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 Architectures

https://www.snap4City.org https://www.Km4City.org

Parte: 0 (2024-25)

Agenda

- Laboratorio DISIT
- Tematiche del corso
- Infrastruttura del DISIT Lab
- Struttura del corso
- Modalità dell'esame

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

Distributed Data Intelligence and Technologies Lab
Distributed Systems and Internet Technologies Lab

Paolo Nesi

Department of Information Engineering

University of Florence

Via S. Marta 3, 50139, Firenze, Italy

tel: +39-055-2758515, fax: +39-055-2758570

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

paolo.nesi@unifi.it , http://www.disit.dinfo.unifi.it/nesi/

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DISIT Lab

- Researchers: 18
- Current Active Projects: 20
- Project in the last 4 years: 45
- Research Budget (last 2 years): 1.5M€
- Foreseen Research Budget (next 2 years): 2.2M€
- SpinOff: 2

KM4CITY

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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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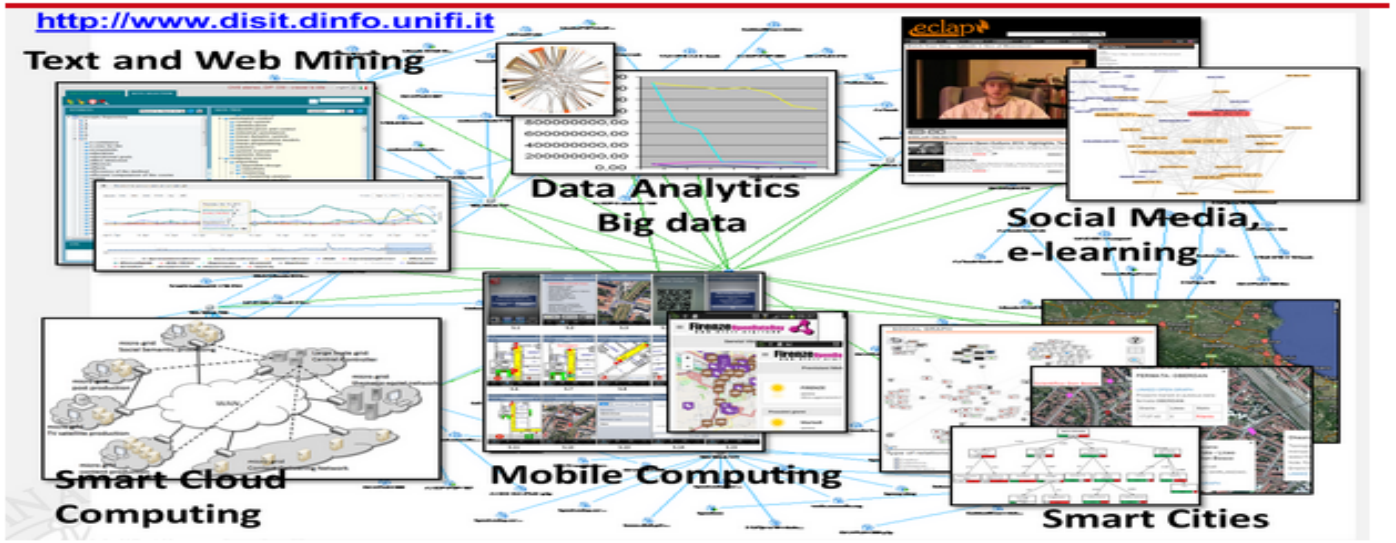
qualsiasi tipo | deep search

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] has covered the role of partner, and also coordinating scientific and technical WP and performing activities of dissemination and assessment. DISIT has received a relevant number of awards and is 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. · VARgroup · THALES · BUSITALIA NORD GRUPPO FERROVIE DELLO STATO ITALIANE · BBC

ALTAIR CHEMICA · TIM · LEONARDO · Rai

ALSTOM · LUTECH · liberologico · SIAE Società Italiana degli Autori ed Editori

COMPUTER GROSS · eutelsat · ENGINEERING · GIUNTI EDITORE

PHILIPS

e-distribuzione · Fondazione per la ricerca e l'innovazione · ENTE CASSA DI RISPARMIO DI FIRENZE · CITTÀ METROPOLITANA DI FIRENZE · COMUNE DI FIRENZE

Fraunhofer

Consiglio Nazionale delle Ricerche · cini · cnit consorzio nazionale interuniversitario per le telecomunicazioni · UNIVERSITY OF PITTSBURGH · Camera di Commercio Firenze · ARPAT Agenzia regionale per la protezione ambientale della Toscana · REGIONE TOSCANA

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 · CONSORZIO LaMMA

Some DISIT Projects

SASUAM: CN MOST, mobilità e trasporti
OPTIFaas: CN MOST, mobilità e trasporti
CAI4DSA: FAIR PE, Intelligenza Artificiale Fondazionale
ISPRA JRC EC, SOC, Security Operation Center, managem
THE: Health LLM, BERT, Decision Support System
TOURISMO Interreg, Decision Support System
AMMIRARE Interreg, simulazione e monitoraggio coste
Herit Data: Tourism and Mng. https://herit-data.interreg-med.eu/
Snap4City: IOT/IOE smart city www.snap4city.org
Trafair: CEF project with several Cities http://trafair.eu/
Km4City: http://www.km4city.org
REPLICATE H2020, SCC1, EC flagship
http://replicate-project.eu/
Sii-Mobility SCN MIUR: http://www.sii-mobility.org
Feedback: retail and GDO Big Data analytics
5G with 3G-Wind, Open Fiber, Estra
RESOLUTE H2020, EC:
http://www.resolute-eu.org
TRACE-IT, RAISSS, TESYSRAIL, ...

CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

Spoke 8
MaaS & Servizi Innovativi per la Mobilità

Centro Nazionale per la Mobilità Sostenibile

OPTIFaaS - Operation and Plan, Transport Infrastructure and Facilities Support as a Service

Italiadomani
PIANO NAZIONALE DI RIPRESA E RESILIENZA

Ministero dell'Università e della Ricerca

Finanziato dall'Unione europea
NextGenerationEU

CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

OPTIFaas

Ecosistema a supporto di una rapida ed efficace condivisione di soluzioni ed opportunità tra **ricercatori** ed **aziende** appartenenti al MOST e **Pubbliche Amministrazioni Locali** ed **Operatori di Trasporto**.

Meccanismo del tipo marketplace:

- **Ricercatori ed Aziende del MO**ST hanno un ambiente in cui proporre e sperimentare proposte e soluzioni;
- **PAL ed OdT** utilizzano sempre soluzioni allo stato dell'arte per la risoluzione di problematiche ed il perseguimento della loro mission.

Il tutto è configurato con modalità ***as a service*** allo scopo di **minimizzare investimenti** in infrastrutture e personale da parte di PAL e OdT

MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

Spoke 8
MaaS & Servizi Innovativi per la Mobilità

Centro Nazionale per la Mobilità Sostenibile

SASUAM - Solutions for Safe, Sustainable and Accessible Urban Mobility

Italiadomani
PIANO NAZIONALE DI RIPRESA E RESILIENZA
Ministero dell'Università e della Ricerca
Finanziato dall'Unione europea
NextGenerationEU

CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

SASUAM

- **metodi e algoritmi scalabili** per la gestione del traffico urbano utilizzando il **paradigma del diagramma fondamentale macroscopico (MFD)** e **una soluzione di ottimizzazione generativa per la decongestione, l'accessibilità e la sicurezza del traffico urbano**.

- La soluzione prevede di **utilizzare i dati e il supporto di validazione della città di Bari** in cui verrà eseguita la sperimentazione estesa.

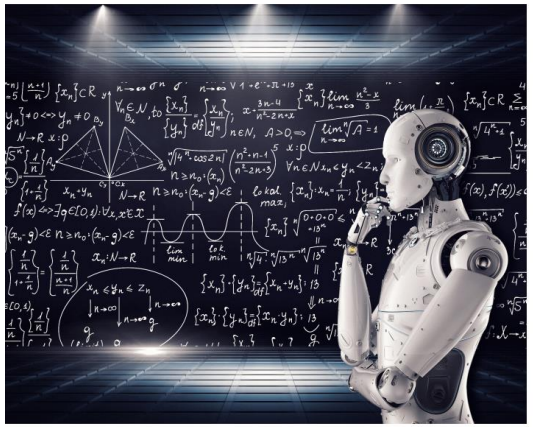
- La soluzione è stata progettata per **contribuire alla sostenibilità urbana**, attraverso l'offerta di **servizi innovativi di analisi, monitoraggio e ottimizzazione del traffico.**

L’ottimizzazione generativa permette di:

- ✓ **Decongestionare le strade:** ottimizzando i tempi dei semafori, i flussi di traffico e le vie di transito per ridurre i punti di congestione critica.
- ✓ **Migliorare l’accessibilità:** Promuovendo la connettività tra le aree urbane, migliorando l'accessibilità per pedoni, ciclisti e veicoli attraverso un miglioramento della pianificazione urbana.
- ✓ **Aumentare la sicurezza:** Implementando strategie per migliorare la sicurezza stradale, ad esempio attraverso la riduzione dei punti di conflitto e l'ottimizzazione dei flussi di traffico.

FUTURE AI RESEARCH

Call for tender for the presentation of intervention proposals for the Creation of Enlarged Partnerships extended to Universities, Research Centres, Enterprises and funding basic research projects to be funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.3 funded from the European Union - NextGenerationEU.



MUR

Piano Nazionale di Ripresa e Resilienza #NEXTGENERATIONITALIA

National Research Council of Italy

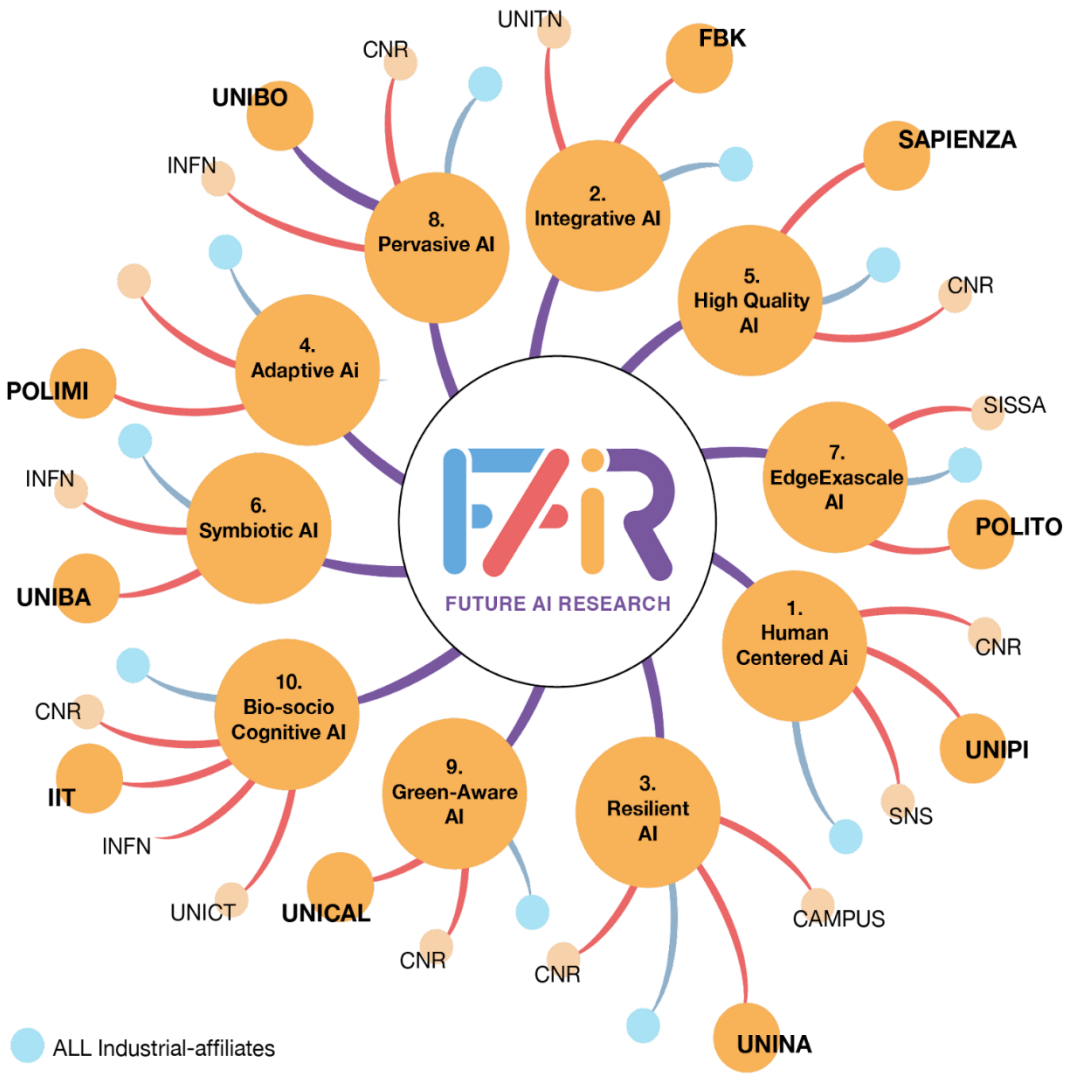


Fig. A.2 Spokes and Affiliates

Collaborative Explainable neuro-symbolic AI for Decision Support Assistant

- **New Algorithms or Models**: Development of novel AI algorithms or models that can enhance decision-making processes.
- **NGDSS Theories**: Contribution to the theoretical understanding of how AI can be effectively integrated into decision support systems.
- **Early Prototype** of the NGDSS, providing a proof of concept for how AI can enhance decision-making in a number of target domains

Interreg
Euro-MED

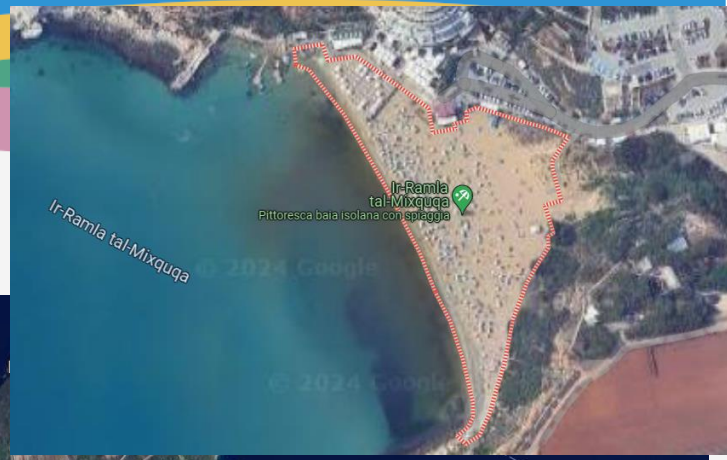
Co-funded by
the European Union

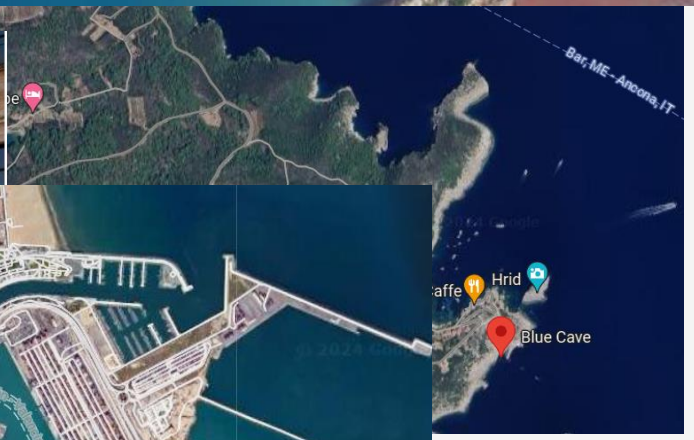
TOURISMO EURO MED

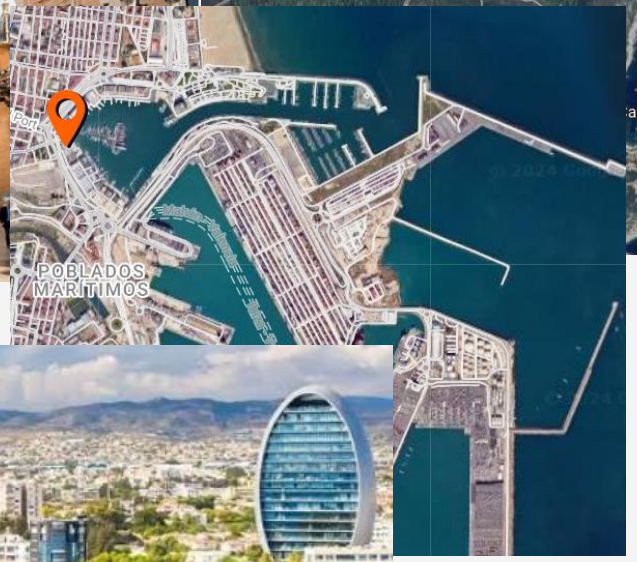
TOURism Innovative and Sustainable Management of flOws

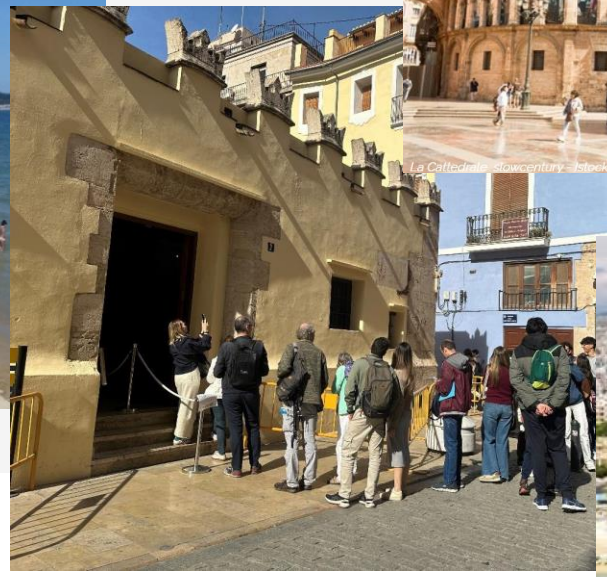
SNAP4CITY

- Pilots of Snap4City on:
  - Greece - READ S.A.: Rodi
  - Italy – FRI, UNIFI: Firenze
  - Spain – FV, FSMLR: Valencia
  - Cyprus – ANELEM: Limassol
  - Bulgaria – VEDA: Varna
  - Croatia – RERA SD: Splitsko-dalmatinska županija
  - Malta – MRDDF: La Valletta



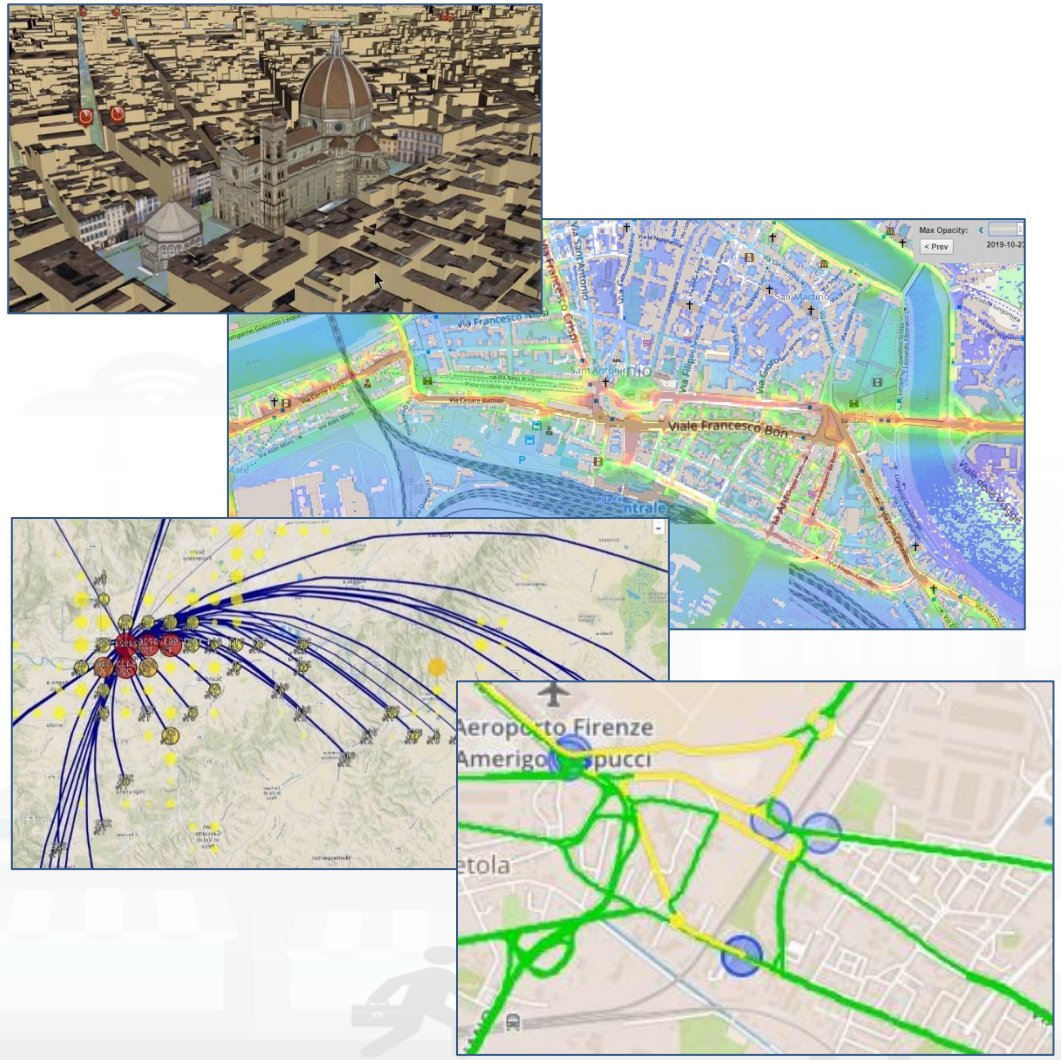






Interreg Euro-MED
Co-funded by the European Union

Smart City Digital Twin

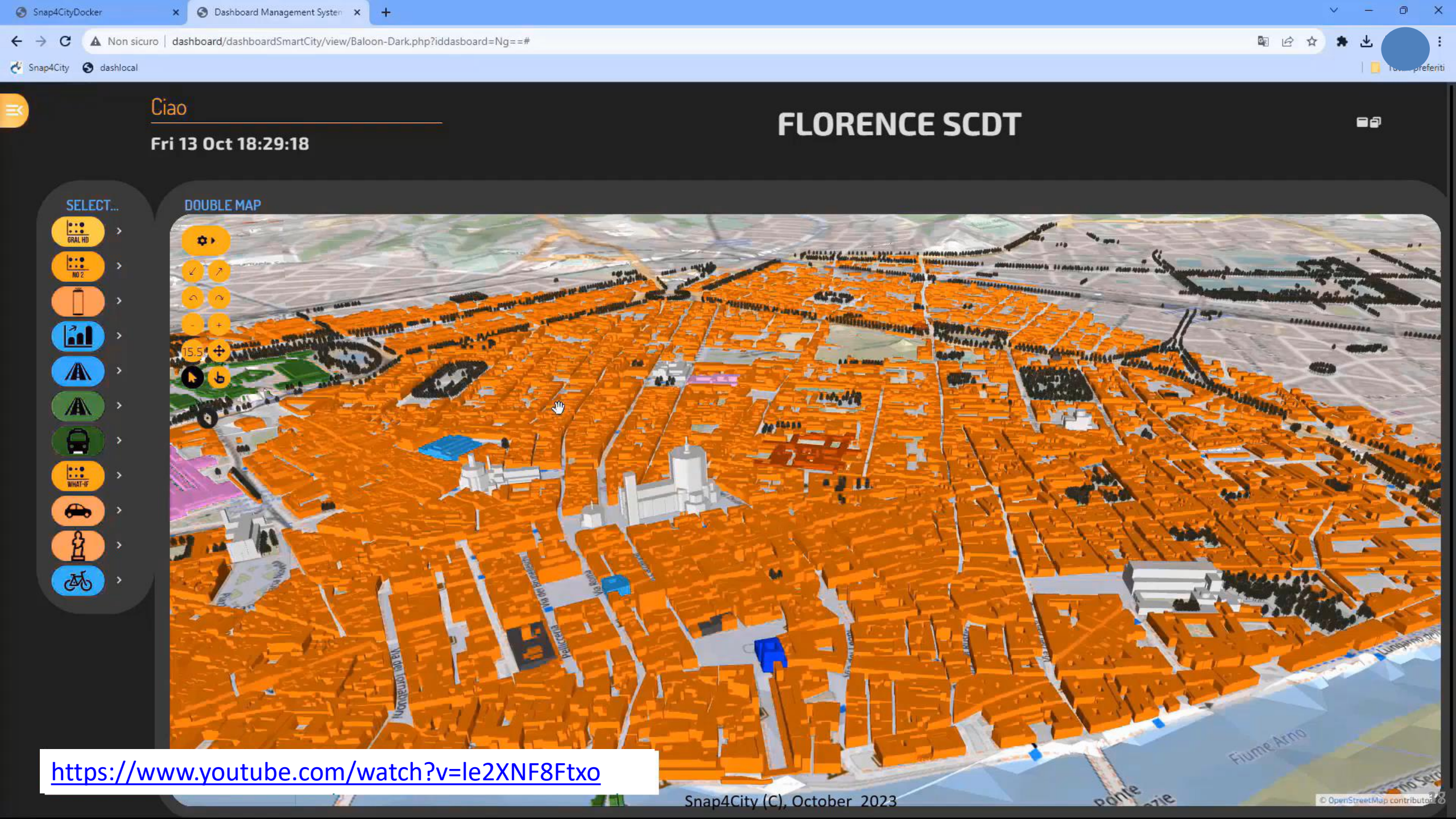


City Digital Model with…

- Intuitive platform
- Any Data TYPE, any data source, any protocol
- Data storage seamless
- Data analytics → artificial intelligence, AI/XAI
- Data Ethics, AI Ethics, GDPR
- Interactive Data Representation, any kind
- Key Performance Indicators, any kind
- What-IF analysis – Simulation, prediction, 2D/3D
- Micro, Meso e macro scales
- Operation, planning tactic and strategic / optimization
- Collaborative and shared representation
- Sustainable, shared, open source 100%

Complex and heterogeneous information, interoperability

- GIS, ITS, AVM, IoT, BIM, CKAN, etc.
- Satellite services
- MaaS, last-mile delivery HUBs
- etc.



https://www.youtube.com/watch?v=le2XNF8Ftxo


Firenze Oggi
Mon 16 May 12:59:27
20991
COLONNINE
SITUAZIONE VIABILI
0 INCIDENTI
0 CHIUSURE AL TRAFFICO
0 CHIUSURE PER CANTIERI
0 PROGR.
0 NON PROG.
0 LIMITAZIONI AL TRAFFICO
0 LIMITAZIONI PER CANTIERI
0 NON PROG.
0 PROGR.
0 TOT. EVENTI SULLA RETE
SMN 42.2
BINA 54.5
FORT 23.2
LEOP 37.3
CALZA 48
S.AM 58.6
PART 55
CARE 13.8
BECC 77.6
ANALYSIS
Energy
Environment
Mobility
Social
Resilience
FLUSSI INGRESSO CIT
TOTA
92207
FLUSSI INGRESSO ZTL
TOTA
15964
Nati italiani 175
Nati s. 48
Dece 499
Matri 72
Unio 2
Manutenzioni Strad 19
Verde 18
Decoro Urba 3
Rein 5
Indicatore Rt per la provincia di
Rt
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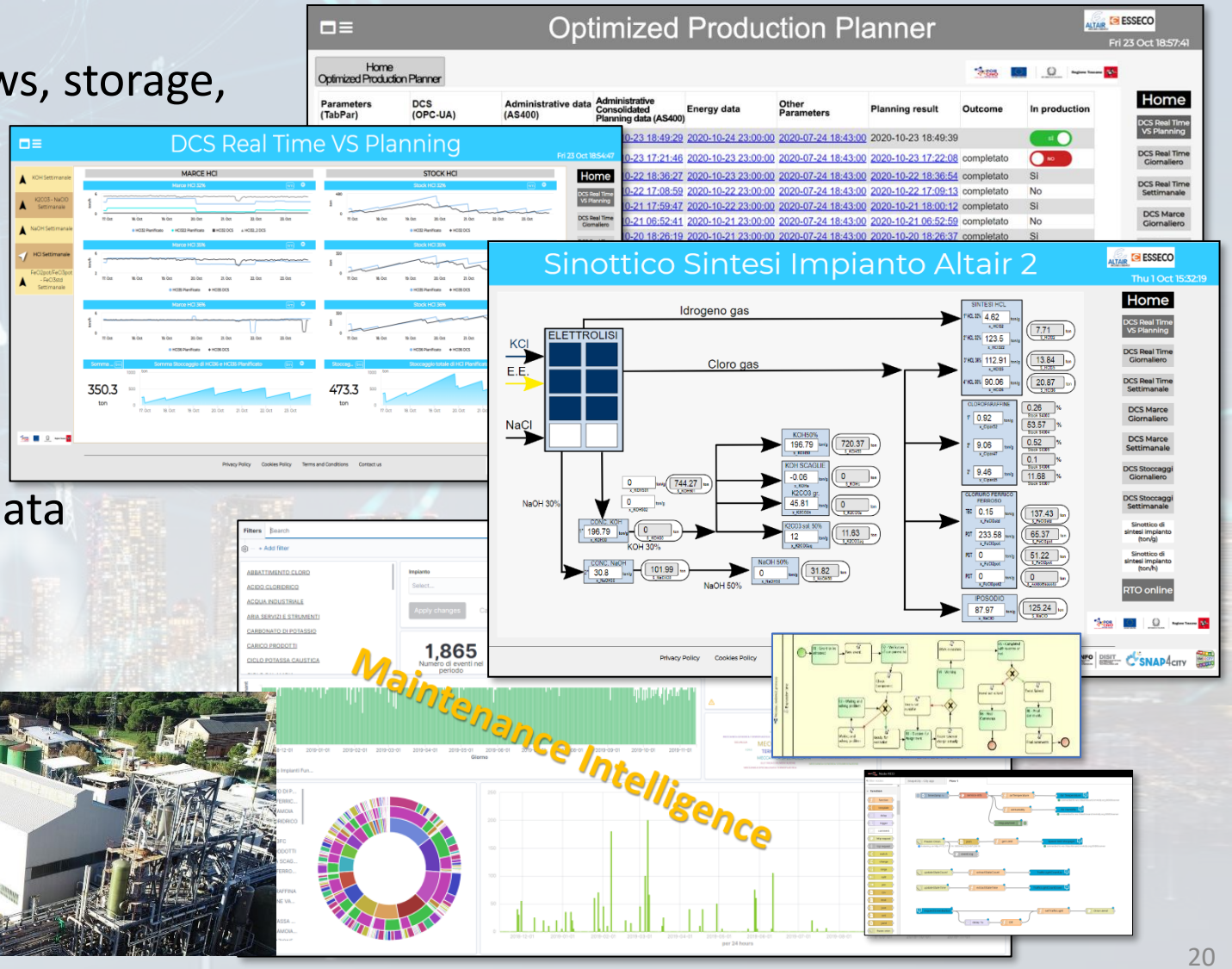
The European House Ambrosetti
The European House Ambrosetti
The European House Ambrosetti
The European House Ambrosetti

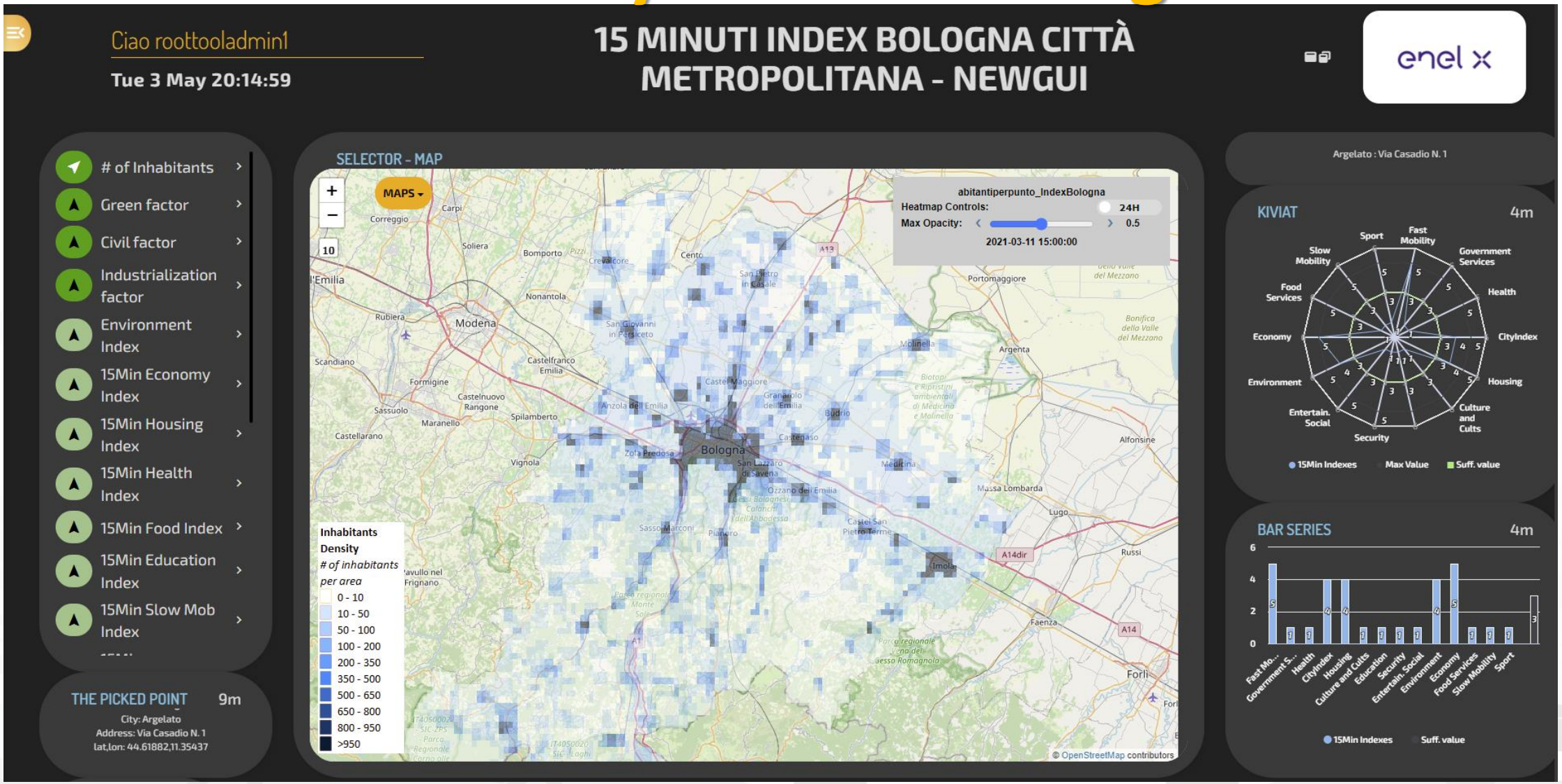
Snap4Altair Decision Support supervision and control, Industry 4.0

reference

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



15MinCityIndex on Bologna



https://www.snap4city.org/dashboardSmartCity/view/Baloon-Dark.php?iddasboard=MzQxMg==

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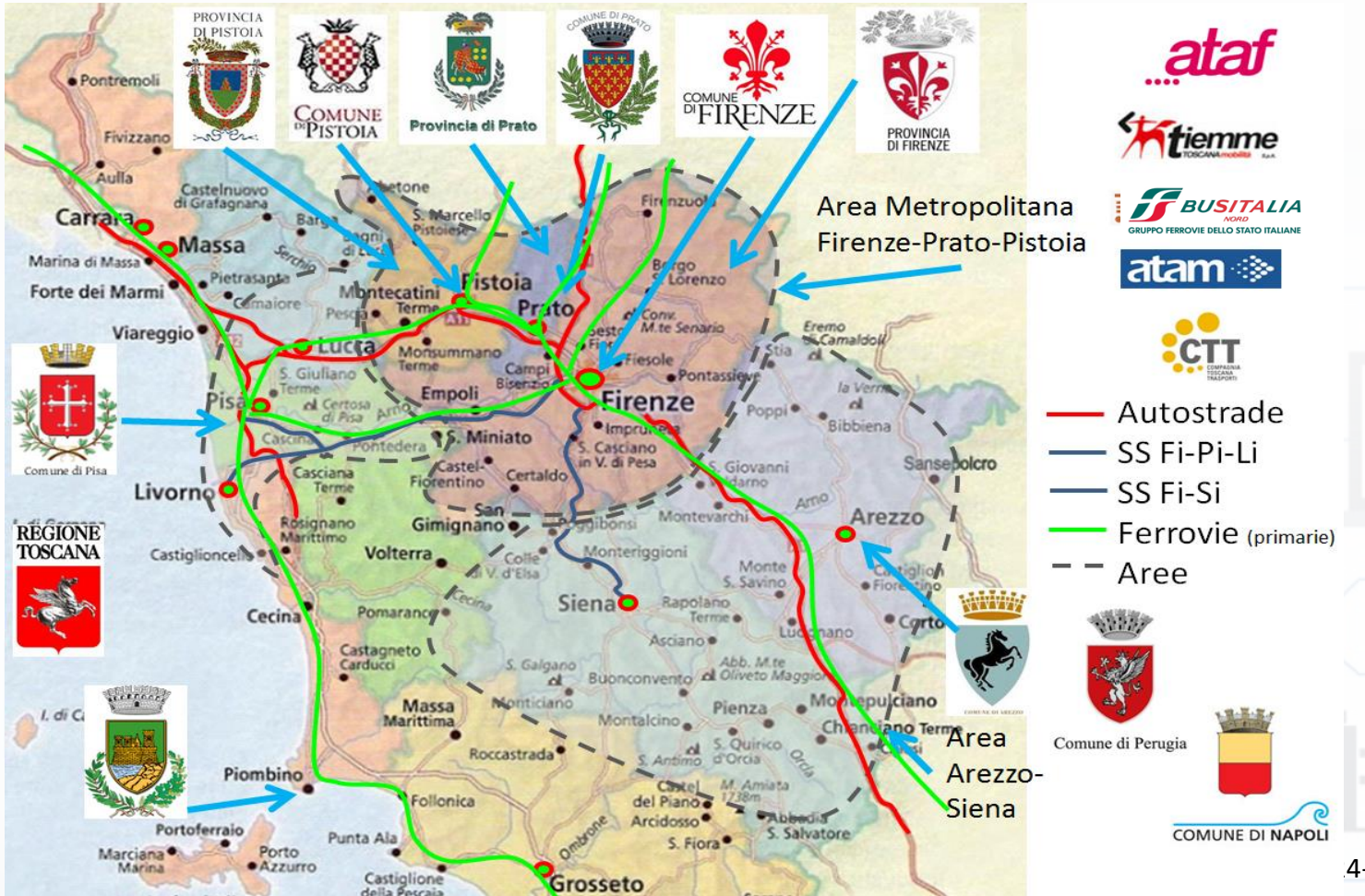
Sii-Mobility

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

DISIT lab,

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

Regione Toscana

Fondazione per la ricerca e l'innovazione

Interreg Mediterranean HERIT-DATA

Sustainable and responsible Tourism Management

Key aspect: **Carrying Capacity**

consider **European Tourism Indicators ETIS**

Respectful of the **ICZM recommendations**

Cultural heritage

Special interest on **UNESCO World Heritage Sites**

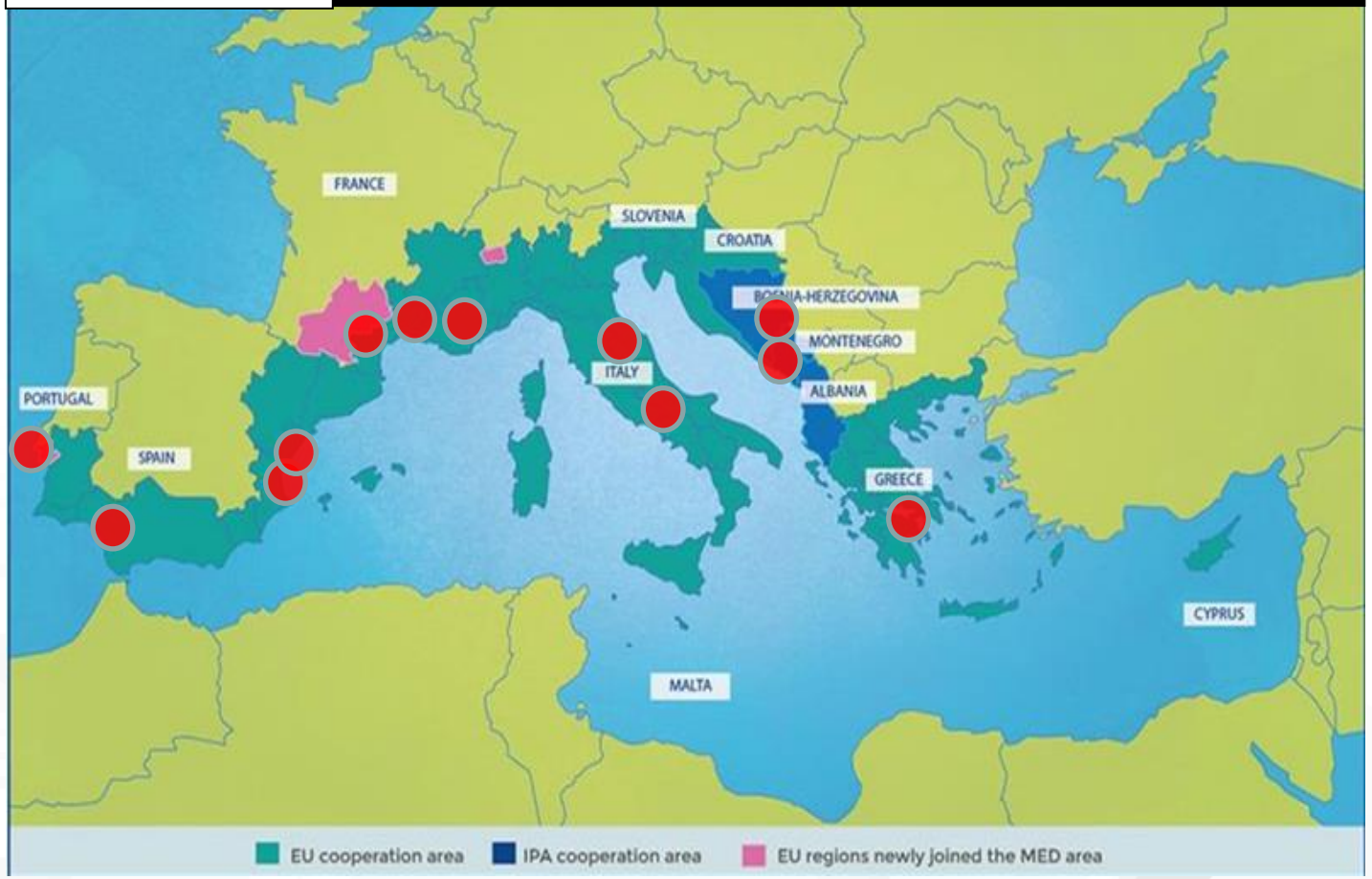
Evaluation of impact

Big & Open data

At service of Planners, visitors, local stakeholders and dwellers

Interreg Mediterranean HERIT-DATA

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



DISIT lab roadmap vs model and tools' usage

2013

Km4City Ontology 1.1

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

2014

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

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.5

Km4City 1.4

2015

ckan

resolute

H2020 (2015-18)

(2016-21) H2020 REPLICATE

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

2016

FIWARE

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

(2016-21) Sii-Mobility MIUR

SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

Km4City 1.6.4

Sii-Mobility

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

EØ15 digital ecosystem (Powered by EXPO MILANO 2015)

(2016-19) MIUR

GHOST SIR

- Sardinia Region Smart City Strategies and plan

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

GREEN IMPACT

POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

2017

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

life weee (2017-20)

- Smart Waste

2018

MOSAiC Mobility 4.0 for SmArt (i) City (2018-20)

- Mobility Demand / Offer Analytics and Strategy

Sii-Mobility

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

IOT/IOE

Km4City 1.6.6

Node-RED

SNAP4CITY

SELECT for Cities H2020 (2017-19)

2019

5G (2018-21)

5G tech
Energy
Industry 4.0
Synoptics

TRAFAIR

CEF (2018-21)

- Traffic and Mobility Impact on Pollution
- NOX predictions

EUROPEAN OPEN SCIENCE CLOUD

SIRIUS

LAID Smart Bed

- Smart Health

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

- Industry 4.0

bee smart city

SNAP4CITY

SODA

Winner of Select4Cities PCP

- Smart Lonato

Reverberi Enetec Gruppo MPES

SNAP4CITY roadmap

2020

- Sii-Mobility
- JRC EUROPEAN COMMISSION Contract
- Interreg Mediterranean HERIT-DATA
  - Smart Tourism
  - 6 Pilots
  - Data Analytics
  - Extended platform
- Interreg MARITTIMO-IT FR-MARITIME MOBI MART
  - Smart Mobility
  - PISA, PUMS
  - Living lab
- smartGARDAlake
- Km4City 1.6.7
- Smart Ambulance (2021-22)

2021

- Enterprise (2021-22) Industry 4.0
- Sii-Mobility
- enel x Contract
- JRC EUROPEAN COMMISSION Contract
- PC4City (2020-21) Monitoring Terrain
- Winner of Open Data Challenge of enel x
- CAPELON
  - Smart Light
  - Sweden

2022

- Almafluida Industry 4.0 (2021-22)
- AMPERE (2021-22) Industry 4.0
- SYN-RG-AI SmartCity
- GRUPPO PRETTO Industry 4.0
- uni.systems SmartCity, 2021-23
- AXIS COMMUNICATIONS AXIS collab SmartCity
- ASYMMETRICA URBAN TECHNOLOGY Asymmetrica Smart City, 2022-23
- ITALFERR GRUPPO FERROVIE DELLO STATO ITALIANE Italferr, Smart City

2023

- JRC EUROPEAN COMMISSION Contract, 2022-23
- ART-ER ATTRATTIVITÀ RICERCA TERRITORIO Contract, 2022-23
- Filippi 2022-2023
- enel x Contract, 15min
- IMPETUS Security and Risk
- Smartea

2024

- MOST CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE CN MOST, 2022-26 — Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
- EI THE, 2022-26 — Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
- G. Agile, 2021-23
- TUSCANY X.0 EDIH 2023-26 — Finanziato dall'Unione europea NextGenerationEU
- Merano, smart light
- OceanRace, Genova, AWS
- Cuneo, smart city
- TOURISMO — Interreg Euro-MED — Co-funded by the European Union
- AMMIRARE — Interreg MARITTIMO-IT FR-MARITIME
- eShare UNIFI TUSS
- Rhodes, smart city
- SASUAM — MOST CENTRO NAZIONALE — Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
- OPTIFaaS — MOST CENTRO NAZIONALE — Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
- FAIR Future Artificial Intelligence Research — Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
- CAI4DSA
- JRC EUROPEAN COMMISSION Contract, 2024-25
- ELLIE IA 2025-2027

https://www.Snap4City.org

100% OPEN SOURCE

PEN Test Passed

EU GDPR COMPLIANT

SNAP4CITY

Node-RED

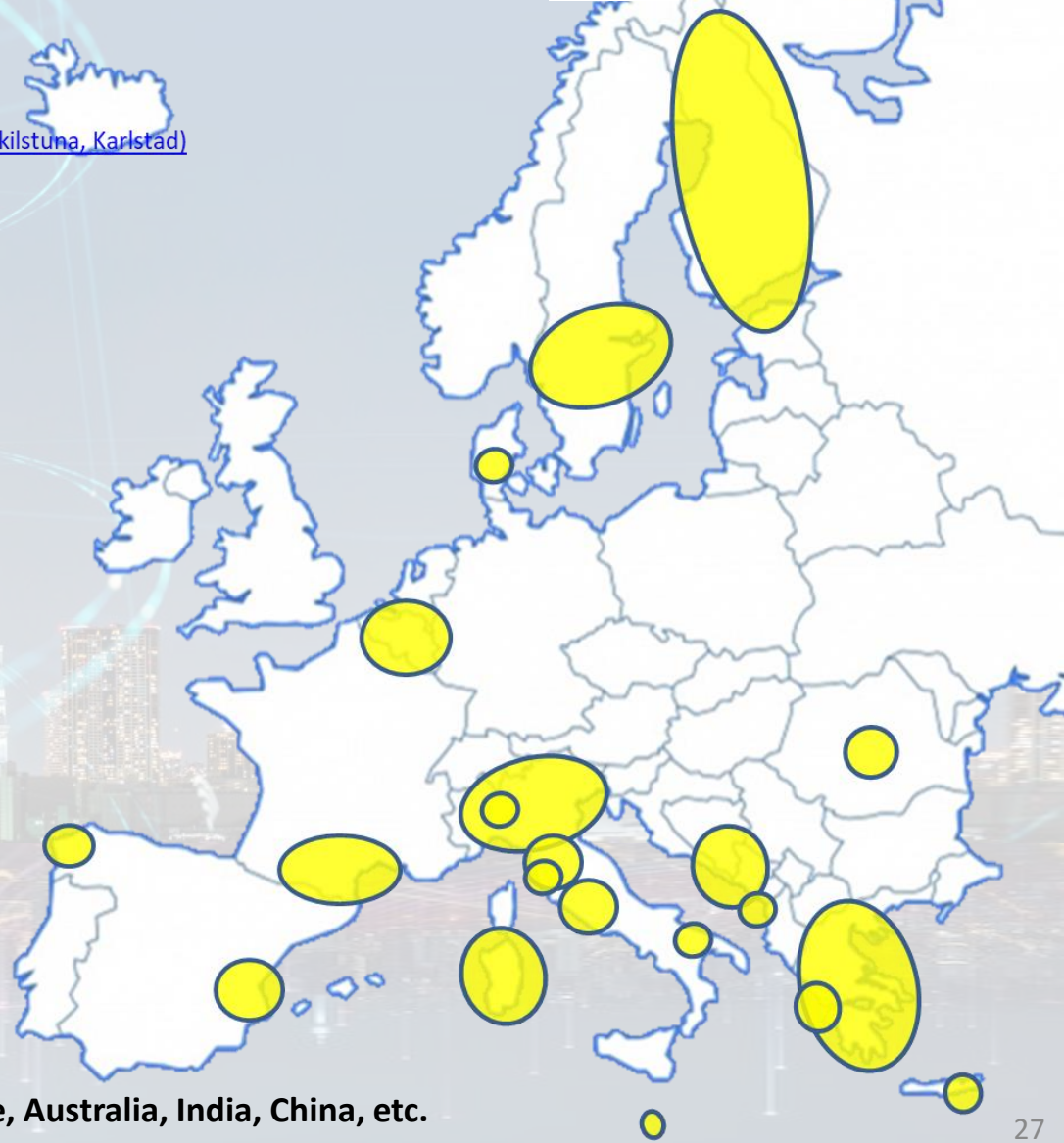
FIWARE

KM4CITY

- 11 running installations in Europe
  - Snap4.city.org, Greece, Merano, Cuneo, …
  - Toscana, Pisa, Sweden, ISPRA, Snap4.eu,
  - Altair, Italmatic, Romania, ….
- 16 projects, 12 pilots on 10 Countries
  - >40 cities/area
- **Widest MULTI-tenant deploy has**
  - 24 Organizations / tenant
  - > 8850 users on
  - > 1800 Dashboards
  - > 17 mobile Apps
  - **> 2.2 Million of structured data per day**
  - > 580 IoT Applications/node-RED
  - > 750 web pages with training
  - > 75 videos, training videos

Main Organizations/areas

- Antwerp area (Be)
- Bari (I)
- Bisevo, Croatia
- Bologna (I)
- Brasov (Ro)
- Capelon (Sweden: Västerås, Eskilstuna, Karlstad)
- Cuneo (I)
- DISIT demo (multiple)
- Dubrovnik, Croatia
- Firenze area (I)
- Garda Lake area (I)
- Greece (Gr)
- Helsinki area (Fin)
- Limassol (Cy)
- Livorno area (I)
- Lonato del Garda (I)
- Malta (Malta)
- Merano (I)
- Modena (I)
- Mostar, Bosnia-Herzegovina
- Oslo & Padova (Impetus)
- Pisa area (I)
- Pistoia (I)
- Pont du Gard, Occitanie (Fr)
- Prato (I)
- Rhodes (Gr)
- Roma (I)
- Santiago de Compostela (S)
- Sardegna Region (I)
- Siena (I)
- SmartBed (multiple)
- Toscana Region (I), SM
- Valencia (S)
- Venezia area (I)
- WestGreece area (Gr)

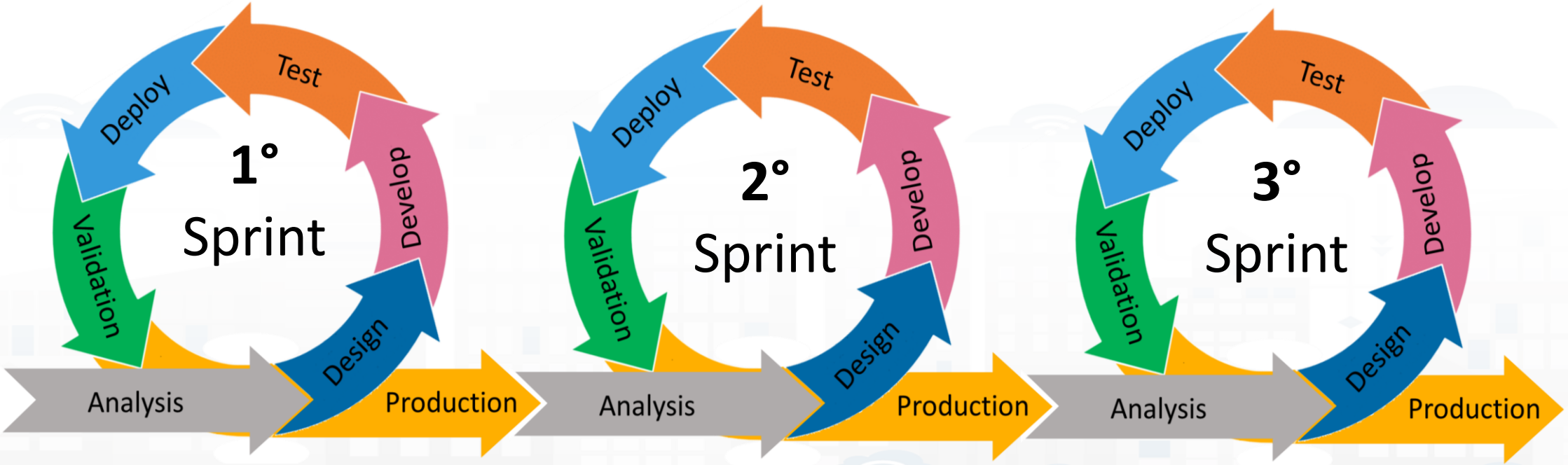


- **+ Israel, Colombia, Brasile, Australia, India, China, etc.**

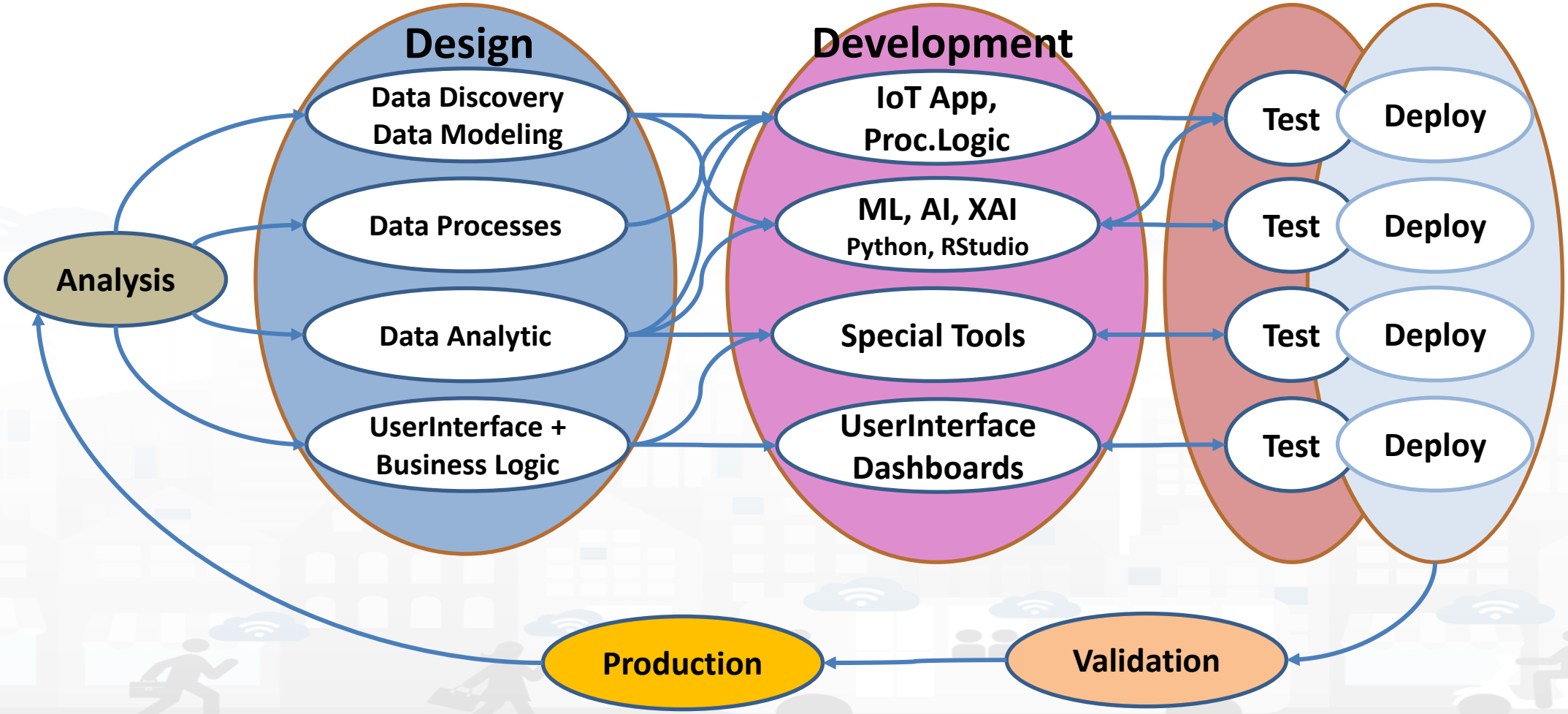
Agenda

- Laboratorio DISIT
- Tematiche del corso
- Struttura del corso
- Infrastruttura del DISIT Lab
- Modalità dell'esame

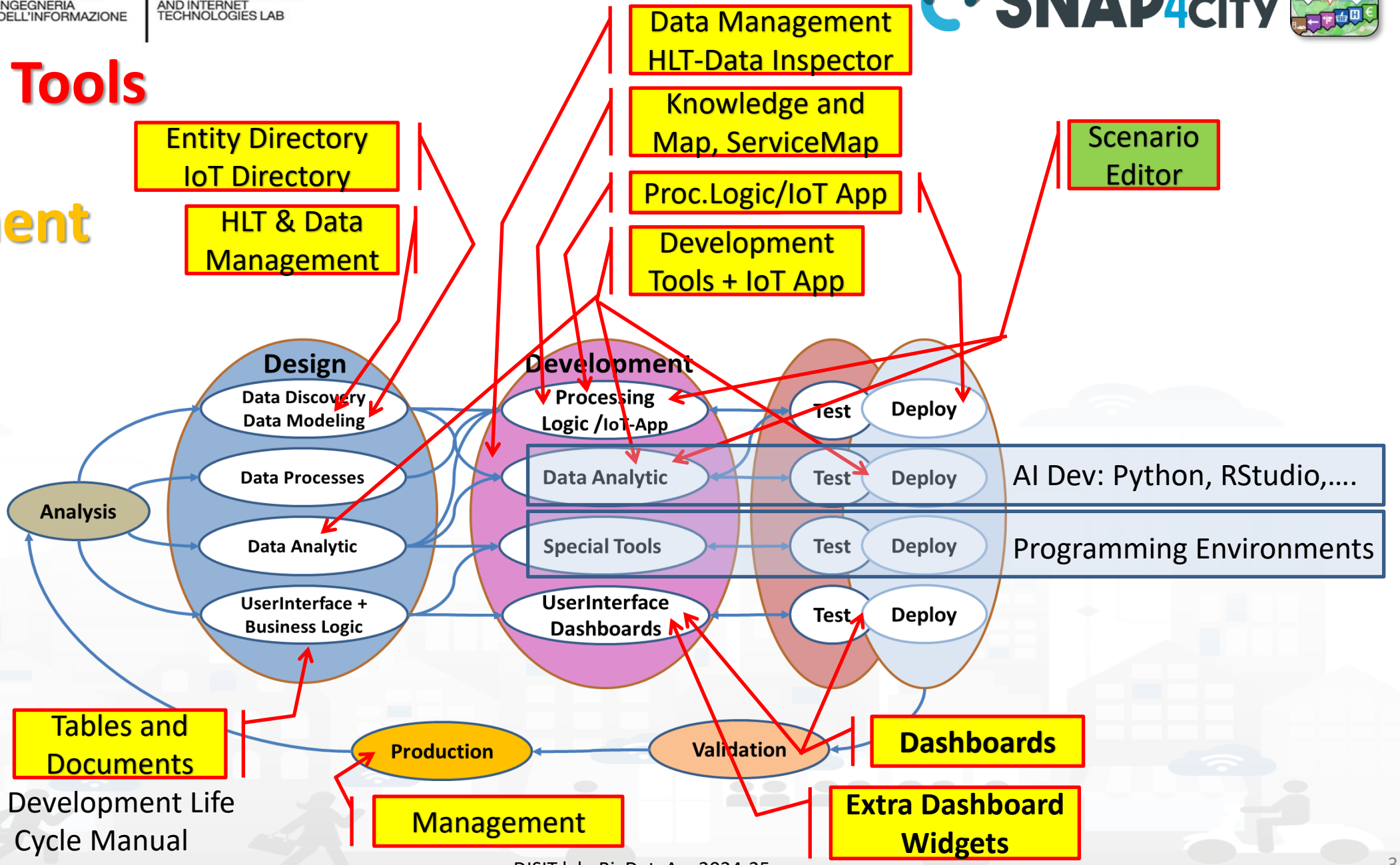
Agile Development Life Cycle by sprint Smart Solutions



Development Life Cycle Smart Solutions



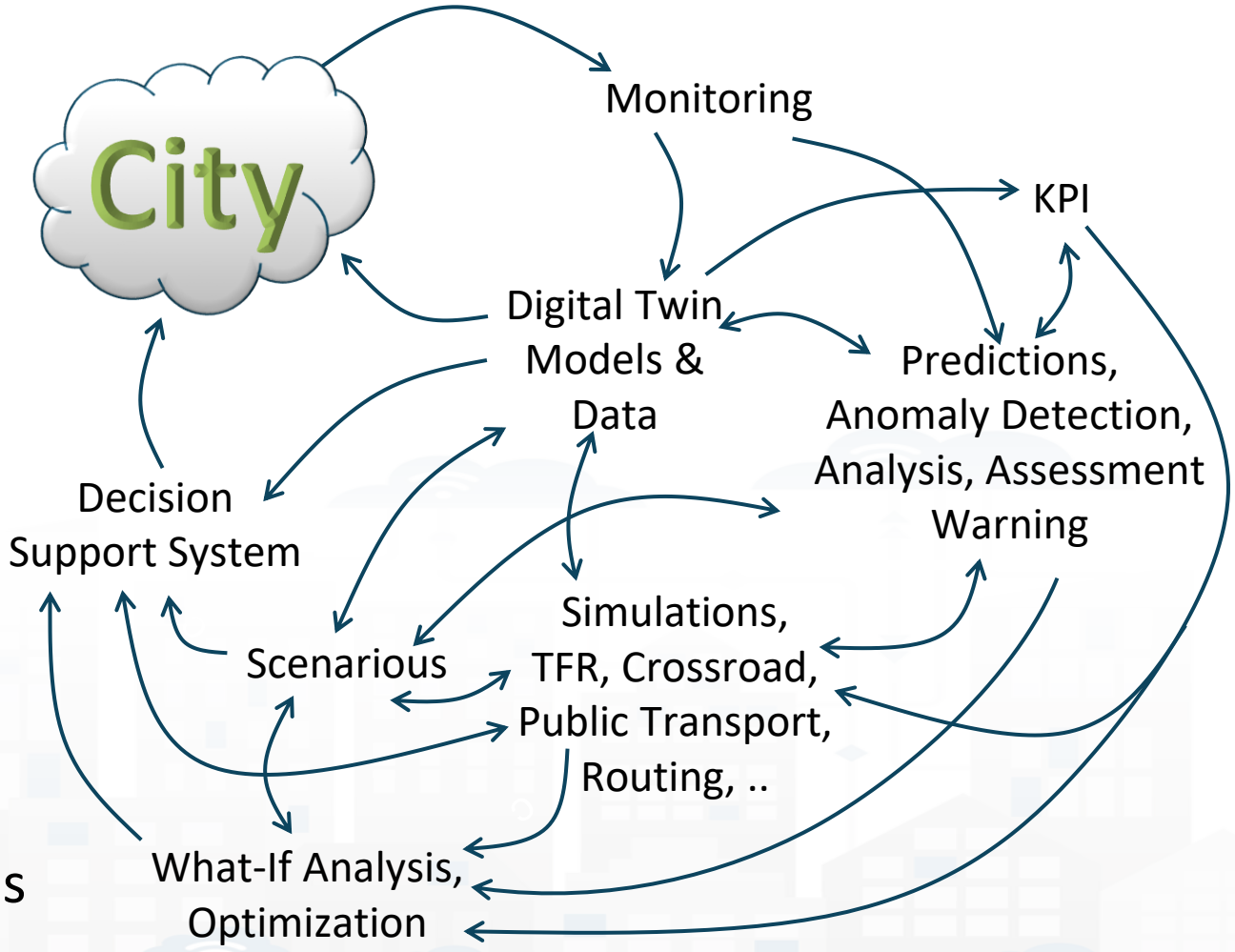
Snap4City Tools vs Development Life Cycle

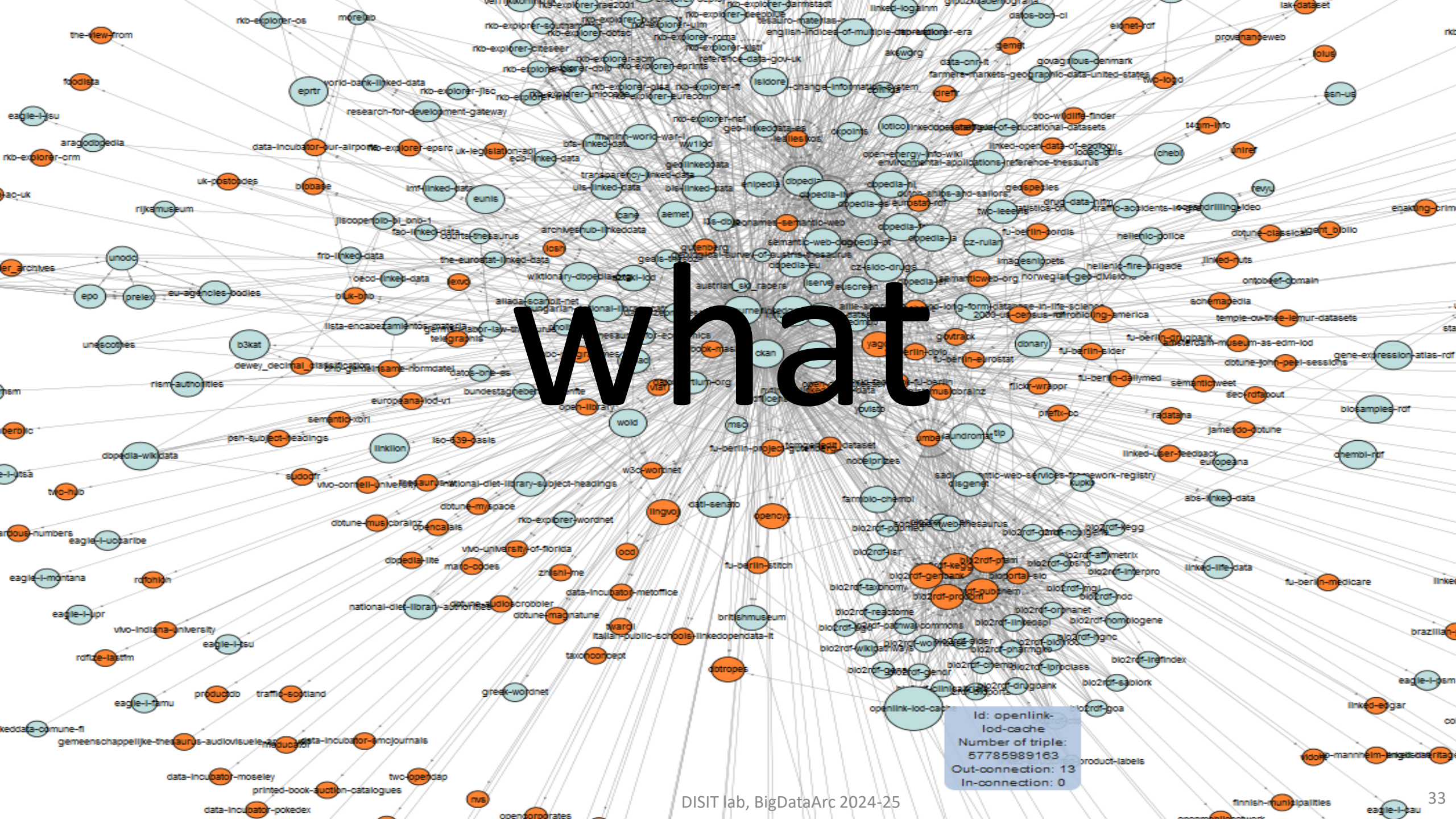


Development Life Cycle Manual

Main tasks

- **Controlling Status: management, and operational**
  - Monitoring via KPI
  - Predictions vs KPI
  - Anomaly detection
  - Neuro-Symbolic analysis
  - Risk assessment
  - Early warning on critical conditions
- **Making plan: tactic and strategic, medium and long range, micro/macro**
  - Simulation & optimization
  - Generative AI Prescriptions, scenarios
  - Resilience to Unexpected unknows
  - What-if analysis wrt scenarios




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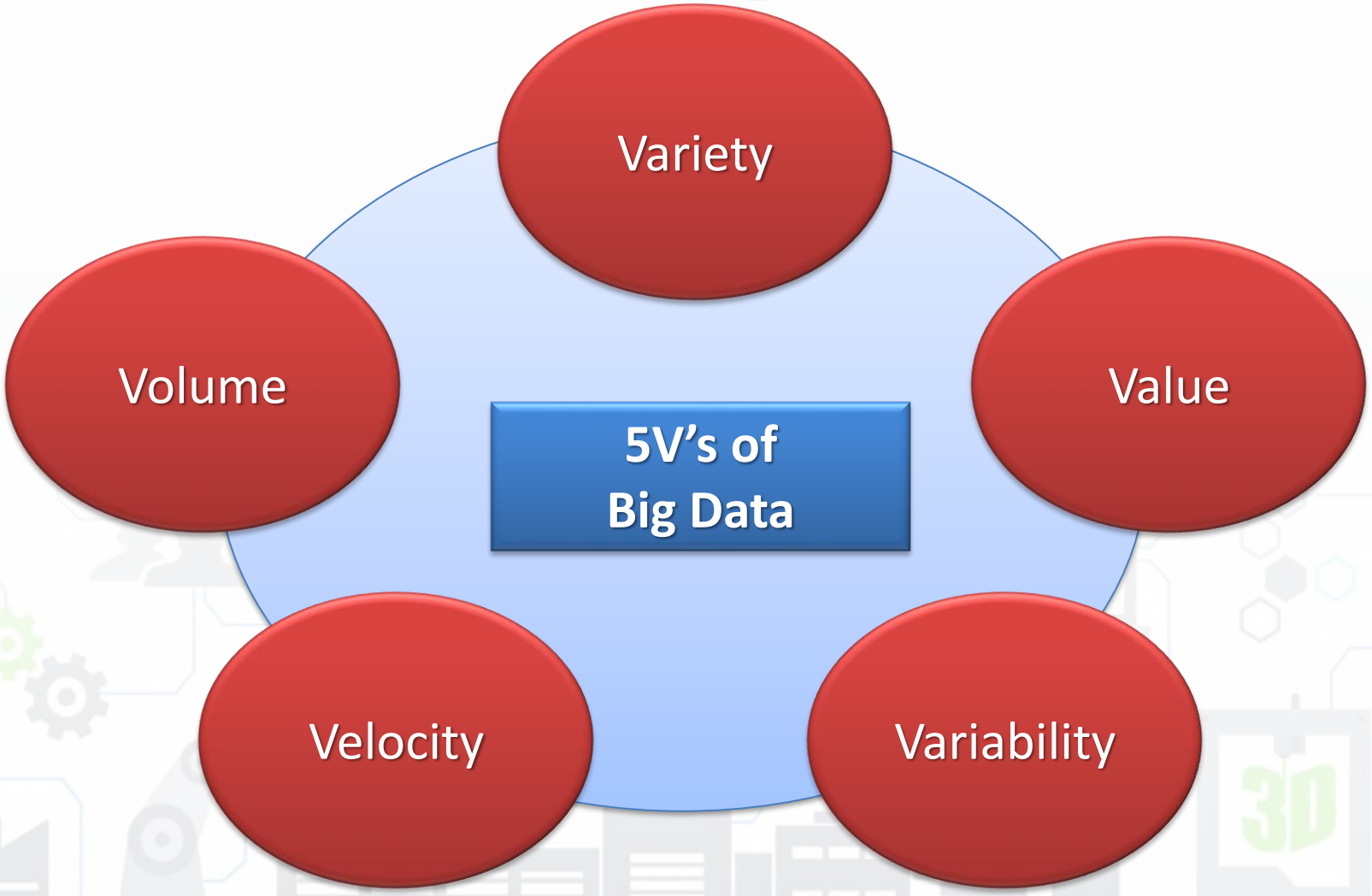
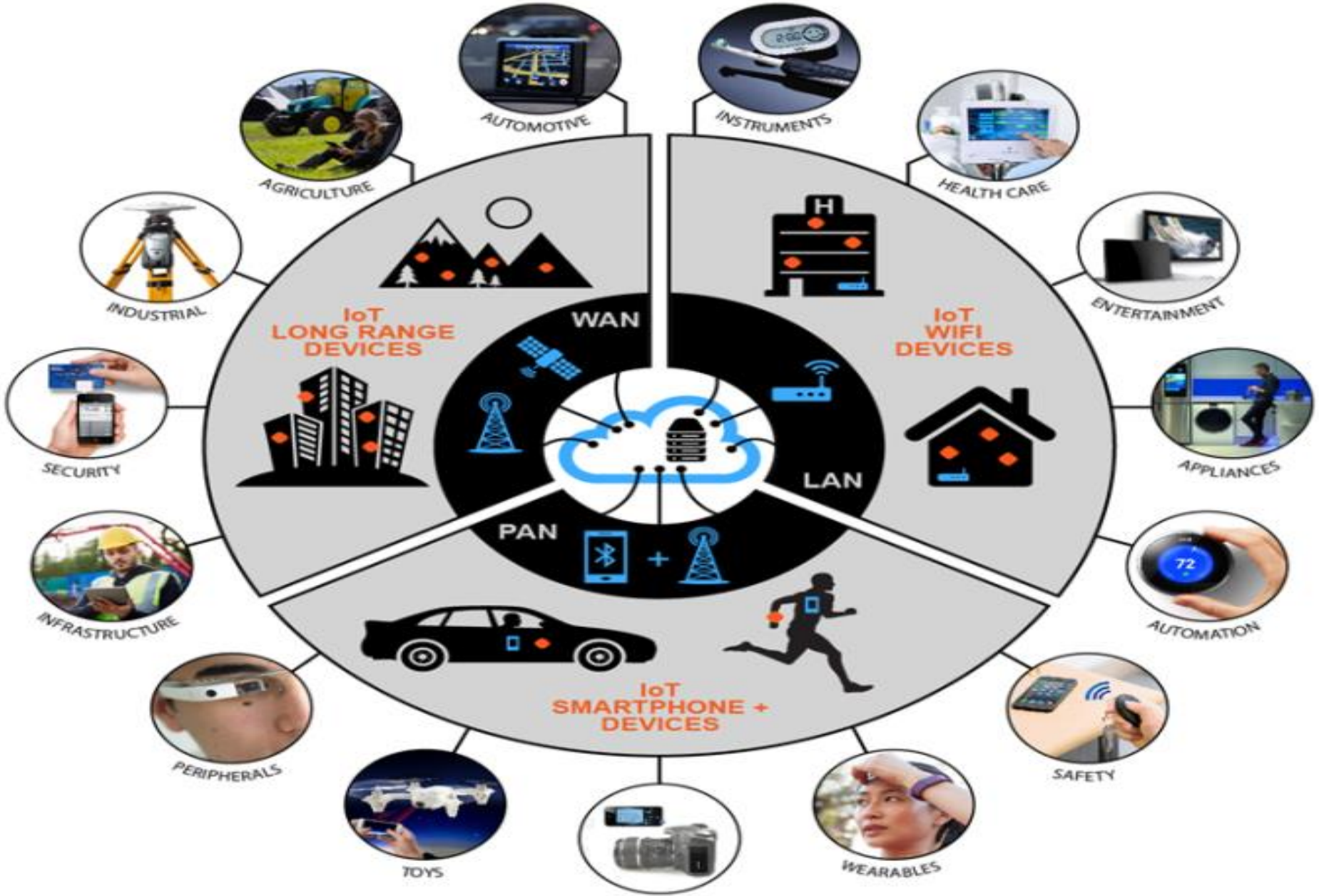
Number of triple: 57785989163
Out-connection: 13
In-connection: 0

5V of Big Data

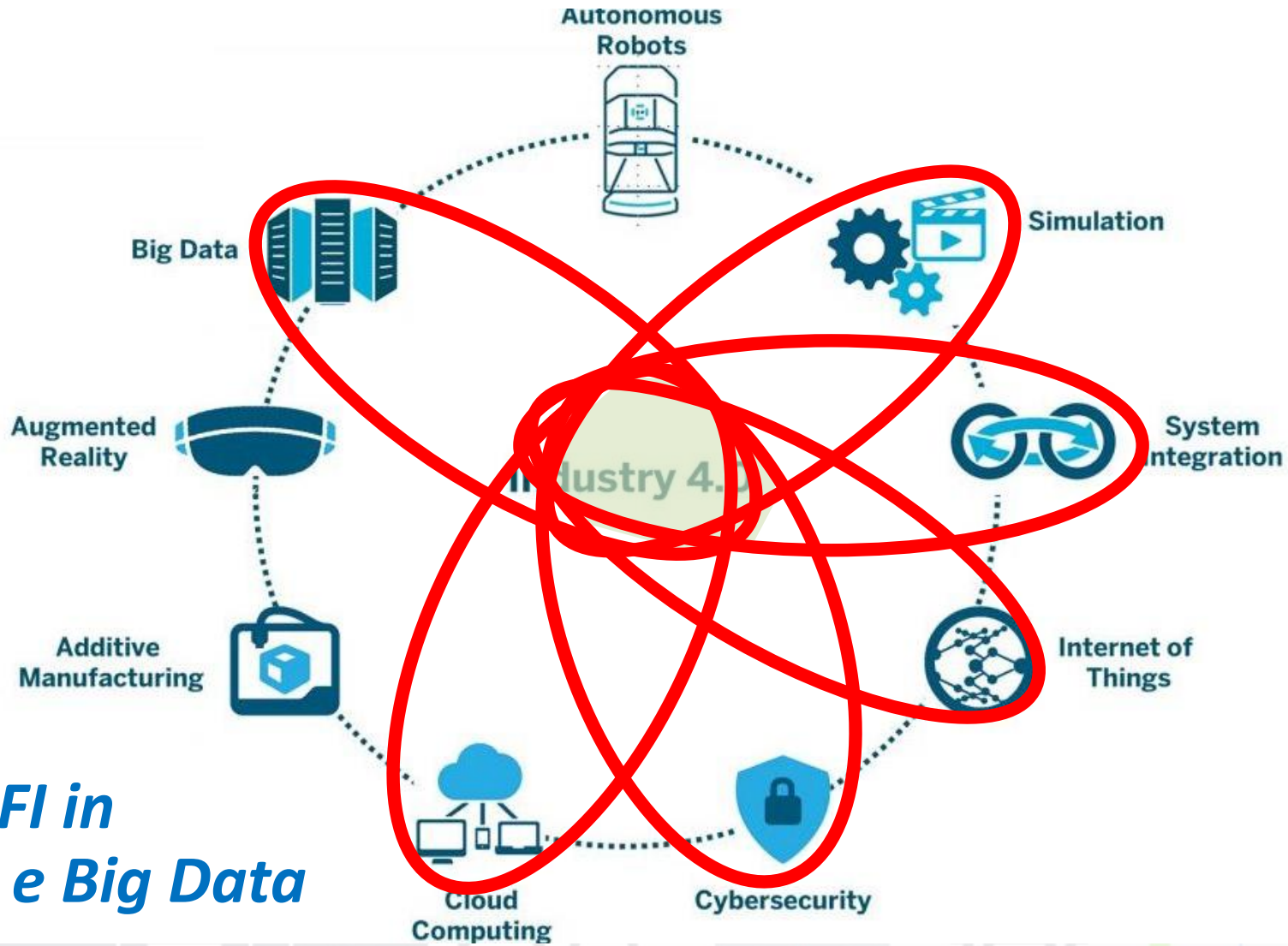


Bia Data & Analytics



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

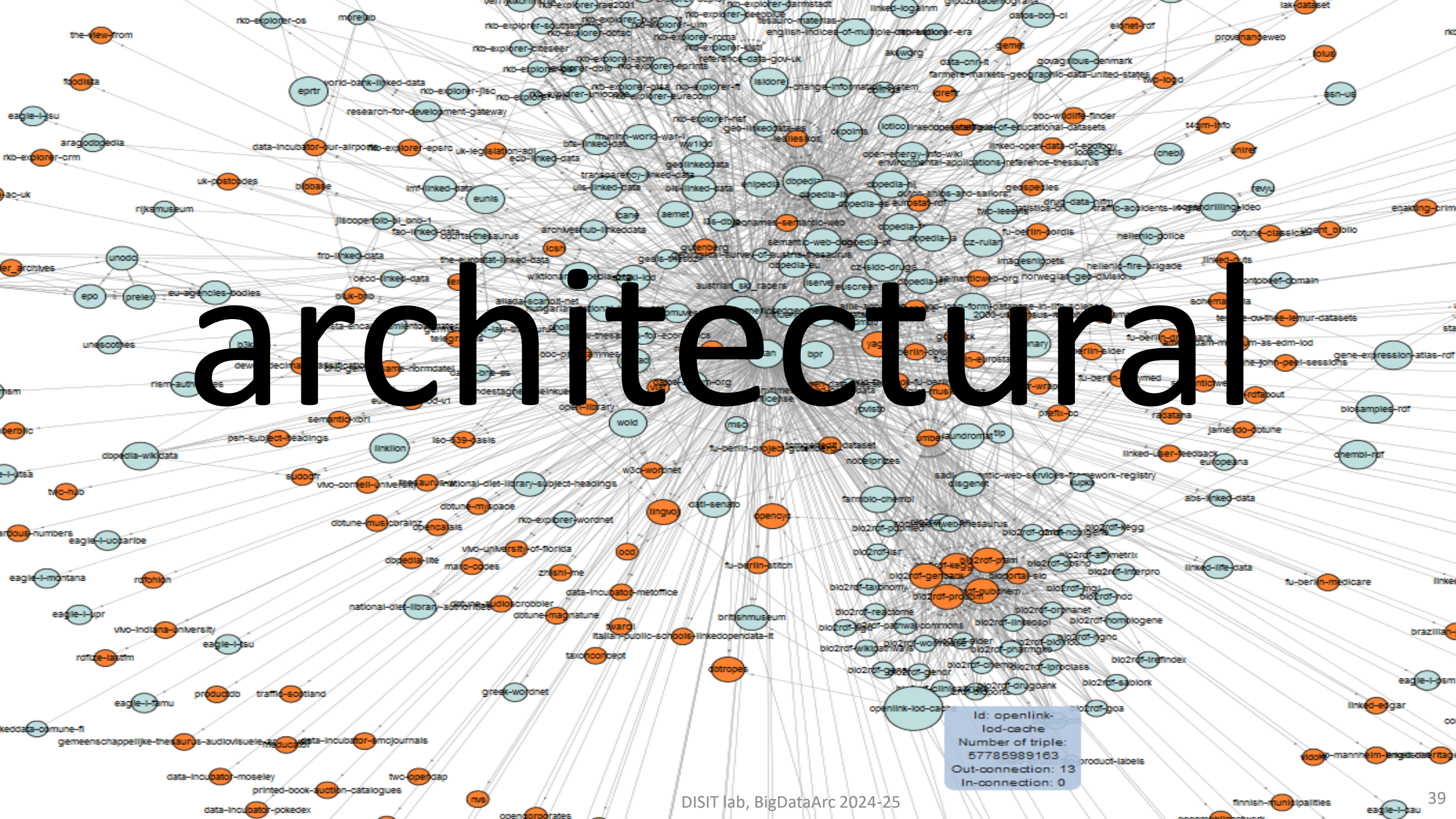
- **Technologies:**
  - **Big Data Architectures:** architectures for managing big data, processing, ingesting and exploiting them in real time
    - **Cloud:** smart cloud, cloud simulation, optimization, containers, ..
    - **Storage, parallel architectures, data driven, etc…..**
    - **IOT/IOE:** internet of things/everything, brokers, microservices, ..
    - **Mobile Computing:** mobile application, user behavior analysis, ..
  - **Big Data Analytics:** data management, prediction, predictive maintenance, early detection, anomaly detection, data intelligence, what-if analysis, simulation, …
    - **Data Mining:** artificial intelligence, machine learning, natural language processing, semantic computing, semantic reasoner, expert systems, statistic analysis, ..
    - **NLP and Sentiment Analysis:** response vigilance, interaction, answering, Personal Assistant, NLP, SA, ..
- **See projects on:** https://www.snap4city.org/download/video/course/da/Snap4City-4th-slot-Data-Analytic-v7-2.pdf

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**.

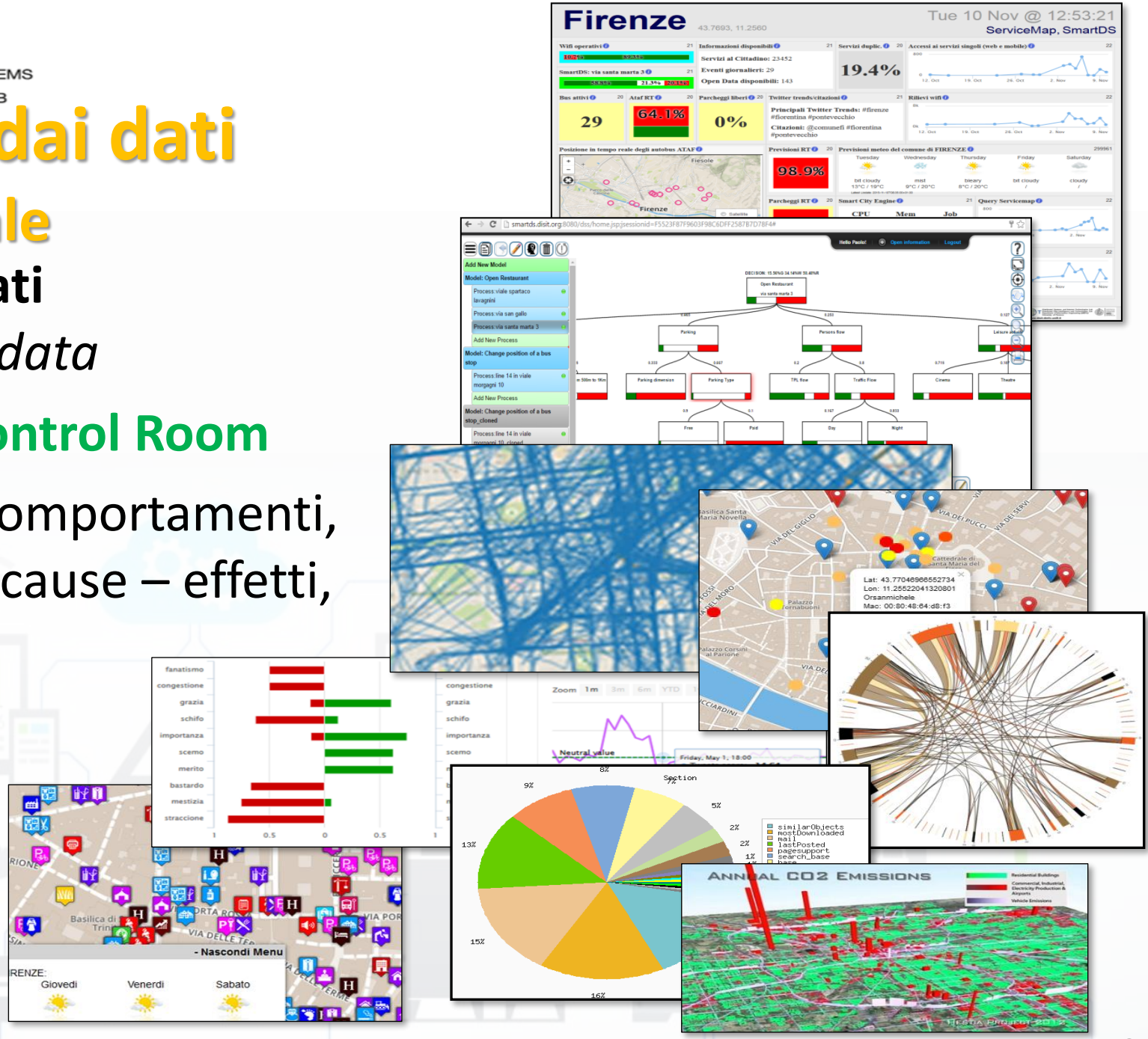
- **Present Domains of DISIT Big Data Analytics and Scientific Research**
  - Mobility and transport
  - Energy and Govern
  - Tourism & user behavior
  - Environment and health
  - Industry 4.0, IOT
  - Security
- **Former**
  - Social Network – Internet Service – Web Data
  - Educational

architectural



Decisioni supportate dai dati periodiche ed in tempo reale

- **Condivisione e Integrazione Dati multidominio:** *semantica e bigdata*
- **Dati →Smart City Engine → 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



Architettura di base Big Data, IOT, Industry 4.0

Data Sources

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

Data Stream analysis

Spark, Storm, Kafka

Big Data Cluster

HDFS, noSQL

Indexing

SOLR, Elastic search

Search and Query

Facet, cluster

Rendering acting

User interface, Dashboard Drill down

Data Transformati on

ETL, NIFI

Data Analytics

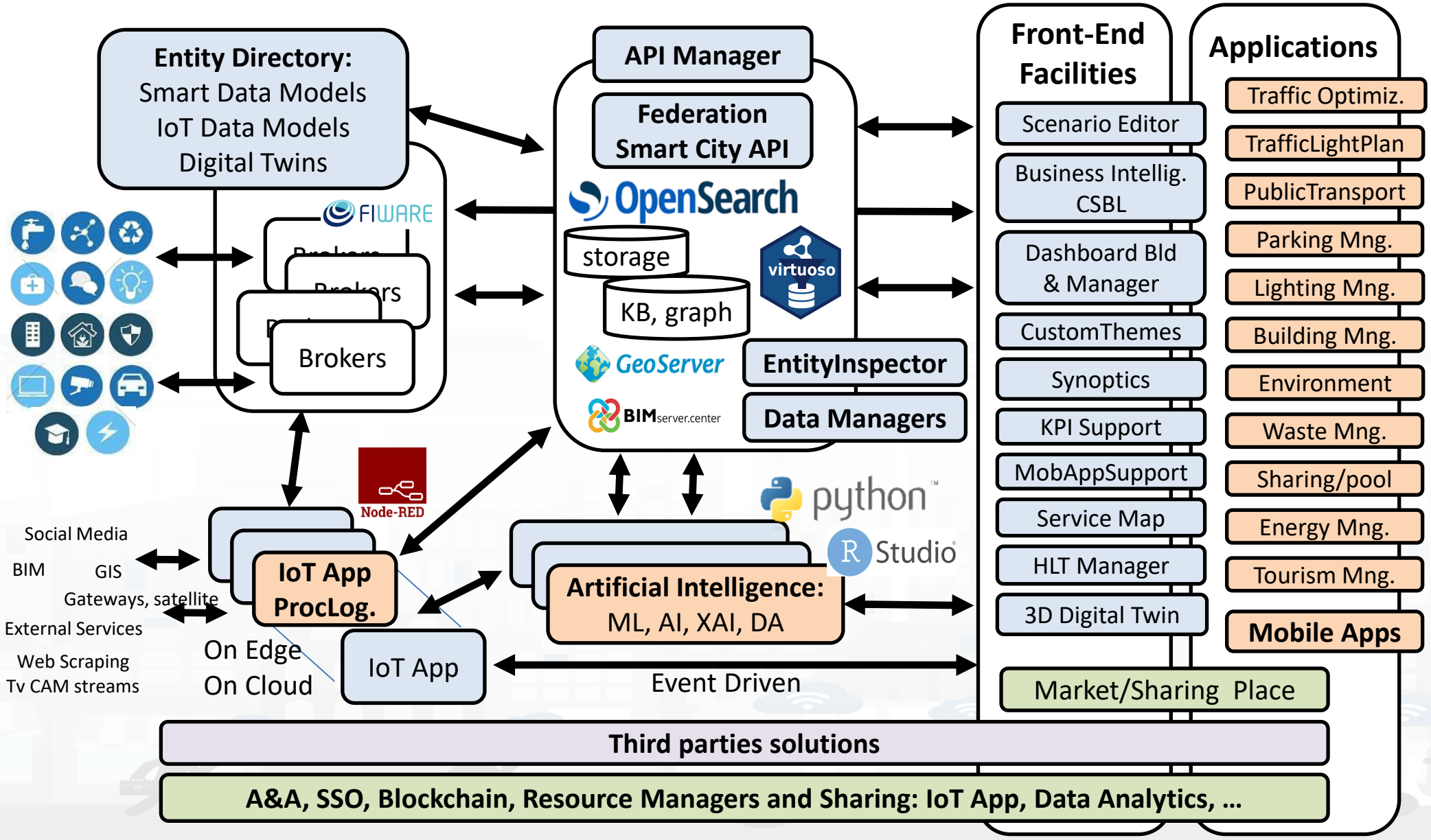
R, TF, …

Visual Analytics

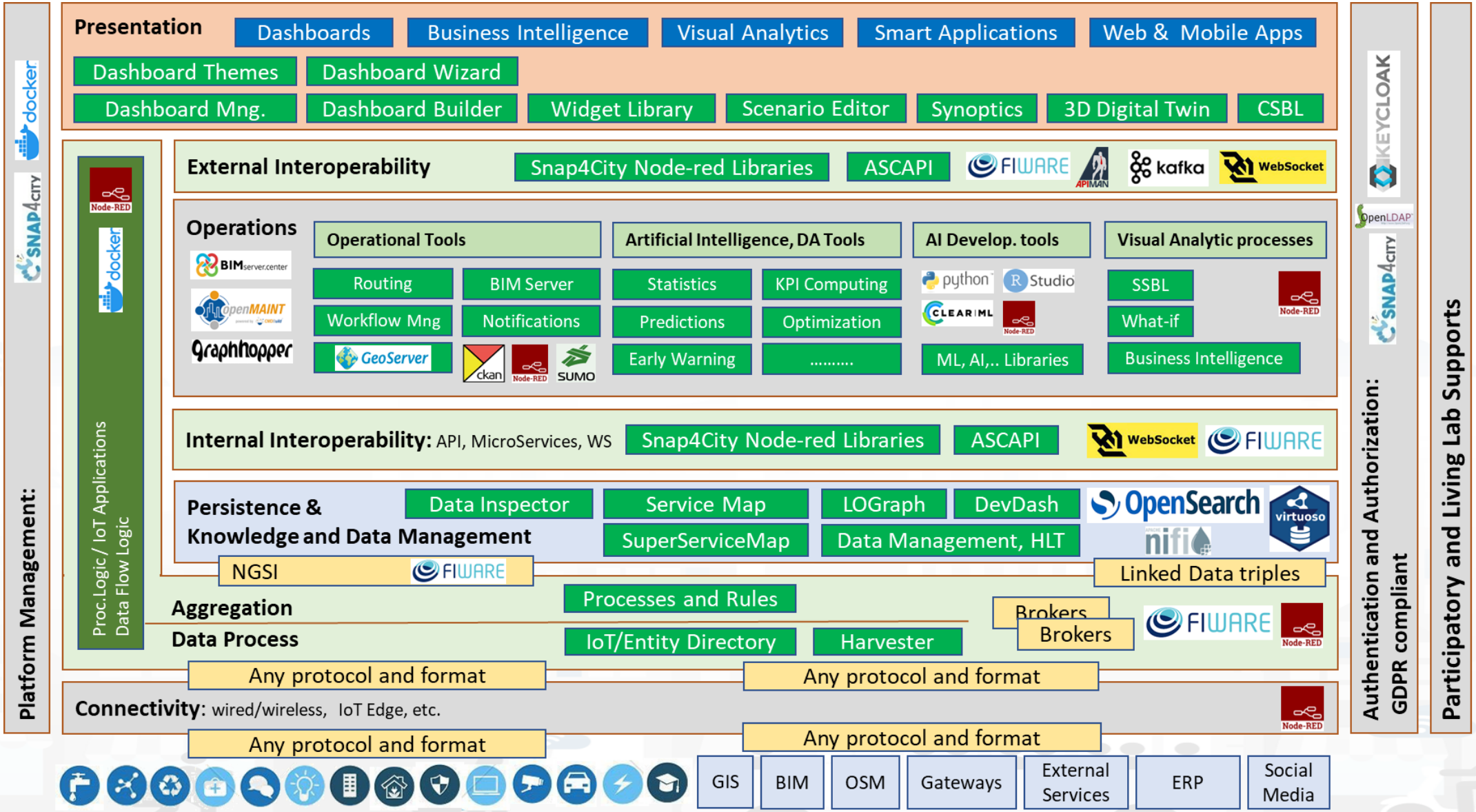
Spec Dash

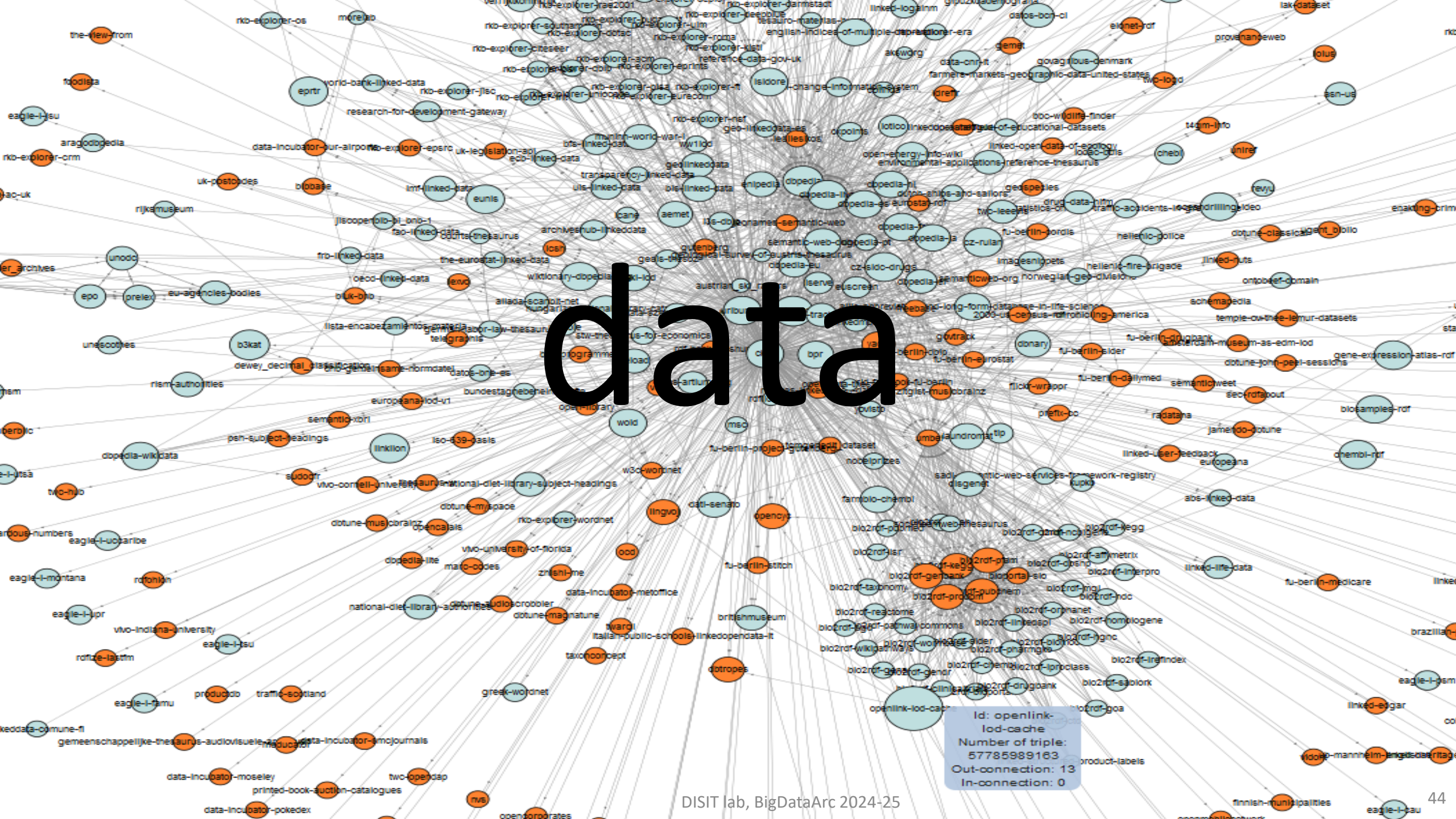
Data Management: security, privacy, licensing, etc.

Tech Arch


Entity Directory:
Smart Data Models
IoT Data Models
Digital Twins
FIWARE
Brokers
Brokers
Brokers
API Manager
Federation
Smart City API
OpenSearch
storage
KB, graph
virtuoso
GeoServer
BIMserver.center
EntityInspector
Data Managers
Front-End
Facilities
Scenario Editor
Business Intellig.
CSBL
Dashboard Bld
& Manager
CustomThemes
Synoptics
KPI Support
MobAppSupport
Service Map
HLT Manager
3D Digital Twin
Applications
Traffic Optimiz.
TrafficLightPlan
PublicTransport
Parking Mng.
Lighting Mng.
Building Mng.
Environment
Waste Mng.
Sharing/pool
Energy Mng.
Tourism Mng.
Mobile Apps
Node-RED
python
R Studio
Social Media
BIM
GIS
Gateways, satellite
External Services
Web Scraping
Tv CAM streams
IoT App
ProcLog.
On Edge
On Cloud
IoT App
Artificial Intelligence:
ML, AI, XAI, DA
Event Driven
Market/Sharing Place
Third parties solutions
A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, …

legenda


Platform Management:
Presentation
Dashboards
Business Intelligence
Visual Analytics
Smart Applications
Web & Mobile Apps
Dashboard Themes
Dashboard Wizard
Dashboard Mng.
Dashboard Builder
Widget Library
Scenario Editor
Synoptics
3D Digital Twin
CSBL
External Interoperability
Snap4City Node-red Libraries
ASCAPI
FIWARE
kafka
WebSocket
Proc.Logic/ IoT Applications
Data Flow Logic
Operations
Operational Tools
Artificial Intelligence, DA Tools
AI Develop. tools
Visual Analytic processes
Routing
BIM Server
Statistics
KPI Computing
SSBL
Workflow Mng
Notifications
Predictions
Optimization
What-if
Early Warning
.....
ML, AI,.. Libraries
Business Intelligence
GeoServer
SUMO
Internal Interoperability: API, MicroServices, WS
Snap4City Node-red Libraries
ASCAPI
WebSocket
FIWARE
Persistence &
Knowledge and Data Management
Data Inspector
Service Map
LOGraph
DevDash
OpenSearch
virtuoso
SuperServiceMap
Data Management, HLT
NGSI
FIWARE
Linked Data triples
Aggregation
Processes and Rules
Brokers
Data Process
IoT/Entity Directory
Harvester
Brokers
FIWARE
Any protocol and format
Any protocol and format
Connectivity: wired/wireless, IoT Edge, etc.
Any protocol and format
Any protocol and format
GIS
BIM
OSM
Gateways
External Services
ERP
Social Media
KEYCLOAK
OpenLDAP
Authentication and Authorization:
GDPR compliant
Participatory and Living Lab Supports


data
Id: openlink-lod-cache
Number of triple: 57785989163
Out-connection: 13
In-connection: 0

Privati Statici

- Codice fiscale
- Foto non condivise
- Aspetti legali
- Cartella clinica
- ..

Pubblici statici (open data)

statistiche: incidenti, censimenti, votazioni

- Statistiche accessi alla ZTL
- Strutture pubbliche UNIFI

posizione dei punti di interesse

- Musei
- Strutture della città
- Servizi attivi

Privati Tempo reale

- Movimenti personali non pubblicati
- Relazioni personali non pubblicate

- comportamenti
- social media
- contributi
- consumi

- Traffico personale
- Posizione mezzi,
- Parcheggi
- Posizione taxi
- Posizione CarSharing …

Pubblici Tempo reale (open data)

- Info traffico
- video camere
- Info Meteo
- Info Ambiente
- Code ai musei pubblici
- Terremoti
- Parcheggi

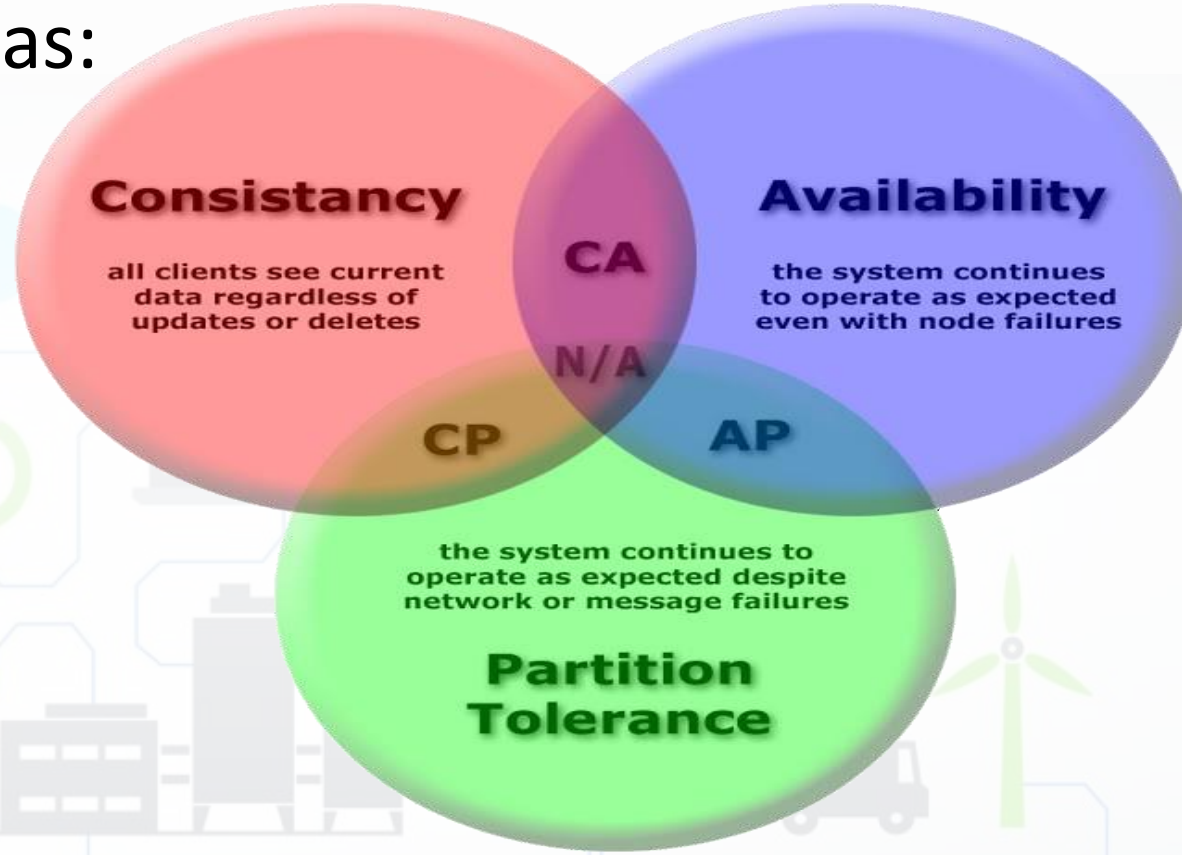
- Stato accessi alla ZTL
- Stato dei servizi

Complessità del Dato

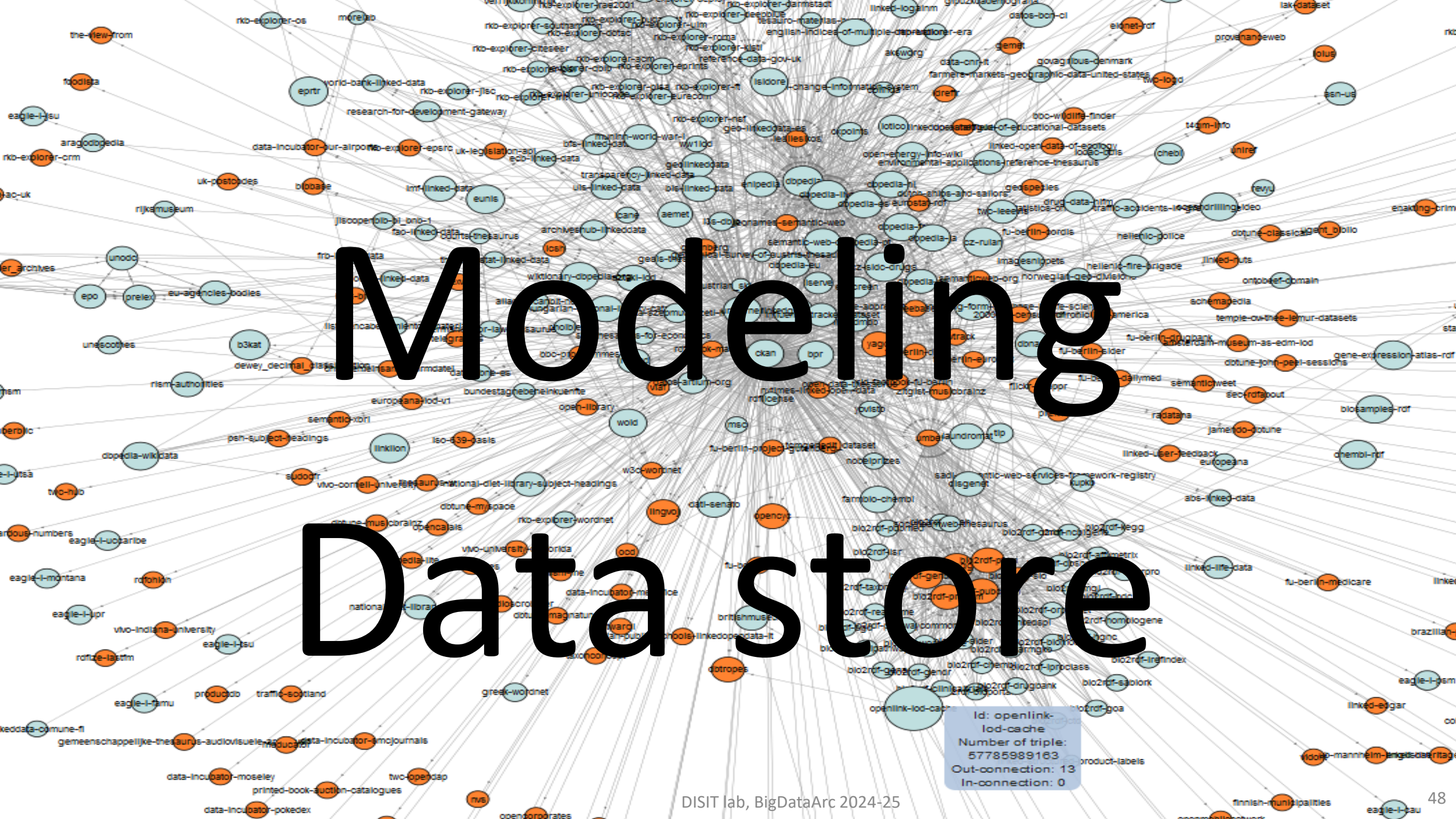
- **Formati diversi, valori sparsi e discontinui** anche in stream
  - Data healthiness, integrity, etc.
- Tecniche: Data Lake per la normalizzazione del dato
  - → big data graveyards based on HDFS
- **Formati e dati non riferibili in modo preciso alla stessa semantica** delle entità in gioco: temperatur*e*, 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, …

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.



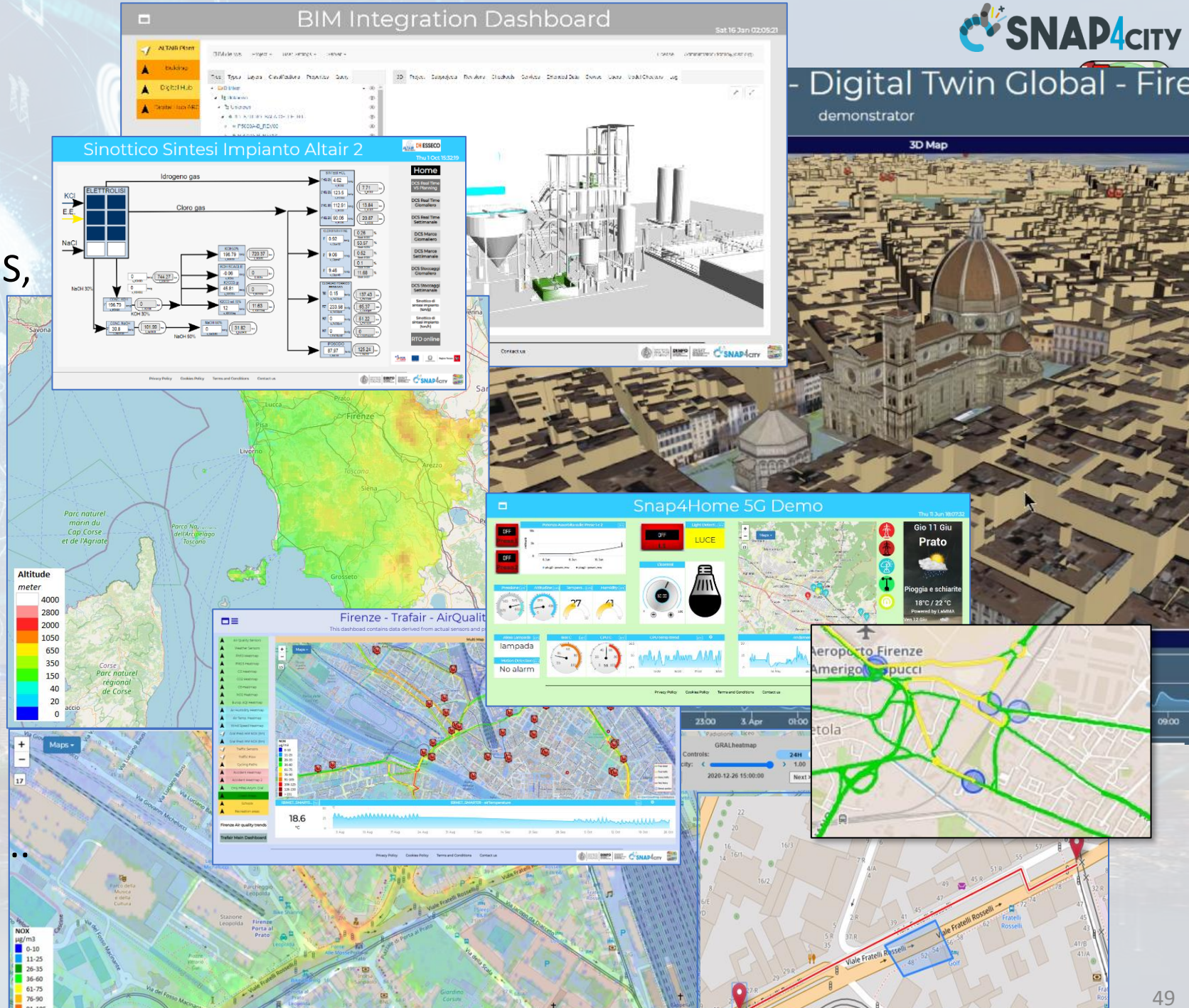
Modeling Data store



High Level Types

DISIT lab, BigDataArc 2024-25

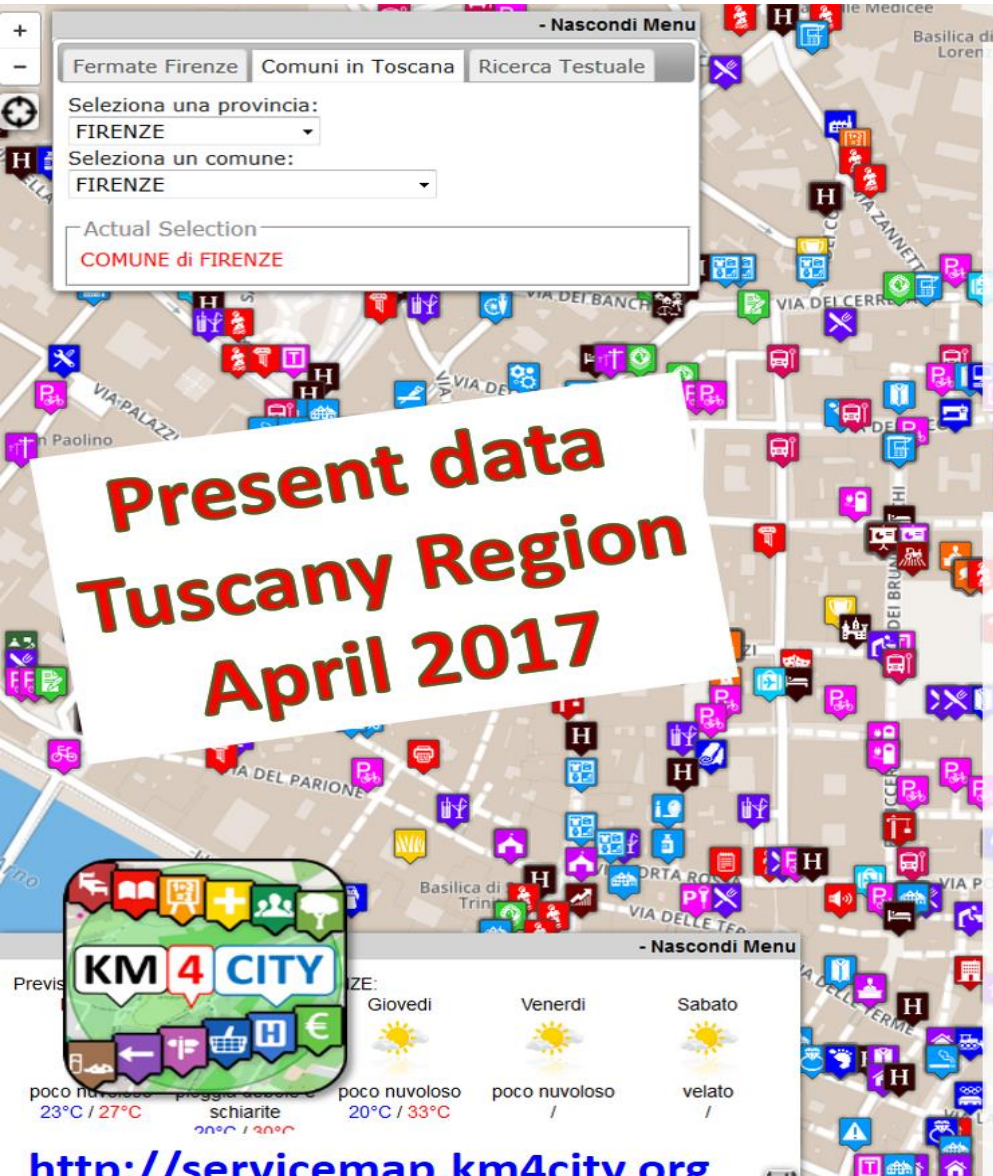
- POI, IOT Devices, shapes,..
  - FIWARE Smart Data Models,
  - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, ..
- traffic flow, typical trends, ..
- trajectories, events, Workflow, ..
- 3D Models, BIM, Digital Twins, ..
- OD Matrices of several kinds, ..
- Dynamic icons/pins, ..
- Synoptics, animations, ..
- KPI, personal KPI,..
- social media data, TV Stream,
- routing, multimodal, constraints, ..
- decision scenarios, ….
- etc.



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

Smart City

http://www.km4city.org



Present data Tuscany Region April 2017

http://servicemap.km4city.org

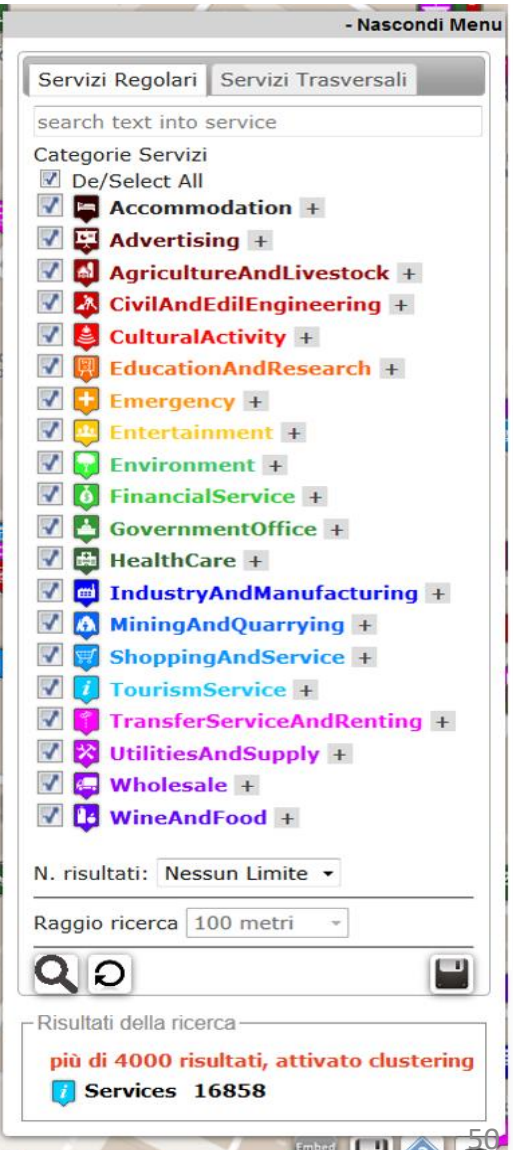
Road Graph (Tuscany region)

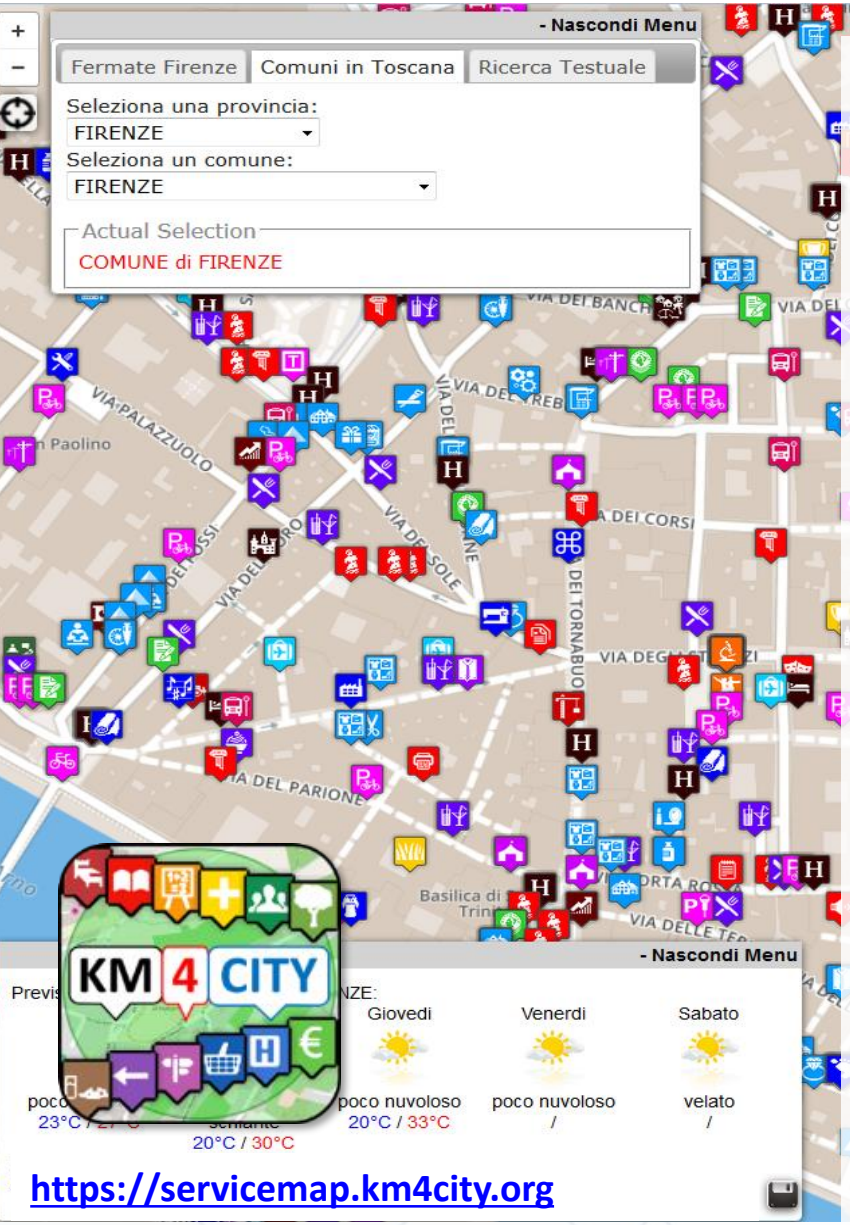
132,923 Roads
389,711 Road Elements
318,160 Road Nodes
1,508,207 Street Numbers

Info on: points, paths, areas, etc.
Services (20 cat, 512 cat.)
16 Pub. Transport Operators
21.280 Bus stops & 1081 bus lines

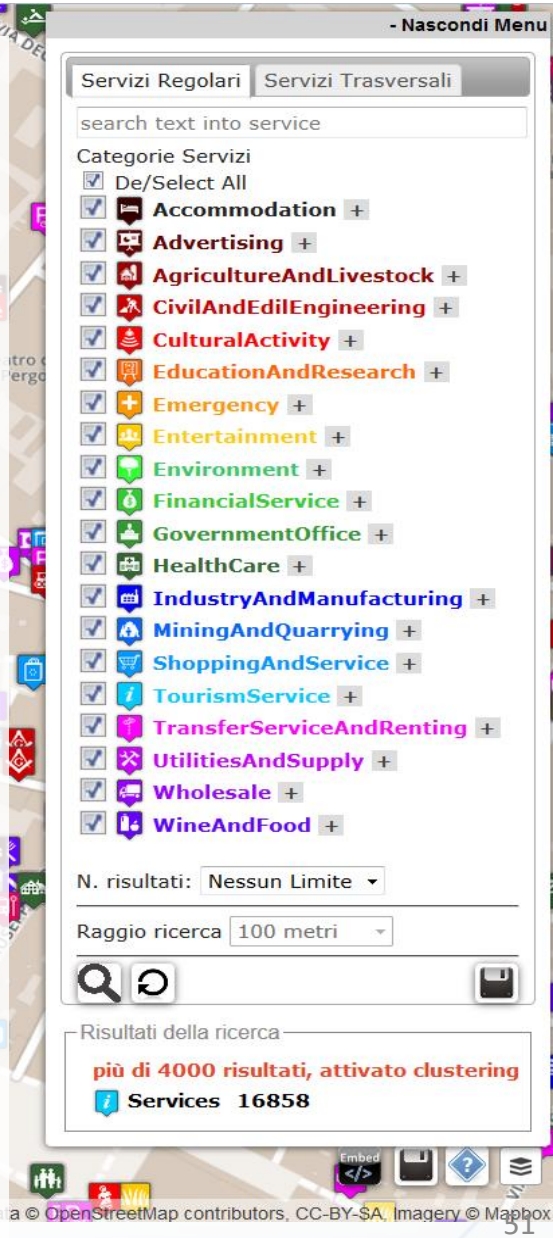
Dynamic/real-time in Tuscany Region

- Real time bus lines: 144 updates X day X line
- 1081 Pub Lines: 1-2 updates per day, time and path
- 210 parking status: 76 updates X day X sensor
- 796 traffic Sensors: 288 updates X day X sensor
- 285 weather area: 2 updates X day X area
- 12 hospital Triage status: 96 updates X day X FA
- 1600 Fuel stations: 1 update X day X station
- 22 Environmental data: 20 updates X day X sensor
- Florence events: about 60 new events X day
- Wi-Fi: > 400.000 measures X day
- App mobiles: > 50.000 measures X day
- more than 40.000 distinct users X day
- From 600.000 to 4.5 M Tweets X day
- .....+ many IOT are coming .....





https://servicemap.km4city.org



What is enabling and providing smart services

- Smart Parking, in Tuscany
- Smart First Aid in Tuscany
- Smart search for POI and public transport srv.
- Public Transportation in Tuscany
- Routing in Tuscany, simple and multimodal
- Social Media Monitoring and acting
- Traffic events and Resilience in Florence
- Bike Sharing in Pisa and Siena
- Recharge stations for e-vehicles
- Entertainment Events in Florence
- Traffic Sensors in Tuscany
- IOT/IOE sensors and actuators
- Weather forecast/condition in Tuscany
- Pollution and Pollination in Tuscany
- People Monitoring, in Tuscany via App
- ..People Monitoring Assessment in the City, in Florence via Wi-Fi

All Point of Interests, cultural activities, IOT, …
Over than 1.2 Million of complex events per day!

Types of NoSQL Database

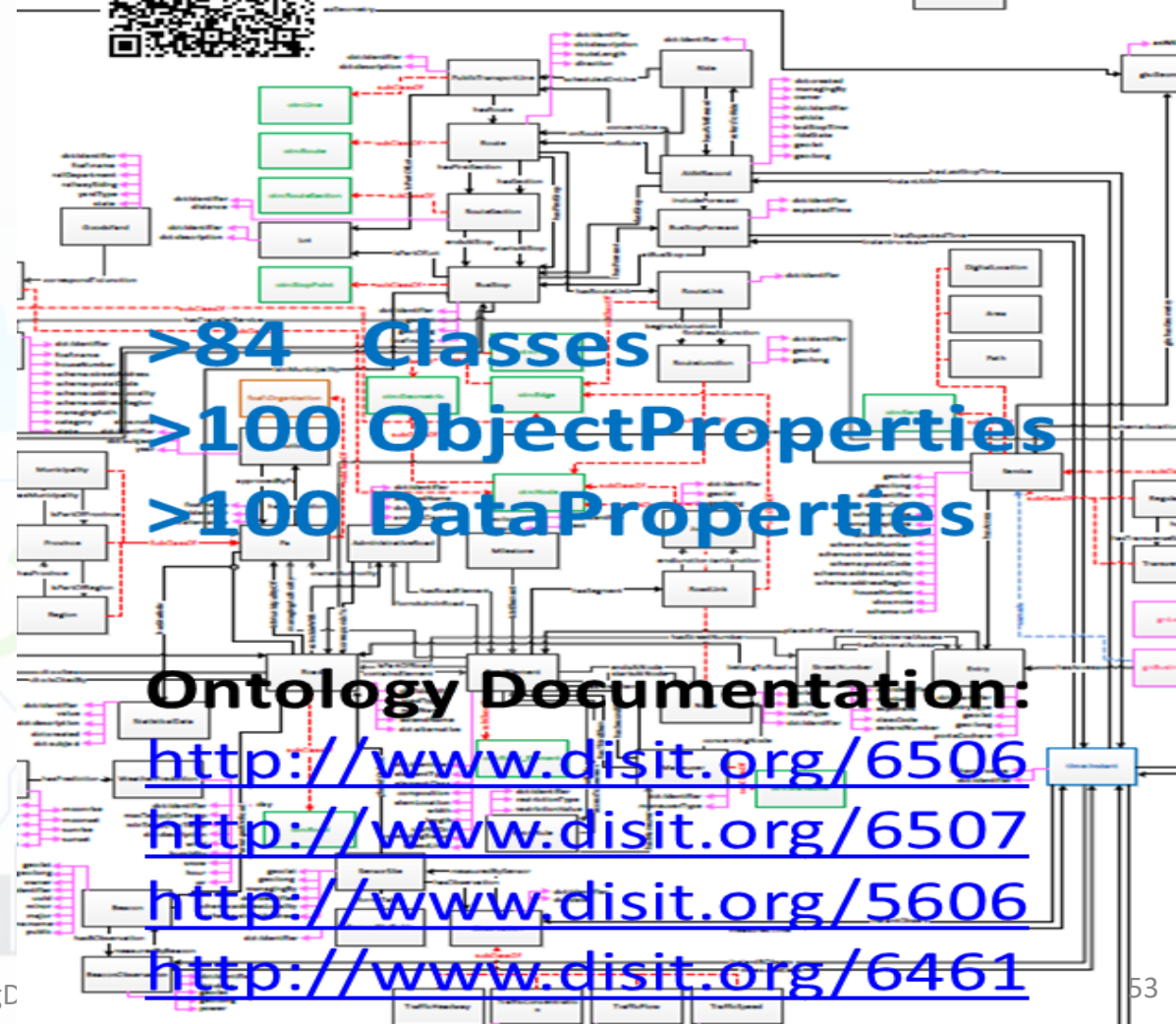
- Key-Value DB
- Col- Family/Big Table DB
- Document DB
- XML DB
- Object DB
- Multivalue DB
- ACID NoSQL
- Graph DB

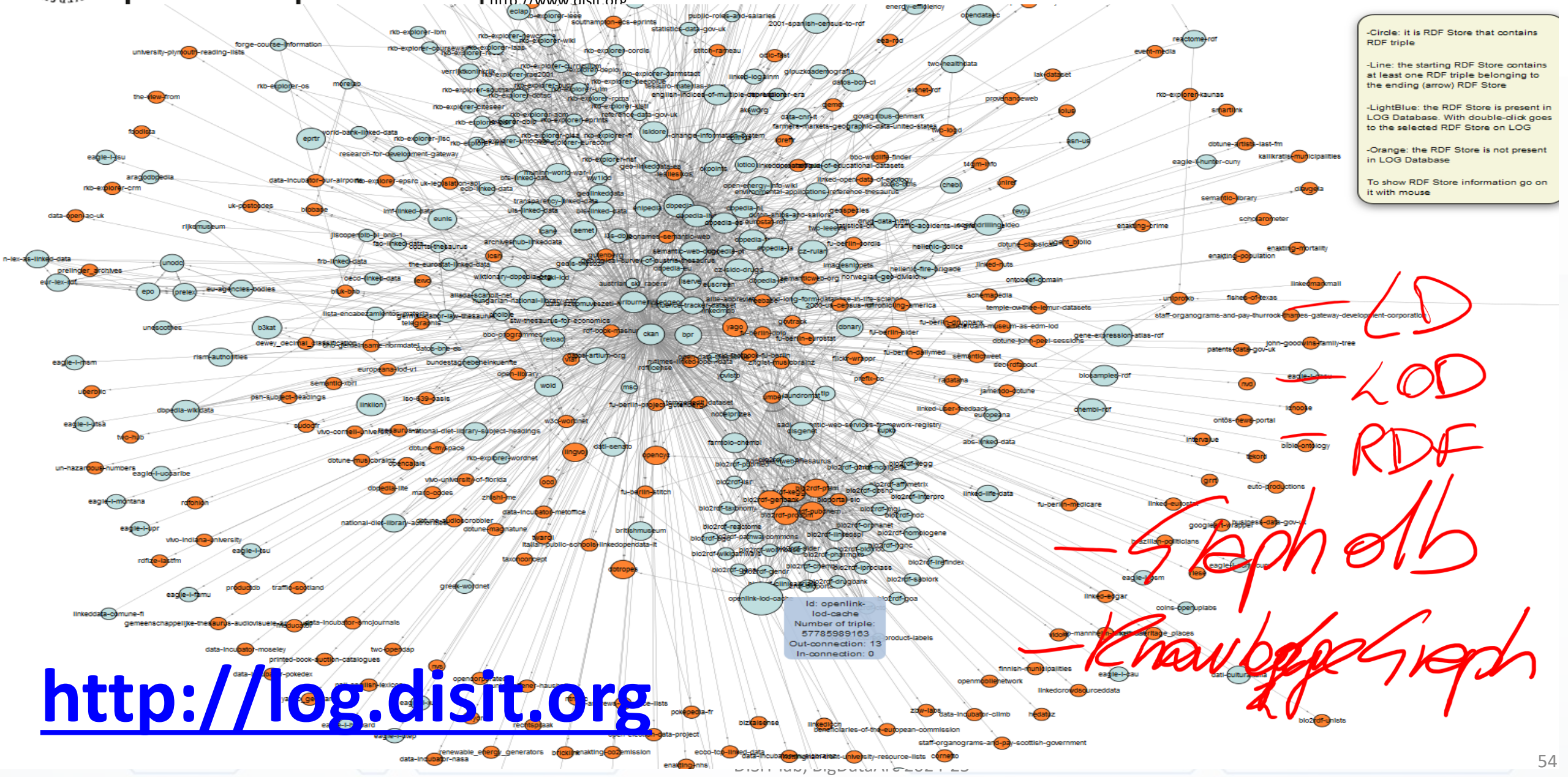
I Dati

- **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***

S-P-O

Smart-city Ontology km4city





http://log.disit.org

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

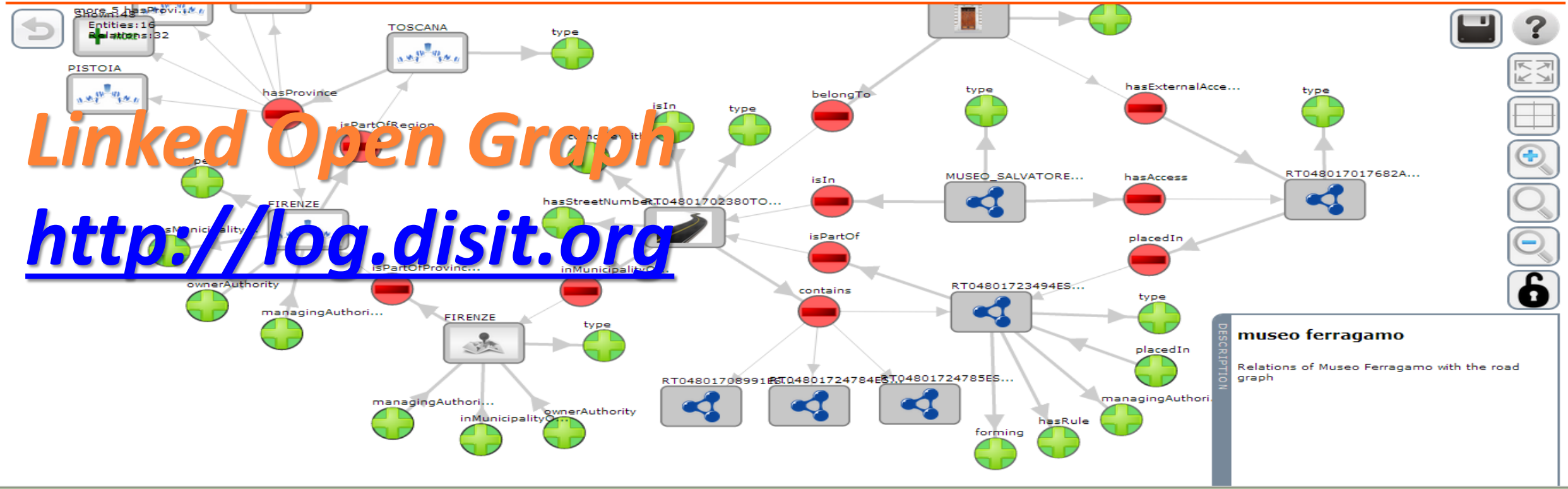
Remove Clear

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

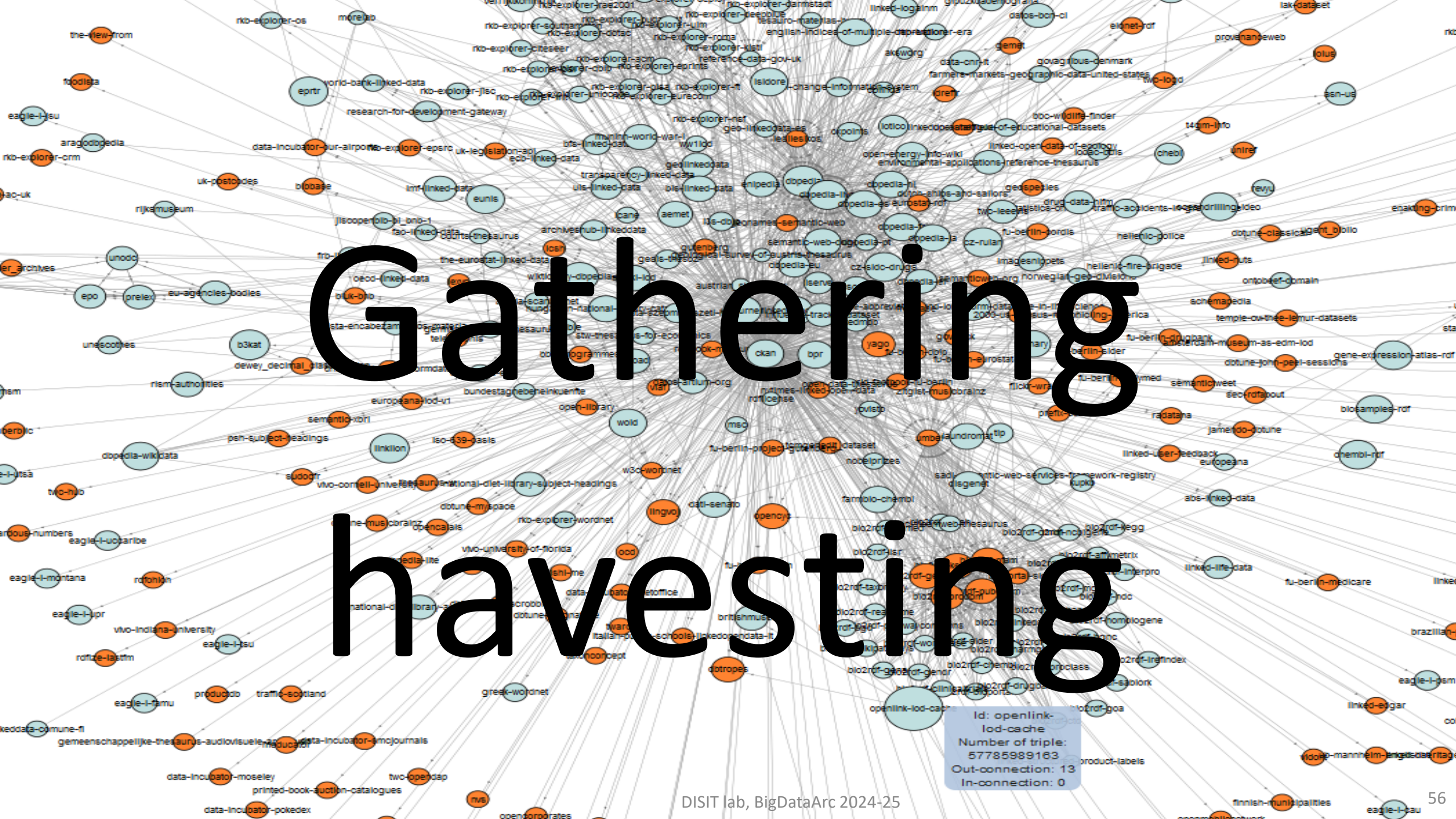
Linked Open Graph



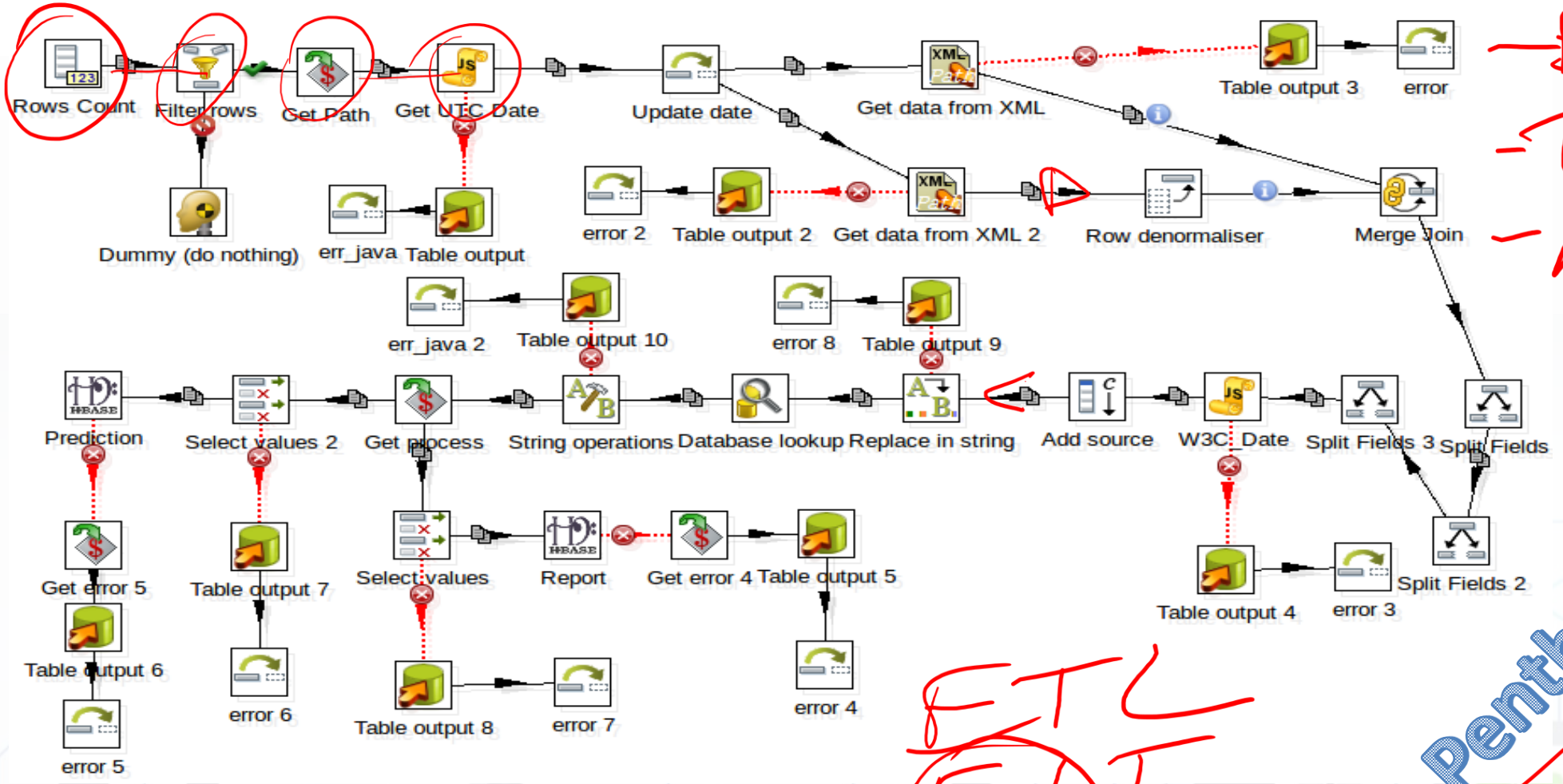
Linked Open Graph

http://log.disit.org

Gathering havesting



Example of ETL



- Extract
- Transform
- Load

ETL

ELT

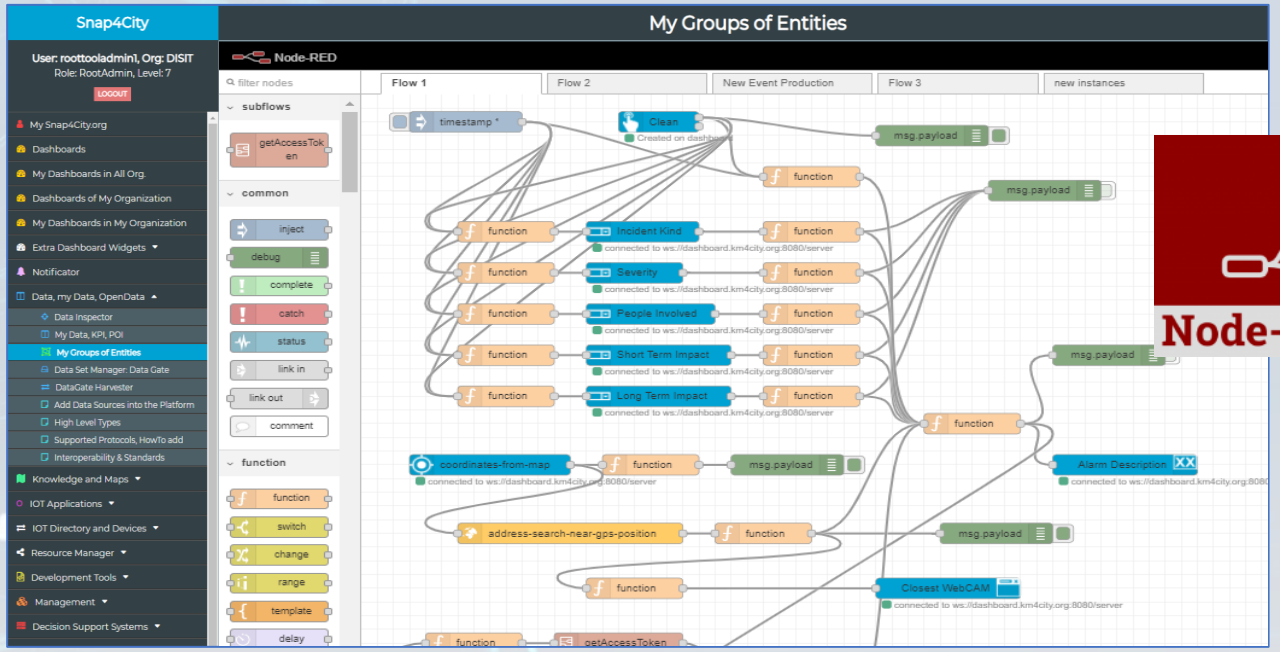
ETL Penthao Kettle

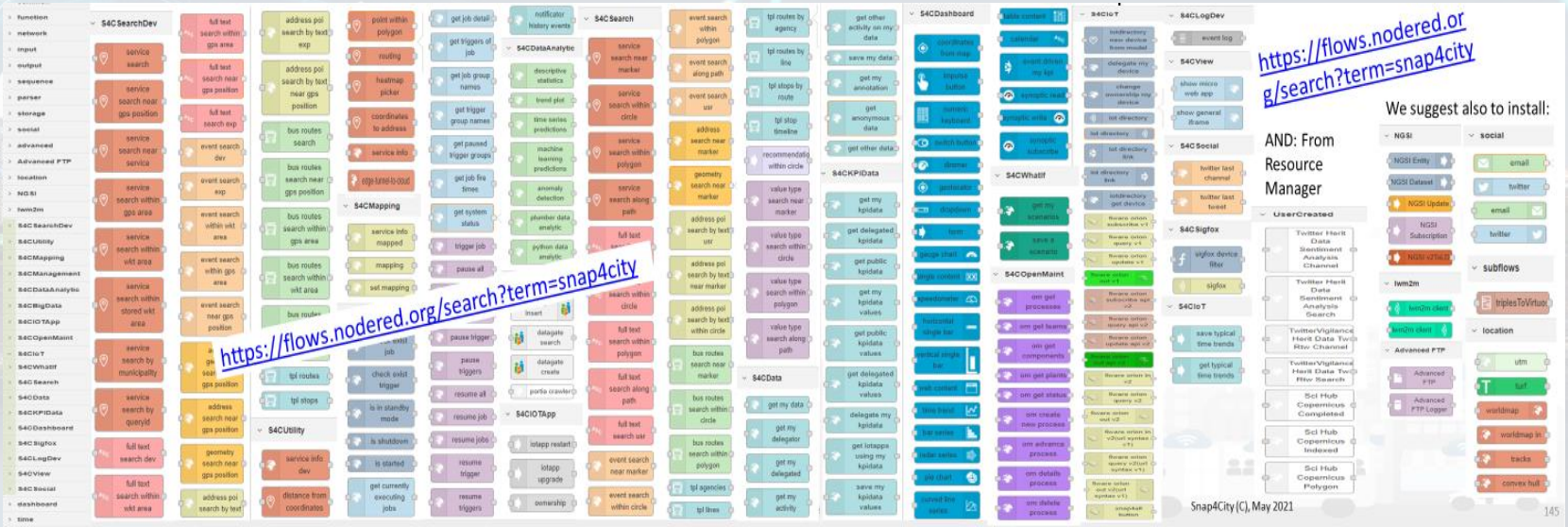
kettle™ pentaho data integration

Batch Processing

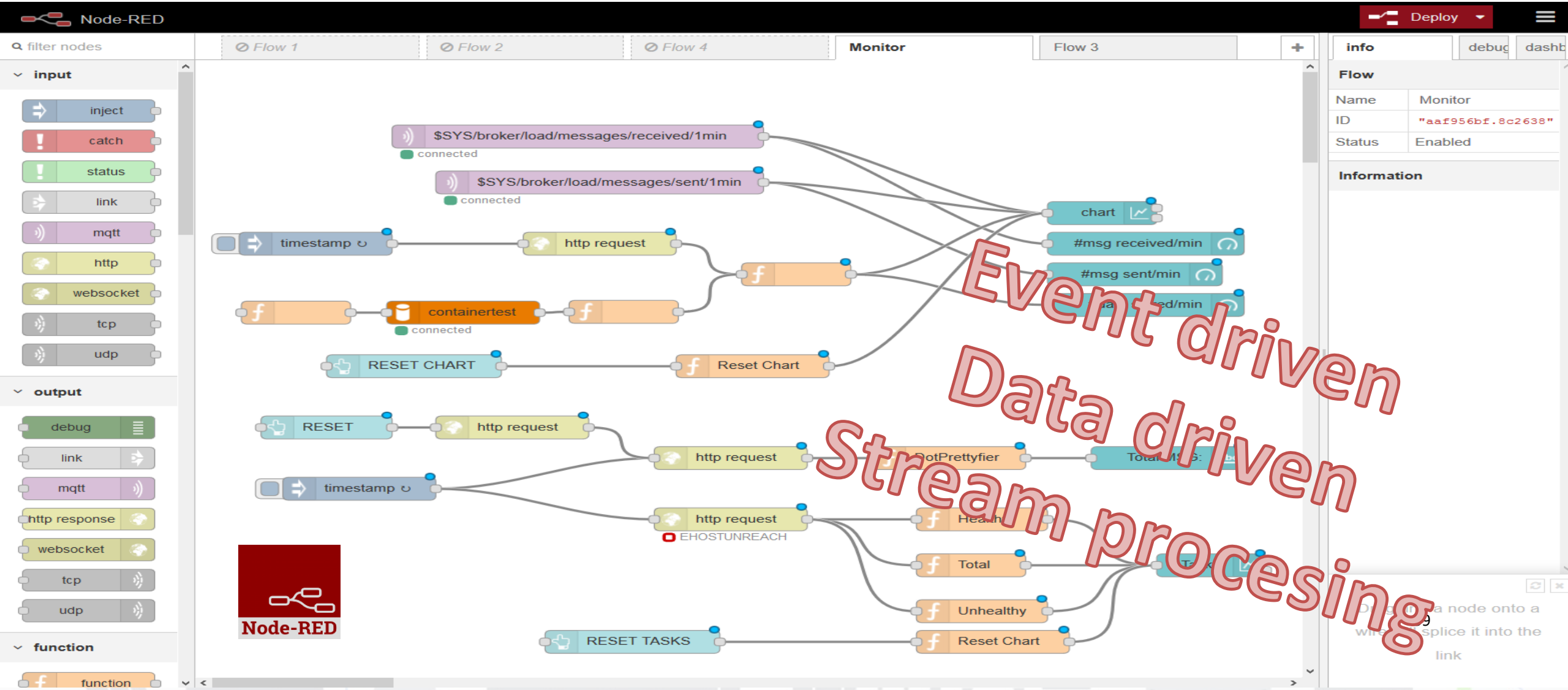
Ingestion, aggreg. → exploitation

- **IoT App Visual Programming, no coding**
  - **Data transformation**
  - **Integration, Interoperab.**
  - **Scripting Data Analytics**
  - **Data ingestion**
  - **Business logic**
- **Edge and Cloud**
- **MicroServices** data driven develop via visual language Node-RED

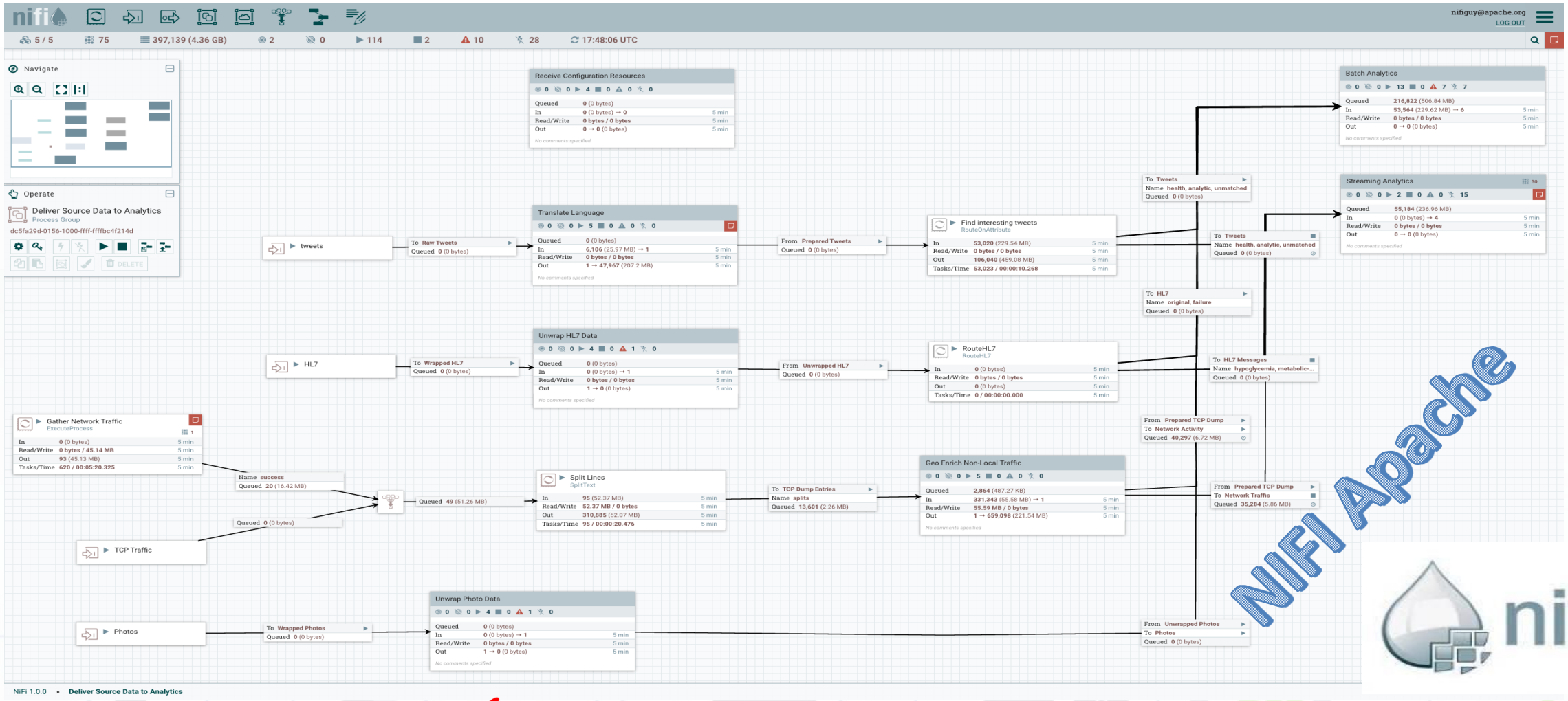




IOT ApplicationsSnap4City



Example of NIFI



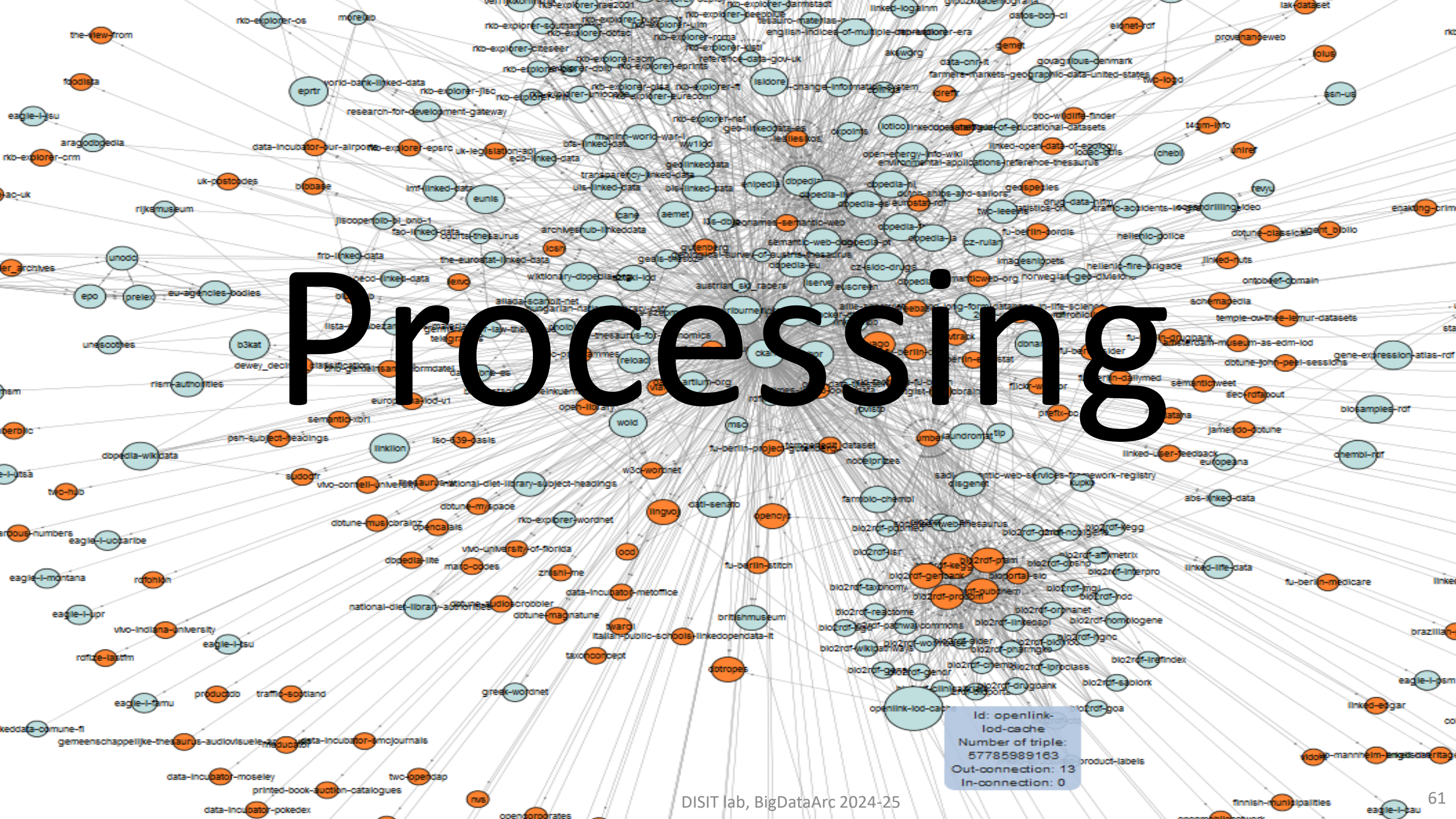
NIFI Apache

nifi

Batch Processing

Evost Rocery

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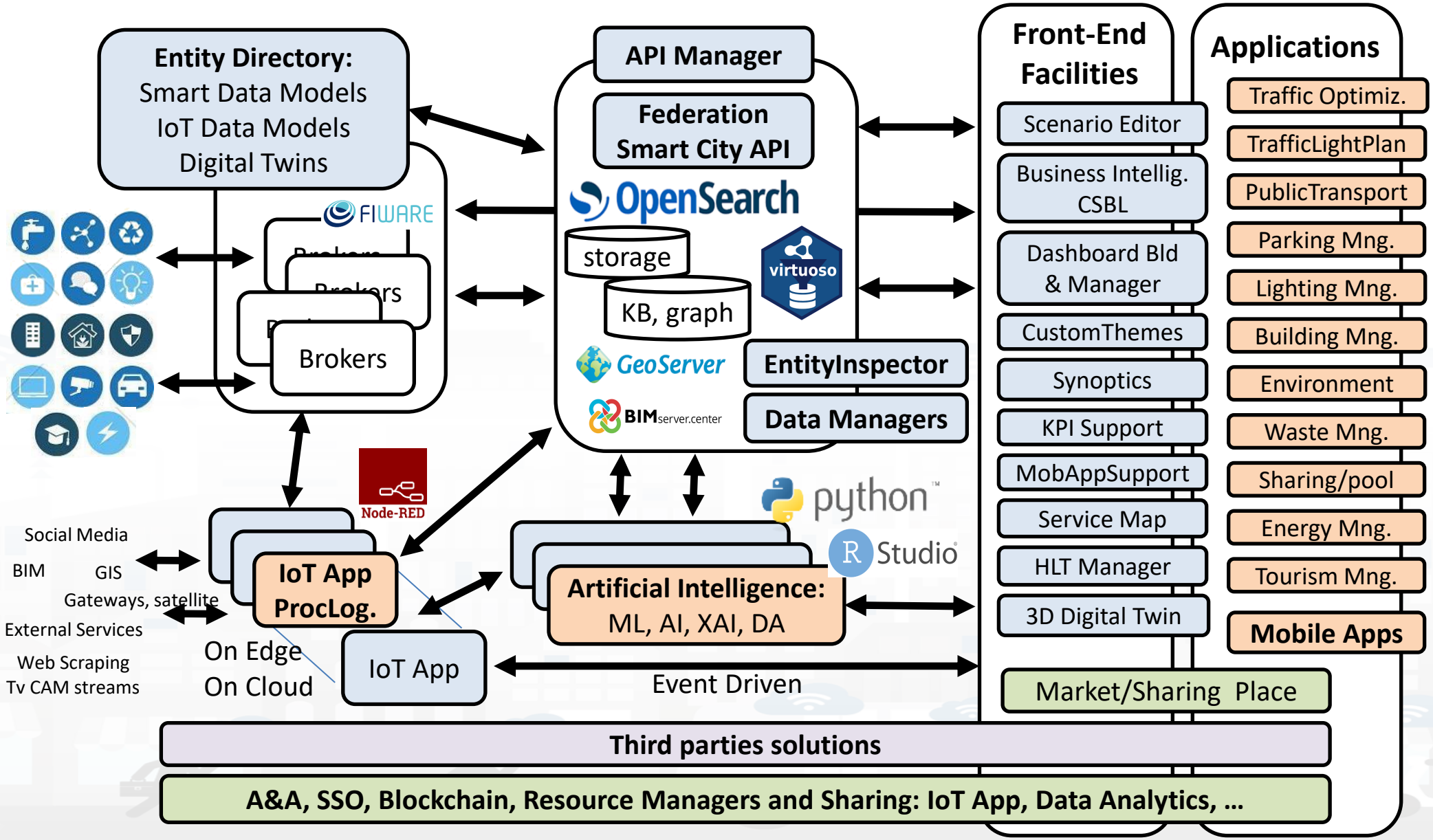
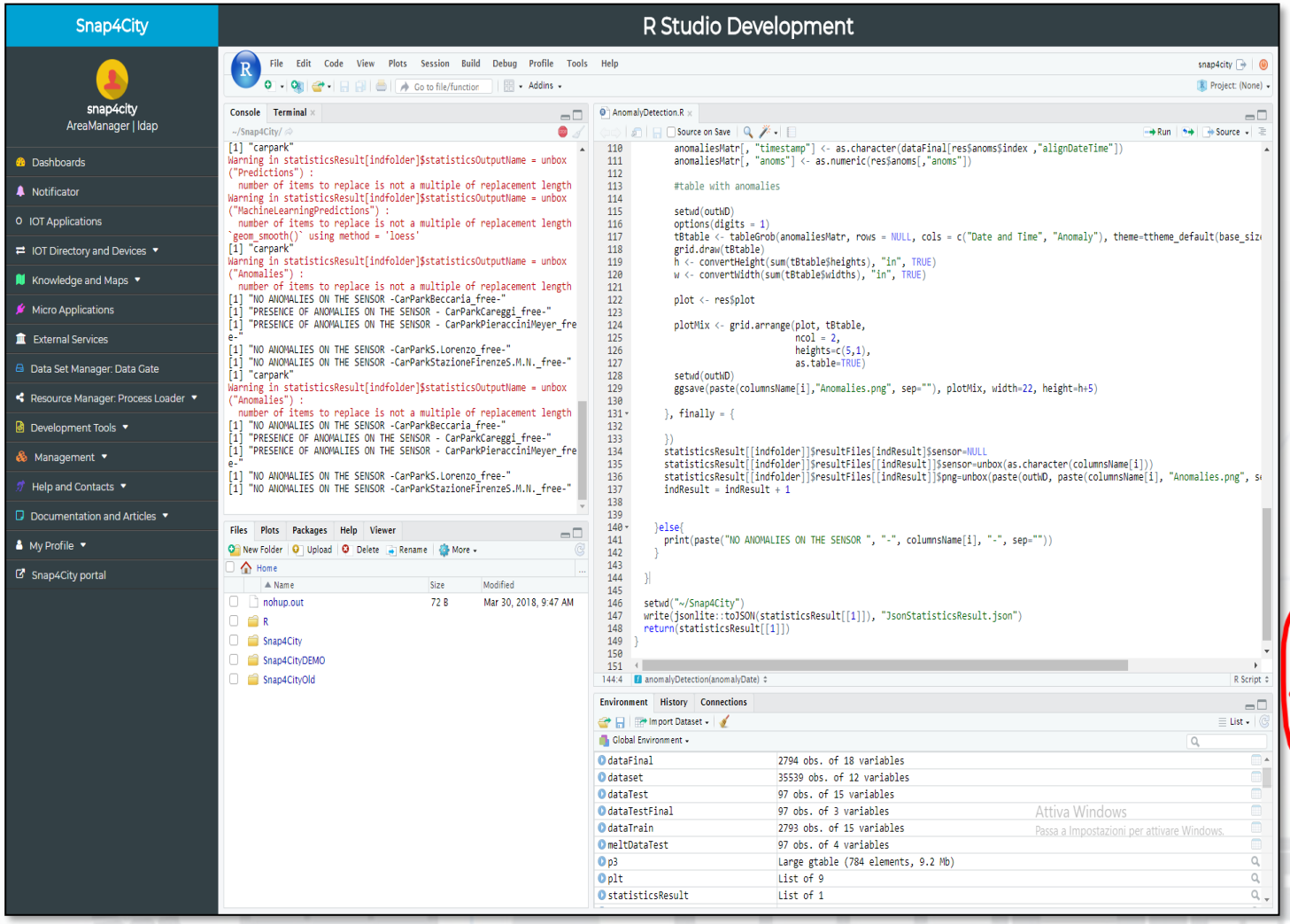
Number of triple: 57785989163
Out-connection: 13
In-connection: 0

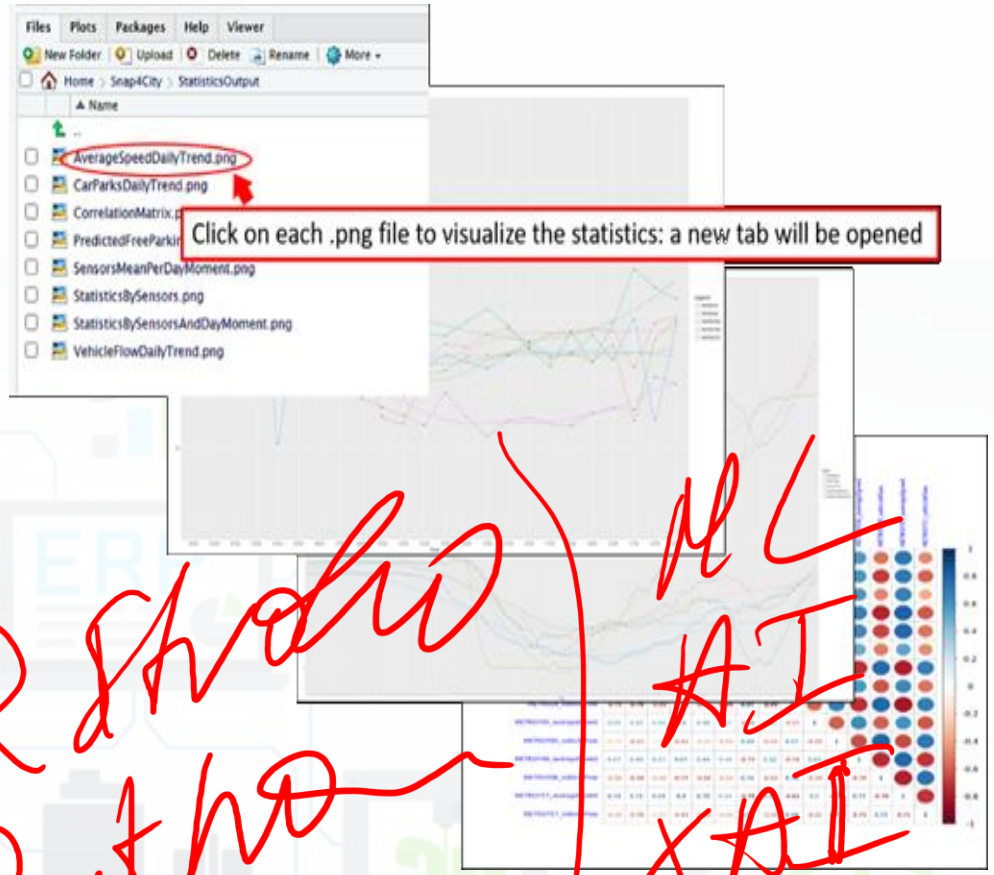
Tech Arch


Entity Directory:
Smart Data Models
IoT Data Models
Digital Twins
FIWARE
Brokers
Brokers
Brokers
API Manager
Federation
Smart City API
OpenSearch
storage
KB, graph
virtuoso
GeoServer
BIMserver.center
EntityInspector
Data Managers
Front-End
Facilities
Scenario Editor
Business Intellig.
CSBL
Dashboard Bld
& Manager
CustomThemes
Synoptics
KPI Support
MobAppSupport
Service Map
HLT Manager
3D Digital Twin
Applications
Traffic Optimiz.
TrafficLightPlan
PublicTransport
Parking Mng.
Lighting Mng.
Building Mng.
Environment
Waste Mng.
Sharing/pool
Energy Mng.
Tourism Mng.
Mobile Apps
Node-RED
python
R Studio
Social Media
BIM
GIS
Gateways, satellite
External Services
Web Scraping
Tv CAM streams
IoT App
ProcLog.
On Edge
On Cloud
IoT App
Artificial Intelligence:
ML, AI, XAI, DA
Event Driven
Market/Sharing Place
Third parties solutions
A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, …

Developer in R Studio, Python + Tensor Flow

NVIDIA

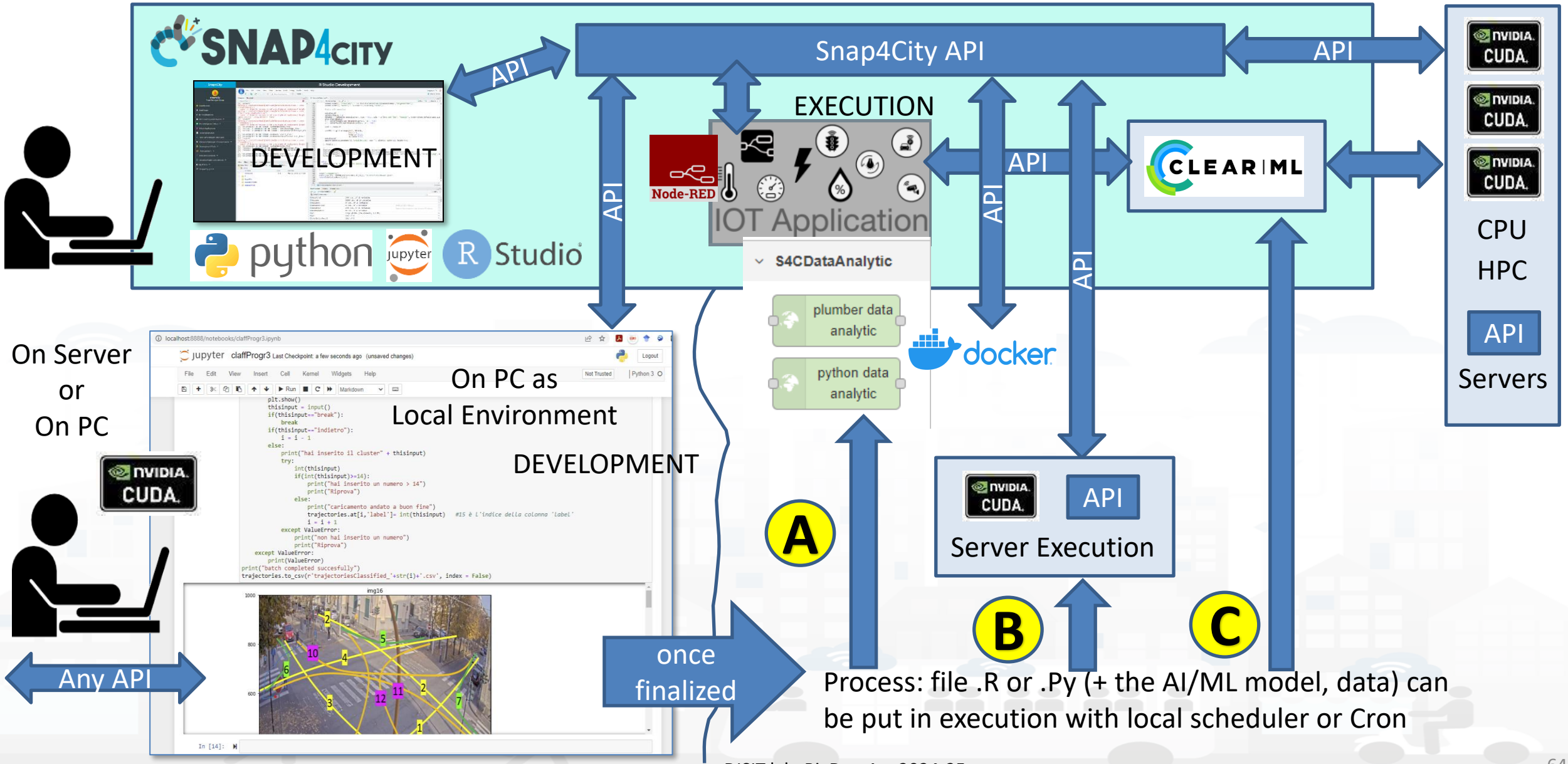




R Studio
Python
Java

ML
AI
XAI

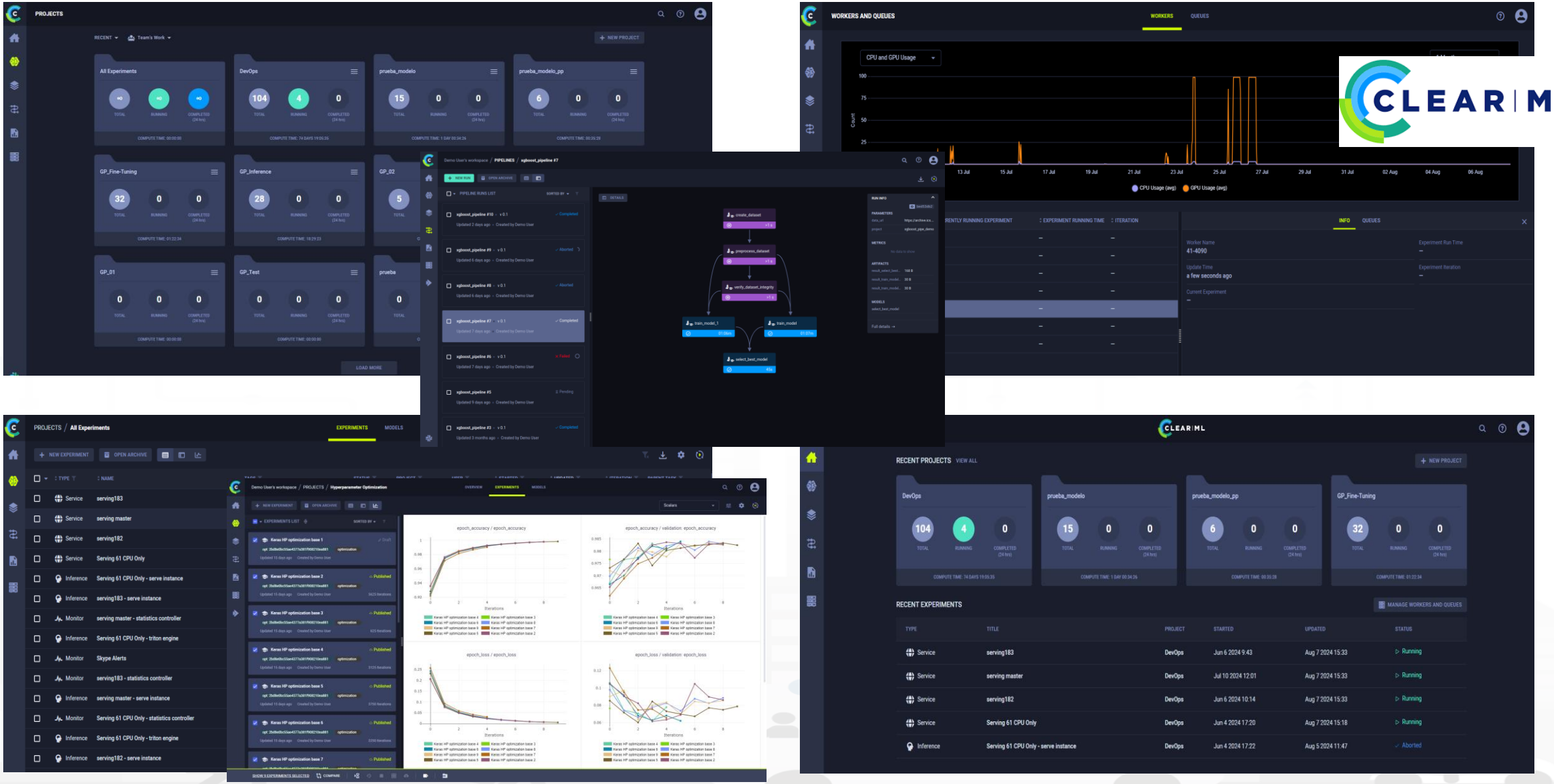
AI/ML Infrastruct.



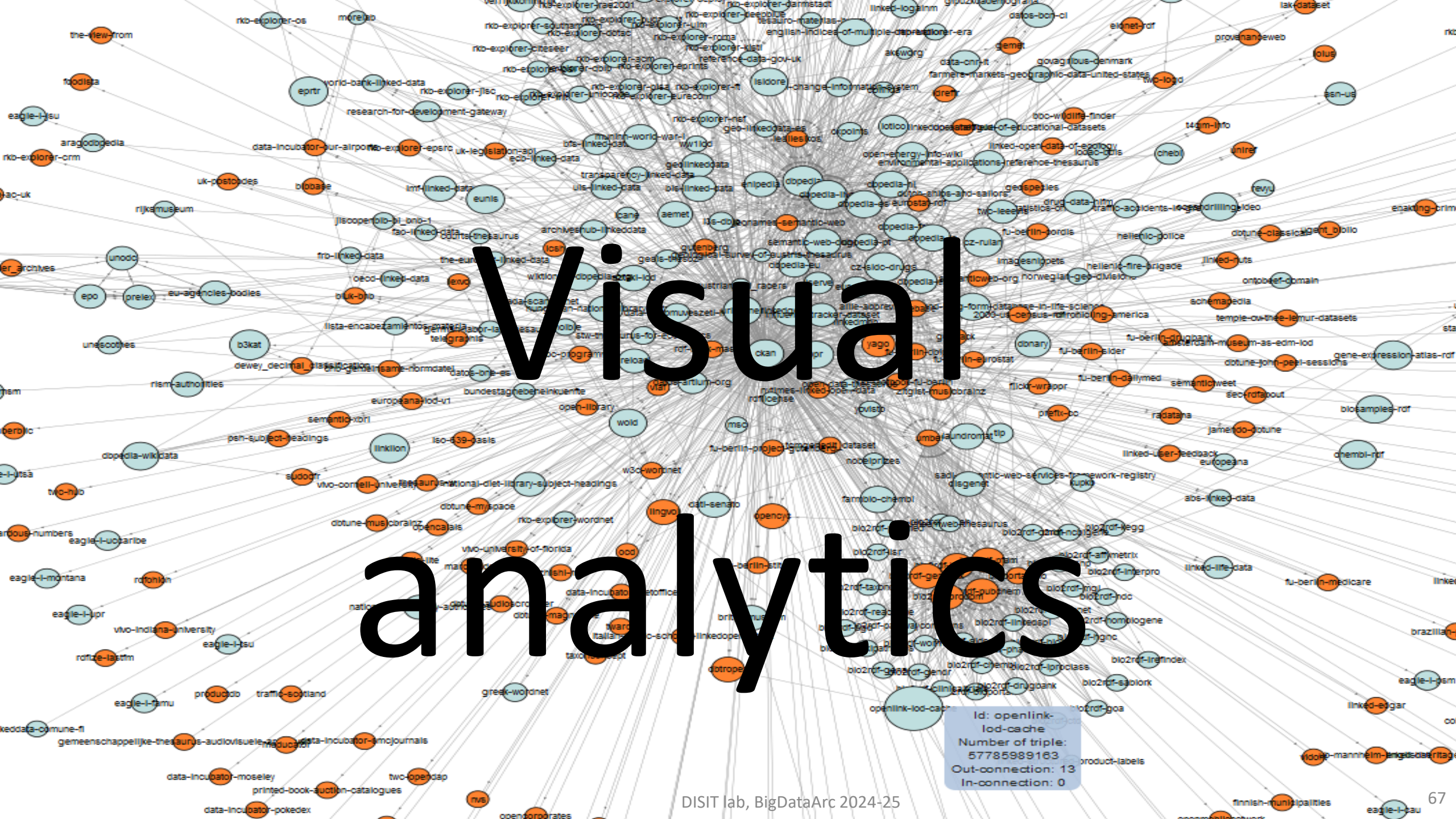
Managing AI/ML operation/development: MLOps

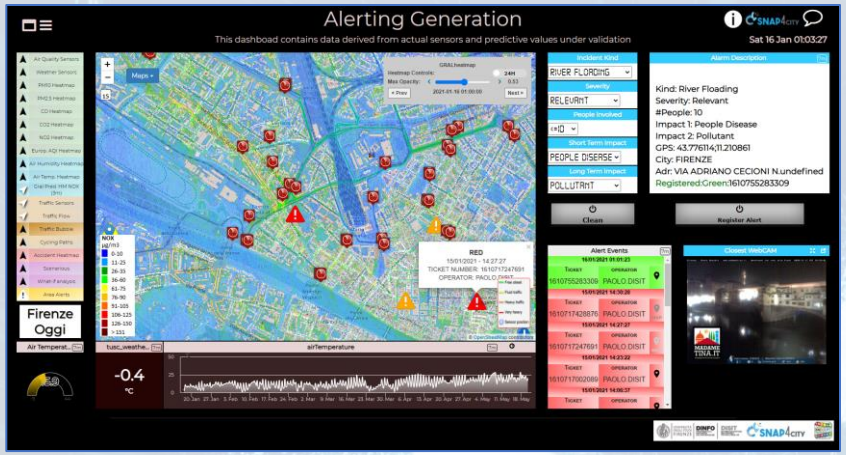
- **Management of AI/ML processes**: training and execution
- **Training needs**: several processes
  - with different parameters and models to be trained, validated and test in batch to find the best results wrt metrics
  - High computational costs, time consuming if the processes have to be sent on GPU/CPU manually
- **Execution needs**, single executions in most cases singularly cheaper, but expensive for large volume of executions:
  - periodically as predictions (saving time if the model is loaded permanent)
  - on demand as optimisation, clustering, etc. (loading model, burning time)

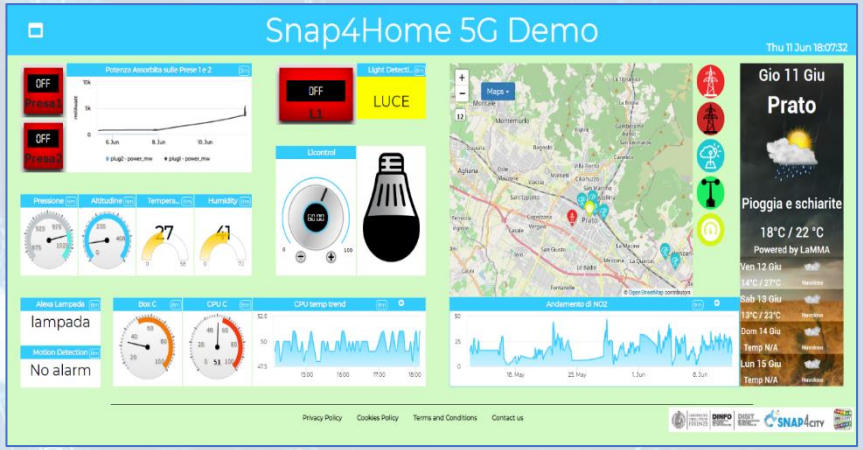
ClearML on S4C

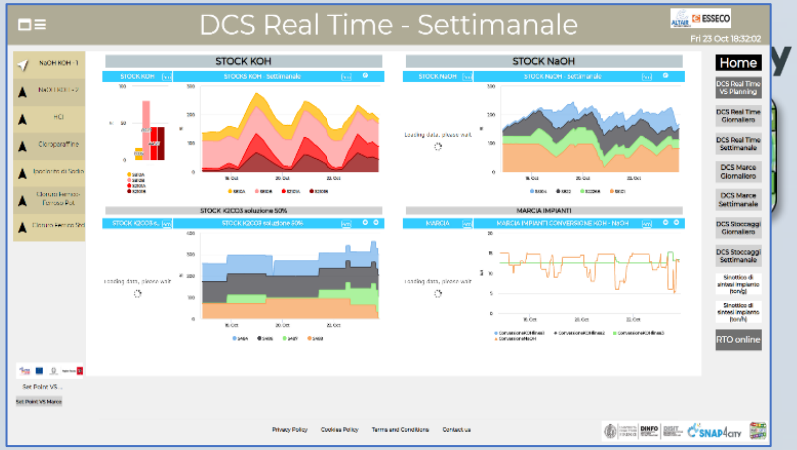


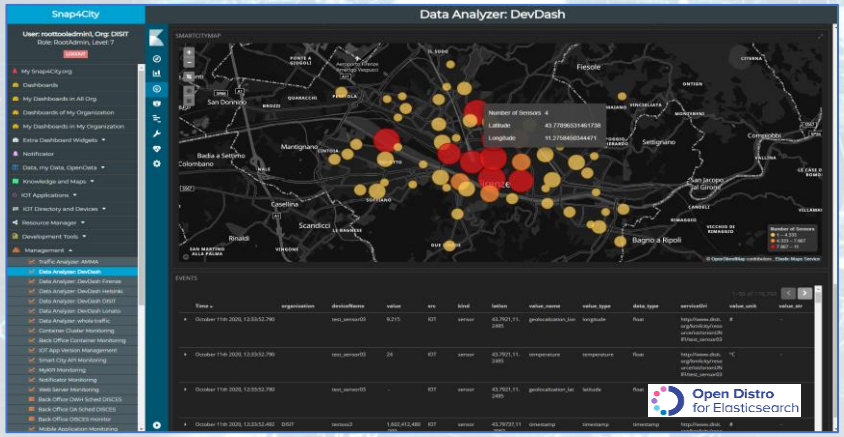
Visual analytics

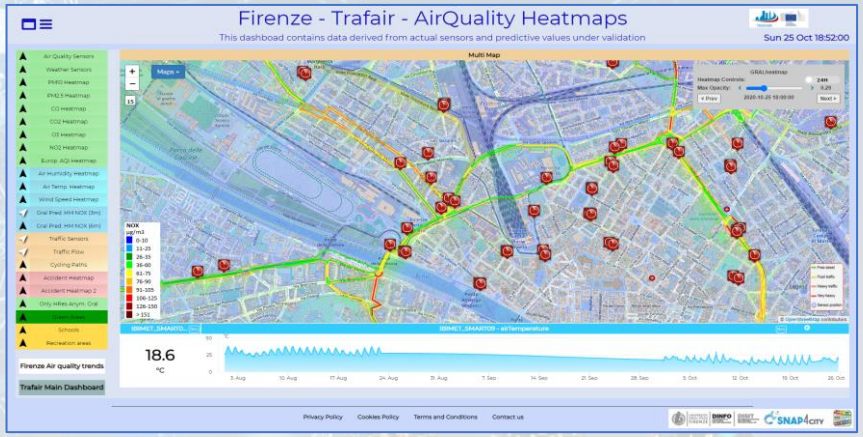


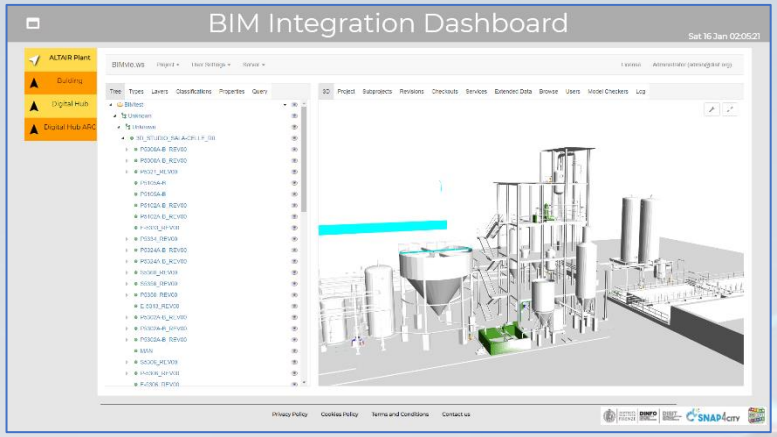

Alerting Generation
This dashboard contains data derived from actual sensors and predictive values under validation
Sat 16 Jan 01:03:27
Firenze Oggi
-0.4
°C


Snap4Home 5G Demo
Thu 11 Jun 18:07:32
LUCE
Gio 11 Giu
Prato
Pioggia e schiarite
18°C / 22 °C
Powered by LaMMA
lampada
No alarm

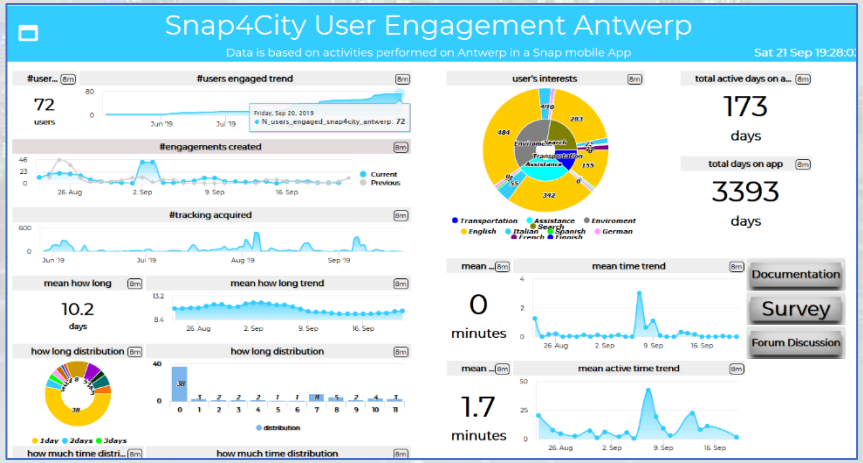

DCS Real Time - Settimanale
Fri 23 Oct 18:32:02
STOCK KOH
STOCK NaOH
Home

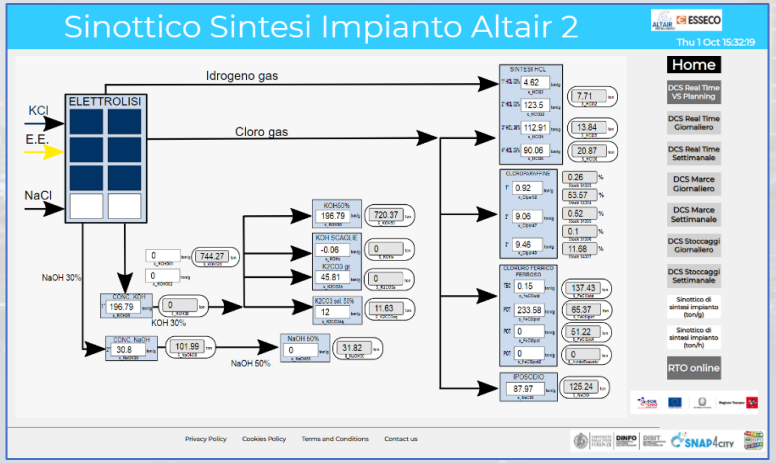

Data Analyzer: DevDash
Open Distro for Elasticsearch

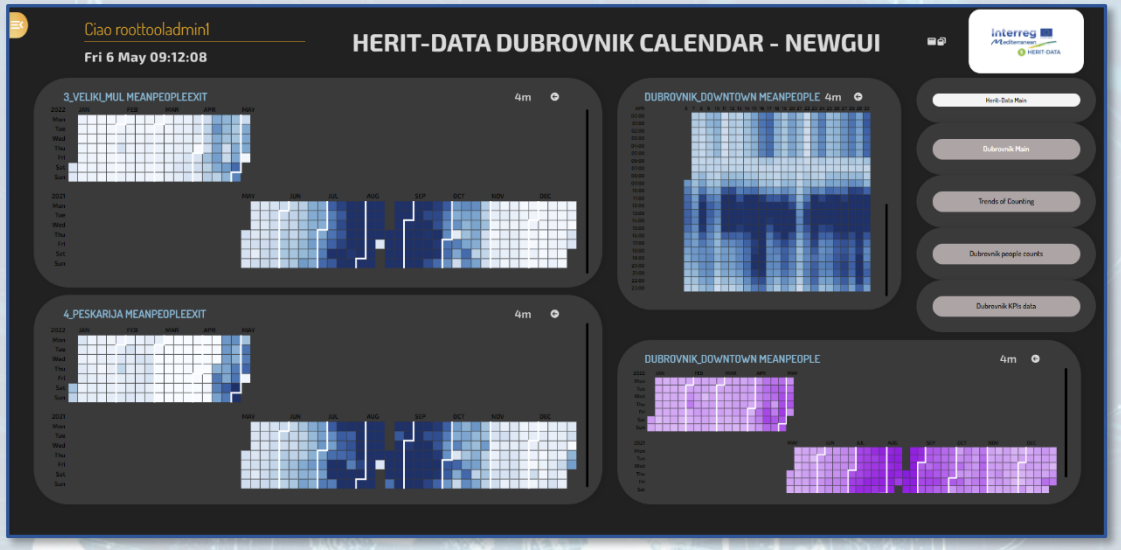

Firenze - Trafair - AirQuality Heatmaps
This dashboard contains data derived from actual sensors and predictive values under validation
Sun 25 Oct 18:52:00
18.6
°C

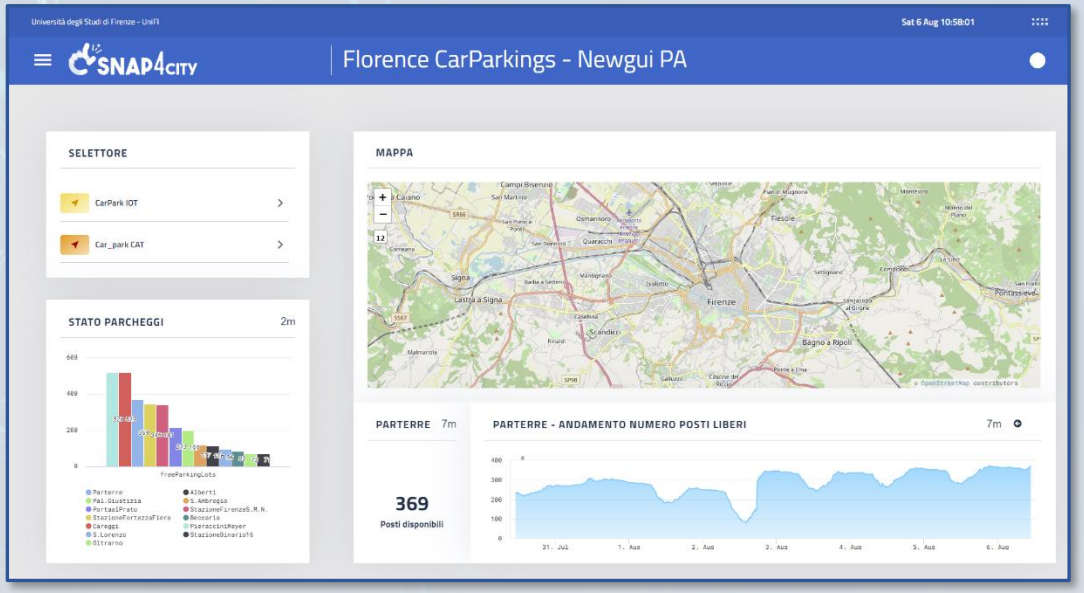

BIM Integration Dashboard
Sat 16 Jan 02:05:21

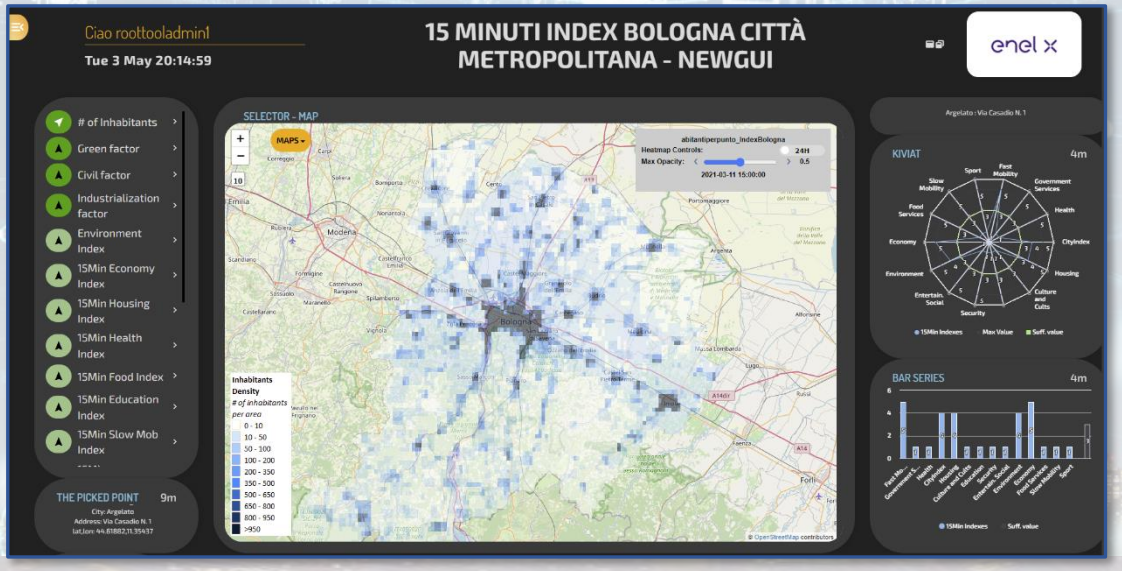

3D Multi Data Map - Digital Twin Global - Firenze
demonstrator
Sun 3 Apr 16:03:52
192

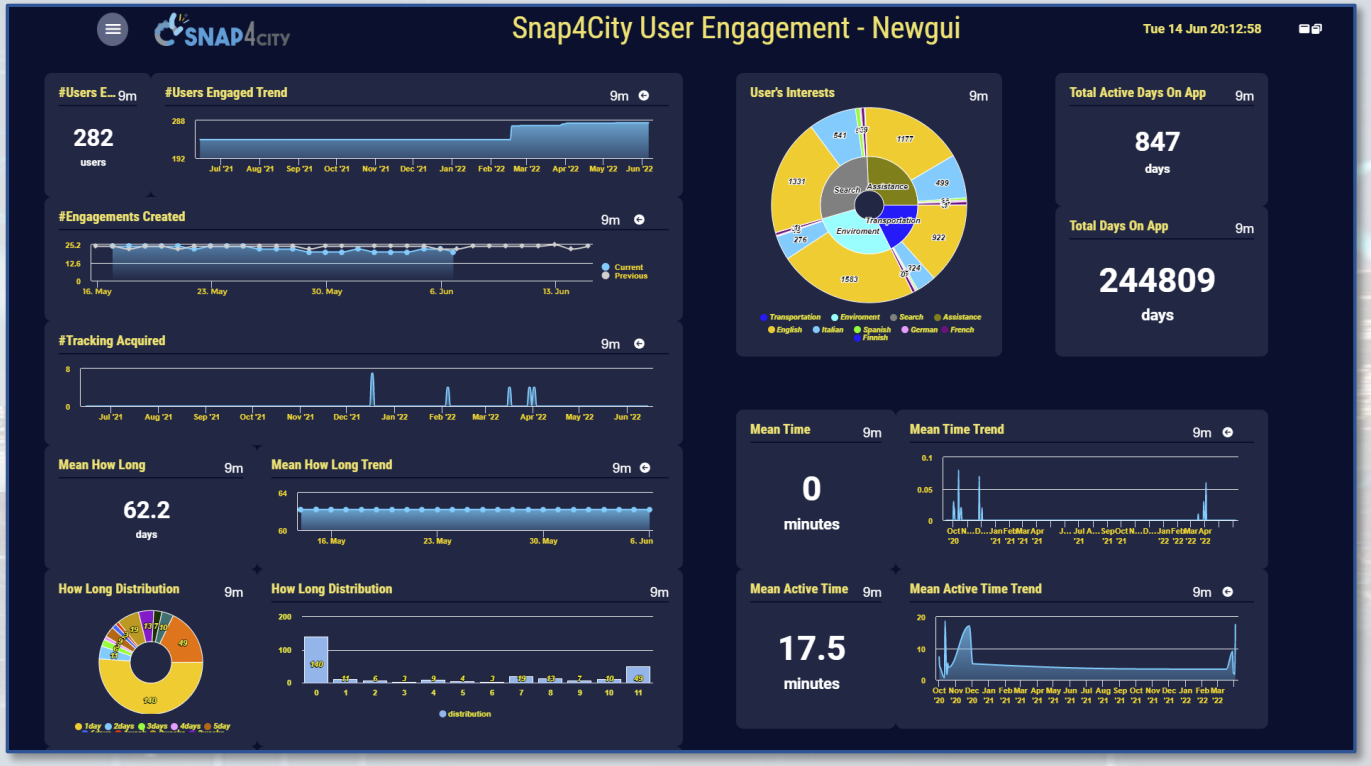

Snap4City User Engagement Antwerp
Data is based on activities performed on Antwerp in a Snap mobile App
Sat 21 Sep 19:28:0
72
users
10.2
days
173
days
3393
days
0
minutes
1.7
minutes
Documentation
Survey
Forum Discussion


Sinottico Sintesi Impianto Altair 2
Thu 1 Oct 15:32:19
Idrogeno gas
Cloro gas
ELETTROLISI
KCl
E.E.
NaCl
NaOH 30%
KOH 30%
NaOH 50%
Home





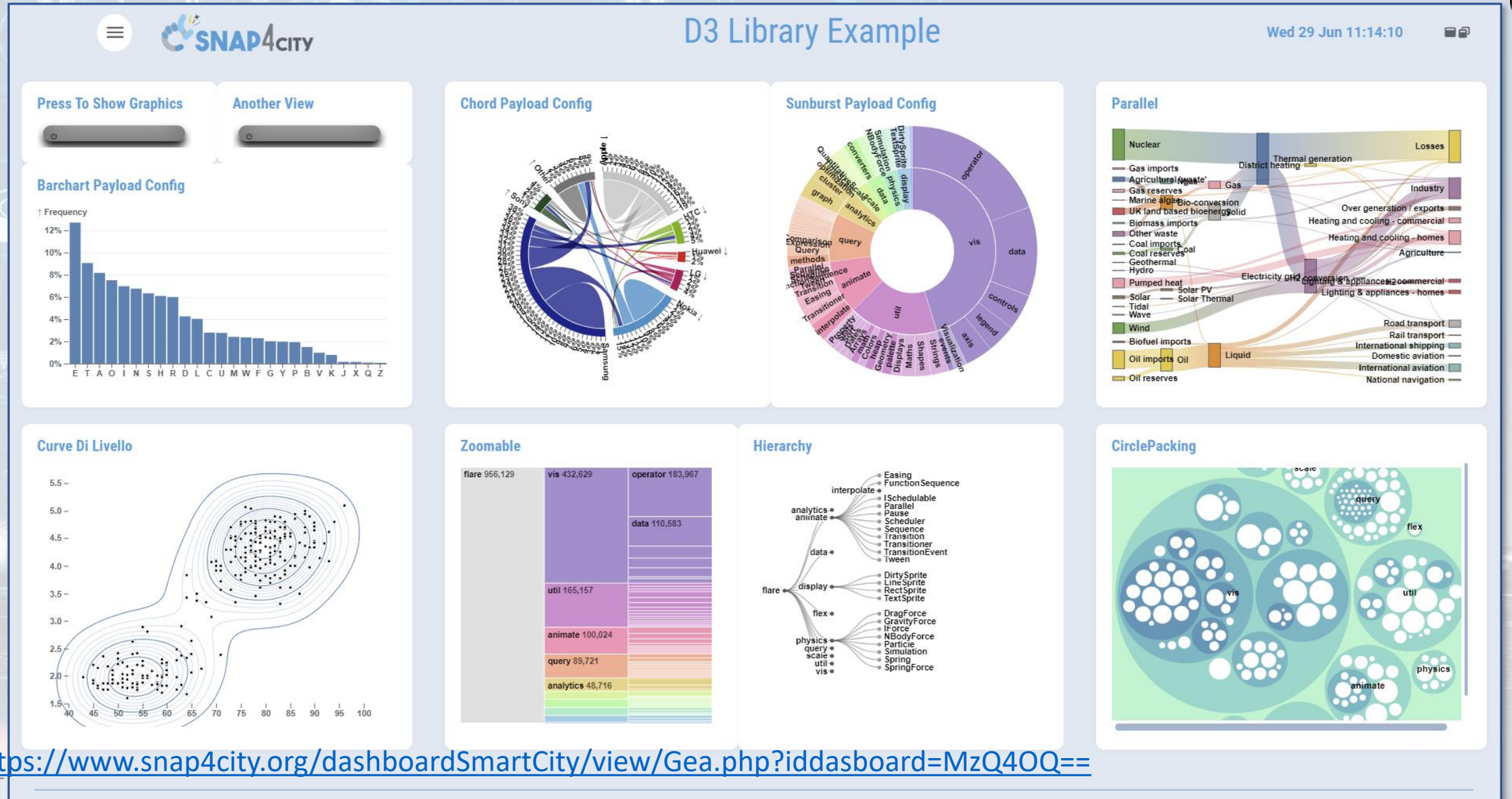




New styles/themes can be developed by specializing a few files from open source

https://www.snap4city.org/793

D3 Graph library capability

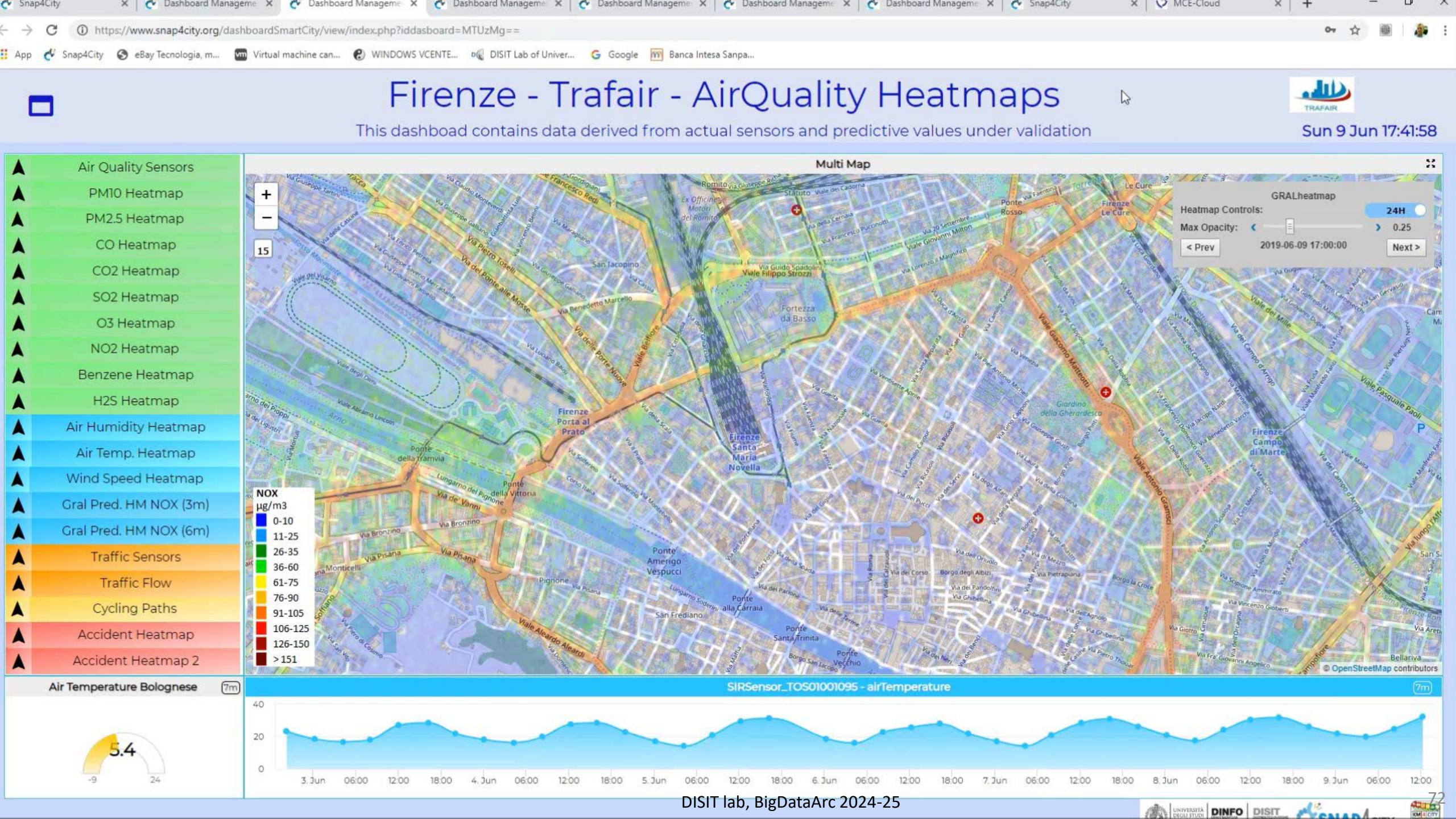


https://www.snap4city.org/dashboardSmartCity/view/Gea.php?iddasboard=MzQ4OQ==

REPLICATE

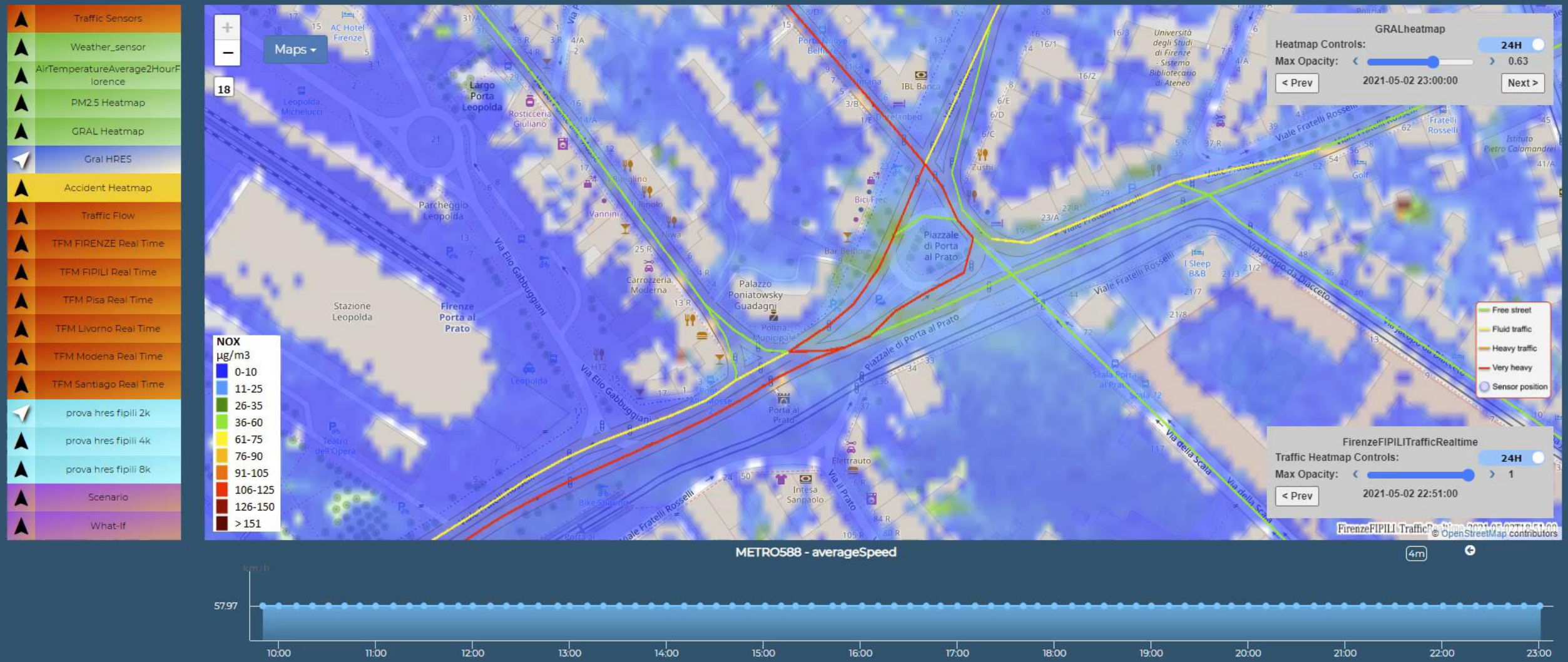
We expect you at Stand 120, Hall P2 , Level 0, Street A
Smart City Expo World Congress 2018
13-15 Novembre 2018, Barcelona, Gran Via Venue
SMARTCITY EXPO WORLD CONGRESS

http://www.darionardella.it/il-sindaco-dario-nardella-in-missione-a-madrid-e-barcellona/


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

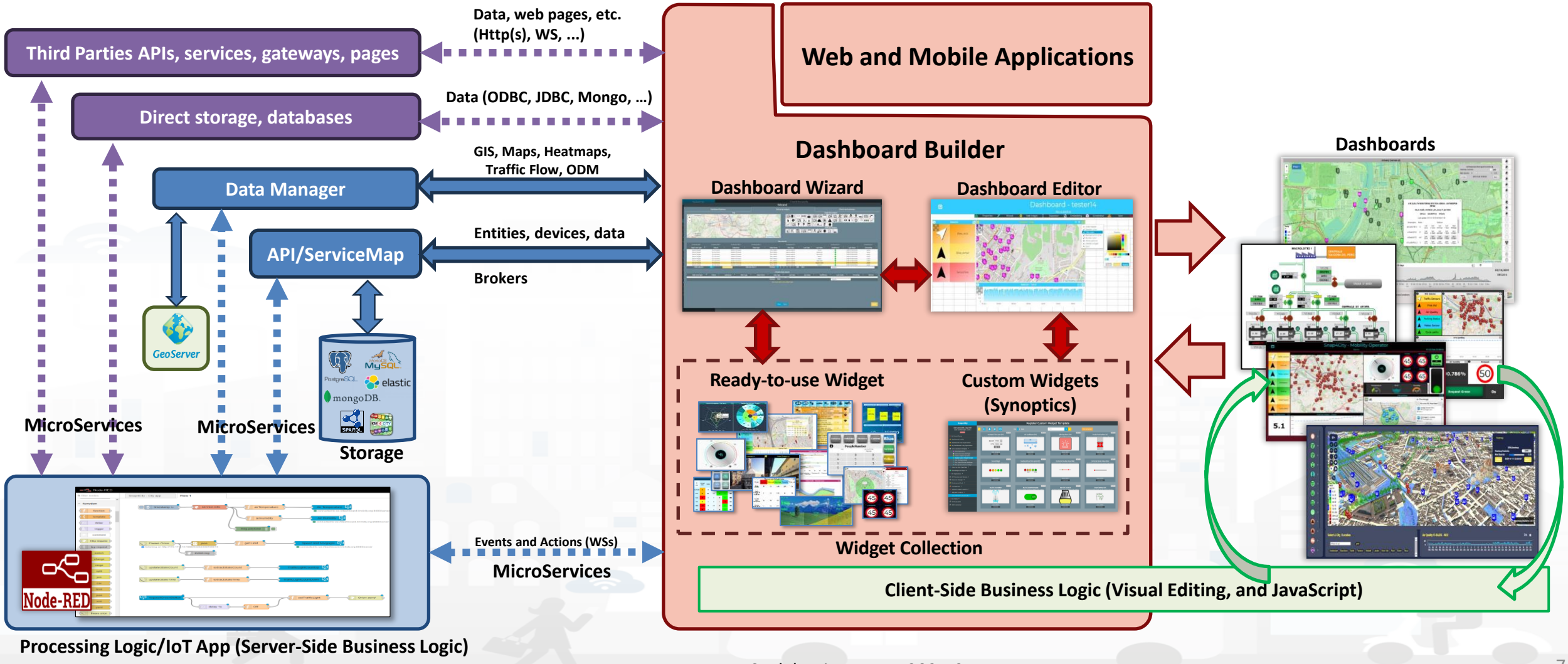
Traffic Flow Manager on multiple cities

Sun 2 May 23:16:31

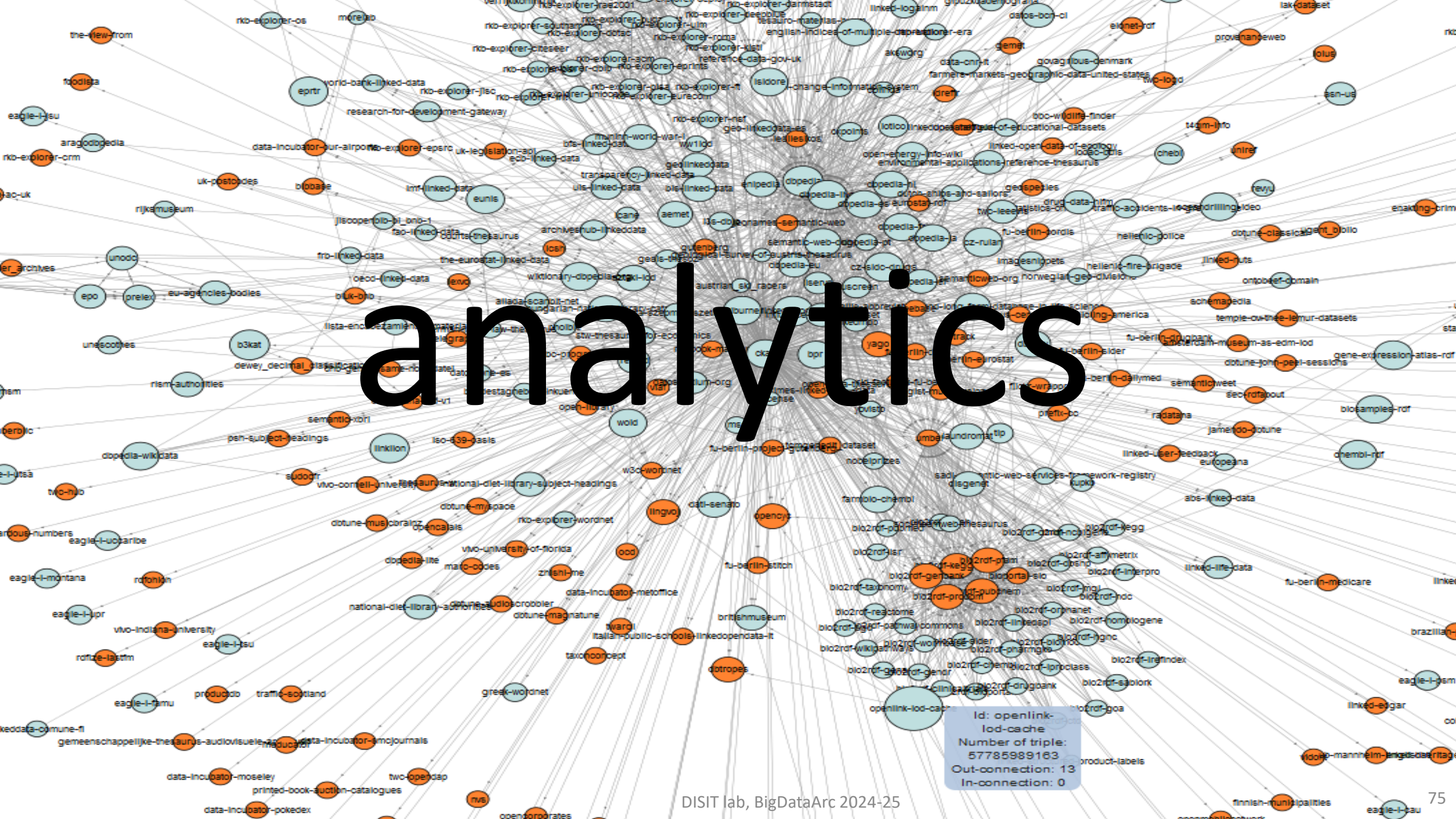


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzEyNg==

How the Dashboards / Apps Exchange data (2024/8)

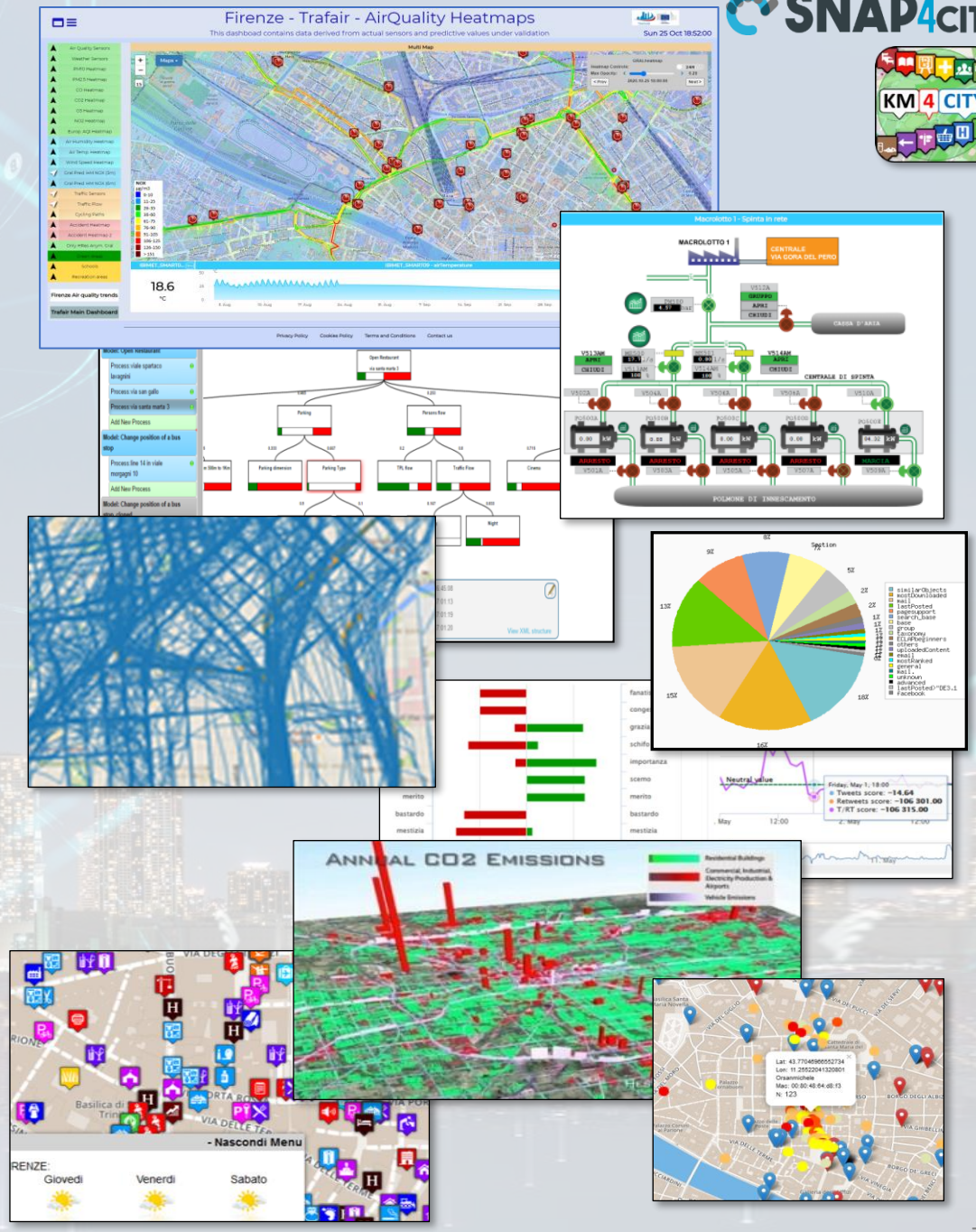


analytics


Id: openlink-lod-cache
Number of triple: 57785989163
Out-connection: 13
In-connection: 0

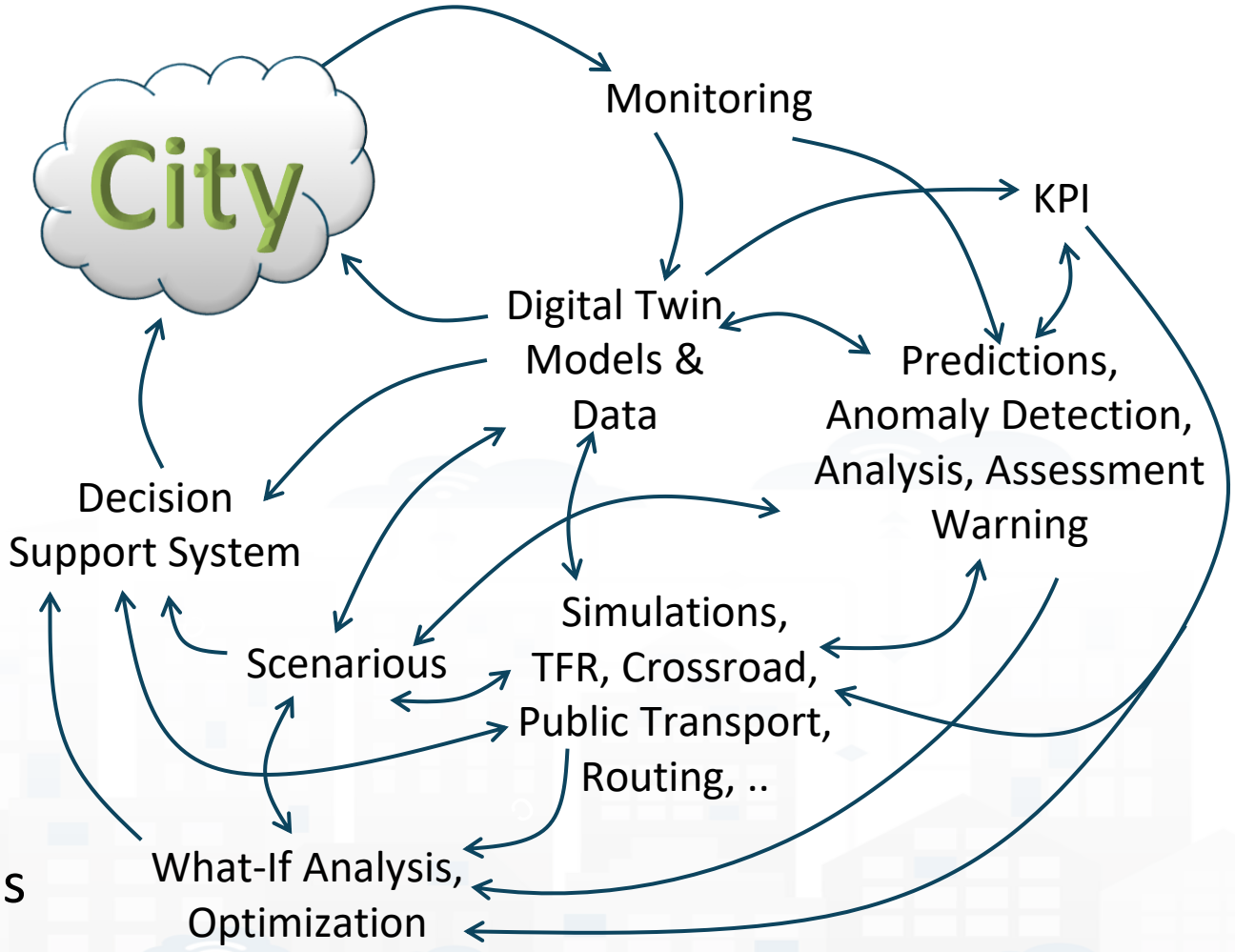
Data Driven Decision Support

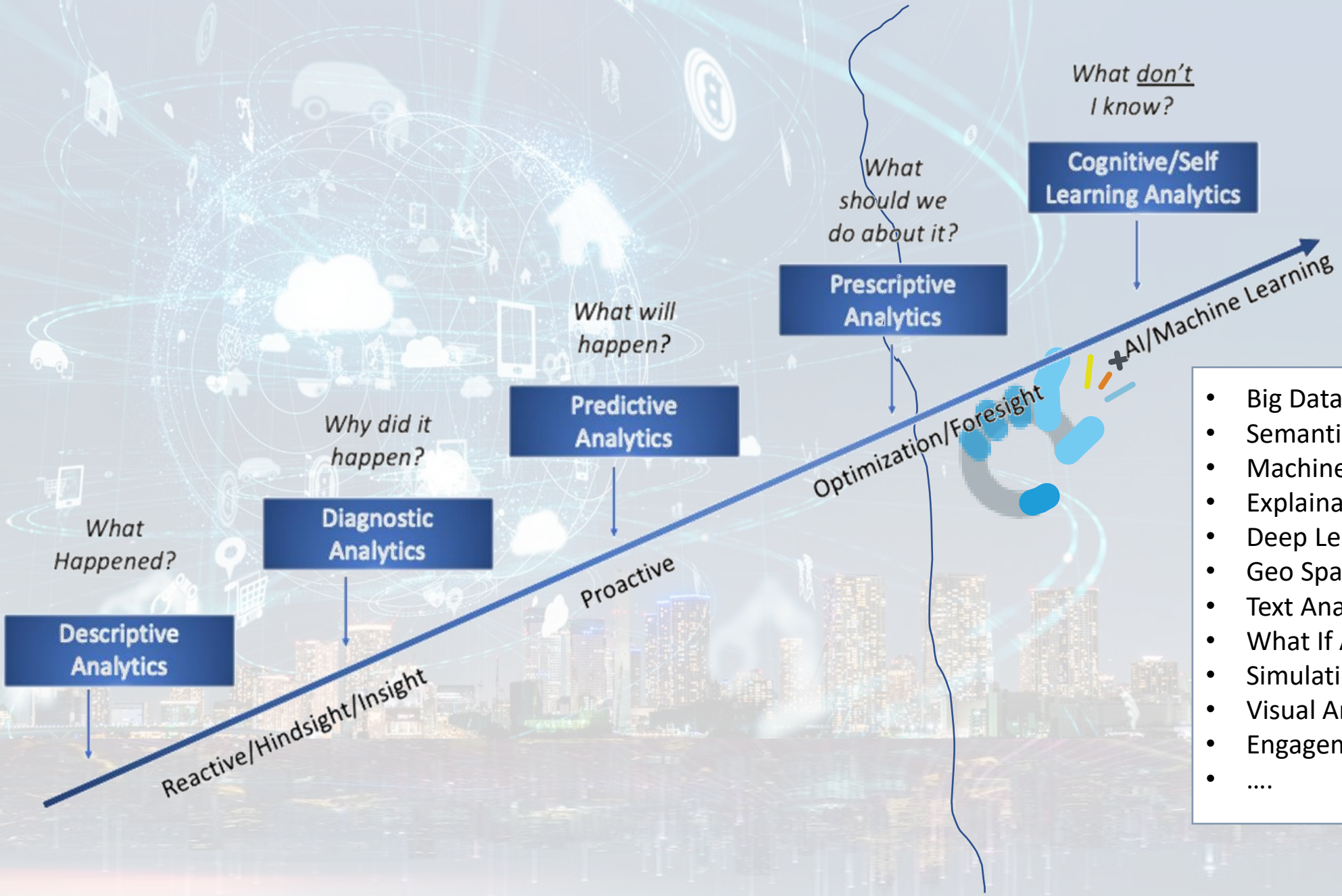
- Decision Support system
- Assessment / Strategies
- Data Rendering, visual analytics
- Data Processing
- Data aggregation, Storage, indexing
- Data Ingestion



Main tasks

- **Controlling Status: management, and operational**
  - Monitoring via KPI
  - Predictions vs KPI
  - Anomaly detection
  - Neuro-Symbolic analysis
  - Risk assessment
  - Early warning on critical conditions
- **Making plan: tactic and strategic, medium and long range, micro/macro**
  - Simulation & optimization
  - Generative AI Prescriptions, scenarios
  - Resilience to Unexpected unknows
  - What-if analysis wrt scenarios

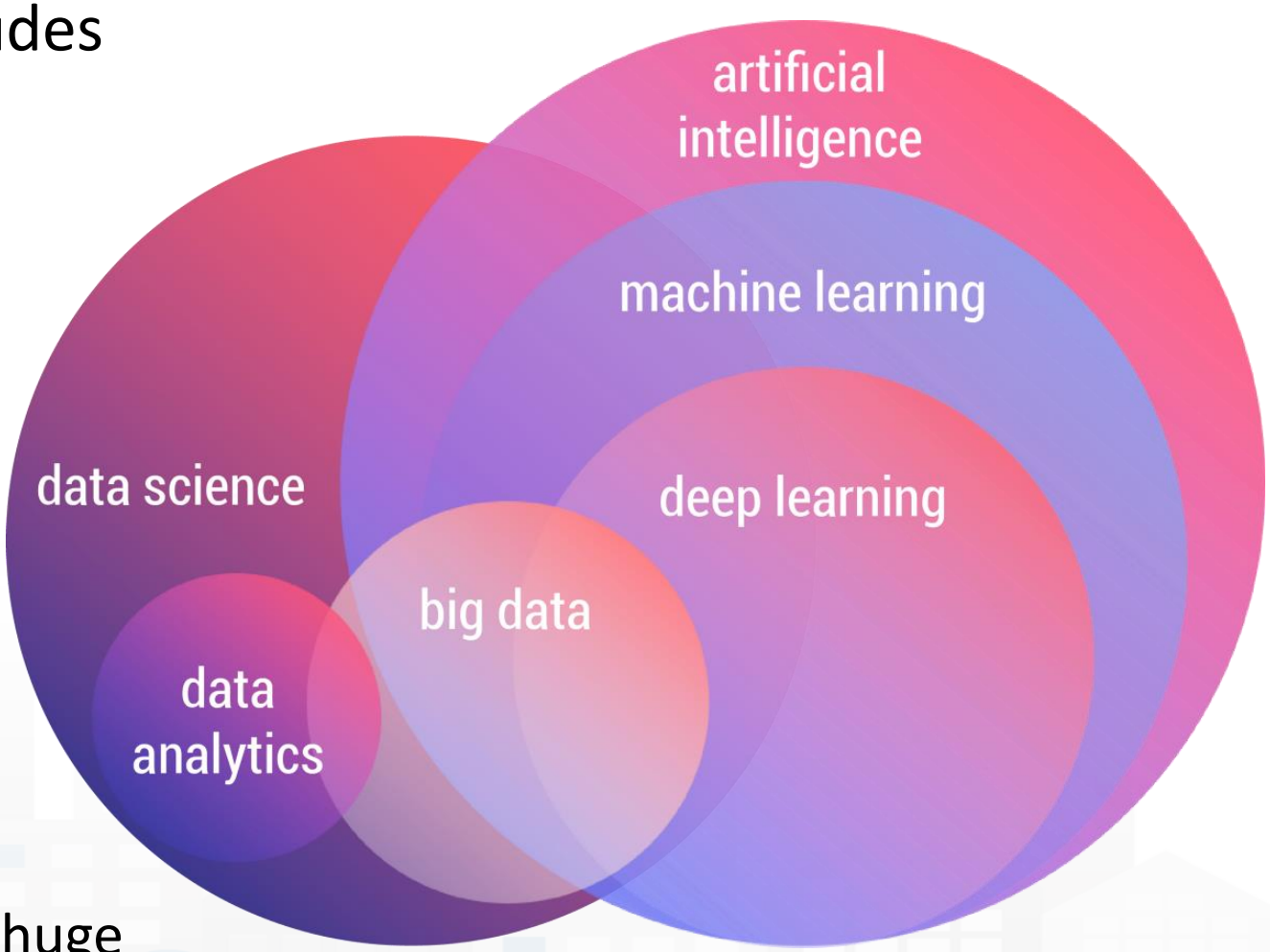




Sentient and active processes

- Big Data Analytics
- Semantic Computing
- Machine Learning
- Explainable Artificial Intelligence
- Deep Learning
- Geo Spatial Reasoning
- Text Analysis, Sentiment Analysis
- What If Analysis
- Simulations
- Visual Analytics
- Engagement Analysis
- ….

- **Artificial Intelligence** usually also includes
  - Code, learn and reasoning
  - Semantic computing, Knowledge Bases
  - Neuro-symbolic reasoning
  - Decision Support Systems
  - Problem solving
- **Machine Learning** usually includes
  - Learn without coding
  - Predictions, decisions (classifications)
  - Supervised or not
  - NLP, vision, pattern recognition
- **Deep Learning** usually includes
  - Capability to learn complex patterns on huge amount of data
  - Specialized ML solutions



Available AI Solutions on Snap4City

https://www.snap4city.org/997

More than 80 Available Solutions & 300 AI applic.

- Mobility and Transport
- Environment, Weather, Waste, Water
- City Users Behaviour and Social analysis
- Energy and Control
- Tourism and People
- Security and Safety
- High Level Decision Support Solutions
  - Asset management
  - Resilience and Risks Analysis
- Low level Techniques

https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

https://www.snap4city.org/download/video/course/p4/

1 NO POVERTY | 2 ZERO HUNGER | 3 GOOD HEALTH AND WELL-BEING | 4 QUALITY EDUCATION

- ***15 Minute City Index:***
  - 13 differente subindexes

7 AFFORDABLE AND CLEAN ENERGY

- Monitoring and Prediction of energy consumption
- Stimulating: Bike sharing, e-bikes, car charge, etc.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

- Industry 4.0 integrated solutions
- Decisions Support Systems
- Process optimization
- Predictive maintenance

11 SUSTAINABLE CITIES AND COMMUNITIES

- Smart City infrastructure: monitoring and resilience
- Effective and Low cost smart solutions
- What-if analysis, Simulations

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

- Monitoring resource consuption,
- business intelligence tools for decision makers,
- Reduction production costs

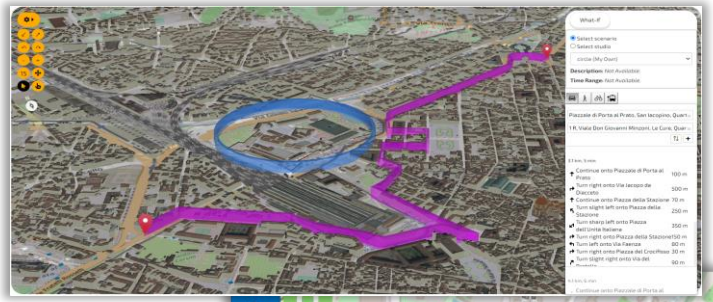
13 CLIMATE ACTION | 15 LIFE ON LAND

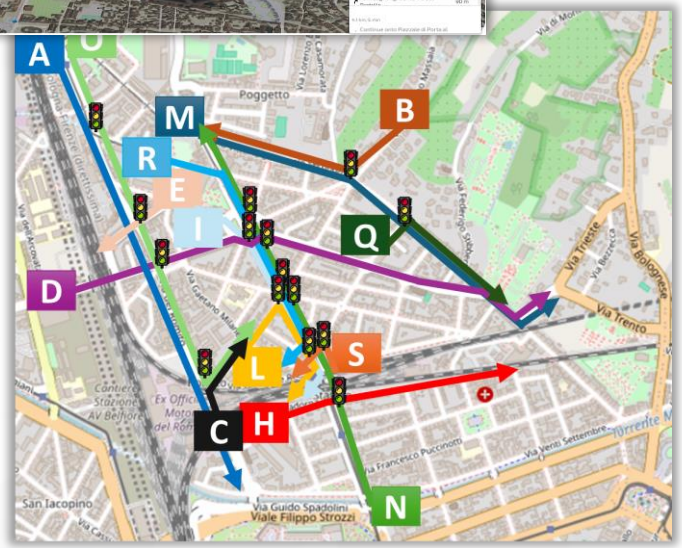
- Monitoring and Predictions for
  - NO2, NOX, CO2, Traffic flow, pollutant, landslide, etc.
  - Traffic flow reconstruction

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

- Shortening justice time
- Predictiction of mediation proneness
- Ethical Explainable Artificial Intelligence

Mobility

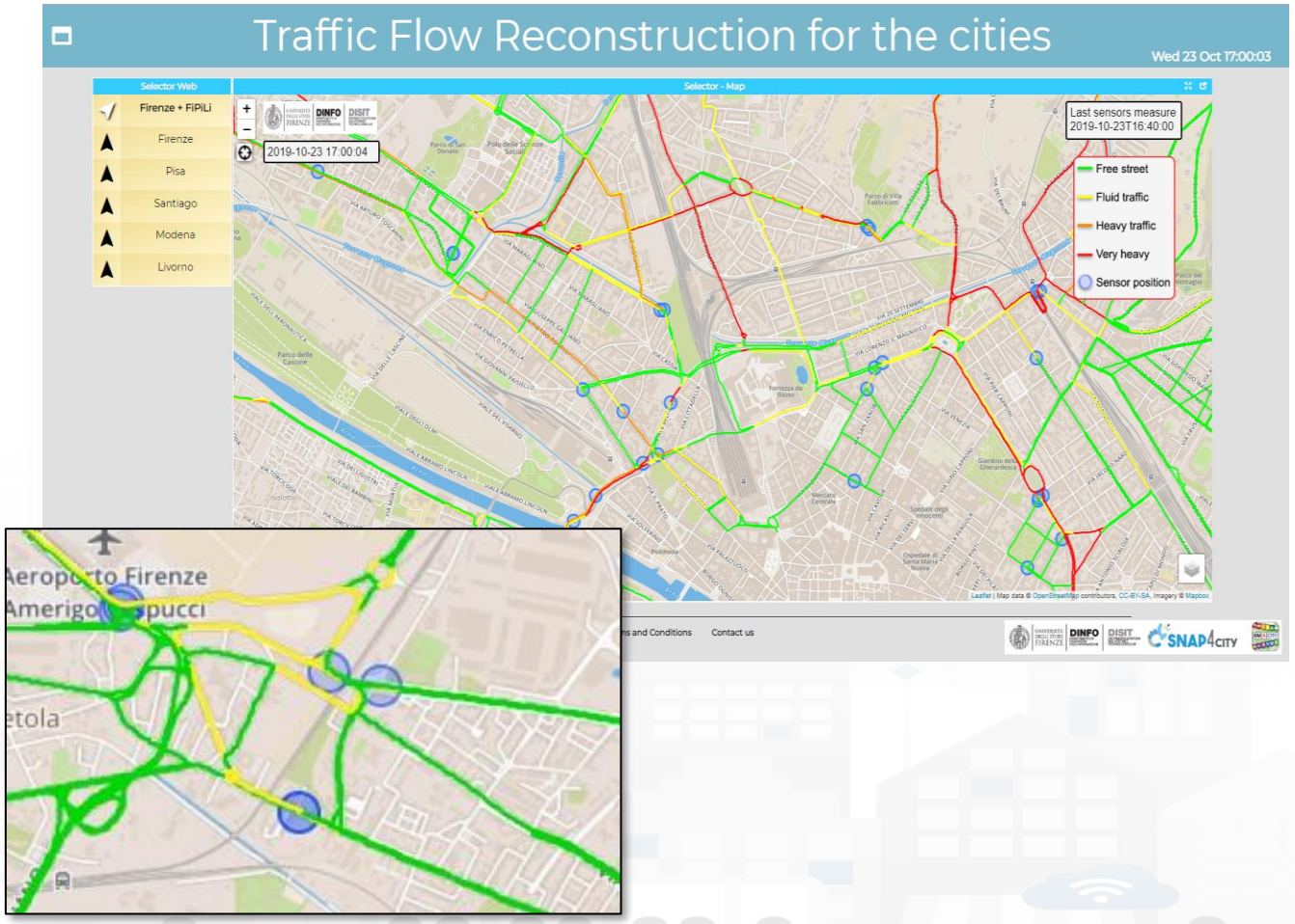




- **Goals:**
  - Decongestion, Decarbonization, costs reductions
  - Improve Accessibility to services
  - Improve Security/Safety of city users
- **Operation and Plan**:
  - Traffic monitoring, prediction, reconstruction, identification of critical conditions (early warning), fleet management, dynamic routing, multimodal routing, city user behaviour analysis
- **Optimization and what-if analysis traffic light, infrastructure**
  - **Reduction**: travel time, waiting time, stops, CO2 emissions, consume fuel, travel time for tramways
- **Public Transport**: analysis of Mobility Demand vs Offer of Transportation
- **Parking Management:** monitoring, prediction, any payments, on/off-road
- **Sharing / Pooling Management**: eShare and mobile app, bikesharing, smart bike, fleet management
- **KPI:** SUMI/SUMP, travel time, emissions, traffic status, accessibility, ..
- **Mobile App**: final users and operators
  - Info Mobility, traffic reconstruction, charging, participation,
  - Parking, payments, overparking, fine reporting, ..
- **Participatory**: problem reporting, ticketing, etc.
- **Data Integration of any kind: env, weather. Tickets, presences, POI, sat, etc.**

Why Dense Traffic Flow Reconstruction ?

- Making decision on mobility and transport solutions → what if analysis
- Controlling pollution
- Dynamic Routing for Firebrigade, Ambulances, general public
- Planning Public Transportation routing



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

Big Data & Analytics

- **Solutions for**
  - **Predicting models**
  - **Early detection**
  - **Anomaly detection**
- **Data Analytics**
  - Data mining, Clustering
  - Semantic computing
  - Machine learning
  - Natural Language Processing, Sentiment Analysis
- **Architetture parallele**
  - Hadoop, Spark, Kafka, map reduce
  - Hdfs, Hbase, Mongo, Virtuoso, RDF stores
  - Distributed Scheduling
  - GPU
- **IOT/IOE**
  - Protocols
  - Devices
  - Data aggregation

XAI

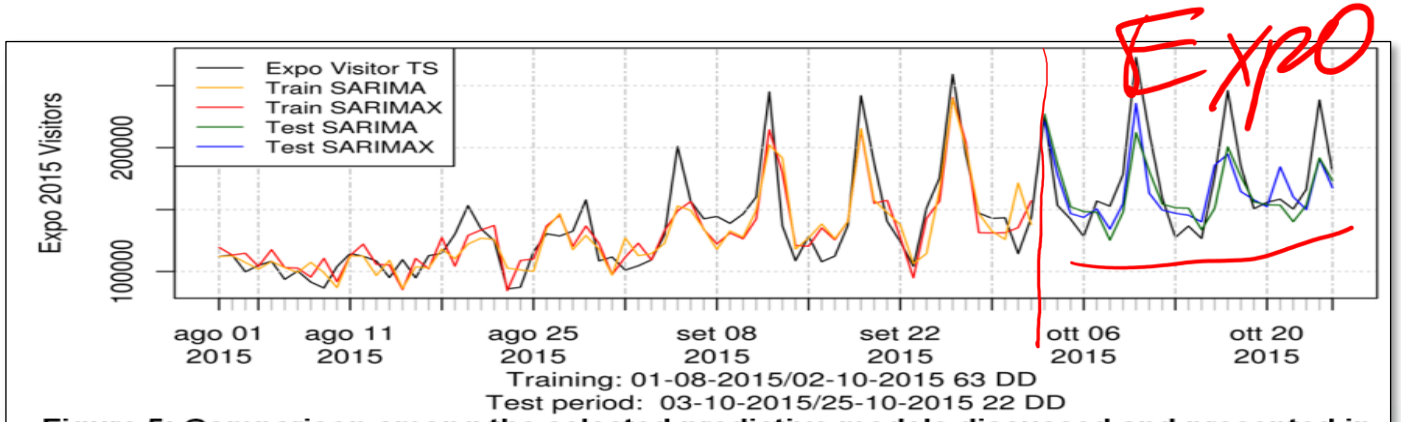
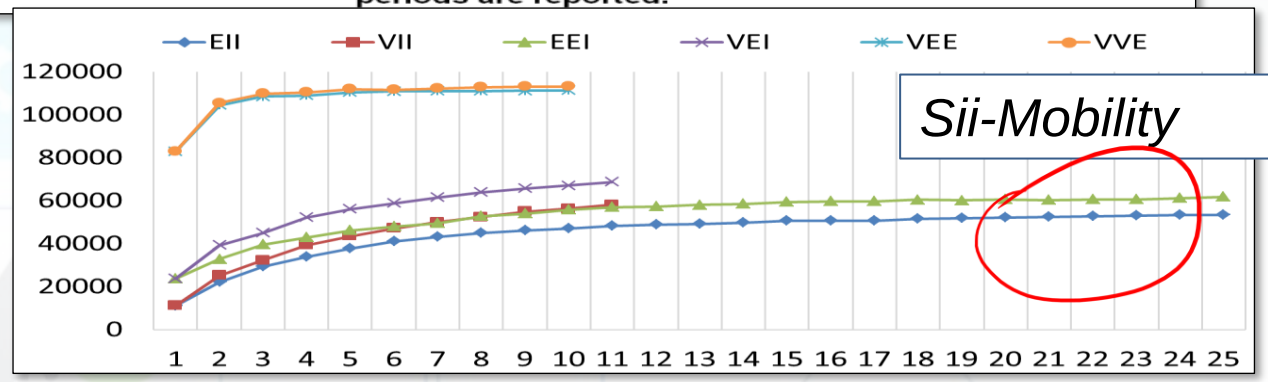
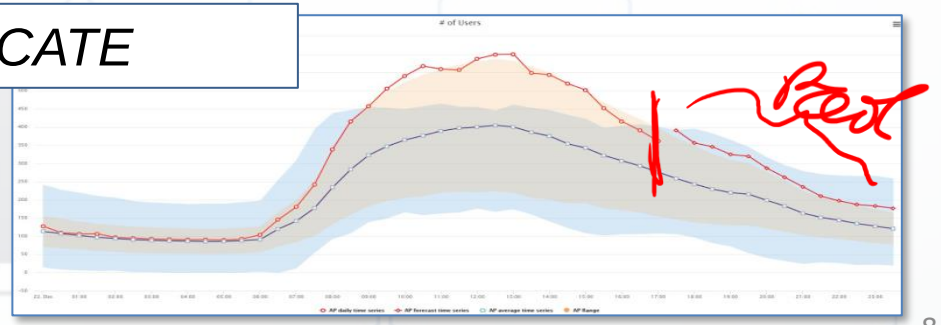


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.



Sii-Mobility

REPLICATE

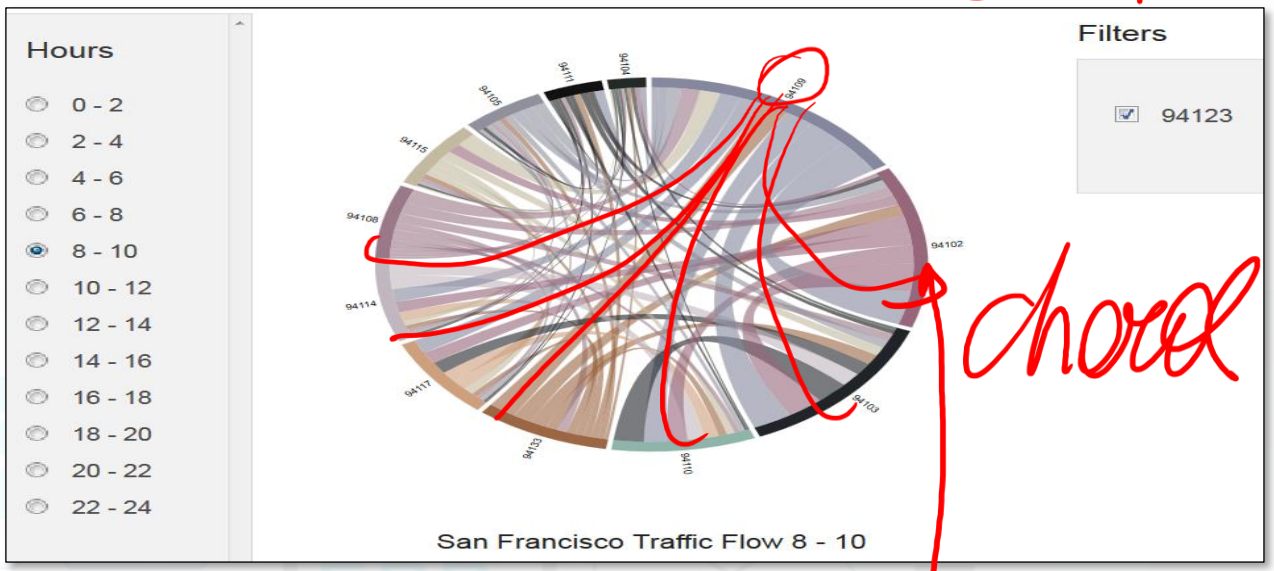


Traffic and People Flow Assessment

http://www.disit.org/6694

ODM

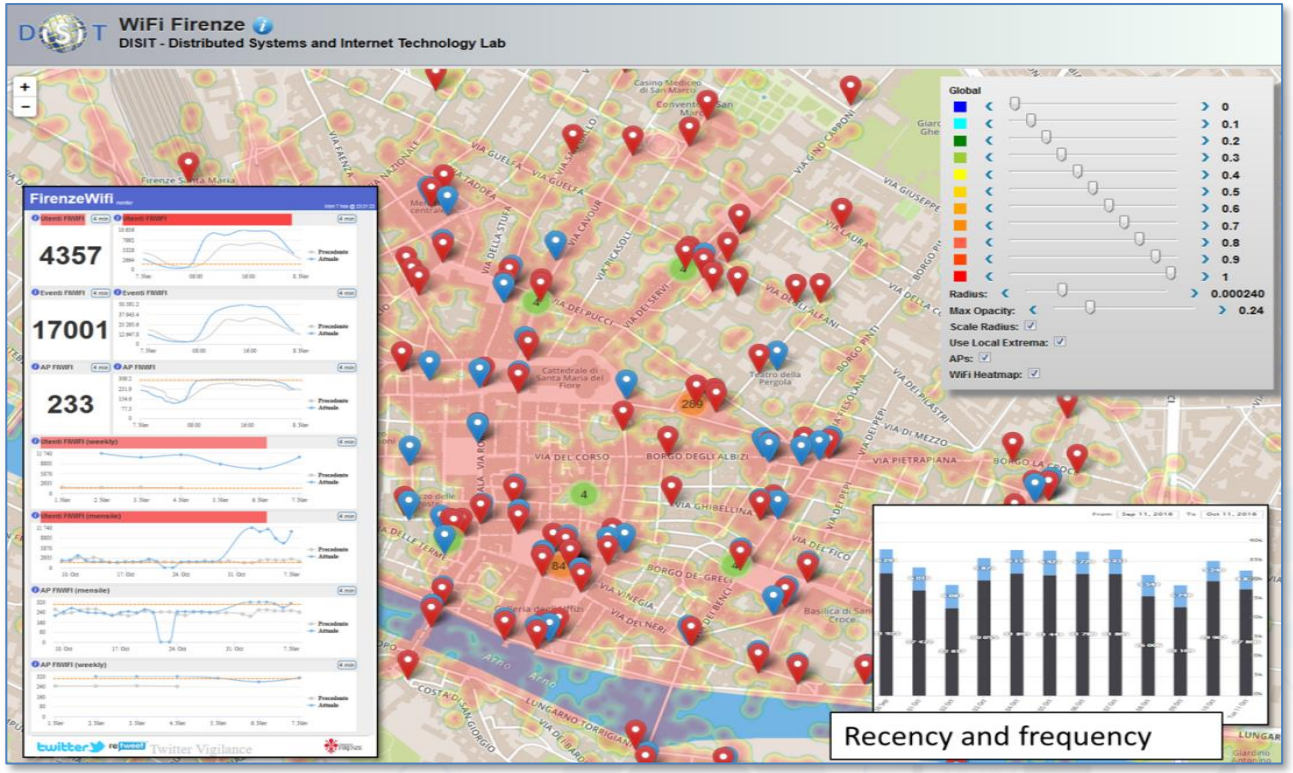
- **Origin Destination Matrix**
  - Specific Sensors, vehicle Kits, mobile App, Wi-Fi Access Points, etc.
- **Assess people and traffic flows to**
  - improve services
  - predict critical conditions on Crit. Infra.
  - take real time decisions and sending messages in push to population
  - Increase city resilience
  - optimize traffic flow
  - take decision of routing

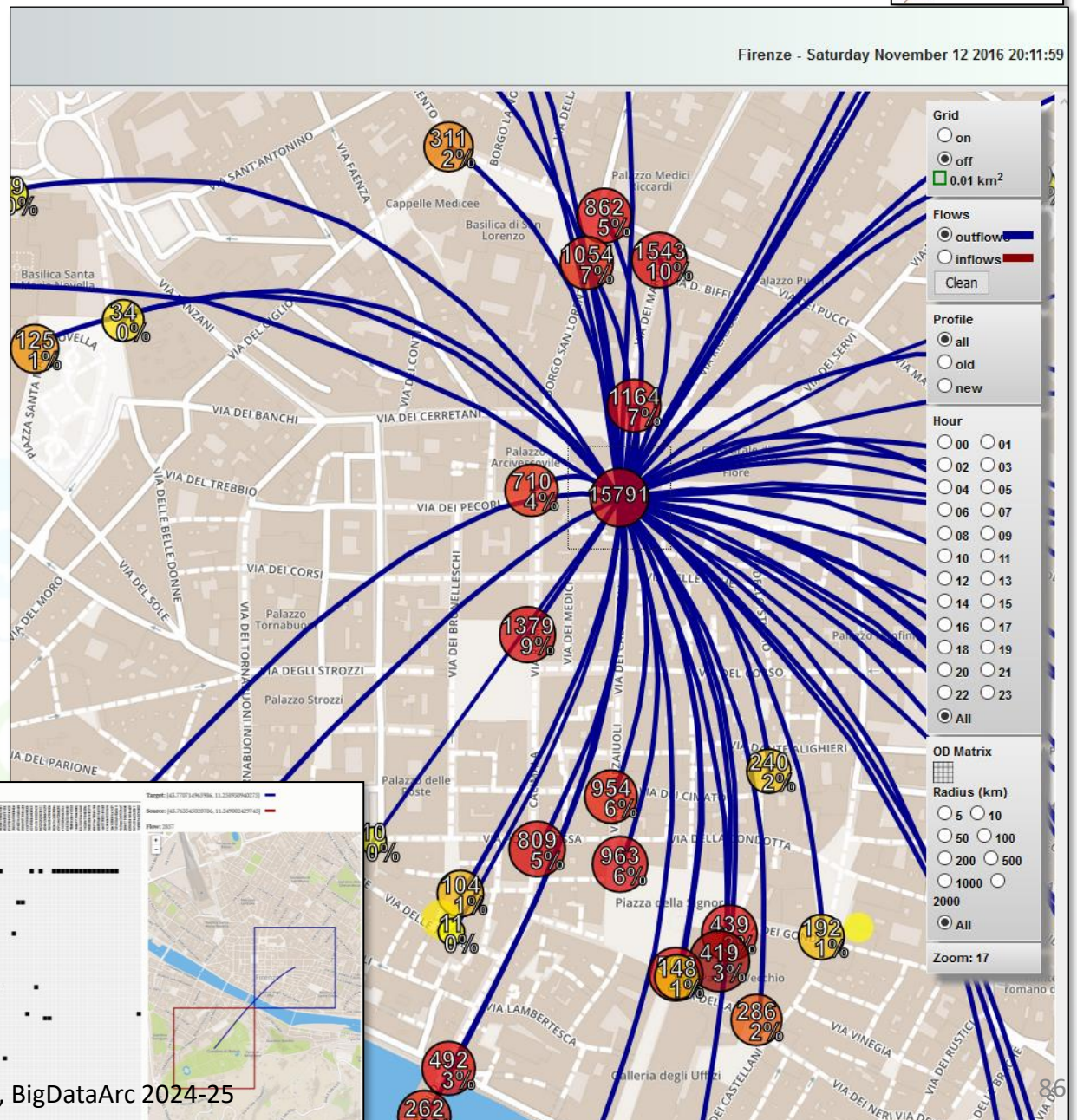


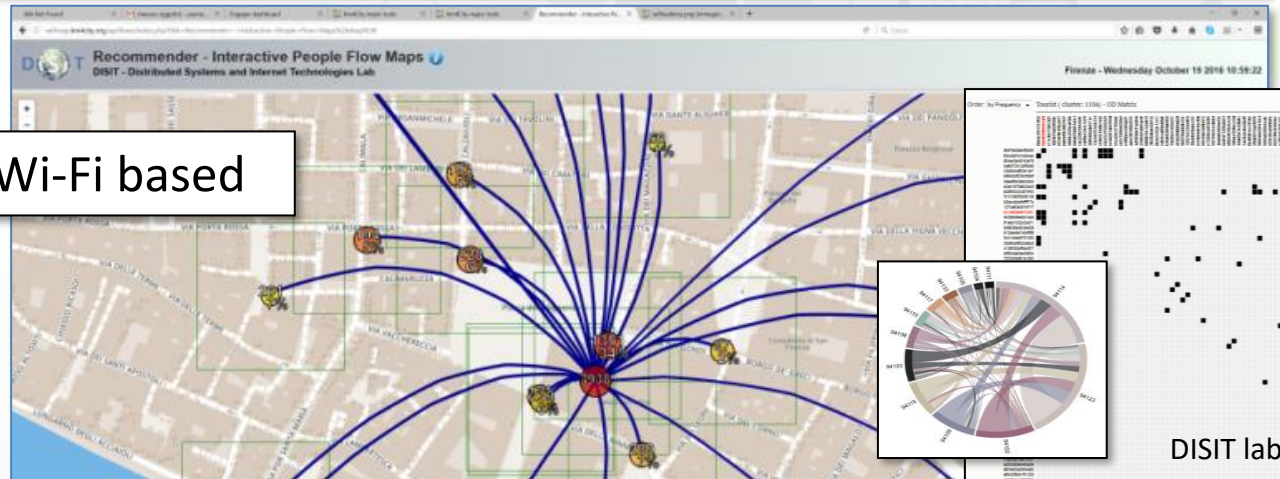
chord

ZIP

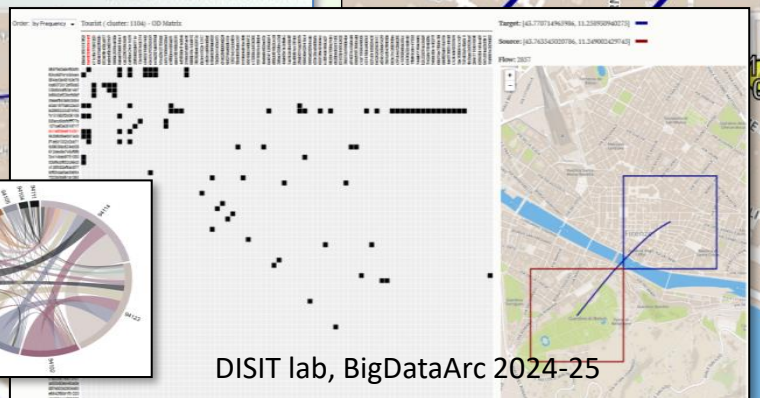
Origin Destination Matrix Estimation



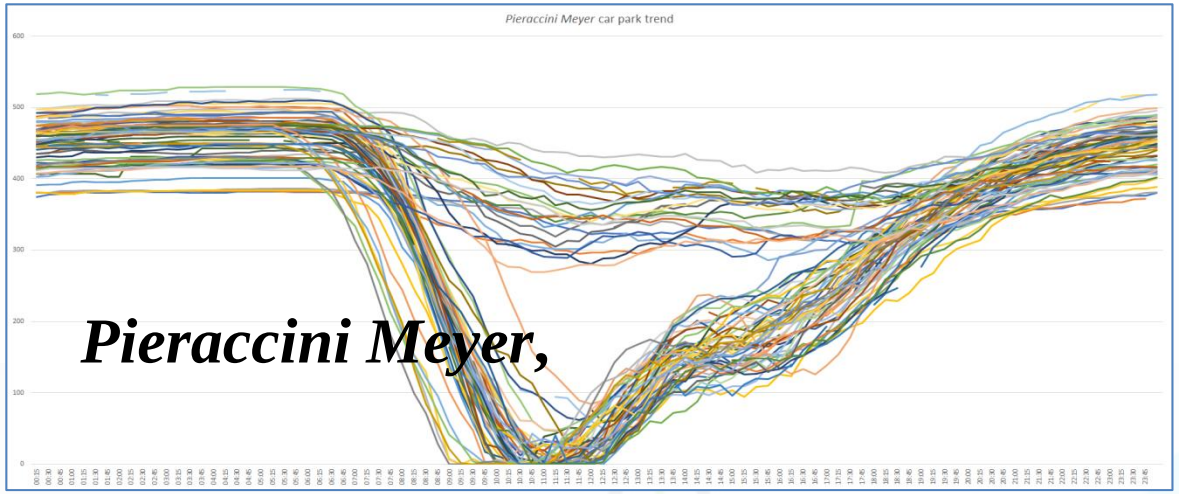


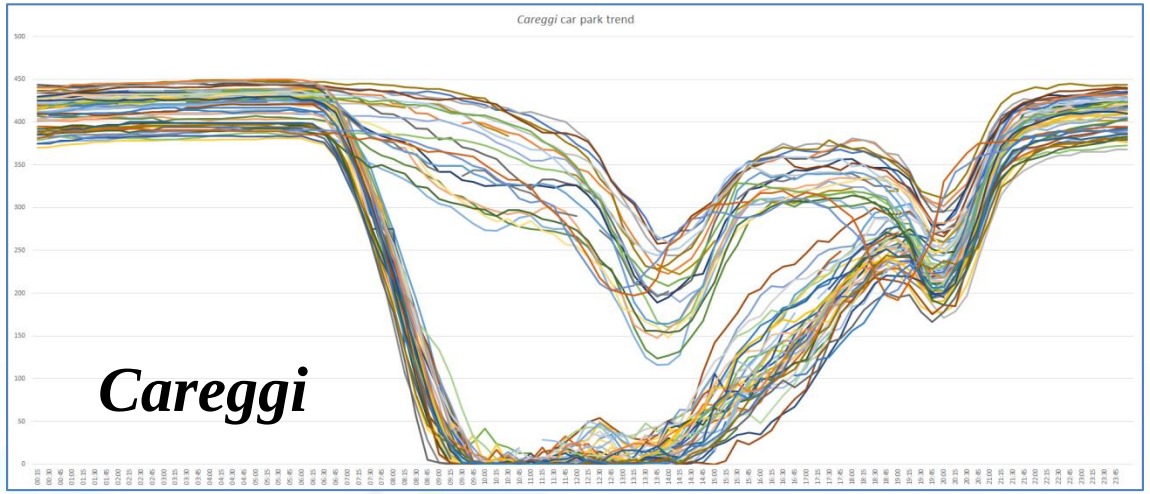


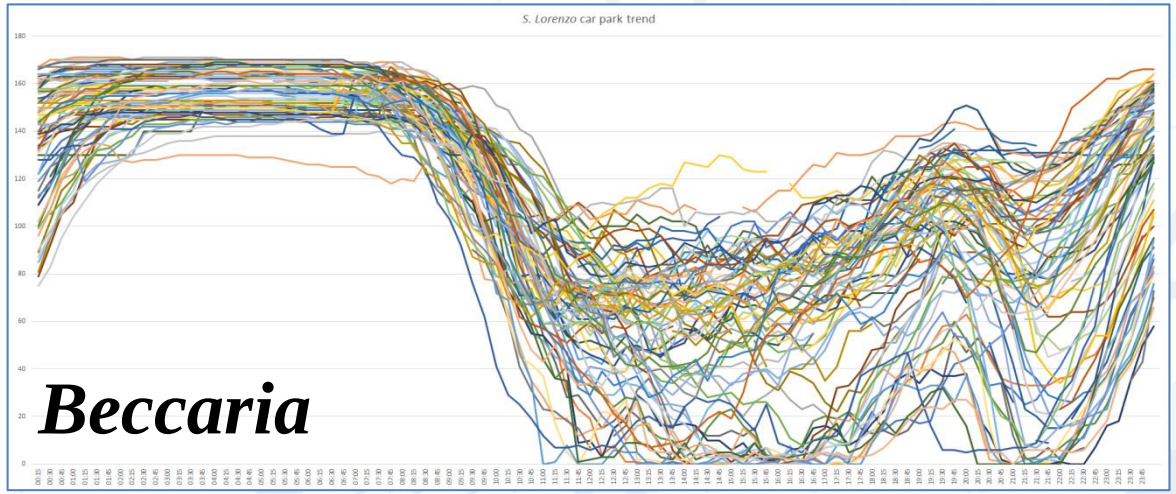
Wi-Fi based

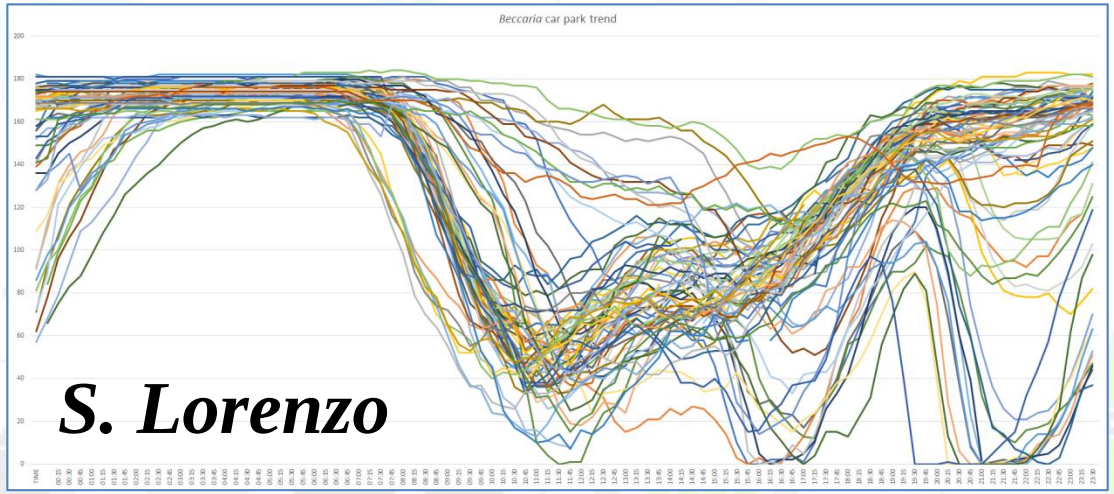


Free Parking space trends



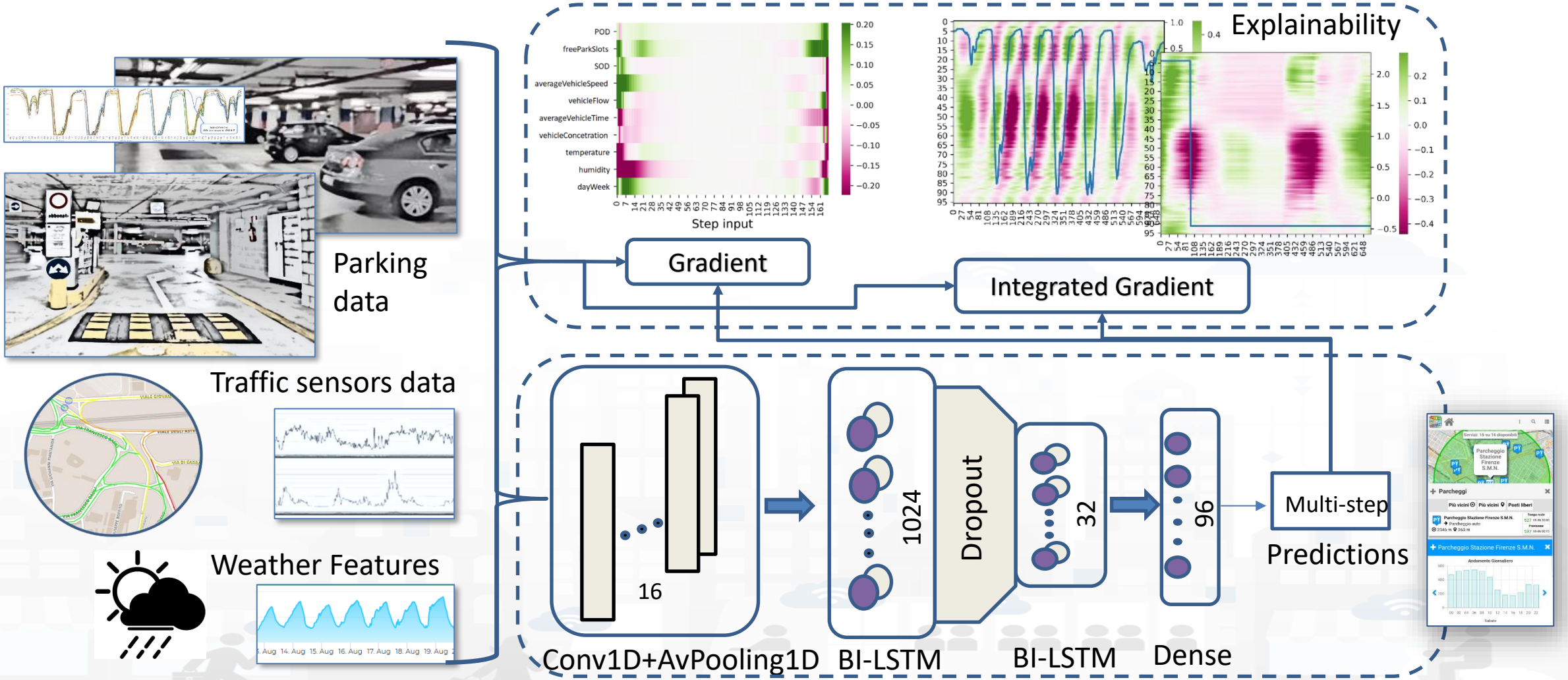




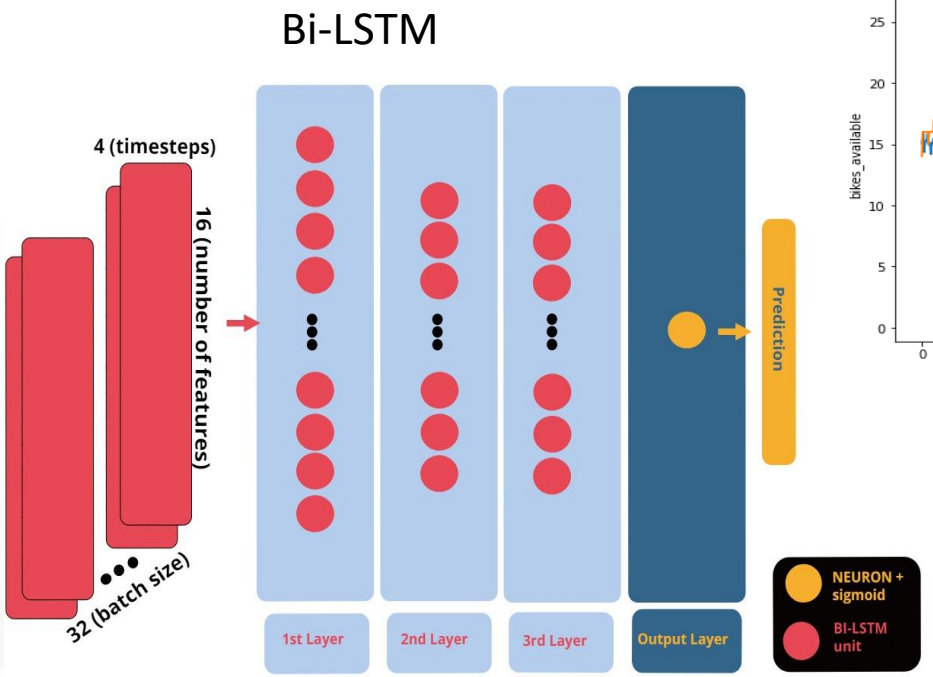


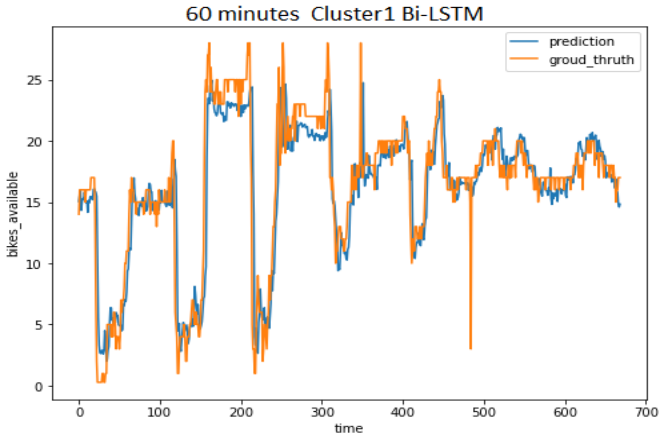
12 parking areas in Florence

Deep Learning AI to surely Park!



Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations

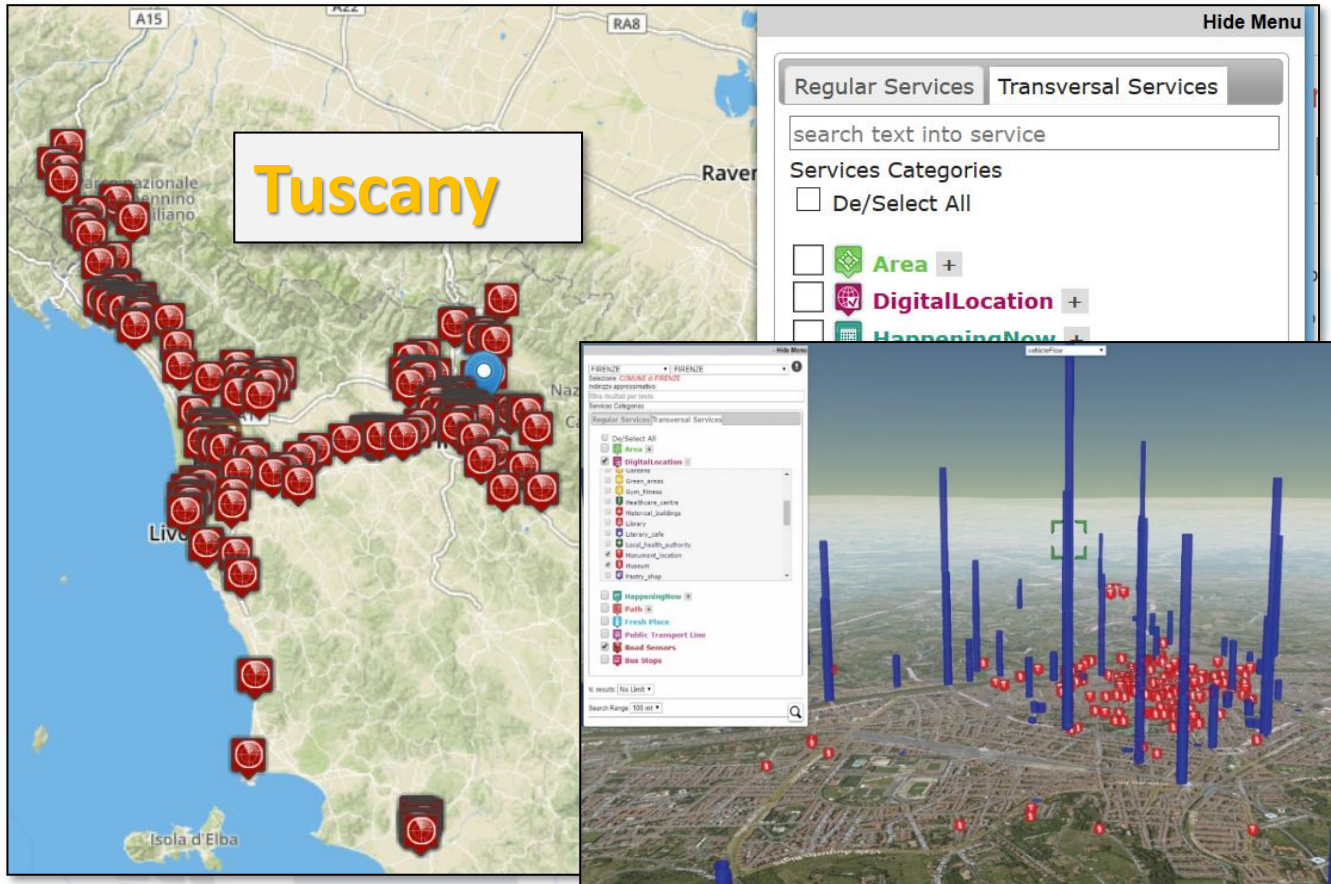


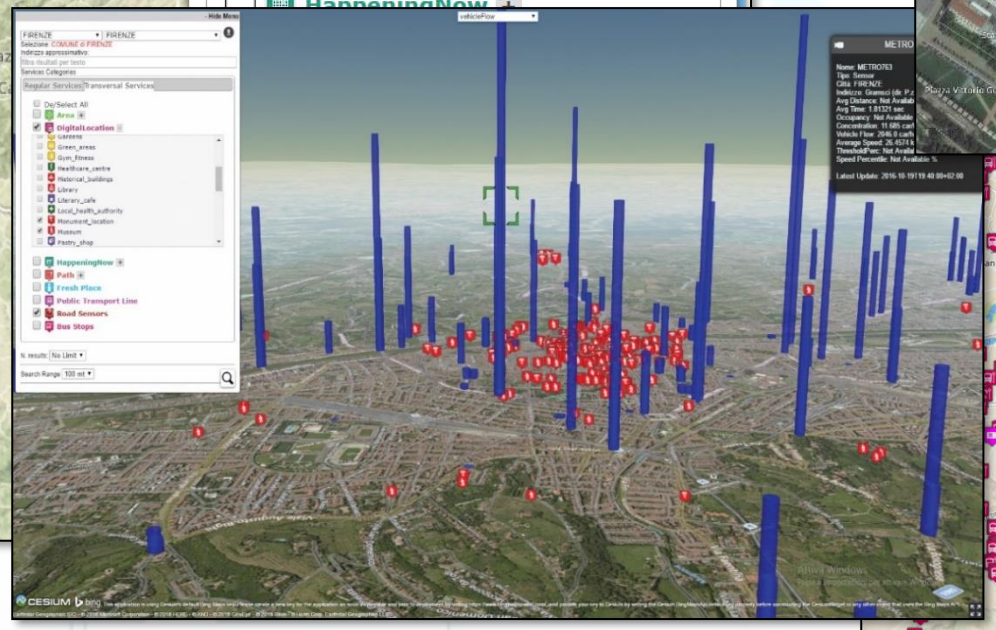


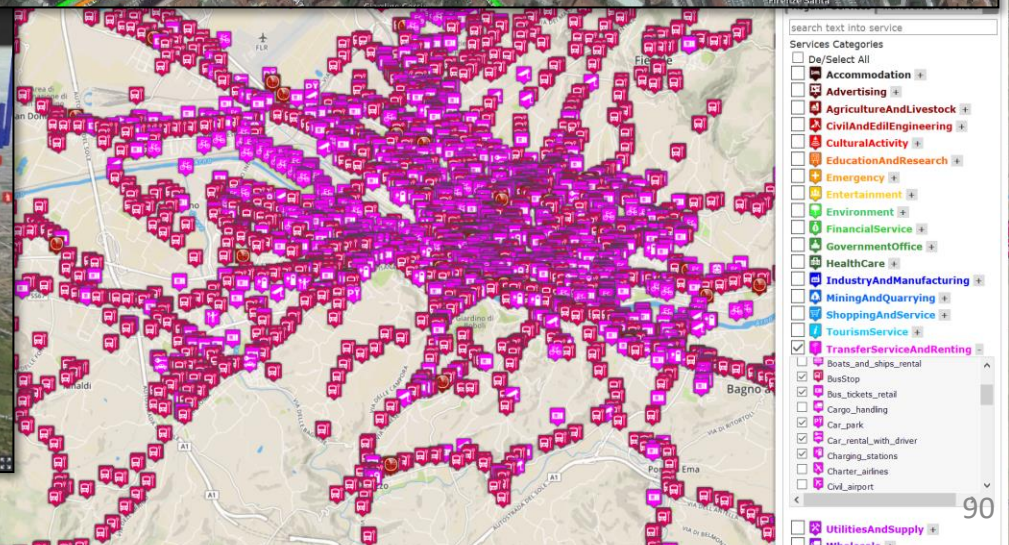
E. Collini, P. Nesi and G. Pantaleo, "Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations," in *IEEE Access*, vol. 9, pp. 124337-124347, 2021, doi: 10.1109/ACCESS.2021.3110794.
https://ieeexplore.ieee.org/abstract/document/9530580

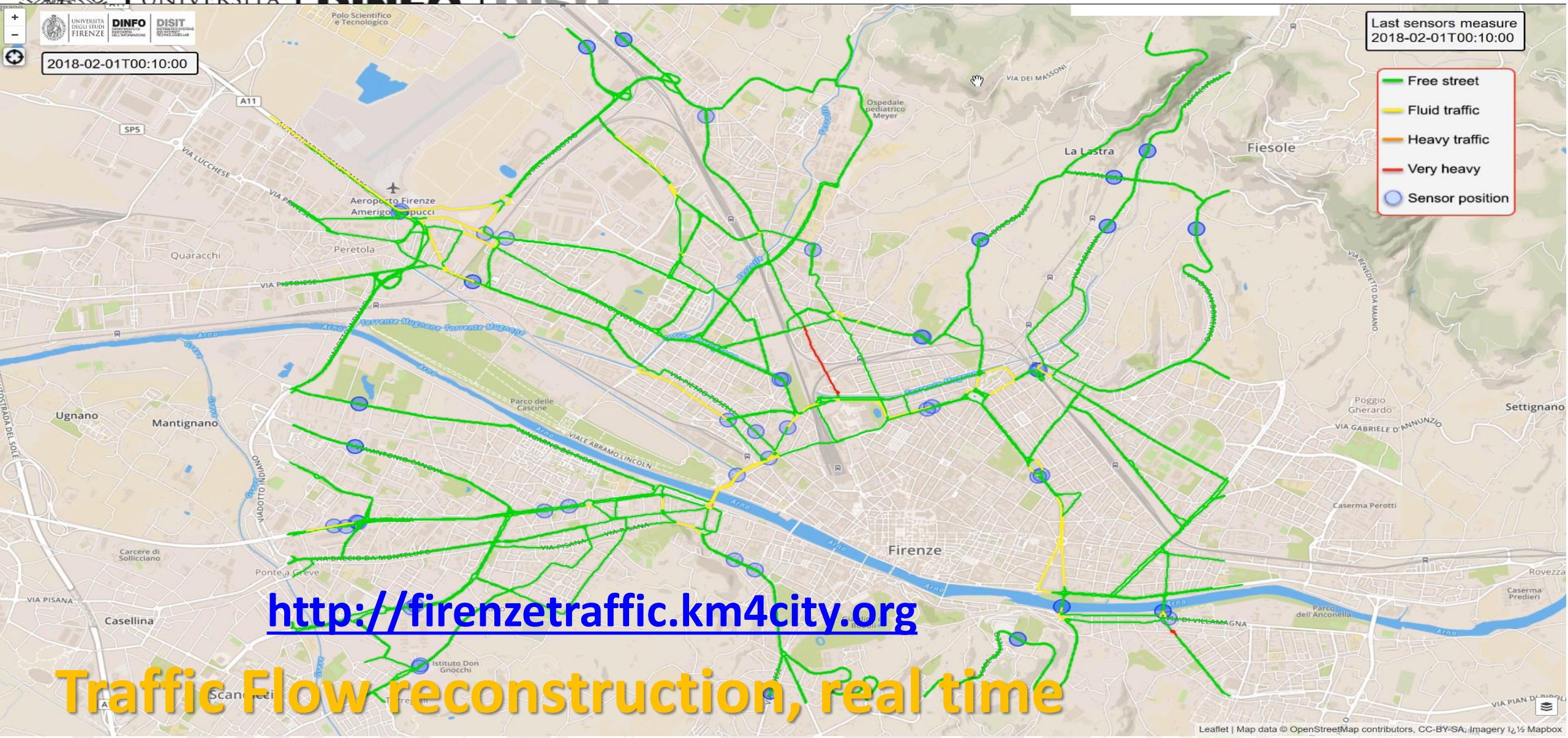
Traffic Flow Tools

- Spire and Virtual Spires (cameras), Bluet
- Specifically located: along, around, ..





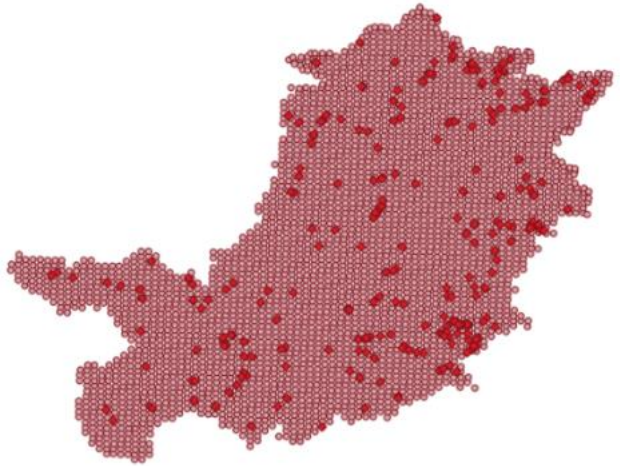


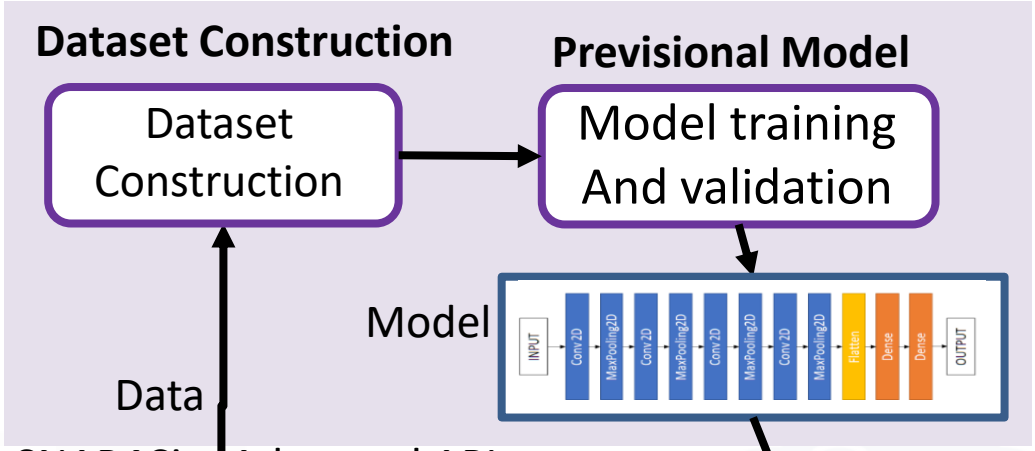


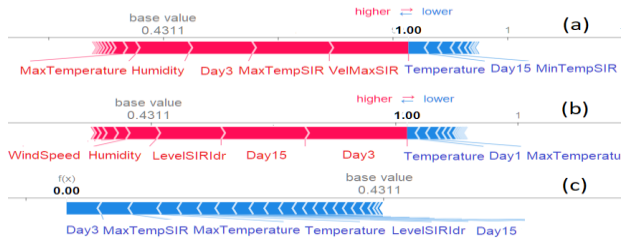
http://firenzetraffic.km4city.org

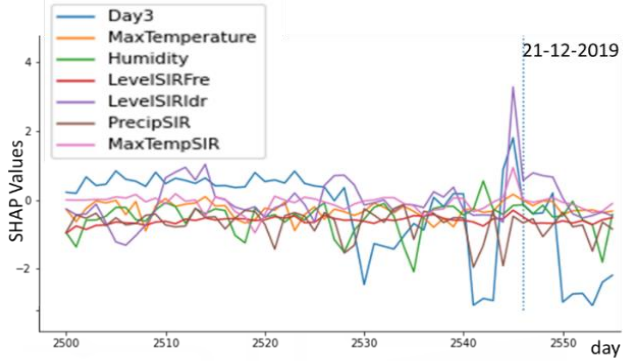
Traffic Flow reconstruction, real time

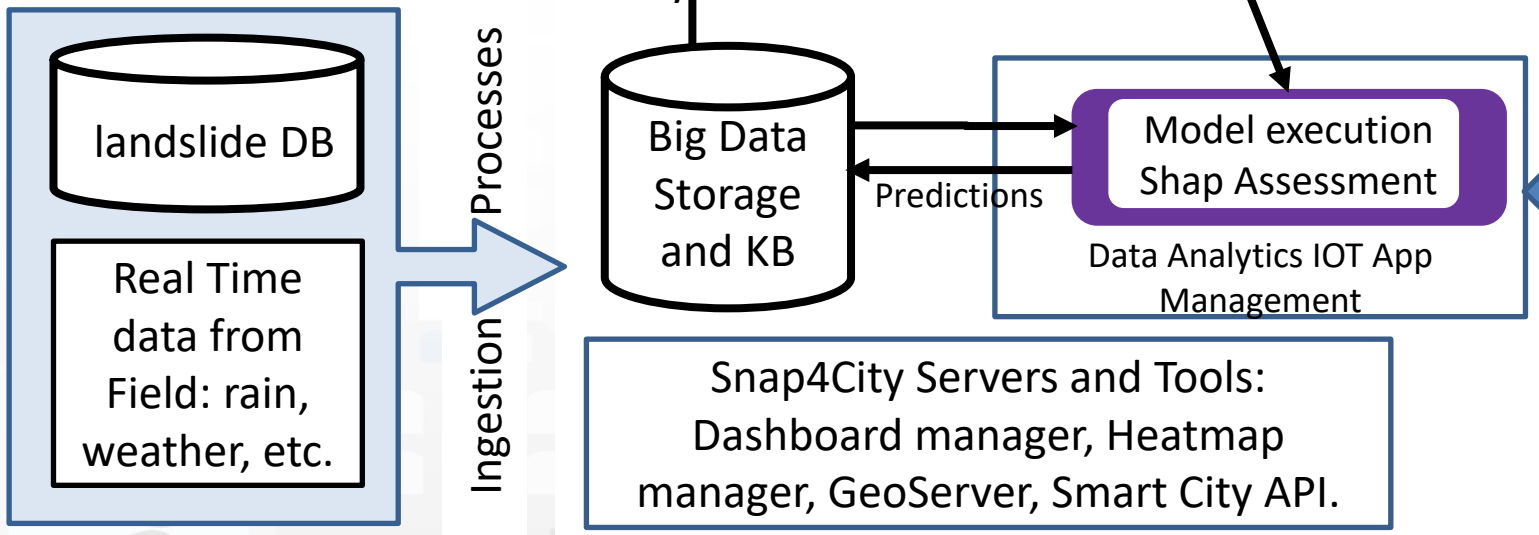
Predicting Land slides



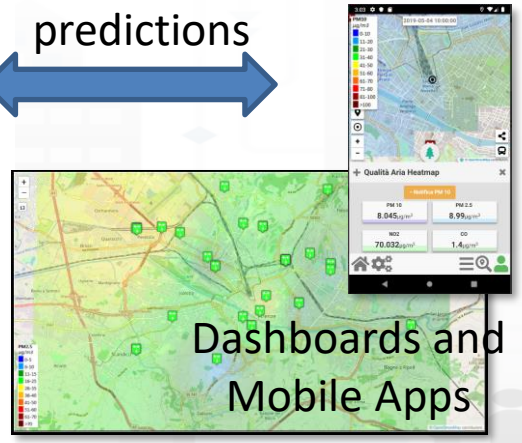








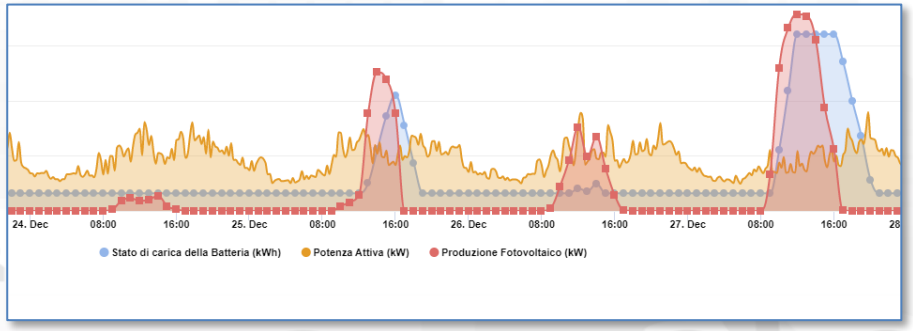
predictions



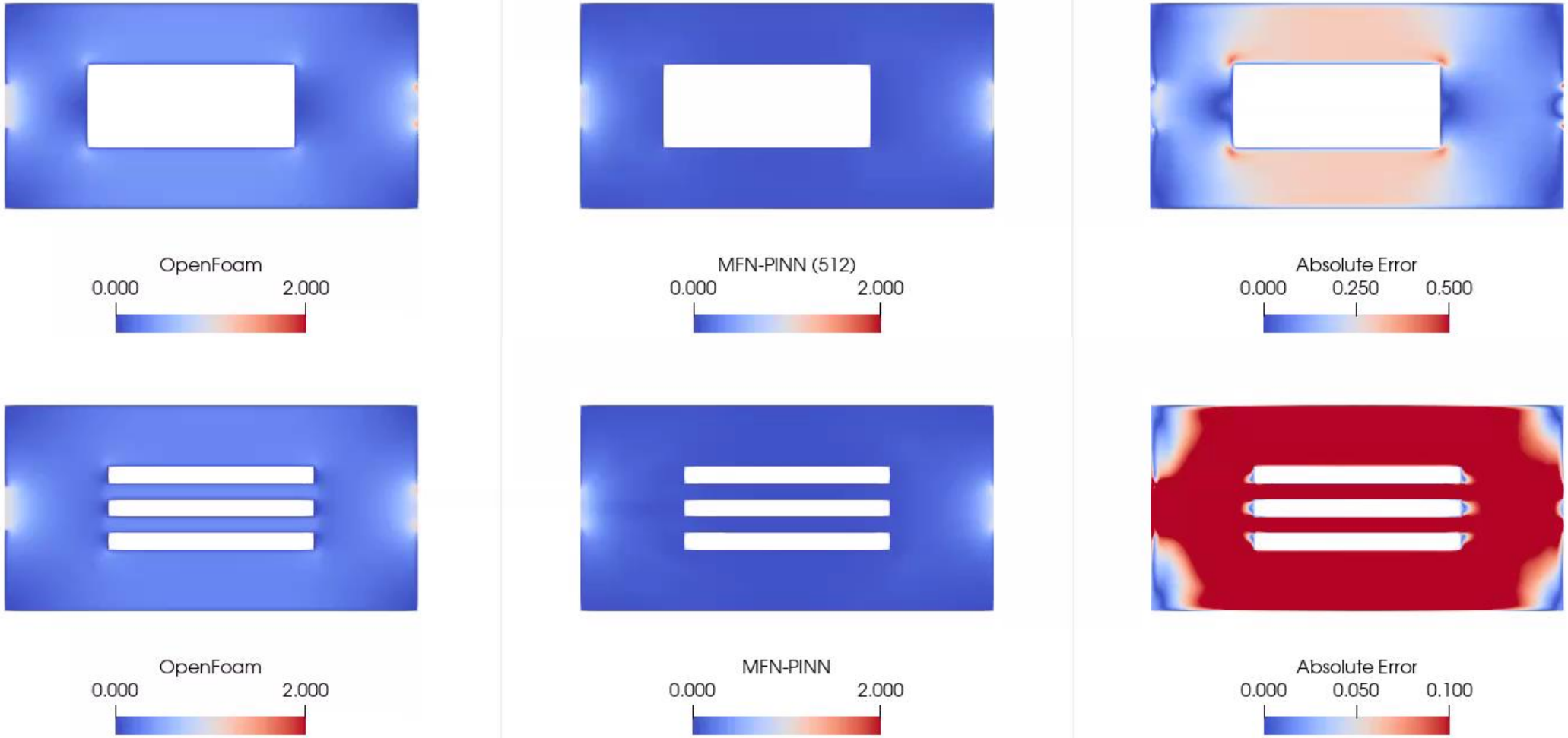
E. Collini, L. A. I. Palesi, P. Nesi, G. Pantaleo, N. Nocentini and A. Rosi, "Predicting and Understanding Landslide Events with Explainable AI," in *IEEE Access*, doi: 10.1109/ACCESS.2022.3158328.
https://ieeexplore.ieee.org/abstract/document/9732490

City Energy and Buildings

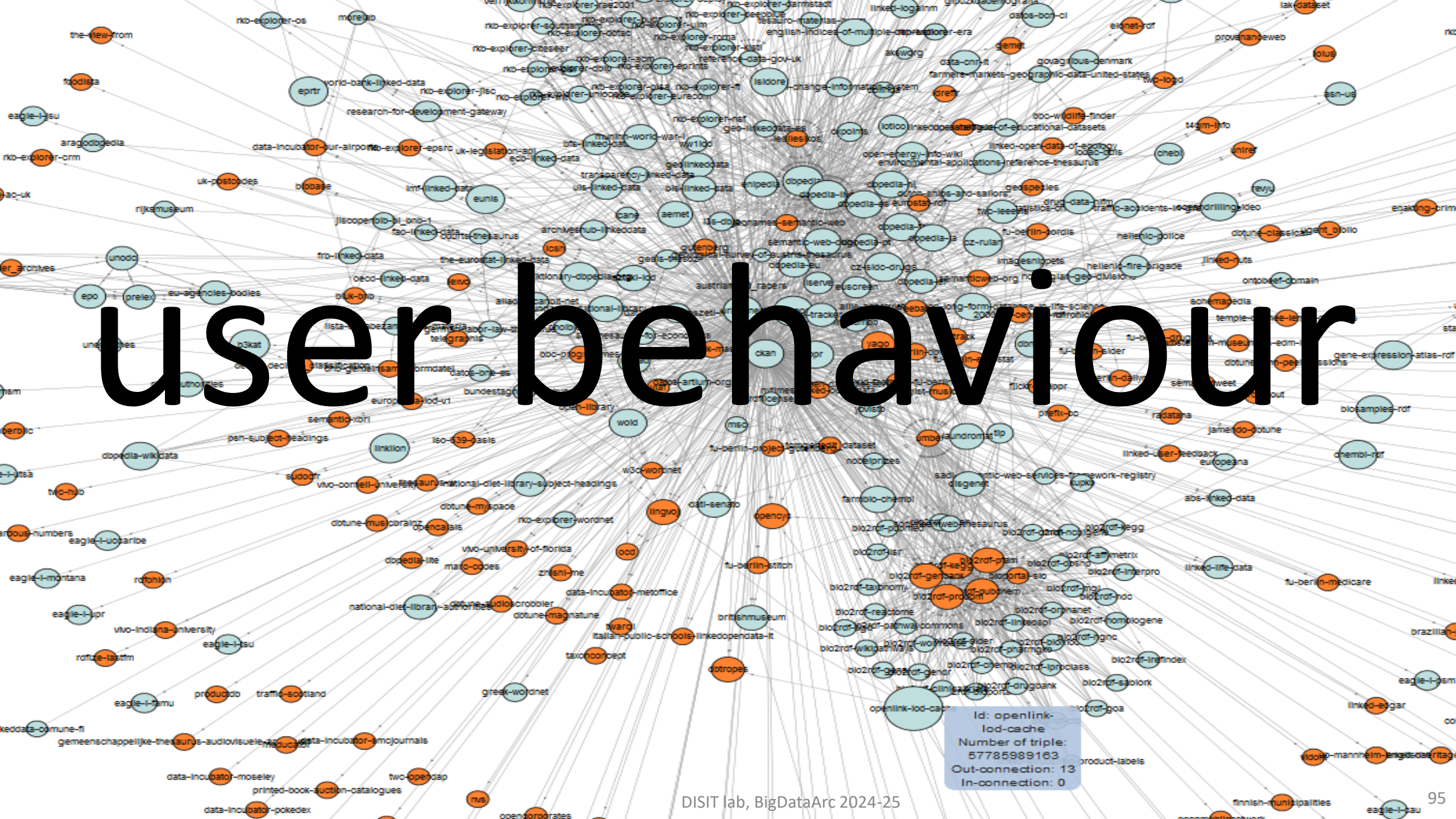
- **Goals:**
  - Energy consumption reduction, increment of efficiency,
  - Areas and building sustainability
  - Improve accessibility to services, security and safety
- **Energy Monitoring:** Building, floors, rooms, recharging poles, cabinets, Community of Energy, Data centers, Energy for Hot / cold, air condition, energy vs temperature and usage, etc.
- **Energy Management:** Predictions, early warning, identification of critical conditions
- **Smart Light Management**: LED/mixt, cabinets, lights vs traffic, lights vs security, energy saving, luminaries profiling, group management.
- **Smart Building Management:** consumption, number of people, etc.
  - Communities of Energy, Photovoltaic plants, sustainability
  - What-if analysis, optimisation tools
- **KPI: Energy consumption, efficiency, pros/cons**
  - Light profiling and adaptation
  - Autoclave industrial plants simulation, Photovoltaic plant simulation
  - consumption / usage, energy vs temperature
- **Mobile App:** monitoring, info-recharge, eSharing, booking, ..
- **Participatory**: problem reporting, ticketing, etc.
- **Integration of any kind**



Comparison of PINN vs OpenFoam and error

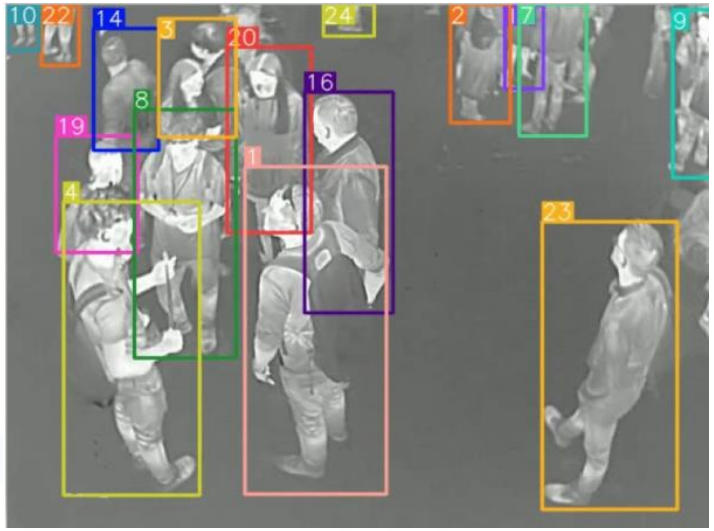


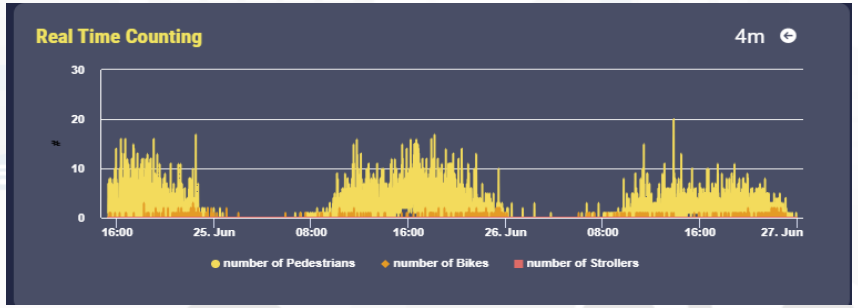
user behaviour



City User Behaviour/services, Tourism and Safety

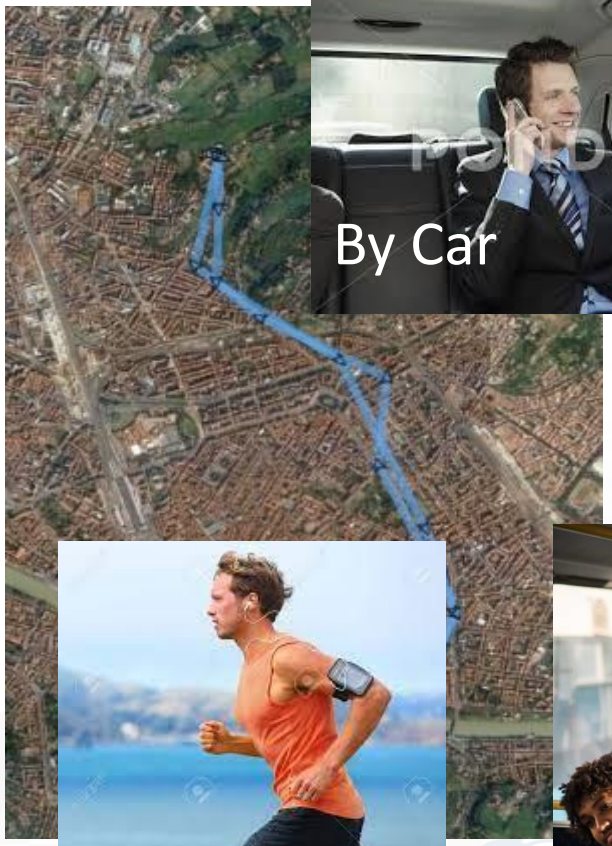
- **Goals:**
  - Improve Quality of Life and quality of services,
  - Over tourism mitigation, sustainability
  - Costs reduction of services
  - Improve accessibility to services: citizens, Tourists, commuters, etc.
  - Improve Security/Safety of city users
- **People Flow Analysis / Management:** in/out-door, retail, attractions
  - Counting, tracking, Flows, ODM, sentiment, etc.,
  - multiple sources: thermal & TV cameras, radar sensors, PAX sniffers, mobile data, …
  - Data and/or OD matrices from: Wi-Fi, traffic data, mobile phone data
  - **Suggestions**: info Tourism, digital signages, engagement, ..
- **Tourists Flows & Retail Management**: predictions of presences, services' reputations, suggestions on second offer, over-tourism, notifications, early warning,
- **KPI**: 15 MinCityIndex, energy vs people, over-tourism, accepted suggetions, precision
- **Mobile App**: final users services/informing and operators
  - Info Tourism, people flows, info mobility, sharing, …
  - Participation, engagement, ..
- **Participatory**: problem reporting, ticketing, etc.
- **Integration of any kind: env/weather, mobility, ticketing, presences, POI, ..**



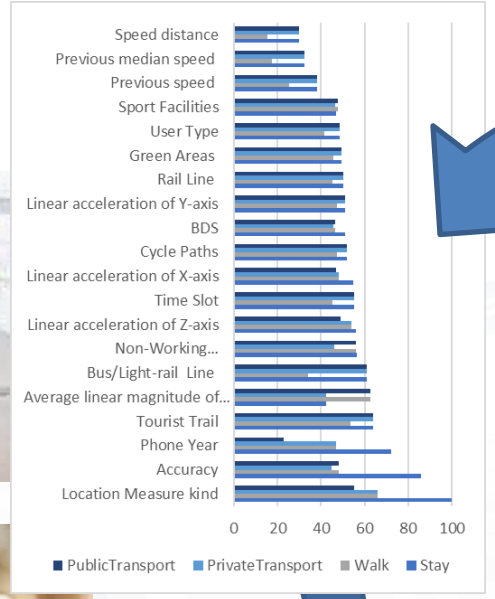


To propose suggestions and Engage city user

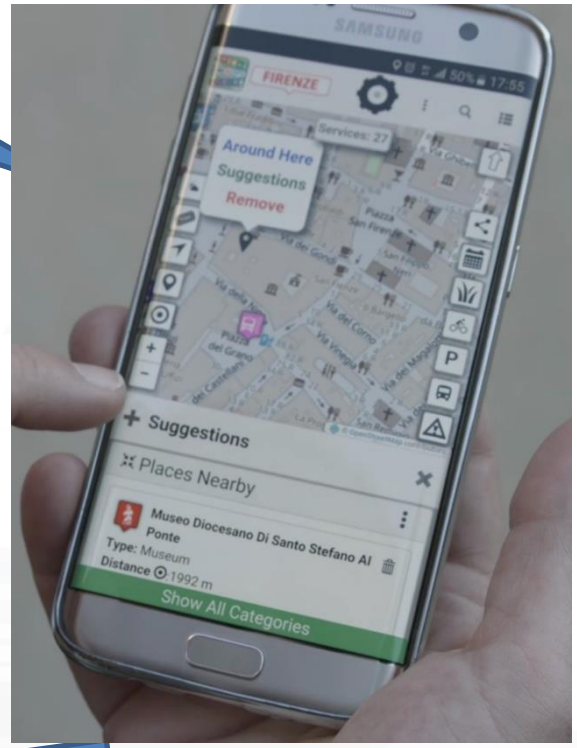
we need to know how they are moving



Walk



Artificial Intelligence Classification



Suggestions

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

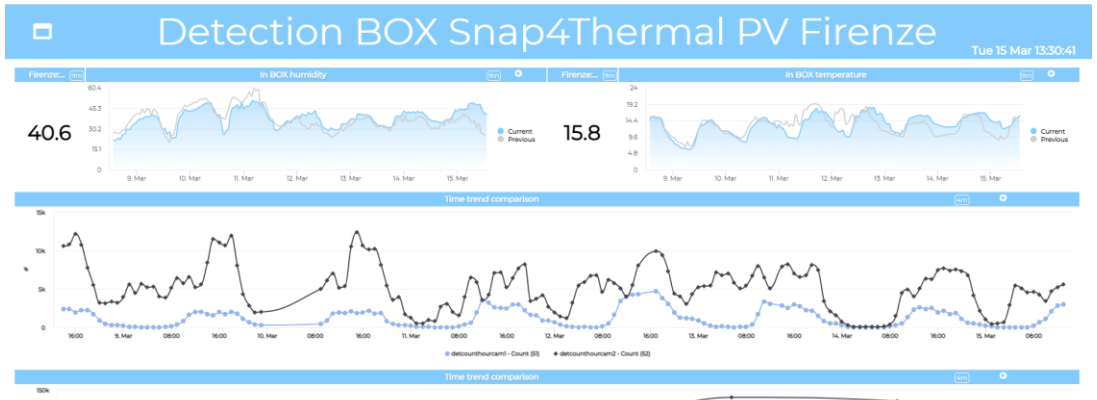
Interreg Mediterranean HERIT-DATA

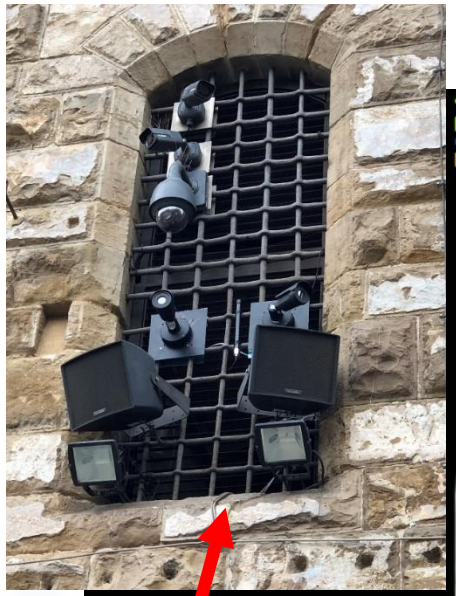
AXIS COMMUNICATIONS

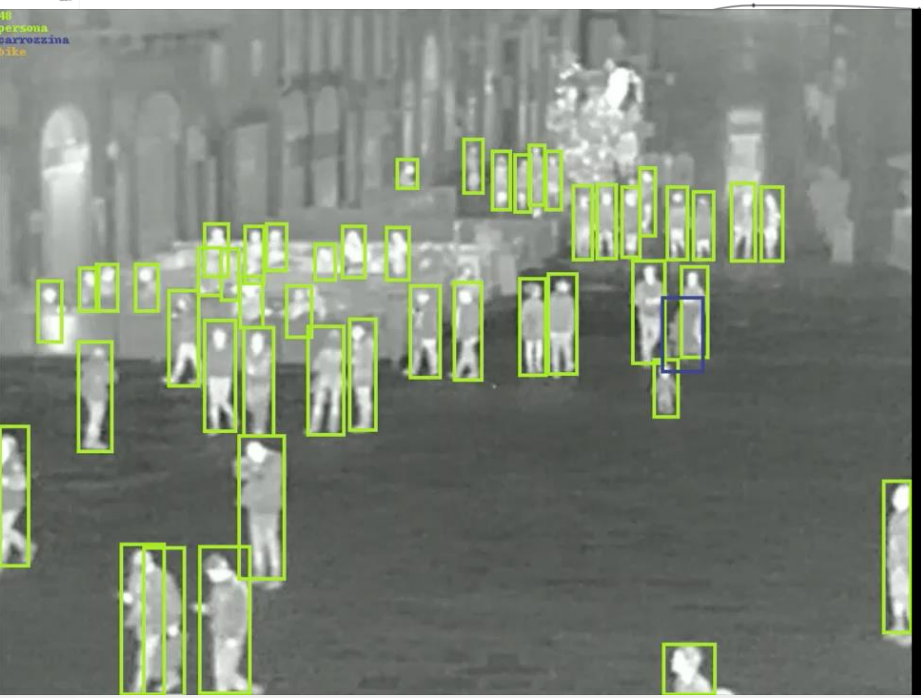
SNAP4CITY

KM4CITY

A view and data from the Thermal Camera







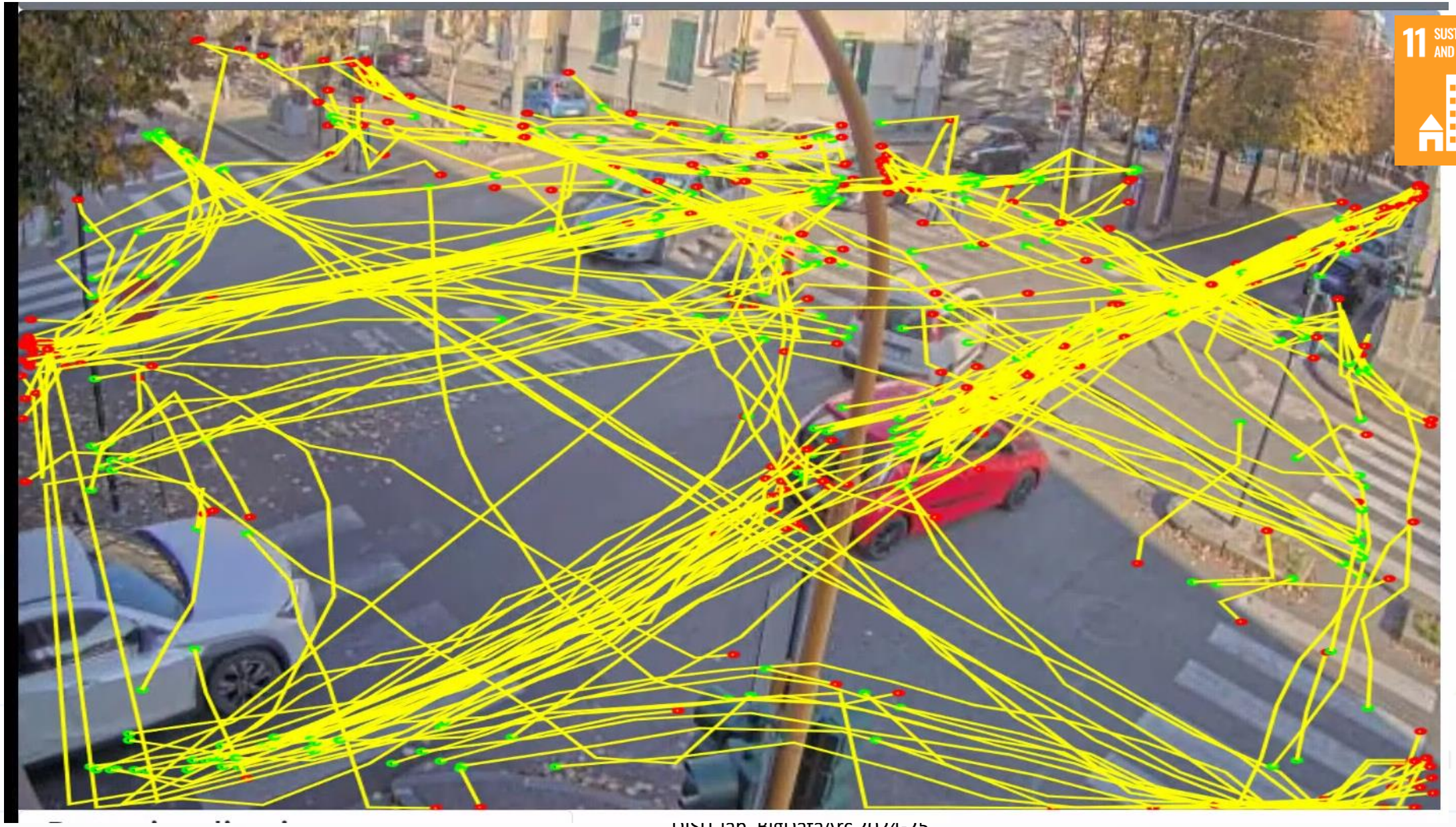
11 SUSTAINABLE CITIES AND COMMUNITIES

Barc 2022

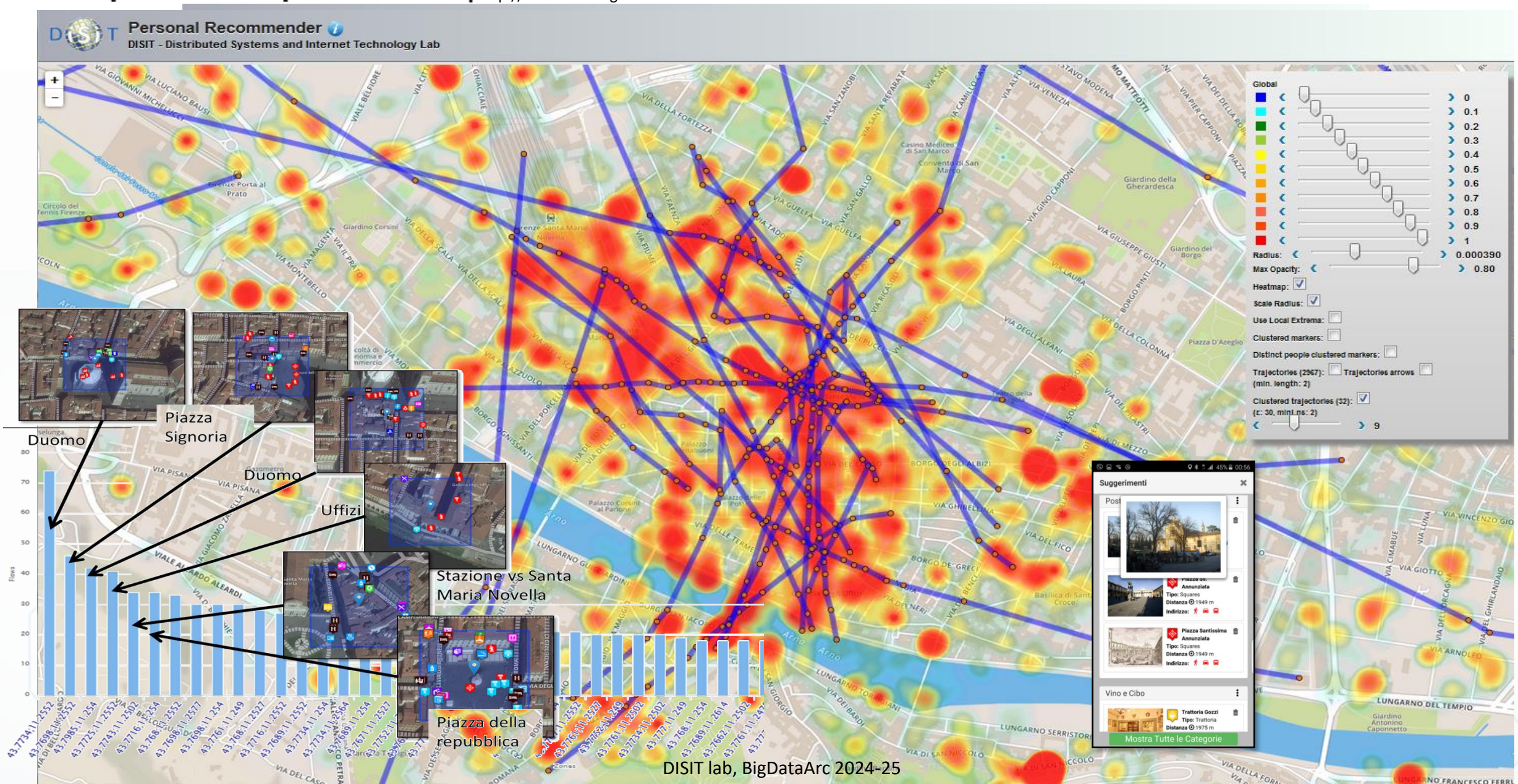

SNAP4CITY
AXIS
COMMUNICATIONS
SPAIN
SPAIN
3D MAP GLOBAL DIGITAL TWIN -NEWGUI


3
1
2
7
6
4
5

11 SUSTAINABLE CITIES AND COMMUNITIES

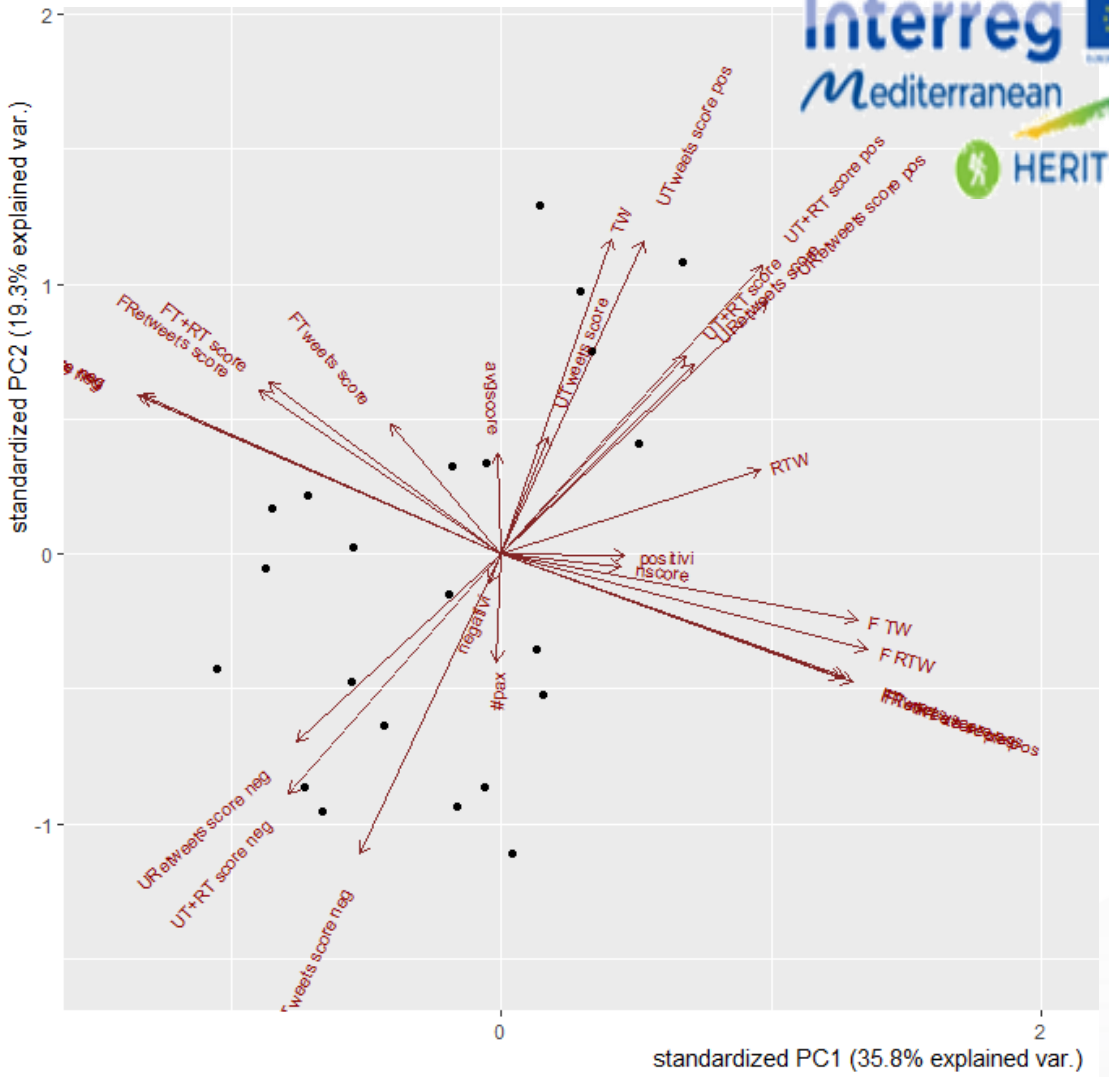


User Behavior Analyzer



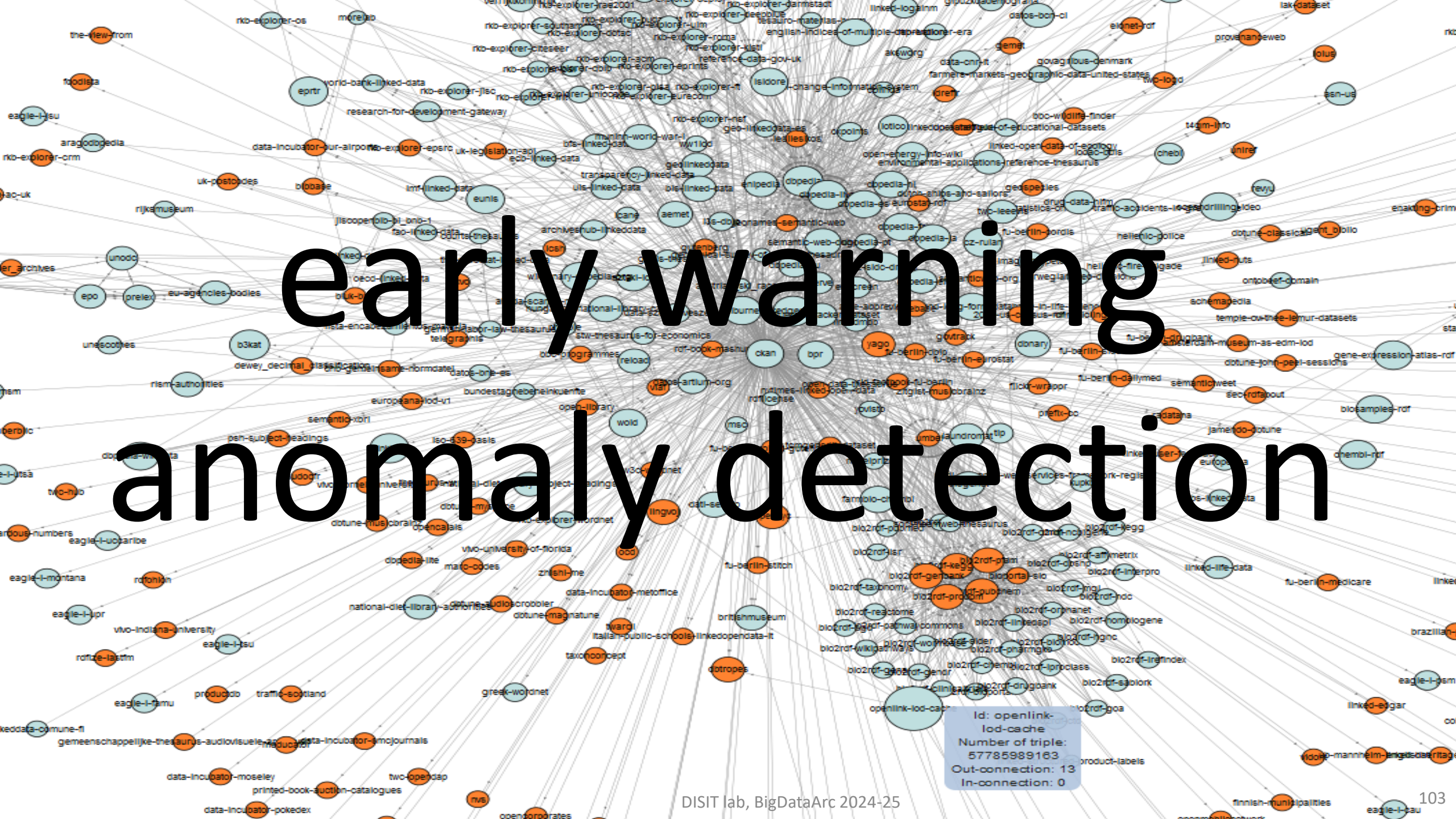
Reputation

- Prediction/estimation of **Average Score of Trip Advisor** as a function of *Twitter Vigilance Metrics + other information*
- Prediction/estimation of **Negative Scores on specific Museum** or service as a function *of Twitter Vigilance Metrics + other information*



Twitter Vigilance

early warning anomaly detection



Horizontal AI Platform/Control

- **Goals:**
  - Increasing quality of Life, quality of services,
  - Decongestion, Decarbonization, Sustainability
  - increase efficiency and production optimization
  - Improve accessibility to services: citizens, Tourists, commuters, etc.
  - Improve security/Safety of city users, risk reduction
  - Costs reduction of services, energy consumption reduction
  - Reduction of emissions and EC taxations
- **Horizontal homogeneous platform Uniform Technology for**
  - **Any Vertical operation/plan:** mobility, energy, environment, security, tourism, infrastructure and assets control, buildings, etc.
  - **AI Solutions**: early warning, predictions, simulations, what-if, optimization; Deep Learning, ML, BERT, LLM, XAI (Shap/Lime),
  - **Development Environment for any vertical, Digital Twin**: City Global and Local, IoT, VR, Visual Programming, business intelligence, CSBL, SSBL, etc.
  - **Interoperability**: any format, any protocol, any video management system, any sensor, any device, etc.

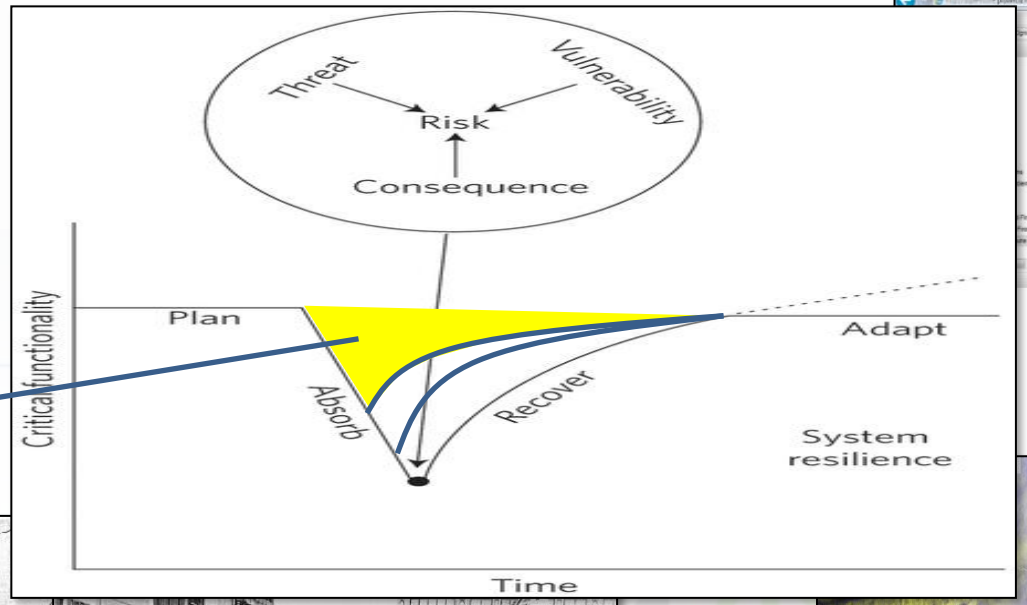
- **KPI:** multidomain KPI, general management, early warning, early detection of critical conditions, 15 Min City Index, SDG
- **Mobile App:** modular applications, operators' modules, multiple cities, etc.
- **Participatory**: problem reporting, ticketing, etc.
- **Integration of any kind**

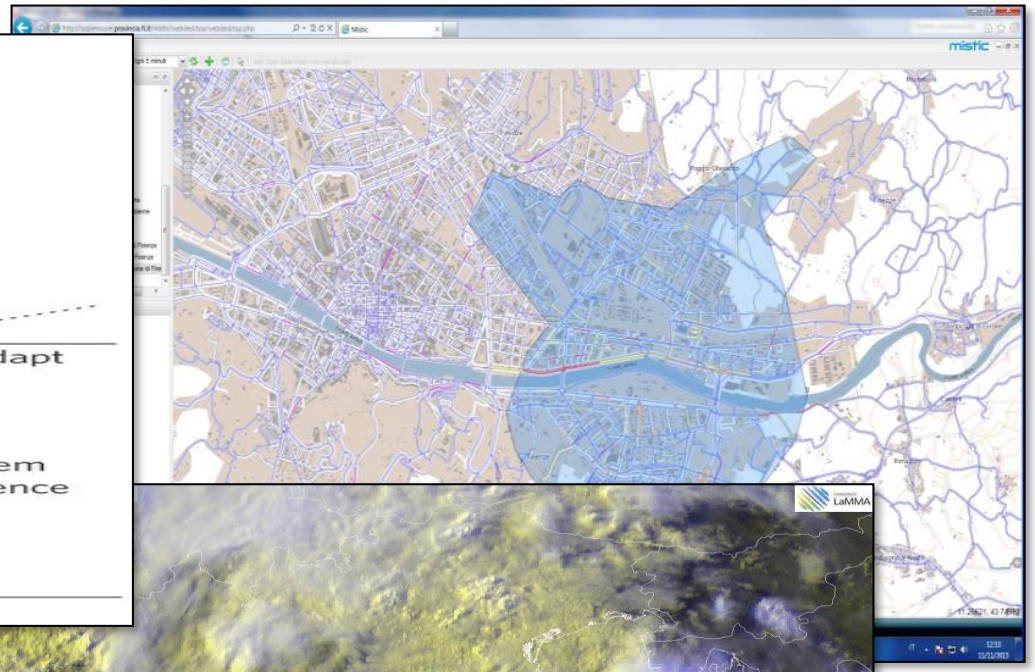
City Resilience

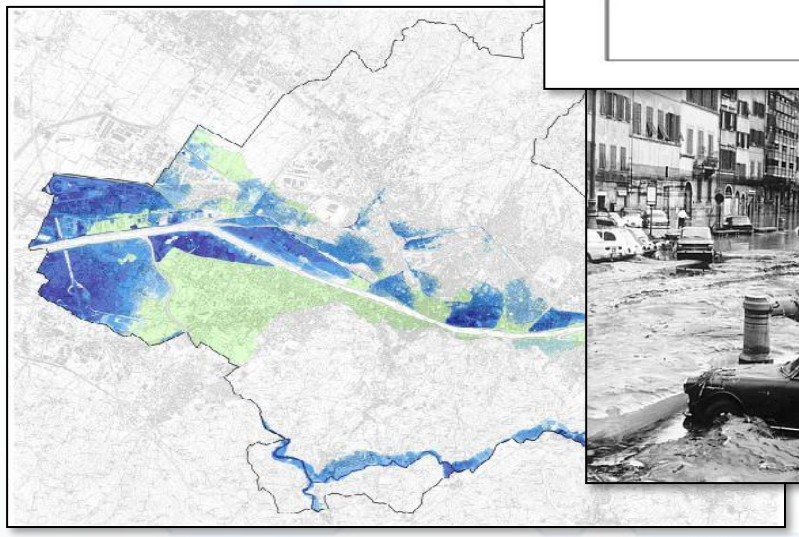
Early warning, detection

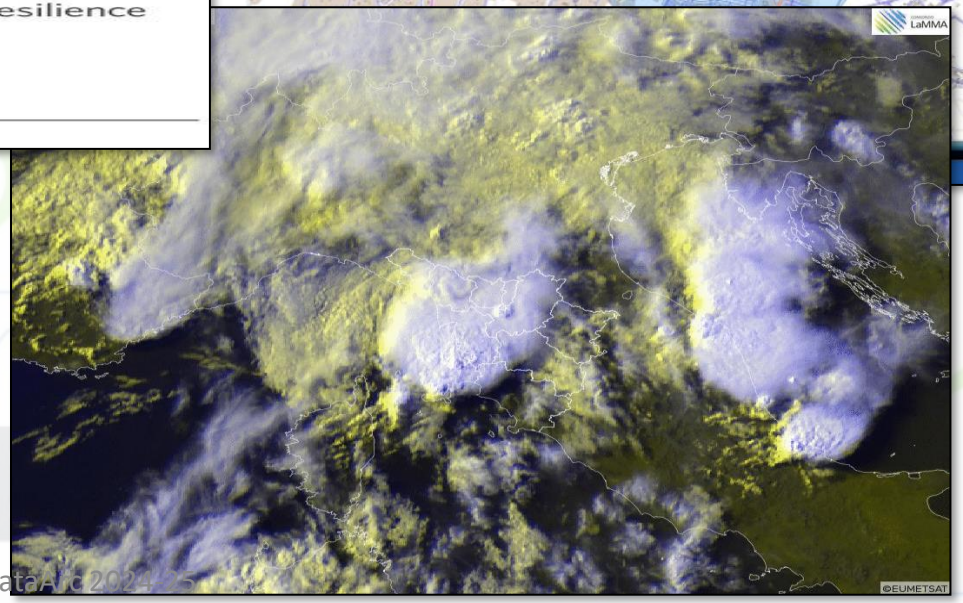
Prepare
Absorb
Recover
Adapt

damage







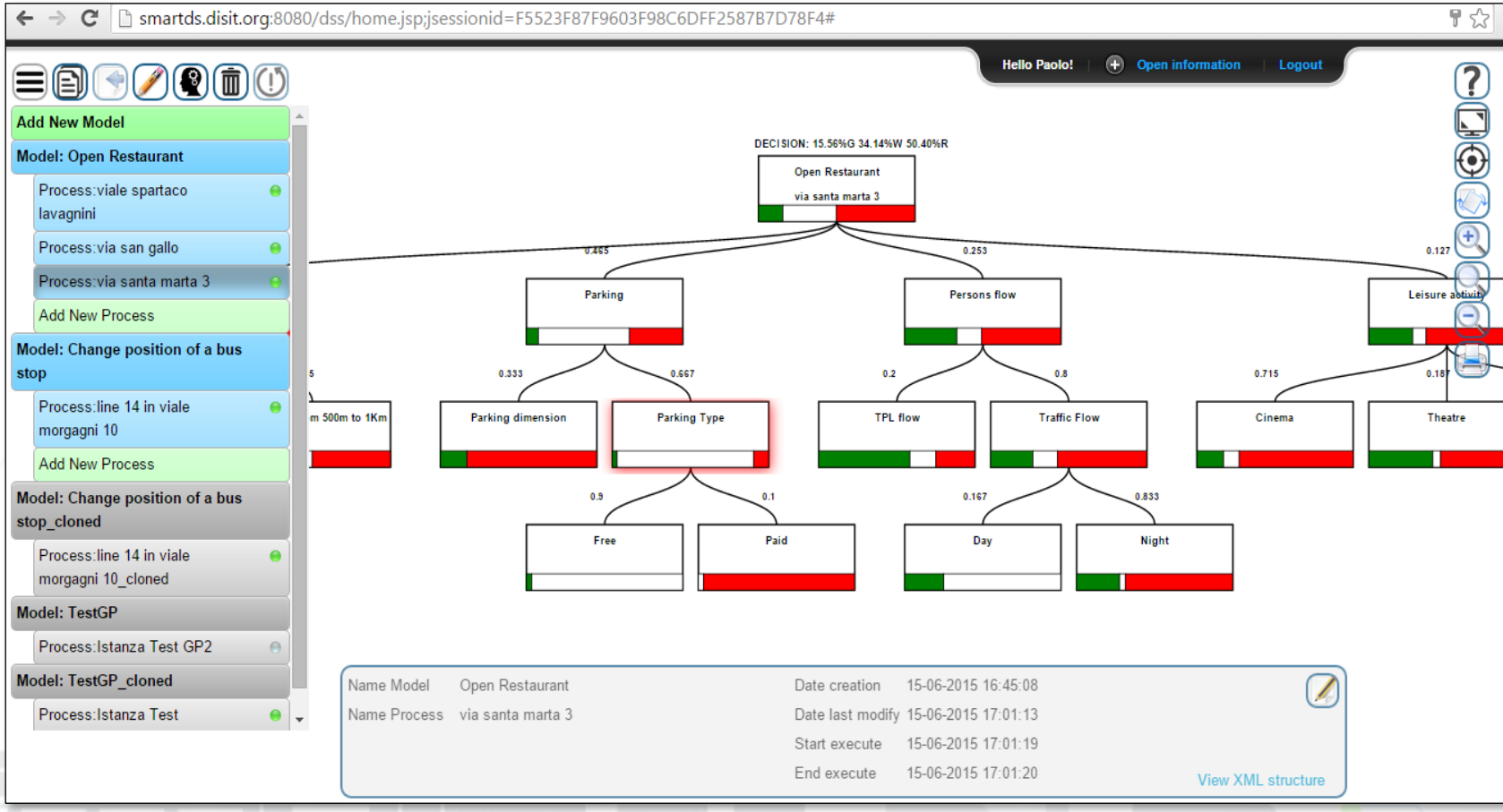


Smart City Decision Support

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

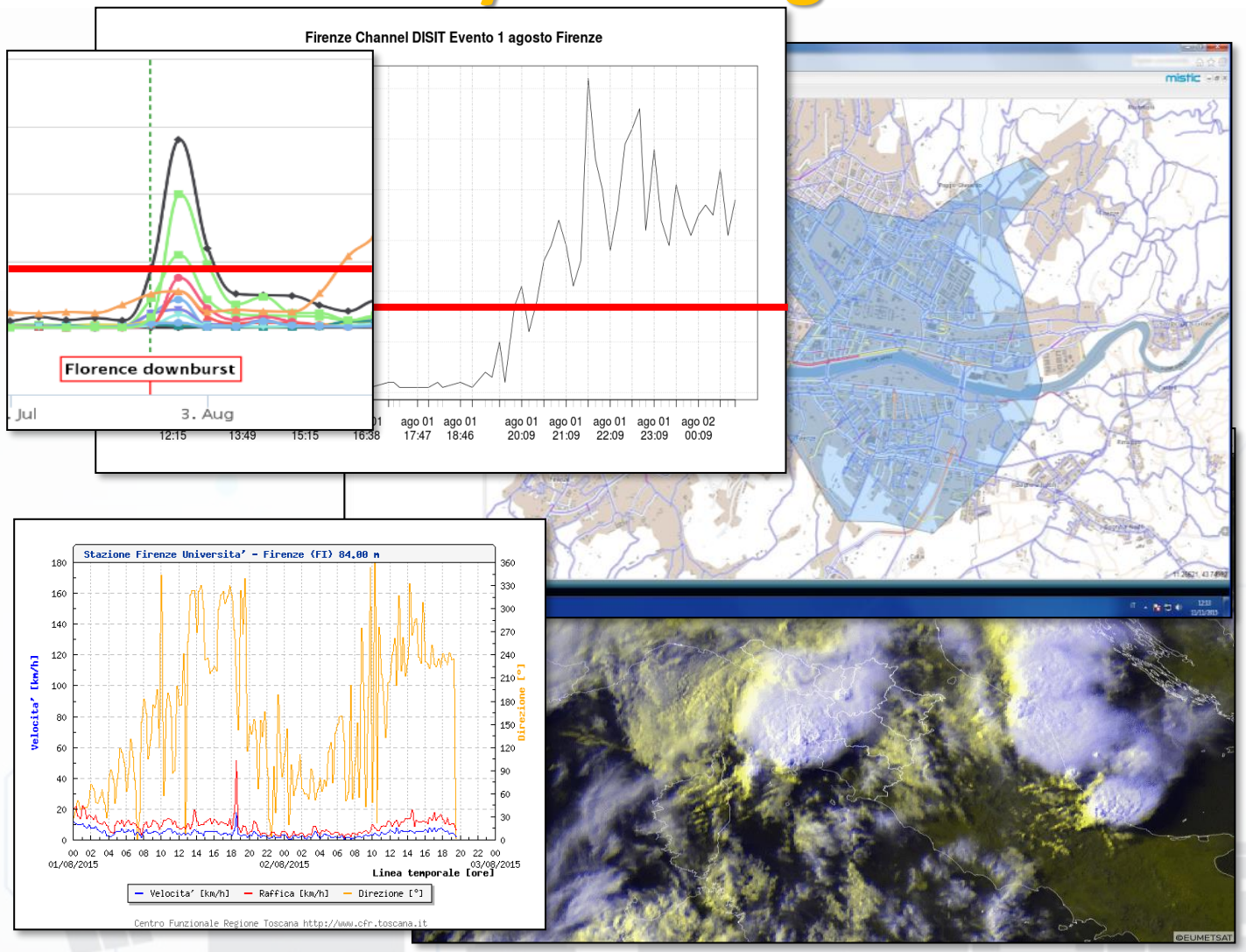
Enforcing

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

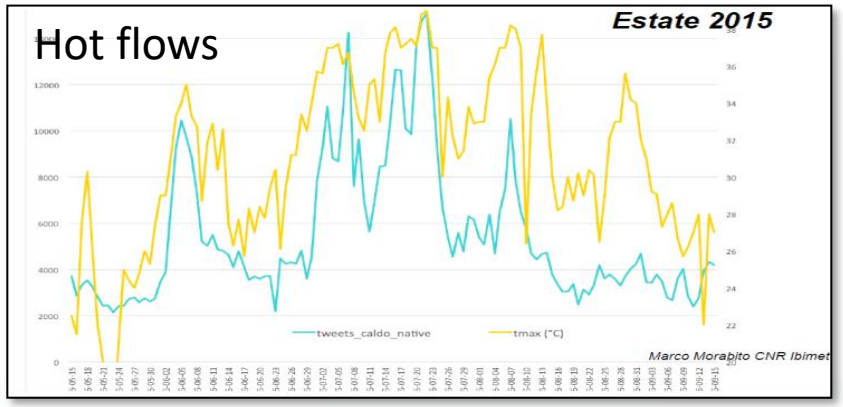


Twitter Vigilance

Early Warning



Predictive models



Attendance at long lasting events: EXPO2015

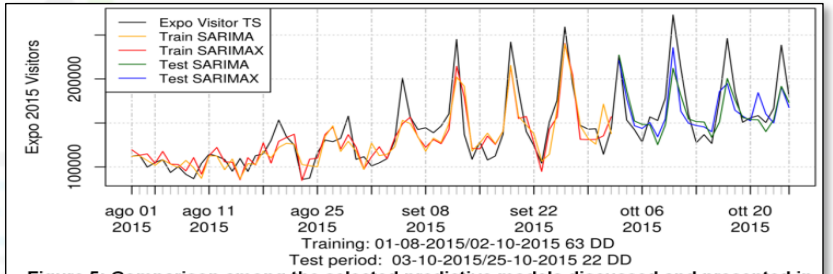
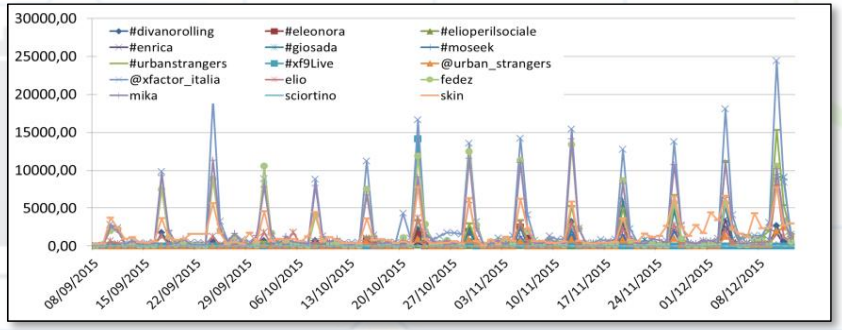
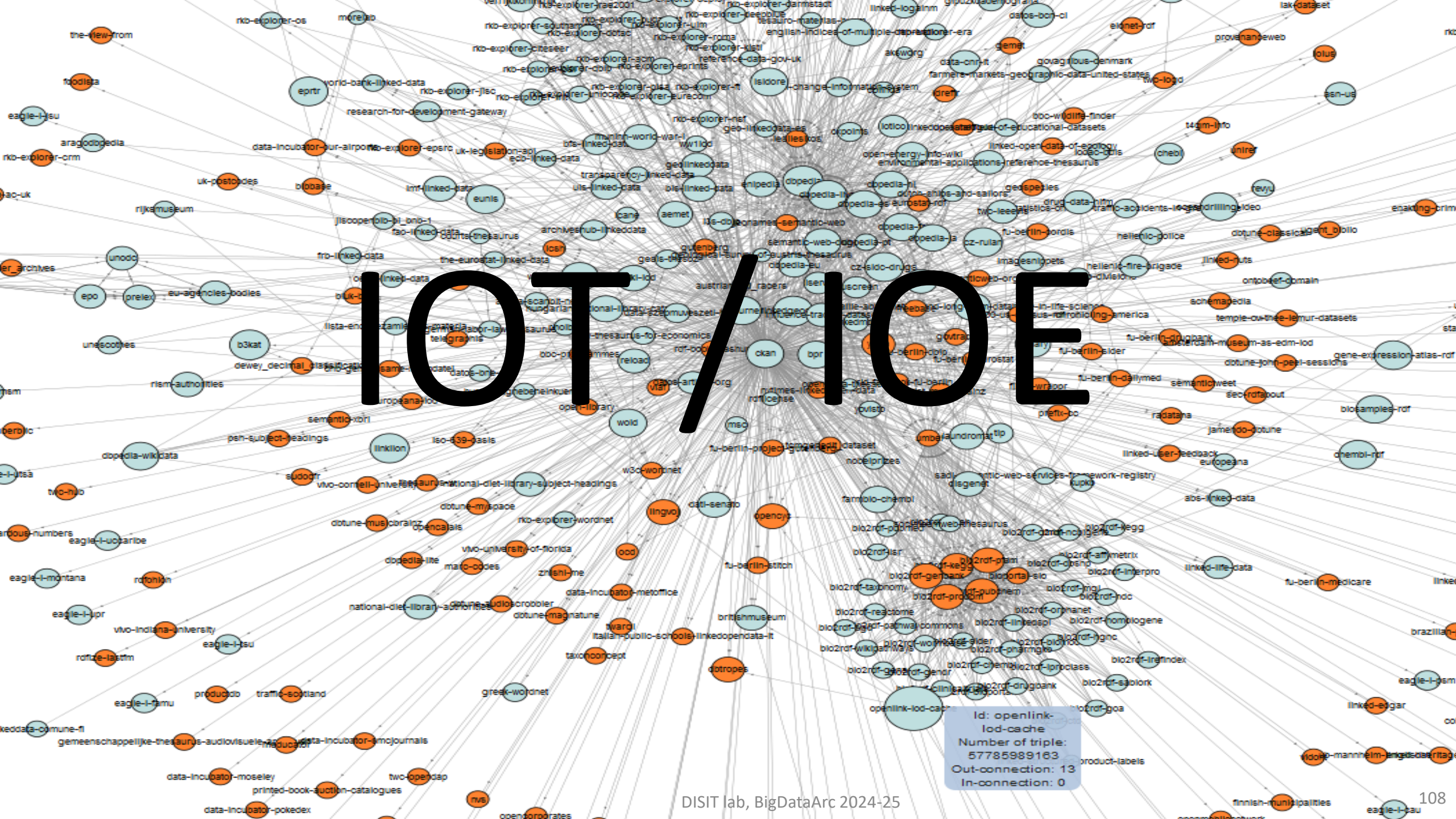


Figure 5: Comparison among the selected predictive models discussed and presented in Tables 2 and 3 with respect to the real number of visitors. Both training and validation periods are reported.

Attendance at recurrent events: TV, footbal

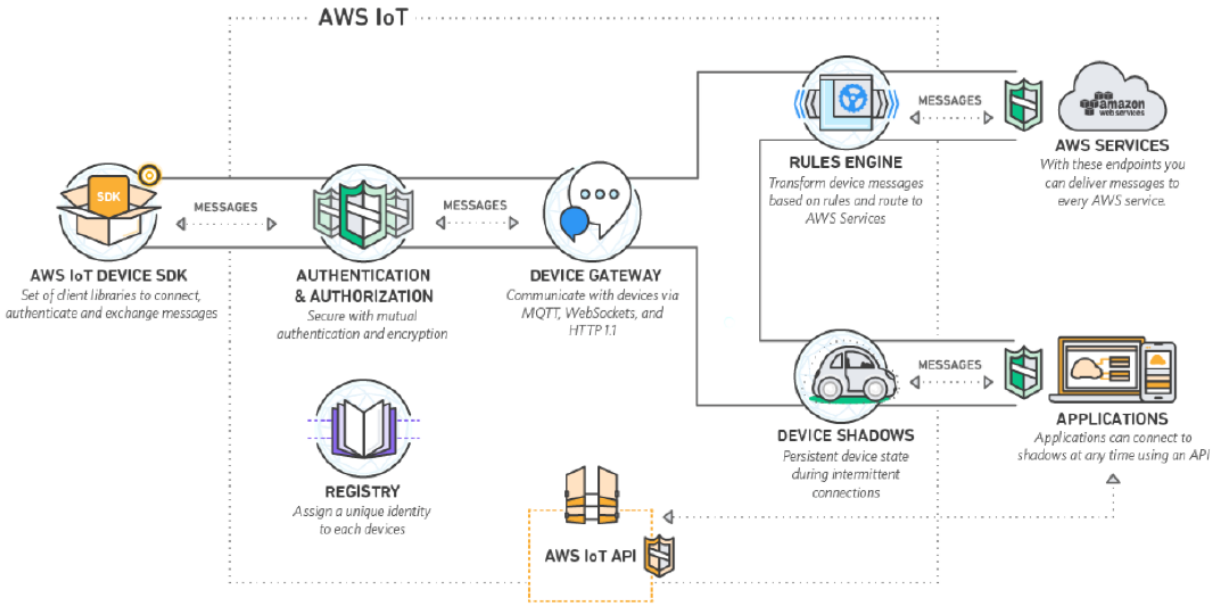


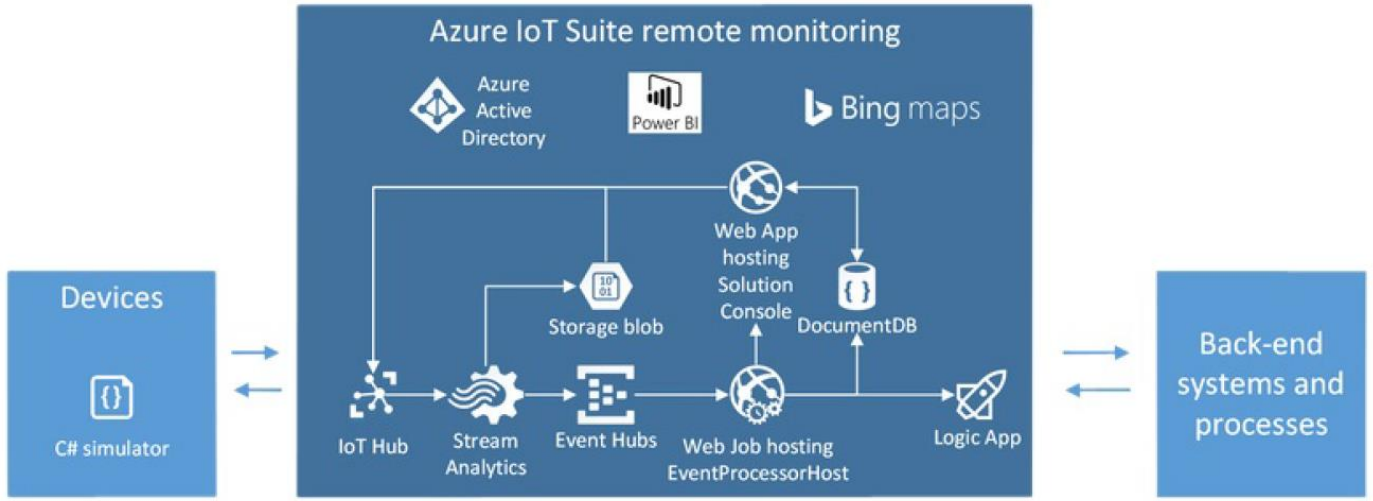
IOT/IOE


Id: openlink-lod-cache
Number of triple: 57785989163
Out-connection: 13
In-connection: 0

Big Data vs IOT/IOE

- Store everything
- Shadow (Data Indexing and storage)
- Access to external services ??
- Access to external context of the territory ??
- IOT Applications??
- Data Traffic Monitoring ??
- Privacy vs GDPR ??

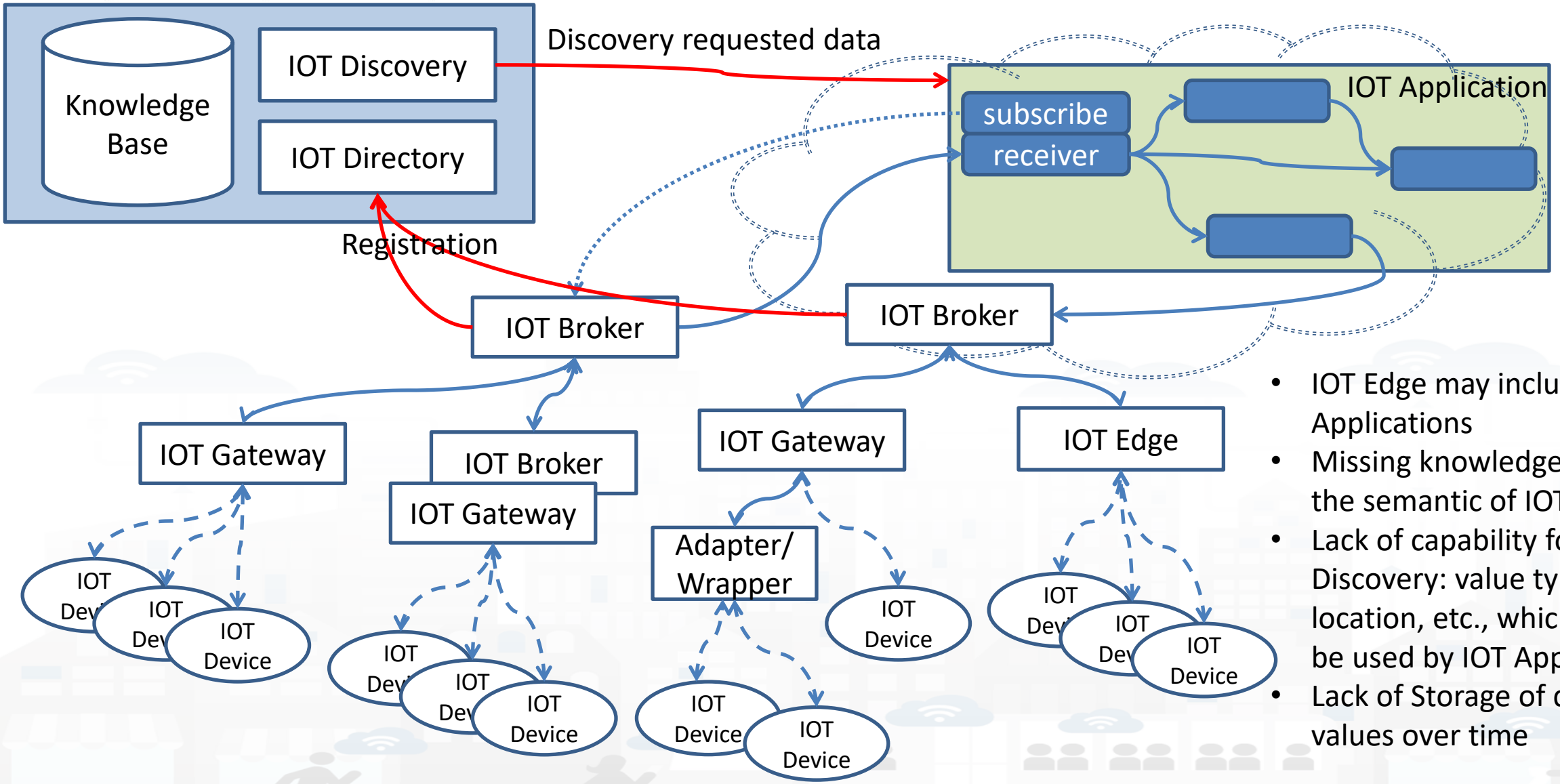




Big Data vs IOT

- In una certa misura minor problemi di volume nei casi specifici
- Maggiori problemi di real time, event driven
- Maggiori problemi di non uniformità
  - degli stream data in ingresso
  - Formati e protocolli diversi per devices e pacchetti di comunicazione dati
- Problemi di tracciabilità del dato
- Problemi di licensing del dato
- Problemi diffusi di security nelle soluzioni ICT: comunicazione, storage, accesso e monitoraggio, etc.

Definitions



- 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

100% OPEN SOURCE

Powered by FIWARE

FREE TRIAL

PEN Test Passed

EU GDPR COMPLIANT

SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

Node-RED

JS Foundation

EØ15 digital ecosystem

NVIDIA

SNAP4CITY

KM4CITY

SMART SOLUTIONS AND DECISION SUPPORT SYSTEMS

CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS - BUSINESS INTELLIGENCE - SIMULATIONS - SMART APPLICATIONS

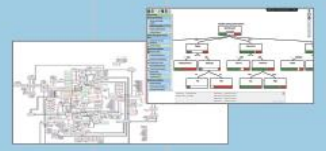
DASHBOARDS - VISUAL ANALYTICS - SYNOPTICS - DIGITAL TWIN - GRAPHICAL WIDGETS - ANALYTICS - GUI CUSTOM STYLES - VISUAL PROGRAMMING

DASHBOARDS, WIDGETS
TEMPLATES

PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW
PEOPLE FLOWS - SDG - 15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - ETC...

API - MICROSERVICES - GIS - BPM
VIDEO - REPORTS - MAPS - 3D ...

ANY: DATA, BROKER, NETWORK AND VERTICAL



EXPERT SYSTEM, KNOWLEDGE BASE
SEMANTIC REASONING
SMART DATA MODEL
IOT DEVICE MODELS, STORAGE

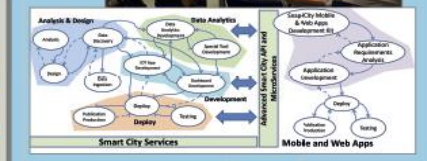
BIG DATA ANALYTICS, ARTIFICIAL INTELLIGENCE
EXPLAINABLE AI, MACHINE LEARNING
OPERATIVE RESEARCH, STATISTICS

VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN

Native and External Applications

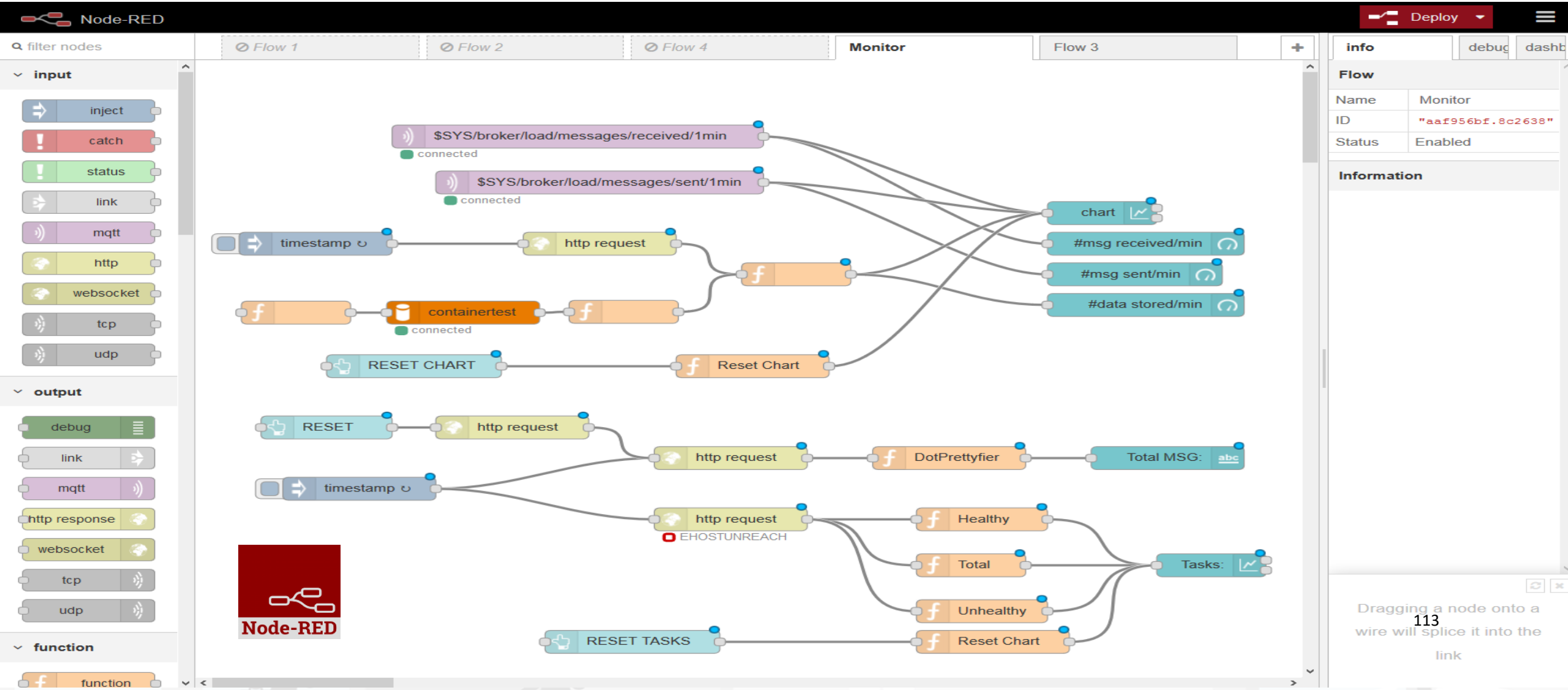
- Smart Parking
- Smart Light
- Smart Waste
- Smart Energy
- Social Media Analysis

...



METHODOLOGIES
LIVING LABS
COURSES AND COMMUNITY
DEVELOPMENT TOOLS

IOT Applications



MicroServices

- S4CIoT
- S4CInfo
- S4CSearch
- S4CView
- S4CDataAnalytic
- S4CDashboard
- S4CSearchDev
- S4CInfoDev
- S4CLogDev
- S4CManagement
- S4CSearchExp
- S4CSearchUsr

fiware orion

fiware orion

ckants

- ckants insert
- ckants search
- ckants create

S4CIoT

- iot directory
- iot directory

S4CInfo

- service info
- tpl agencies
- tpl lines
- tpl routes by agency
- tpl routes by line
- tpl routes by stop name
- tpl routes by line stop name
- tpl stops by route

S4CSearch

- service search by queryid

S4CView

- show general iframe
- show micro web app

S4CDataAnalytic

- descriptive statistics
- trend plot
- time series predictions
- machine learning predictions

S4CDashboard

- city dashboard
- city dashboard
- geolocation

S4CSearchDev

- service search
- full text search dev
- event search dev
- address geometry search near gps position
- address poi search by text
- bus routes search

S4CInfoDev

- tpl routes
- tpl stops

S4CLogDev

- event log

S4CSearchExp

- 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
- full text search within wkt area
- full text search within gps area
- full text search near gps position
- full text search exp
- event search within wkt area
- event search within gps area
- event search near gps position
- event search exp
- address search near gps position
- geometry search near gps position
- address poi search by text exp
- address poi search by text near gps position
- 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

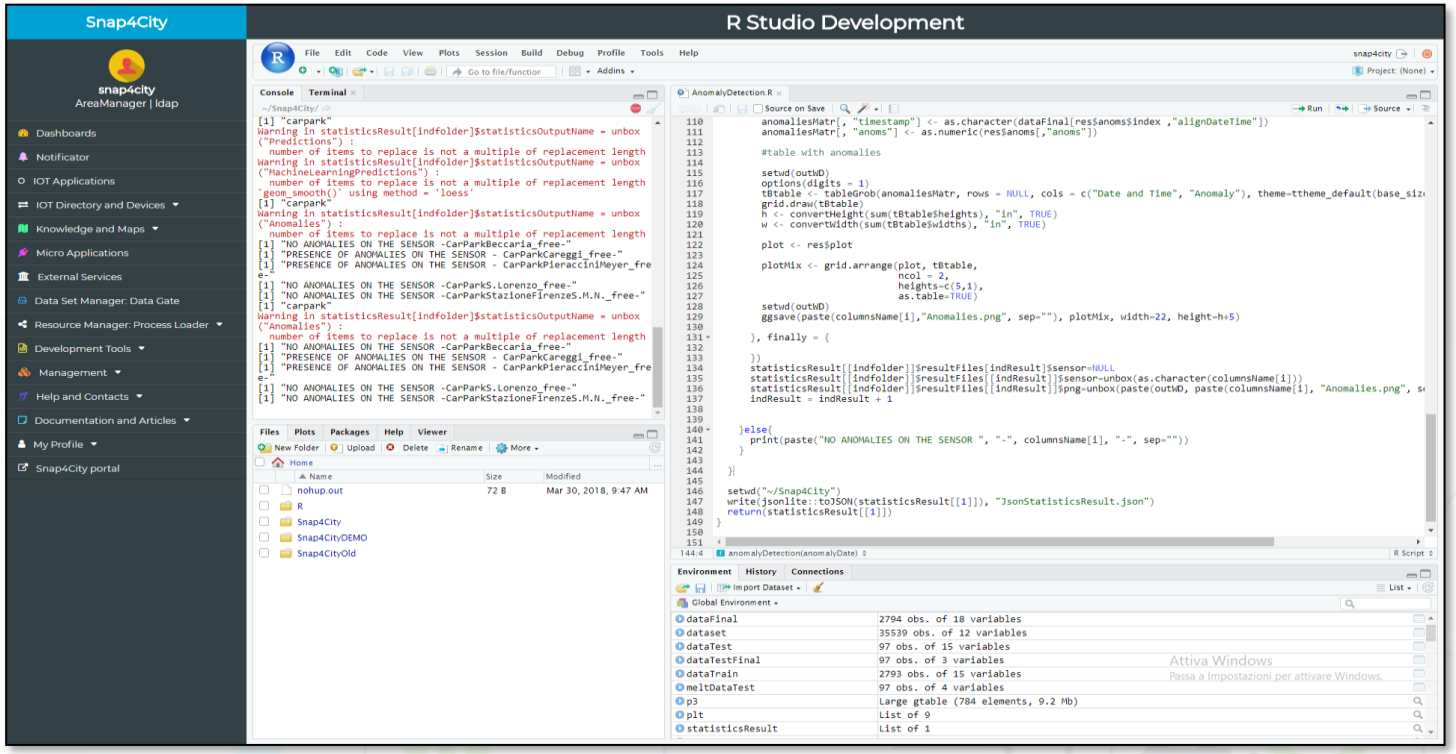
S4CSearchUsr

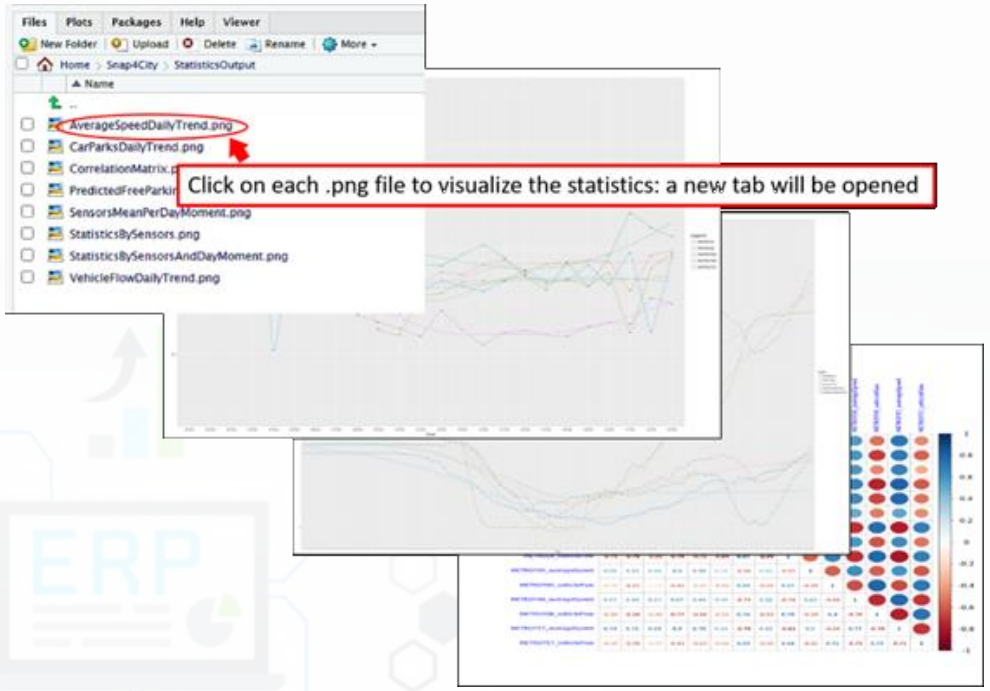
- service search near marker
- service search within circle
- service search within polygon
- service search along path
- full text search near marker
- full text search within circle
- full text search within polygon
- full text search along path
- full text search usr
- event search near marker
- event search within circle
- event search within polygon
- event search along path
- 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

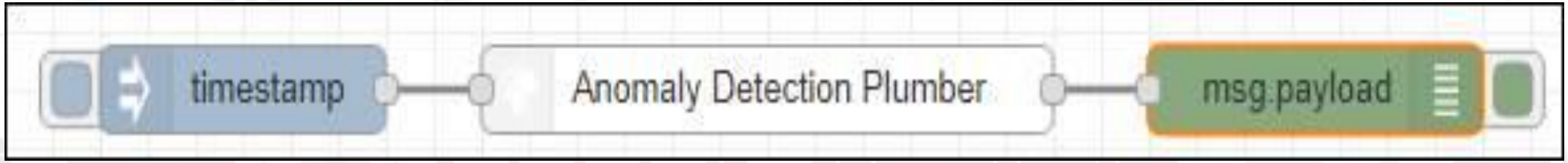
S4CManagement

- check exist job
- check exist trigger
- get currently executing jobs
- get job detail
- get triggers of job
- get job group names
- get trigger group names
- get paused trigger groups
- trigger job

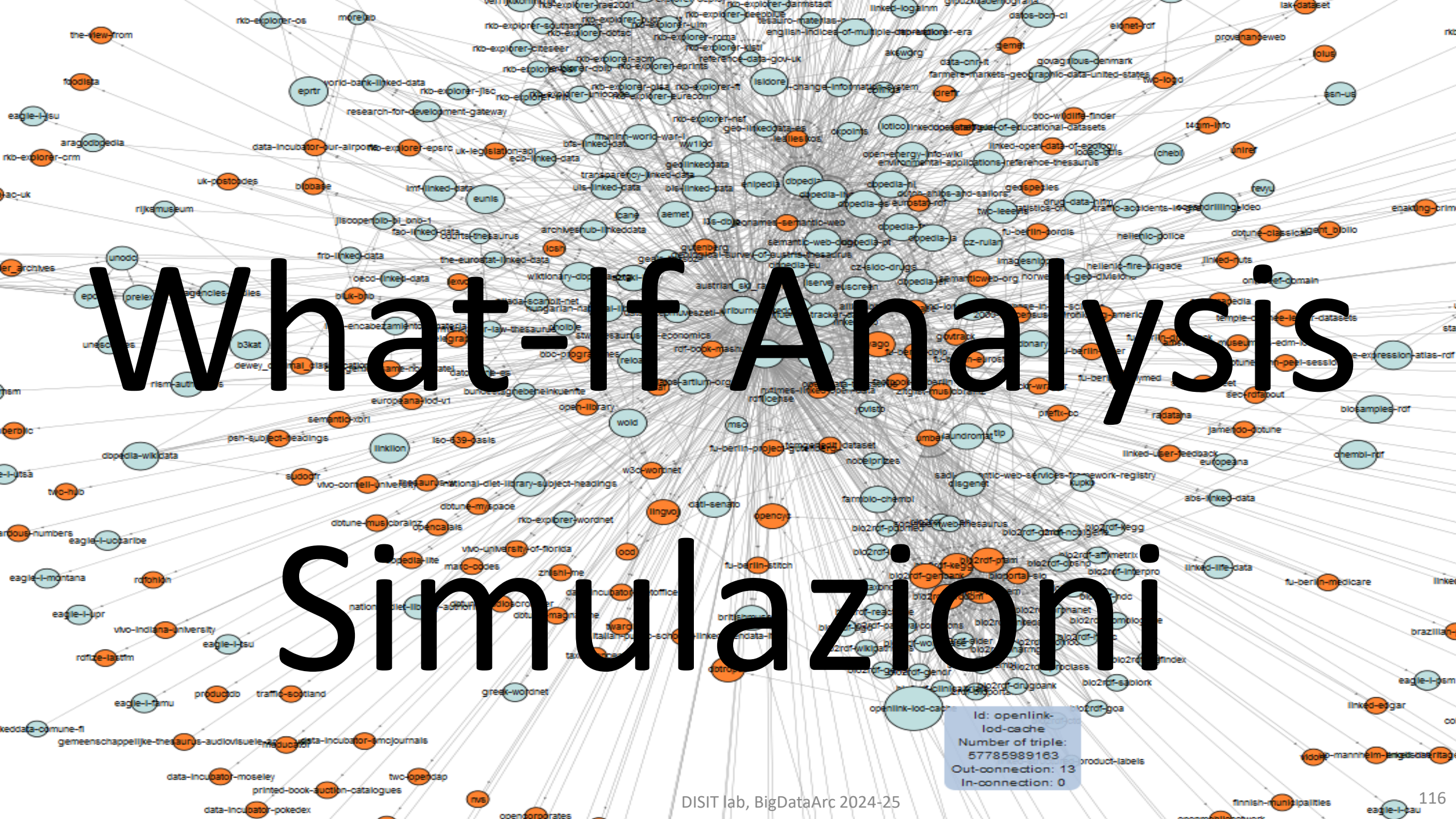
Developer in R Studio + Tensor Flow





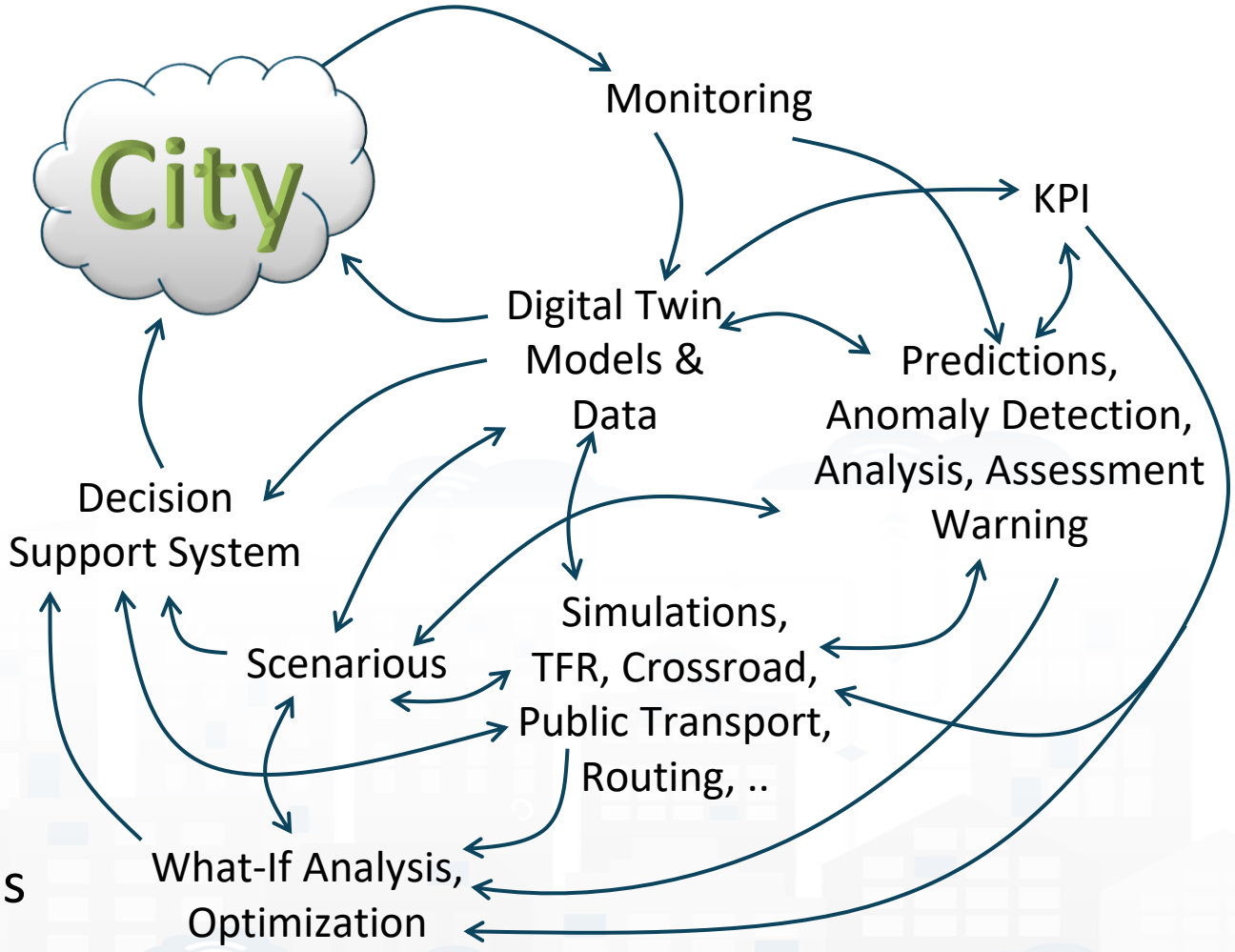


What-If Analysis Simulazioni



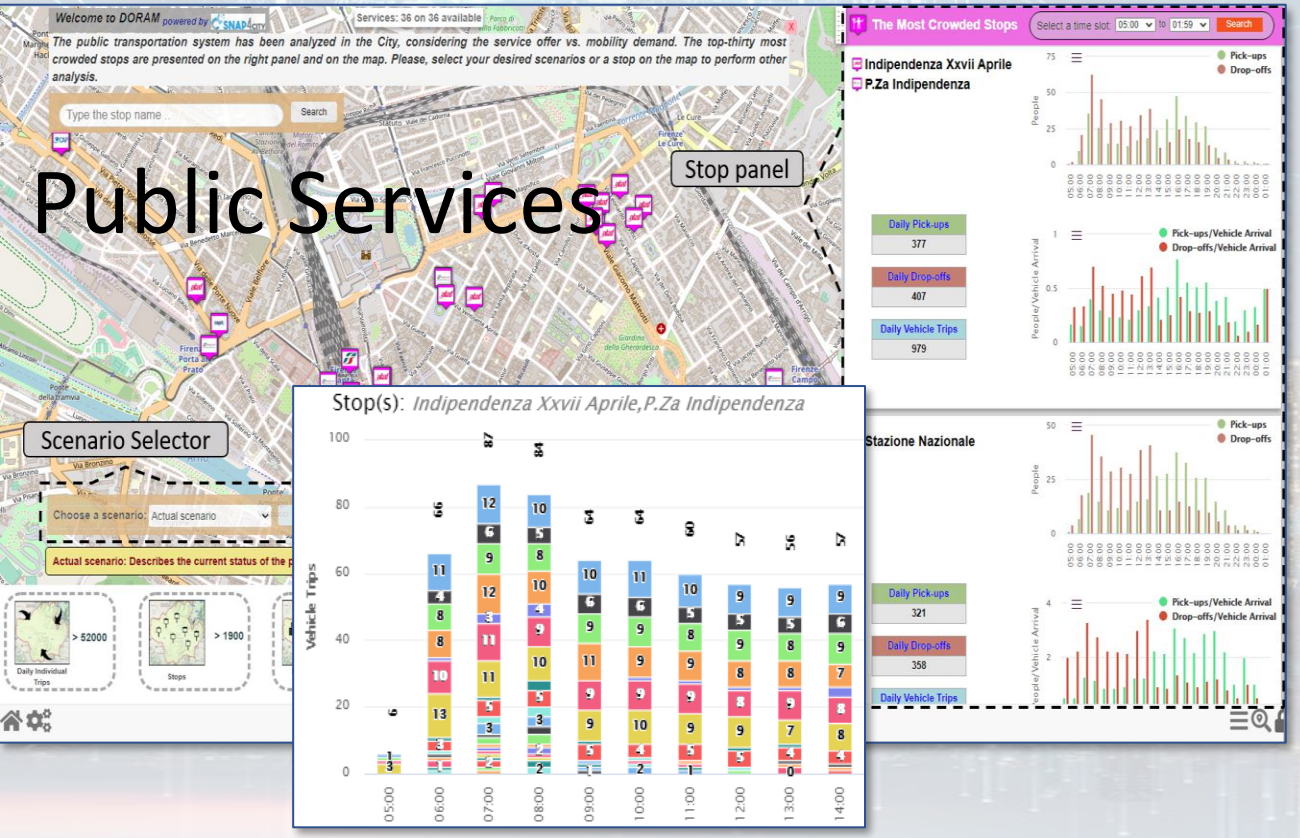
Main tasks

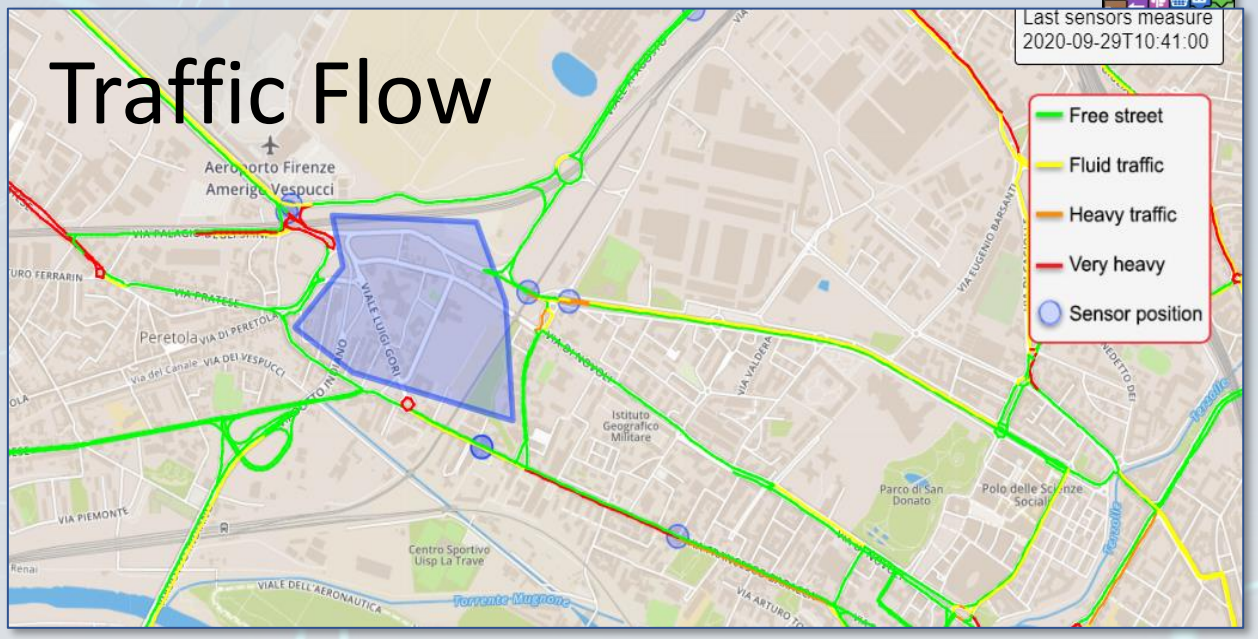
- **Controlling Status: management, and operational**
  - Monitoring via KPI
  - Predictions vs KPI
  - Anomaly detection
  - Neuro-Symbolic analysis
  - Risk assessment
  - Early warning on critical conditions
- **Making plan: tactic and strategic, medium and long range, micro/macro**
  - Simulation & optimization
  - Generative AI Prescriptions, scenarios
  - Resilience to Unexpected unknows
  - What-if analysis wrt scenarios

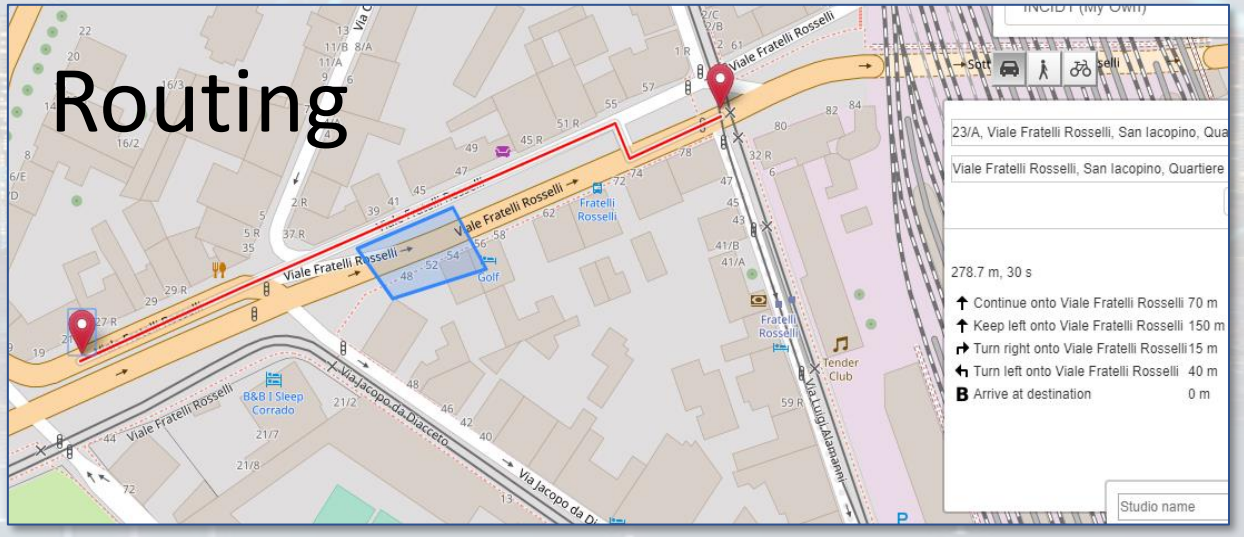


What-if Analysis

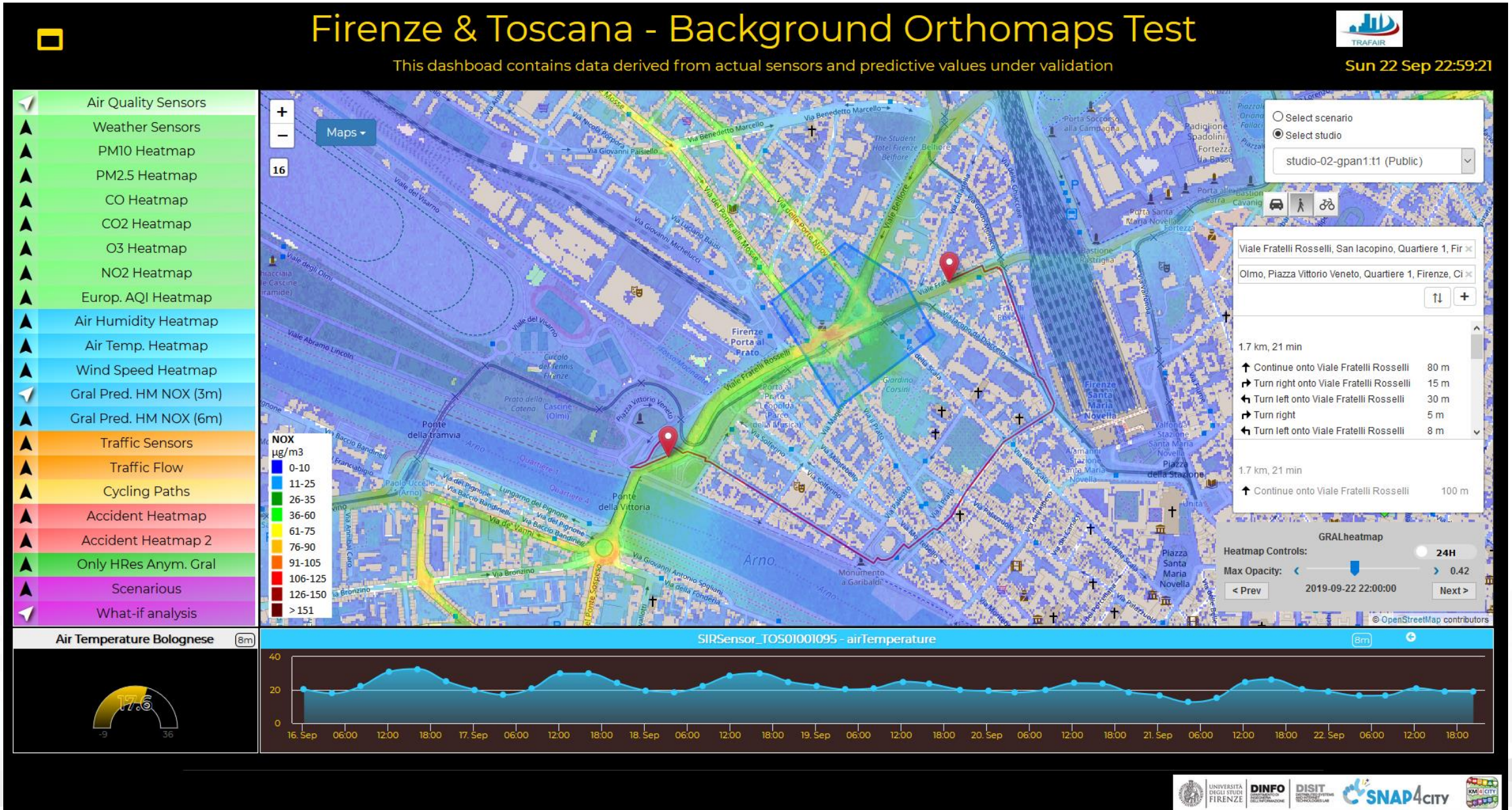
- Definition of scenarious impact on
  - Traffic, Pollutant, parking, public transport, private flows, etc.
  - KPI analysis





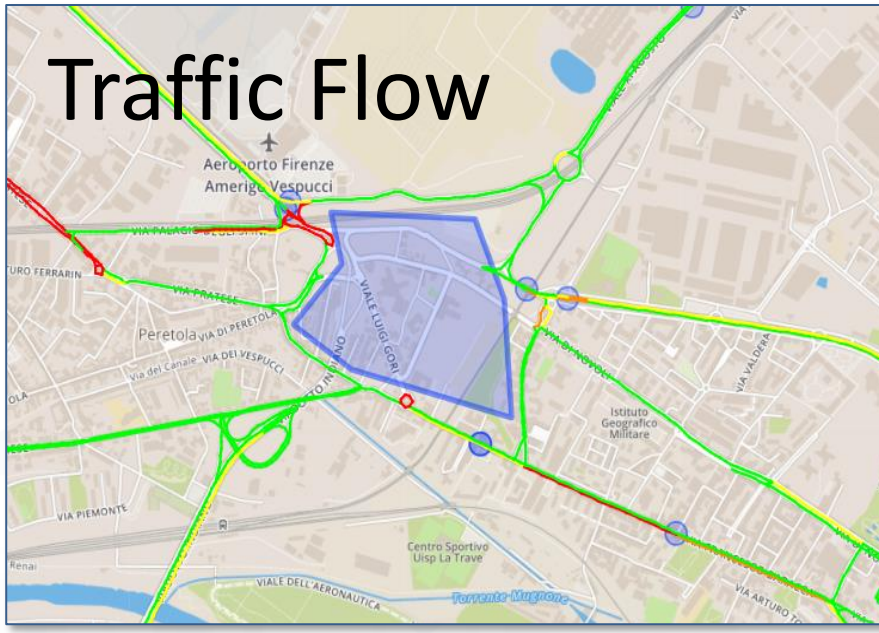


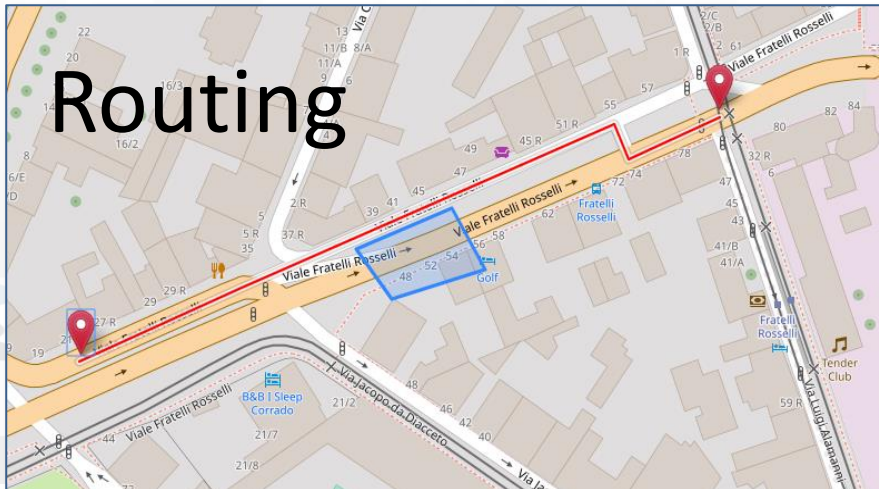
What-If analysis



Decision Support Systems, What-if

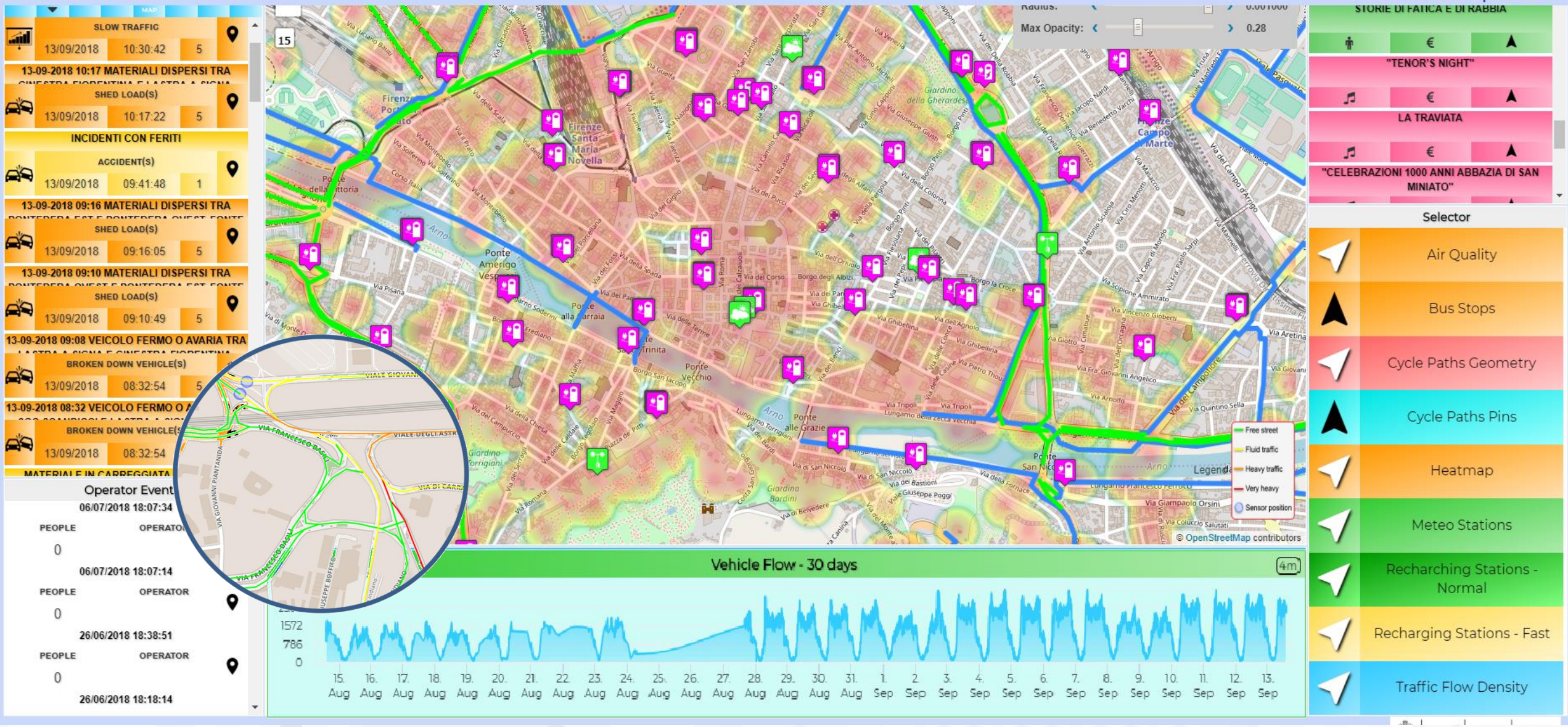
- **Event planning, via what-if analysis**
  - Change in the graph structure of the city
  - Impact on the flow of people and vehicles
  - Adaptation: public transport, traffic, pedestrian management, etc.
- **Immediate reaction to natural events or not**
  - Everything is ready and updated in real time
  - Each view is contextualized in terms of data: descriptive and prescriptive
- **Digital Twin**
  - More detail in the context integrated data
  - Greater realism in deductions and representations
  - Less fragmentation and non-uniformity in the views to support decisions





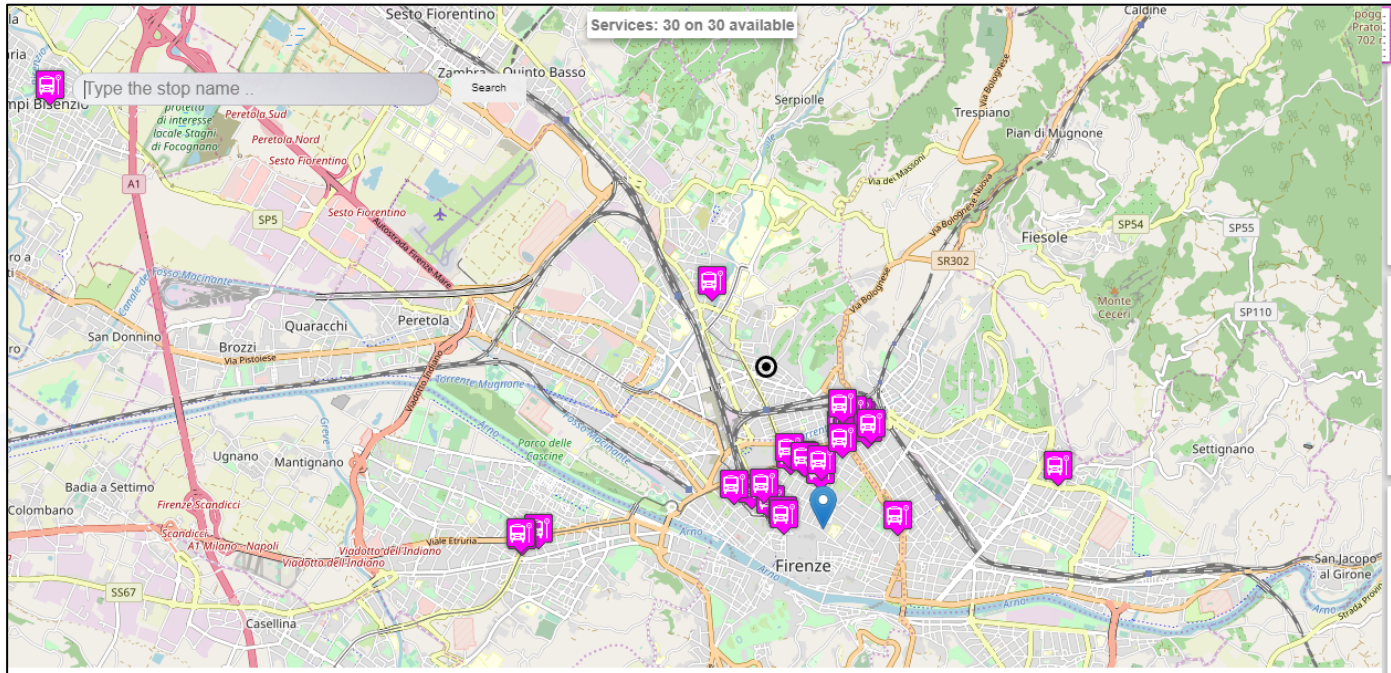
Multi-Widget Map

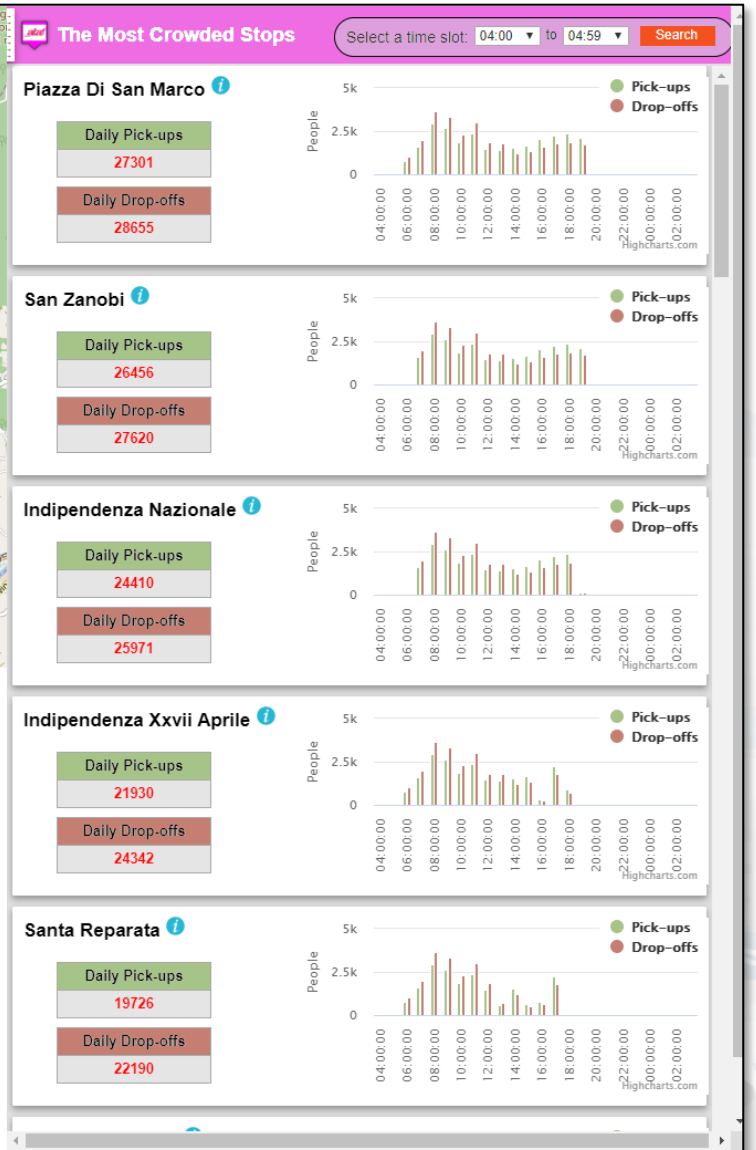
Thu 13 Sep 13:07:01



https://main.snap4city.org/view/index.php?iddasboard=OTc2

Bus Stop Analysis: identification of criticalities





> 42300
Daily individual Production Trips

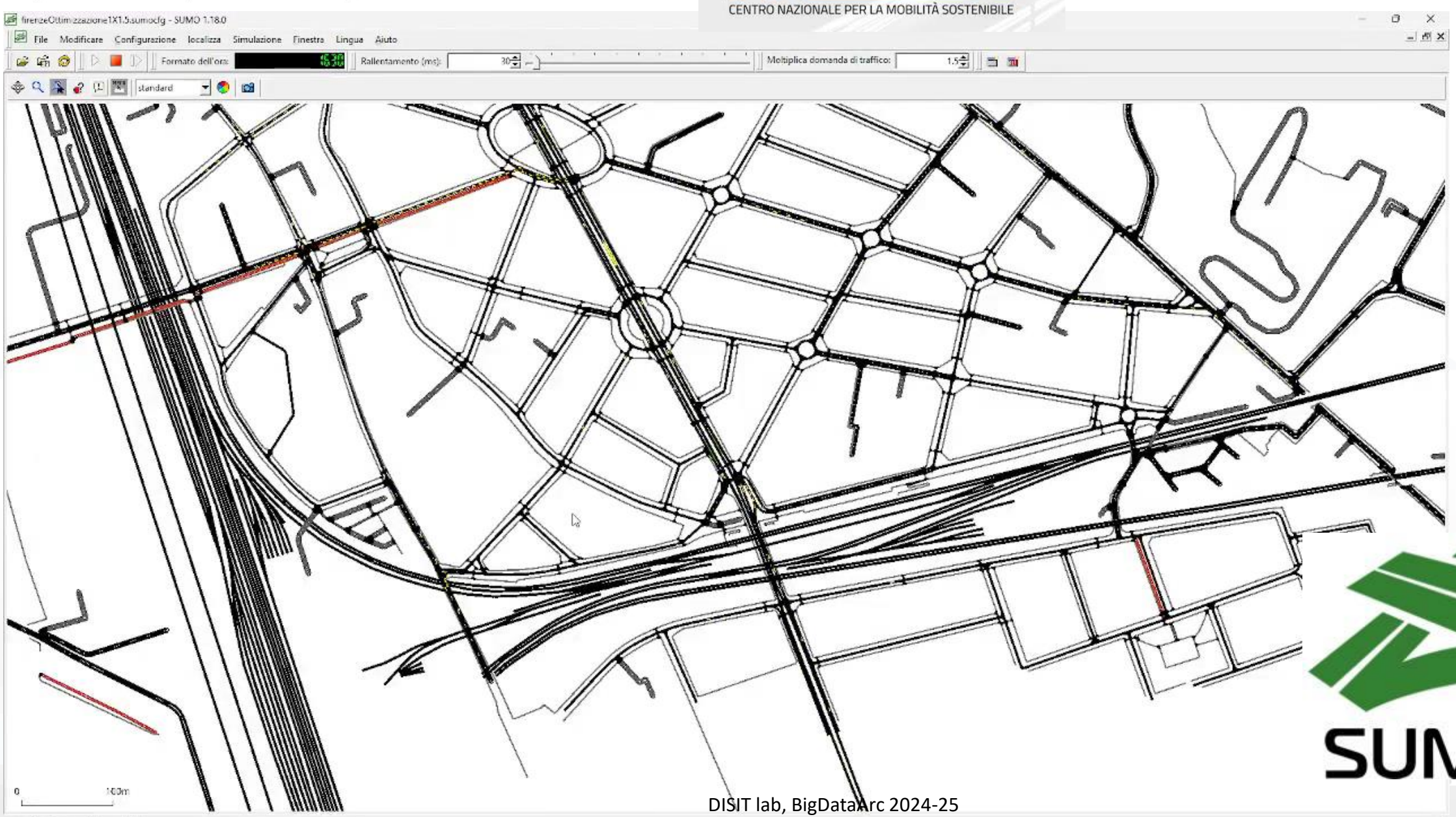
> 52900
Daily Individual Attraction Trips

21289
Daily bus trips

1875
Bus Stops

31070
Residential Buildings

31059
Service Providers


firenzeOttimizzazione1X1.5.sumocfg - SUMO 1.18.0
File Modificare Configurazione localizza Simulazione Finestra Lingua Aiuto
Formato dell'ora:
Rallentamento (ms):
Moltiplica domanda di traffico:
standard
0
100m

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

SNAP4CITY | KM4CITY

https://www.snap4city.org/dashboardSmartCity/view/Baloon.php?iddasboard=MzcxNw==

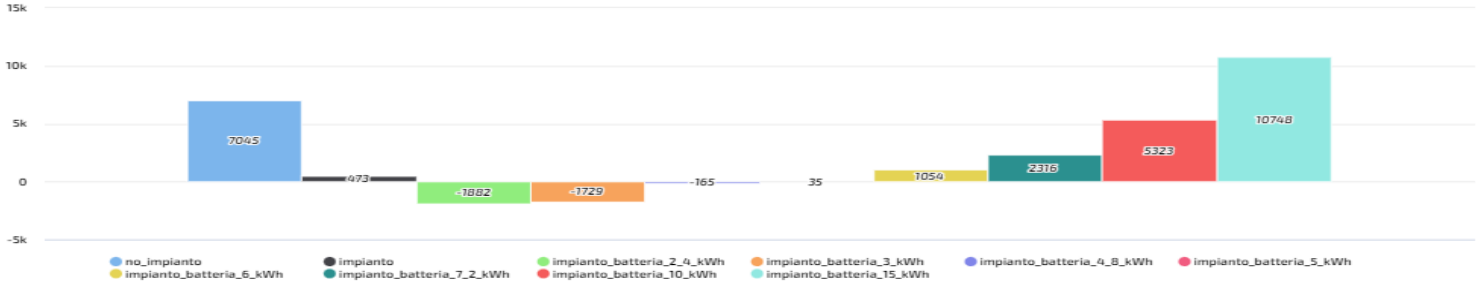
Ciao roottooladmin1

Tue 4 Apr 13:15:34

SIMULATORE IMPIANTO FOTOVOLTAICO

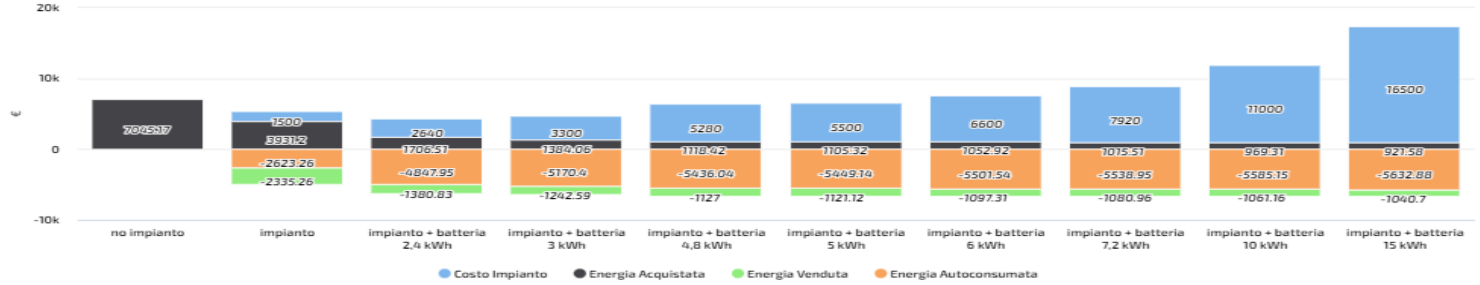
COSTO COMPLESSIVO NEGLI ANNI DI INVESTIMENTO

599m



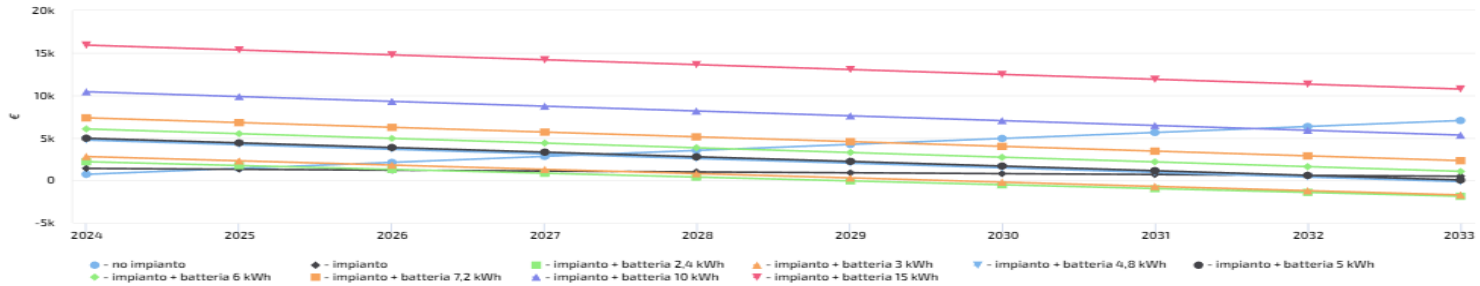
COSTO COMPLESSIVO NEGLI ANNI DI INVESTIMENTO PARTIZIONATO

599m



ANDAMENTO PREZZO CUMULATIVO ANNUO

599m



Manuale Utente

English Version

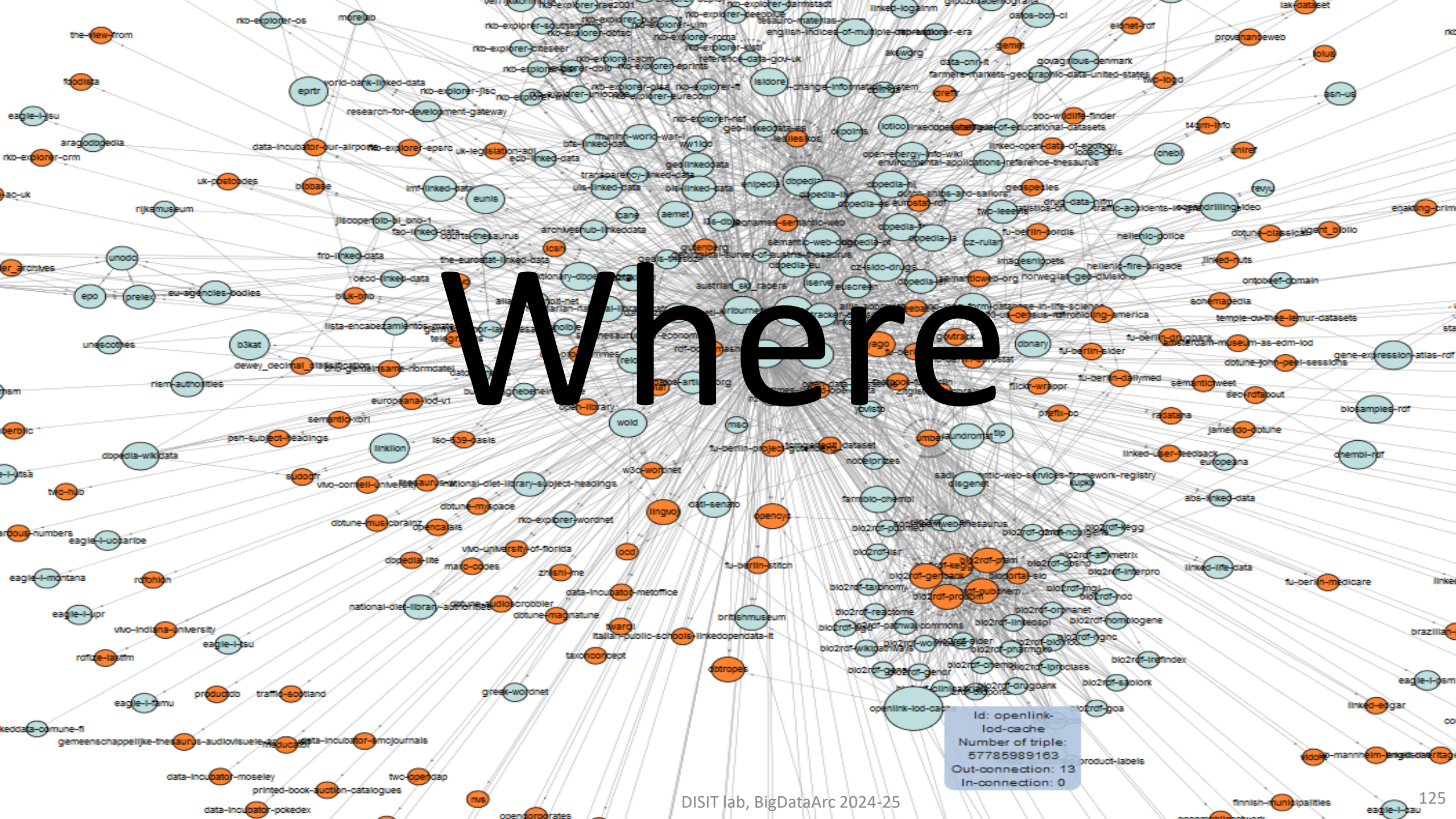
PARAMETRI DELL'IMPIANTO

Ti consigliamo un impianto con batteria da 2,4 kWh

Gruppo di Consumo Annuale	2000 kWh
Prezzo Energia Vendita (€/kWh)	0,15
Prezzo Energia Acquisto (€/kWh)	0,35
Anni di Investimento	10
Mese da simulare	Gennaio

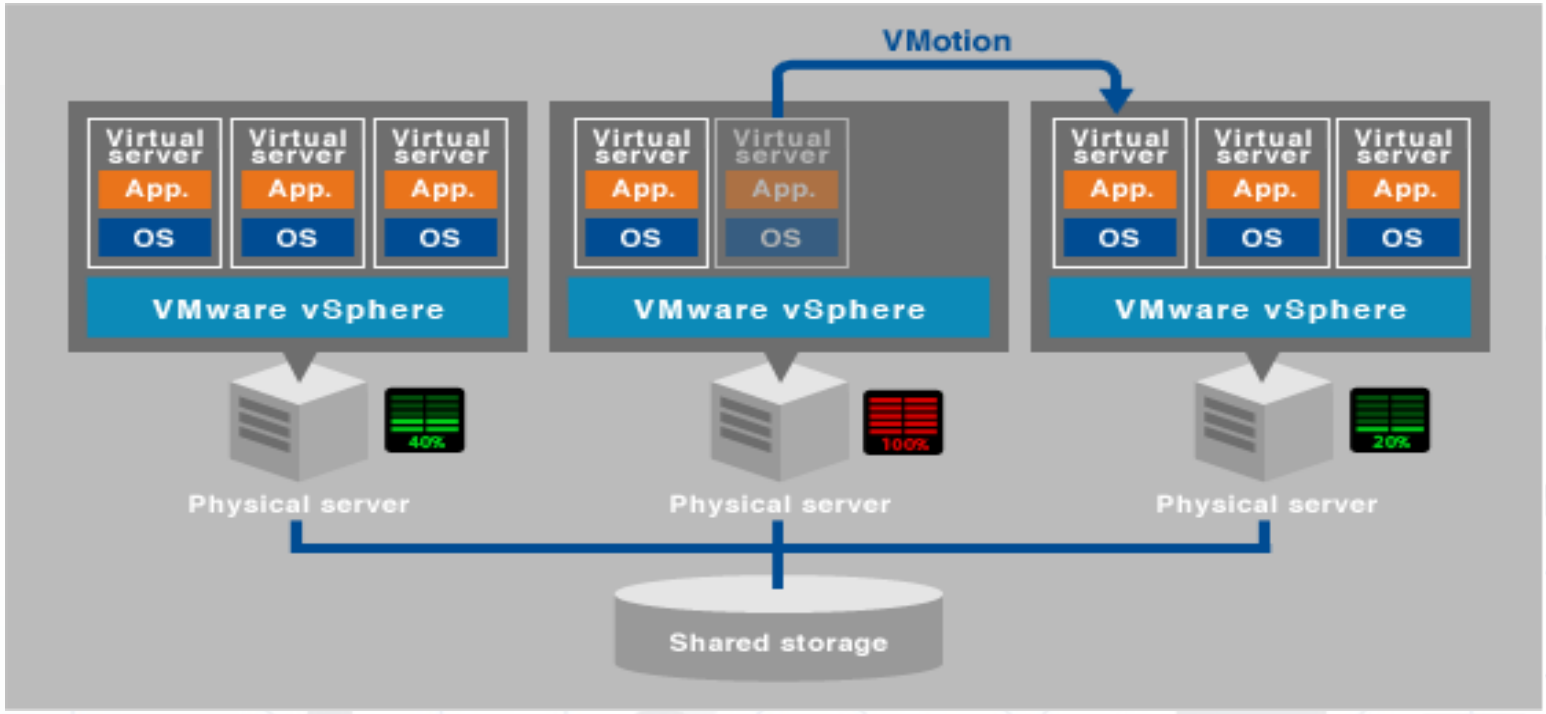
Invia

7 AFFORDABLE AND CLEAN ENERGY

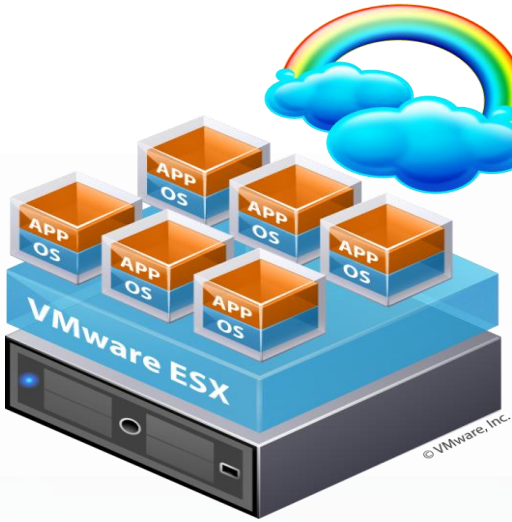

Where
Id: openlink-lod-cache
Number of triple: 57785989163
Out-connection: 13
In-connection: 0

Virtualizzazione e Cloud

- HA: High Availability,
  DRS: Distributed Resource Scheduler



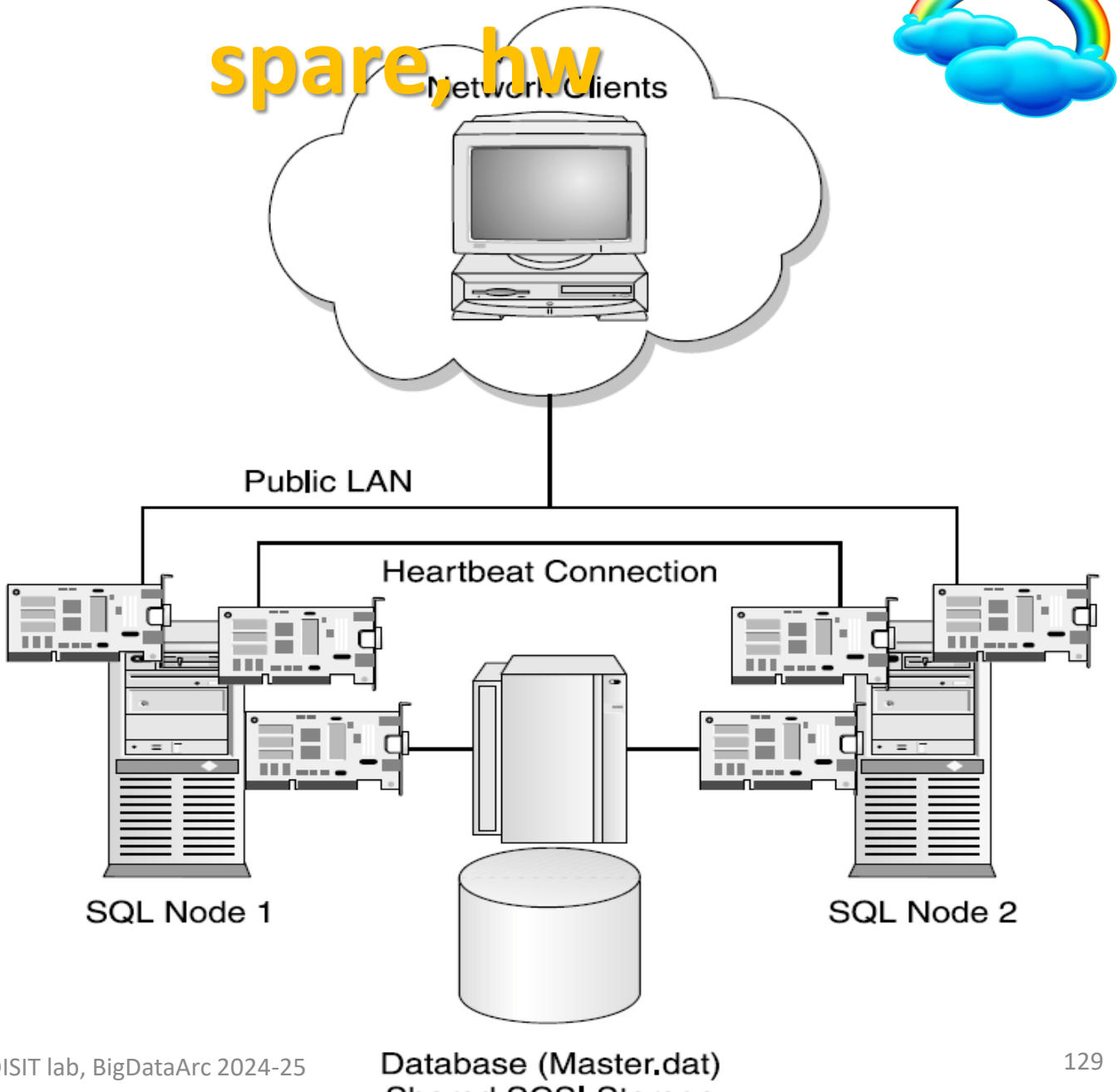
Cloud computing e Virtualizzazione

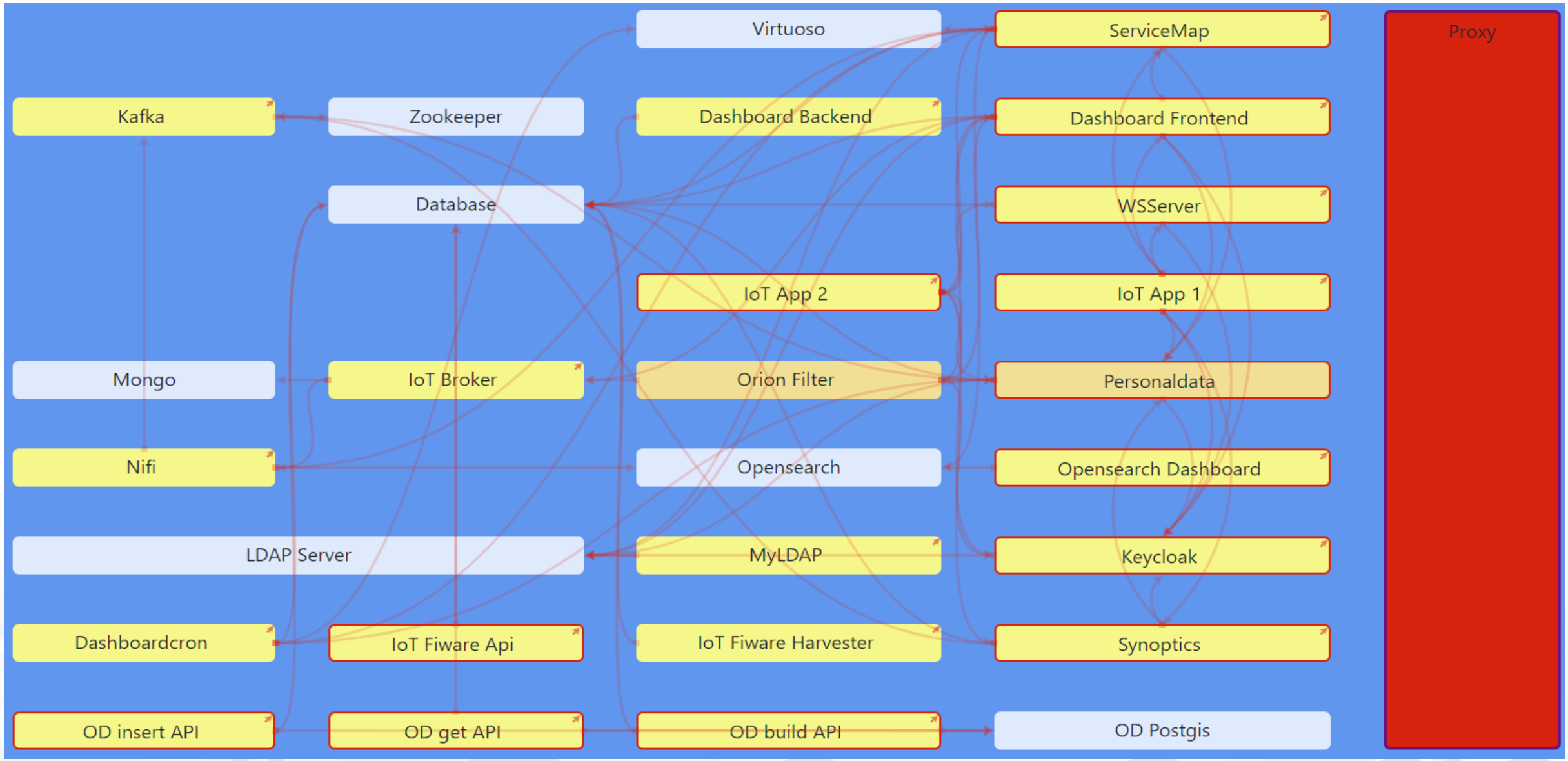


- **Motivations for Cloud computing and Virtualization**
- **Virtual Machine concepts:** emulation, para-virtualization, snapshots
- **Cloud Computing,** cloud vs grid, goals of cloud computing
- **High Availability,** Workload Balancing
- **vSphere Infrastructure,** Vmotion, Power Management, Resource Scheduling, Fault Tolerance
- **Security on the Cloud**
- **Conversions** among VM and physical machines
  - Covnersions: P2V, V2V
- **vCenter, datacenters and cluster management**
  - Performance analysis for the cloud
- **Comparison** among Cloud computing solutions
- **ICARO project**

High Availability: Hot spare, hw

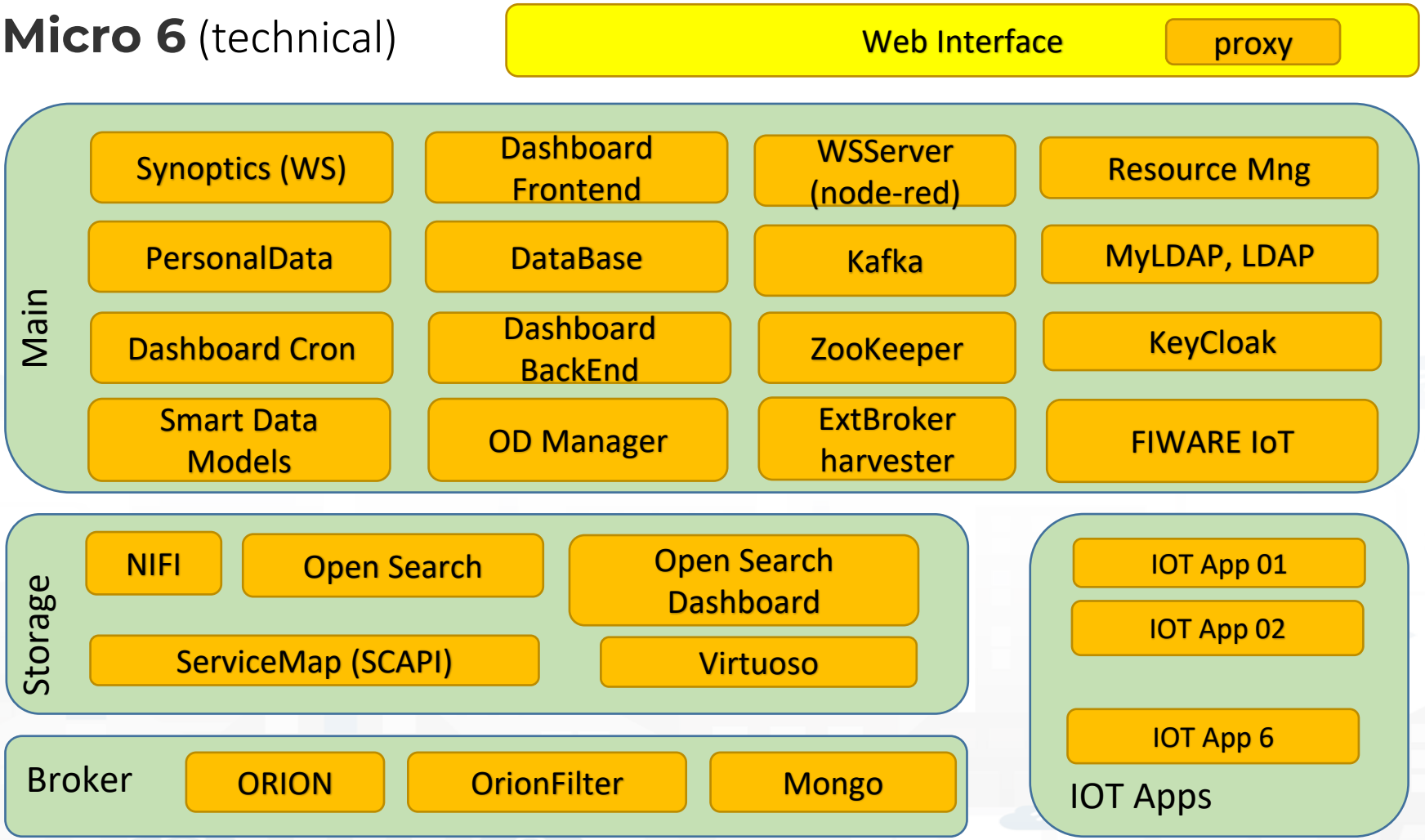
- Three separate networks cards
  - Front end
  - Heartbeat
  - Database NAS/SAN
- UPS/APC solutions with
  - 2 UPS, each of which with network card
- NAS/SAN
  - Raid 5 or 6, 60
  - Fiber connection




Virtuoso
ServiceMap
Proxy
Kafka
Zookeeper
Dashboard Backend
Dashboard Frontend
Database
WSServer
IoT App 2
IoT App 1
Mongo
IoT Broker
Orion Filter
Personaldata
Nifi
Opensearch
Opensearch Dashboard
LDAP Server
MyLDAP
Keycloak
Dashboardcron
IoT Fiware Api
IoT Fiware Harvester
Synoptics
OD insert API
OD get API
OD build API
OD Postgis

Micro 6 model

Micro 6 (technical)



1Hour installation and ready to use

Agenda

- Laboratorio DISIT
- Tematiche del corso
- Infrastruttura del DISIT Lab
- Struttura del corso
- Modalità dell'esame

Infrastructure and support

- **Research group since 1994**
- **Cloud and data center** with >700 TByte storage in raid 50/60,
  - >800 CPU cores, >45000 GPU cores, >8 Tbyte RAM
  - Managing several infrastructures
- **DISIT lab/Snap4City.org :** development and testing r**eference** for:
  - FIWARE Certificates and Experts
  - GAIA-X, EOSC, Node-RED library, etc.
  - Nodo CINI per: Big data, Smart City, Security
- **Open Data and Linked Open Data center**
  - **Integration of more than 800 different Open Data**
  - **LOD** for global linked data https://LOG.disit.org

DISIT Lab: Infrastruttura

DISITLAB3 - vSphere Client

File Edit View Inventory Administration Plug-ins Help

Home ▸ Inventory ▸ Hosts and Clusters

Search Inventory

disit-dc

Getting Started | Summary | Virtual Machines | Hosts | IP Pools | Performance | Tasks & Events | Alarms | Permissions | Maps | Storage Views

Custom Map

Time since last data update: 02:37 Refresh

Overview

Map Relationships:

Custom Map

Host Options

- [x] Host to VM
- [ ] Host to Network
- [ ] Host to Datastore

VM Options

- [x] Fault Tolerance relationships
- [x] VM to Network
- [ ] VM to Datastore
- [ ] Show only powered on VMs

Apply Relationships

Recent Tasks Alarms

Administrator

Corsi di docenti DISIT lab

- **Magistrale in Informatica, Magistrale in Artificial Intelligence**
  - **Big Data Architectures** – Prof. Paolo Nesi (Big Data, Data Analytics, Architecture, Cloud, IoT)
  - **Knowledge Engineering** – Prof. Pierfrancesco Bellini (Knowledge Engineering, Natural Language Processing)
  - **Security and Privacy** – Proff. Nesi and Bellini (Web security, privacy, GDPR, tracking)
- **Dottorati:**
  - PhD-AI, dottorato nazionale in Intelligenza Artificiale: P. Nesi
  - PhD del DINFO, dottorato in Ingegneria Informatica: P. Nesi, P. Bellini
- **Altri corsi:**
  - Master in Big Data-MABIDA: architetture, Big Data, Knowledge engineering, Natural Language Processing, cloud, etc.
  - Master IOT Industria 4.0 di Pisa – Prof. P. Nesi
  - Data Intelligence – Corso di Intelligence e Sicurezza Nazionale – Prof. Paolo Nesi
  - Altri master…..
- **Triennale**
  - Sistemi Distribuiti – Prof. Paolo Nesi
  - Sistemi Operativi – Prof. Pierfrancesco Bellini
  - Fondamenti di Informatica – Prof. Gianni Pantaleo, Stefano Bilotta

Agenda

- Laboratorio DISIT
- Tematiche del corso
- Infrastruttura del DISIT Lab
- Struttura del corso
- Modalità dell'esame

Big Data Architectures, 2024

Corso a 6 CFU

- **Overview del corso e del Lab (queste slide)**
- **Cloud:**
  - virtualizzazione, HA, DRS, FT, architetture
- **Architetture**
  - Data Lake vs Data Warehouse
  - Batch and Data Stream processing:
  - IOT Architecture: AWS, Azure IOT, Google IOT,
  - Snap4City IOT/IOE, IOT Industry 4.0
- **Development Life Cyle for Big Architecture**
  - Agile for Big Data Architectures
  - Containers: Docker, Kubernetes
  - MLOps, AI, ML
- **Analytics, AI, DL, RL, LLM**
  - Mobility and Transport: traffic flow reconstruction, modeling, etc.
  - Big Data Analytics (base): Time Series, predictions,
  - Visual Analytics: Business intelligence, Dashboard (esteso)
- ***Storage Optional:***
  - *VIDEO: Indexing and Search: SOLR, SOLR Sharded, Elastic Search*
  - *VIDEO: Big Data Storage Confronto: Hbase, Mongo*
- **3 CFU per arrivare a 9**
  - **Esercitazioni**

Modello del Corso

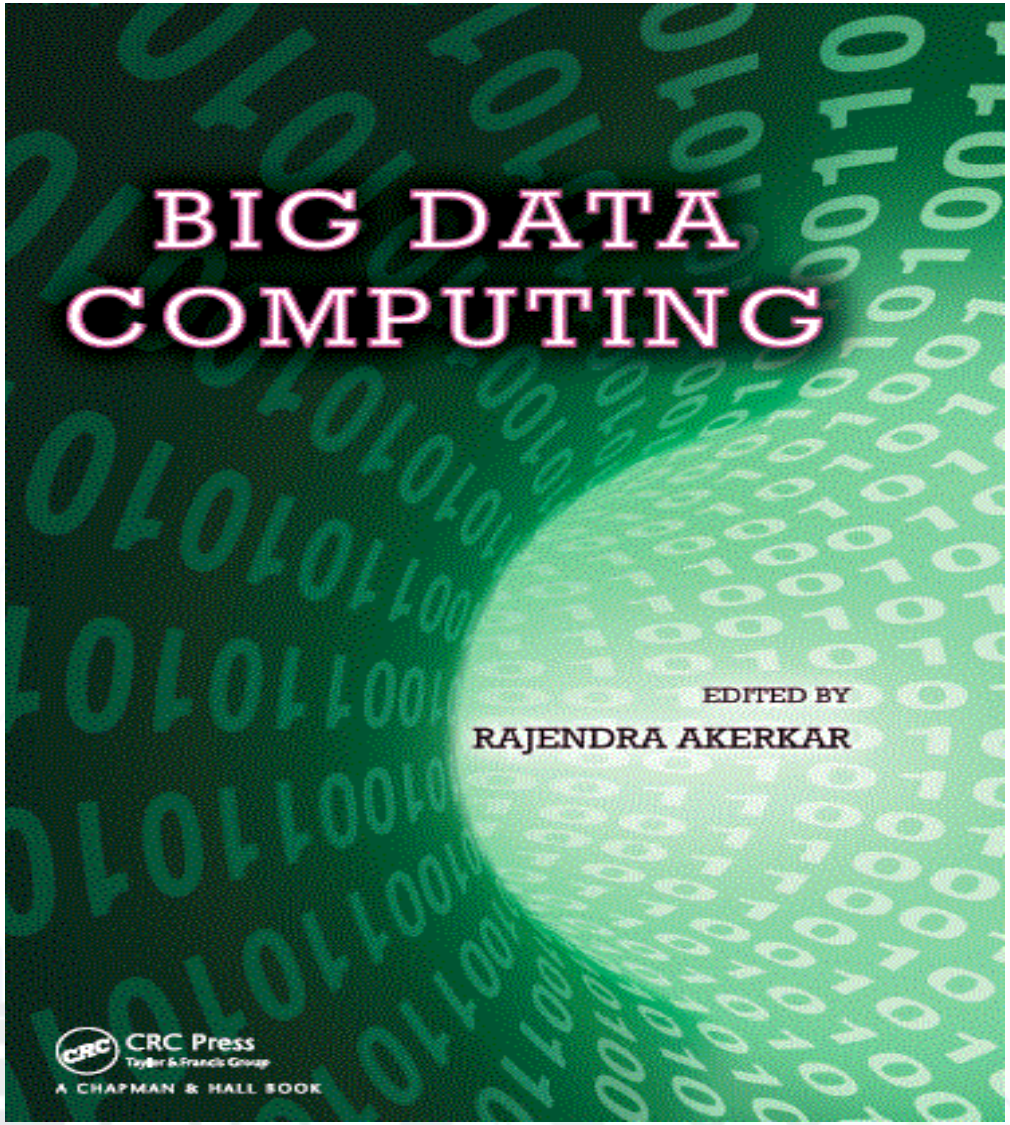
- **Tipicamente per ogni argomento sono presentati:**
  - Requisiti e motivazioni dello sviluppo dell'argomento
    - Punto di vista dell'utente e del gestore
  - Stato dell'arte
    - Basi teoriche e tecnologiche, Eventuali standard
    - Prodotti di mercato (leader), pro e contro
  - Recenti Innovazioni e tendenze
  - Confronti fra le varie tecnologie e nuove soluzioni, pro e contro
  - Dettagli progettuali
  - Aspetti prestazionali e di scalabilità
- **Seminari di altri studenti e/o esperti, ….**

Ricevimento

- **Ricevimento per la didattica frontale**
  - Skype, cercatemi come: Paolo.nesi@unifi.it
  - qualsiasi ora,
    - rispondo in chat se necesario fissiamo via skype una call

P. Bellini, M. Di Claudio, P. Nesi, N. Rauch, "Tassonomy and Review of Big Data Solutions Navigation", in "Big Data Computing", Ed. Rajendra Akerkar, Western Norway Research Institute, Norway, Chapman and Hall/CRC press, ISBN 978-1-46-657837-1, eBook: 978-1-46-657838-8, **july 2013**, in press.

http://www.tmrfindia.org/bigdata.html



Agenda

- Laboratorio DISIT
- Tematiche del corso
- Infrastruttura del DISIT Lab
- Struttura del corso
- Modalità dell'esame

Superamento esame

- Corso a 6 CFU
  - Modalita' per il superamento dell'esame: Orale
    - Chi preferisce puo' fare elaborato
  - Eventuale Project Work (PW) / Laboratorio per 3 CFU
    - Modalità: discussione elaborato
- Corso a 9 CFU
  - Modalita' per il superamento dell'esame: solo elaborato
- Eventuali: PW, stage, tesi anche collegati fra loro

Elaborati

http://www.disit.org/5492

- **Gli elaborati (singoli o coppie di studenti) possono essere di tipo**
  - (Tipo A) con sviluppo di software, moduli singoli, installazioni, test, valut. prestazioni.
  - (Tipo B) con sviluppo algoritmi di Data Analytics, ML, AI, XAI, DL, RL, GNN, etc.
  - (Tipo C) con sviluppo di moduli e processi di Data Warehouse.

  Lo studente può
  - chiedere la sostituzione dell'elaborato e/o del tutor di laboratorio tramite email al docente.
  - decidere di interrompere l'elaborato in ogni momento chiedendo la valutazione e consegnando la relazione breve di alcune pagine.