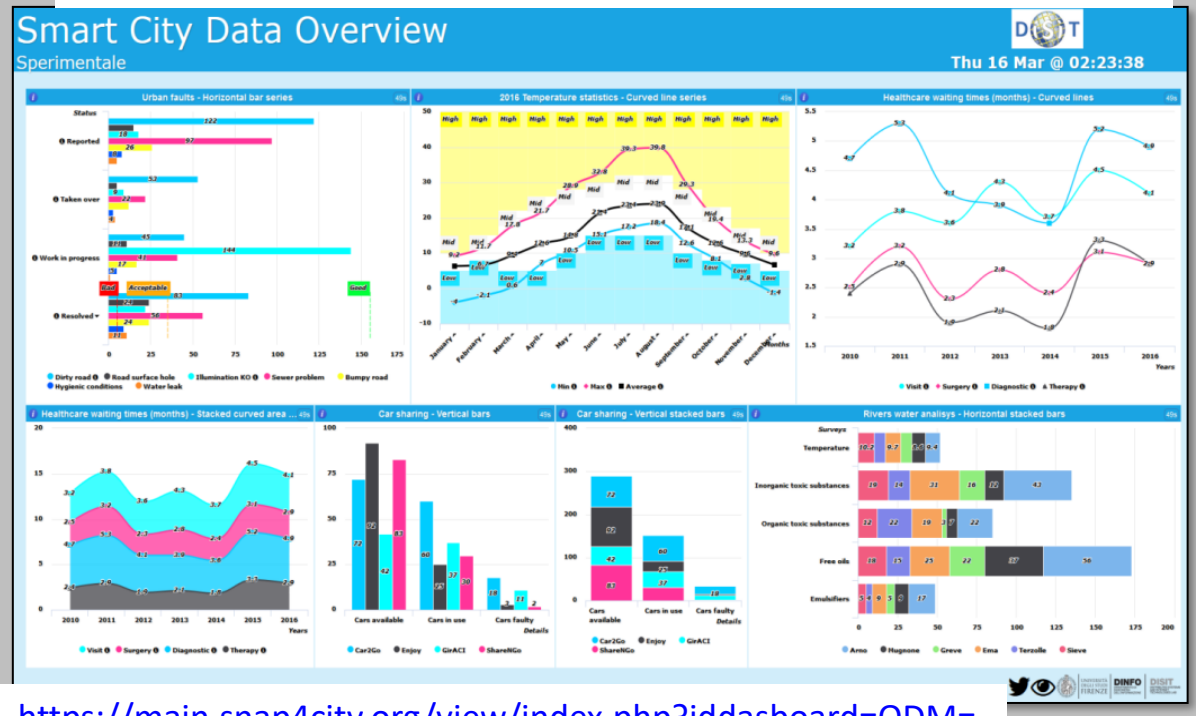
https://main.snap4city.org/view/index.php?iddasboard=Nzc=



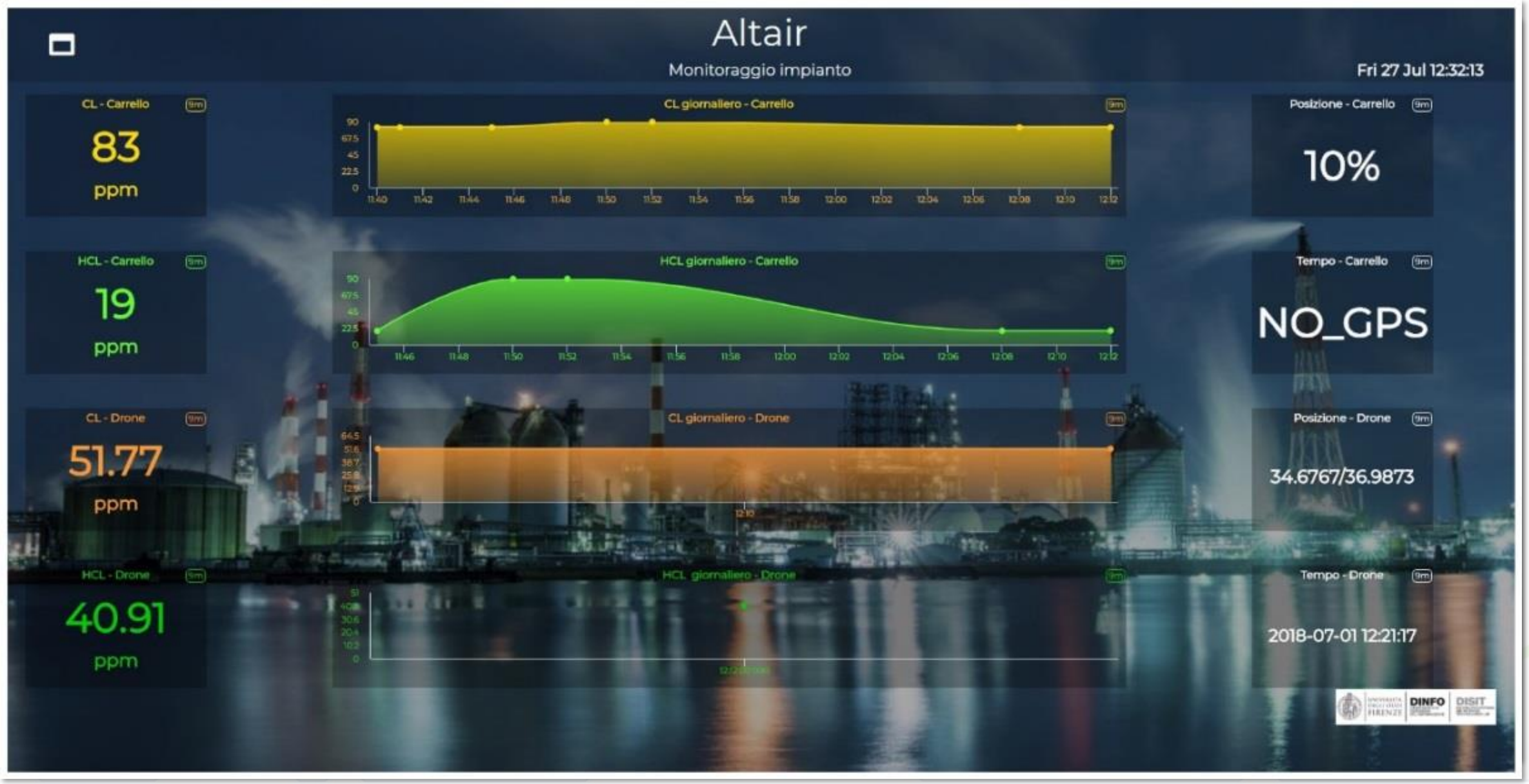
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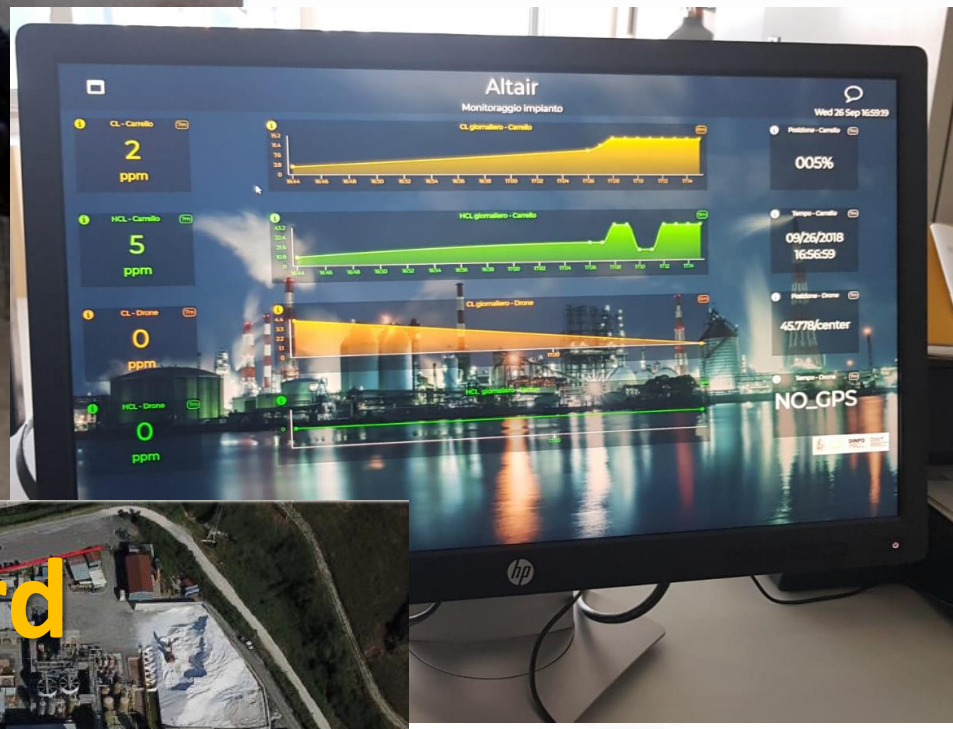
https://main.snap4city.org/view/index.php?iddasboard=MTAw



https://main.snap4city.org/view/index.php?iddasboard=ODM=


Altair
Monitoraggio impianto
Fri 27 Jul 12:32:13
CL - Carrello
83
ppm
CL giornaliero - Carrello
Posizione - Carrello
10%
HCL - Carrello
19
ppm
HCL giornaliero - Carrello
Tempo - Carrello
NO_GPS
CL - Drone
51.77
ppm
CL giornaliero - Drone
Posizione - Drone
34.6767/36.9873
HCL - Drone
40.91
ppm
HCL giornaliero - Drone
Tempo - Drone
2018-07-01 12:21:17





Chemical Plant Dashboard



Green Impact Capacity (GIC)

Altair Control room



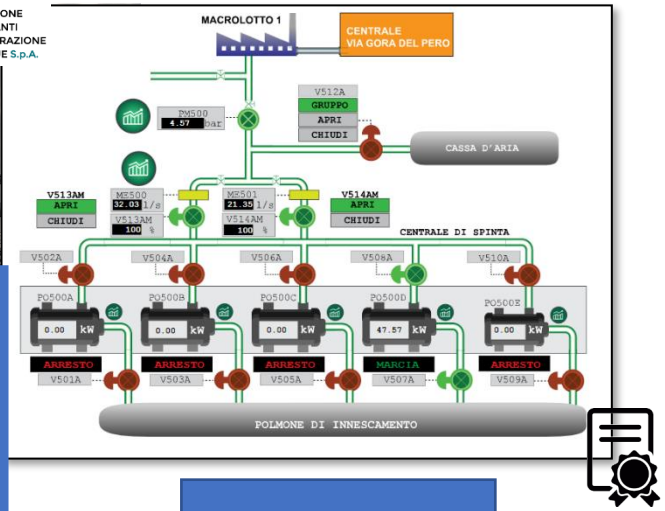
Prato
Smart City vs Industry 4.0

GIDA set up

Smart City data from many sources

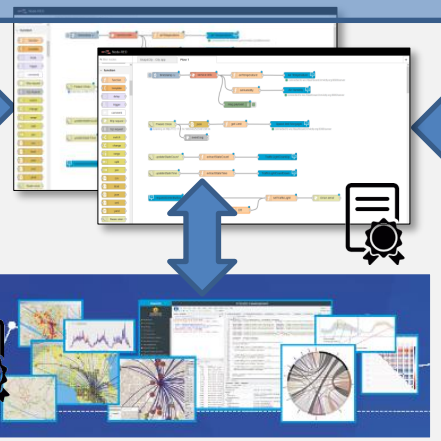




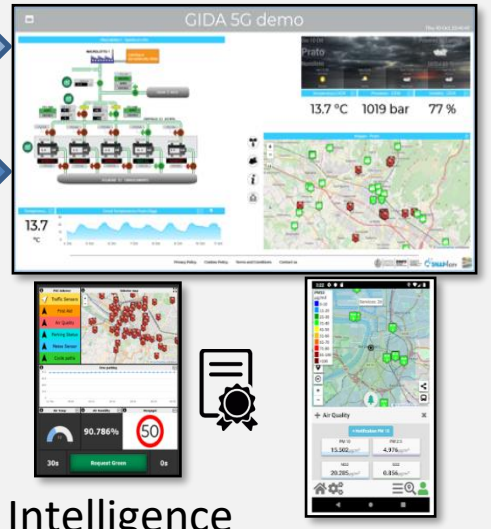


IOT Data Shadow Snap4City

IOT Applications



Dashboards and Apps



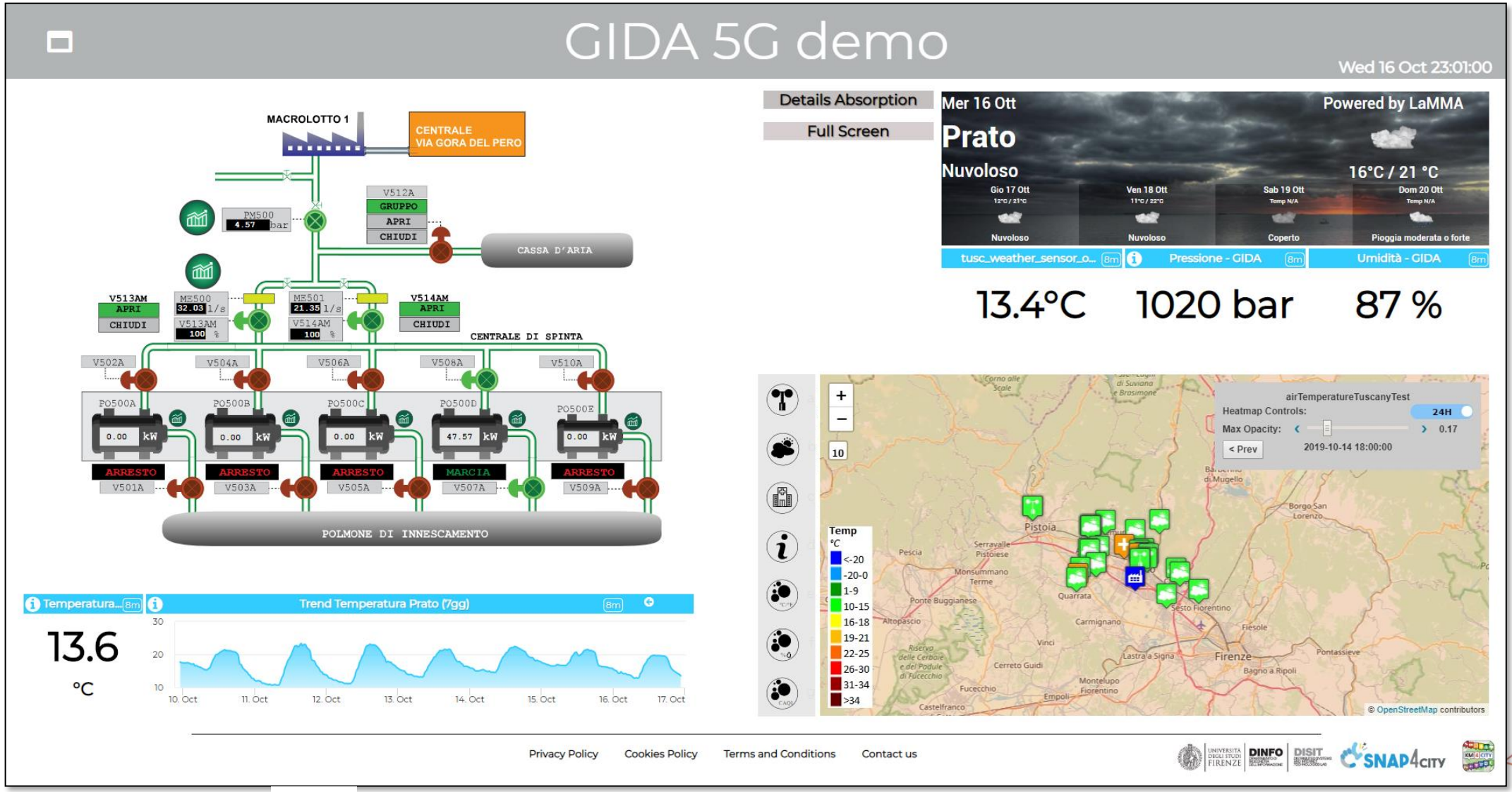
Big Data Analytics, Artificial Intelligence

ModBus to Snap4City Gateway Edge

5G network devices

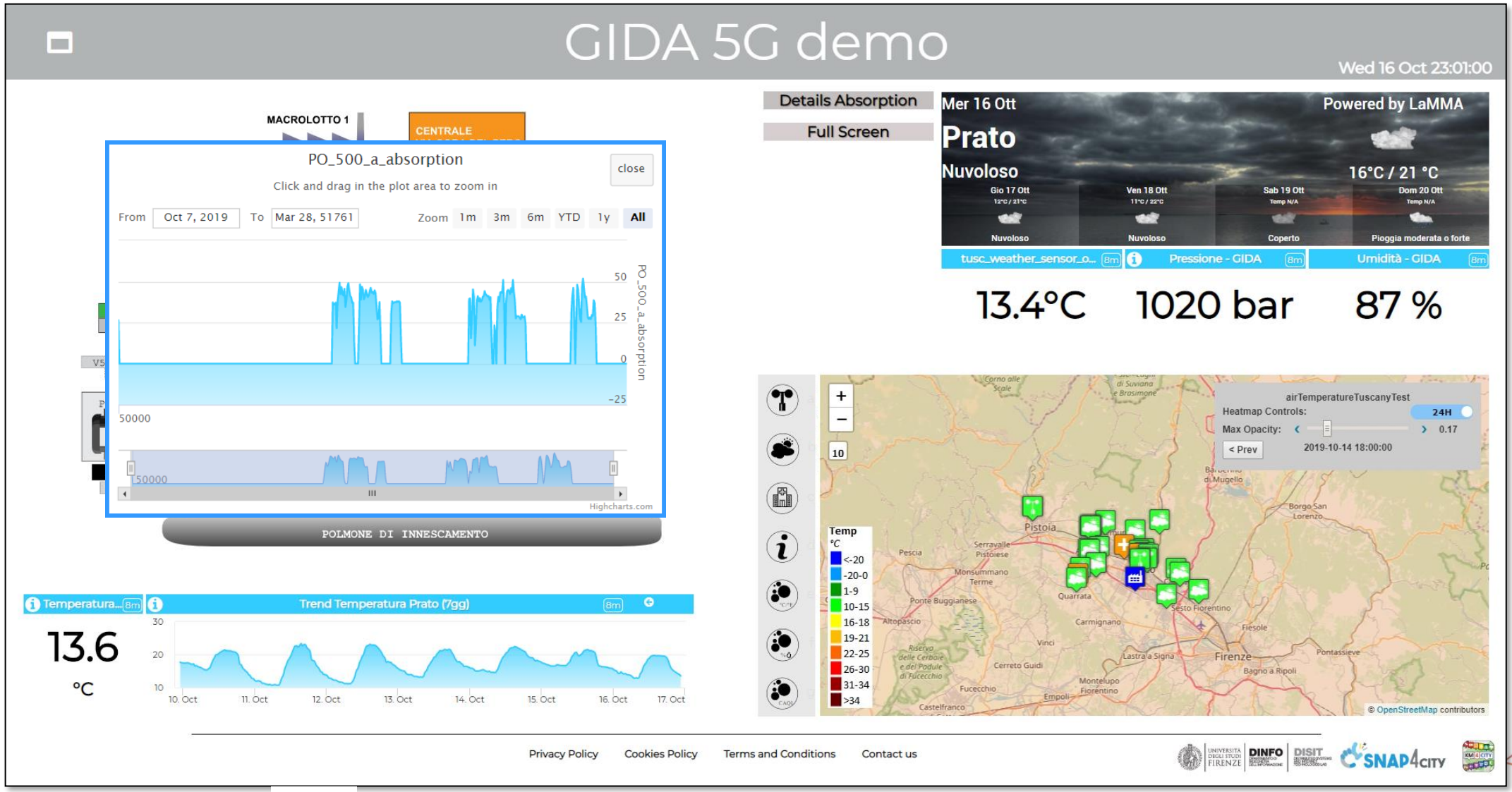
Telemonitoring Telecontrol

Dashboards & Services:



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjIyNg==

Demo UC5 GIDA



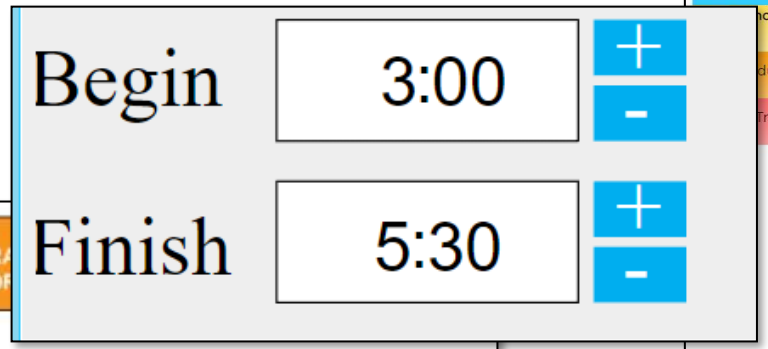
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjIyNg==

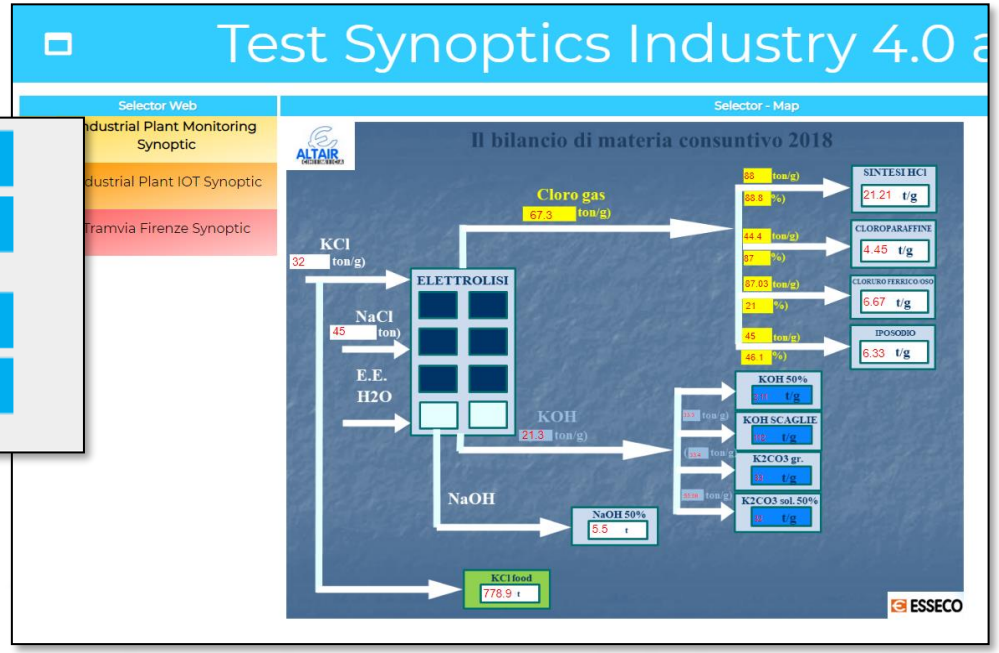
Custom Widgets

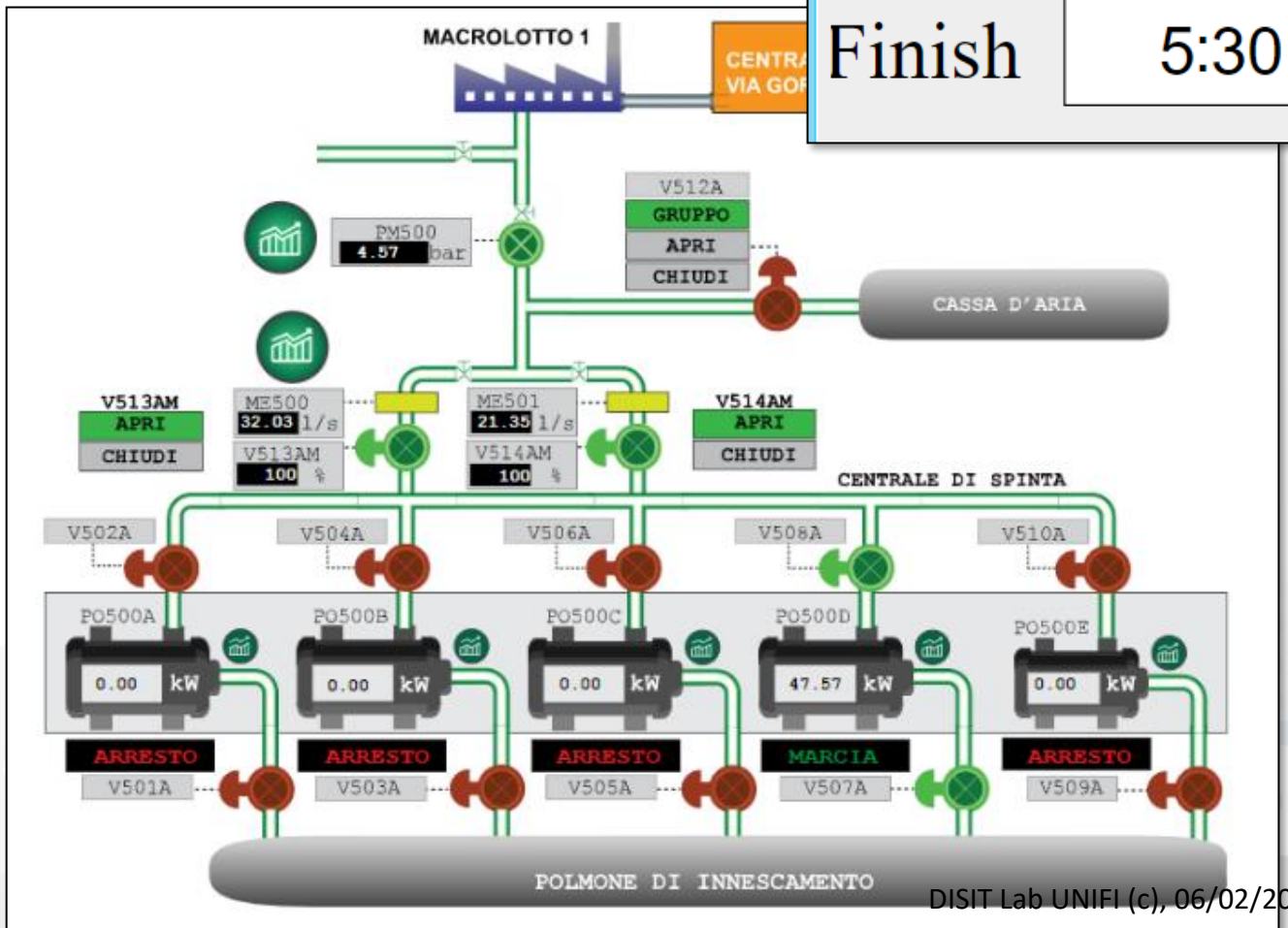
Custom Dashboards and Widgets (interactive, Animations, etc.)

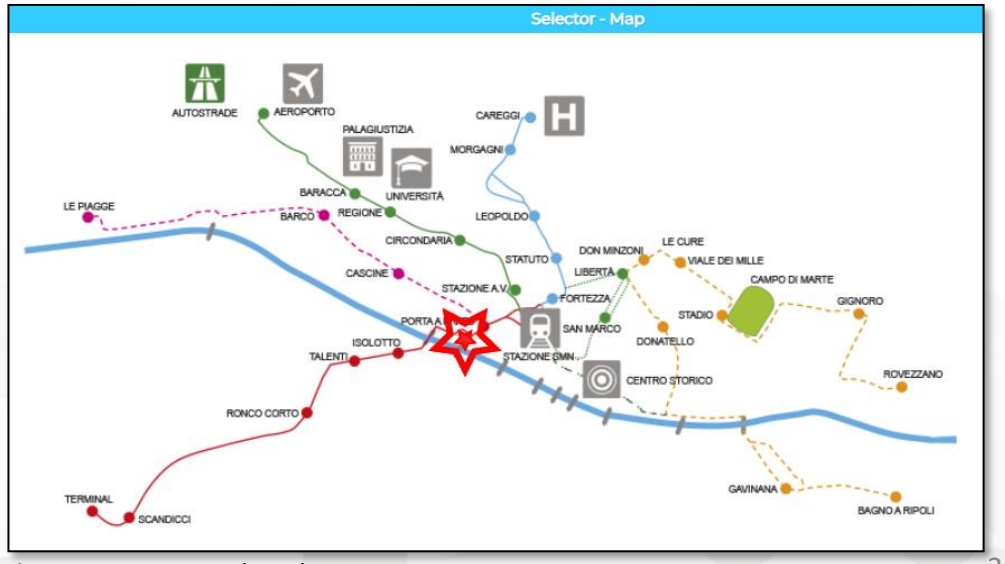
-- SVG for graphic design

-- MyKPI for collecting data





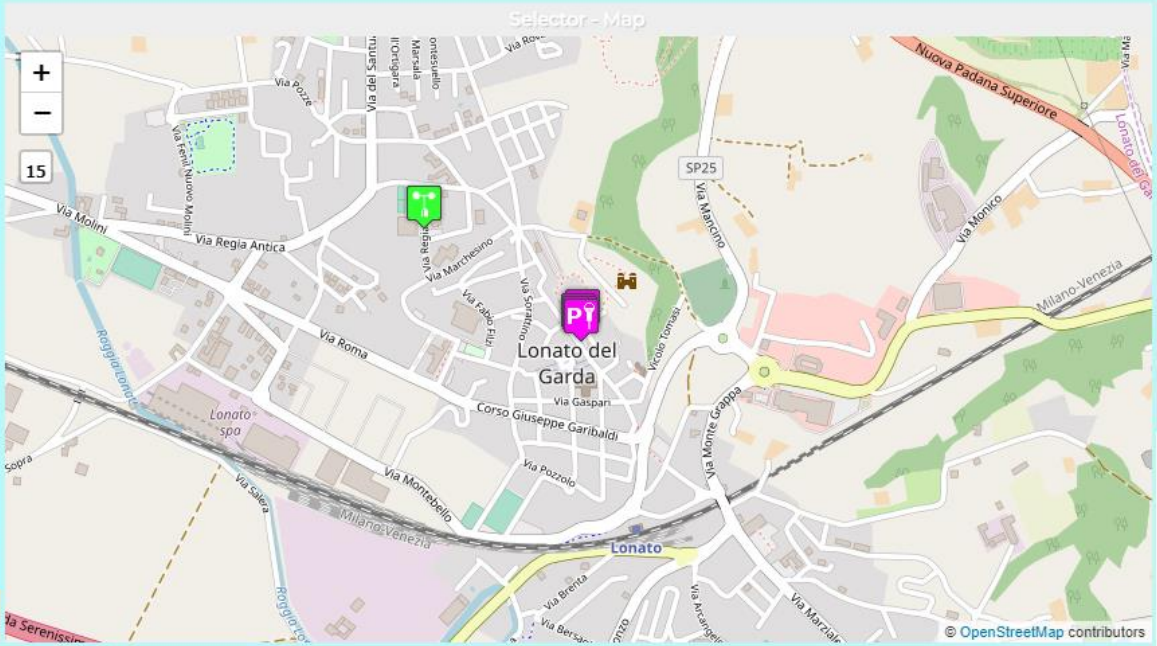


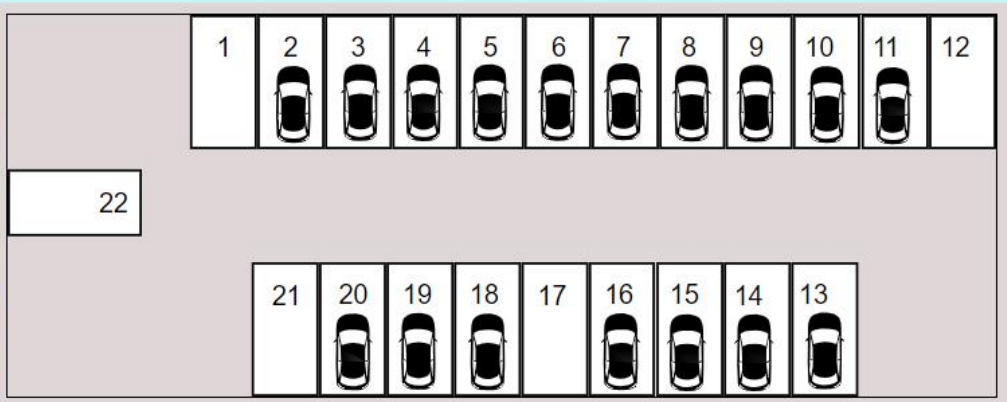


Smart Lonato del Garda - cam

Tue 12 Nov 19:31:54

- Slot 1
- Slot 2
- Slot 3
- Slot 4
- Slot 5
- Slot 6
- Slot 7
- Slot 8
- Slot 9
- Slot 10
- Slot 11
- Slot 12
- Slot 13
- Slot 14
- Slot 15
- Slot 16
- Slot 17
- Slot 18
- Slot 19
- Slot 20
- Slot 21
- Slot 22
- Environment
- other





view cam



AVG time of free slot 9m
08 minuti

5
free slots

Median of Busy Slots 9m
1 ora e 23 minuti

Max Present Duration 9m
53 ore e 01 minuto

View main

Slot 1 - Status 9m
0
status

Slot 15 - Seconds of Occupancy 9m



pressure 9m
976.2
mbar

humidity % 9m
82.7
%

temperature 9m
10.7
°C

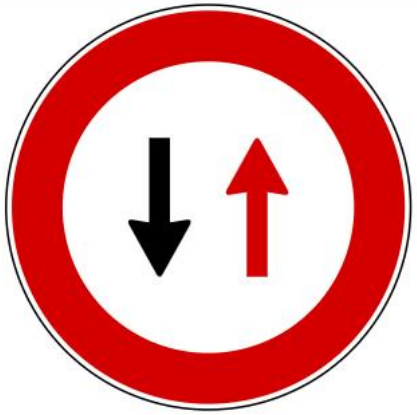
AirSensEUR_RVB01 - temperature (week) 9m



SVG Custom Widgets Examples

Sat 19 Dec 00:10:12

Precedence Italians Road signals



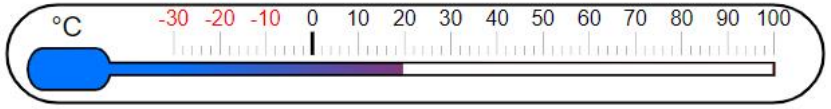
Select a code from 0 to 11 to change the road sign

New		Last confirmed: None
7	8	9
4	5	6
1	2	3
0	.	Canc
Confirm		

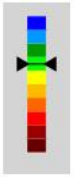
s... **Smart Light Luminosity**



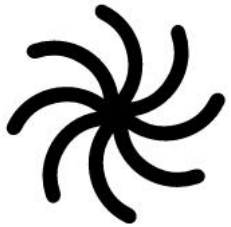
Air Temperature in Florence



PM10 level - Bologna



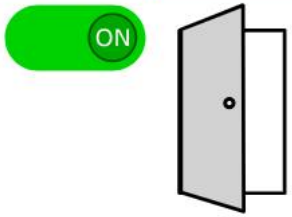
fan **Fan velocity**





Symbols Legenda

open/... **M...**



Dynamic Prohibition...



Prohibition Traffic Signs Co...

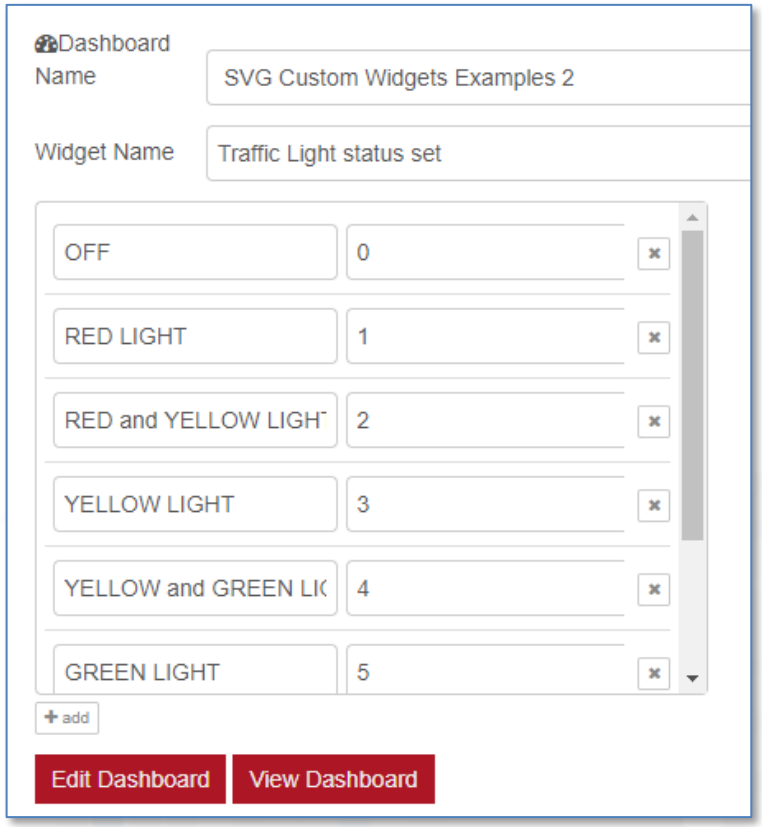
New		Last confirmed: None
7	8	9
4	5	6
1	2	3
0	.	Canc
Confirm		



Prohibition Traffic Signs Legenda

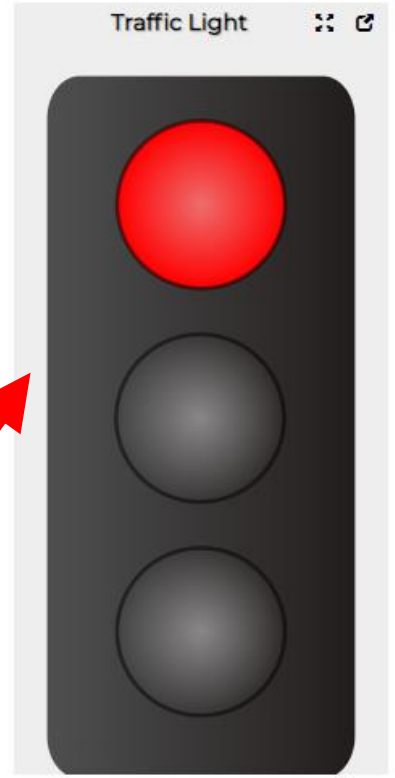
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk0NQ==

Selector

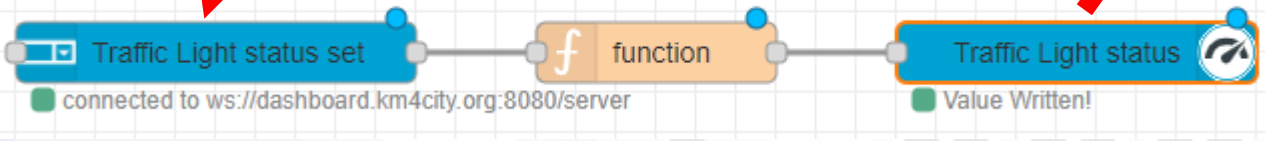




- Selecting MSG to be sent on the Business Logic IOT Application







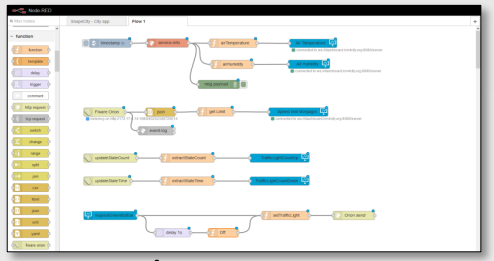

```
msg.payload = {value:JSON.parse(msg.payload).selected};
return msg;
```

Developing Dashboards



SOME RIGHTS RESERVED
BY NC ND

Dashboard Development



IOT Applications

Knowledge Base, Km4City



Knowledge and Storage Data from the Field and City + MyKPI ++

Widget Collection





Micro Applications

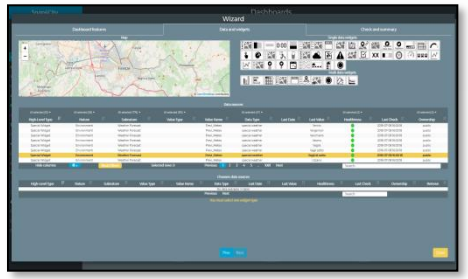


External Services



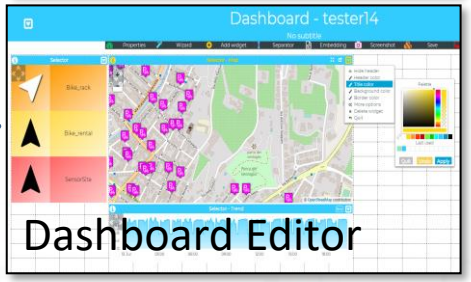
Custom Widgets/ Synoptics

Dashboard Wizard



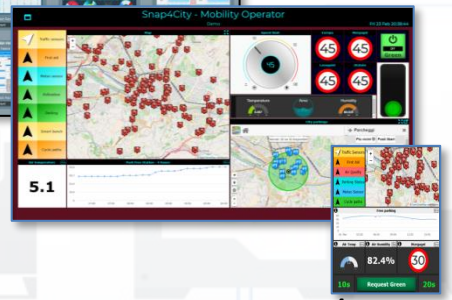
Create, save, load, delegate, grant access





Dashboard Editor



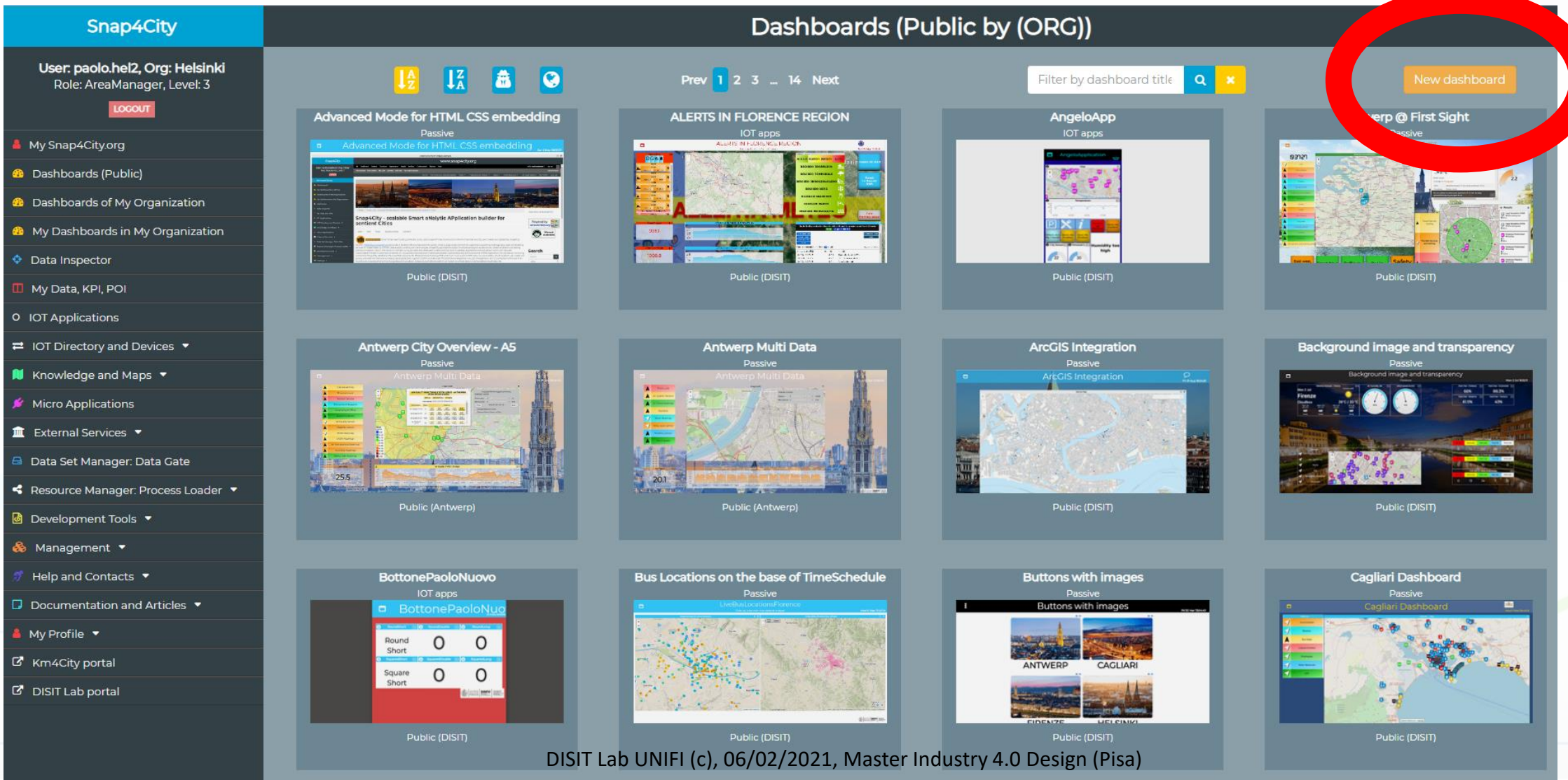


Public Dashboard Collection

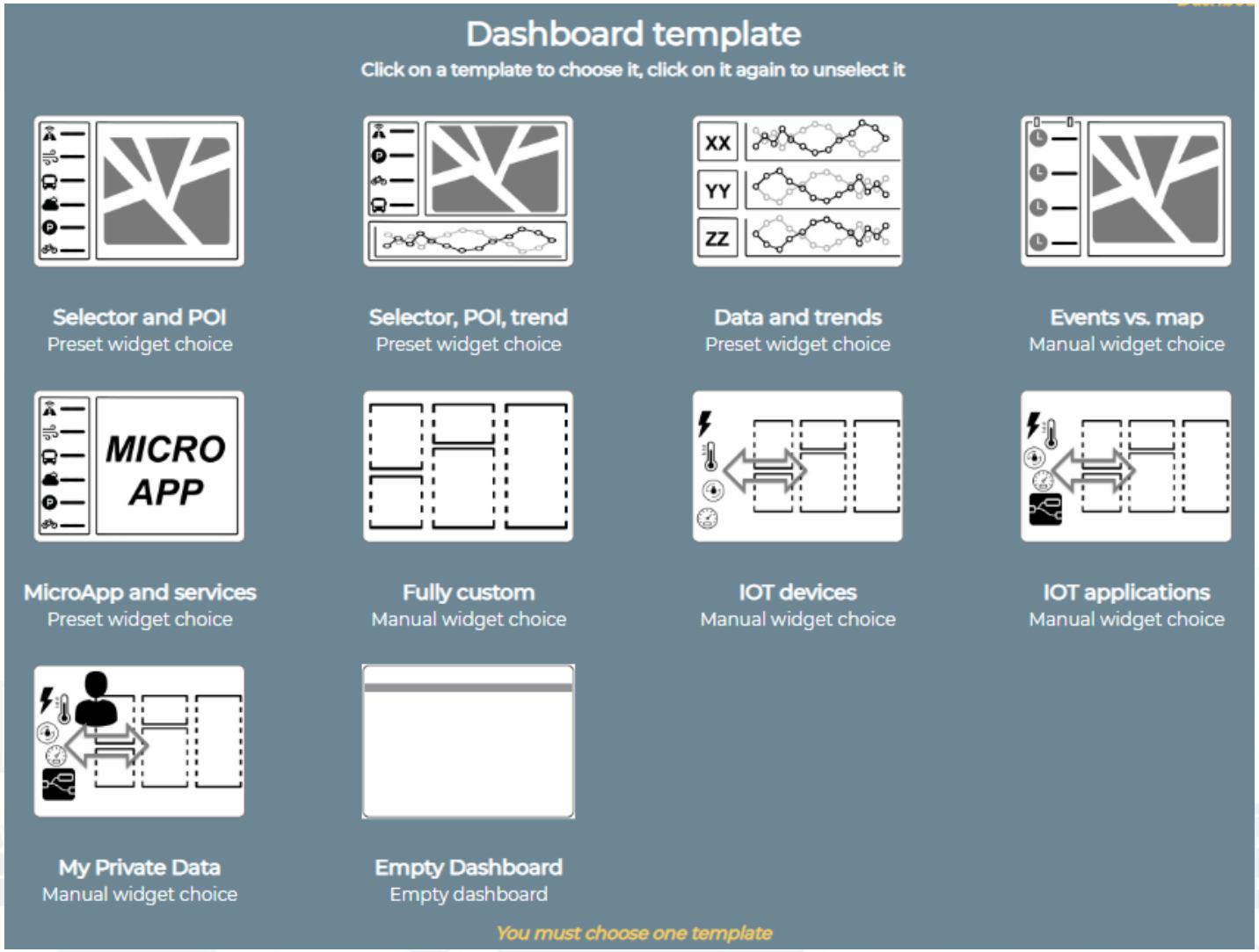


My Own Dash/App

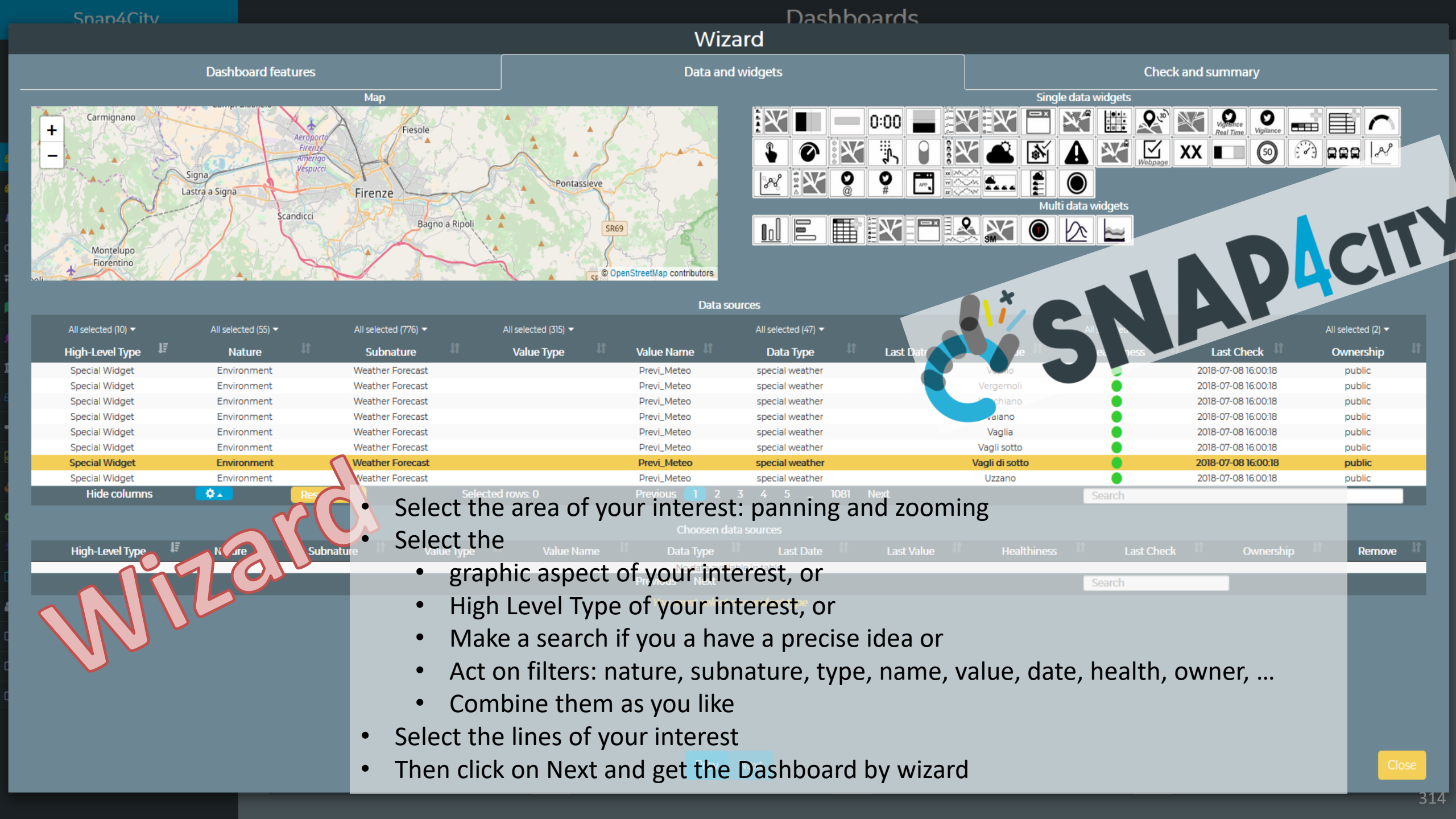
Dashboard List and Editor



From Templates to Wizard and Dashboards

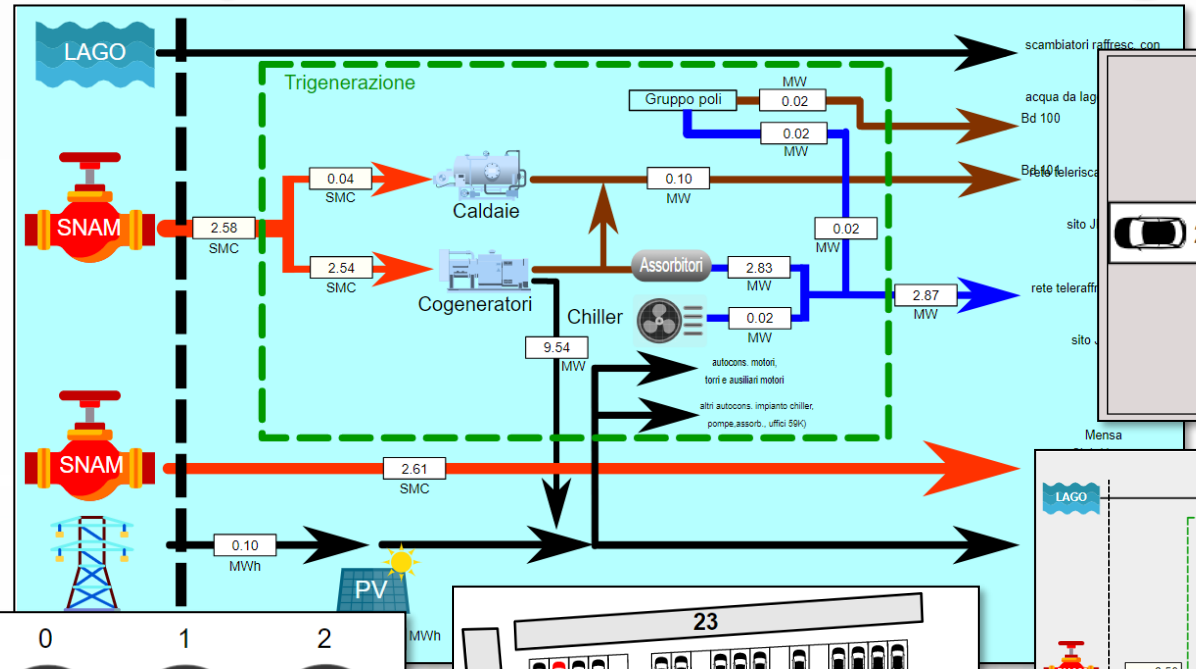


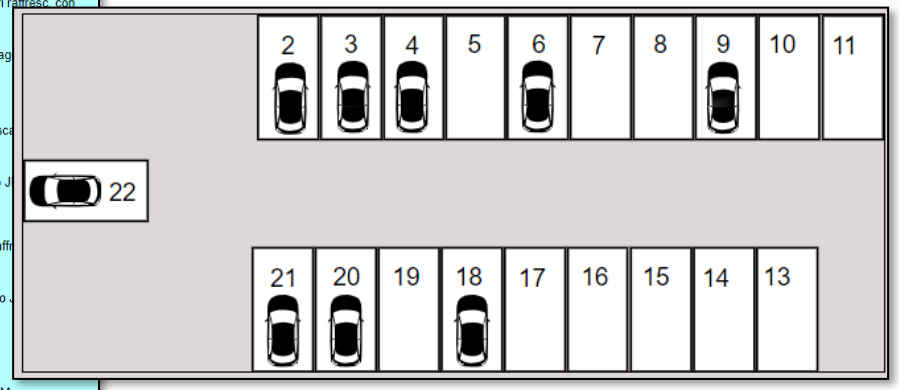
- to create a new Dashboard
- to add widgets and/or groups of them on any Dashboard

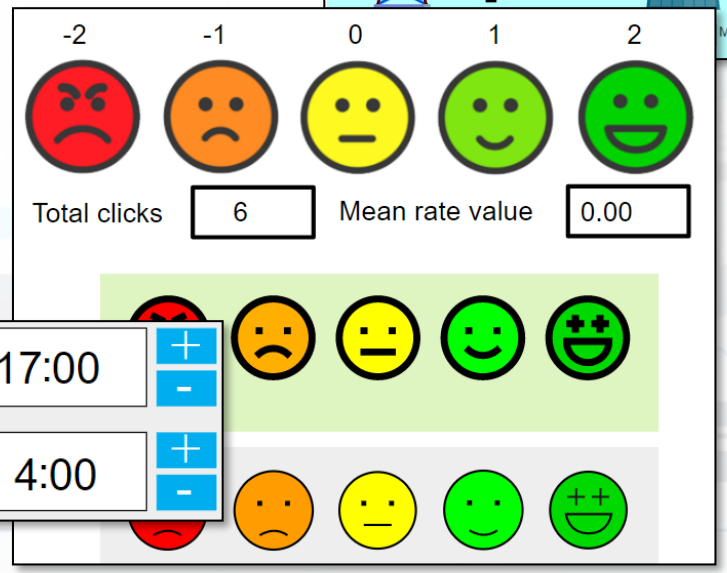

Wizard
Dashboard features
Data and widgets
Check and summary
Map
Carmignano
Fiesole
Aeroporto Firenze Amerigo Vespucci
Signa
Lastra a Signa
Firenze
Pontassieve
Scandicci
Bagno a Ripoli
SR69
Montelupo Fiorentino
© OpenStreetMap contributors
Single data widgets
Multi data widgets
Data sources
All selected (10)
All selected (55)
All selected (776)
All selected (315)
All selected (47)
All selected (2)
High-Level Type
Nature
Subnature
Value Type
Value Name
Data Type
Last Check
Ownership
Special Widget Environment Weather Forecast Previ_Meteo special weather 2018-07-08 16:00:18 public
Vagli di sotto
Vaglia
Vagli sotto
Uzzano
Hide columns
Selected rows: 0
Previous 1 2 3 4 5 1081 Next
Search
Choosen data sources
Value Name
Data Type
Last Date
Last Value
Healthiness
Last Check
Ownership
Remove
Close
Wizard
Select the area of your interest: panning and zooming
Select the
graphic aspect of your interest, or
High Level Type of your interest, or
Make a search if you a have a precise idea or
Act on filters: nature, subnature, type, name, value, date, health, owner, …
Combine them as you like
Select the lines of your interest
Then click on Next and get the Dashboard by wizard
SNAP4CITY

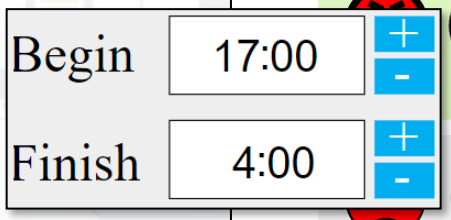
Special Custom Widgets

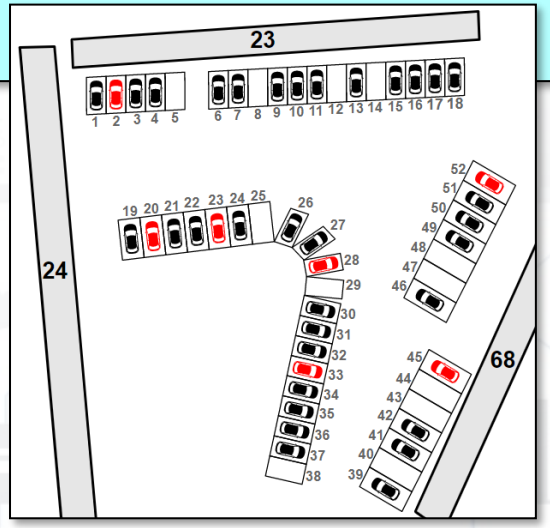
- Smart parking
- Smart Energy
- Smart Light
- Smart ….
- Energy View
- Custom Controls

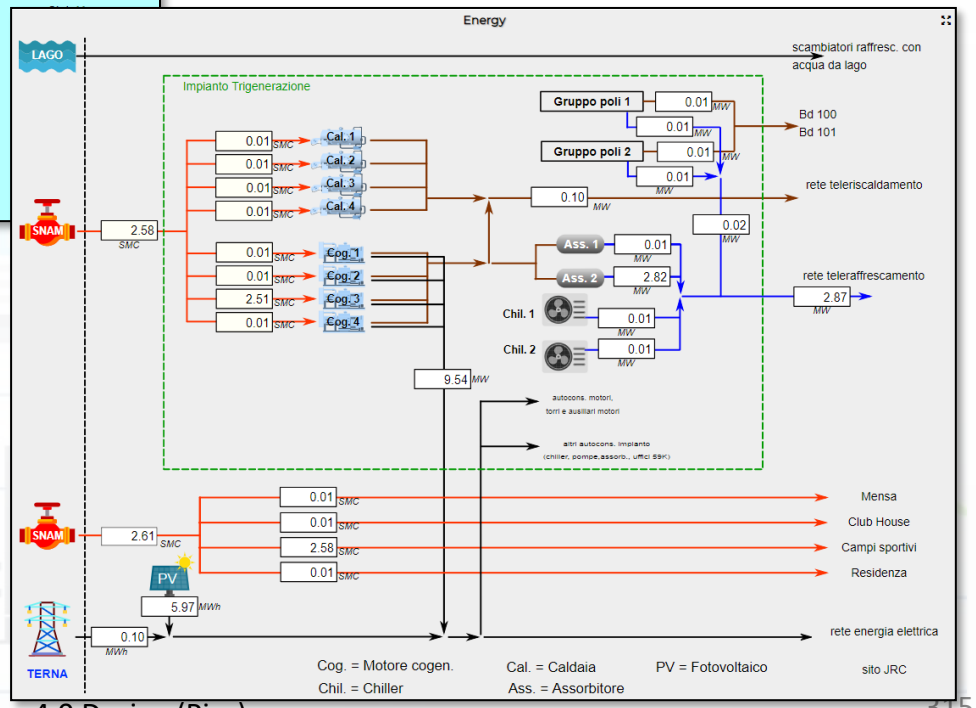






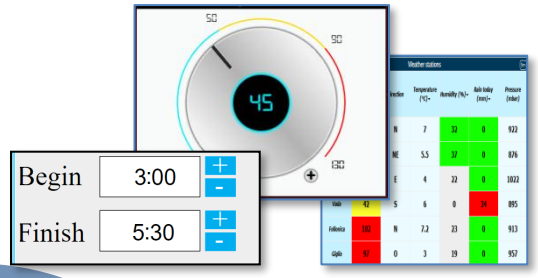






Dashboard List and Editor



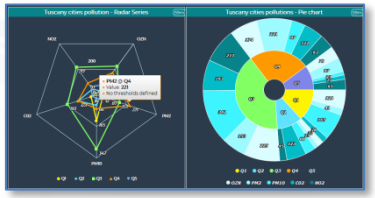


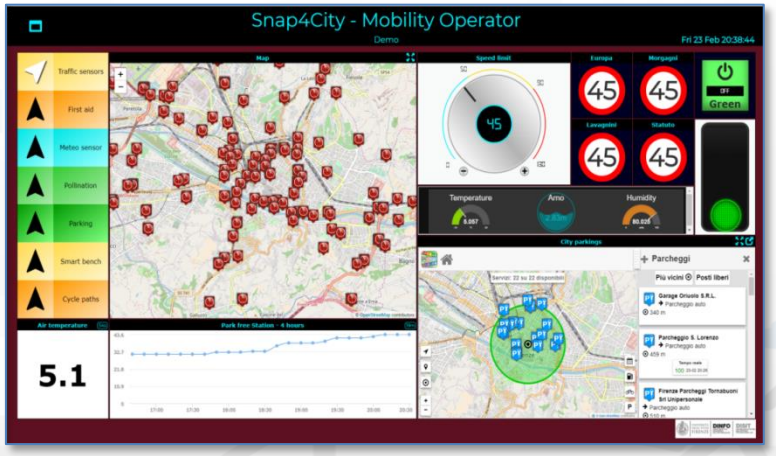




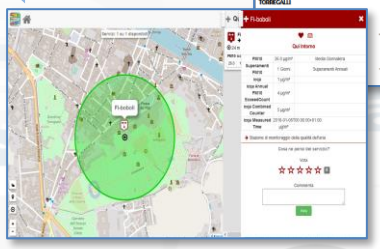




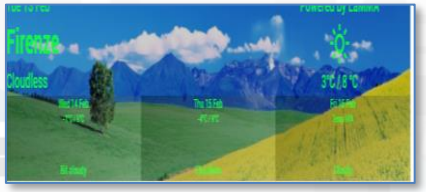


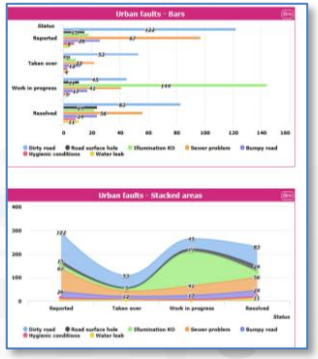












Developing new Dashboard Graphic Widget

- The development of new Widget is feasible for programmers
  - in PHP, JavaScript and CSS
    - The starting point is the Core Snap4City Virtual Machine Appliance StartSNAP4CITYVM: https://www.snap4city.org/drupal/node/504 https://www.snap4city.org/471
    - While the source code is also accessible on GitHub/DISIT
    - see TC3.11 - New graphics widget can be easily created, Dashboard Widget Creation
  - creating a new Graphic widget via SVG and programming: Custom Synoptics and Widgets for Dashboards https://www.snap4city.org/504

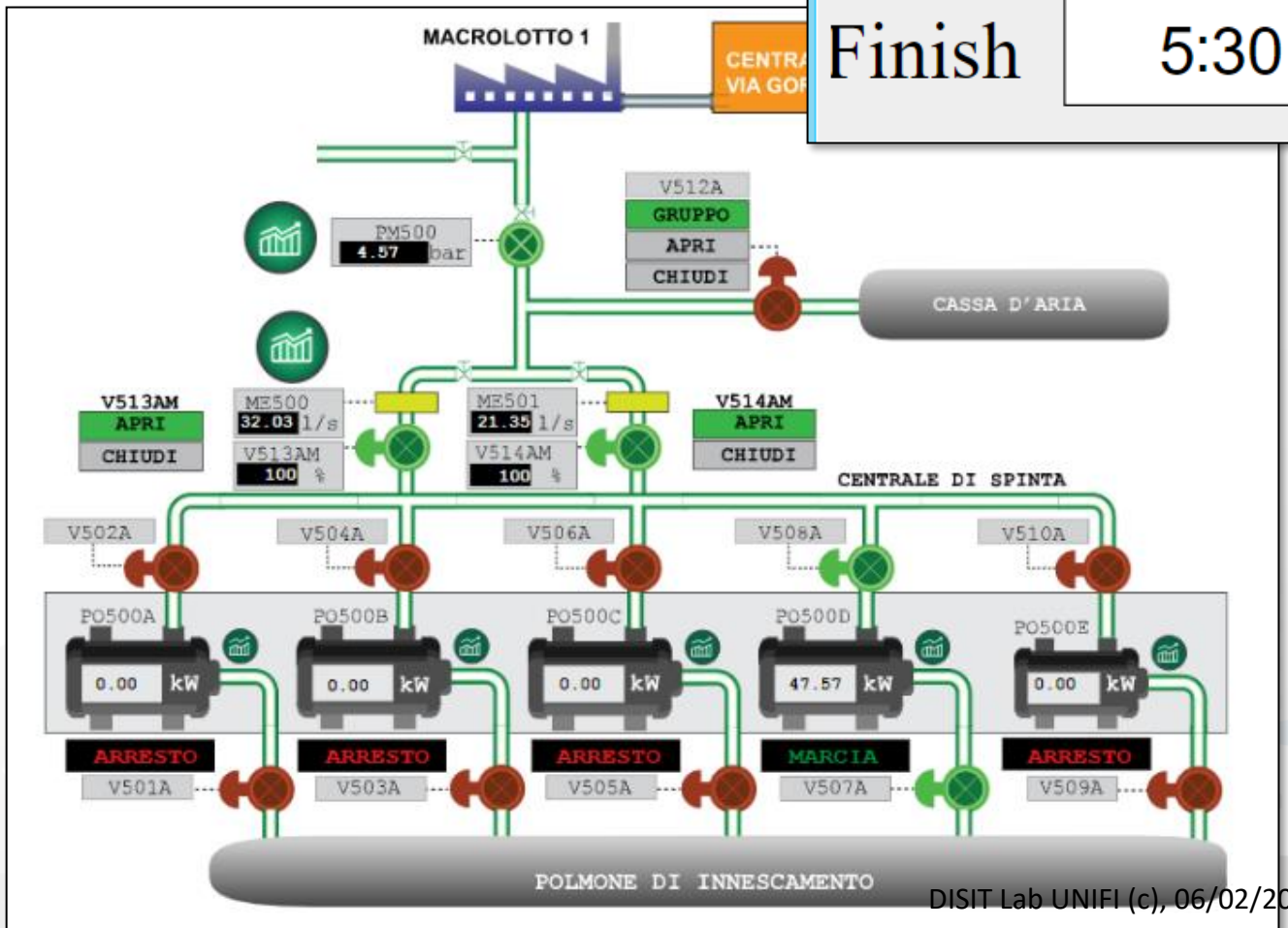


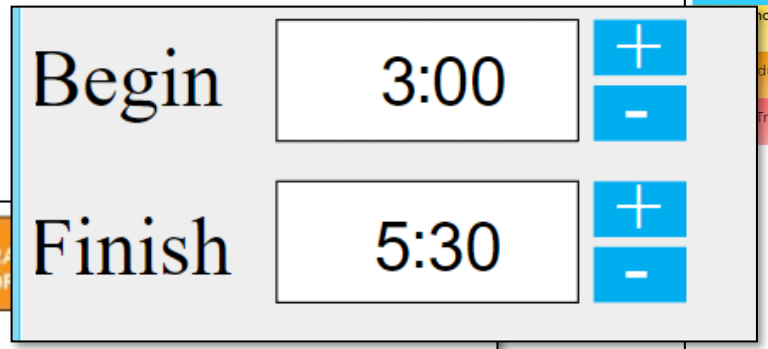
Custom Widgets

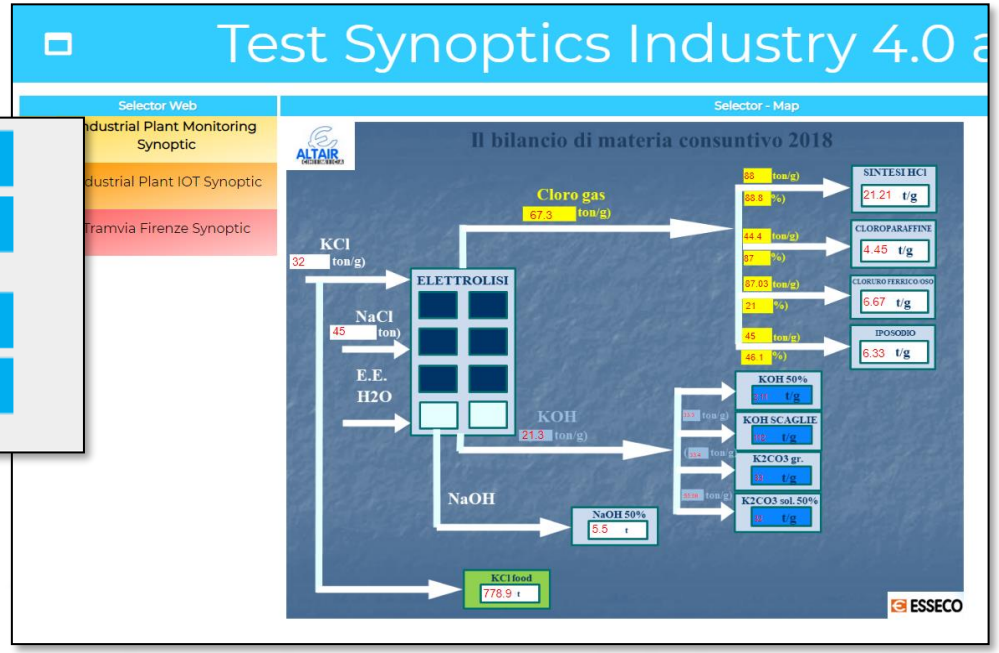
Custom Dashboards and Widgets (interactive, Animations, etc.)

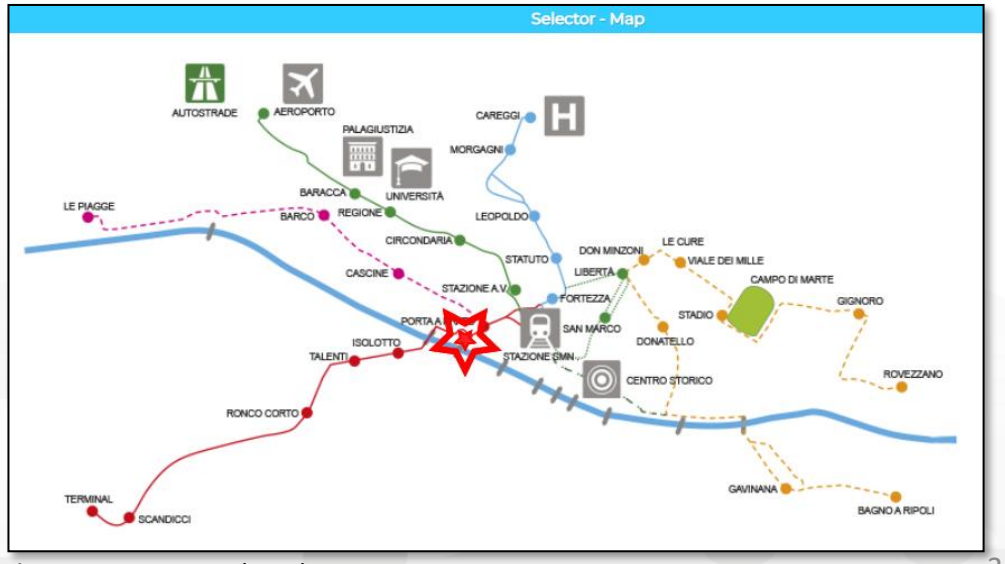
-- SVG for graphic design

-- MyKPI for collecting data









Dashboards summary and further readings

- **Suitable** as: City Dashboard, App interface, and Control Room Dashboards, Situation Room Dashboard, Operator Dashboard
- **Created** visually compounding graphic Widgets
  - Each widget can be set to have an autonomous update
  - Each metric/data-source may have associated with an alarm: blinking and sending events to people and machines in different manners
- **Can be**: public or private, private dash can be delegated or passed in ownership
- See https://main.snap4city.org/management/dashboards.php?linkId=dashboardsLink&fromSubmenu=false&sorts[title_header]=1
- See the following tutorials
  - **HOW TO: create a Dashboard in Snap4City**
  - **HOW TO: add data sources to the Snap4City Platform**
  - **US1. Using City Dashboards**
  - **US2. Using and Creating Snap4City Applications with Dashboards**
  - **US4. Creating City Dashboards and related Event Monitoring and Actions**

Data Protection, Personal Data vs GDPR



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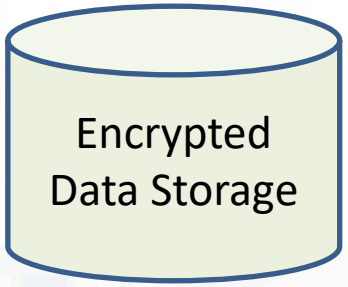
GDPR: General Data Protection Regulation

- **Users are** going to decide to:
  - provide access to who, for do what, until we consent
  - accept terms of use by **signed** consent **for each** data management **service**, *before was a simple informed consent*
- **from each service, the user has** to be capable to
  - **See** what the provider collect in terms of its Data Type: traces, logs, paths, profiles, accesses, IOT devices, sensors, maps, etc.
  - **Download**, **delete**, **inspect** each single Data Type
  - **Auditing** and **Revoke access** or **grant** access right to **each single Data Type**
  - **Delete all Data Types in single shot** or singularly (**forget all about me**)

- Correctness
- Transparency
- Security
- Integrity
- Privacy
- Auditing
- ….

GDPR: General Data Protection Regulation

- If personal data are **published by the owner**
  - the data have to be **released anonymously**,
    → also in this case they can be **revoked at any time**:
  - **Complexity reside** on: *distributed vs centralized control, revoke of Votes/scores, comments, …. If they are saved singularly or they already exploited in processing*
- GDPR also imposes **Technical Constraints** such as:
  - **Secure connection** in any private data exchange
  - **Encrypted** data store for all private data
  - **Decoupling** data and personal IDs
  - Allow the **Auditing** of private data usage
- **Relevant taxation** is foreseen when rules are violated, % of turnover

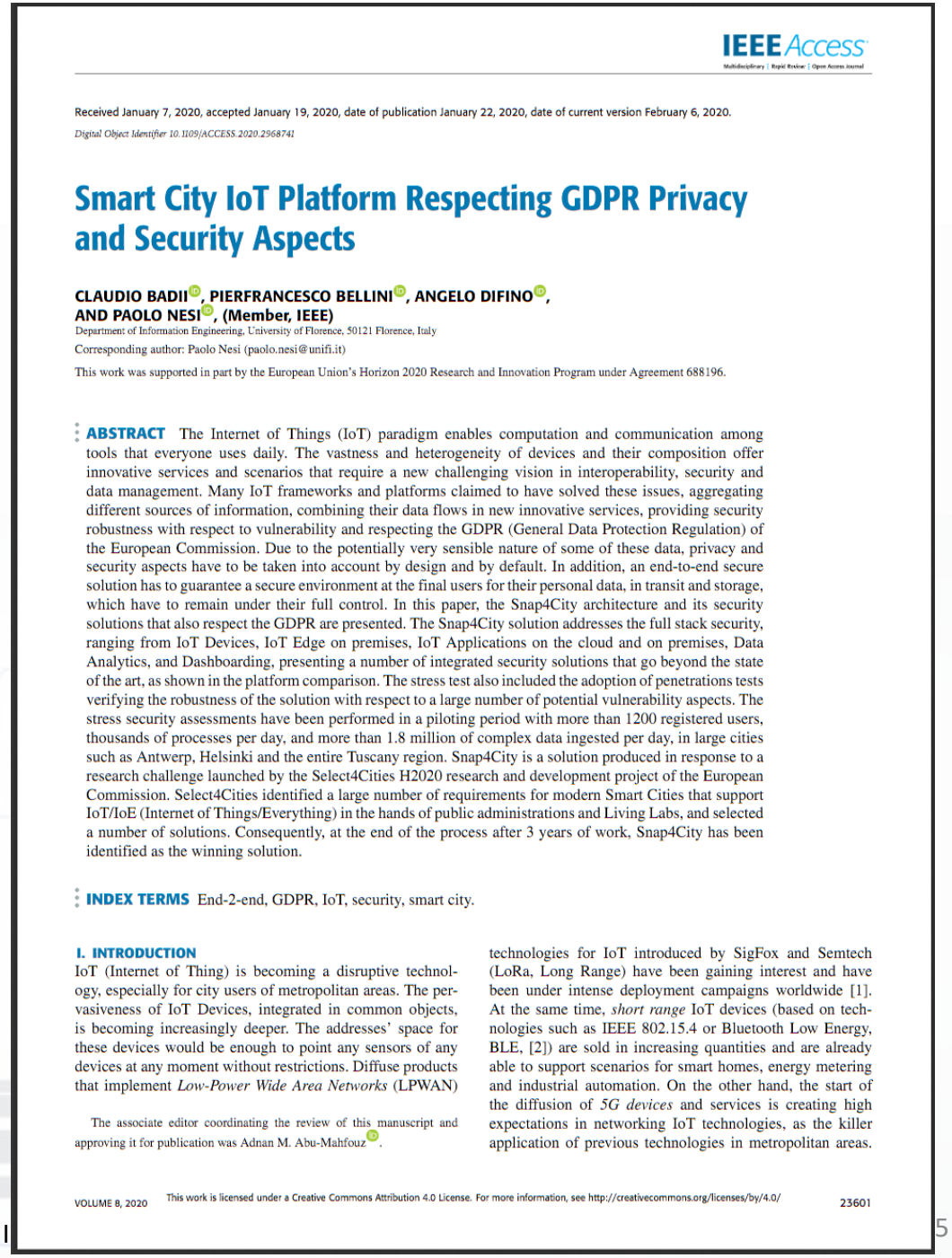


GDPR vs Snap4City

GDPR Compliance Verification Feature	Verif.	Reqs.
Signed consent	UI	R8
User profile management and control	UI	R13
Data Type private as default	UI	R8
Rights to access per element	UI	R9
Rights to transfer per element	UI	R10
Rights to erase per element and total	UI	R13
Rights to revoke/change per Data Type	UI	R10
An interface for Right management for Data Type	UI	R9
Clear Terms of Use and Privacy Policy	UI	--
Auditing Tools for Data Type	UI	R14
Publish as Anonymous	UI	R9
Encrypt personal users' data	Code	R12
Secure Authentication and Authorization	Code	R3
Data protection by Design	Code	R17
Secure connection	Code	R6
Security Control, data breach control, anonymization, etc.	PEN Test	R15, R16, R18

IEEE Access

- C. Badii, P. Bellini, A. Difino, P. Nesi, "Smart City IoT Platform Respecting GDPR Privacy and Security Aspects", accepted for publication on IEEE Access, 2020. 10.1109/ACCESS.2020.2968741 https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8966344



IEEE Access

Received January 7, 2020, accepted January 19, 2020, date of publication January 22, 2020, date of current version February 6, 2020.
Digital Object Identifier 10.1109/ACCESS.2020.2968741

Smart City IoT Platform Respecting GDPR Privacy and Security Aspects

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Department of Information Engineering, University of Florence, 50121 Florence, Italy
Corresponding author: Paolo Nesi (paolo.nesi@unifi.it)

This work was supported in part by the European Union's Horizon 2020 Research and Innovation Program under Agreement 688196.

ABSTRACT The Internet of Things (IoT) paradigm enables computation and communication among tools that everyone uses daily. The vastness and heterogeneity of devices and their composition offer innovative services and scenarios that require a new challenging vision in interoperability, security and data management. Many IoT frameworks and platforms claimed to have solved these issues, aggregating different sources of information, combining their data flows in new innovative services, providing security robustness with respect to vulnerability and respecting the GDPR (General Data Protection Regulation) of the European Commission. Due to the potentially very sensible nature of some of these data, privacy and security aspects have to be taken into account by design and by default. In addition, an end-to-end secure solution has to guarantee a secure environment at the final users for their personal data, in transit and storage, which have to remain under their full control. In this paper, the Snap4City architecture and its security solutions that also respect the GDPR are presented. The Snap4City solution addresses the full stack security, ranging from IoT Devices, IoT Edge on premises, IoT Applications on the cloud and on premises, Data Analytics, and Dashboarding, presenting a number of integrated security solutions that go beyond the state of the art, as shown in the platform comparison. The stress test also included the adoption of penetrations tests verifying the robustness of the solution with respect to a large number of potential vulnerability aspects. The stress security assessments have been performed in a piloting period with more than 1200 registered users, thousands of processes per day, and more than 1.8 million of complex data ingested per day, in large cities such as Antwerp, Helsinki and the entire Tuscany region. Snap4City is a solution produced in response to a research challenge launched by the Select4Cities H2020 research and development project of the European Commission. Select4Cities identified a large number of requirements for modern Smart Cities that support IoT/IoE (Internet of Things/Everything) in the hands of public administrations and Living Labs, and selected a number of solutions. Consequently, at the end of the process after 3 years of work, Snap4City has been identified as the winning solution.

INDEX TERMS End-2-end, GDPR, IoT, security, smart city.

I. INTRODUCTION

IoT (Internet of Thing) is becoming a disruptive technology, especially for city users of metropolitan areas. The pervasiveness of IoT Devices, integrated in common objects, is becoming increasingly deeper. The addresses' space for these devices would be enough to point any sensors of any devices at any moment without restrictions. Diffuse products that implement *Low-Power Wide Area Networks* (LPWAN) technologies for IoT introduced by SigFox and Semtech (LoRa, Long Range) have been gaining interest and have been under intense deployment campaigns worldwide [1]. At the same time, *short range* IoT devices (based on technologies such as IEEE 802.15.4 or Bluetooth Low Energy, BLE, [2]) are sold in increasing quantities and are already able to support scenarios for smart homes, energy metering and industrial automation. On the other hand, the start of the diffusion of *5G devices* and services is creating high expectations in networking IoT technologies, as the killer application of previous technologies in metropolitan areas.

The associate editor coordinating the review of this manuscript and approving it for publication was Adnan M. Abu-Mahfouz.

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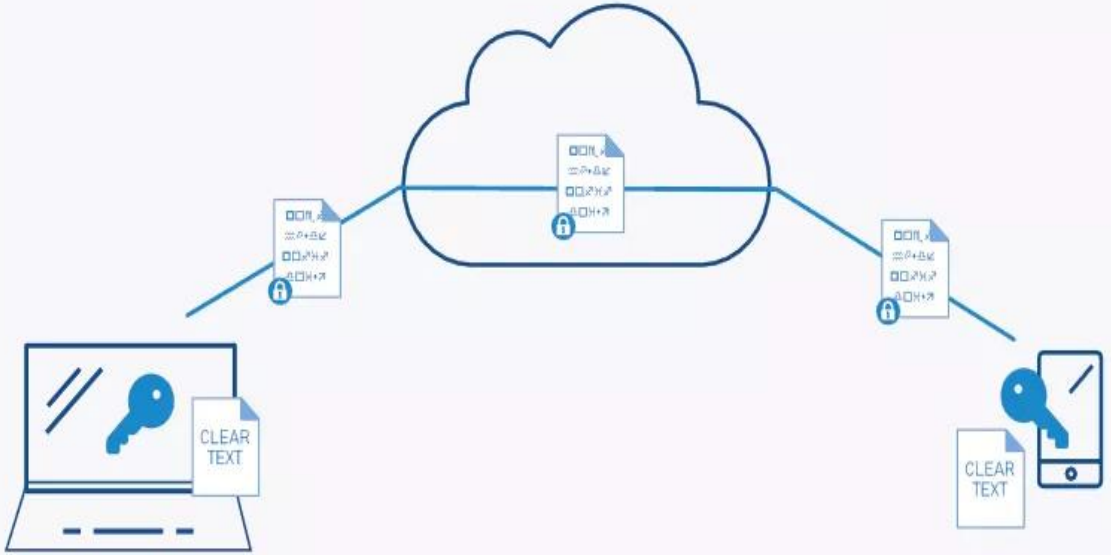
Considerations on Privacy and Security



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Sicurezza and privacy

- End-2-End security: dal **device alla Dashboard**
  - Canale protetto in modo da non permettere a nessuno di inserirsi nella catena di monitoraggio, comando e controllo, a livello di device
  - I dati possono essere privati, vanno gestiti in accordo al GDPR
  - Protocolli come: HTTPS, TLS
  - Uso di certificati.



- Lo **storage** adottato dovrebbe permettere di avere aree isolate e protette
- **L'interoperabilità**, è un requisito che puo' vincolare ad usare certi protocolli, non sempre con garanzia di protezione

Sicurezza and Privacy

- I processi delle **IOT Application, i processi NIFI, ETL, e di Data Analytics**, etc., possono dover accettare e/o accedere ad un data protetto o anche personali.
- Spesso i **processi vengono inseriti in Container** che ne possono aumentare la privacy e security.
  - I Container possono essere fragili visto che possono essere soggetti a riconfigurazione nel momento in cui sono migrati fra VM → implica avere sistemi di gestione sofisticati.
- Tutte le **versioni temporanee** dei dati che sono create dal batch processing nelle soluzioni Big Data sono ovviamente un problema per la Privacy e GDPR

Sicurezza

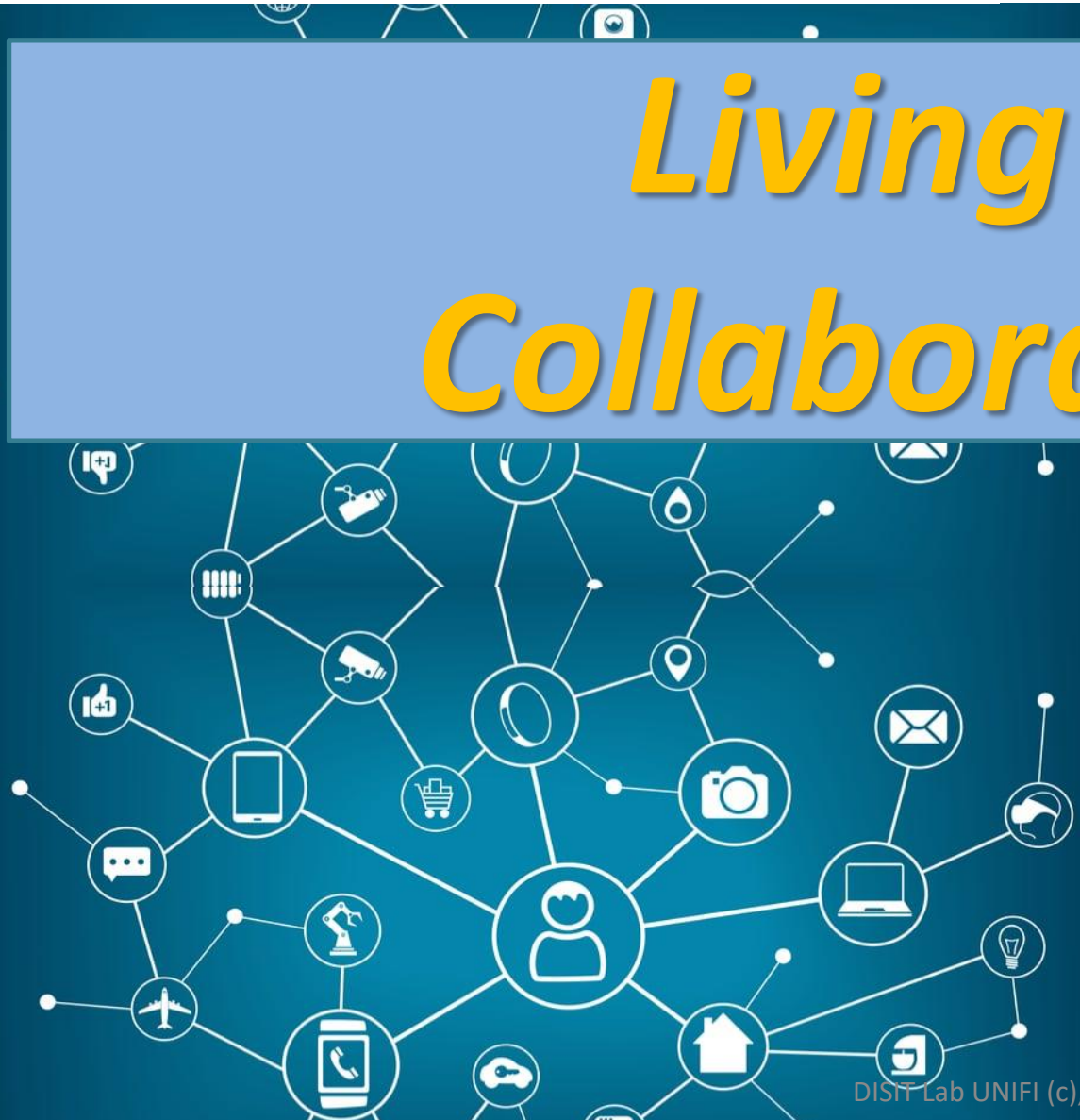
- La maggior parte dei **noSQL data base** non forniscono grandi soluzioni per la protezione, ma puo' essere possibile inserire i dati nello store encrypted data.
  - La maggior parte non gestiscono in modo nativo informazioni encrypted
  - Alcuni storage possono avere dei meccanismi di autenticazione e SSO.
  - La Maggior parte dei noSQL storage non garantiscono le licenze e non fanno enforcing.
  - In alcuni GraphDB e' possibile avere delle license e gestire l'accesso a livello grafo.

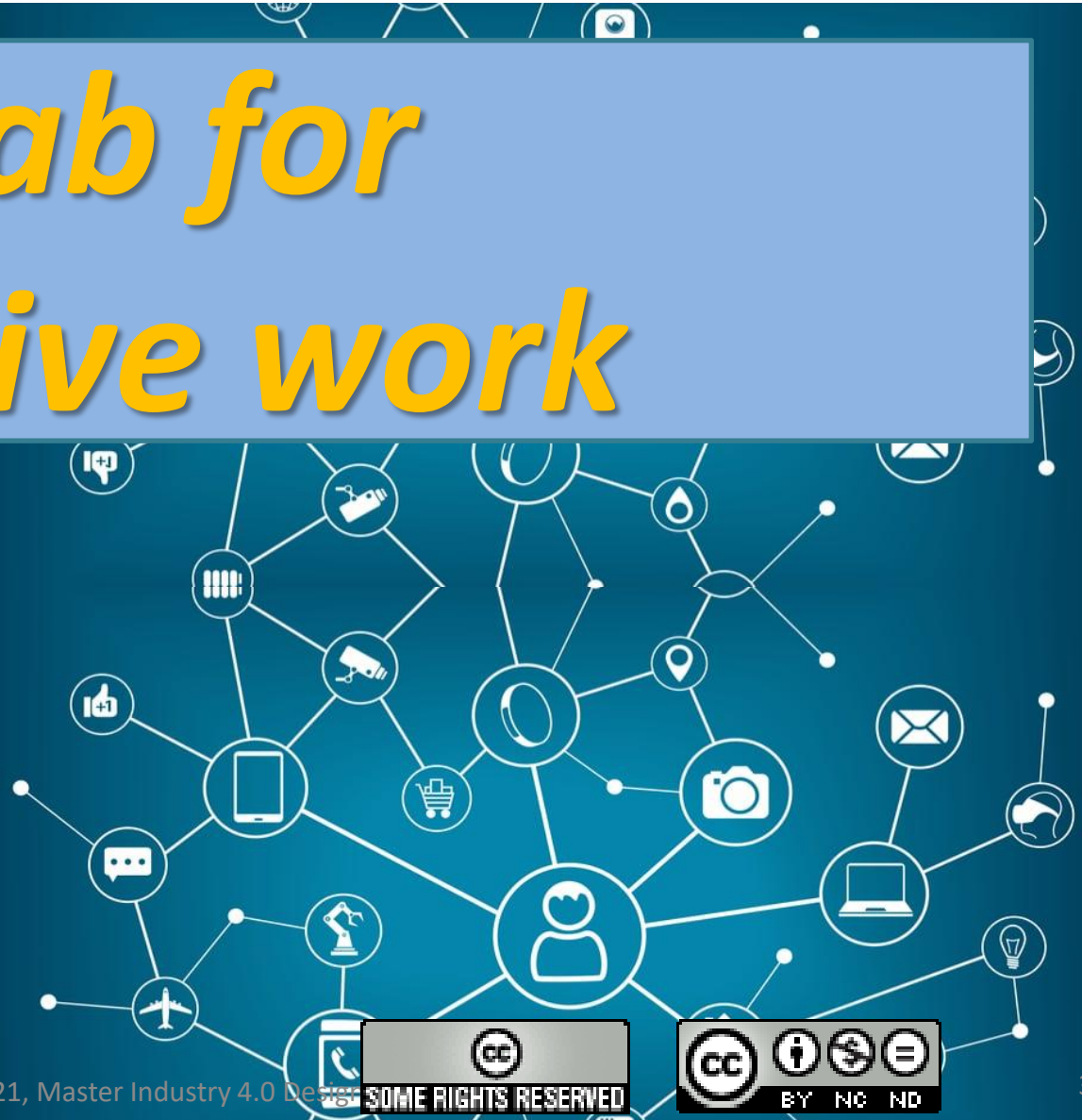
Conclusioni

- Big Data nel caso di Industria 4.0 spesso implica IOT/IOE

- Le problematiche presenti vanno inquadrate a livello di sistema, visto che le problematiche che emergono non possono essere risolte con tecniche tradizionali
  - Gli aspetti di Big Data, 3, 4, 5V fanno parte del problema
  - Gli aspetti IOT→ IOE fanno parte del problema
  - Security and Privacy vanno messe dentro By Design fin dalle prime fasi.

Living Lab for Collaborative work





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Agenda

- Big Data Architecture
- Data Warehouse
- Data Storage
- Data Processing
- Data Analytics
- Visual Analytics
- Dashboards
- **Living lab for Collaborative work**
- Deploy and Install Snap4 .. Solutions
- Acknowledgment



Snap4City has been Created to satisfy requirements of:

European Network of Living Labs

- **ENOLL**: https://www.openlivinglabs.eu/
  - European Network of Living Labs

EIP-SCC

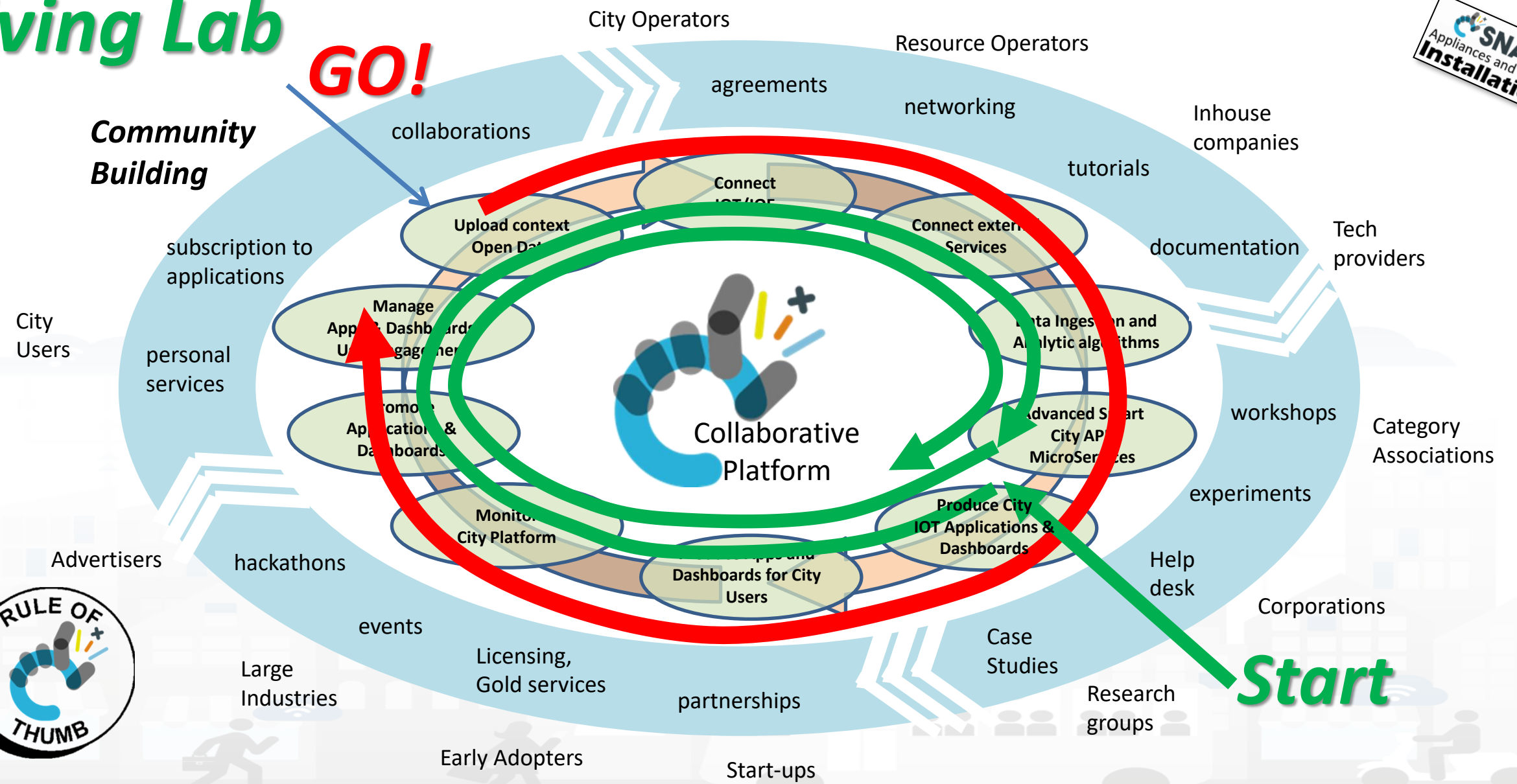
- **EIP-SCC**: European Innovation Partnership on Smart Cities and Communities
  - https://eu-smartcities.eu/

SELECT for Cities

- **Select4Cities**: Pre-Commercial Procurement Project to develop a data-driven, Internet-of-Everything (IoE) platform for large-scale urban co-creation
  - https://www.select4cities.eu/

Smart City Start Up vs Living Lab

GO!



SELECT

for Cities

CERTIFICATE OF ACHIEVEMENT

1° place award to

UNIVERSITY OF FLORENCE - DEPARTMENT OF INFORMATION ENGINEERING

for SNAP4CITY

for successfully completing the
SELECT for Cities PCP competition
19.11.2019

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 688196

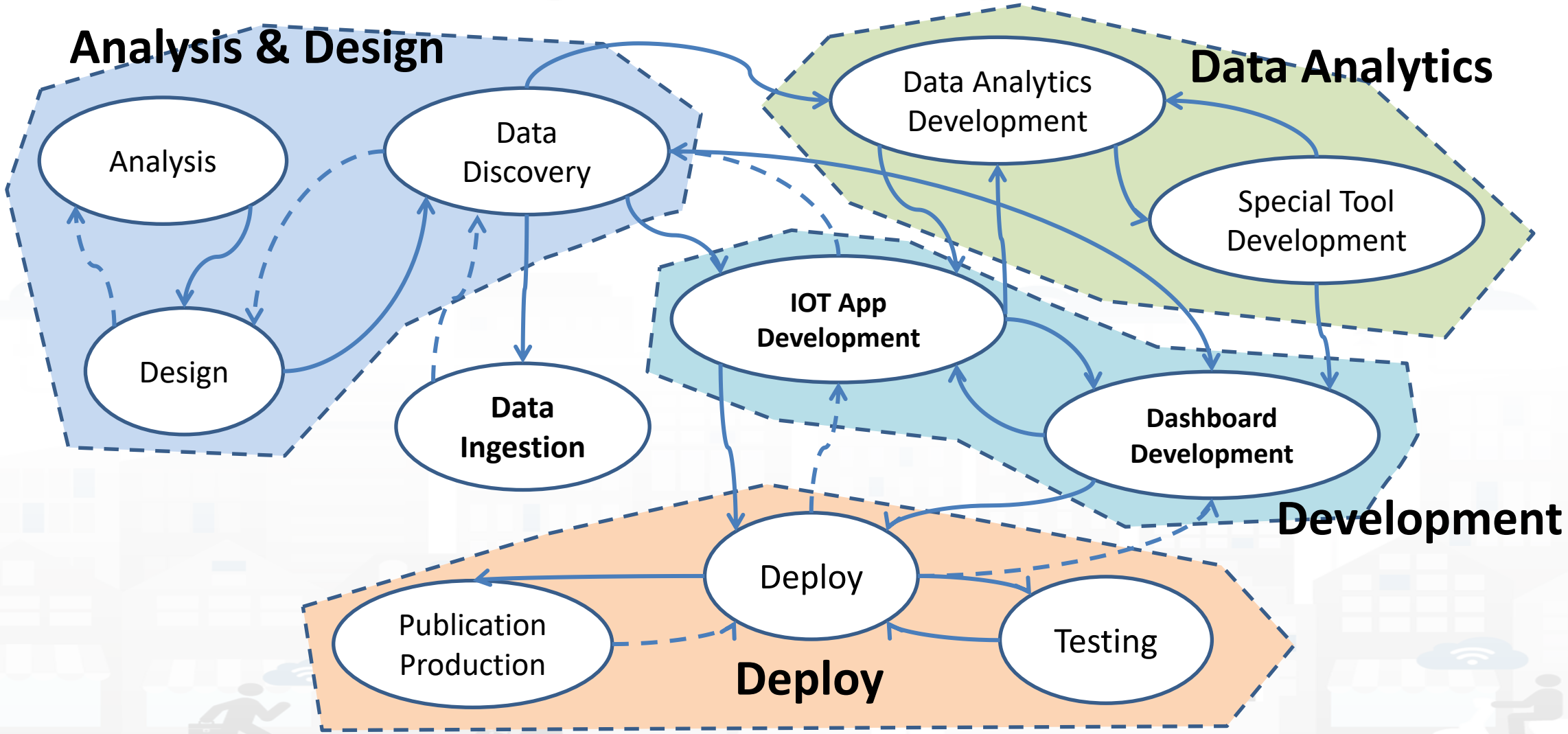
DIGIPOLIS
FORUM VIRIUM HELSINKI
CITY OF COPENHAGEN
Buyers Group

Development Life Cycle for IOT Applications

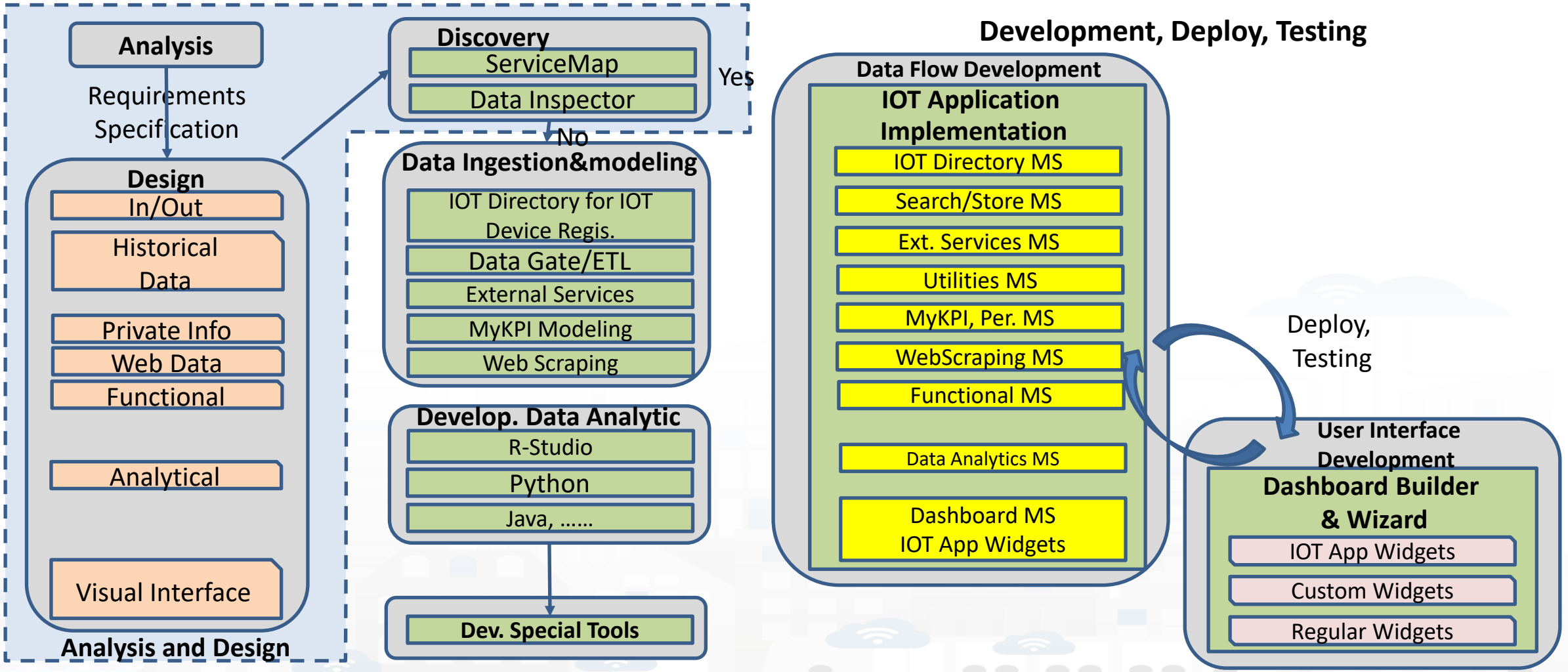


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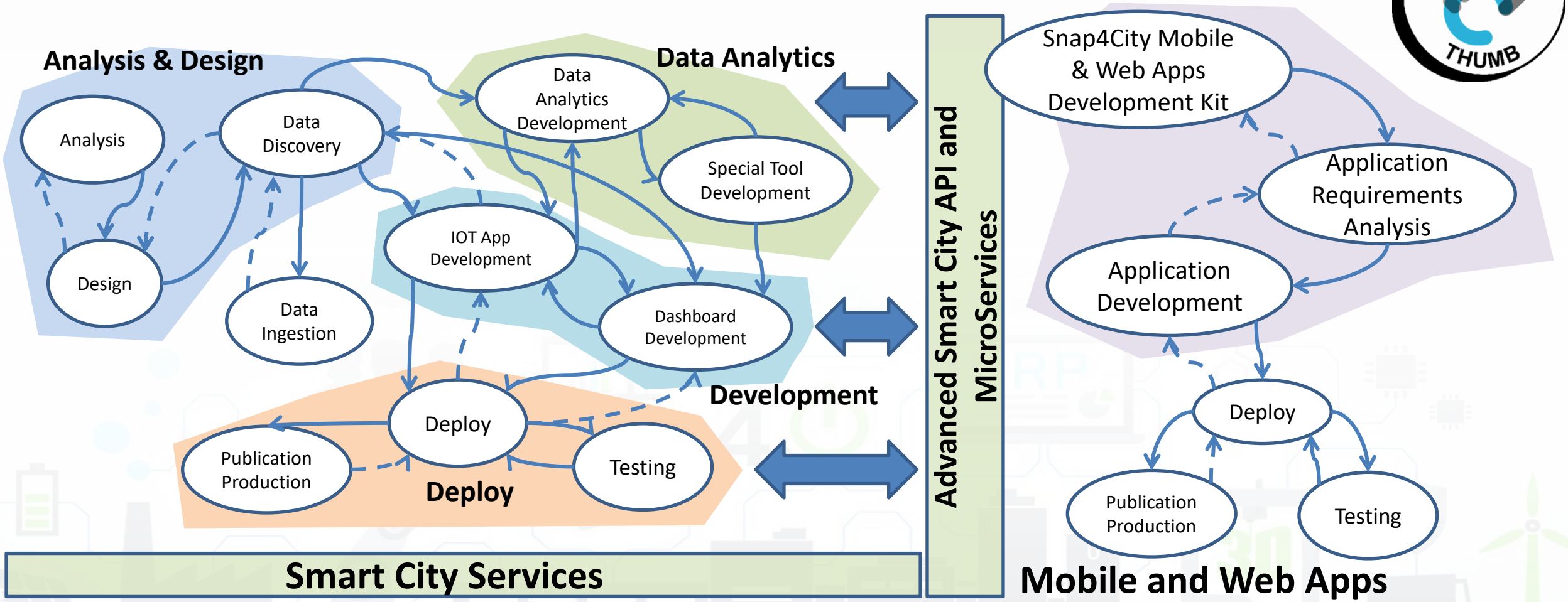
High level life cycle



Detailed Life Cycle



Develop Mobile & Web Applications Exploiting Snap4City Smart City Services



Deploy and Install Snap4… Solutions



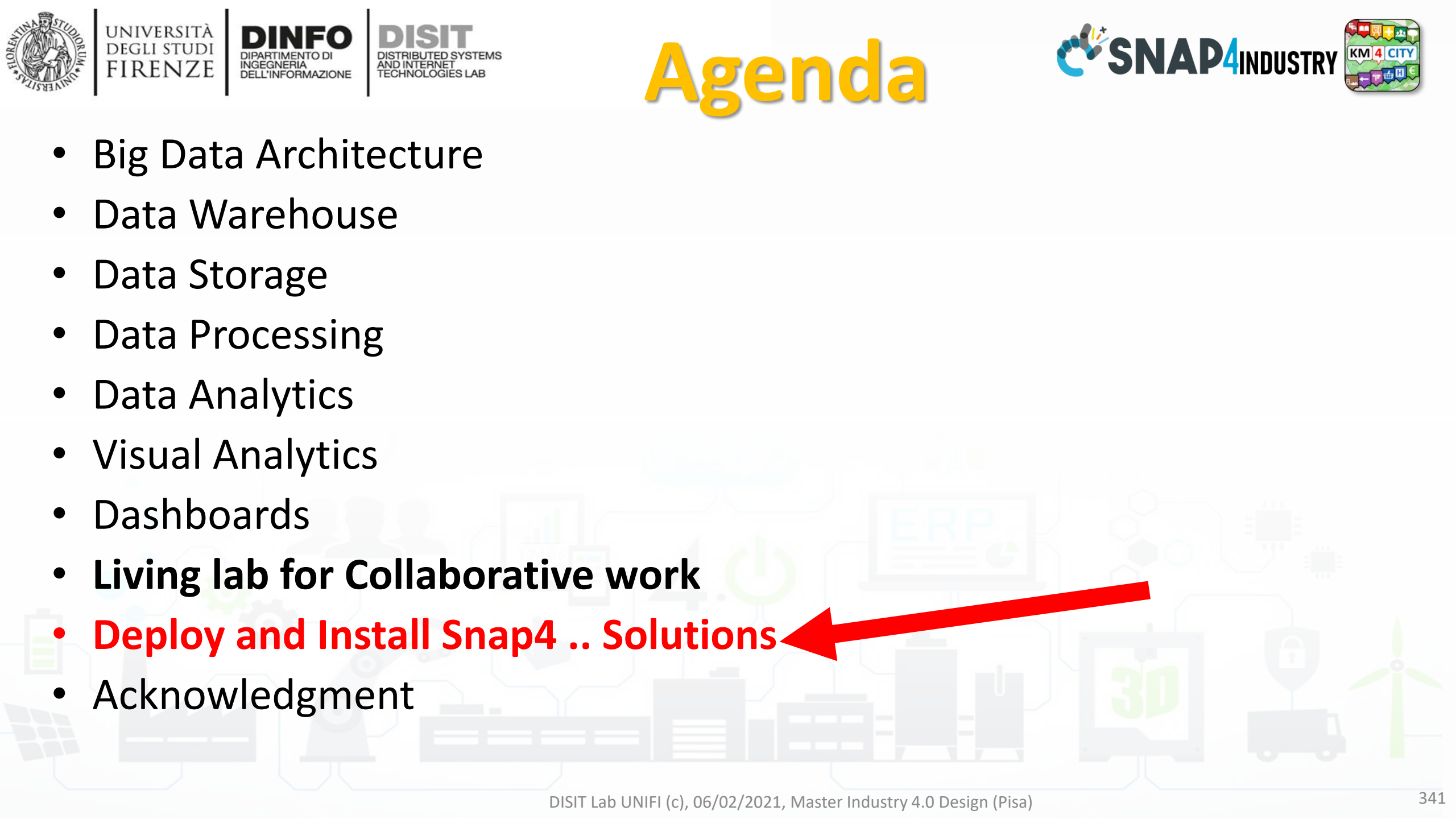
https://www.snap4city.org/471

To get an updated version read it!

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Smart City Functional Architecture

Transport systems Mobility, parking



Public Services, Govern, events, …



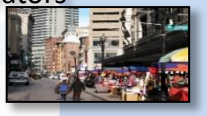
Sensors, IOT Cameras, Wi-Fi



Environment, Water, energy



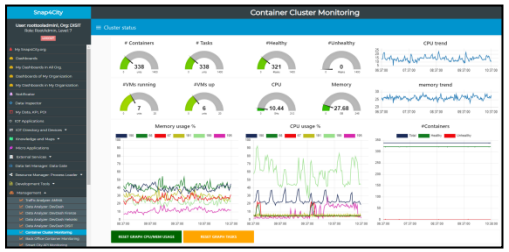
Shops, services, operators

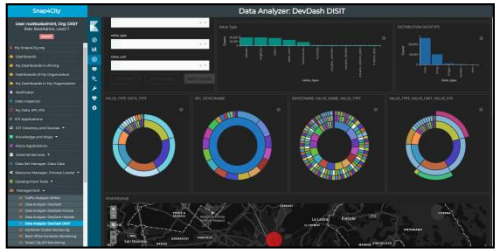


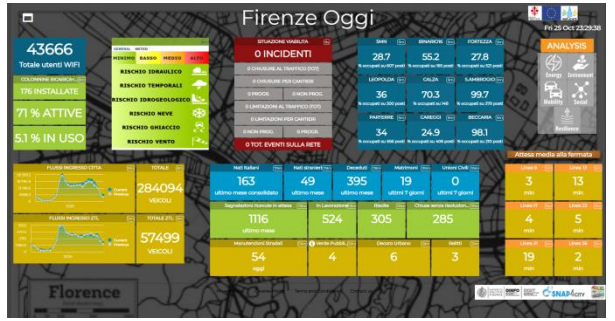
Social Media

Social Media Crawler and Manager









Data Sources PULL Data

Data Sources, Brokers, External Services Data Driven, Real Time

Data Ingestion, aggregation, regularization, reconcile ETL, NIFI, DISCES

Big Data Cluster HDFS, Hbase, Phoenix

Knowledge base Semantic reasoners

Indexing and aggregating Elastic search

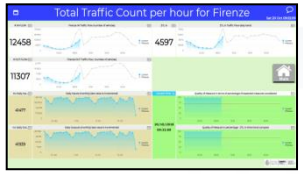
Data Analytics R, Tensor Flow, Python, MapReduce, …

IOT Applications Node-RED + Snap4City MicroSrvs

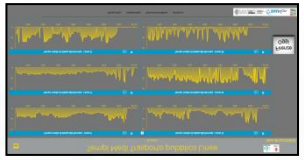
Search and Query, Smart City API Facet, semantic search

Visual Analytics Special dash/ tools

Rendering Acting, Widgets, MicroApps User interface, Interactive Dashboard, Drill down, maps, heatmaps

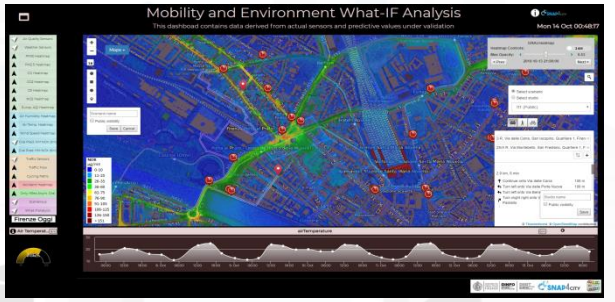






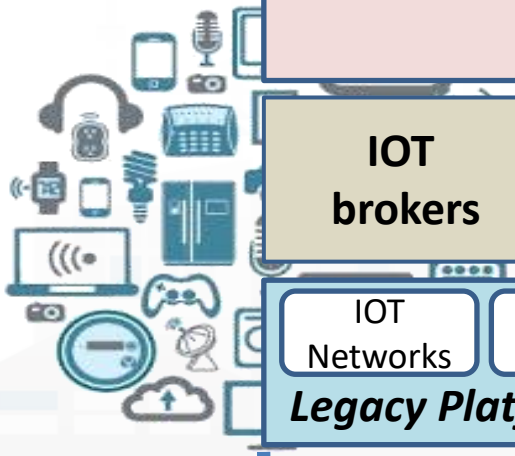






Inform, announce, Act!, warning, alarms, What-IF, ..

Overview of Snap4City platform, for Buyers, for all



Other Services And Servers

Cluster for Smart Processes container: ingestion, analytics, scraping, etc.

Cluster for big data storage: static and real time, Indexing and search

IOT brokers

IOT Networks | Social Media | CRM | ..... | GIS

Legacy Platform

Back End

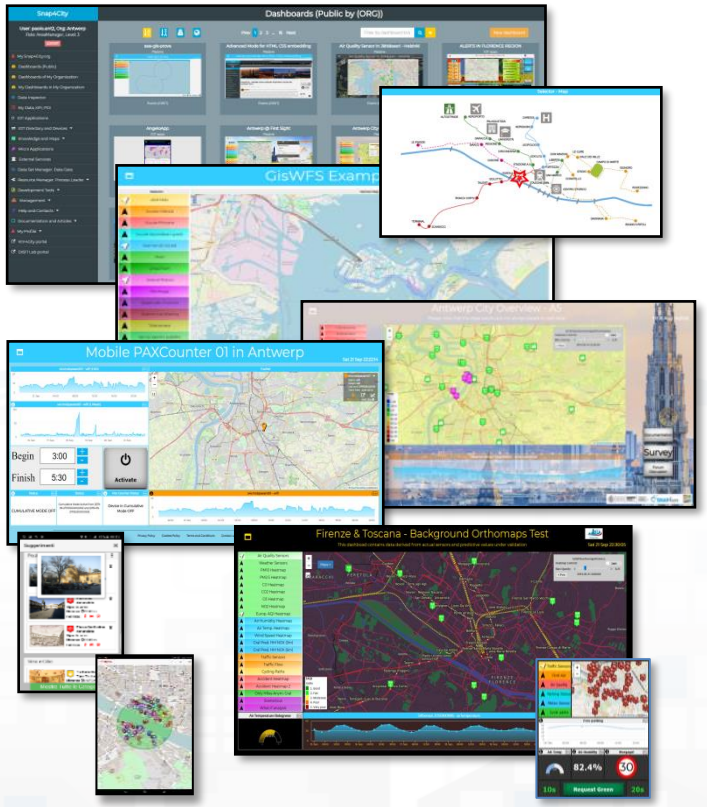
Snap4City MAIN
Dashboard, User Management, etc.

Knowledge base, semantic Store

HeatMaps and Maps

Living Lab Portal

Front End



Mobile Apps, Dashboards

Overview of Snap4City platform, for Buyers, for all

Services
- CKAN DataGate
- Routing Server
- Chat Manager
- R Studio Server
- ETLSDK Server
- Engager Server
- ……. Server

Container Cluster
MCLSCont, NCLSCont
Marathon, Mesos, Zookeeper, Disces-EM, Executing in Container: IOT App, Web Scraping, R-Studio, Python, Java, ETL, ...

[DataCluster]
ETL-VM
Phoenix HBASE, HDFS DISCES, ETL support

IOTOBSFs
- IOTBrokers, secure

Data Shadow Cluster
IOTDSES
NIFI, Elastic Search, DevDash, Amma

IOT Networks | Social Media | CRM | ….. | GIS

Legacy Platform

Back End

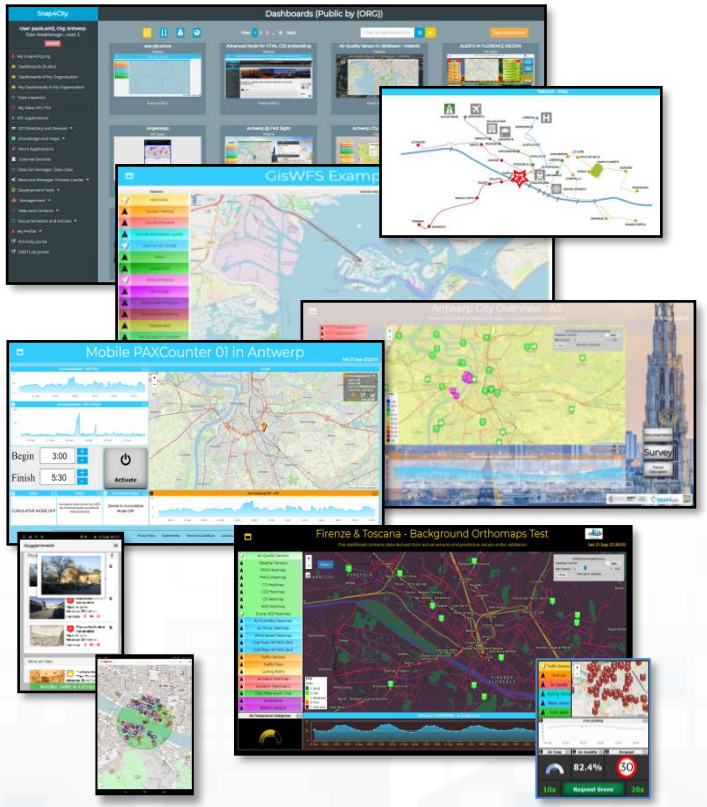
Snap4City MAIN
Dashboard Builder, Data Inspector, User Stats, ExternalSrv, Res Manager, MyKPI, MyPOI, Synoptic, IOT Device Manager, Micro Applications, Authorization/ Authentication, Roles, …

KBSSM
KB/ServiceMap, .. SmartCity API, WFS, ServiceMap3D, LOG/FLINT, SuperServiceMap, Virtuoso

GISGeoServer
Heatmap Manager, WFS, WMS

Living Lab Portal
Drupal support CRM, ..

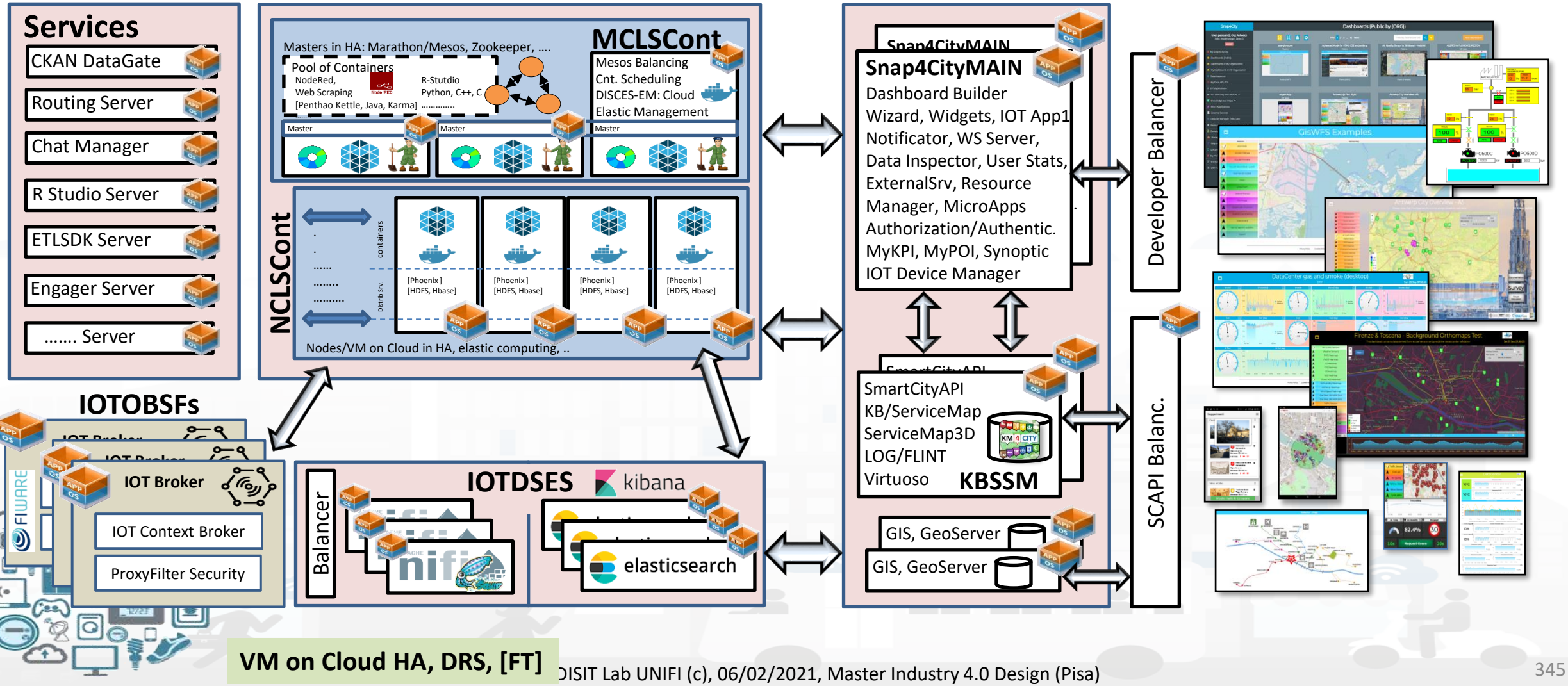
Front End



Mobile Apps, Dashboards

RULE OF THUMB

F: FullPlatform) For Huge scale Smart City with a Huge number of smart applications and processes on cloud (thousands), any number of IOT brokers



Acknowledgment

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DISIT lab roadmap vs model and tools' usage

2013
Km4City Ontology 1.1

- Tuscany, Road Graph
- Mobility
- culture, tourism
- Events
- Parking
- Services
- Linked open graph

2014
- Weather Forecast
- Real Time Wi-Fi
- Entertainment
- LOD

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015
Km4City 1.5

- Resilience Decision Support
- Smart First Aid
- User Behaviour Analysis, predictions
- Risk Analysis

ckan, resolute

H2020 (2015-18)

2016
(2016-21) H2020 REPLICATE

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

Sii-Mobility (2016-21) MIUR

SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

FIWARE

2017
Km4City 1.6.4

Sii-Mobility

- Origin-Destination and trajectories
- Traffic Reconstruction
- Offer Analysis
- OBU, smart devices

E0l5 digital ecosystem (Powered by EXPO MILANO 2015)

(2016-19) MIUR GHOST SIR

- Sardinia Region Smart City Strategies and plan

GREEN IMPACT C.A.P.A.C.I.T.Y.

GREEN IMPACT
POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

- IOT/IOE, IOT App
- Living Lab
- Maker Support
- IOT Edge
- Smart City IOT
- GDPR,
- Privacy & Security

life weee (2017-20)

- Smart Waste

2018
MOSAiC MObility 4.0 for SmArt (i) CiTy (2018-20)

- Mobility Demand / Offer Analytics and Strategy

Sii-Mobility

- User engagement
- Bike Sharing
- Data Analytics ++
- Social Predictions
- OBD2

IOT/IOE

Km4City 1.6.6

Node-RED

SNAP4CITY SELECT for Cities H2020 (2017-19)

2019
5G (2018-21)

- 5G tech
- Energy
- Industry 4.0
- Synoptics

TRAFAIR CEF (2018-21)

- Traffic and Mobility Impact on Pollution
- NOX predictions

EUROPEAN OPEN SCIENCE CLOUD

SIRIUS

LAID Smart Bed

- Smart Health

GREEN FIELD PEAS Soda4.0 (Optimization and Automated Decision System 4.0)

- Industry 4.0

bee smart city

- Smart Lonato

Reverberi Enetec Gruppo MPES

- PCP Award

SELECT for Cities 1° place award to SNAP4CITY

2020
- Smart Tourism
- 6 Pilots
- Data Analytics
- Extended platform

2021
- CAPELON
- Sweden

smartGARDAlake

Interreg MARITTIMO-IT FR-MARITIME MOBI MART

- Smart Mobility
- PISA, PUMS
- Living lab

Interreg Mediterranean HERIT-DATA

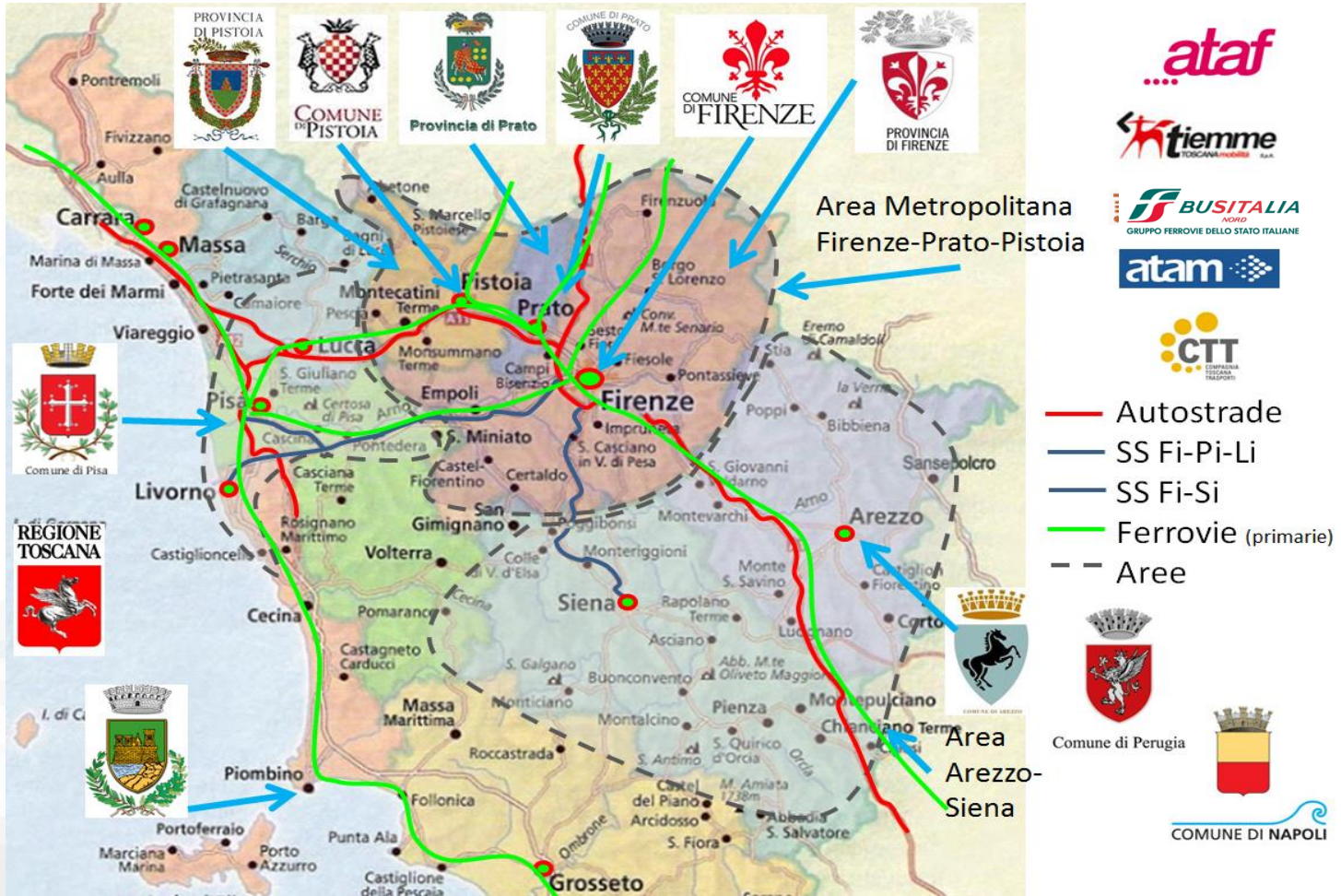
…2022

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

Sii-Mobility

http://www.Sii-Mobility.org

- *Experimentations and validation in Tuscany*
- *Integration with present central station and subsystems*
- *DISIT lab, Università di Firenze, is the tech-scientific coordinator*



ECM; Swarco Mizar; Inventi In20; Geoin; QuestIT; Softec; T.I.M.E.; LiberoLogico; MIDRA (autostrade, motorola); ATAF; Tiemme; CTT Nord; BUSITALIA; A.T.A.M.; Effective Knowledge; eWings; Argos Engineering; Elfi; Calamai & Agresti; Project; Negentis

UNIVERSITÀ DEGLI STUDI FIRENZE
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Sii-Mobility

http://www.Sii-Mobility.org

MIUR MINISTERO DELL'ISTRUZIONE DELL'UNIVERSITÀ E DELLA RICERCA

KM 4 CITY

Commenti dei cittadini, Social Media





AVM trasporto Pubblico

Merci







Sensori su trasporto Privato



Sensori, sistema monitoraggio

Sensori Parcheggi





UTC





Infomobility





Varchi Telematici, ZTL

Monitoraggio traffico, autostrade





Rete Ferroviaria



Parametri ambientali



Servizi ed enti



Ordinanze: eventi, lavori pubblici, ..



Emergenze, polizia, 118



General Objectives

http://www.Sii-Mobility.org

- Reduce the social costs of mobility
  - minor inconvenience,
  - greater efficiency,
  - greater sensitivity to the needs of the citizen,
  - lower emissions,
  - better environmental conditions;
  - info-training programs to help city user in getting virtuous habits;
  - reduce transportation costs and travel times for users, for operators and administrations,
  - optimization solutions.
- **simplify the use of mobility systems**
  - innovative sensors for AVM and private transport on the territory
  - integrated systems for payment and identification
  - driving / offline routing solutions
  - connect the drive, smart drive or walk
  - Integration of data from operators and different type sources
  - advanced management of resources measurement of flows realization of sensors, actuators
- **Testing on municipalities and provinces of Tuscany**
- **Contribute to the improvement of national and international standards**

REPLICATE

Horizon 2020
European Union Funding
for Research & Innovation

REnaissance of PLaces
with Innovative Citizenship
And TEchnology

http://replicate-project.eu/

- demonstrate Smart City technologies in energy, transport and ICT in districts in:
  - San Sebastian, Florence and Bristol,
  - follower cities of Essen, Nilufer and Lausanne
- Cities are the customer: considering local specificities
- Solutions must be replicable, interoperable and scalable.
  - Integrated Infrastructure: deployment of ICT architecture, from internet of things to applications
  - Low energy districts
  - Urban mobility: sustainable and smart urban services

1 (coordinator) FOMENTO DE SAN SEBASTIAN FSS SPAIN
2 AYUNTAMIENTO DE SAN SEBASTIAN SAN SEBASTIAN SPAIN
3 COMUNE DI FLORENCE FLORENCE ITALY
4 BRISTOL COUNCIL BRISTOL UNITED KINGDOM
5 STADT ESSEN ESSEN GERMANY
6 NILUFER BELEDIYESI NILUFER TURKEY
7 VILLE DE LAUSANNE LAUSANNE SWITZERLAND
8 IKUSI ANGEL IGLESIAS, S.A. IKUSI SPAIN
9 ENDESA ENERGÍA, S.A. ENDESA SPAIN
10 EUROHELP CONSULTING, S.L. EUROHELP SPAIN
11 ILUMINACION INTELIGENTE LUIX, S.L. LUIX SPAIN
12 FUNDACION TECNALIA RESEARCH & INNOVATION TECNALIA SPAIN
13 EUSKALTEL, S.A. EUSKALTEL SPAIN
14 COMPAÑÍA DEL TRANVÍA DE SAN SEBASTIÁN DBUS SPAIN
15 CONSIGLIO NAZIONALE DELLE RICERCHE CNR ITALY
16 ENEL DISTRIBUZIONE, SPA ENEL ITALY
17 MATHEMA, SRL MATHEMA ITALY
18 SPES CONSULTING SPES ITALY
19 TELECOM ITALIA, SPA TELECOM ITALY
20 UNIVERSITA DEGLI STUDI DI FLORENCE UNIFI ITALY: DINFO.DISIT Lab and DIEF
21 THALES ITALIA, SPA THALES ITALY
22 ZABALA INNOVATION CONSULTING ZABALA SPAIN
23 TECHNOMAR TECHNOMAR GERMANY
24 UNIVERSITY OF BRISTOL UOB UNITED KINGDOM
25 UNIVERSITY OF OXFORD UOXF UNITED KINGDOM
26 BRISTOL IS OPEN, LTD BIO UNITED KINGDOM
27 ZEETTA NETWORKS ZEETTA UNITED KINGDOM
28 KNOWLE WEST MEDIA CENTRE, LGB KWMC UNITED KINGDOM
29 TOSHIBA RESEARCH EUROPE, LTD TREL UNITED KINGDOM
30 ROUTE MONKEY, LTD ROUTE MONKEY UNITED KINGDOM
31 ESOTERIX SYSTMES, LTD ESOTERIX UNITED KINGDOM
32 NEC LABORATORIES EUROPE, LTD NEC UNITED KINGDOM
33 COMMONWHEELS CAR CLUB CIC CO-WHEELS UNITED KINGDOM
34 UNIVERSITY OF THE WEST OF ENGLAND UWE UNITED KINGDOM
35 ESADE BUSINESS SCHOOL ESADE SPAIN
36 SISTELEC SOLUCIONES DE TELECOMUNICACION, S.L. SISTELEC SPAIN

DISIT Lab
(Pisa)



Horizon 2020
European Union Funding
for Research & Innovation

http://www.resolute-eu.org

- Develop European Resilience Management Guidelines (ERMG)
  - Develop a conceptual framework for creating/ maintaining Urban Transport Systems
- Enhance resilience through improved support of human decision making processes, particularly by training professionals and civil users on the ERMG and the RESOLUTE system
- Operationalize and validate the ERMG by implementing the RESOLUTE Collaborative Resilience Assessment and Management Support Systems (CRAMSS) for Urban Transport Systems addressing Road and Urban Rail Infrastructures
  - Pilots in Florence and Athens
- Adoption of the ERMG at EU and Associated Countries level

University of Florence: DISIT lab DINFO (Proj coordinator), DISIA and DST	UNIFI	IT
THALES	THALES	IT
ATTIKOMetro	ATTIKO	GR
Comune di Firenze	CDF	IT
Centre for Research and Technology Hellas	CERTH	GR
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.	FHG	DE
HUMANIST	HUMANIST	FR
SWARCO Mizar	SWMIZ	IT
Associação para o Desenvolvimento da Investigação no Instituto Superior de Gestão	ADI-ISG	PT
Consorzio Milano Ricerche	CMR	IT

http://trafair.eu/

TRAFAIR

Understanding Traffic Flows to Improve Air quality

- **Objective:**
  - to develop a service that **combines traffic data on air quality**, weather conditions, and traffic flows in order to allow citizens and municipalities to estimate the level of pollution resulting from varying traffic flow conditions.
- **Where:**
  - **Zaragoza, Florence, Modena, Livorno, Santiago de Compostela, and Pisa**

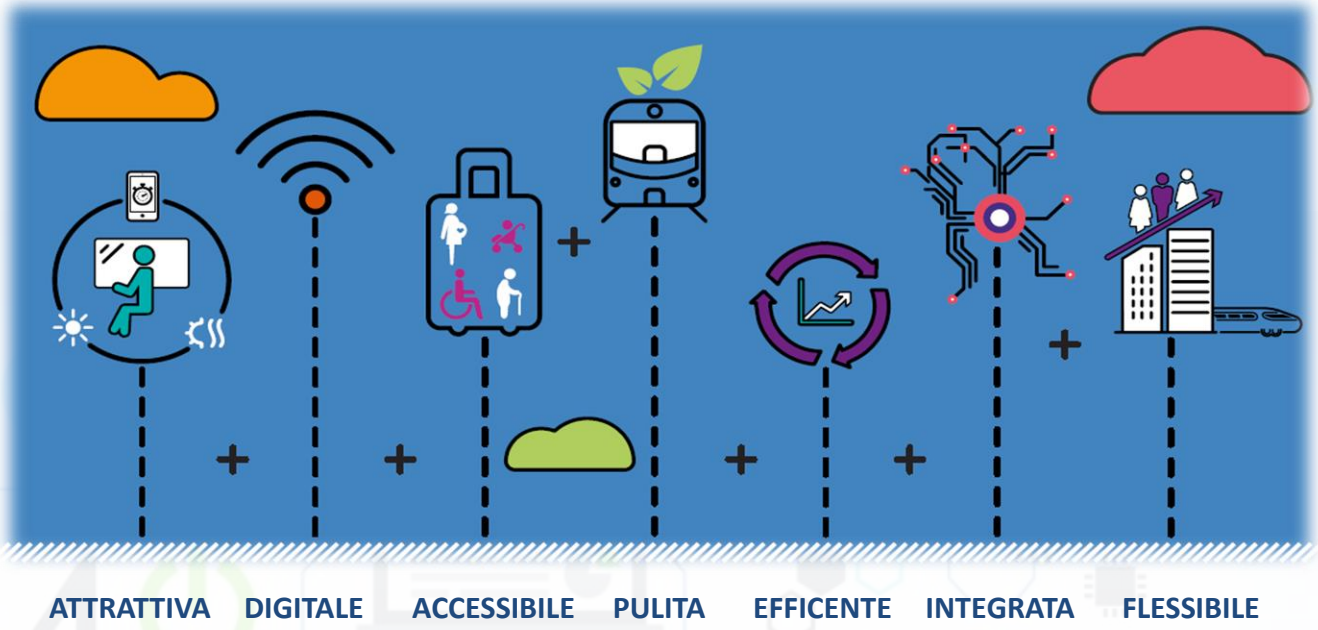
- Università degli studi di Modena e Reggio Emilia (UNIMORE) -- Italy
- **Università degli Studi di Firenze – DISIT DINFO -- Italy**
- Universidade de Santiago de Compostela (USC) - Spain
- Comune di Modena (CMO) - Italy
- Regione Toscana (TR) - Italy
- Concello de Santiago de Compostela (CSC) - Spain
- Fundación Pública Gallega Centro Tecnológico de Supercomputación de Galicia (Fundacion CESGA) - Spain
- Universidad de Zaragoza (UNIZAR) - Spain
- Lepida S.p.A. (LP) - Italy

MObility 4.0 for SmArt (i) City

Tools for Mobility operators

- Demand Analysis
- Prediction on Parking
- Connected Drive
- Offer Analysis
- Simulation of Mobility
- Etc.

Where: in Tuscany



ALSTOM Kiunsys Move on! UNIVERSITÀ DEGLI STUDI FIRENZE
TAGES devitalia Telecomunicazioni cnit

WEEE: Waste from Electrical and Electronic Equipment

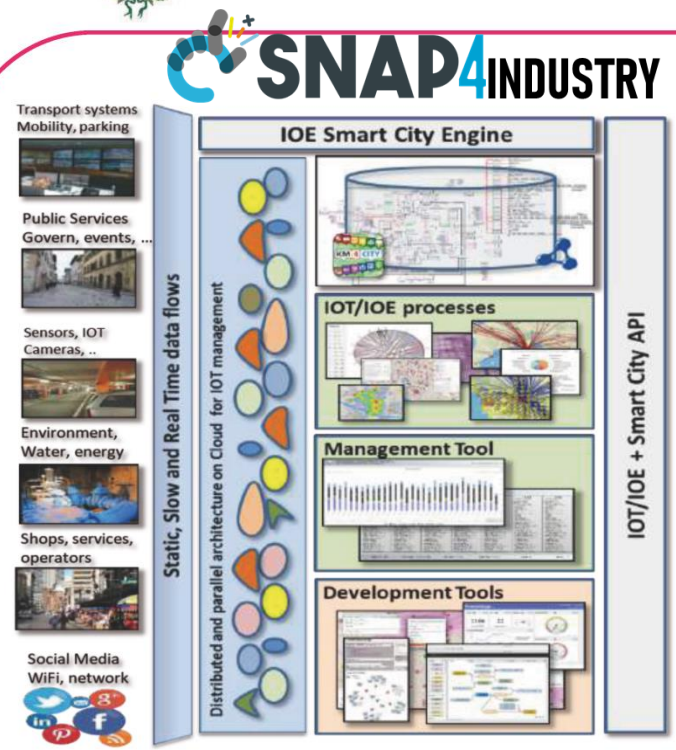
- **maximize the collection of WEEE** in Tuscany through a new governance model based on the involvement of SMEs and awareness raising activities towards citizens and its **replication in Andalucía**.
- Actions:
  - Improve the regional governance
  - Support municipalities in capacity building of public officials and improving services to citizens.
  - Develop a system of **services and incentives for SMEs**
  - Develop IT tools for companies and citizens: a **software** and **guidelines** for the simplification of administrative and bureaucratic activities and an **App** to easily locate collection sites.
  - Develop an awareness raising **information campaign** to increase public attention on the topic.
  - Test the **replicability and transferability** of project results through the implementation of actions in the Region of Andalucía.

http://www.regione.toscana.it/-/life-weee

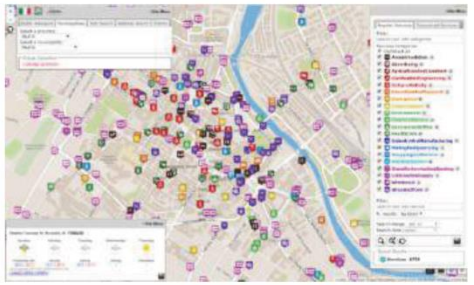
SENSORI E IOT - PRATO

Piattaforma IoT/IoE abilitata dal 5G per applicazioni di:

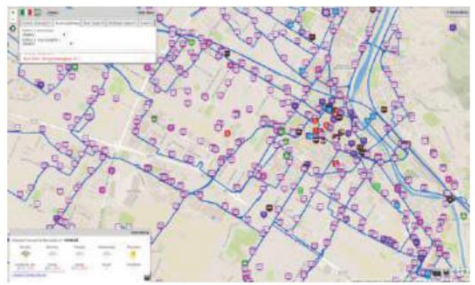
- Smart City management (in ottica Smart City)
- monitoraggio utenze in modo smart
- industrial automation (in ottica Industria 4.0)







Punti di interesse e servizi su Prato

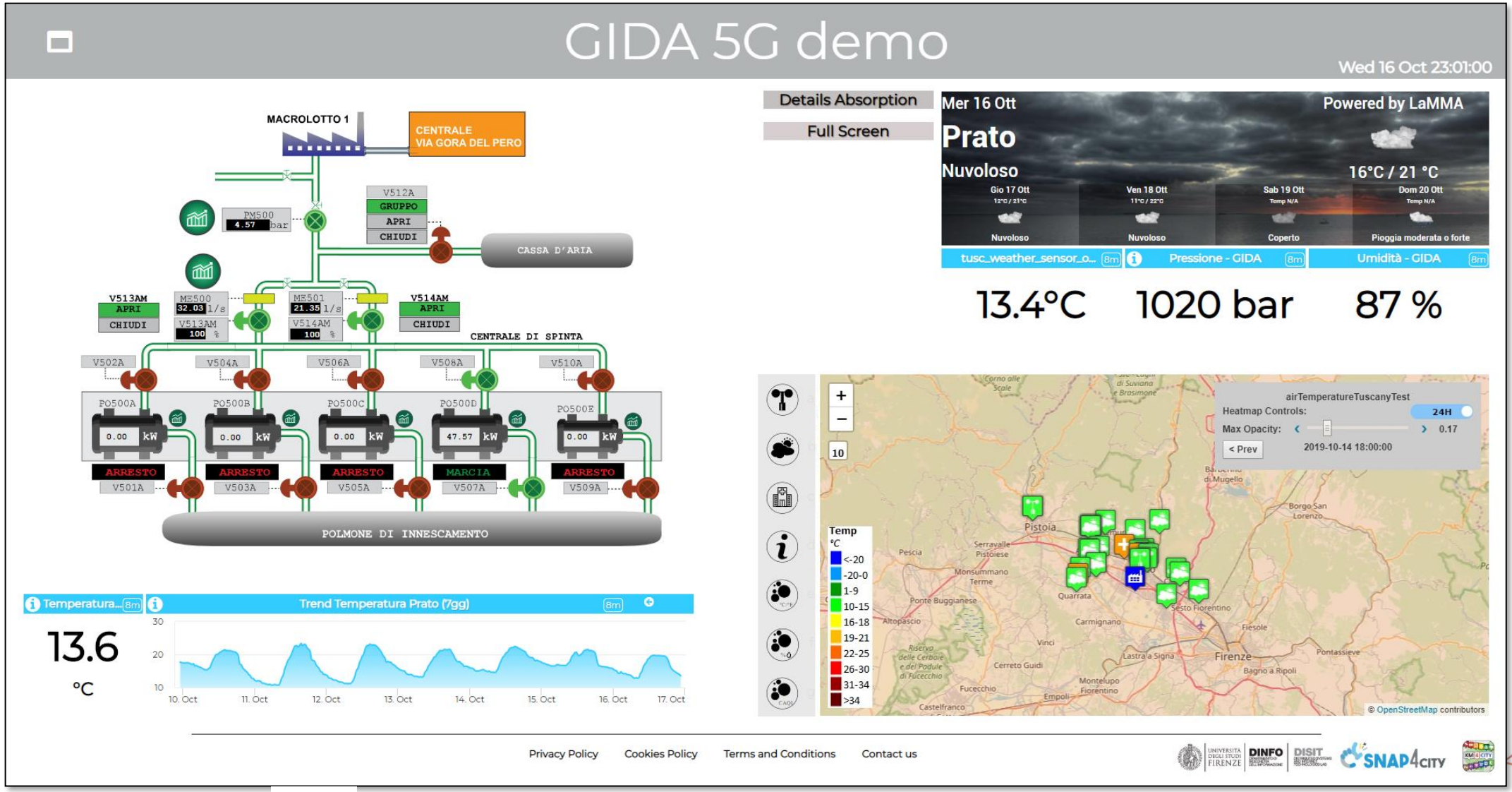


Use Case LEADER estra

Partner coinvolti open fiber, ZTE Leading 5G Innovations, Università degli Studi Firenze, cellnex driving telecom connectivity, SSE Sirio Sistemi Elettronici, PIN - Polo Universitario Città di Prato

Aziende/Enti Coinvolti Qualcomm, Interporto della Toscana Centrale, Unione Industriale Pratese Confindustria Prato, centria Reti Gas, Publiacqua, GIDA, Programma Ambiente

Dashboards & Services:



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjIyNg==

Green Impact Capacity (GIC)

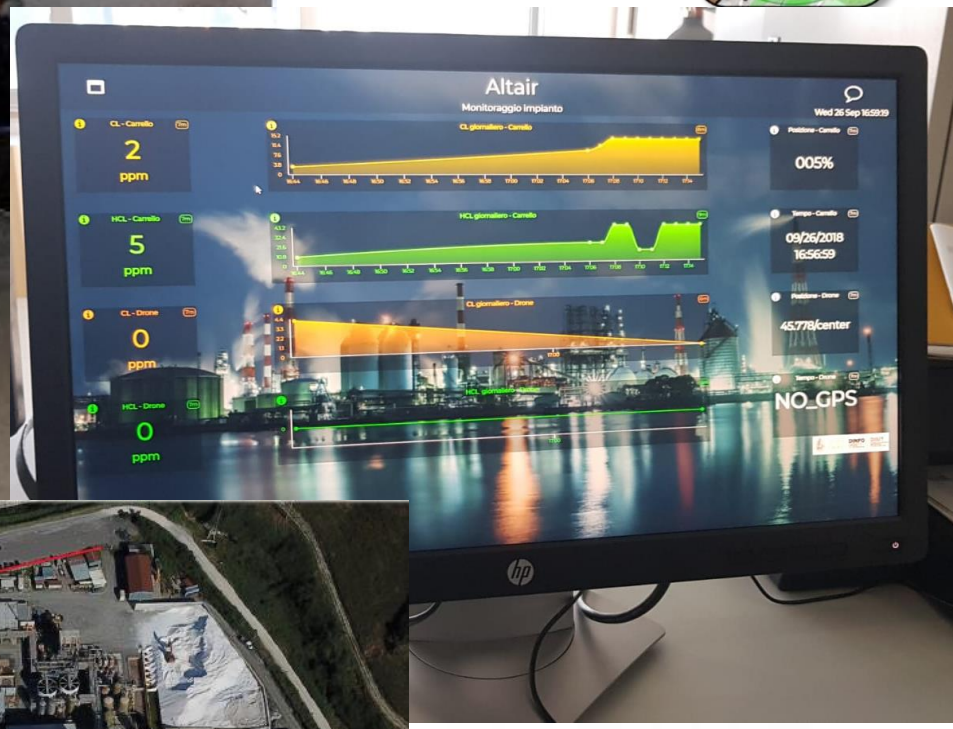




- Improve productivity of chemical plant
- Keep GREEN the environmental impact
- Exploiting innovative technologies
- Diversify the production
- Monitoring environmental conditions





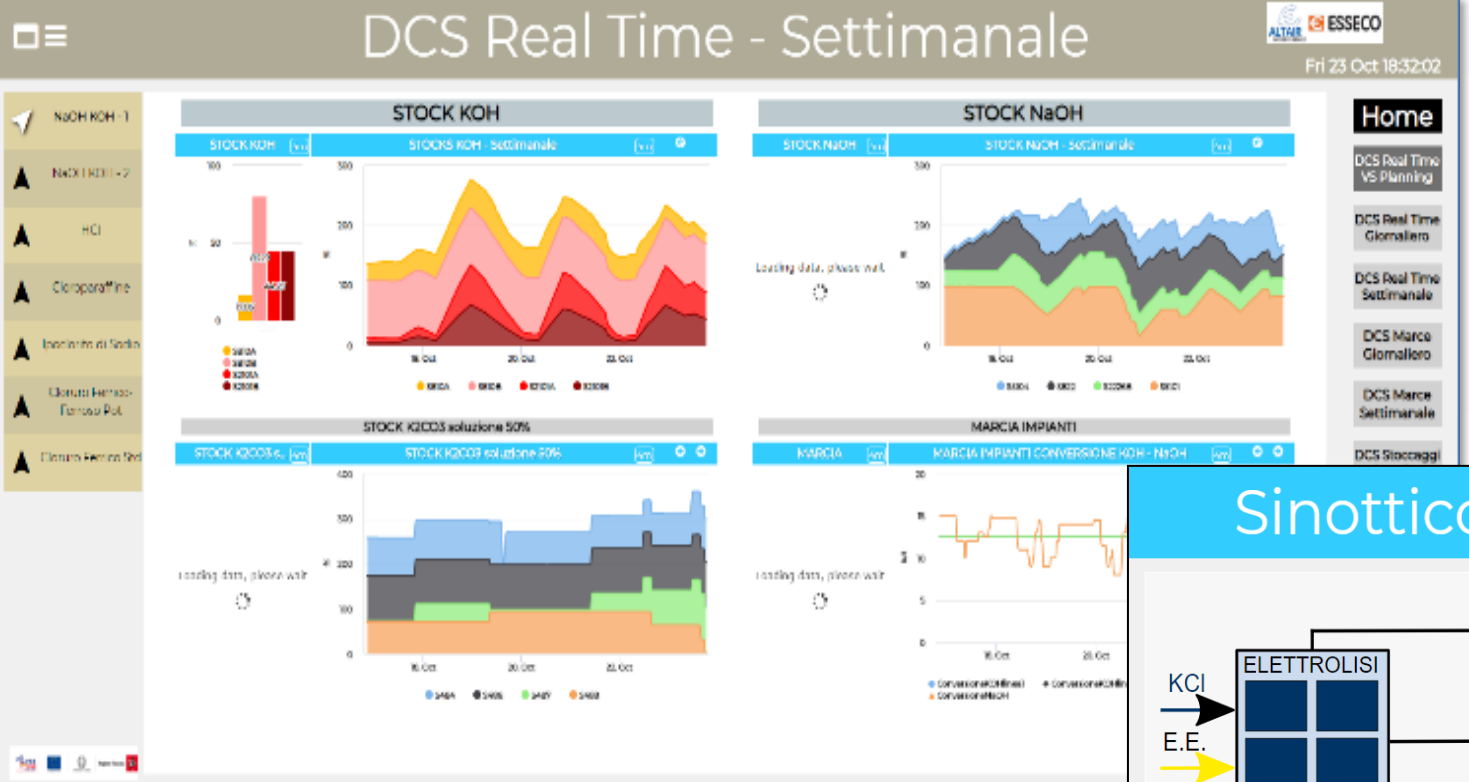


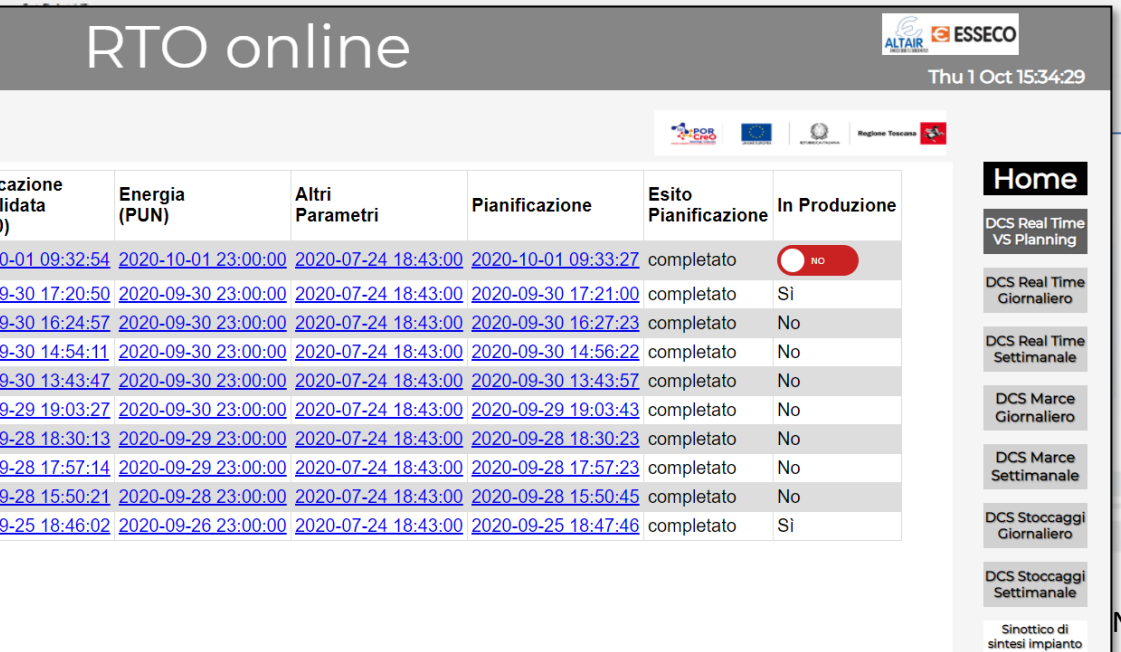


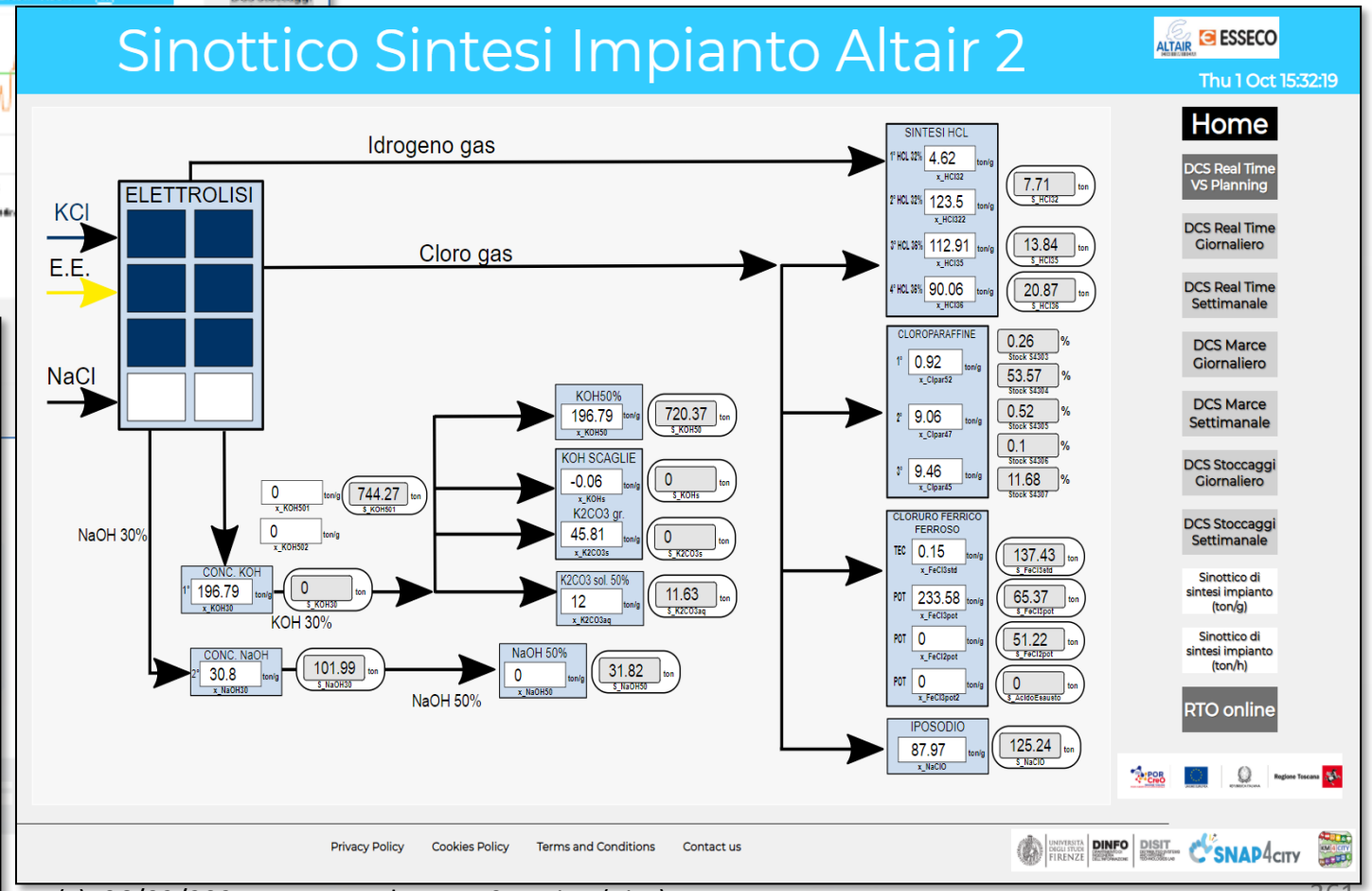
Green Impact Capacity (GIC)

Altair Control room

SNAP4INDUSTRY


DCS Real Time - Settimanale
ESSECO
Fri 23 Oct 18:32:02
STOCK KOH
STOCK NaOH
STOCK K2CO3 soluzione 50%
MARCIA IMPIANTI
Home
DCS Real Time VS Planning
DCS Real Time Giornaliero
DCS Real Time Settimanale
DCS Marce Giornaliero
DCS Marce Settimanale
DCS Stoccaggi


RTO online
ESSECO
Thu 1 Oct 15:34:29
Energia (PUN)
Altri Parametri
Pianificazione
Esito Pianificazione
In Produzione
2020-10-01 23:00:00
2020-07-24 18:43:00
completato
NO
2020-09-30 23:00:00
Sì
No
2020-09-29 23:00:00
2020-09-28 23:00:00
Home
DCS Real Time VS Planning
DCS Real Time Giornaliero
DCS Real Time Settimanale
DCS Marce Giornaliero
DCS Marce Settimanale
DCS Stoccaggi Giornaliero
DCS Stoccaggi Settimanale


Sinottico Sintesi Impianto Altair 2
ESSECO
Thu 1 Oct 15:32:19
Idrogeno gas
Cloro gas
KCl
E.E.
NaCl
ELETTROLISI
NaOH 30%
KOH 30%
NaOH 50%
SINTESI HCL
CLOROPARAFFINE
CLORURO FERRICO FERROSO
IPOSODIO
Home
DCS Real Time VS Planning
DCS Real Time Giornaliero
DCS Real Time Settimanale
DCS Marce Giornaliero
DCS Marce Settimanale
DCS Stoccaggi Giornaliero
DCS Stoccaggi Settimanale
Sinottico di sintesi impianto (ton/g)
Sinottico di sintesi impianto (ton/h)
RTO online
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Terms and Conditions
Contact us

Interreg Mediterranean

HERIT-DATA

https://herit-data.interreg-med.eu/

Sustainable Heritage Management towards **Mass Tourism Impact** thanks to a holistic use of **Big and Open Data**

BUDGET: 4.195.515,20 €

- City of Dubrovnik development agency (Croatia)
- Turisme Comunitat Valenciana (Spain)
- AVITEM (France)
- Center for Spatial Research (Bosnia and Herzegovina)
- Conference of peripheral maritime regions of Europe (France)
- Santa María Real Foundation for Historical Heritage (Spain)
- Valenciaport Foundation (Spain)
- Foundation for Research and Innovation (Italy)
- Region of Western Greece (Greece)
- Occitanie Region (France)
- Faculty of Sciences and Technology (Portugal)

Sustainable and responsible Tourism Management

Key aspect: **Carrying Capacity**

consider **European Tourism Indicators ETIS**

Respectful of the **ICZM recommendations**

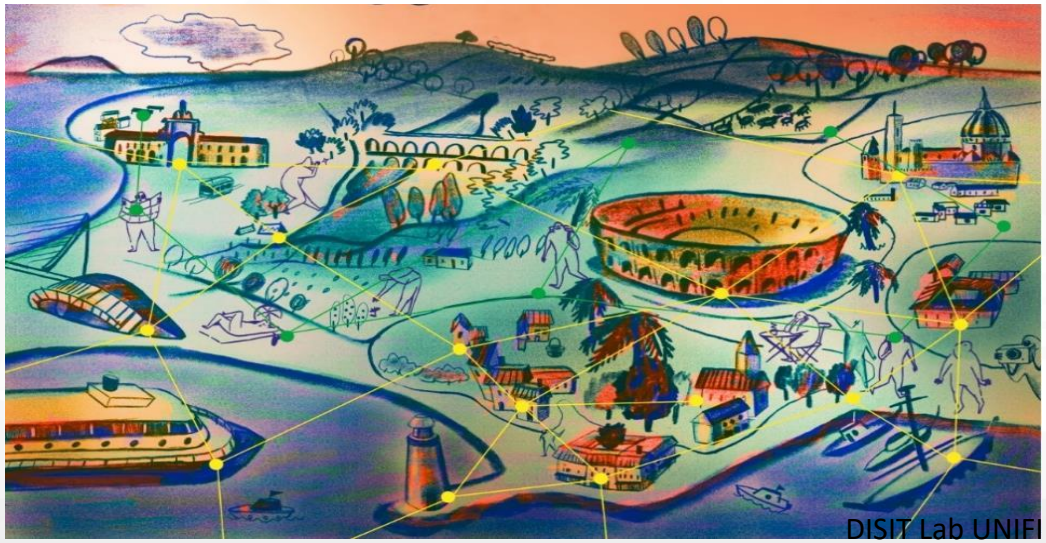
Evaluation of impact

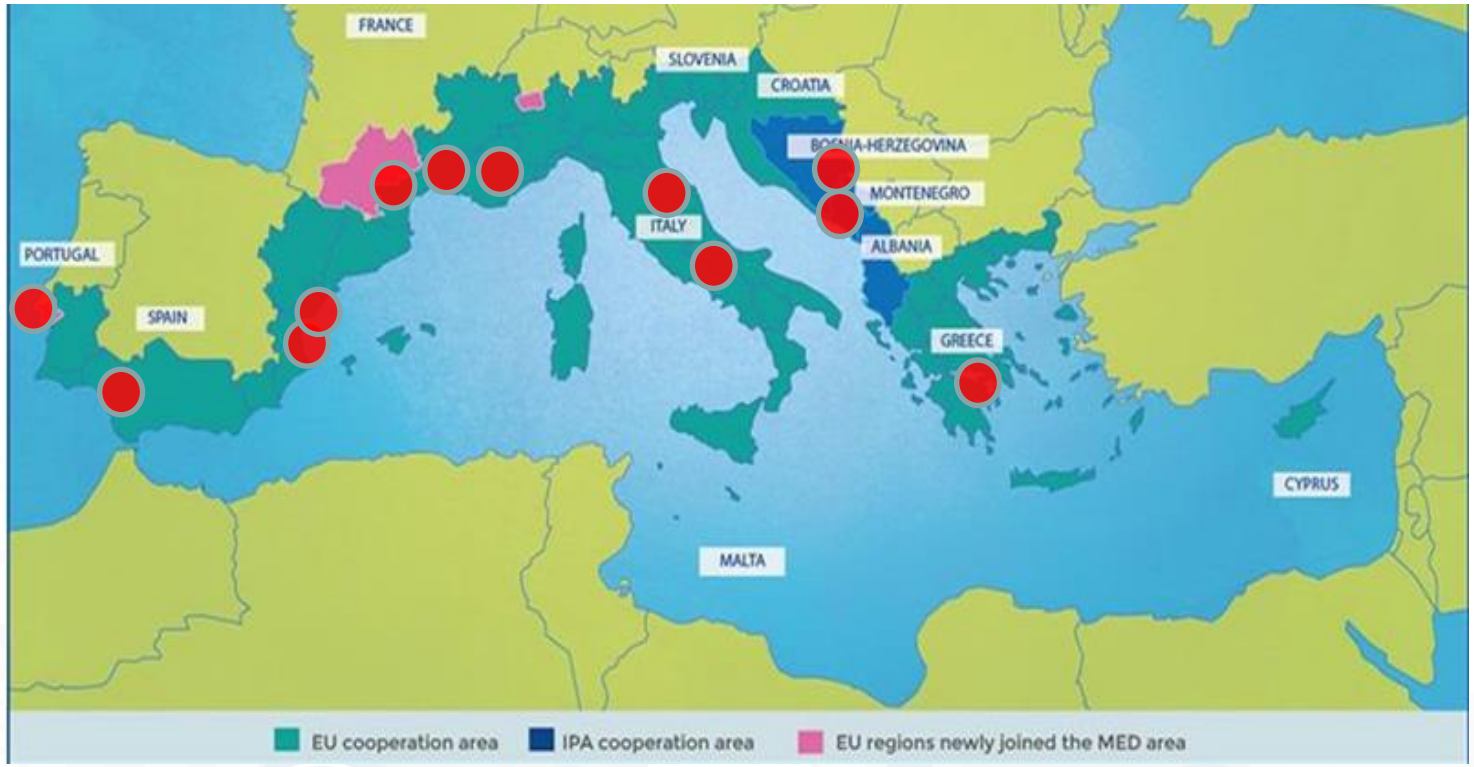
Cultural heritage

Special interest on **UNESCO World Heritage Sites**

Big & Open data

At service of Planners, visitors, local stakeholders and dwellers





Regione Toscana

Fondazione per la ricerca e l'innovazione

Interreg

UNIONE EUROPEA

MARITTIMO-IT FR-MARITIME

Fondo Europeo di Sviluppo Regionale

MOBIMART

MOBilità Intelligente MARe Terra

http://interreg-maritime.eu/web/mobimart

MOBI MART

REGIONE TOSCANA

REGIONE LIGURIA

CORSE CORSICA

REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA

RÉGION SUD PROVENCE ALPES CÔTE D'AZUR

Autorità di Sistema Portuale del Mar Tirreno Settentrionale

PROVINCIA DI LIVORNO

COMUNE DI GENOVA

Autorità di Sistema Portuale del Mare di Sardegna

Dalla **Sardegna** alla **Costa Azzurra**, passando per **Corsica**, **Toscana** e **Liguria**: un **unico strumento di infomobilità** per consentire a cittadini, turisti e pendolari di viaggiare tra le 5 regioni, pianificare gli spostamenti ed essere informati in tempo reale.

Questo l'obiettivo di **MOBIMART** - MOBilità Intelligente MARe Terra, proposto da una partnership di 11 Enti pubblici. Focus del progetto è l'**integrazione dei servizi di trasporto** che gli utenti utilizzano durante il viaggio, considerato come un unico tragitto dalla partenza all'arrivo, indipendentemente dal mezzo- nave, bus, treno, aereo - e a prescindere dalle barriere amministrative e morfologiche dei territori attraversati.

Cuore delle attività, la realizzazione di una **piattaforma integrata** per fare comunicare tra loro in modo intelligente i servizi di trasporto, facilitando gli **spostamenti intermodali** e rendendo più semplice l'**accesso alle informazioni**.

Il progetto intende intervenire su:
1) **L'innovazione dello scambio informativo tra sistemi** al momento non dialoganti, con l'obiettivo di sviluppare servizi anche oltre il termine del progetto, per consolidare le relazioni tra territori transfrontalieri.
2) **La molteplicità e la digitalizzazione dei prodotti realizzati**: siti web, travel planner – strumenti per la pianificazione dei viaggi da punto a punto - app per device mobili, canali social.

Per giungere a questi obiettivi il progetto sarà strutturato in un percorso triennale suddiviso in due step principali:
1) la standardizzazione delle informazioni sulla mobilità provenienti dai sistemi dei partner, in modo che siano tutte utilizzabili in un'unica piattaforma
2) la creazione di servizi di infomobilità specifici relativi ai porti, ai territori di Province e Comuni, alle Regioni.

Il progetto MOBIMART è finanziato nell'ambito del Programma Interreg Italia-Francia Marittimo 2014-2020 per un totale complessivo di 6.098.030,52 euro, di cui 5.183.325,94 euro provenienti dal Fondo Europeo di Sviluppo Regionale (FESR).



Feedback Project

Personal Assistant

Operators

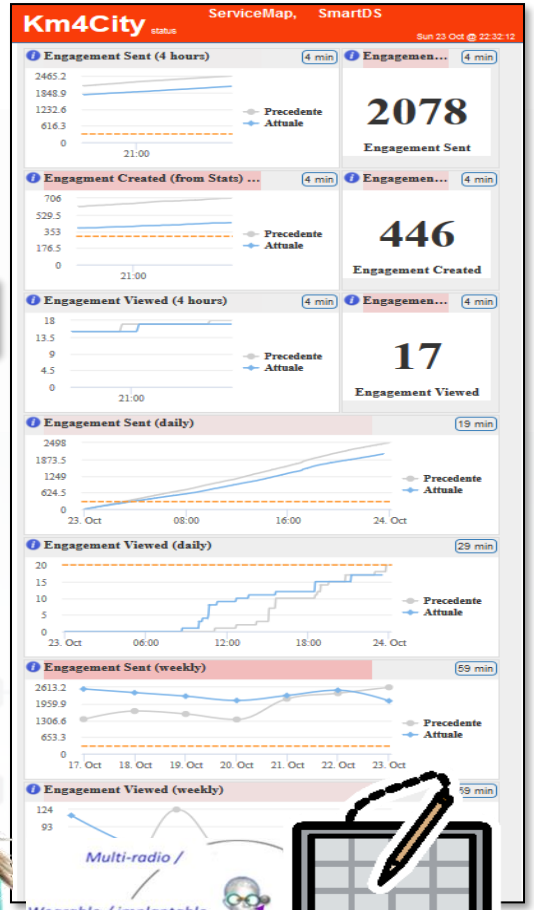
Strategy Editor and feedback

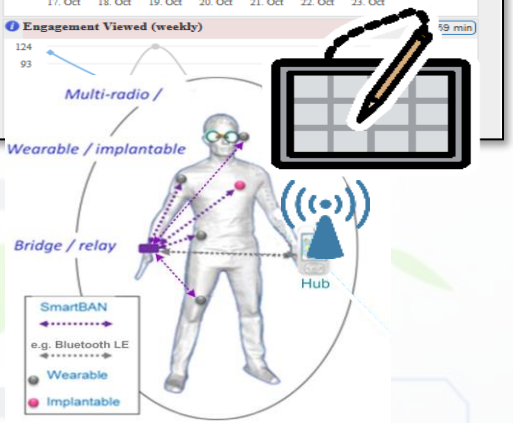


Rule name	Type	#sent	#viewed	#viewed on #sent	Description
daily_event_de	ENGAGEMENT	1 (0%)	0 (0%)	0%	Suggest (in german) an event currently on in Flore
daily_event_en	ENGAGEMENT	1720 (2.12%)	70 (7.1%)	4.07%	Suggest (in english) an event currently on in Florence
	- commuter	5 (0.29%)	0 (0%)	0 (0%)	
	- student	14 (0.81%)	0 (0%)	0 (0%)	
	- tourist	1462 (85%)	25 (35.71%)	25 (1.71%)	
	- citizen	113 (6.57%)	39 (55.71%)	39 (34.51%)	
	- operator	0 (0%)	0 (0%)	0 (0%)	
	- disabled	0 (0%)	0 (0%)	0 (0%)	
	- all	119 (6.92%)	6 (8.57%)	6 (5.04%)	
daily_event_es	ENGAGEMENT	6 (0.01%)	4 (0.41%)	66.67%	Suggest (in spanish) an event currently on in Florence
daily_event_fr	ENGAGEMENT	6 (0.01%)	0 (0%)	0%	Suggest (in french) an event currently on in Florence
daily_event_it	ENGAGEMENT	5459 (6.73%)	296 (30.02%)	5.42%	Suggest (in italian) an event currently on in Florence
parking_en	ASSISTANCE	141 (0.17%)	128 (12.98%)	90.78%	Alert (in english) if the user parked in a residential parking zone
parkin					parked in a residential parking zone
parkin					parked in a residential parking zone
shoot					ion for a nearby point-of-interest

Inform
Engage
Stimulate / recommend
Anomalies Detection
Provide Bonus, incentives







Main running instances

- Sii-Mobility → mobility and transport, sustainability
- REPLICATE → ICT, smart City Control room, Energy, IOT
- RESOLUTE → Resilience, ICT, Big Data
- GHOST → Strategies, smart city
- TRAFAIR → Environment & transport
- MOSAIC → mobility and transport
- WEEE Life → Smart waste, environment
- Smart Garda Lake → Castelnuovo del Garda
- 5G → Industry 4.0 vs SmartCity
- Green Impact → Industry 4.0, Chemical Plant
- SmartBed (laid → smart health
- Green Field Peas (soda) → Industry 4.0, Chemical plant
- MobiMart and PISA Agreement → data aggregation, mobility and transport, Living Lab
- Lonato del Garda → smart parking, environment
- Herit Data → tourism, culture and management
- ISPRA JRC → site management and services
- Capelon (Sweden) → smart light solutions

Acknowledgements

- Thanks to the European Commission for founding. All slides reporting logo of **Snap4City** https://www.snap4city.org **of Select4Cities H2020** are representing tools and research founded by European Commission for the **Select4Cities** project. **Select4Cities** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation Programme (grant agreement n° 688196)
- **TRAFAIR is a CEF** project. All slides reporting logo of TRAFAIR project are representing tools and research founded by the EC on CEF programme http://trafair.eu/
- Thanks to the European Commission for founding. All slides reporting logo of **REPLICATE H2020** are representing tools and research founded by European Commission for the REPLICATE project. **REPLICATE** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation Programme (grant agreement n° 691735).
- Thanks to the European Commission for founding. All slides reporting logo of **RESOLUTE H2020** are representing tools and research founded by European Commission for the RESOLUTE project. **RESOLUTE** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation Programme (grant agreement n° 653460).
- Thanks to the MIUR for co-founding and to the University of Florence and companies involved. All slides reporting logo of **Sii-Mobility** are representing tools and research founded by MIUR for the Sii-Mobility SCN MIUR project.
- **Km4City** *is an open technology and research line of DISIT Lab exploited by a number of projects. Some of the innovative solutions and research issues developed into projects are also compliant and contributing to the Km4City approach and thus are released as open sources and are interoperable, scalable, modular, standard compliant, etc.*





State of the Art Solutions vs Snap4City

	IOT Discovery Abstraction	Authentication, Authorization	Security end-2-end, secure on IOT and Dashboards	Open HW and Open SW	Integrated Community management	Data Types: IOT Devices, IOT App, Dashboard, Data	Data Type: Publish/share, Delegation, Consent and change	Data Type: Download and Delete	Auditing on Data Type Access	Open Source end-to-end	Scalability IOT	Visual Programming end-to-end applications	Advanced Smart City API, MicroServices	Multi Domain Semantic Platform	Standard based Modules and IOT, Open Devices	Resource Sharing	Data Analytics integrated	Dashboard H24/7, protected connection	Multi-protocol on IOT
		G				G	G	G	G										
Snap4City	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KAA [53]	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	N	(Y)	N	N	Y	Y
Thingsboard [55]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	Y	MQTT,coap, http
IOT eclipse.org [56]	N	N	N	(Y)	N	Y	N	N	N	Y	Y	N	N	N	Y	N	N	N	Y
IOT IGNITE [57]	N	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y	N	N	N	N	N	Y	MQTT
FIWARE [47]	N	Y	N	Y	N	N	N	Y	N	Y	(Y)	(N)	Y	N	Y	N	N	Y	Y
ARM mbed IoT [48]	Y	Y	Y	Y	Y	N	(N)	N	Y	Y	Y	N	N	N	Y	N	N	Y	Limited
Airvantage [51]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	Y	MQTT, HTTP
AWS [43]	Y	Y	Y	Y	N	Y	(N)	Y	Y	N	Y	N	N	N	Y	Y	(Y)	Y	Limited
Azure IOT [44]	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N	N	Y	Y	(Y)	Y	Limited
PTC ThingWorkx [59]	N	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	N	N	Y	N	N	Y	Y
Bosch IoT Suite [58]	Y	Y	Y	Y	Y	(Y)	(N)	Y	Y	N	Y	Y	Y	N	Y	N	Y	Y	Y
CISCO Jasper [55]	Y	Y	Y	Y	N	(Y)	(N)	N	Y	N	Y	N	N	N	N	--	(Y)	Y	N
Siemens MindSphere [60]	Y	Y	Y	(Y)	N	Y	(N)	Y	Y	N	Y	Y	N	N	Y	N	Y	Y	Y
Carriots [54]	Y	Y	Y	(Y)	N	Y	N	N	Y	N	Y	N	N	N	--	N	N	Y	MQTT
Google IOT [45]	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	N	N	N	(Y)	(Y)	MQTT, HTTP
Homekit Apple [50]	Y	Y	Y	Y	N	Y	N	N	Y	N	(Y)	N	N	N	N	Y	N	Y	Limited
Smarthing Samsung [52]	Y	Y	Y	Y	Y	Y	(Y)	Y	Y	N	(Y)	N	N	N	N	N	N	Y	Limited

•end