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 https://www.Km4City.org



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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

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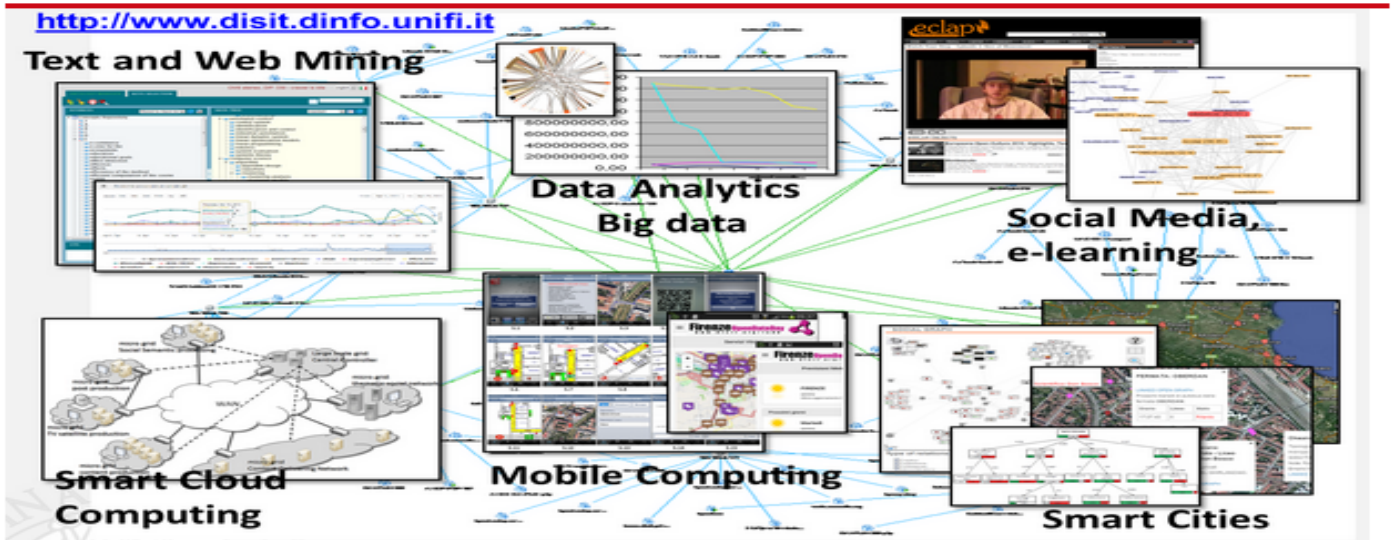
qualsiasi tipo | deep search

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 [illegible] and distri[illegible] has covered the role of partner, and also coordinating scientific and tech[illegible] WP and performing activities of dissemination and assessment. DISIT has received a relevant number of awards and is directly involved into top level international conferences, advisory 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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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

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 · Node-RED · anci toscana · COMUNE DI FIRENZE · CITTÀ METROPOLITANA DI FIRENZE

Fondazione per la ricerca e l'innovazione · liberologico · europeana think culture · BMG

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 · University of Pittsburgh · 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

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DISIT projects

- **Snap4City: IOT/IOE smart city https://www.snap4city.org**
- **Trafair: CEF project con varie Citta'**
- **Mosaic: Mobility and transport model**
- **Smart City of Florence Metropolitan Area**
- **Km4City: http://www.km4city.org**
- **REPLICATE H2020, SCC1, EC flagship**
  - http://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, ….**
- **Mobile Emergency:**
  - http://www.disit.org/5404



SNAP4CITY

REPLICATE

resolute

Sii-Mobility

TRAFAIR

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

LAID Smart Bed

GREEN FIELD PEAS Soda4.0

5G

MOSAiC

Coll@bora

TESYS RAIL



feedback

Trace-IT

RAISSS

Smart COMMUNITIES Tech Italian Technology Cluster for Smart Communities

Regione Toscana

MIUR

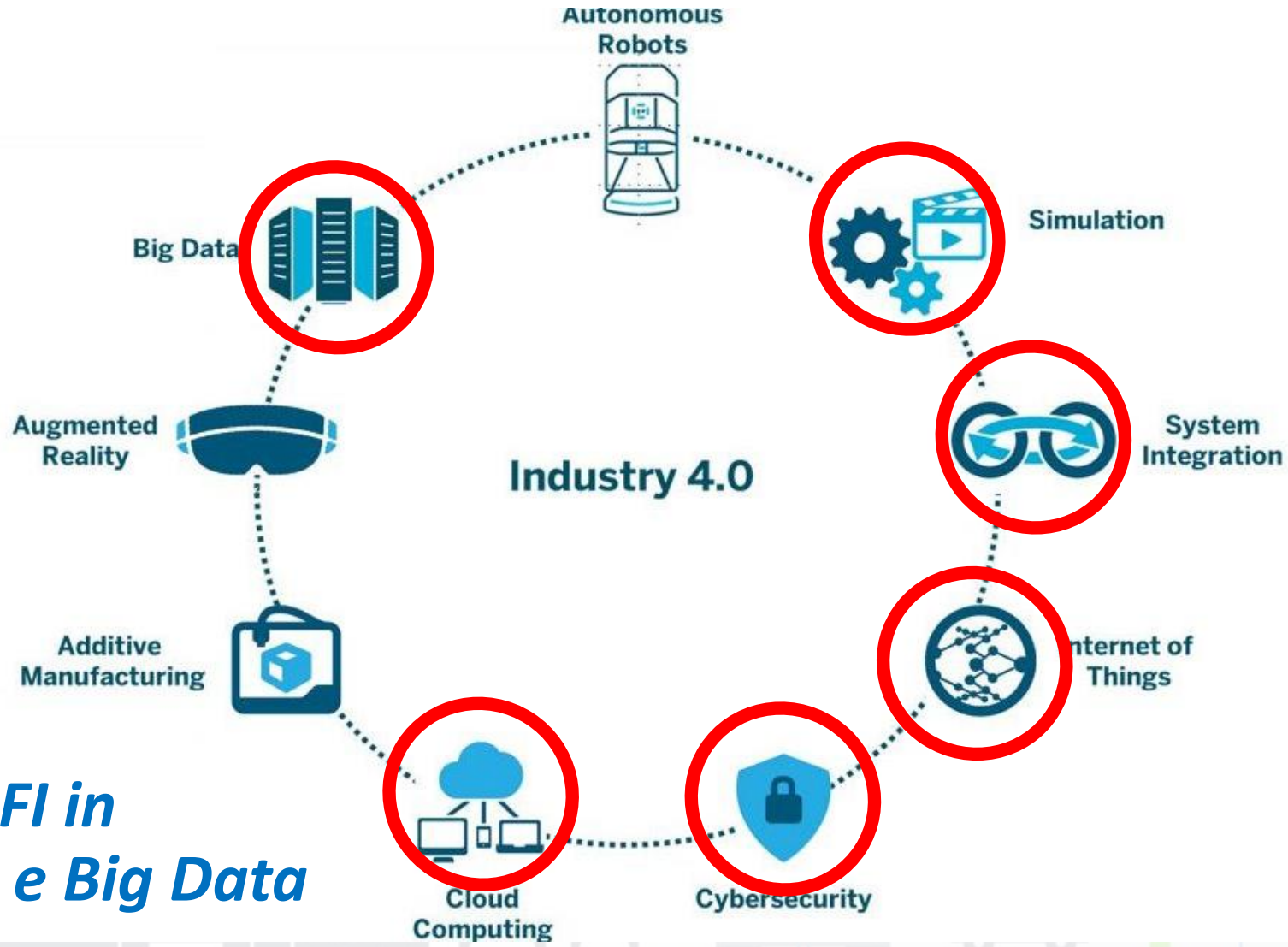
Horizon 2020 European Union Funding for Research & Innovation

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

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**

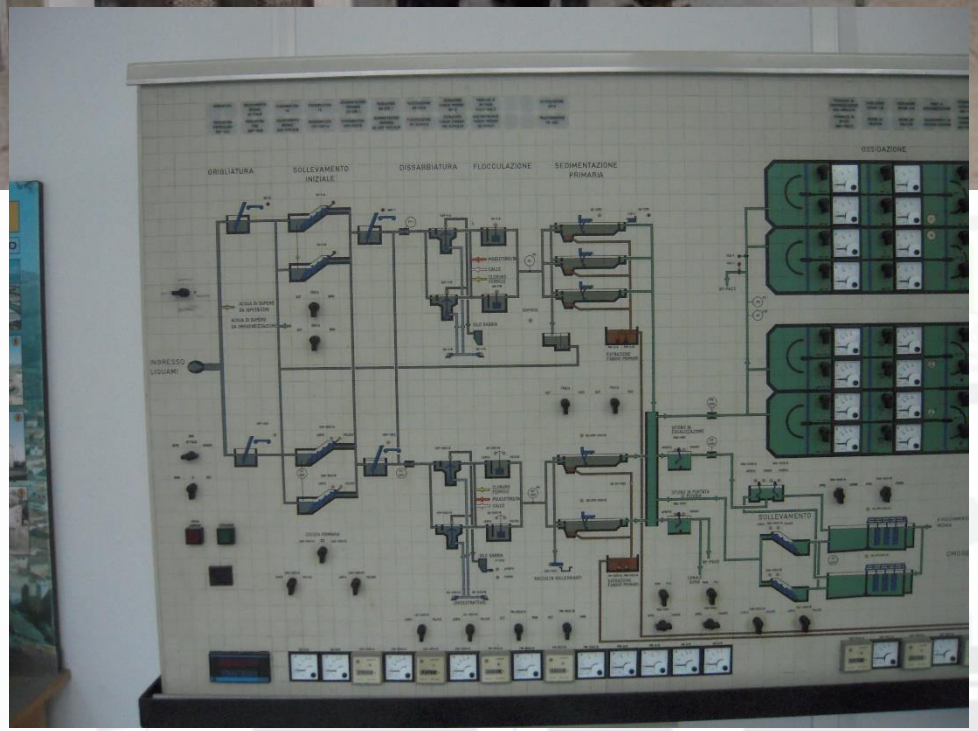
DISIT: Application Fields

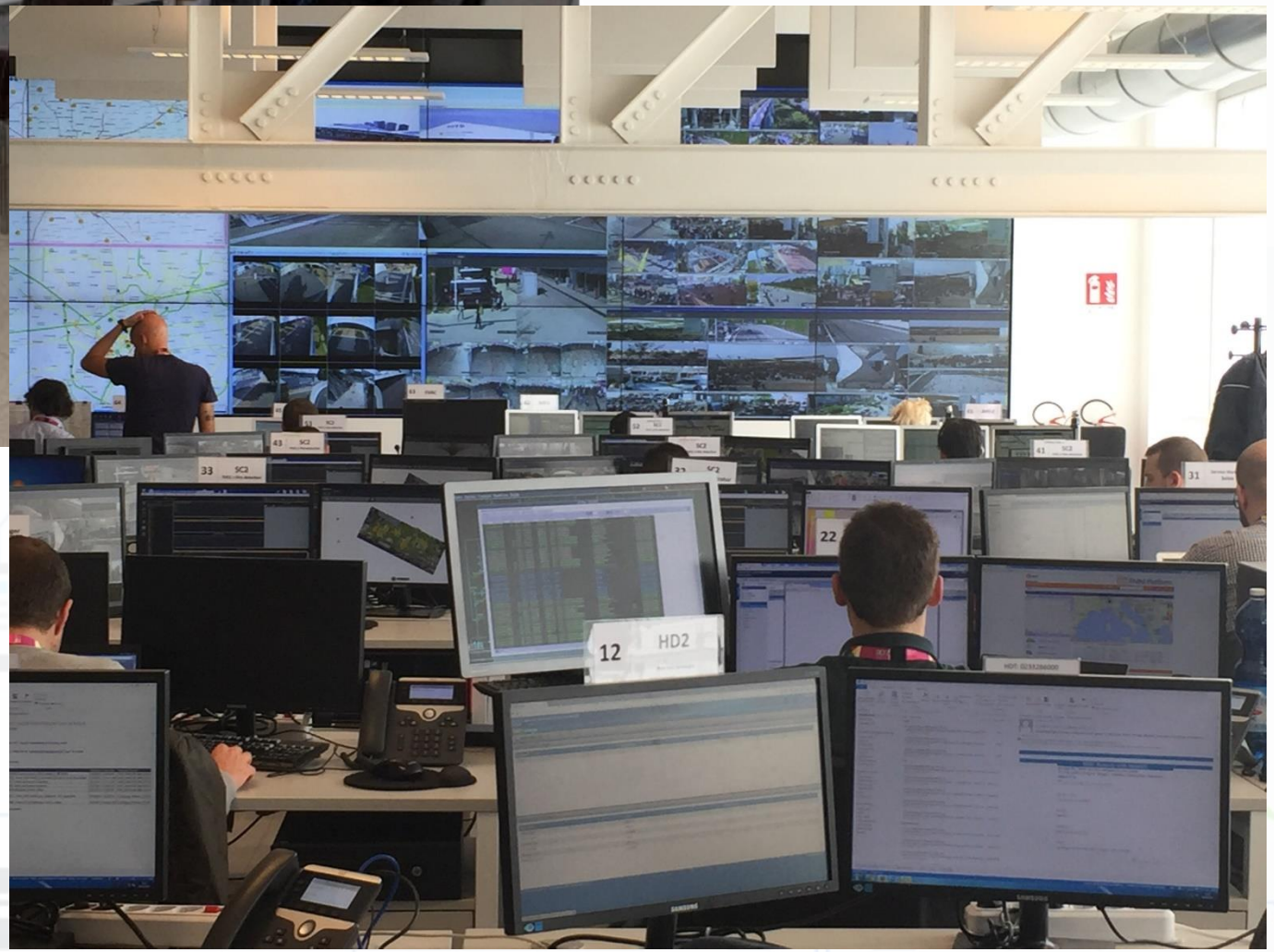
Increasing investments in Big Data can lead to interesting discoveries in **science**, **medicine**, benefits and gains in the **ICT sector** and in **business** contexts, new services and opportunities for digital **citizens** and **web users**.

- **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
- **Semantic Reasoners: Km4City, Cloud, Eclap, ..**
- **Virtual Assistant: PAVAL, OSIM**
- Cloud management and simulation
- Data Analytic – Scientific Research
- Security for IOT and Big Data
- Energy and Govern
- Healthcare and Medicine
- Social Network – Internet Service – Web Data

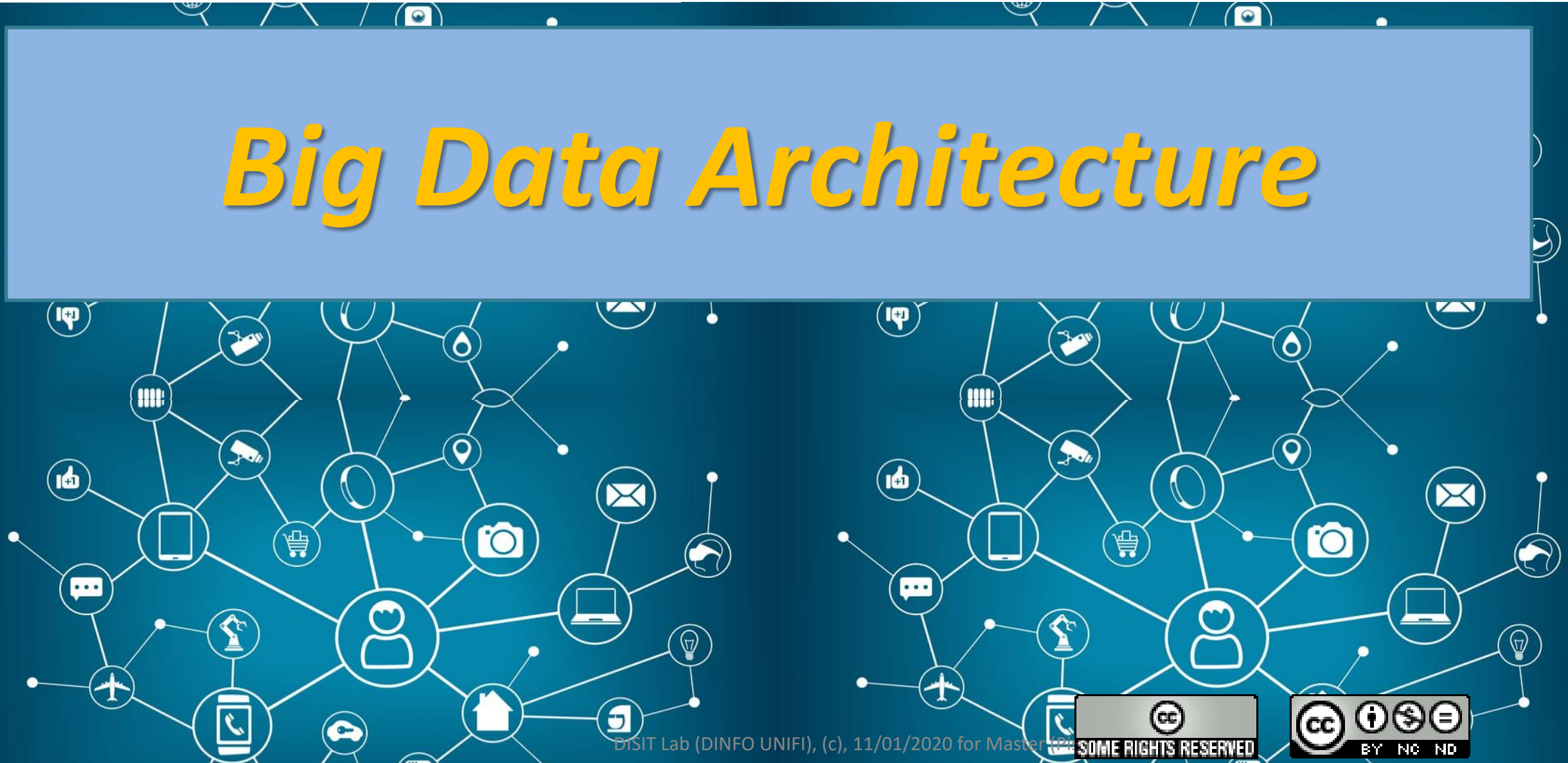
Control Room







Big Data Architecture



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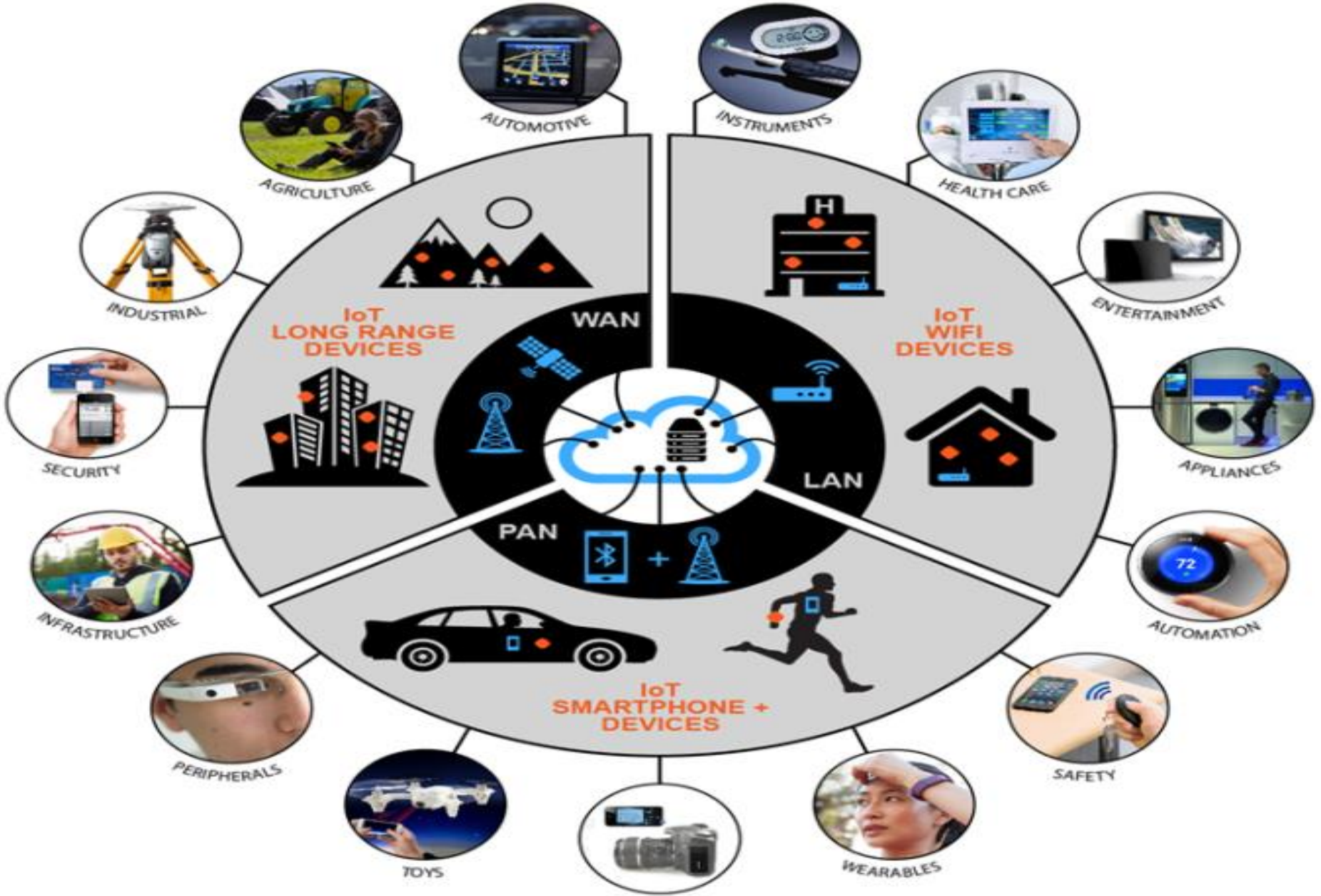
Agenda

- **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
- Acknowledgment

Big Data & Analytics



Classic Architectural Models



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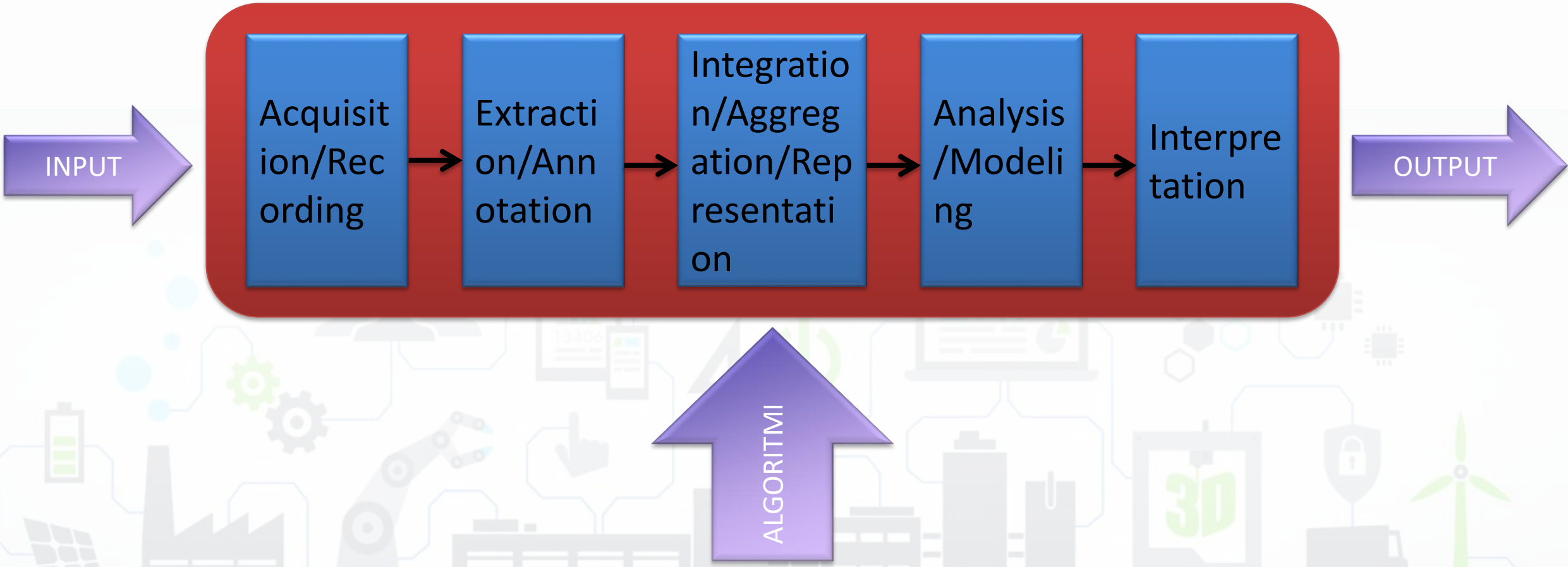
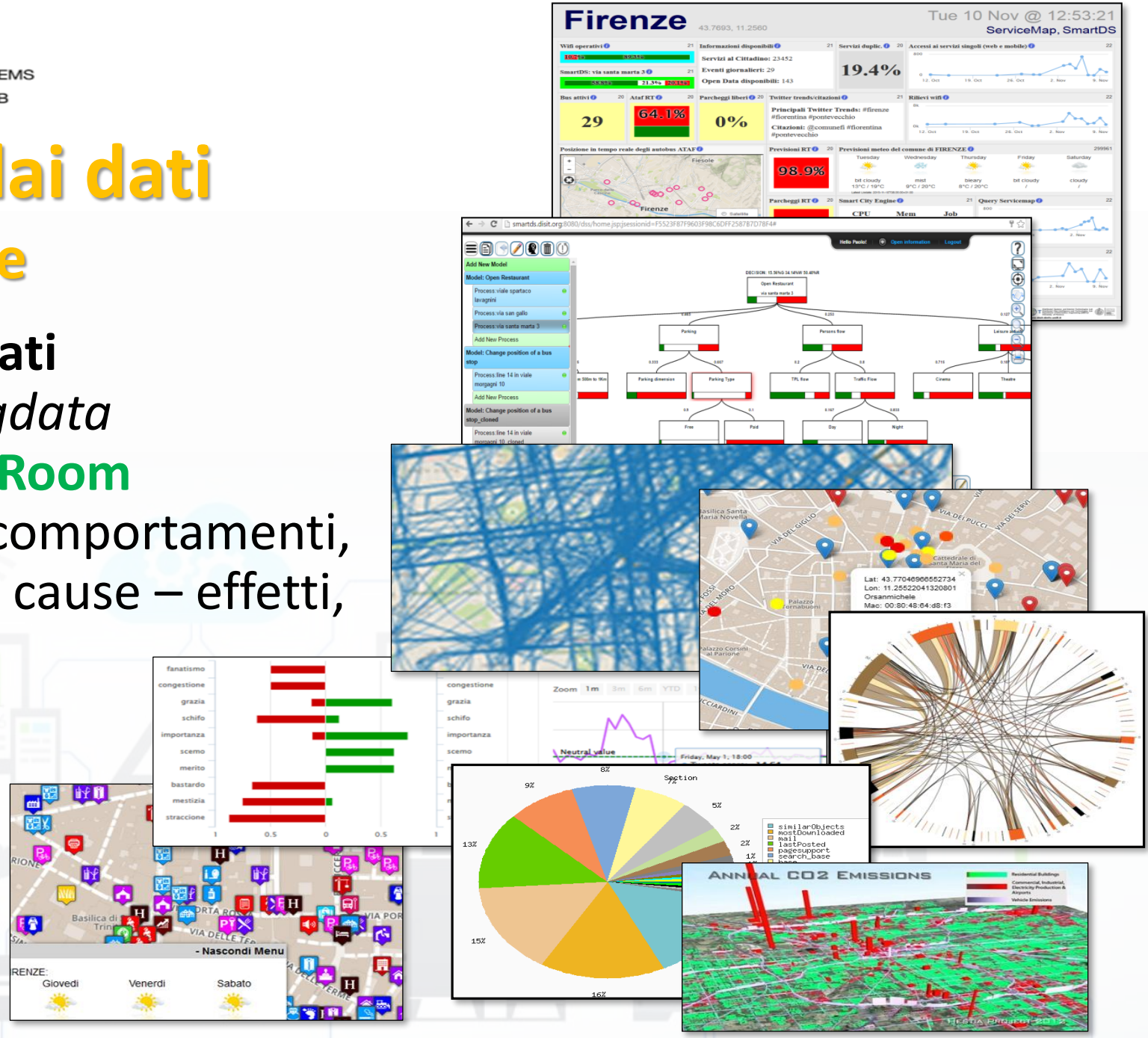
Pipeline


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:

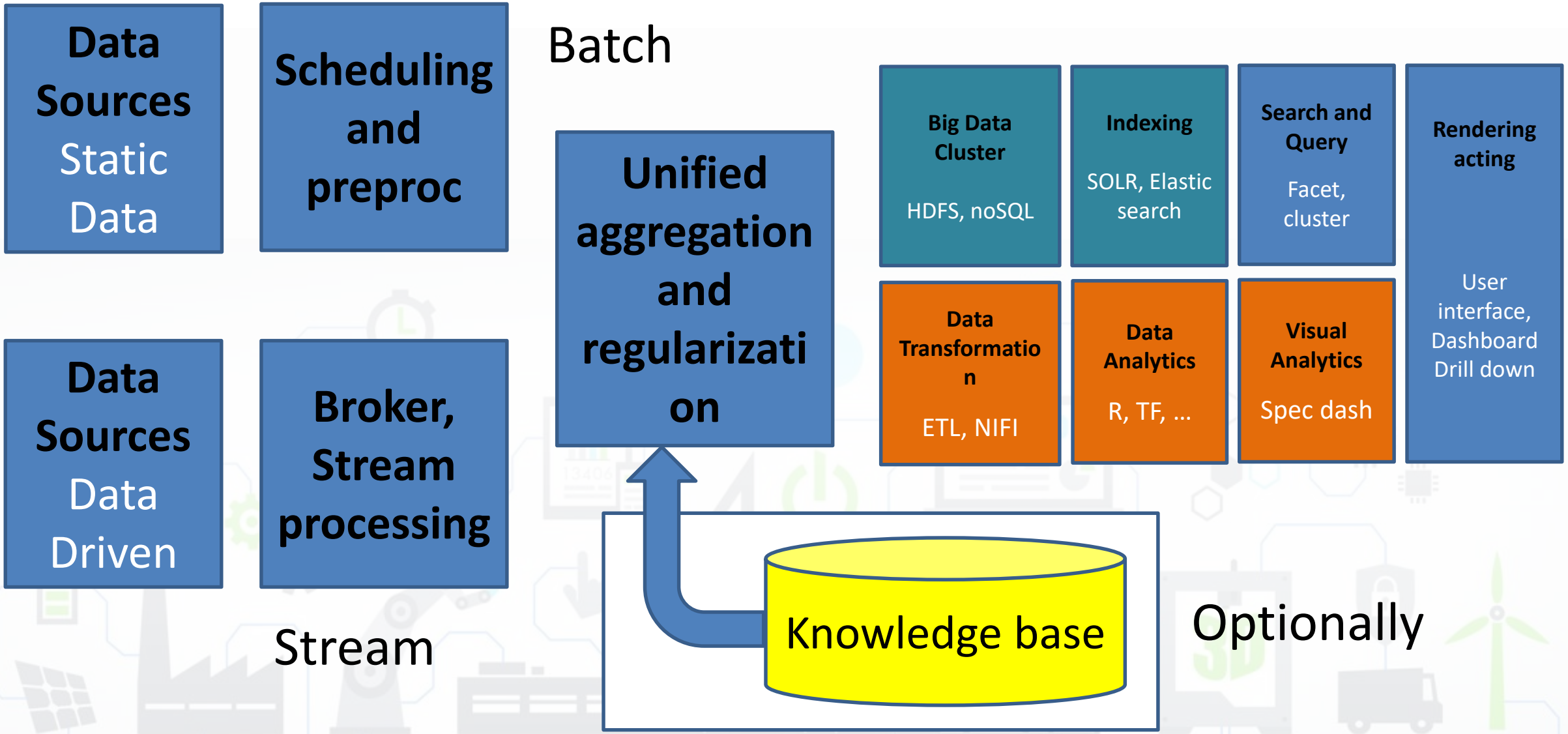
- in grado di operare H24/7, in HA (high availability, 99.999% up time)?
- in grado di reggere il carico delle richieste? è scalabile?
- in grado di lavorare alla massima precisione in predizione?
- in grado di rispondere in tempo reale?
- resiliente: recupera stabilità a fronte di eventi inattesi?
- 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	Data Stream analysis	Big Data Cluster	Indexing	Search and Query	Rendering acting
Transations sys, sensors Social media, ws, etc.	Spark, Storm, Kafka	HDFS, noSQL	SOLR, Elastic search	Facet, cluster	User interface, Dashboard Drill down
		Data Transformation ETL, NIFI	Data Analytics R, TF, …	Visual Analytics Spec Dash	

Data Management: security, privacy, licensing, etc.

Lambda Architecture



Snap4City/Snap4Industry Architecture



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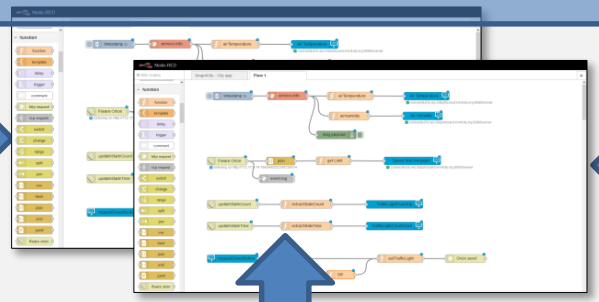
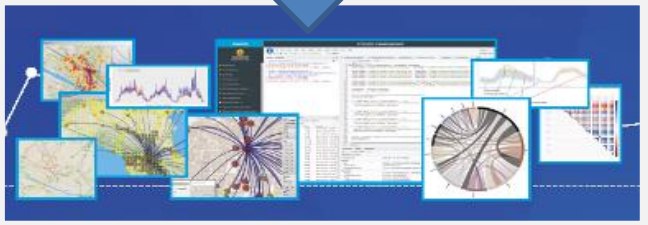
Dashboards with data driven IOT Applications enforcing intelligence

IOT and data World

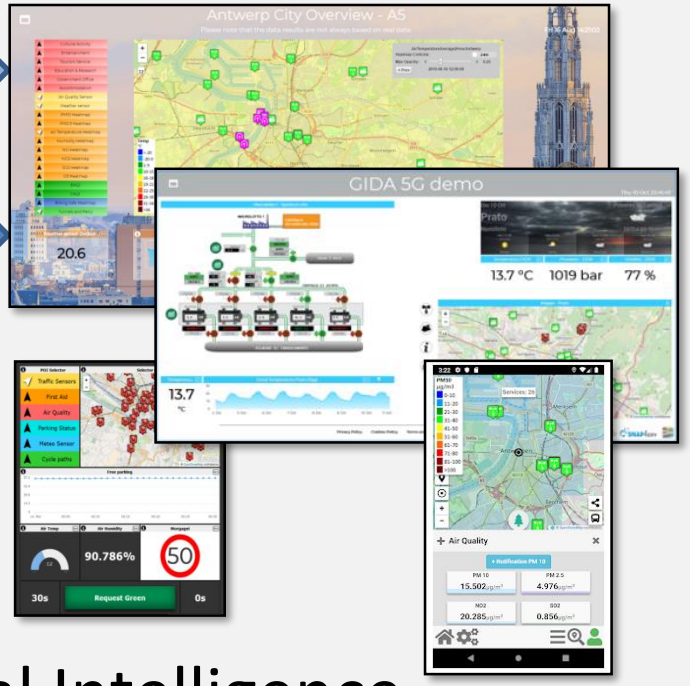


IOT Applications





Dashboards and Apps



Big Data Analytics, Artificial Intelligence

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

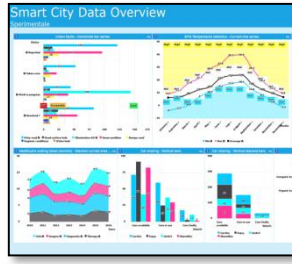
Data Analytics
R, Tensor Flow, Python, MapReduce, …

IOT Applications
Node-RED + Snap4City MicroSrvs

Search and Query, Smart API
Facet, semantic search

Visual Analytics
Special dash/ tools

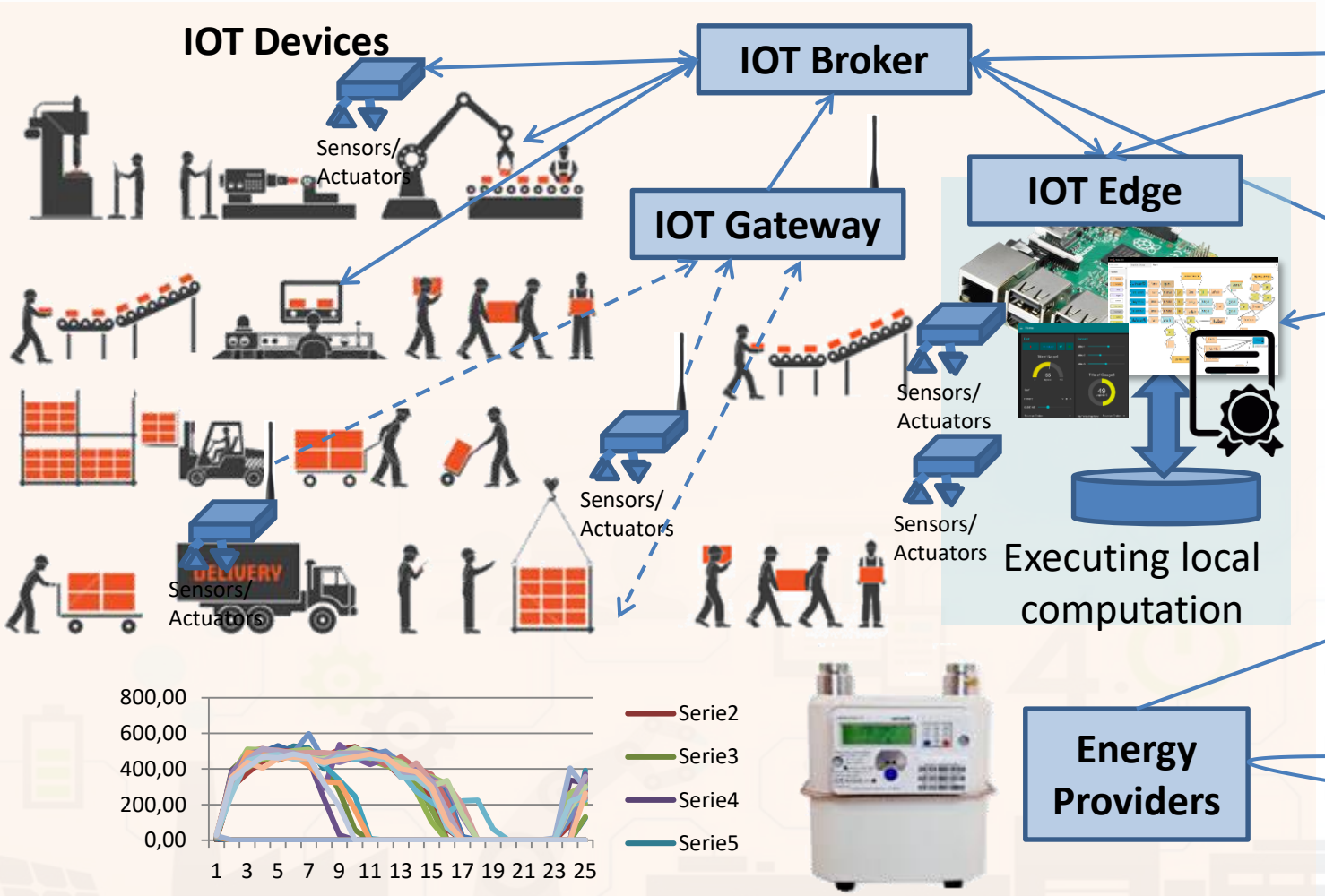
Rendering Acting, Widgets, MicroApps
User interface, Interactive Dashboard, Drill down, maps, heatmaps

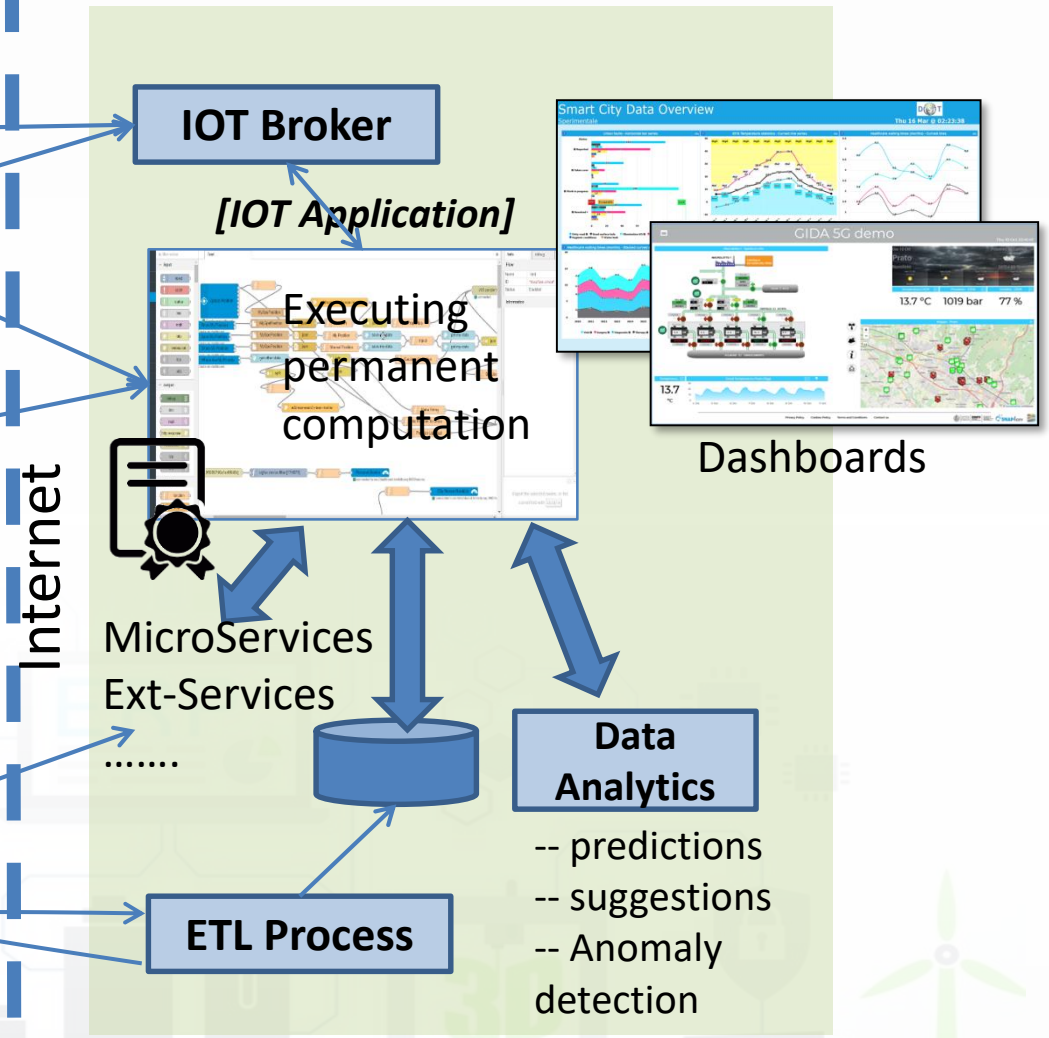


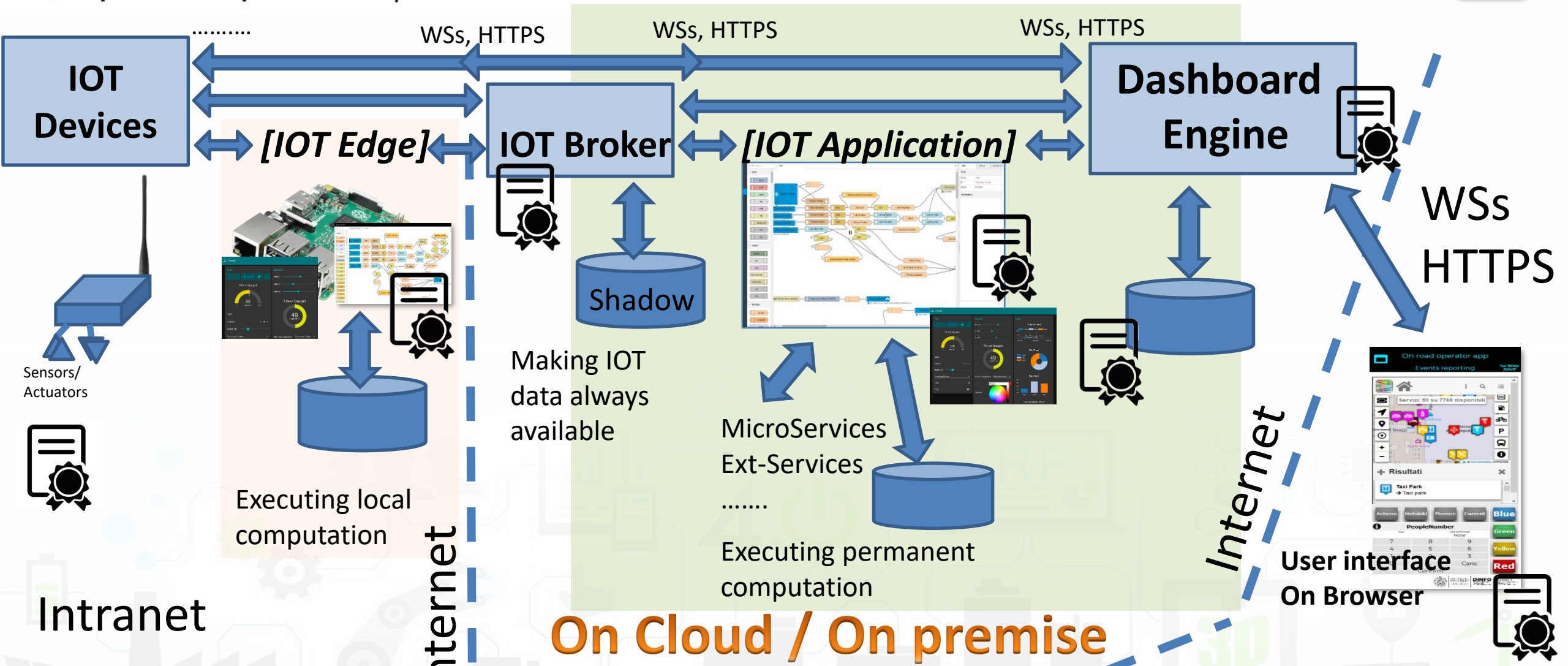


Inform, announce, Act!, warning, alarms, What-IF, ..

Industry 4.0 Application






.....
WSs, HTTPS
WSs, HTTPS
WSs, HTTPS
IOT Devices
[IOT Edge]
IOT Broker
[IOT Application]
Dashboard Engine
WSs
HTTPS
Sensors/
Actuators
Shadow
Making IOT data always available
MicroServices
Ext-Services
.....
Executing permanent computation
Executing local computation
Internet
Internet
User interface
On Browser
Intranet
On Cloud / On premise
End 2 end security

Smart City Functional Architecture

Transport systems Mobility, parking



Public Services, Govern, events, …



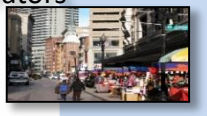
Sensors, IOT Cameras, Wi-Fi



Environment, Water, energy



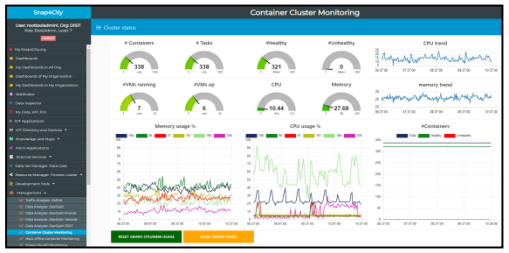
Shops, services, operators



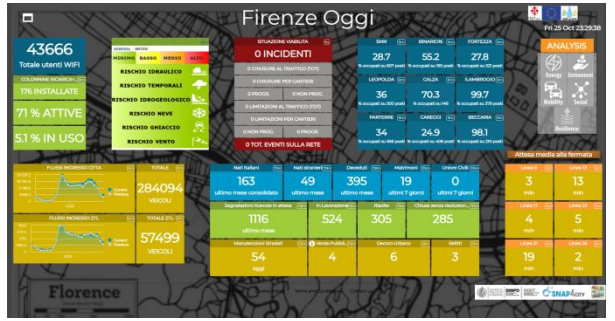
Social Media

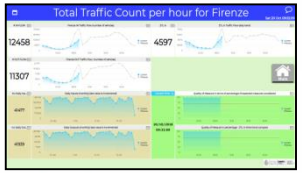
Social Media Crawler and Manager



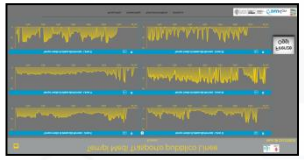






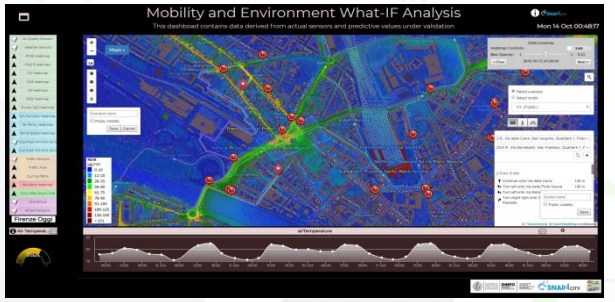












Data Sources PULL Data

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

SNAP4CITY

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

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

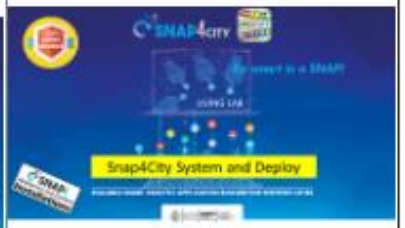
IOT MNG - DATA MNG - DATA INSPECTOR – PROCESS MNG – USER ENGAGEMENT – GDPR MNG ...

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

https://www.snap4City.org

https://www.snap4city.org/501

November 2019 Training for Barcelona Smart City World Expo Congress

	1st day	2nd day	3rd day	4th day	5th day	6th day
what	General	Dashboards	IOT App, App, Network	Data Analytics	DataWareHouse Data Ingestion	System and Installation
PDF						 Installations
Inter active						

The updated Snap4City mobile development App Kit as open source for developing mobile and web App using Cordoba Apache is accessible on GitHUB from:

https://github.com/disit/snap4cityAppKit

Swagger documentation of Smart City API is on: https://www.km4city.org/swagger/external/index.html

7th day, the Mobile App Development exploiting the Smart city API					
Slides ENG in PDF about the structure of the kit and main tools		interactive SLIDES ENG about the structure of the kit and main tools		video ENG on HOW to use the Dev Kit from zero	

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
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Snap4Industry as a Lambda Architecture







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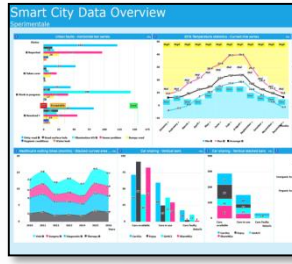
Search and Query, Smart API Facet, semanti search

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, …

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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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

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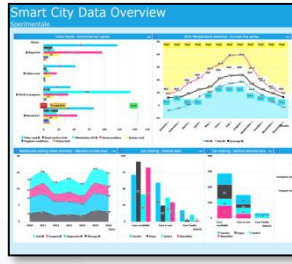
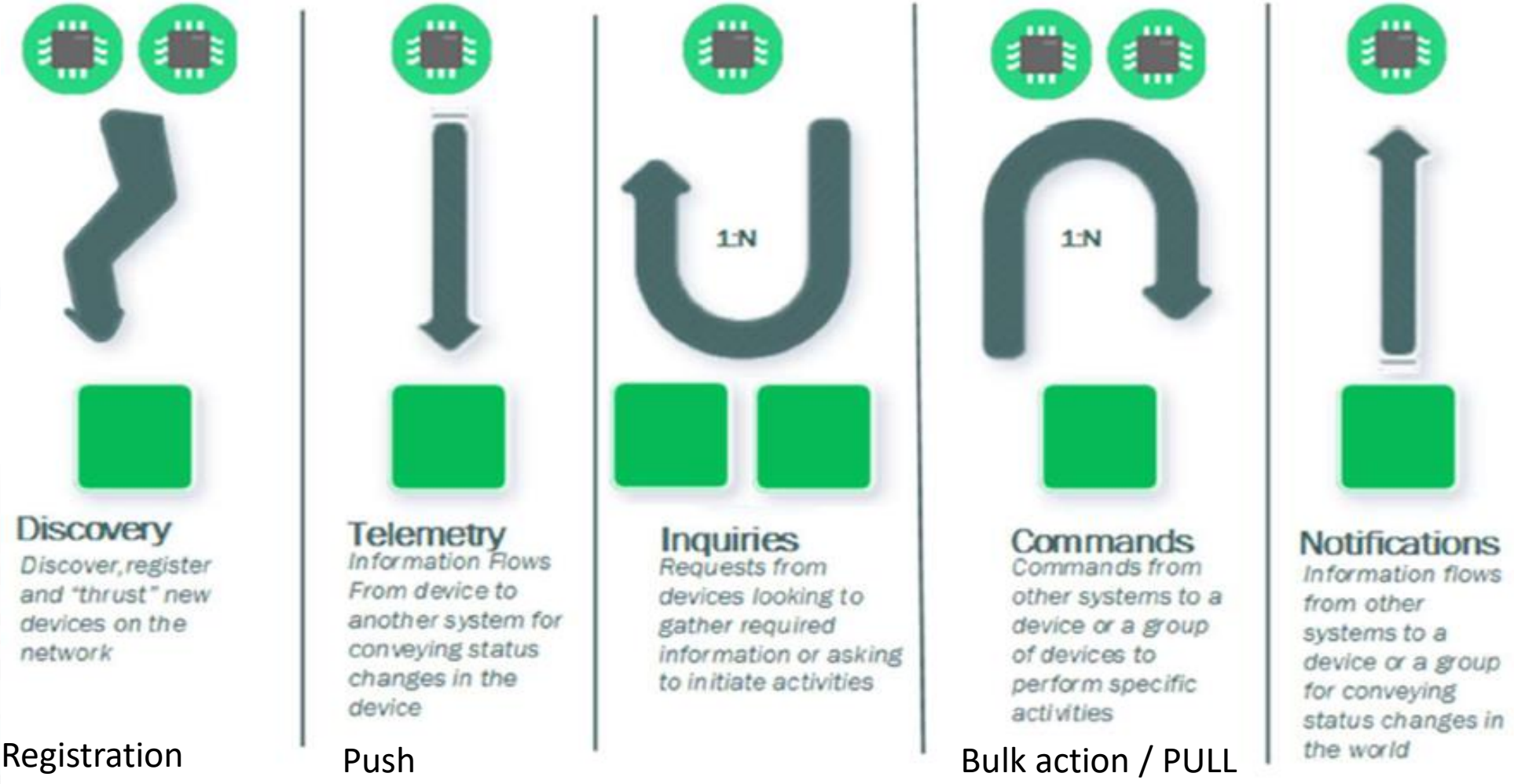




Inform, announce, Act!, warning, alarms, What-IF, ..

IOT/IOE Protocols

Communication Patterns



Registration

Push

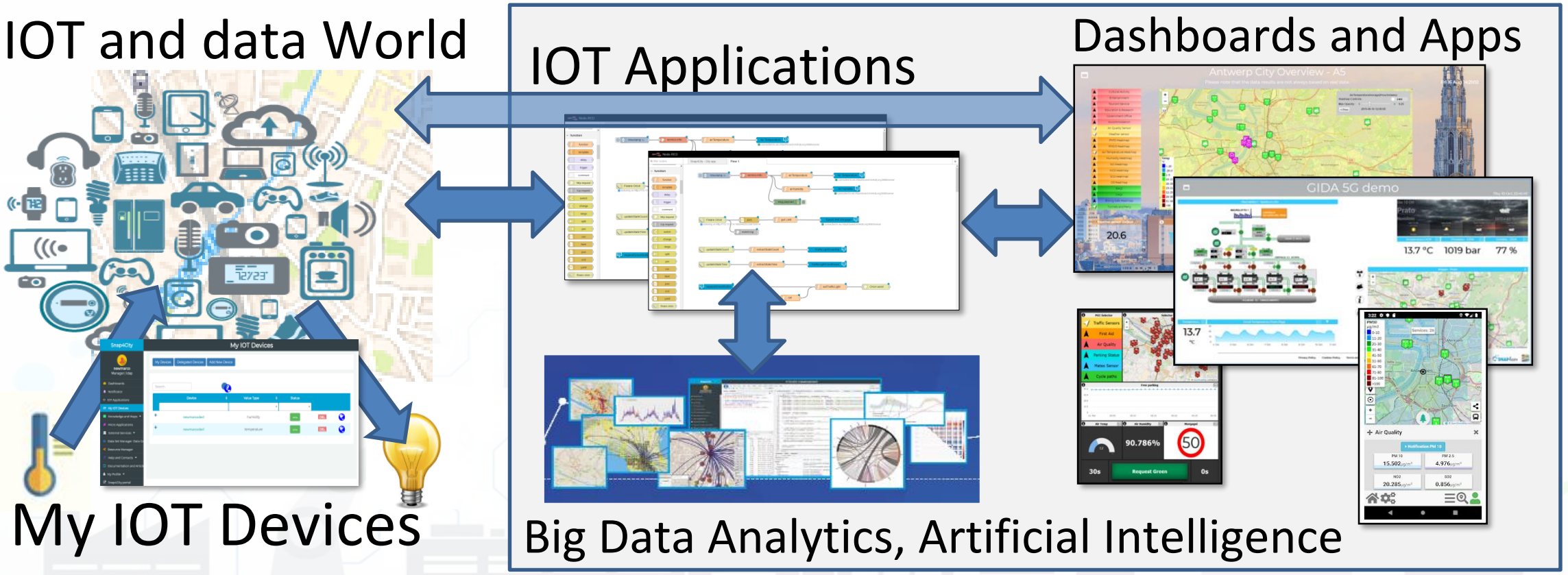
Bulk action / PULL

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

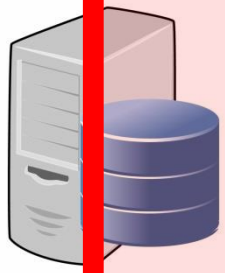
Standards and Interoperability

Compliant with: AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, NGSI, 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, WFS, WMS, ODBC, JDBC, Elastic Search, Phoenix, XML, JSON, CSV, db, GeoJSON, Enfuser FMI, Android, Raspberry Pi, Local File System, ESP32, Libelium, IBIMET, OBD2, SVG, XLS, XLSX, TXT, HTML, CSS, etc.

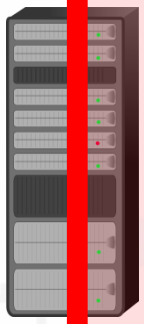
Dashboards with data driven IOT Applications enforcing intelligence



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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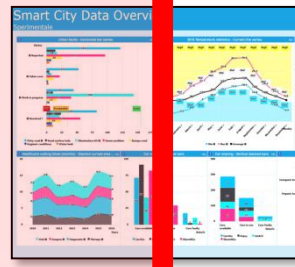





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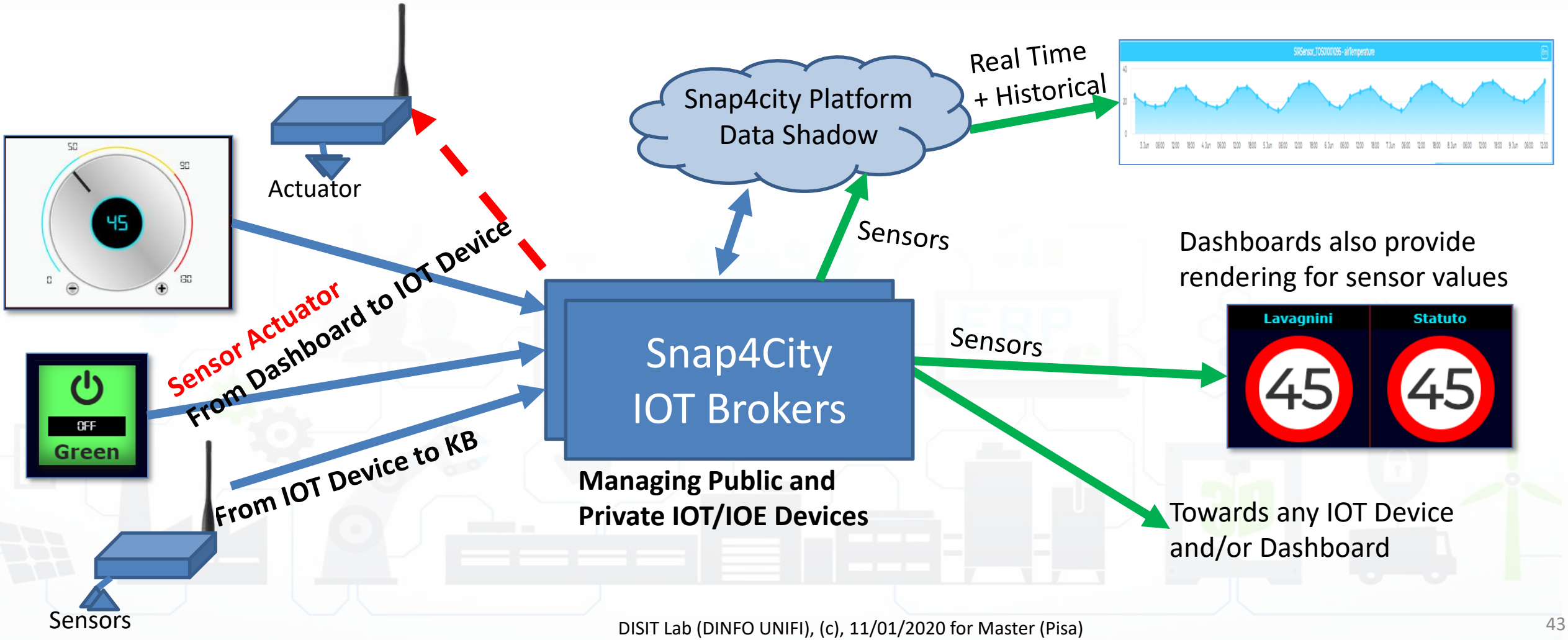
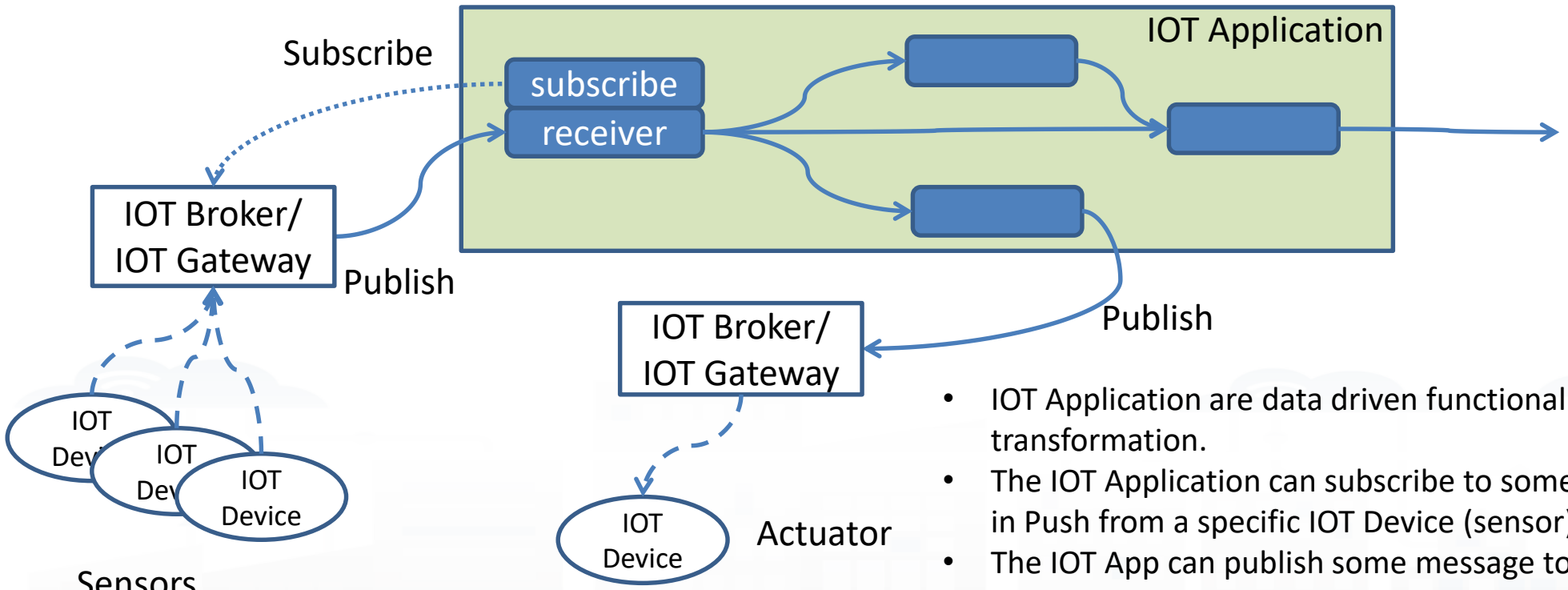
IOT Data Driven



IOT Basic

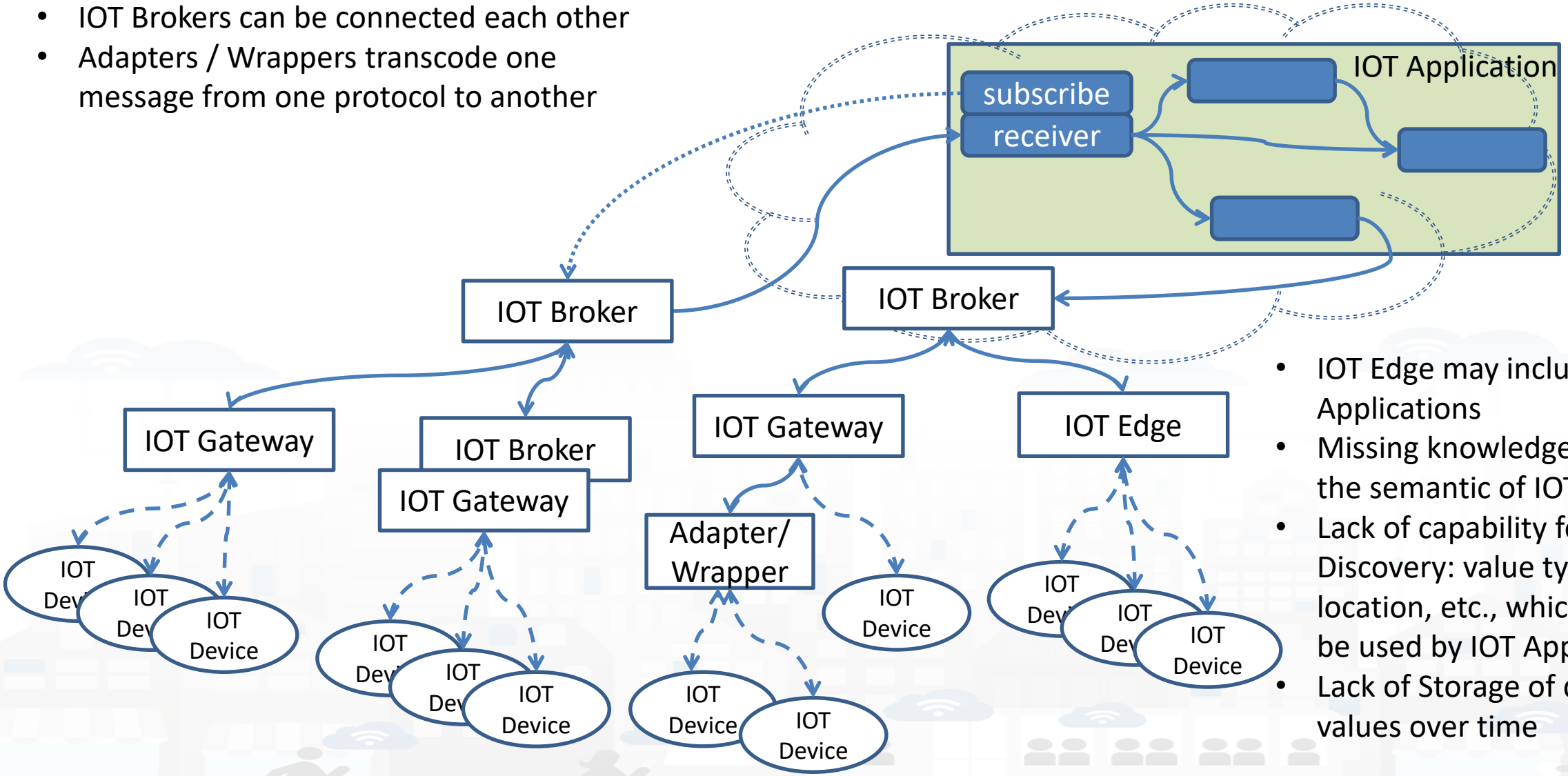


- Sensors are programmed to send data (i) periodically, or (ii) when a relevant change occurs in the sensor value, or (iii) when events occur (for example a change of status of something), etc.
- Actuator perform some action on the field: change of status, reset, turn on something, change setting value,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

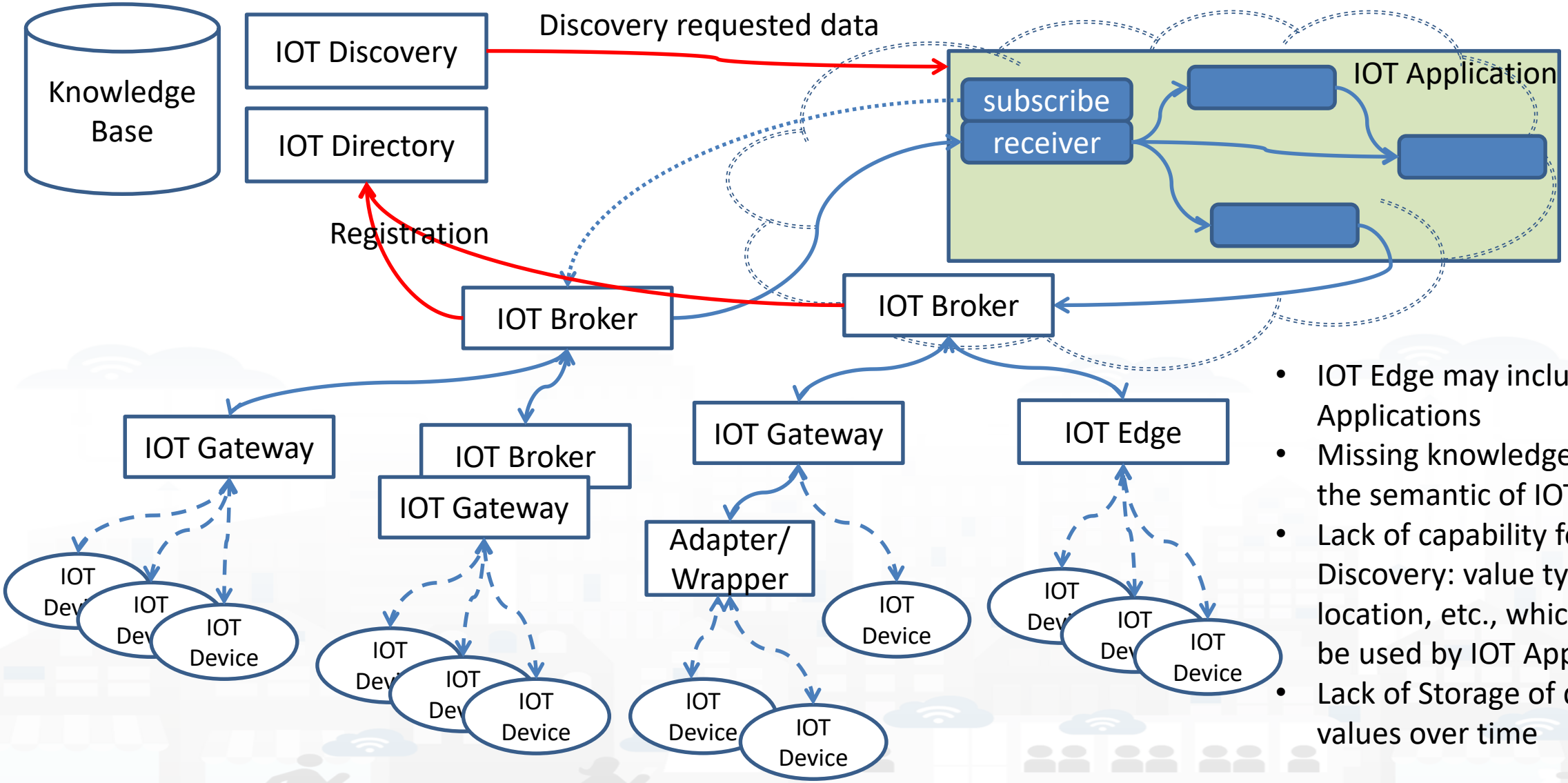
Definitions

- 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

Definitions



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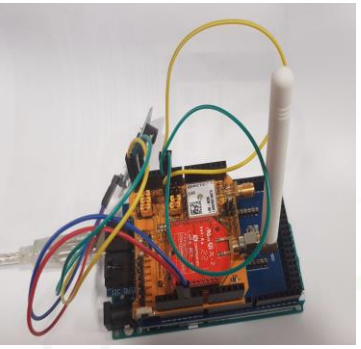
IOT Devices

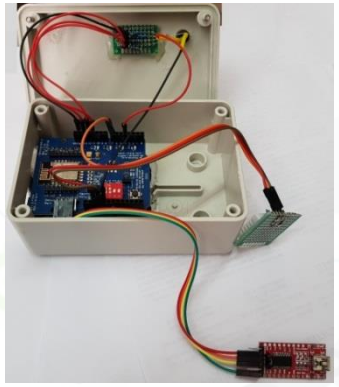
Sensors/
Actuators

IOT Edge Devices

LoraWAN +
Arduino +
I2C, NGSI



Arduino,
Wi-Fi, NGSI



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



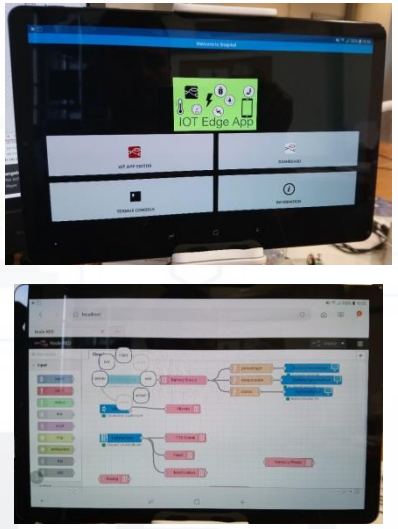
Snap4All PAX
Counter
LoraWAN
WIFI, NGSI,
GPS



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

Data Ingestion/ Transformation Tools



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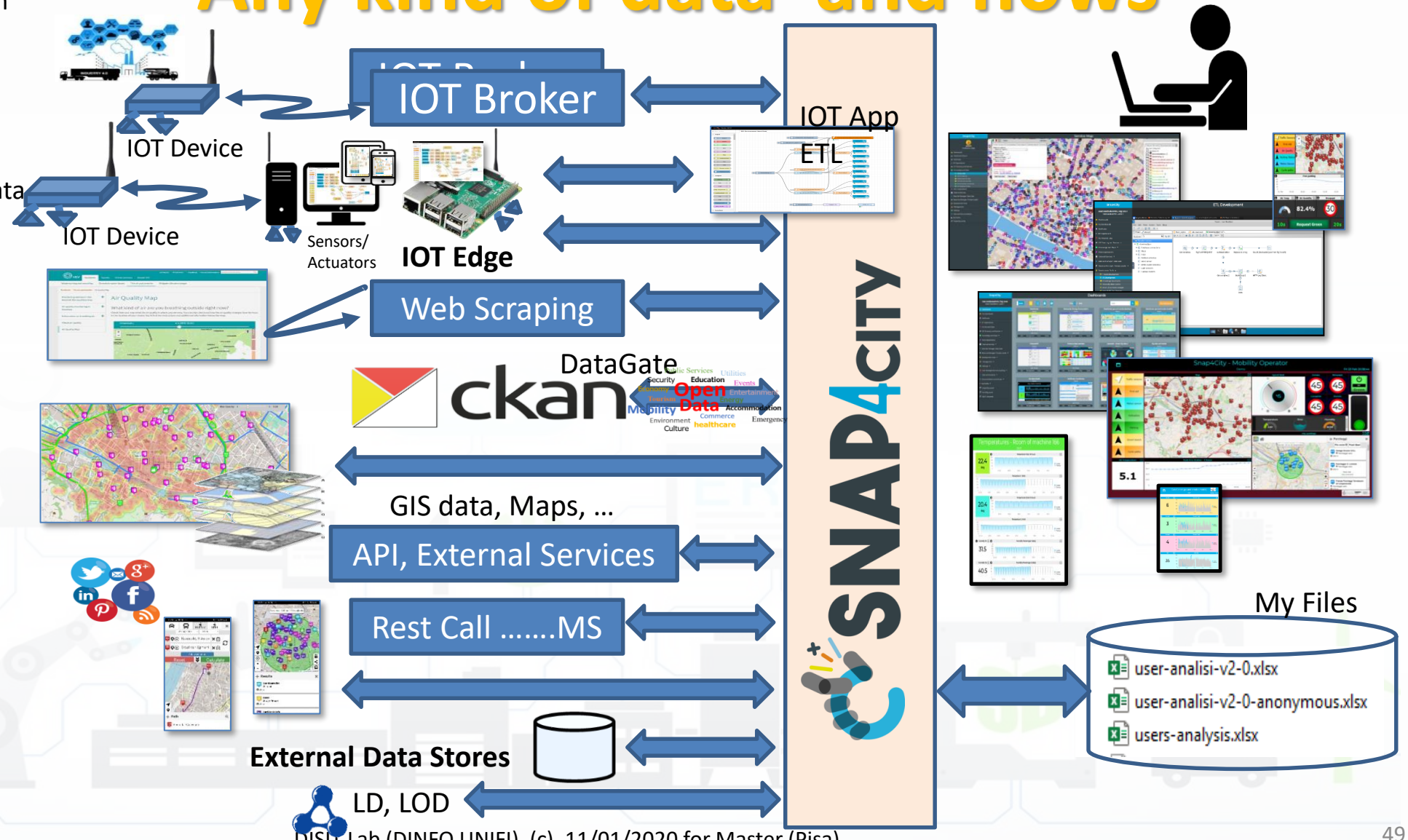
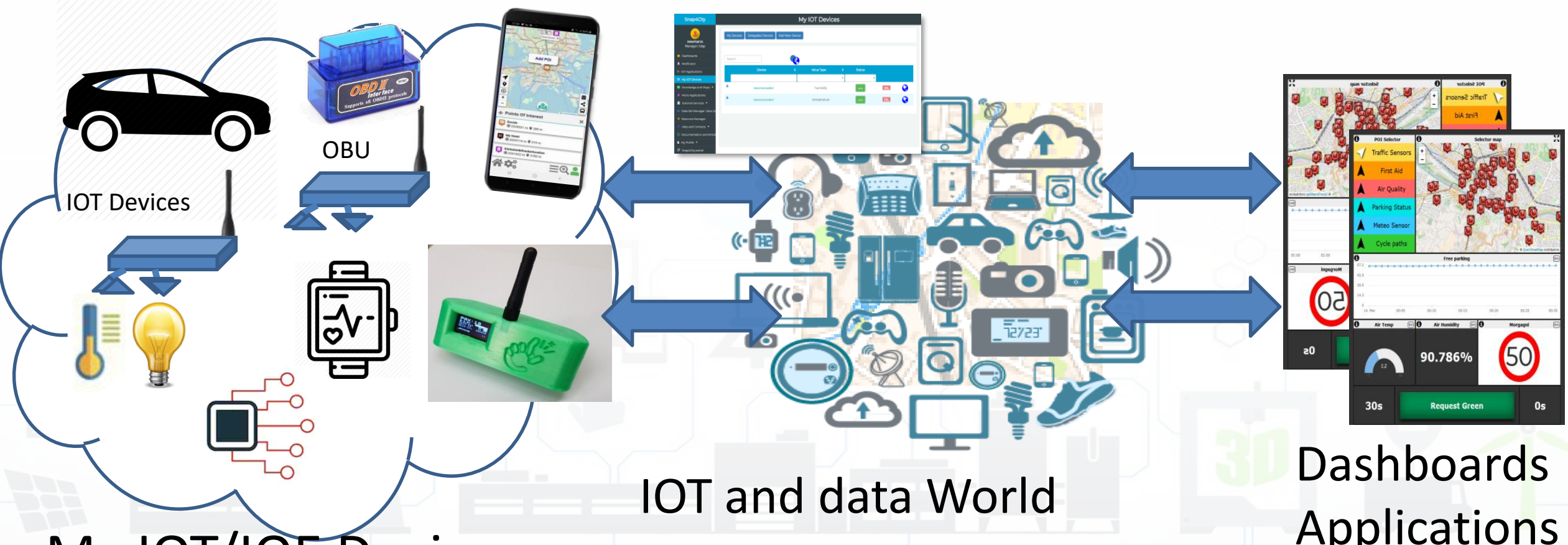
Any kind of data and flows

- **Open Data:**
  - Data gate, federation of Open Data Portals
  - ETL processes (PULL)
  - IOT Application processes
- **IOT Networks:**
  - IOT Application processes, data driven or PULL
  - IOT Brokers (Push) → IOT Shadow
- **Web Pages:**
  - Web scraping, crawling processes
- **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

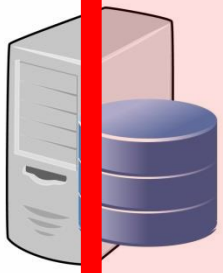
IOT Applications

- 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

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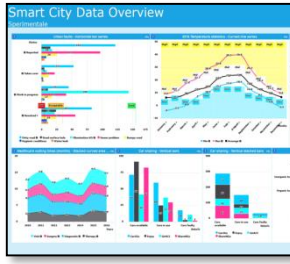





Data Sources, Brokers, External Services Data Driven, Real Time

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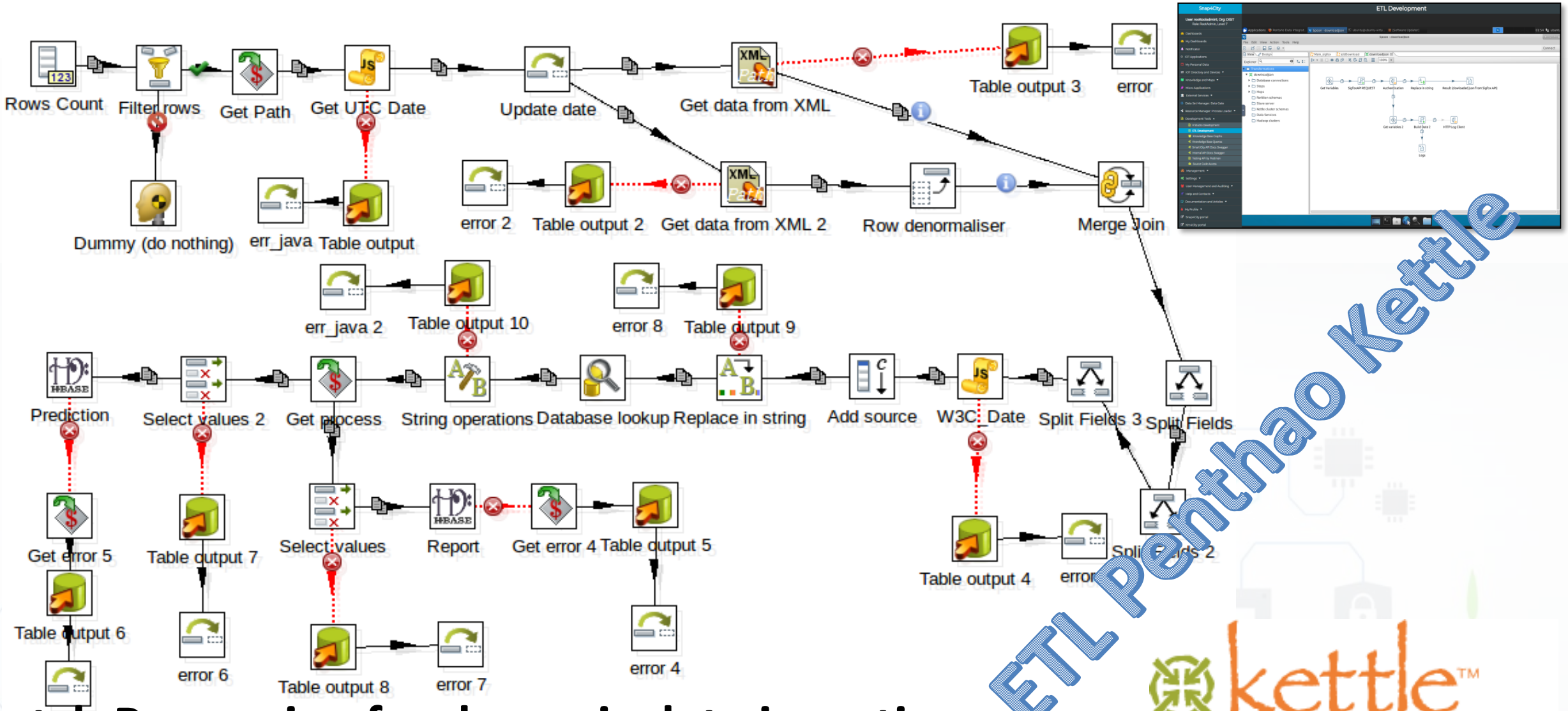
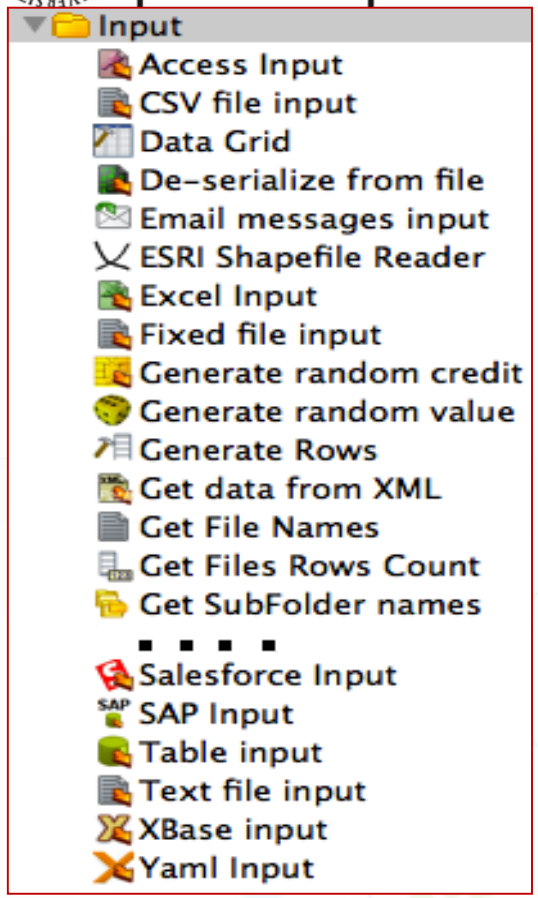
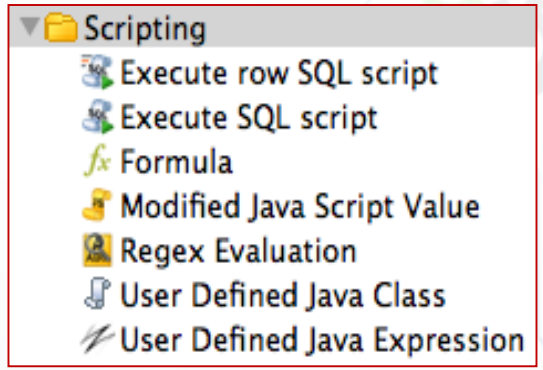
Integrated ETL development

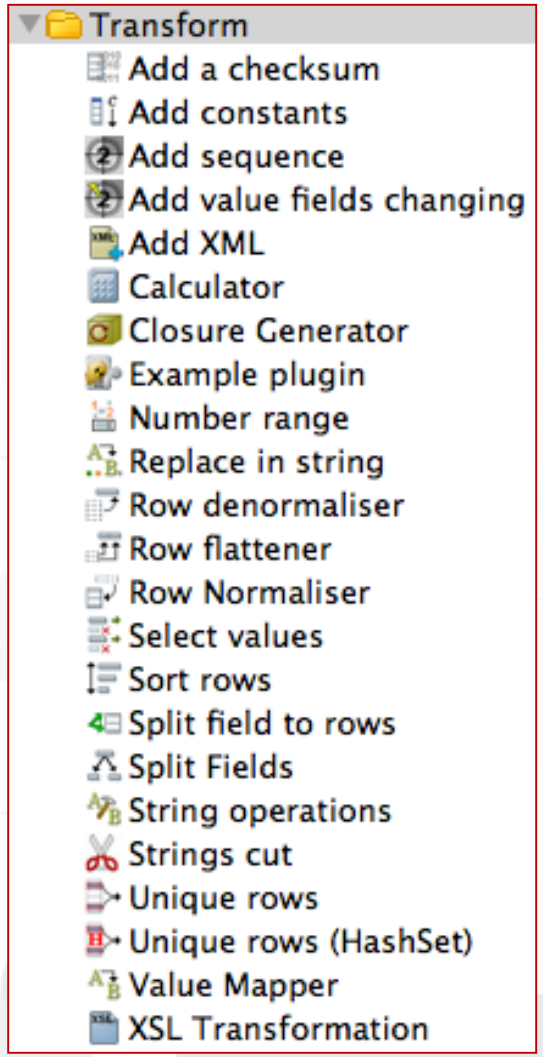


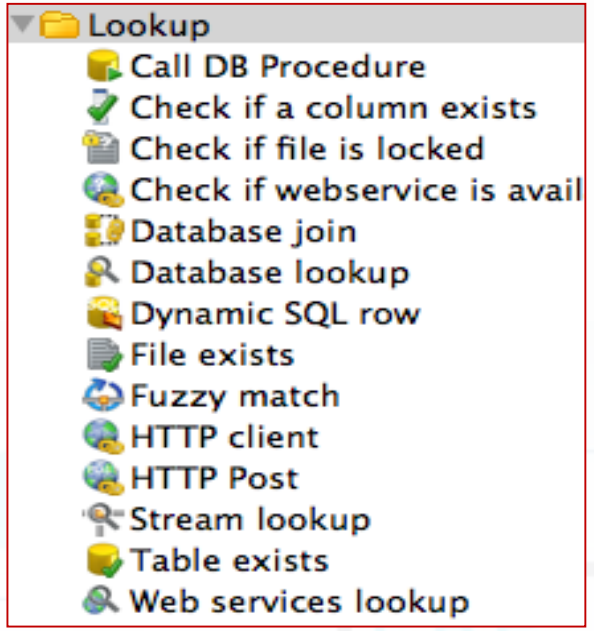
Batch Processing for dynamic data ingestion

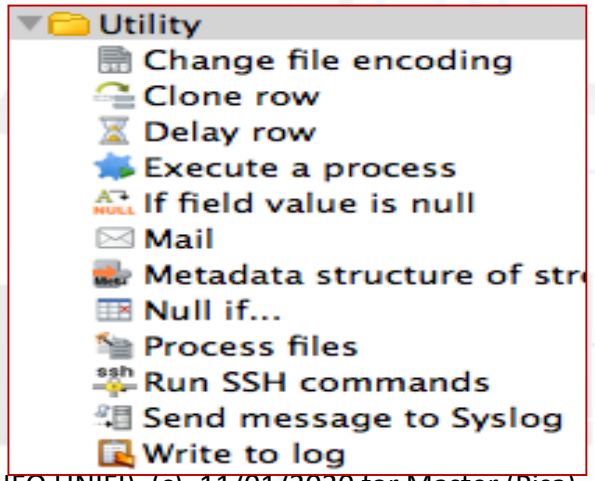
Type of Transformations in Spoon

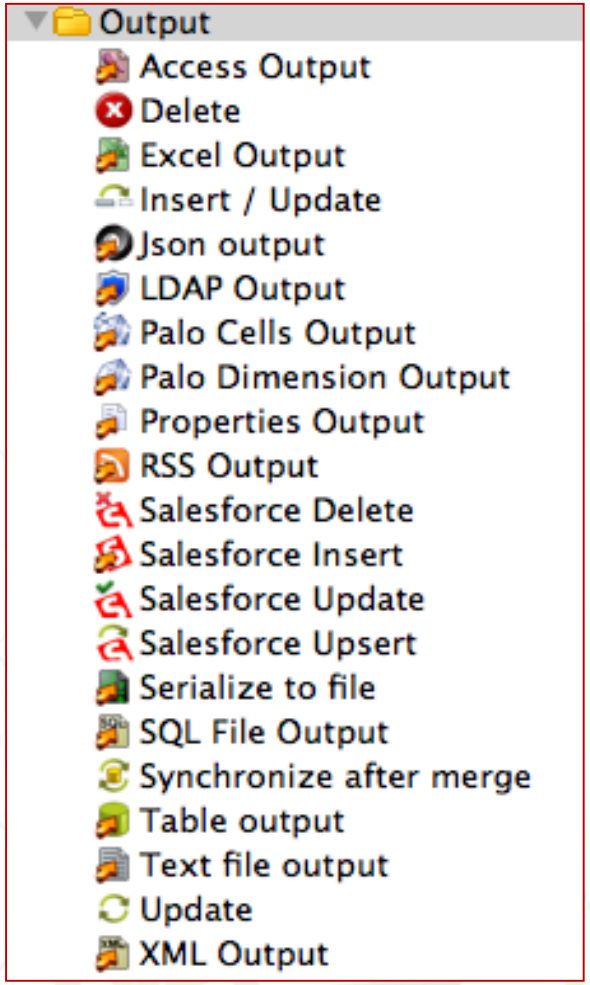












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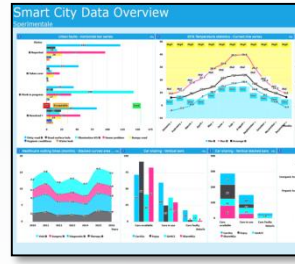



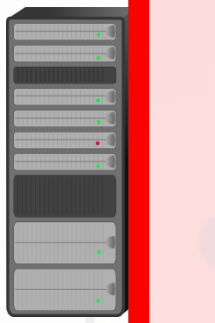

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IOT Architecture

IOT Device

IOT Device

IOT Device

IOT Device

FI-WARE IOT Orion Broker

AMQP

COAP

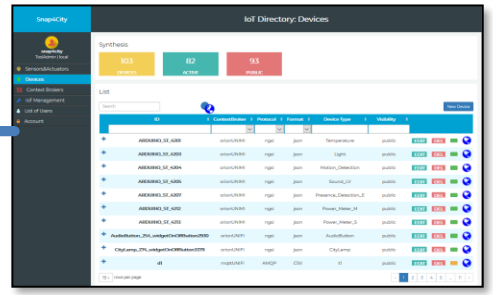
sigfox

THE THINGS NETWORK TheThingsNetwork

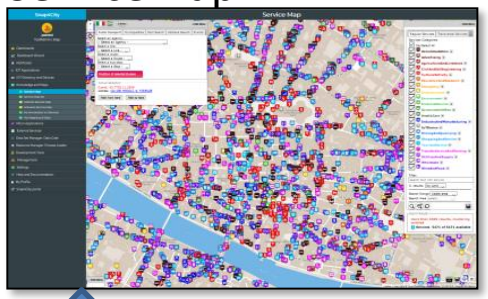
One M2M

.....

IOT Directory



ServiceMap



Registering
Discovery

Browsing
Discovering

Data Shadow,
Elastic Search

Knowledge Base,
Km4City



Advanced Smart City API

Snap4City MicroServices Node-RED

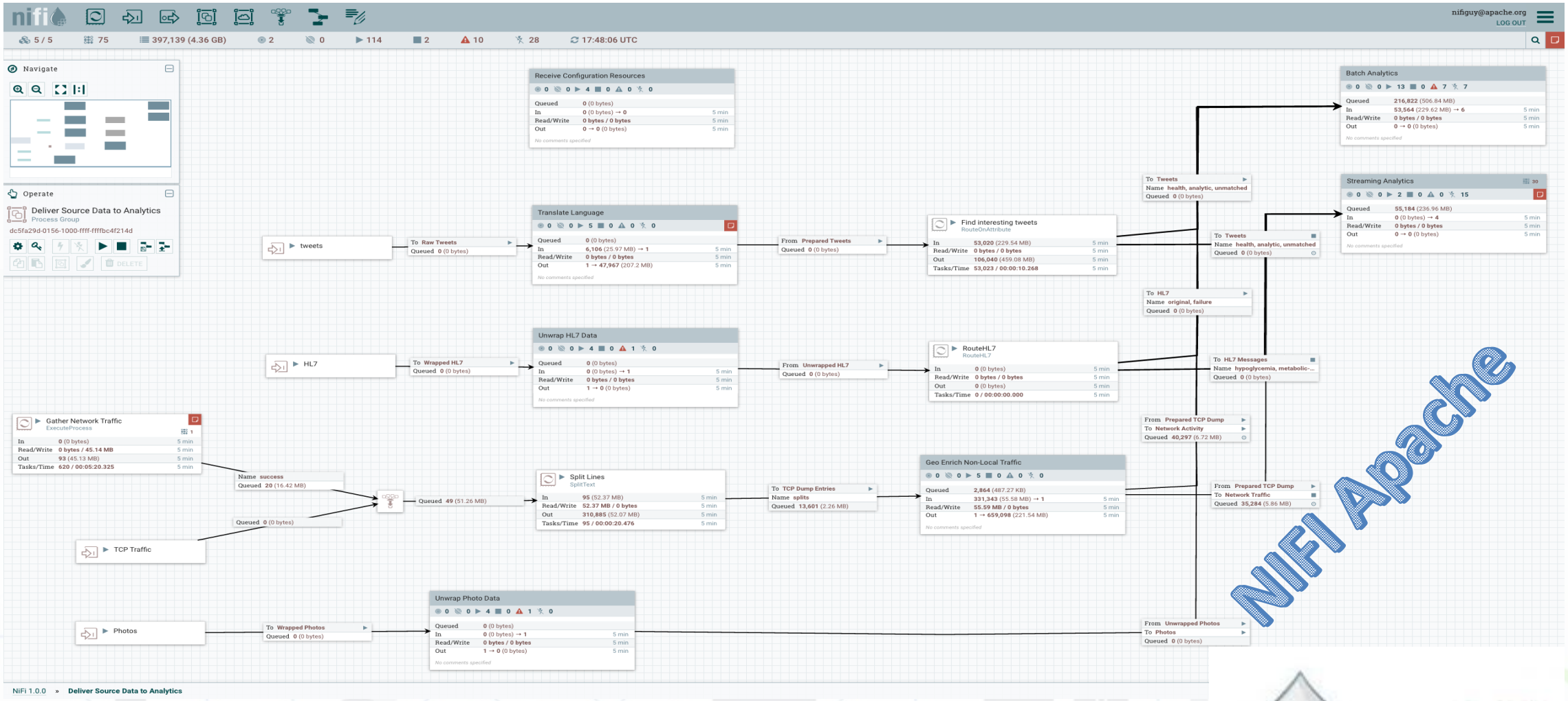


Elastic Management of IOT Applications



Dashboard

Example of NIFI

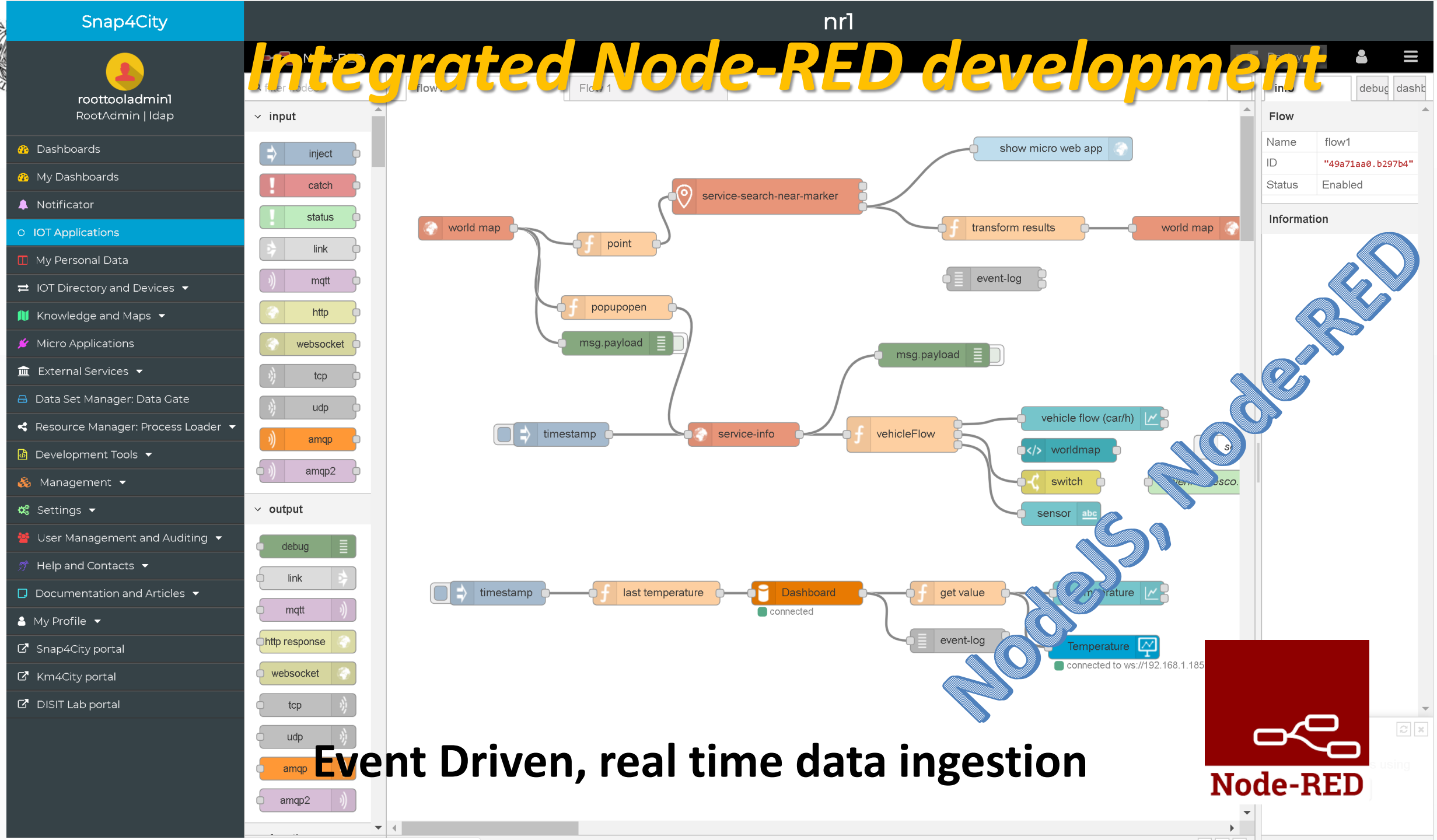


NIFI Apache

nifi

Batch and Data Driven Processing

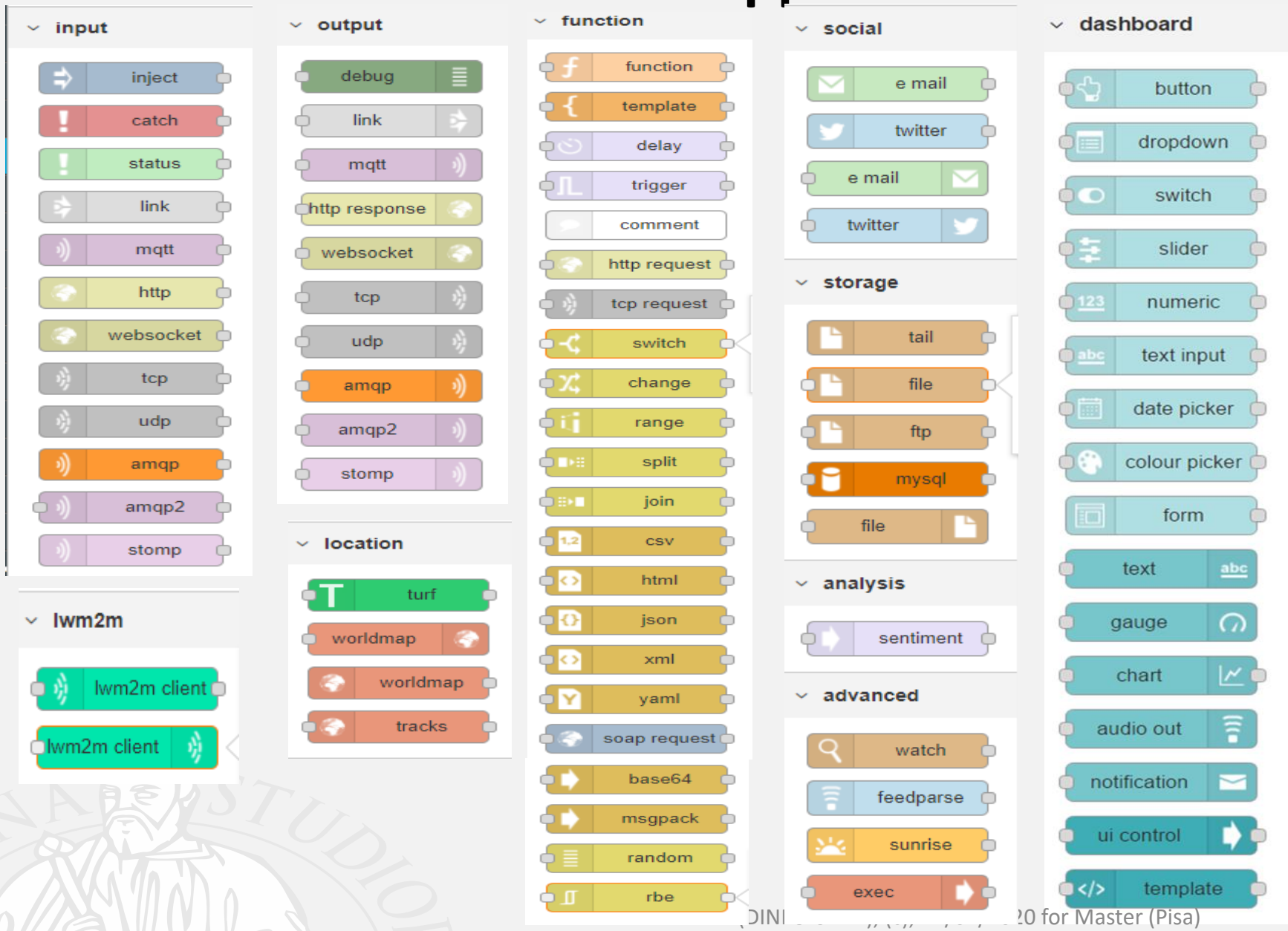
Integrated Node-RED development



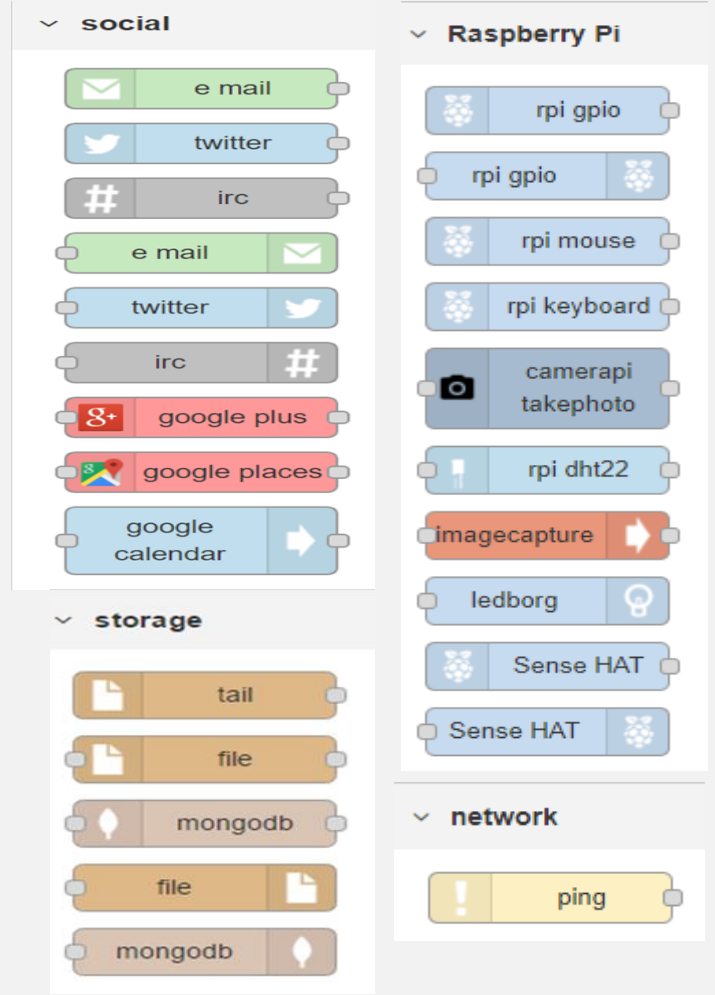
Event Driven, real time data ingestion

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



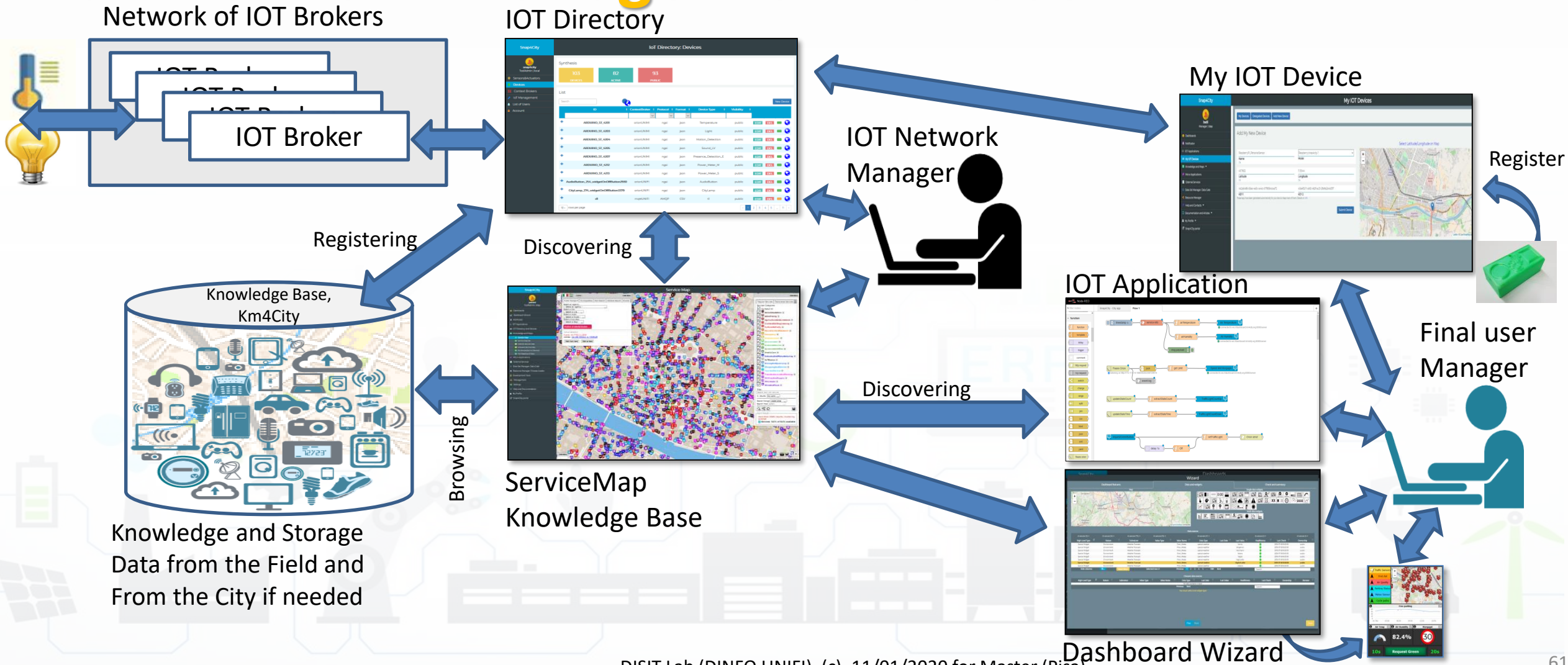


+ on IOT Edge Raspberry



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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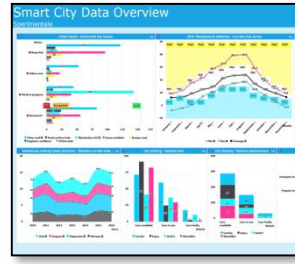
Node-RED + Snap4City MicroSrvs

Search and Query, Smart API
Facet, semantic search

Visual Analytics
Special dash/ tools

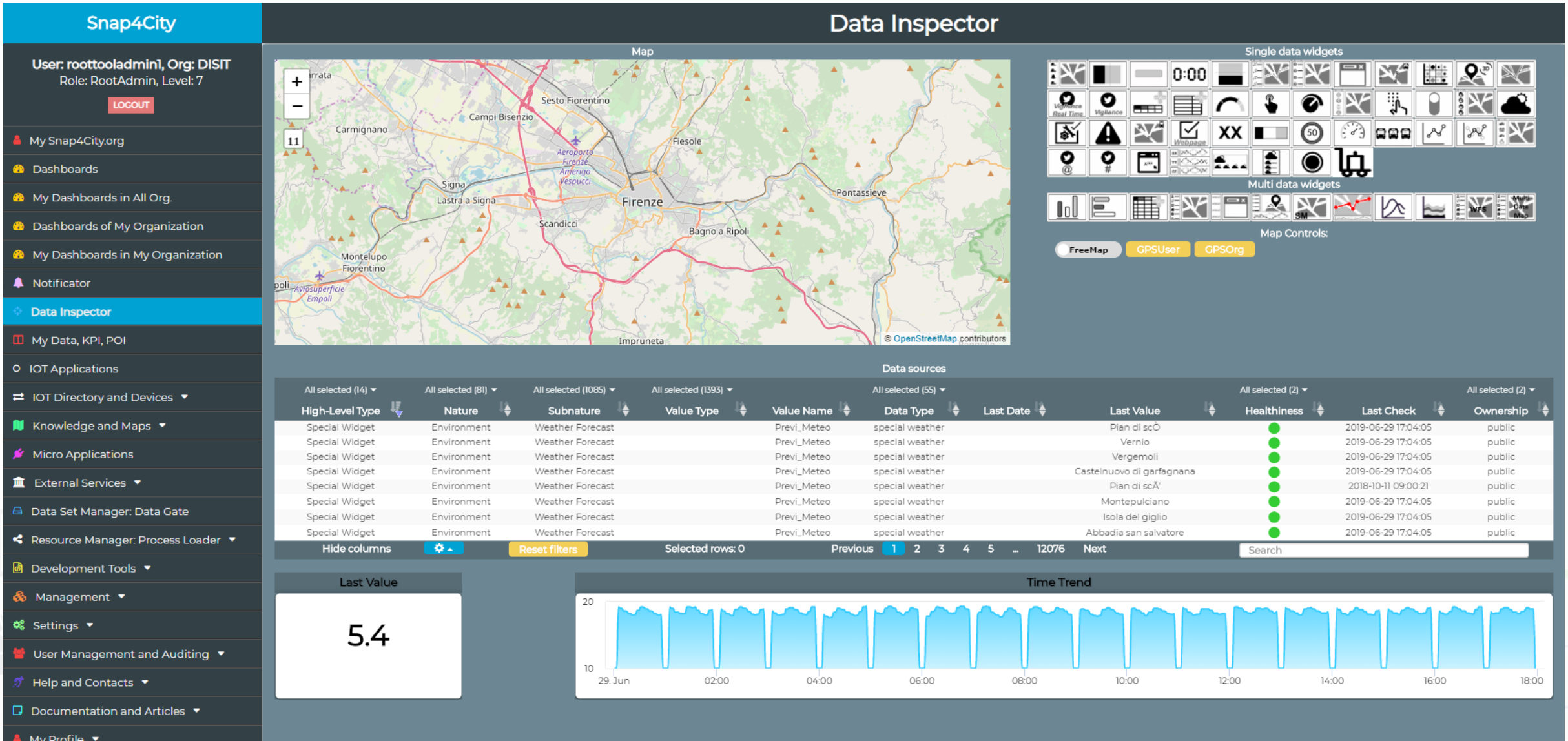
Rendering Acting, Widgets, MicroApps
User interface, Interactive Dashboard, Drill down, maps, heatmaps





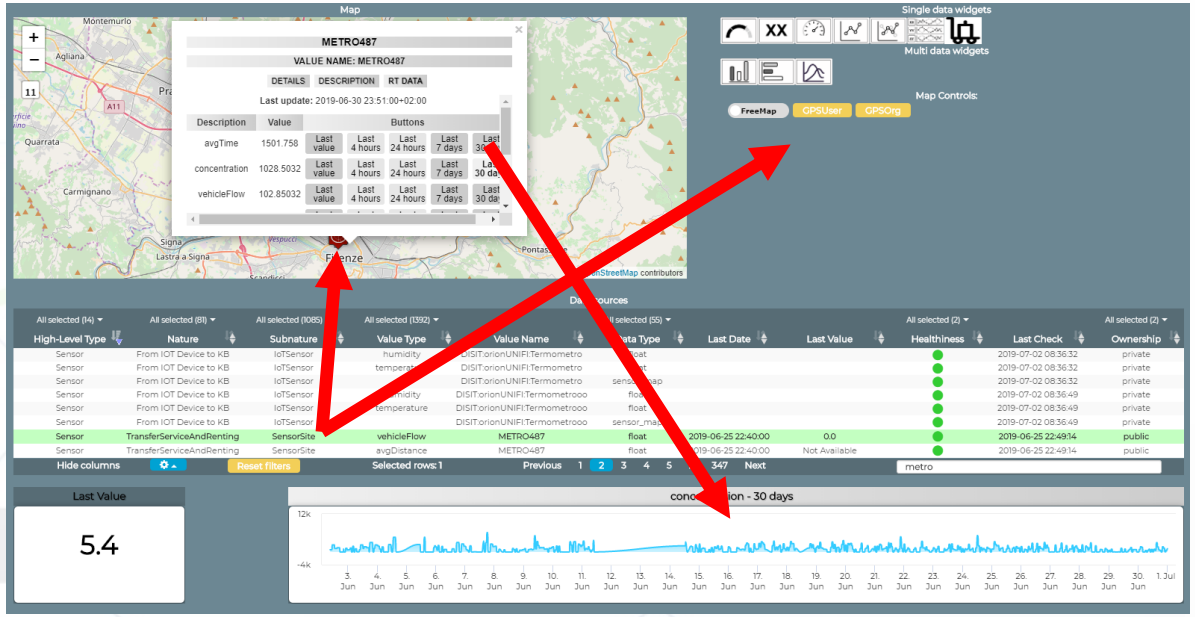
Inform, announce, Act!, warning, alarms, What-IF, ..

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

All selected (12)	All selected (68)	All selected (845)	All selected (827)		All selected (49)			All selected (2)		All selected (2)
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

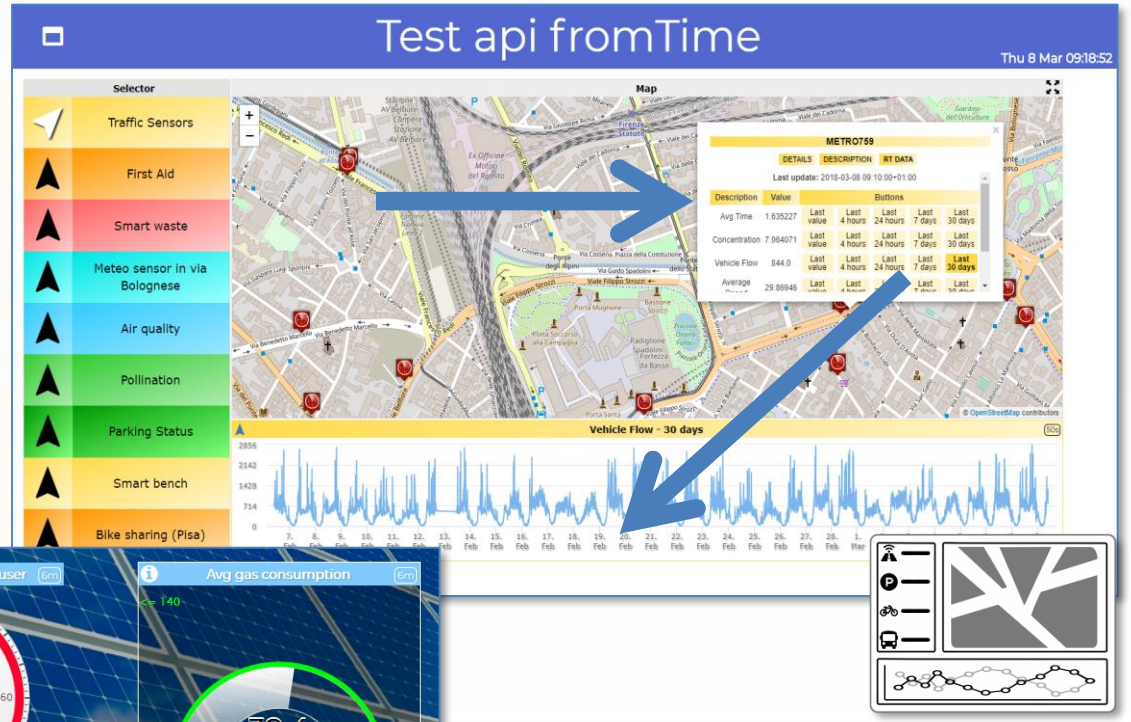
RealTime

Status

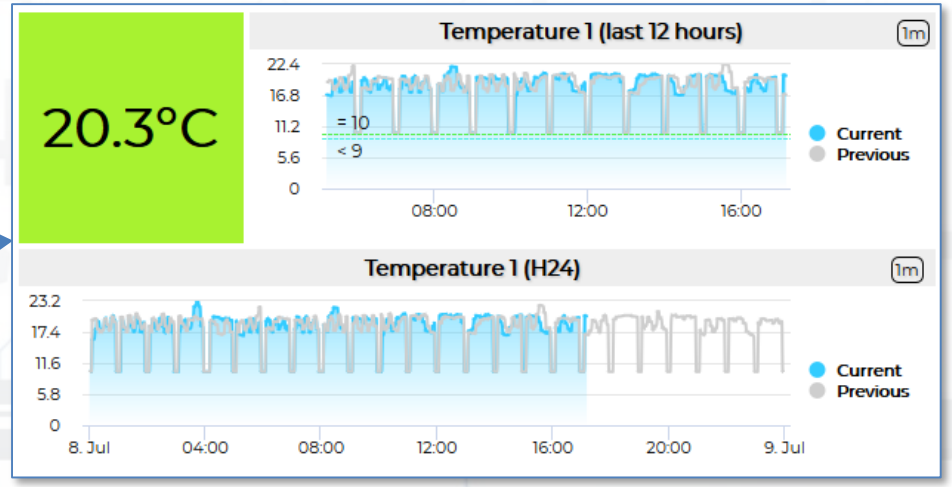
HLT: Sensors

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

HLT: Sensors

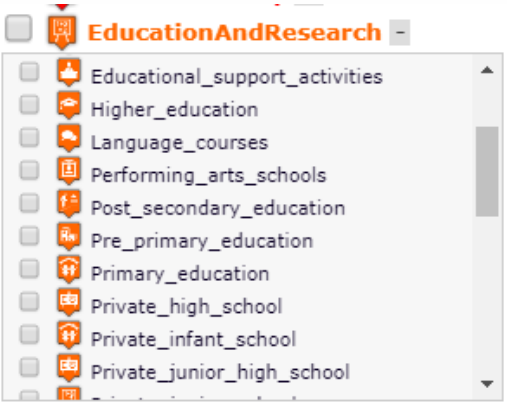
- Sensors can arrive in platform as follows (see **Nature**)
  - ***ETL processes*** in PULL
    - **As Periodic processes**
  - **From IOT Devices to KB** (knowledge base). Registered via IOT Directory, arriving via IOT Broker and saved into the Data Shadow,
    - **IOT data driven process** in PUSH
  - **From Dashboard to IOT Devices** (echo) is a virtual sensor **Sensor Actuators (HLT)**,
    - **IOT data driven process** in PUSH

IOT Data Driven

Nature

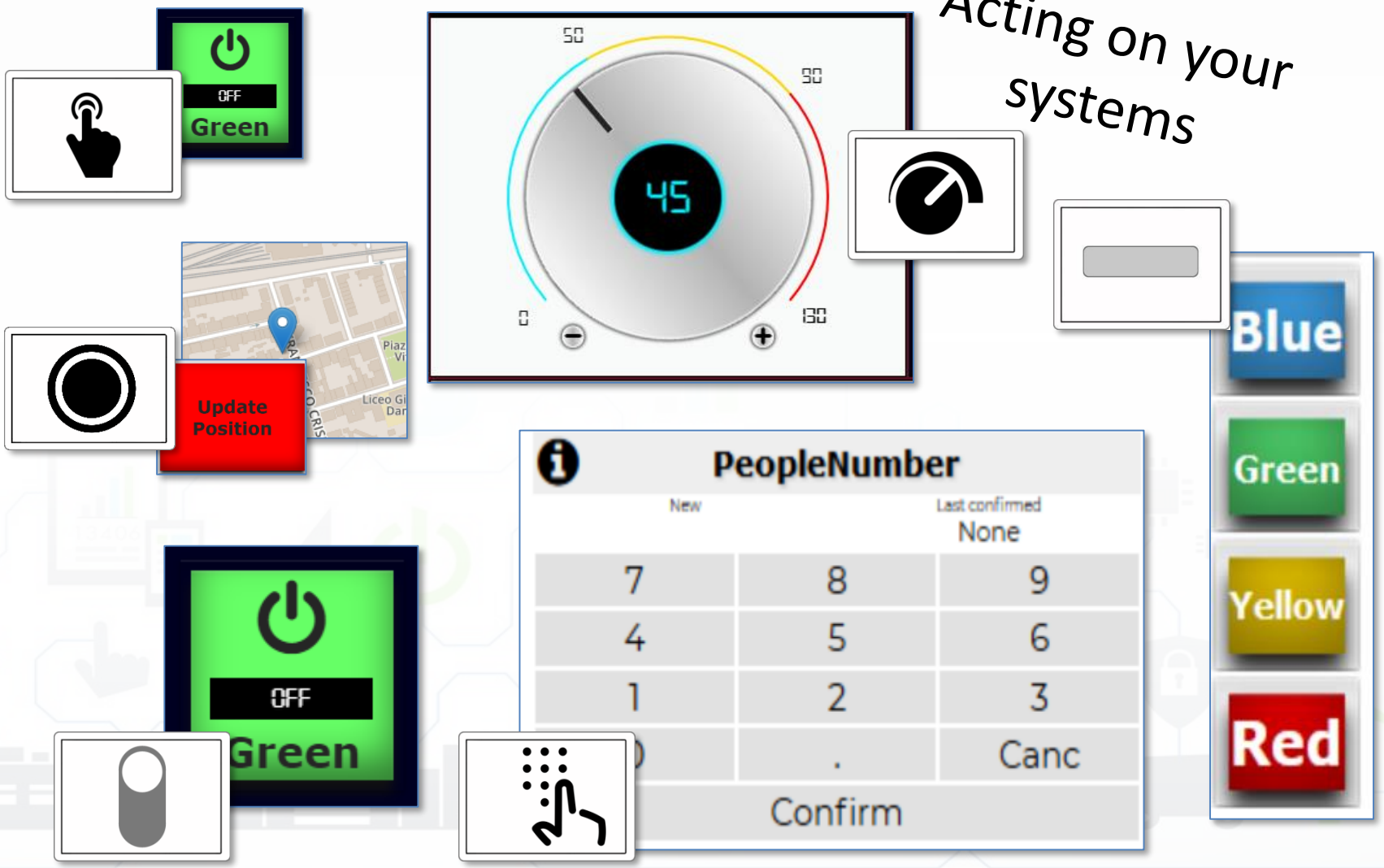
- Accommodation +
- Advertising +
- AgricultureAndLivestock +
- CivilAndEdilEngineering +
- CulturalActivity +
- EducationAndResearch +
- Emergency +
- Entertainment +
- Environment +
- FinancialService +
- GovernmentOffice +
- HealthCare +
- IndustryAndManufacturing +
- IoTDevice +
- MiningAndQuarrying +
- ShoppingAndService +
- TourismService +
- TransferServiceAndRenting +
- UtilitiesAndSupply +
- Wholesale +
- WineAndFood +

SubNature



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

- **Complex Event**
- **Dashboard-IOT App**
- **External Service**
- **Heatmap**
- **KPI (Key Performance Indicator)**
- **MicroApplication**
- My Personal Data
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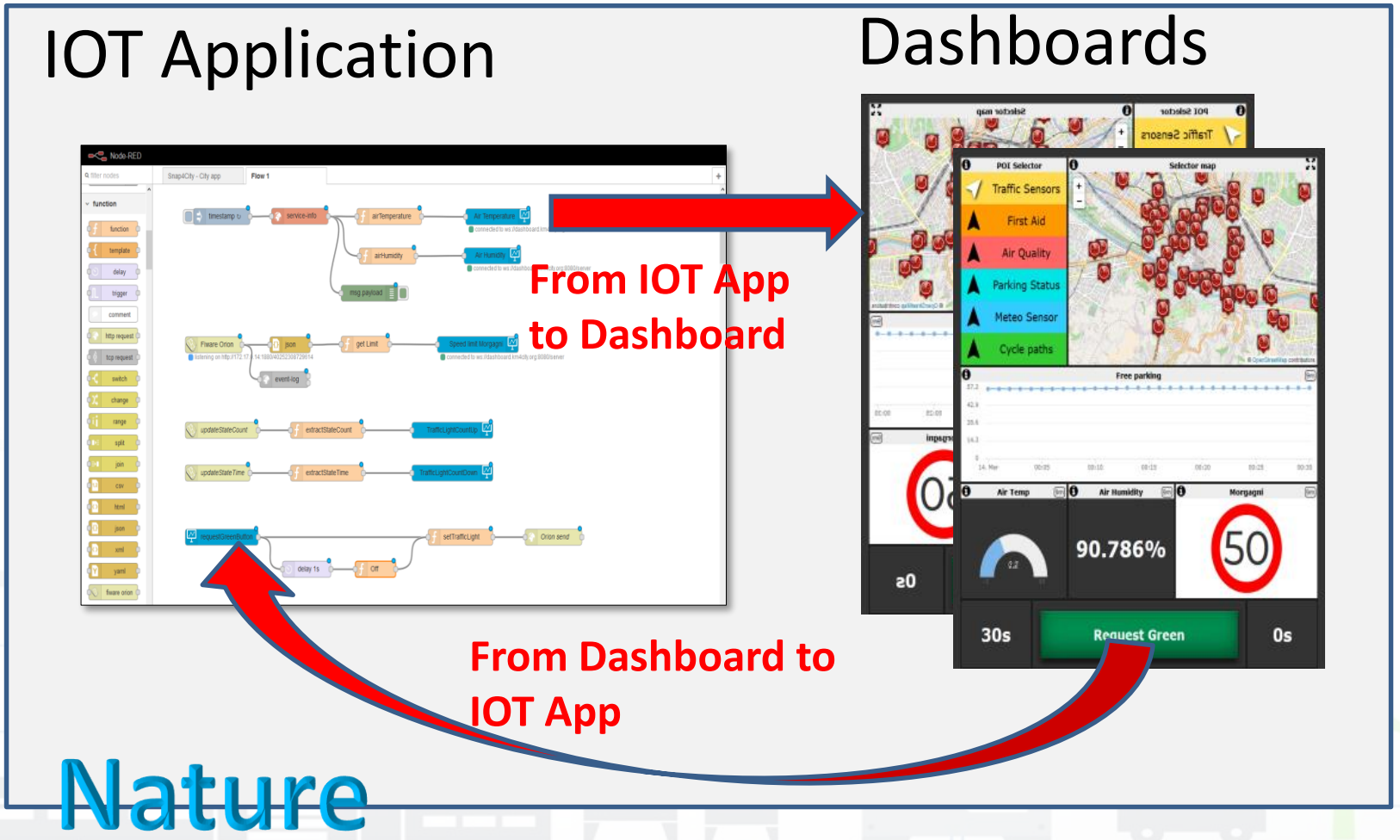

Data Gathering and Knowledge Management

- 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

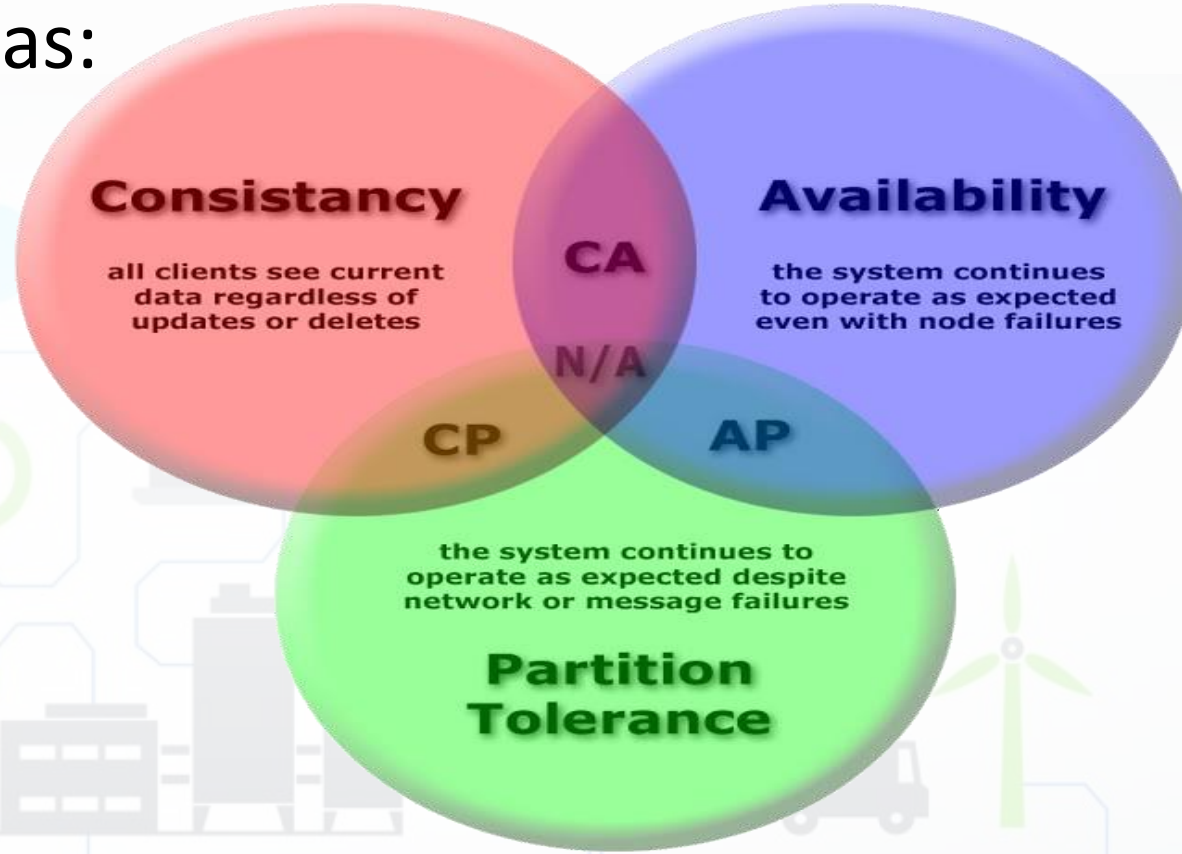
Types of NoSQL Database

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

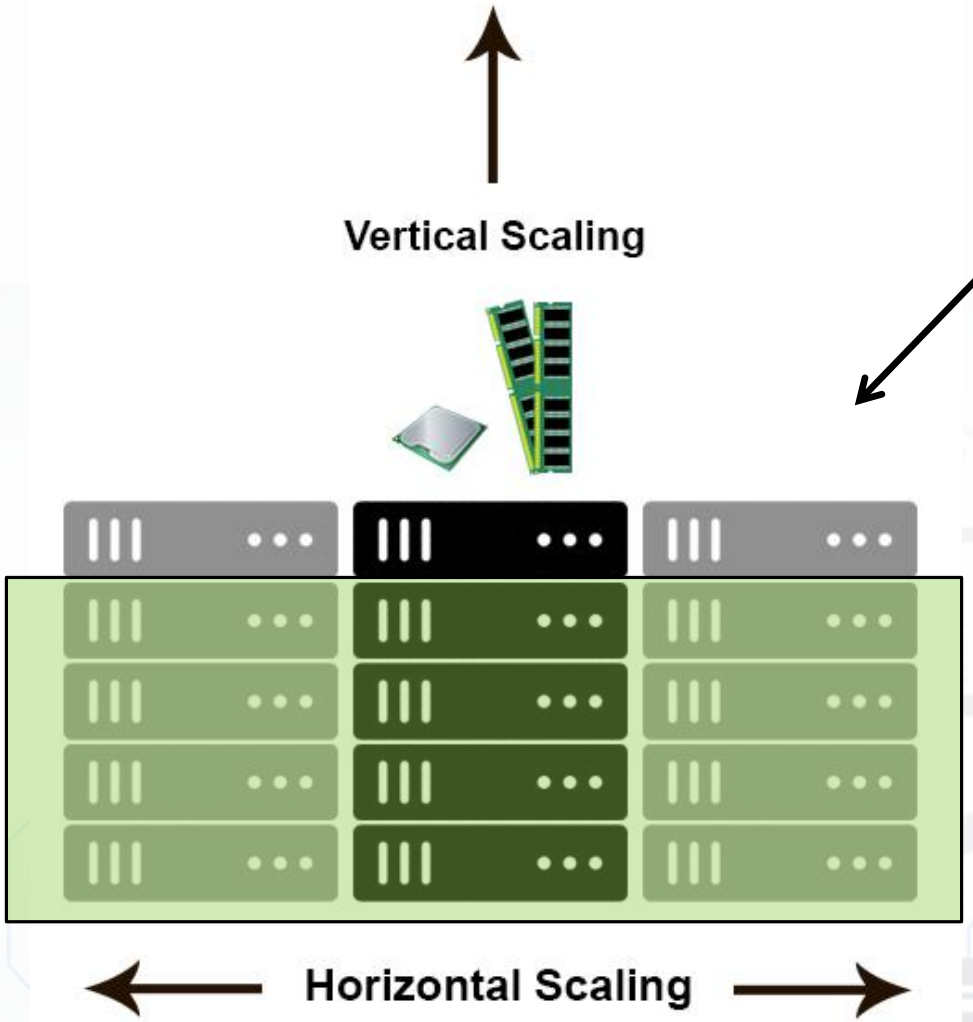


CAP theorem

- 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

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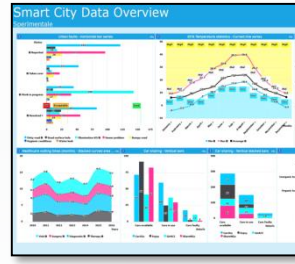
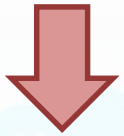




Inform, announce, Act!, warning, alarms, What-IF, ..

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

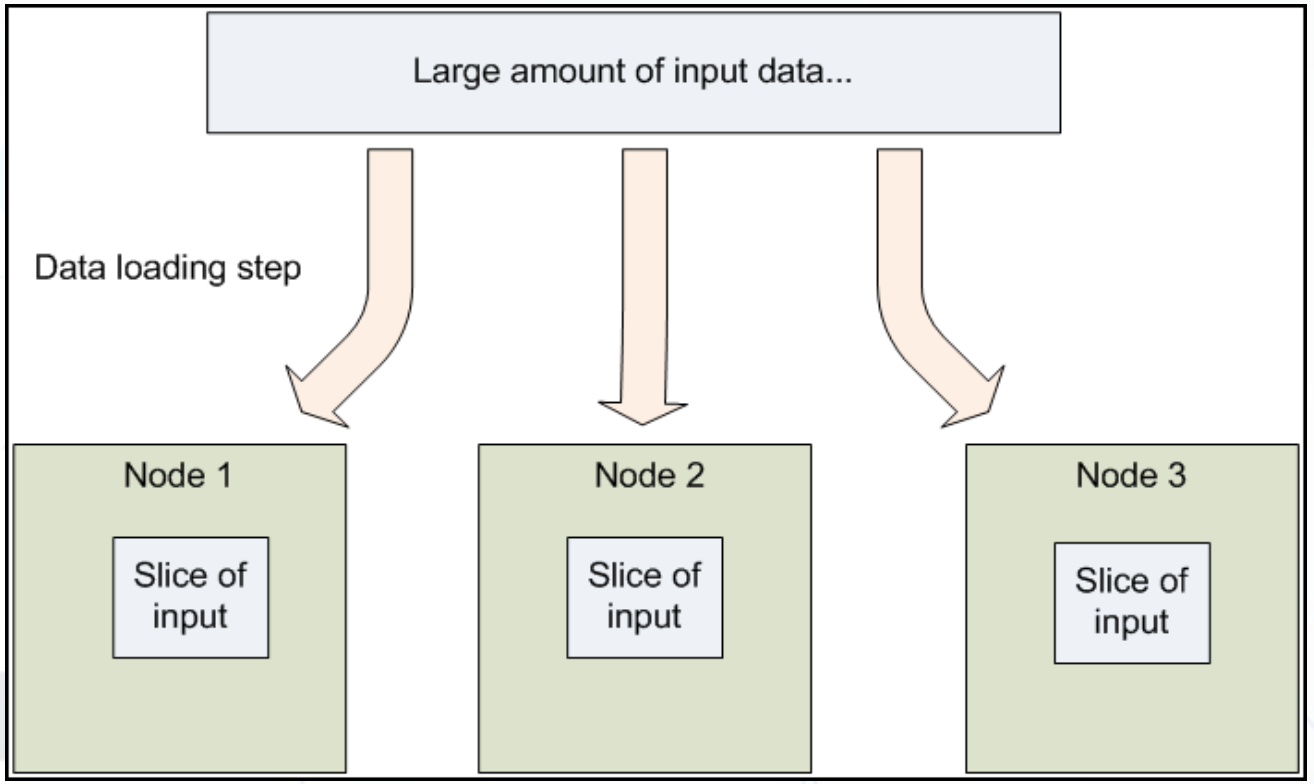
- A significative performance increase may be perceived only with a high number of nodes.
- Parallel computational paradigms, such as MPI (Message Passing Interface) may have better performance on a cluster composed by 2, 4, or up to 10 thousand nodes.
- Hadoop is specifically designed to have a linear 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 !!!

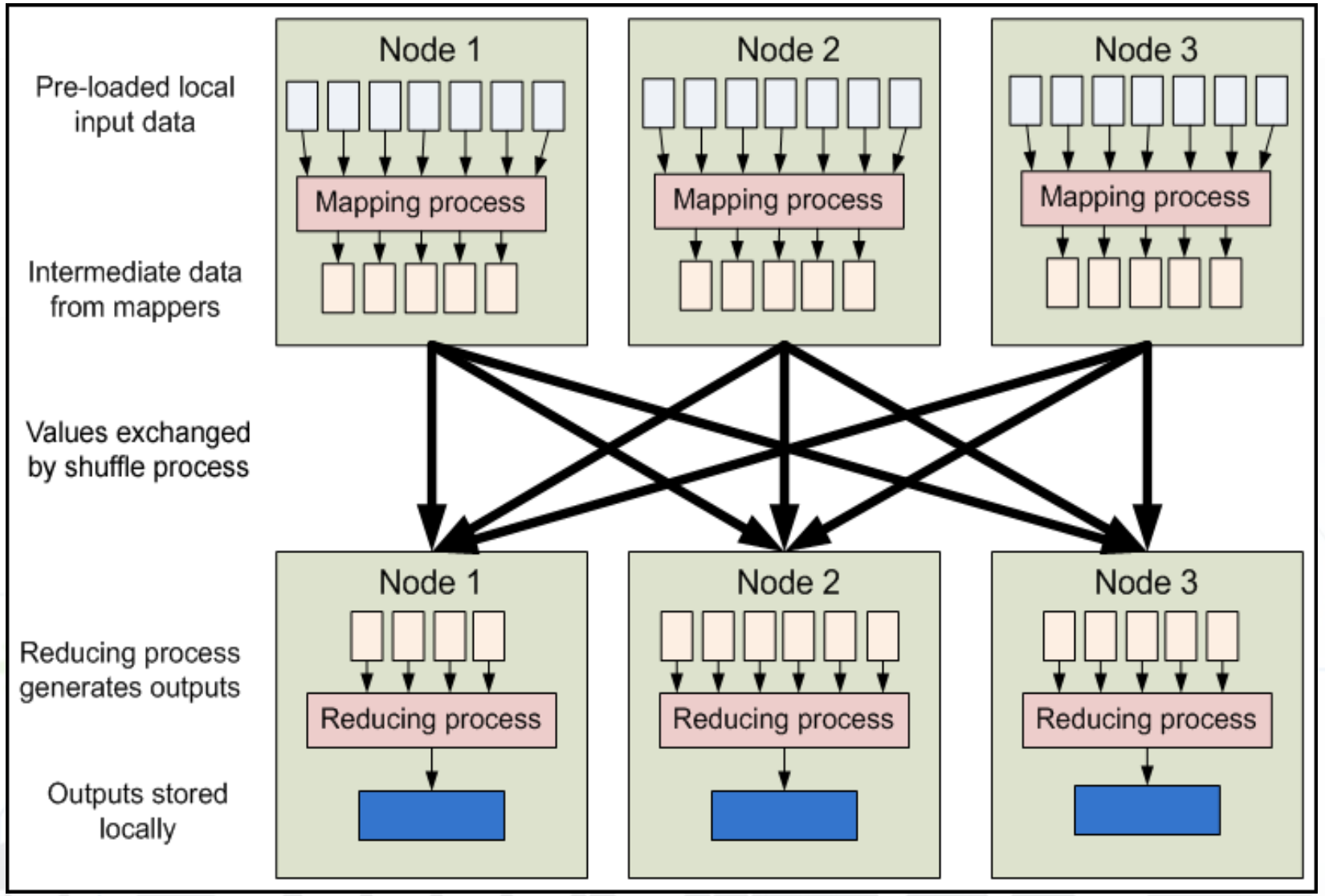


Processes vs Data

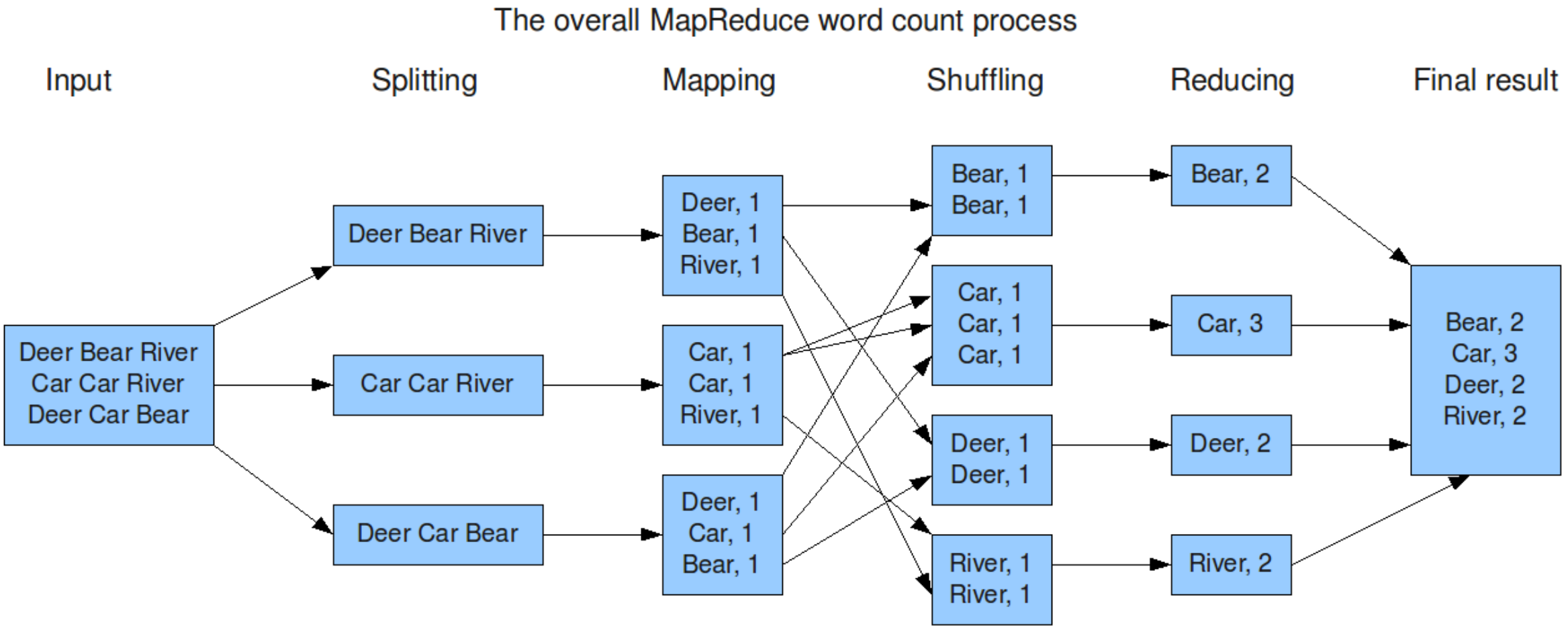
- Processes works on specific chunks of data. The allocations of processes depend on the position of the chunks they need to access,
- That is: data locality.
  - This reduces the data flow among nodes
  - Avoid communications among nodes to serve computational nodes
  - Hadoop is grounded on moving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

MapReduce: Isolated Processes

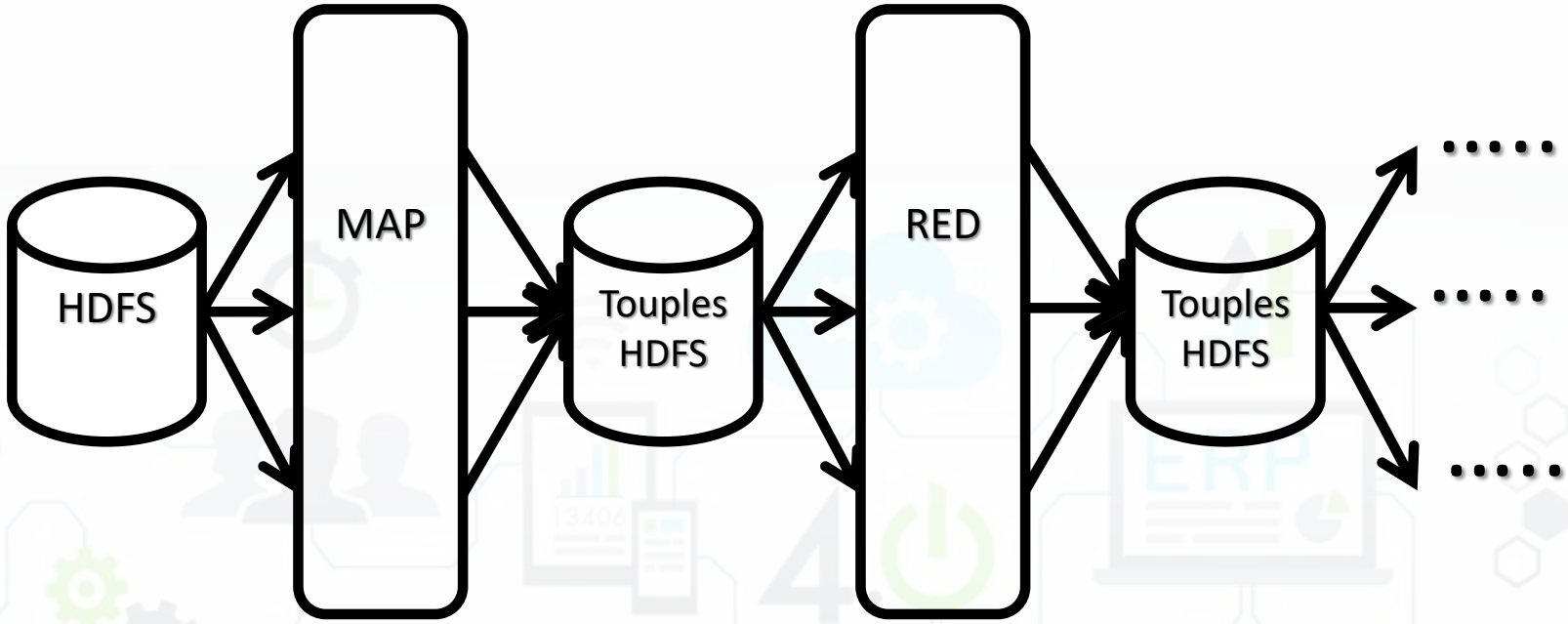
- The main idea:
  - Each individual record is processed by a task in isolation from one another.
    Replications allow to reduce communications for: contour conditions, data overlap, etc.
- This approach does not allow any program to be executed.
- Algorithms have to be converted into parallel implementations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

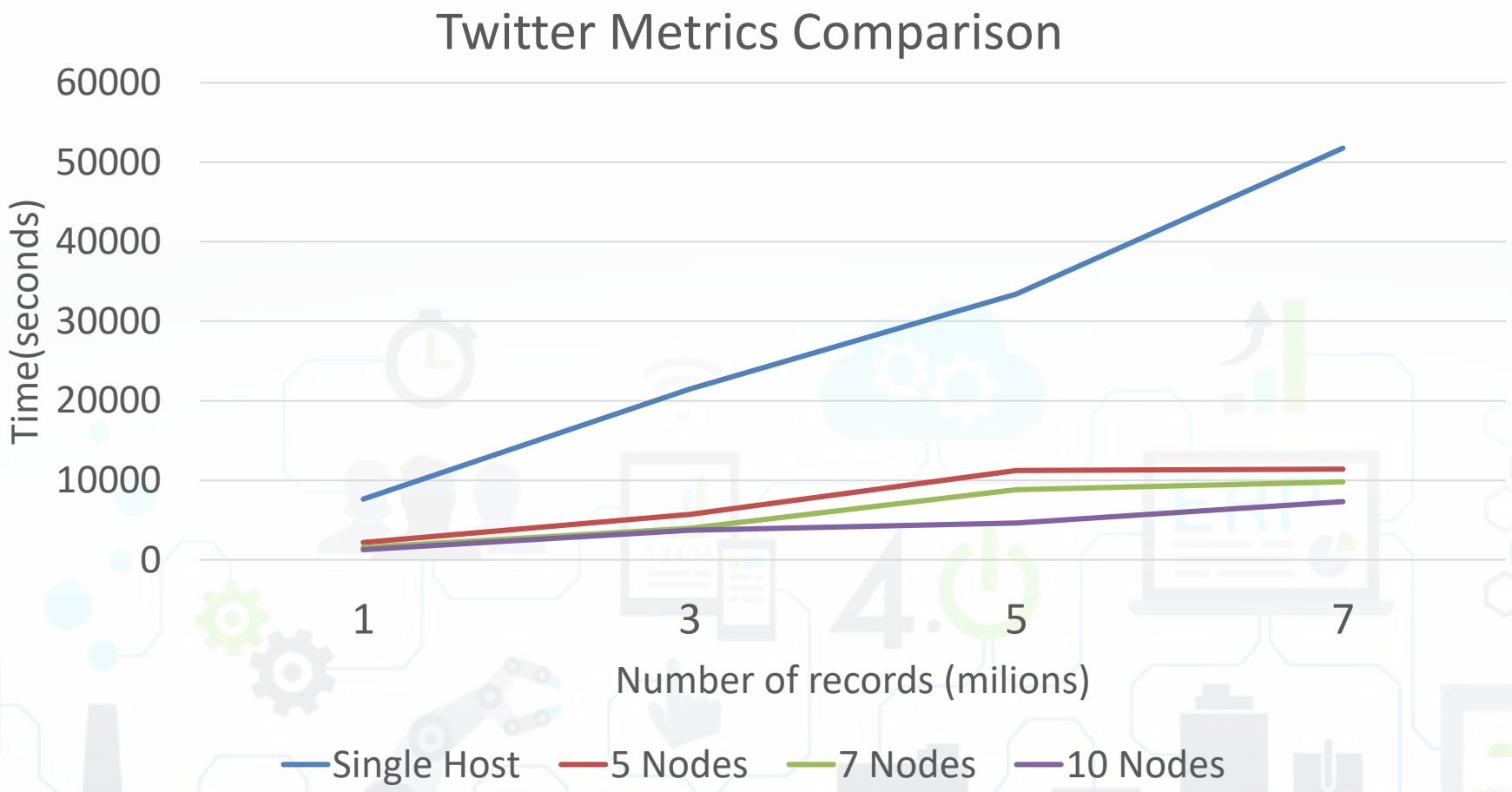


Classic MapReduce

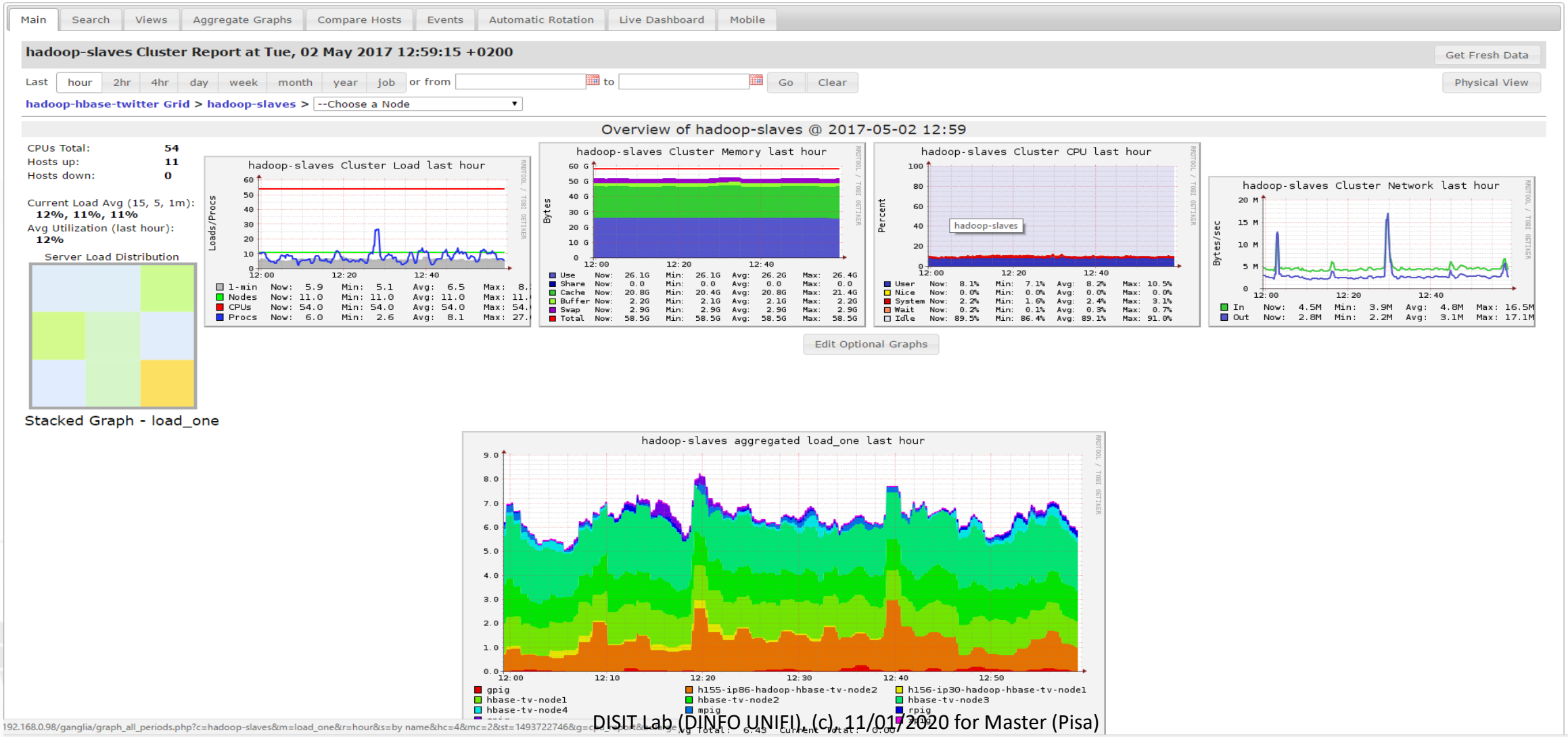


- In processes with several iterations the R/W cost may be too high even if performed in parallel

Single Host vs Hadoop



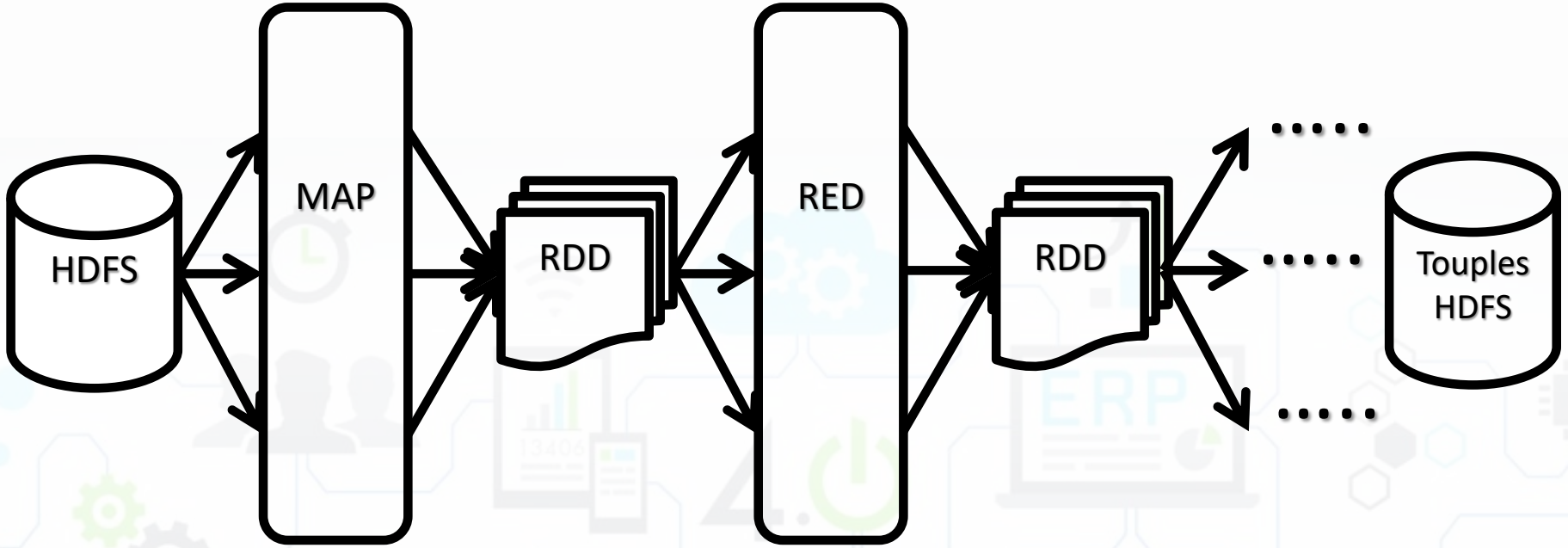
Ganglia: Monitoring MapReduce



Host level detail



Iterations with Spark



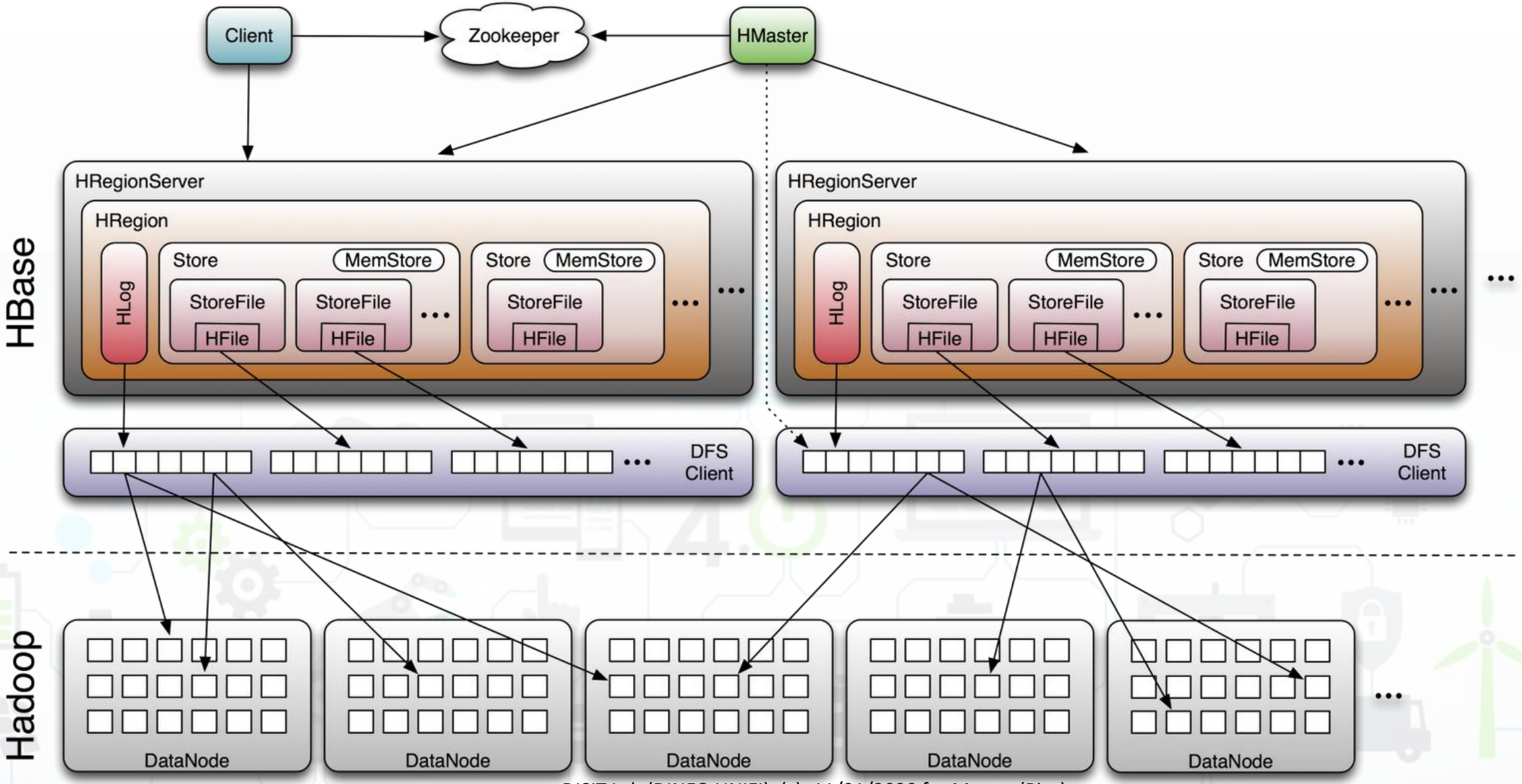
- In processes with several iterations the R/W is going to performed in memory and only finally on HDFS

HBASE on top of HDFS

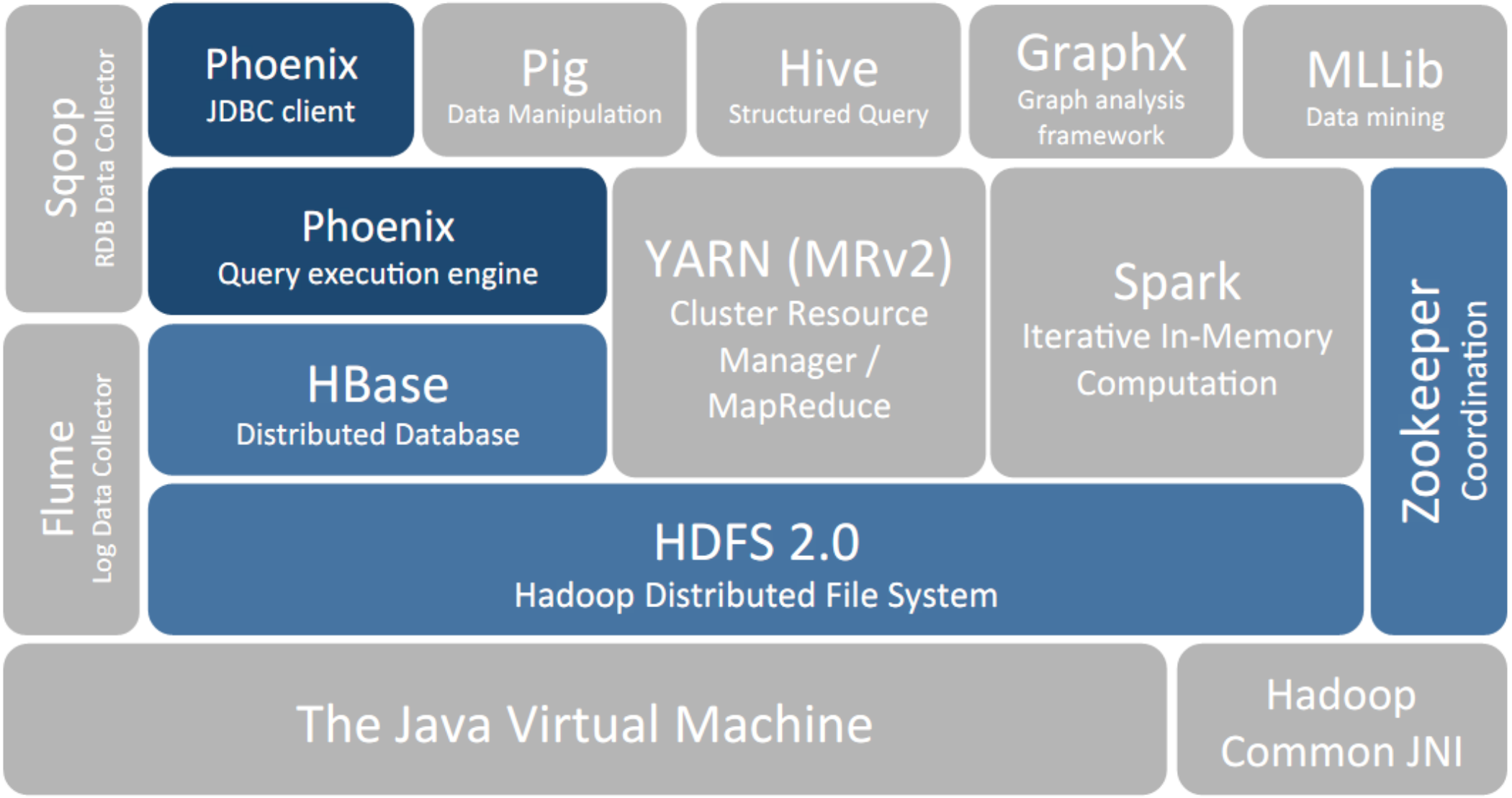


- HBase is a NoSQL (schema-less), column-oriented database.
- It is open source, sparse, consistently distributed, sorted map modeled after Google's BigTable.
- Developed as part of Apache's Hadoop project and runs on top of Hadoop Distributed File System.
- Horizontaly, linearly scalable

Big Picture


Client
Zookeeper
HMaster
HBase
HRegionServer
HRegion
HLog
Store
MemStore
StoreFile
HFile
DFS Client
Hadoop
DataNode

Apache Phoenix



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Knowledge Representation



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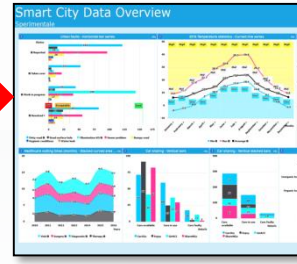




Inform, announce, Act!, warning, alarms, What-IF, ..

Exploiting Expert System

Visual Analytics
Special dashboards and tools

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

IOT Applications
Node-RED + Snap4City MicroServices

Search and Query, Smart API
Facet, semantic search

Knowledge base
Semantic reasoners



Indexing and aggregating
Elastic search

Big Data Cluster
HDFS, Hbase, Phoenix

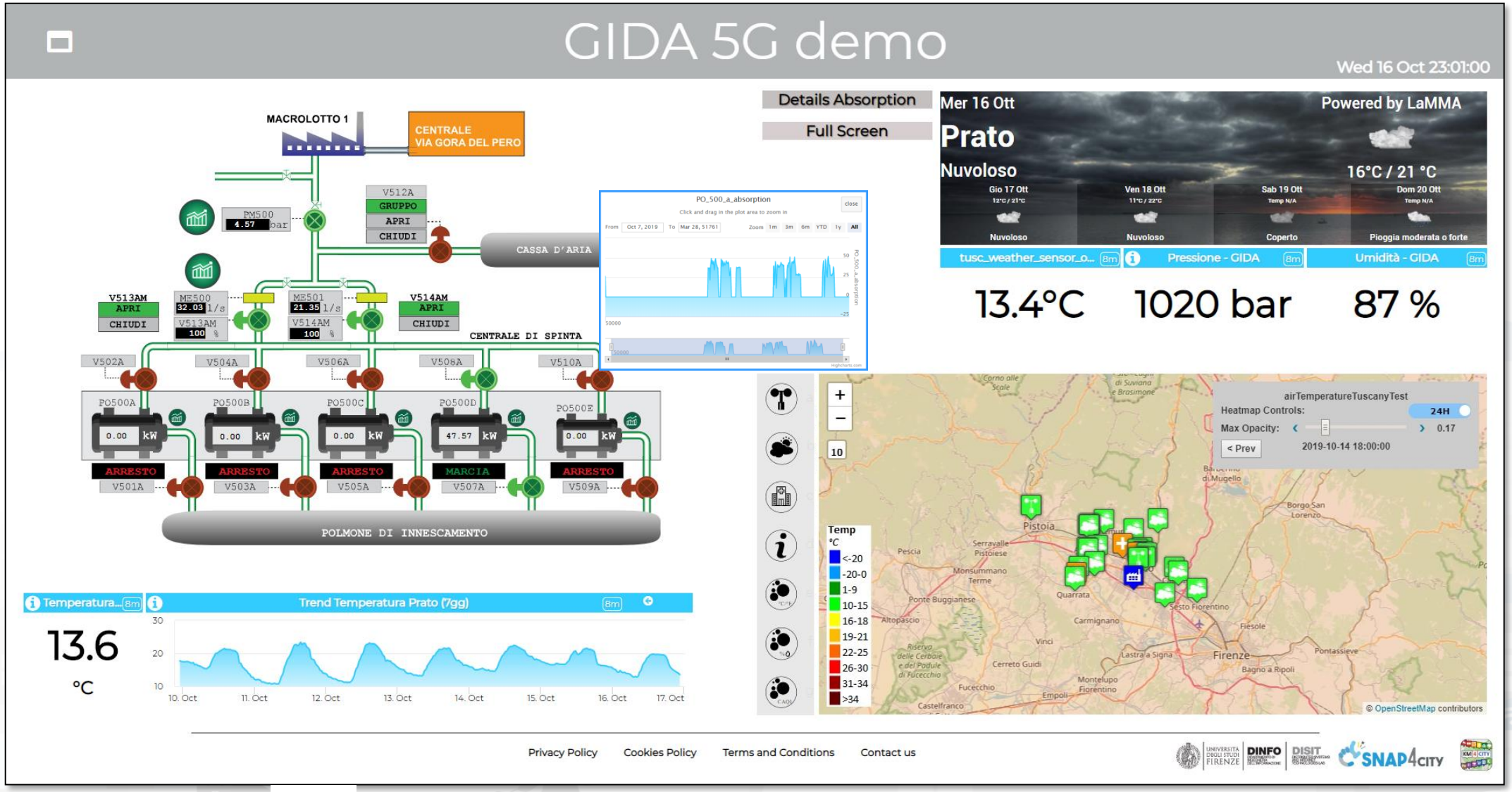
Rendering Acting, Widgets, MicroApps
User interface, Interactive Dashboard, Drill down, maps, heatmaps





- **Semantic RDF store**
  - Discovery
  - Spatial queries
  - Relationships queries
- **Tabular/documental+index**
  - Time Series
  - multifiltering

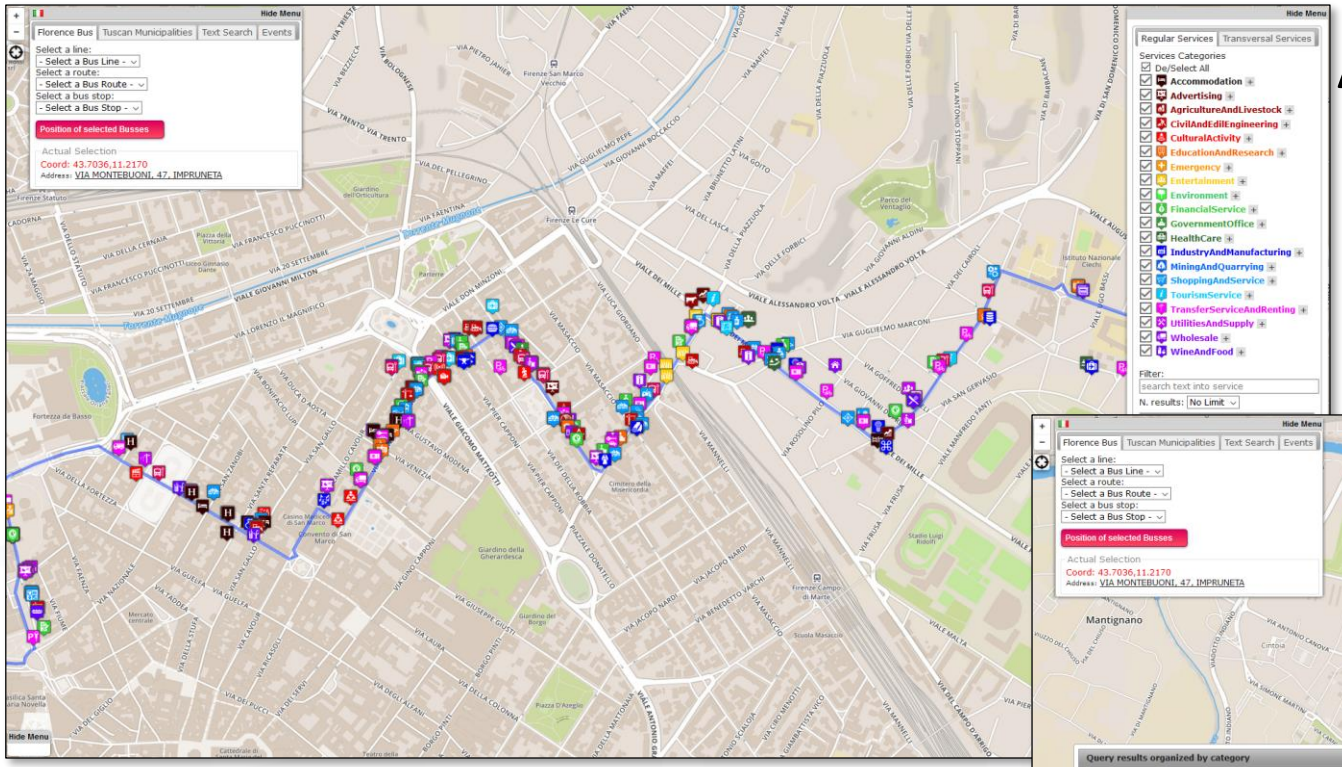
Demo UC5 GIDA



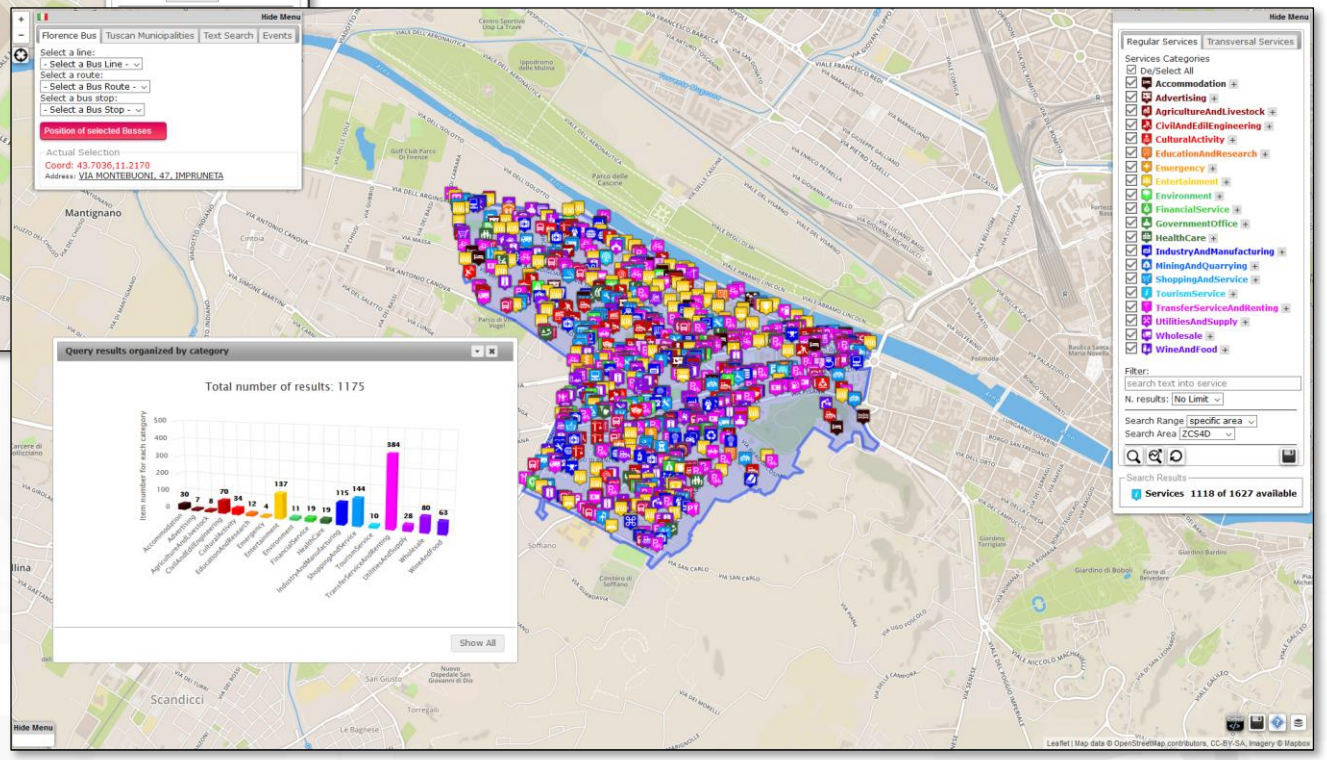
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjIyNg==

Along a path

Sii-Mobility

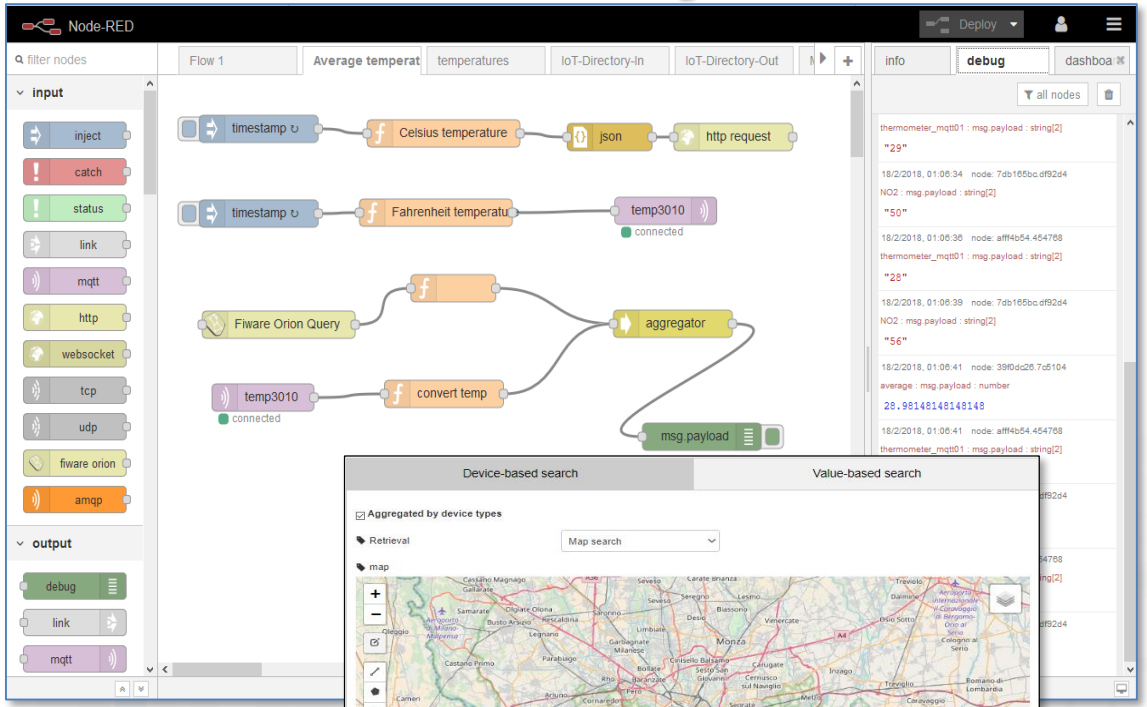


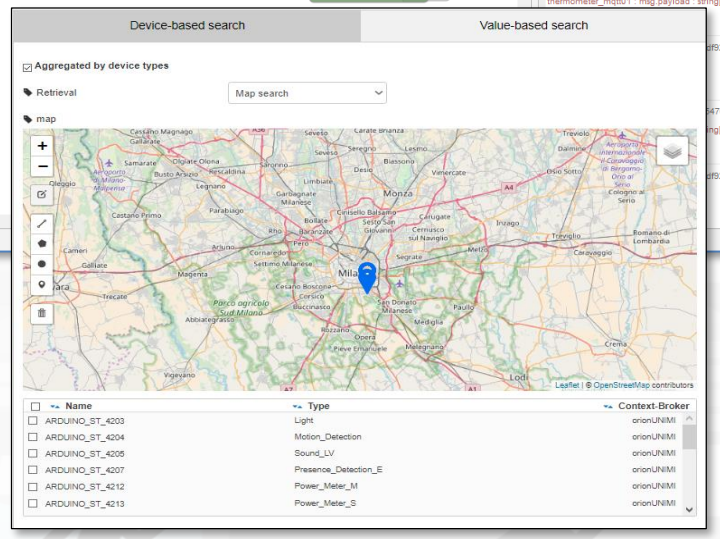
Inside an area

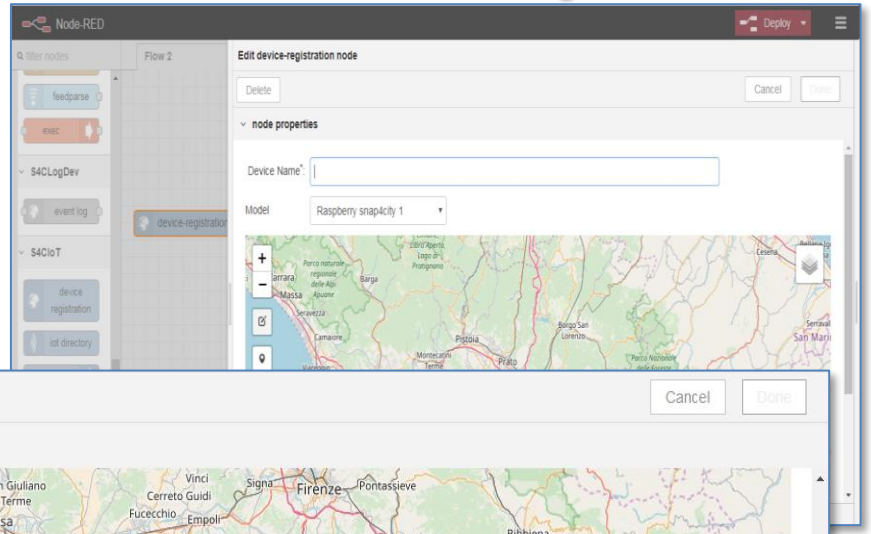


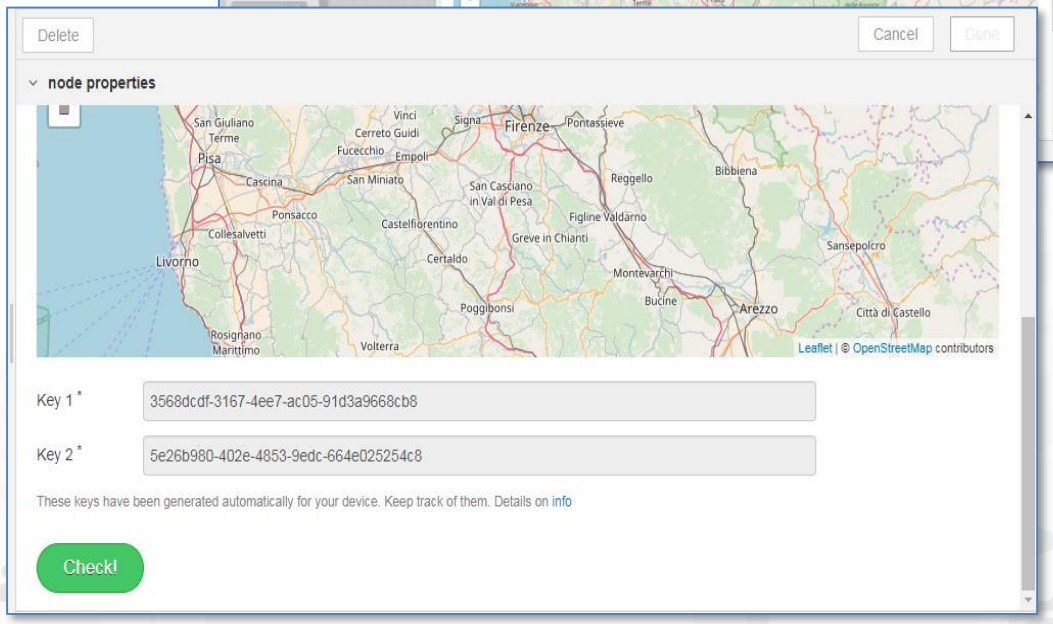
ServiceMap: https://servicemap.km4city.org

IOT Discovery on IOT Application Development



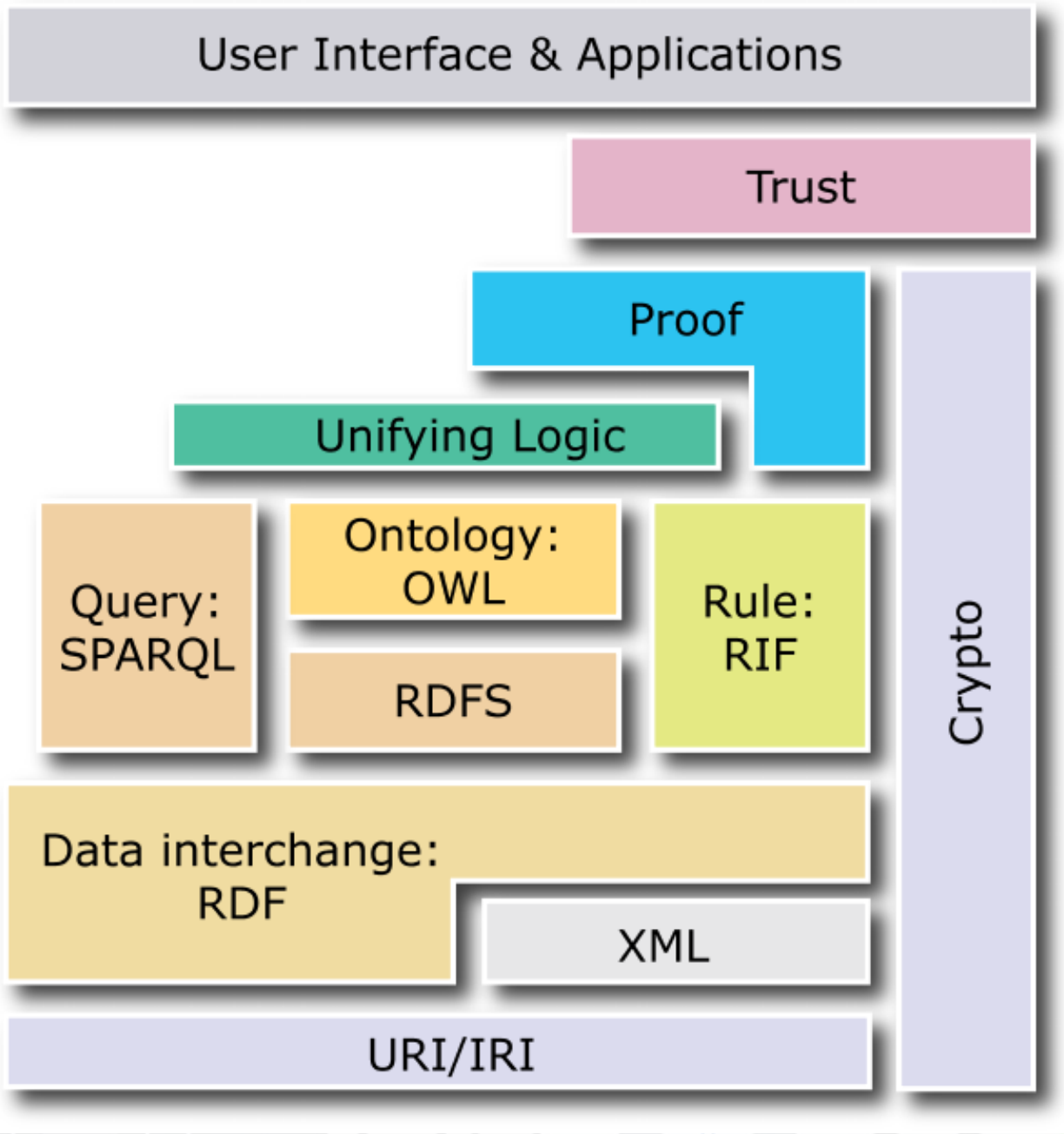






Semantic Web stack

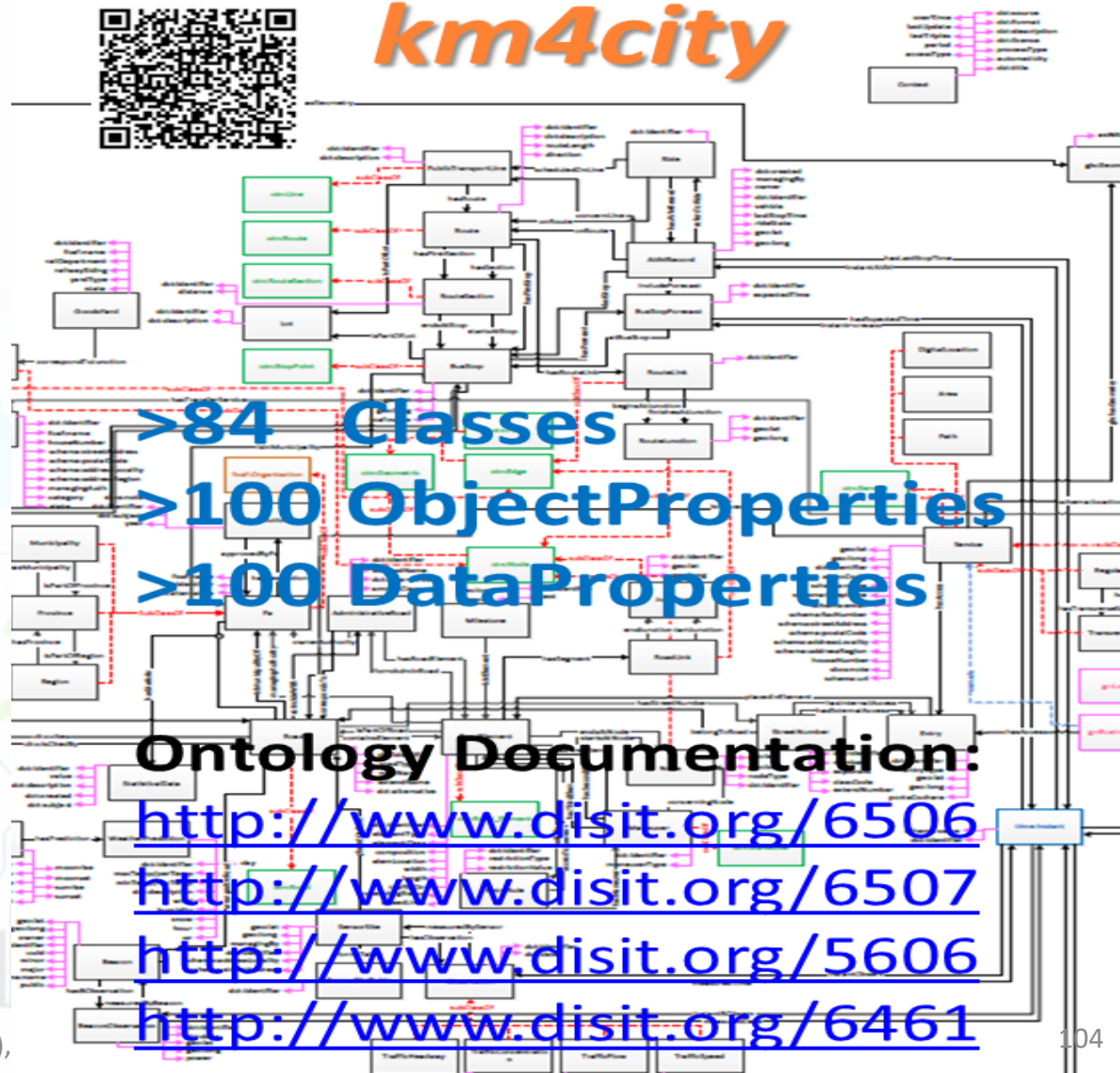
- Triples at the basis:
  - <o> <r> <s>
  - E.g.:
    - Carlo figliodi Bruno
- Relationships are also specialized and not only those of OOP
  - SKOS = Simple Knowledge Organization System



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

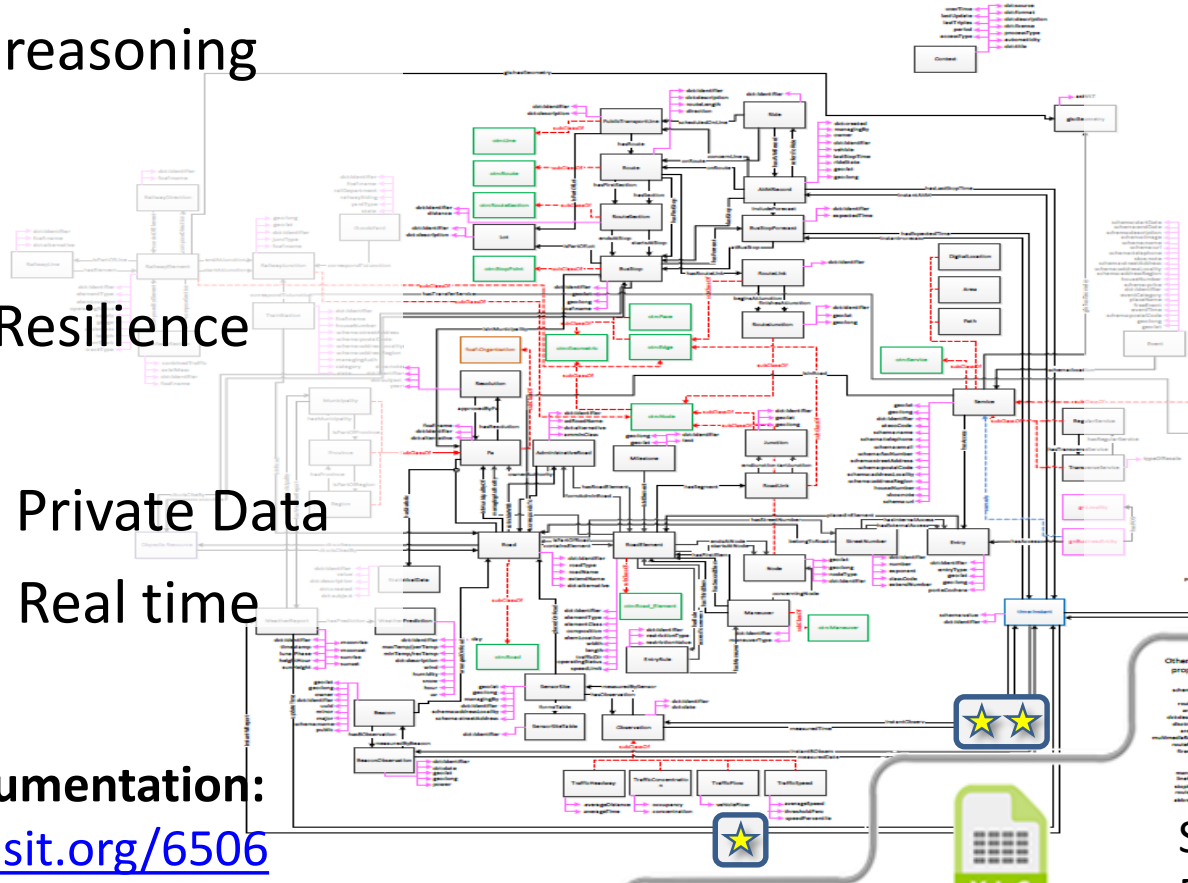
- Ontological model
  - Modeling relationships and excluding those not modeled,
  - Posing semantic queries on what can be viable or what may exists
- Addition of Data allows to have reasoners on spatial, temporal, relational aspects exploiting
  - Defined Relationships (specialization, generalization)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

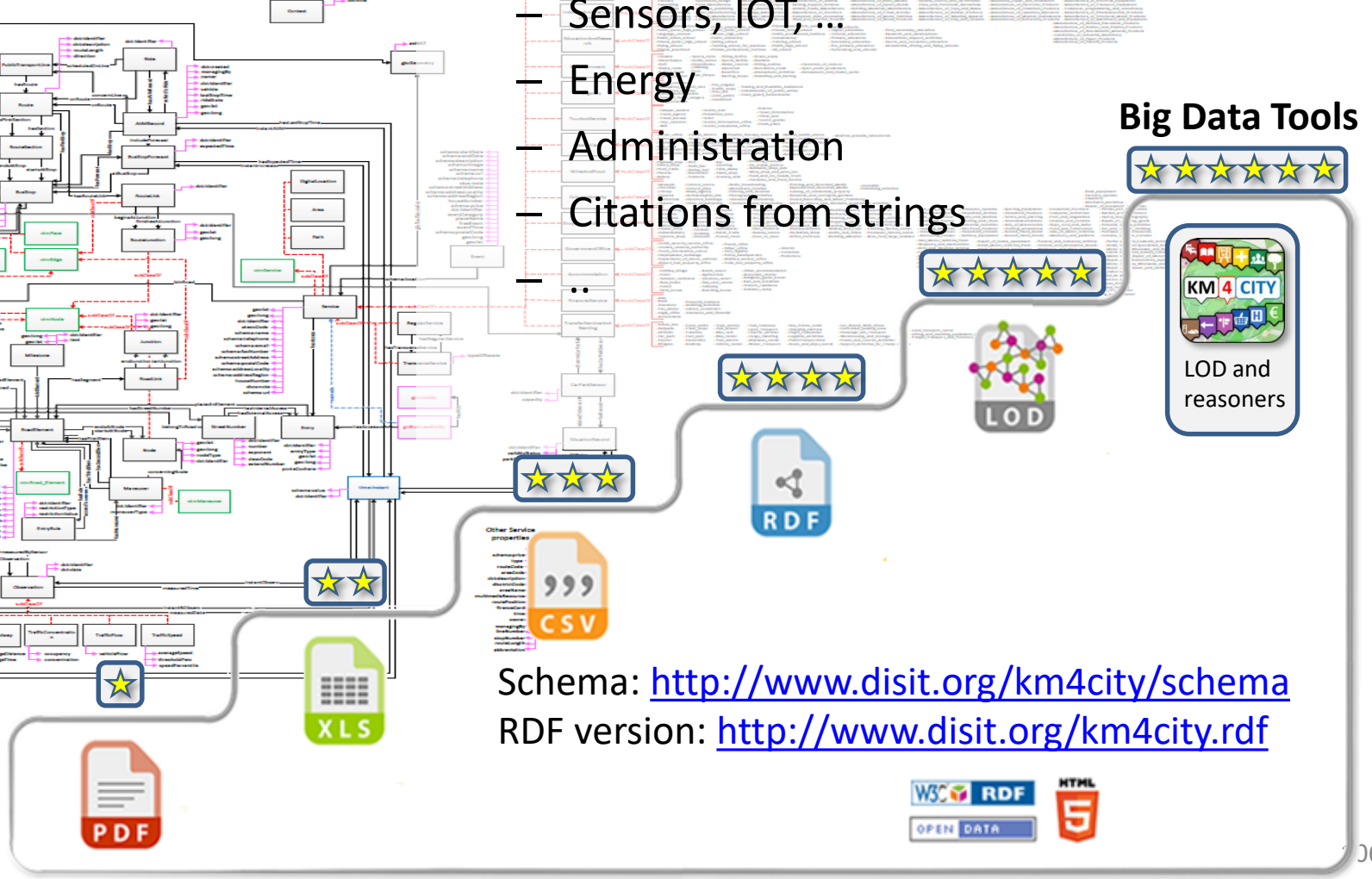
Km4City: Knowledge Base

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

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

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

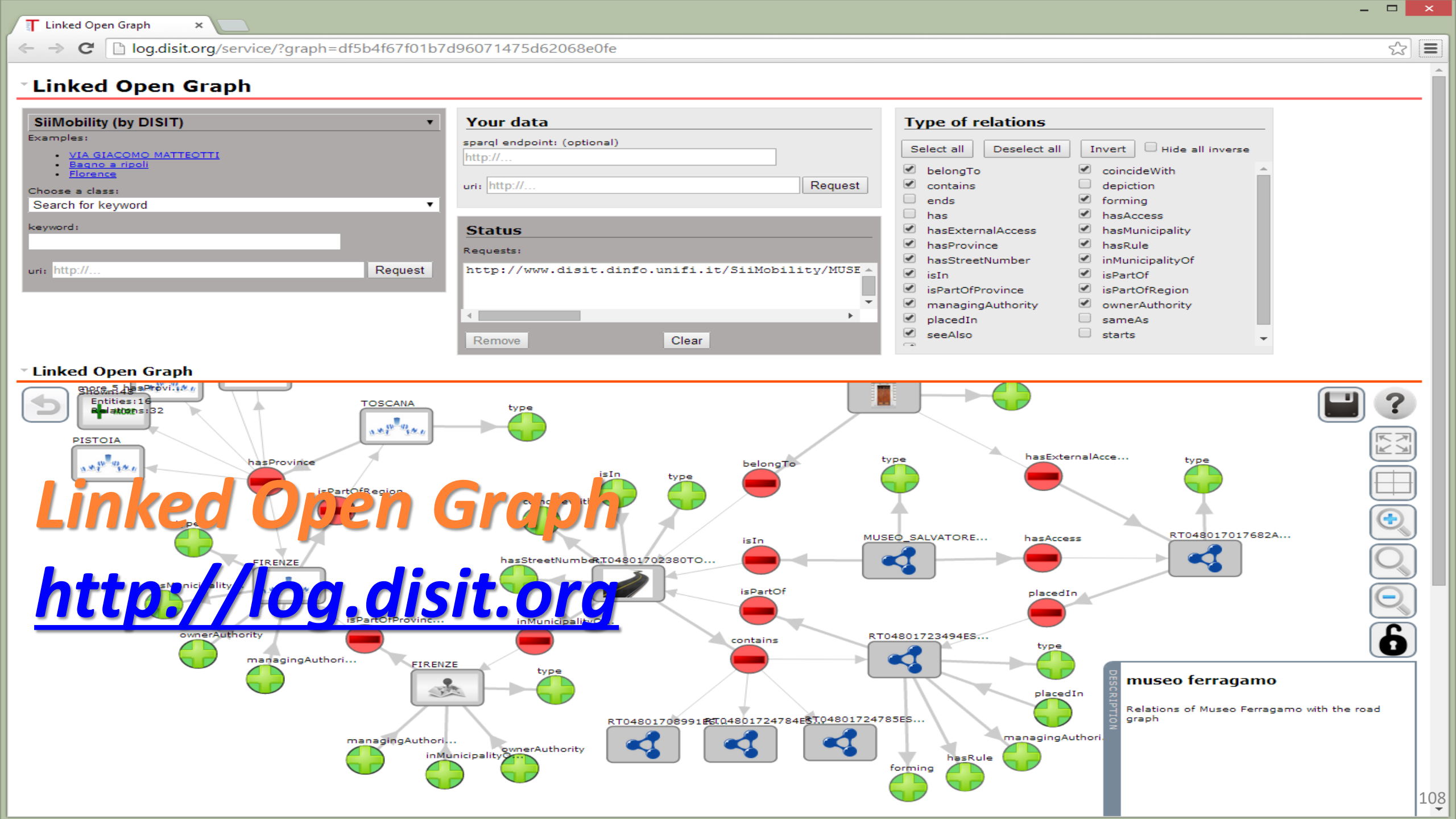


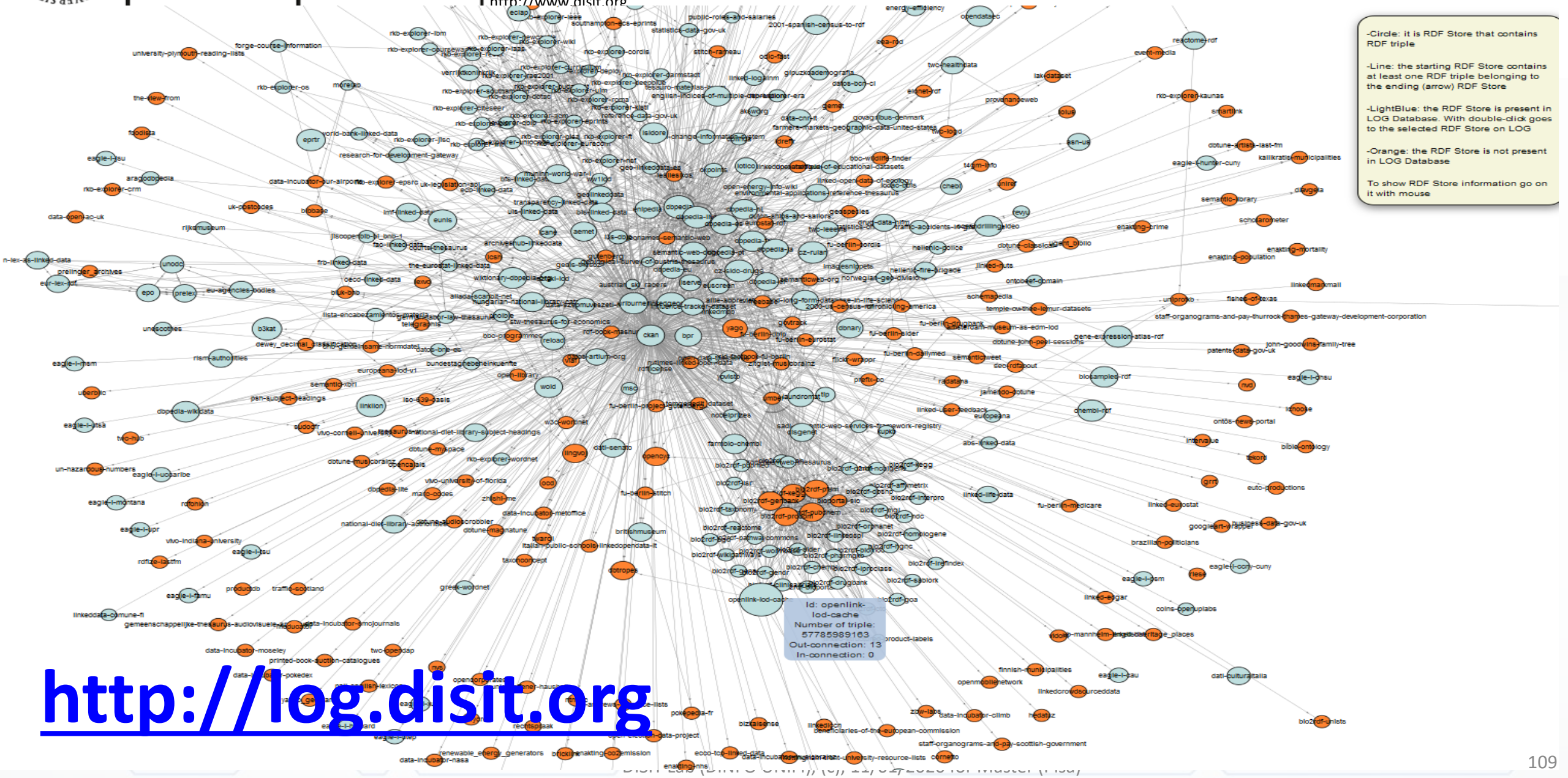


Schema: http://www.disit.org/km4city/schema
RDF version: http://www.disit.org/km4city.rdf

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
MUSEO_SALVATORE...
hasAccess
RT048017017682A...
isIn
hasStreetNumber
RT04801702380TO...
isPartOf
placedIn
FIRENZE
ownerAuthority
managingAuthori...
contains
RT04801723494ES...
type
placedIn
FIRENZE
type
RT04801724784ES...
RT04801724785ES...
managingAuthori...
ownerAuthority
inMunicipalityO...
forming
hasRule
managingAuthori...
museo ferragamo
Relations of Museo Ferragamo with the road graph
DESCRIPTION
Linked Open Graph
http://log.disit.org
108



http://log.disit.org

Elastic Search, Kibana



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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

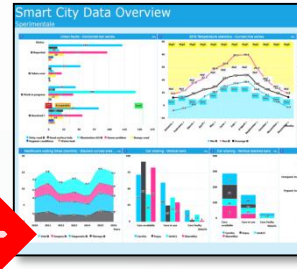
Data Analytics
R, Tensor Flow, Python, MapReduce, …

IOT Applications
Node-RED + Snap4City MicroSrvs

Search and Query, Smart API
search

Visual Analytics Special dash/ tools

Rendering Acting, Widgets, MicroApps
User
interactive Dashboard, Drill down, heatmaps





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

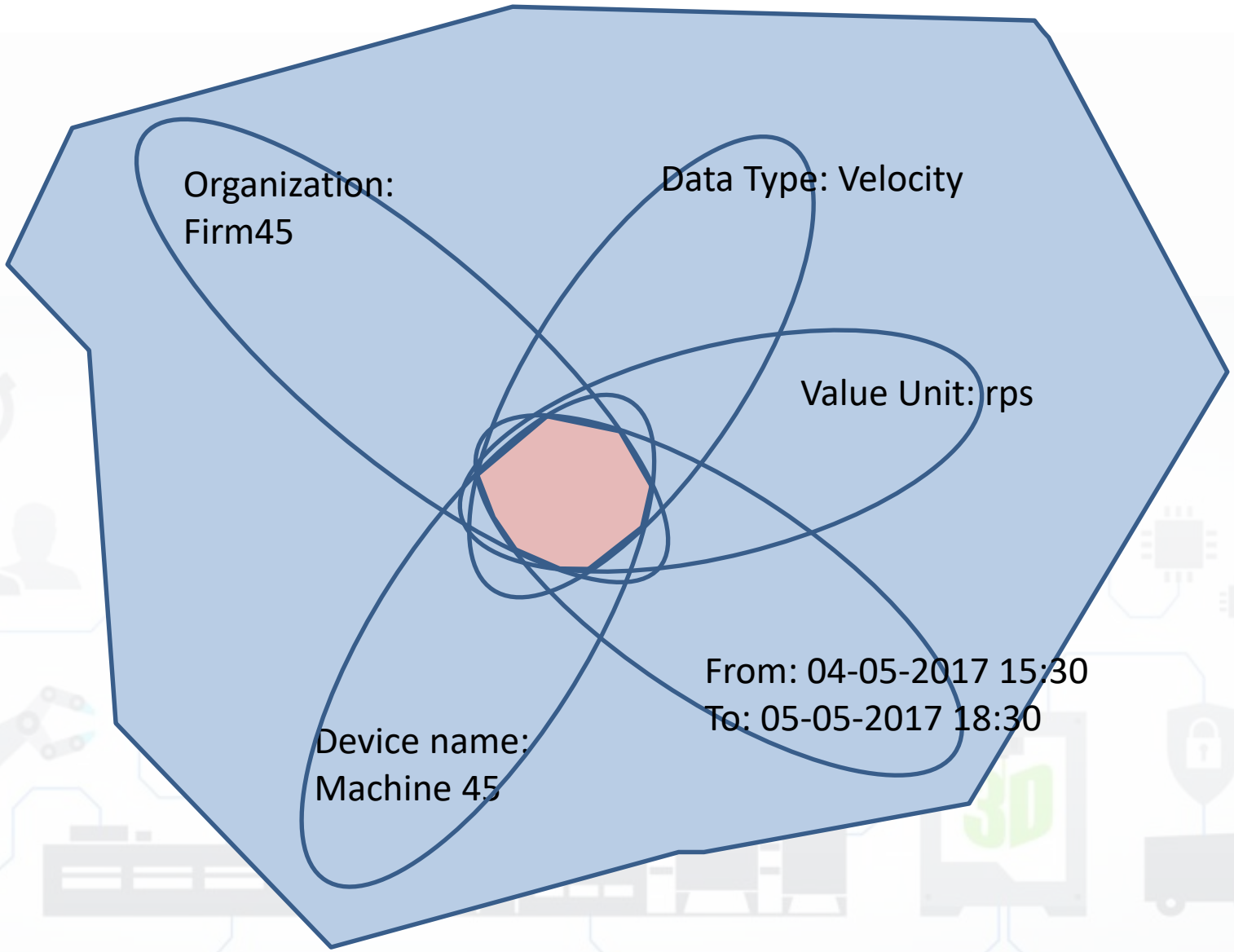
Elastic Search

- 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),



Data Indexing: Multiple views





Two aspects of Elastic Search usage

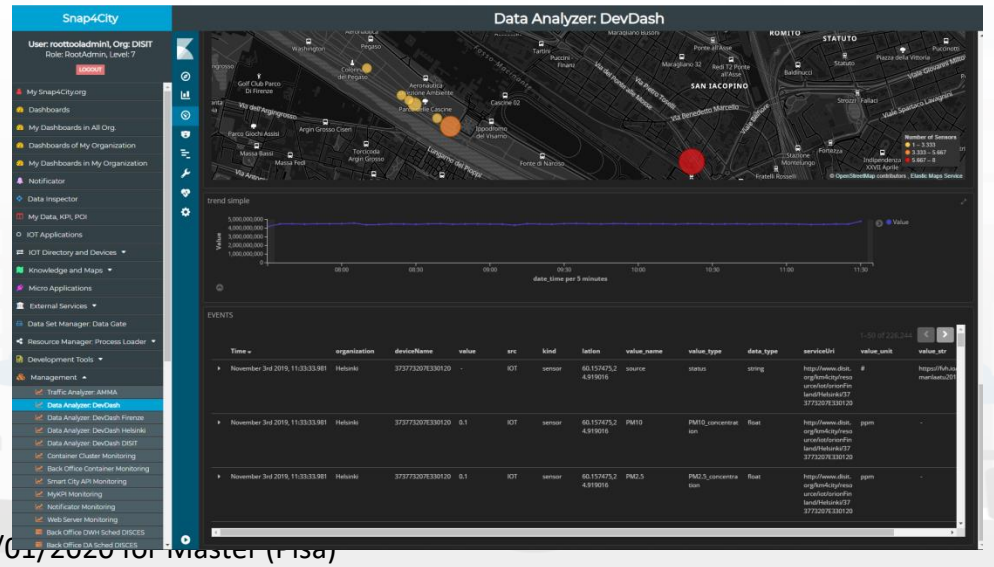
- Elastic Search is a scalable index and storage that can be used as a Data Lake in some sense.
- All «has» to the normalized to enable full filtering and faceting/grouping
- The user interface can be Kibana, Grafana. Open Source and paid versions
- In Snap4City/Snap4Industry two usage of ElasticSearch/Kibana: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





Operator Business Analysis Dashboards: DevDash, AMMA

- Dynamic Filtering, Adaptable, …
- Full data details, drill down,…
- Synergic with **Data Inspector** which addresses data relationships, processing and information



Data Analyzer: DevDash

Snap4City

User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7
LOGOUT

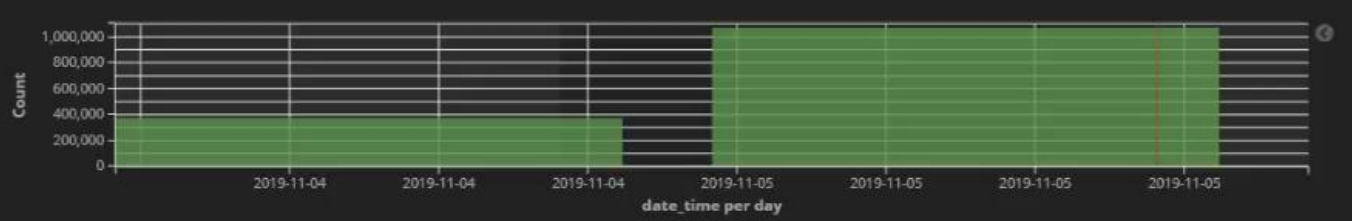
- My Snap4City.org
- Dashboards
- My Dashboards in All Org.
- Dashboards of My Organization
- My Dashboards in My Organization
- Notificator
- Data Inspector
- My Data, KPI, POI
- IOT Applications
- IOT Directory and Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
- Management
  - Traffic Analyzer: AMMA
  - Data Analyzer: DevDash
  - Data Analyzer: DevDash Firenze
  - Data Analyzer: DevDash Helsinki
  - Data Analyzer: DevDash DISIT
  - Container Cluster Monitoring
  - Back Office Container Monitoring
  - Smart City API Monitoring
  - MyKPI Monitoring
  - Notificator Monitoring
  - Web Server Monitoring
  - Back Office DWH Sched DISCES

Dashboard / Sensors-ETL-IOT-v4 Full screen Share Clone Edit Auto-refresh Last 24 hours

Search... (e.g. status:200 AND extension:PHP) Options

Add a filter +

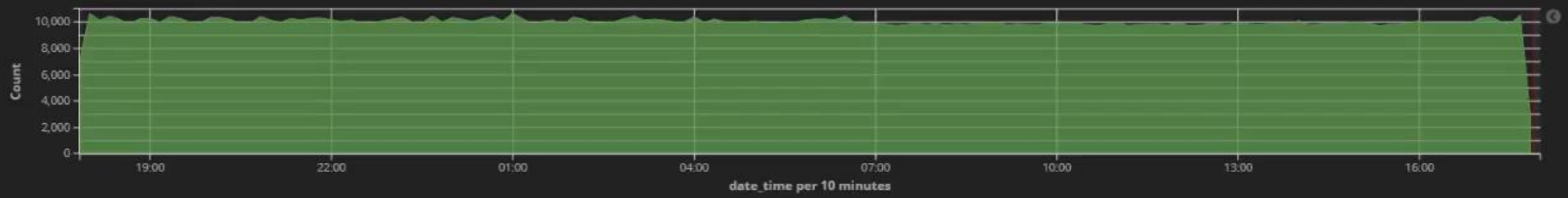
COUNTEVENTS



HITS

1,444,442
HITS

EVENT COUNTS



Facet Fields

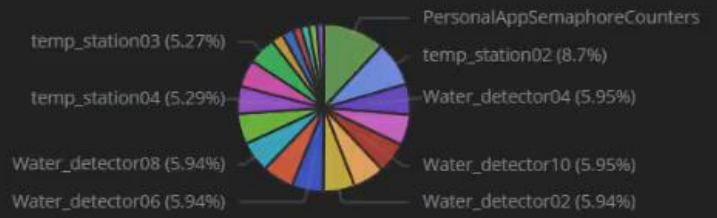
organization

deviceName
Select...

kind
Select...

src
Select...

DEVICE NAME

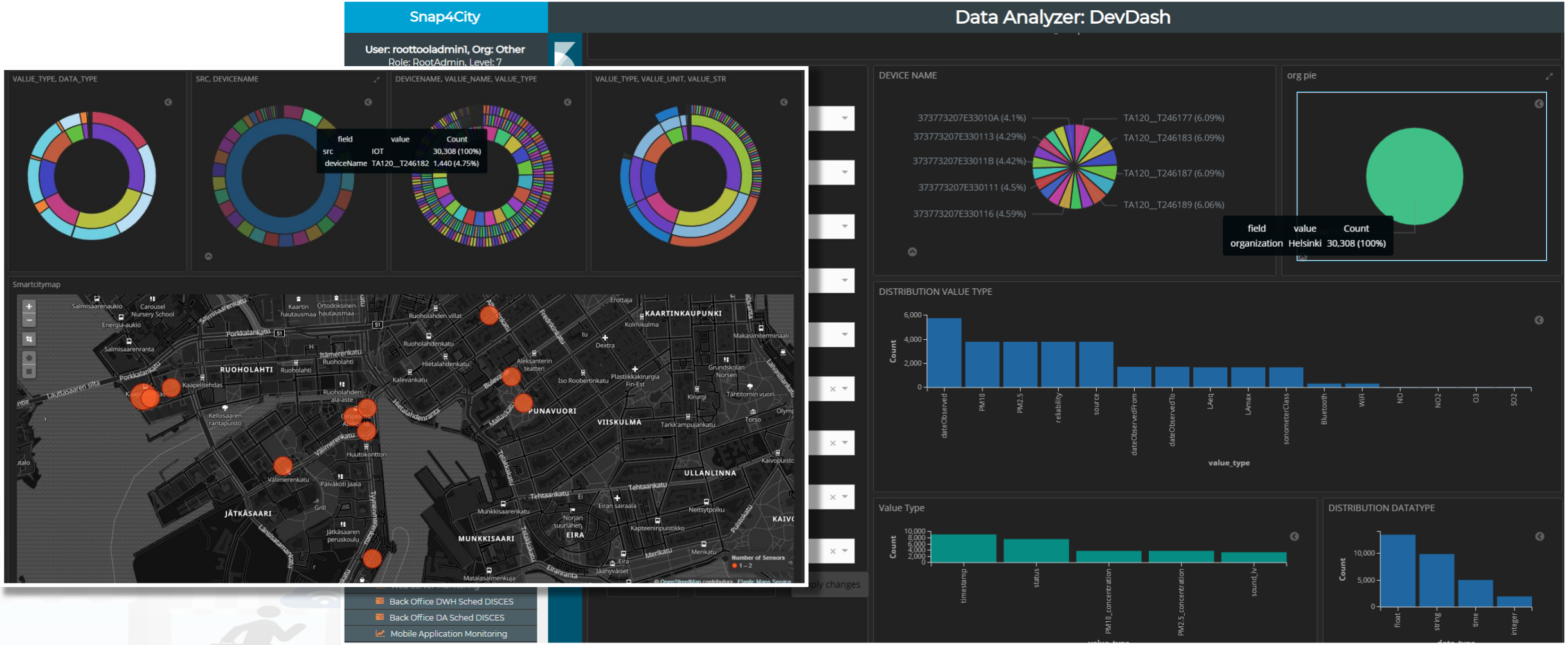


org pie



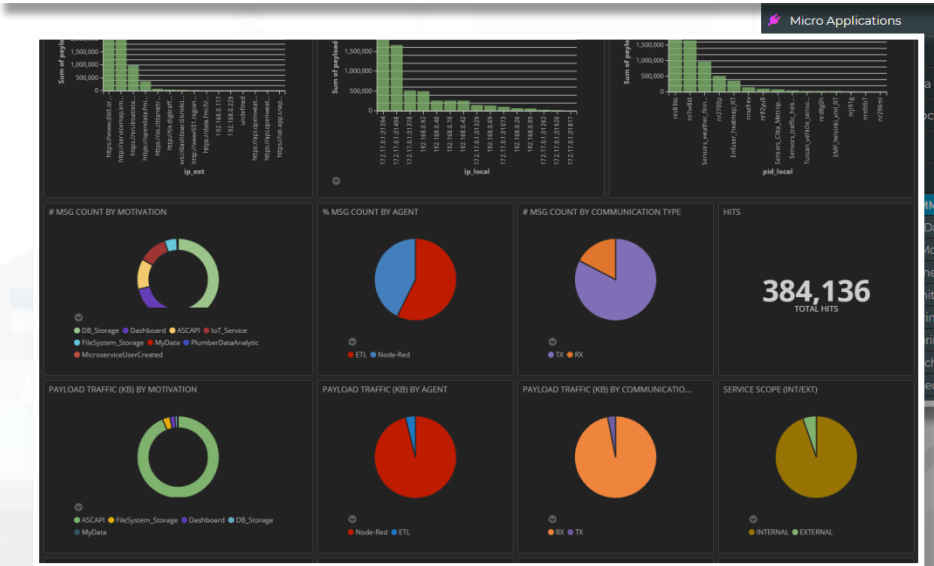
DISTRIBUTION VALUE TYPE

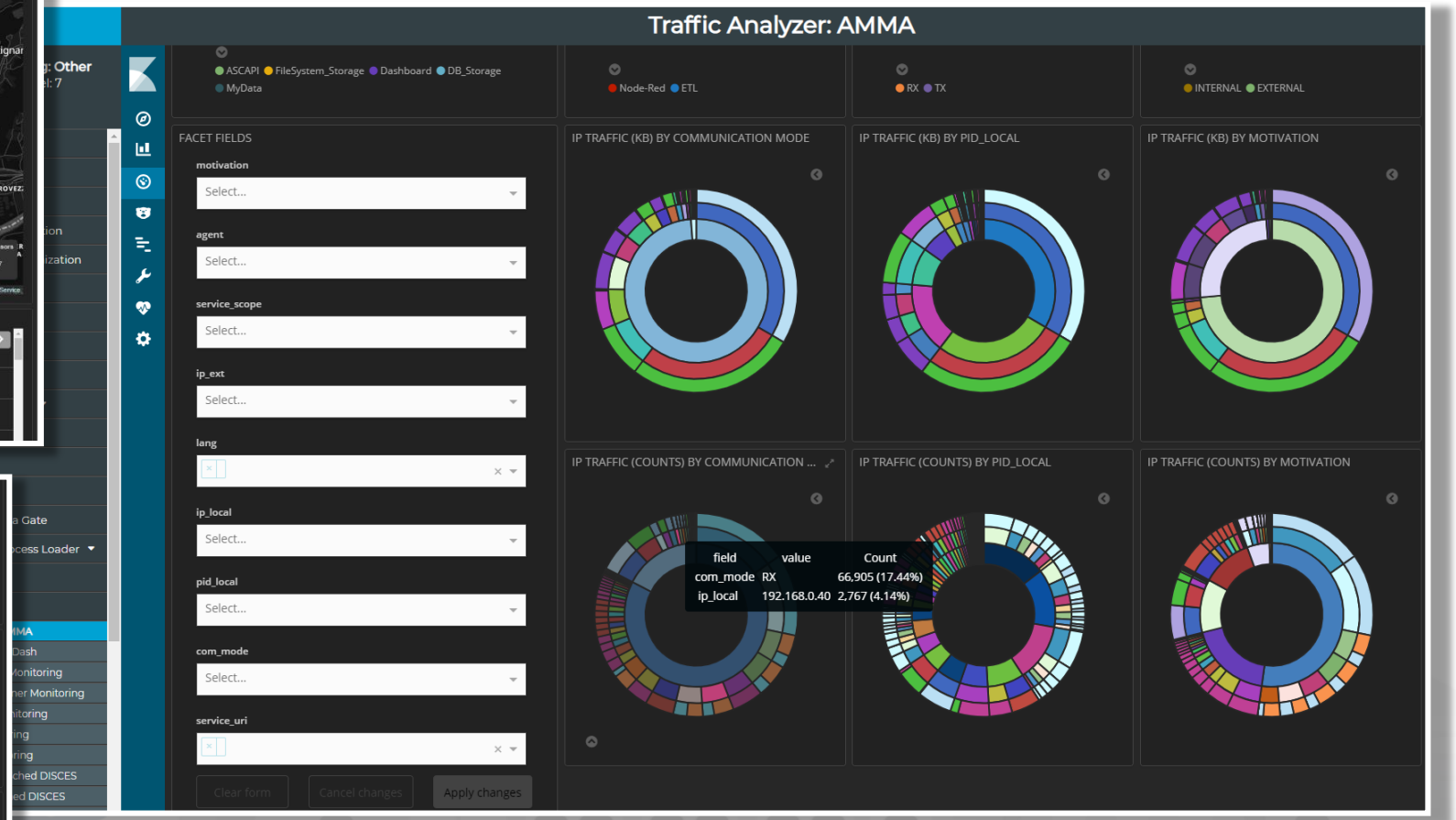
DevDash by Elastic Search + Kibana



AMMA by Elastic Search + Kibana







AMMA (1)

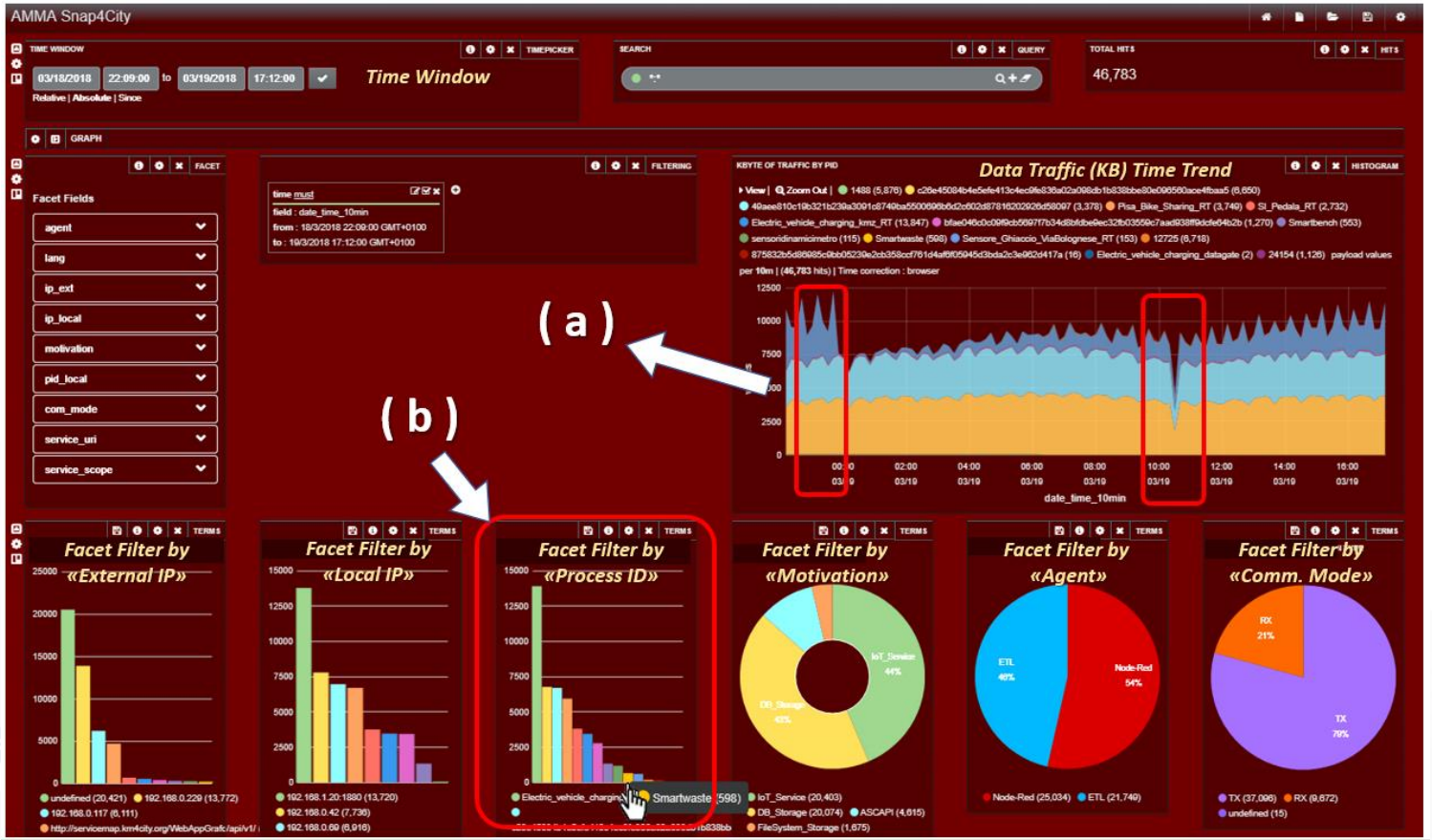
Monitor data traffic flows among IoT devices, services, applications etc. and detect potential anomalies

quantitatively monitoring data/message traffic and flows

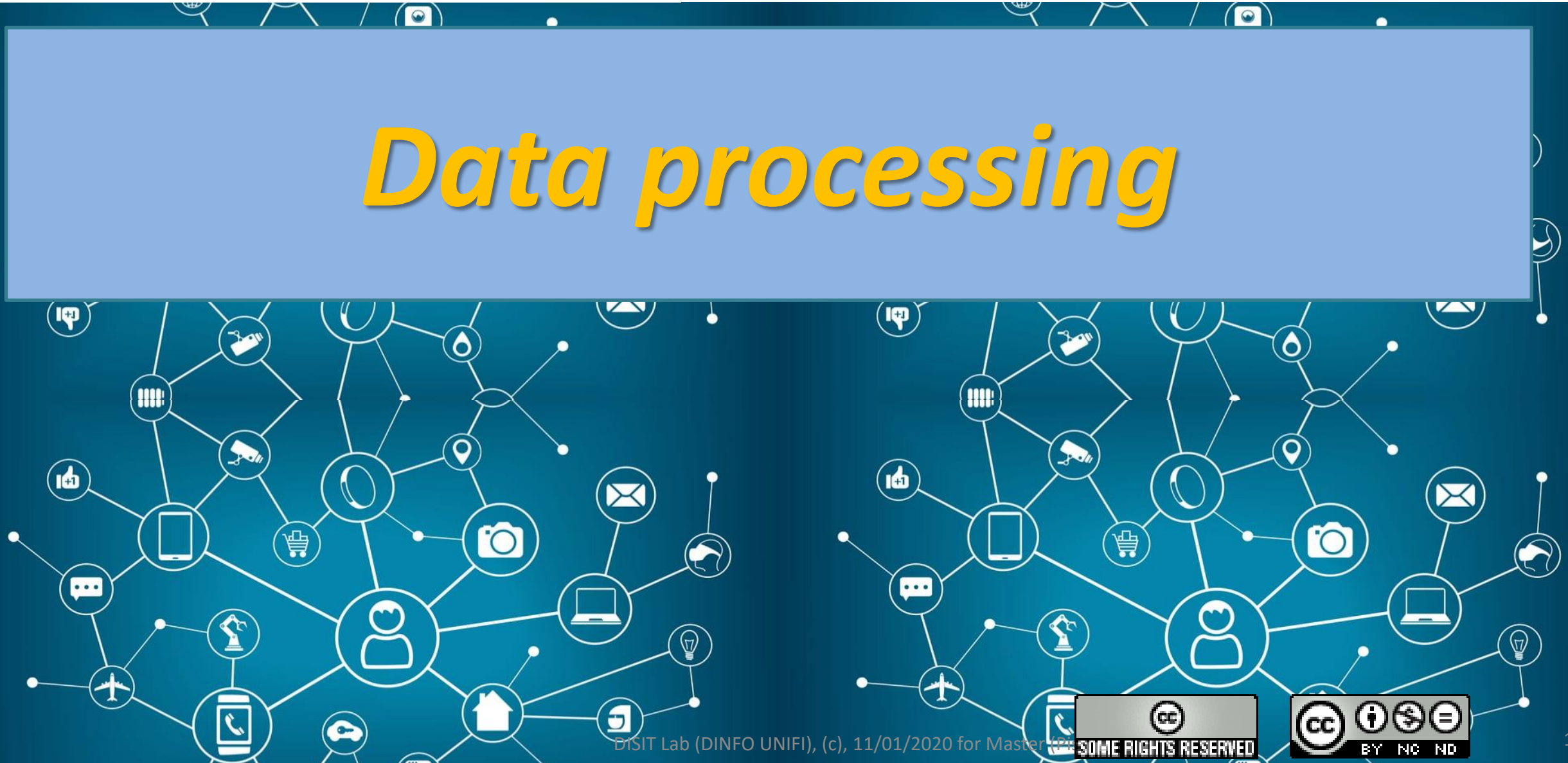
Unexpected behaviors can be revealed by inspecting the data flow time trend:

a) detecting peaks or valleys in the trend

b) drill-down on data to identify single/more malfunctioning devices and/or services



Data processing



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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.

kettle™ pentaho data integration

nifi

Node-RED

- **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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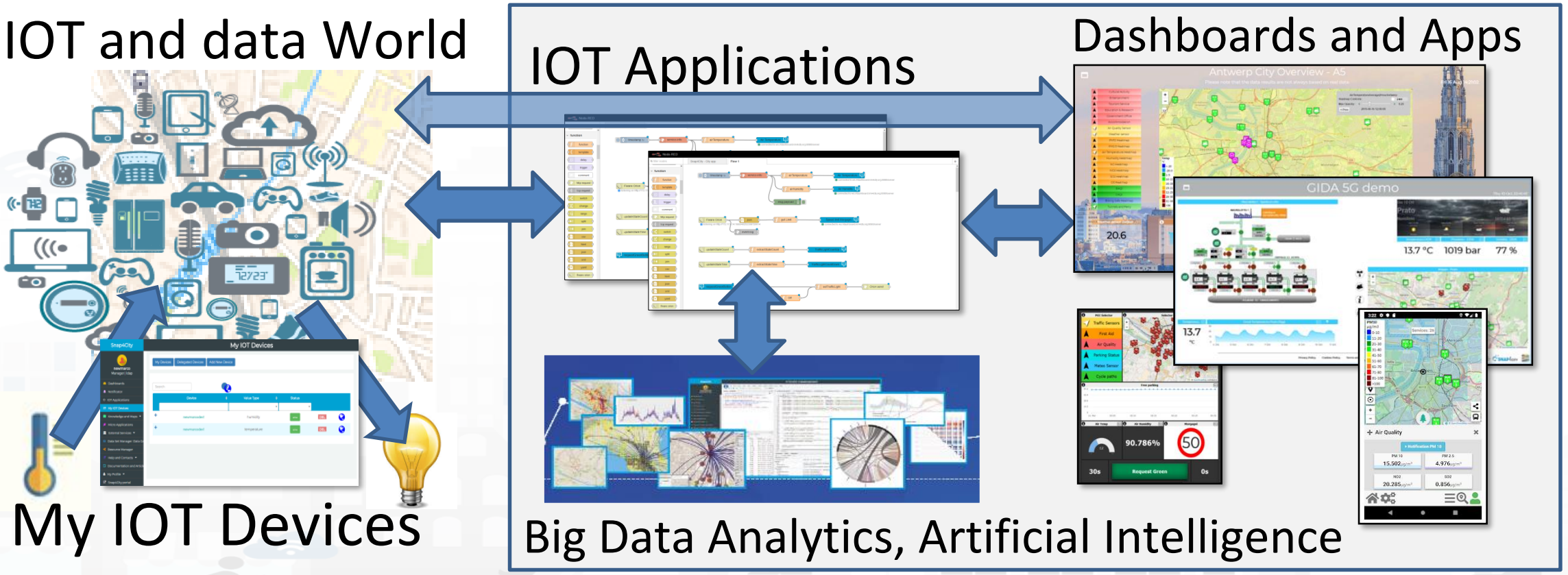
Dashboards with data driven IOT Applications enforcing intelligence



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

SNAP4CITY

IOT/IOE on the field

On Cloud

(1) Registration

(0) Sensors & Actuators

Raspberry pi

Sensors/ Actuators

IOT Directory

(2) Discovery

Sensors/ Actuators

Sensors/ Actuators

-- PC: Win, Linux

Sensors/ Actuators

Internet

IOT Edge
With IOT App distributed

(1) Registration

Sensors/ Actuators

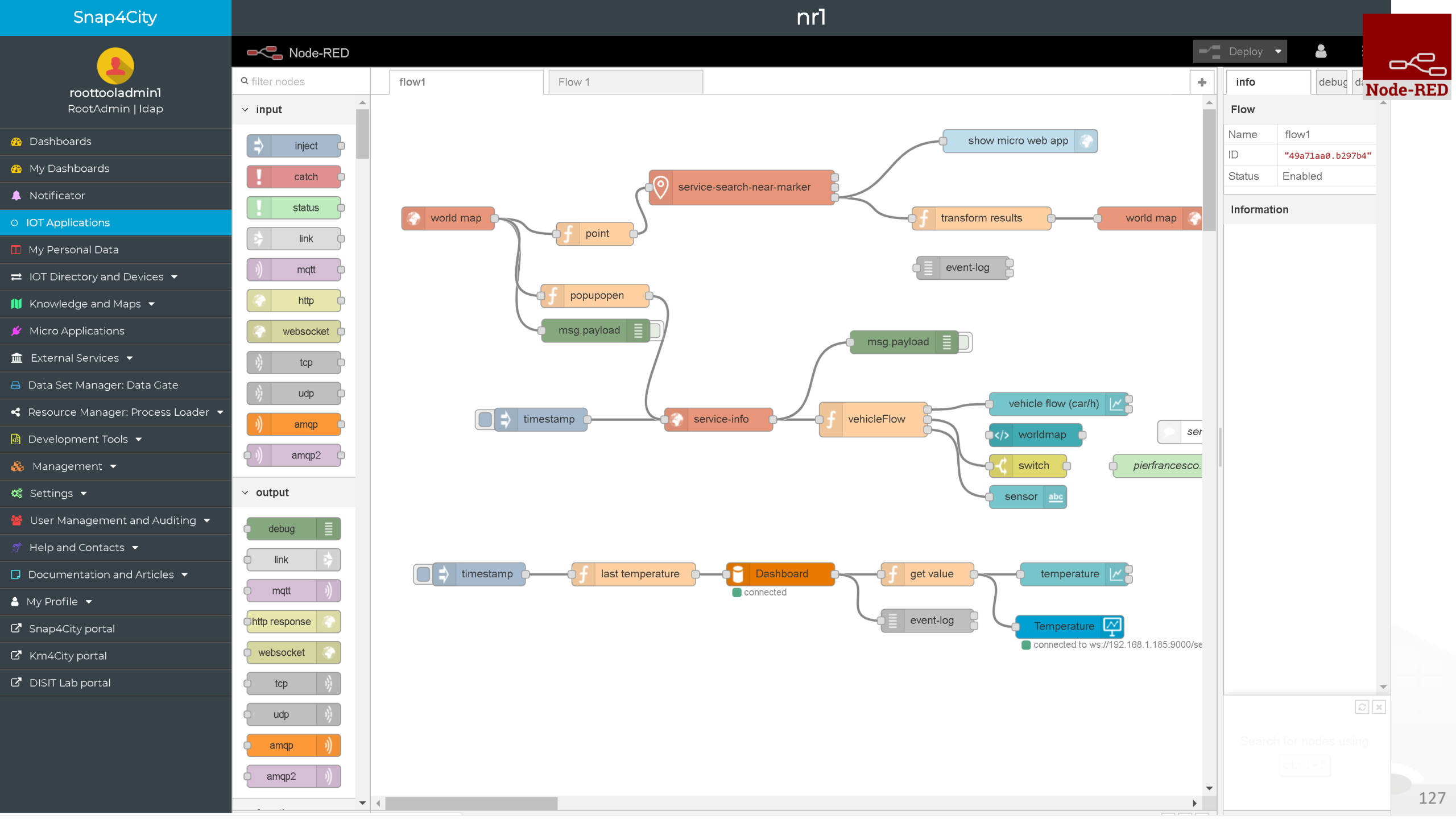
IOT Button

IOT Brokers

Mobiles

Sensors/Actuators

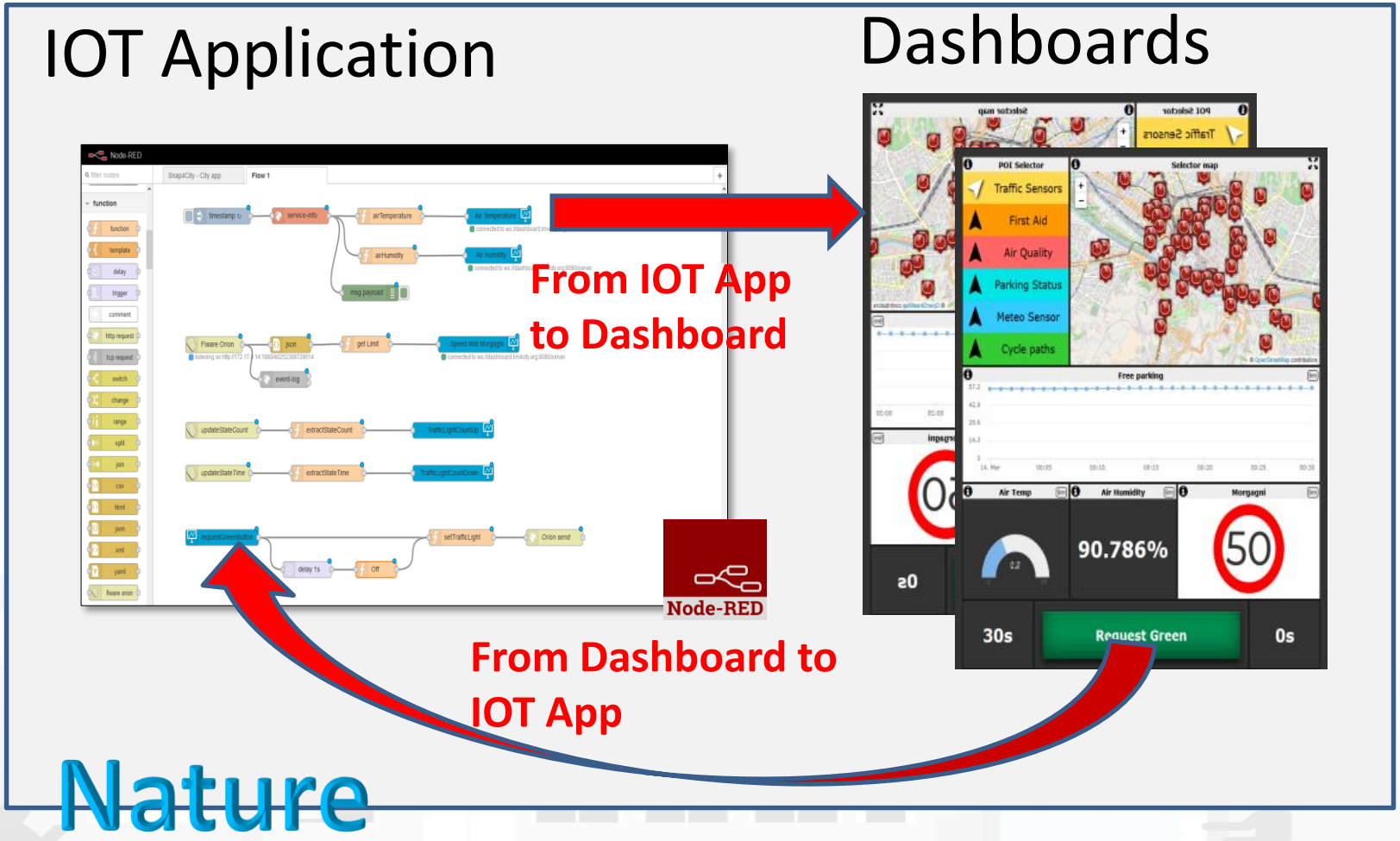
IOE Devices


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)

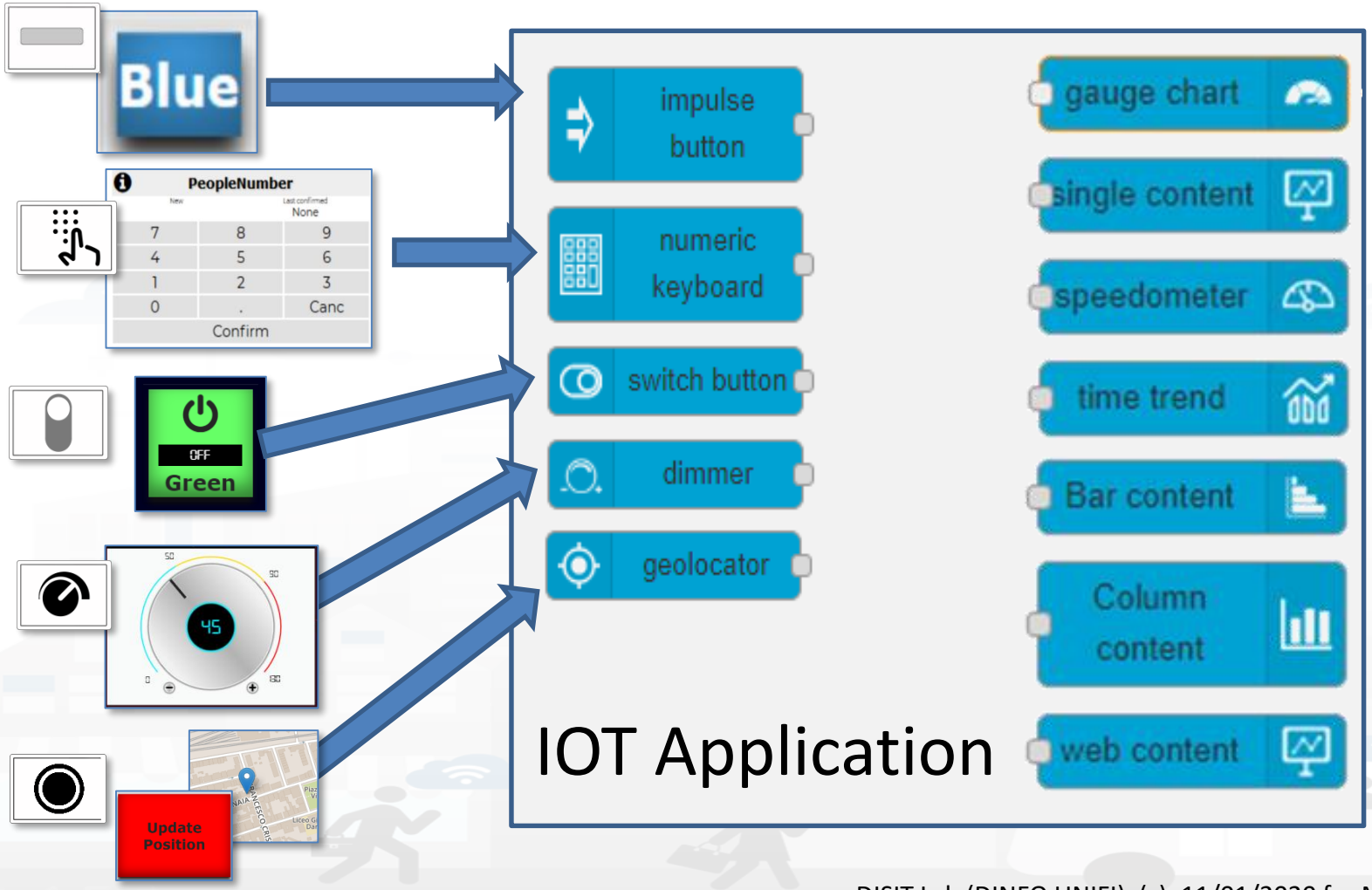


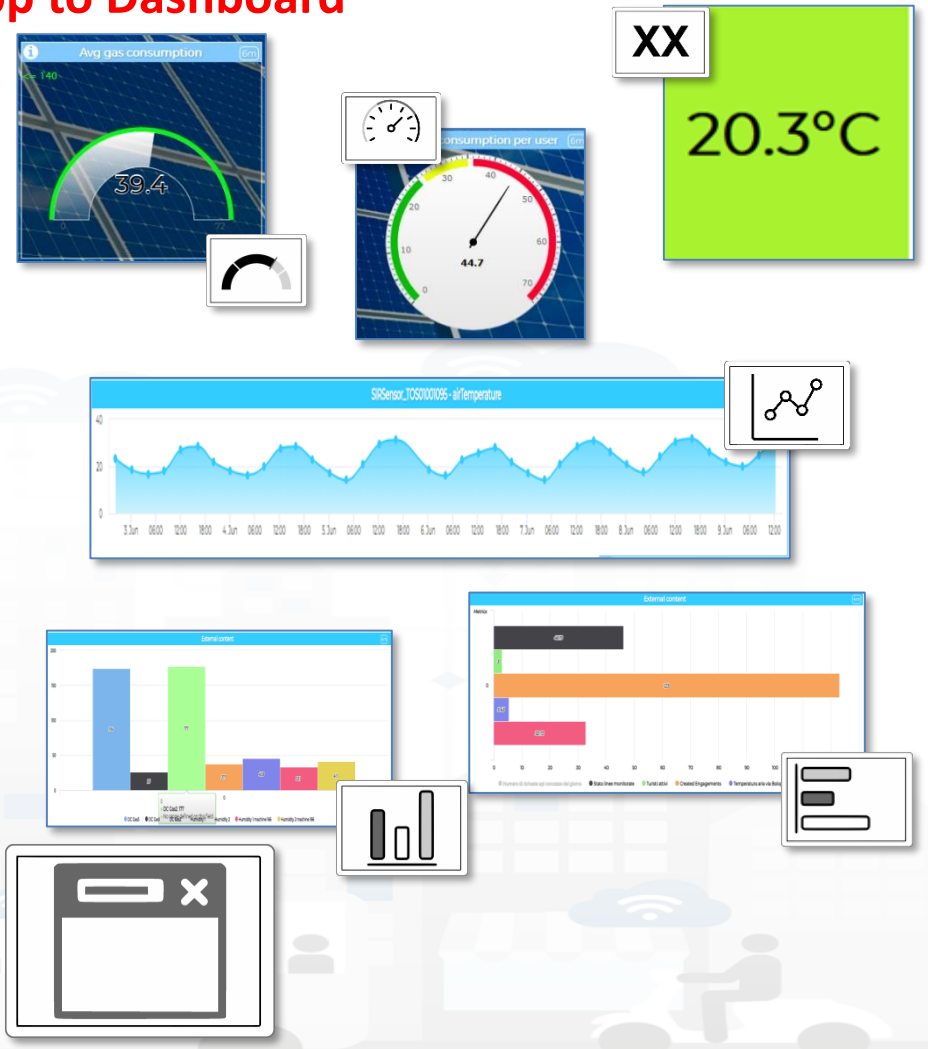
Dashboard-IOT App

Nature

From Dashboard to IOT App

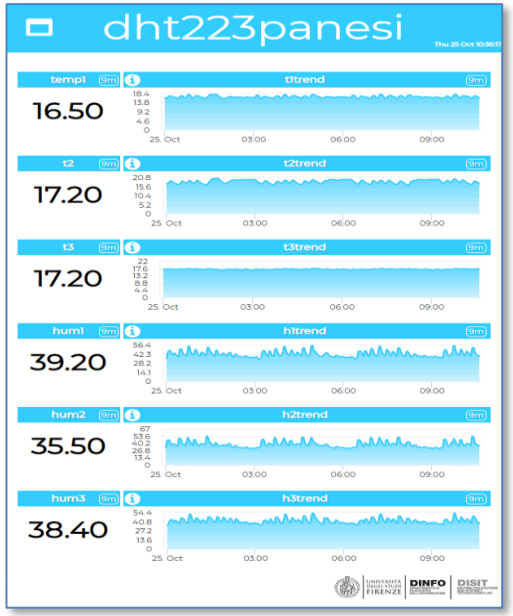
From IOT App to Dashboard



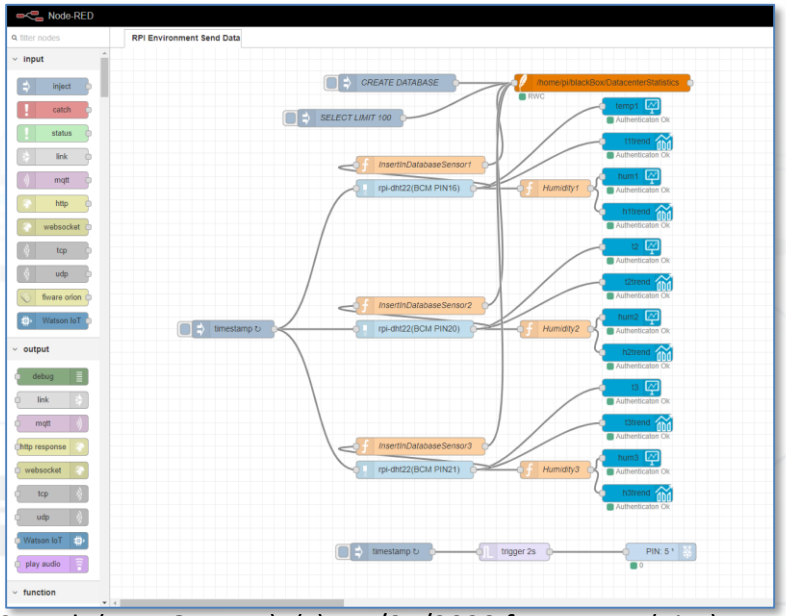


IOT Edge on Raspberry Pi

- 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**





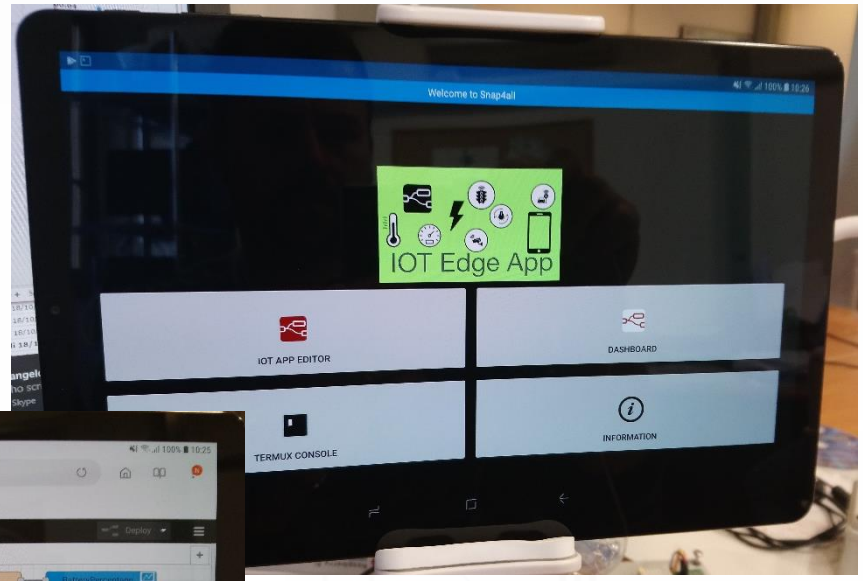


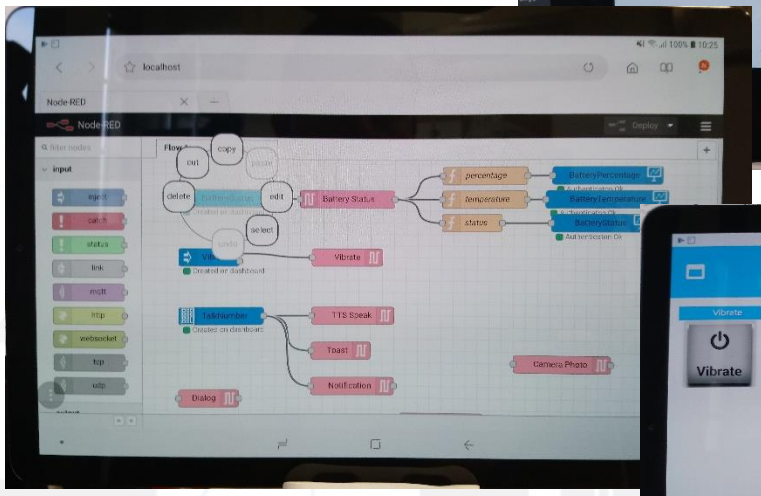


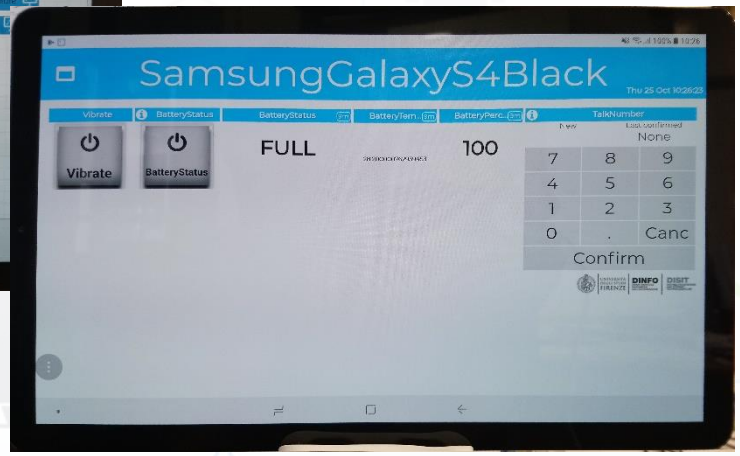
MicroServices:
- DHT
- ModBus
- any shield
- etc....

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**

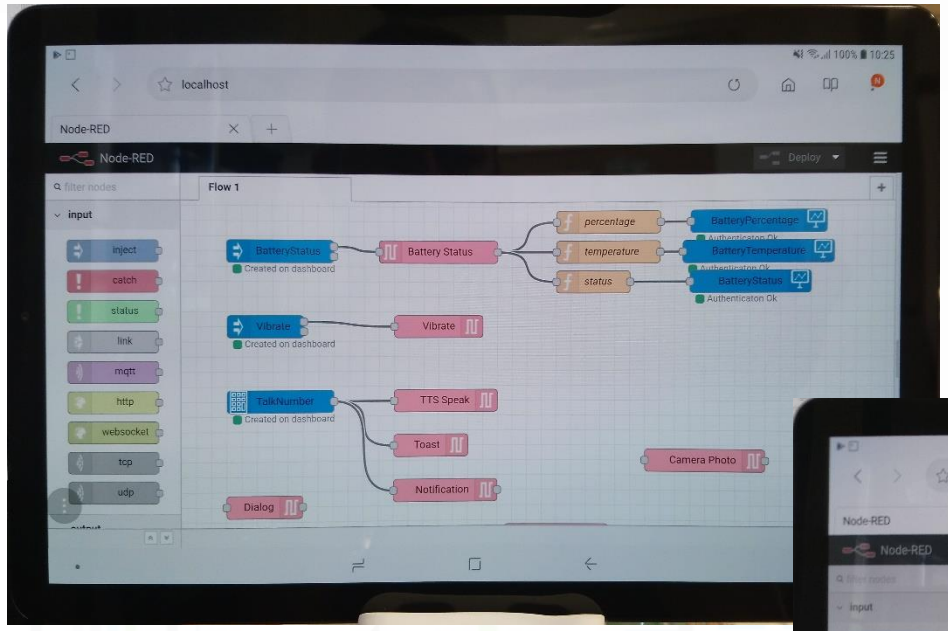


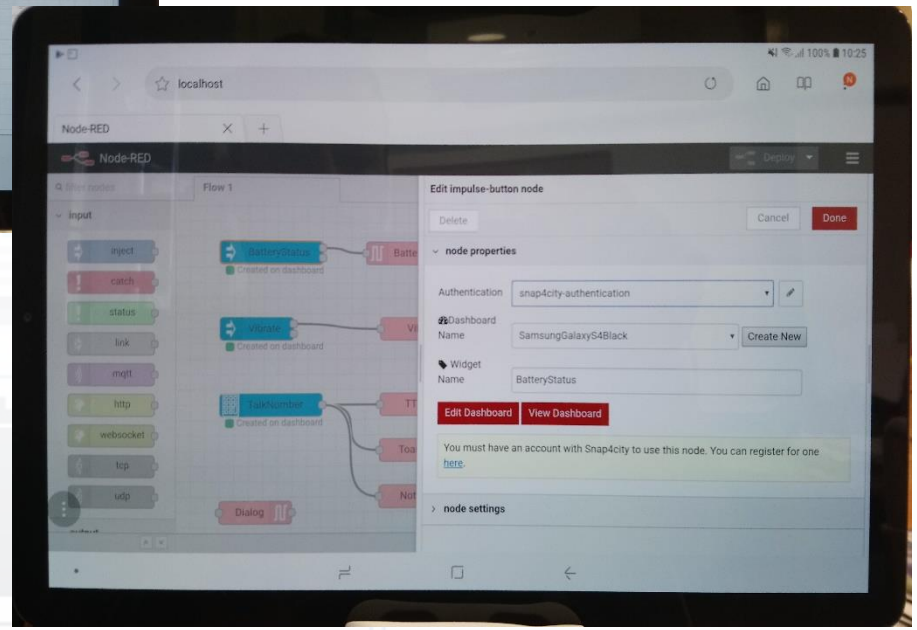




IOT Edge Snap4All App for Android

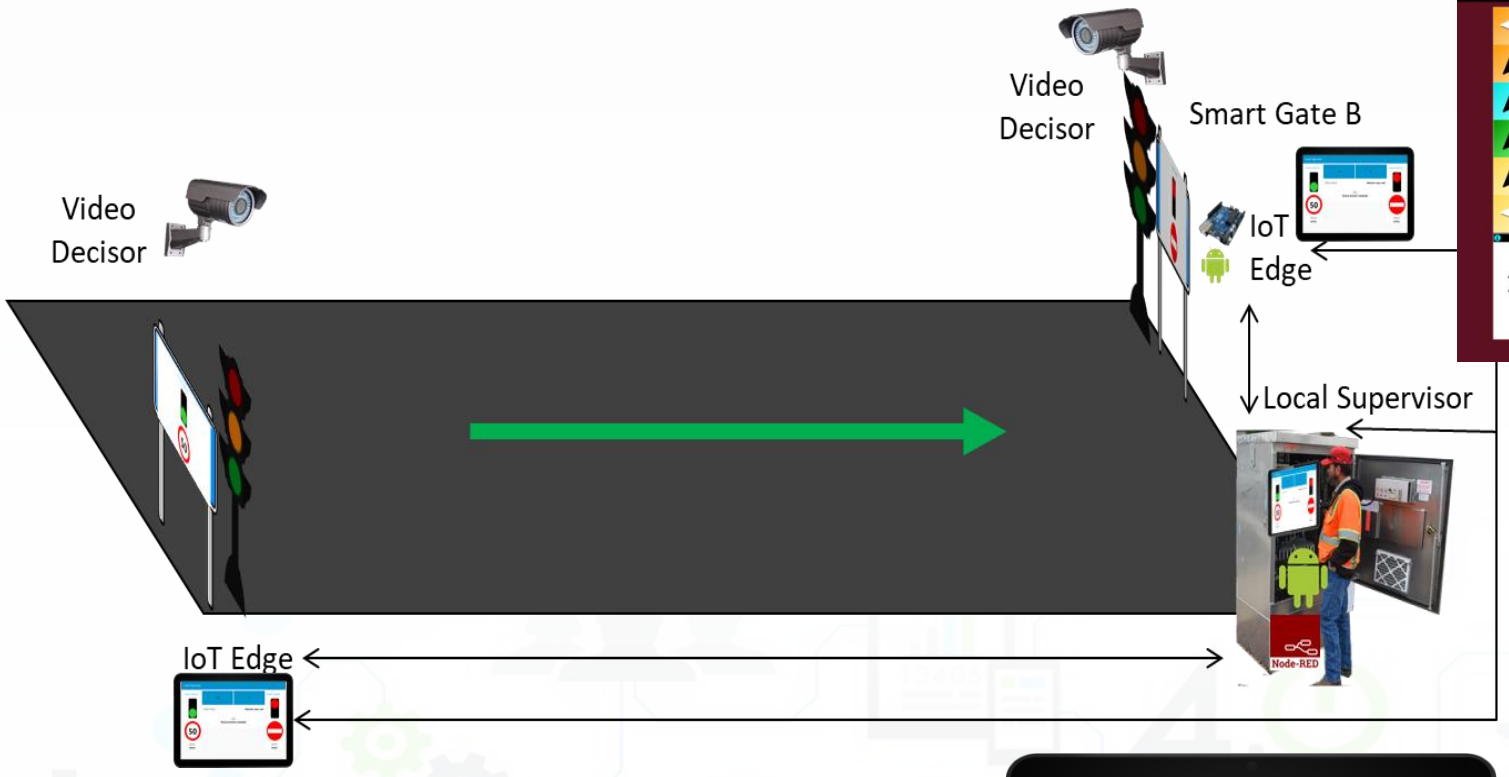
- termux-battery-status
- termux-camera-info
- termux-clipboard-get
- termux-contact-list
- termux-telephony-cellinfo
- termux-telephony-deviceinfo
- termux-tts-engines
- termux-camera-photo
- termux-clipboard-set
- termux-dialog
- termux-download
- termux-location
- termux-tts-speak
- termux-vibrate
- termux-sms-inbox
- termux-toast
- termux-sms-send
- termux-share
- termux-notification
- termux-wifi-connectioninfo
- termux-wifi-scaninfo

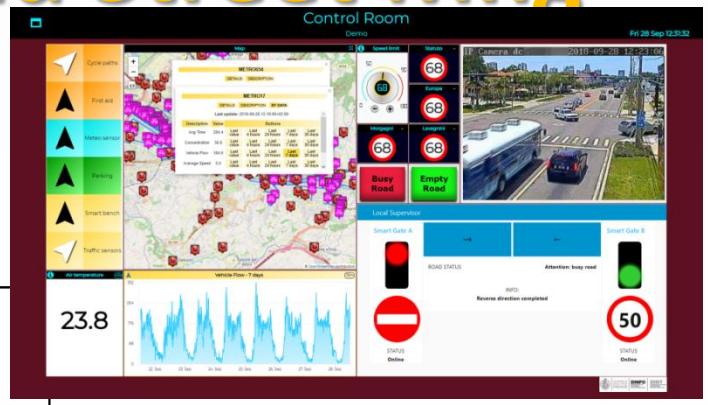




MicroServices:
- Snap4City
- Termux Snap4City specific
- etc.

Sii-Mobility: Dynamic Signage and Street Mng

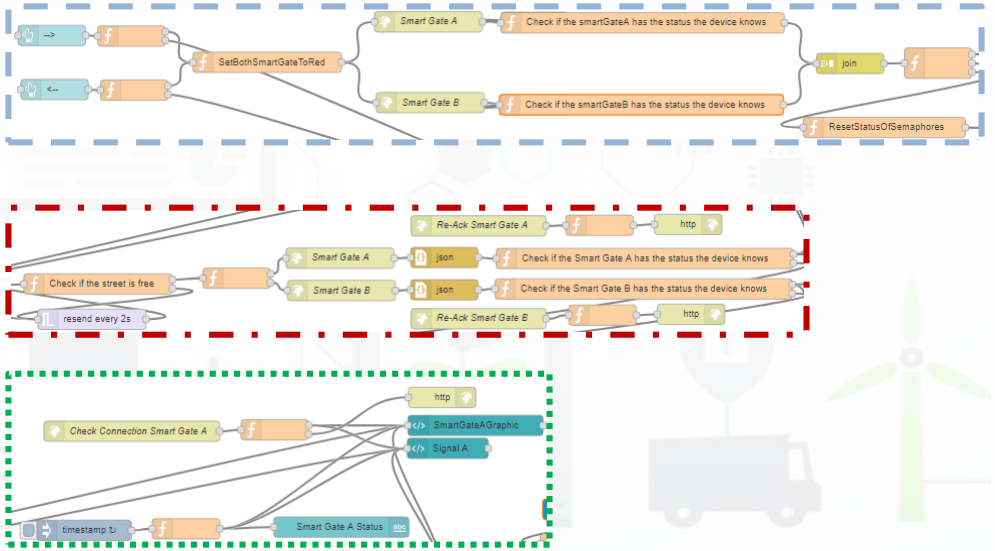




Control Room

Local Control Dashboard

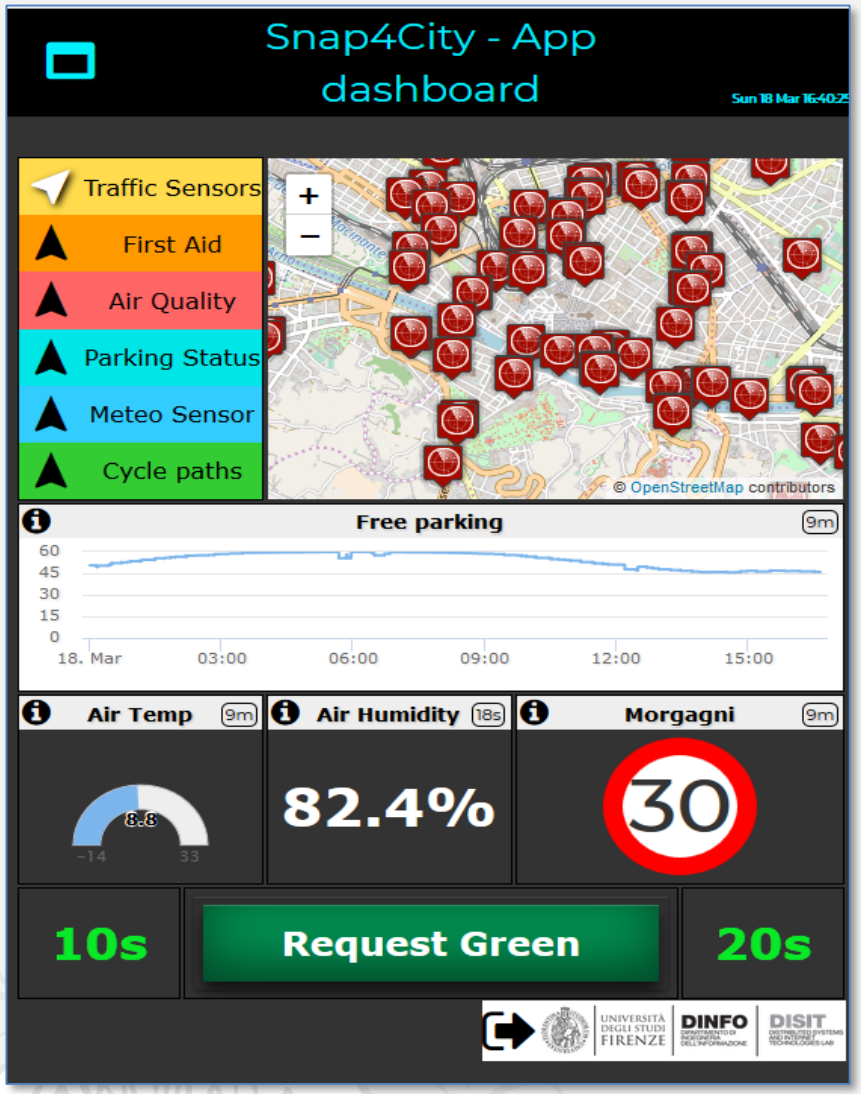


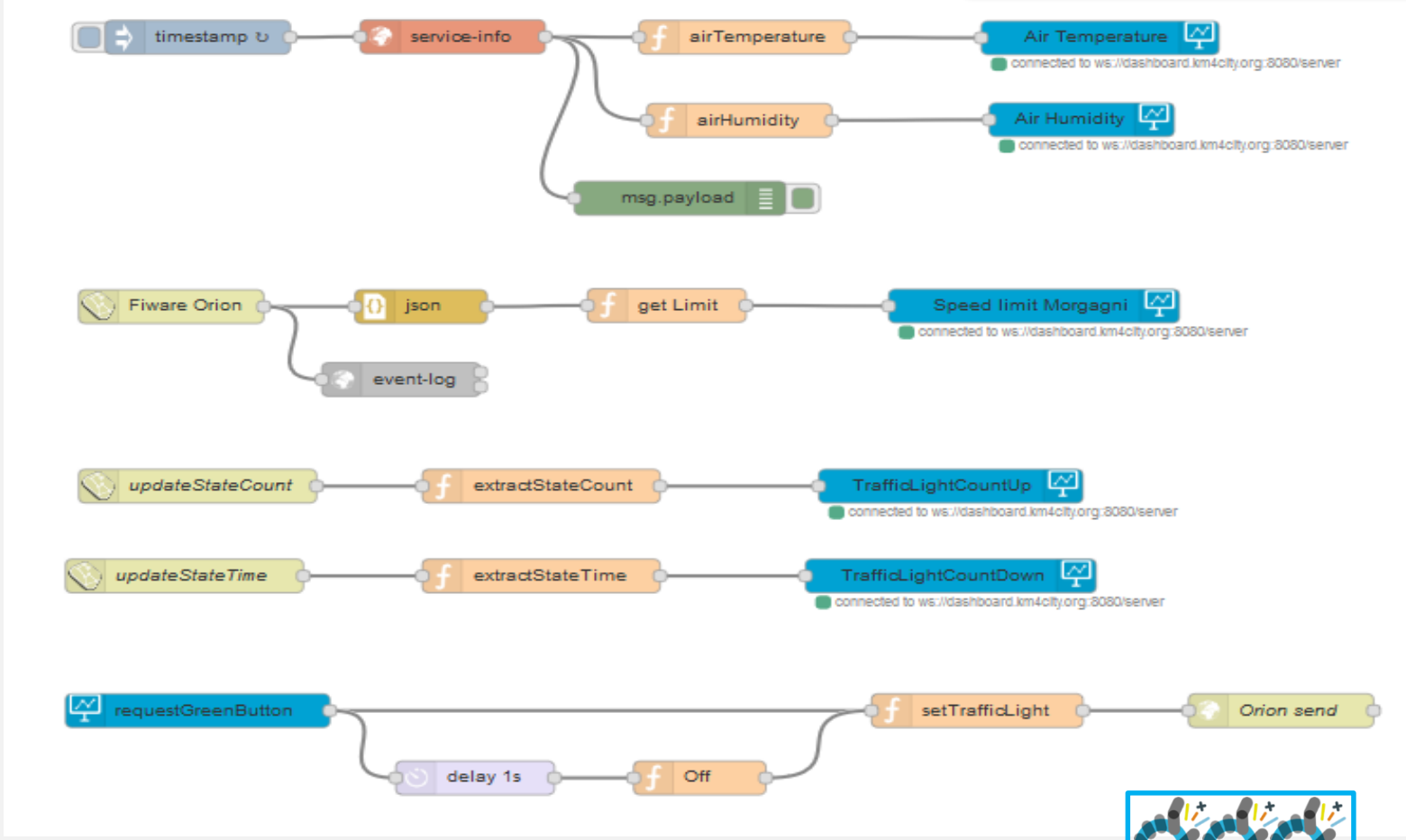


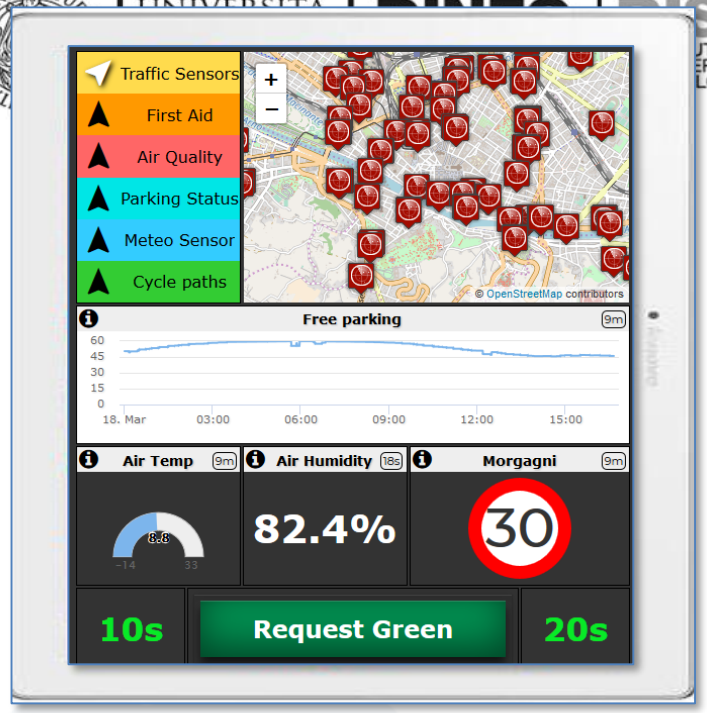
Safe and resilient solution manging Degradated conditions

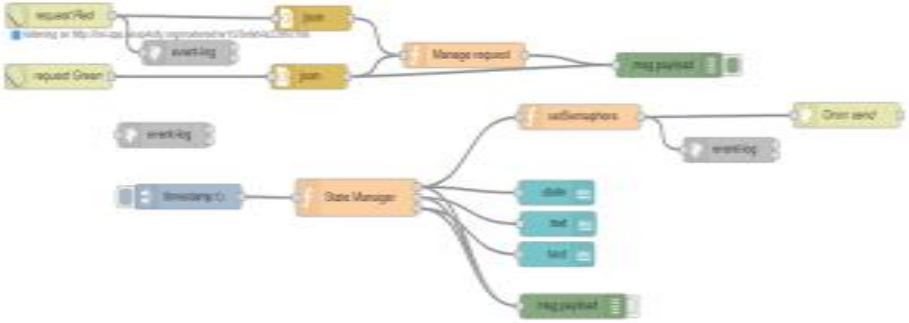
IOT Application with City Dashboard simple development








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







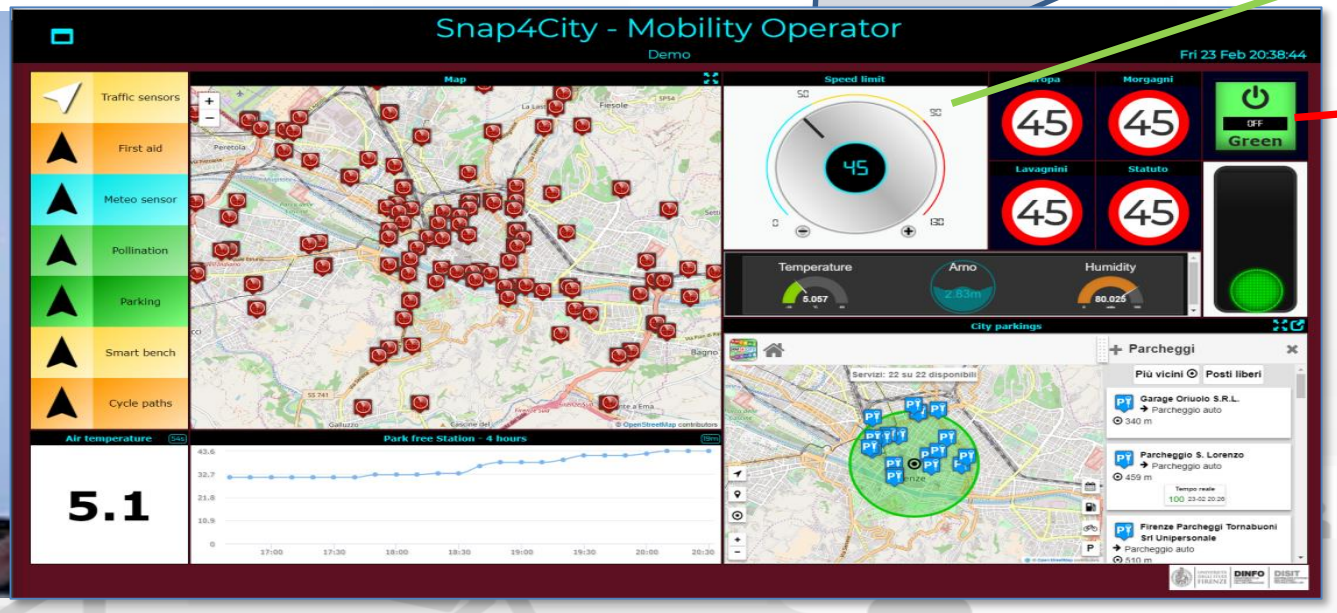

30

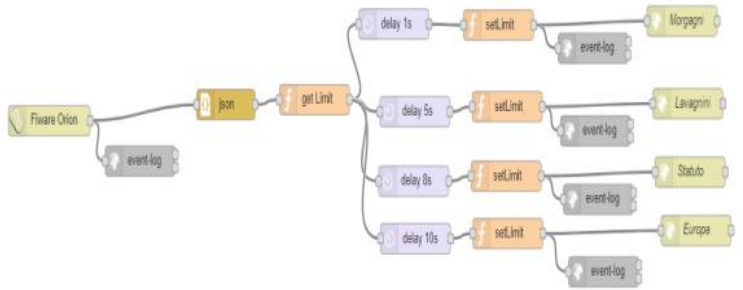

30


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 auto
340 m
Parcheggio S. Lorenzo
Parcheggio auto
459 m
Firenze Parcheggi Tornabuoni Srl Unipersonale
Parcheggio auto
Air temperature
5.1
Park free Station - 4 hours

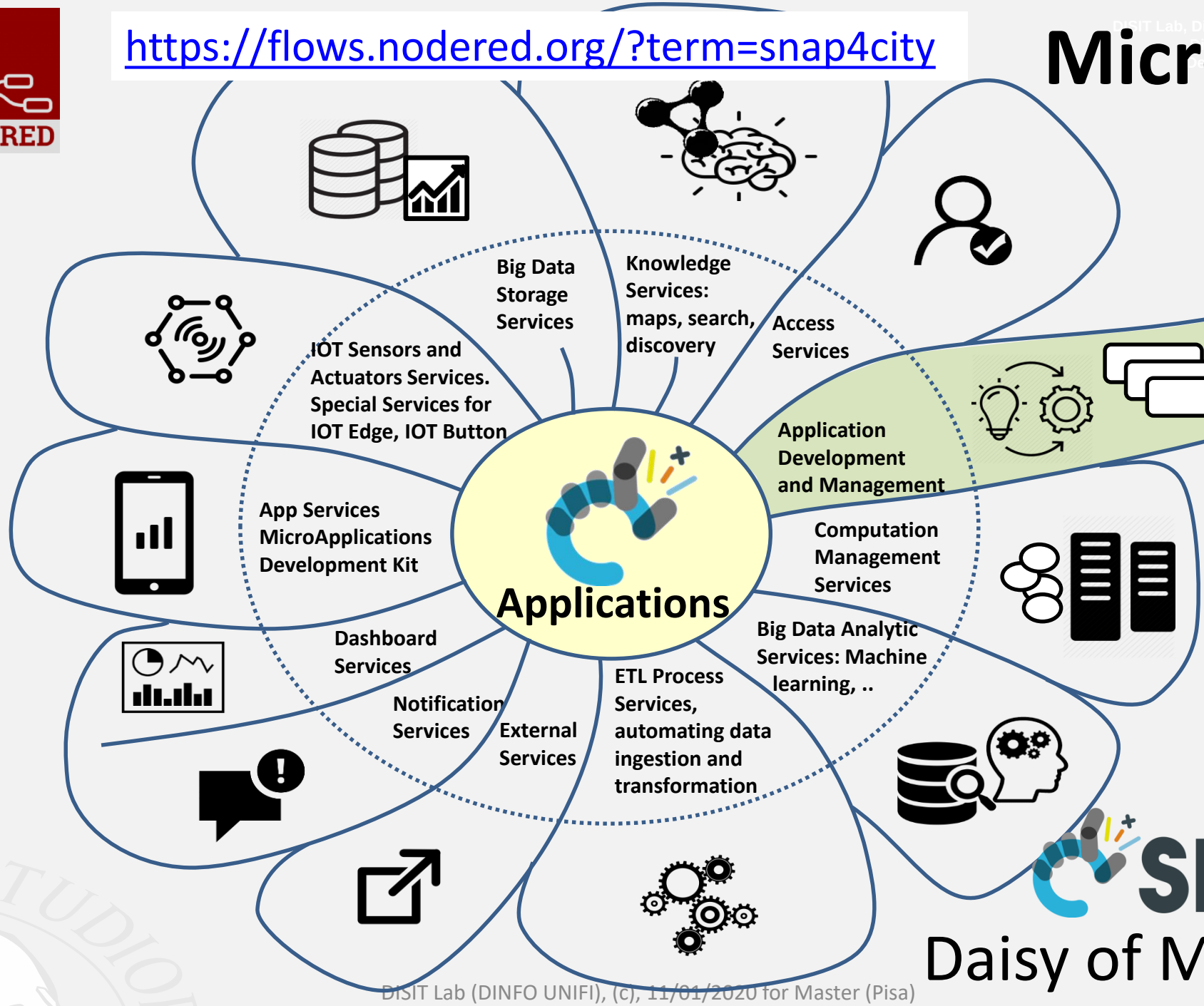

Fiware Orion
event-log
json
get Limit
delay 1s
delay 5s
delay 8s
delay 10s
setLimit
setLimit
setLimit
setLimit
event-log
event-log
event-log
event-log
Morgagni
Lavagnini
Statuto
Europa

- input
- output
- function
- social
- storage
- analysis
- advanced
- lwm2m
- S4CSearchDev
- S4CMapping
- S4CManagement
- S4CDataAnalytic
- S4CBigData
- S4CSearch
- S4CData
- S4CDashboard
- S4CSigfox
- S4CIoT
- S4CLogDev
- S4CView
- S4CSocial
- location
- dashboard

Node-RED

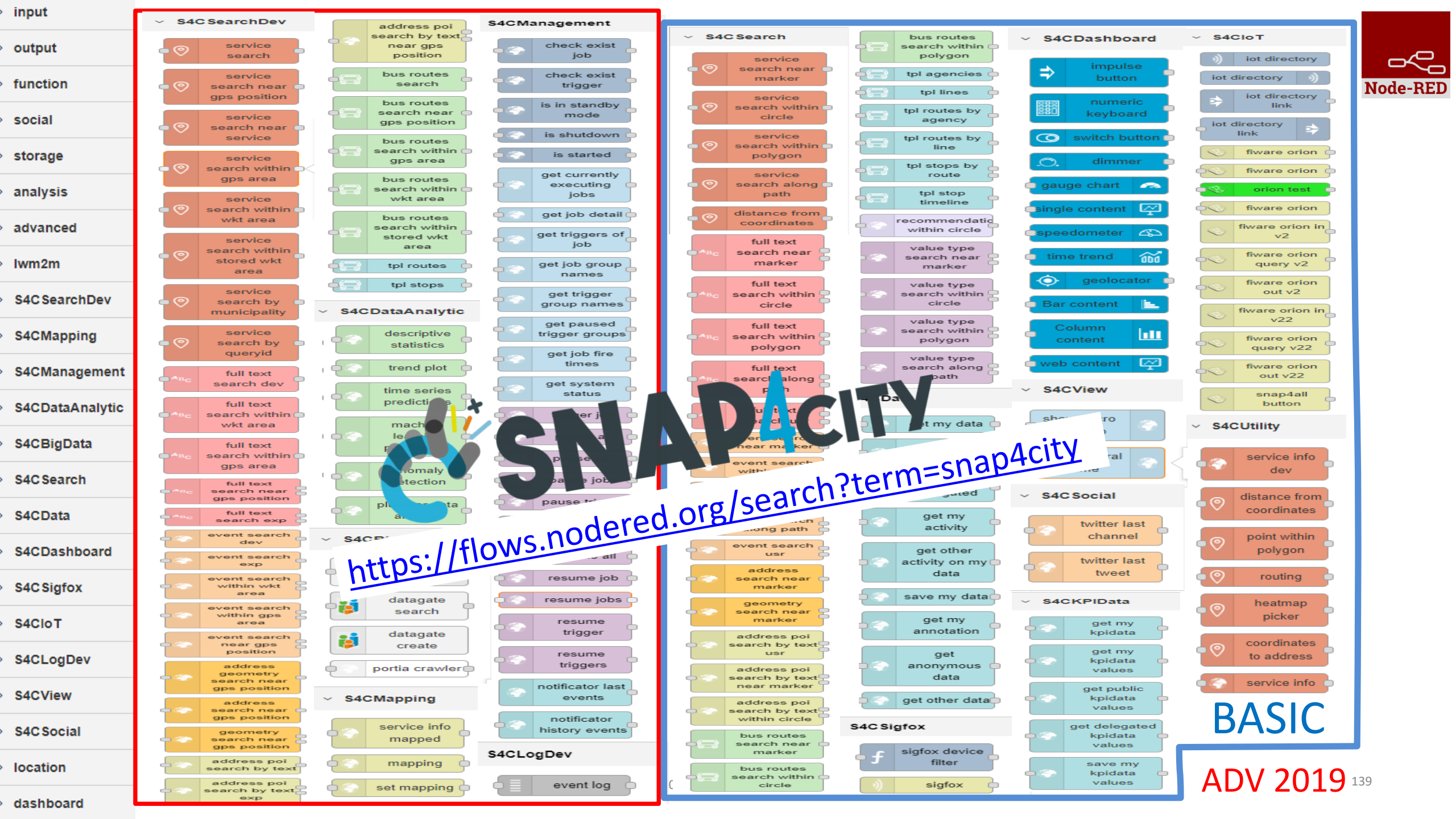
https://flows.nodered.org/?term=snap4city

MicroServices Areas



SNAP4CITY

Daisy of MicroServices


input
output
function
social
storage
analysis
advanced
lwm2m
S4CSearchDev
S4CMapping
S4CManagement
S4CDataAnalytic
S4CBigData
S4CSearch
S4CData
S4CDashboard
S4CSigfox
S4CIoT
S4CLogDev
S4CView
S4CSocial
location
dashboard
S4CSearchDev
service search
service search near gps position
service search near service
service search within gps area
service search within wkt area
service search within stored wkt area
service search by municipality
service search by queryid
full text search dev
full text search within wkt area
full text search within gps area
full text search near gps position
full text search exp
event search dev
event search exp
event search within wkt area
event search within gps area
event search near gps position
address geometry search near gps position
address search near gps position
geometry search near gps position
address poi search by text
address poi search by text exp
address poi search by text near gps position
bus routes search
bus routes search near gps position
bus routes search within gps area
bus routes search within wkt area
bus routes search within stored wkt area
tpl routes
tpl stops
S4CDataAnalytic
descriptive statistics
trend plot
time series predictions
datagate search
datagate create
portia crawler
S4CMapping
service info mapped
mapping
set mapping
S4CManagement
check exist job
check exist trigger
is in standby mode
is shutdown
is started
get currently executing jobs
get job detail
get triggers of job
get job group names
get trigger group names
get paused trigger groups
get job fire times
get system status
resume job
resume jobs
resume trigger
resume triggers
notificator last events
notificator history events
S4CLogDev
event log
S4CSearch
service search near marker
service search within circle
service search within polygon
service search along path
distance from coordinates
full text search near marker
full text search within circle
full text search within polygon
event search usr
address search near marker
geometry search near marker
address poi search by text usr
address poi search by text near marker
address poi search by text within circle
bus routes search near marker
bus routes search within circle
bus routes search within polygon
tpl agencies
tpl lines
tpl routes by agency
tpl routes by line
tpl stops by route
tpl stop timeline
recommendation within circle
value type search near marker
value type search within circle
value type search within polygon
value type search along path
get my activity
get other activity on my data
save my data
get my annotation
get anonymous data
get other data
S4CSigfox
sigfox device filter
sigfox
S4CDashboard
impulse button
numeric keyboard
switch button
dimmer
gauge chart
single content
speedometer
time trend
geolocator
Bar content
Column content
web content
S4CView
S4CSocial
twitter last channel
twitter last tweet
S4CKPIData
get my kpidata
get my kpidata values
get public kpidata values
get delegated kpidata values
save my kpidata values
S4CIoT
iot directory
iot directory
iot directory link
iot directory link
fiware orion
fiware orion
orion test
fiware orion
fiware orion in v2
fiware orion query v2
fiware orion out v2
fiware orion in v22
fiware orion query v22
fiware orion out v22
snap4all button
S4CUtility
service info dev
distance from coordinates
point within polygon
routing
heatmap picker
coordinates to address
service info
SNAP4CITY
https://flows.nodered.org/search?term=snap4city
BASIC
ADV 2019
Node-RED

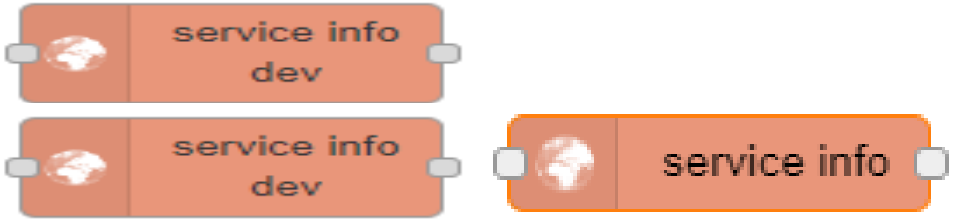
S4CSearch

Node-RED

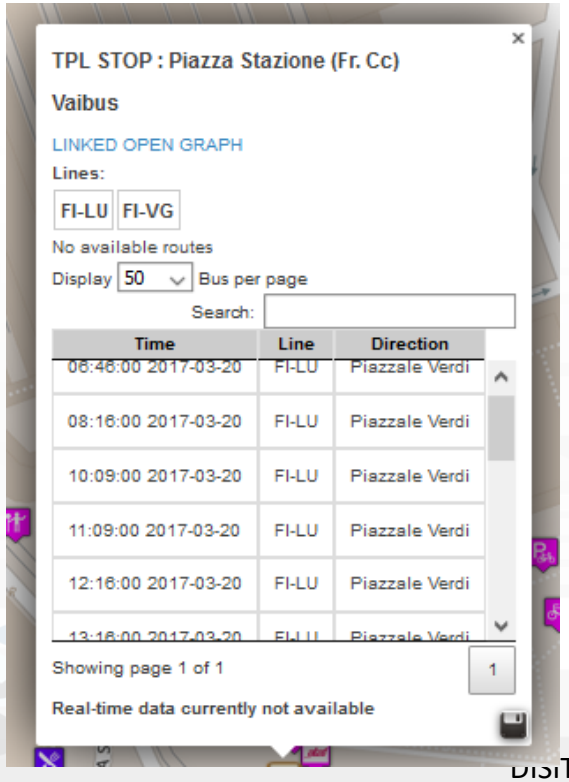
S4CUtility

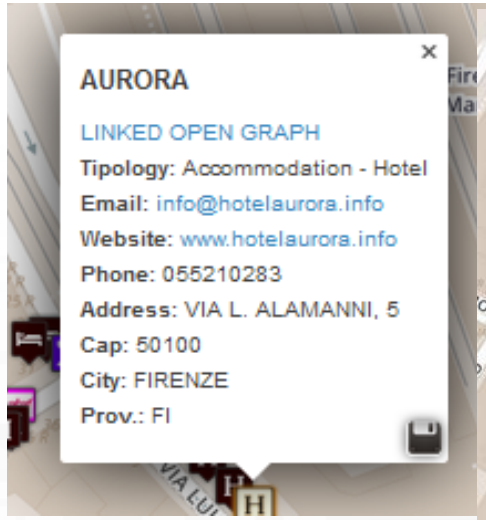


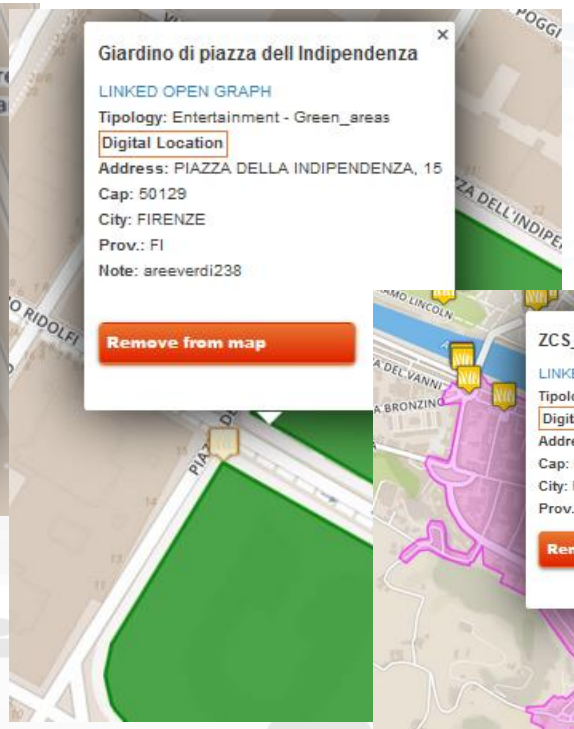
- ANY kind of sensors
- **To Get DATA of a Service / POI /sensor**
  - Historical and real time
  - Real Time

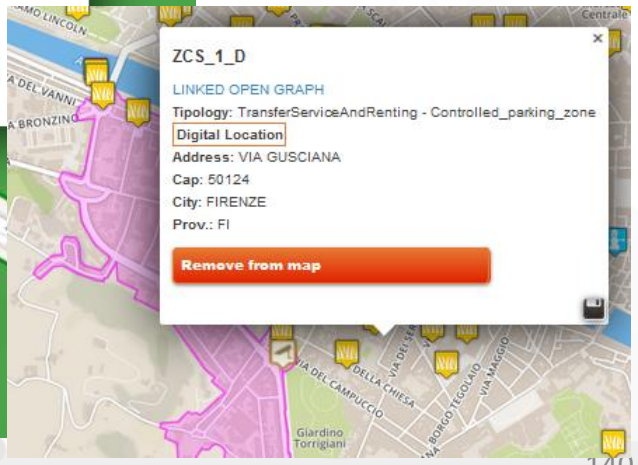








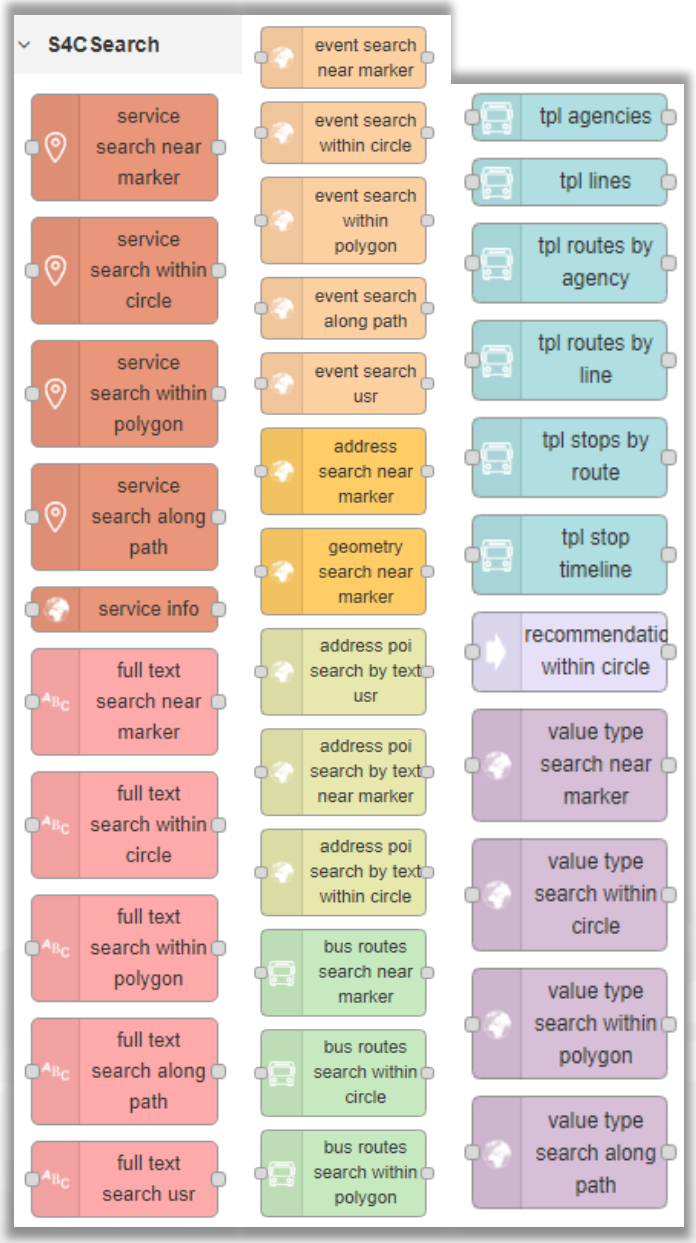




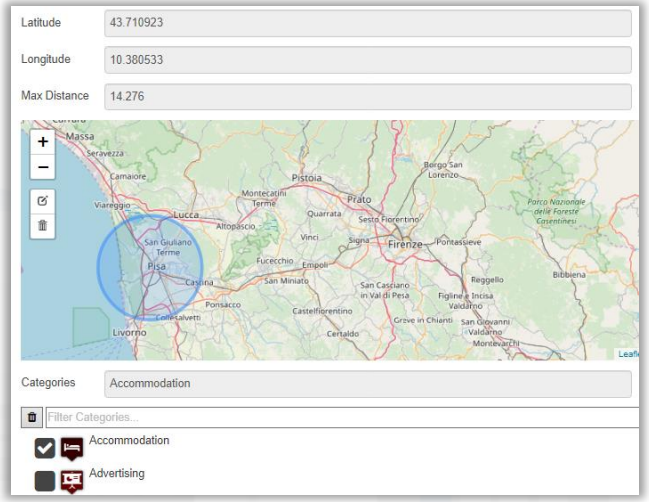
S4CSearch

Smart City Entities Search

Simple and Fast



- **For example to search for:**
  - POIs:
    - near a GPS position, from text, along a path, in an area, etc..
  - Public Transport information / data
  - Suggestions
  - Public Transport Means Routes/Paths
  - Events in the area
  - Value Type (kind of data)
  - Etc.
- **To Get DATA of a Service / POI /sensor**
  - Real Time
  - ANY kind of senso



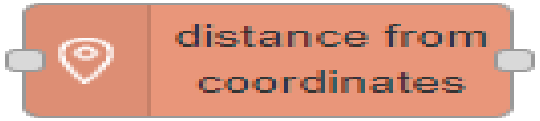


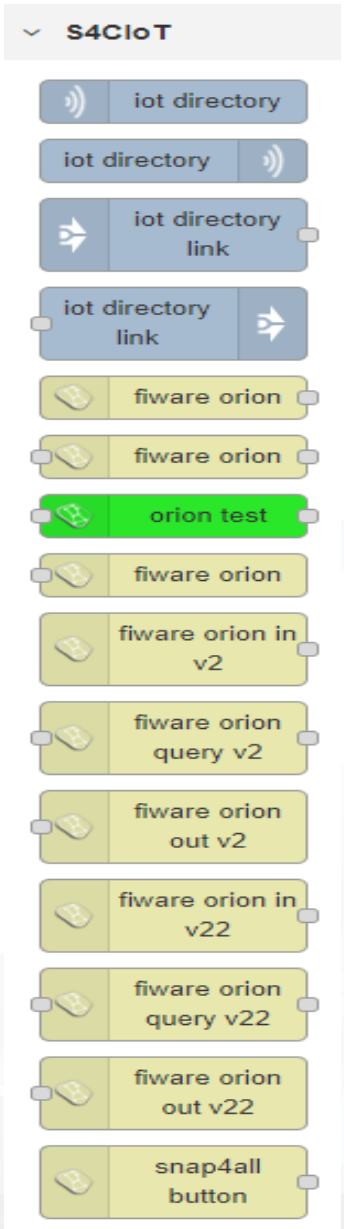
S4CSearch



- **For example to search for:**
  - POIs:
    - near a GPS position, from text, along a path, in an area, etc..
  - Public Transport information / data
  - Suggestions
  - Public Transport Means Routes/Paths
  - Events in the area
  - Value Type (kind of data)
  - Etc.
- **To Get DATA of a Service / POI /sensor**
  - Real Time
  - ANY kind of sensors
- **Distance from GPS point**

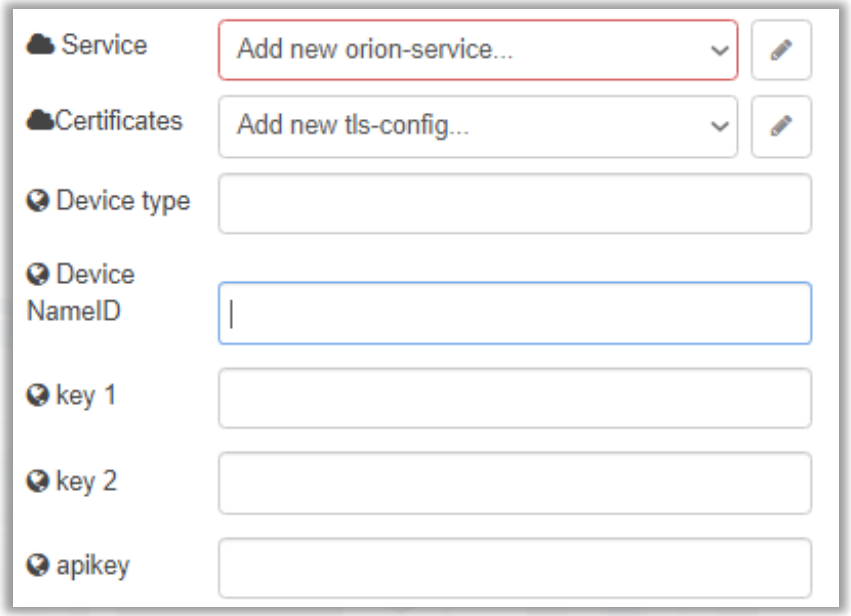






- **Search** for IOT Devices in a given area, or for kind (temperature, model, location, producer, Broker, …)
- **Subscribe** to one or more IOT Devices independently on their protocol, broker, owner, etc.
- **Send** data to IOT devices
- Establish with IOT Devices **Secure** certified Connections

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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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

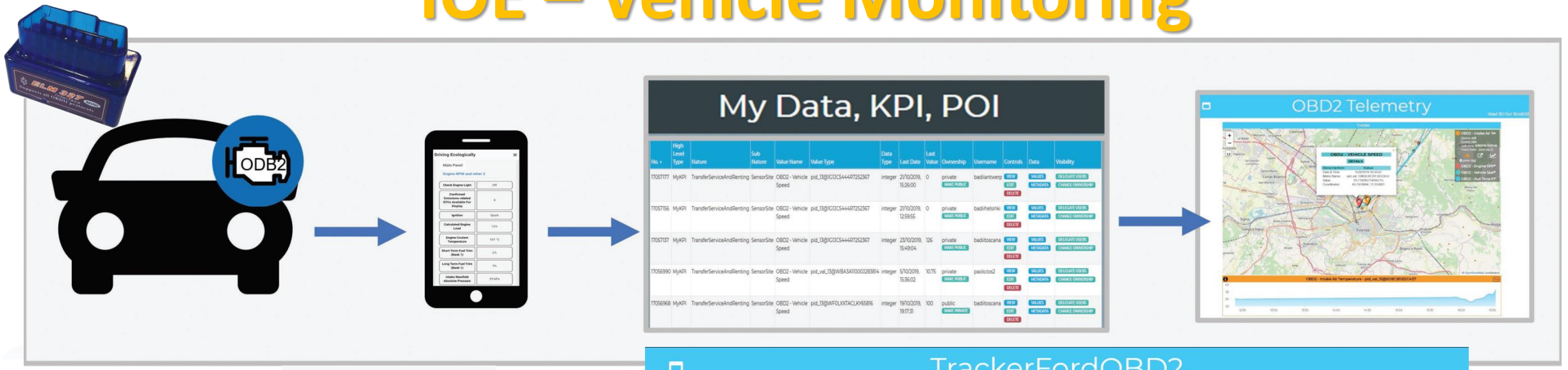
LoRa® Wi Fi Bluetooth™

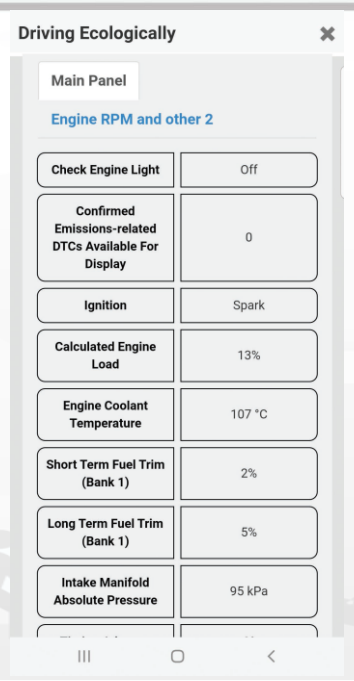
https://www.snap4city.org/drupal/node/456

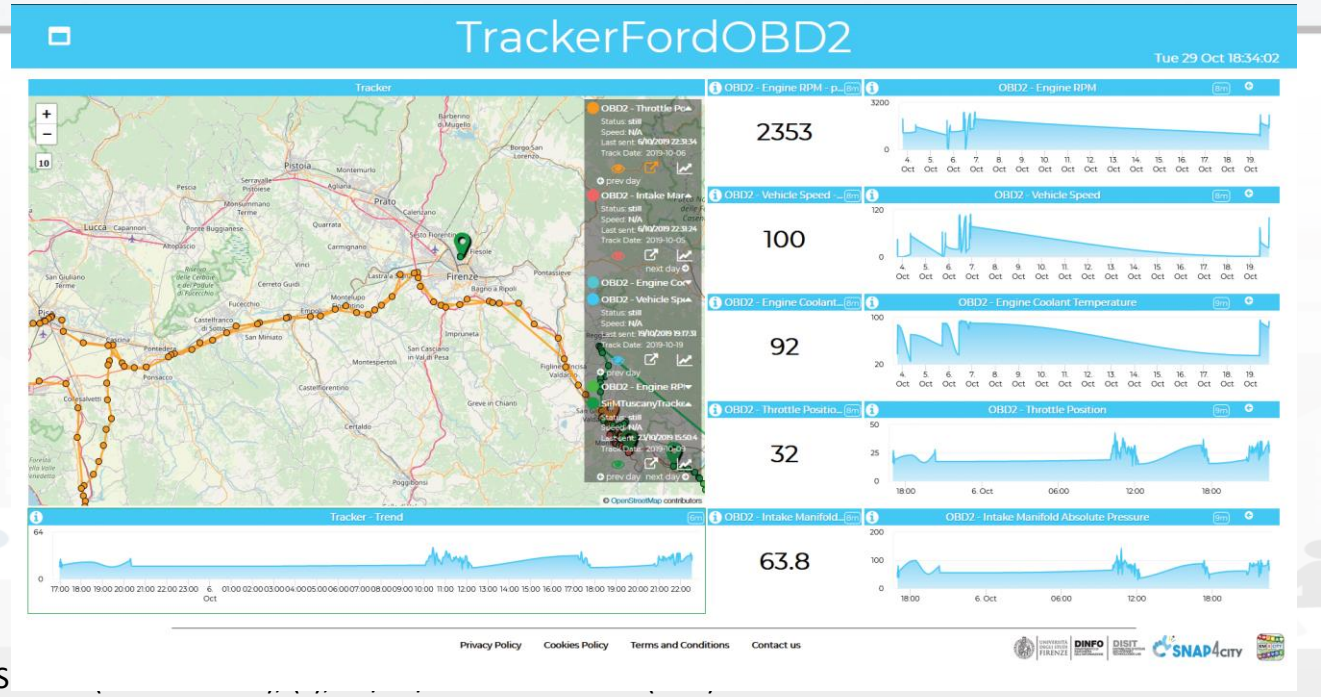
Programmable PAX counting



IOE – Vehicle Monitoring







MyKPI: Tracking of Devices and Mobiles

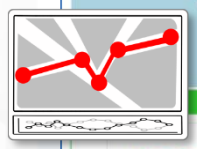
- Real Time Trajectories for
  - Mobile Phone
  - Moving IOT Devices
  - OBU, Vehicular Kits
  - Multiple tracks
  - Day by day
- Micro Application



Mobile
PAX Counter

Apps







OBD2

OBU



IoT Security



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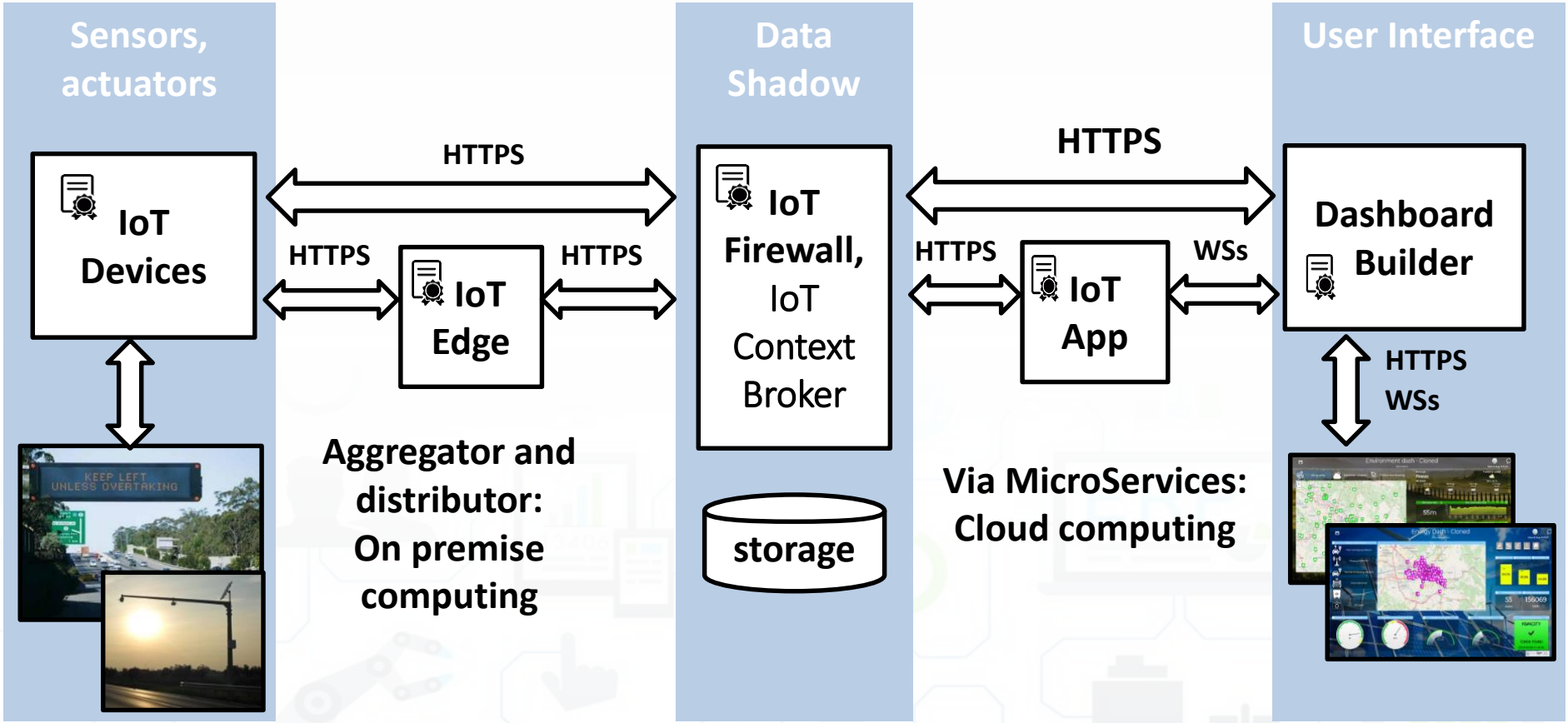
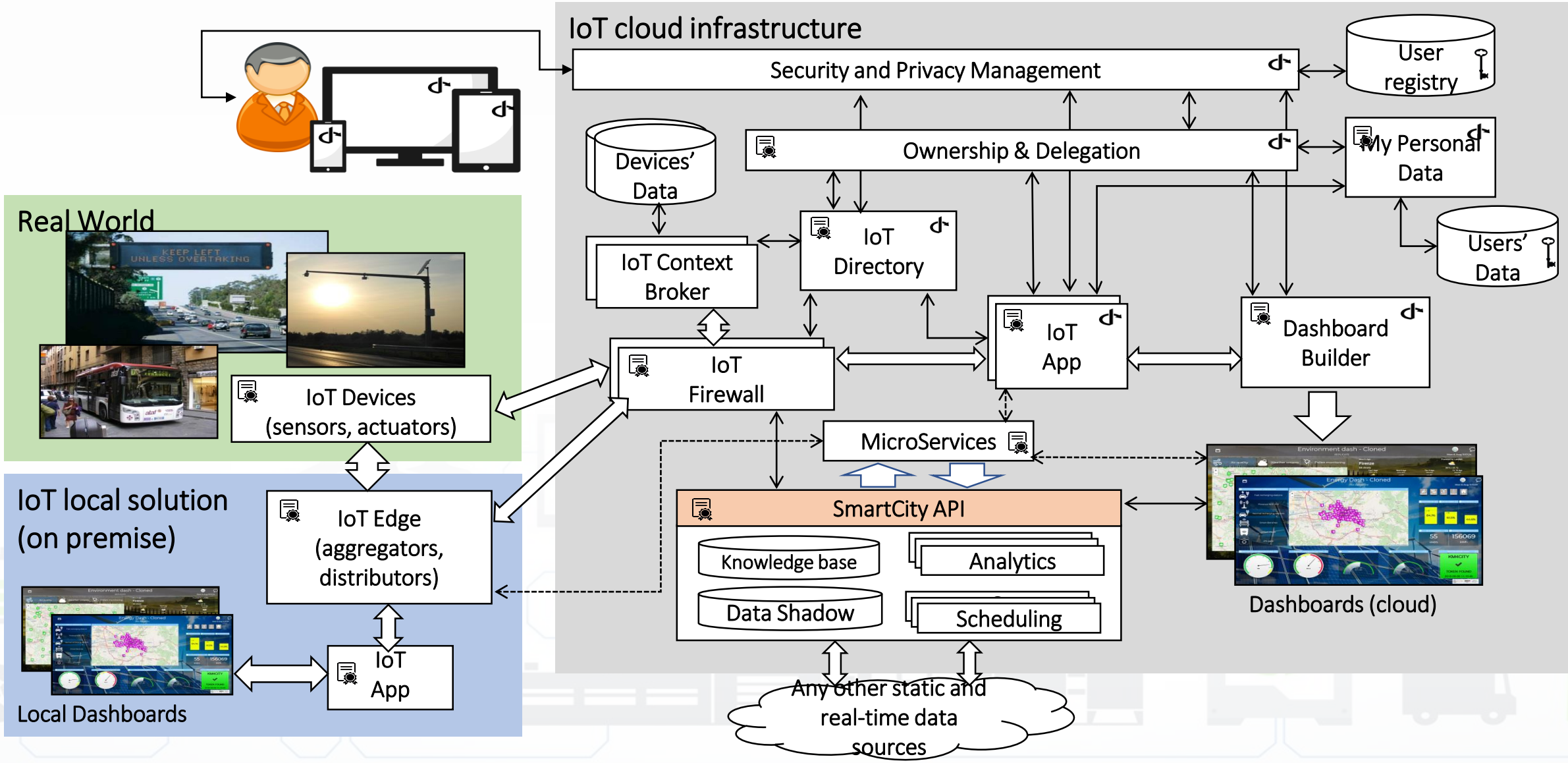
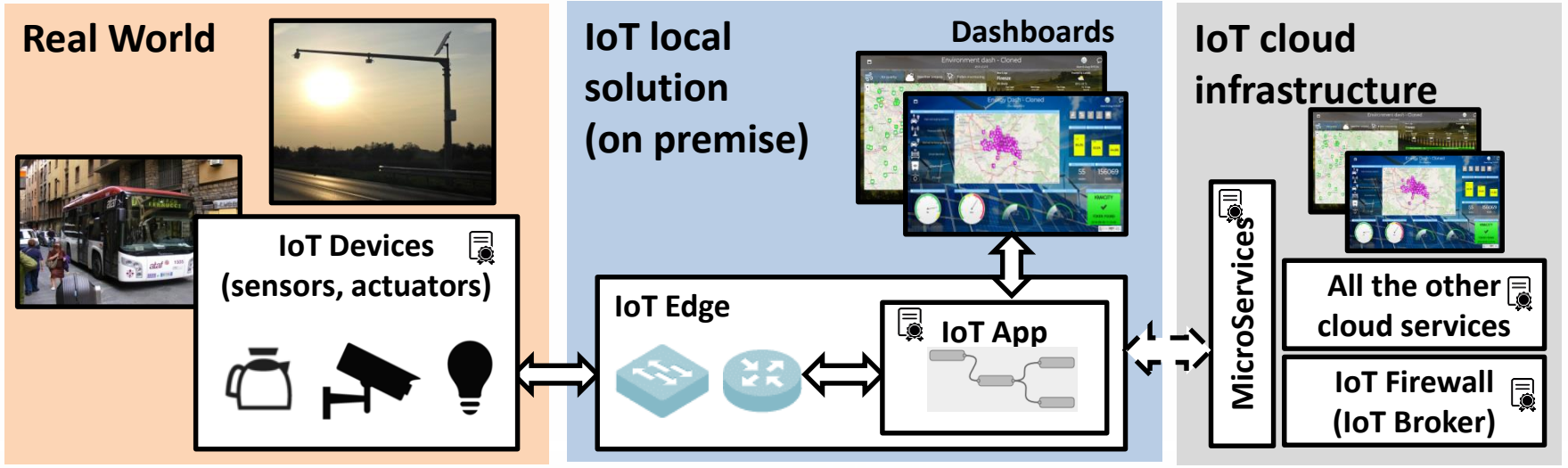
The secure stack

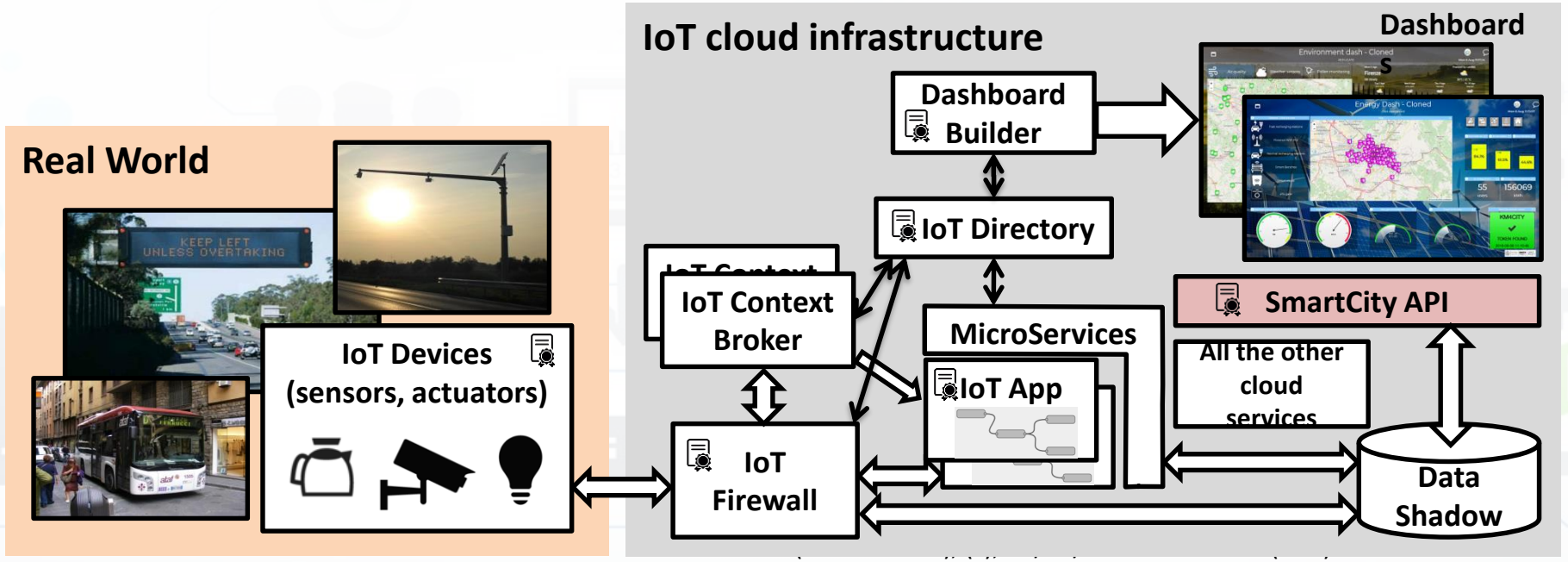


Secure Architecture

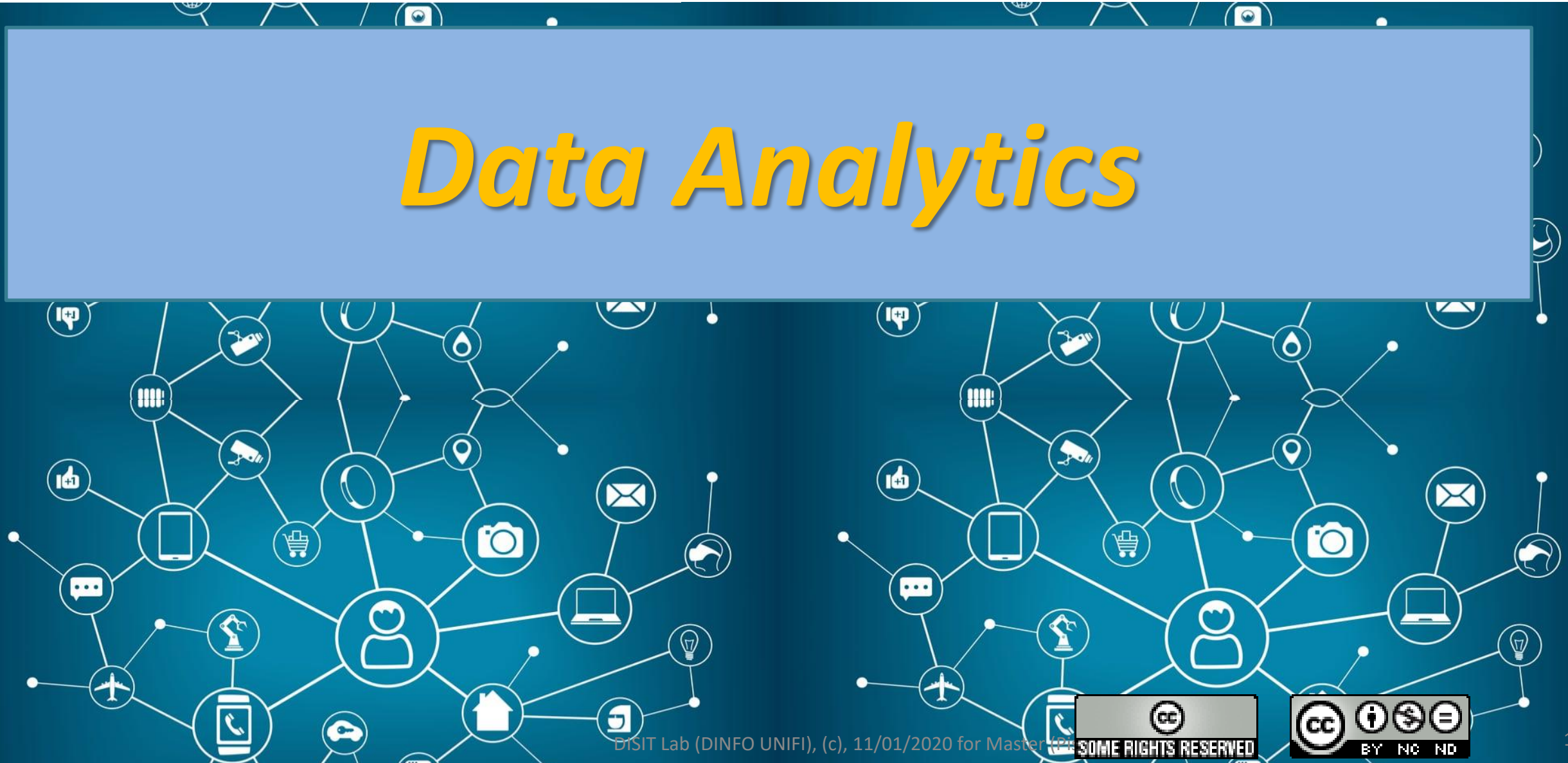


OnPremise vs Cloud





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

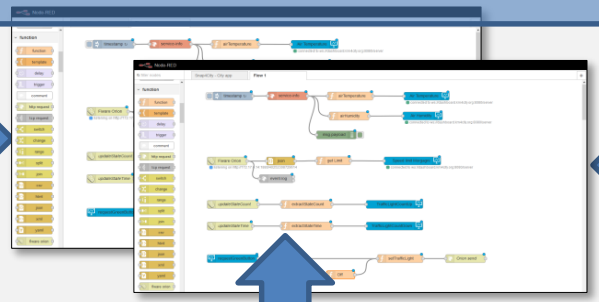
- Developing and Exploiting Data Analytics as MicroServices
- Smart Parking
- User Behaviour Analysis
- Traffic Flow Reconstruction
- Environmental Data: Predictions, Early Warning
- Anomaly Detection
- Intelligence on Maintenance Data
- Suggestions for Retail
- Predicting ReTweet Proneness

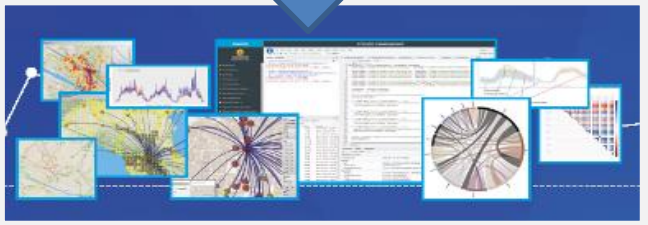
Dashboards with data driven IOT Applications enforcing intelligence

IOT and data World

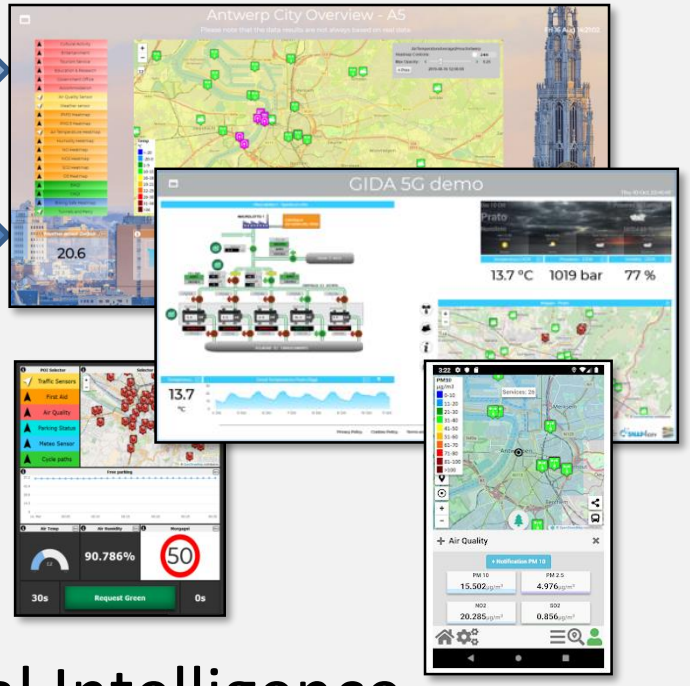


IOT Applications

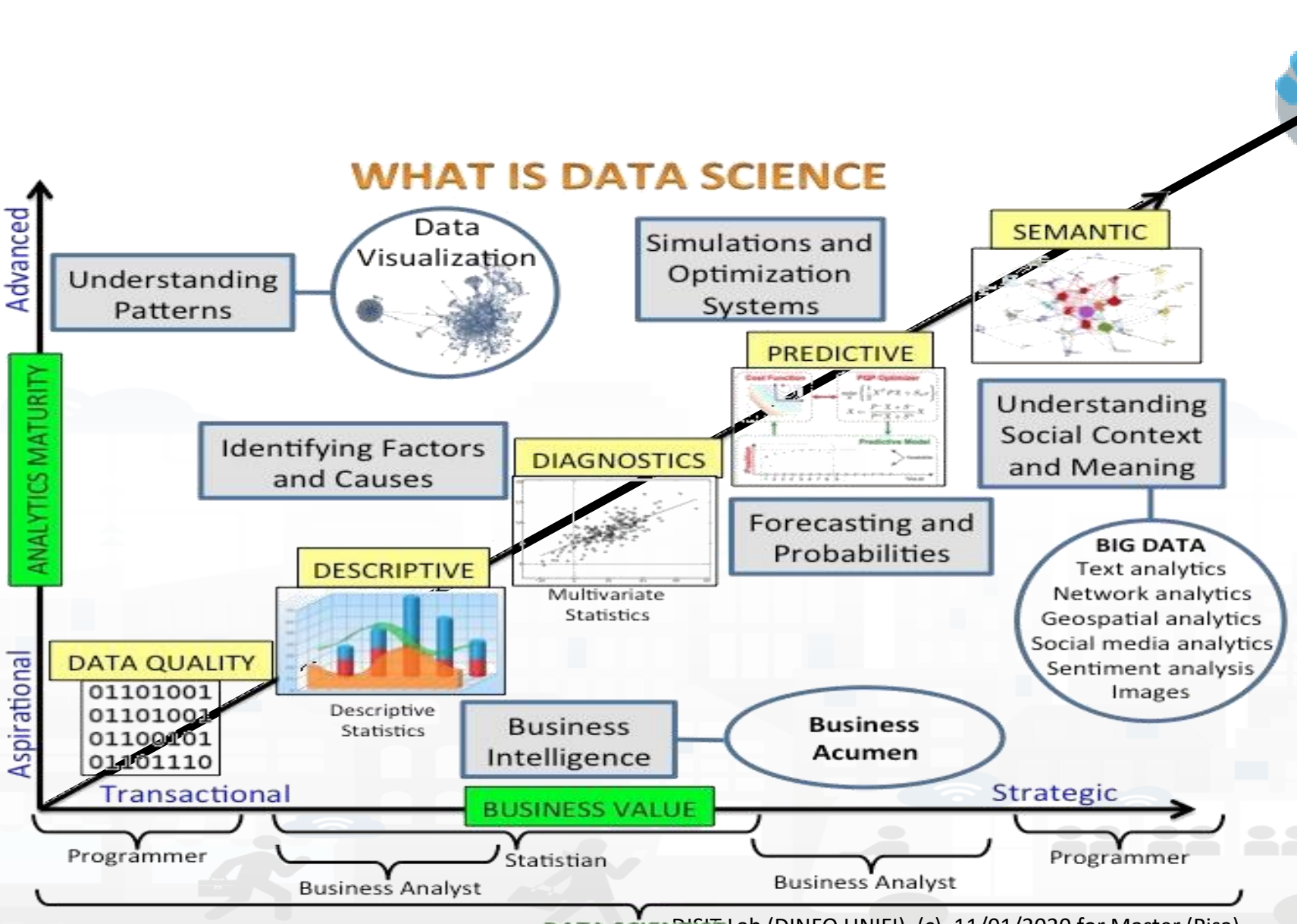




Dashboards and Apps



Big Data Analytics, Artificial Intelligence

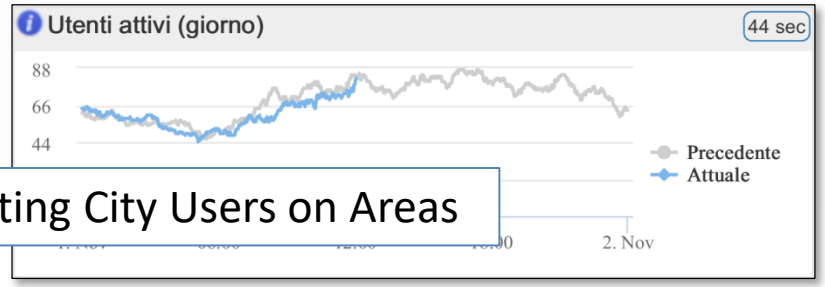


Sentient and active processes

- 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

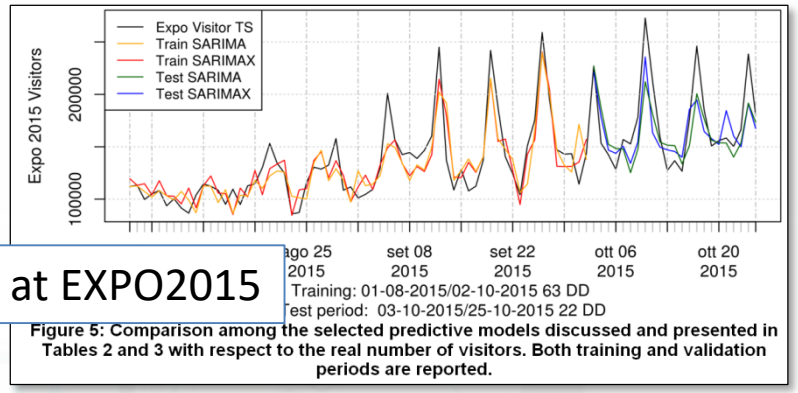
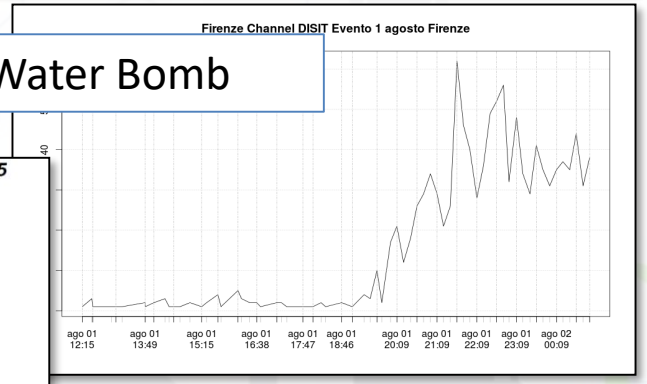
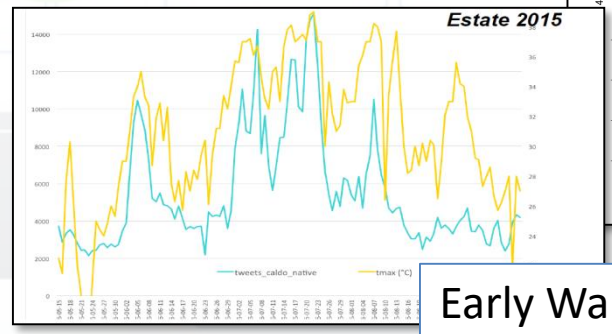


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.

Predicting at EXPO2015



Early Warning Water Bomb



Early Warning Hot in Tuscany

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

Developing and Exploiting Data Analytics as MicroServices



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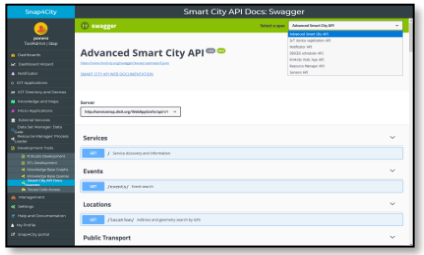
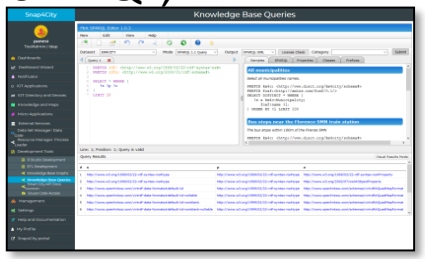
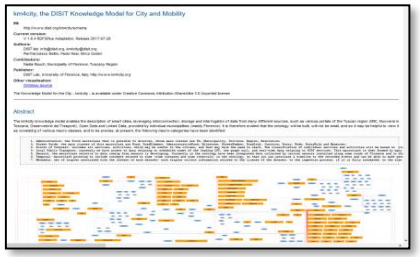
Data Analytics Dev. in R Studio and/or Tensor Flow

Swagger



SPARQL, FLINT





Ontology Schema



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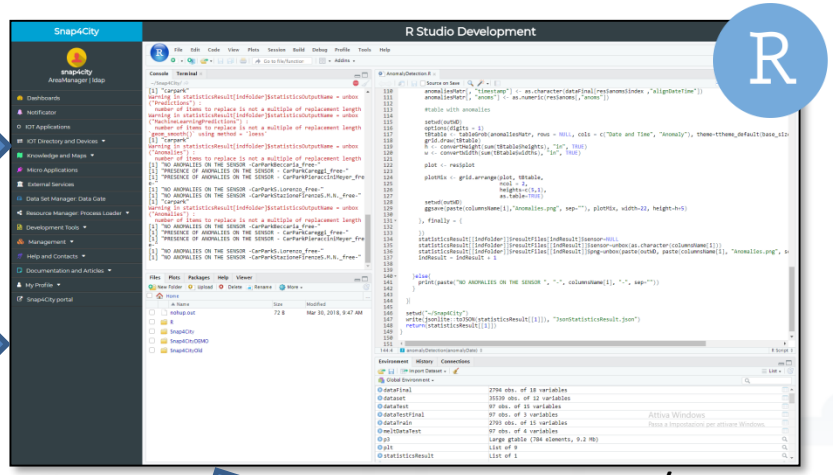
Knowledge Base, Km4City



Big Data Store Facility

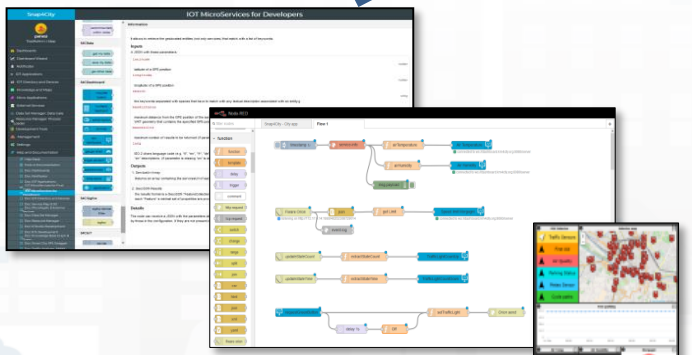
Smart City API from Knowledge Base and other tools



R Studio



Creating MicroServices



Using them into IOT Applications

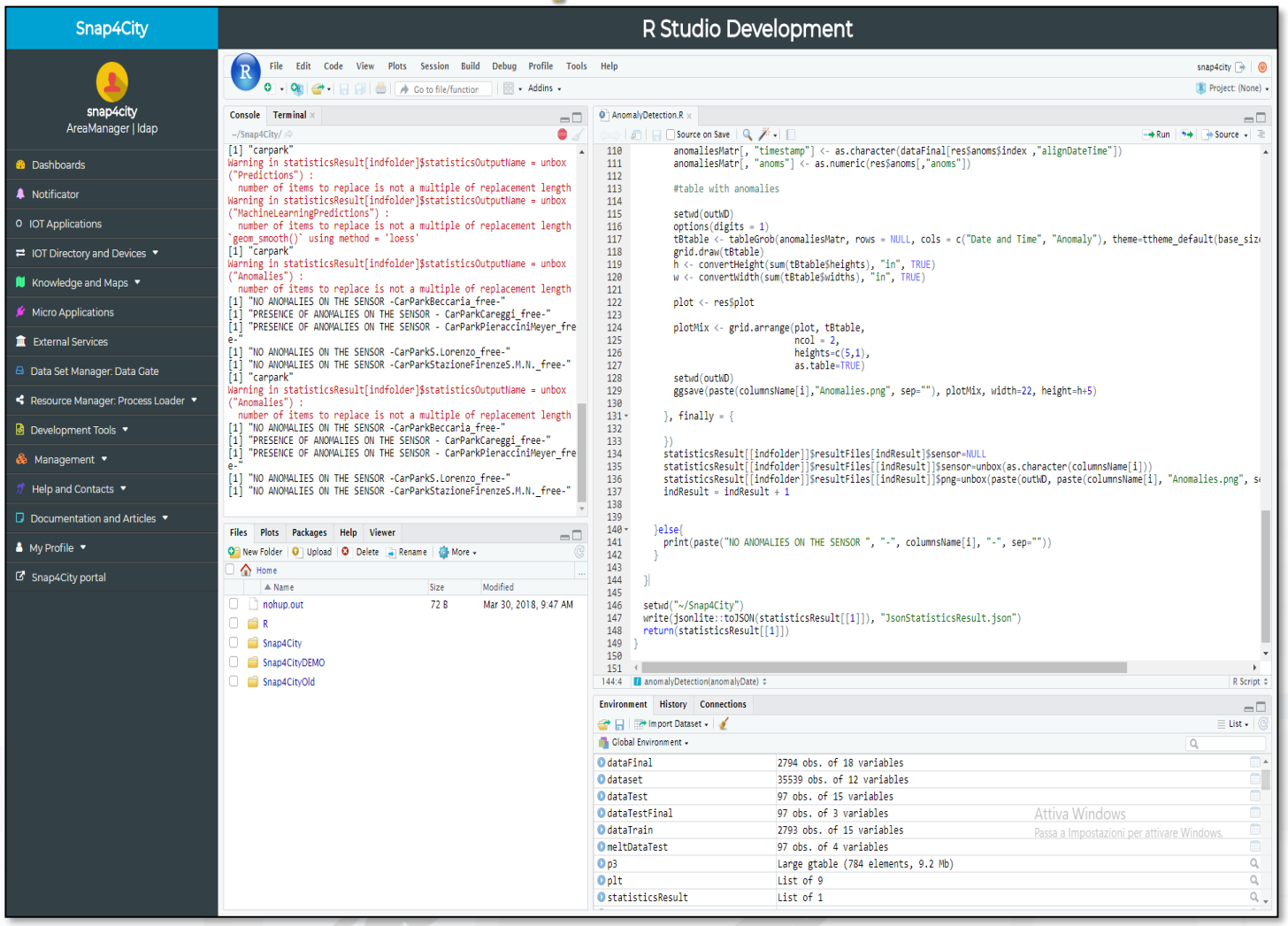
Saving / Sharing reusing



Resource Manager



Developer in R Studio + Tensor Flow





Data Analytics in R Studio Con Tensor Flow

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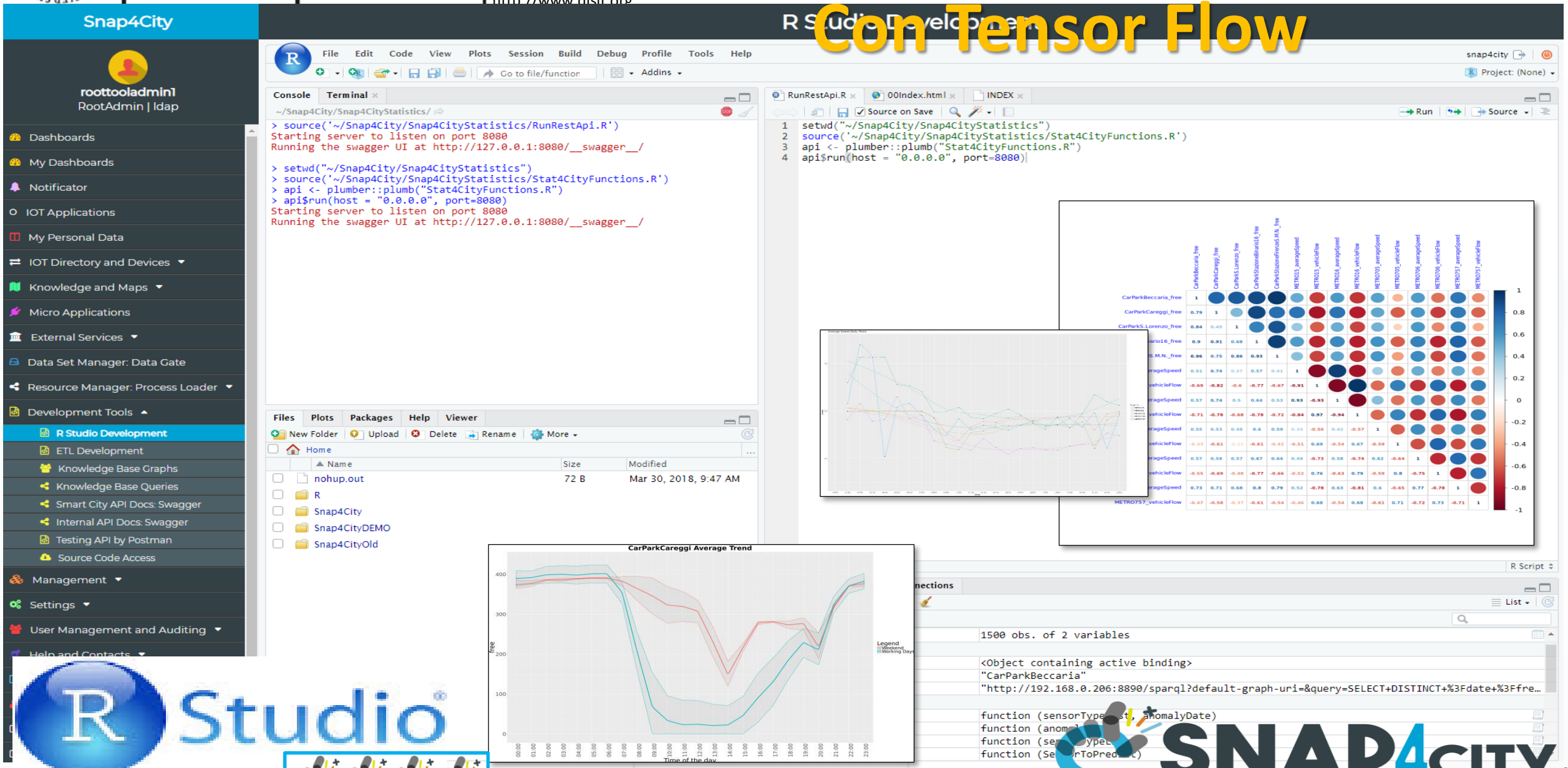
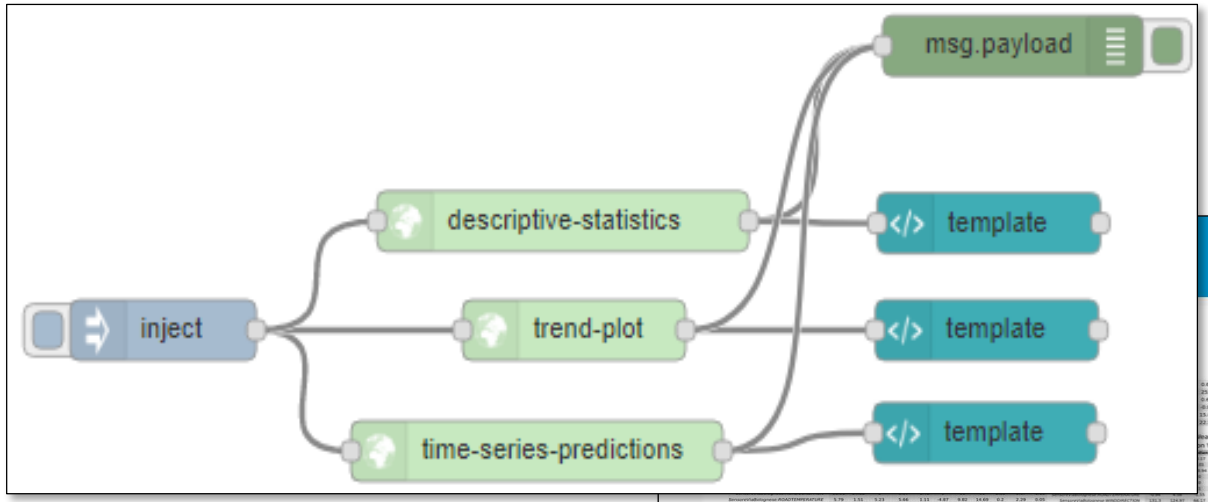
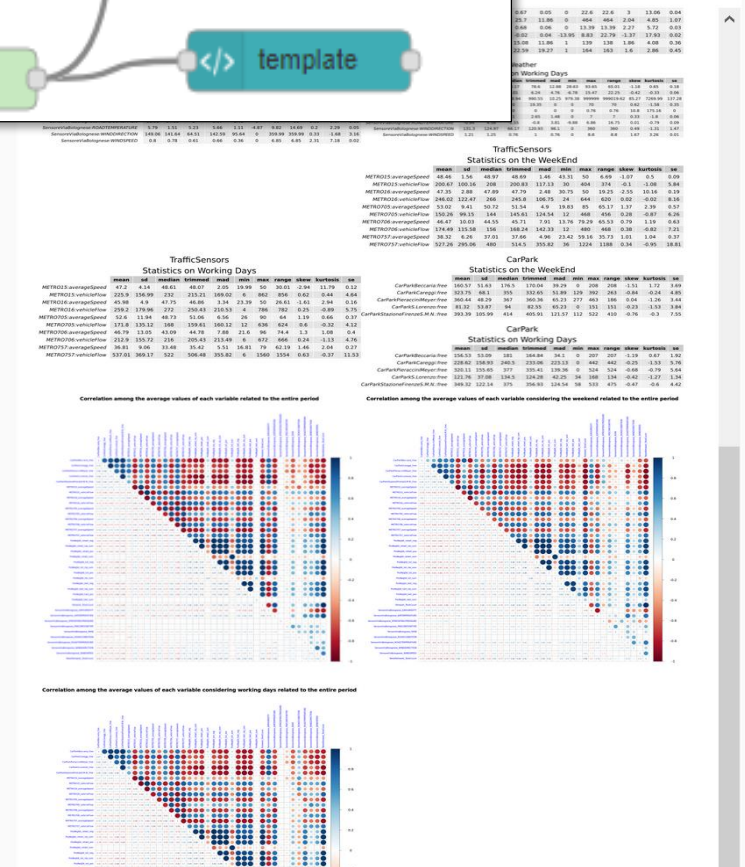
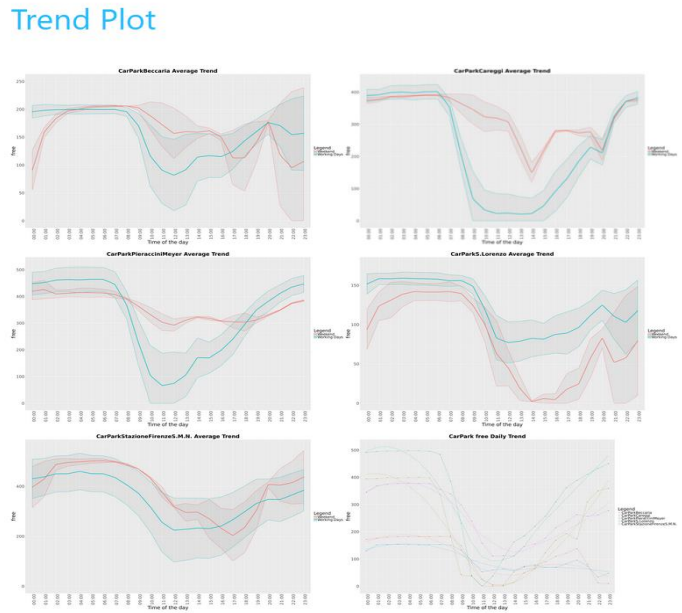


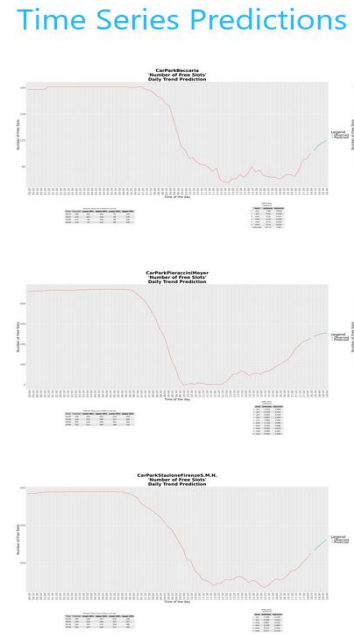
From R studio data analytics to MicroService



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

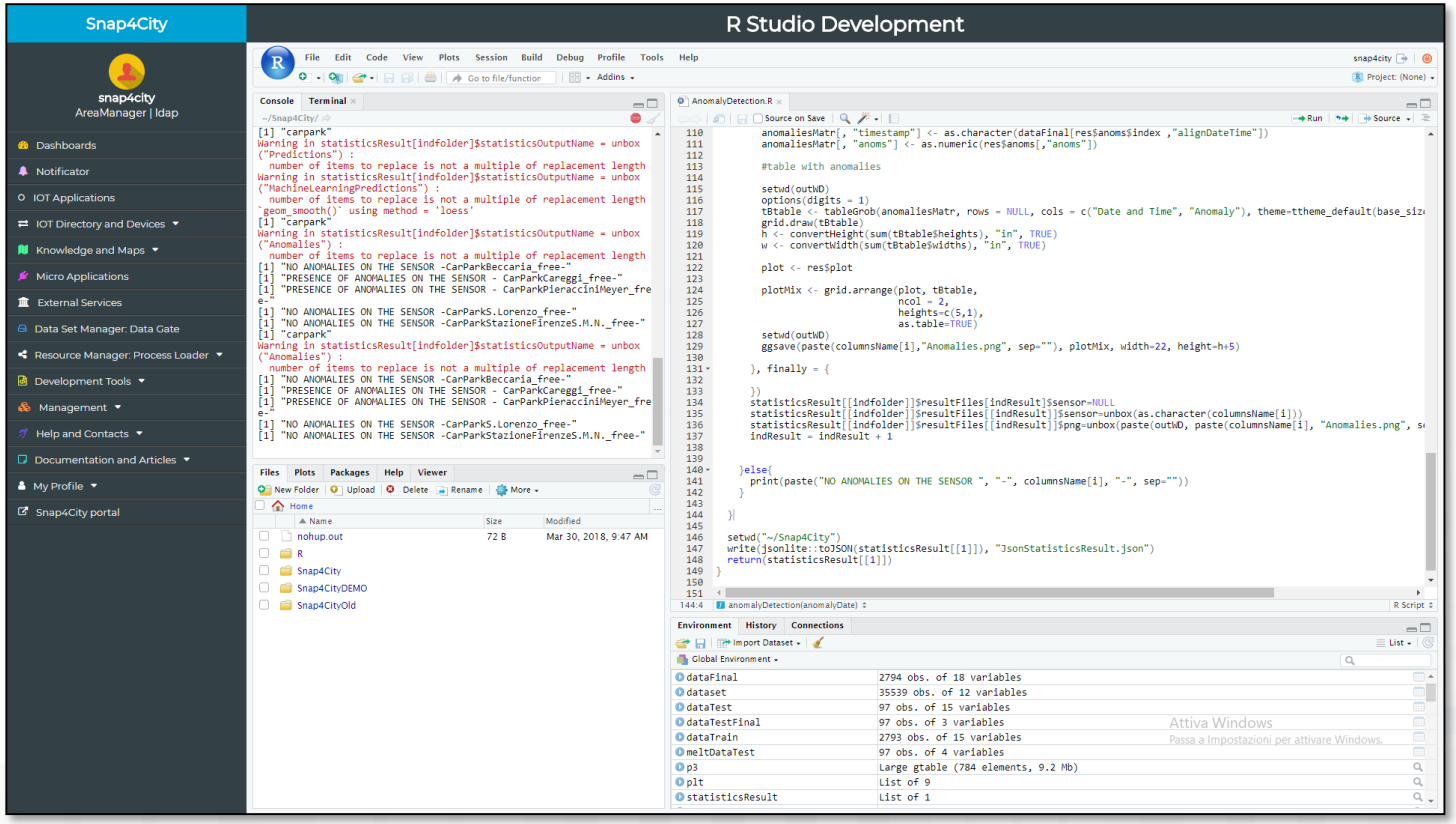


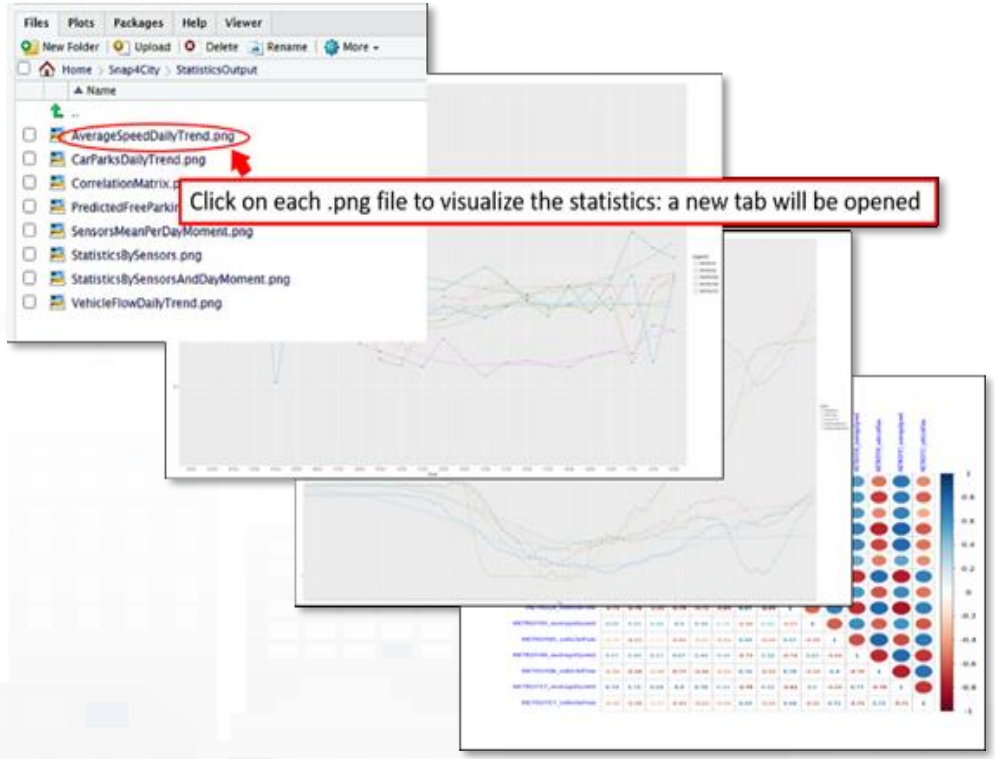


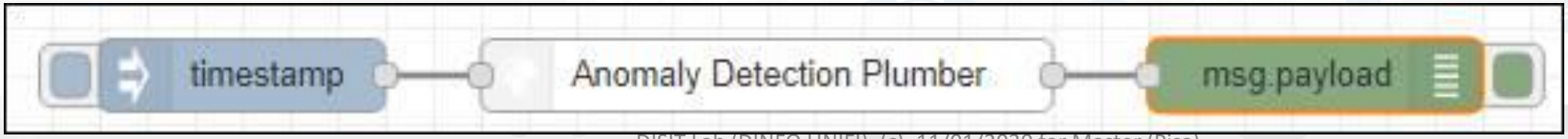


SNAP4CITY

Developing in R Studio and/or Tensor Flow

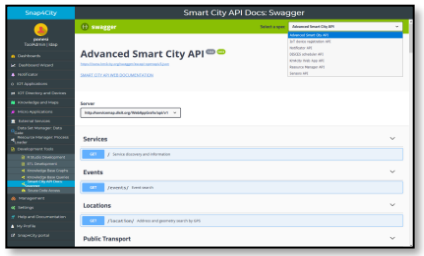




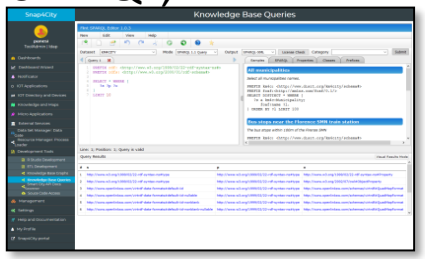


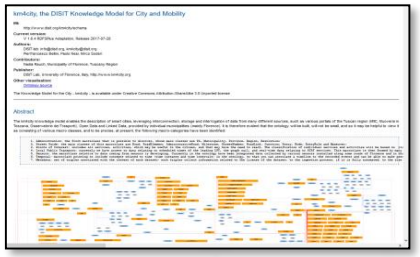
Data Analytics Dev. in Java, Python, ..

Swagger



SPARQL, FLINT





Ontology Schema



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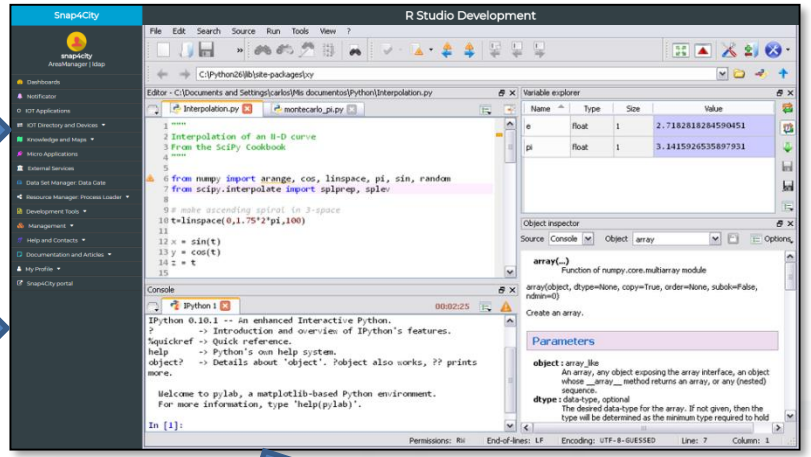
Knowledge Base, Km4City

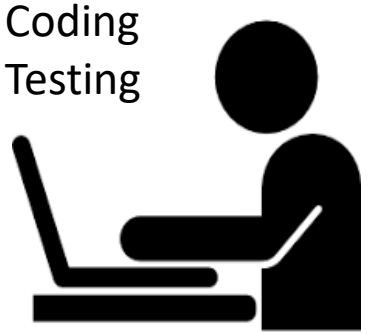


Big Data Store Facility

Smart City API from Knowledge Base and other tools

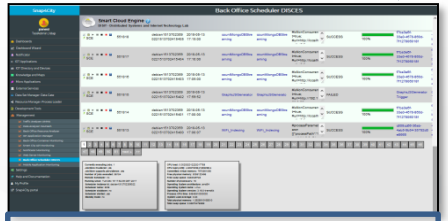


Coding
Testing



Saving /
Sharing
resusing

DISCES scheduler



Monitoring



Resource Manager



Process
Process
Process
Process

Distributed Back Office

Data sources

Smart Parking



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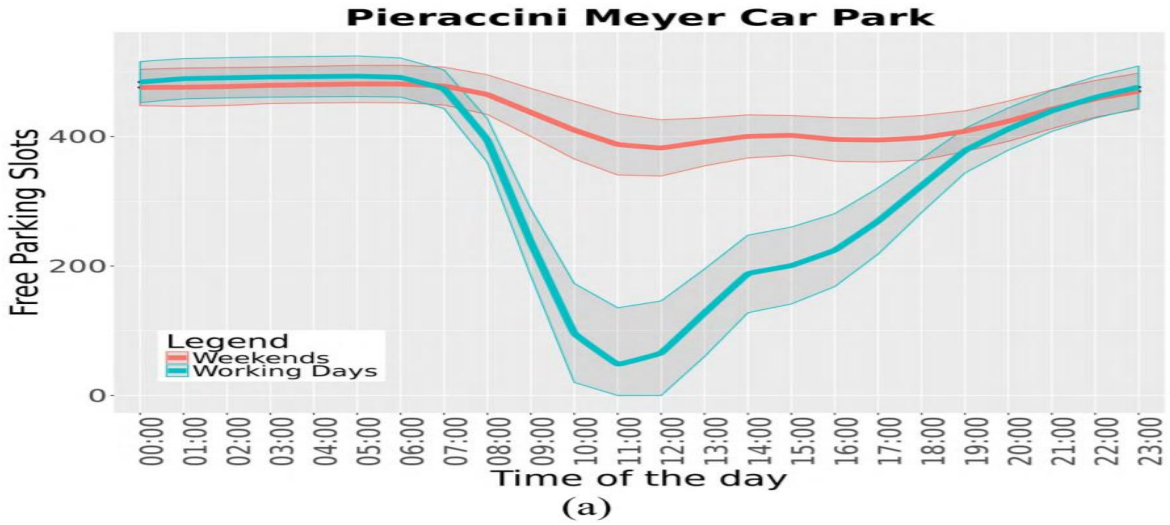
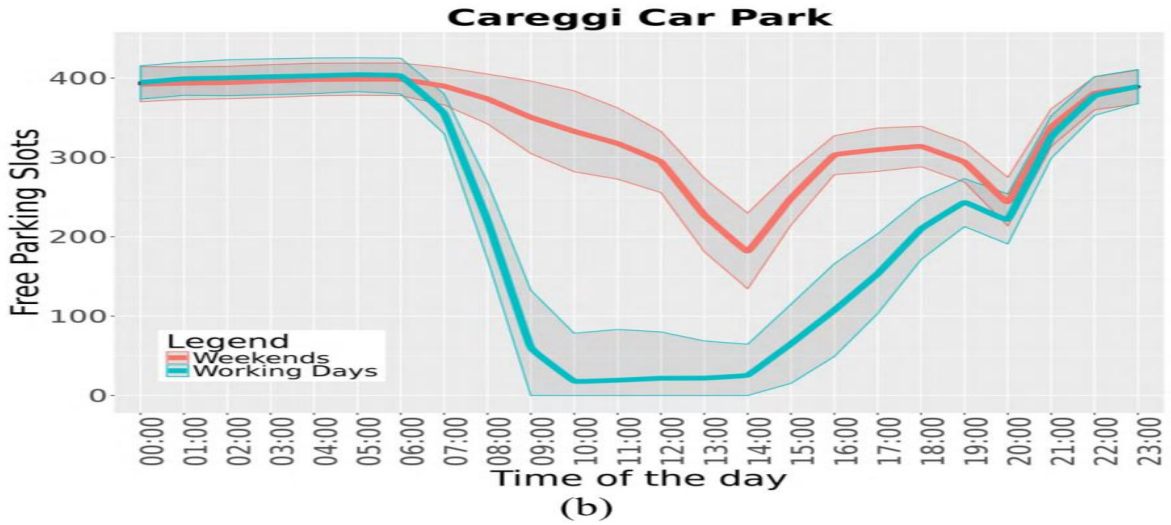
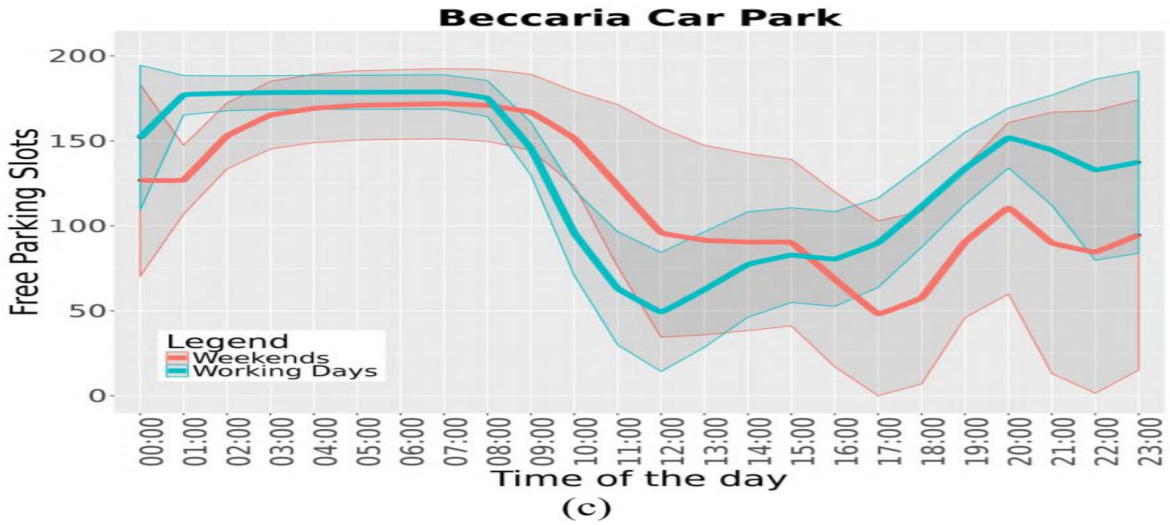
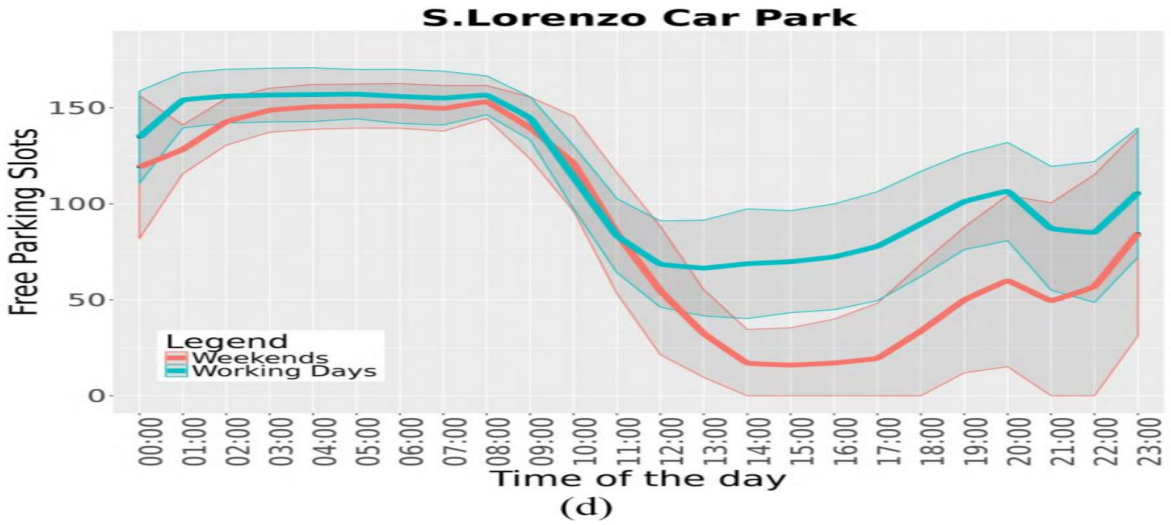
Free Parking space trends







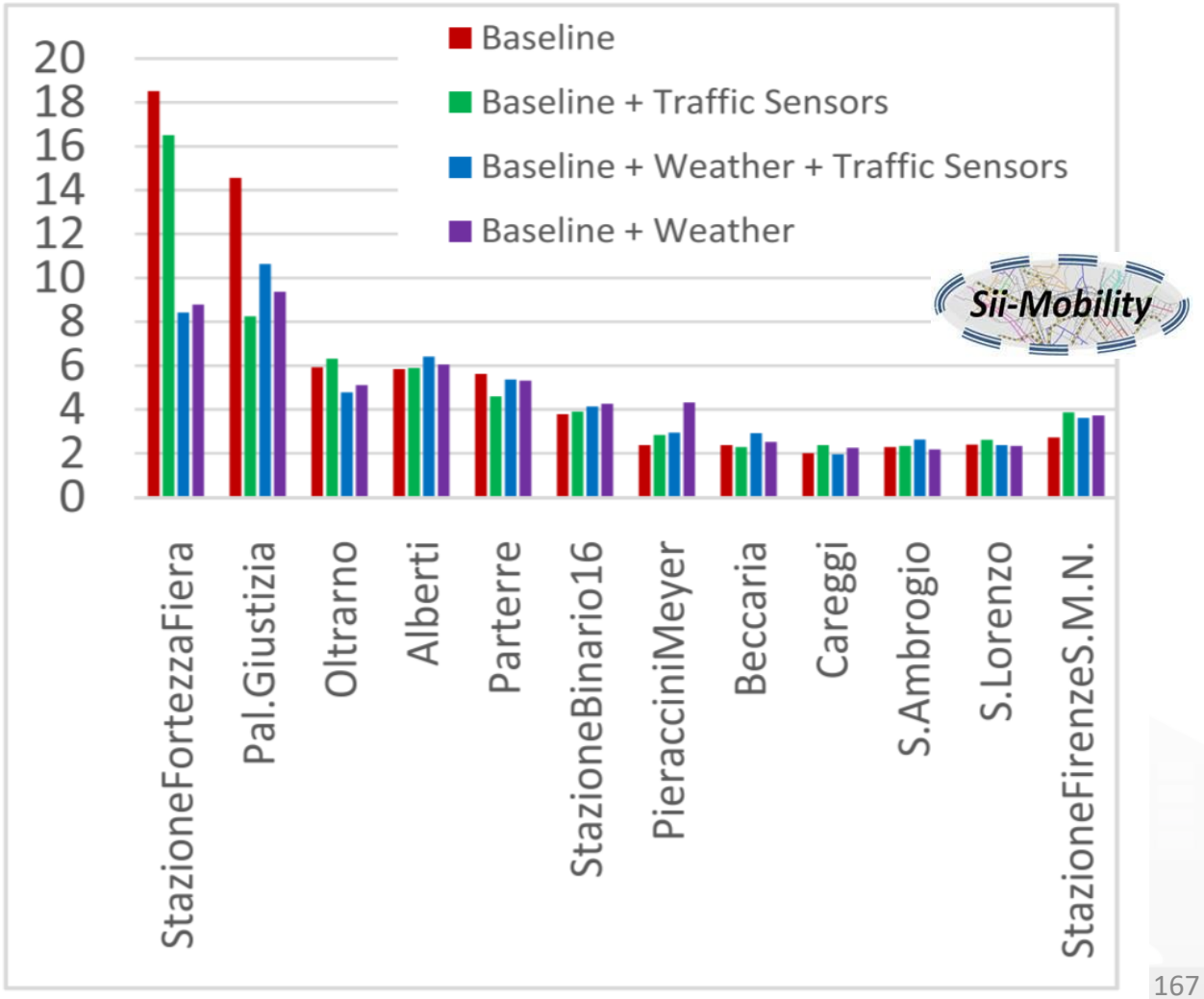


12 parking areas in Florence

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

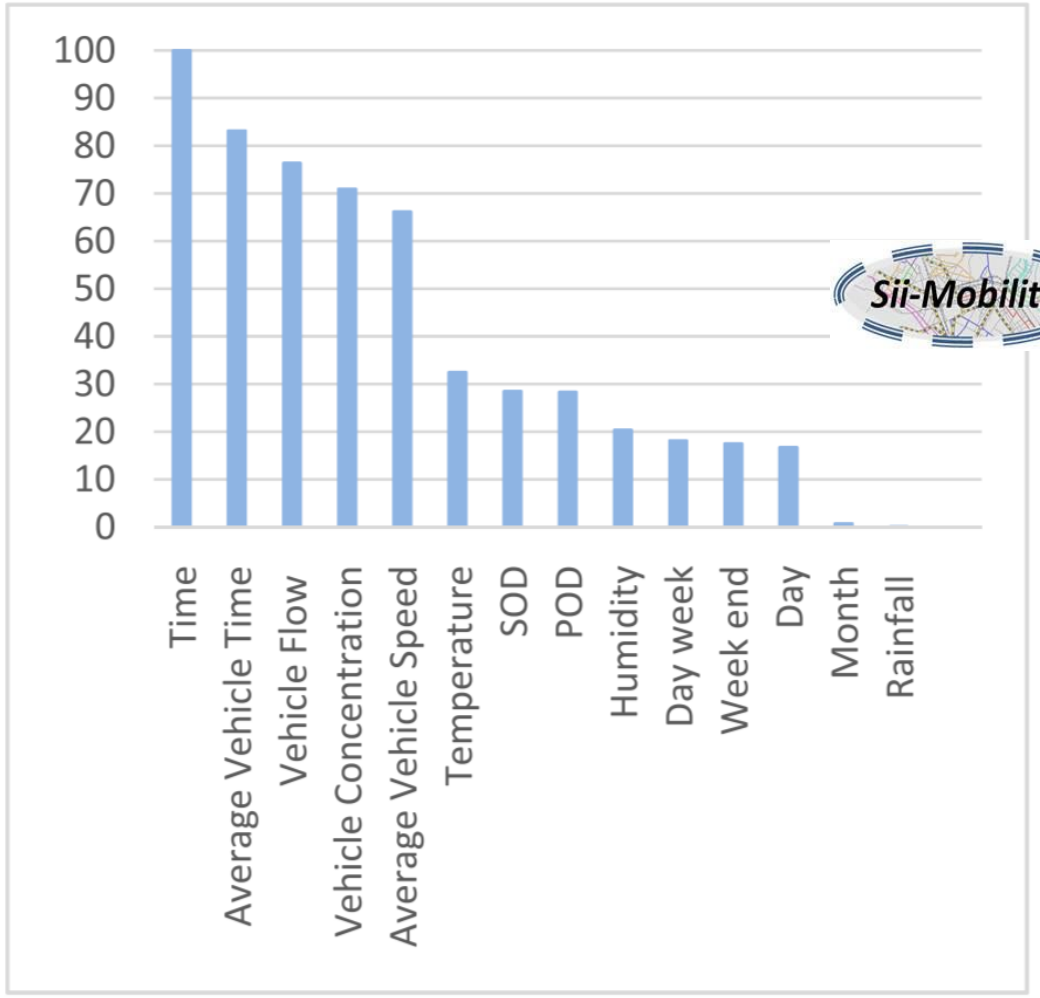


Free Parking PREDICTIONS

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



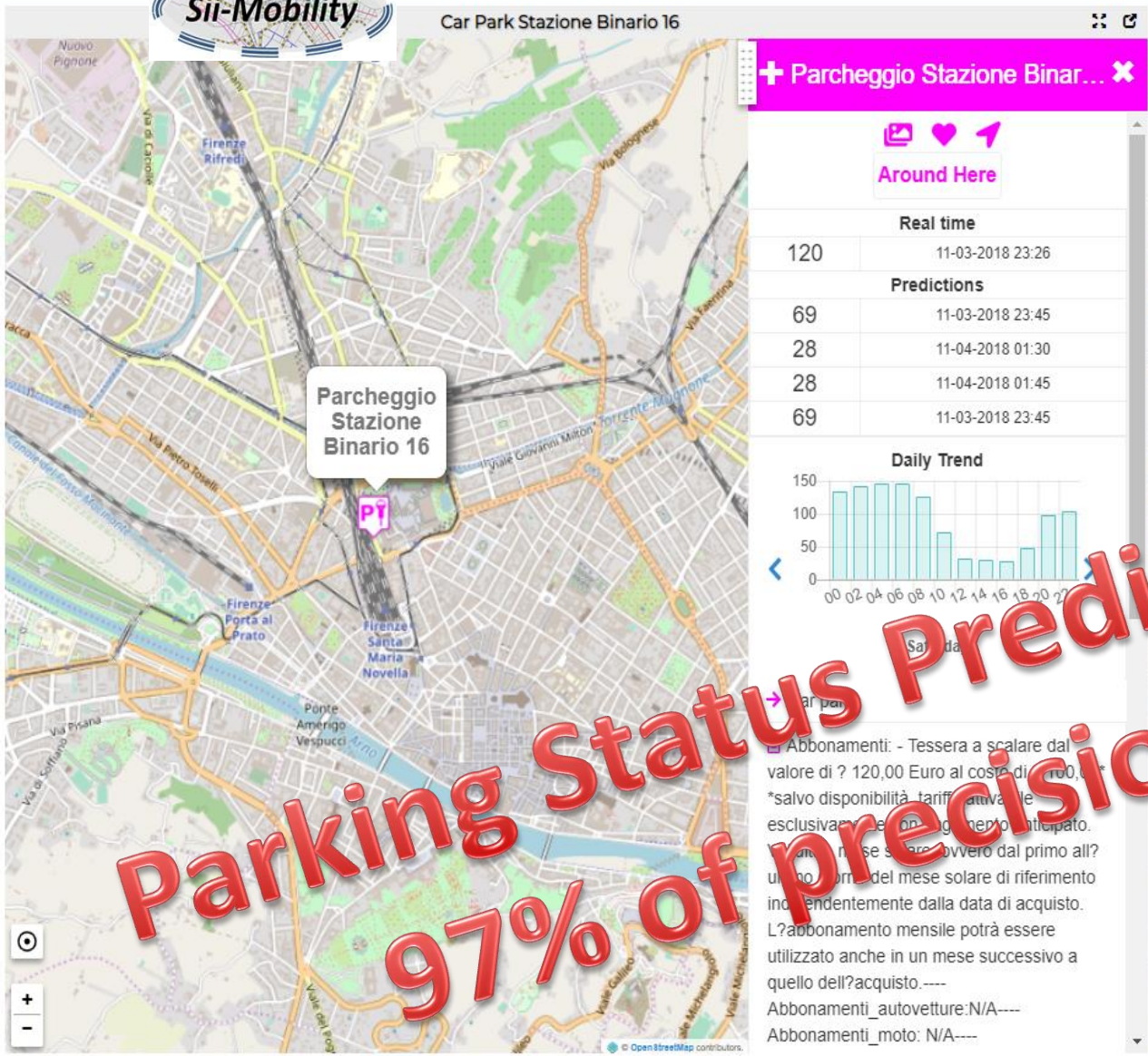
Active on Mobile Apps as:

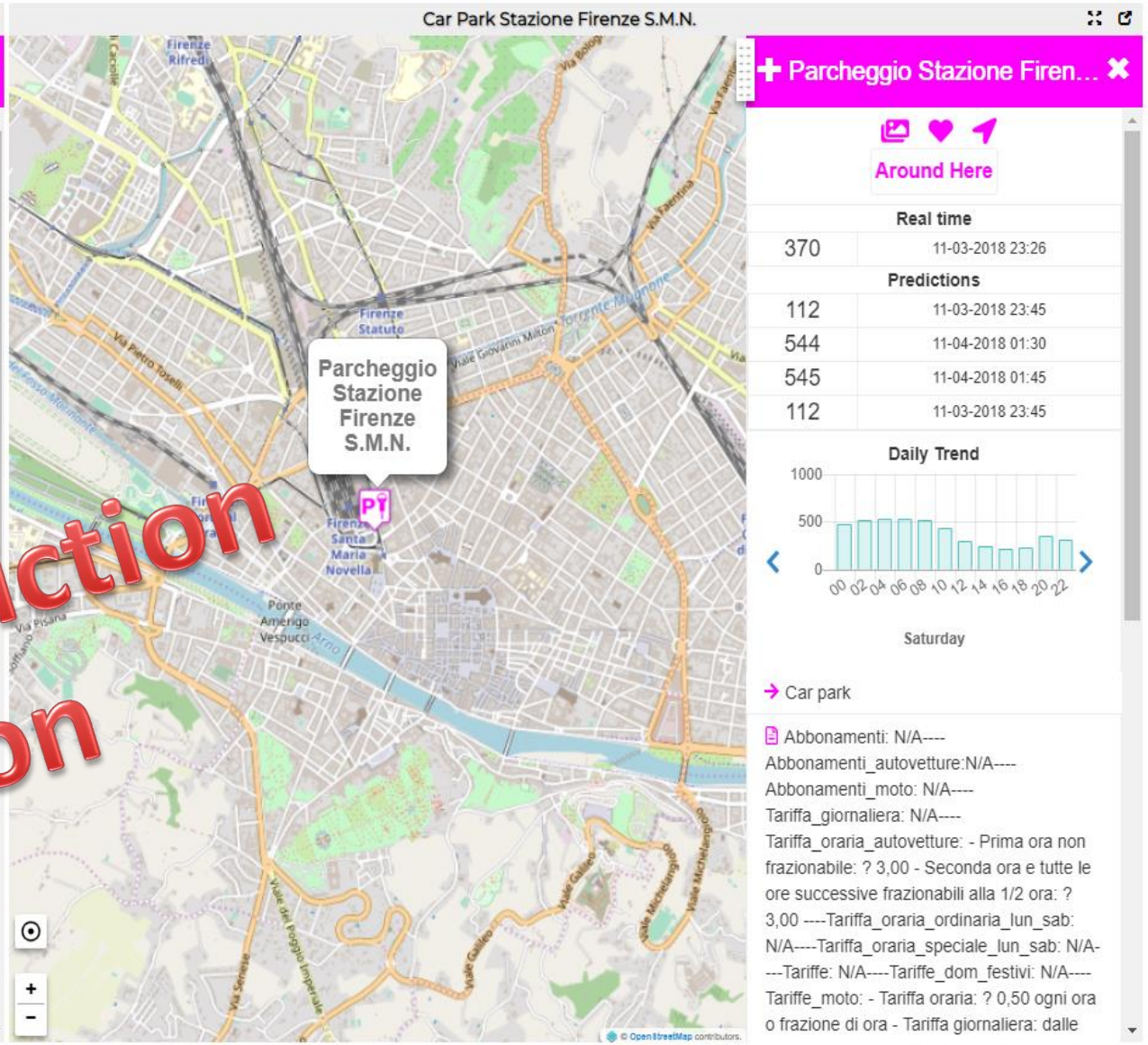
- «Firenze dove cosa»
- «Toscana dove cosa»

Precision: 97,5%

Monitoring Station for Parking

Sat 3 Nov 23:39:55





Parking Status Prediction

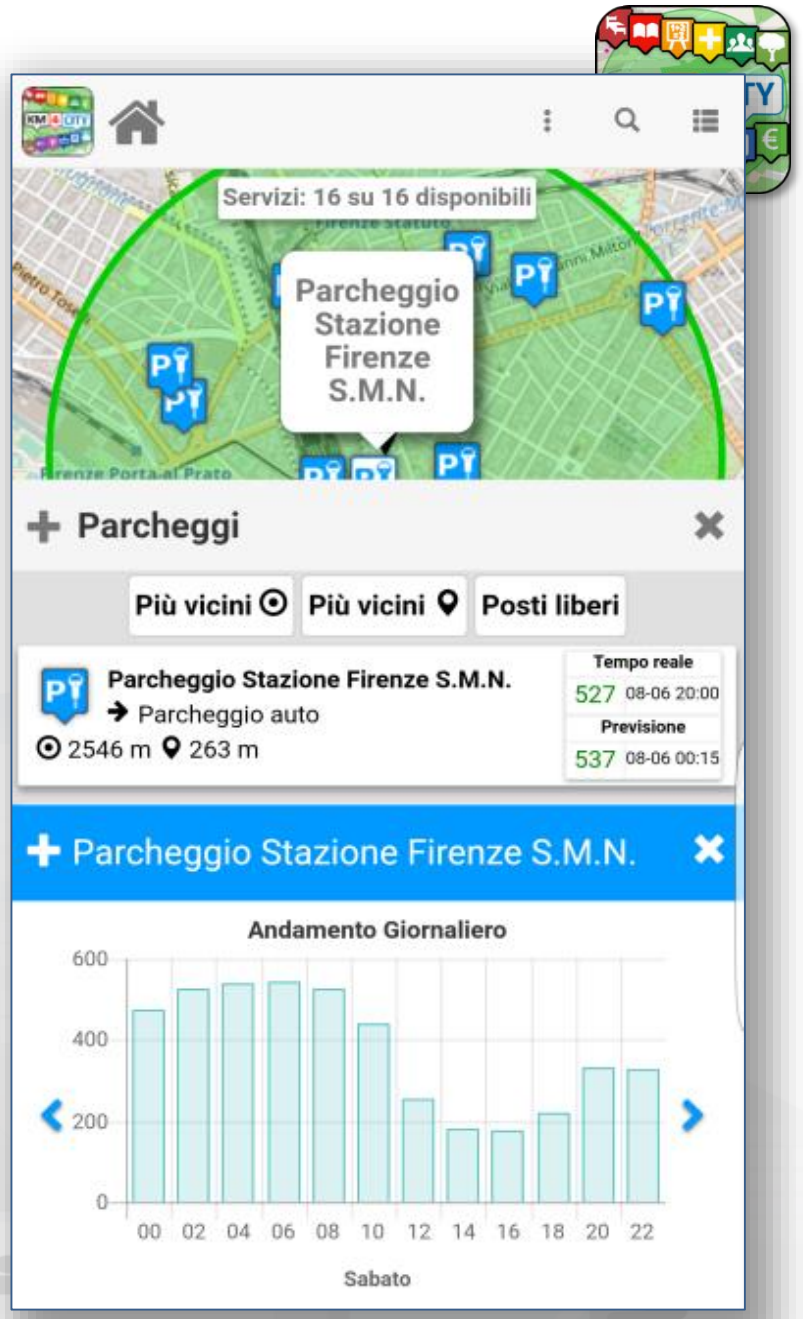
97% of precision

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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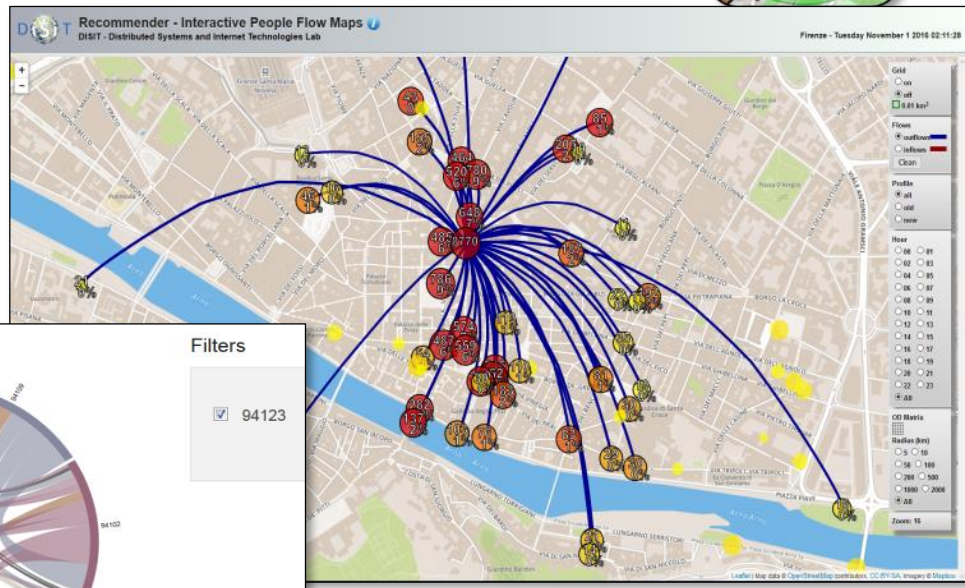
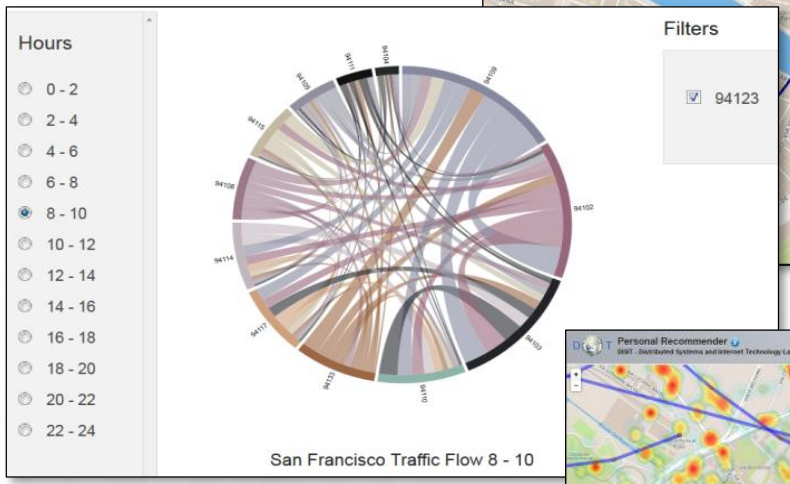
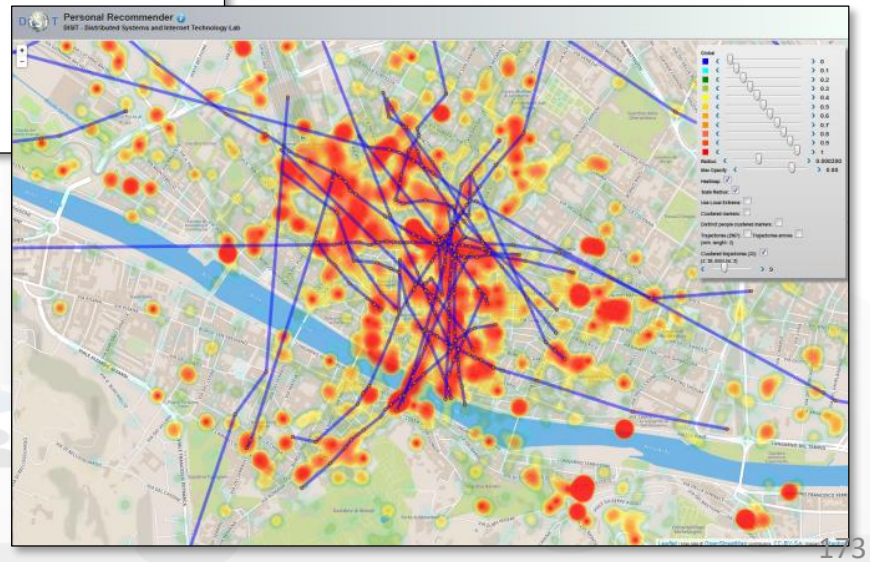
User Behaviour Analysis

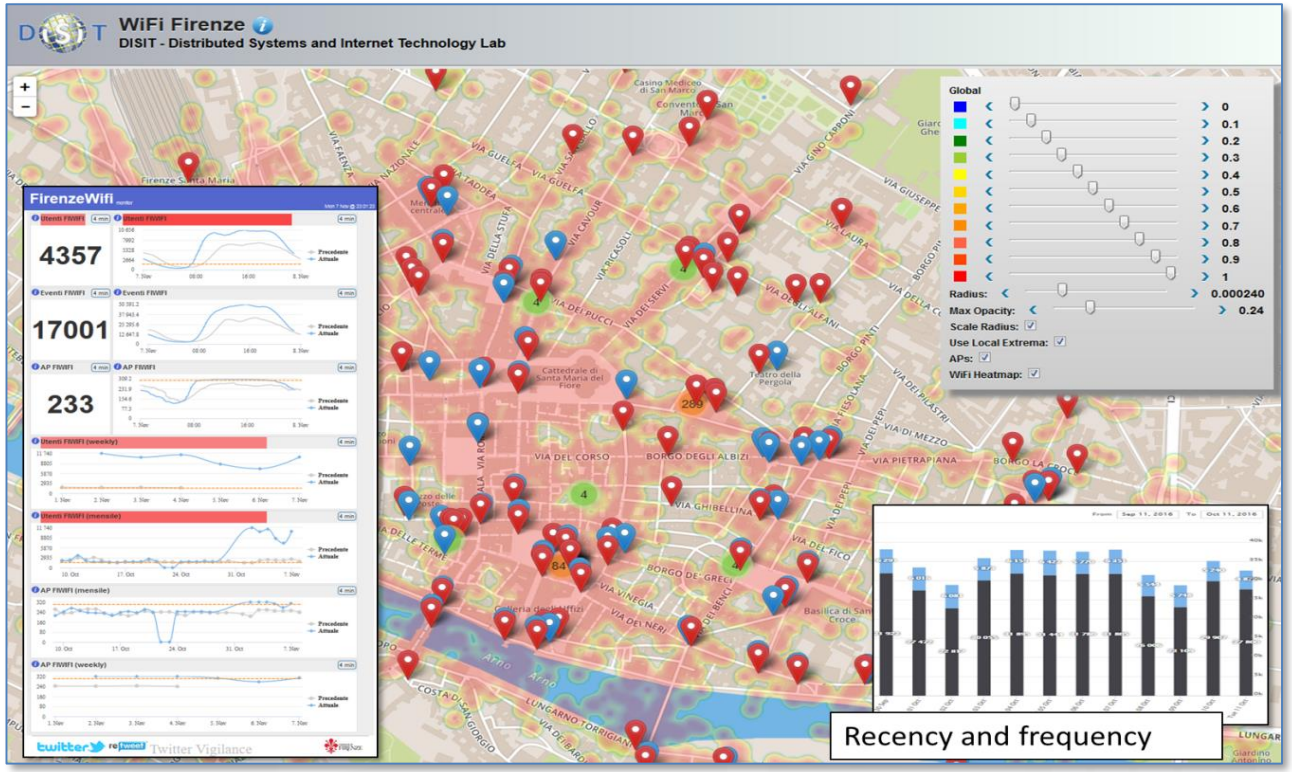
- **Monitoring movements by traffic flow sensors**
  - Spires and virtual spires
- **Monitoring movements from Mobile Cells**
  - Unsuitable for precise tracking and OD production
- **Monitoring movements from Wi-Fi**
- **Monitoring movements** and much more from mobile Apps

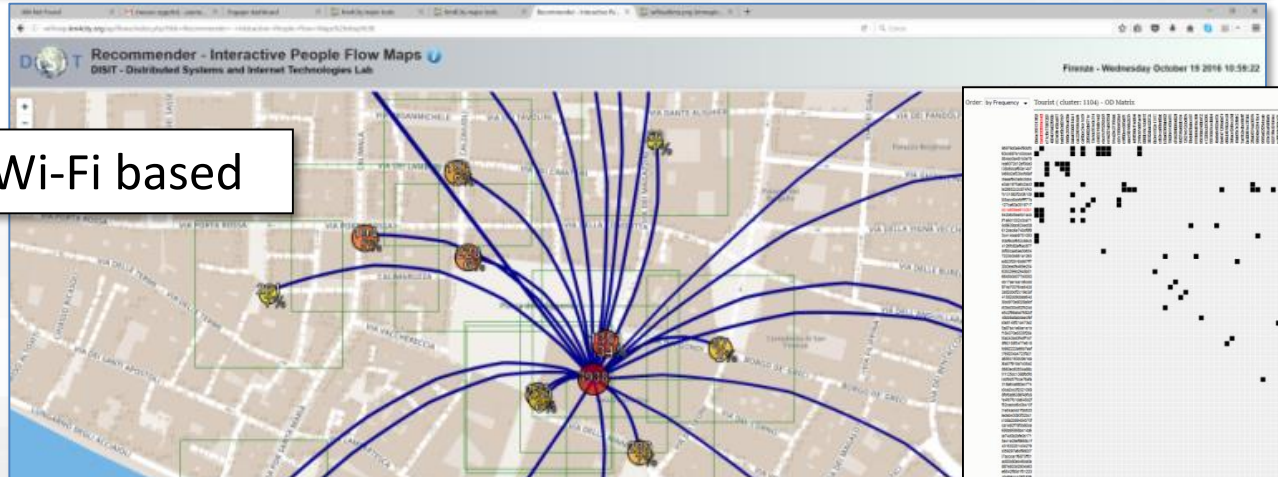




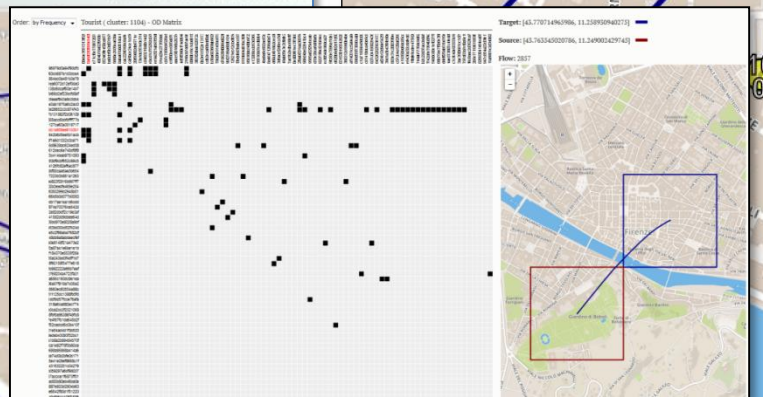


Origin Destination Matrix Estimation





Wi-Fi based



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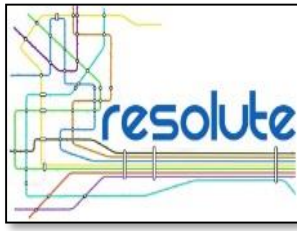
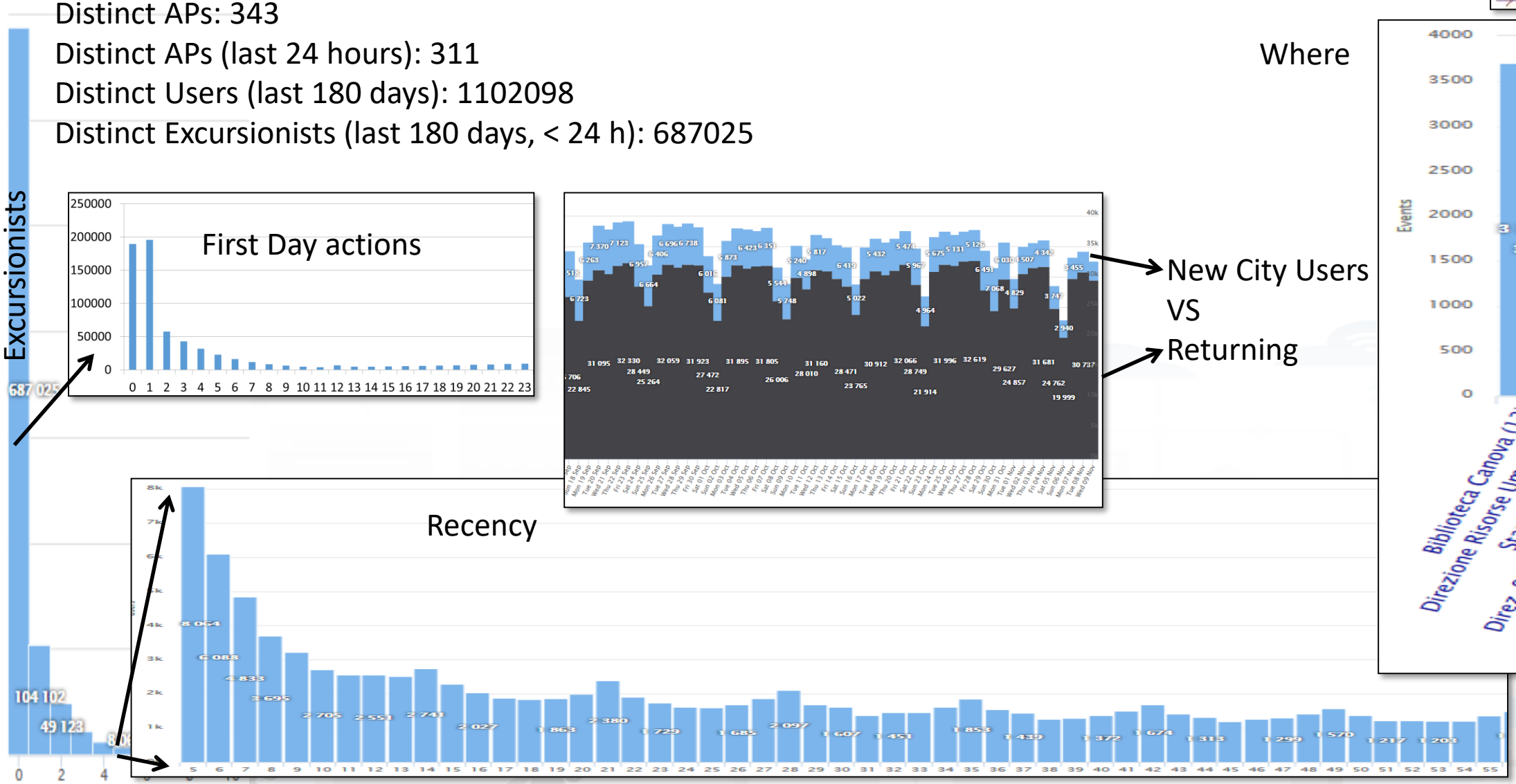
User Behaviour Analysis



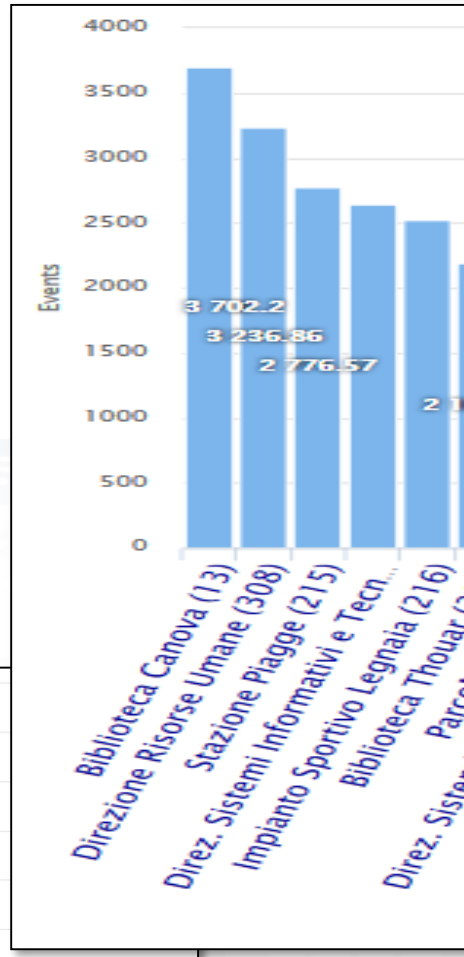
Distinct APs: 343
Distinct APs (last 24 hours): 311
Distinct Users (last 180 days): 1102098
Distinct Excursionists (last 180 days, < 24 h): 687025

Excursionists



New City Users
VS
Returning

Where

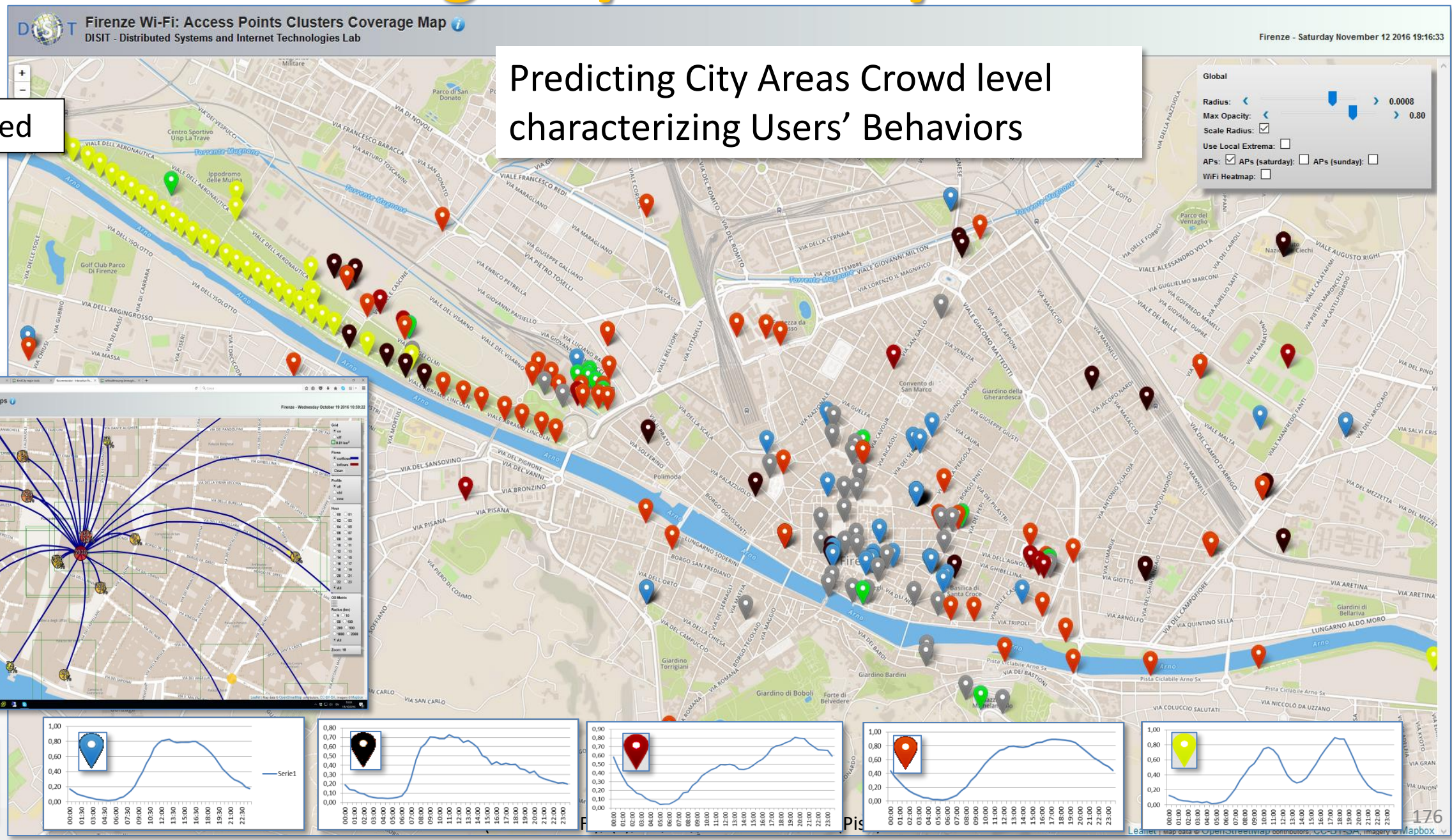


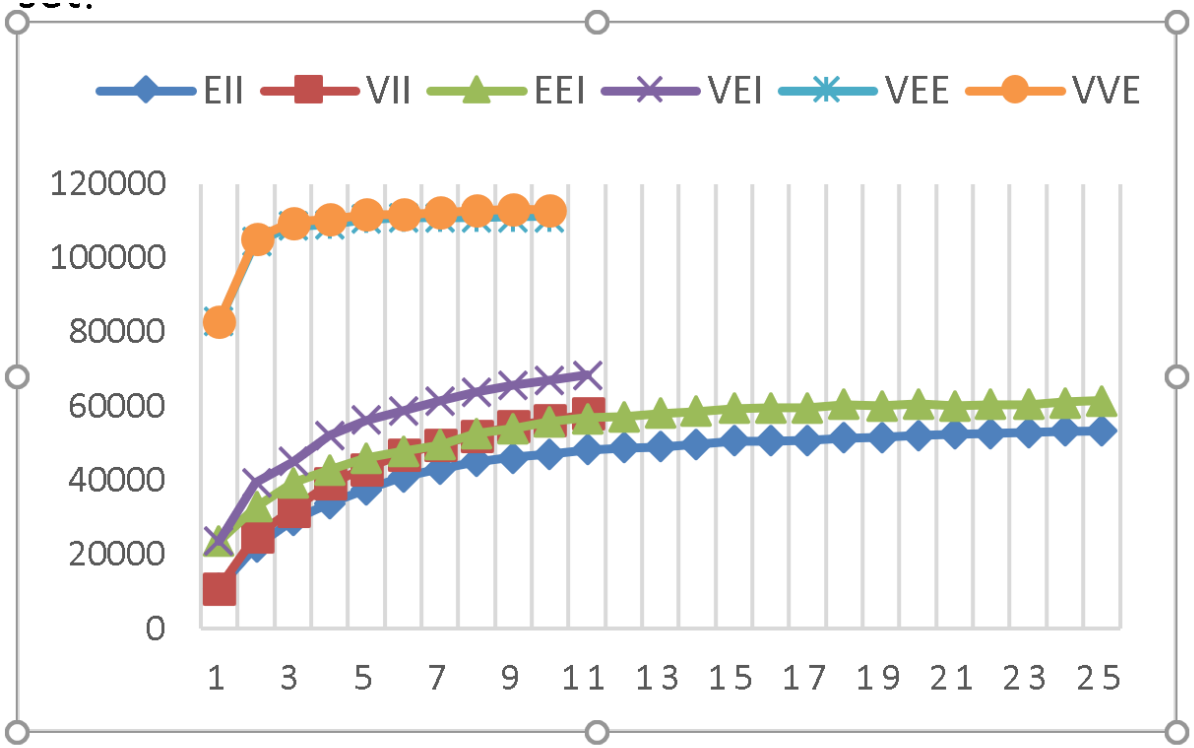
Recency

Characterizing City Areas by User Behavior

Wi-Fi based

Predicting City Areas Crowd level characterizing Users' Behaviors





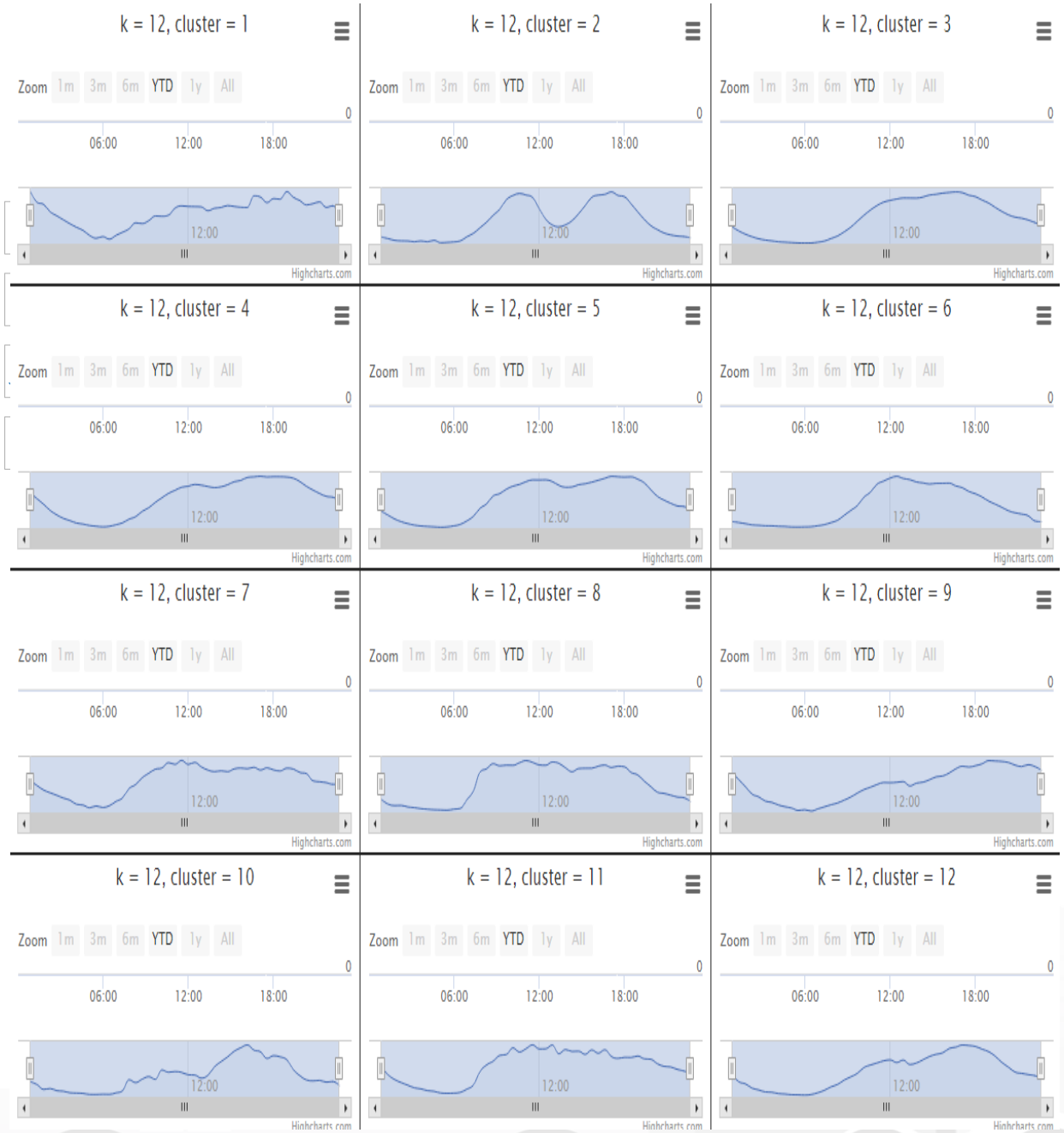
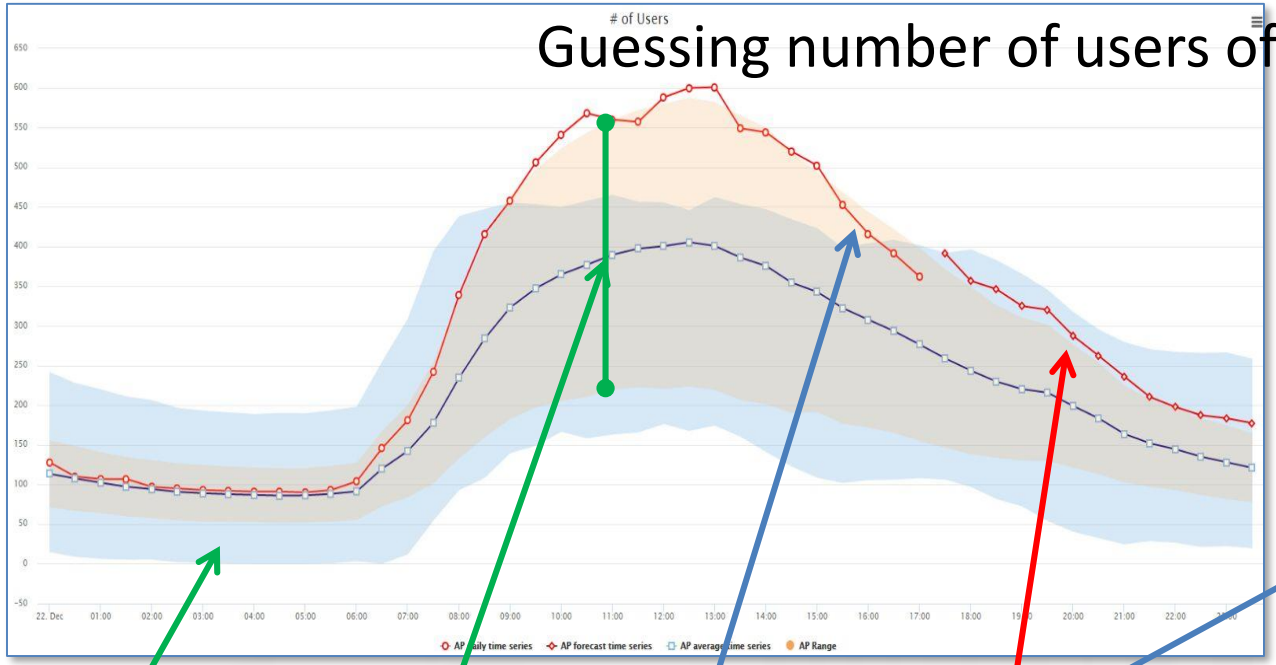
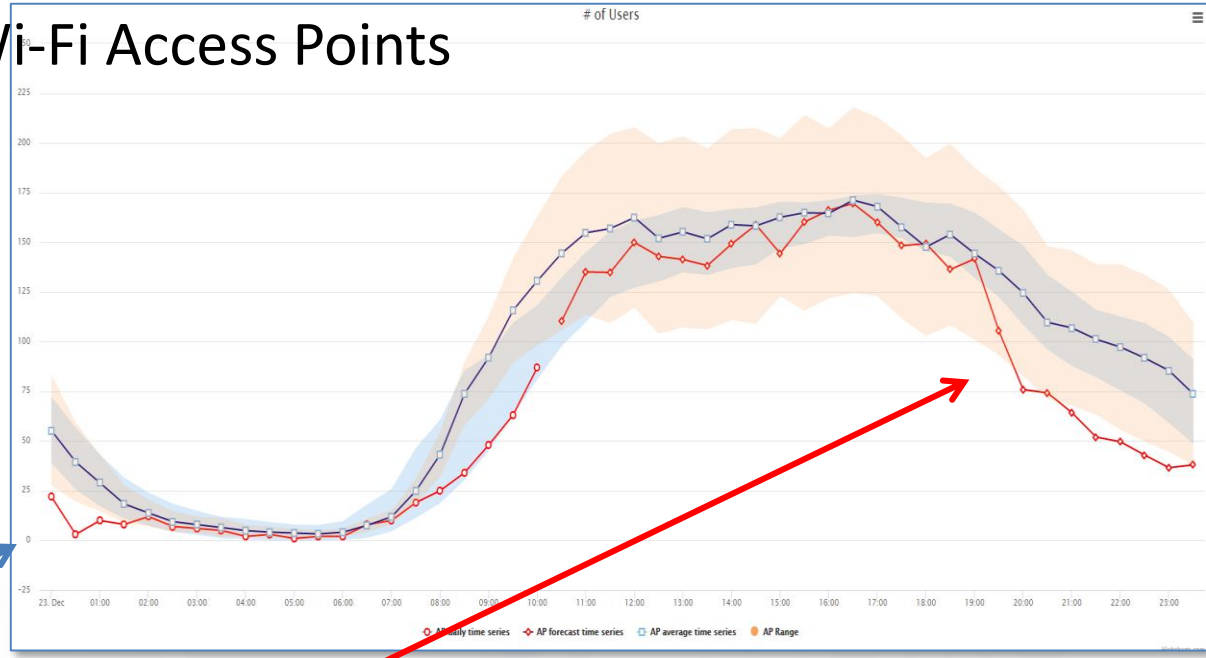


Figure 14 – Average BIC for mixture models vs K number of cluster, higher values are better, the curves are truncated at the best value for K they found.

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

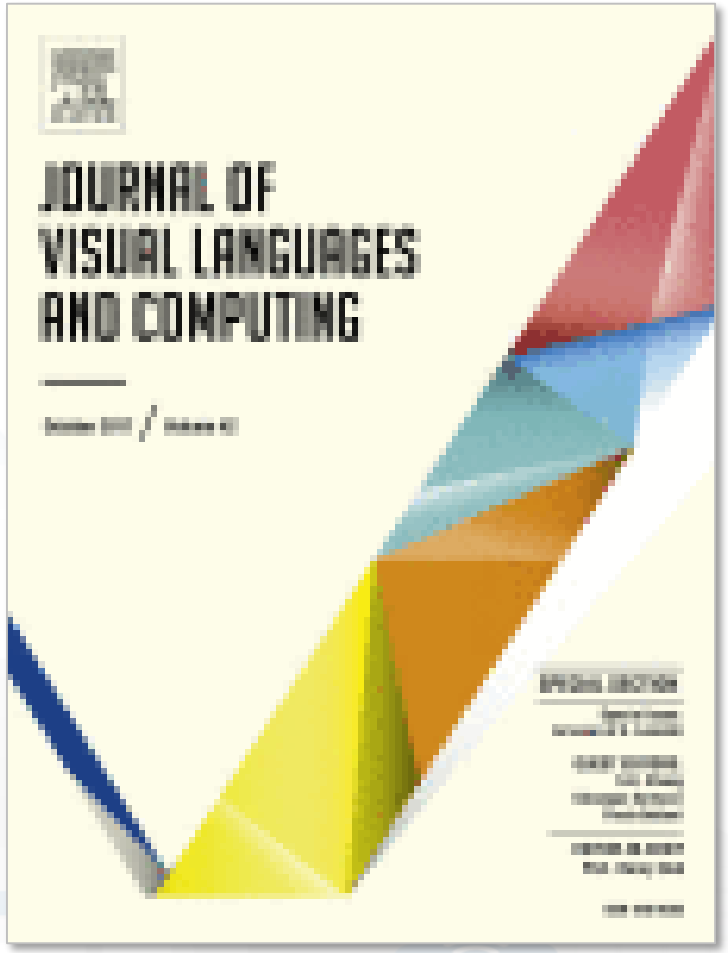
AP prediction for the next time slot in the day on the basis of past weeks

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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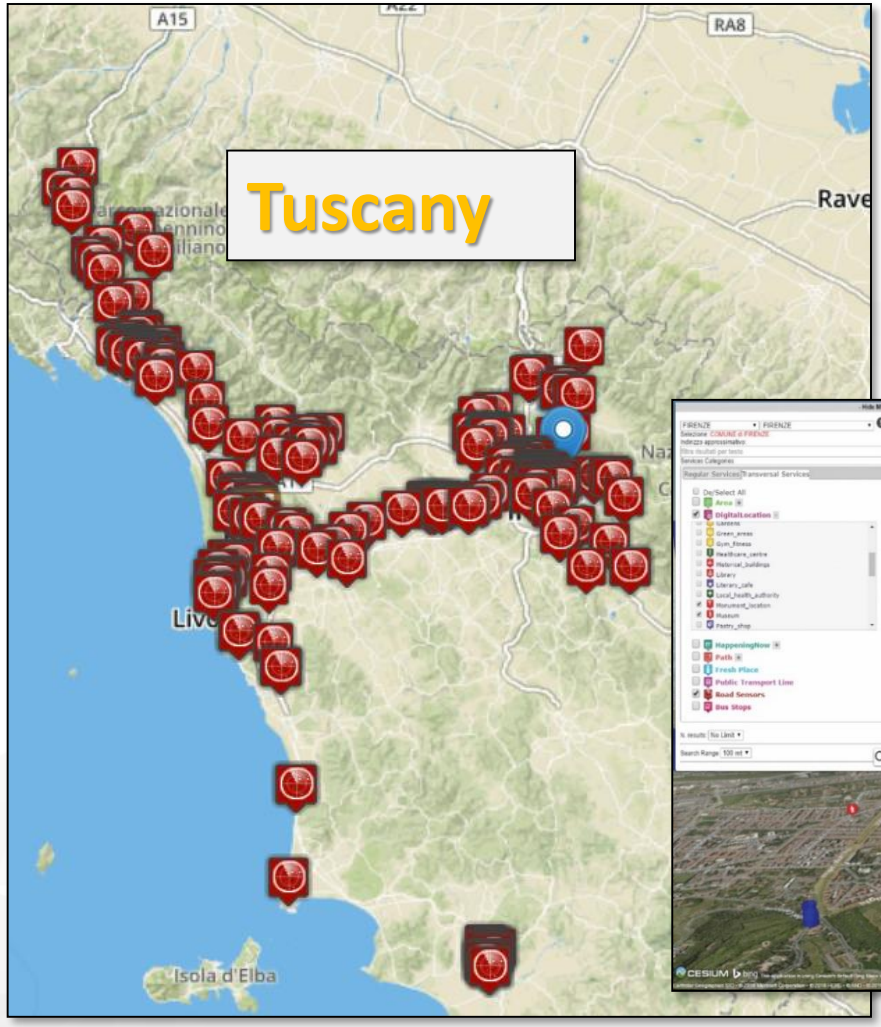
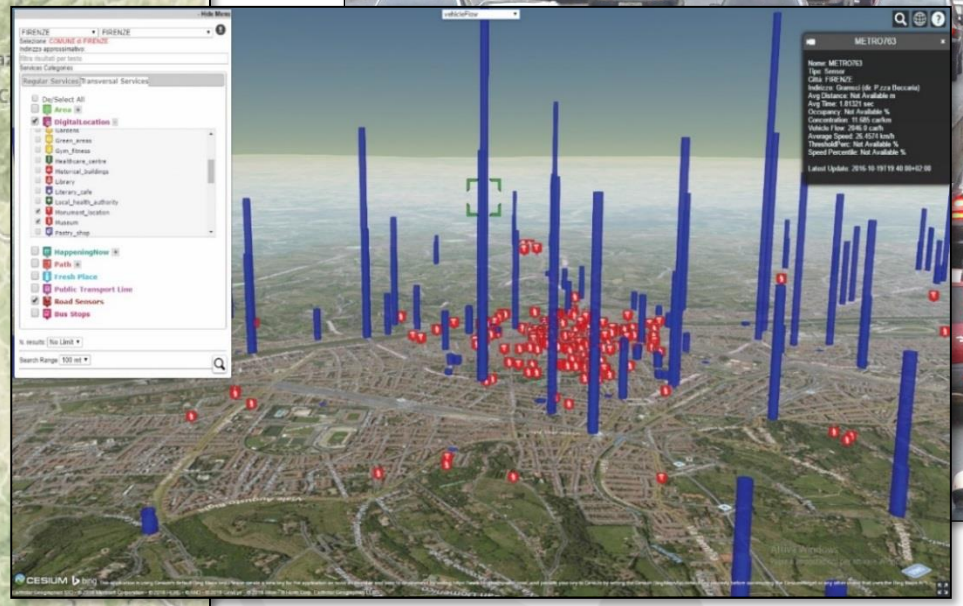
Traffic Flow Tools

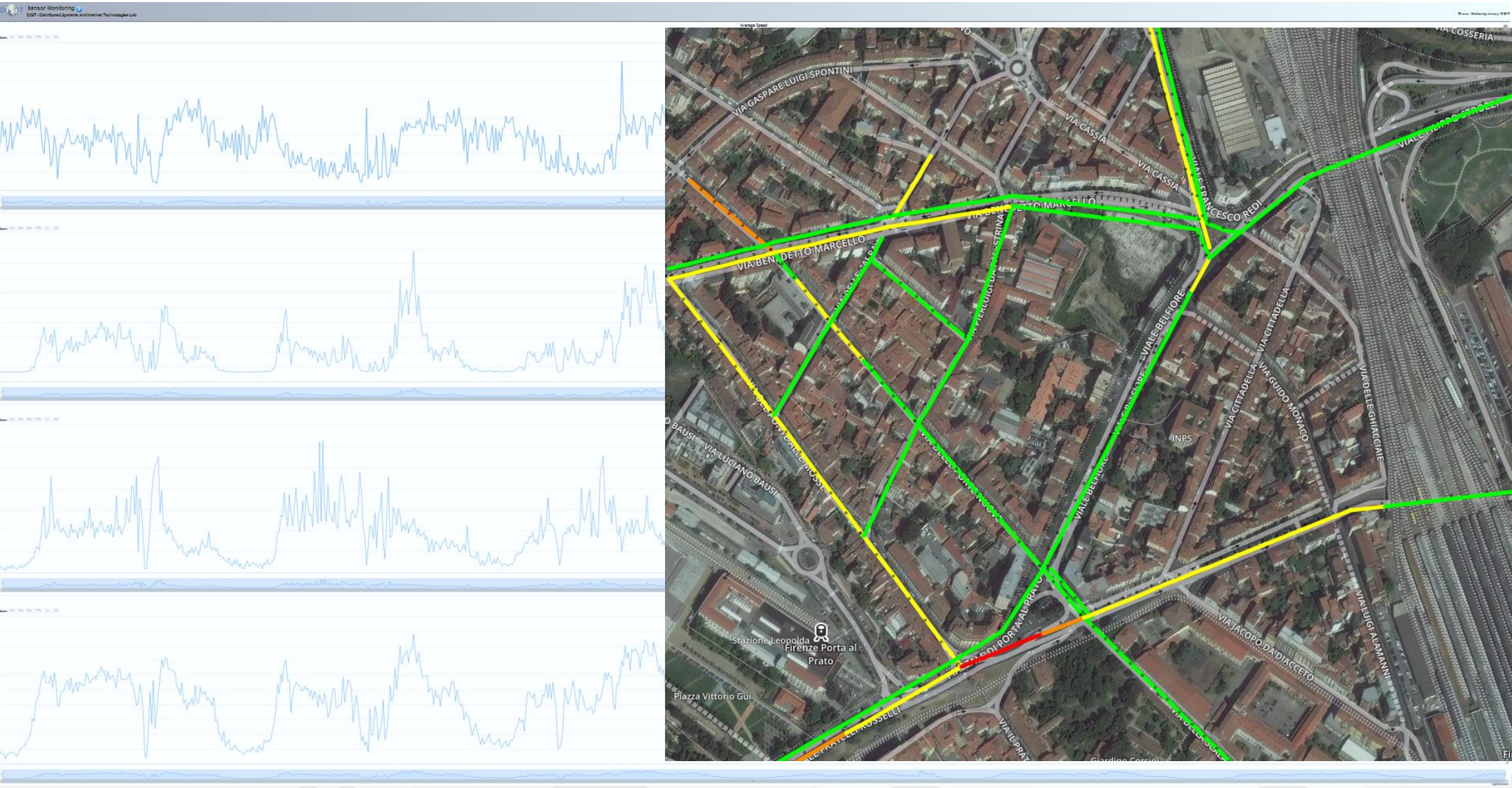
Spire and Virtual Spires (cameras), Bluetooth, ...

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



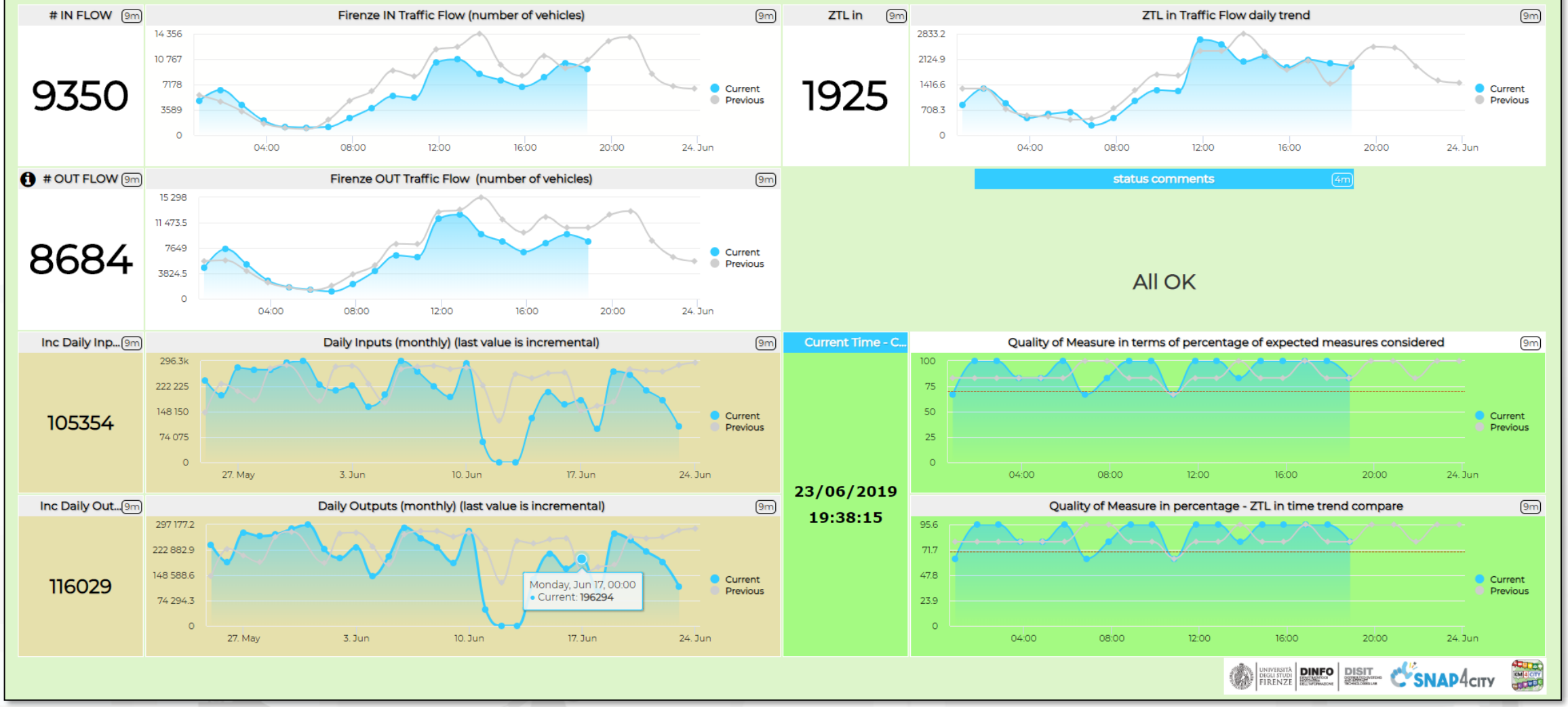


Traffic Flow data



Traffic Flow Monitoring - Firenze - Cloned

Sun 23 Jun 19:38:15



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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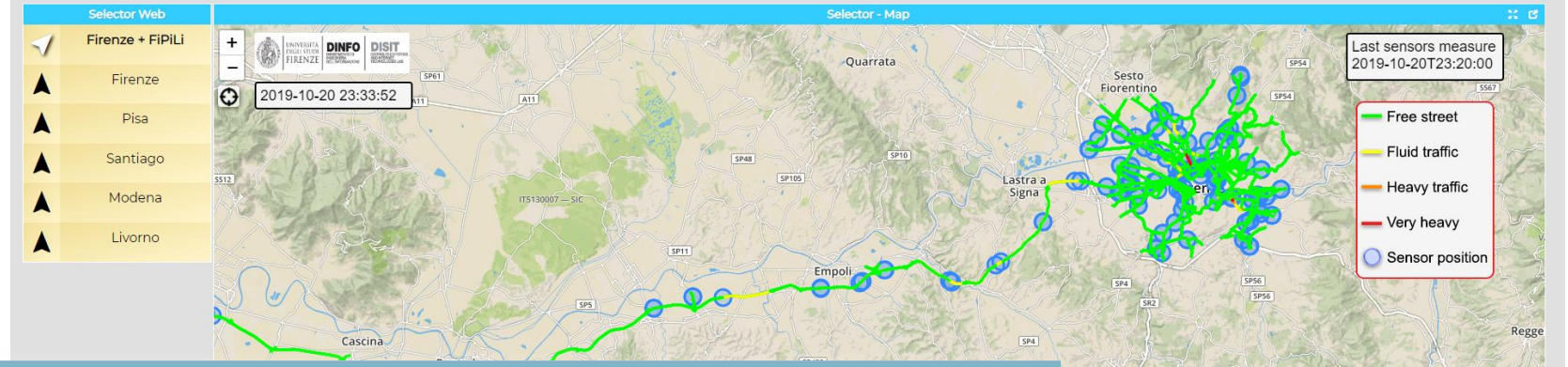
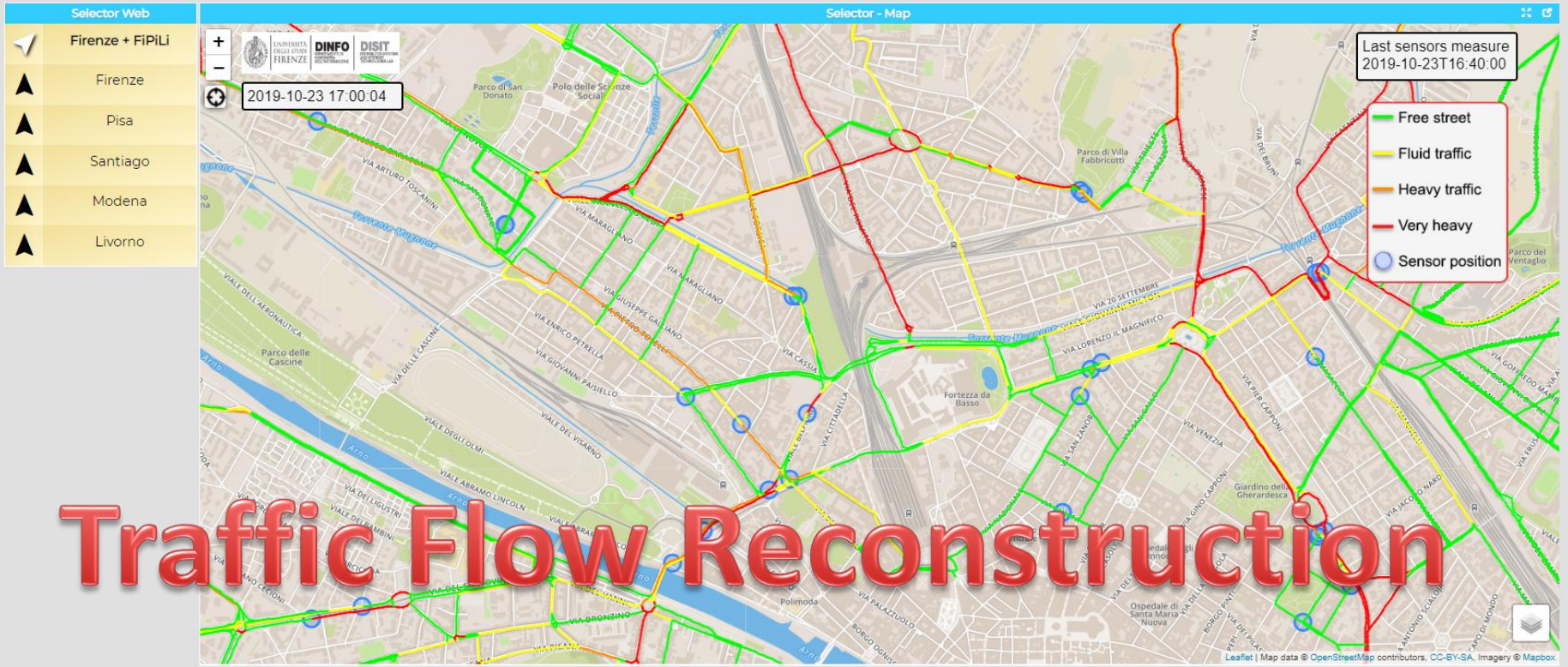
Traffic Flow Reconstruction for the cities



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

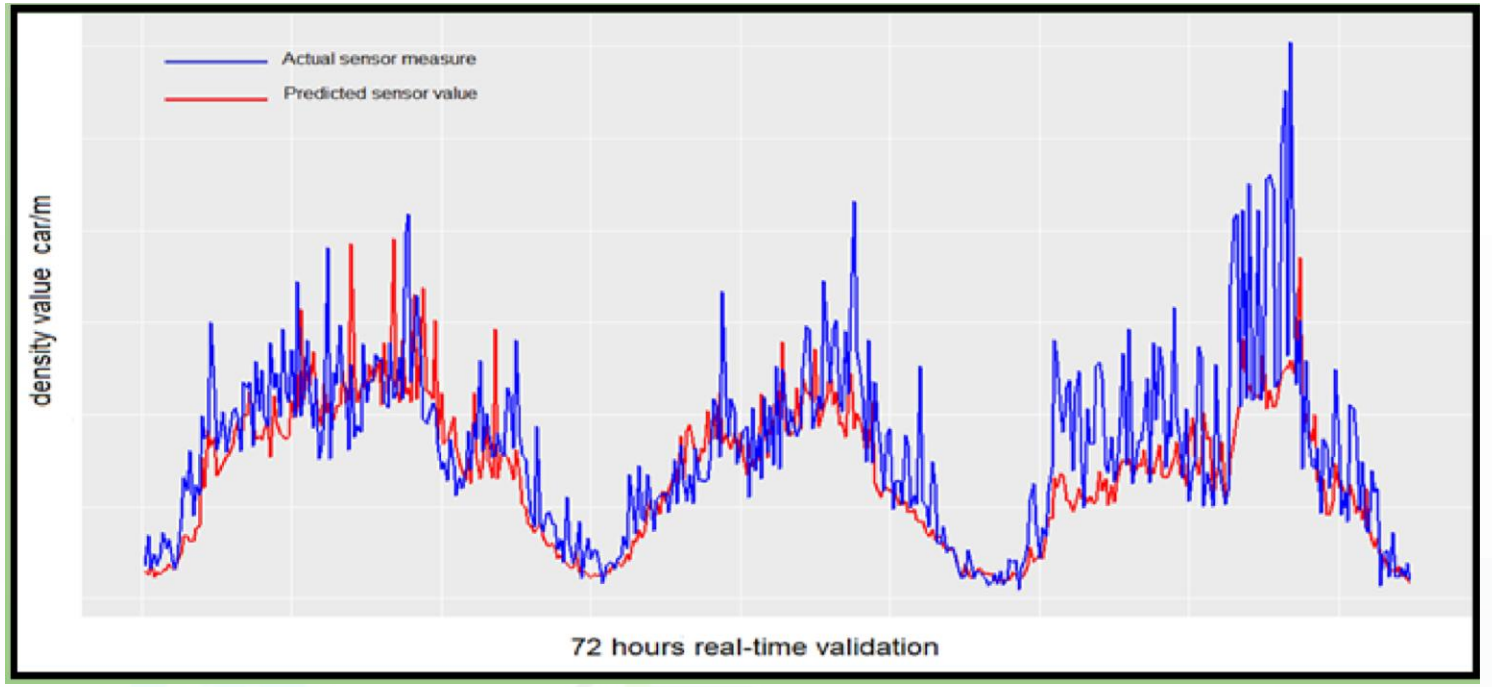
The vehicular traffic flow is propagated in the city graph according to a fluid dynamics model which is based on the conservation law of the vehicles. In a single road, it is described by the following partial differential equation:

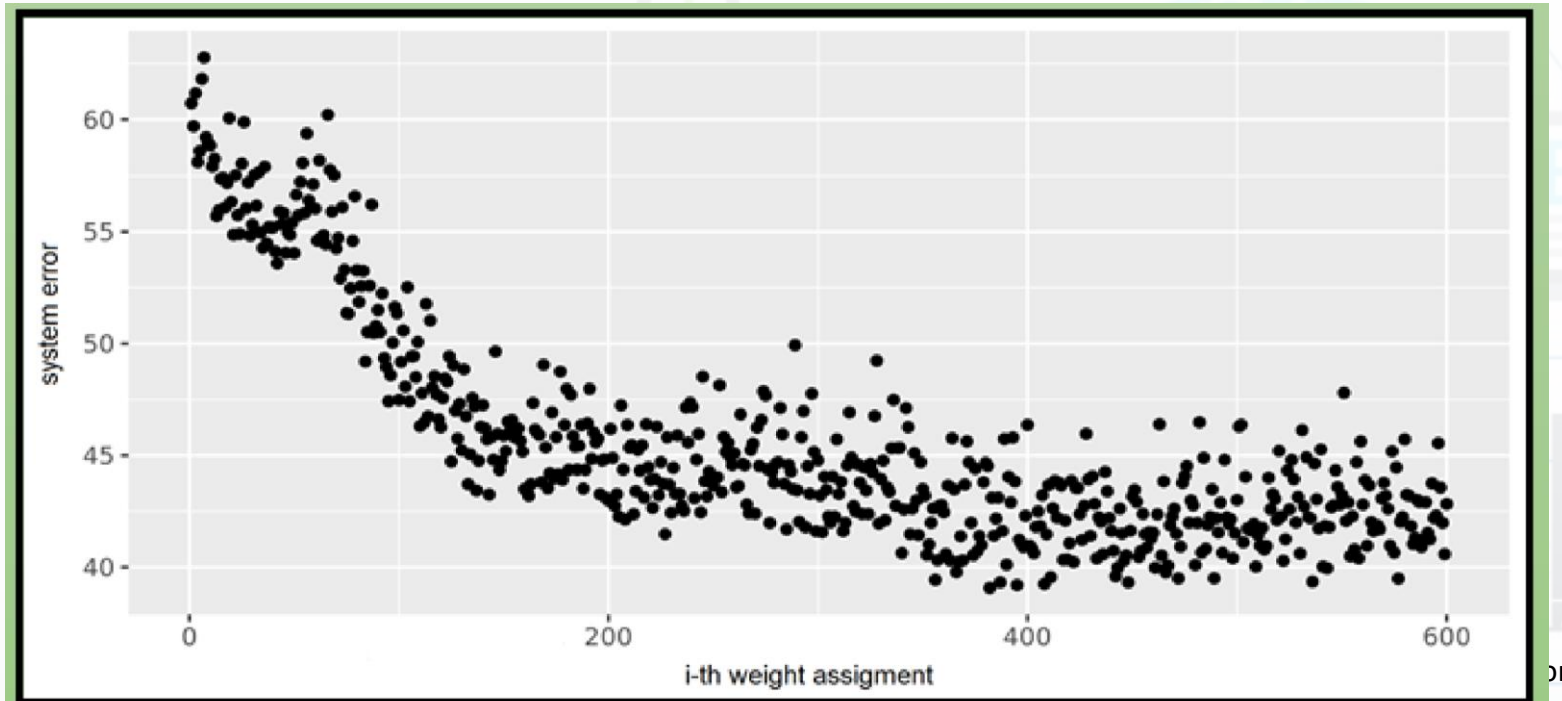
$$\frac{\partial \rho(t,x)}{\partial t} + \frac{\partial f\left(\rho(t,x)\right)}{\partial x} = 0$$

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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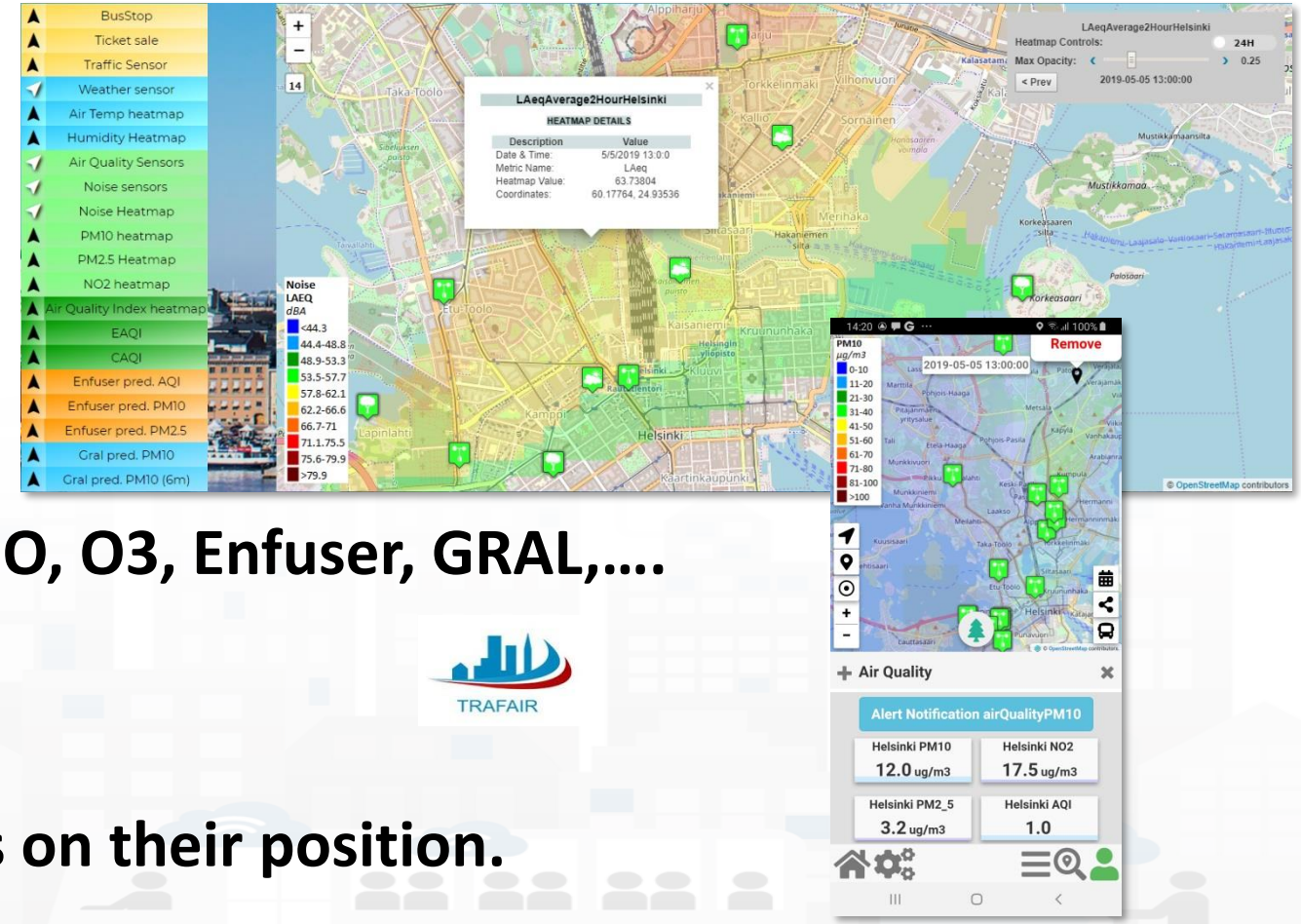
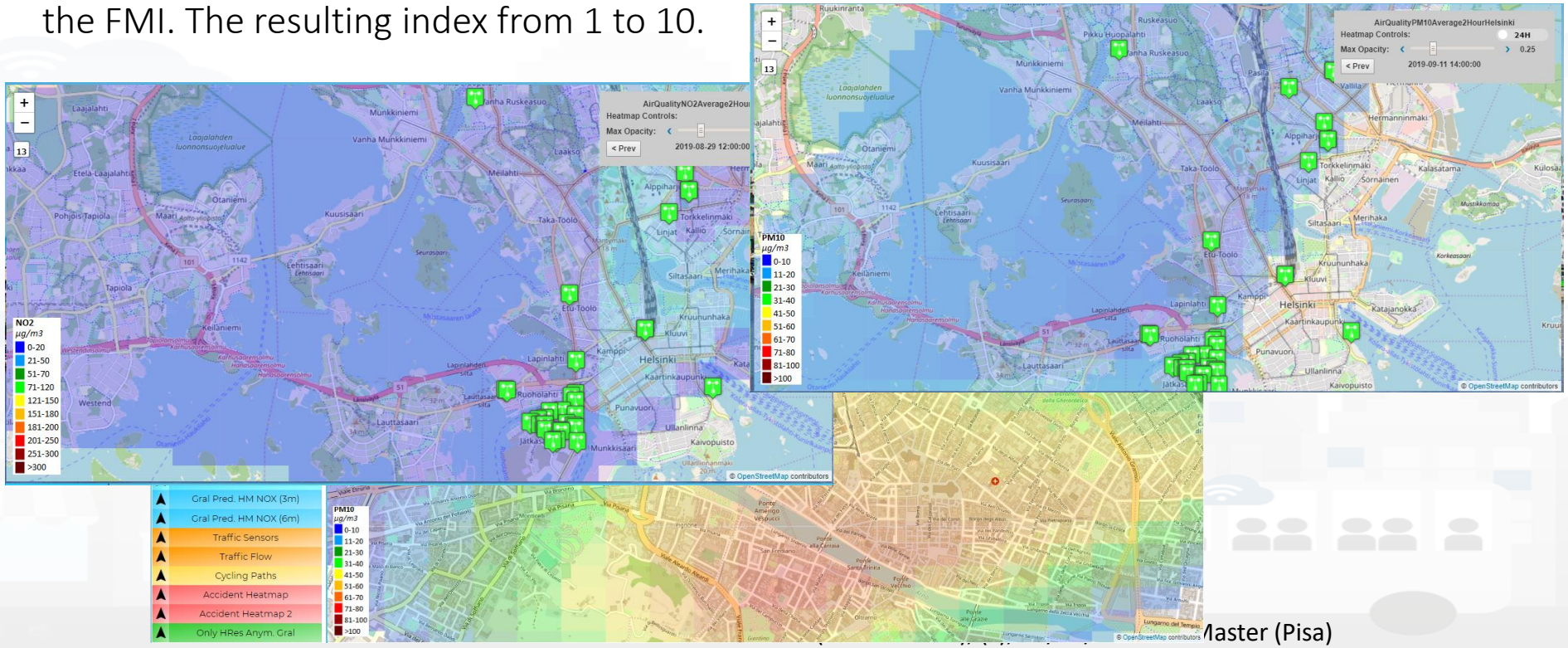
Data Analytics: Heatmaps

- 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



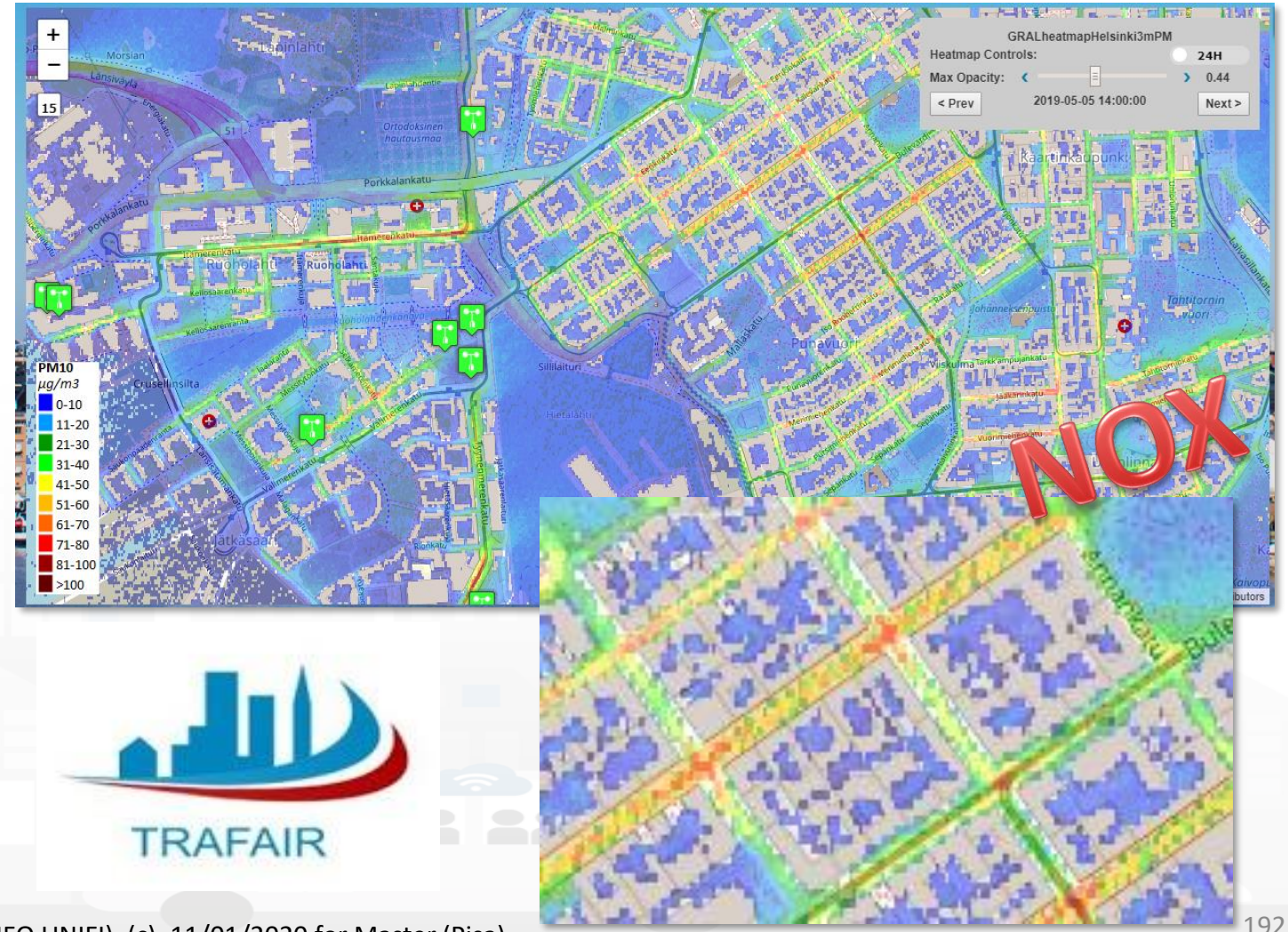
Environmental Real Time Measures

- **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

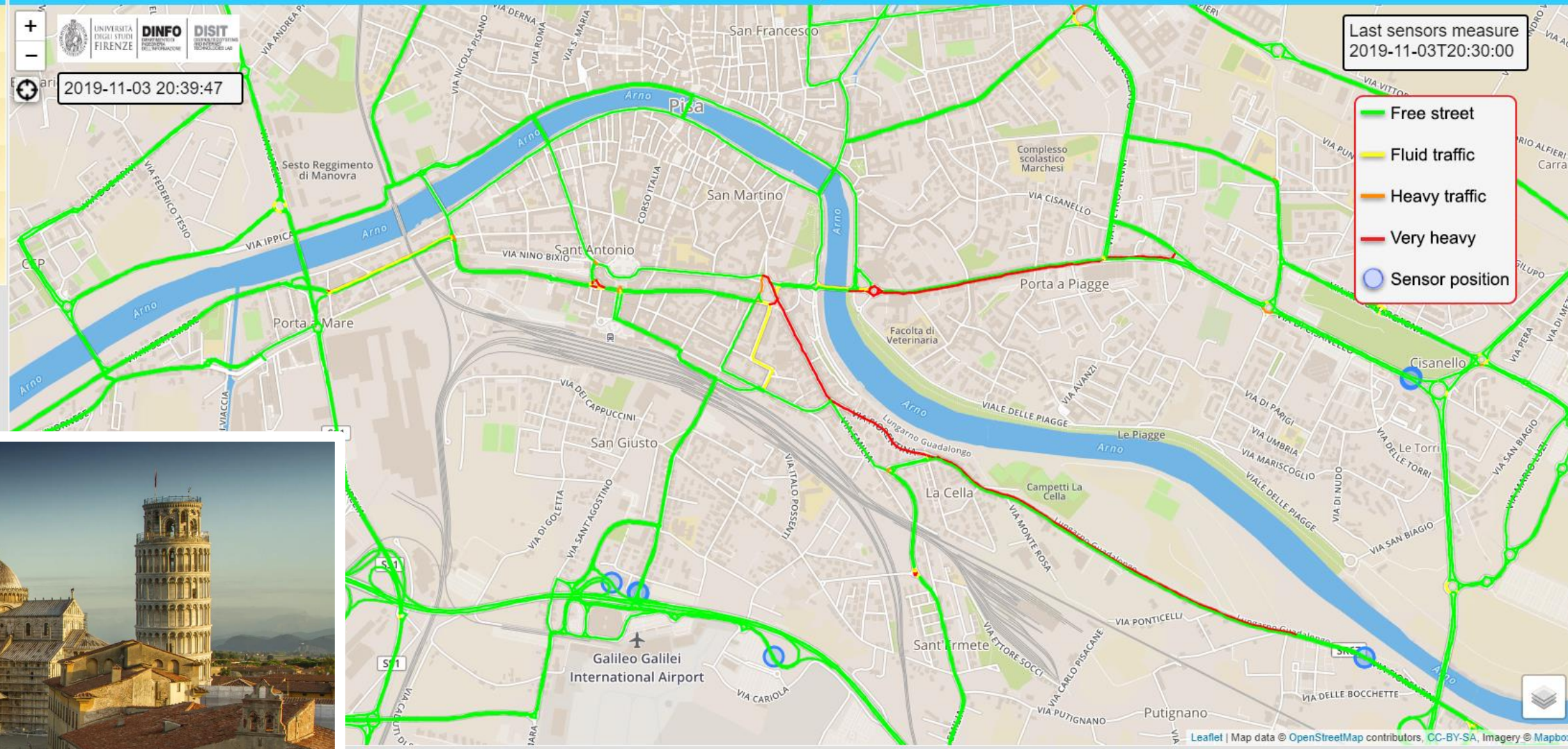
Traffic Flow Reconstruction for the cities

Sun 3 Nov 20:39:47

Selector Web

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

Selector - Map



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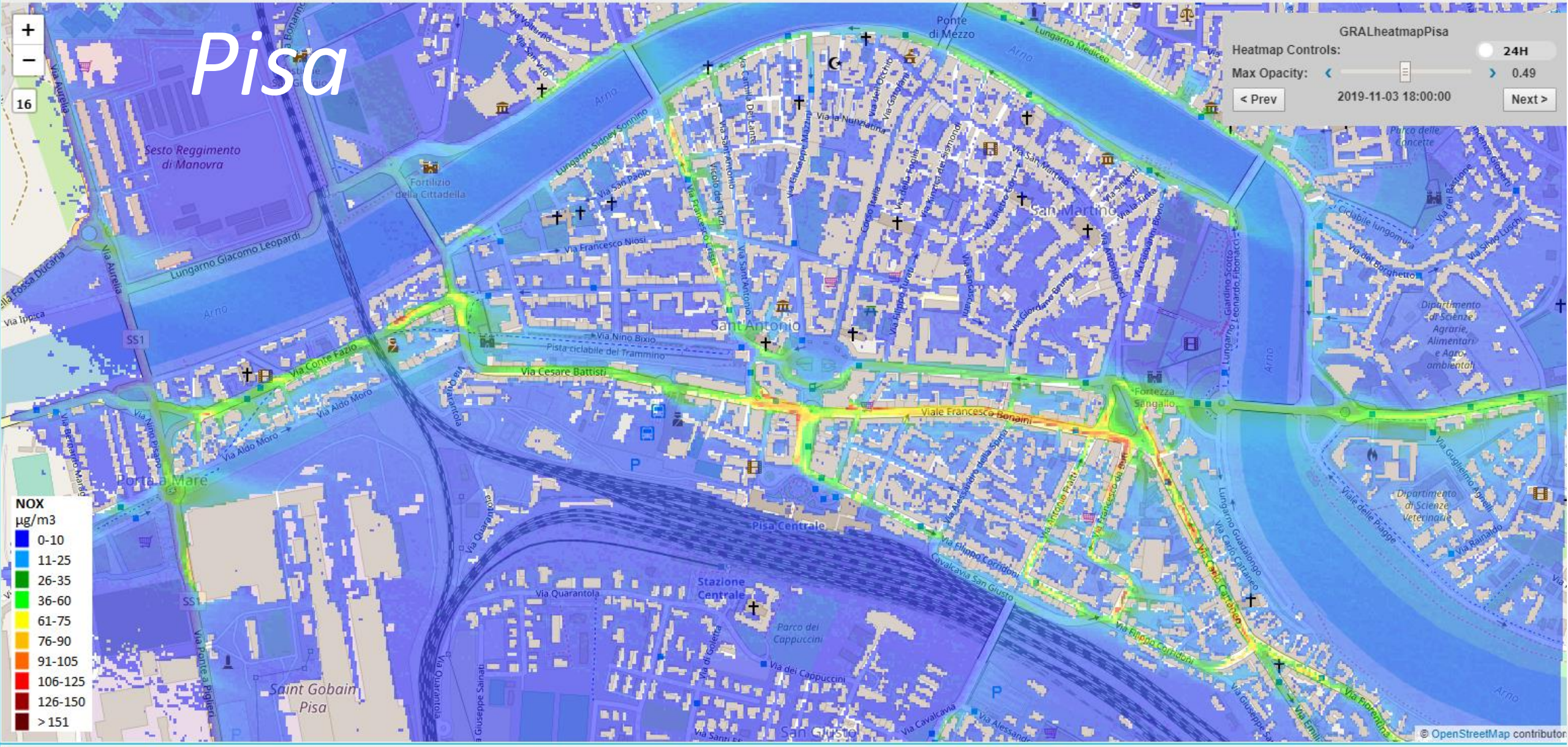
SNAP4CITY | KM4CITY

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



Livorno

Anomaly Detection



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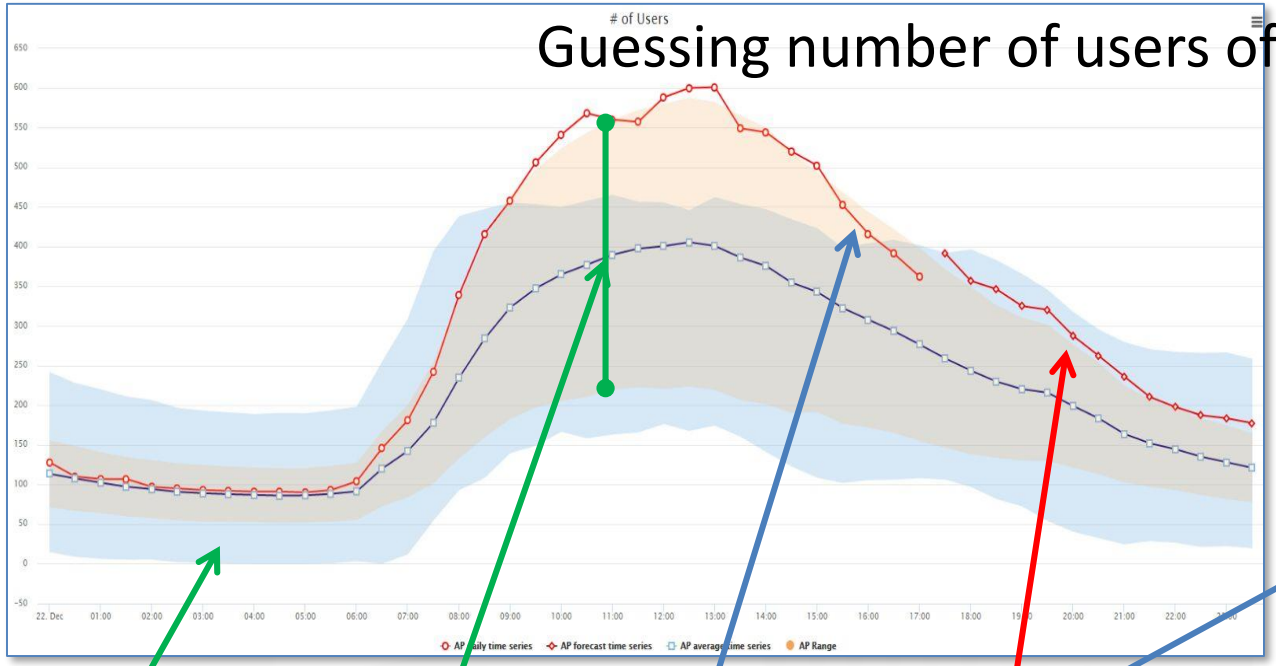
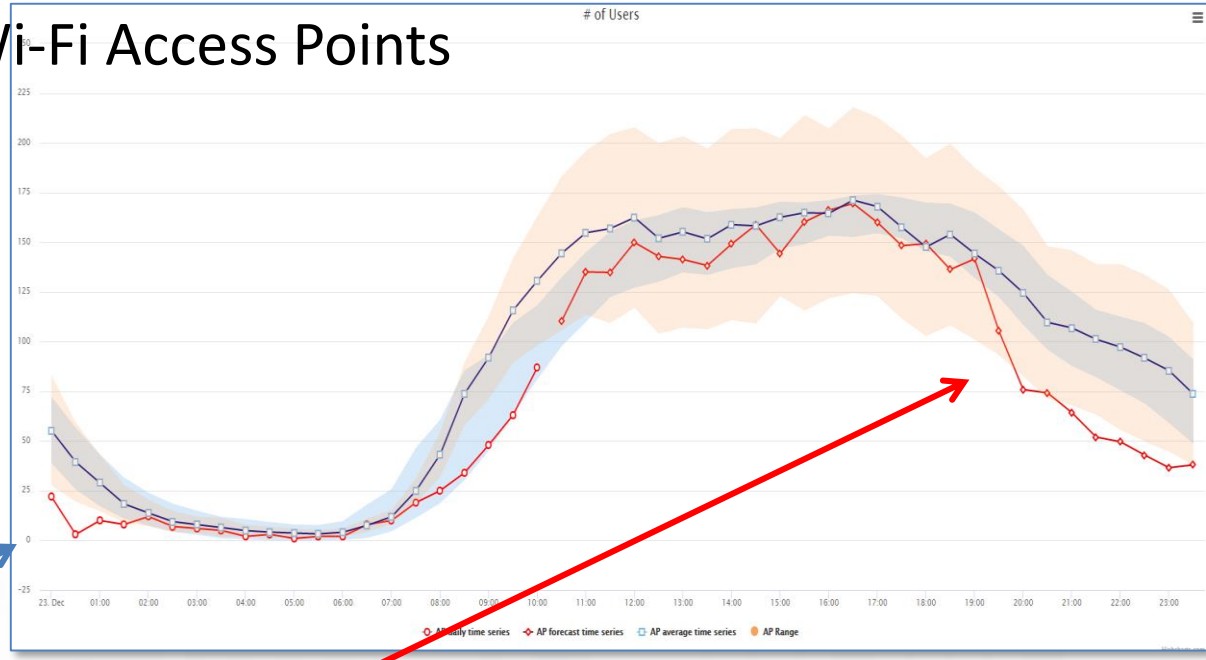
Prediction and Identification of Anomalies

Guessing number of users of Wi-Fi Access Points





Cluster confidence

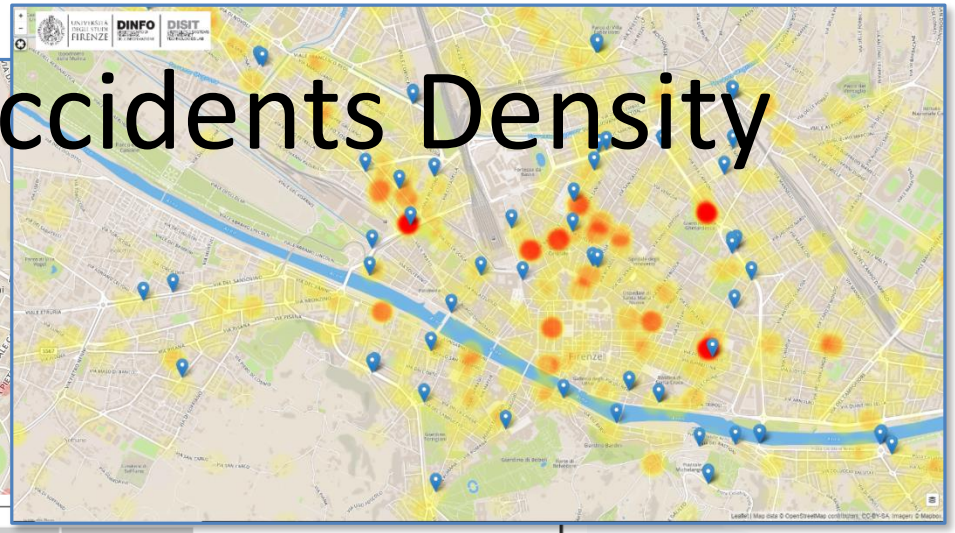
AP average and confidence

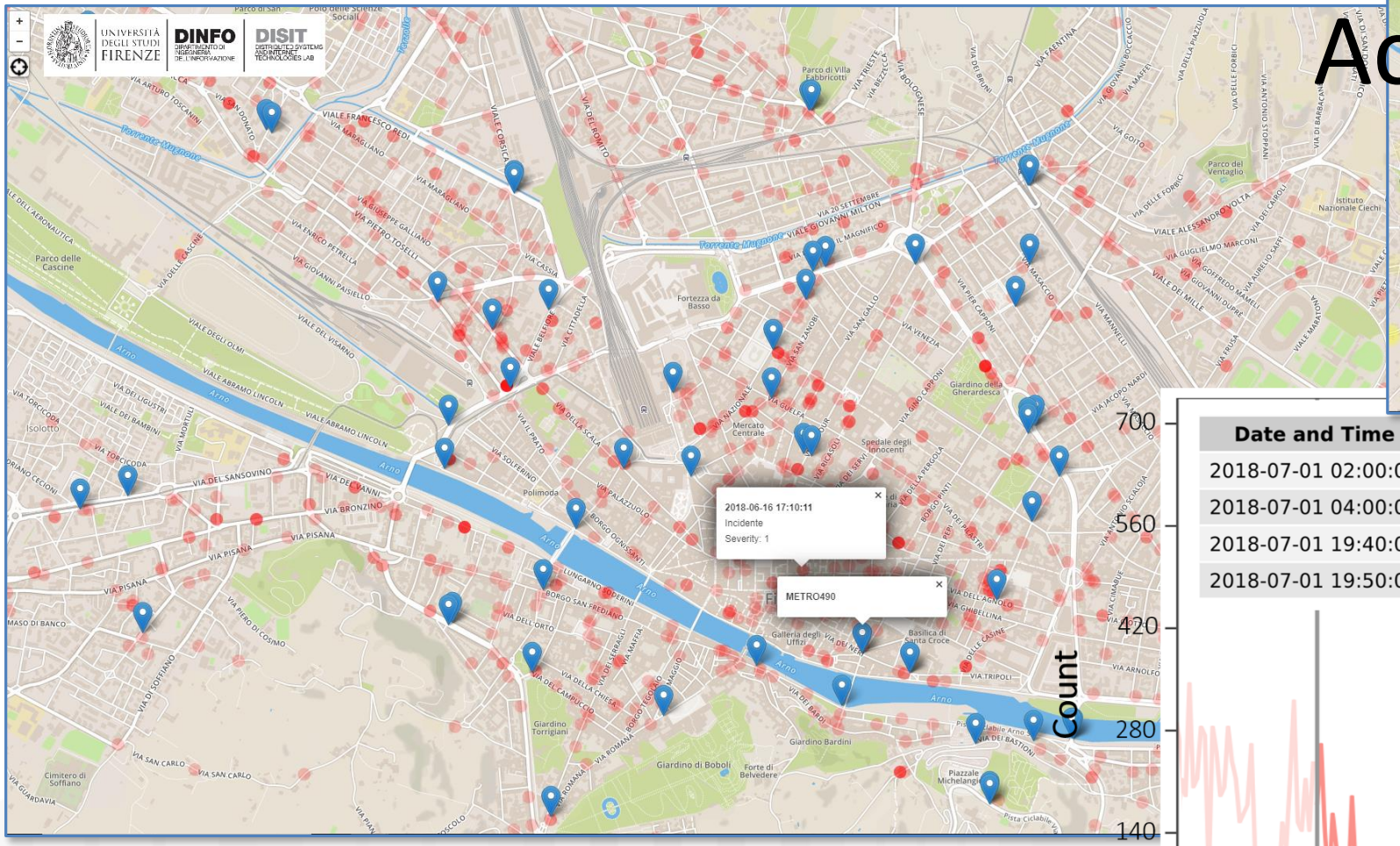
Actual AP trend for today

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

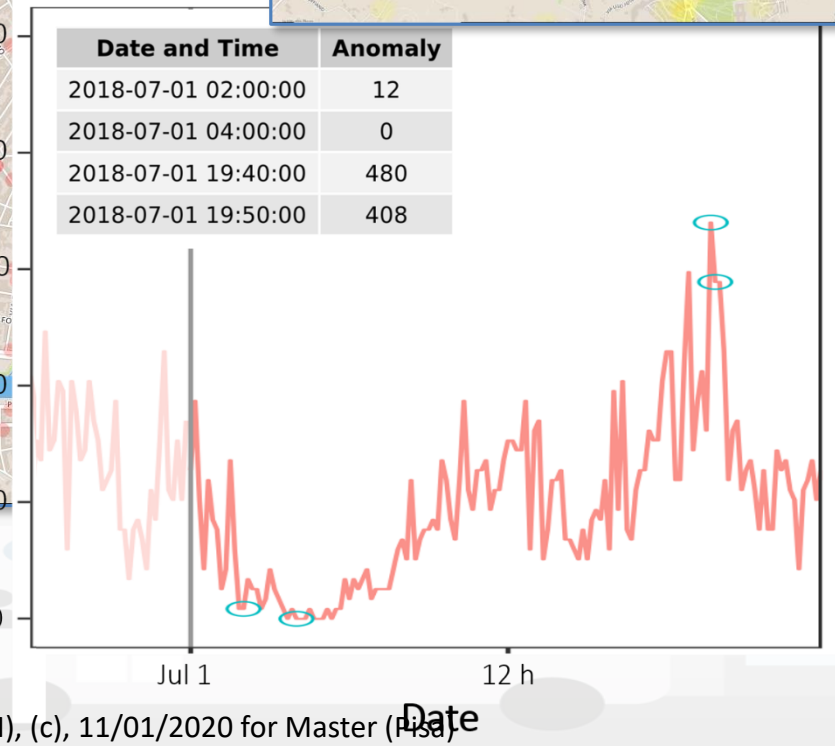
Predictive precision of the 95%

Anomaly Detection





Date and Time	Anomaly
2018-07-01 02:00:00	12
2018-07-01 04:00:00	0
2018-07-01 19:40:00	480
2018-07-01 19:50:00	408



Accidents vs Traffic

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Intelligence on Maintenance Data



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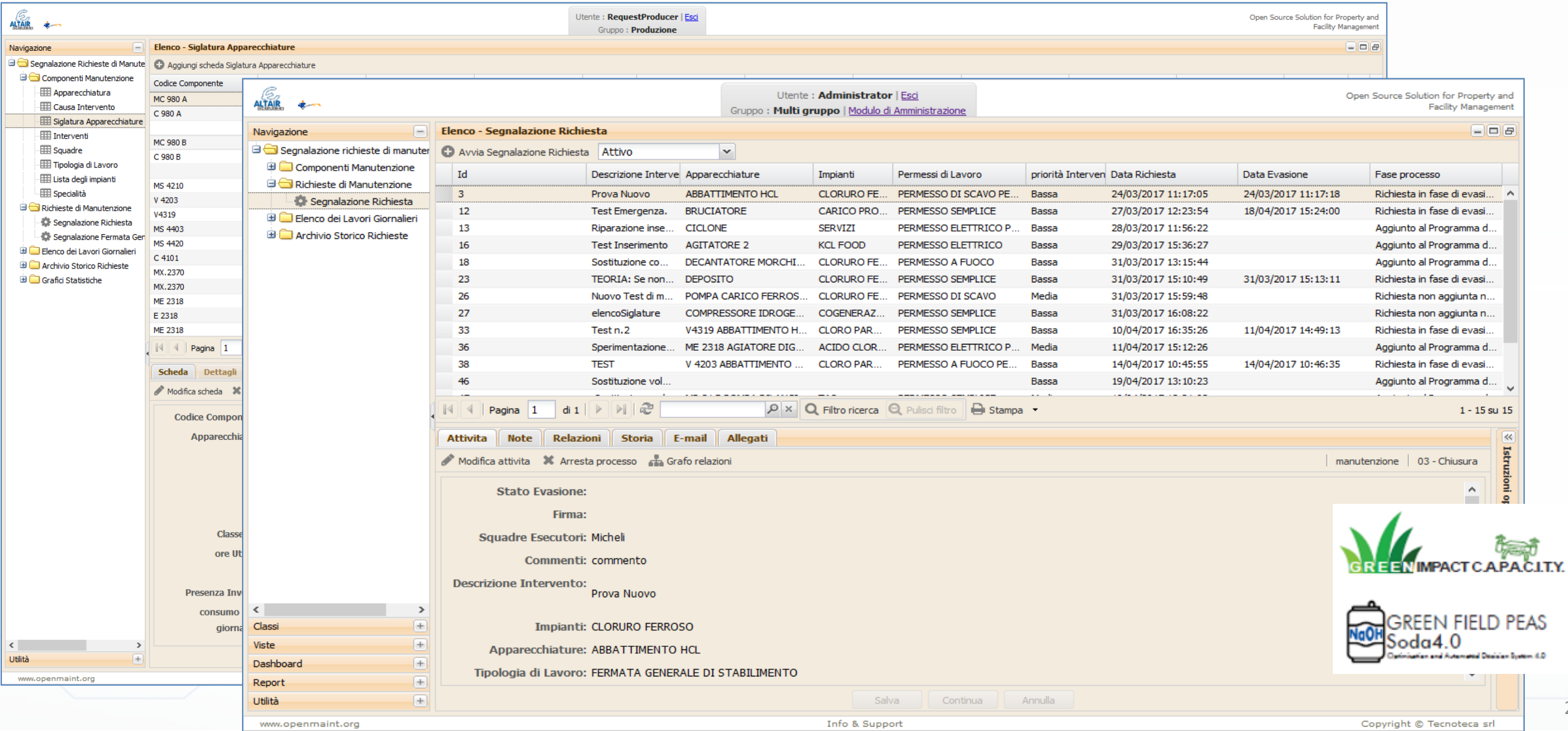
Solution for Asset Management and Maintenance

- 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

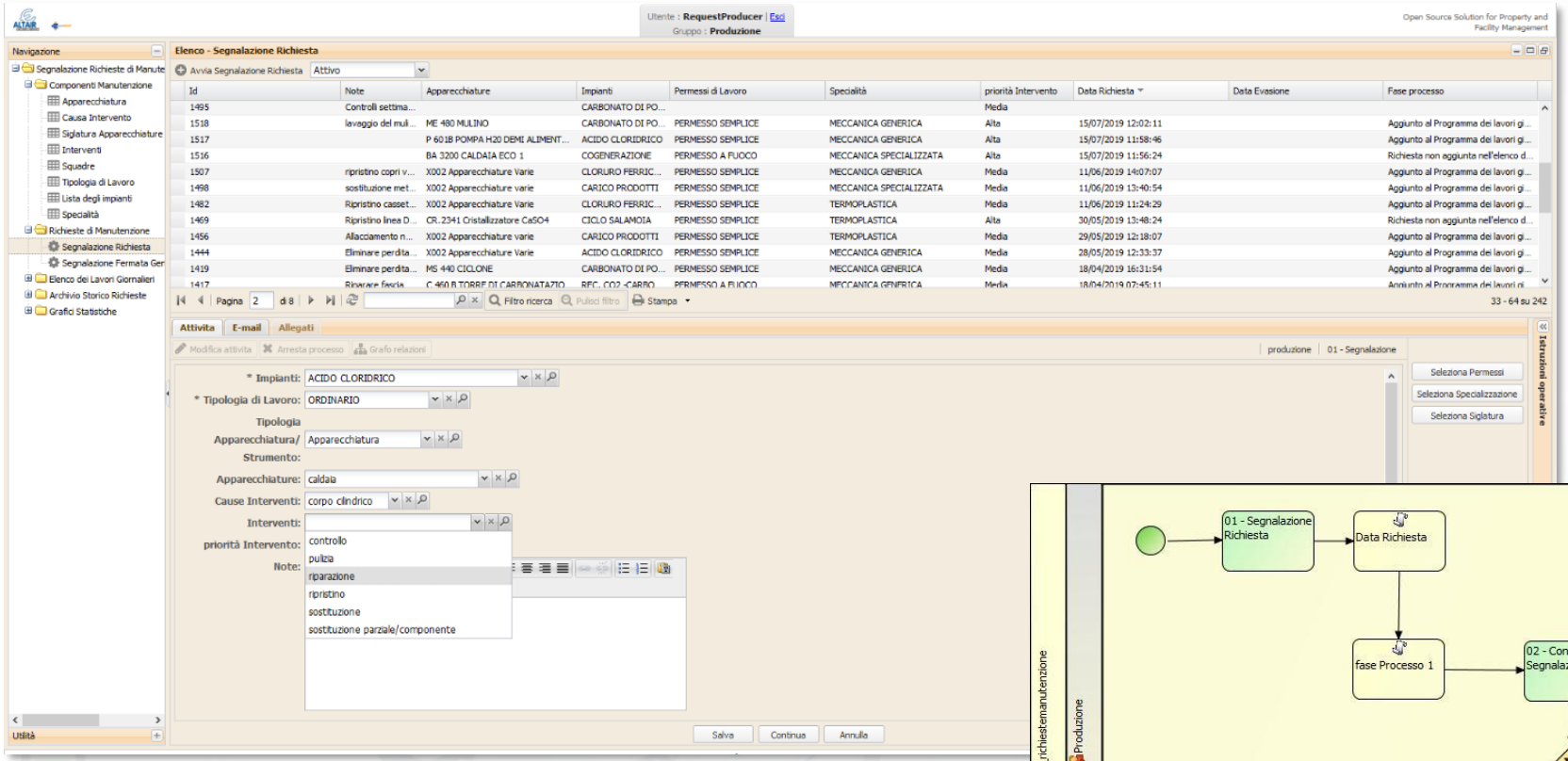
GREEN IMPACT C.A.P.A.C.I.T.Y.

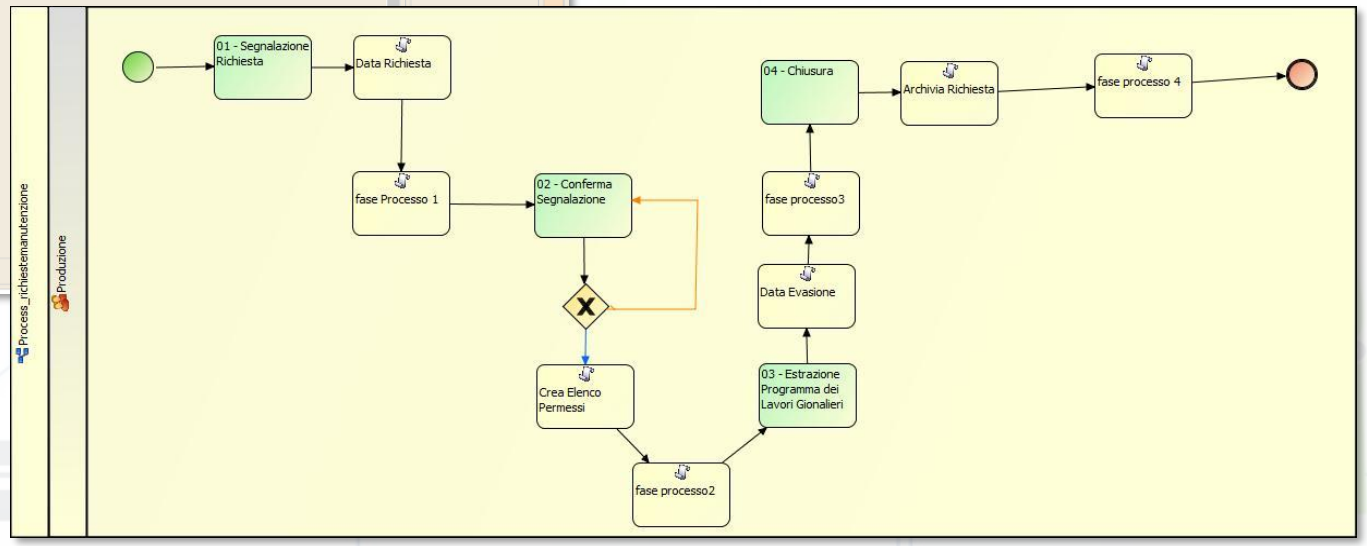
GREEN FIELD PEAS Soda4.0

Assets inventory and management



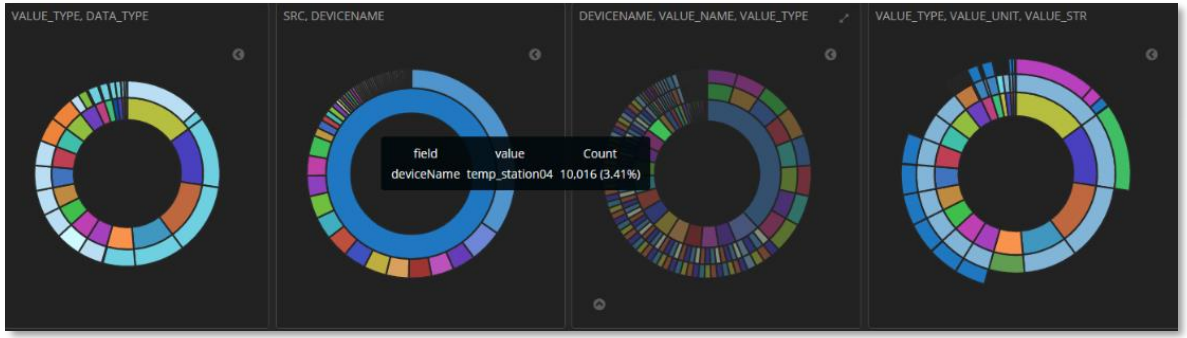
Maintenance: ticket management

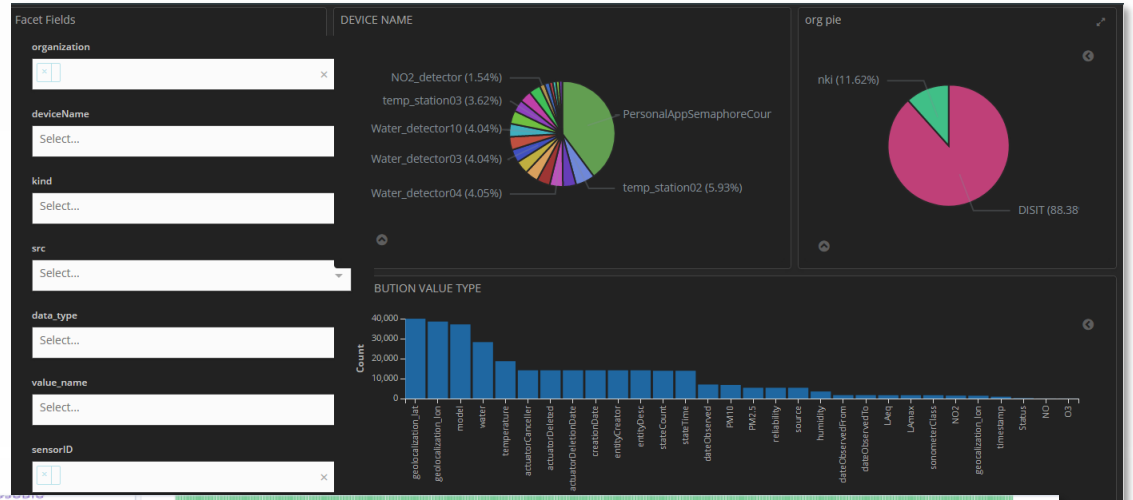


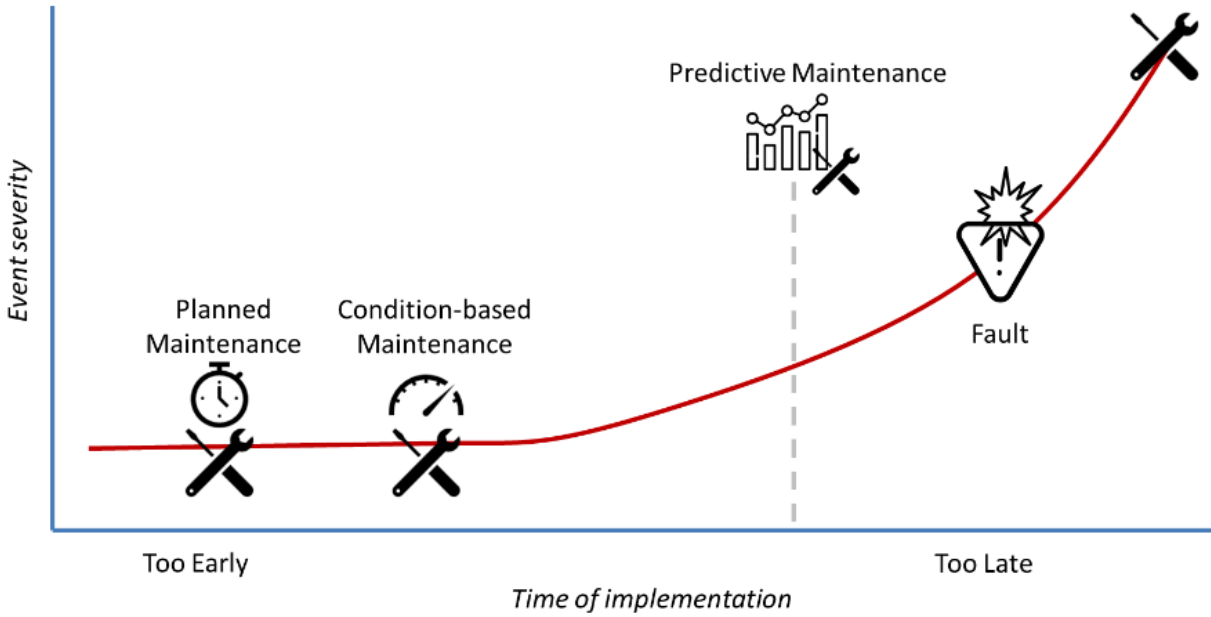


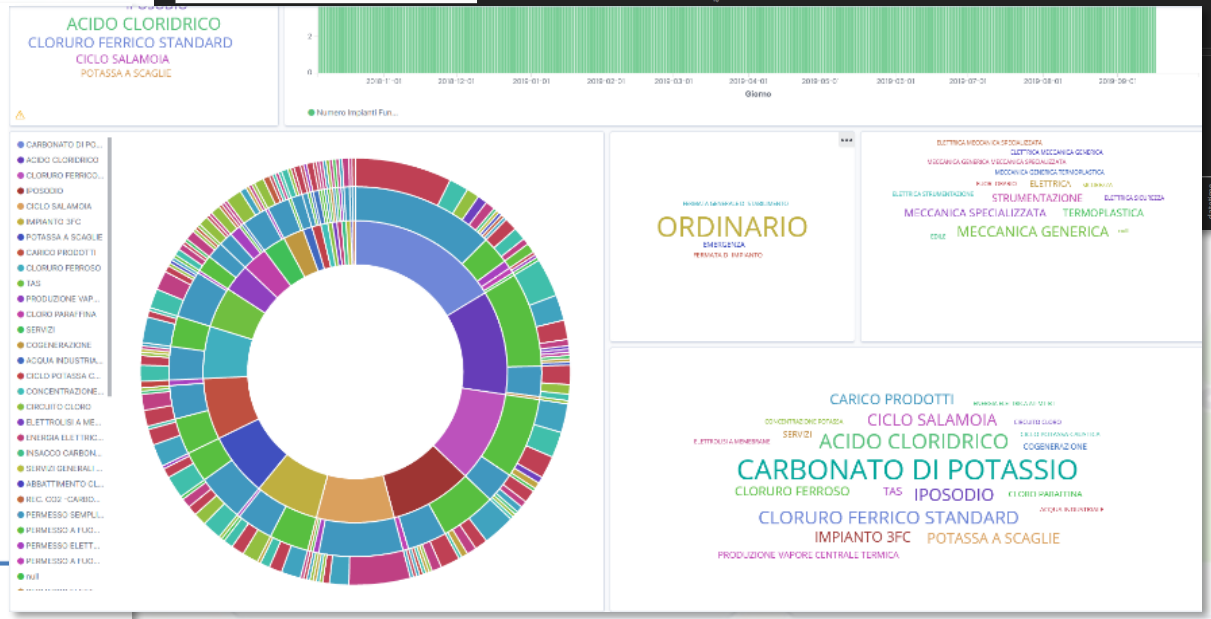
Personalised Workflows

Business Intelligence and Predictive Maintenance









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





FERMATA DI IMPIANTO
ORDINARIO
EMERGENZA
FERMATA GENERALE DI STABILIMENTO

- CARBONATO DI P...
- CLORURO FERRIC...
- CICLO SALAMOIA
- ACIDO CLORIDRICO
- IPOSODIO
- IMPIANTO 3FC
- CARICO PRODOTTI
- POTASSA A SCAG...
- CLORURO FERRO...
- TAS
- CLORO PARAFFINA
- PRODUZIONE VA...
- SERVIZI
- CICLO POTASSA ...
- CICLO SALAMOIA...





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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

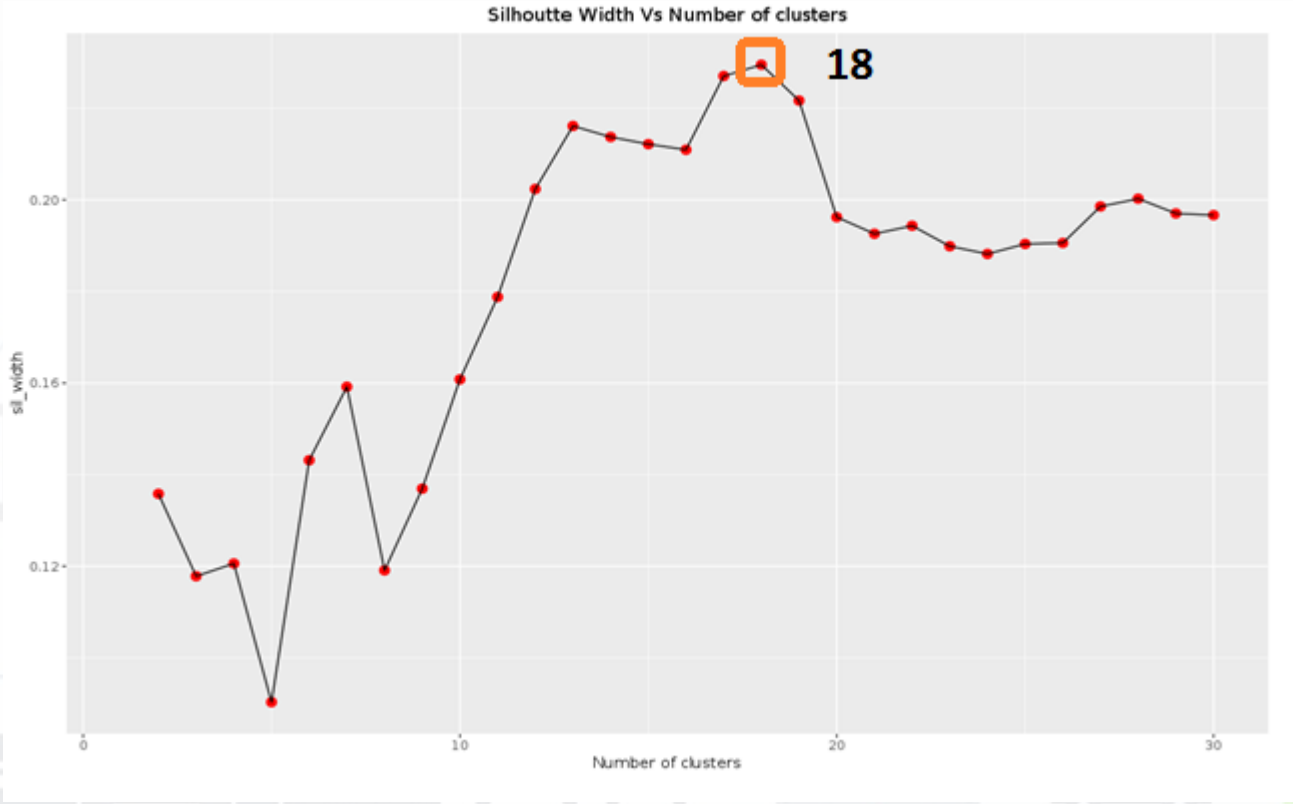
Dataset:
Customer retail fashion and large scale retail distribution

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

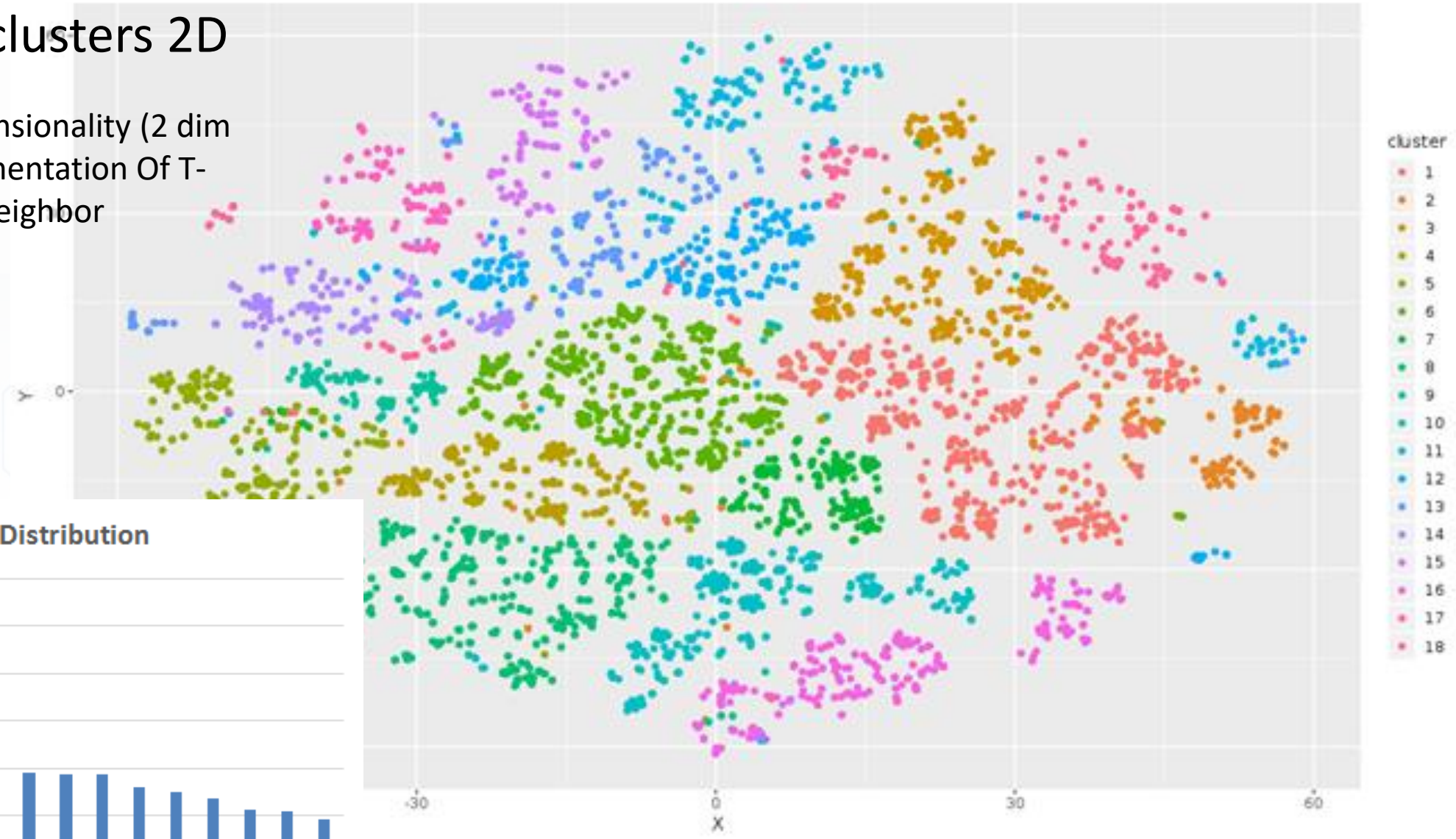
Calculate optimal number of clusters: **Silhoutte analysis**
(The location of the maximum is considered as the appropriate

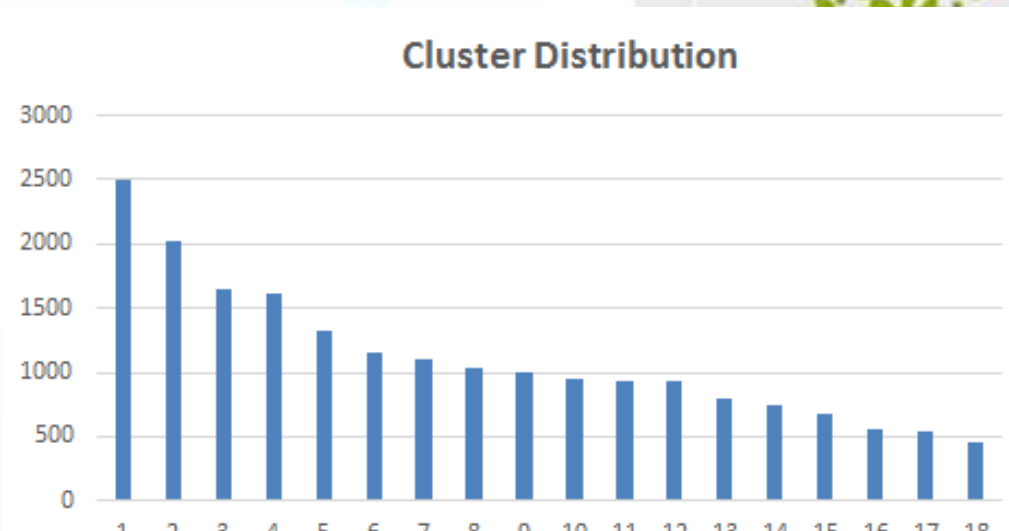


1: Products Segmentation

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

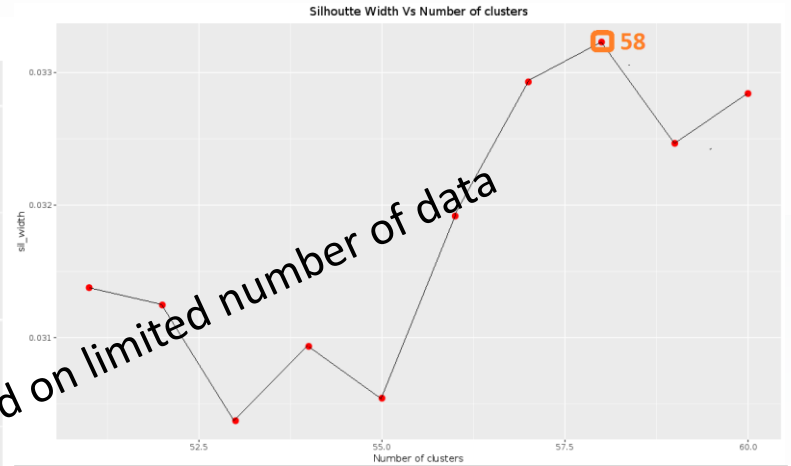
Early TEST on Interest Customer for customer

Mixed data Methods: K-Medoids

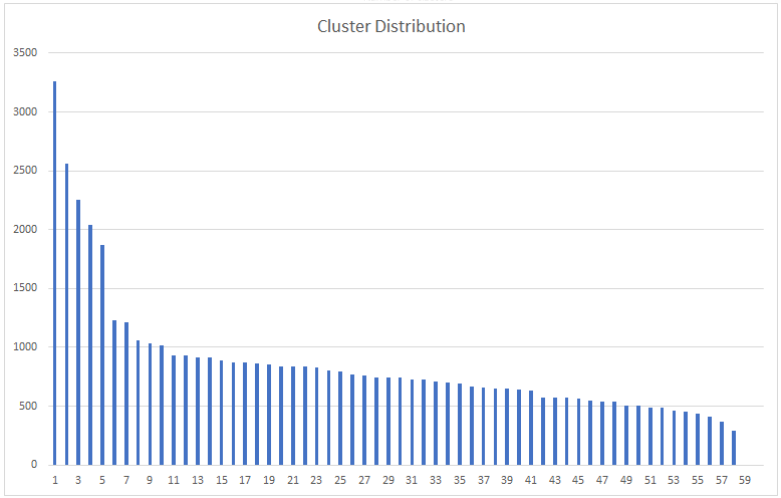
Calculate optimal number of clusters: **Silhoutte analysis** (The location of the maximum is considered as the appropriate number of clusters).

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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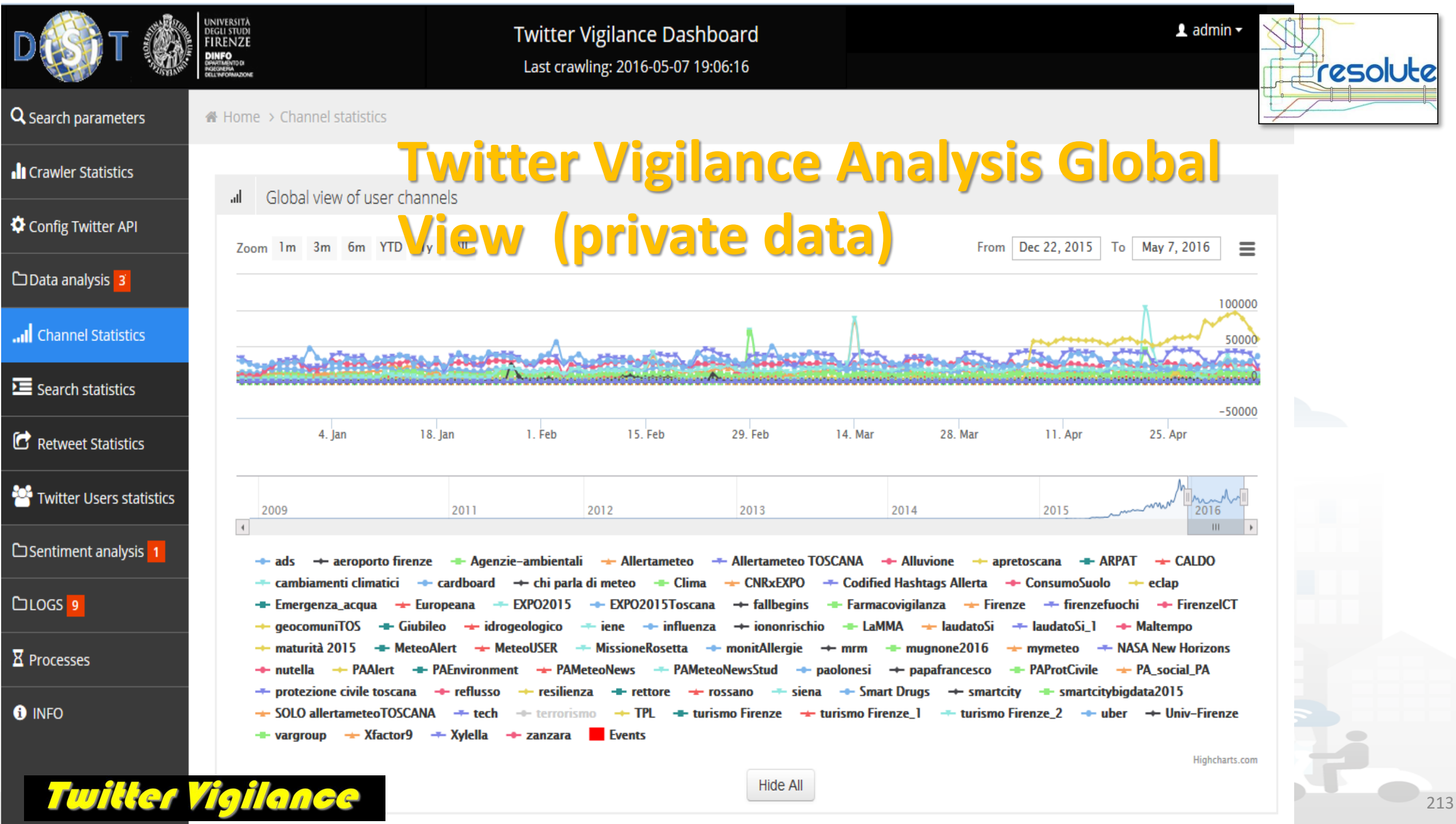
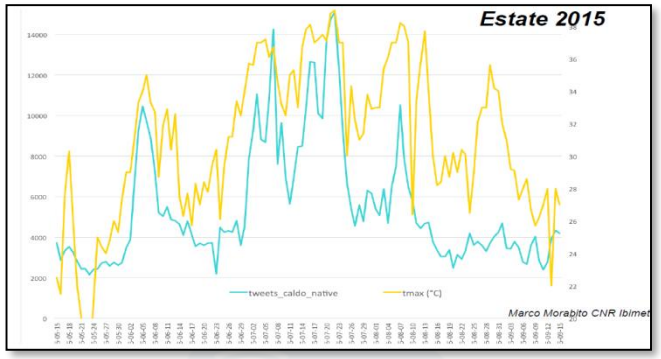


Twitter Vigilance Analysis Global View (private data)

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



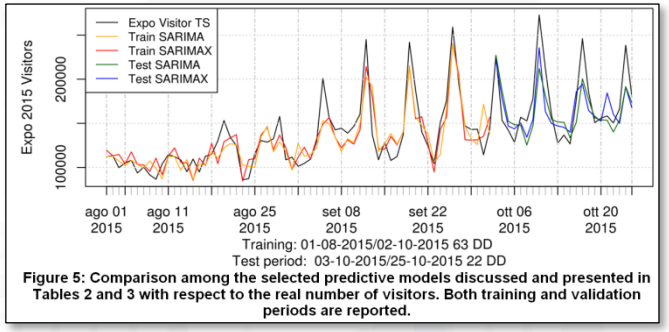
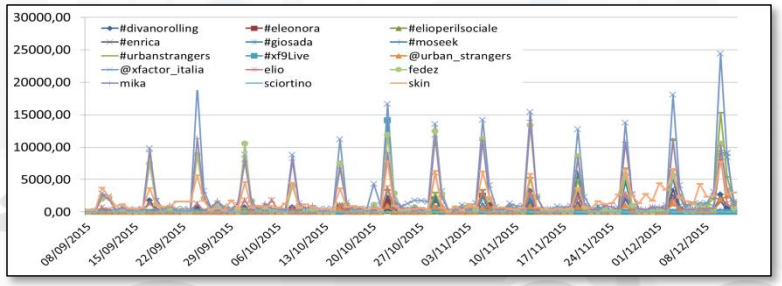
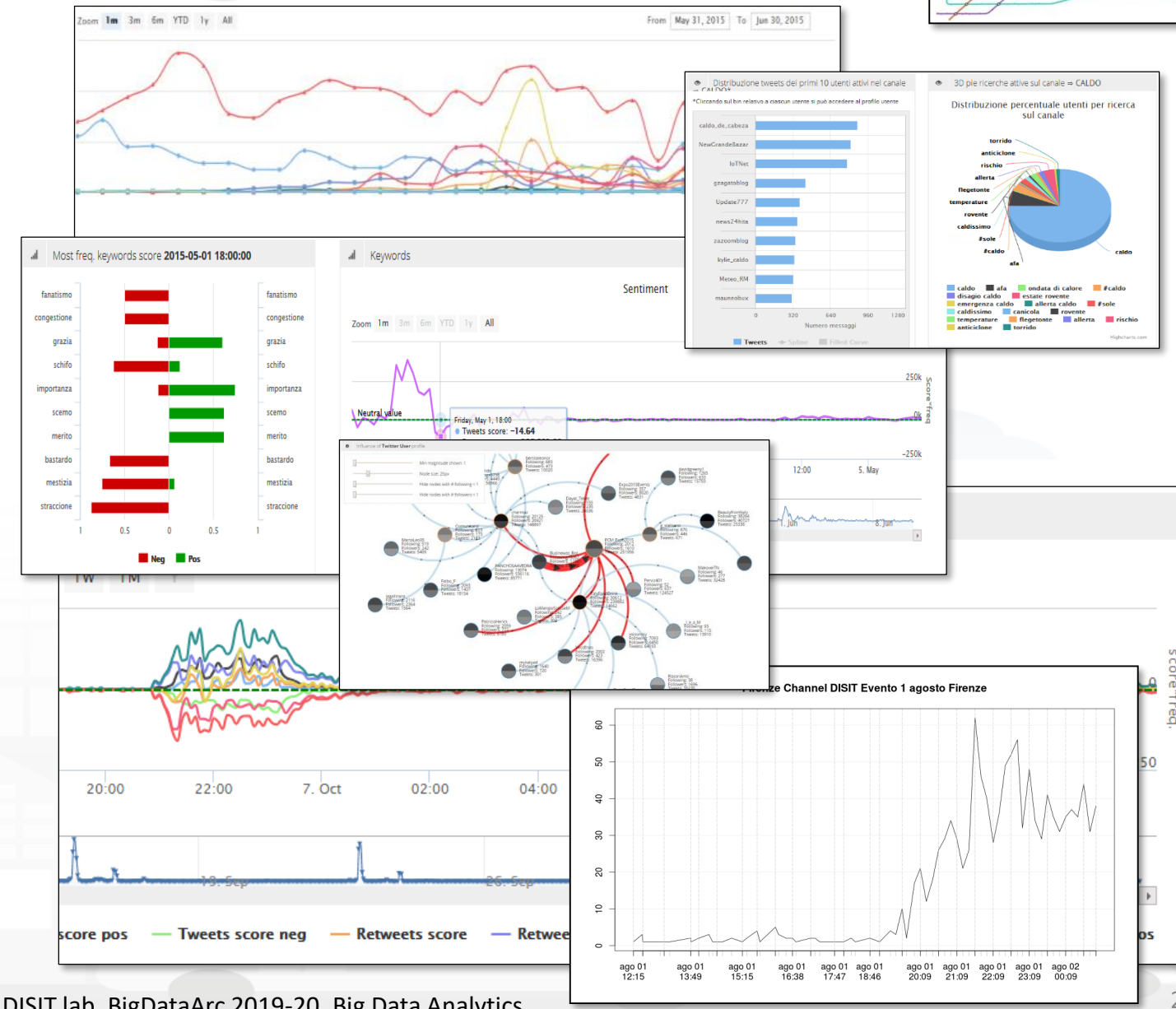


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.

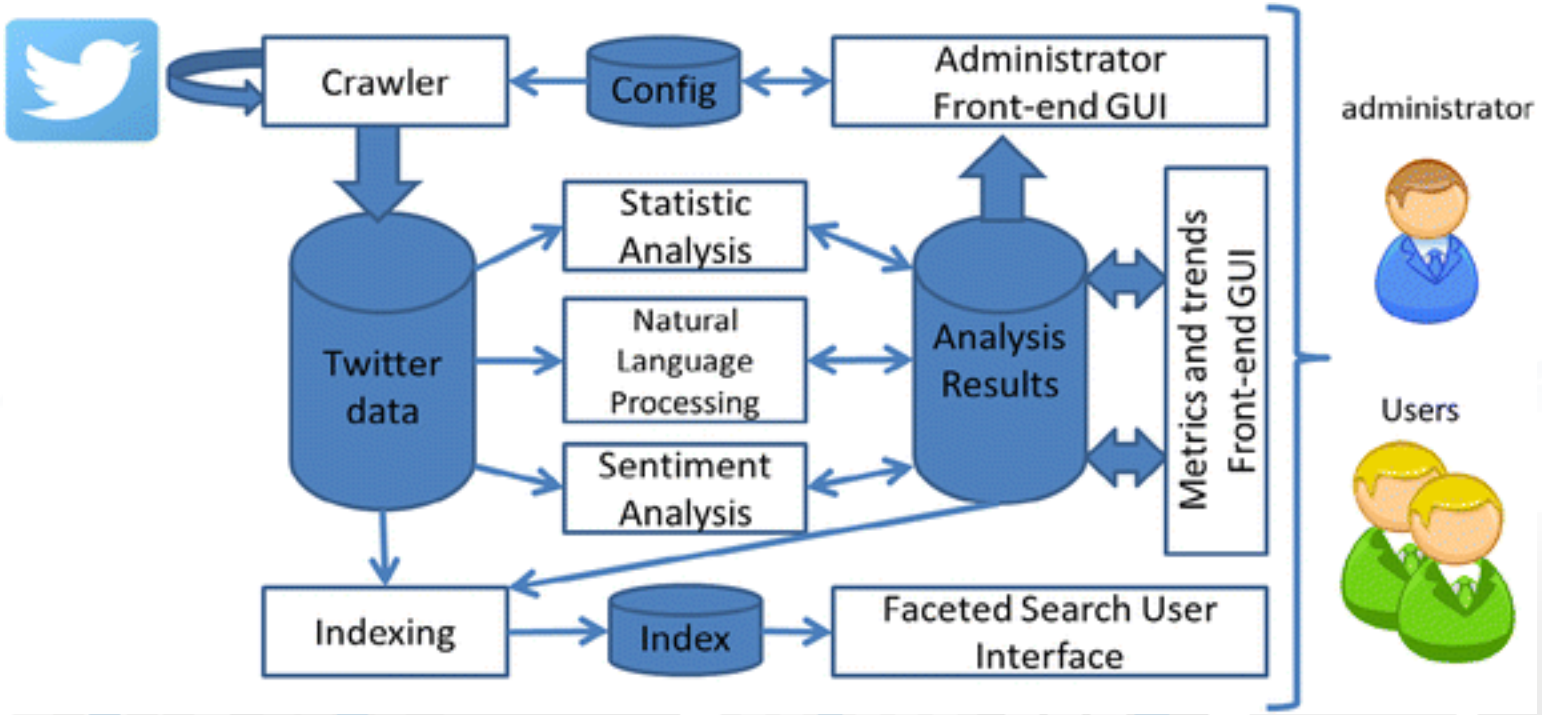


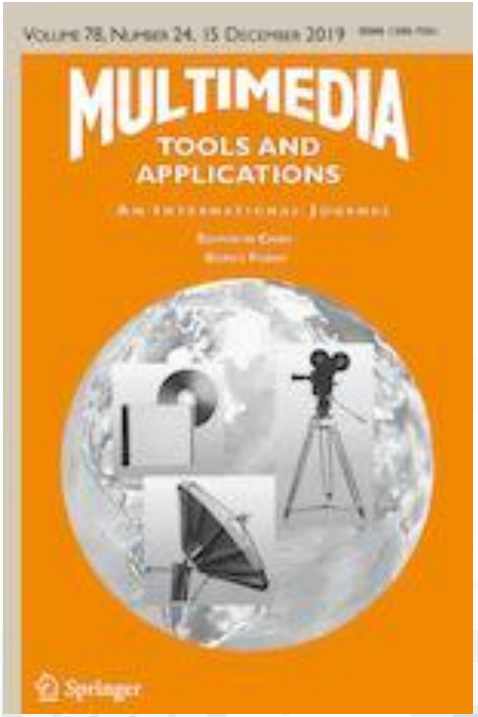
Twitter Vigilance

- 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



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

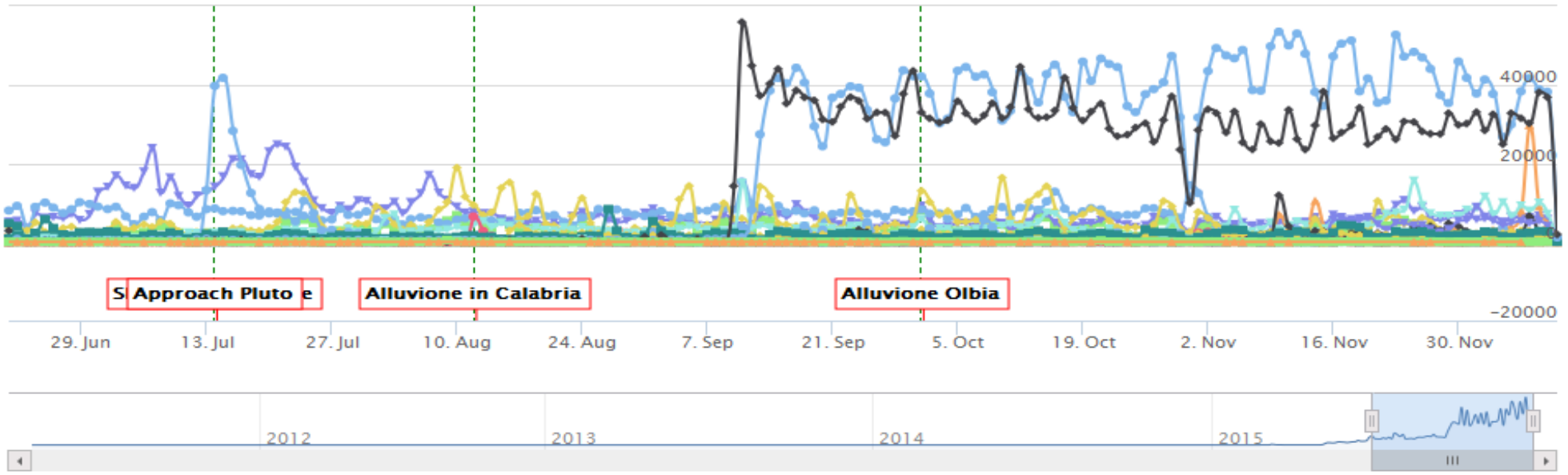
- Search parameters
- Data analysis 4
- Channel statistics
- Search statistics
- Retweet statistics
- Twitter Users statistics
- INFO

Home > Channel statistics

Global view of user channels

Zoom 1m 3m 6m YTD 1y All

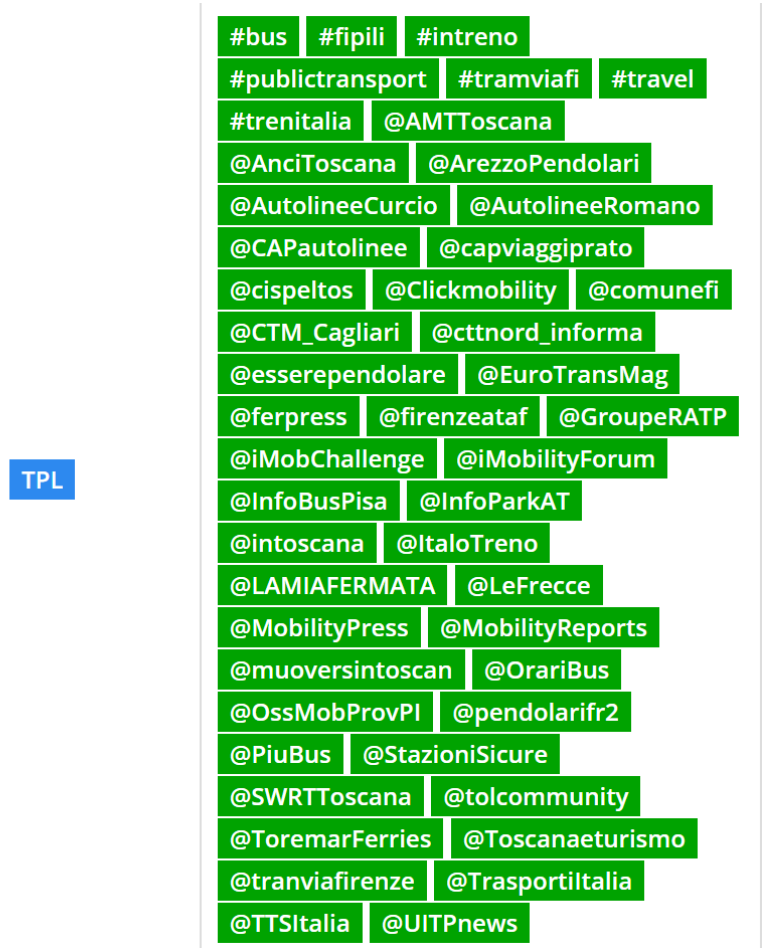
From Jun 20, 2015 To Dec 11, 2015



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

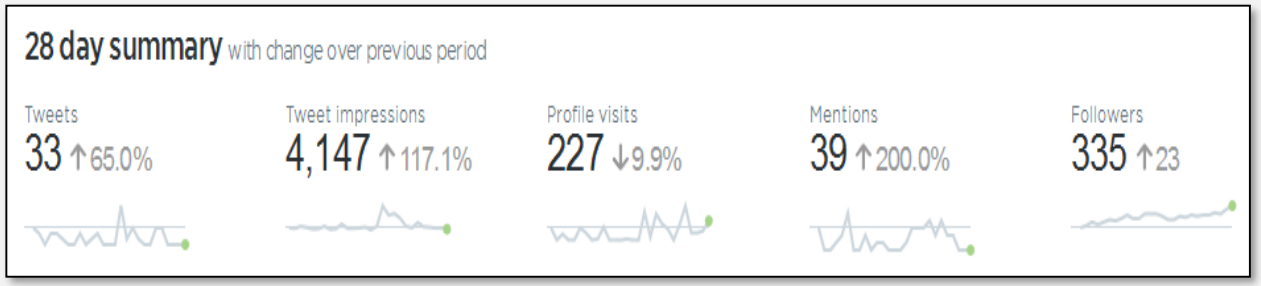


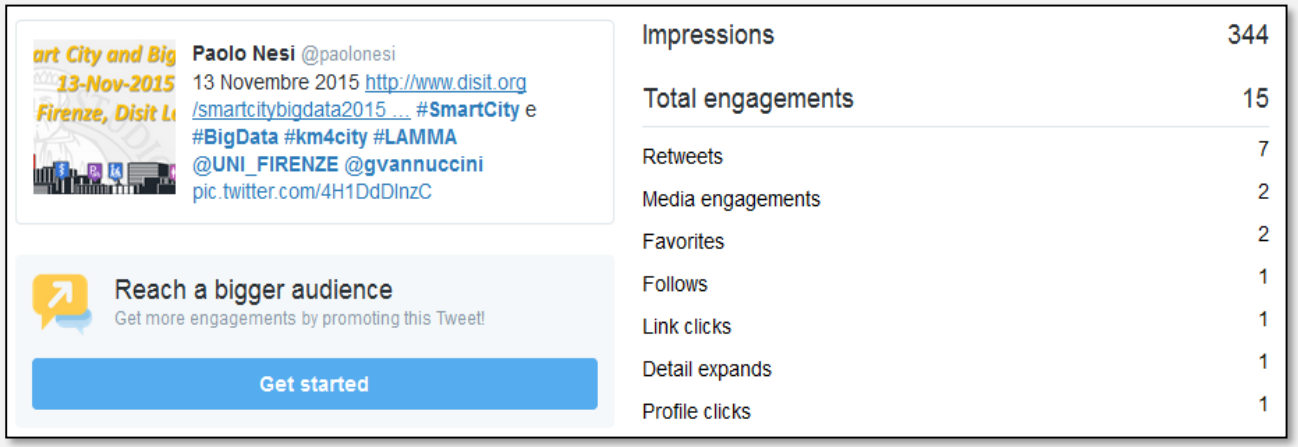
Twitter Vigilance

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

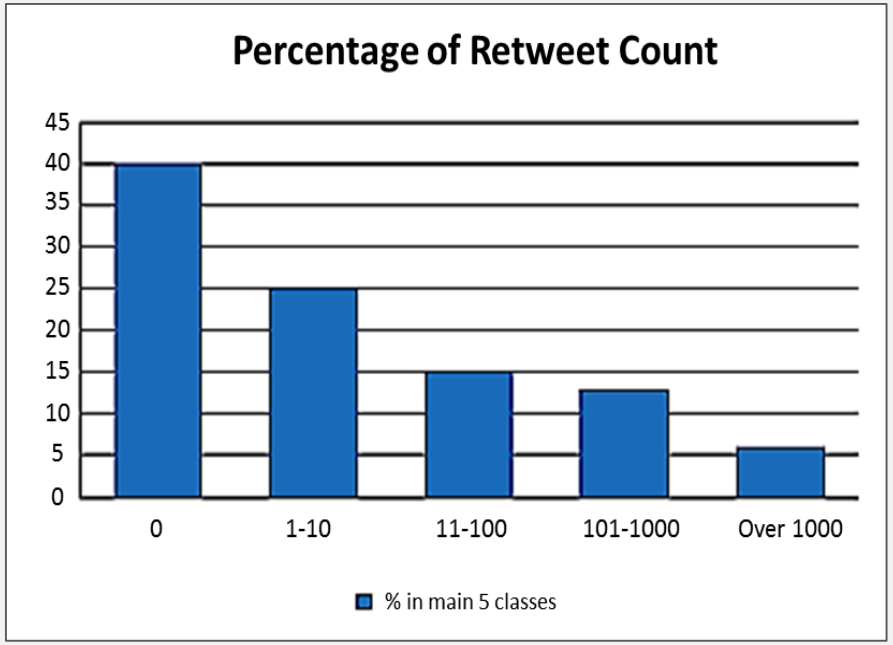
DISIT Lab, Distributed Data Intelligence and Technologies
Distributed Systems and Internet Technologies
Department of Information Engineering (DINFO)
http://www.disit.dinfo.unifi.it

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

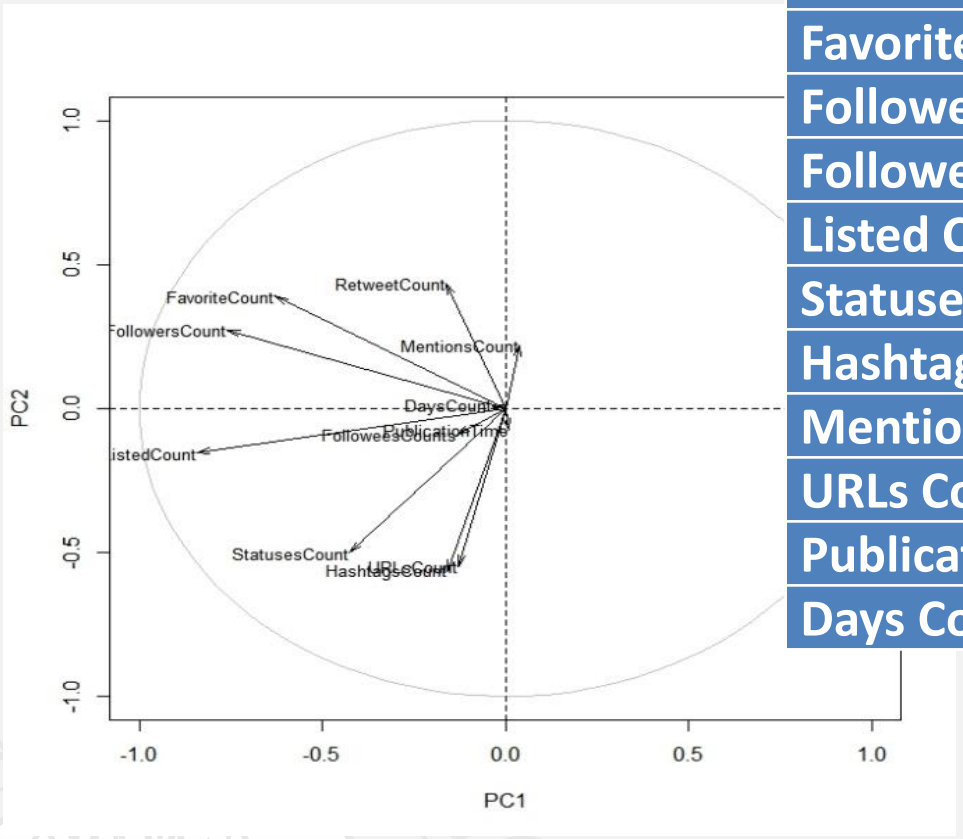
Data sets:

- 100 Million of Tweet
- 500 K
- 100 K



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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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

Case Study C

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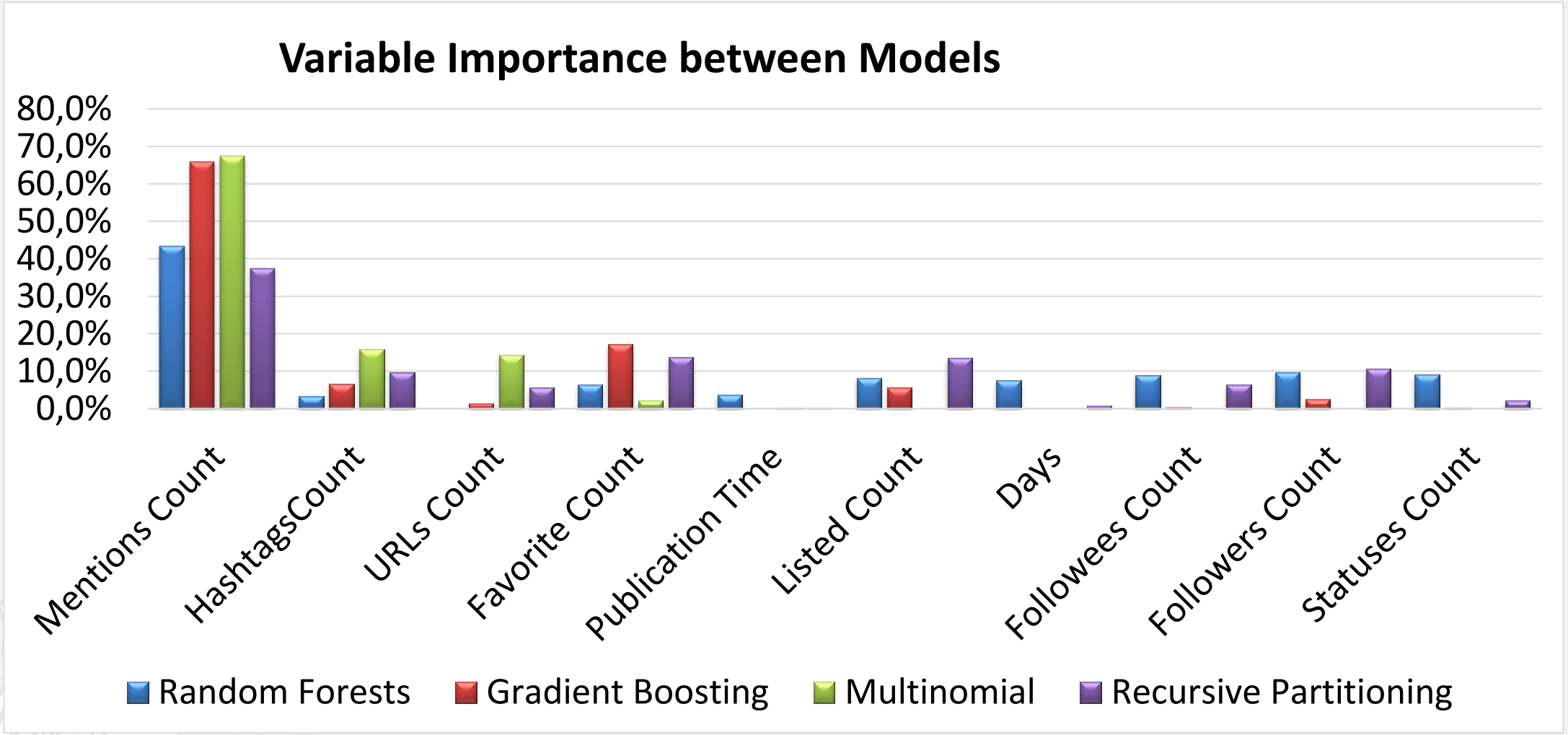
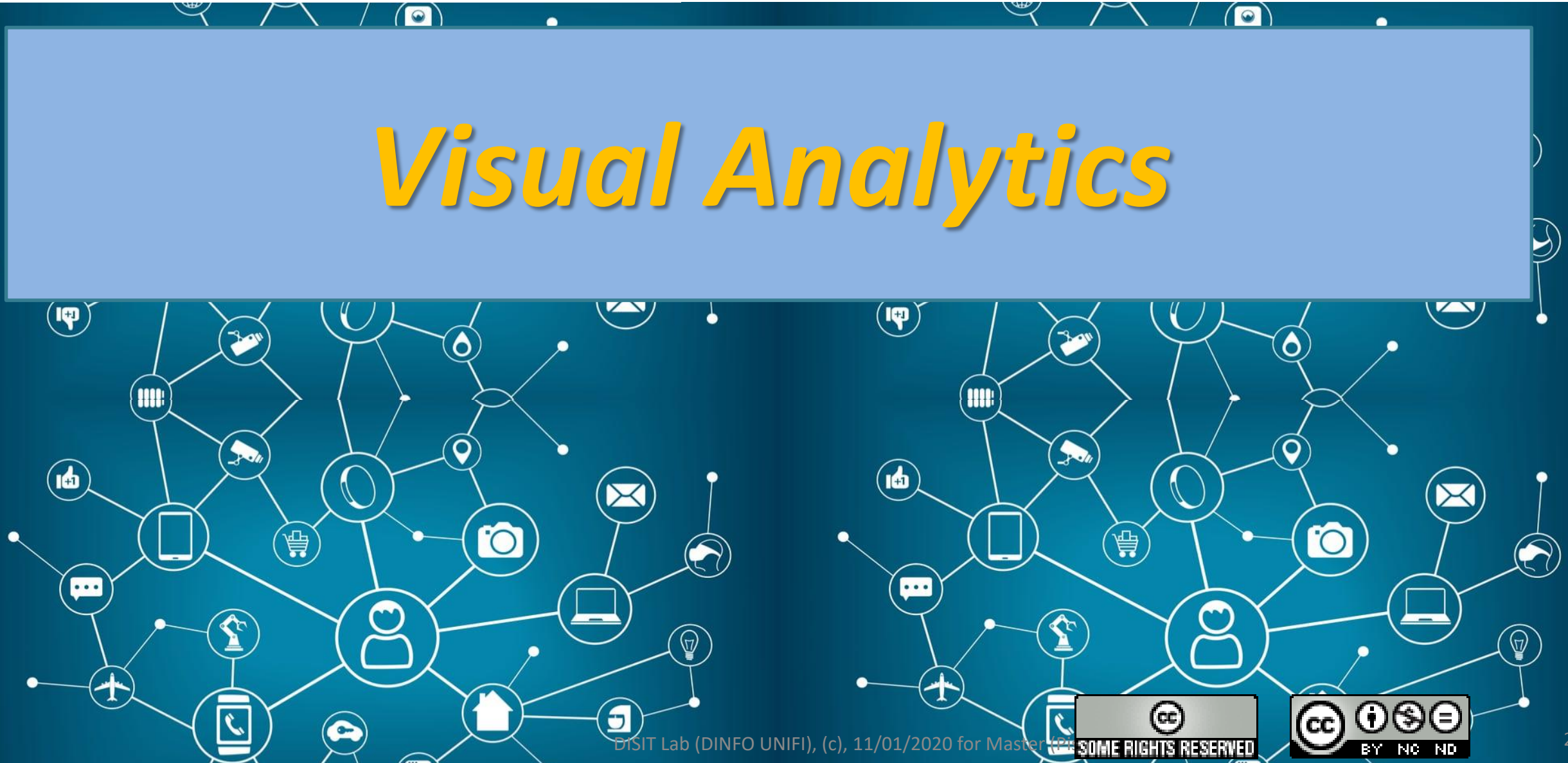
Predictive models VS metrics relevance



Visual Analytics



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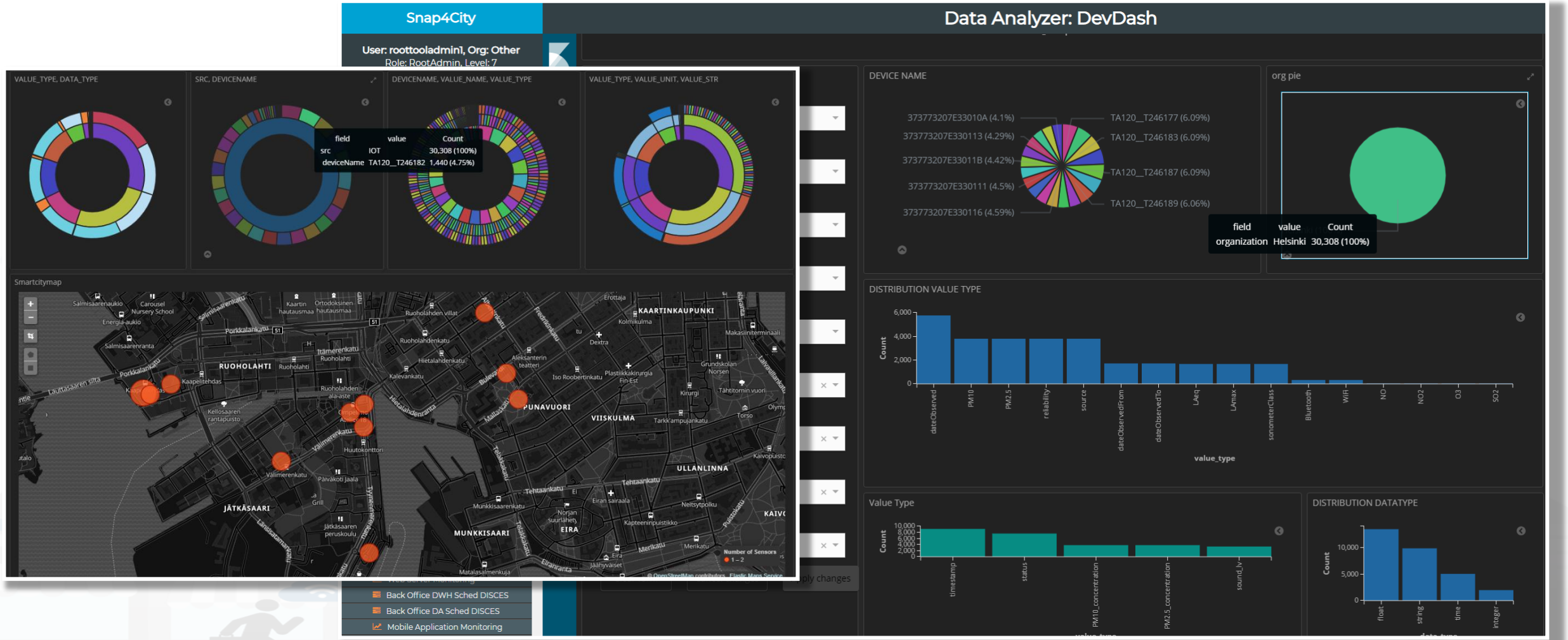
Agenda

- 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



What If Analysis



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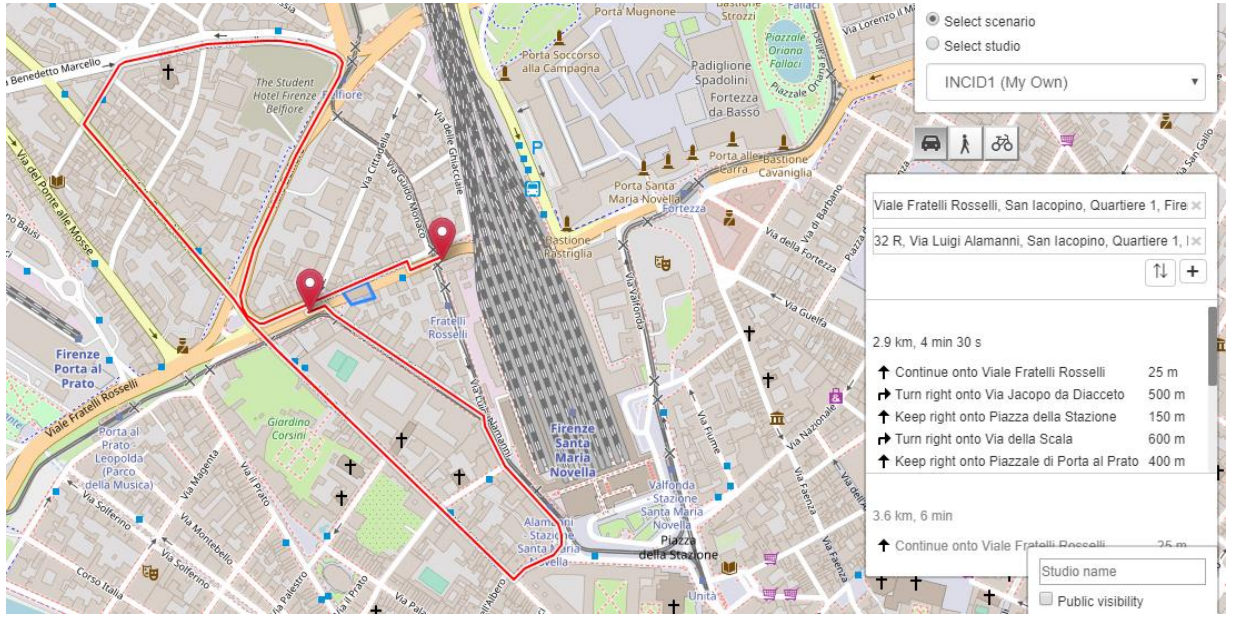
What-If Analysis

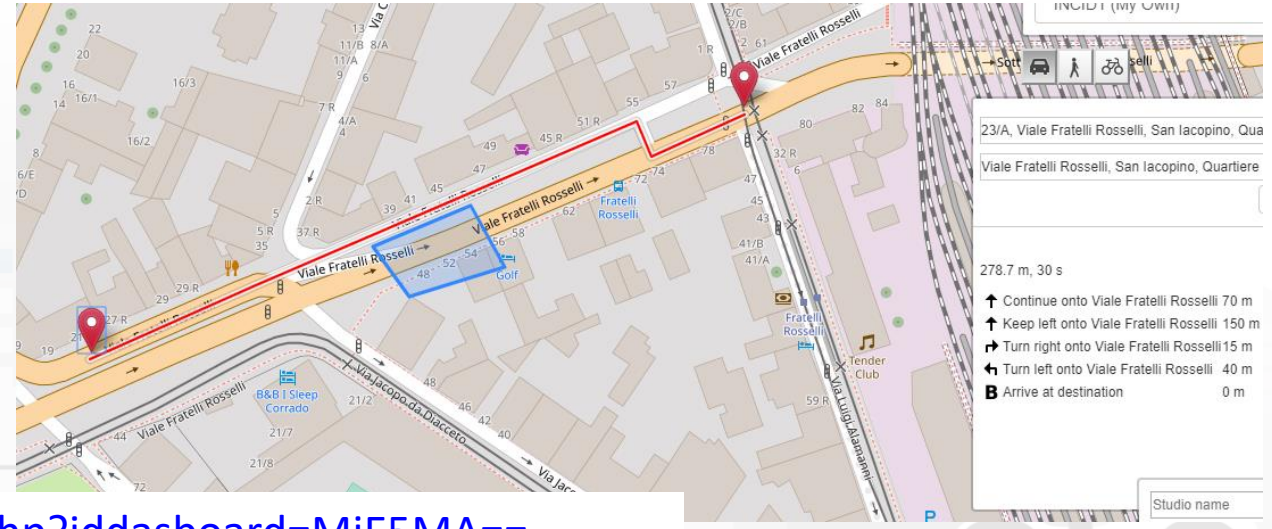
Accidents and elements blocking Points and Shapes taken into account for:

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

Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment





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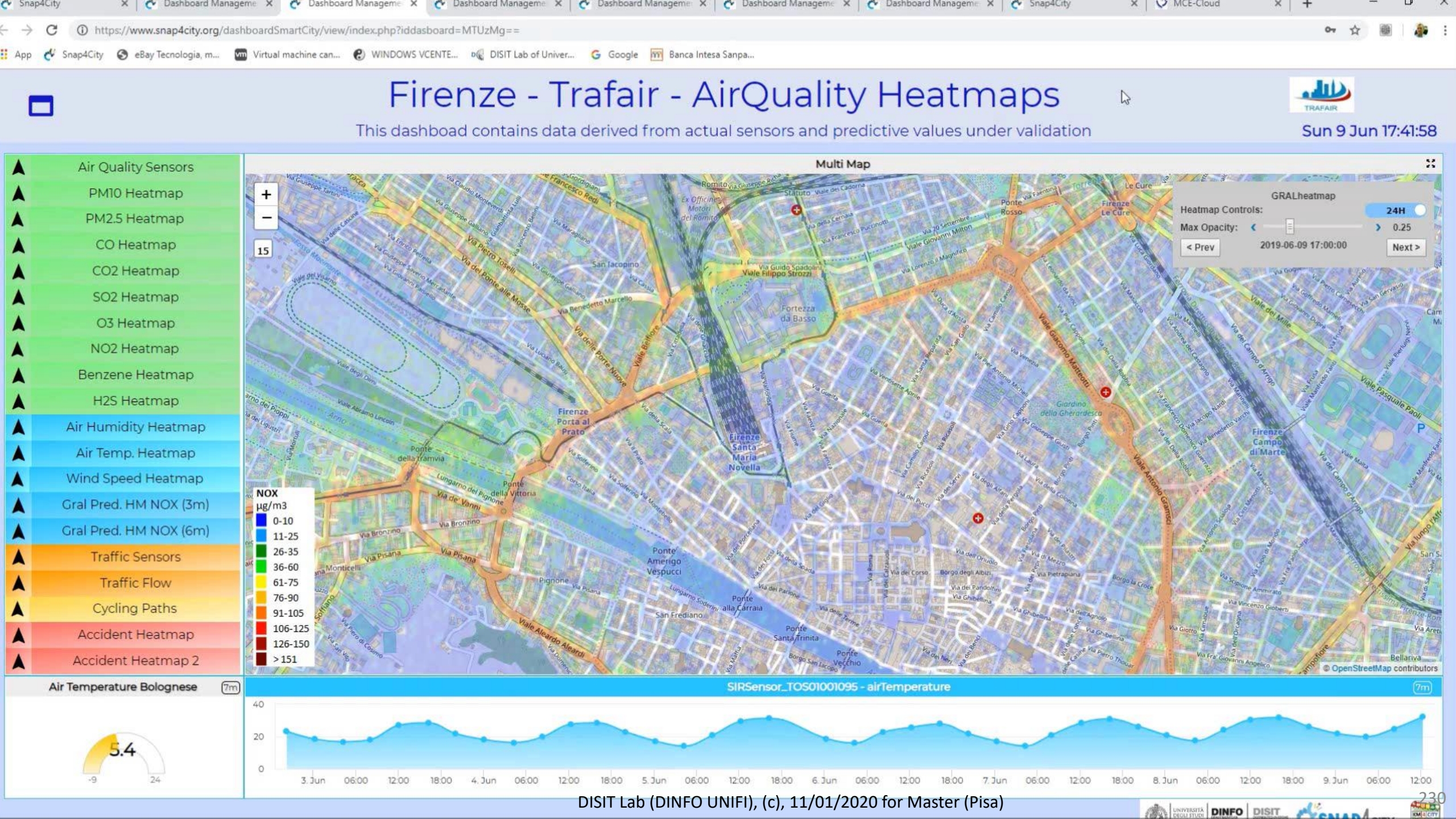

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Firenze - Trafair - AirQuality Heatmaps
This dashboad contains data derived from actual sensors and predictive values under validation
Sun 9 Jun 17:41:58
Air Quality Sensors
PM10 Heatmap
PM2.5 Heatmap
CO Heatmap
CO2 Heatmap
SO2 Heatmap
O3 Heatmap
NO2 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
Multi Map
GRALheatmap
Heatmap Controls:
24H
Max Opacity:
0.25
< Prev
2019-06-09 17:00:00
Next >
NOX
µg/m3
0-10
11-25
26-35
36-60
61-75
76-90
91-105
106-125
126-150
> 151
© OpenStreetMap contributors
Air Temperature Bolognese
5.4
SIRSensor_TOS01001095 - airTemperature

What-If analysis

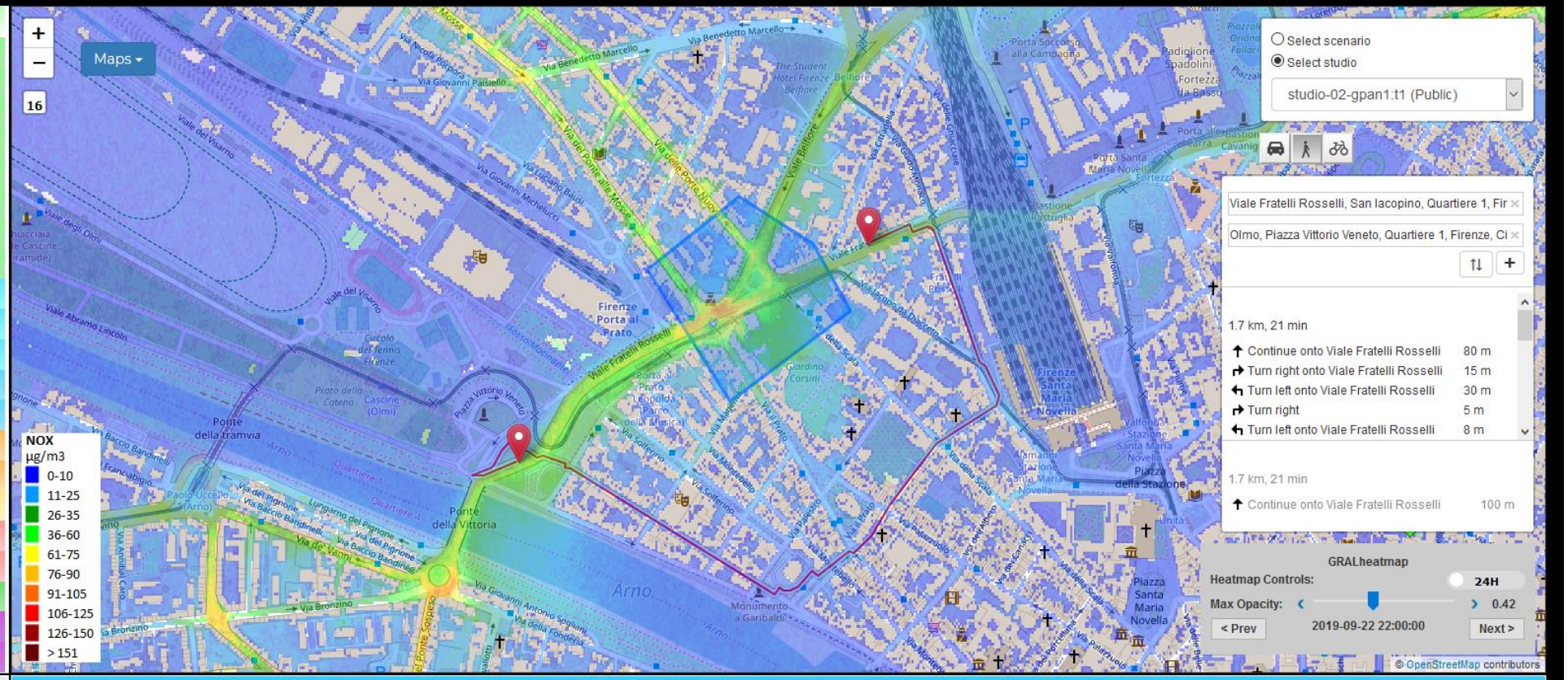
Firenze & Toscana - Background Orthomaps Test

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

TRAFAIR

Sun 22 Sep 22:59:21

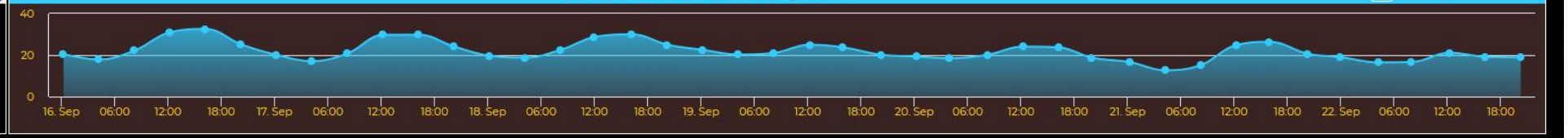
- Air Quality Sensors
- Weather Sensors
- PM10 Heatmap
- PM2.5 Heatmap
- CO Heatmap
- CO2 Heatmap
- O3 Heatmap
- NO2 Heatmap
- Europ. AQI Heatmap
- Air Humidity Heatmap
- Air Temp. Heatmap
- Wind Speed Heatmap
- Gral Pred. HM NOX (3m)
- Gral Pred. HM NOX (6m)
- Traffic Sensors
- Traffic Flow
- Cycling Paths
- Accident Heatmap
- Accident Heatmap 2
- Only HRes Anym. Gral
- Scenarious
- What-if analysis



Air Temperature Bolognese 8m



SIRSensor_TOS01001095 - airTemperature 8m



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

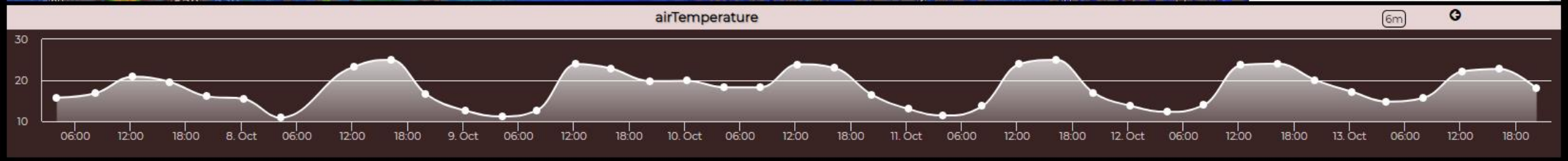
- Air Quality Sensors
- Weather Sensors
- PM10 Heatmap
- PM2.5 Heatmap
- CO Heatmap
- CO2 Heatmap
- O3 Heatmap
- NO2 Heatmap
- Europ. AQI Heatmap
- Air Humidity Heatmap
- Air Temp. Heatmap
- Wind Speed Heatmap
- Gral Pred. HM NOX (3m)
- Gral Pred. HM NOX (6m)
- Traffic Sensors
- Traffic Flow
- Cycling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

Firenze Oggi

Air Temperat... 6m







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Mobile App Development, User Engagement



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SNAP4CITY KM4CITY

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,



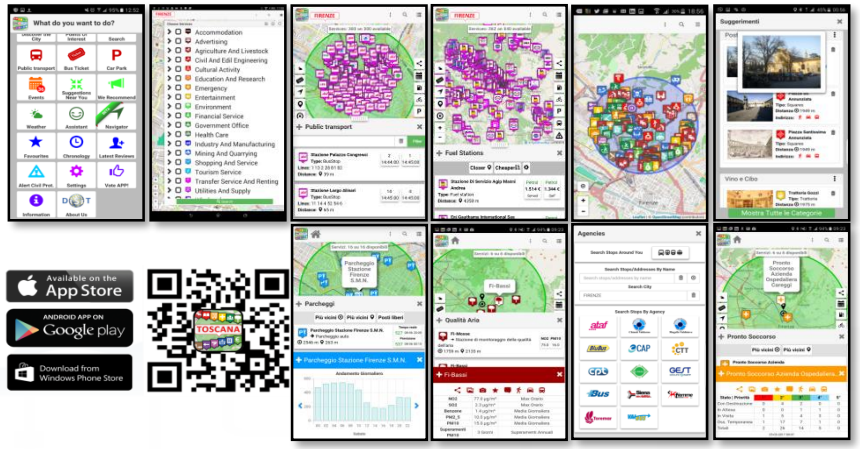




Inform, announce, Act!, warning, alarms, What-IF, ..

Web and Mobile App Developers, to generate

Mobile Apps



Web App HTML5



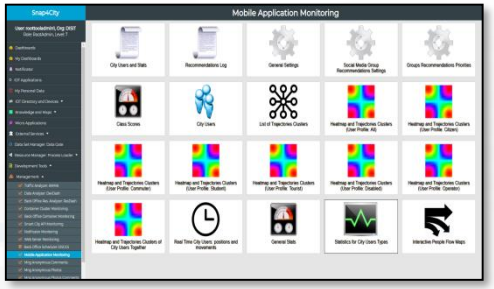
Embed into Web pages



City User



Advanced Smart City API

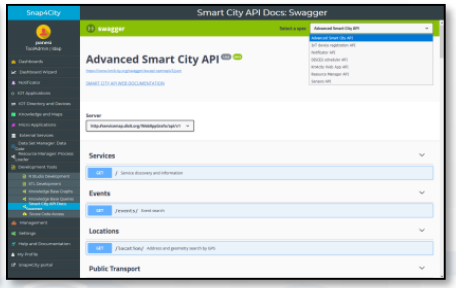


Mobile Application Monitoring Administrator

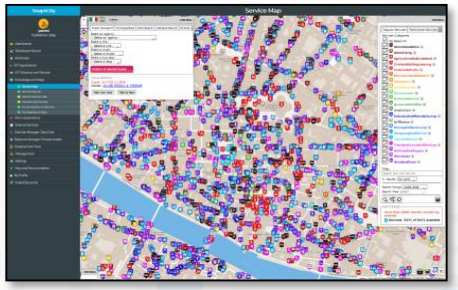




Km4City Open Source examples dev. tool kit



Swagger

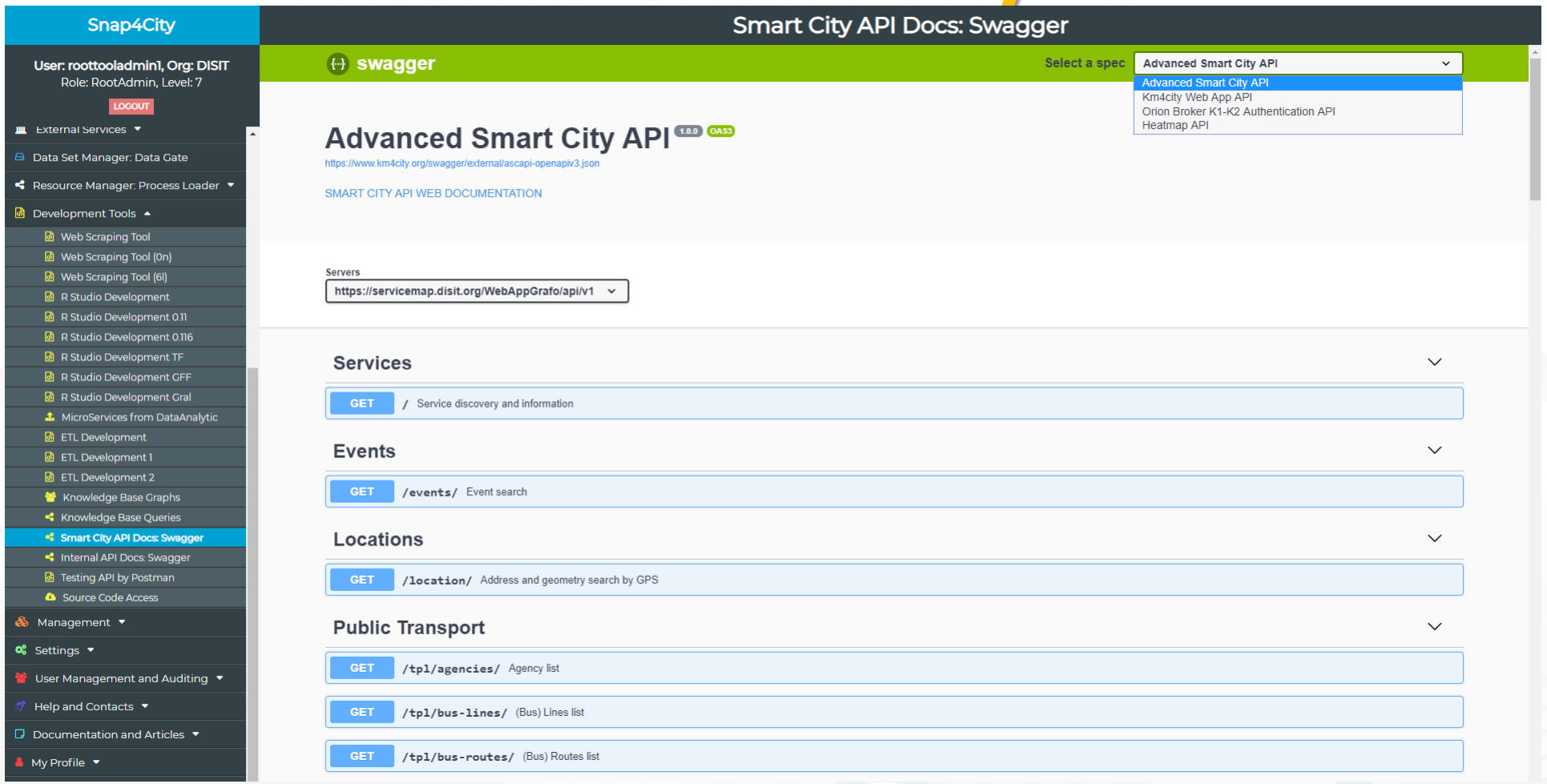


ServiceMap

Developer



External Smart City API



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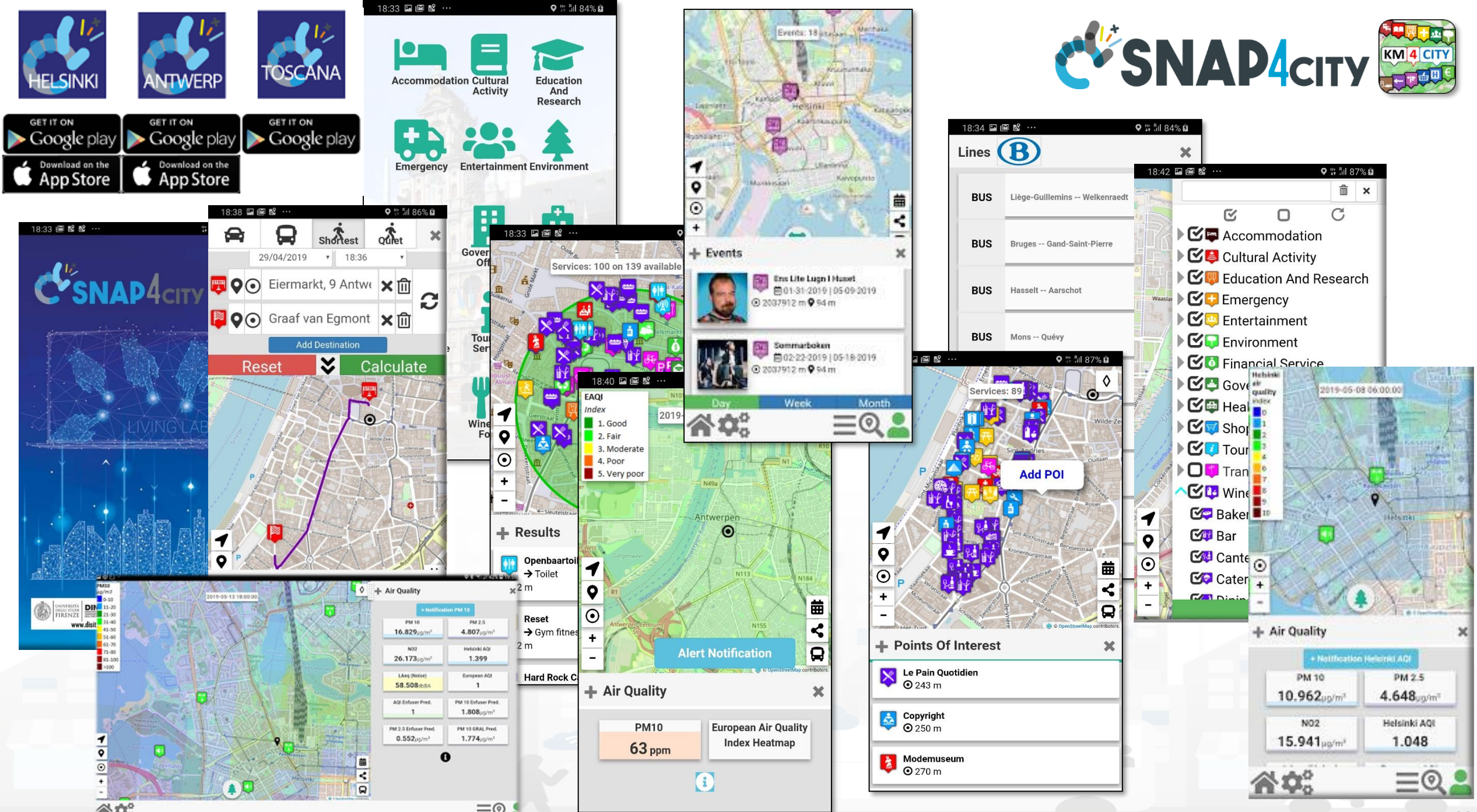
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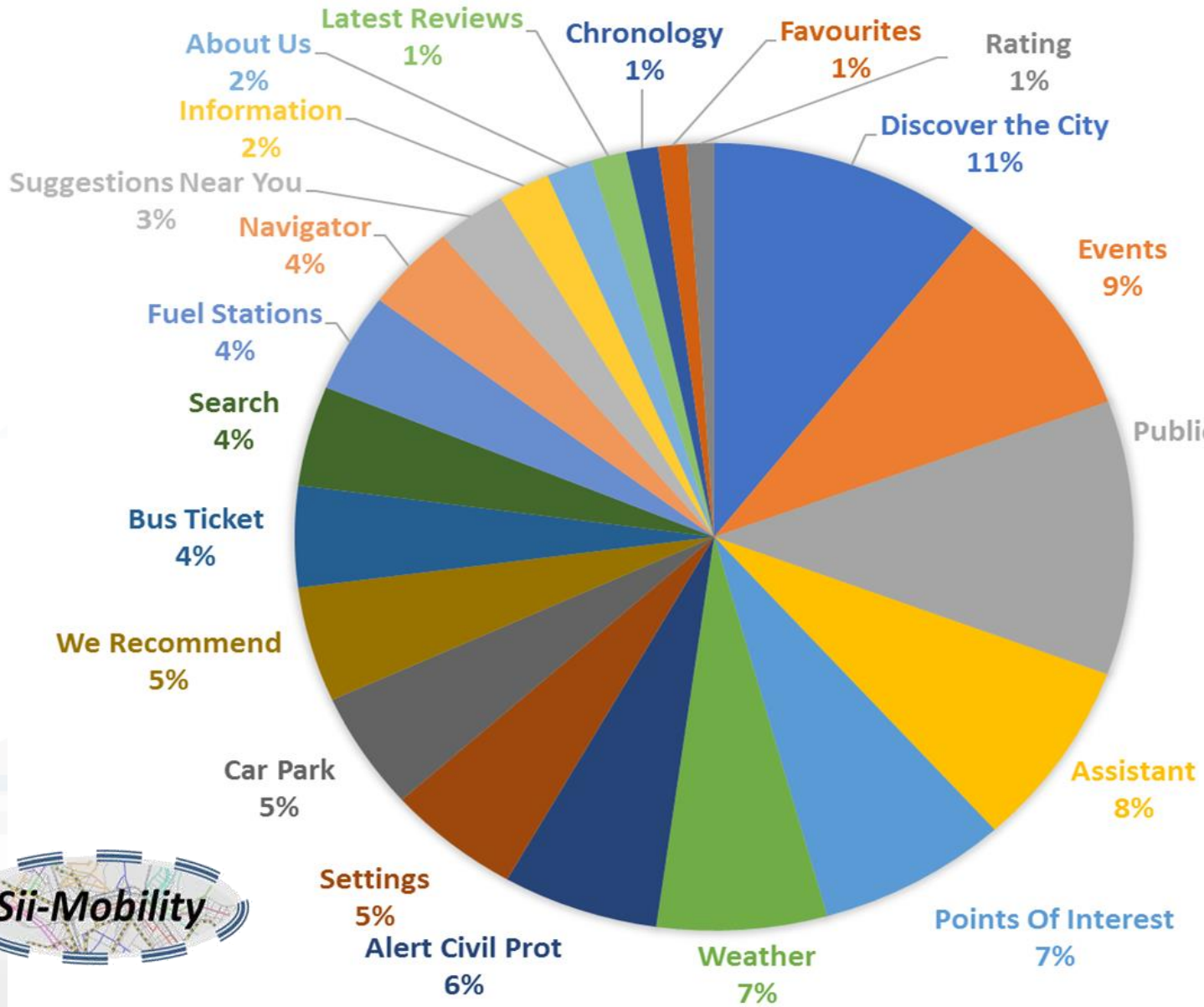
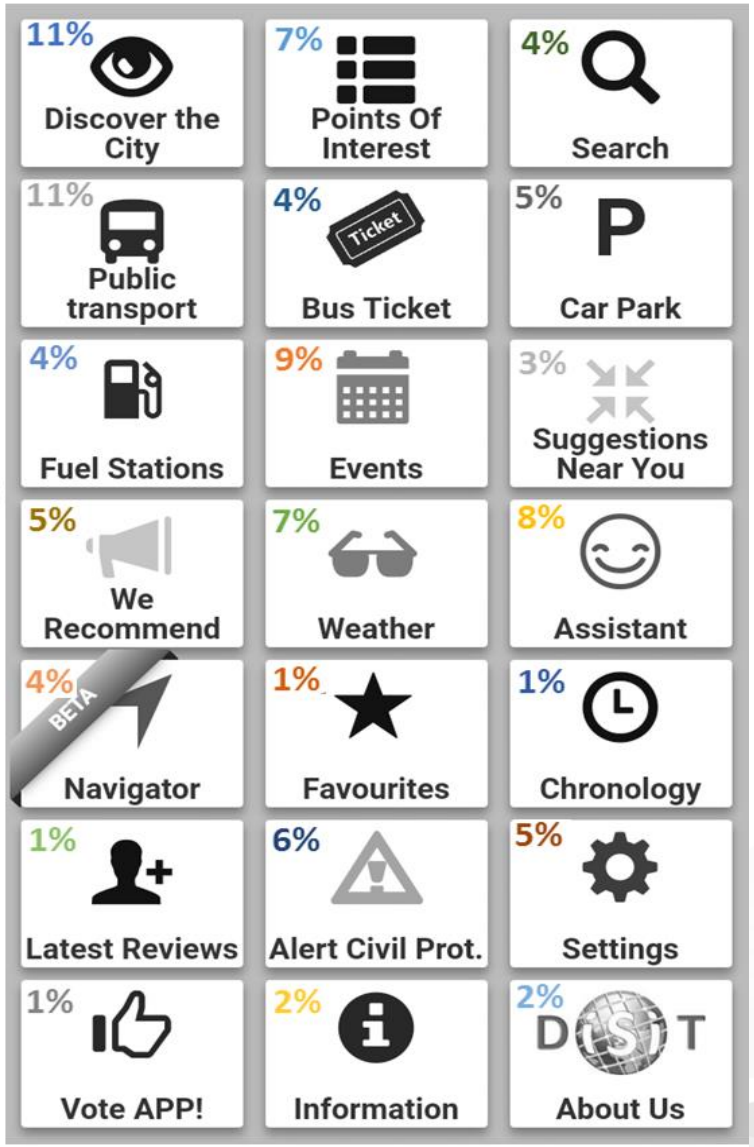
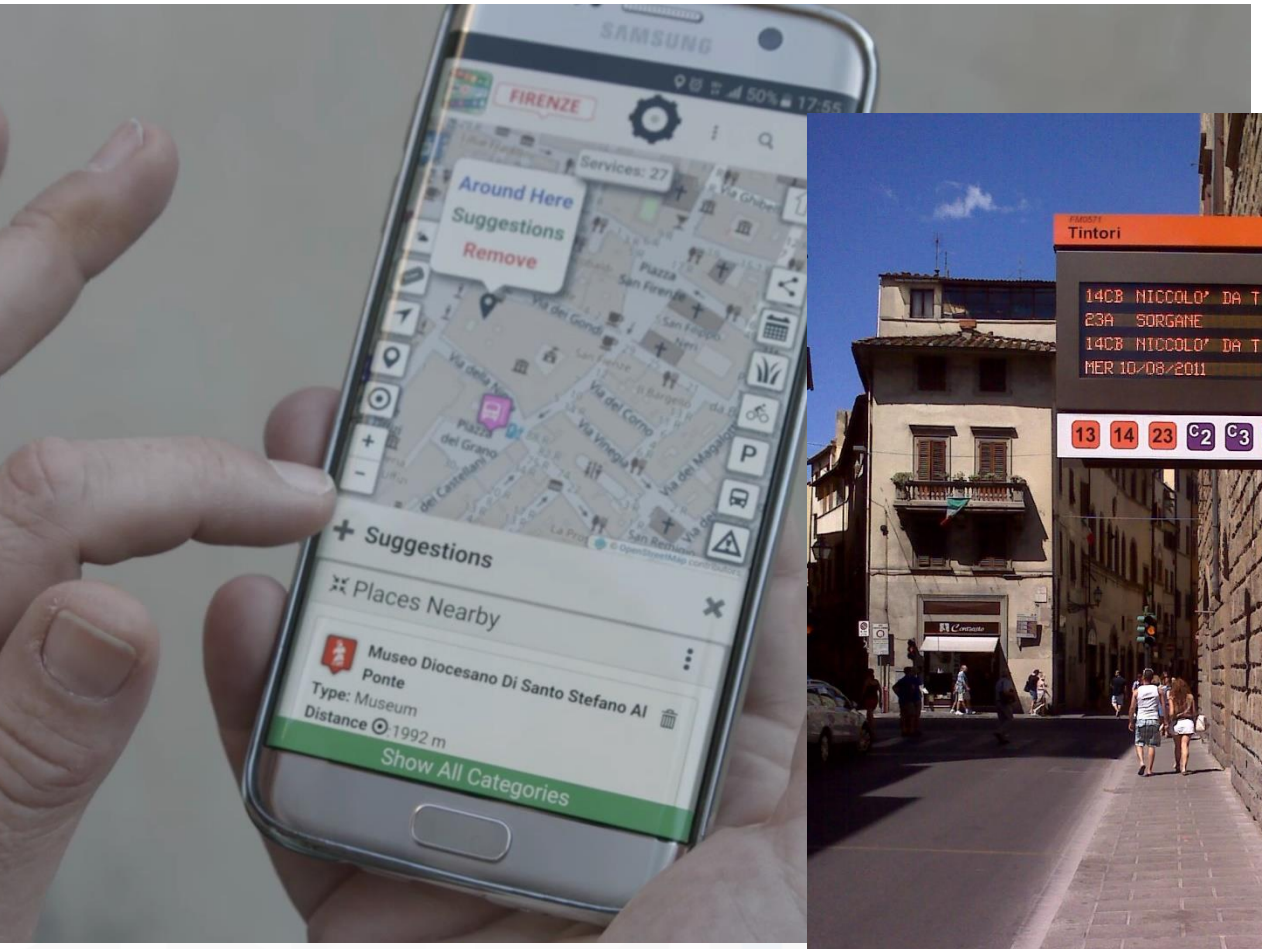
ANTWERP
TOSCANA
GET IT ON Google play
Download on the App Store
SNAP4CITY
KM 4 CITY
Accommodation
Cultural Activity
Education And Research
Emergency
Entertainment
Environment
Shortest
Quiet
Add Destination
Reset
Calculate
Events
Day
Week
Month
Services: 100 on 139 available
EAQI
Index
1. Good
2. Fair
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
Services: 89
Add POI
Points Of Interest
Le Pain Quotidien
243 m
Copyright
250 m
Modemuseum
270 m
Financial Service
Bar
Air Quality
PM 10
10.962
PM 2.5
4.648
NO2
15.941
Helsinki AQI
1.048

Users' preferences





Sii-Mobility





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



Campaing on Sustainable Mobility

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.
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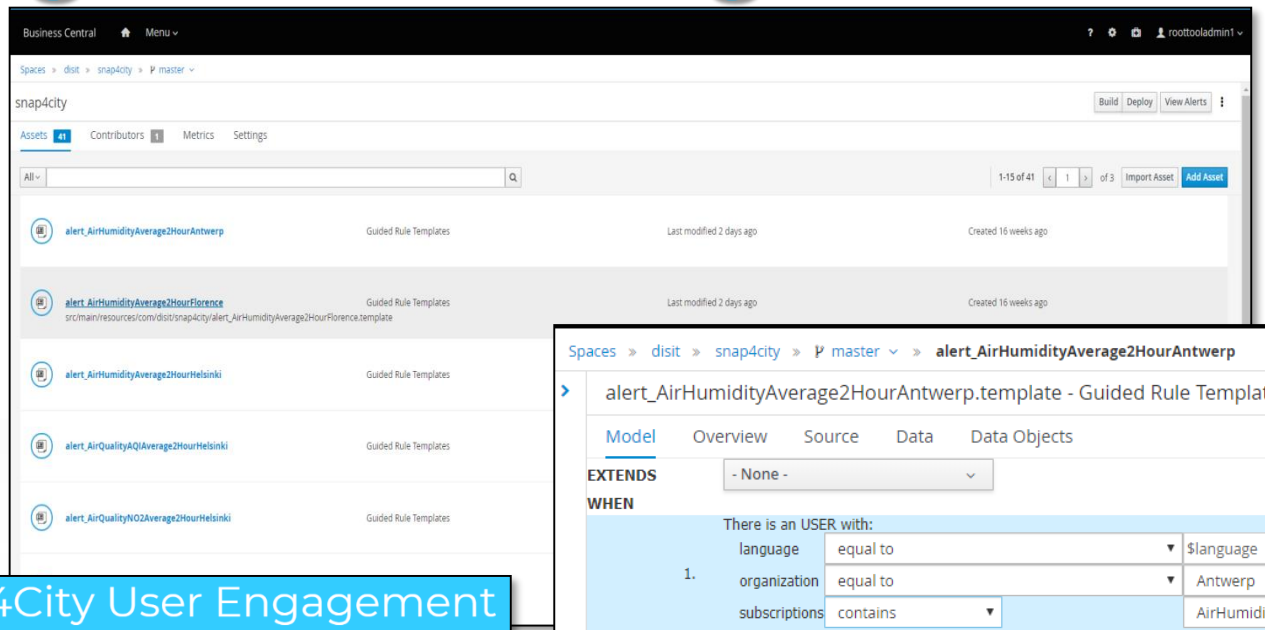
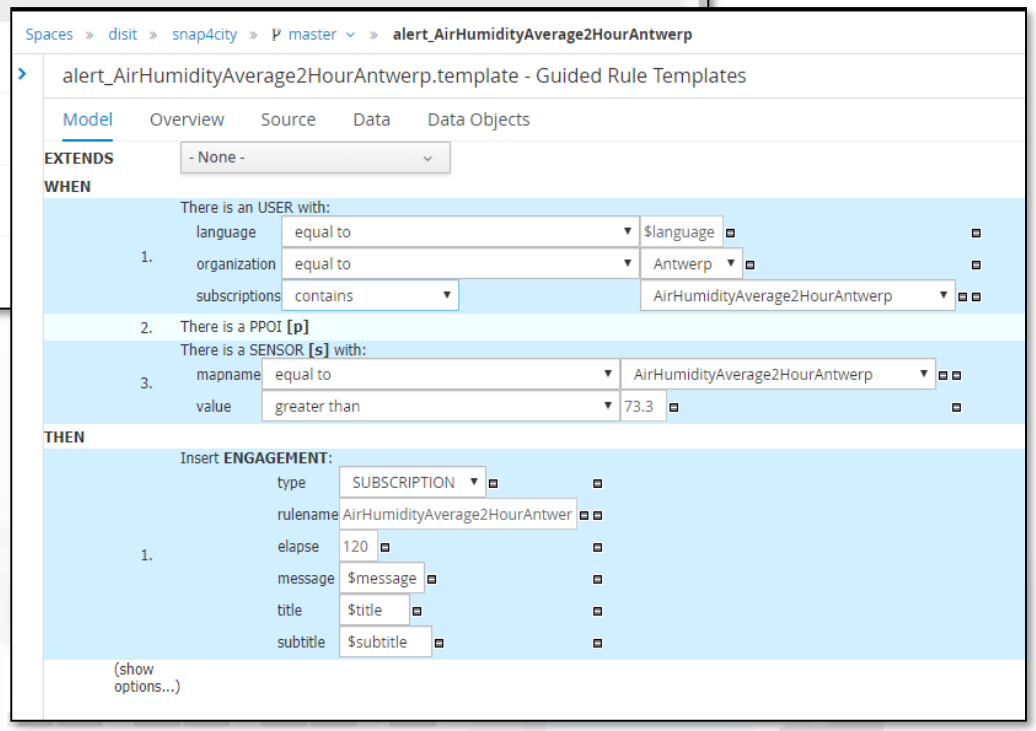
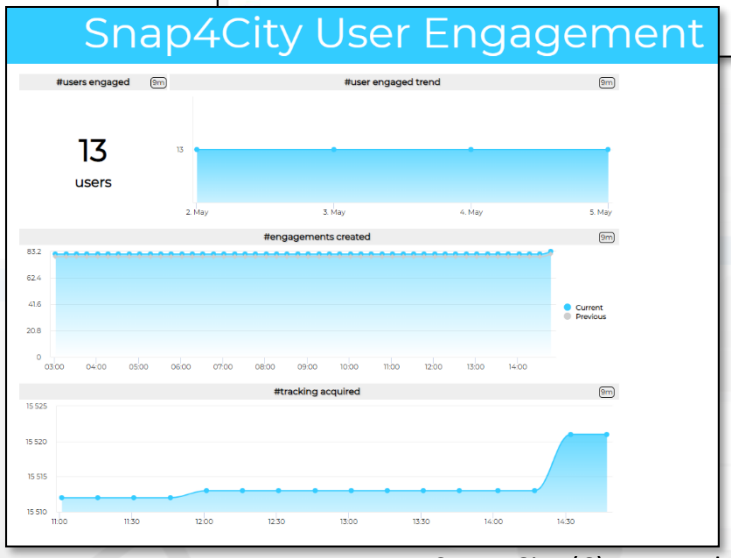
TOSCANA
ataf
BUSITALIA
GRUPPO FERROVIE DELLO STATO ITALIANE
MIUR
UNIVERSITÀ DEGLI STUDI FIRENZE
DINFO
DISIT

Engagement Manager

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

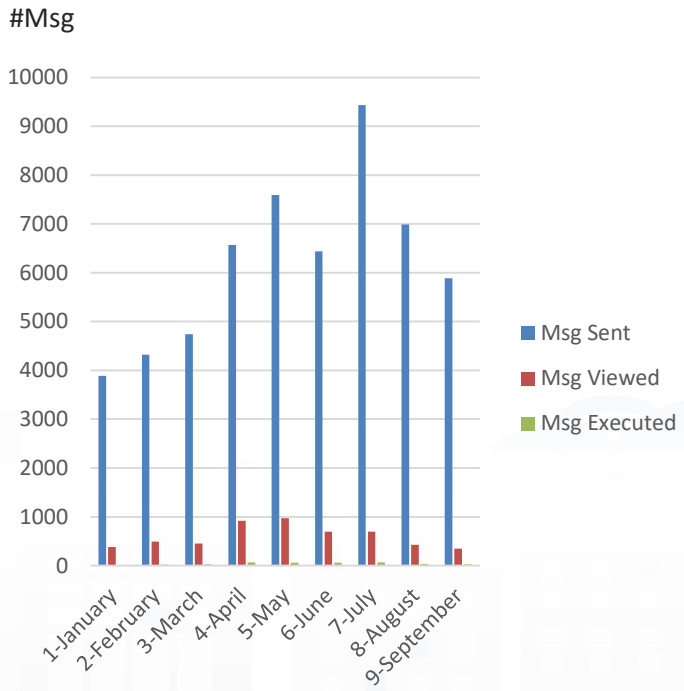


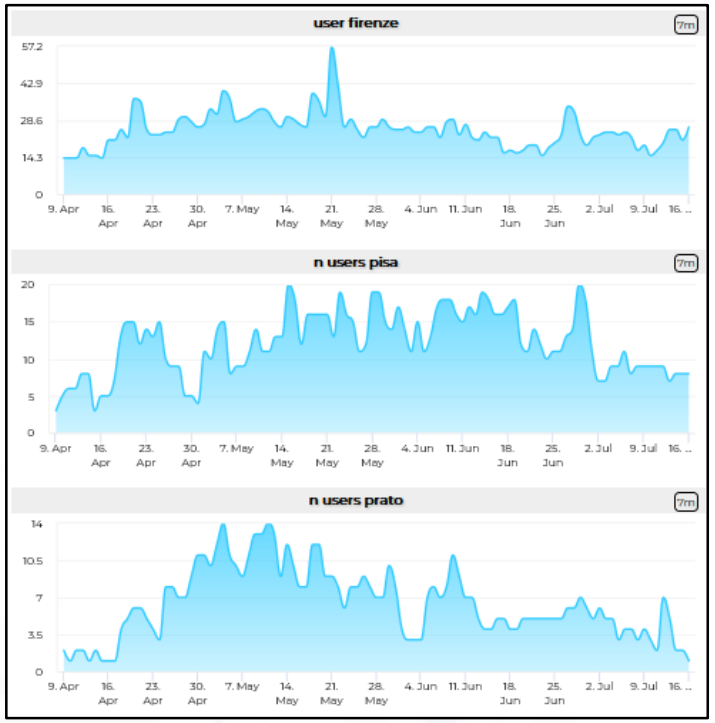


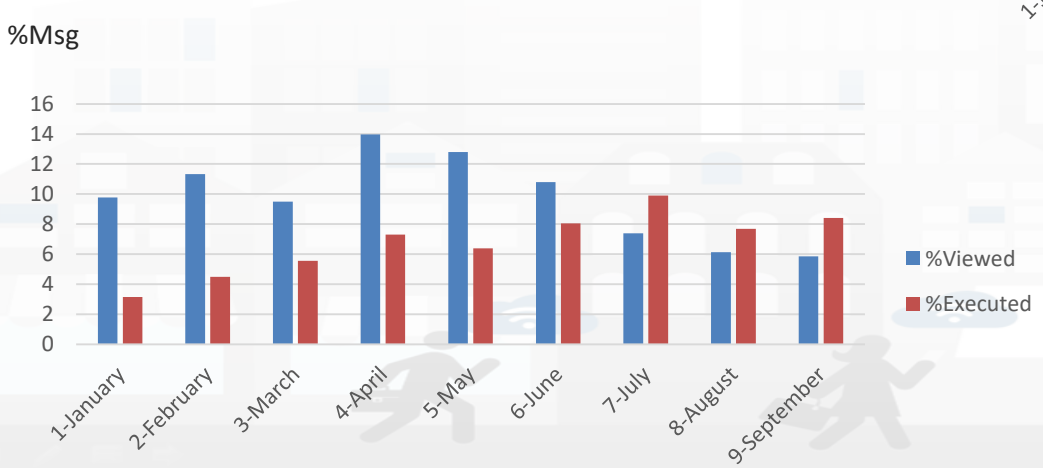


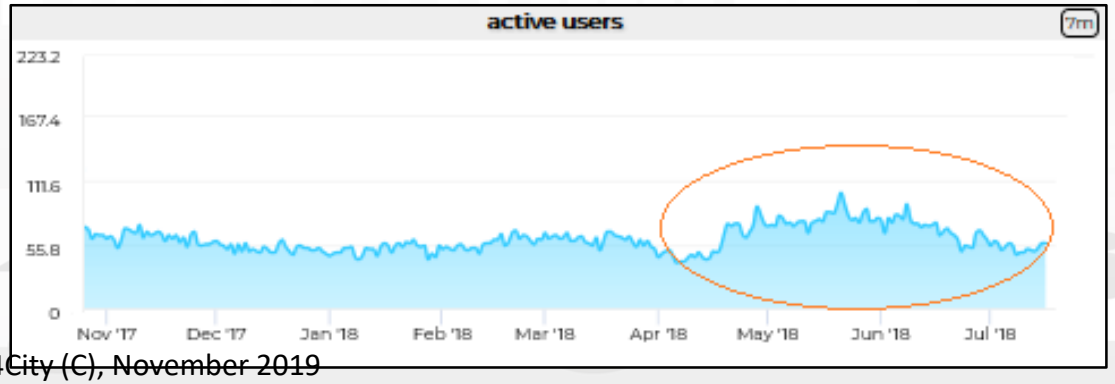
Validation of user Engagement

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





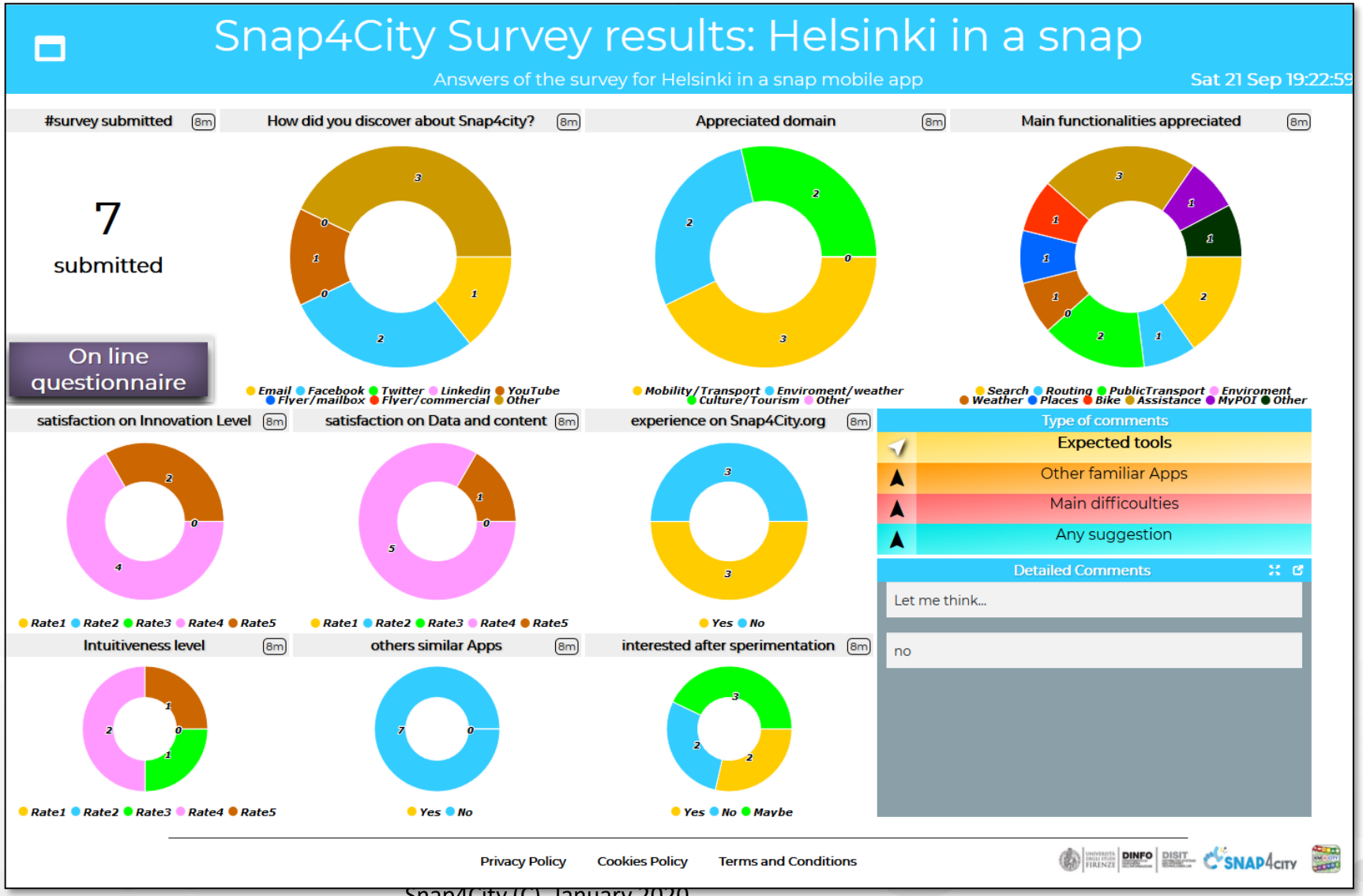




Helsinki

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

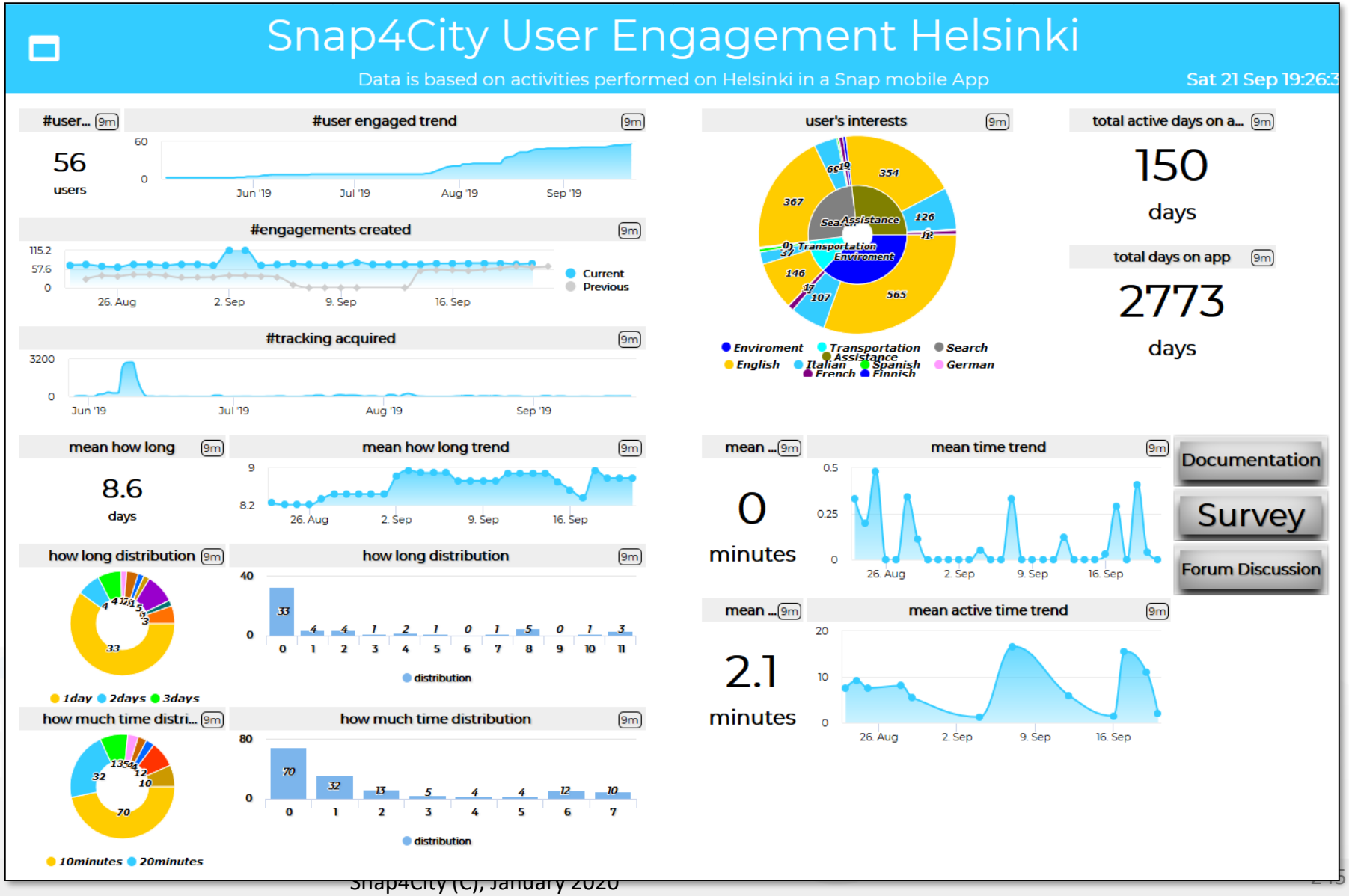


Helsinki

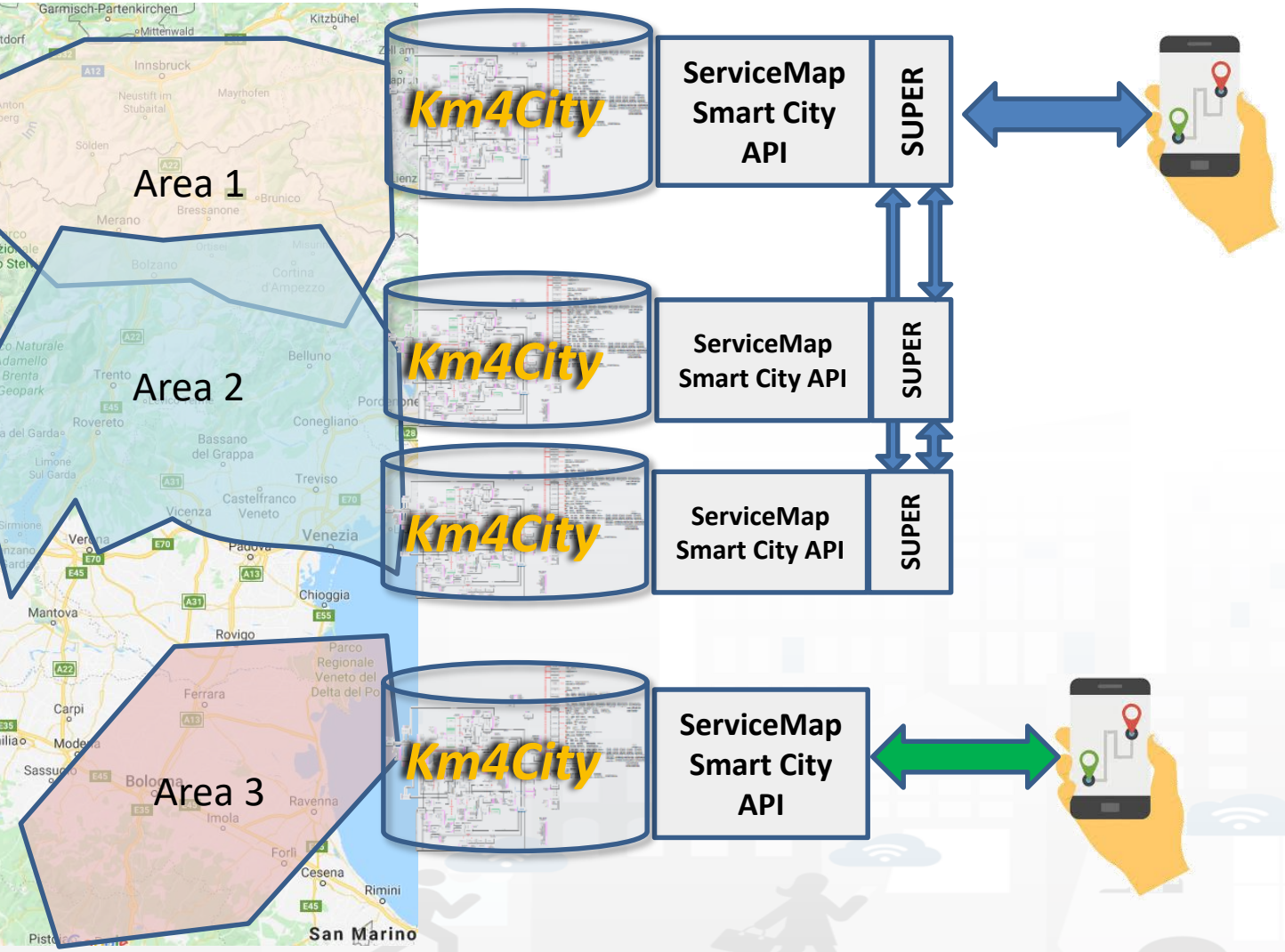
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTc1OA==

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.

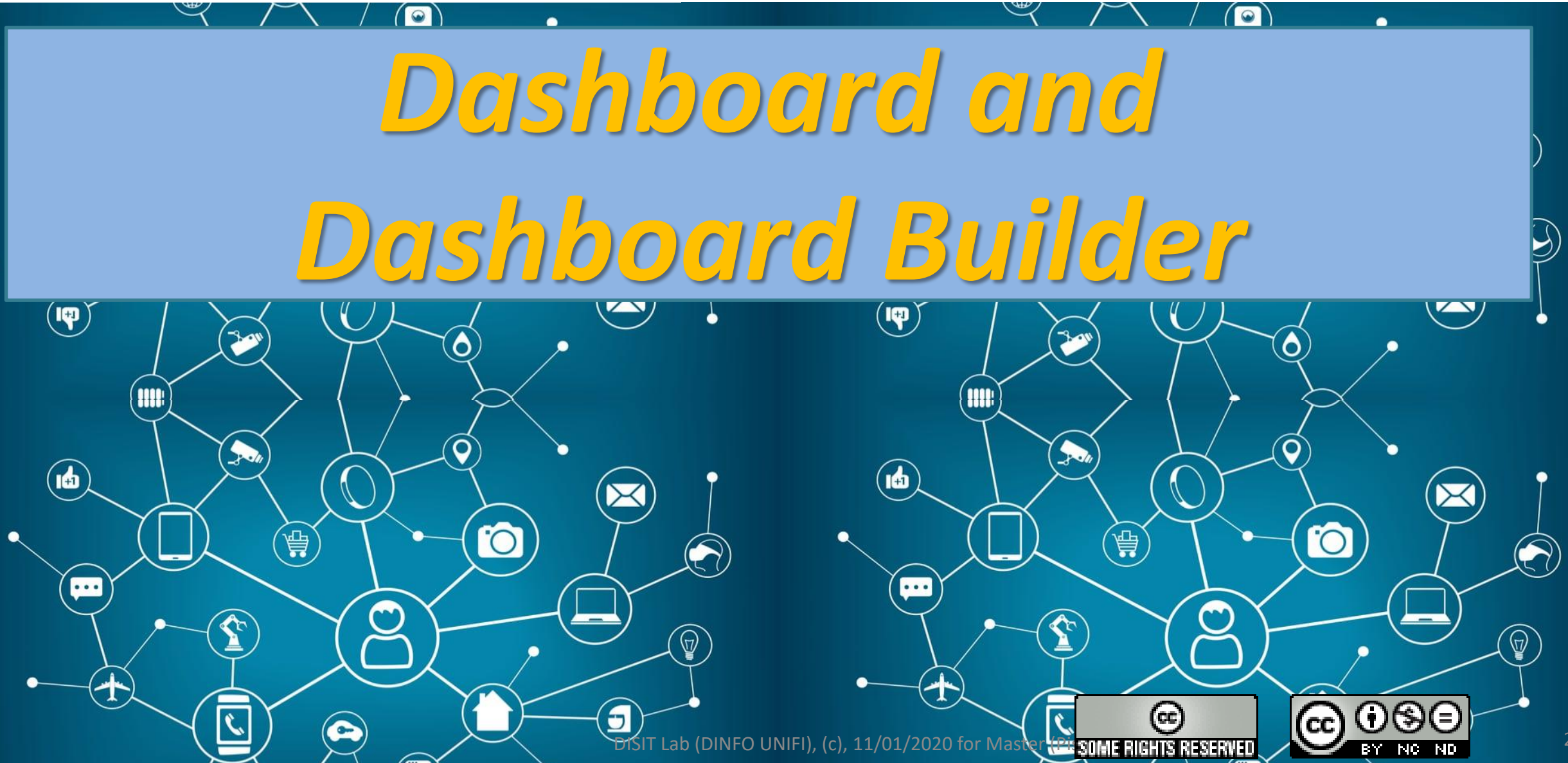


Multiple Knowledge Bases Km4City/ServiceMap



- 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 ServiceMap 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 (ServiceMap) is not mandatory so that separate services can be produced as well
- SuperServiceMap and ServiceMap presents the same Smart City APIs.

Dashboard and Dashboard Builder



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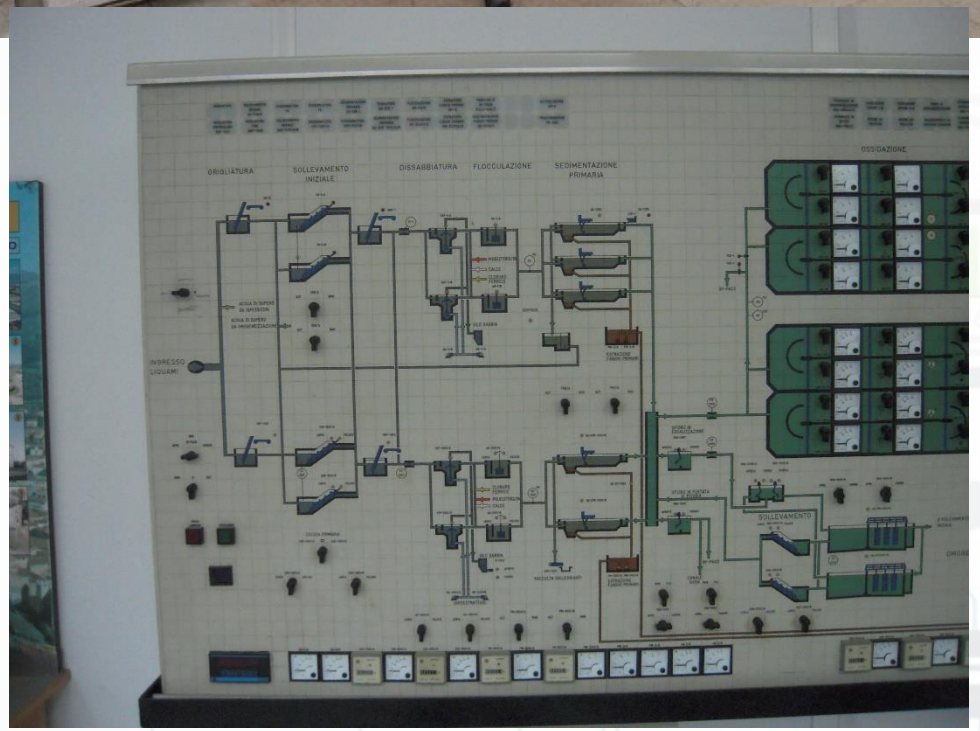
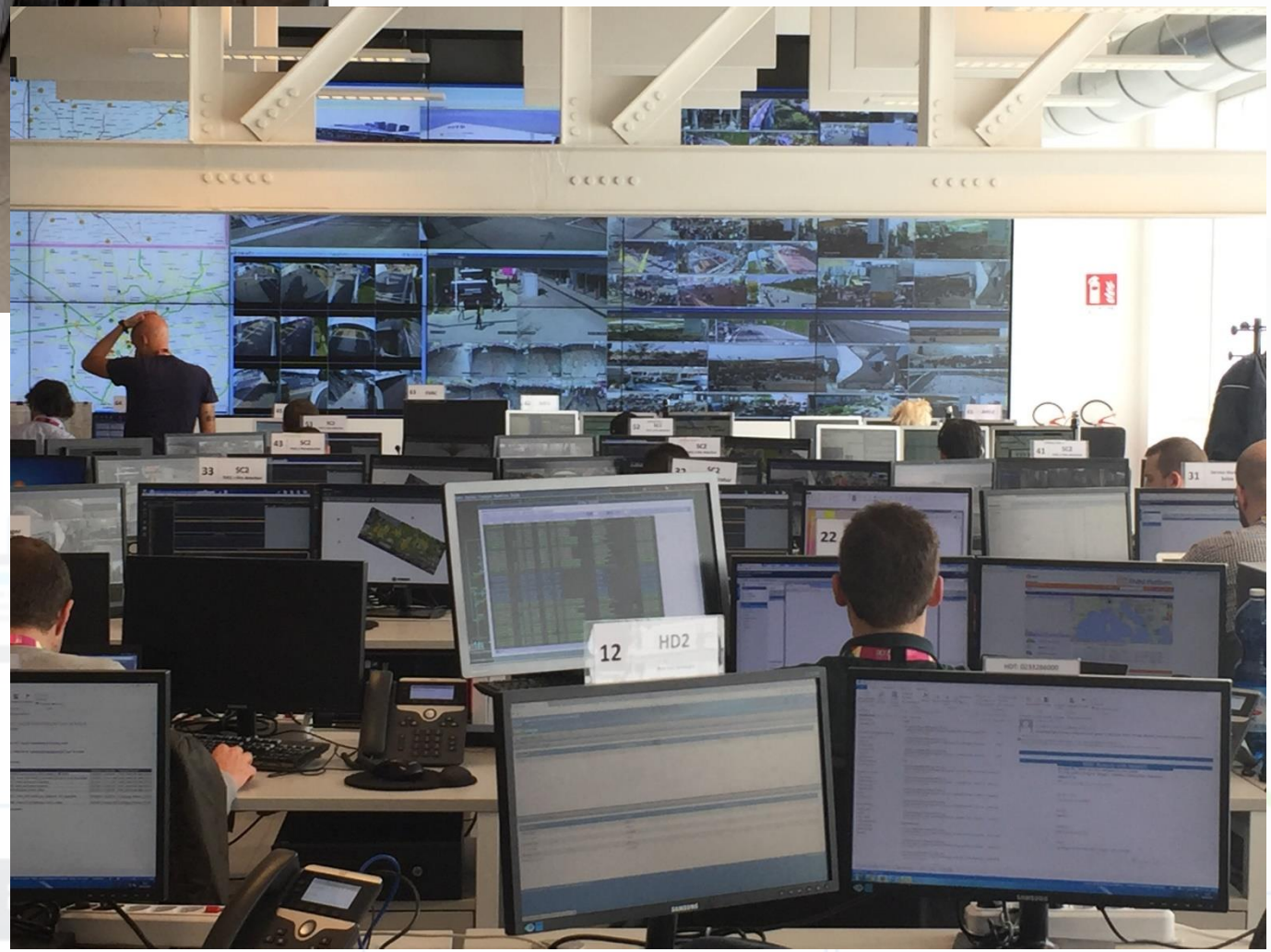
Agenda

- 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 & 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
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
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	BINARIO16	FORTEZZA
28.7 % occupati su 607 posti	55.2 % occupati su 165 posti	27.8 % occupati su 521 posti
LEOPOLDA	**CALZA**	**S.AMBROGIO**
36 % occupati su 300 posti	70.3 % occupati su 148	99.7 % occupati su 379 posti
PARTERRE	**CAREGGI**	**BECCARIA**
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
26 393.2 / 19 794.9 / 13 196.6 / 6598.3 / 0
Current / Previous
12:00

TOTALE
284094
VEICOLI

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

TOTALE ZTL
57499
VEICOLI

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

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

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

Attesa media alla fermata

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

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

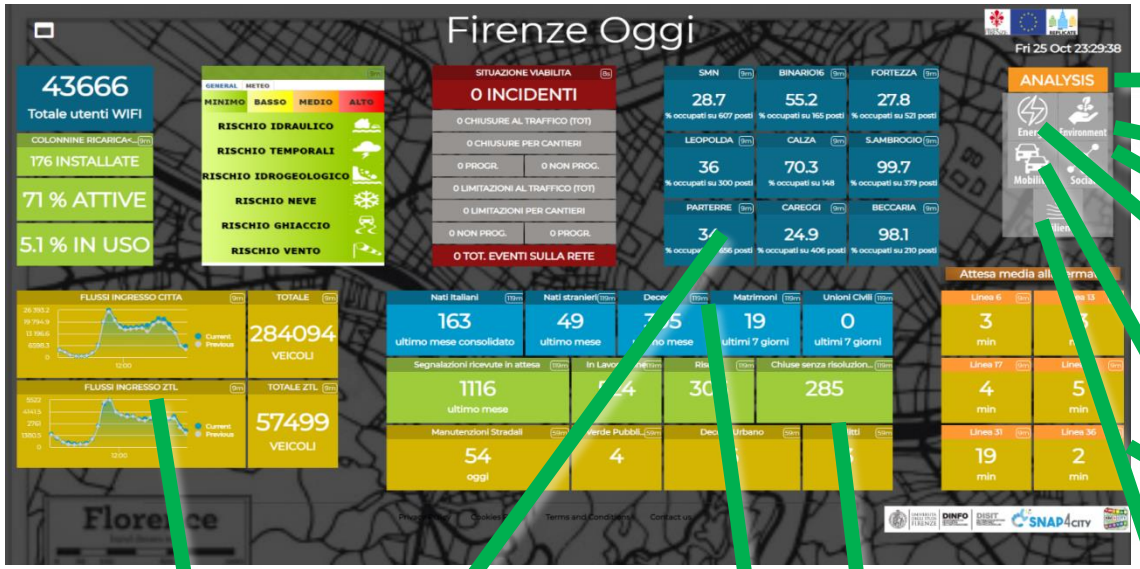
Smart City Control Room

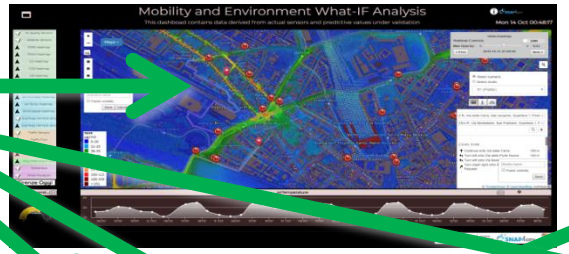
a set of dashboards and tools

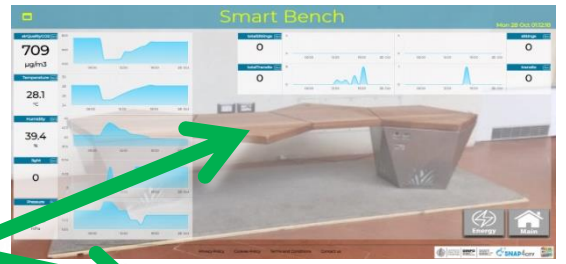
This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement Nº 691735

REPLICATE

FIRENZE CITTÀ FARO



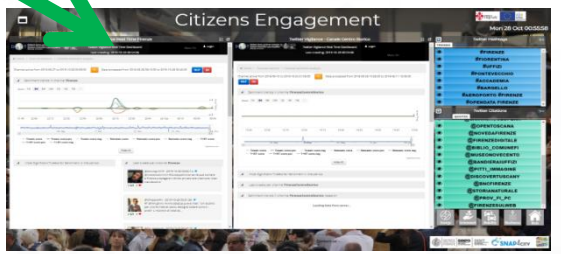


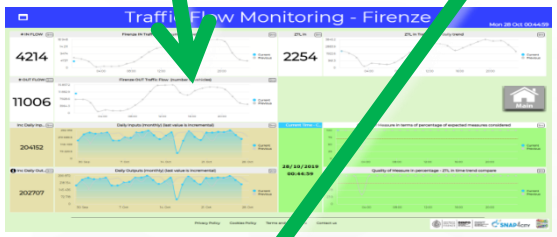




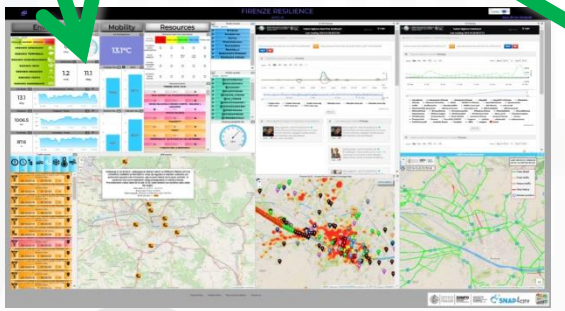


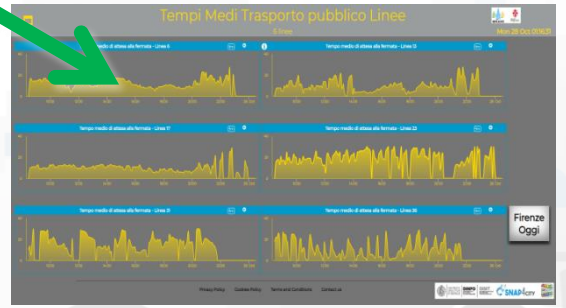
















Storage vs processing



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

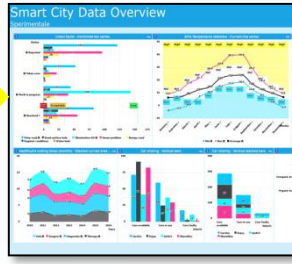
Data Analytics
R, Tensor Flow, Python, MapReduce, …

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,



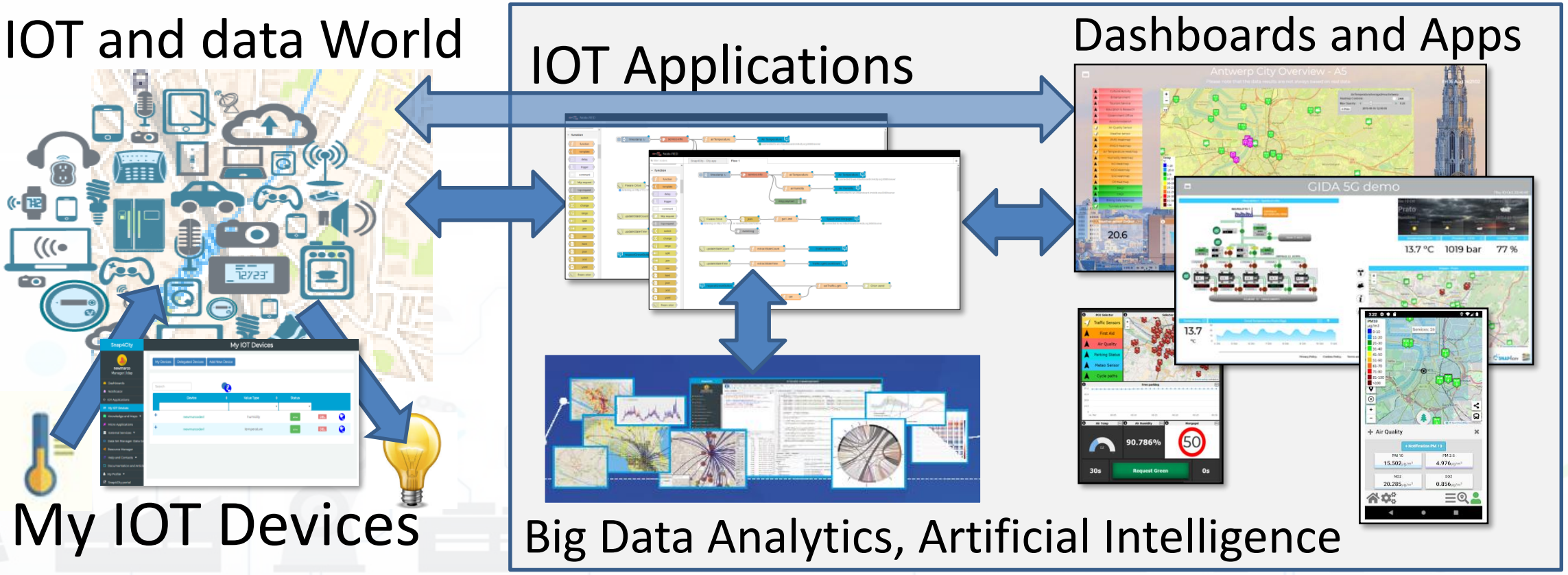




Inform, announce, Act!, warning, alarms, What-IF, ..

Sentient Solutions

Dashboards with data driven IOT Applications enforcing intelligence



Different kind of Dashboards for Different User Kind



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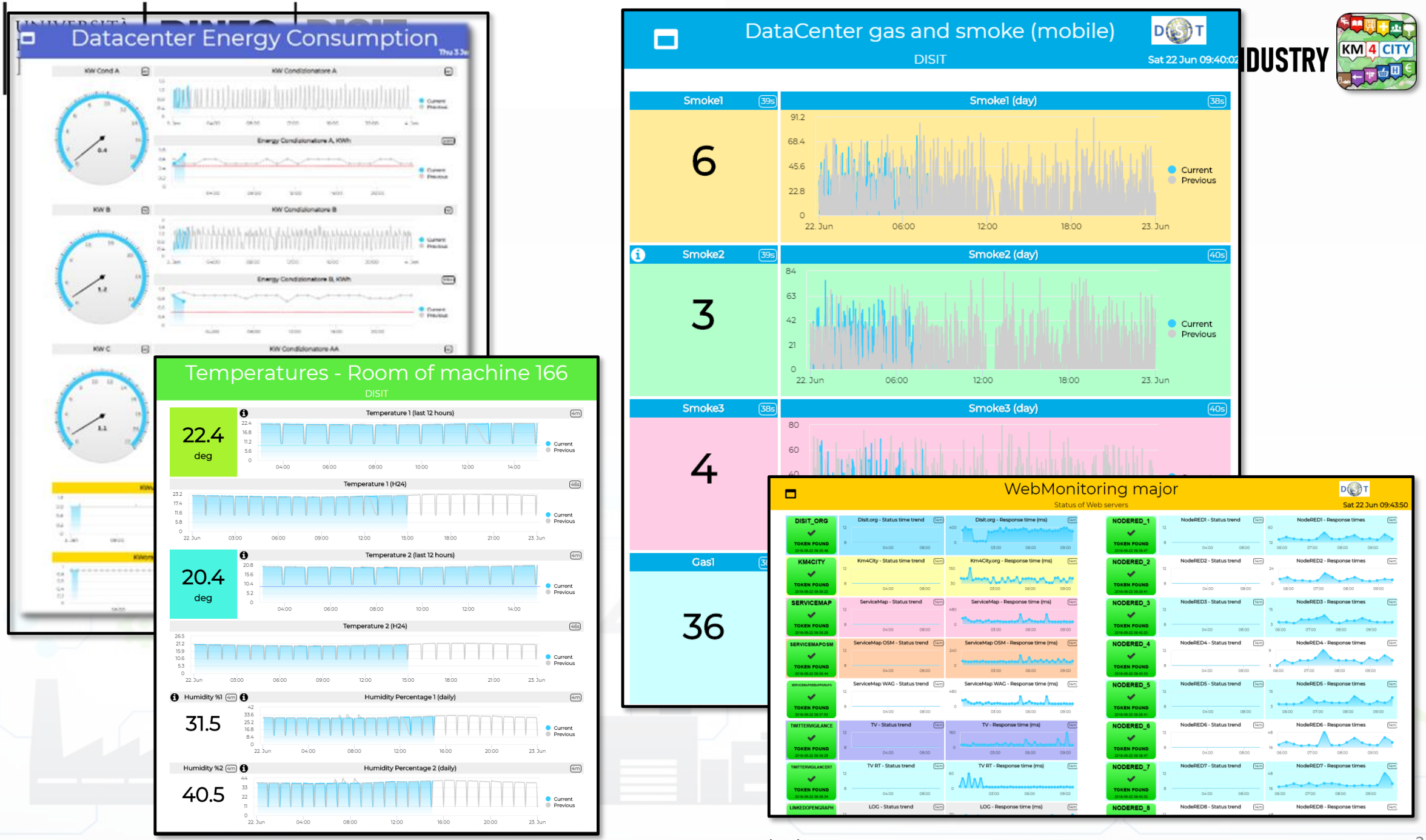
Datacenter Energy Consumption
DataCenter gas and smoke (mobile)
DISIT
Sat 22 Jun 09:40:02
Smoke1
6
Smoke1 (day)
Smoke2
3
Smoke2 (day)
Smoke3
4
Smoke3 (day)
Gas1
36
Temperatures - Room of machine 166
DISIT
22.4
deg
Temperature 1 (last 12 hours)
Temperature 1 (H24)
20.4
deg
Temperature 2 (last 12 hours)
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
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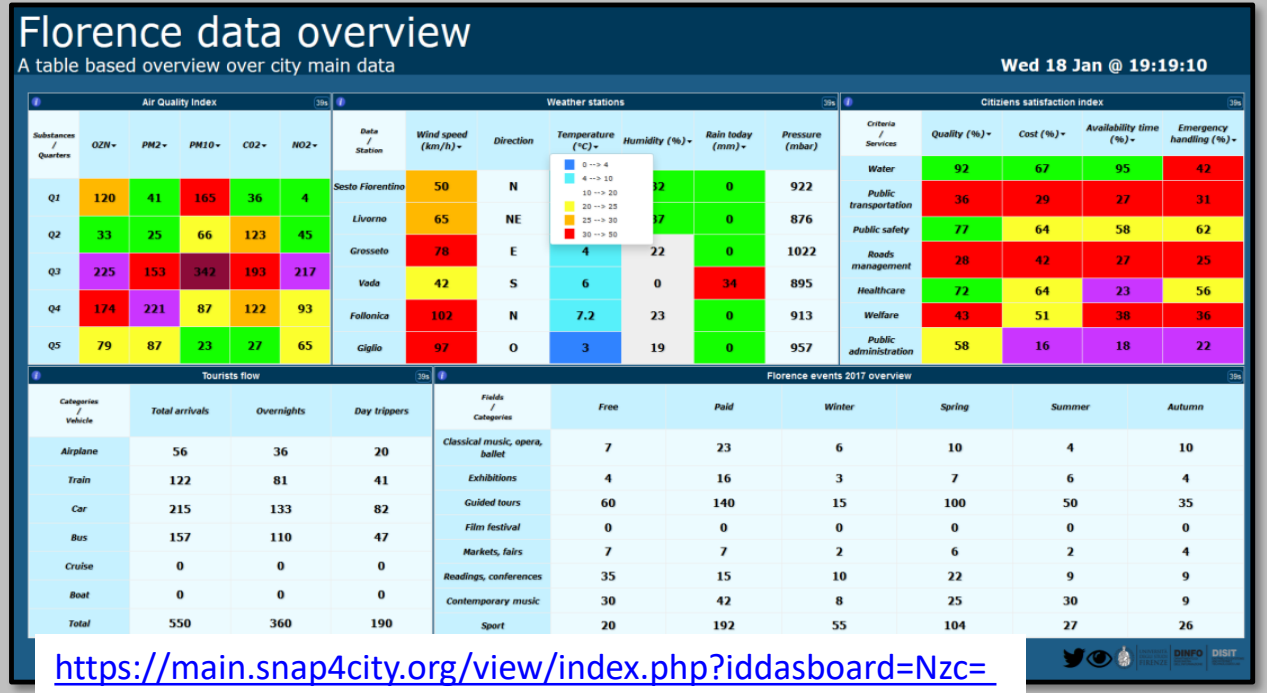
NODERED_7
NODERED_8



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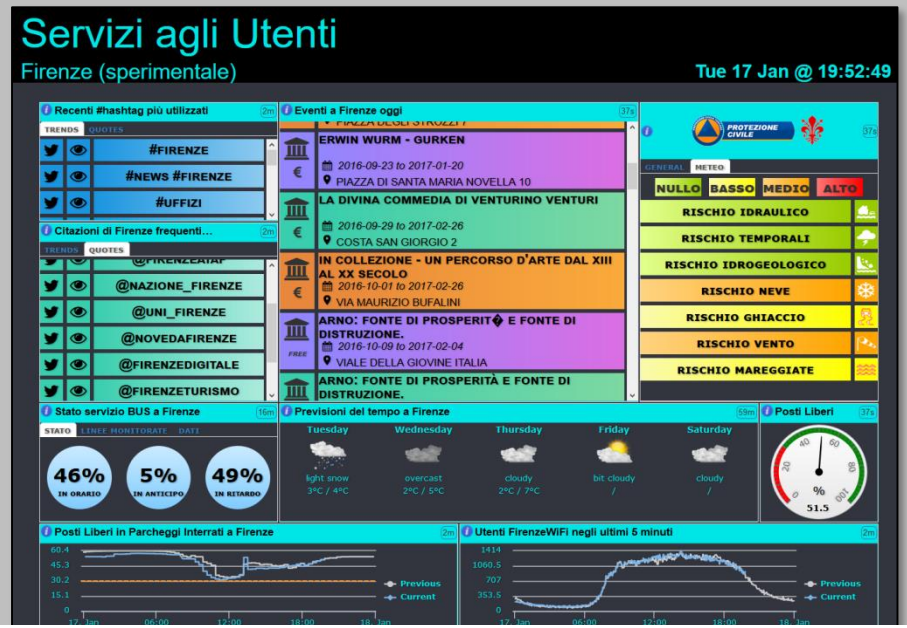

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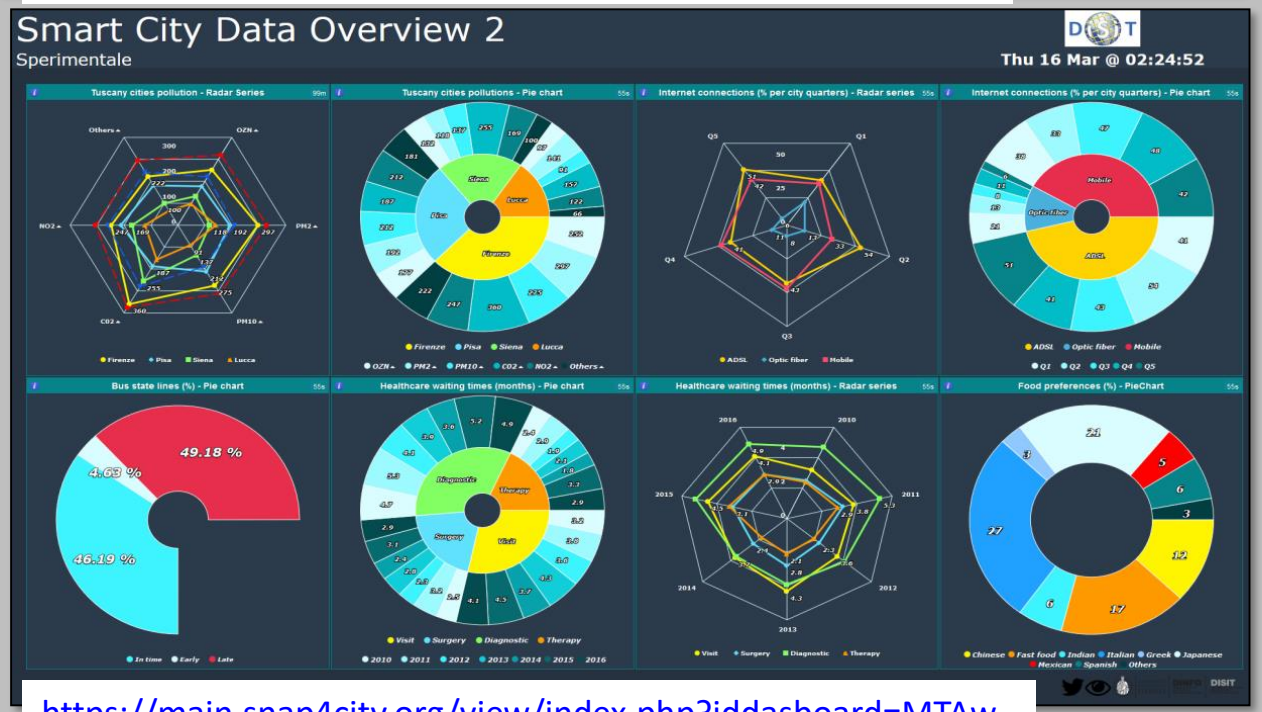

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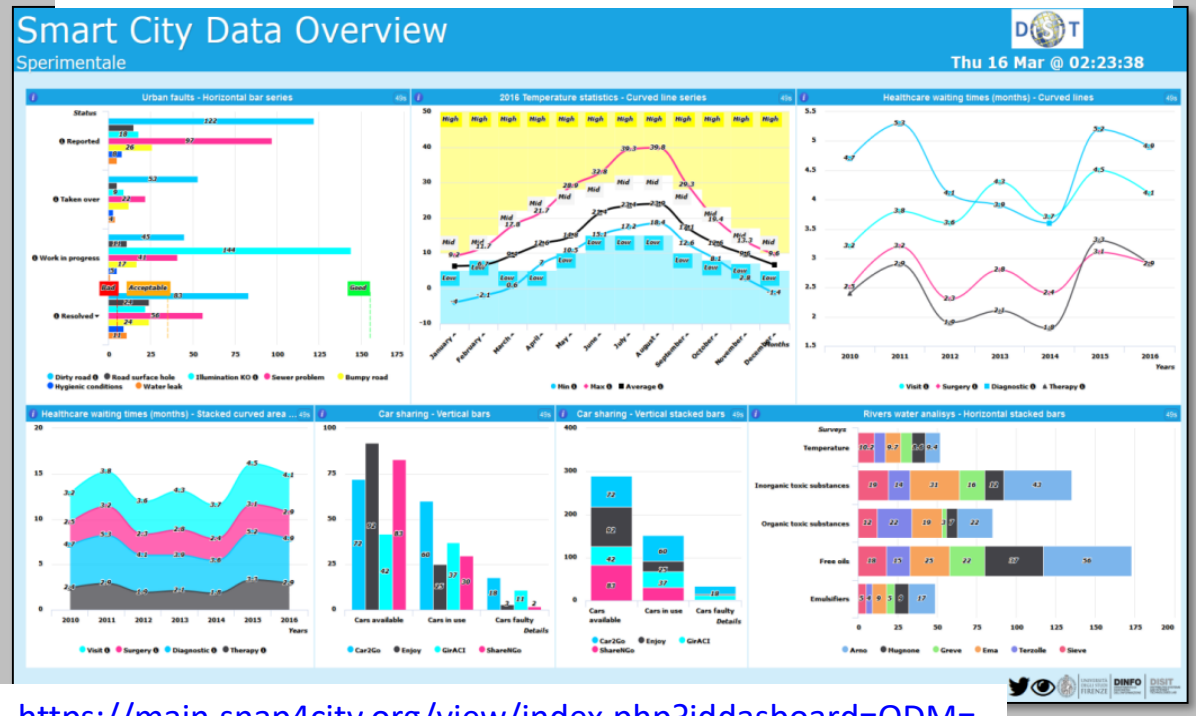

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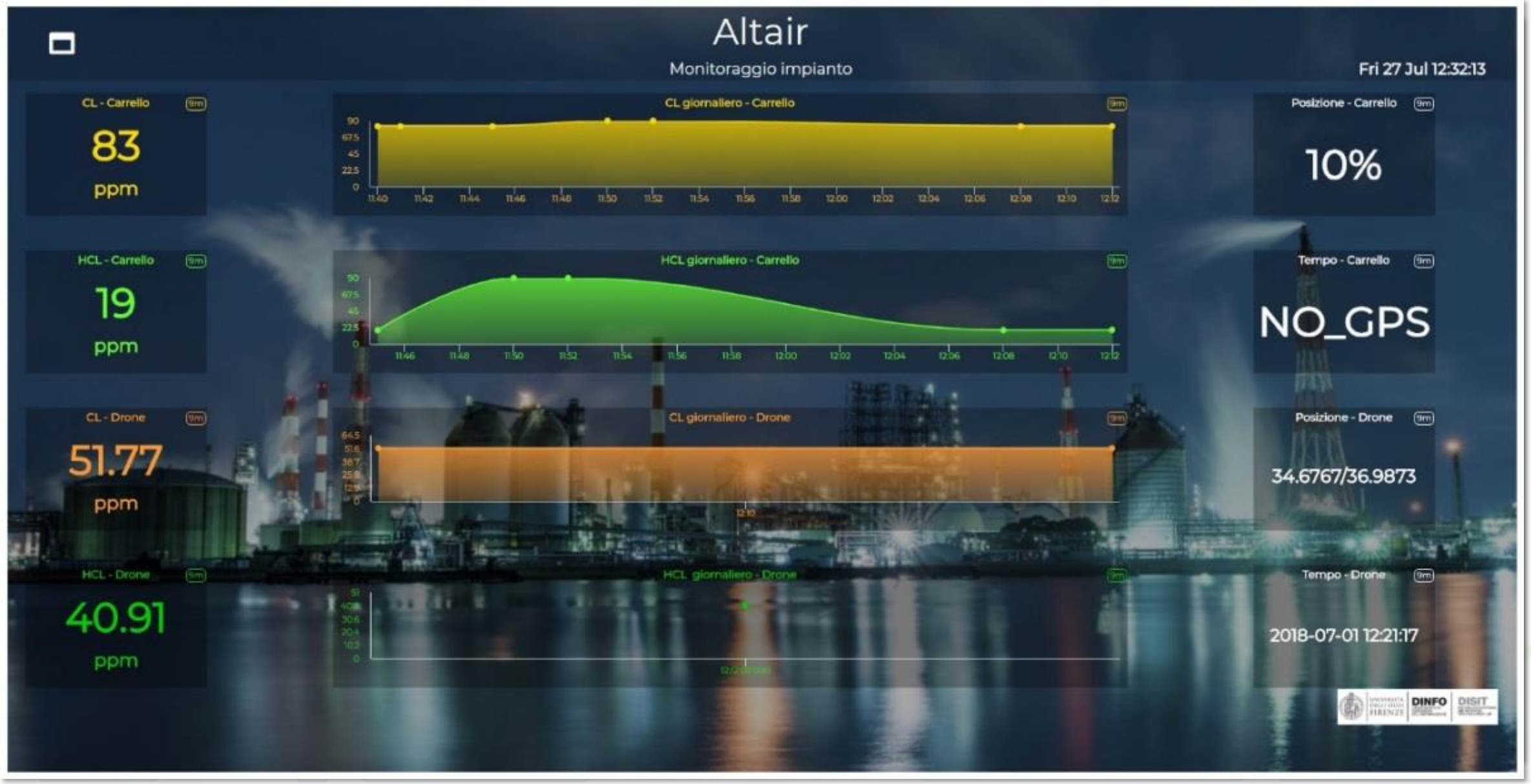
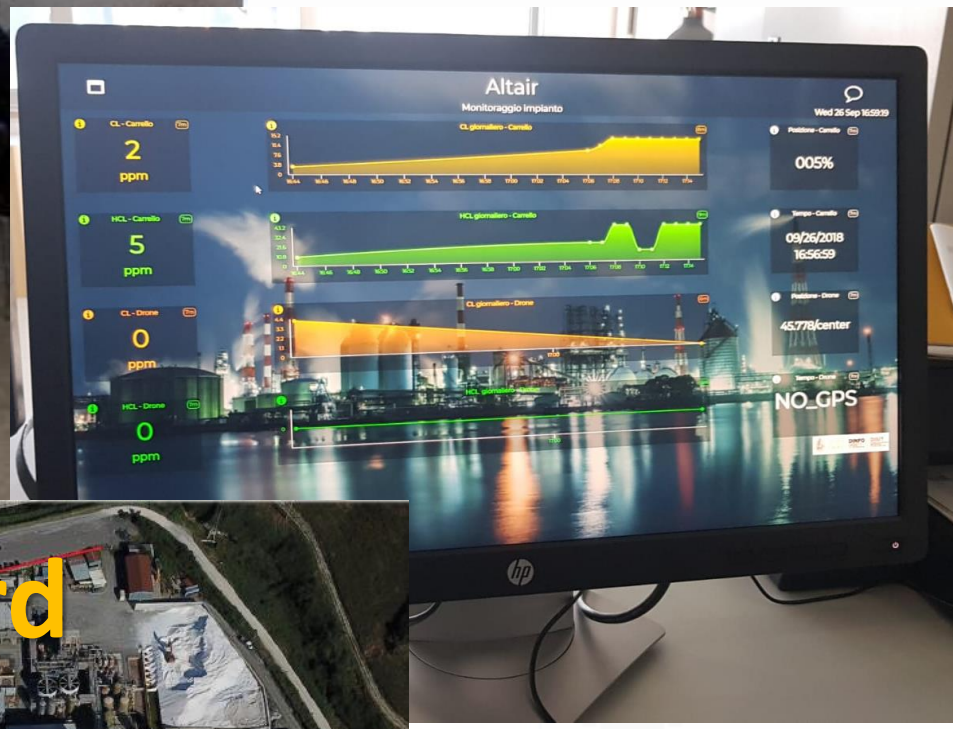

Altair
Monitoraggio impianto
Fri 27 Jul 12:32:13
CL - Carrello
83
ppm
CL giornaliero - Carrello
Posizione - Carrello
10%
HCL - Carrello
19
ppm
HCL giornaliero - Carrello
Tempo - Carrello
NO_GPS
CL - Drone
51.77
ppm
CL giornaliero - Drone
Posizione - Drone
34.6767/36.9873
HCL - Drone
40.91
ppm
HCL giornaliero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

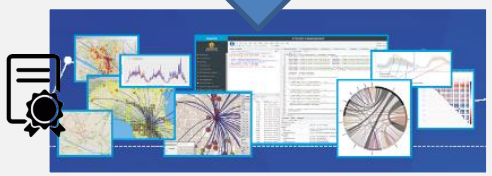


Dashboards and Apps



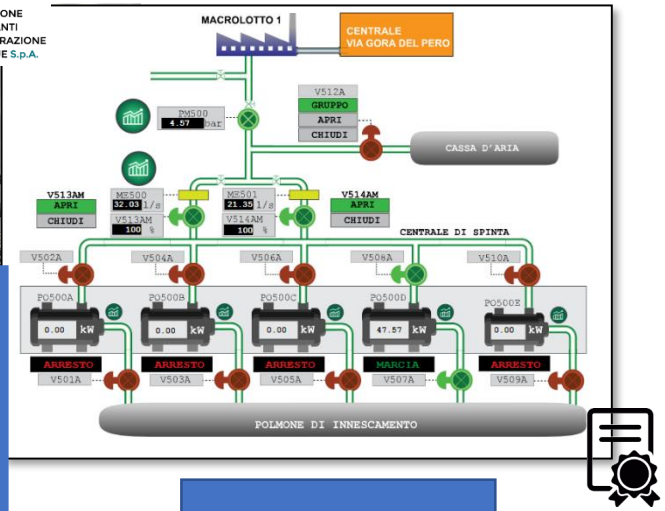






Big Data Analytics, Artificial Intelligence





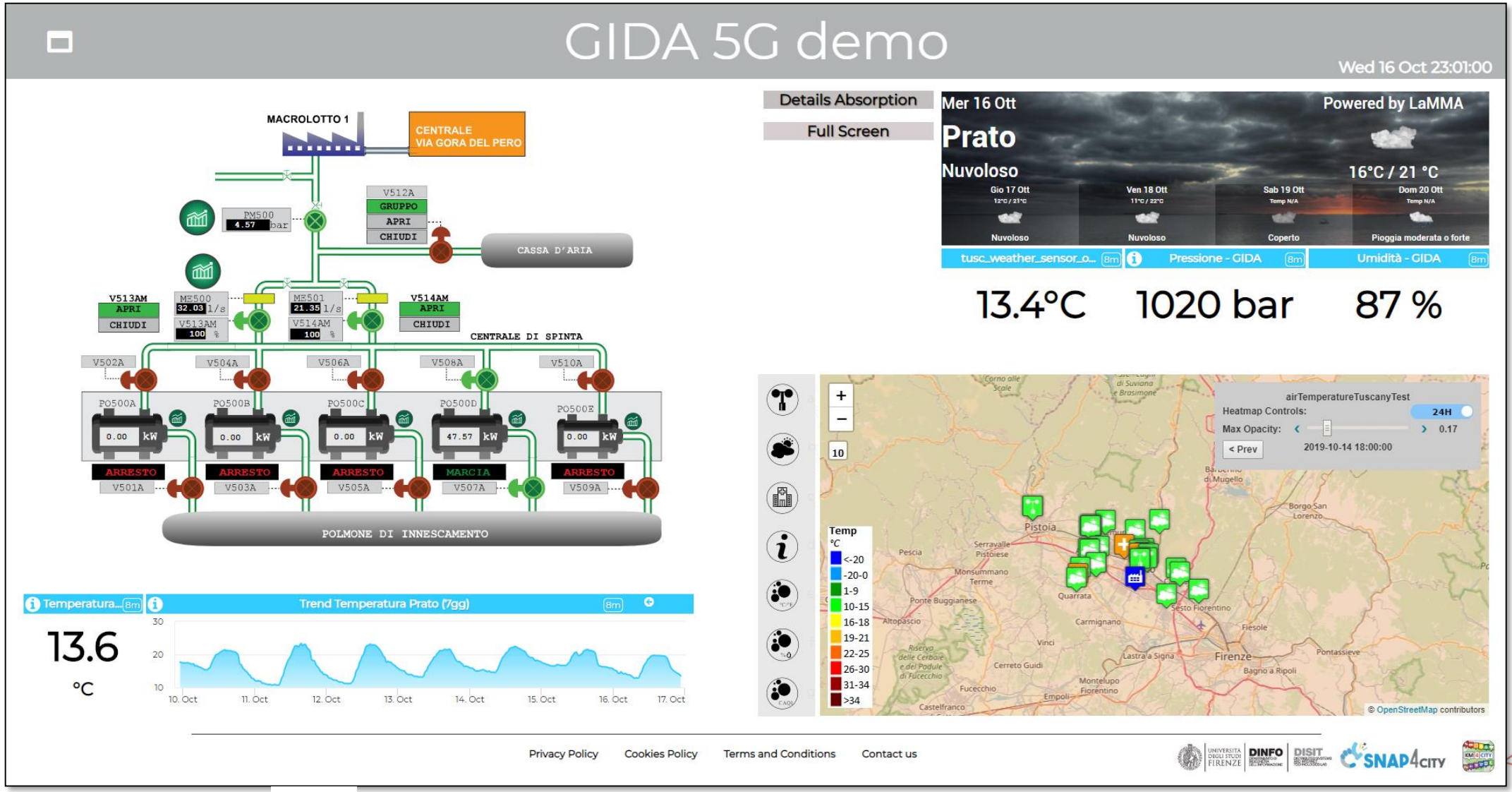
IOT Data Shadow Snap4City

ModBus to Snap4City Gateway Edge

5G network devices

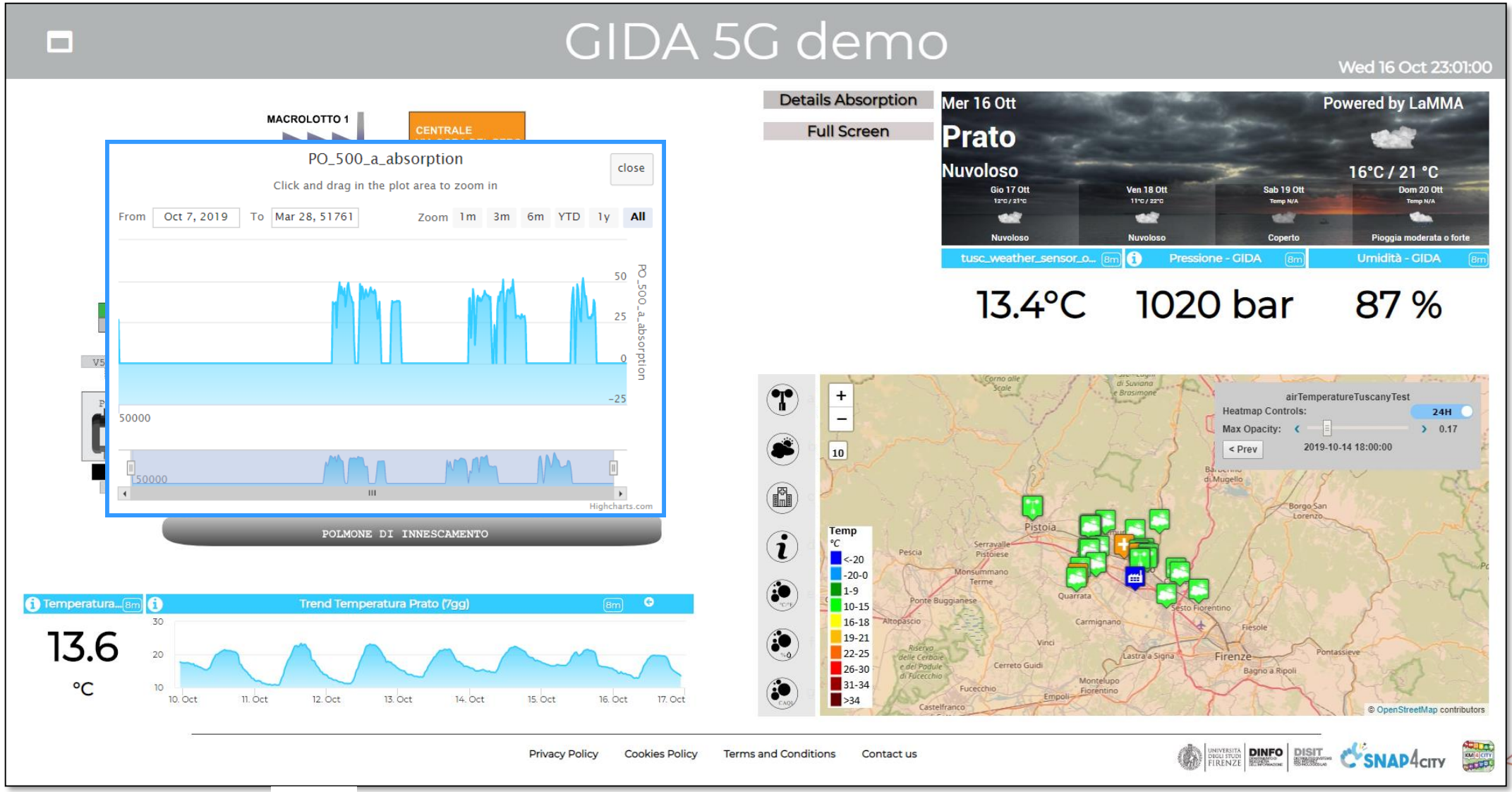
Telemonitoring Telecontrol

Dashboards & Services:



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

Demo UC5 GIDA



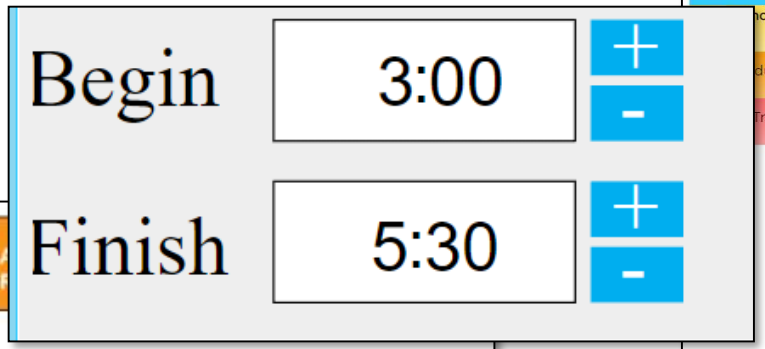
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjIyNg==

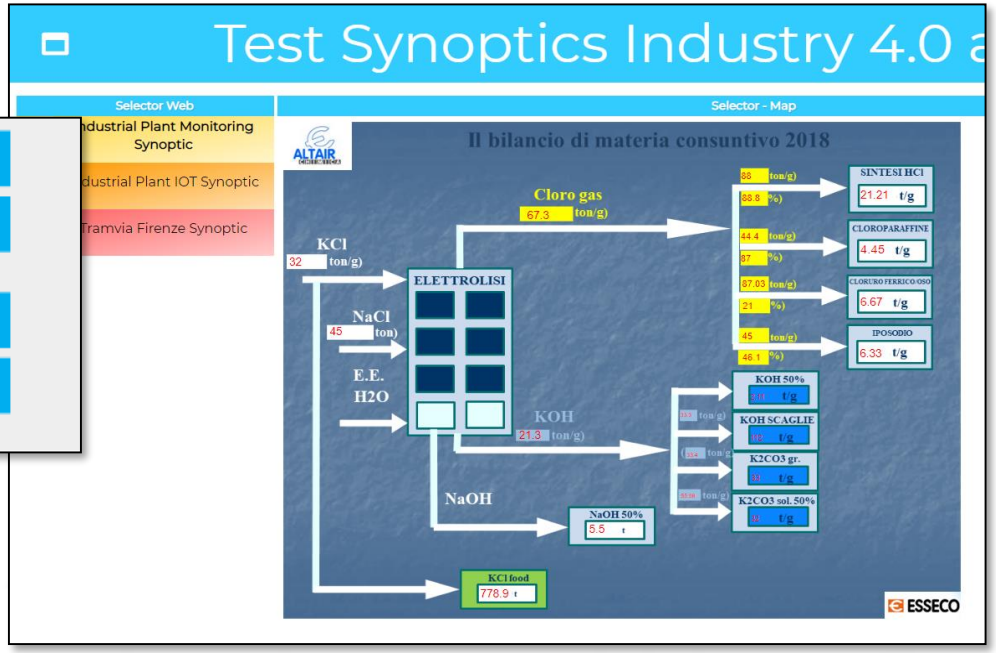
Custom Widgets

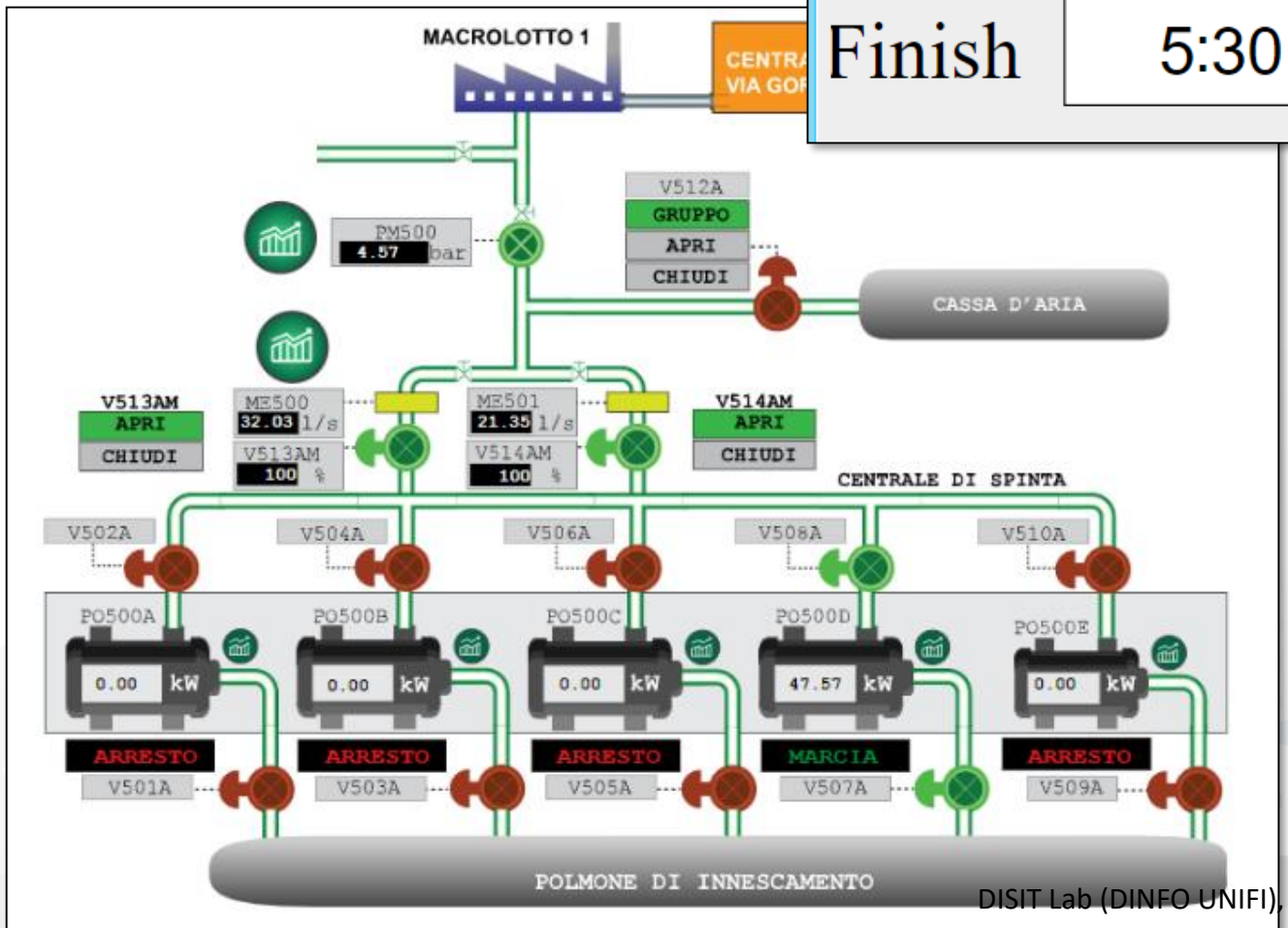
Custom Dashboards and Widgets (interactive, Animations, etc.)

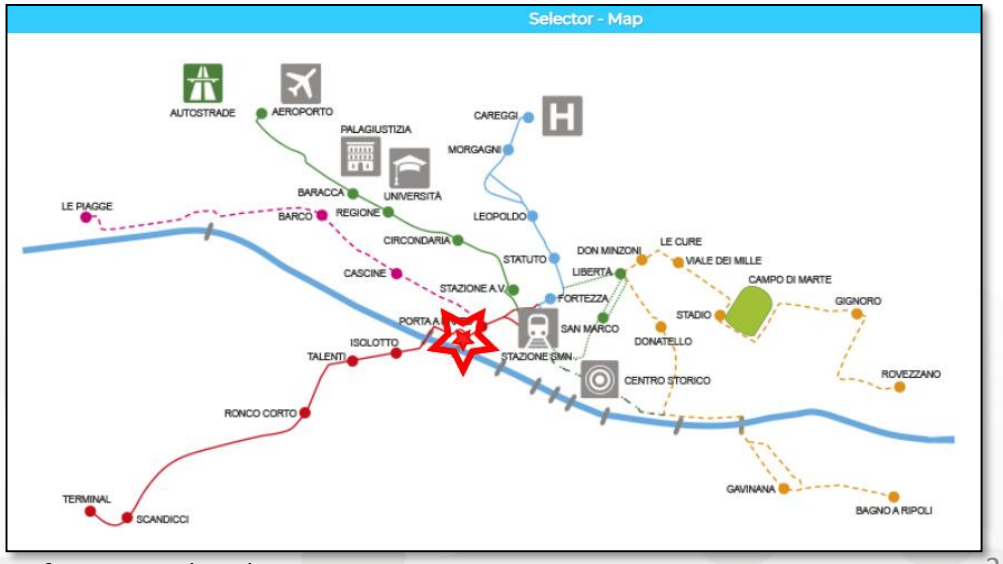
-- SVG for graphic design

-- MyKPI for collecting data





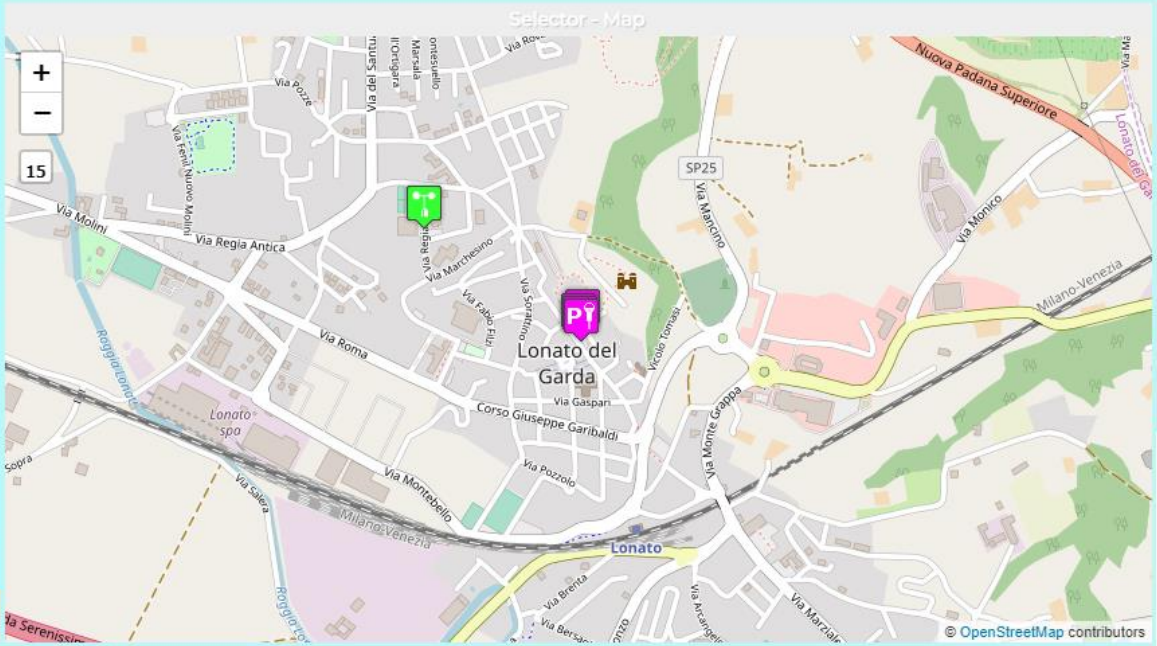


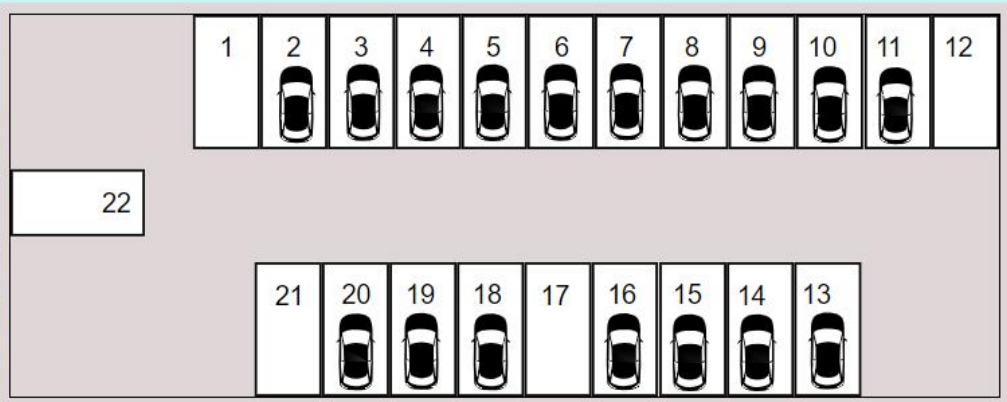


Smart Lonato del Garda - cam

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



Developing Dashboards



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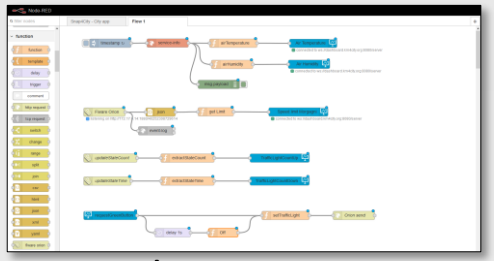
Dashboard Development



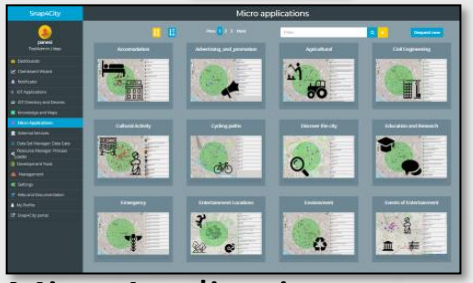
IOT Applications



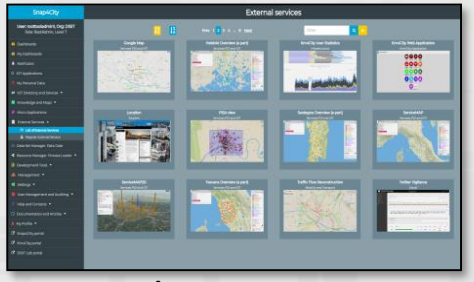
Knowledge and Storage Data from the Field and City

Widget Collection



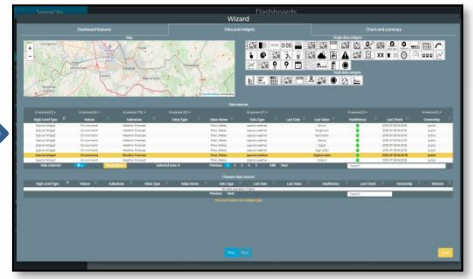


MicroApplications



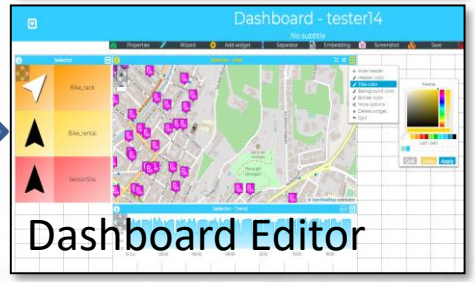
External Services

Dashboard Wizard



Create, save, load, delegate, grant access

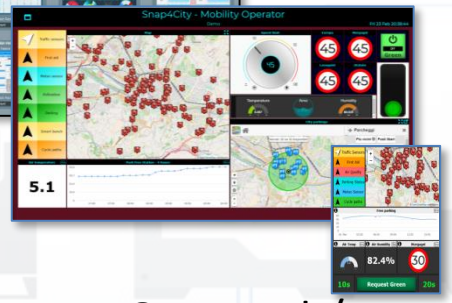




Dashboard Editor



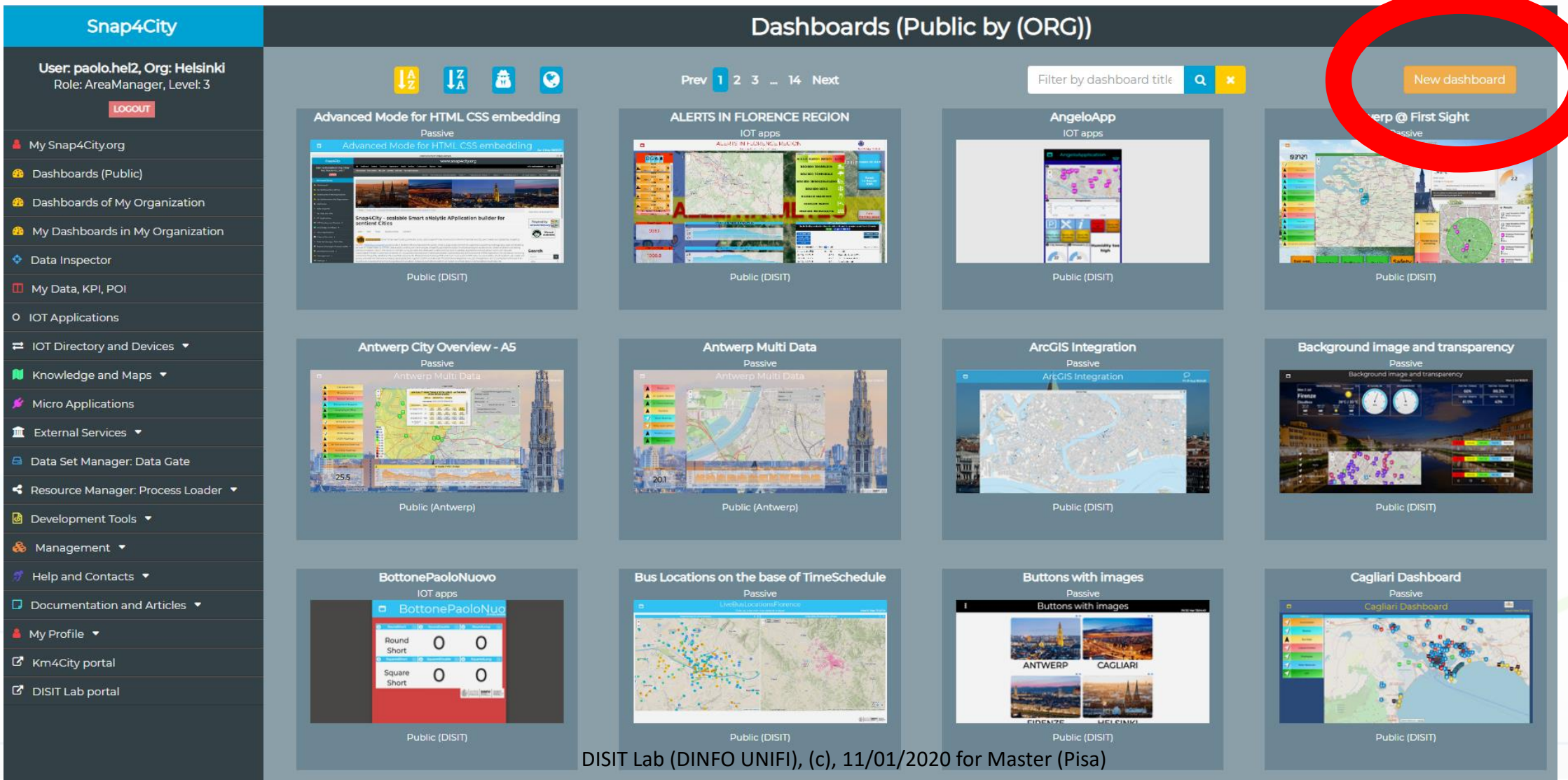
Public Dashboard Collection



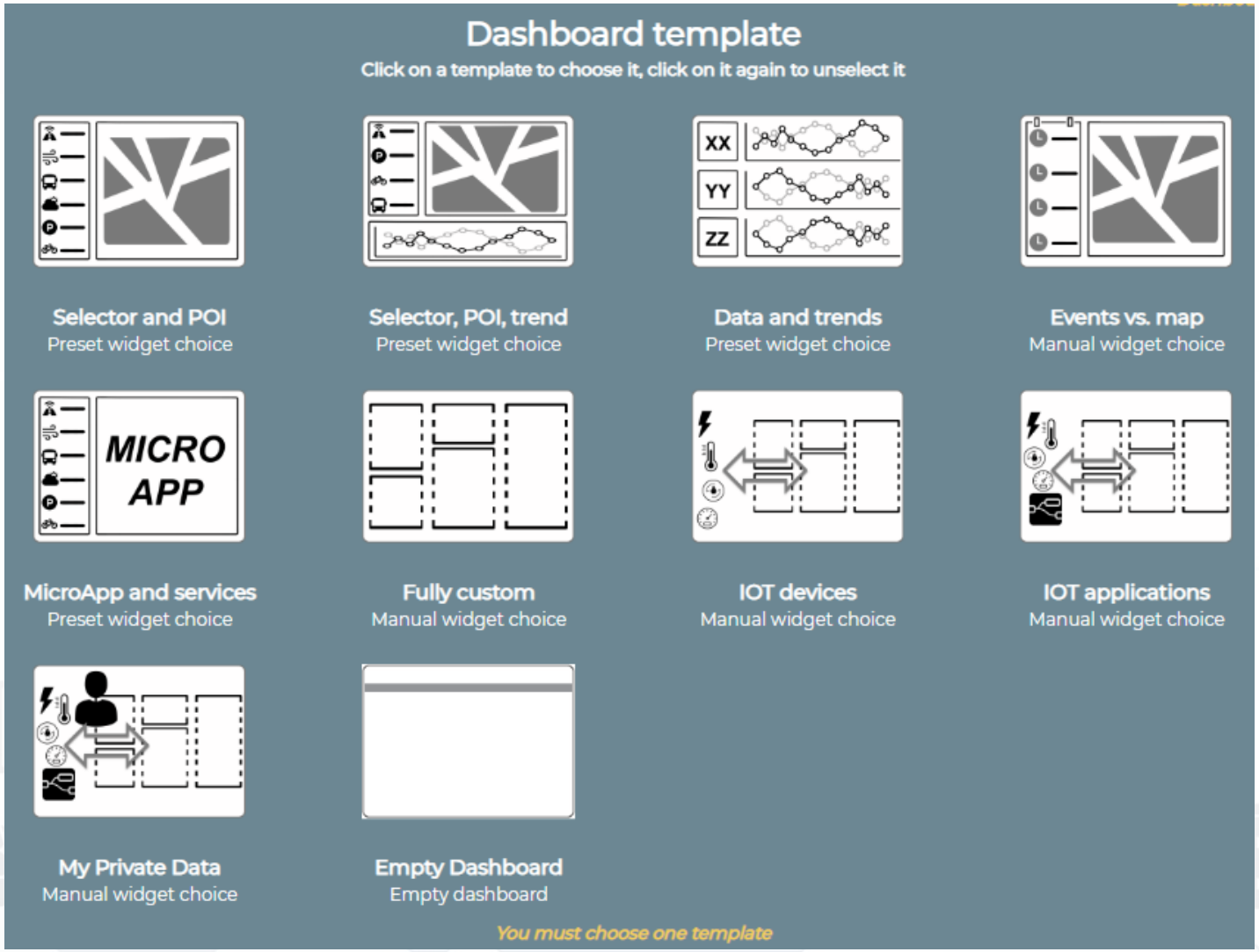
My Own Dash/App



Dashboard List and Editor



From Templates to Wizard and Dashboards

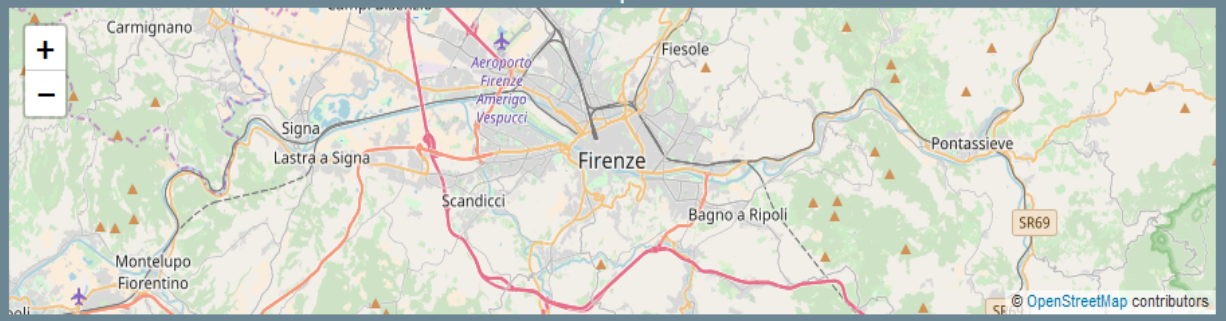


- to create a new Dashboard
- to add widgets and/or groups of them on any Dashboard

Wizard

Dashboard features | Data and widgets | Check and summary

Map



Single data widgets



Multi data widgets



Data sources

High-Level Type	Nature	Subnature	Value Type	Value Name	Data Type	Last Date	Last Value	Healthiness	Last Check	Ownership
All selected (10)	All selected (55)	All selected (776)	All selected (315)		All selected (47)					All selected (2)
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather				2018-07-08 16:00:18	public
Special Widget	**Environment**	**Weather Forecast**		**Previ_Meteo**	**special weather**		**Vagli di sotto**		**2018-07-08 16:00:18**	**public**
Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		Uzzano		2018-07-08 16:00:18	public

Hide columns | Selected rows: 0 | Previous 1 2 3 4 5 ... 1081 Next | Search

Choosen data sources

High-Level Type	Nature	Subnature	Value Type	Value Name	Data Type	Last Date	Last Value	Healthiness	Last Check	Ownership	Remove

Previous Next | Search

Close

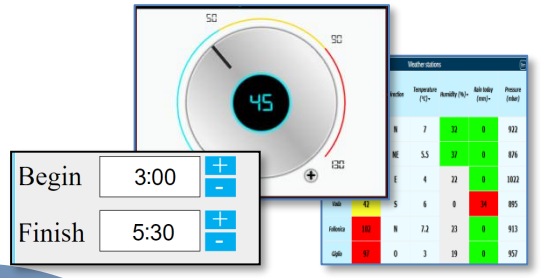
SNAP4CITY

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

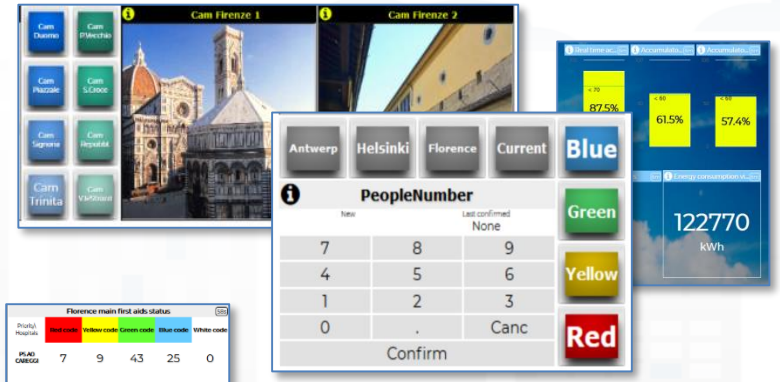
Dashboard List and Editor

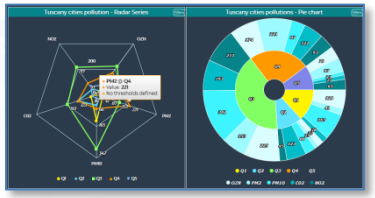


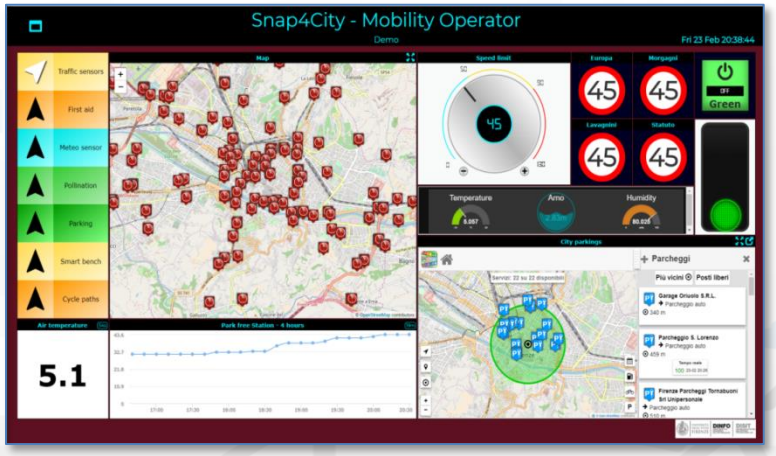


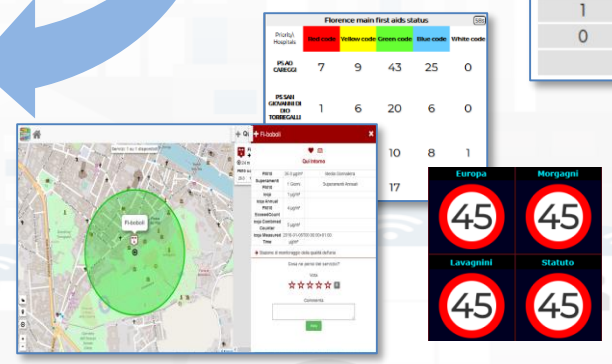




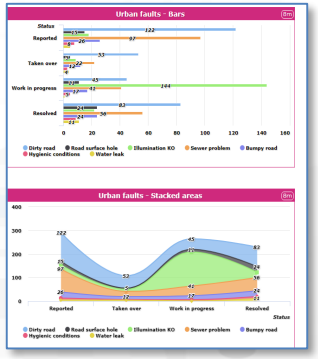












Developing new Dashboard Graphic Widget

- 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

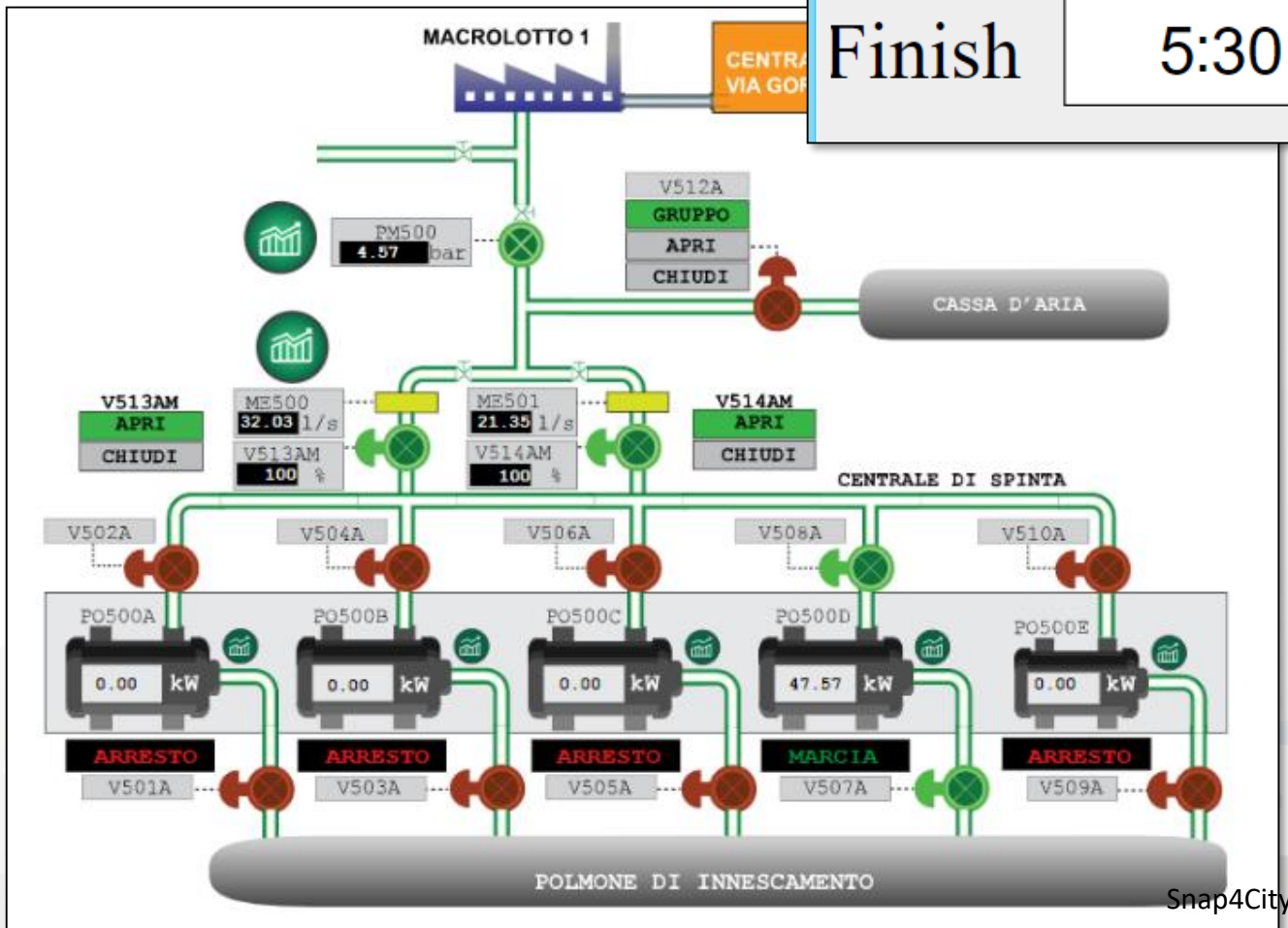


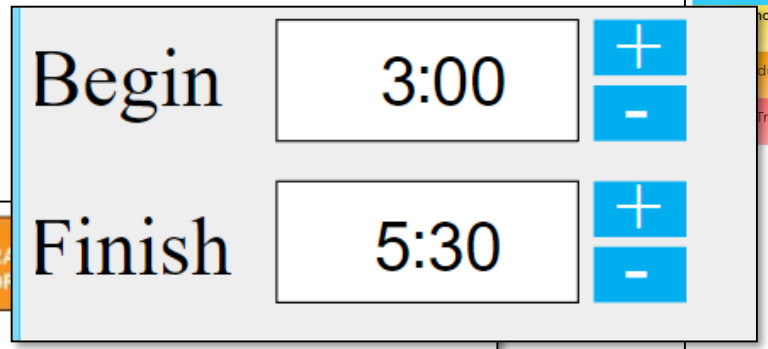
Custom Widgets

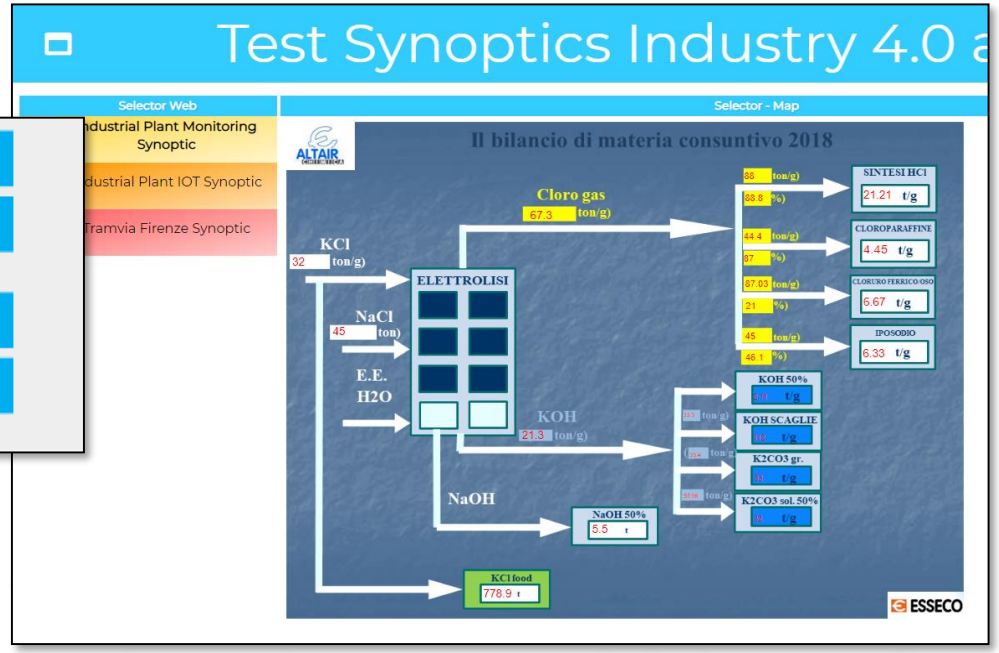
Custom Dashboards and Widgets (interactive, Animations, etc.)

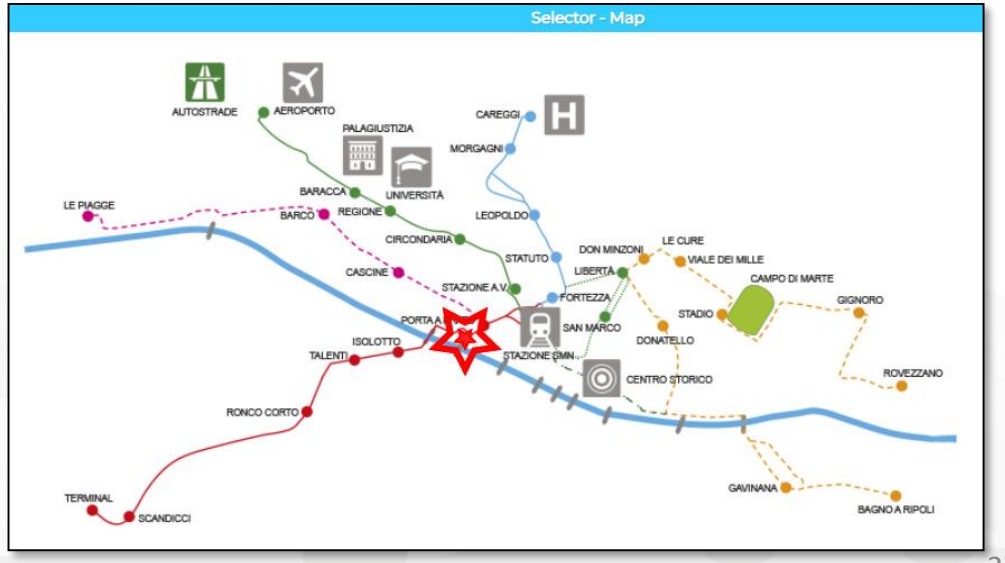
-- SVG for graphic design

-- MyKPI for collecting data

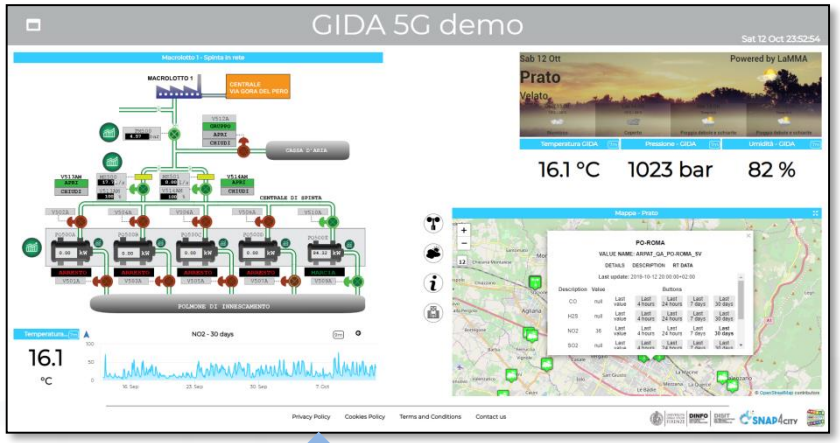








Creating custom Widgets for Dashboards



WS secure

MyKPI

IOT Edge

IOT Devices

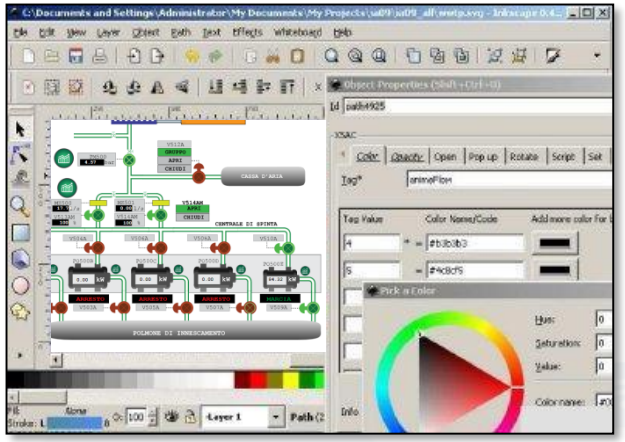
USING

Producing and Publishing

SVG

HTML

SNAP4CITY JS Library



Designer





JS programmer



DEVELOPING

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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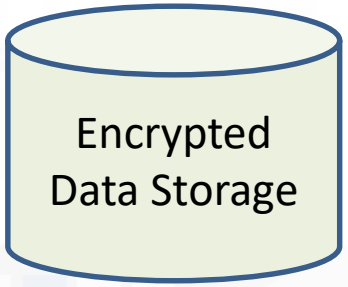
GDPR: General Data Protection Regulation

- **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



Considerations on Privacy and Security



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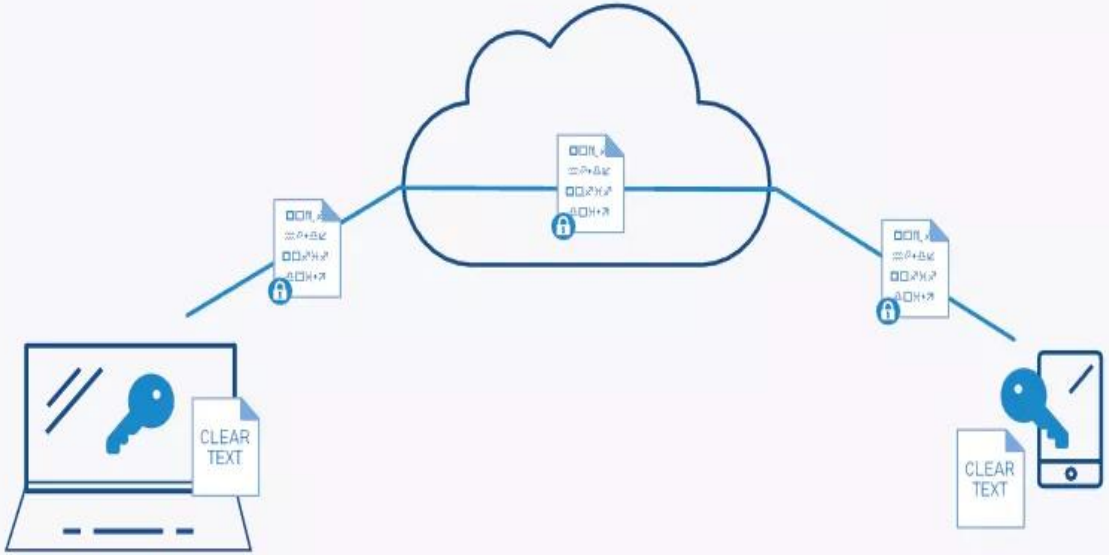
Sicurezza and privacy

- 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/

SELECT

for Cities

CERTIFICATE OF ACHIEVEMENT

1° place award to

UNIVERSITY OF FLORENCE - DEPARTMENT OF INFORMATION ENGINEERING

for SNAP4CITY

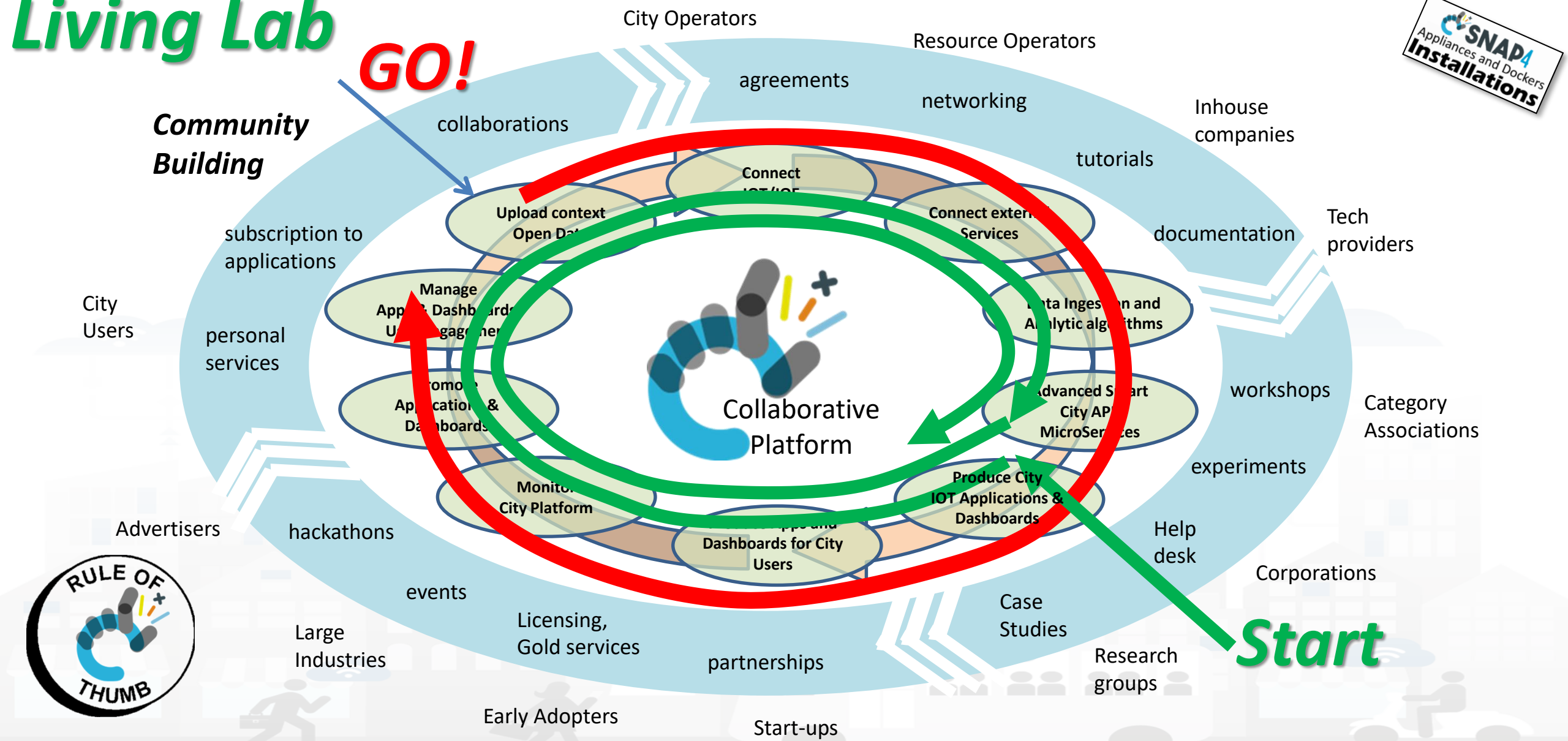
for successfully completing the
SELECT for Cities PCP competition
19.11.2019

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

Smart City Start Up vs Living Lab

GO!



Living Lab Flexibility

Snap4City Satisfies all Requirements of ENOLL Select4Cities and EIP-SCC

- **Multiple modalities to perform the same activities**
- **Tuned for Beginners and Skilled people**
- **Visual interface and programming tools**
- **Resources and artefacts sharing for learn acceleration and co-working**
- **Open Living and co-working Portal: https://www.Snap4City.org**

Snap4City

User: adifino, Org: DISIT
Role: Manager, Level: 4

- Dashboards (Public)
- Dashboards of My Organization
- My Dashboards in My Organization
- IOT Applications
- My IOT Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager
- Help and Contacts
- Documentation and Articles
- My Profile
- Snap4City portal
- Km4City portal
- DISIT Lab portal

Your Level

All Tools

Snap4City

Home | Partners and Interoperability | Tools | Tutorials and Videos | Blog | Contributions

Home / Tutorials and Videos / Welcome: how to start using Snap4City for beginners

Welcome: how to start using Snap4City for beginners

Personalized Suggestions

Snap4City developers suggest you reading:

You have already created a **Dashboard**. Now, you may decide to make it public (visible and accessible) to all on WEB, or to provide access in view to other specific users that you know by nickname.
In addition, you can pass the Ownership of a **Dashboard** to some other user of the system, and you can clone the **Dashboard** as well. So that you can create **Dashboard** for other users as well.
We sugget to test these functionaltiies since you can:

- access to Data Set **Manager** to upload/download, share data sets as files in CSV: https://datagate.snap4city.org/ssologin_handler
- upload data for the **knowledge base** and **dashboards** via Data Set **Manager**,
- access and share of resources as: **dashboards**, **IOT Applications**, blocks, etc.; https://processloader.snap4city.org/.../ssoLogin.php?redirect=page.php%3FshowFrame=false
- access to help and contacts, FAQ, documentation and articles
- manage personal data: profile, IOT Sensors, **Annotations**, Personal Data, **Dashboards**..; https://www.snap4city.org/drupal/myprofiledata
- Auditing Access to My Data according to **GDPR**.

See this ... capabilities development ... the above possibilities:

TC1.10. Dashboard delegation to access, and passage of ownership, and/or cloning

Exercises

If you are not registred please apply for a **free registration from https://www.snap4city.org** and then pass to ACCESS AT THE TOOLS and full Snap4City environment

Snap4City puts in the hands of City Users a flexible environment to quickly create a large range of smart city applications/views exploiting heterogeneous data and services of stakeholders by IOT/IOE and big data technologies. For Snap4City, City Users can be citizens, students, operators, researchers, decision makers, developers, etc. see Users' Roles on Snap4City.

- **Manager:** is a **final user**, has the capability of: accessing and creating Dashboards with a large set of data (high level types as: POI, sensors, KPI, micro applications, external services, etc.), attaching alerts and notifications; registering IOT Devices; creating IOT Applications exploiting MicroServices; loading and sharing data sets; managing personal data and annotations; full access to documentation, help desk, FAQ, coworking; managing personal profile and data according to GDPR; **NOTE:** accessible features are mainly visual and simple to understand and to use, and provide a limited number of parameters on each dialog and for each action. Default values of created elements can be changed editing elements.
- **AreaManager:** is a **Developer/researcher, students, city operator**, with additional capabilities with respect to the Manager to: register IOT Brokers; creating advanced IOT applications; create massive data transformation processes; create data analytics in multiple languages, testing and load them, create microservices; adding external services; sharing results, loading shapes; analyzing performance of the back office; **NOTE:** technical views and details are fully accessible

SLIDES





NEWS

Flyer

News

VIDEOS

Suggested Activities to be performed to Learn HOW to use Snap4City:

This page would guide you along few steps to ... how the solution allows you to incrementally pass from **Level 0 to 5, from a Manager to an Area Manager:**

- Level 0 user: access at data/services views of the city by using public Dashboards; (Public User) **(overview on dashboards)**
- Level 1 user: create personal/professional views/dashboards on ... (Private User, Manager) **(Dashboards can be created)**

Full Search

Search

Search

Your Org

Organization Groups

DISIT
- Operativo

Recent comments

- 1 month 6 days ago

Last Art.

Recent content

Ti Suggeriamo come realizzare la tua prima Dashboard (Step 1) new
roottooladmin1

Benvenuto al nostro Sindaco ed al suo Team
new
roottooladmin1

We sugges to Antwerp Developers: How to manange my Dashboards

Username: adifino

Powered by www.km4city.org

Living Lab training

- Snap4City Living Lab Life Cycle
- TC8.6 - Snap4City Living Lab Life Cycle
- US8. Using the Living Lab Support tools
- Snap4City platform: from cloud to data analytic as a Living Lab for Student and Researchers
- Contributing as city stakeholder: company, citizen/developer, researcher, etc., to the Living Lab
- TC8.1 - Snap4City Portal as a support for Living Labs, collaborative and co-work, Snap4City Portal as a single point to information Access and Discussion

Satisfy all Requirements of ENOLL



Development Life Cycle for IOT Applications



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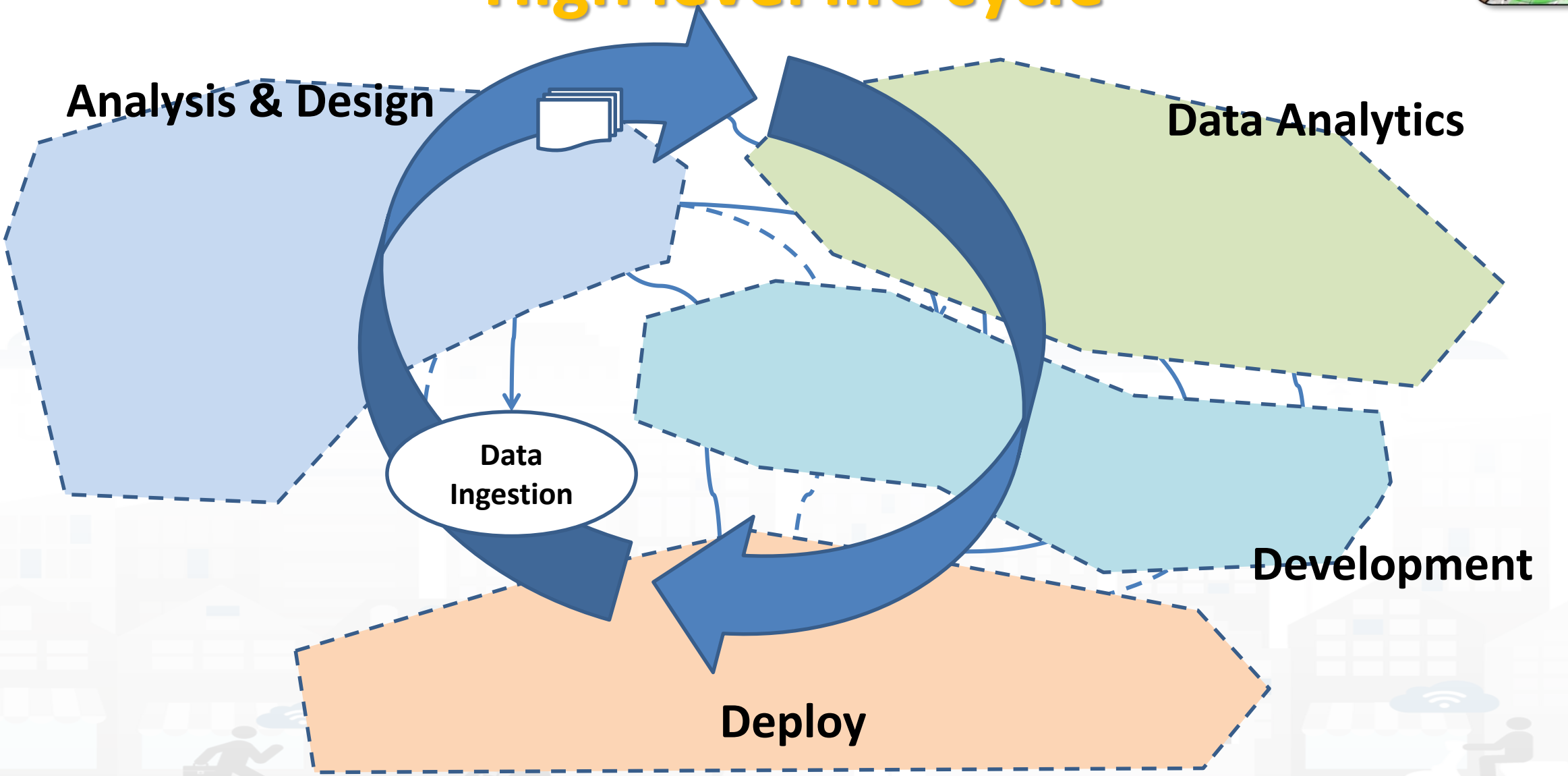
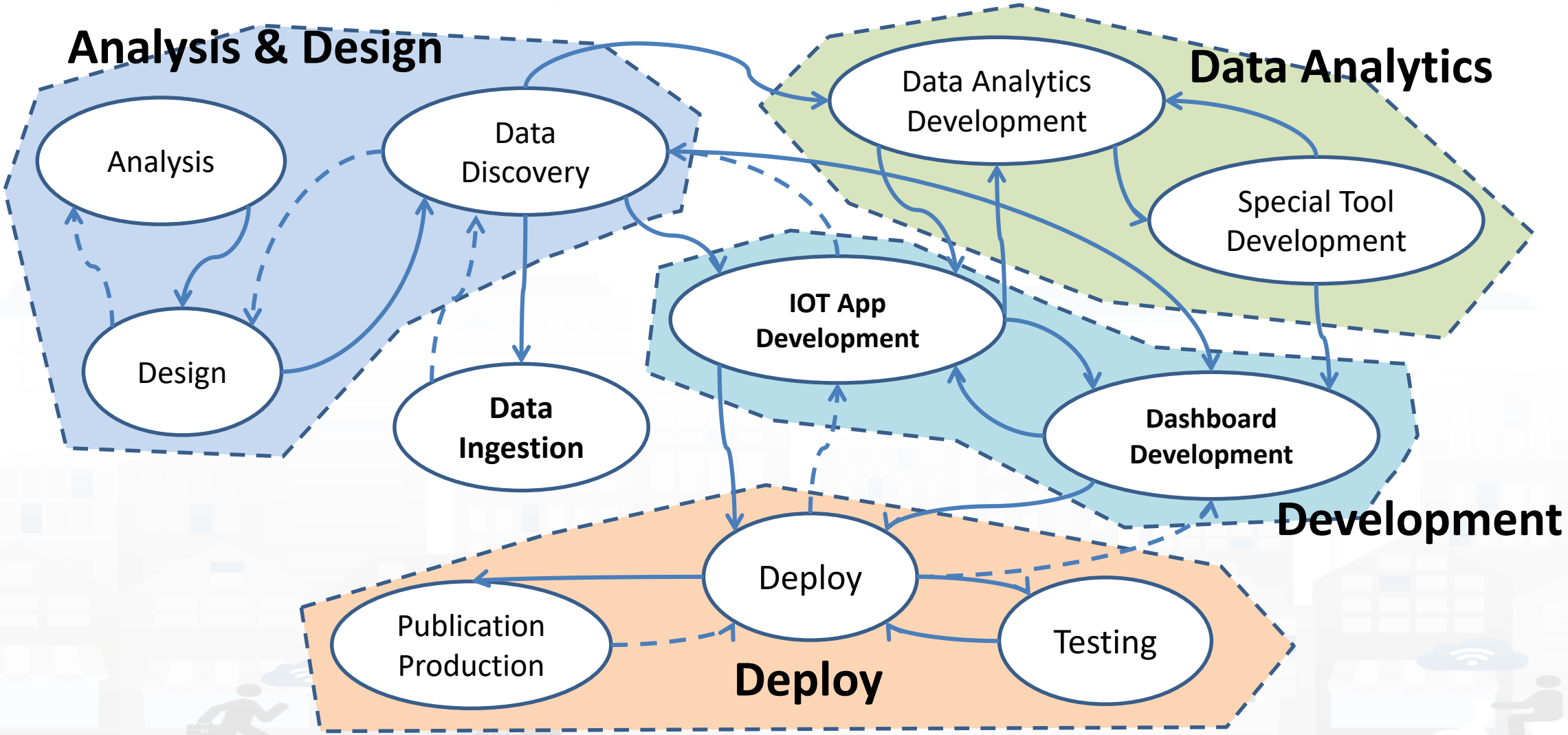
BY NC ND

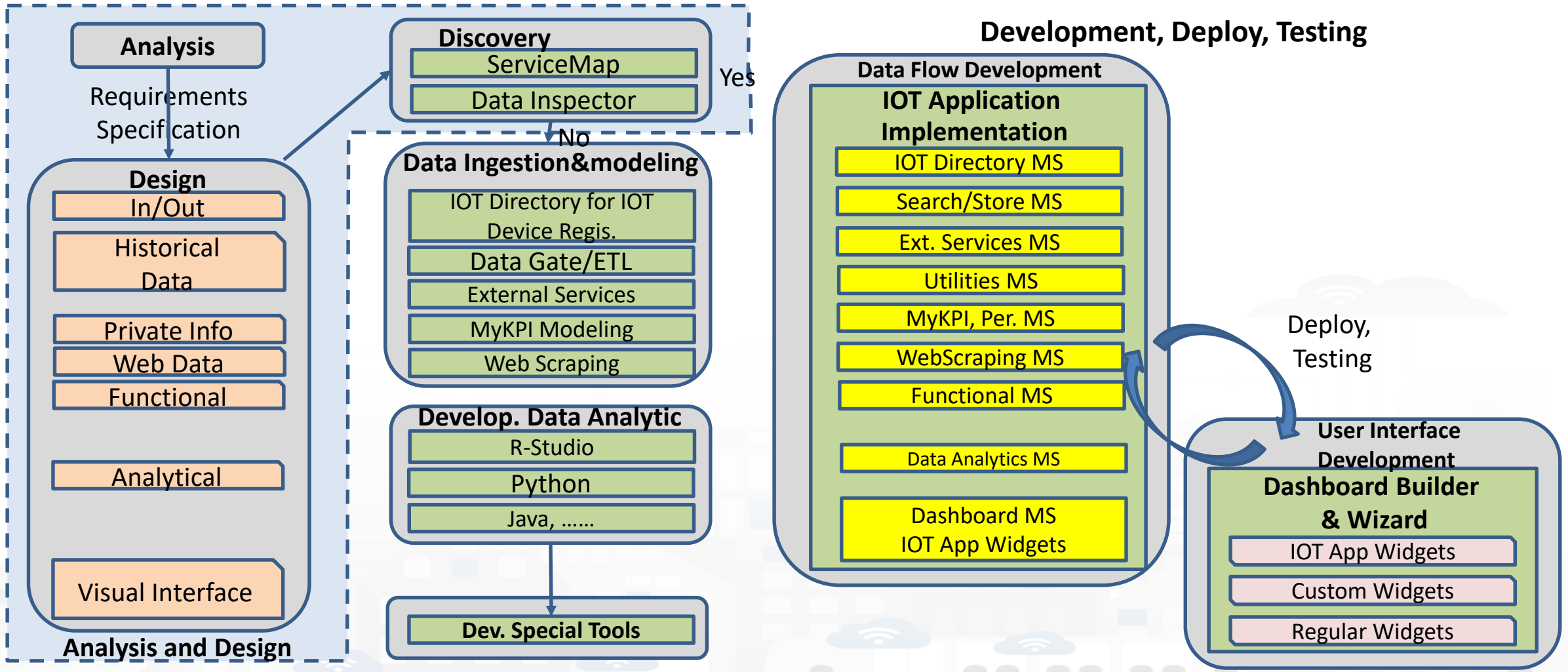
High level life cycle



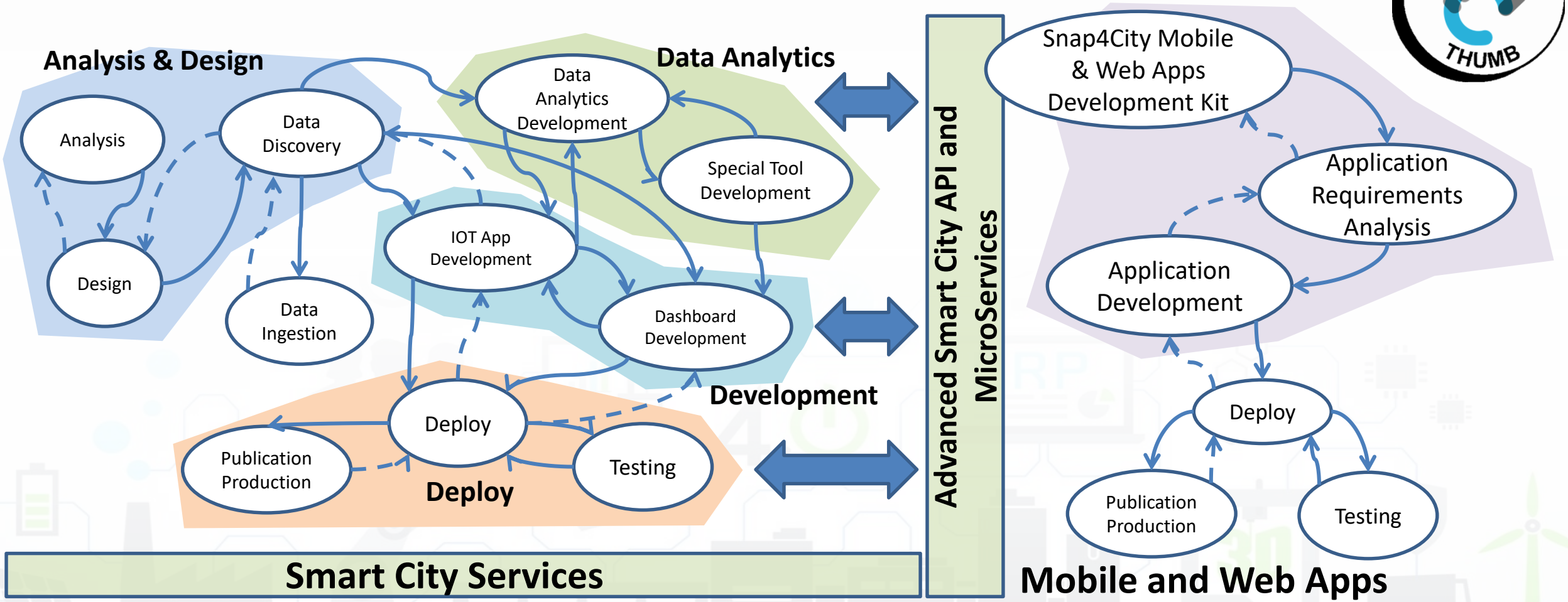
High level life cycle



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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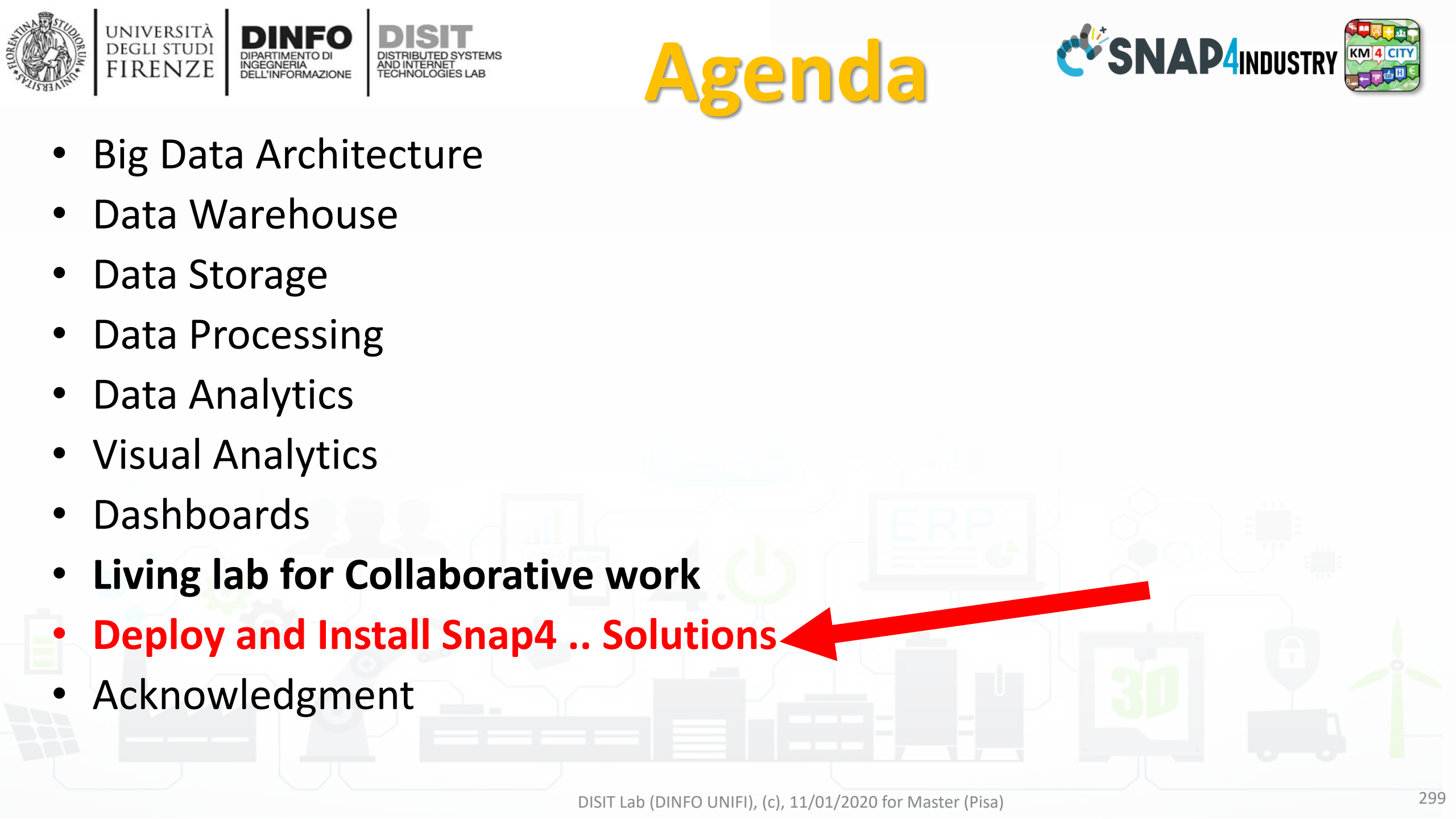
BY NC ND

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



Smart City Functional Architecture

Transport systems Mobility, parking



Public Services, Govern, events, …



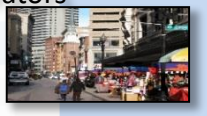
Sensors, IOT Cameras, Wi-Fi



Environment, Water, energy



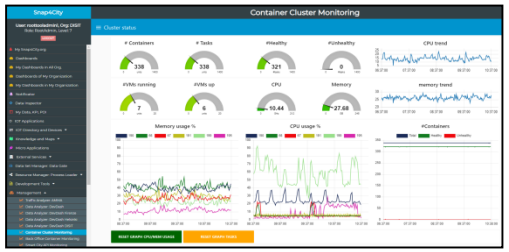
Shops, services, operators

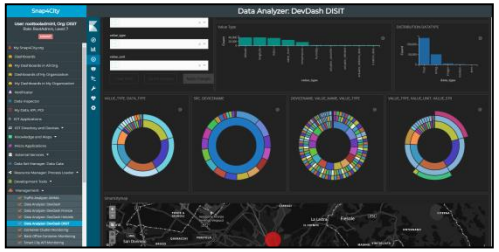


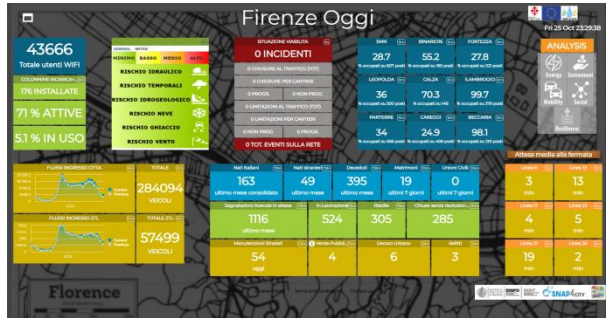
Social Media

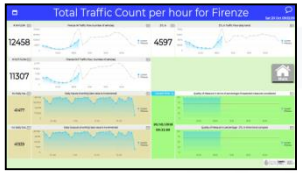
Social Media Crawler and Manager



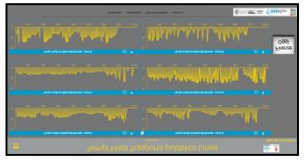






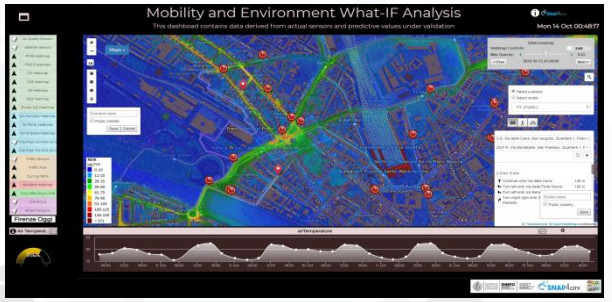












Data Sources PULL Data

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

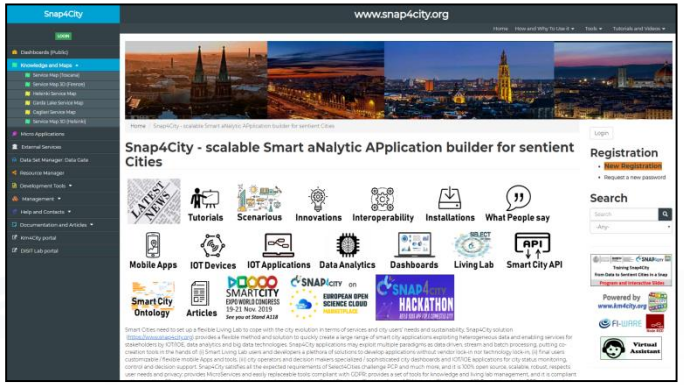
Visual Analytics Special dash/ tools

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

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

How to adopt Snap4City

Https://www.snap4city.org



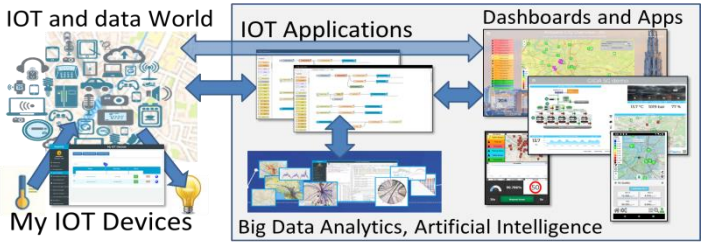
Smart City as a Service

- Supporting Org
- 100% Open Source Platform: Github
- Further developments
- Publishing Appliances and Dockers
- Training courses, docs
- Consulting
- Forums
- Etc.

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

Download and deploy

On your premise





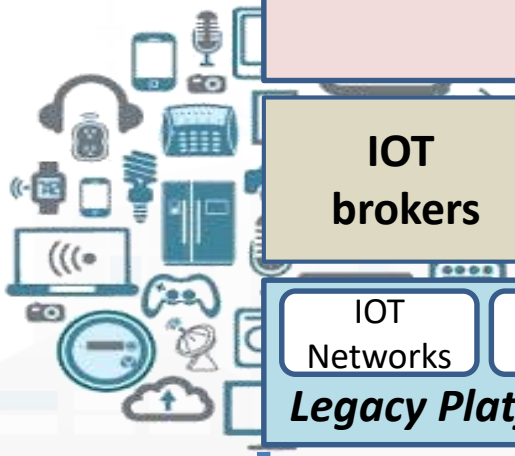
Installation on your premise

- Virtual Machines or Dockers
- Different configurations
  - From small to scalable
  - Exploiting your legacy tools
  - Interoperable with any tool
- No vendor lock-in, No tech lock-in

Mixed solutions! For example:

- Start on Cloud as Smart City as a Service
  - Migrate on premise on the fly
- Start on Cloud into a sand box
  - Pass to install on premise what you need

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

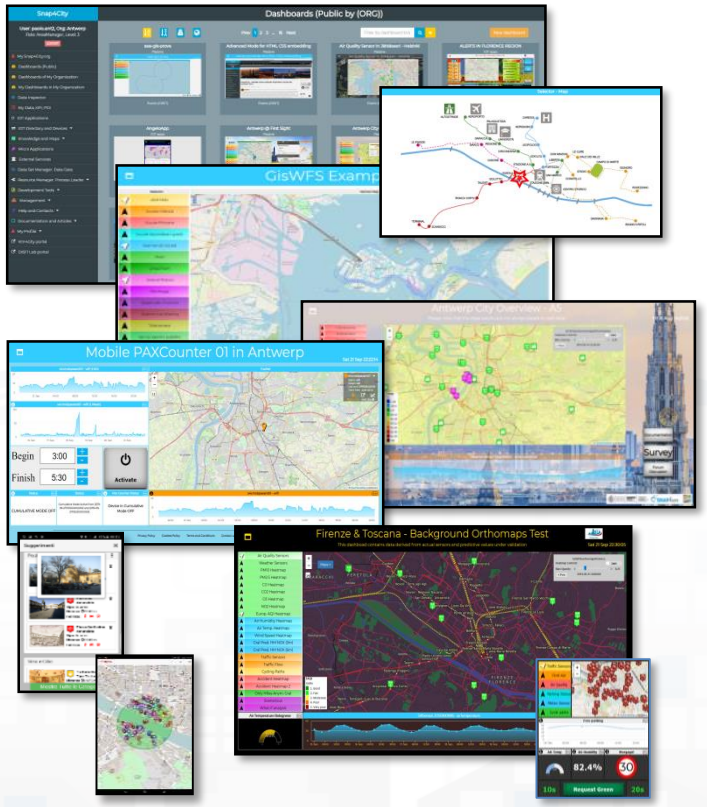
Snap4City MAIN
Dashboard, User Management, etc.

Knowledge base,
semantic Store

HeatMaps and Maps

Living Lab Portal

Front End



Mobile Apps, Dashboards

RULE OF THUMB

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

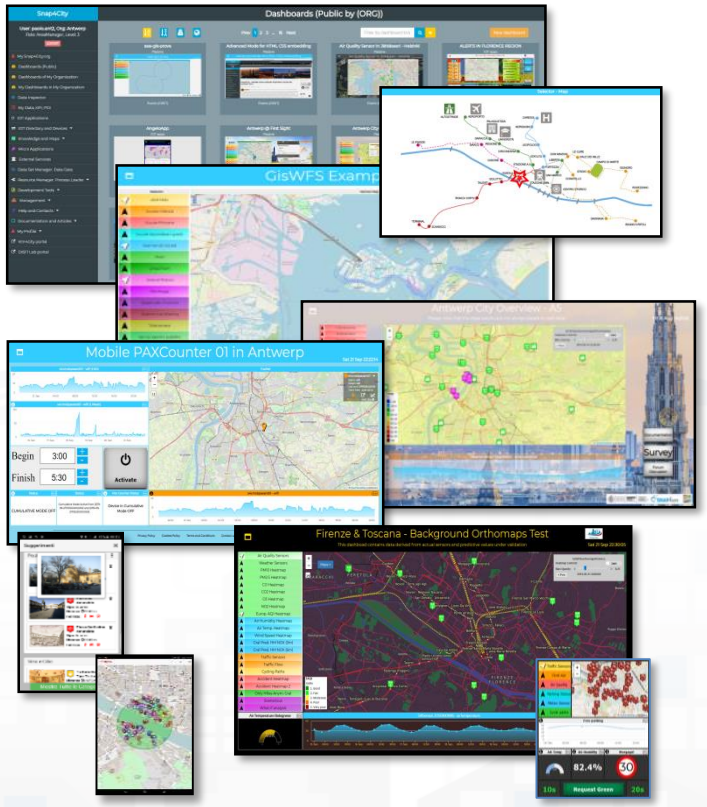
Snap4City MAIN
Dashboard Builder, Data Inspector, User Stats, ExternalSrv, Res Manager, MyKPI, MyPOI, Synoptic, IOT Device Manager, Micro Applications, Authorization/ Authentication, Roles, …

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

GISGeoServer
Heatmap Manager, WFS, WMS

Living Lab Portal
Drupal support CRM, ..

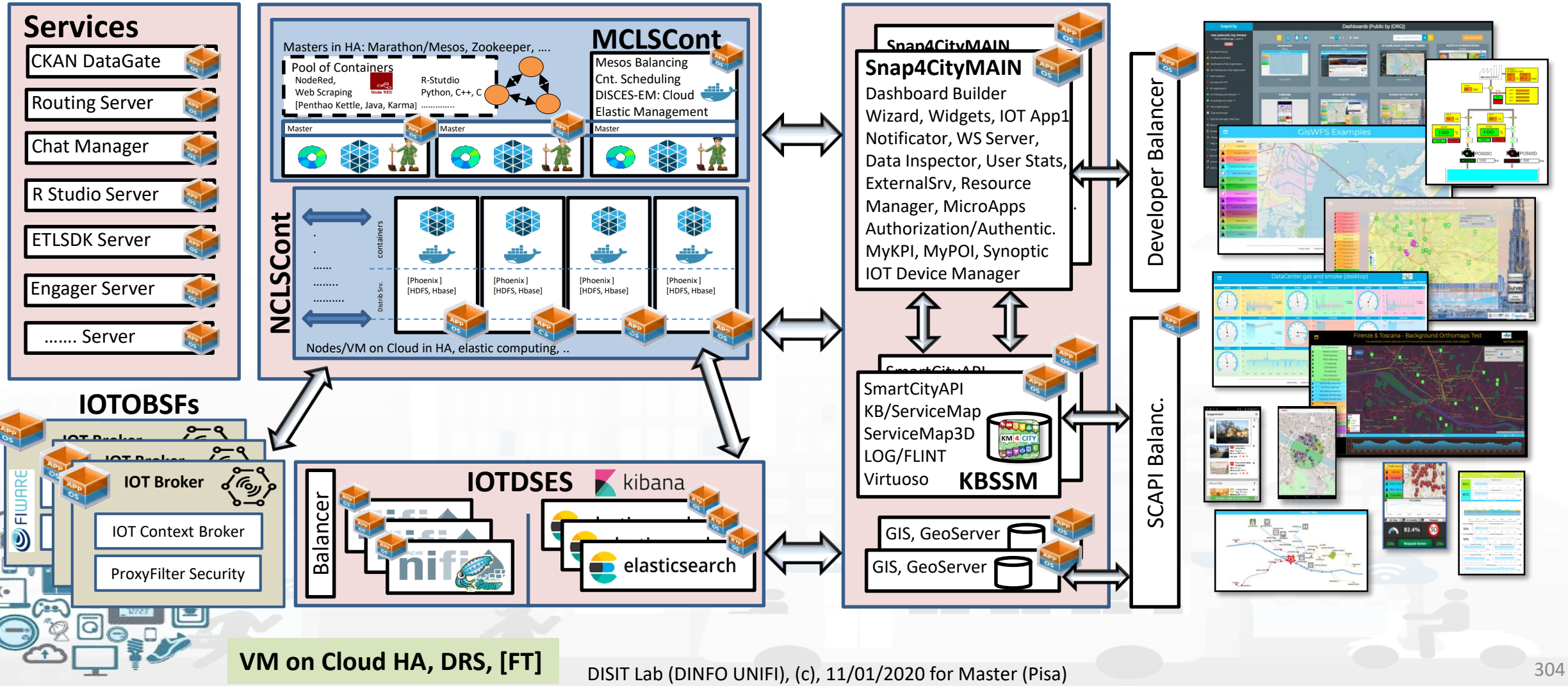
Front End



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
- Events
- LOD

ckan

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015

- Sardinia Region Smart City Strategies and plan

FIWARE

SII-MOBILITY SCN (2016-19)

Km4City 1.5 (2015-18)

resolute

H2020

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

E015 digital ecosystem

2016

- Infomobility
- Mobile App
- Routing
- Multimodality

Km4City 1.6.2

- Smart Energy
- Sustainable Mobility
- Control Room Dashboard

REPLICATE (2016-21) H2020

Km4City 1.6.4

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

GHOST SIR (2016-19)

GREEN IMPACT CAPACITY

Km4City 1.6.6 IOT/IOE

Node-RED

SNAP4CITY

SELECT for Cities H2020 (2017-19)

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

life weee (2017-20)

- Smart Waste

2017

TRAFAIR CEF (2018-21)

GREEN IMPACT
POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

2018

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

MOSAiC (2018-20)

- Mobility Demand / Offer Analytics and Strategy

(2018-21) 5G

5G tech
Energy
Industry 4.0
Synoptics

- Traffic and Mobility Impact on Pollution
- NOX predictions

2019

EUROPEAN OPEN SCIENCE CLOUD

2020

…2022

Reverberi Enetec
Gruppo MPES

bee smart city

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

SIRIUS

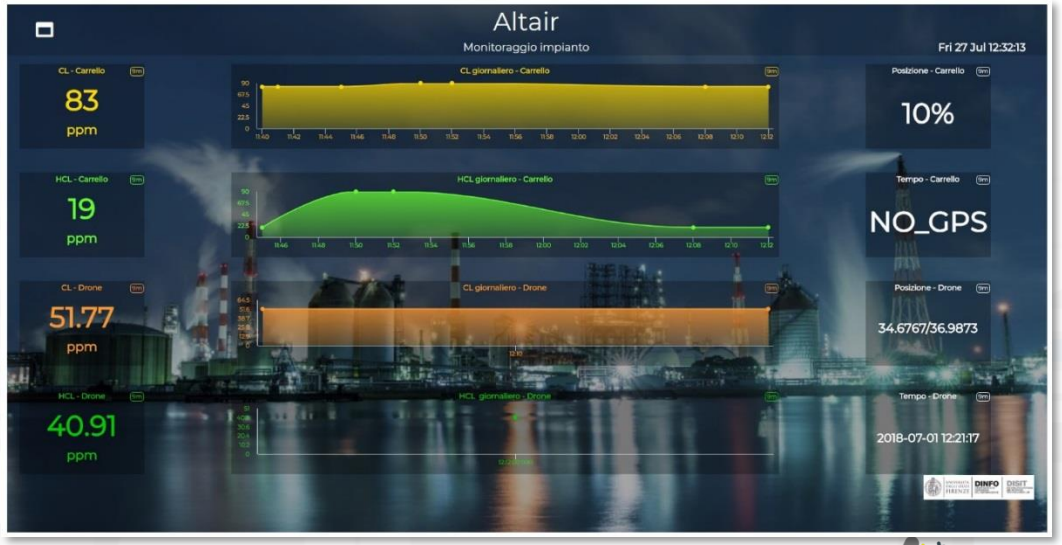
LAID Smart Bed

Green Impact Capacity (GIC)

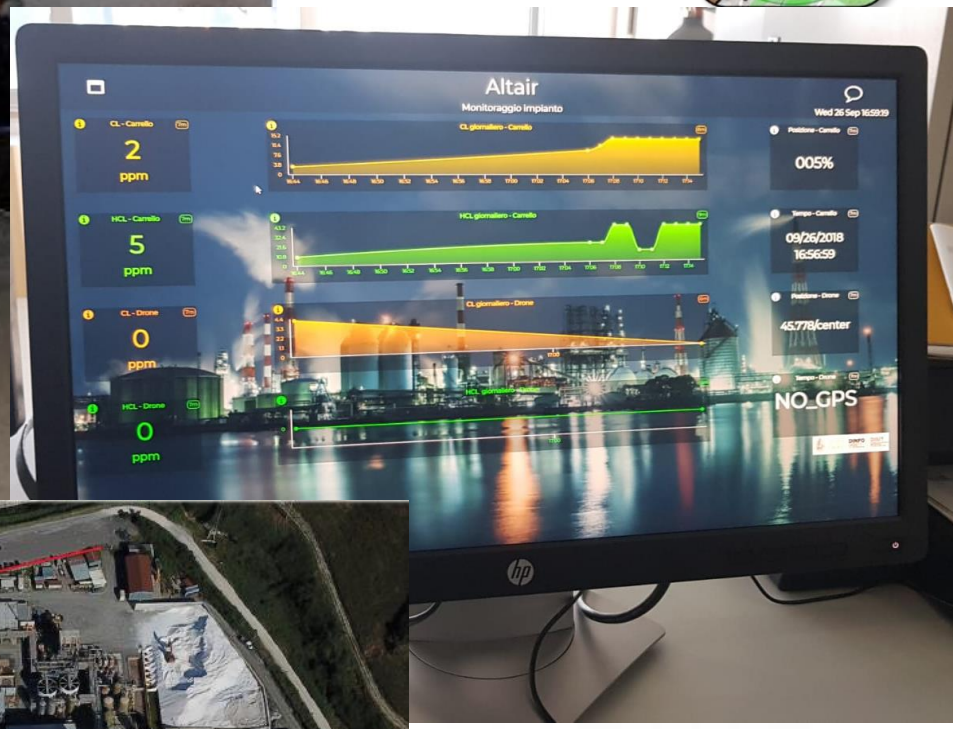




- Improve productivity of chemical plant
- Keep GREEN the environmental impact
- Exploiting innovative technologies
- Diversify the production
- Monitoring environmental conditions









Green Impact Capacity (GIC)

Altair Control room

Experimenting 5G

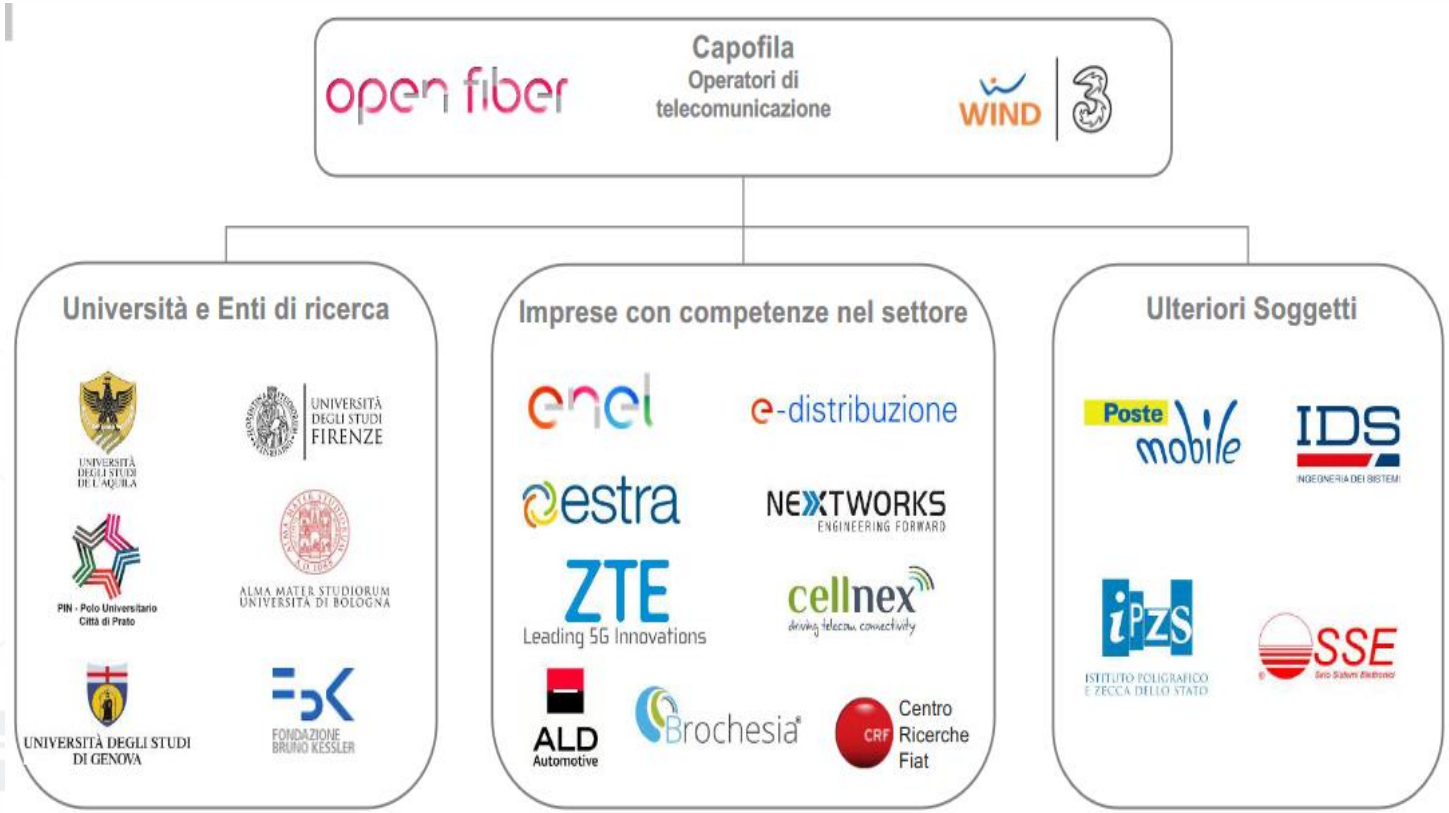
Fields:

- Internet of Things: Industry IOT, Smart City
- Mobility and transport
- Safety & Security: video analysis
- Culture and Tourism, Education, Health

Where in Italy:

- Prato and L'Aquila

Partners:

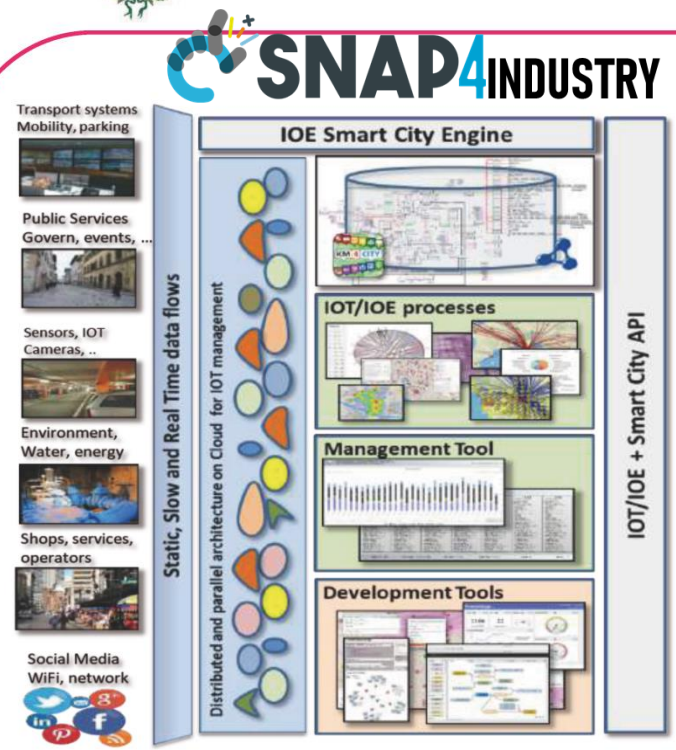


MINISTERO DELL'ISTRUZIONE DELL'UNIVERSITÀ E DELLA RICERCA

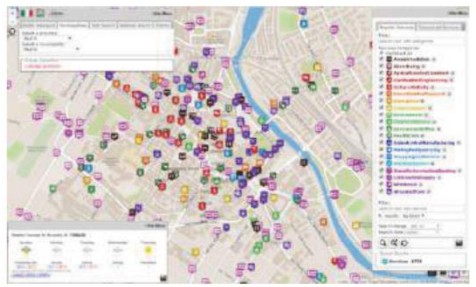
SENSORI E IOT - PRATO

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

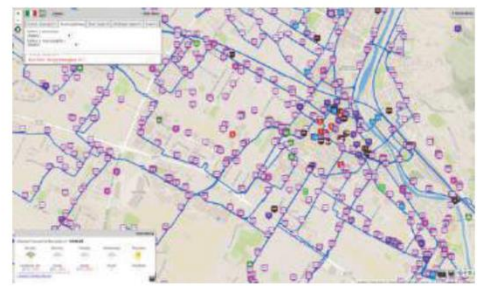
- Smart City management (in ottica Smart City)
- monitoraggio utenze in modo smart
- industrial automation (in ottica Industria 4.0)







Punti di interesse e servizi su Prato

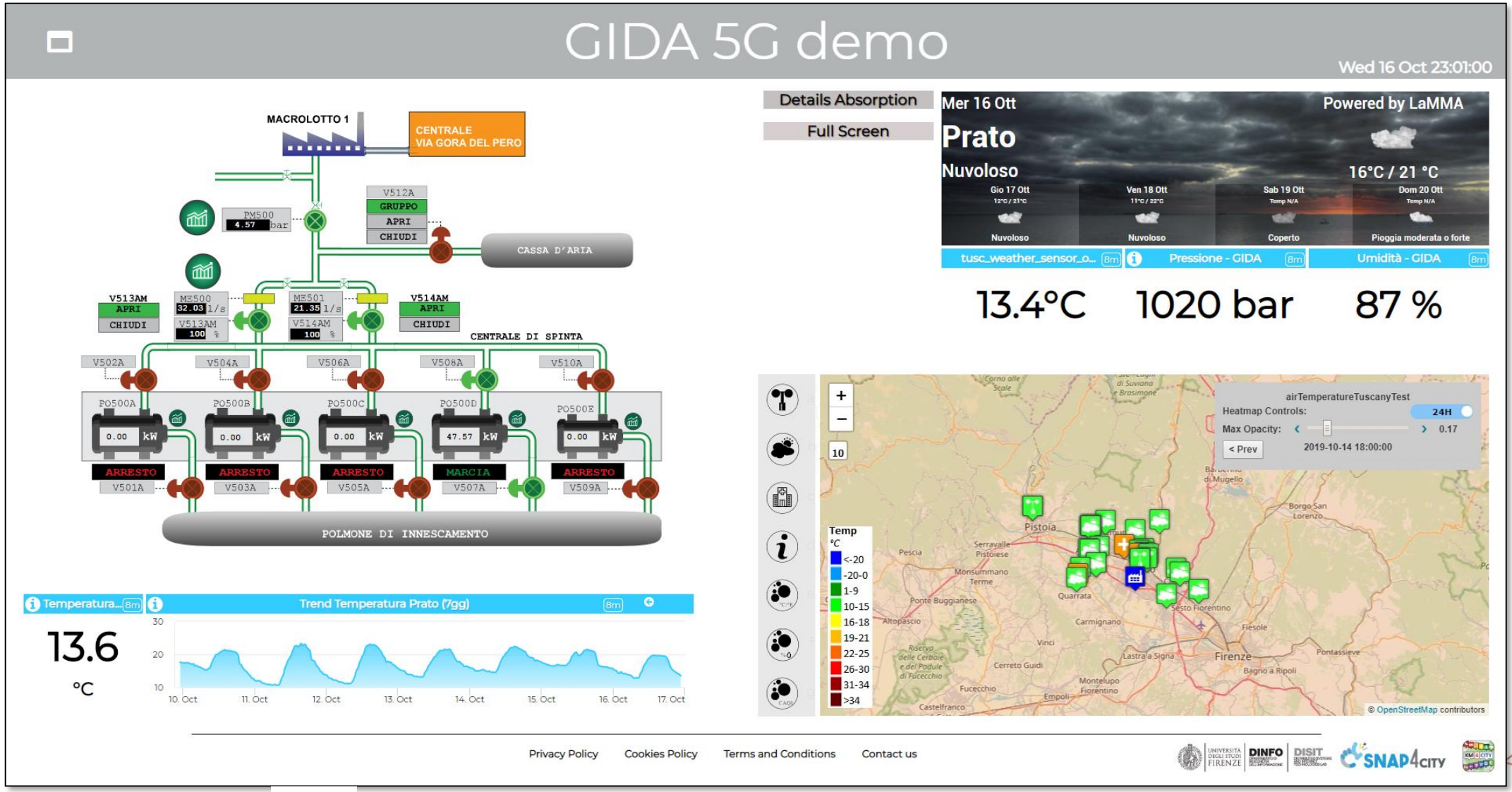


Use Case LEADER estra

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==

Feedback Project

Personal Assistant

Operators

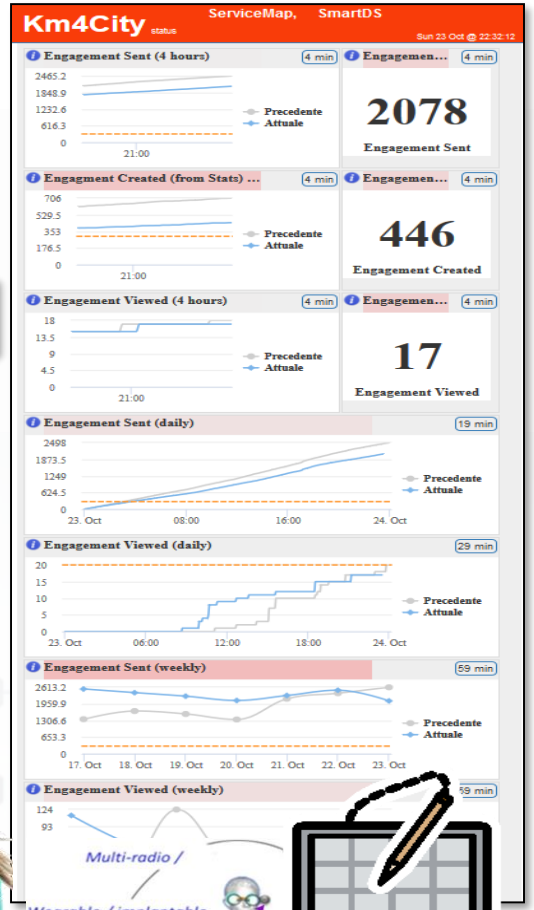
Strategy Editor and feedback

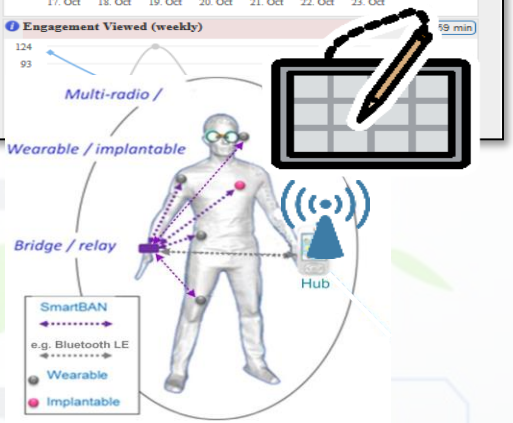


Rule name	Type	#sent	#viewed	#viewed on #sent	Description
daily_event_de	ENGAGEMENT	1 (0%)	0 (0%)	0%	Suggest (in german) an event currently on in Flore
daily_event_en	ENGAGEMENT	1720 (2.12%)	70 (7.1%)	4.07%	Suggest (in english) an event currently on in Florence
	- commuter	5 (0.29%)	0 (0%)	0 (0%)	
	- 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





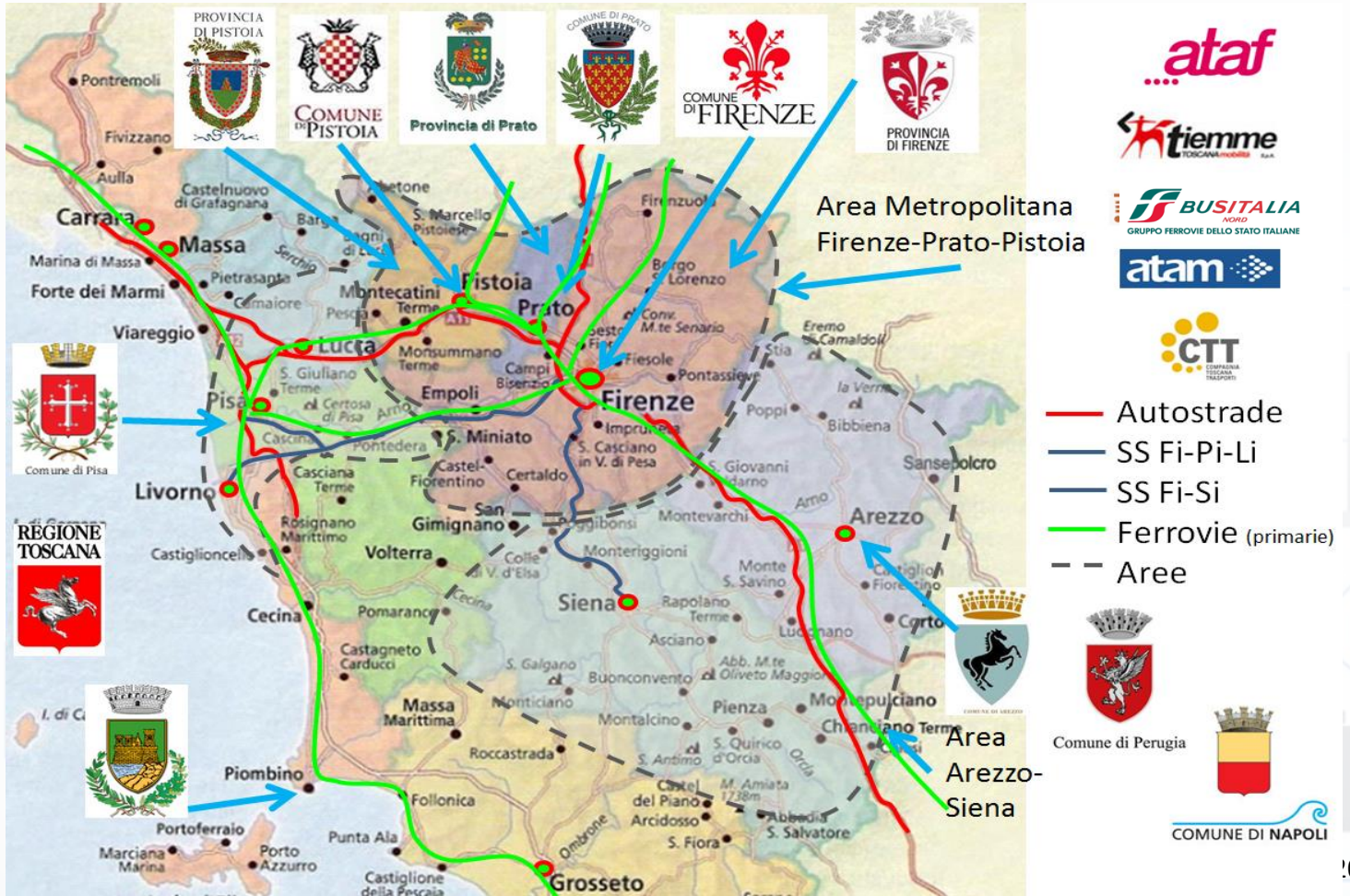


UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB http://www.disit.org

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

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
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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



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
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HUMANIST	HUMANIST	FR
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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**

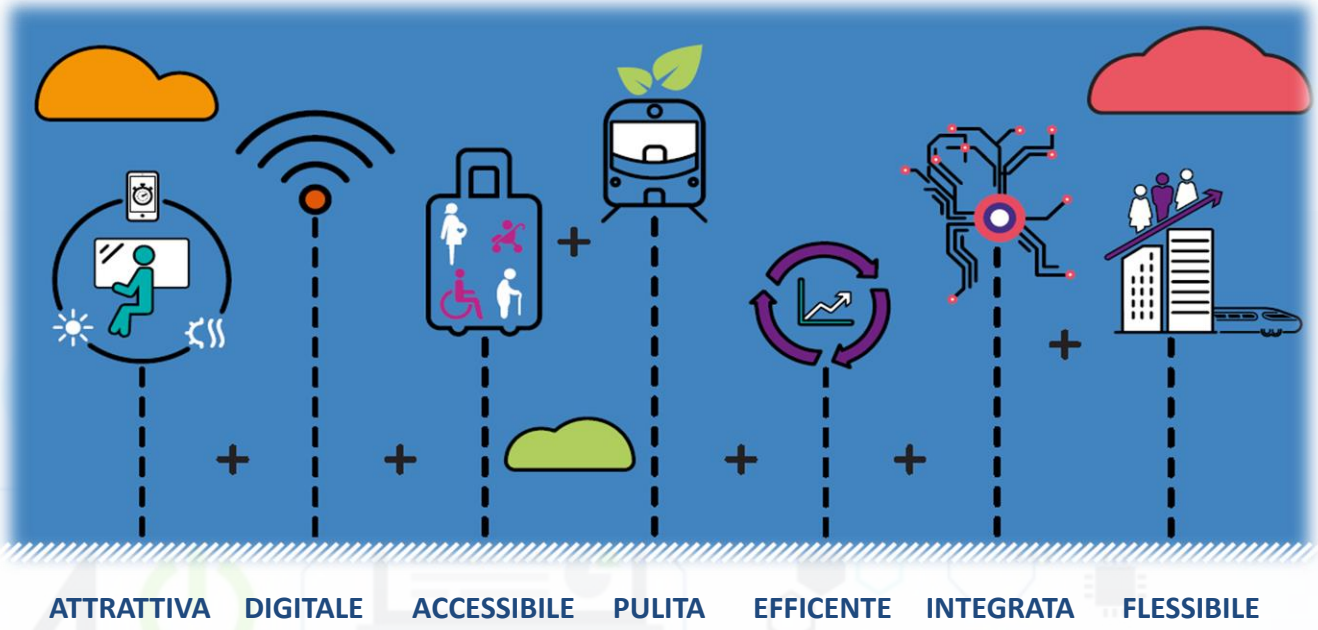
- Università degli studi di Modena e Reggio Emilia (UNIMORE) -- Italy
- **Università degli Studi di Firenze – DISIT DINFO -- Italy**
- Universidade de Santiago de Compostela (USC) - Spain
- Comune di Modena (CMO) - Italy
- Regione Toscana (TR) - Italy
- Concello de Santiago de Compostela (CSC) - Spain
- 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



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

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