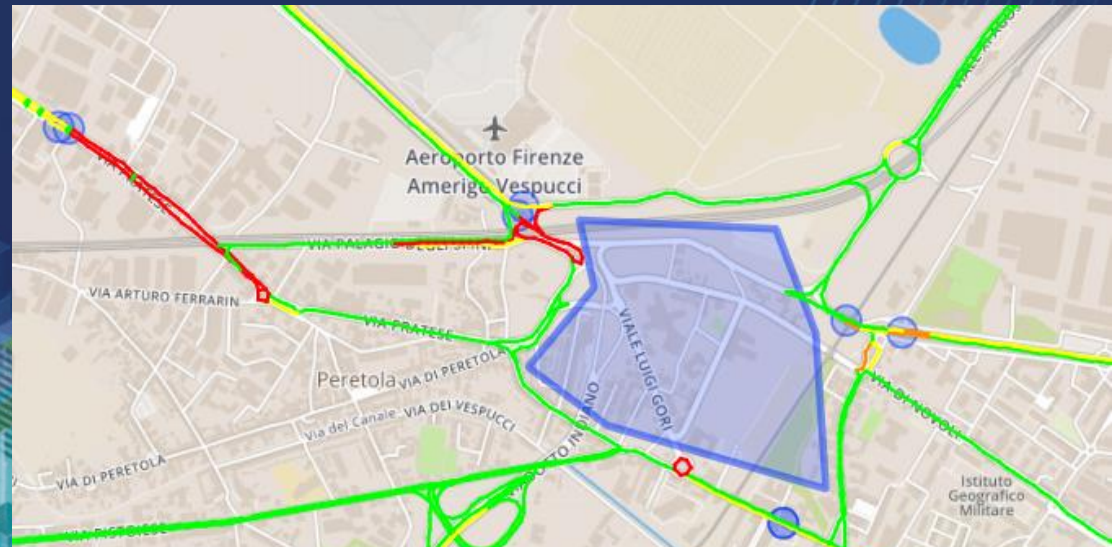
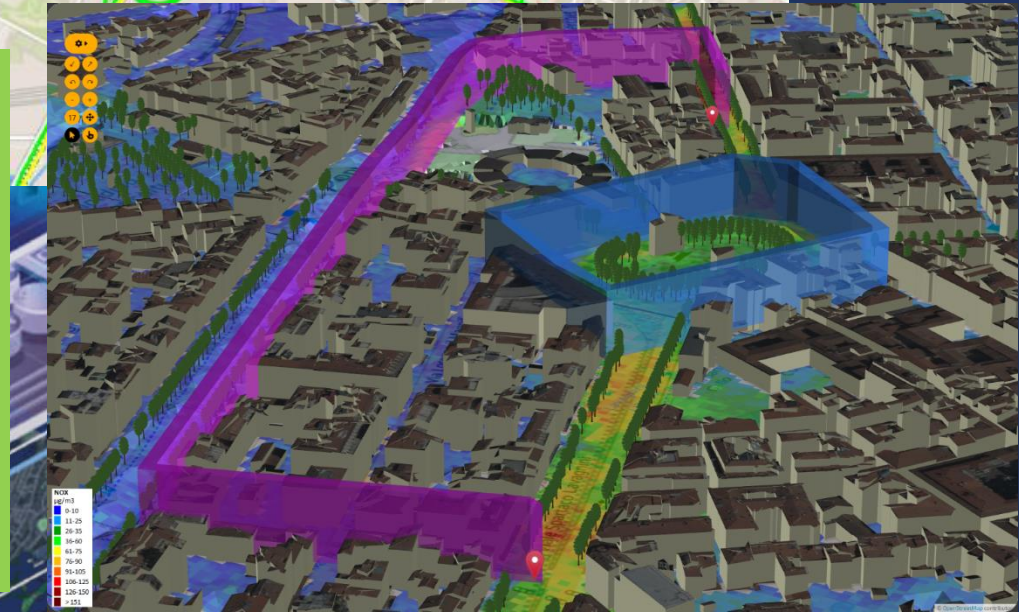




www.snap4city.org
www.snap4solutions.org



Mobility and Transport Operation and Plan Digital Twin



DIGITAL TWIN SOLUTIONS TO SETUP SUSTAINABLE DECISION SUPPORT SYSTEMS AND BUSINESS INTELLIGENCE



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FIRENZE

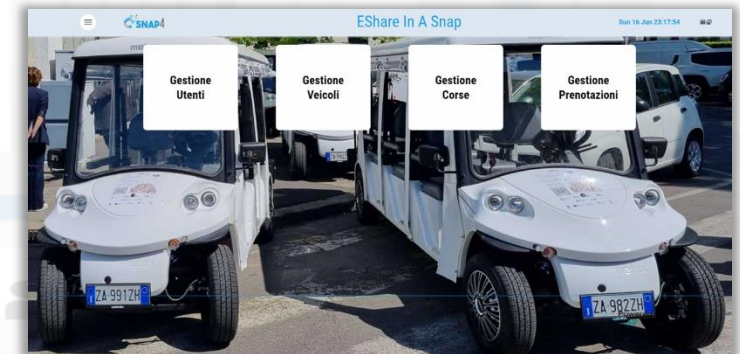
DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB



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.





Digital Twin Solutions for Sustainability

OPERATION AND PLAN - CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS - OPTIMIZATION - APPLICATIONS

CONTROL AND PLAN

MOBILITY AND TRANSPORT

SMART ENERGY AND SMART BUILDING

ENVIRONMENT AND WASTE MANAGEMENT

CITY USER'S SERVICES AND TOURISM MANAGEMENT

- DEVELOPMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES
- LIVING LABS
- GUI CUSTOM STYLES
- FULL APPLICATIONS, DASHBOARDS AND VIEWS
- MOBILE APPS



VISUAL ANALYTICS - SYNOPTICS - GRAPHICAL WIDGETS - ANALYTICS - BUSINESS INTELLIGENCE - SIMULATIONS

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

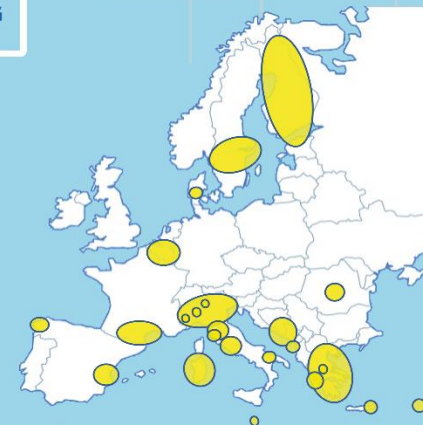
VIDEO - REPORTS - MAPS - 3D ...

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

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

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

FULL INTEROPERABILITY, ANY: DATA, BROKERS, NETWORKS AND VERTICALS



Powered by FIWARE

FREE TRIAL

PEN Test Passed

EU GDPR COMPLIANT

SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

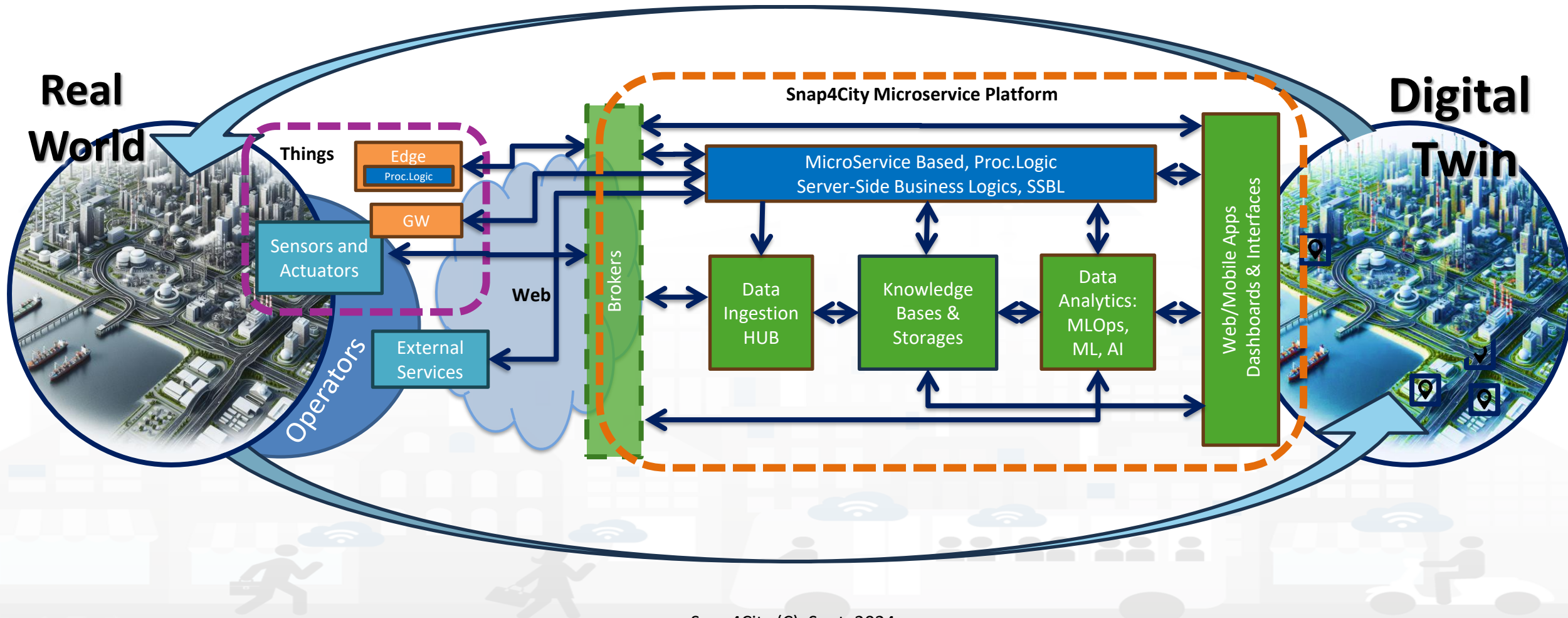
Node-RED

JS Foundation

E015 digital ecosystem

NVIDIA

Digital Twin Development Platform



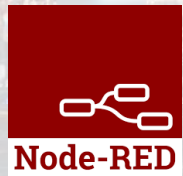
Standards and Interoperability (6/2023)



Compliant with:

- **IoT:** NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, Proximus, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models
- **General:** HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, SOAP, WSDL, FTP, FTPS, WebSocket, WebSocket Secure, GML, WFS, WMS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, VMS,
- **Formats:** JSON, GeoJSON, XML, CSV, GeoTIFF, OWL, WKT, KML, SHP, db, XLS, XLSX, TXT, HTML, CSS, SVG, IFC, XPDL, OSM, Enfuser FMI, Lidar, gITF, GLB, DTM, GDAL, Satellite, D3 JSON, ...
- **Database:** Open Search, MySQL, Mongo, HBASE, SOLR, SPARQL, ODBC, JDBC, Elastic Search, Phoenix, PostGres, MS Azure, ..
- **Industry:** OPC/OPC-UA, OLAP, ModBUS, RS485, RS232,..
- **Mobility:** DATEX, GTFS, Transmodel, ETSI, NeTEx, ..
- **Social:** Twitter, FaceBook, Telegram, ..
- **Events:** SMS, EMAIL, CAP, RSS Feed, ..
- **OS:** Linux, Windows, Android, Raspberry Pi, Local File System, AXIS, ESP32, etc.

<https://www.snap4city.org/65>



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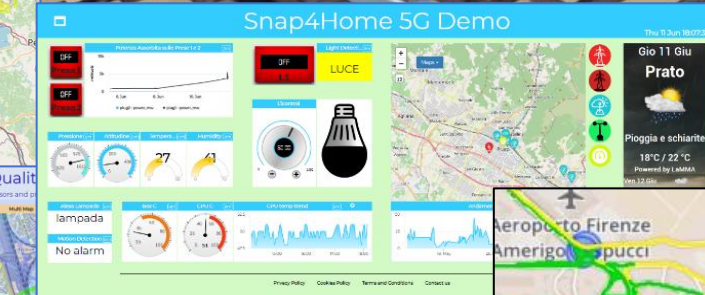
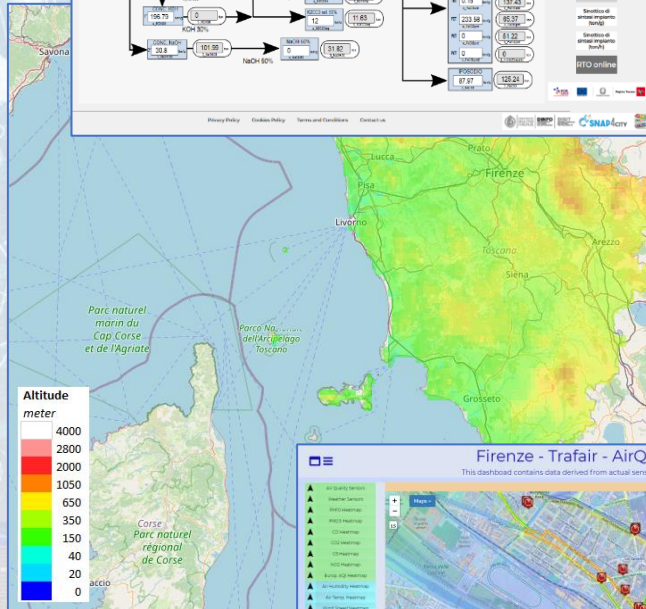
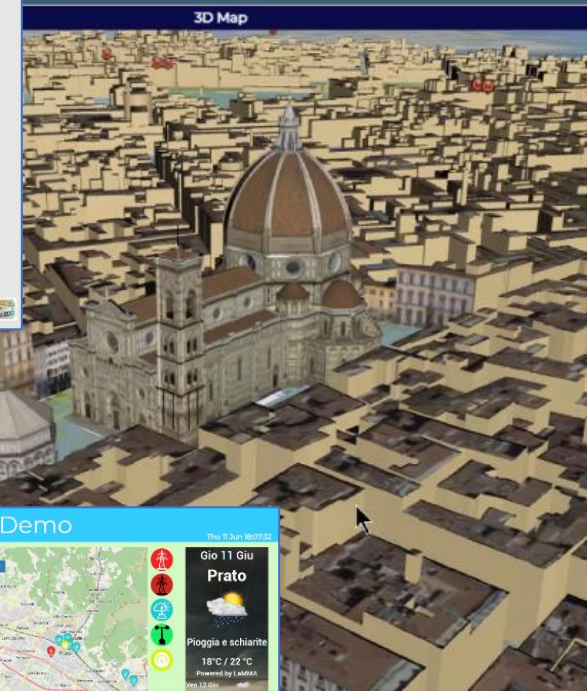
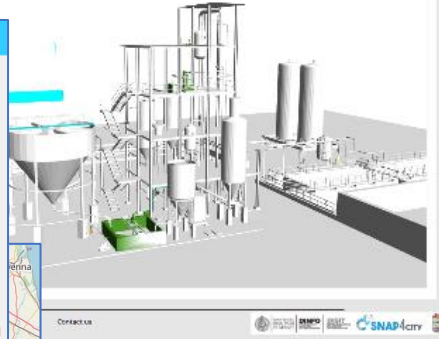
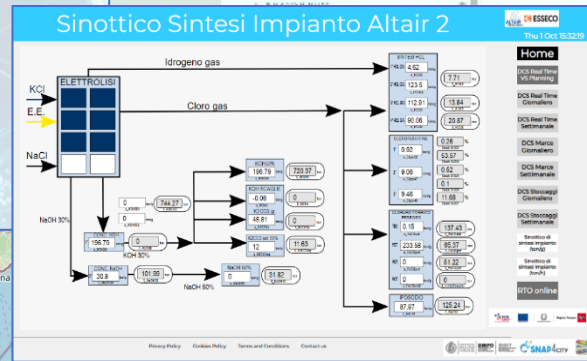
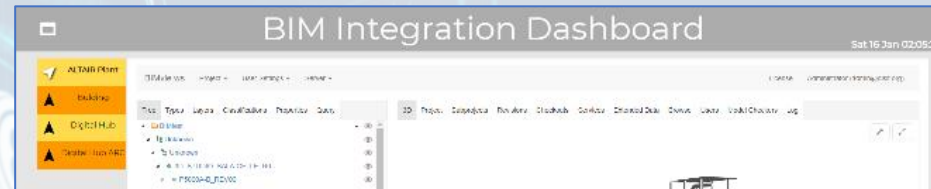
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High Level Types

Snap4City (C), Sept. 2024

- 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.



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DELL'INFORMAZIONE

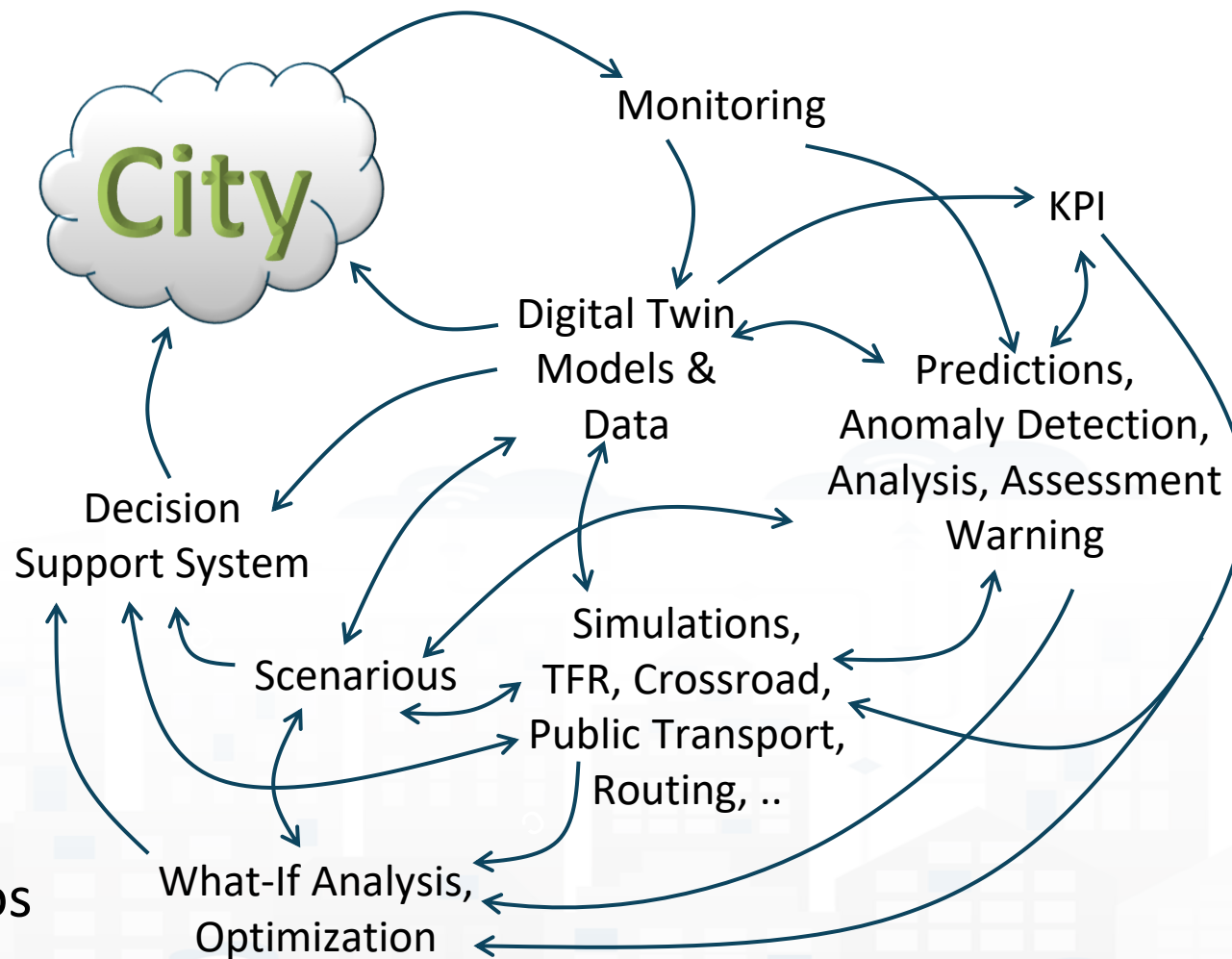
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AND INTERNET
TECHNOLOGIES LAB

- **Controlling Status: management, and operational**

- Monitoring via KPI
- Predictions vs KPI
- Anomaly detection
- Neuro-Symbolic analysis
- Risk assessment
- Early warning on critical conditions

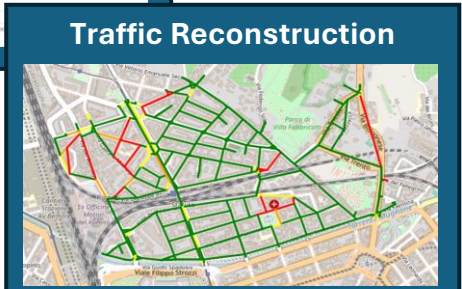
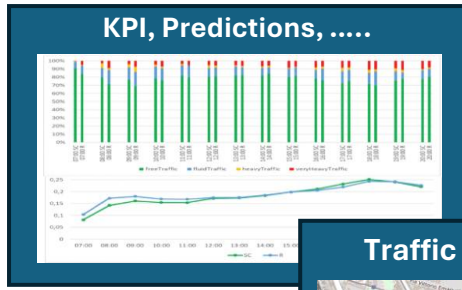
- **Making plan: tactic and strategic, medium and long range, micro/macro**

- Simulation & optimization
- Generative AI Prescriptions, scenarios
- Resilience to Unexpected unknowns
- What-if analysis wrt scenarios



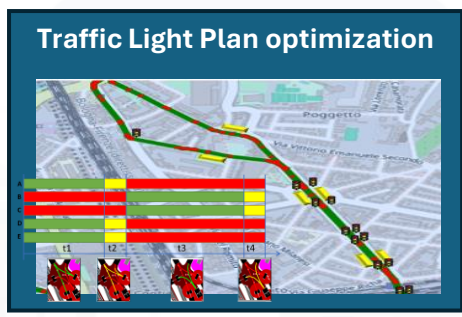


Monitoring



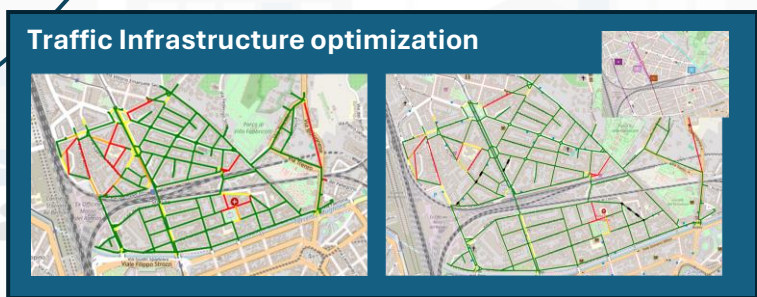
Digital Twin
Models &
Data

Predictions,
Anomaly Detection,
Analysis, Assessment
Warning

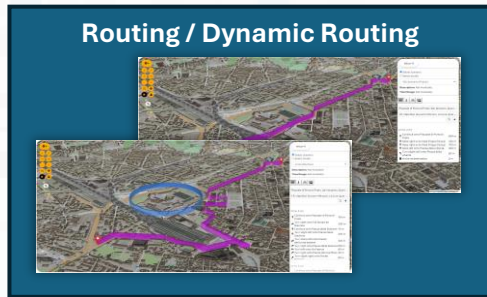
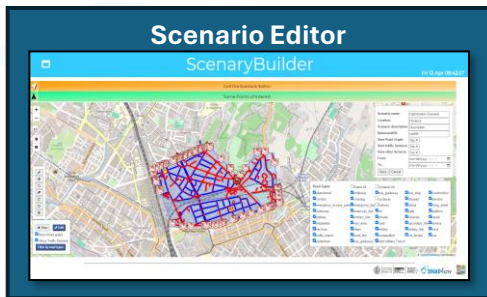


Decision
Support System

Scenarios
TFR, Crossroad,
Public Transport,
Routing, ..



What-If Analysis,
Optimization





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INTERNET TECHNOLOGIES LAB
DISTRIBUTED DATA INTELLIGENCE
AND TECHNOLOGIES LAB

SNAP4CITY



Application: eSharing and Pooling

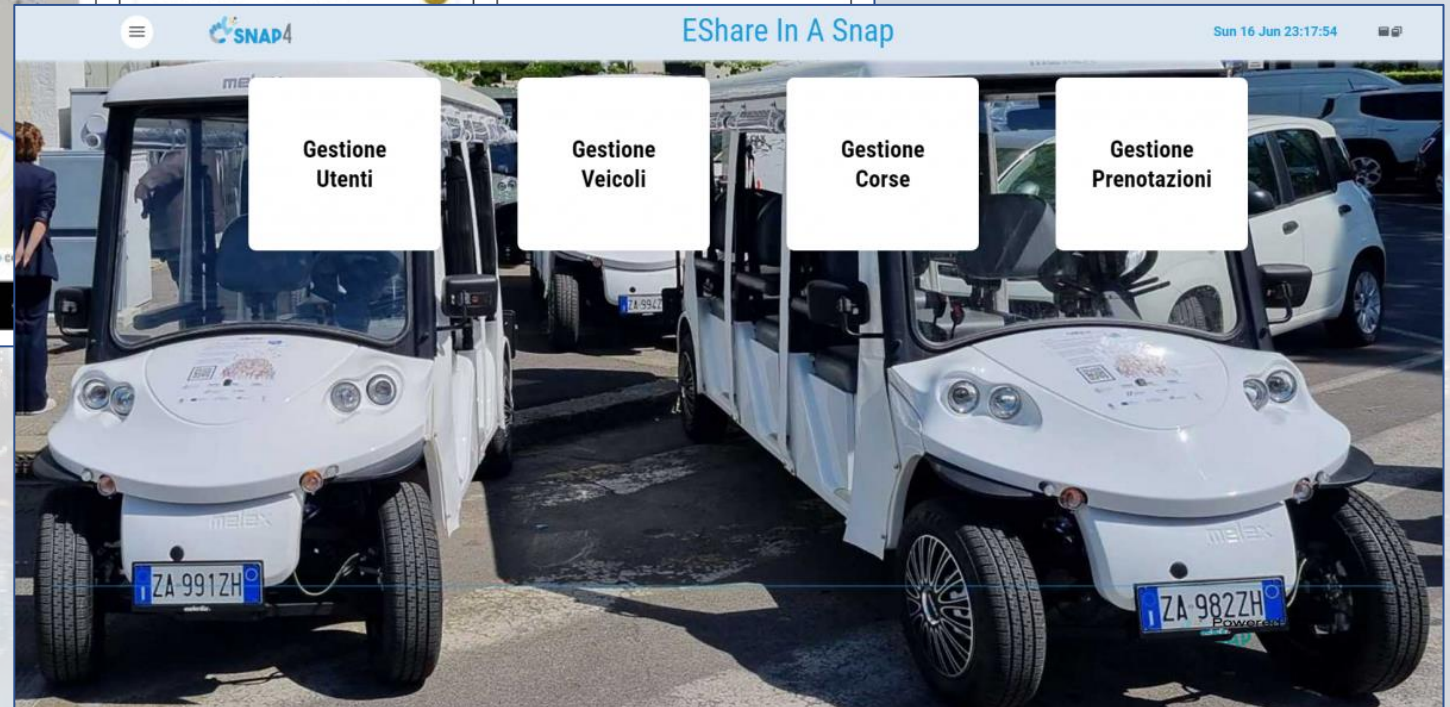
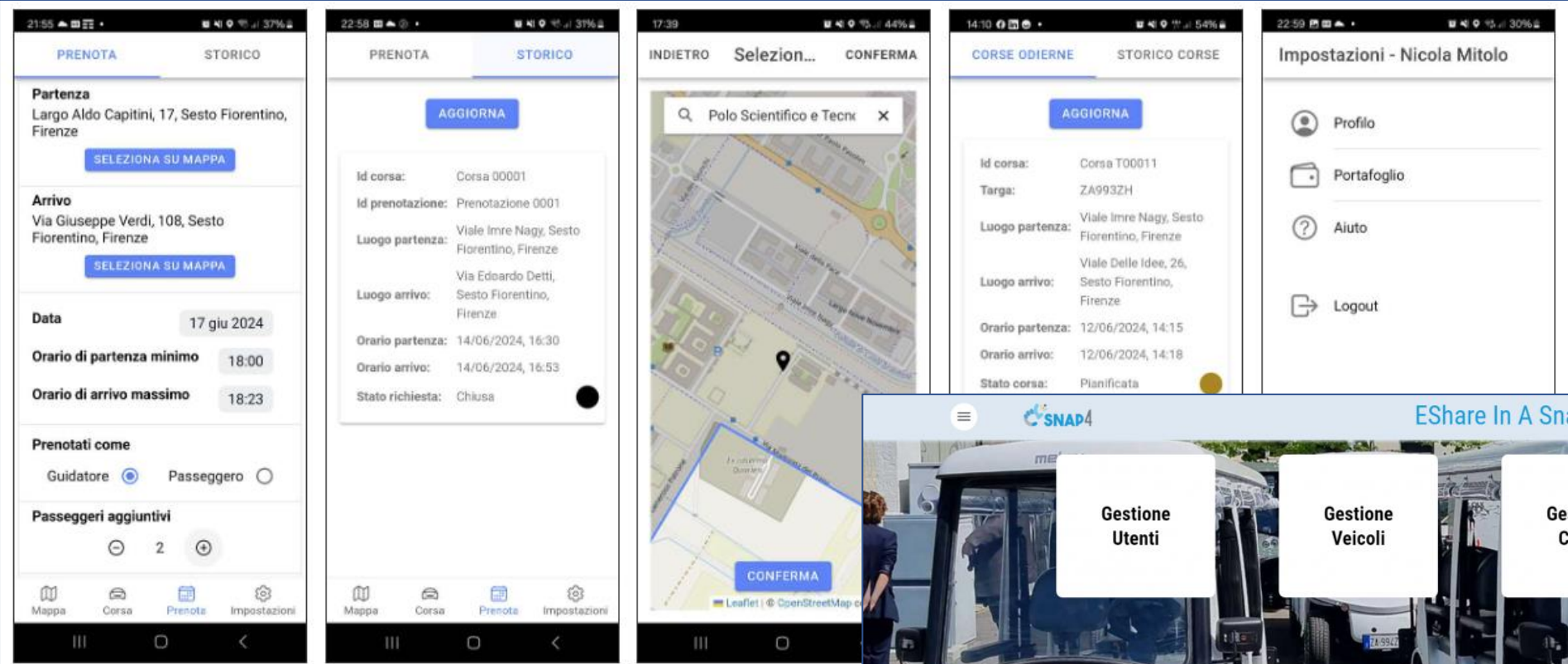
FROM CITY
DASHBOARD TO
APPLICATIONS

DATA AND
KNOWLEDGE
MANAGEMENT



eShare in a Snap, by Snap4 s.r.l.

eShare in a Snap, by Snap4



Integrated car sharing and pooling
Multiple drivers on the same means
Dynamic pooling and e-sharing

eShare in a Snap, by Snap4



Gestione Veicoli

Sun 16 Jun 23:09:13

Ricarica tutti i veicoli

show area

Selector - Map

Vehicle	Batteria	condition	Data	Blocco	Targa	status	Km/h	Actions
vehicle_ZA994ZH	97.75	Ok	16/06/2024 04:36	On	ZA994ZH	closed	0	[P] [E]
vehicle_ZA993ZH	98.67	Ok	16/06/2024 21:44	On	ZA993ZH	closed	0	[P] [E]
vehicle_ZA991ZH	92.64	Ok	16/06/2024 21:13	On	ZA991ZH	closed	0	[P] [E]
vehicle_ZA992ZH	88.76	Ok	16/06/2024 22:09	On	ZA992ZH	closed	0	[P] [E]
vehicle_ZA983ZH	87.33	Ok	16/06/2024 23:06	On	ZA983ZH	closed	0	[P] [E]

Time Trend Batteria

Time Trend Velocità

Gestione Prenotazioni Con Pool

Sun 16 Jun 23:14:32

Tutte le prenotazioni Domani

Dal 16/06/2024 Al 16/06/2024 Cerca

Svuota mappa Svuota pool Svuota mappa e pool
Simula percorso Assegna veicolo e crea pool

Elenco Prenotazioni

Reservation	Passenger	Data
mary_Reservation_0003	2	14/06/2024 17:31
bofra3_Reservation_0001	2	14/06/2024 17:35
michelangelosanto_Reservation_0001	0	15/06/2024 18:19
michelangelosanto_Reservation_0002	0	16/06/2024 19:58
simonemaga96_Reservation_0003	0	16/06/2024 21:20

User	driver?	Inizio Pooling	Fine Pooling	Inizio Richiesto	Fine Richiesta	Distanza Pooling (m)	Distanza diretta (m)
bofra3	Si	17/06/2024 10:10	17/06/2024 10:32	17/06/2024 10:10	17/06/2024 10:33	6059	4313
mary	No	17/06/2024 10:12	17/06/2024 10:20	14/06/2024 07:10	14/06/2024 07:30	2249	1883
michelangelosanto	Si	17/06/2024 10:15	17/06/2024 10:33	17/06/2024 10:05	17/06/2024 10:20	4783	4292

Veicoli disponibili

Targa	Status	Distanza (metri)	Ha corse precedenti?	Posti totali	Data
vehicle_ZA981ZH	closed	49	No	8	16/06/2024 23:08
vehicle_ZA980ZH	closed	51	No	8	16/06/2024 23:12
vehicle_ZA982ZH	closed	220	No	8	16/06/2024 23:13

Pool Prenotazioni

Reservation	Passenger	Data	driver?	Inizio	Fine	status	userID	Actions
bofra3_Reservation_0001	2	14/06/2024 17:35	yes	17/06/2024 10:10	17/06/2024 10:33	requested	bofra3	[Map] [Up] [Down]
mary_Reservation_0003	2	14/06/2024 17:31	yes	14/06/2024 07:10	14/06/2024 07:30	requested	mary	[Map] [Up] [Down]

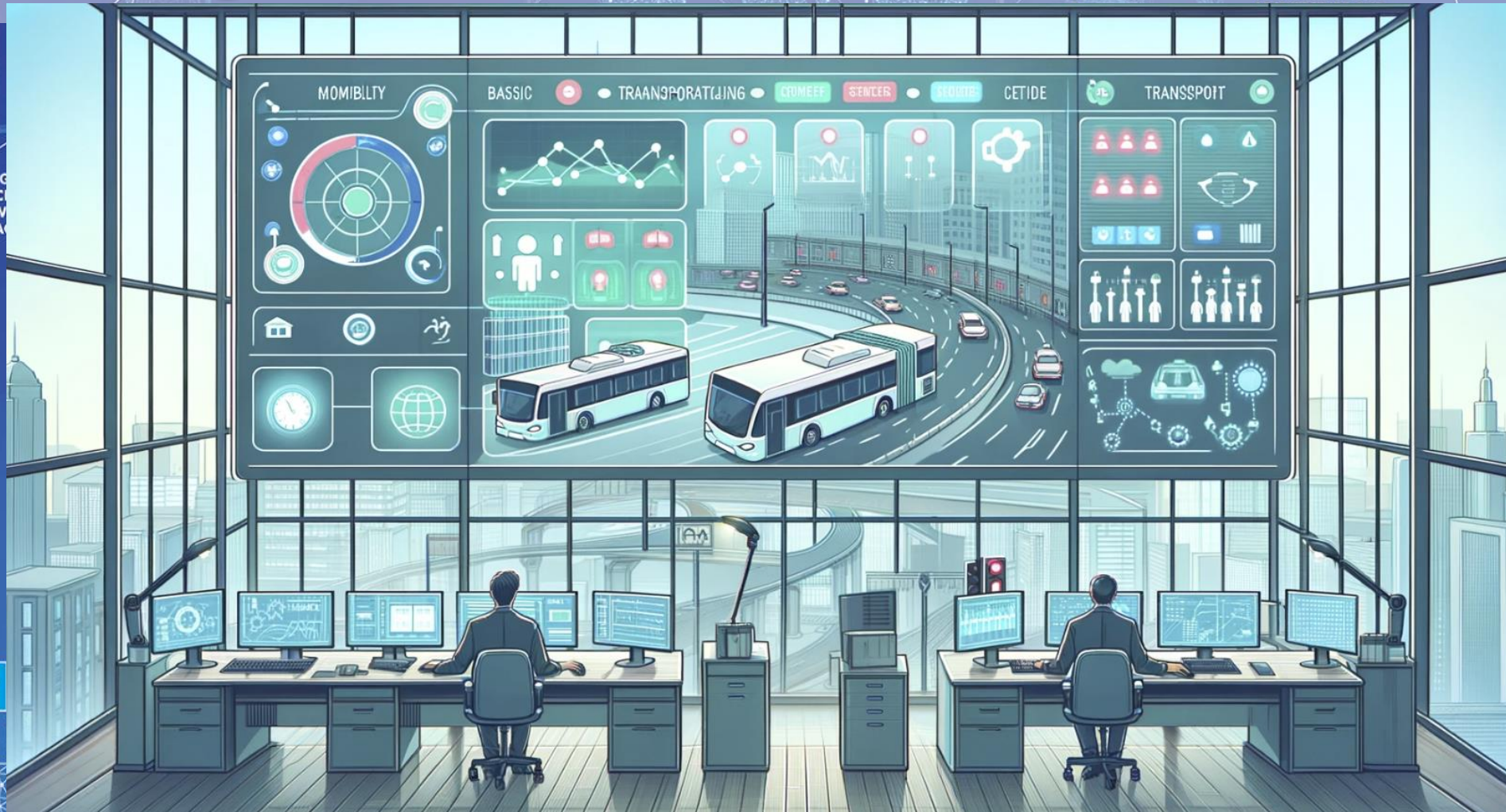
Integrated car sharing and pooling
Multiple drivers on the same means
Dynamic pooling and e-sharing



Mobility Monitoring and Control

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA C
AND C
KNOW
MANA



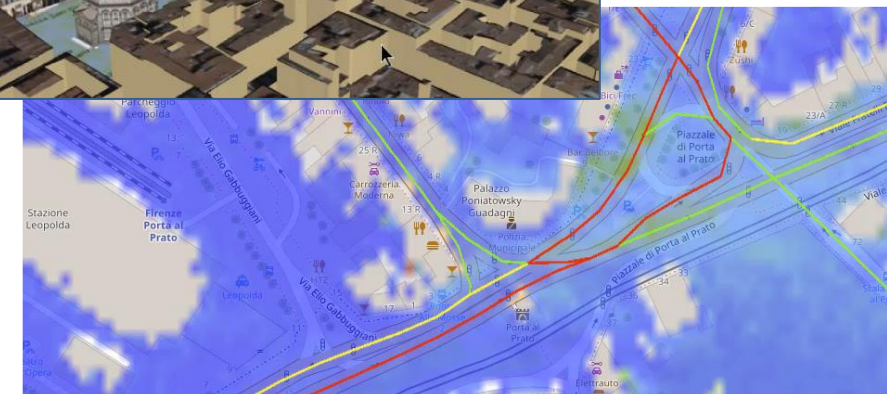
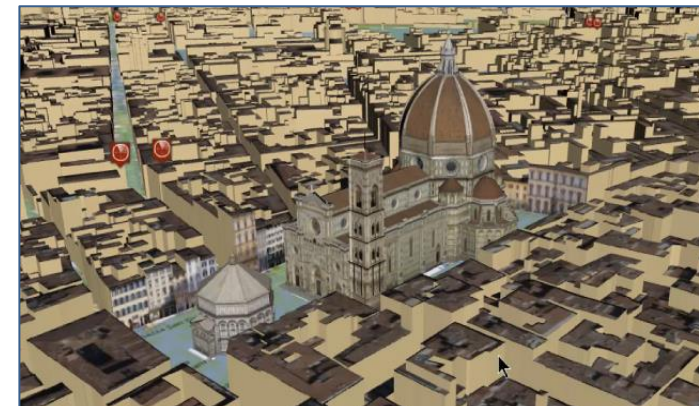
HOW TO ADOPT
SNAP4CITY, AND
OUR ROADMAP

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

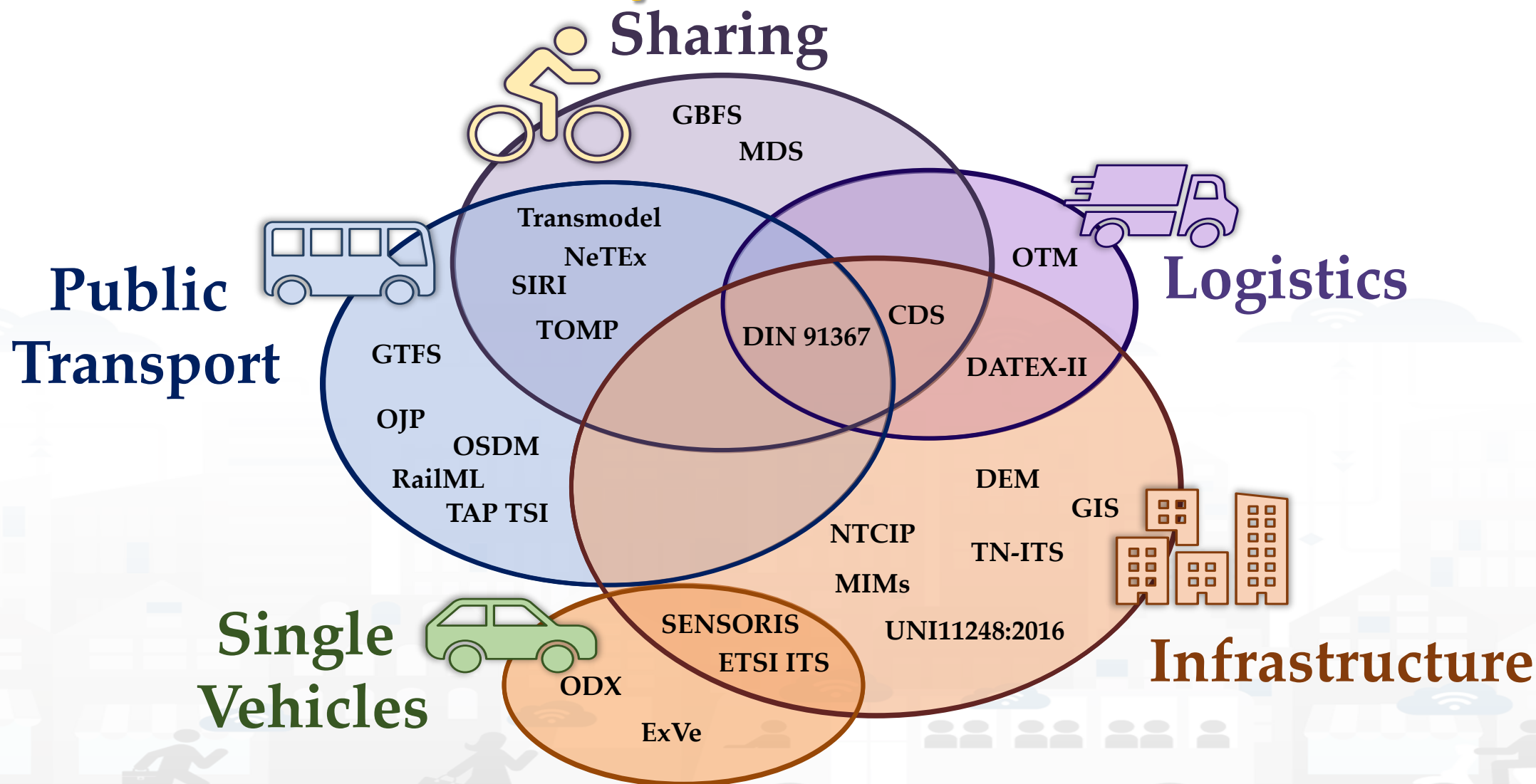
SNAP4CITY
AND KM4CITY
PROJECTS



- **Controlling Status: management, and operational**
 - Monitoring via KPI
 - Computing predictions and KPI
 - Anomaly detection, Early warning
 - Control Rooms, situation rooms
- **Reacting: Computing in real time**
 - Changing semaphore maps
 - Changing Dynamic signage
 - Real time Info Mobility
 - User engagement via Mobile Apps
 - What-if analysis
 - etc.,



Mobility data formats



Data and standards	Temporal domain			Mobility Domain					Mobility Subdomain											Format																		
	Static	Historic	Real-time	Infrastructure	Logistic	Sharing	Public Transport (PT)	Single Vehicles	Census	Road network	Urban elements	Traffic Signals	POI	Buildings	Terrain	Weather	Pollution	PT Urban: Bus, Tram, ...	PT: Railways	Journey Planning User	notification Vehicle Status / Diagnosis	Excel	SDMX	XML	CSV	JSON	GeJSON	Protocol Buffers (PBF)	Esri Shapefiles	SVG	SQLite	RDF	PNG	GeoTIFF	Esri grid ASCII (ASC)	ASN.1		
Statistical data	X	X		X	X	X	X	X														X	X		X	X												
GIS data (governemnt)	X			X						X	X		X	X												X		X										
GIS data (OSM)	X			X						X	X	X		X	X											X	X	X	X	X			X					
TN-ITS	X		X							X														X														
DEM (DTM, DSM)	X													X	X																X	X	X					
CDS	X	X	X	X	X	X				X	X															X	X											
GTFS	X						X															X																
GTFS-RT			X				X															X																
NeTEx	X					X	X															X	X															
SIRI			X			X	X															X	X															
Transmodel	X		X			X	X															X	X	X														
OJP			X				X															X	X	X														
TAP TSI	X		X				X															X	X															
RailML	X		X				X															X	X															
OSDM	X						X															X	X															
GBFS	X		X			X																																
MDS	X	X	X			X																																
DIN SPEC 91367			X	X	X	X	X			X	X		X									X	X	X												X		
OTM			X		X																																	
IoT/loE Sensors - TV Cam			X	X						X			X			X	X																					
DATEX-II			X	X	X					X	X	X	X																									
NTCIP			X	X								X																										
UNI11248:2016			X	X							X																											
TOMP	X		X			X	X															X	X	X														
ETSI ITS			X	X			X			X												X	X														X	
SENSORIS		X	X	X			X			X																		X										
ExVe			X				X																		X		X											
ODX			X				X																		X													

Key Performance Indicators, KPI



- **United Nations Sustainable Development Goals, SDGs** (for which cities can do more to achieve some of the 17 SDGs, <https://sdgs.un.org/goals>);
- **15 minutes cities** (where primary services must be accessible within 15 minutes on foot);
- **objectives of the European Commission** in terms of pollutant emissions for: NO2, PM10, PM2.5 (https://environment.ec.europa.eu/topics/air_en);
- **SUMI: mobility and transport vs env**
 - <https://www.snap4city.org/951>
- **SUMP/PUMS: mobility and transport vs env.**
- **ISO indicators:** city smartness, digitization, tech level.
- **Low Level/Real Time:** global traffic, quality of service, betweenness, centrality, queue, time to travel, etc.

Global
&
Local

Periodic
&
Realtime

Air Quality Directive				WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
PM _{2.5}	One day			25 µg/m ³ (*)	99 th percentile (3 days/year)
PM _{2.5}	Calendar year	Target value, 25 µg/m ³	The target value has become a limit value since 1 January 2015	10 µg/m ³	
PM ₁₀	One day	Limit value, 50 µg/m ³	Not to be exceeded on more than 35 days per year.	50 µg/m ³ (*)	99 th percentile (3 days/year)
PM ₁₀	Calendar year	Limit value, 40 µg/m ³ (*)		20 µg/m ³	
O ₃	Maximum daily 8-hour mean	Target value, 120 µg/m ³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m ³	
NO ₂	One hour	Limit value, 200 µg/m ³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m ³ (*)	
NO ₂	Calendar year	Limit value, 40 µg/m ³		40 µg/m ³	



• **15 Minute City Index:**

- 13 subindexes: energy, slow mobility, fast mobility, housing, economy education, culture and cults, health, entertainment, gov, food, security...



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



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



- Smart City infrastructure: monitoring and resilience, long terms predictions
- Effective and Low cost smart solutions
- What-if analysis, Simulations
- Origin Destination matrices computation



- business intelligence tools for decision makers
- Reduction production costs
- Monitoring resource consumption
- Optimization of Waste Collection



- Monitoring and Predicting: NO₂, NO_x, CO₂, Traffic flow, pollutant, landslide, waste, etc.
- Traffic flow reconstruction
- Demand vs Offer of Mobility analysis



- Shortening justice time
- Anonymization and indexing legal docs.
- Prediction of mediation proneness
- Ethical Explainable Artificial Intelligence

15MinCityIndex

What would support my neighborhood to become a 15-Minute City?

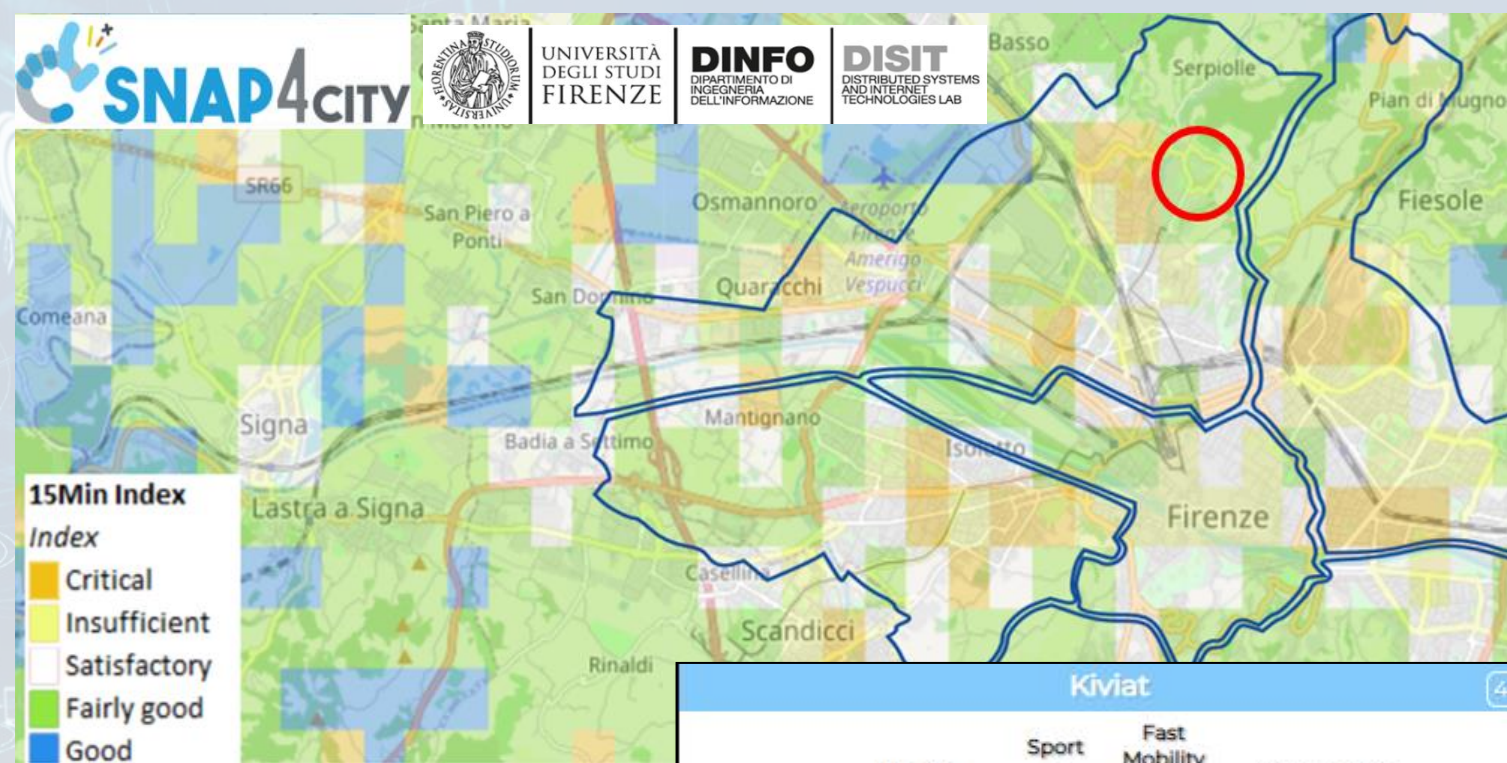
Using the Open Data:

We developed a data analytic tool based on municipal and national open data to assess services adequacy for people living in each 15 minutes areas of the city.

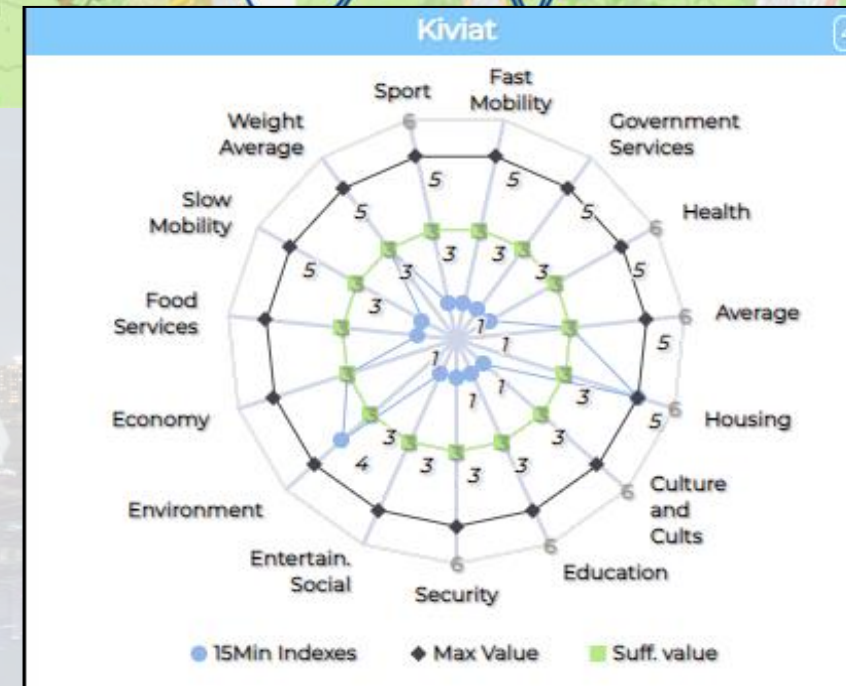
Good public transport services: bus, new tram line, train stations, cycle paths.



Careggi/Rifredi is a relevant district in Florence because of hosting the main Florence/Tuscany hospitals Careggi and Meyer, but also university headquarters and many other workplaces.



The tool supports the becoming of a 15-Minute city evaluating the service level in various domains.



<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MjkzOA==>

15MinCityIndex on Bologna



Ciao roottooladmin!

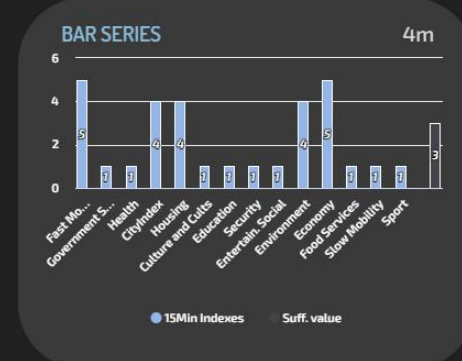
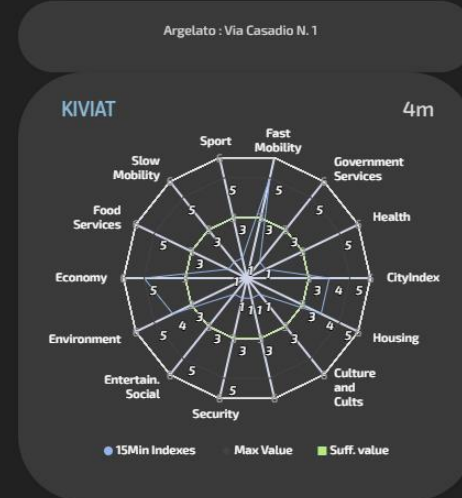
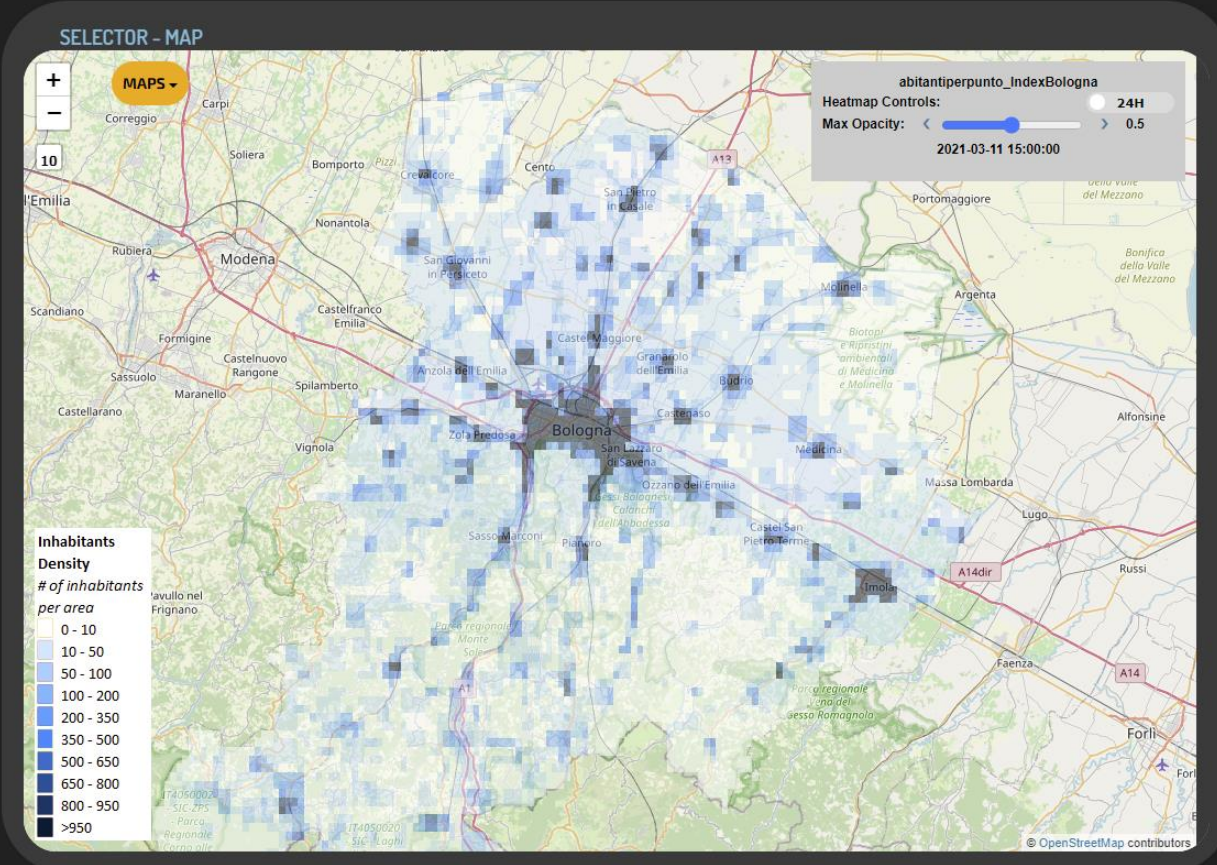
Tue 3 May 20:14:59

15 MINUTI INDEX BOLOGNA CITTÀ METROPOLITANA - NEWGUI



- ▶ # of Inhabitants
- ▶ Green factor
- ▶ Civil factor
- ▶ Industrialization factor
- ▶ Environment Index
- ▶ 15Min Economy Index
- ▶ 15Min Housing Index
- ▶ 15Min Health Index
- ▶ 15Min Food Index
- ▶ 15Min Education Index
- ▶ 15Min Slow Mob Index

THE PICKED POINT 9m
 City: Argelato
 Address: Via Casadio N. 1
 Lat,lon: 44.61882,11.35437



1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

7 AFFORDABLE AND CLEAN ENERGY

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

15 LIFE ON LAND

IoT App....

Snap4City

User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7
[Logout](#)

- My Snap4City.org
- Dashboards
- My Dashboards in All Org.
- Dashboards of My Organization
- My Dashboards in My Organization
- Extra Dashboard Widgets
- Notifier
- Data, my Data, OpenData
- Knowledge and Maps
- IOT Applications
 - IOT Applications
 - MicroServices for IOT Applications
 - MicroServices from DataAnalytic
 - IOT MicroServices for Final Users
 - IOT MicroServices for Developers
 - Doc: IOT Applications
 - How to Develop IOT Applications
 - Create A MicroService from RestCall
- IOT Directory and Devices
- Resource Manager
- Development Tools
- Management
- Decision Support Systems
- Settings
- User Management and Auditing
- Help and Contacts

15MinIndex

Node-RED

filter nodes

GPS to COMUNE | GPS to COUNT | GPS to HeatmapVal | GPS to Florence Qu | GPS to ZCS | GPS and Values to | GPS to Civic Numbe | GPS to Road Length | GPS to Cycl

subflows

- InjectedTimes

input

- inject
- catch
- status
- link
- mqtt
- http
- websocket
- top
- udp
- amqp2
- stomp

output

- debug
- link
- mqtt
- http response
- websocket
- tcp

Smart City Control Room

Florence Metropolitan City



reference



- **Multiple Domain Data**

- Thousands of Open/Private data, POI, IOT, etc.
- **mobility and transport:** accidents, public transport, parking, traffic flow, Traffic Reconstruction, KPI, ...
- **AND:** environment, civil protection, gov KPI, covid-19, social & social media, people flow, tourism, energy, culture, ...

- **Multiple dash/tool Levels & Decision Makers**

- Real Time monitoring, Alerting, quality assess.
- Predictions, KPI, DSS, what-if analysis

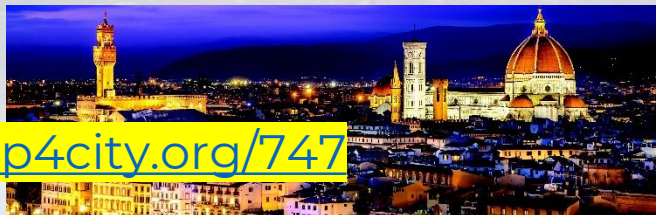
- **Historical and Real Time data**

- Billions of Data

- **Services Exploited on:**

- Multiple Levels, Mobile Apps, API

- **Since 2017**



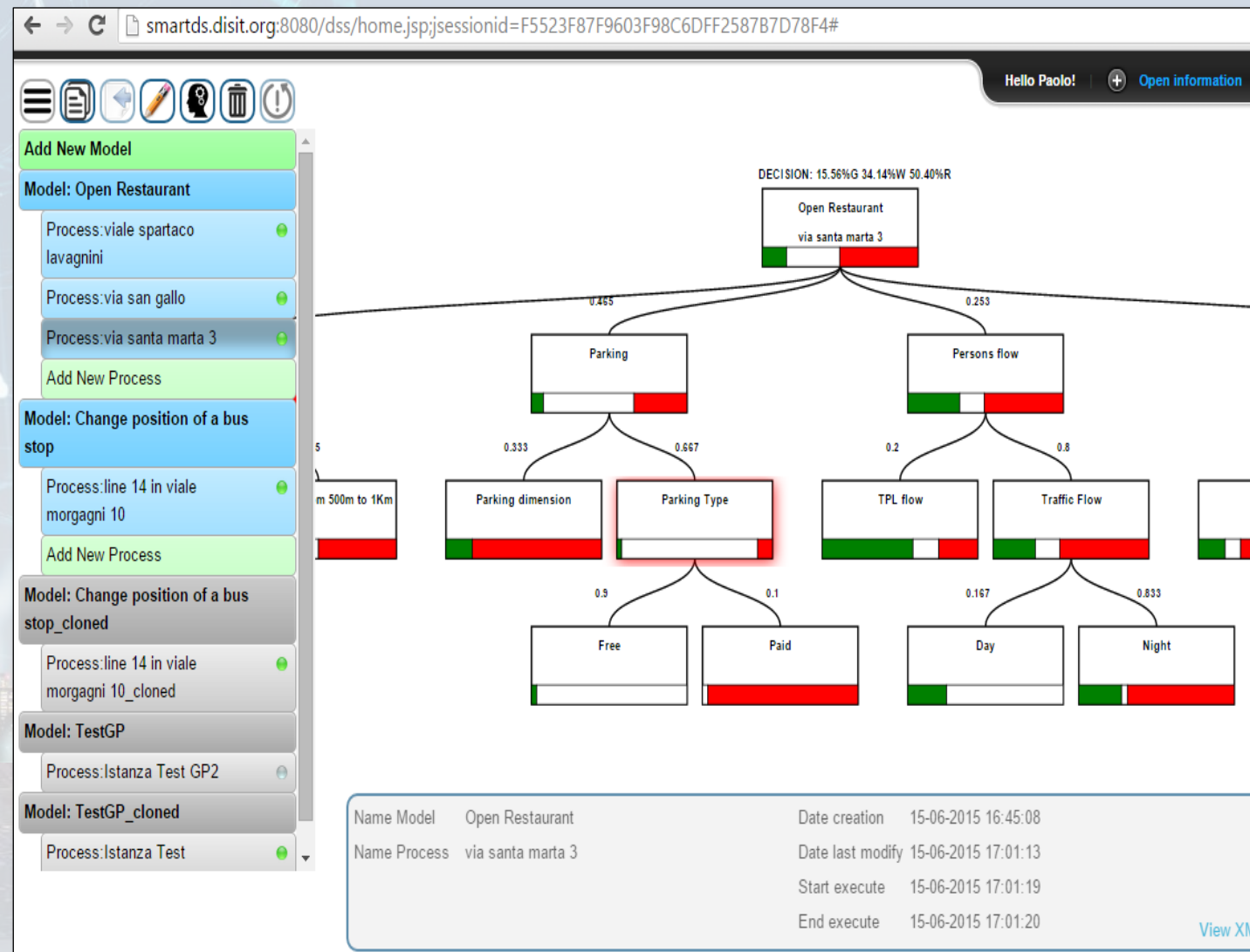
<https://www.snap4city.org/747>



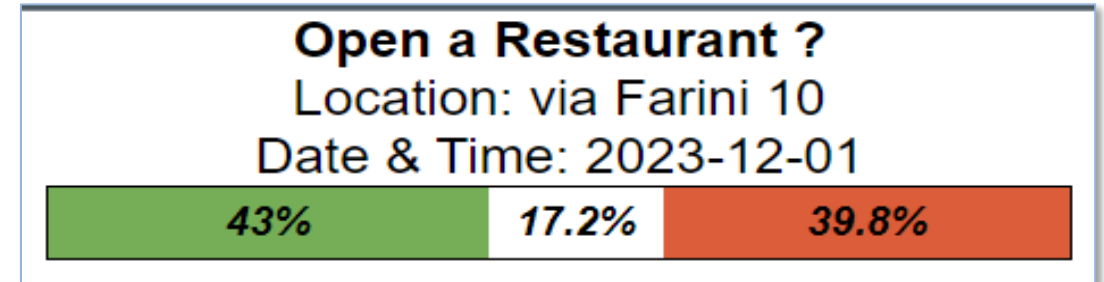


Smart Decision Support, system thinking

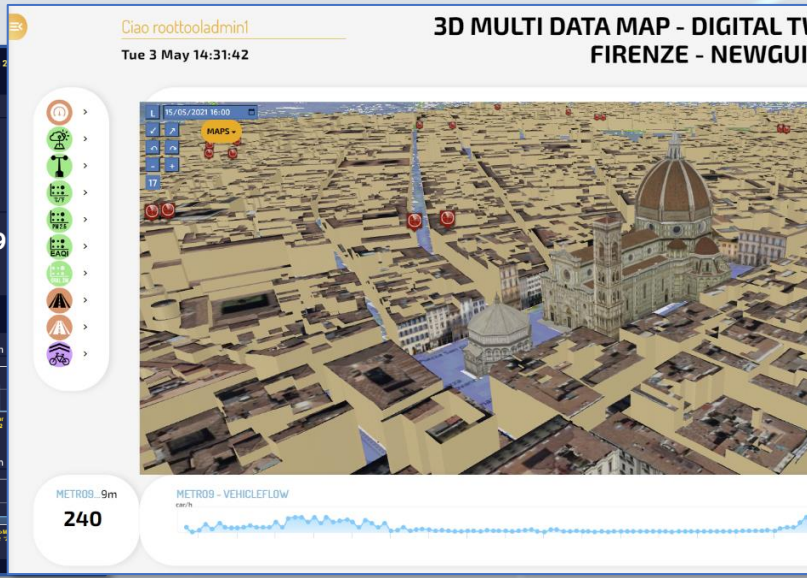
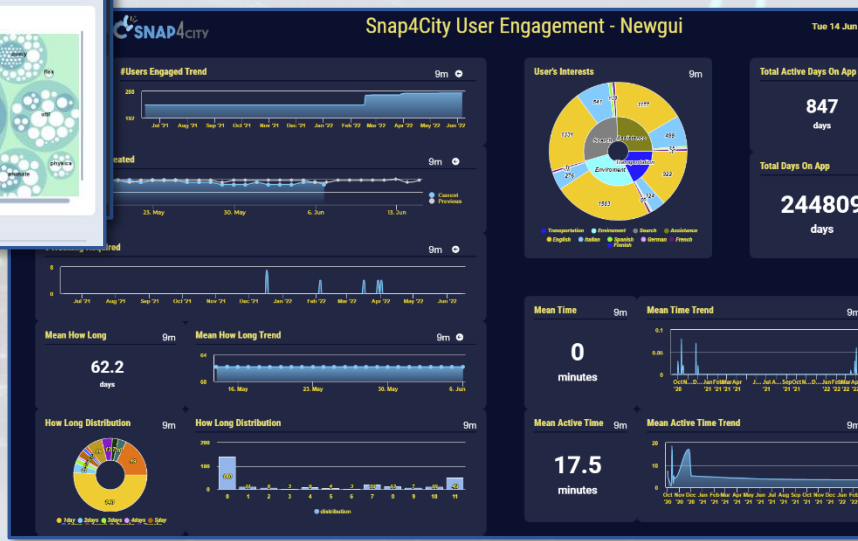
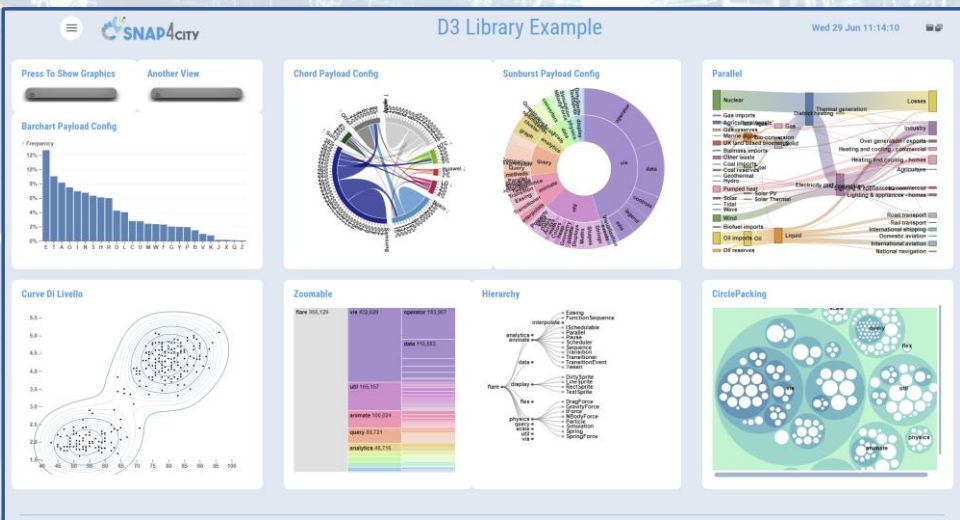
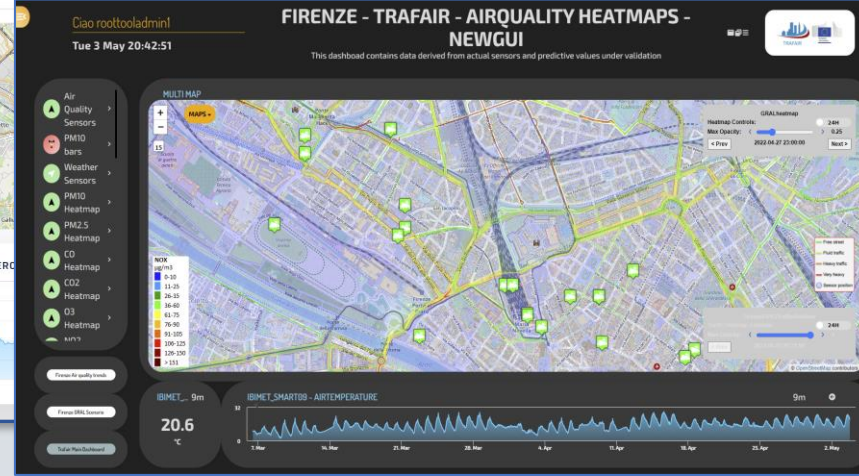
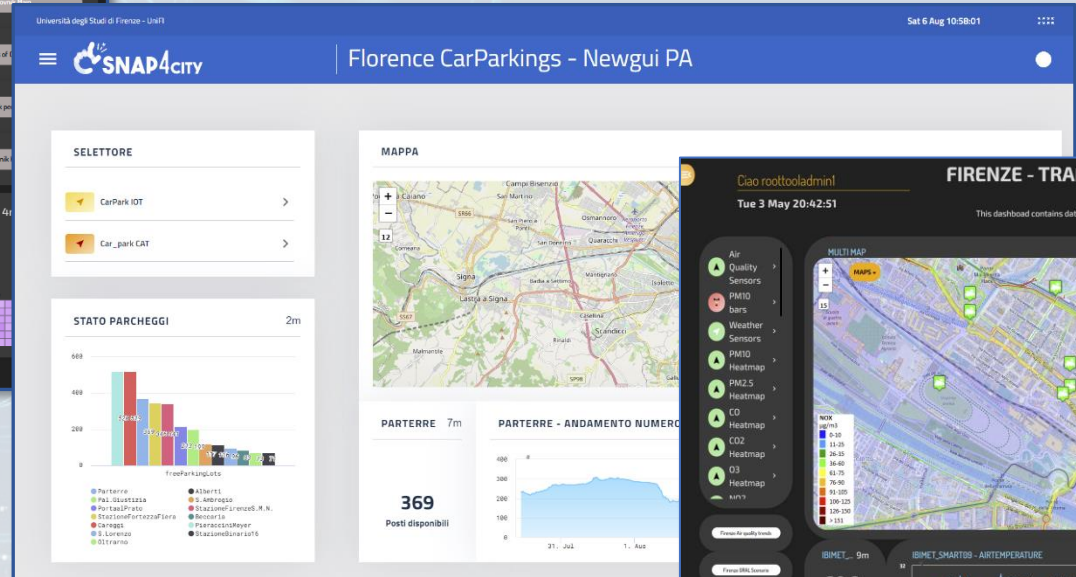
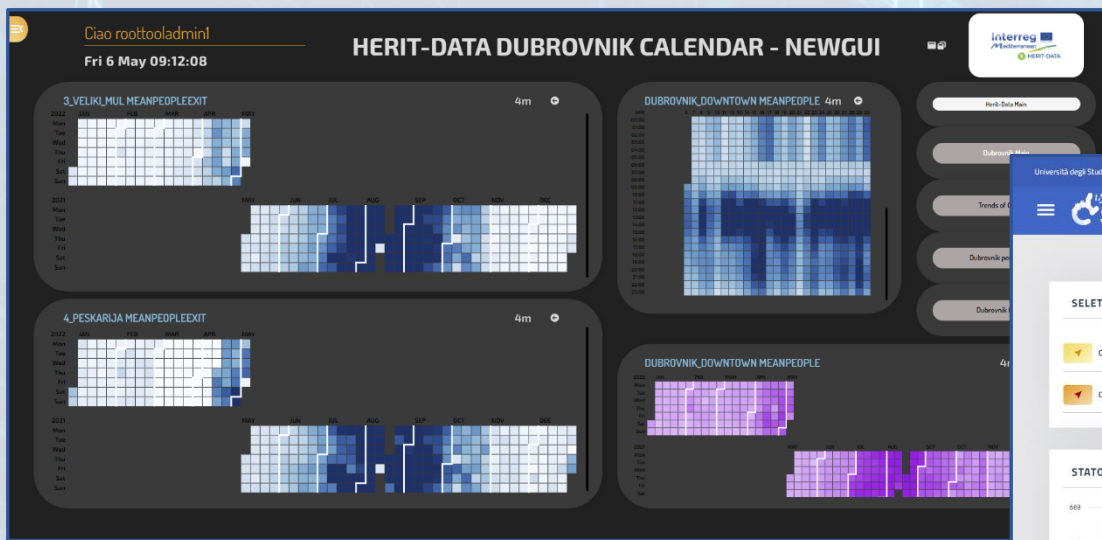
- **Smart Decision Support System** based on System Thinking plus
- Actions to city reaction, resilience, smartness, ...
- Enforcing Mathematical model for propagation of decision confidence..
- Collaborative work, ...
- Processes connected to city data: DB, RDF Store, Twitter, etc.
- Production of alerts/alarms
- Data analytics process
- Twitter Processes
- reuse, copy past, ...



- Supports the definition of the **Decision Tree Model, DTM**, in terms of System Thinking, with Italian Flag and combinations
- Allows the **statistic composition** of subDecisions probabilities
- **Generating a DTM as an IoT App,**
- **IoT Apps with DTM can**
 - be customized
 - compute root values in real time in any context: location, parameters, etc.
 - Single DTM root value can be produced on Dashboard
 - Several DRM root values can be represented on dashboard as heatmaps for Green/White/Red values



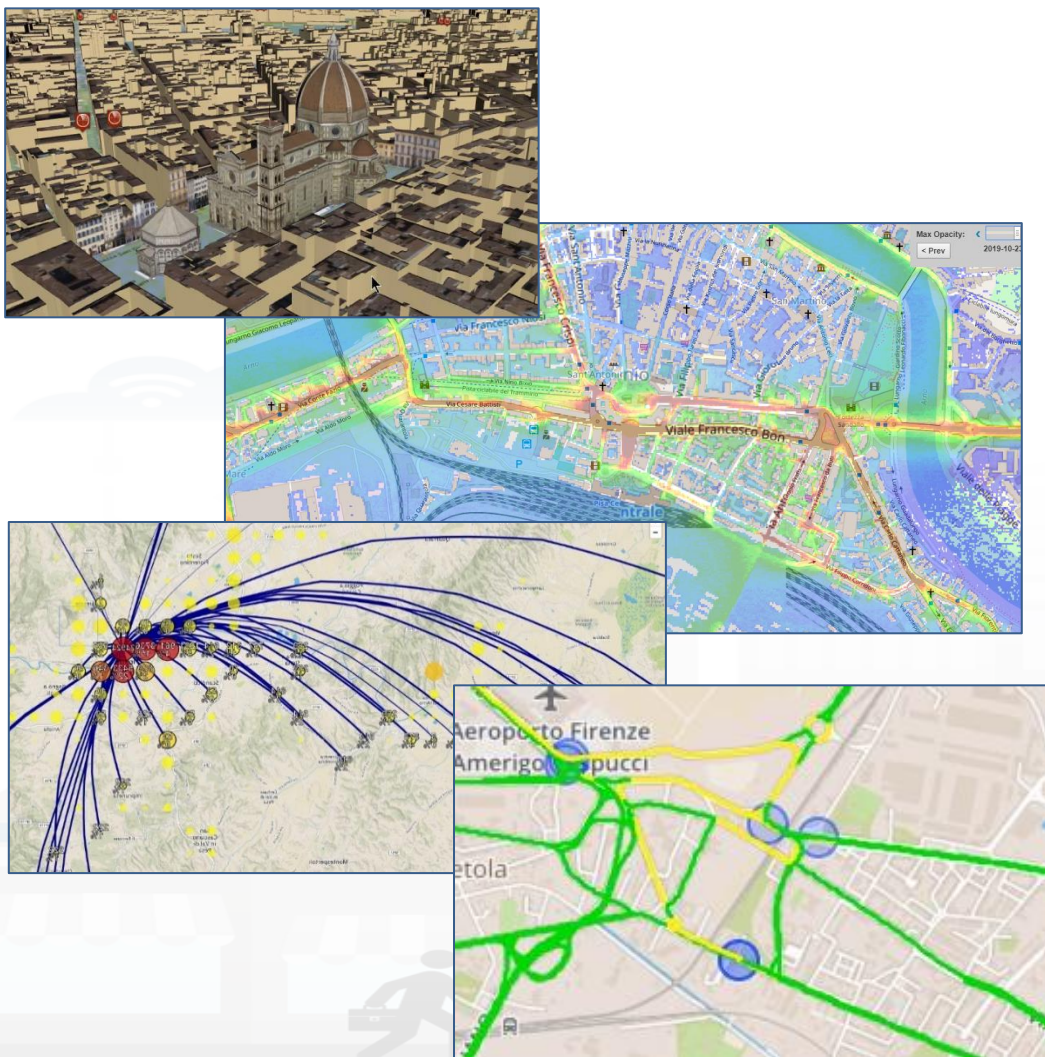
Different Themes



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

<https://www.snap4city.org/793>

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%

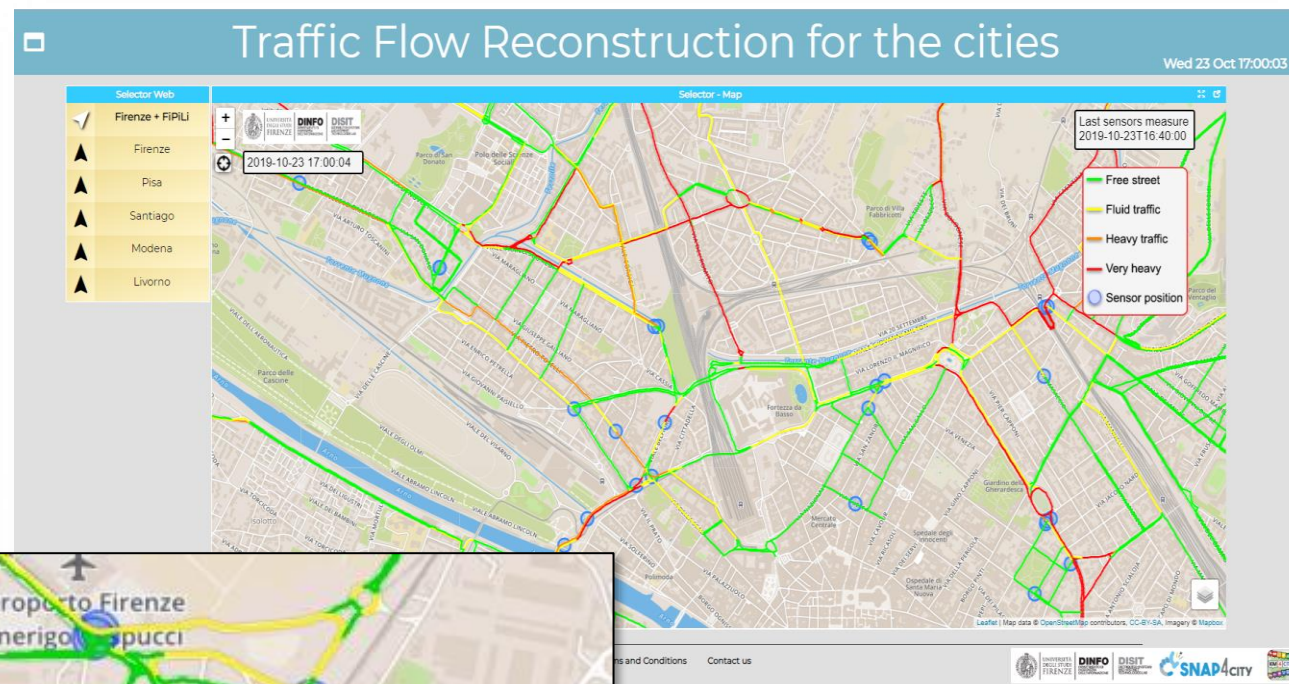


Complex and heterogeneous information, interoperability

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

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?idashboard=MTc5NQ==>



Ciao roottooladmin!

Fri 2 Sep 19:13:07

3D MAP GLOBAL DIGITAL TWIN - NEWGUI



3D MAP

Enable Lights

Datetime: 02/08/2022 10:11

Enable dynamic shadows (experimental)

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

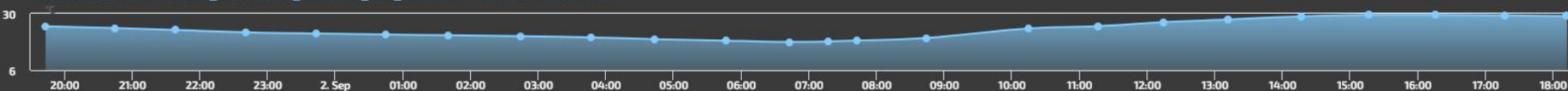
FirenzeFIPILITrafficRealtime

Traffic Heatmap Controls: 24H

Max Opacity: 1

< Prev 2022-09-02 18:56:00

DISIT:ORIONUNIFI:TUSC_WEATHER_SENSOR_OW_3176959 - AIRTEMPERATURE



Ciao

Fri 13 Oct 18:29:18

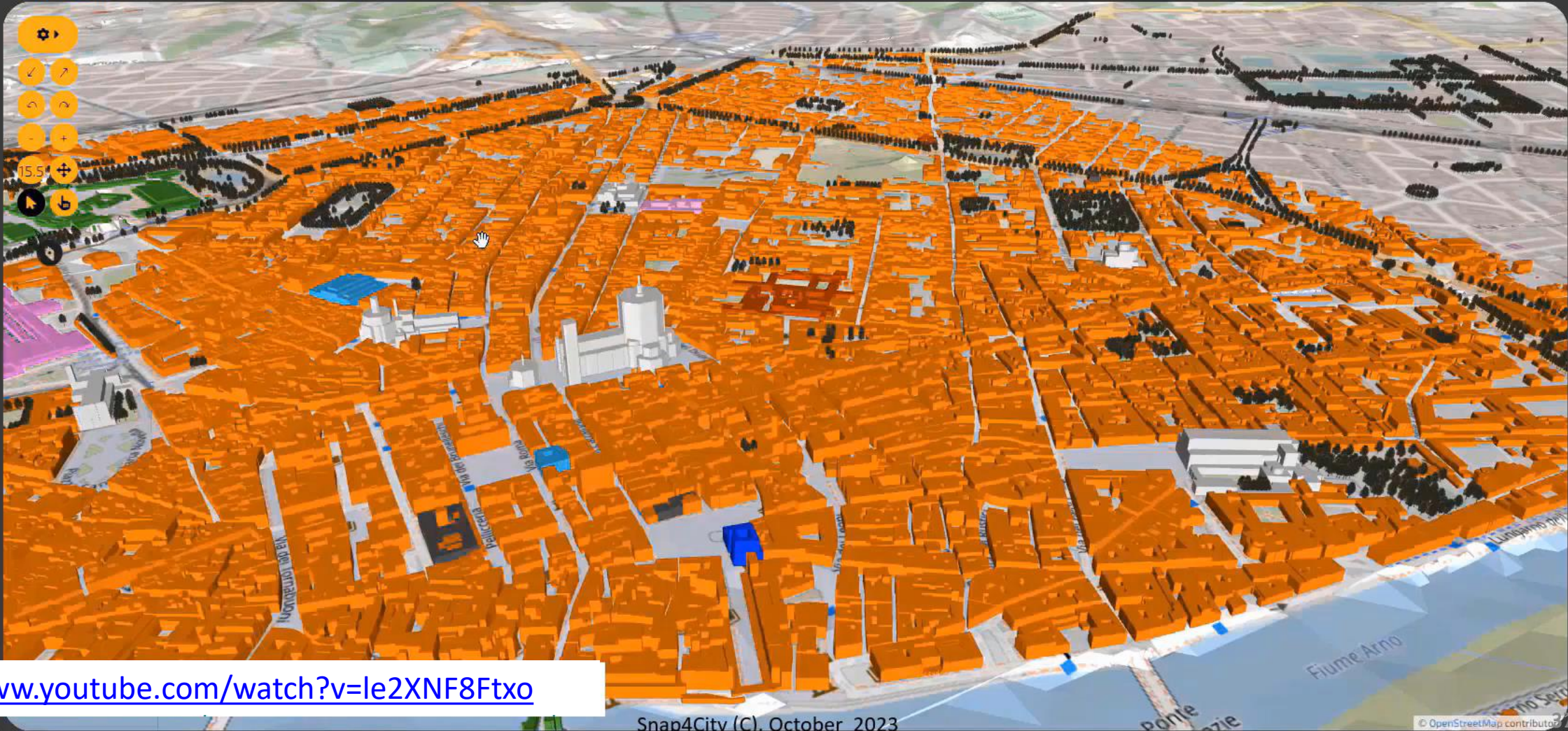
FLORENCE SCDT

SELECT...

- GRAL HD
- NO 2
-
-
-
-
-
- WHAT-IF
-
-

DOUBLE MAP

-
-
-
-
- 15.5
-
-



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



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB

 **SNAP4CITY**



OCULUS



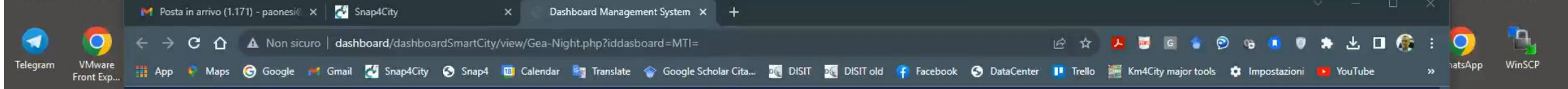


Exploiting Google API with Snap4City engine

- Select any city/locality and see if 3D Representation of your city is Available
- Snap4City re-rendering and distribution engine allows to
 - Optimize distribution of data
 - Integrate any kind of data on Digital Twin with 3D tileds of Google
 - PIN, IoT Data
 - Traffic Flows
 - Cycling paths
 - 3D shapes superimposed
 - Etc.

Snap4City Digital Twin Engine and data + 3D Google Data





Florence Testing

Mon 18 Sep 17:40:57

Selector

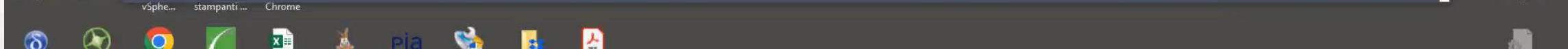
-
-
-
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-
-
-

Double Map

OBS è già in esecuzione

OBS è già in esecuzione! A meno che non si intendeva effettuare questa operazione, chiudere tutte le istanze esistenti di OBS prima di provare a eseguirne una nuova. Se avete OBS impostato per minimizzarsi nell'area di notifica, si prega di controllare per vedere se è ancora in esecuzione.

Avvia comunque Annulla



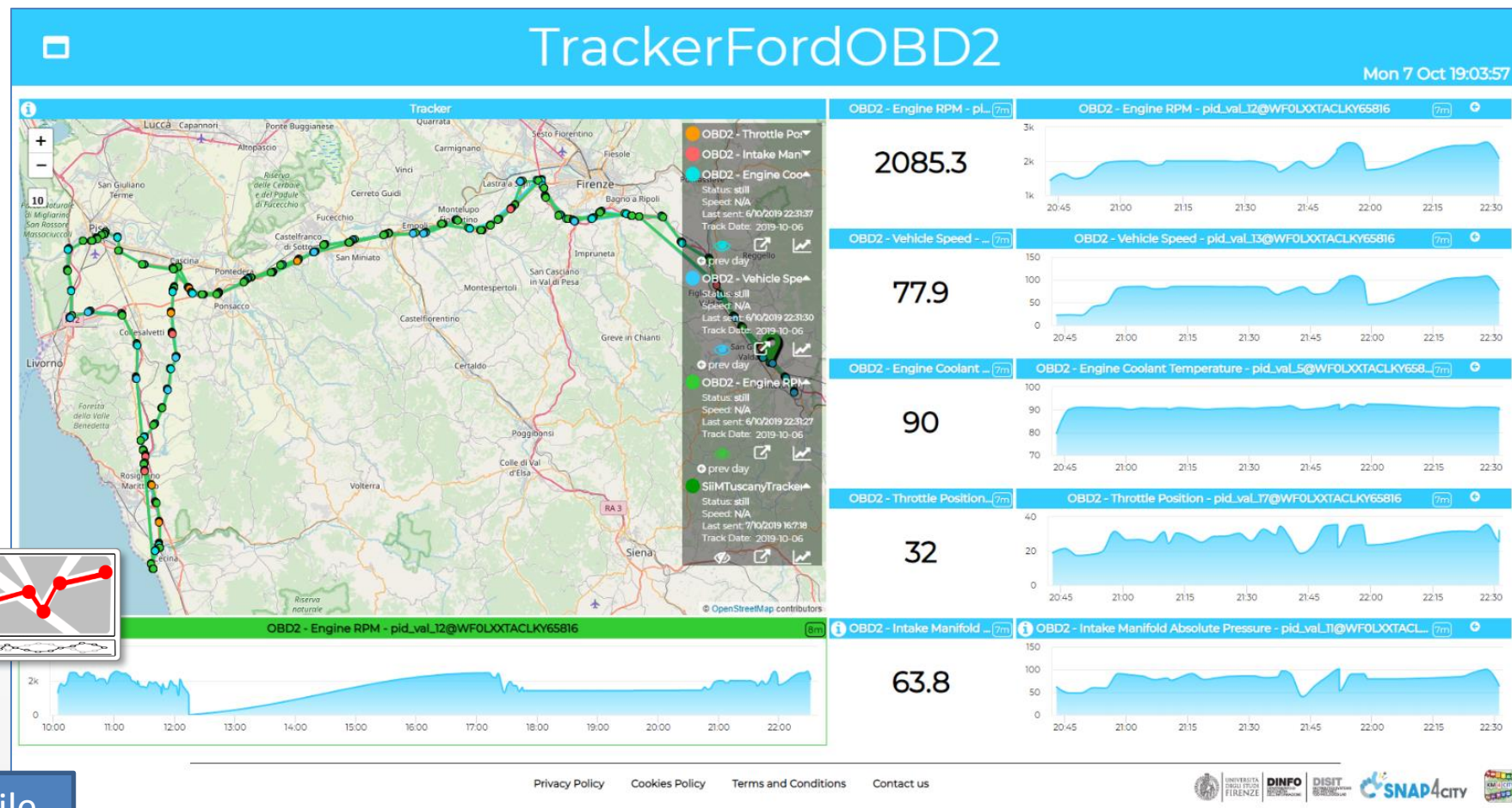
SELECT...

- 100-30
- NO 2
- Bar chart
- Line graph
- Bus
- WHAT-IF
- Car
- Bike



MyKPI: Tracking of Devices and Mobiles

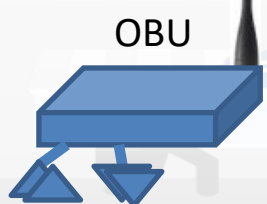
- Real Time Trajectories for
 - Mobile Phone
 - Moving IOT Devices
 - OBU, Vehicular Kits
 - Multiple tracks
 - Day by day
- Micro Application



Mobile
PAX Counter

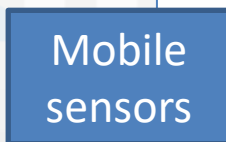


Apps



OBU

OBD2



Mobile
sensors

Custom Dynamic Pins



Custom Pins on Map - test GP

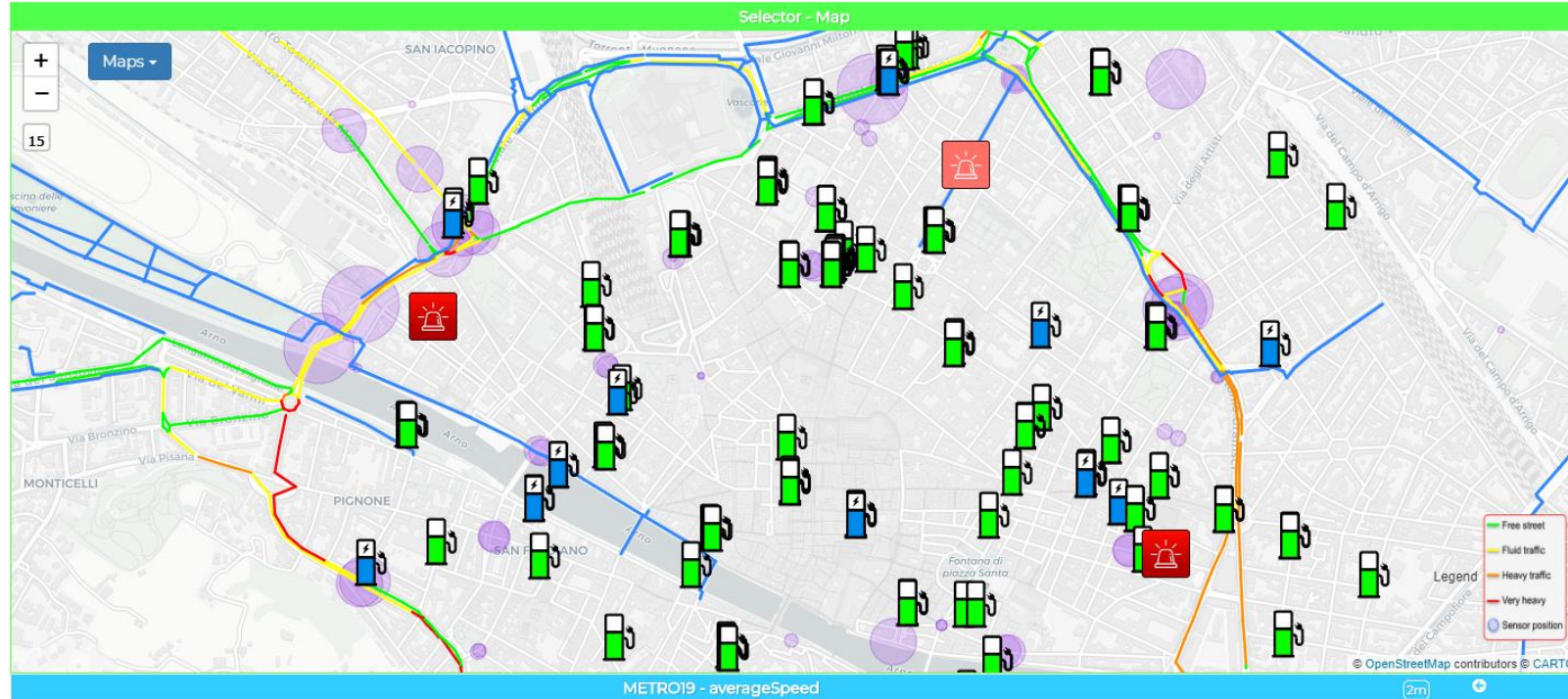
Sat 31 Oct 11:35:41



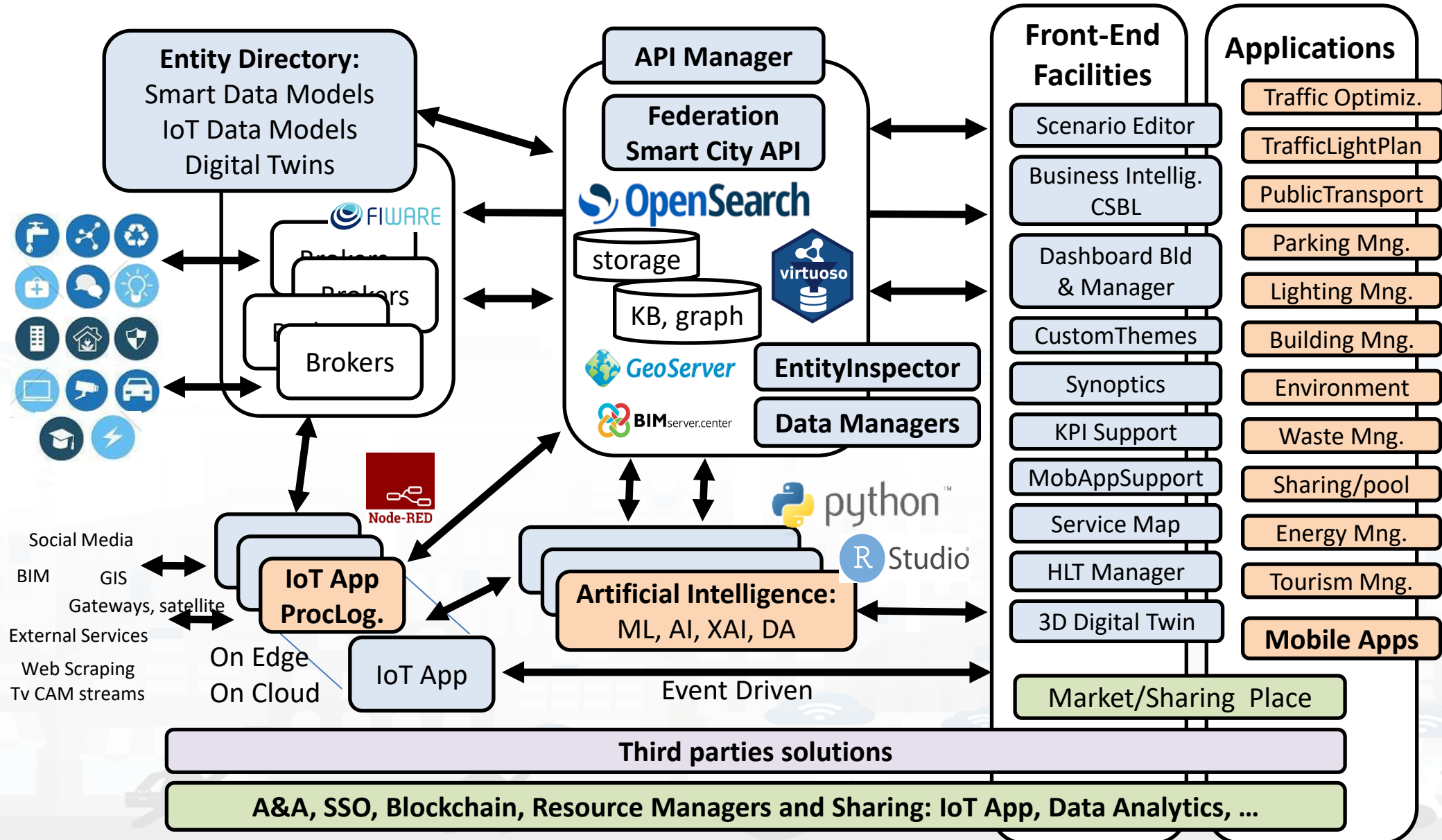
Selector

-
-
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-

METRO19 - avera... (2m)



<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=Mjk5MA==>



Decision Support System: Immediate response and Tactical and Strategic Plans, via **What-if Analysis**

FROM CITY
DASHBOARD TO
APPLICATIONS

FORGING &
MANAGING OPEN
ARCHITECTURE
AND ECOSYSTEMS

IOT APPLICATIONS
AND DEVICES

CAPACITY FOR
MEMBERS

SNAP4CITY
ARCHITECTURE AND
ECOSYSTEM, OPENED
TO DEVELOPERS
AND STAKEHOLDERS

TWITTER
VIGILANCE SOCIAL
MEDIA ANALYSIS

SNAP4CITY
AND KM4CITY
PROJECTS



Immedant Response

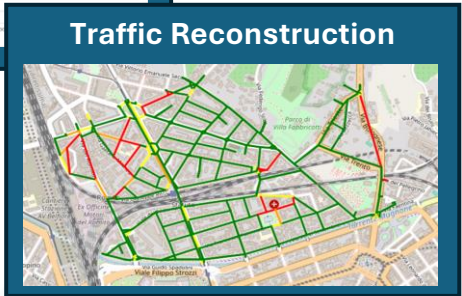
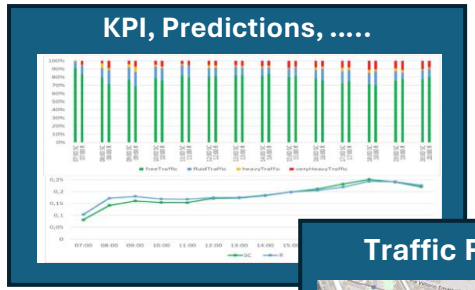
Immediant Response and Tactical & S Strategiv Planning

NAP4CITY THE
VIEW OF THE
ADMINISTRATORS

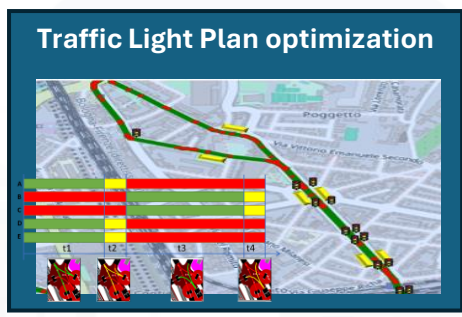




Monitoring

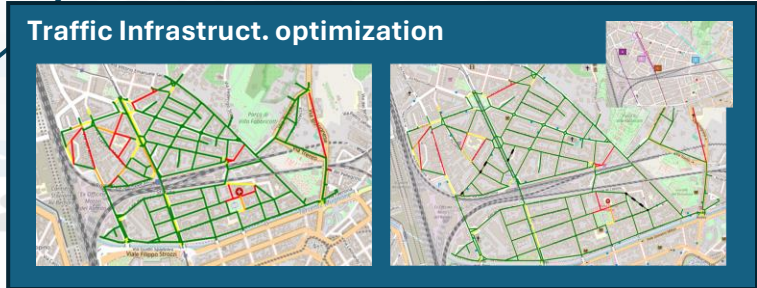


Predictions,
Anomaly Detection,
Analysis, Assessment
Warning



Digital Twin
Models &
Data

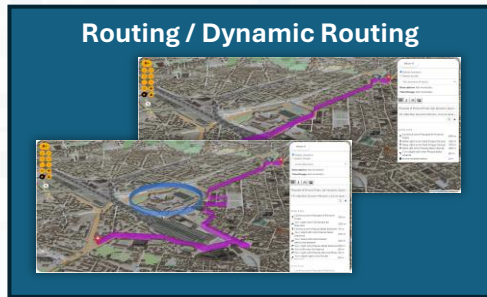
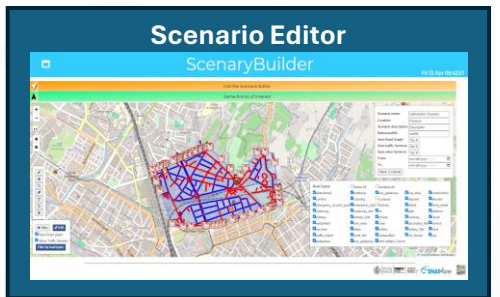
Simulations,
TFR, Crossroad,
Public Transport,
Routing, ..



Decision
Support System

Scenarios

What-If Analysis,
Optimization



Select map

Zoom

The interface includes a central map area with various road segments represented by colored lines and arrows. On the left, there are zoom controls (+, -, 20) and a home button. Below the map, there are editing tools (edit, add, delete, copy, paste) and a 'View/Edit' toggle. A 'Filter by road types' button is also present. On the right, there are two configuration panels: 'Edit Road Segment' and 'Category Street'. The 'Edit Road Segment' panel includes fields for Scenario name, Location, Scenario description, Reference KB, and checkboxes for Save Road Graph, Save traffic Sensors, and Save other Sensors. It also has 'From' and 'To' date pickers and 'Save', 'Show Summary', and 'Cancel' buttons. The 'Category Street' panel includes a dropdown for Category Street (set to 'primary'), a text input for Nr. Lanes (set to '3'), a dropdown for Direction (set to 'Positive direction'), a dropdown for Restrictions (set to 'Select or create restriction'), and an 'Update' button. At the bottom center, there is a 'Road Types' panel with a grid of checkboxes for various road categories like 'abandoned', 'bridleway', 'bus_guideway', etc. At the bottom right, there is a list of 'Properties of Road Elements'.

Edit Road Segment

New Scenario

Editing

Drag & drop

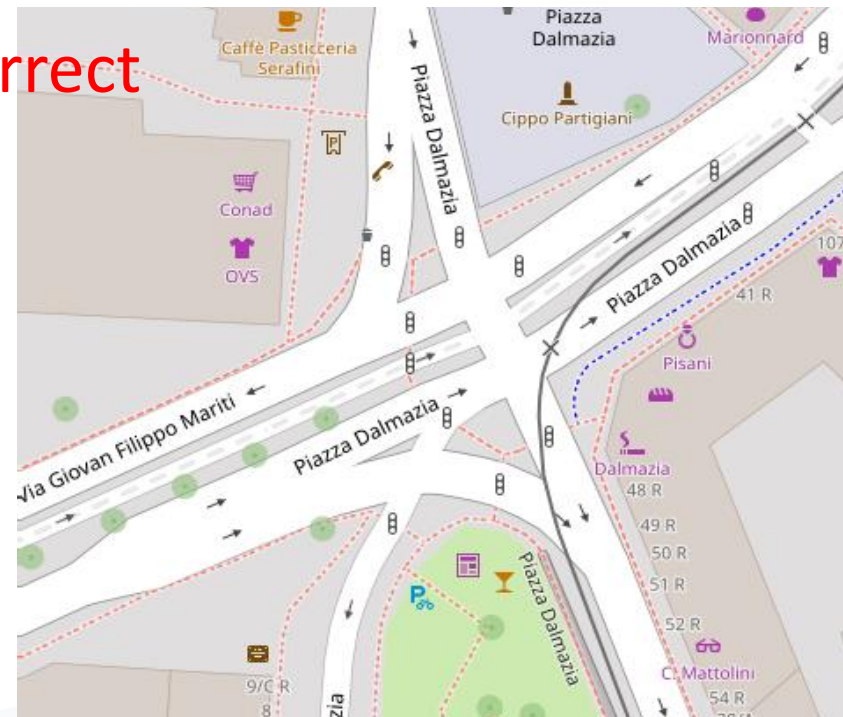
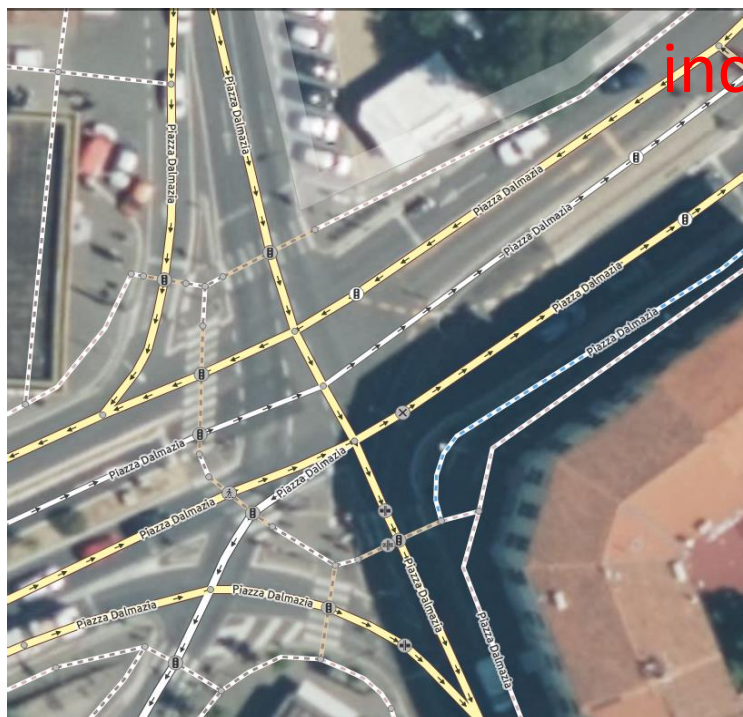
Split & Join

Delete

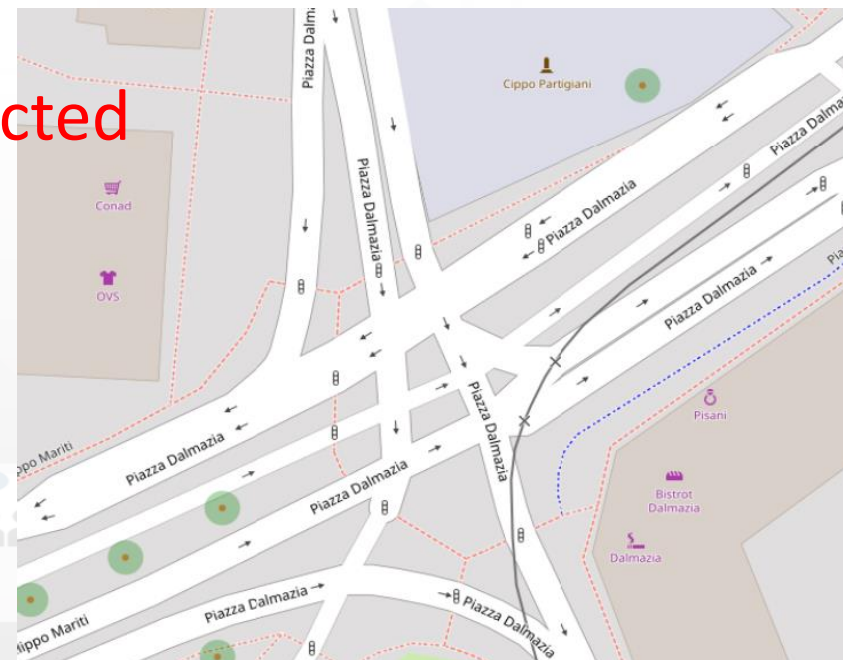
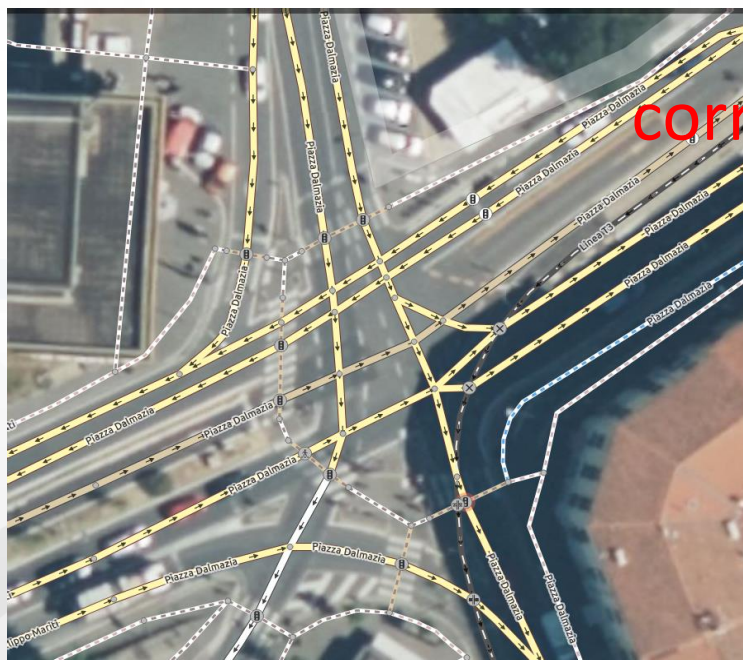
Do and Undo

identifier
composition
elemLocation
elementClass
elementType
length
operatingStatus
speedLimit
trafficDir
width
highwayType
route

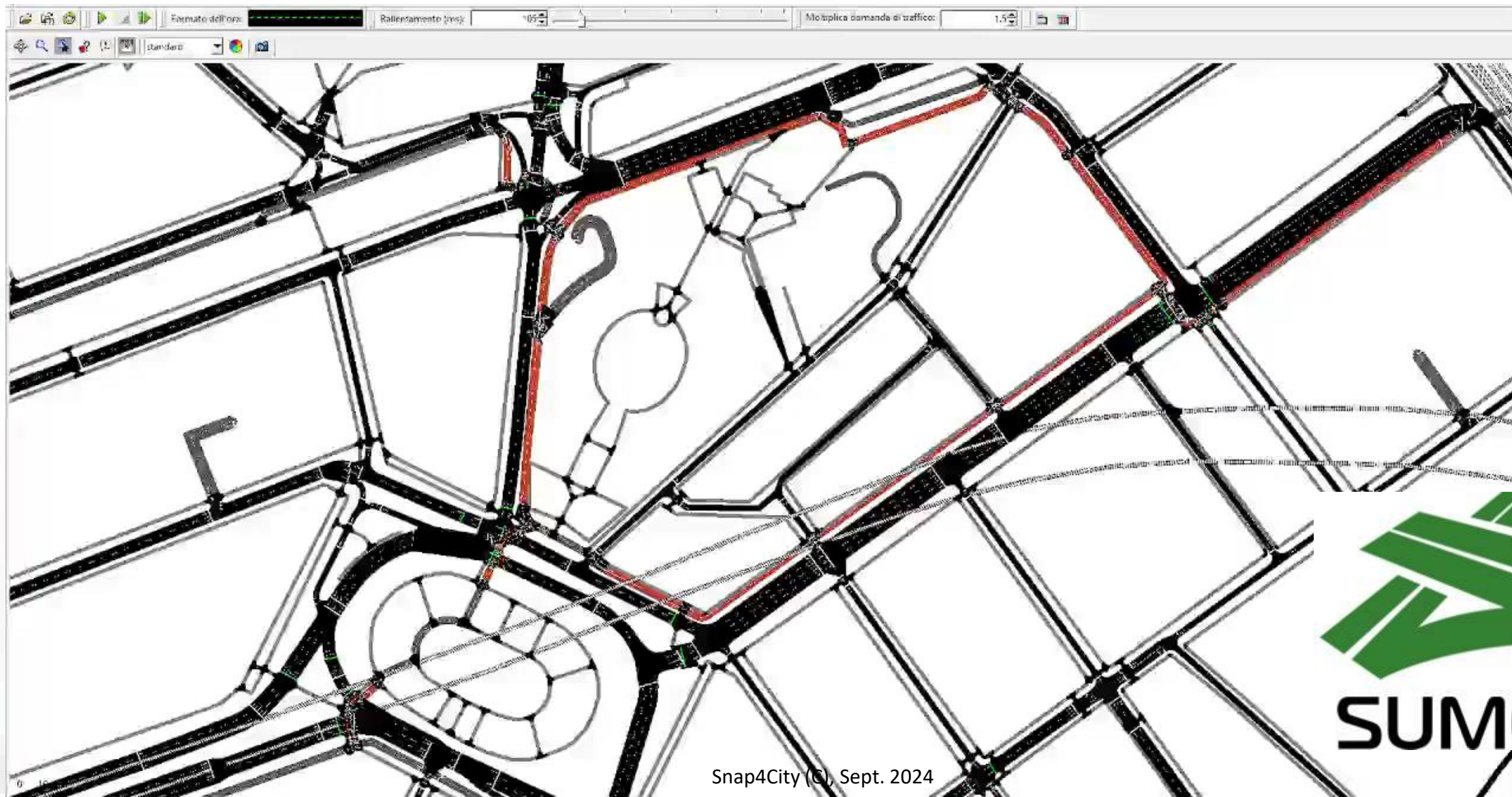
OSM data with non
correct viability in Piazza
Dalmazia, Firenze



After Correction of OSM
data defining a correct
viability of Piazza Dalmazia,
Florence. Regeneration of
the TILES for the maps



Micro Simulation



Decision Support Systems, What-if

○ Event planning, via what-if analysis

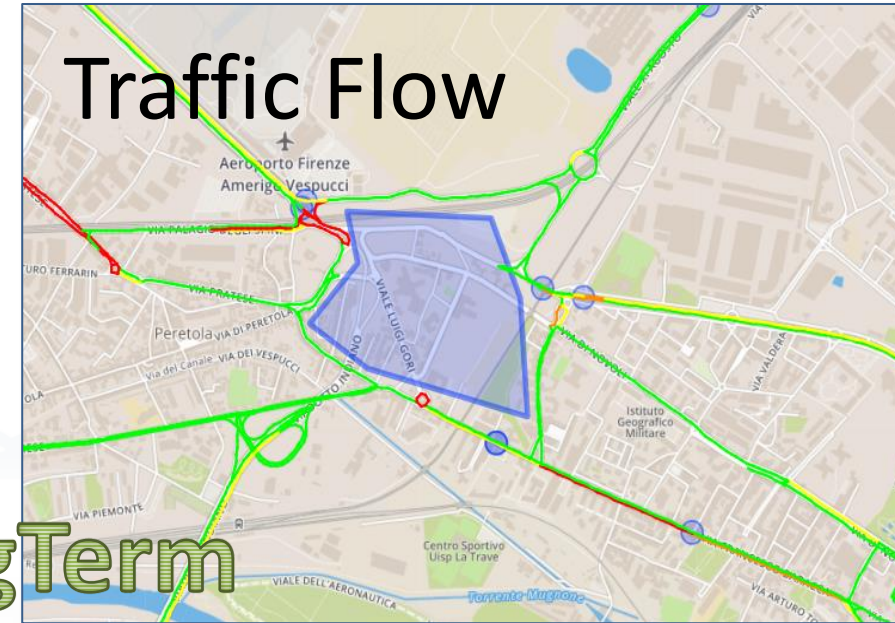
- Change in the graph structure of the city
- Impact on the flow of people and vehicles
- Adaptation: public transport, traffic, pedestrian management, etc.

○ 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

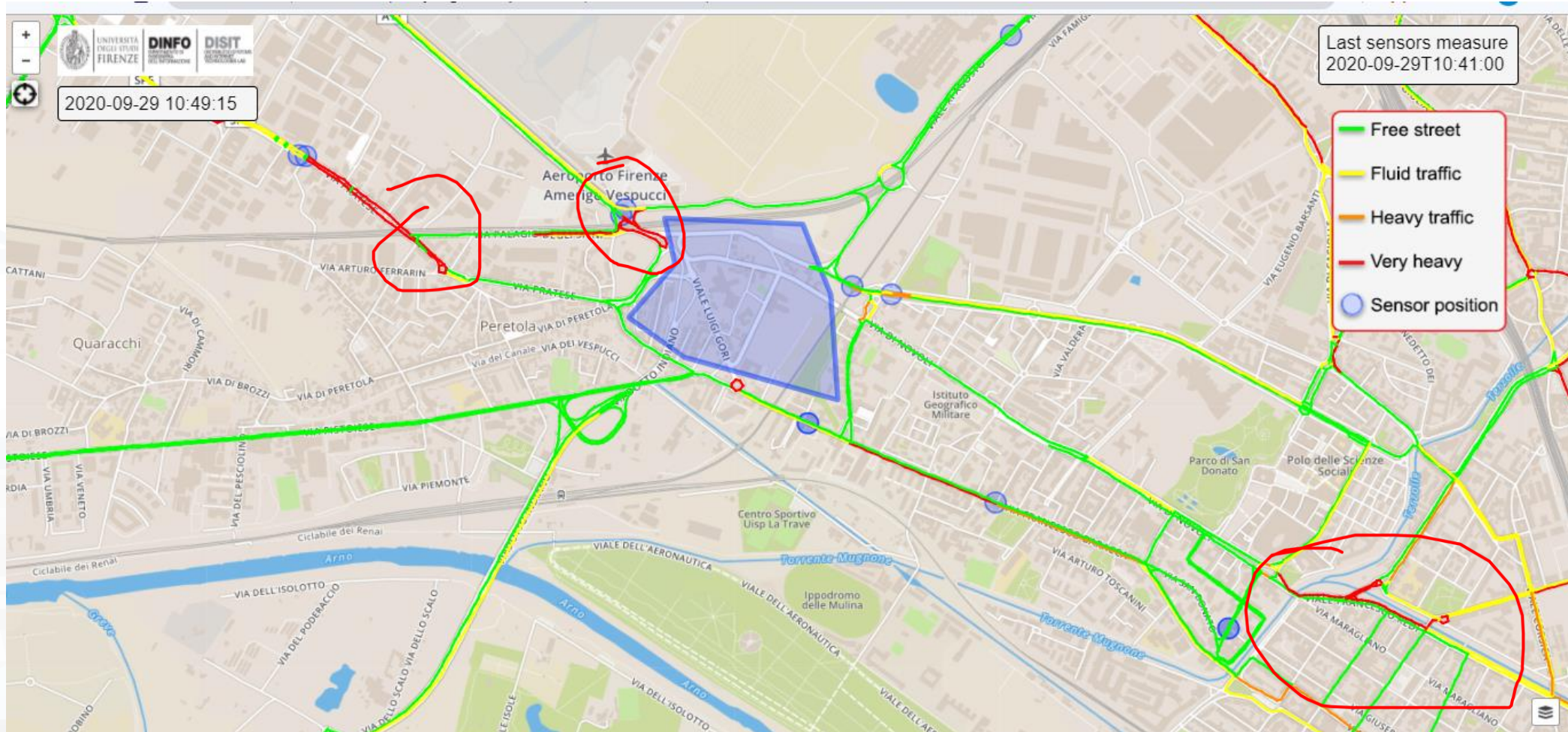


LongTerm



ShortTerm

Computation of Traffic Flow Evolution, cascade effects



Ciao roottooladmin!

Wed 14 Feb 22:40:02

FIRENZE - TRAFAIR - AIRQUALITY HEATMAPS - NEWGUI

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



- U3 Heatmap
- NO2 Heatmap
- Europ. AQI Heatmap
- Air Humidity Heatmap
- Air Temp. Heatmap
- Wind Speed Heatmap
- Gral Pred. HM NOX (3m)
- Gral Pred. HM NOX (6m)
- Traffic Sensors
- Traffic Flow

MULTI MAP

MAPS

View Edit

Show Road graph

Show Traffic Sensors

Scenario name:

Location:

Scenario description:

ReferenceKB:

Save Road Graph:

Save traffic Sensors:

Save other Sensors:

From:

To:

Free street

Fluid traffic

Heavy traffic

Very heavy

Sensor position

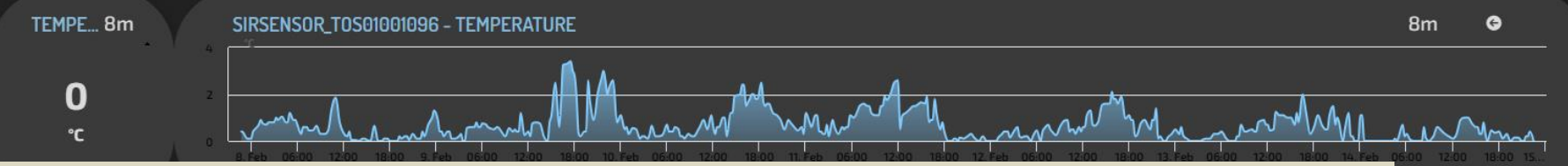
FirenzeFIPILITrafficRealtime

Traffic Heatmap Controls: 24H

Max Opacity:

2024-02-08 23:00:00

- Firenze Air quality trends
- Firenze GRAL Scenario
- TraFair Main Dashboard



<https://www.snap4city.org/dashboardSmartCity/view/Baloon-Dark.php?iddashboard=MzQyMw==>

Road Types:

<input type="checkbox"/> Select All	<input type="checkbox"/> Unselect All
<input checked="" type="checkbox"/> abandoned	<input checked="" type="checkbox"/> bridleway
<input checked="" type="checkbox"/> corridor	<input checked="" type="checkbox"/> crossing
<input checked="" type="checkbox"/> emergency_access_point	<input checked="" type="checkbox"/> emergency_bay
<input checked="" type="checkbox"/> motorway	<input checked="" type="checkbox"/> motorway_link
<input checked="" type="checkbox"/> primary	<input checked="" type="checkbox"/> primary_link
<input checked="" type="checkbox"/> residential	<input checked="" type="checkbox"/> rest_area
<input checked="" type="checkbox"/> services	<input checked="" type="checkbox"/> steps
<input checked="" type="checkbox"/> traffic_island	<input checked="" type="checkbox"/> tram
<input checked="" type="checkbox"/> secondary	<input checked="" type="checkbox"/> yes
<input checked="" type="checkbox"/> bus_guideway	<input checked="" type="checkbox"/> bus_stop
<input checked="" type="checkbox"/> construction	<input checked="" type="checkbox"/> disused
<input checked="" type="checkbox"/> elevator	<input checked="" type="checkbox"/> island
<input checked="" type="checkbox"/> living_street	<input checked="" type="checkbox"/> platform
<input checked="" type="checkbox"/> no	<input checked="" type="checkbox"/> path
<input checked="" type="checkbox"/> private	<input checked="" type="checkbox"/> raceway
<input checked="" type="checkbox"/> road	<input checked="" type="checkbox"/> raised
<input checked="" type="checkbox"/> tertiary	<input checked="" type="checkbox"/> secondary_link
<input checked="" type="checkbox"/> trunk_link	<input checked="" type="checkbox"/> tertiary_link
<input checked="" type="checkbox"/> unclassified	<input checked="" type="checkbox"/> track
<input checked="" type="checkbox"/> via_ferrata	<input checked="" type="checkbox"/> via_ferrata
<input checked="" type="checkbox"/> bus_guideway	<input checked="" type="checkbox"/> ohm.military.Trench

Category Street: primary

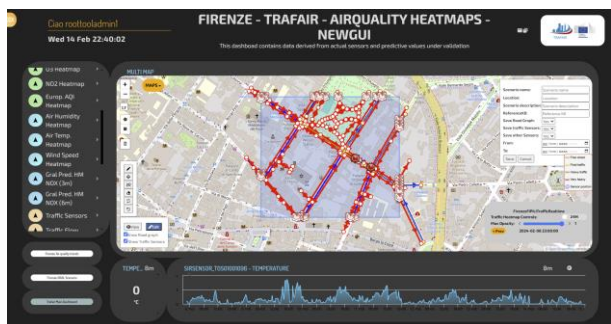
Nr.Lanes: 3

Speed Limit (km/h):

Direction: Positive direction

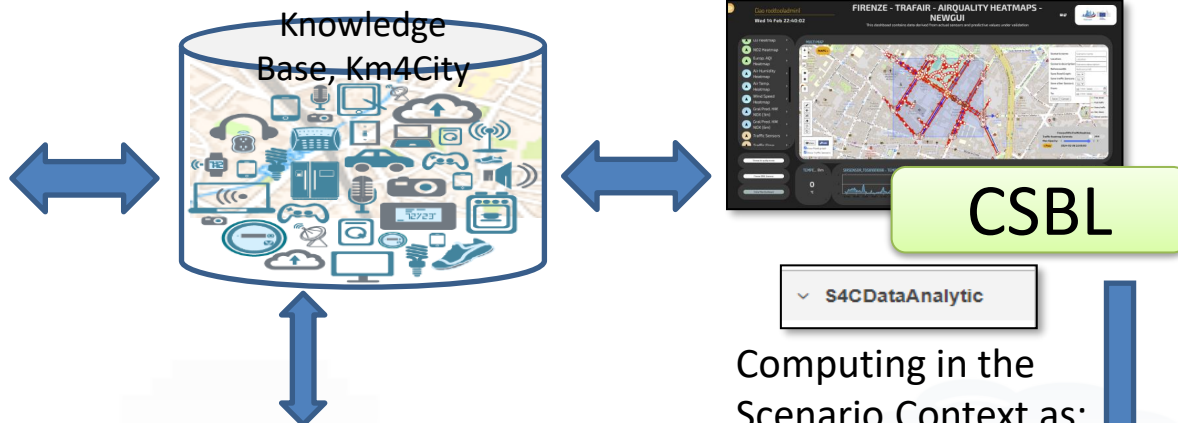
Restrictions: Select or create restriction

The actual Scenario Exploitation



Defining Context via Editing Scenario:

- Select area and data
- Editing roads, POI, IoT entities, ..
- Save/load, share
- Change status

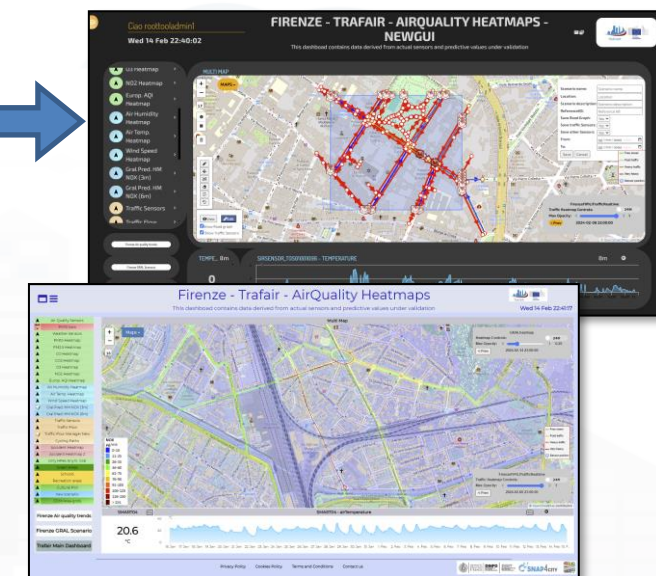


A Scenario includes:

- Metadata as Entity/Device
 - Status and versions, date time
 - Period of validity
 - Big data:
 - Road graphs, cycling, pedestrian seg.
 - List of data, sensors
 - Etc.
- KPI, Metrics, SUMI, SUMP, 15MinCity Index
 - Heatmaps
 - OD Matrices
 - Traffic Flow reconstructions
 - Predictions
 - Routing, constrained routing
 - Early Warnings
 - Etc.

ReLoading Scenario in JavaScript

- Evolve Scenarios
- Use Scenario to context the Data Analytics: R Studio, Python for computing



What-if on TFR

Traffic Flow Analysis By Scenario

Mon 23 Sep 12:53:12

- ▶ Scenario Editor
- ▶ Some Points of Interest
- ▶ Traffic Sensors
- ▶ Air Quality Sensors
- ▶ Weather Sensors (OW)
- ▶ Bus Stops
- ▶ Tram Stops

INIT to ACC

Compute TFRS

Compute KPI

Show TFR

Data Update

enrico909 2024-09-23 12:06:03 (tfr)

2024-09-23T15:00:00+02:00

Calculate KPI

KPI	Value
Total CO2 emissions [ug/m^3]	13,979.071
Total fuel consumed [l]	0.249
Traffic state objective function [#]	3.935
number of vehicles [#]	51.394
total kilometers [km]	3.886
total travel time [s]	314.575

DISIT:OrionUNIFI:METRO1098 - VehicleFlow 8m

Time Series 3m

My Profile

What-if on TFR

Elaborati, stage e tesi al DISIT | Snap4City | Dashboard Management System | Posta in arrivo (1.746) - paone

snap4city.org/dashboardSmartCity/view/Gea-Night.php?iddashboard=NDI1MQ==

Apps | Maps | Google | Gmail | Snap4City | YouTube | Calendar | Snap4 | Translate | Google Scholar Cita... | ChatGPT | DISIT | DISIT old | Facebook | DataCenter | Vc7 | Km4City major tools | Trello | Google Forms | News | All Bookmarks

Traffic Flow Analysis By Scenario

Mon 16 Sep 18:30:19

Selector - Map

TABS

INIT to ACC | Compute TFRS | Compute KPI | Show TFR

Data Update0

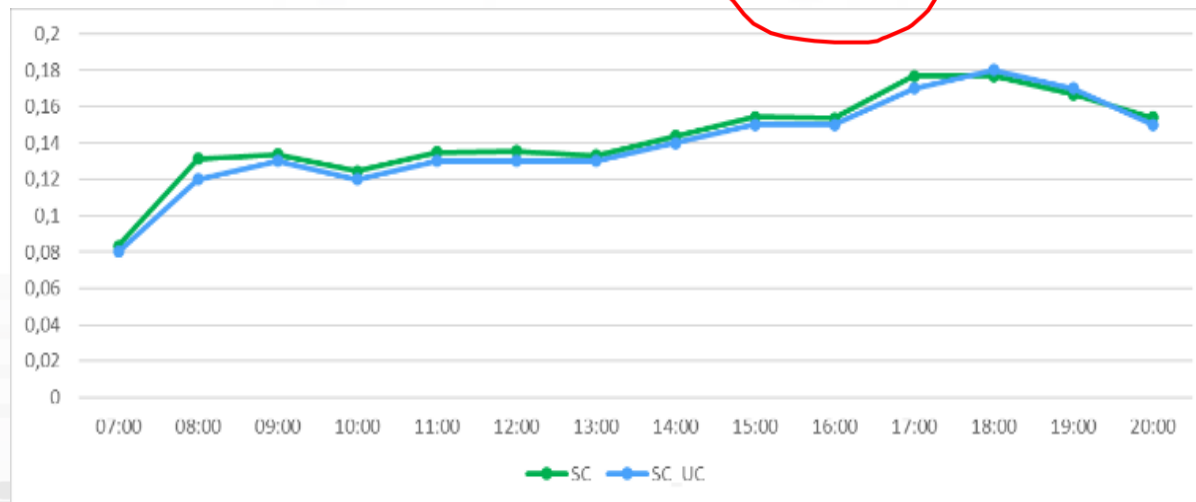
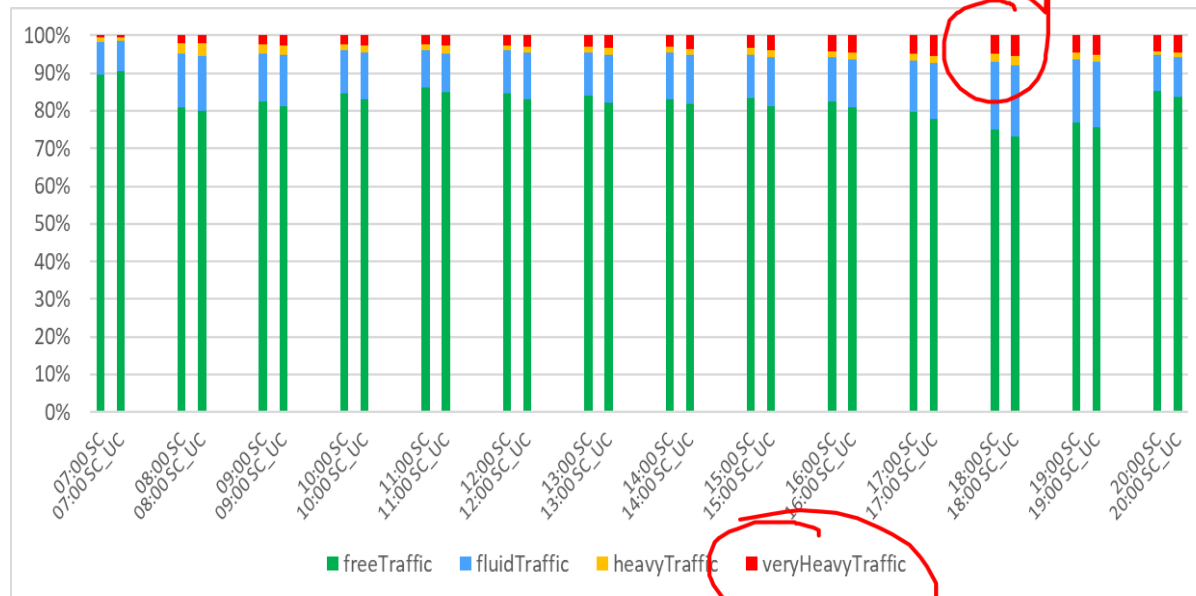
Select a Scenario

Scenario Version

Execution

What-if

	analysis results of $SC_{i,T}$	Actual Traffic Flow results of R_{T1}
09:00		
15:00		

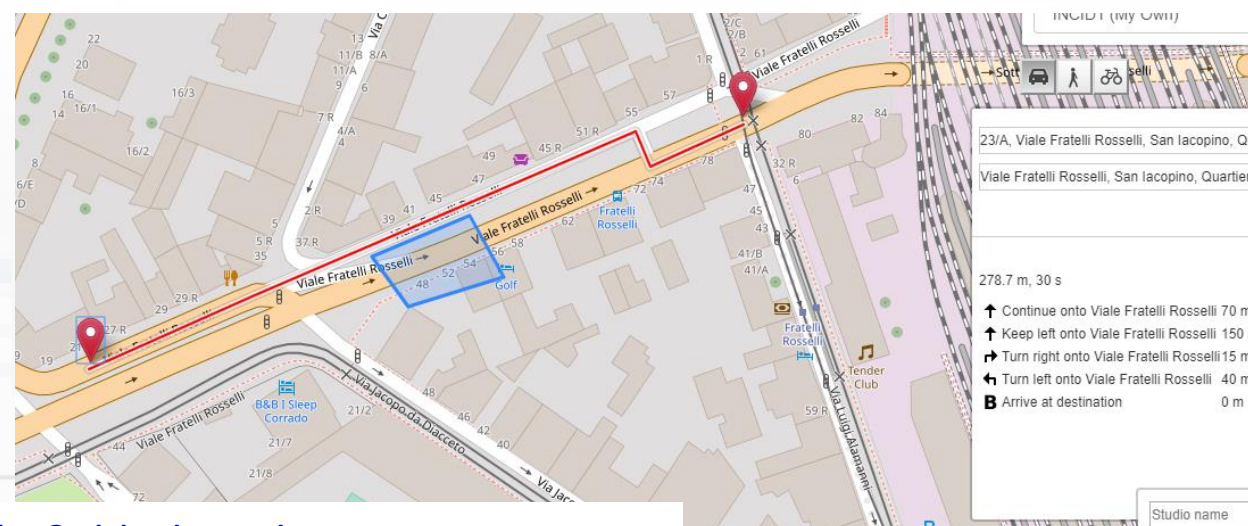
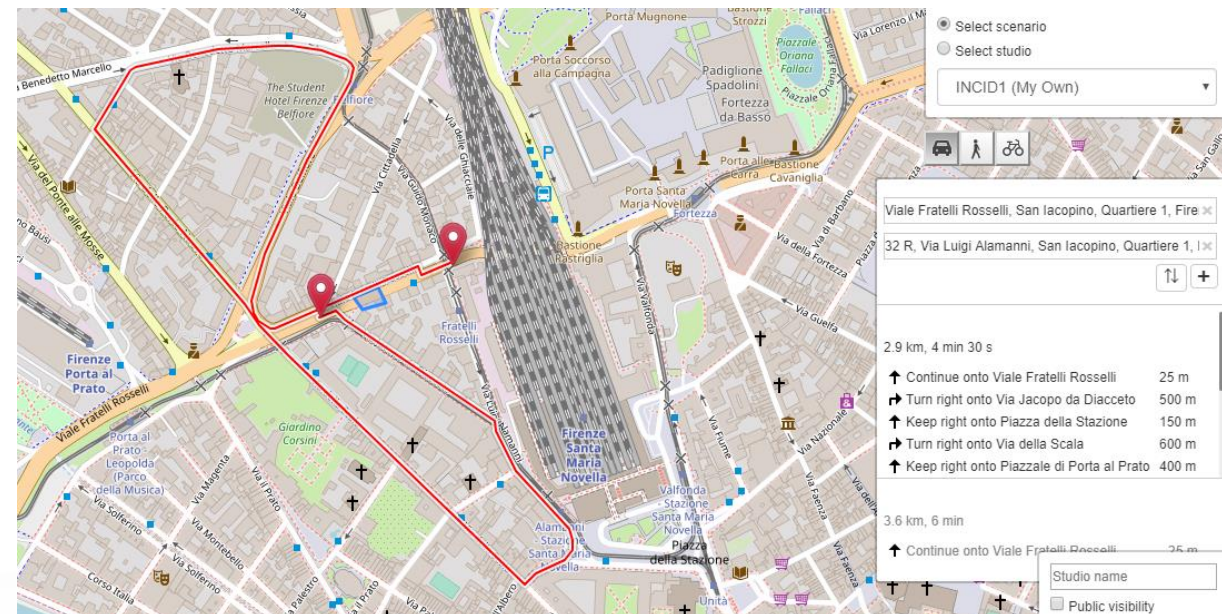


Accidents and elements blocking Points and Shapes taken into account for:

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

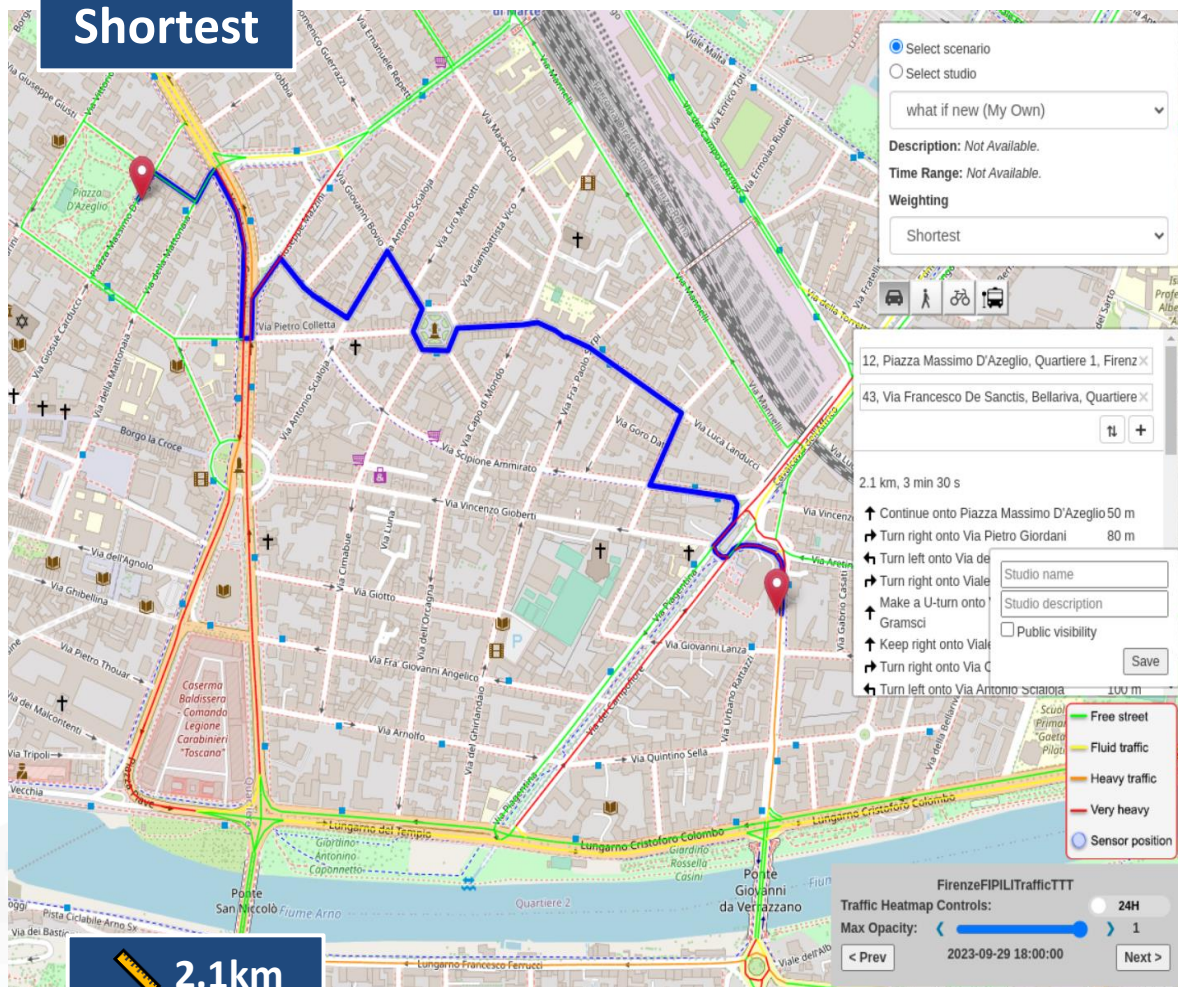
Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment

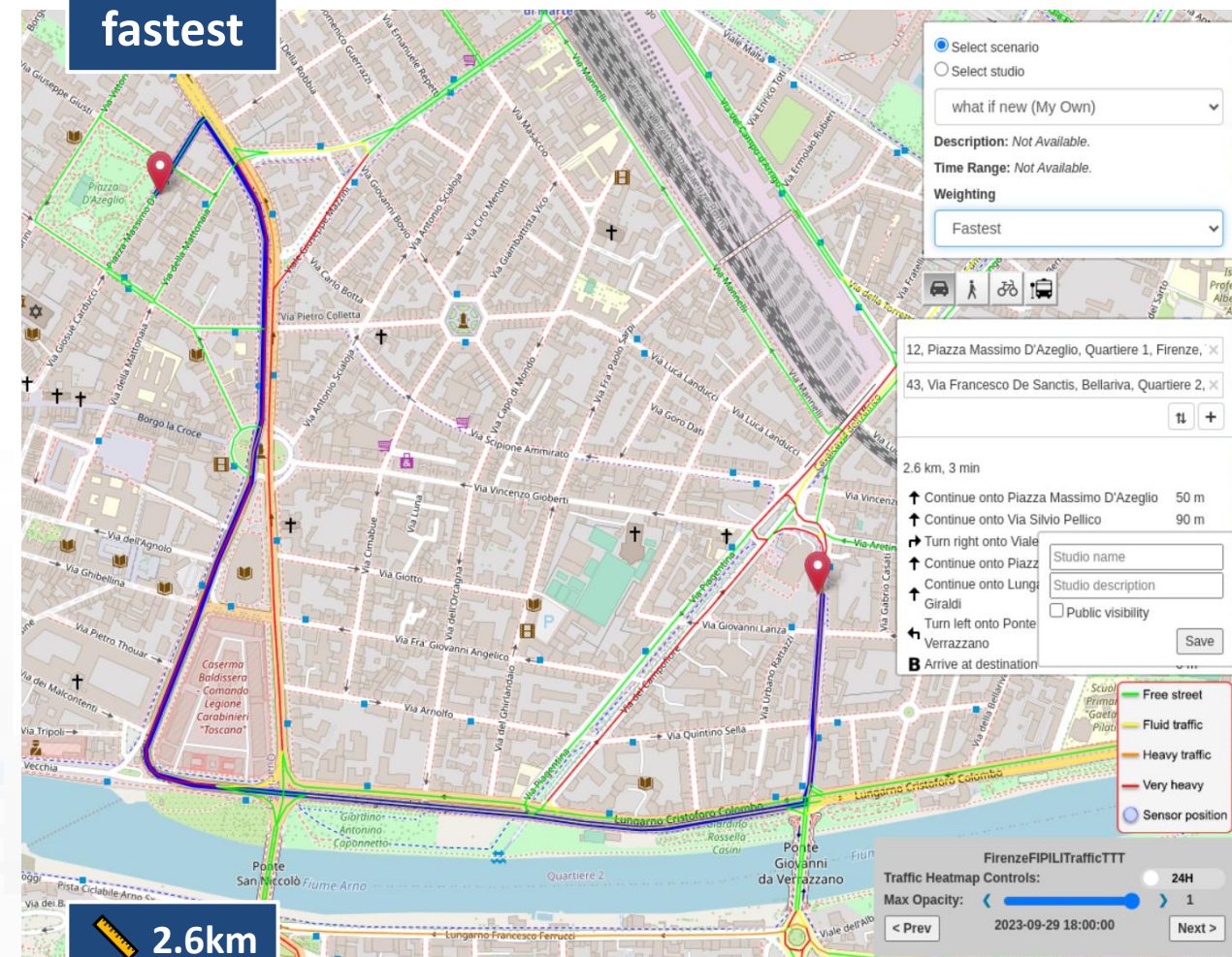


Constrained Dynamic Routing: Traffic Flow

Shortest



fastest



2.1km

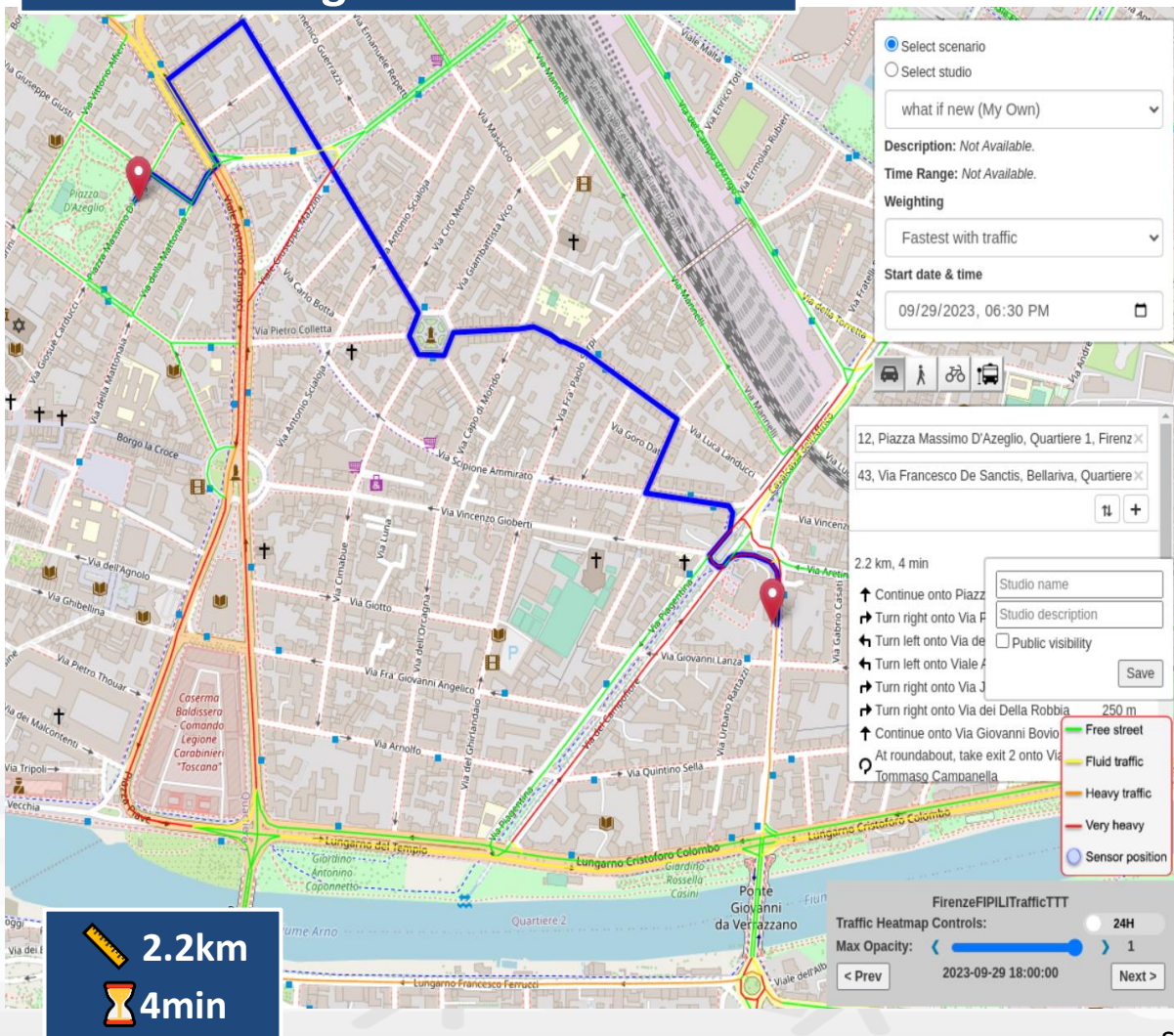
3min 30s

2.6km

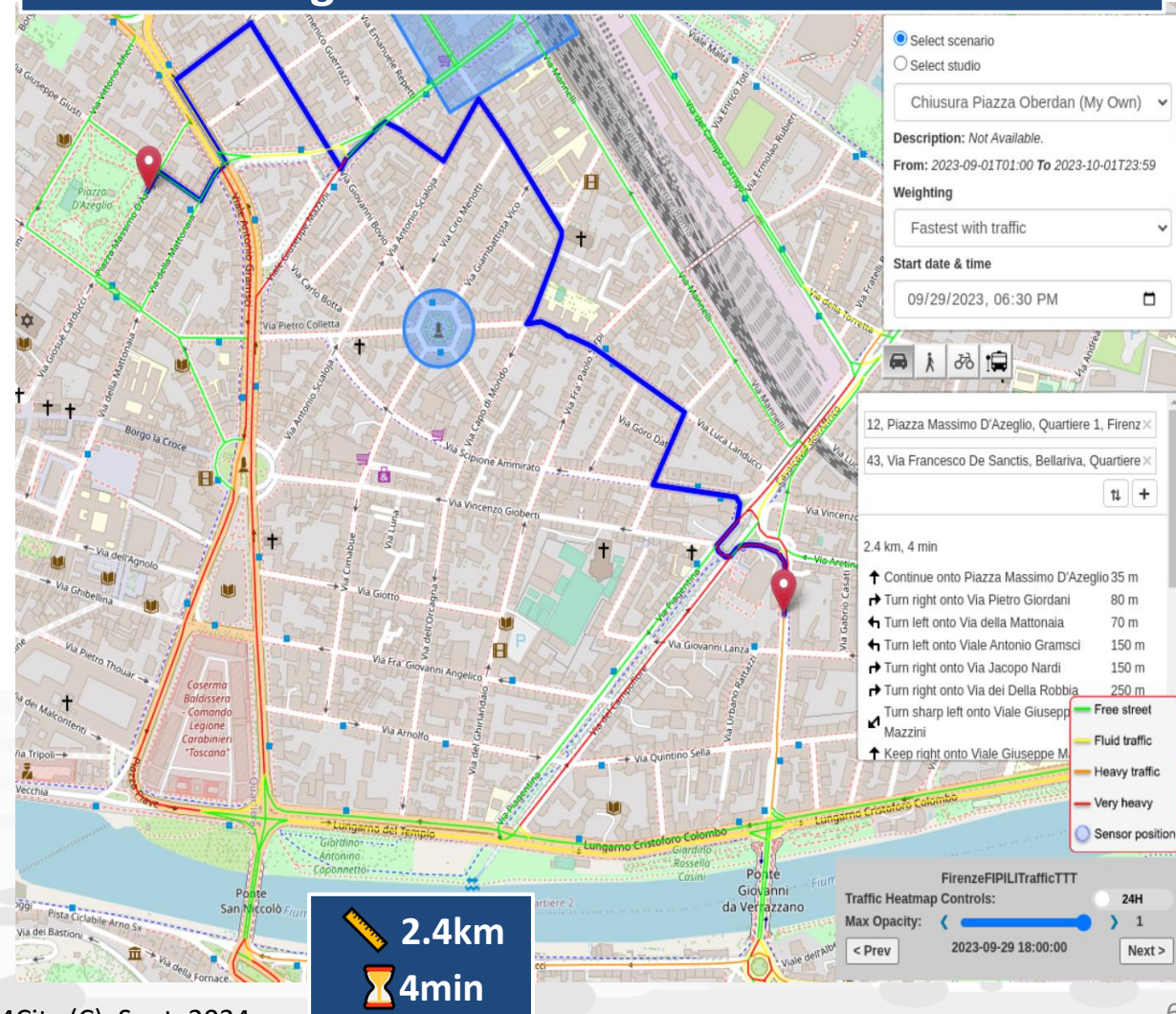
3min

Constrained Dynamic Routing: Traffic Flow

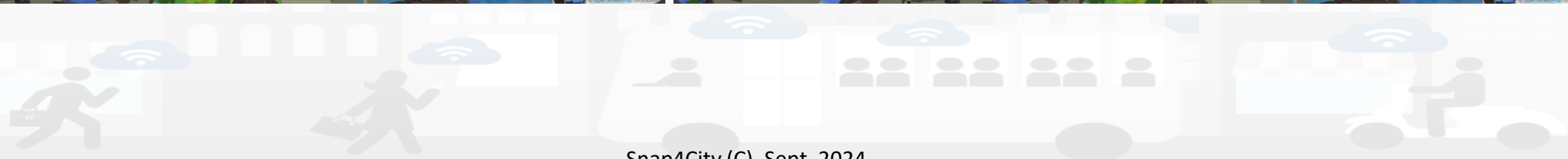
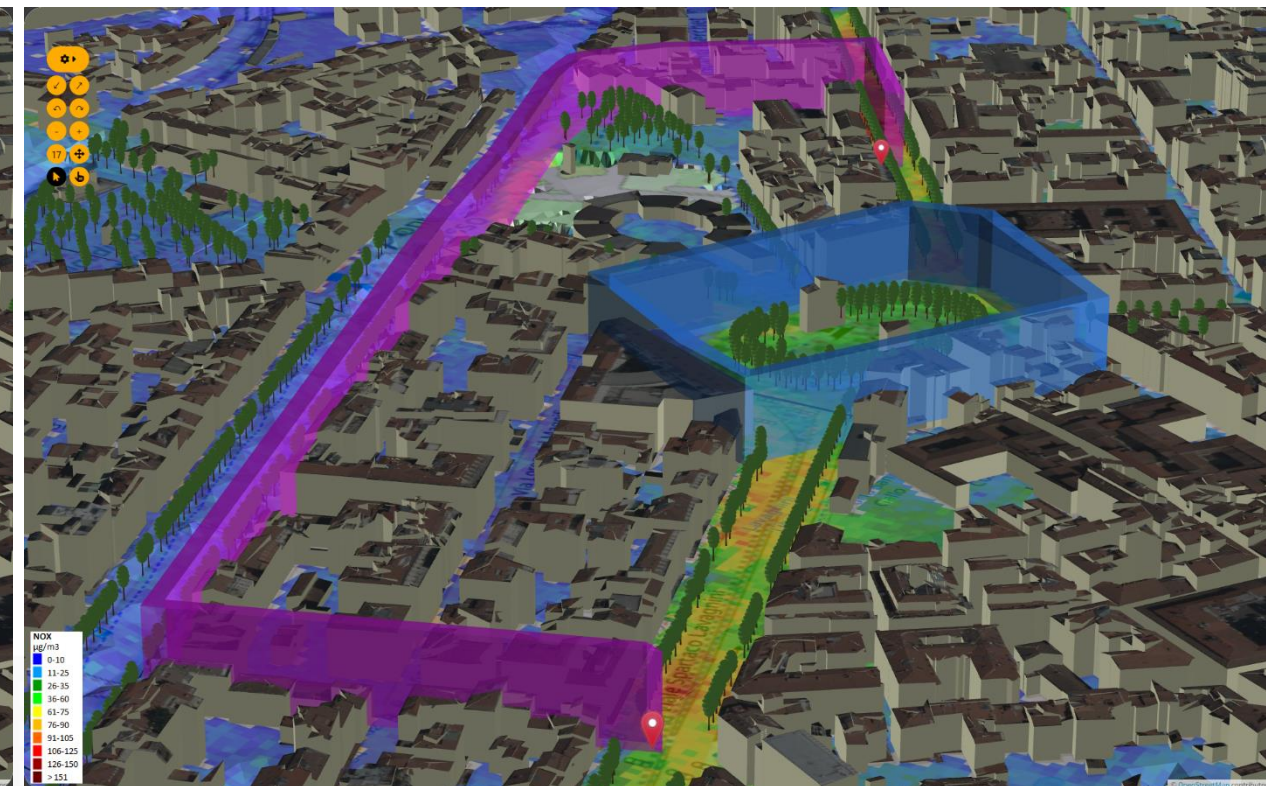
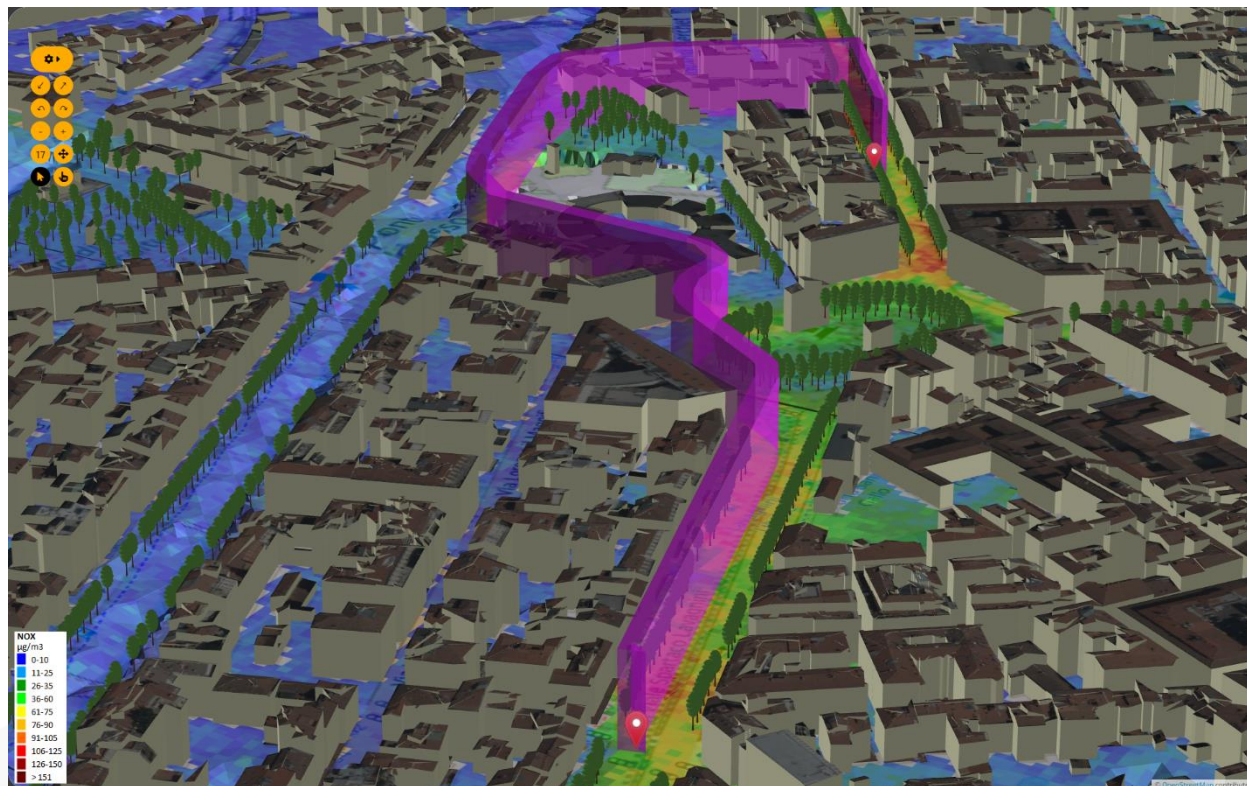
Fastest taking into account traffic



Fastest taking into account traffic and blocked areas



Dyamic Routing in 3D space



Data Analytic Artificial Intelligence, XAI, Machine and Deep Learning

FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS

FROM CITY DASHBOARD TO APPLICATIONS

SNAP4CITY FOR BEGINNERS

SNAP4CITY ARCHITECTURE AND ECOSYSTEM, CONNECTED TO DEVELOPERS AND STAKEHOLDERS

TWITTER VIGILANCE SOCIAL MEDIA ANALYSIS

SNAP4CITY AND KM4CITY PROJECTS

IOT/IIOT DEVICES AND NETWORKS

DATA ANALYTICS, BUSINESS INTELLIGENCE, WHAT-IF, AND SCENARIO ANALYSIS

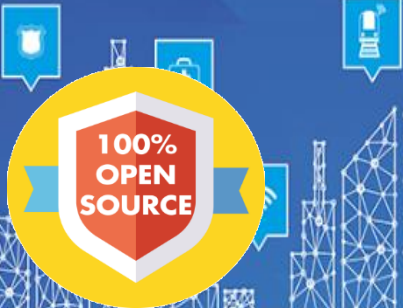
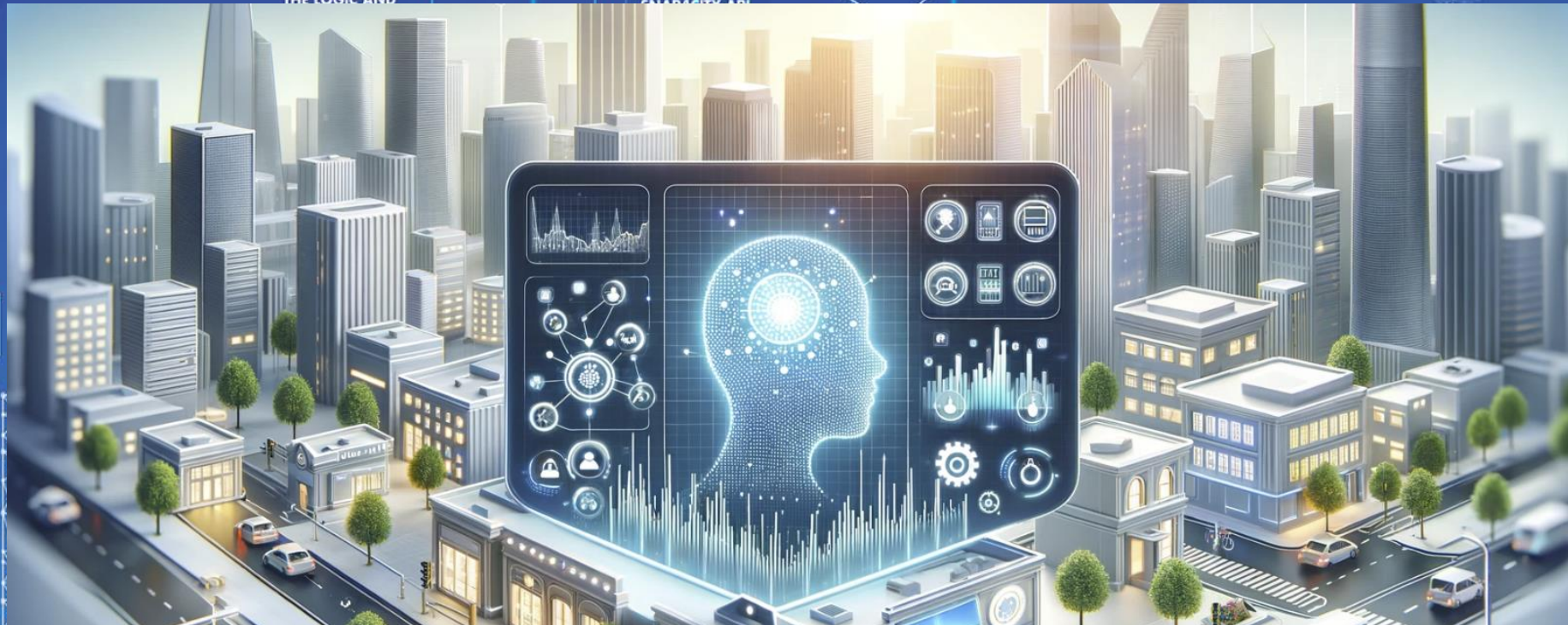
HOW TO ADOPT SNAP4CITY AND FOR ADAPT

DECISION SUPPORT SYSTEMS AND CITY RESILIENCE

IOT APPLICATIONS, THE LOGIC AND

ADVANCED SMART CITY API, MICROSERVICES, SNAP4CITY API

SNAP4CITY THE VIEW OF THE ADMINISTRATORS





Available AI Solutions on Snap4City

More than 80 Available Solutions & 300 AI applic.

<https://www.snap4city.org/997>

- **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**

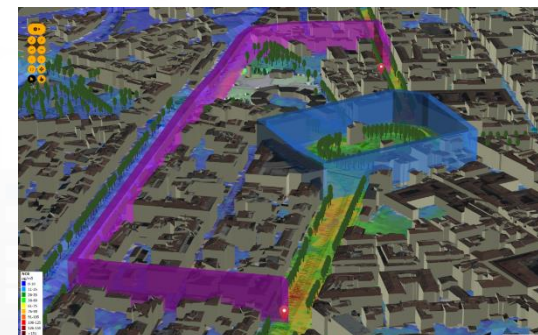


https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

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

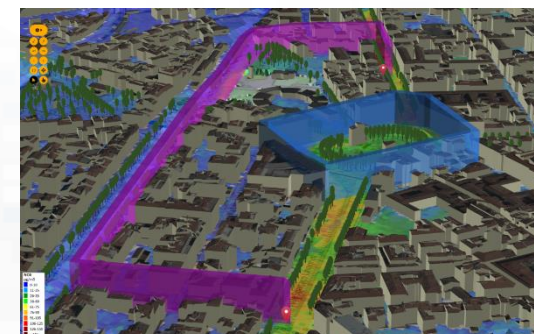
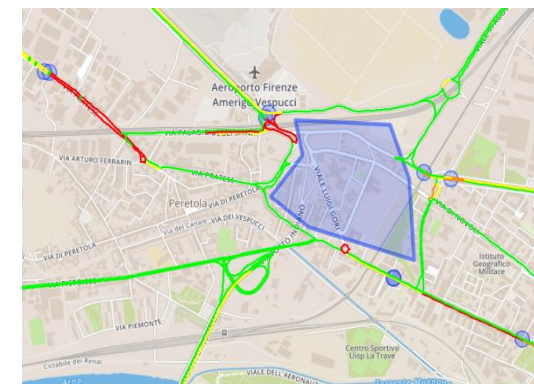
Mobility and Transport Domain (2024/8)

- **Goals:**
 - Decongestion
 - Decarbonization
 - Accessibility to services
 - Security/Safety of city users
- **Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)**
 - Monitoring traffic, parking, people flow, services, boats, ports, beaches, etc.
 - Early detection/warning of critical conditions: traffic, congestion, security/safety
 - Managing Smart Parking, transportation services, fines, etc.
 - Managing fleets: personal, sharing, waste collection, maintenance, etc.
 - Managing E-sharing, pooling services, MaaS, etc.
 - Managing entrances in city areas: restricted areas, touristic busses, etc.
 - Production of suggestions, recommendations, nudging
 - Computing predictions of any kind
- **Solutions for Planning (optimization and what-if analysis)**
 - Reduction of traffic congestion, via optimization: traffic light plans, viability, routing
 - Reduction of Pollutant Emissions, via optimization: traffic light plans, viability
 - Optimization of transportation offers wrt multimodal mobility demand
- **Algorithms and computational solutions, see next slide**



Tools for Mobility and Transport (2024/8)

- Optimisation of viability of an area for reducing congestion, waiting time, stops
- Optimisation of Traffic Light Plans, synchronization, in an area for reducing congestion, waiting time, stops
- Predictions for: traffic flow, smart parking, smart bike sharing, people flows, etc. (ML, DL)
- What if analysis: routing, traffic flow, demand vs offer, pollutant, etc. (Simulation + ML)
- Traffic flow reconstruction from sensors and other sources (simulation + ML)
- Public Transportation: Ingestion and modelling of GTFS, Transmodel, NeTEx, etc. (DP)
 - Analysis of the **demand mobility vs offer transport** of according to public transportation and multiple data sources (Simulation)
 - Assessing **quality of public transportation** (analysis)
- Accidents heatmaps, anomaly detection (analysis, ML)
- Road light controlled by traffic conditions
- Tracking fleets, people, via devices: OBU, OBD2, mobile apps, etc. (DP)
- Routing and multimodal routing (multistop travel planning), constrained routing, dynamic routing (DA)
- Computing **Origin Destination Matrices** from different kind of data (analysis, DP, DP)
- Computing **typical trajectories** on the basis of tracks (analysis, ML)
- Fleet management, monitoring, booking, allocation, maintenance
- Computing Messages for Connected drive (DP)
- Slow and Fast Mobility **15 Minute City Indexes** (analysis, DP, ...ML)
- Computing and comparing traffic flow on devices and at the city border (analysis)
- **Typical time trends** for traffic flow and IoT Time series. (analysis, ML)
- **Impact of COVID-19** on mobility and transport
- Computing SUMI, PUMS, etc. (mainly DP)
- **Definition of Scenarios:** traffic, road graph, conditions, etc.
- Etc.

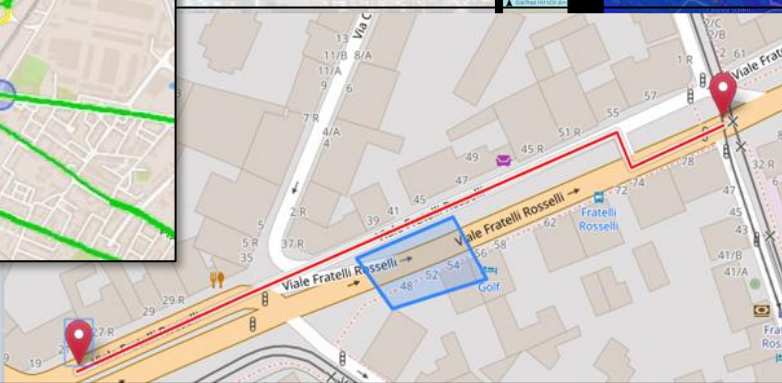
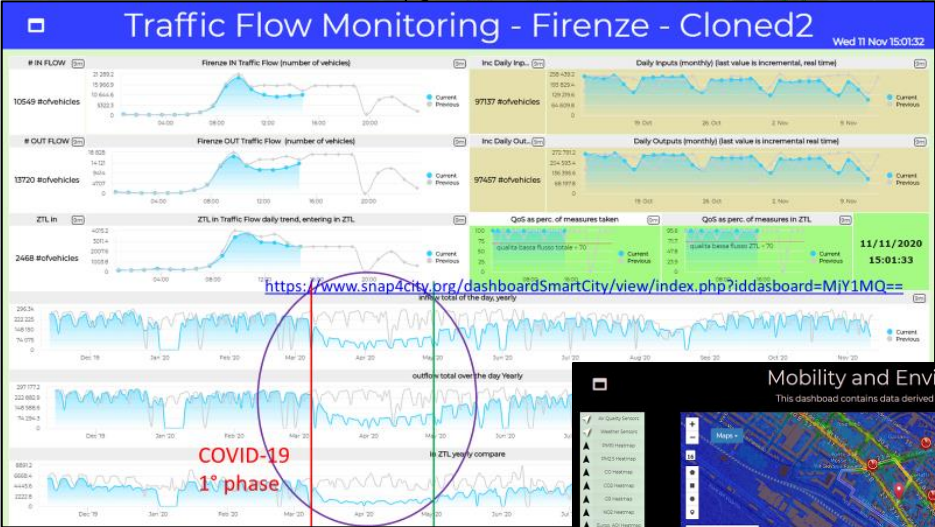


Mobility and Transport Traffic Flow Analysis

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

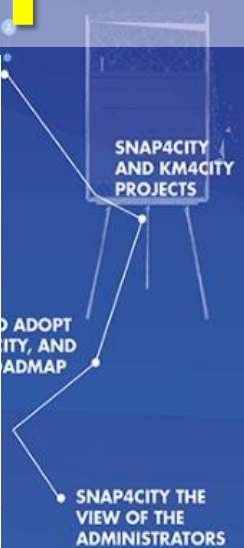
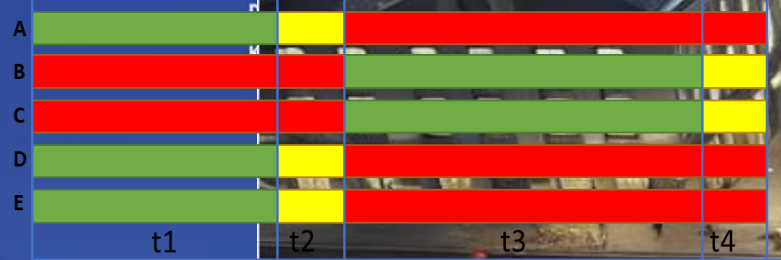


- **Multiple Domain Data**
 - Traffic Flow sensors, city structure, weather
- **Decision Makers Multiple Locations**
 - Real time Monitoring, predictions
 - Traffic Flow Predictions,
 - Traffic Reconstructions, routing
 - Dashboards, What-IF analysis
 - Mobile App, people flows
- **Historical and Real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



Traffic Light Plan Optimization

Macroscopic GA-based Multi-Objective Traffic Light Optimization (MaMoTLO)



<https://www.snap4city.org/1015>

11 SUSTAINABLE CITIES AND COMMUNITIES



Traffic Light Plan Optimisation, Digital Twin

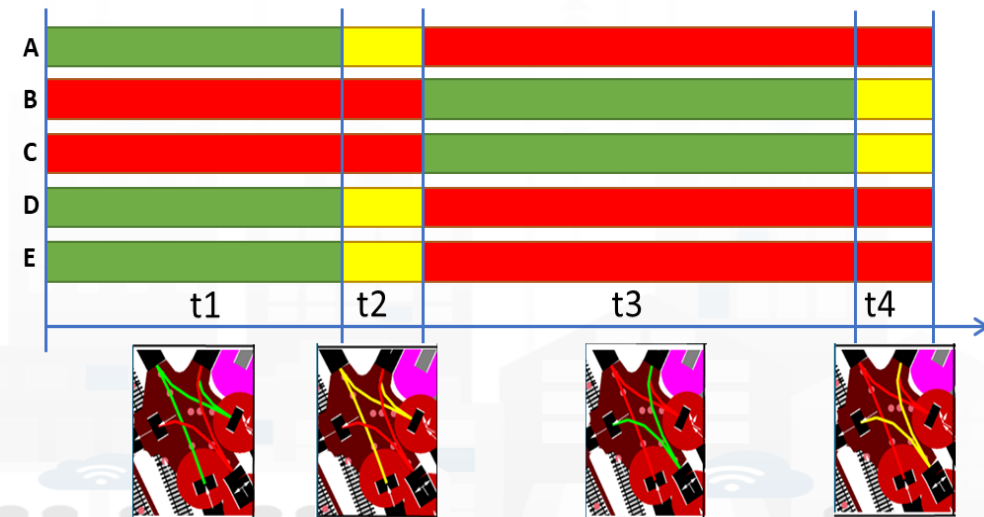
- **Match Multiple Objectives and Synchronization:**

- public and private traffic, tramway priority
- Micro and Macro Scales
- **AI: Genetic Algorithms, Reinforced Learning**
 - Fixed and Actuated Cycles
 - Adjusted on Demand

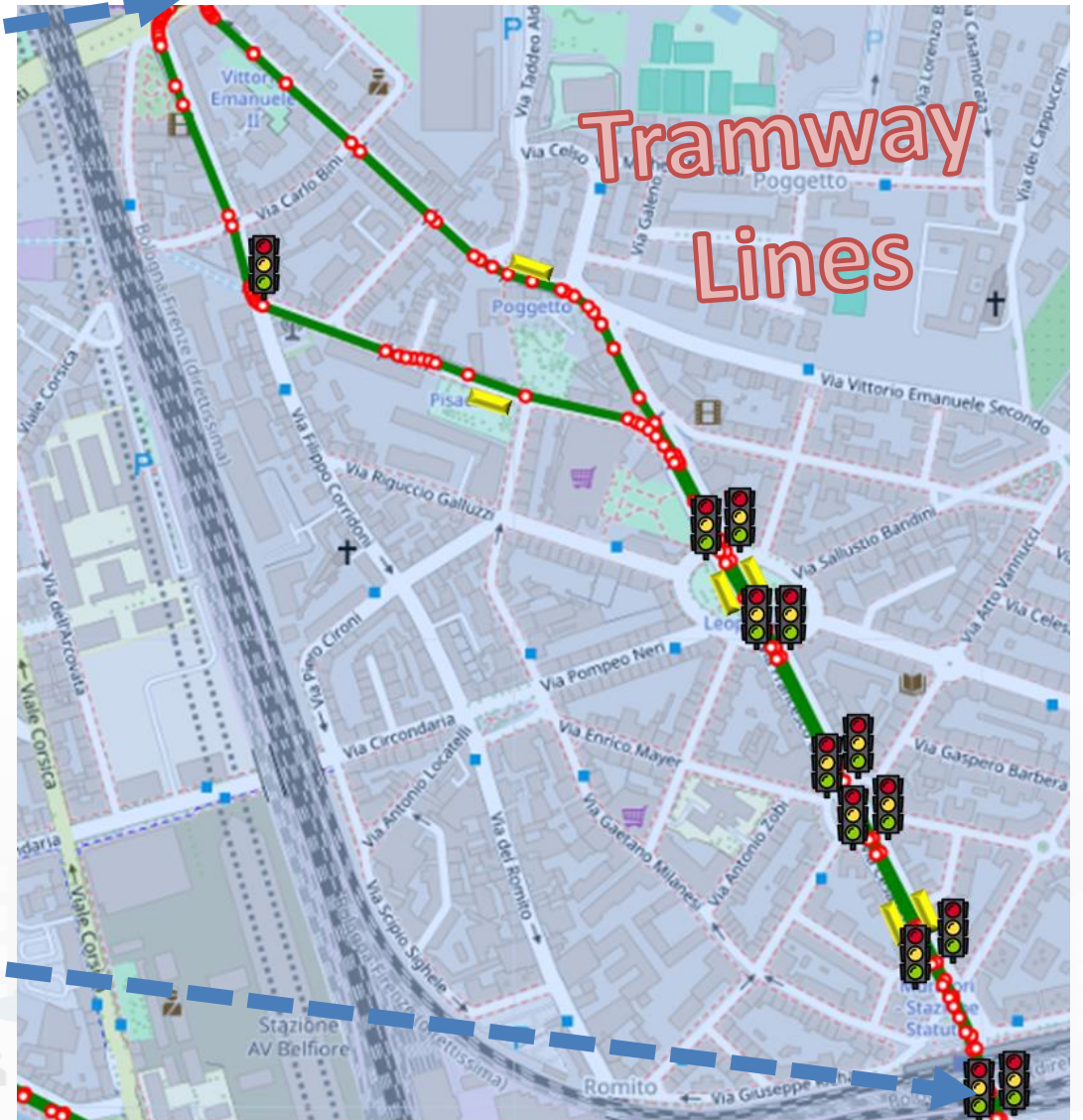
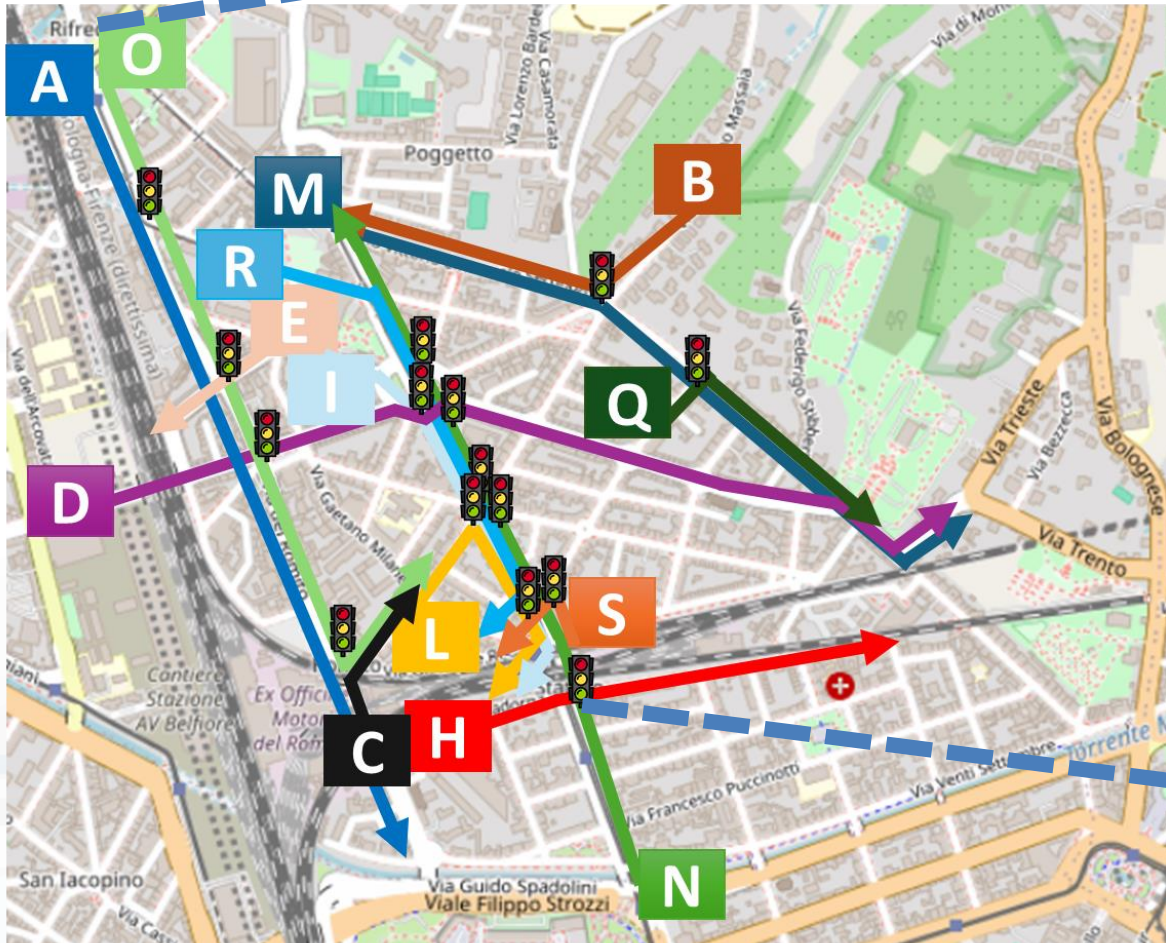
- **Validation/integ.** with *SUMO* simulation

- Travel Time, waiting time, waiting count
- Specific travel time on directions
- CO2 emissions, etc.

- **Reductions from 5% to 15%**



Example, main paths

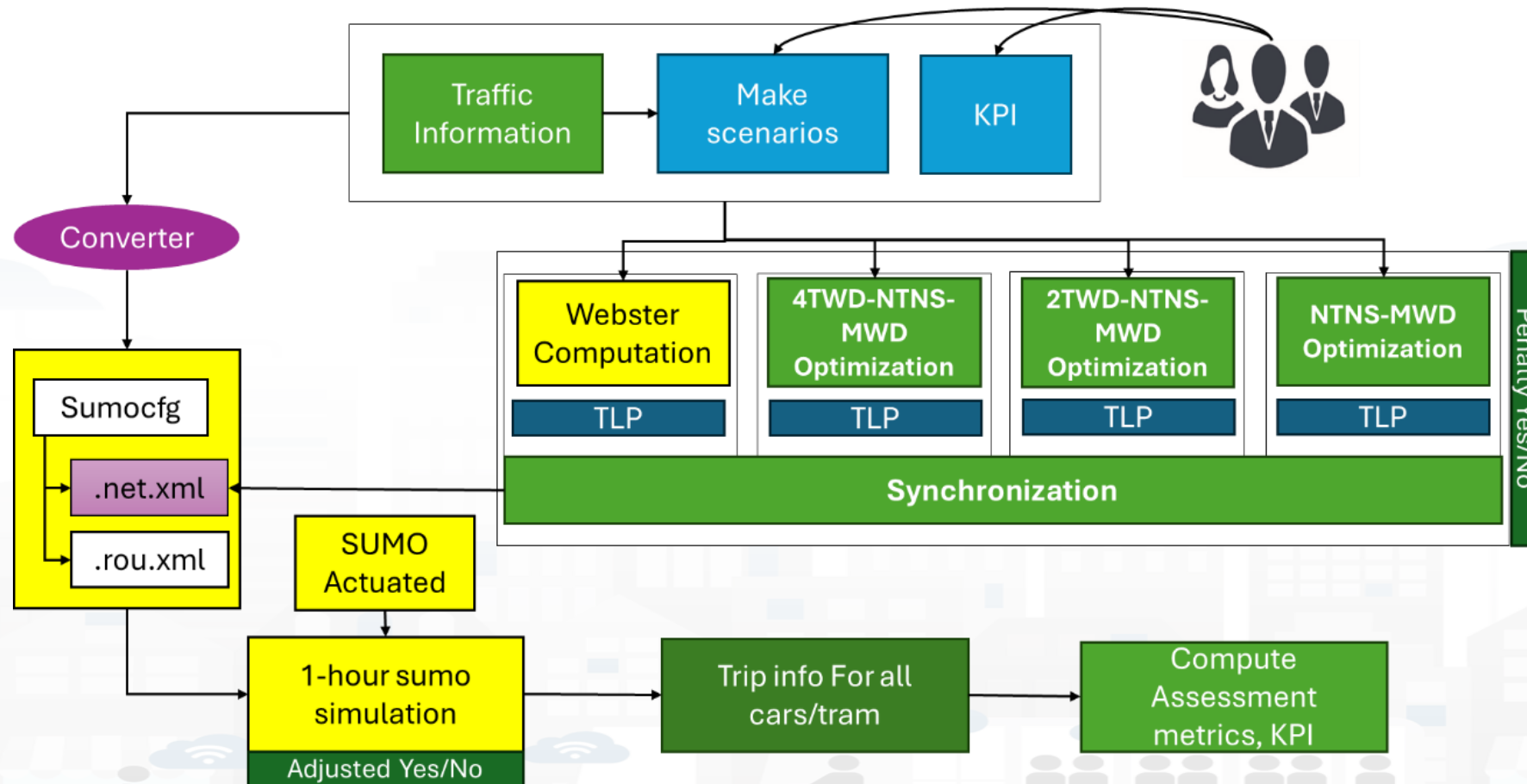


Mean Travel Time

	Traffic Load	MTTall	MTT dir_N	MTT dir_M	MTT dir_A	MTT TW Careggi	MTT TW Costanza
4TW-NTNS-MWD-P	1.5	3542.50	198.90	242.14	197.64	436.00	427.00
4TW-NTNS-MWD-A	1.5	3242.71	178.33	243.28	195.79	436.00	427.00
4TW-NTNS-MWD-P-A	1.5	3242.71	178.33	243.28	195.79	436.00	427.00
2TW-NTNS-MWD-P	1.5	4538.02	207.40	456.14	615.00	436.00	427.00
2TW-NTNS-MWD-A	1.5	3940.07	179.30	428.67	481.53	436.00	429.75
2TW-NTNS-MWD-P-A	1.5	4380.63	182.05	456.59	654.21	436.00	427.00
SUMO Actuated	1.5	3409.13	280.09	515.34	200.66	497.54	499.81
Webster	1.5	6474.95	465.45	441.93	210.50	1379.25	493.87
WebsterAdjusted	1.5	4035.08	195.82	441.09	205.66	463.87	447.06

4TWD-NTNS-MWD-P-A: optimization by prioritizing traffic **directions**, the normalized number of vehicles stops, *NTNS*, the mean waiting delay *MWD*, for all traffic lights, and post synchronization, with Penalty and Adjust dynamically performed

TLP Optimization possibilities





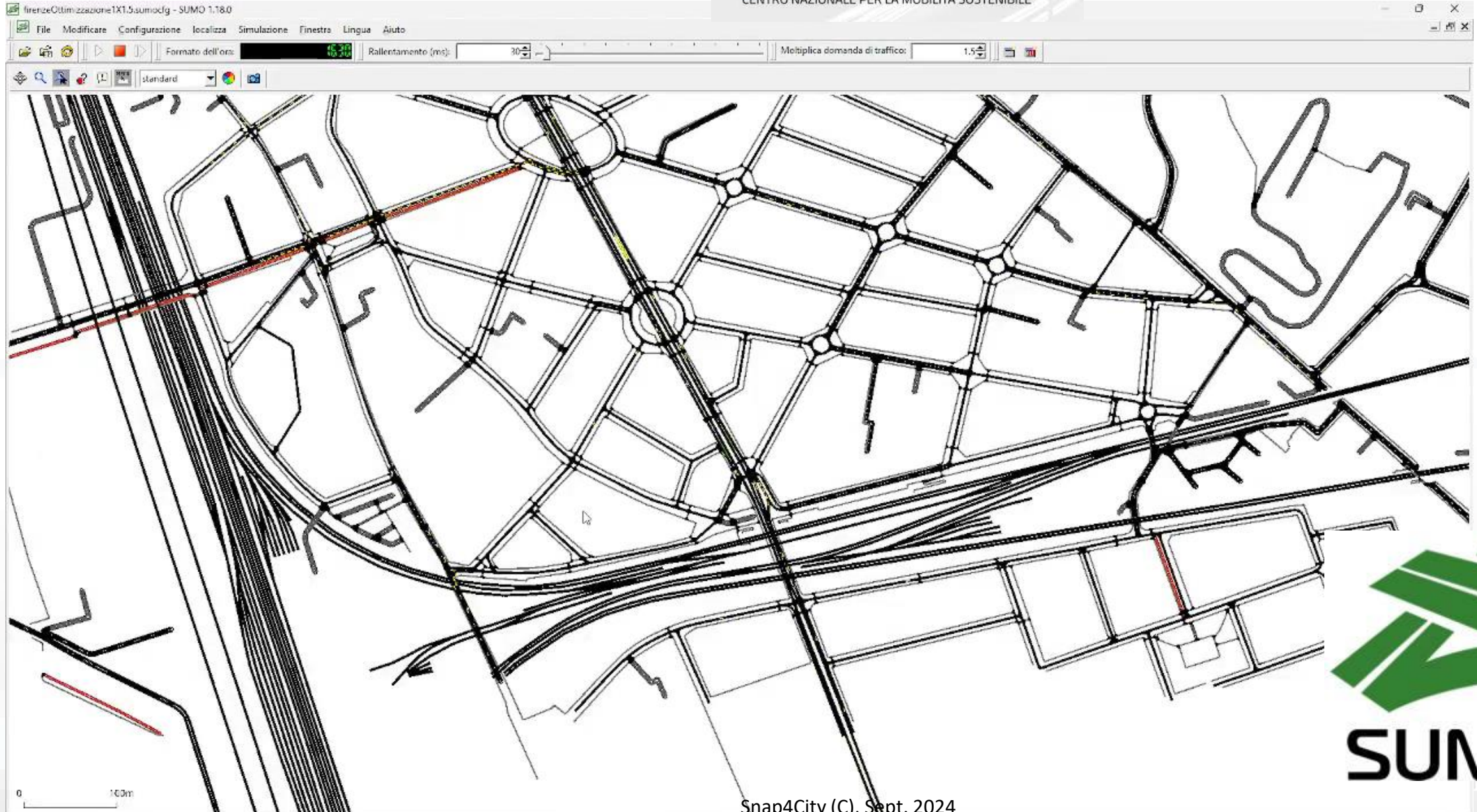
UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

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

MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

SNAP4CITY





Traffic Infrastructure Optimization

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA GAIN
AND CITY
KNOWLEDGE
MANAGEMENT

11 SUSTAINABLE CITIES
AND COMMUNITIES



MOST

CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

TO ADOPT
CITY, AND
ROADMAP

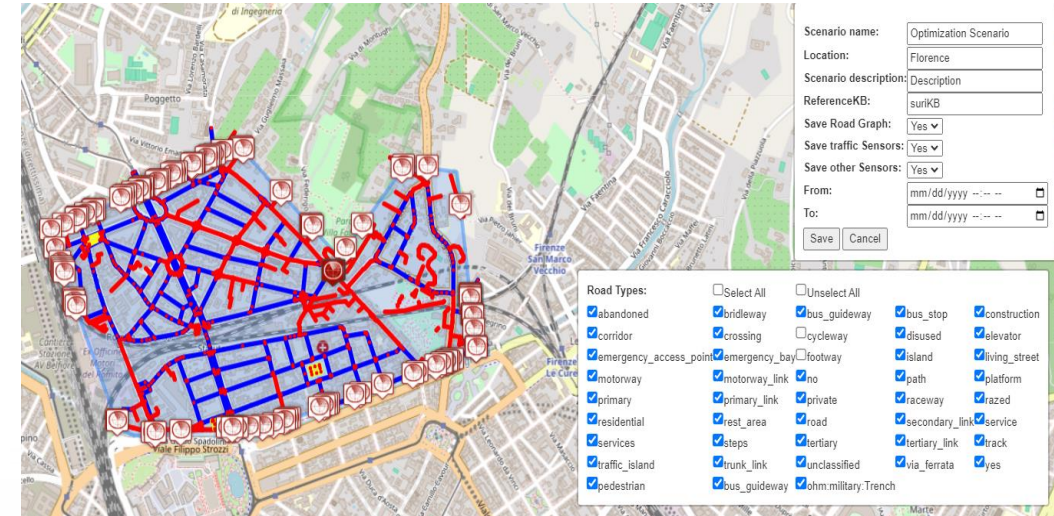
SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

<https://www.snap4city.org/1014>

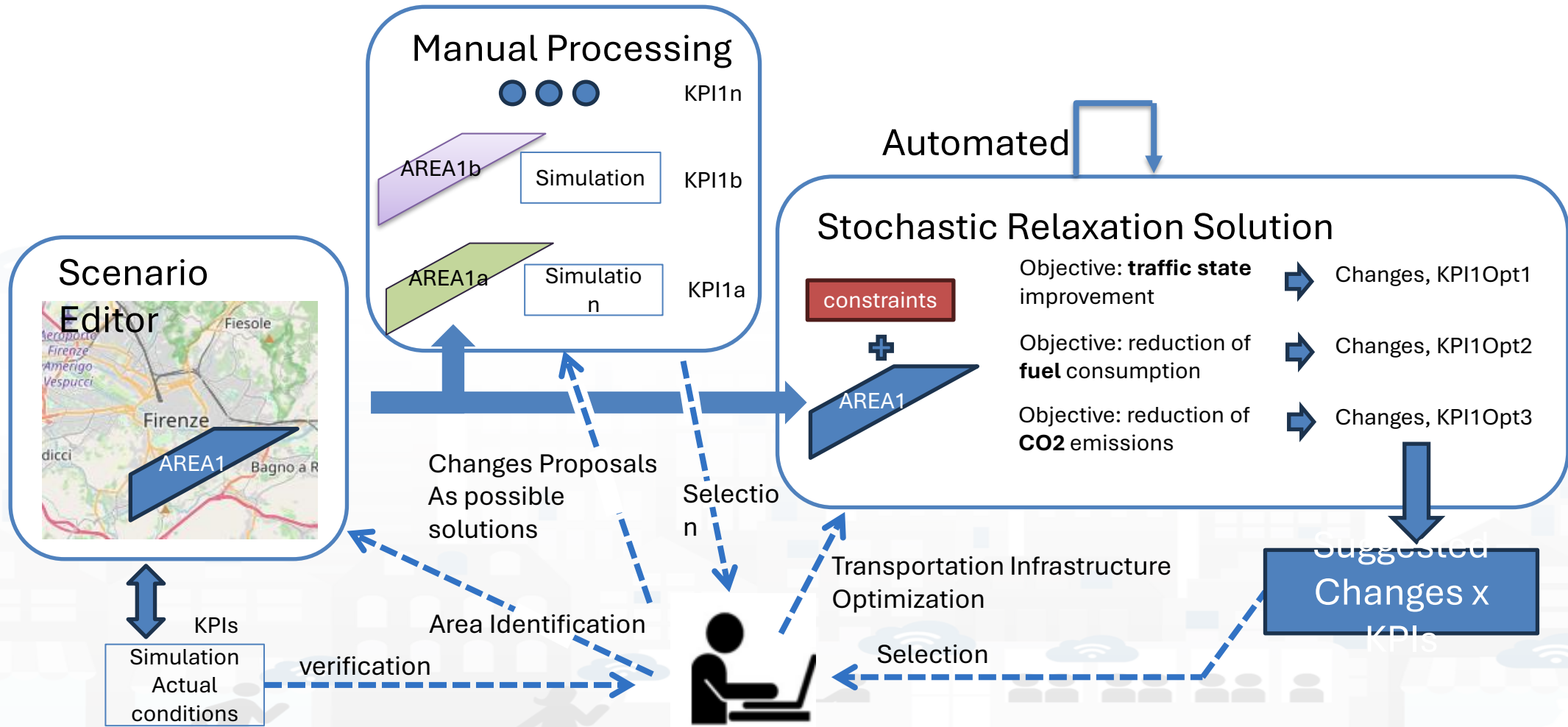


Traffic Infrastructure Optimisation, Digital Twin

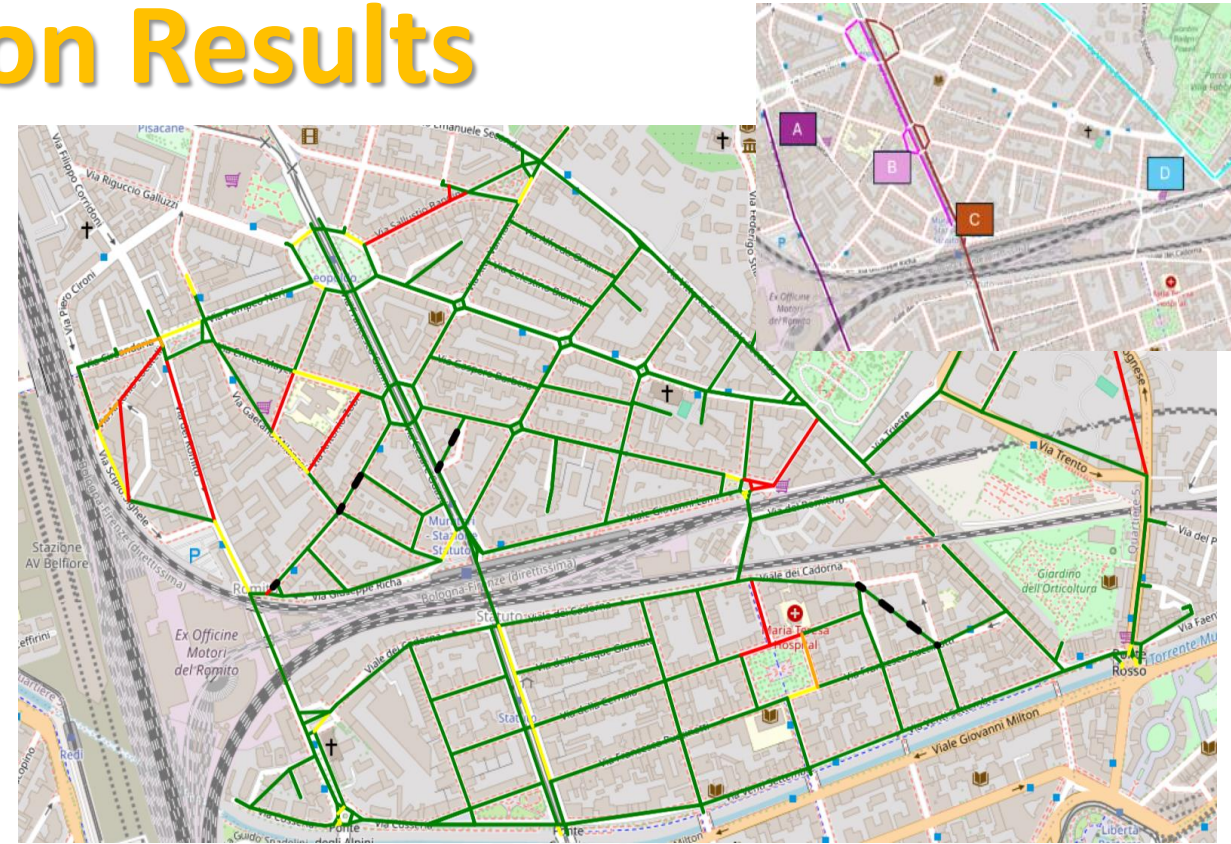
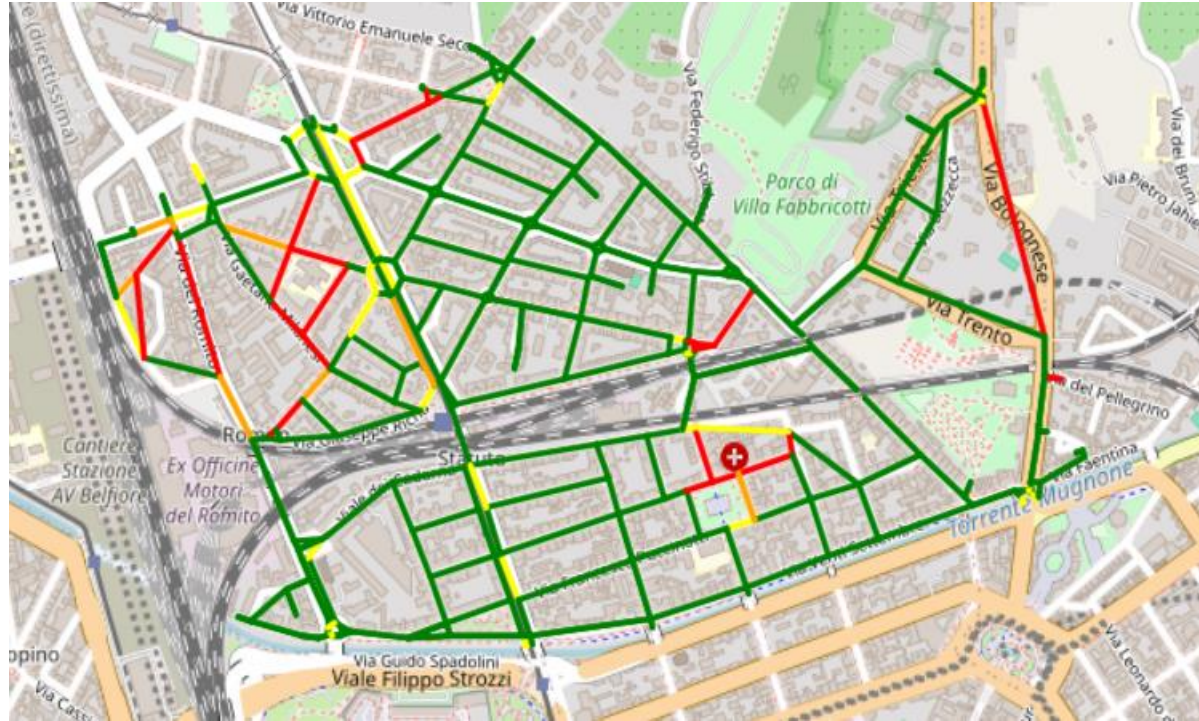
- **Identification of Scenario**
(Scenario Editor), any changes
 - Definition of traffic loads by flows
- **What-if or Automated Optimisation**
- **Automated Optimisation:**
 - Stochastic Relaxation, Simulated Annealing, Traffic Flow Reconstruction
 - Multiple objectives targeting
 - Travel time, emissions, fuel consumption, traffic status
 - Limiting the number of changes



Traffic Infrastructure Optimisation



Optimization Results



Case max 4 changes	KPI estimation on the best solution		
Optimization Target	Traffic State	Fuel	CO2
Optim 4 Traffic State	91.341 -21%	17.964	128536
Optim 5 Fuel	91.514	16.633 -35%	128227
Optim 6 CO2	92.859	19.192	127876 -23%
Original	115.475	25.680	165822

Travel Time [s]	Path A	Path B	Path C	Path D	Total Time
Original Scenario	183.2	59.6	80.9	132.5	456.4
Optim 4 Traffic State	93.2	60.0	63.7	96.0	313.1
Optim 5 Fuel	89.6	51.2	59.7	96.4	296.9
Optim 6 CO2	89.5	53.2	58.4	100.1	301.3

-51% **-14%** **-28%** **-28%**

TOP

Traffic Flow

11 SUSTAINABLE CITIES
AND COMMUNITIES



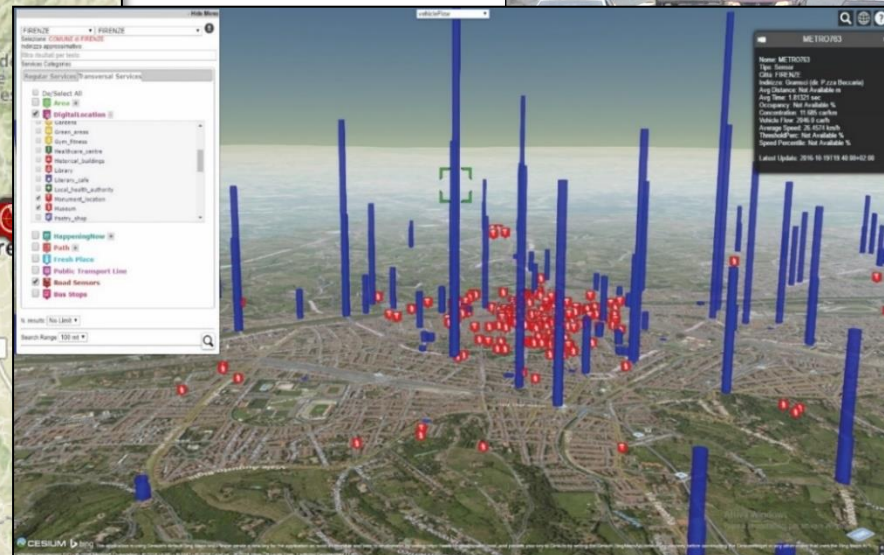
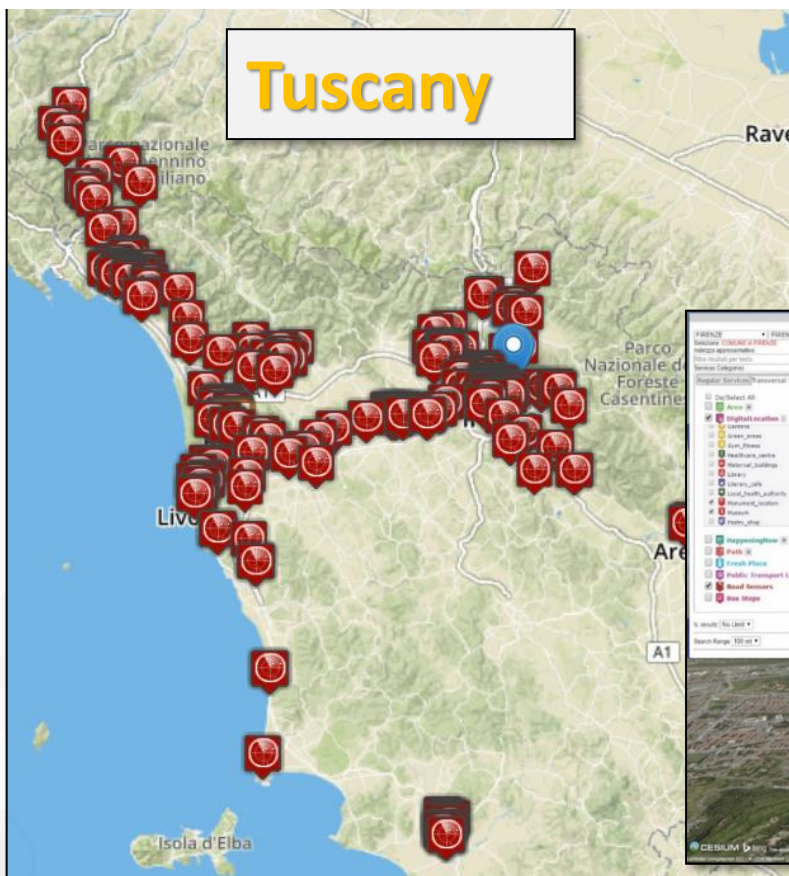
13 CLIMATE
ACTION

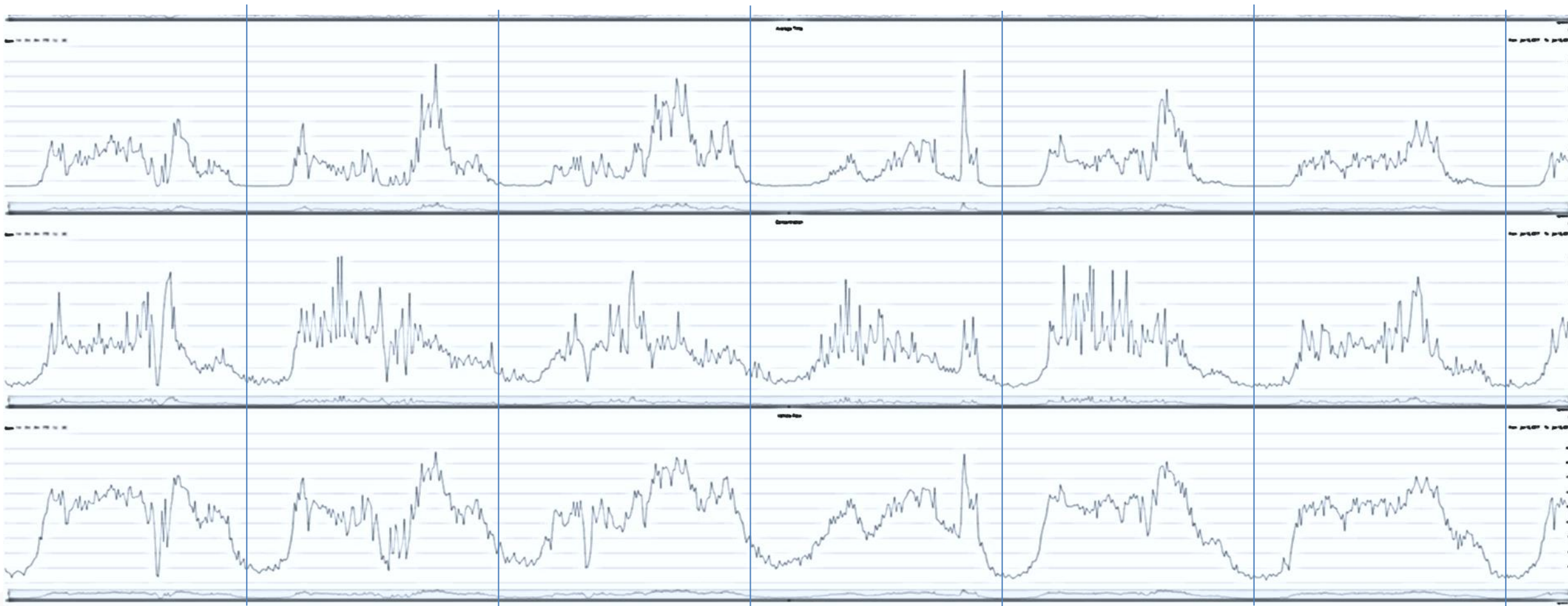


Traffic Flow Tools

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

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





- Day by day traffic flow, on the week data from 3 sensors

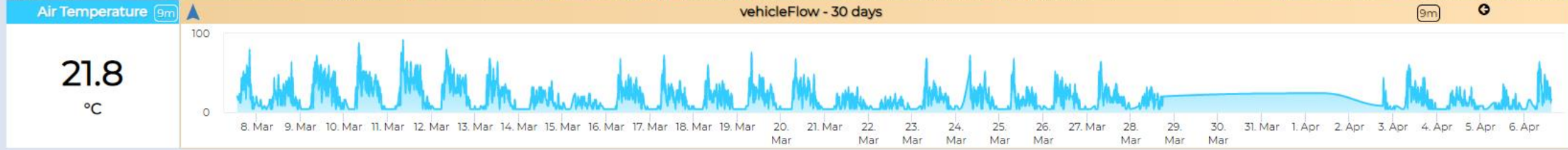
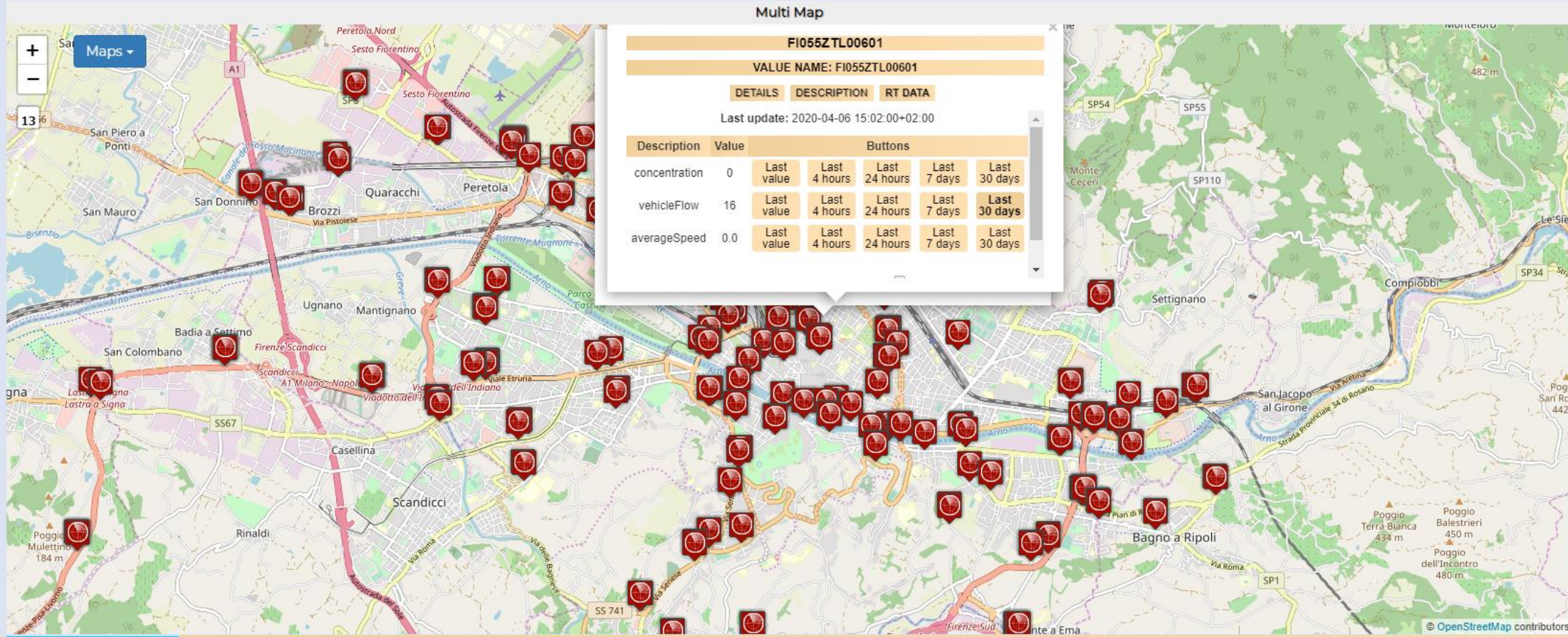
Firenze - Trafair - AirQuality Heatmaps



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

Mon 6 Apr 15:12:27

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



Air quality trends

<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MTUzMg==>

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Traffic Flow Monitoring - Firenze - Cloned2

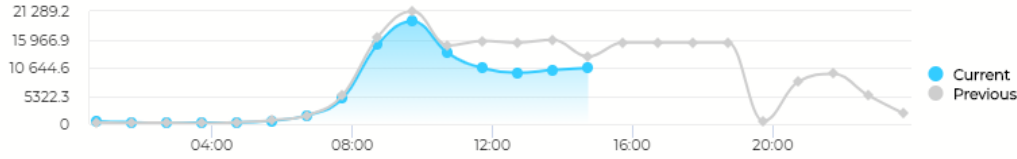
Wed 11 Nov 15:01:32

IN FLOW 9m

Firenze IN Traffic Flow (number of vehicles)

9m

10549 #ofvehicles

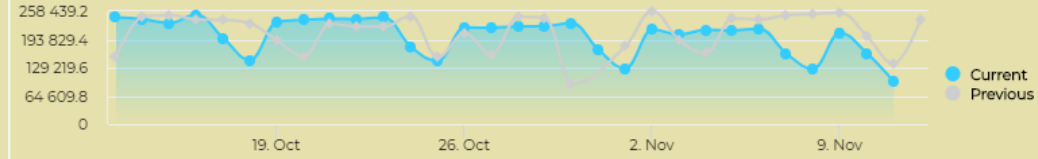


Inc Daily Inp... 9m

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

9m

97137 #ofvehicles

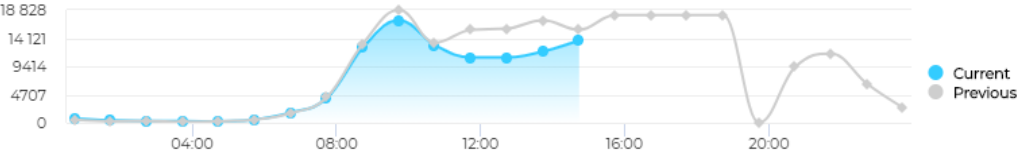


OUT FLOW 9m

Firenze OUT Traffic Flow (number of vehicles)

9m

13720 #ofvehicles

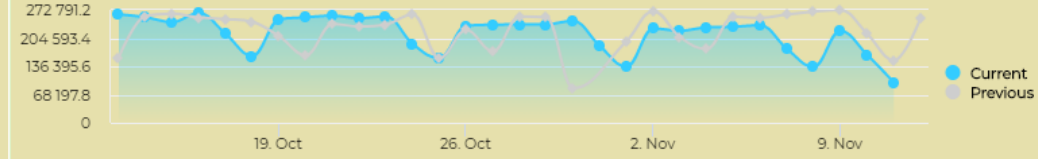


Inc Daily Out... 9m

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

9m

97457 #ofvehicles

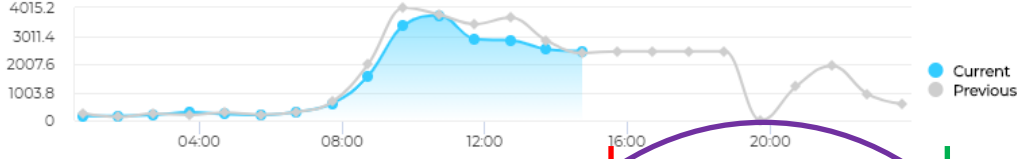


ZTL in 9m

ZTL in Traffic Flow daily trend, entering in ZTL

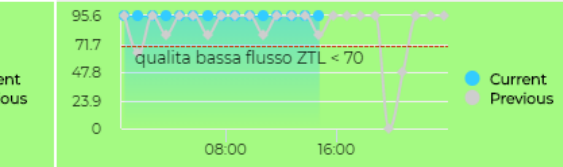
9m

2468 #ofvehicles



QoS as perc. of measures taken

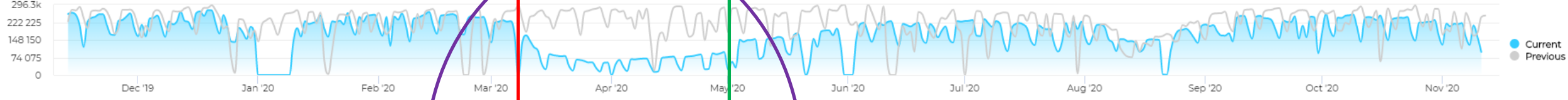
QoS as perc. of measures in ZTL



11/11/2020
15:01:33

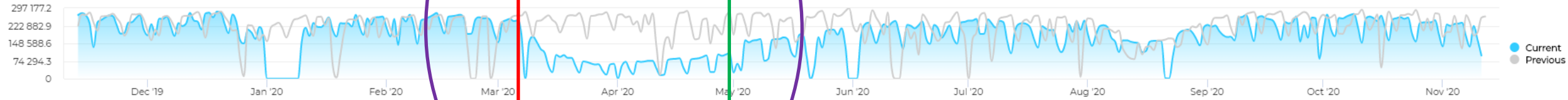
inflow total of the day, yearly

9m



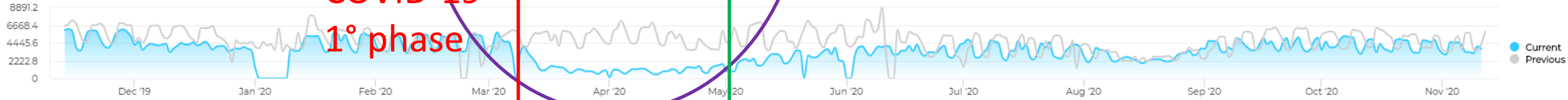
outflow total over the day Yearly

9m

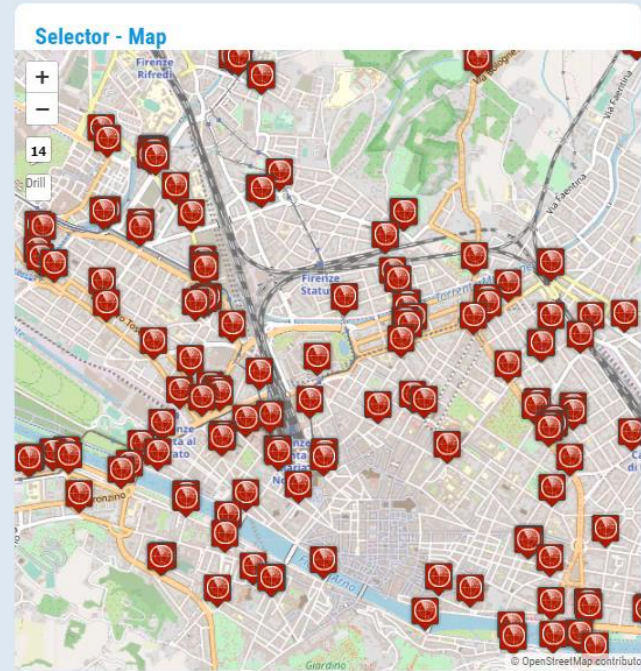


in ZTL yearly compare

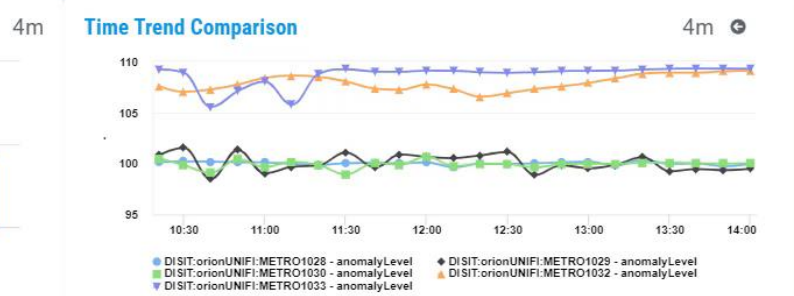
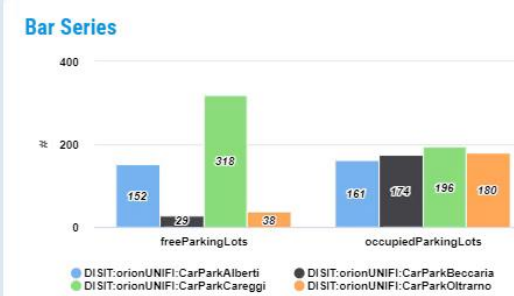
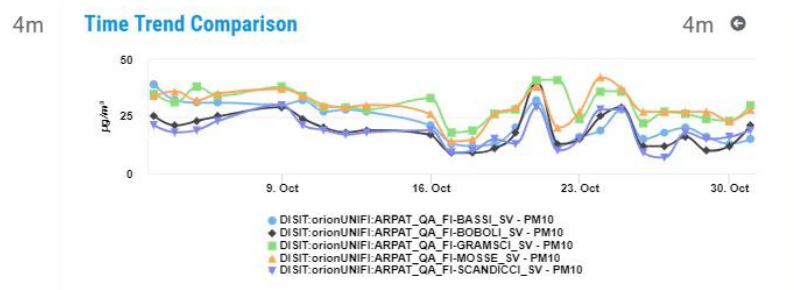
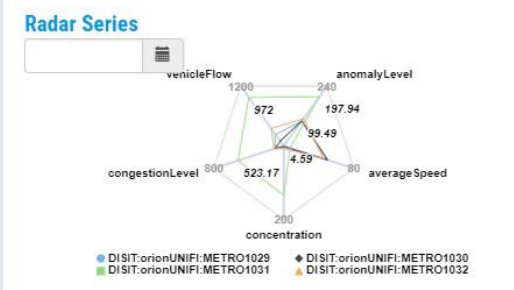
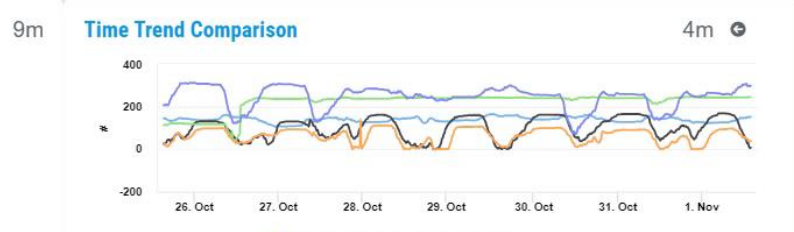
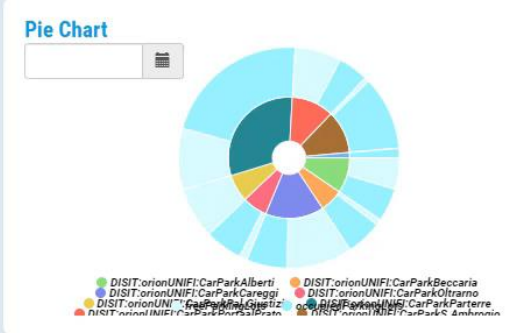
9m



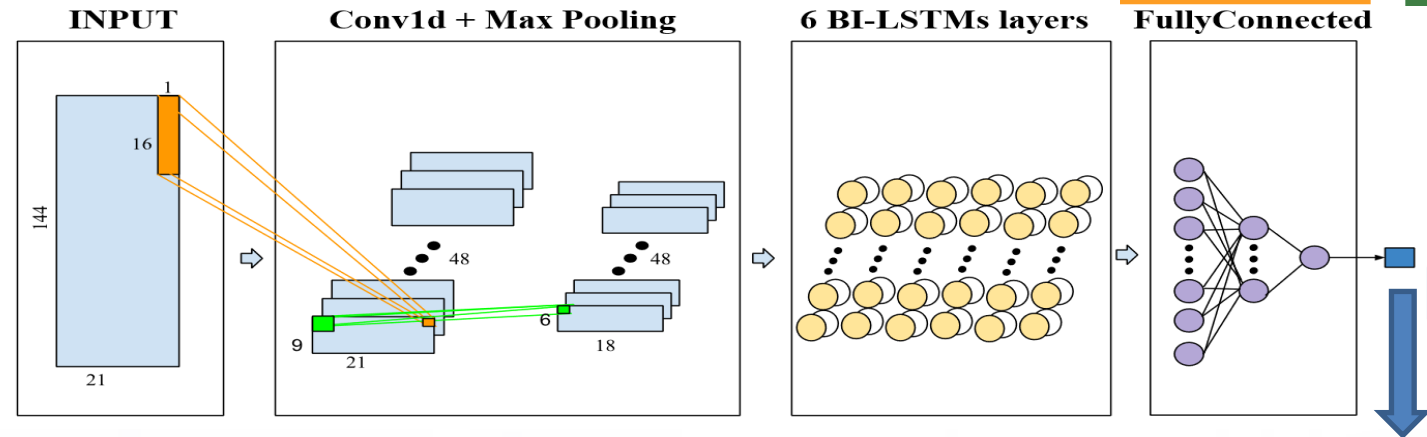
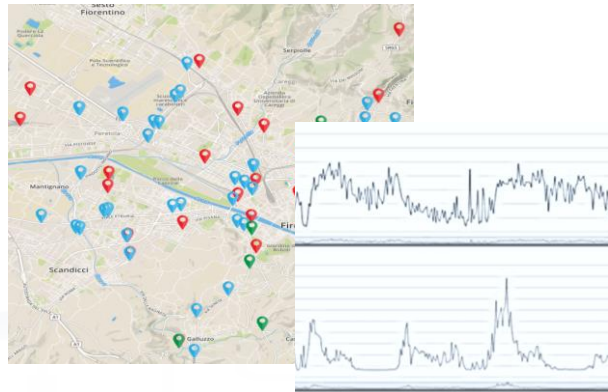
COVID-19
1° phase



- ### Selector
- ▲ Car_park
 - ▶ metrotrafficsensor
 - ▲ Air_quality_monitoring_station
 - ▲ Weather_sensor

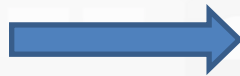


Short-Term Prediction of City Traffic Flow via Convolutional Deep Learning



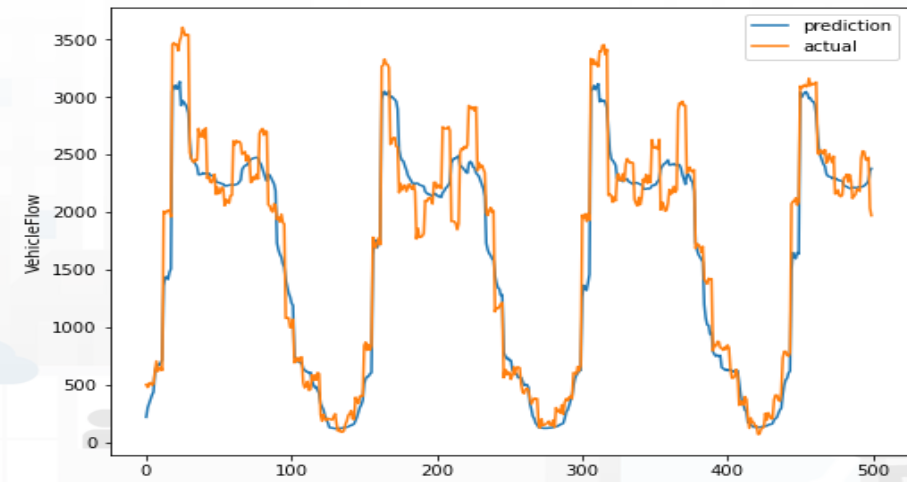
Urban data:

- Date-time
- Traffic
- Temporal
- Seasonality
- Pollution
- Weather



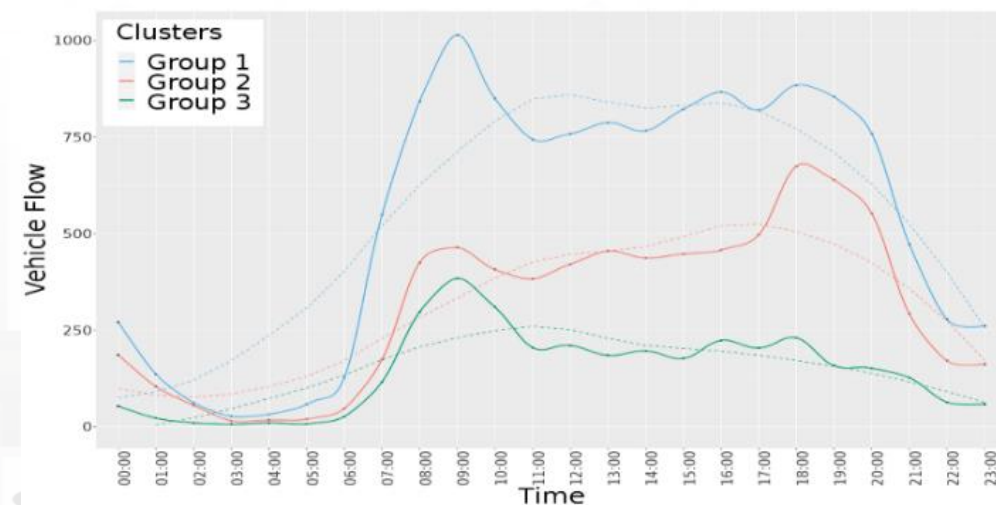
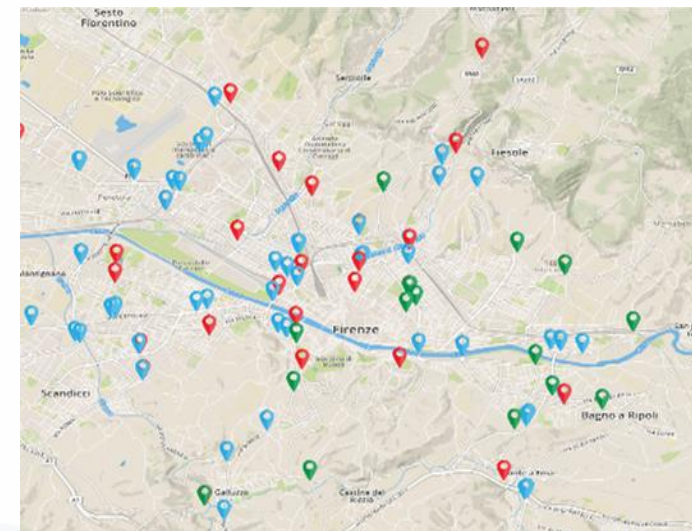
- RF
- XGBOOST
- DNN
- LSTM
- BI-LSTM
- Autoencoder BI-LSTM
- Attention CONV-LSTM
- CONV-BI-LSTM

CONV-BI-LSTM



Clustering traffic flow sensors

- The clustering has been performed on the basis of the time trend H24, considering the normalized vehicle flow measures.
- The optimal number of clusters turned out to be 3 and it has been identified by using **elbow** criteria
- **K-means** clustering method has been applied to identify clusters
 - The optimal number of clusters resulted to be equal to **3**, and it has been identified by using the **Elbow** criteria



Best compromise

Category	Feature	Description
Traffic Trafplus	Traffic Flow	Real number of vehicles recorded every 10 minutes
	AverageSpeed	Average speed of vehicles (Km/h)
	Concentration	Number of vehicles in terms of road occupancy (%)
DateTime	timeOfTheDay	Time of the day {1, 144}
	dayOfTheYear	Day of the year {1, 366}
seasonality	dayOfTheWeek	Day of the week {1,7}
	Weekend	0 for working days, 1 else
	Year	The year of the observation
Temporal	Previous observation's difference of the previous week (dP)	the difference between the number of vehicles in the observation day (d) at the time slot t and the number of available vehicles during the previous time slot (t-1) of the previous day (d-1)
	Subsequent observation's difference of the previous week (dS)	the difference between the number of vehicles in the observation day (d) at the time slot t and the number of vehicles during the successive time slot (t+1) of the previous day (d-1).
	Previous week observation ($PwVF$)	the number of vehicles of the previous week (d-7) in the same time slot (t).
Weather	Air Temperature	City temperature one hour earlier than Time (°C)
	Humidity	City humidity one hour earlier than Time (%)
	Pressure	City pressure one hour earlier than Time (millibar mb)
	Wind Speed	City wind speed one hour earlier than Time (KM/h)
AirPoll	CO	Concentration of CO one hour earlier than Time
	NO2	Concentration of NO2 one hour earlier than Time
	O3	Concentration of O3 one hour earlier than Time
	PM10	Concentration of PM10 one hour earlier than Time
	PM2.5	Concentration of PM2.5 one hour earlier than Time

Comparing performance

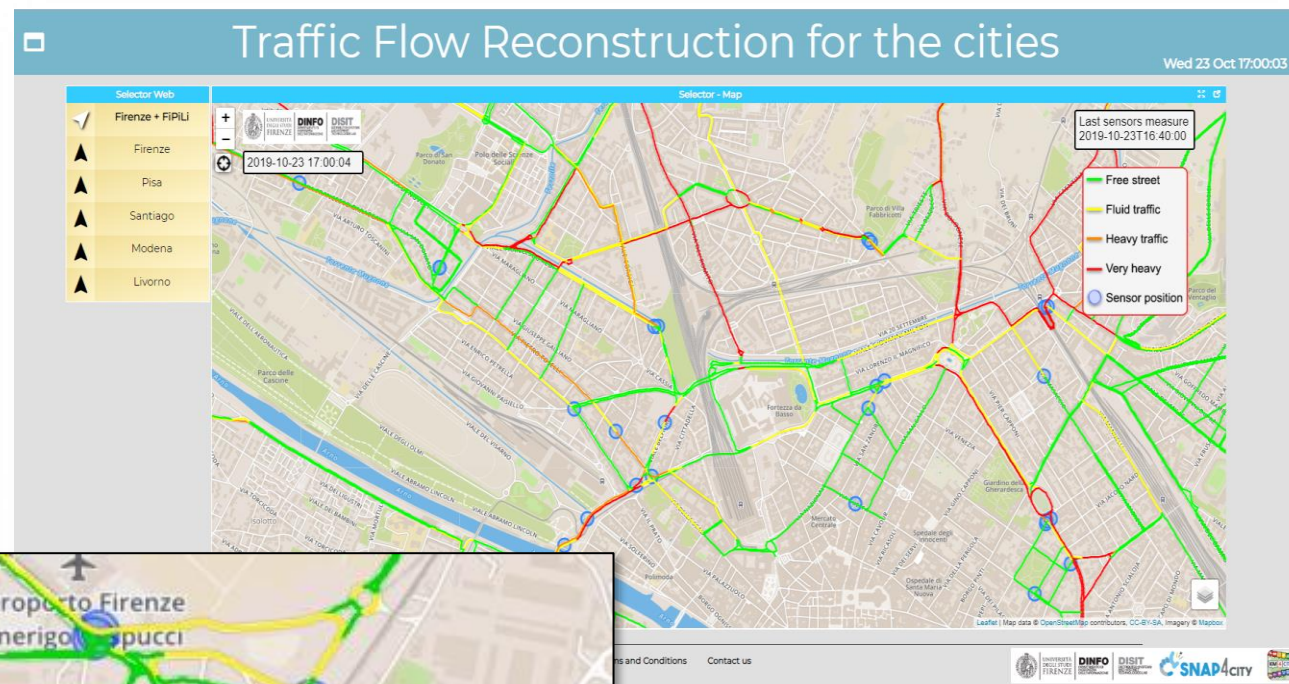
Processing time	Training execution		Prediction execution (s)
	Duration (s)	Max GPU	
RF	14.681	On CPU	0.023
XGBOOST	4.352	On CPU	0.002
DNN	748.431	25%	0.056
LSTM	527.623	40%	0.017
BI-LSTM	681.874	42%	0.021
Autoencoder BI-LSTM	3240.564	38%	0.033
Attention-based CONV-LSTM	2579.248	41%	0.023
CONV-BI-LSTM	353.672	39%	0.102

Please take note of the wide difference from the training and the execution times

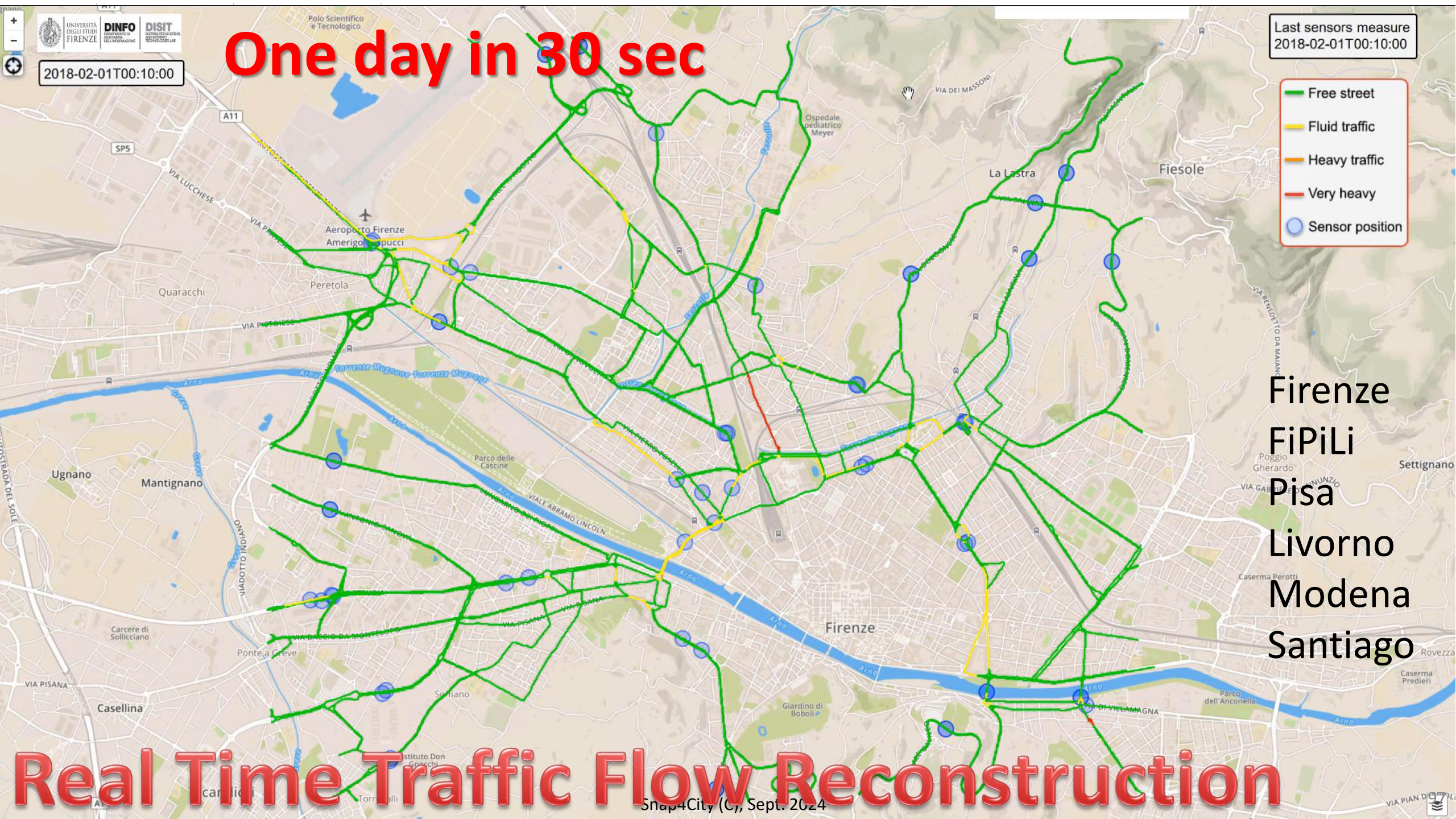
Best compromise

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?idashboard=MTc5NQ==>



2018-02-01T00:10:00

One day in 30 sec

Last sensors measure
2018-02-01T00:10:00

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

Firenze
FiPiLi
Pisa
Livorno
Modena
Santiago

Real Time Traffic Flow Reconstruction

Traffic Flow Reconstruction for the cities

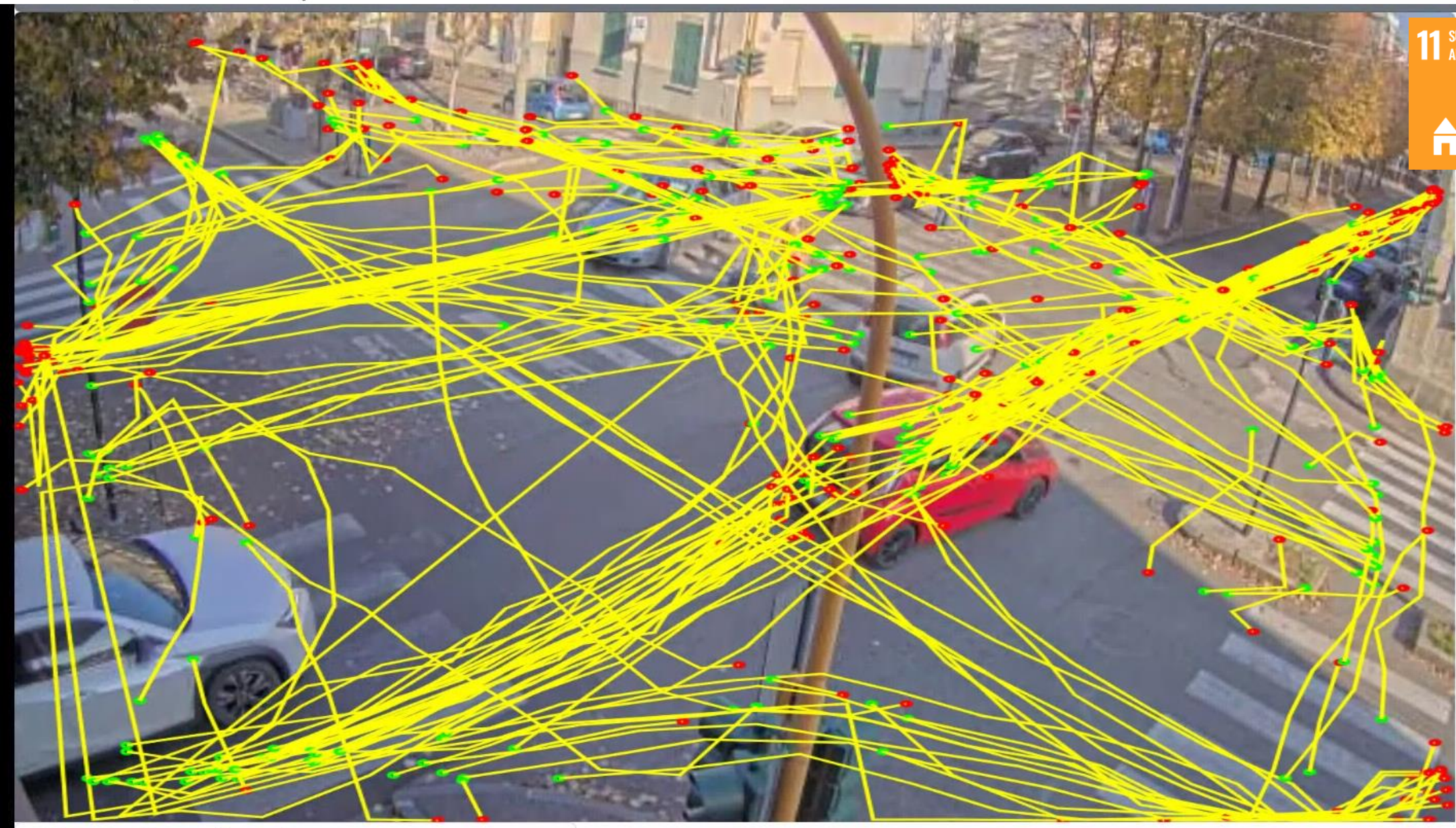
Sun 3 Nov 20:37:43

- Selector Web
- ▲ Firenze + FiPiLi
 - ▲ Firenze
 - ▲ Pisa
 - ▲ Santiago
 - ▲ Modena
 - ▲ Livorno

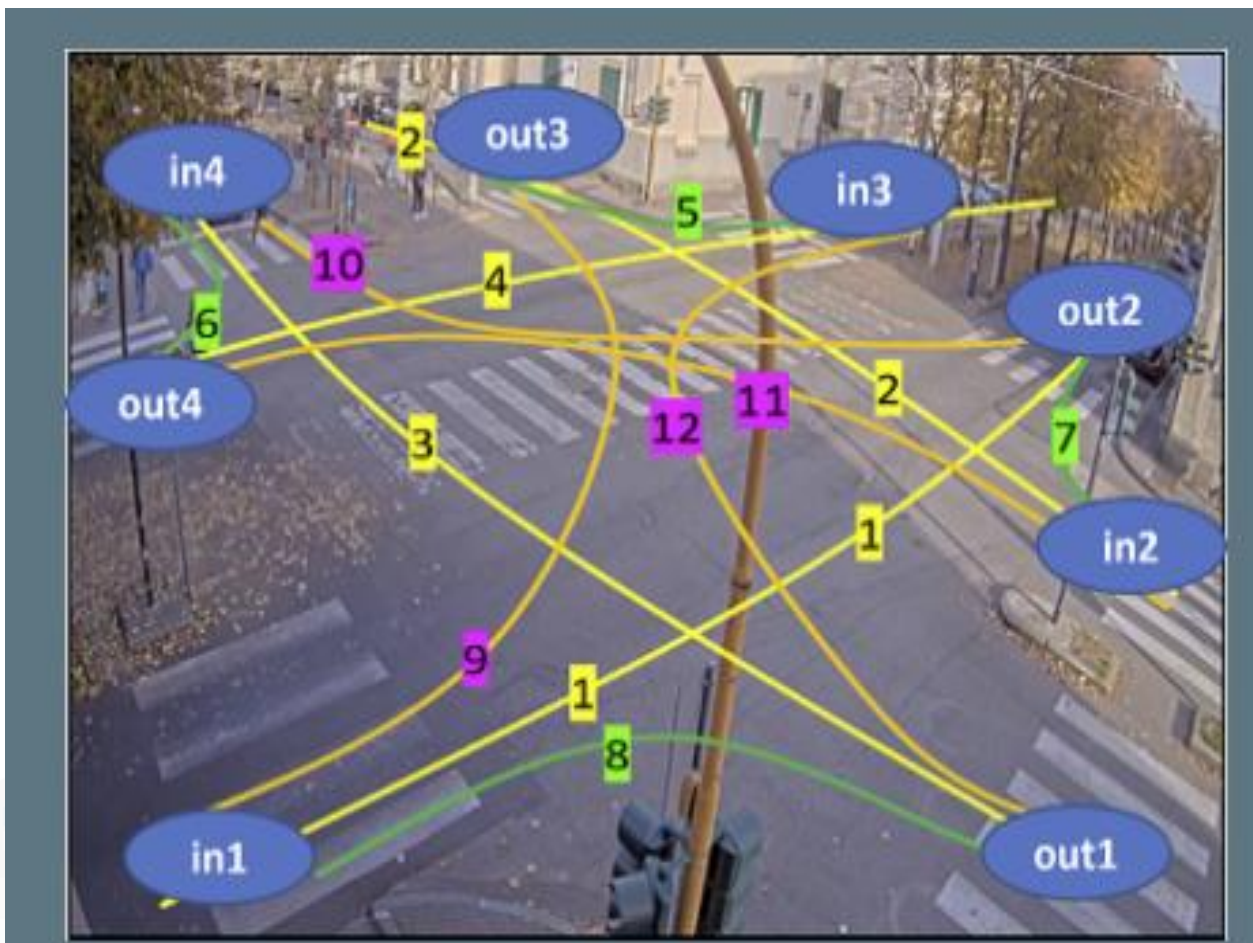


Santiago di Compostela

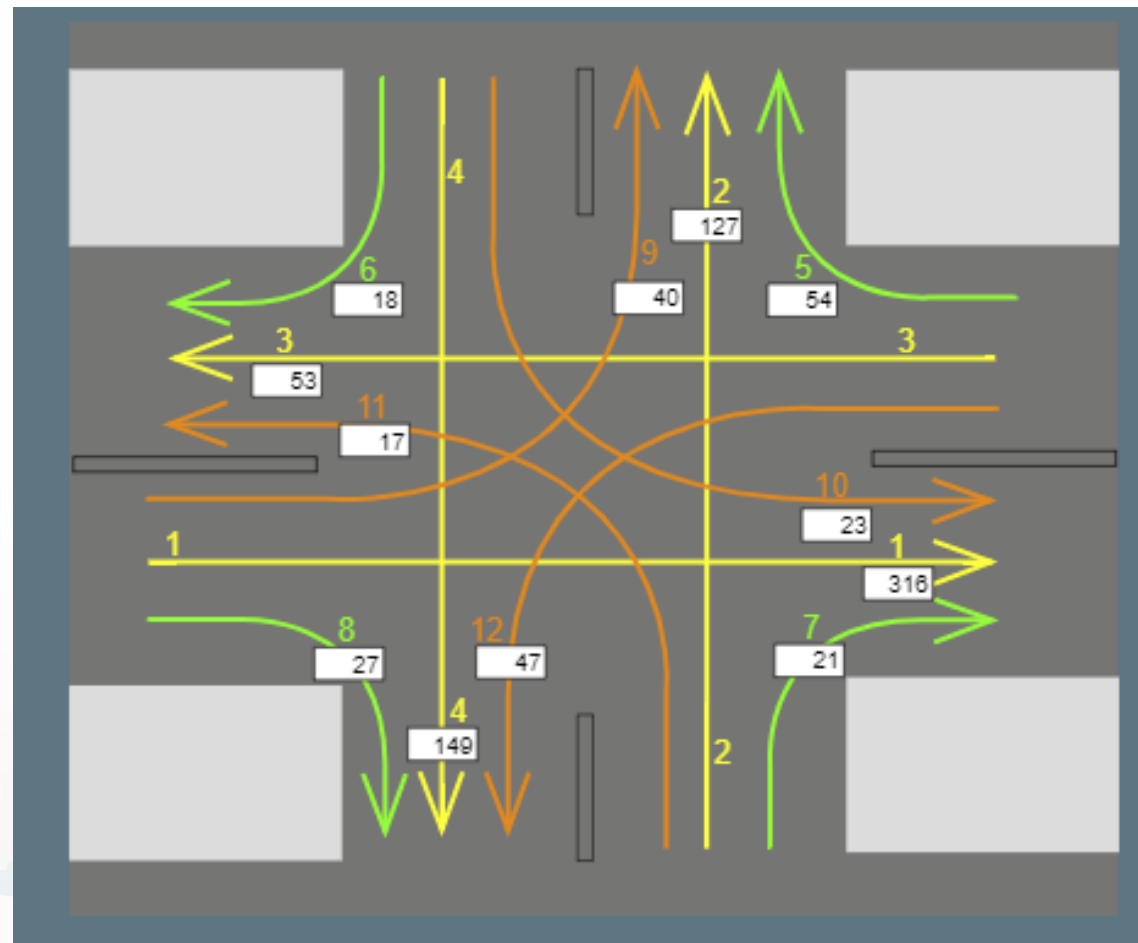
11 SUSTAINABLE CITIES
AND COMMUNITIES



Real time Clustering: legenda and synoptic



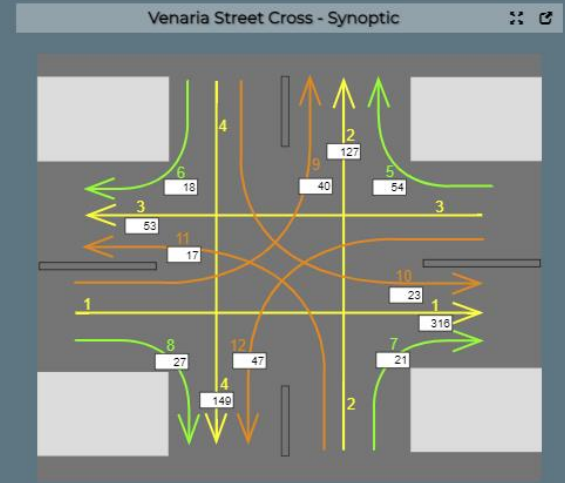
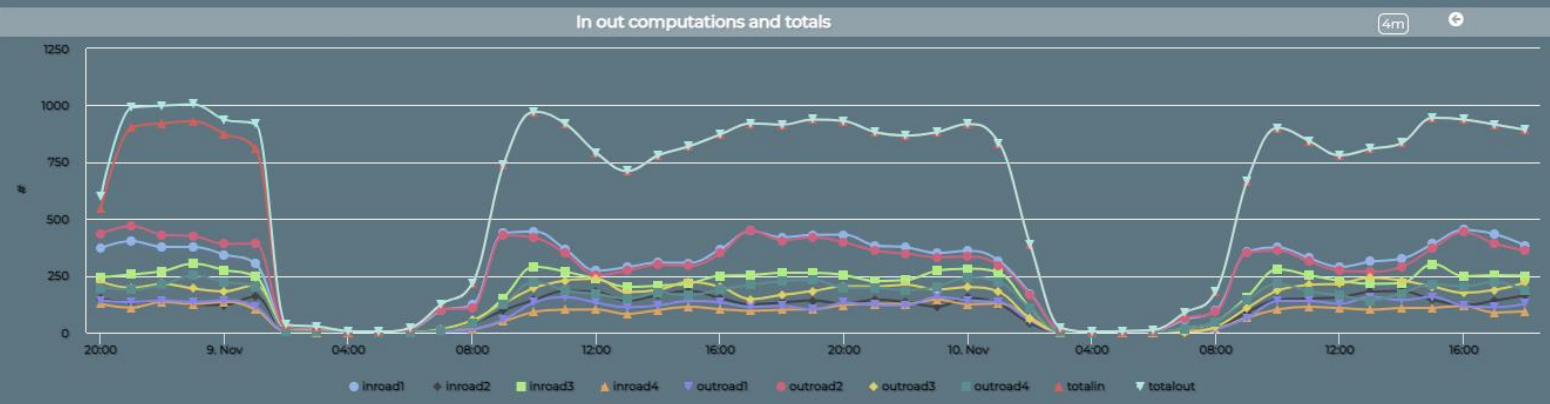
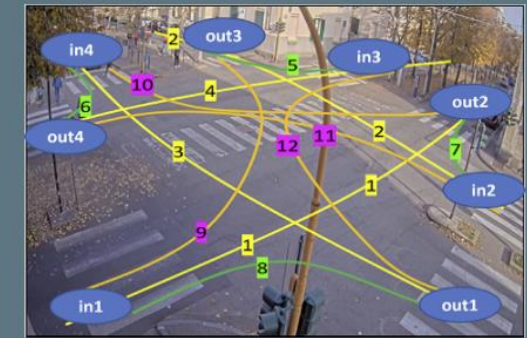
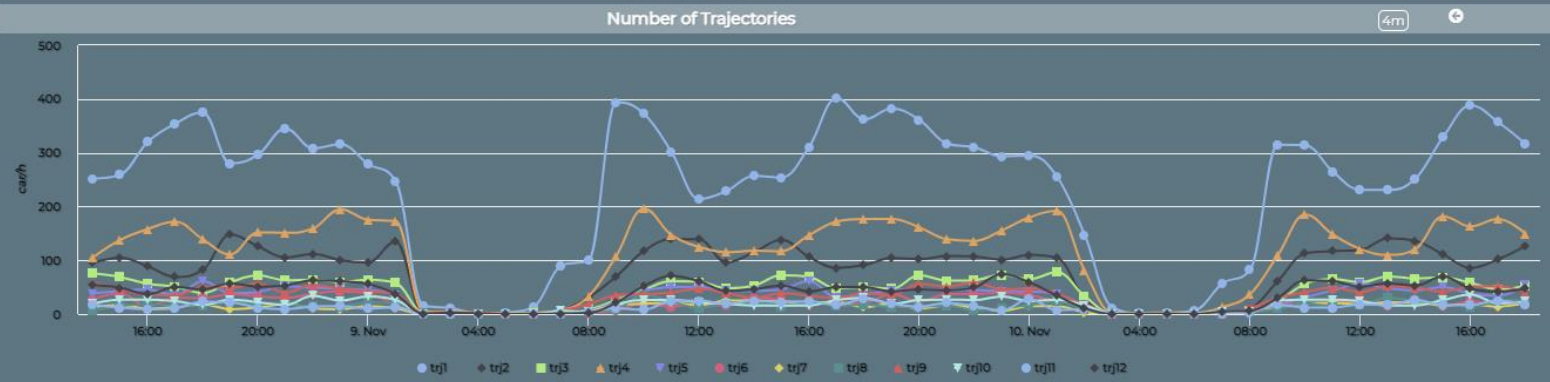
Legenda



Synoptic with real time data

Monitoring Cross Road Venaria - (AXIS Camera)

Wed 10 Nov 18:50:53



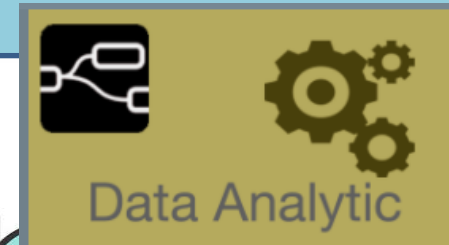
<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MzI5Ng==>

Public Transport Offer

11 SUSTAINABLE CITIES
AND COMMUNITIES



13 CLIMATE
ACTION



Data Analytic



Public Transport Offer

- Via
 - Dashboards
 - MicroApplications
 - Mobile Apps
 - ServiceMap

Public Transport Information/file/streams

- **Other sources as ODM and POI: parking, sharing, etc.**
- **Models used for:** busses, train, ferry, metro, tramways, etc.
- **Include:**
 - Public Transport Lines, Rides with paths and timeline, stops, polylines for paths, etc.
 - real time data about the position of the vehicles: train, busses, etc.
 - Multi operator data
- **Information is modelled as**
 - **GTFS** format: multiple files in XML
 - **Transmodel** format
 - **Netex** format
- **GTFS files can be ingested on Snap4City via**
 - **Python** which takes GTFS files and convert them in triples «.n3» file for the Knowledge Base
 - https://github.com/disit/smart-city-etl/tree/master/TrasformazioneTPLBus_new_model/Triplification/Models
 - Former version: https://www.snap4city.org/download/snap4cityETL/TPL_bus_gtfs/
 - **GTFS RT can be ingested via IoT App and sent to the Broker**
 - **Chouette** and then
 - using a Python developed by **Snap4City to converter** to produce Triples for the Knowledge Base, service map
 - <https://github.com/disit/snap4city/blob/master/Snap4CityGTFS/chouette-gtfs-n3.py>
- **Transmodel (EN12896) or Neptune files can be ingested in Snap4City via**
 - **Chouette** and then, with a certain level of adaptation,
 - using a Python developed by **Snap4City to converter** to produce Triples for the Knowledge Base, service map
 - <https://github.com/disit/snap4city/blob/master/Snap4CityGTFS/chouette-gtfs-n3.py>

Origin Destination Matrices

11 SUSTAINABLE CITIES
AND COMMUNITIES



13 CLIMATE
ACTION



ODM, Traffic Flow

ODM Origin Destination Matrices

Selectornew

- Admin Areas
- Areas or grids
- Traffic Sensors
- Traffic Flow
- Traffic Flow Manager New

Map

Flow

0-2%
2-3%
3-4%
4-5%
5-6%
6-7%
7-8%
8-9%
9-10%
10-100%

Origin-Destination Map Controls:

- Show all polygons: ON
- Time period: week
- Precision: municipality
- Flow: outflow
- Max Opacity: 0.6
- 2022-07-07 00:00:00
- week

Traffic Heatmap Controls:

- 24H
- Max Opacity: 1
- 2023-11-01 03:00:00

<https://www.snap4city.org/dashboardSmartCity/view/Gea-Night.php?iddashboard=Mzk3Nw==>

ODM Origin Destination Matrices

Wed 1 Nov 10:50:01

Select or new

- ▶ Admin Areas >
- ▶ Areas or grids >
- ▶ Traffic Sensors >
- ▶ Traffic Flow >
- ▶ Traffic Flow Manager New >

Map

+
-
13

Origin-Destination Map

Controls:

Show all polygons: ON

Time period: week Start

Precision: municipality

Flow: outflow

Max Opacity: 0.32

< Prev 2022-07-07 00:00:00
<< week

FirenzeFIPILITrafficRealtime

Traffic Heatmap Controls: 24H

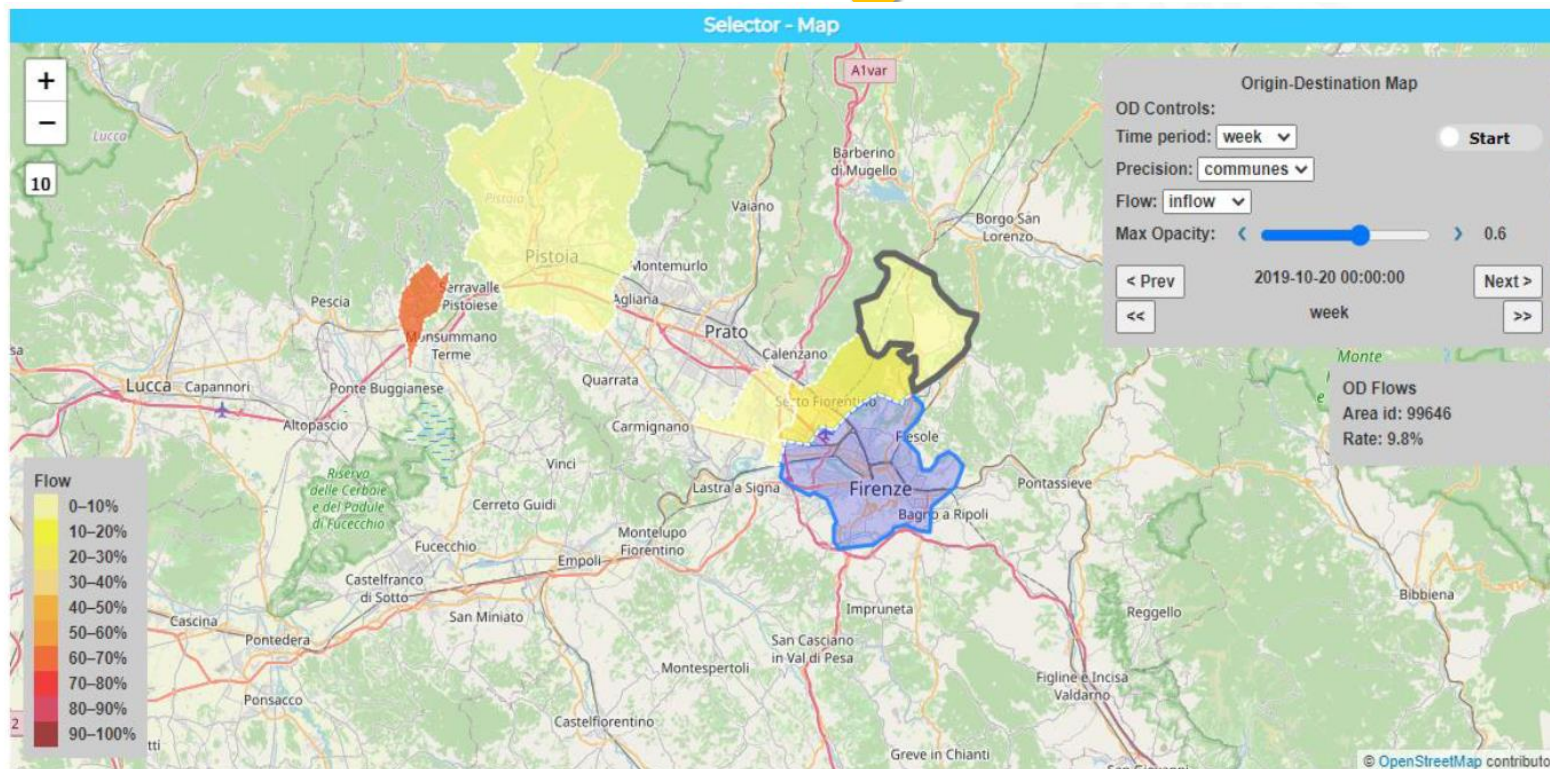
Max Opacity: 1

< Prev 2023-11-01 03:00:00

My Profile

[Privacy Policy](#) [Cookies Policy](#) [Terms and Conditions](#) [Contact us](#)

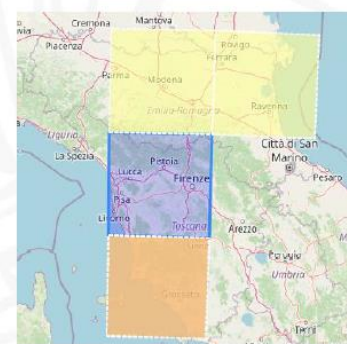
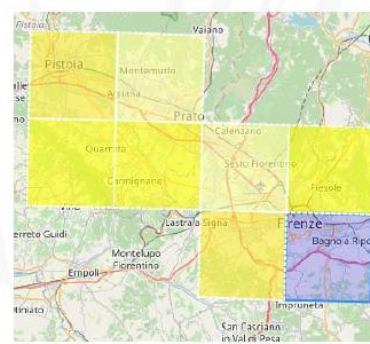
Different Origin Destination Matrices



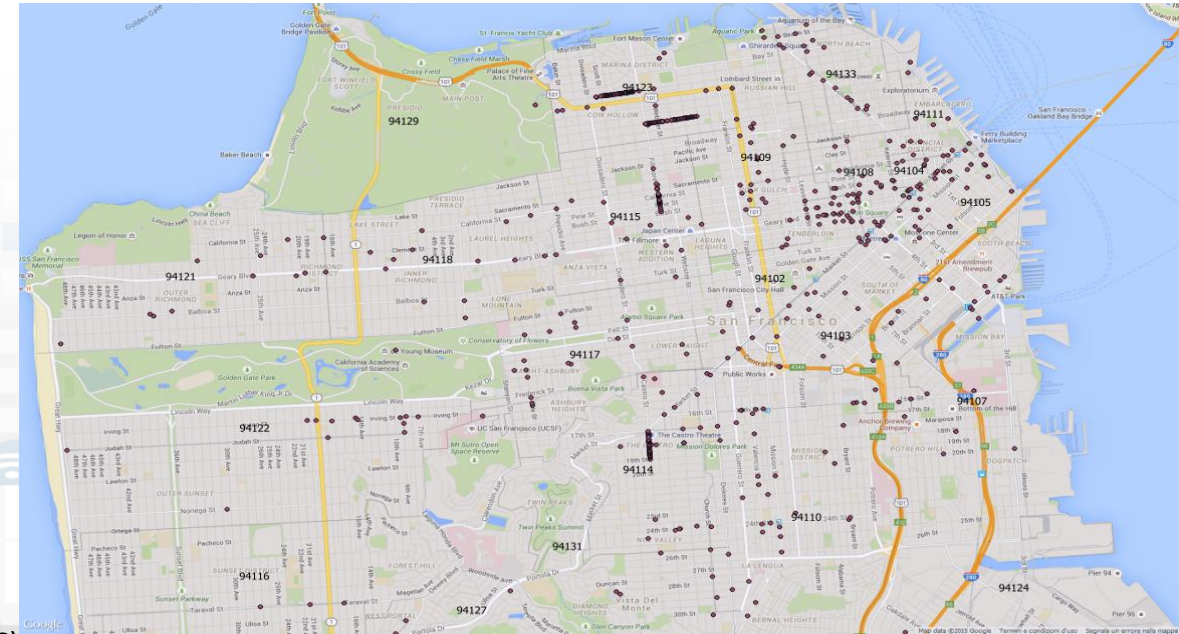
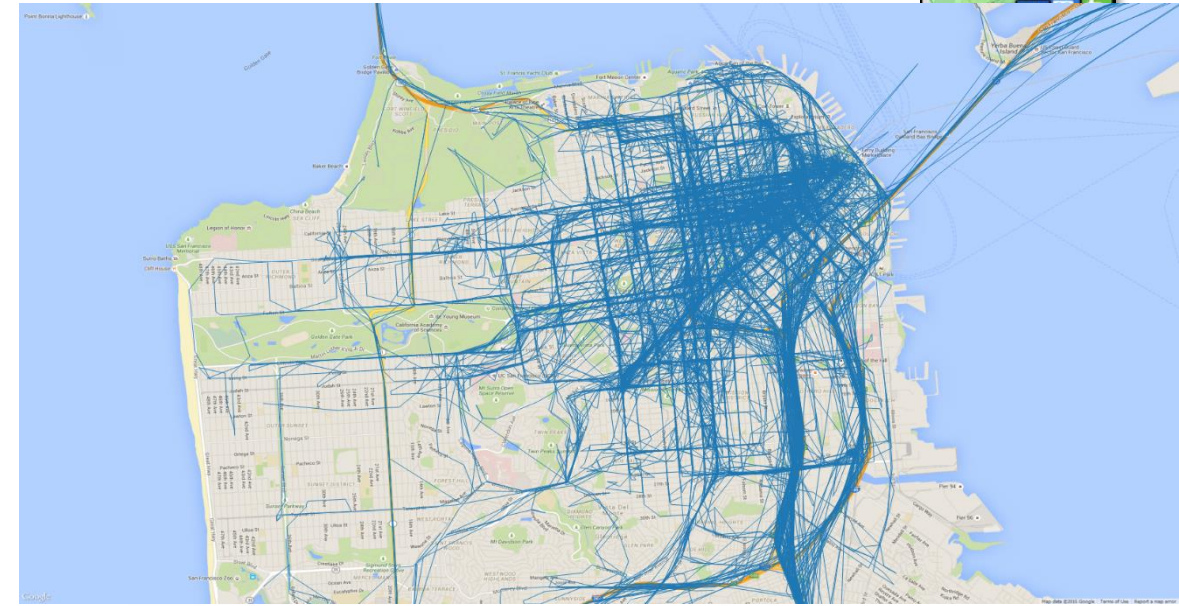
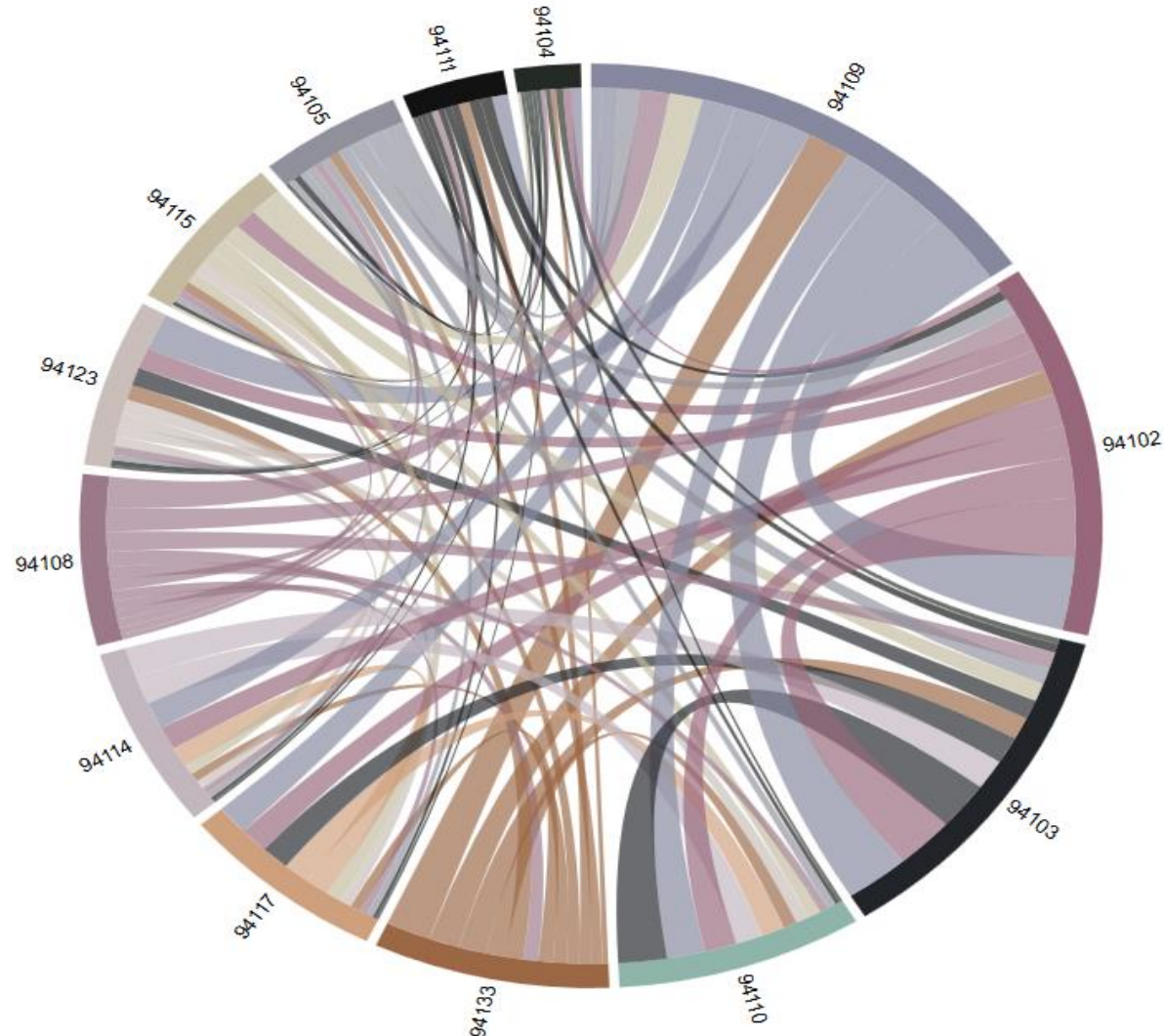
- Get specific value
- Time window
- Opacity
- Animation
- Inflow/outflow
- Sequence of OD matrices: next/prev

shapes

- Shapes: city, region, territories, etc.
 - GADM <https://gadm.org/>, and ACE
- Squared MGRS:
 - 1m, 10m, 100m, 1Km, 10Km, 100Km



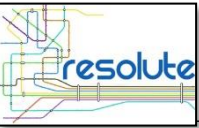
San Francisco



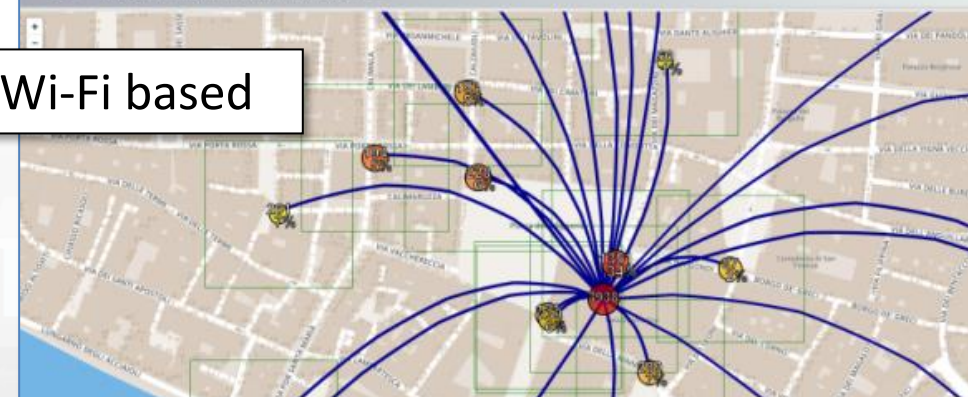
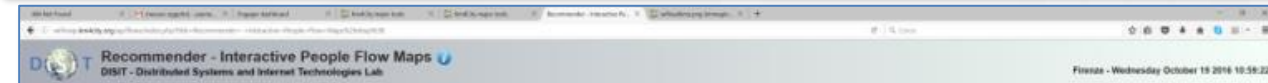
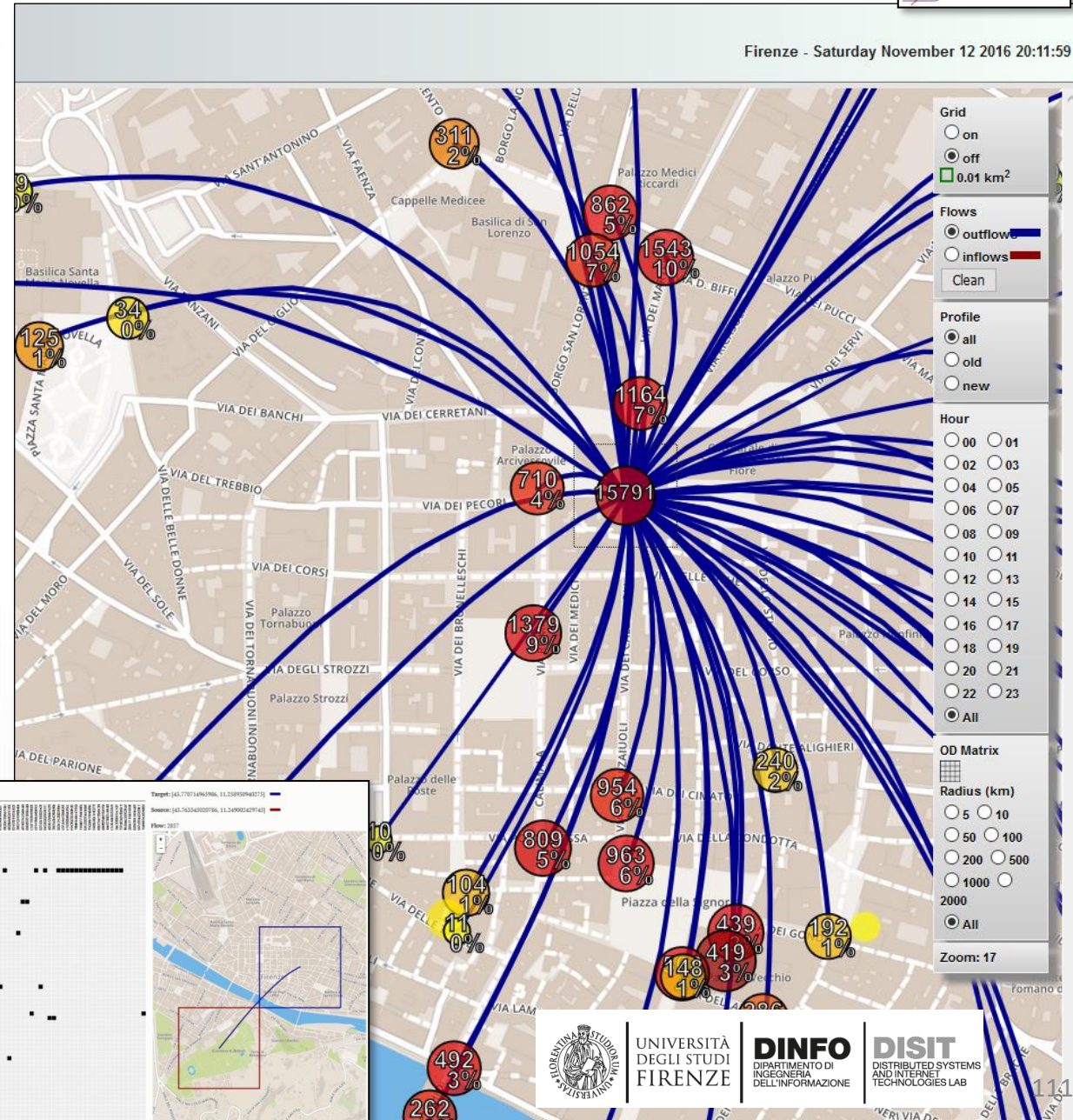
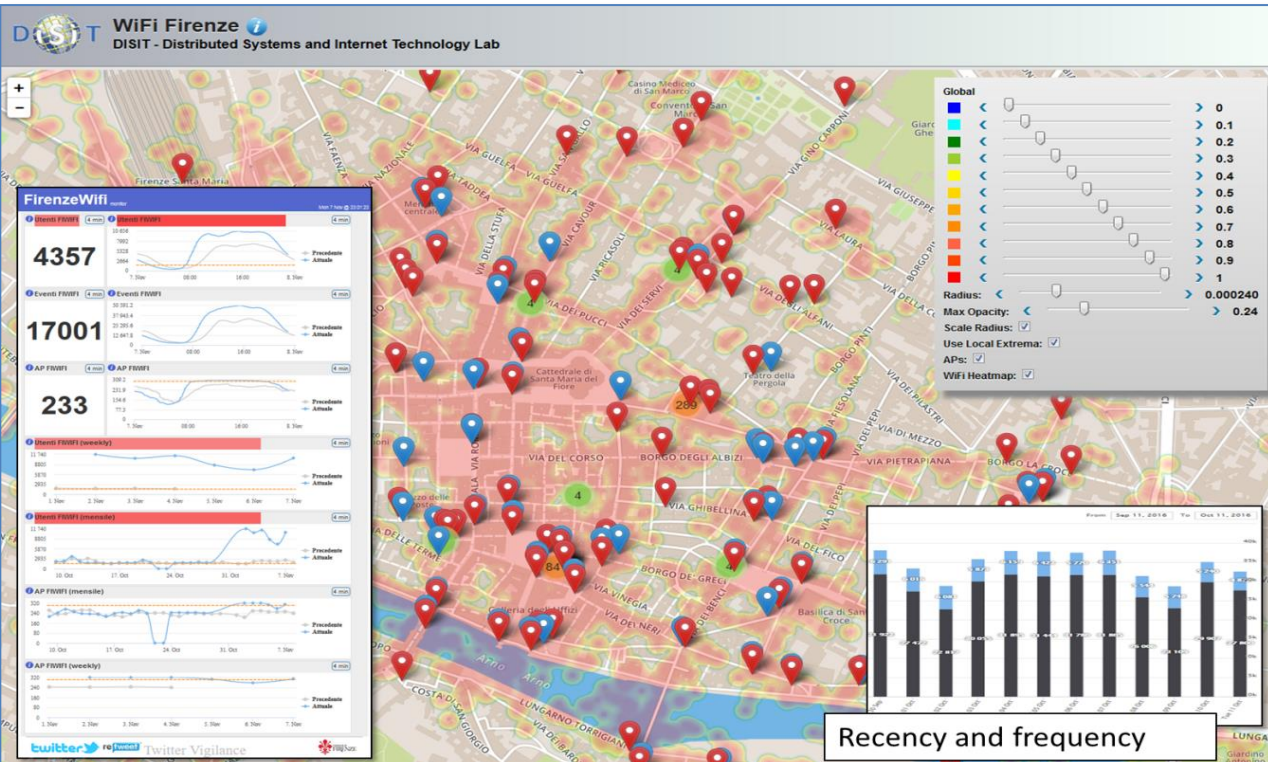
San Francisco OD matrix as a chord diagram, from TAXI OBU data

- 13 central ZIP areas of the city (real cab flows),
- ONLY on FLOW: from to

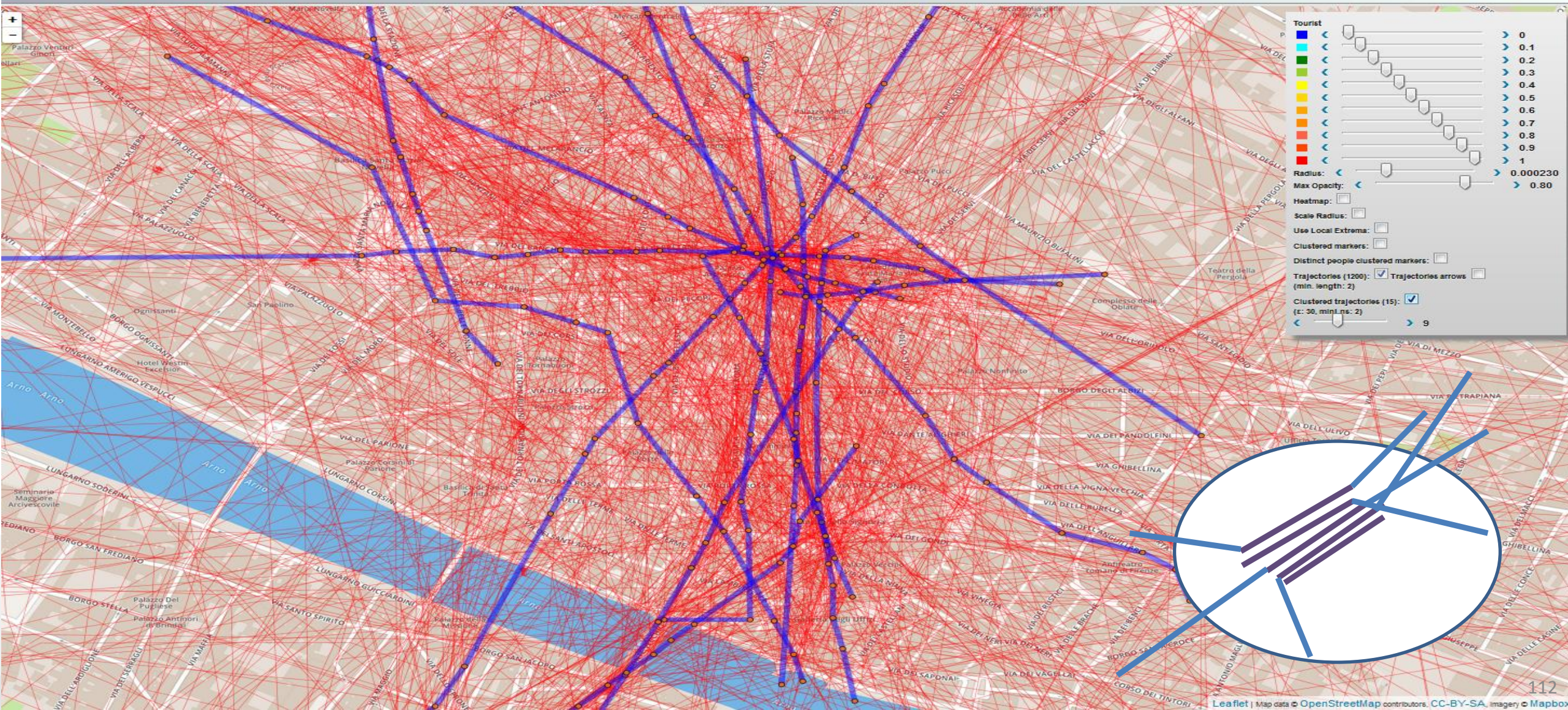
Origin Destination Matrix Estimation



Firenze - Saturday November 12 2016 20:11:59



Cluster di Trajectories



Smart Parking

11 SUSTAINABLE CITIES
AND COMMUNITIES



13 CLIMATE
ACTION



Data Analytic



Smart Parking

- **Main features**

- On-road and off-road, multiple sensors kinds
- Profiled parking slots: regular, residential, disable, charging, forbidden, etc.
- Multiple: areas, cities, and business models/profiles
- Multiple payment modalities and wallets
- User profiling and models
- Fine detection and management, overparking, etc.



- **Mobile App** for City Users and on road Operators
- **Smart Parking Manager:** operator controller and notifications to on-road operators

Road Parking



Parking Conditions Monitoring

Mon 23 Sep 16:47:53



- Status of Slots >
- Types of Slots >
- As Pins >
- Geolocation >
- Parking Zone >

Parking Slots

PARKINGSLOT_4515

DETAILS DESCRIPTION RT DATA

Last update: 2024-09-17 15:14:33.590+02:00

Description	Value	Buttons
dateObserved	2024-09-17T13:08:33.357Z	Last 4h 24h 7d 30d 6m
geometry	{ "coordinates": [[[[11.11...]]]] }	Last 4h 24h 7d 30d 6m
groupid	alberti_13	Last 4h 24h 7d 30d 6m
parkingstatcolor	19	Last 4h 24h 7d 30d 6m
parkingtypecolor	16	Last 4h 24h 7d 30d 6m
sensorId	sensor_24	Last 4h 24h 7d 30d 6m
slotType	handicap	Last 4h 24h 7d 30d 6m
status	BUSY	Last 4h 24h 7d 30d 6m
vehicleType	car	Last 4h 24h 7d 30d 6m

Total Parking KPIs

Total free slots:	33
Total occupied slots:	87
Total busy authorized:	12
Total busy paid users:	41
Total busy paid anon:	28
Total busy paid anon over:	6
Total fined cars:	3
Total to be fined:	1
Total forbidden:	2

PARKINGSLOTAREA - Free Slots Trend

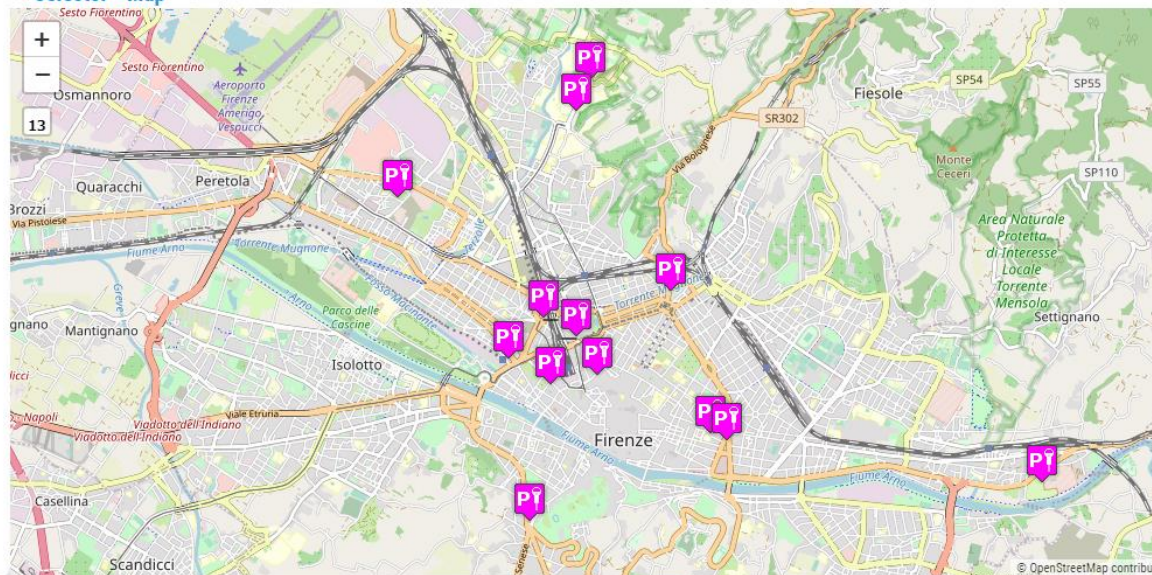


Management

Selector

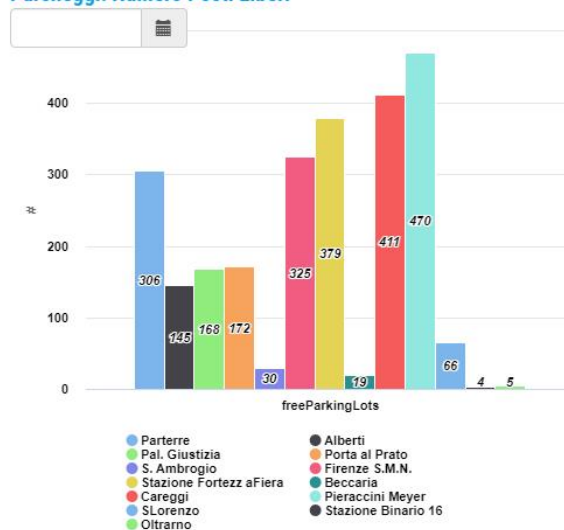
- Parterre
- Piazza Alberti
- Palazzo di Giustizia
- Porta al Prato
- S. Ambrogio
- Stazione Firenze S.M.N.
- Stazione Fortezza Fiera
- Piazza Beccaria

Selector - Map



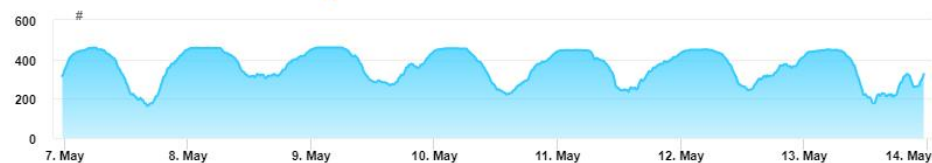
Parcheggi: Numero Posti Liberi

4m



Stazione Firenze S.M.N. - Free Parking Lots

9m



Andamento Posti Occupati

4m



Smart City / Smart Parking + Environment

Reverberi, Lonato del Garda



reference

- **Multiple Domain Data**

- Smart Parking, Environment, Wi-Fi

- **Multiple Decision Makers**

- City Officer, operators
- Data monitoring, alerting
- analytics

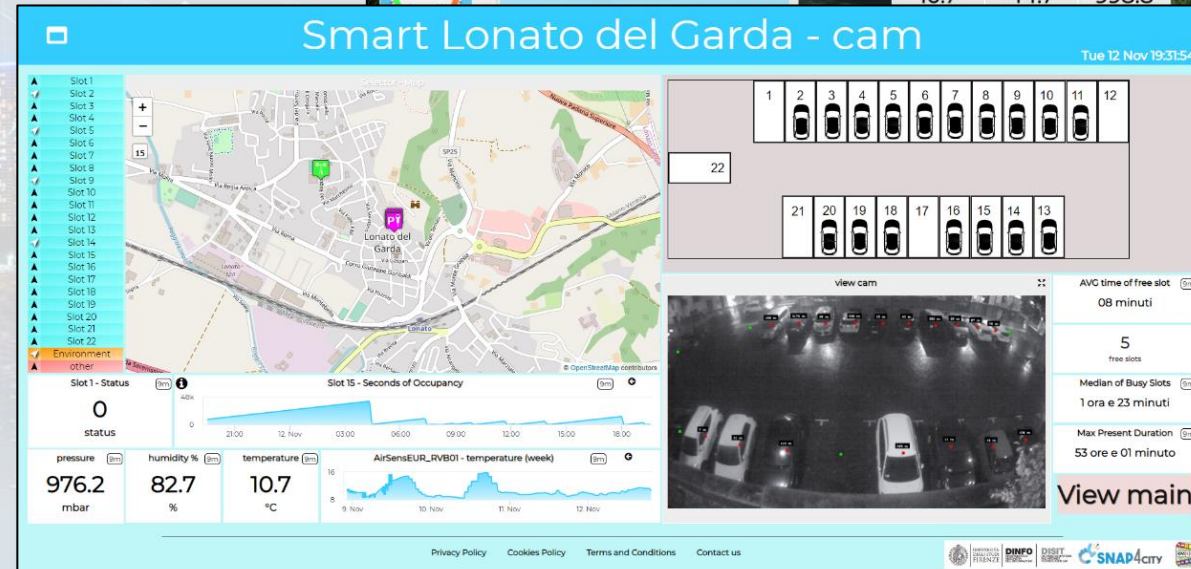
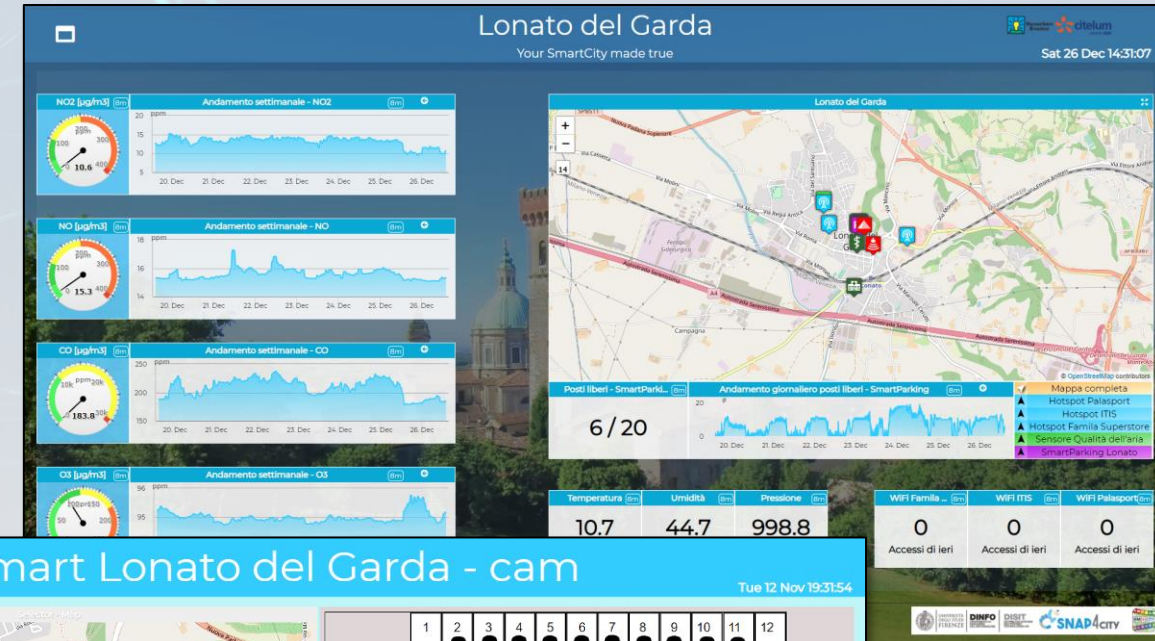
- **Historical and Real Time data**

- Dashboards

- **Services Exploited on:**

- Dashboards, API

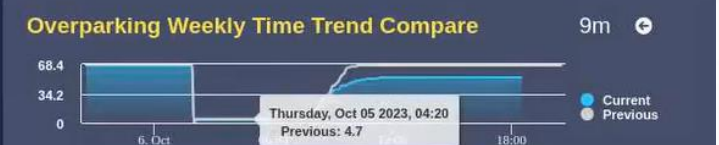
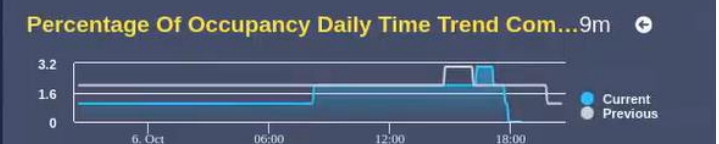
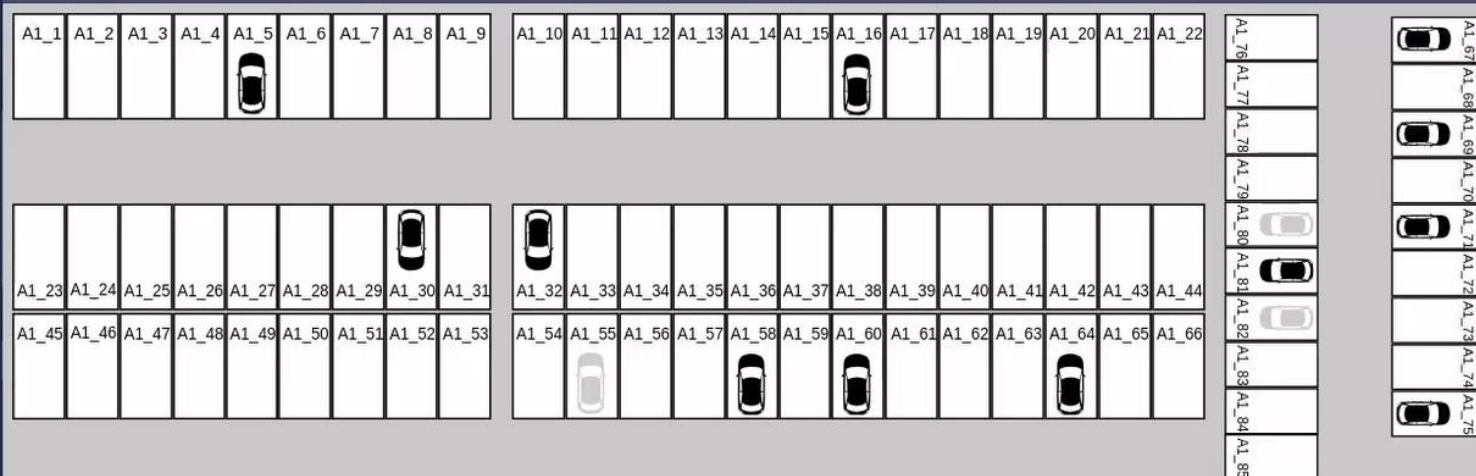
- **Since 2019**



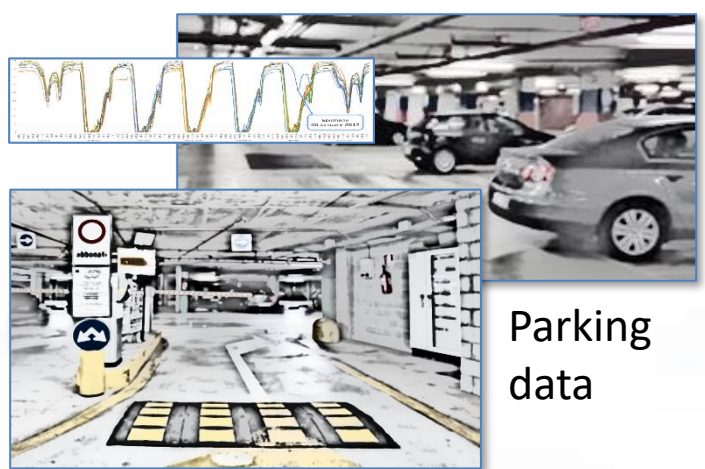
Snap4ISPRA Parking

Parking 58C

Fri 6 Oct 18:33:41



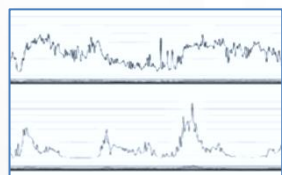
Deep Learning AI to surely Park!



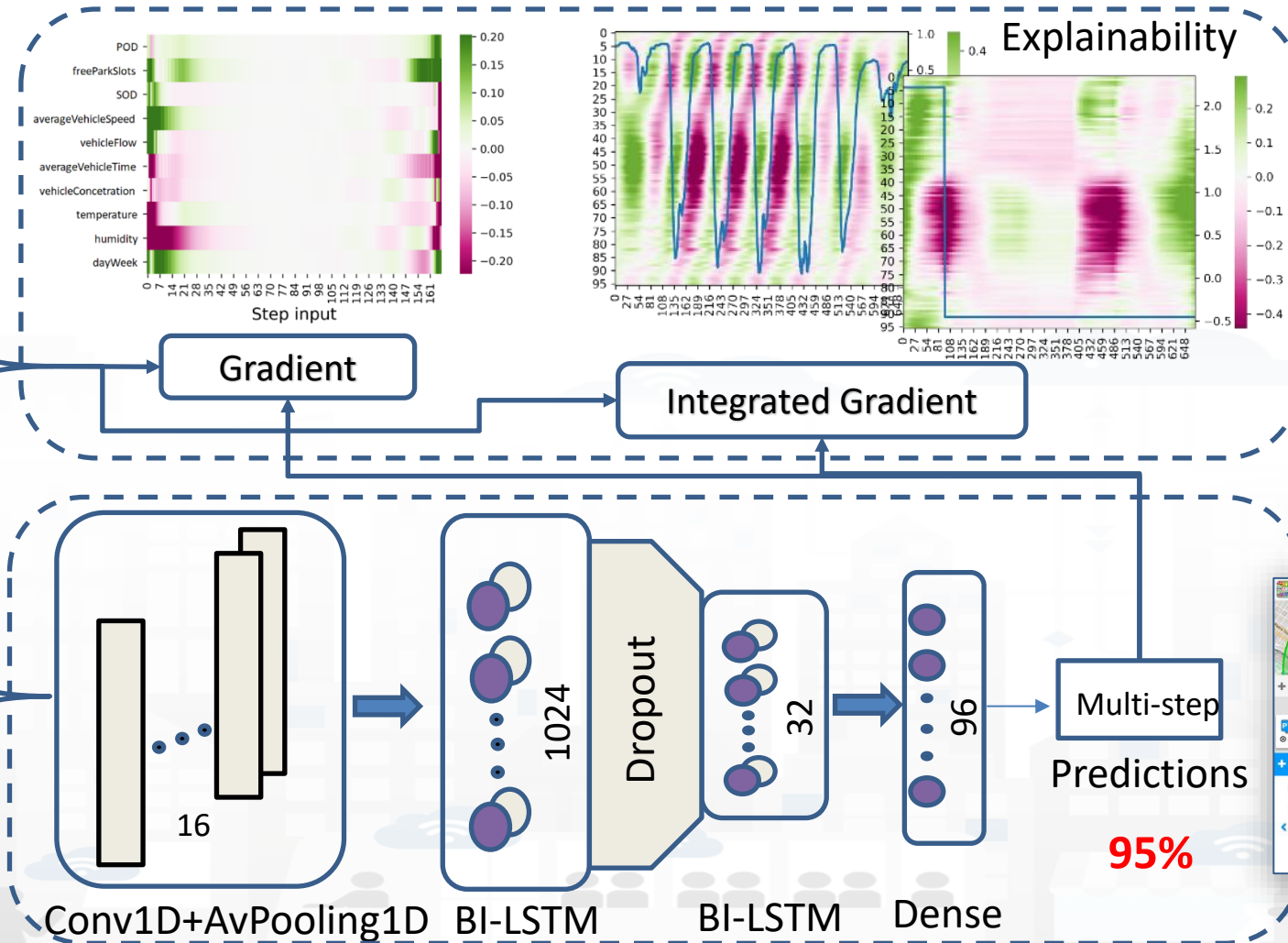
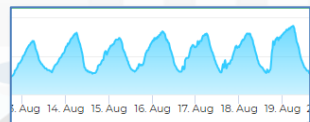
Parking data



Traffic sensors data



Weather Features



Smart Bike

Free Bike predictions

11 SUSTAINABLE CITIES
AND COMMUNITIES

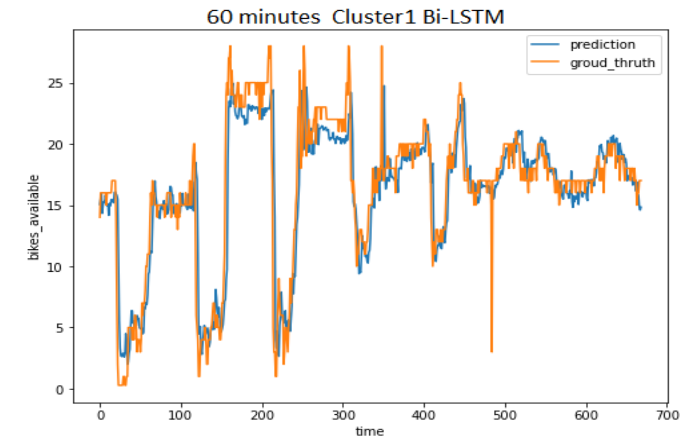
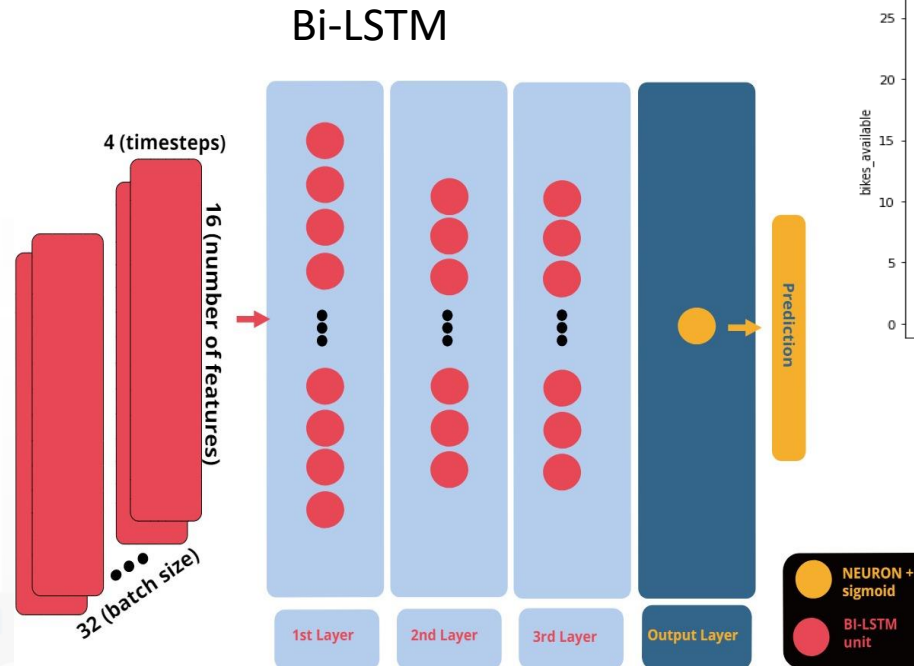


13 CLIMATE
ACTION



Data Analytic

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



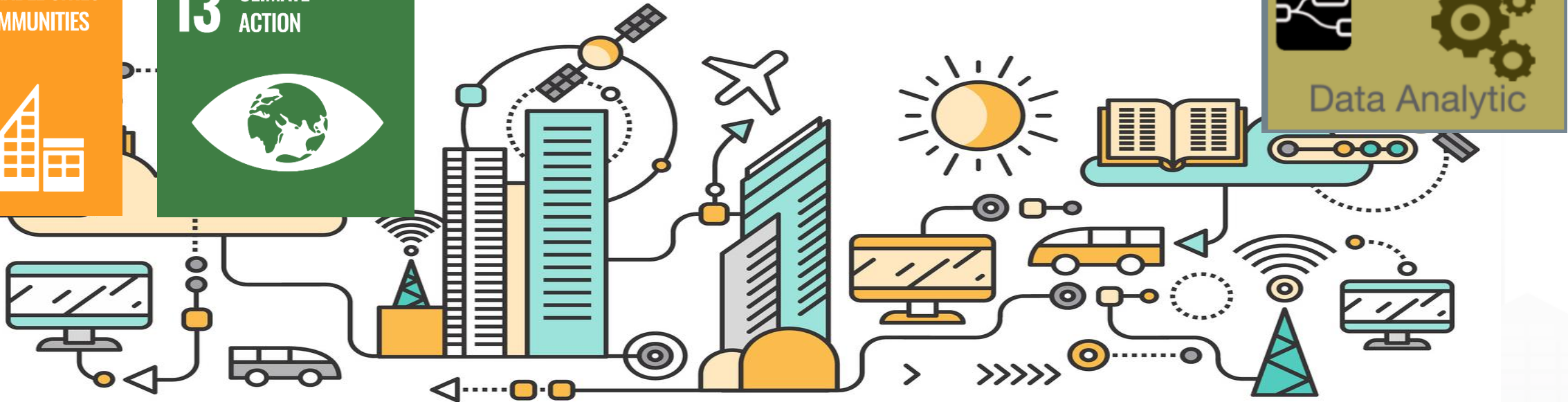
E. Collini, P. Nesi and G. Pantaleo, "Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations," in *IEEE Access*, vol. 9, pp. 124337-124347, 2021, doi: 10.1109/ACCESS.2021.3110794.
<https://ieeexplore.ieee.org/abstract/document/9530580>

Public Transport Analysis

11 SUSTAINABLE CITIES
AND COMMUNITIES



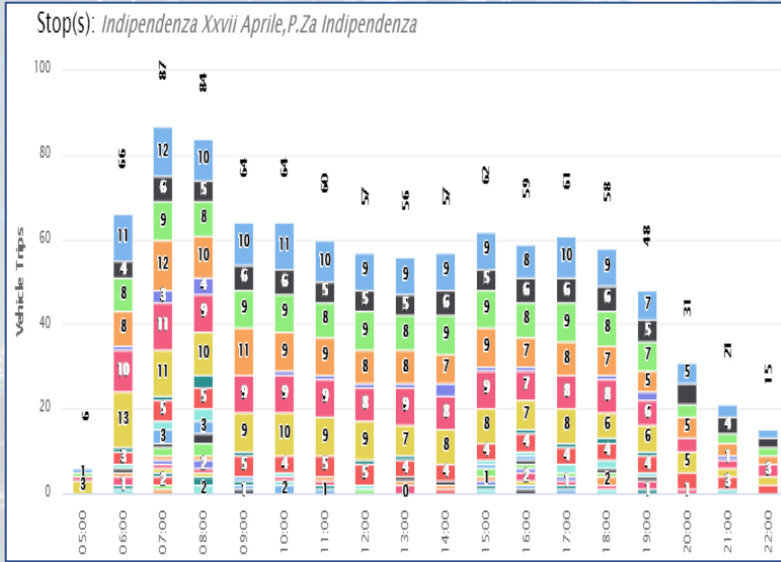
13 CLIMATE
ACTION



What-if Analysis on Pub Transport

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

Public Services



Welcome to DORAM powered by SNAP4CITY

Services: 36 on 36 available

The public transportation system has been analyzed in the City, considering the service offer vs. mobility demand. The top-thirty most crowded stops are presented on the right panel and on the map. Please, select your desired scenarios or a stop on the map to perform other analysis.

Type the stop name ... Search

Stop panel

Scenario Selector

Choose a scenario: Actual scenario

Actual scenario: Describes the current status of the public transportation network. (More Info)

Daily Individual Trips > 52000
 Stops > 1900
 Residential Buildings > 31000
 Service Providers > 32000
 Mobility Operators > 10
 Transport Modes = 3

The Most Crowded Stops Select a time slot: 05:00 to 01:59 Search

Indipendenza Xxvii Aprile
P.Za Indipendenza

377
 407
 979

Stazione Nazionale

321
 358

Welcome to DORAM powered by Services: 36 on 36 available

The public transportation system has been analyzed in the City, considering the service offer vs. mobility demand. The top-thirty most crowded stops are presented on the right panel and on the map. Please, select your desired scenarios or a stop on the map to perform other analysis.

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- Daily Individual Trips > 52000
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The Most Crowded Stops

Select a time slot: 05:00 to 01:59 Search

Indipendenza Xxvii Aprile
P.Za Indipendenza

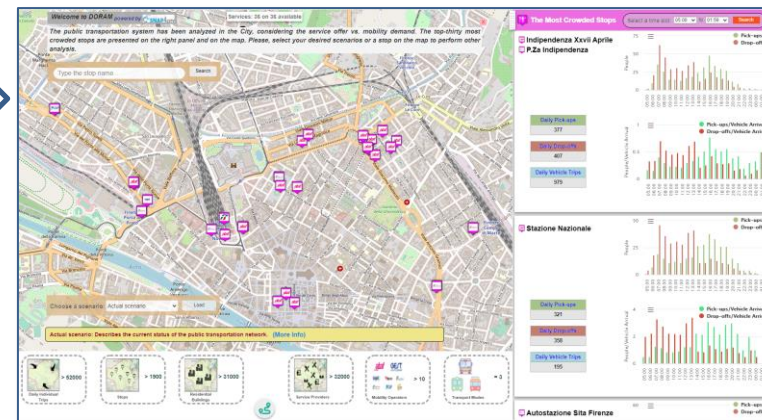
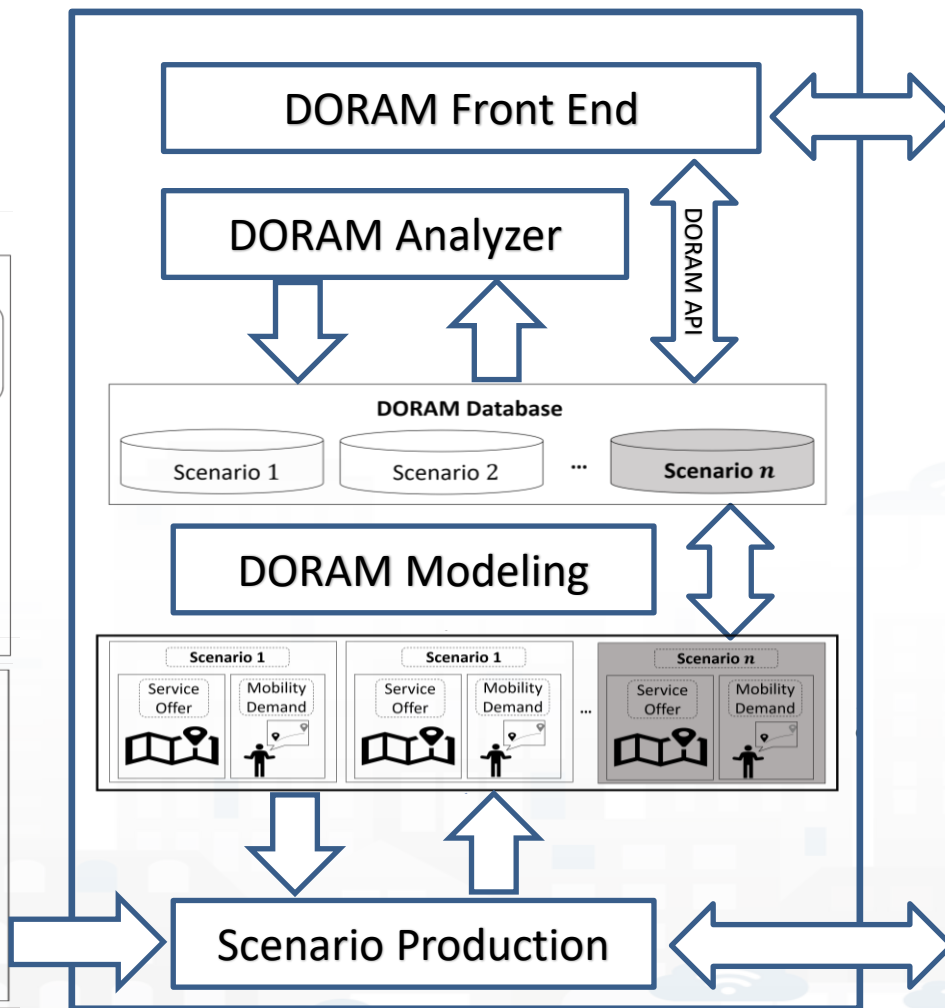
424

Daily Pick-ups	377
Daily Drop-offs	407
Daily Vehicle Trips	979

Stazione Nazionale

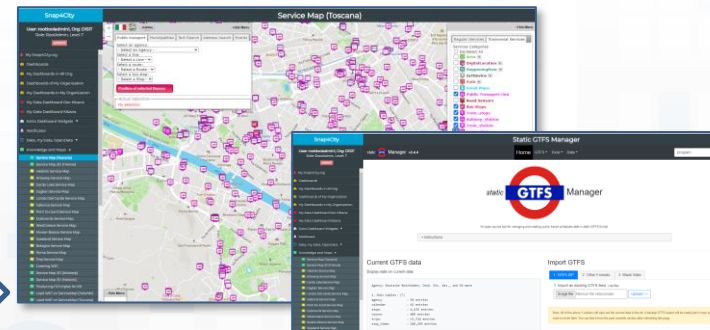
Daily Pick-ups	321
Daily Drop-offs	358
Daily Vehicle Trips	

DORAM



DORAM tool

Snap4City tools for City data



GTFIS Editor and browser

<https://www.snap4city.org/odanalyzer/#b>

User Behavior Analysis

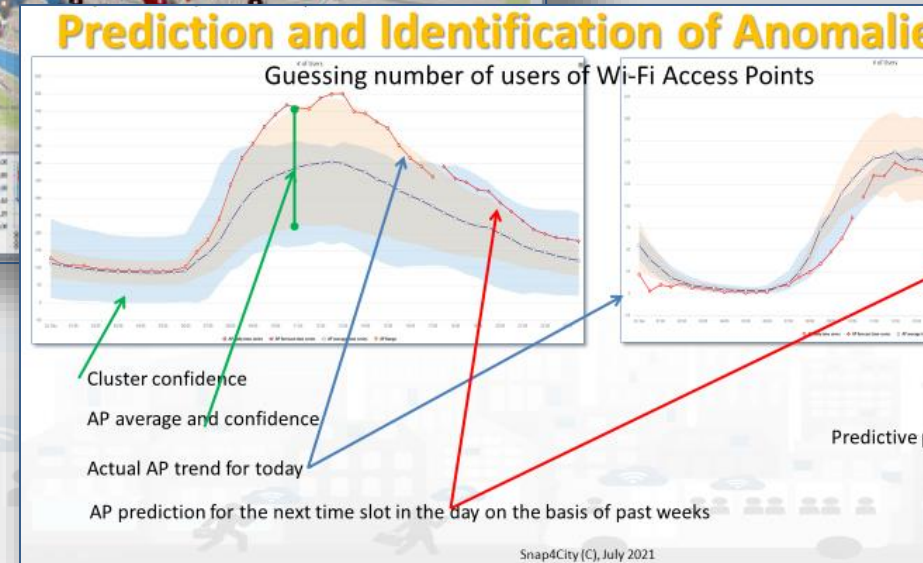
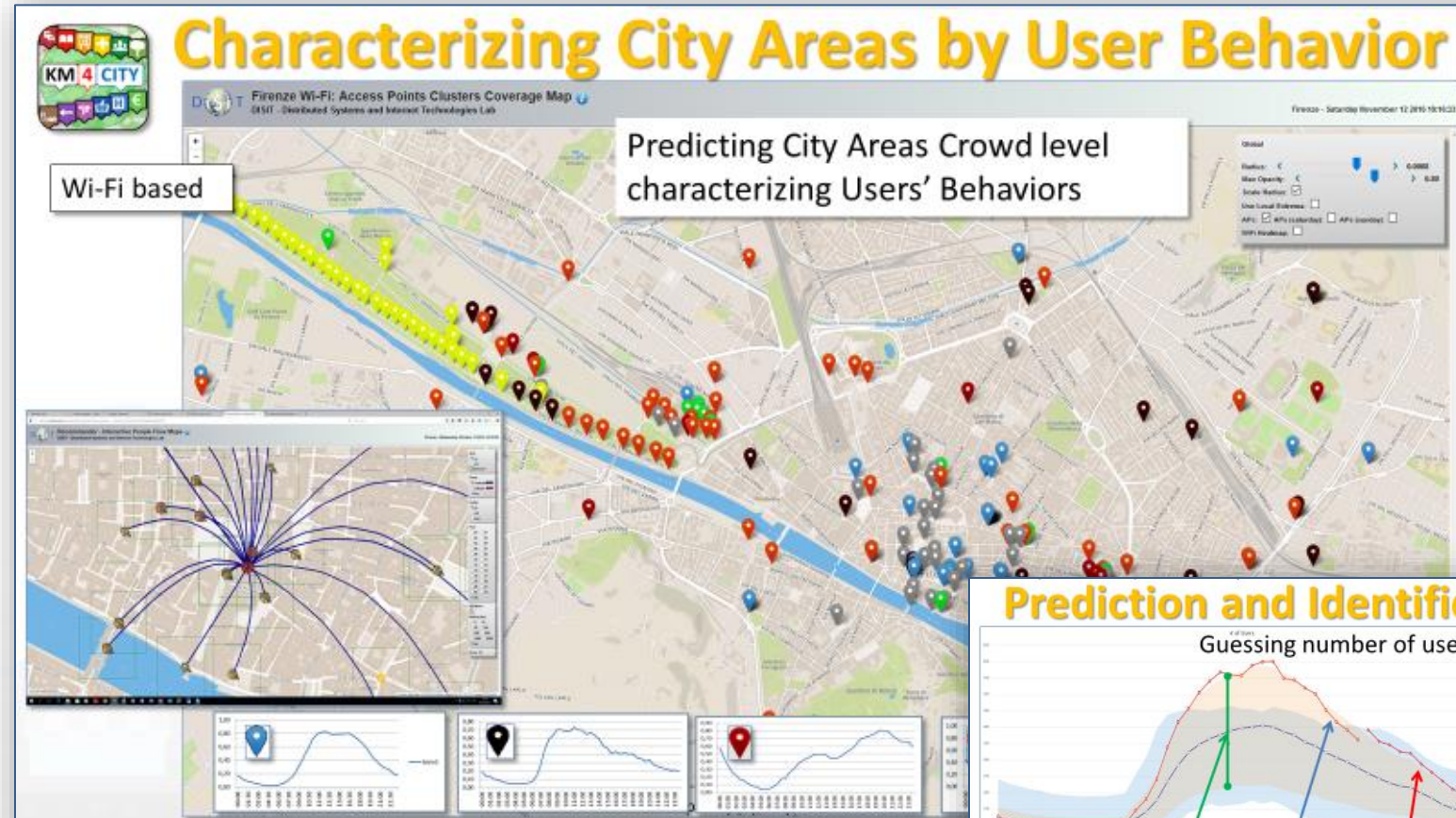
11 SUSTAINABLE CITIES
AND COMMUNITIES

13 CLIMATE
ACTION

Data Analytic

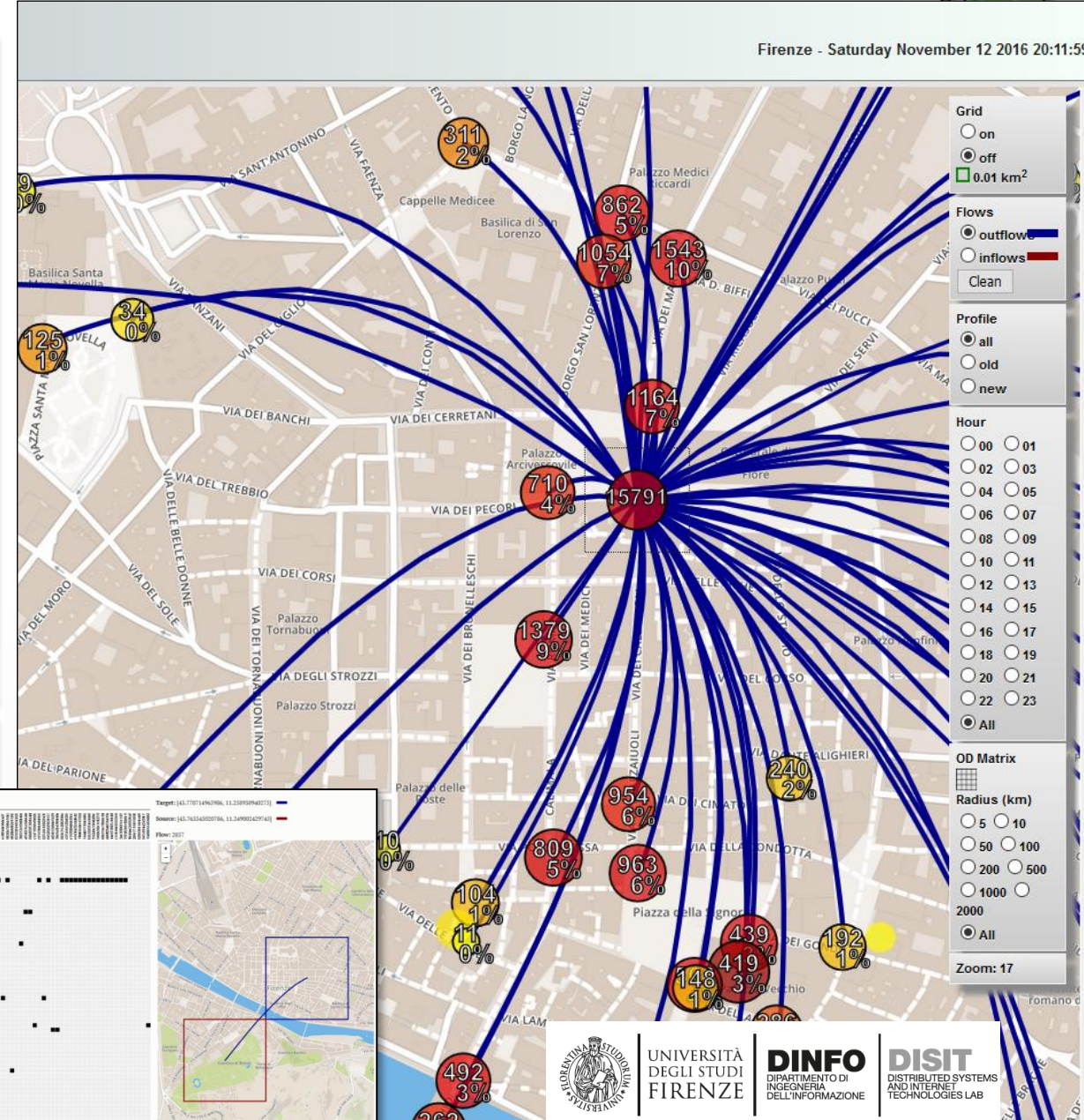
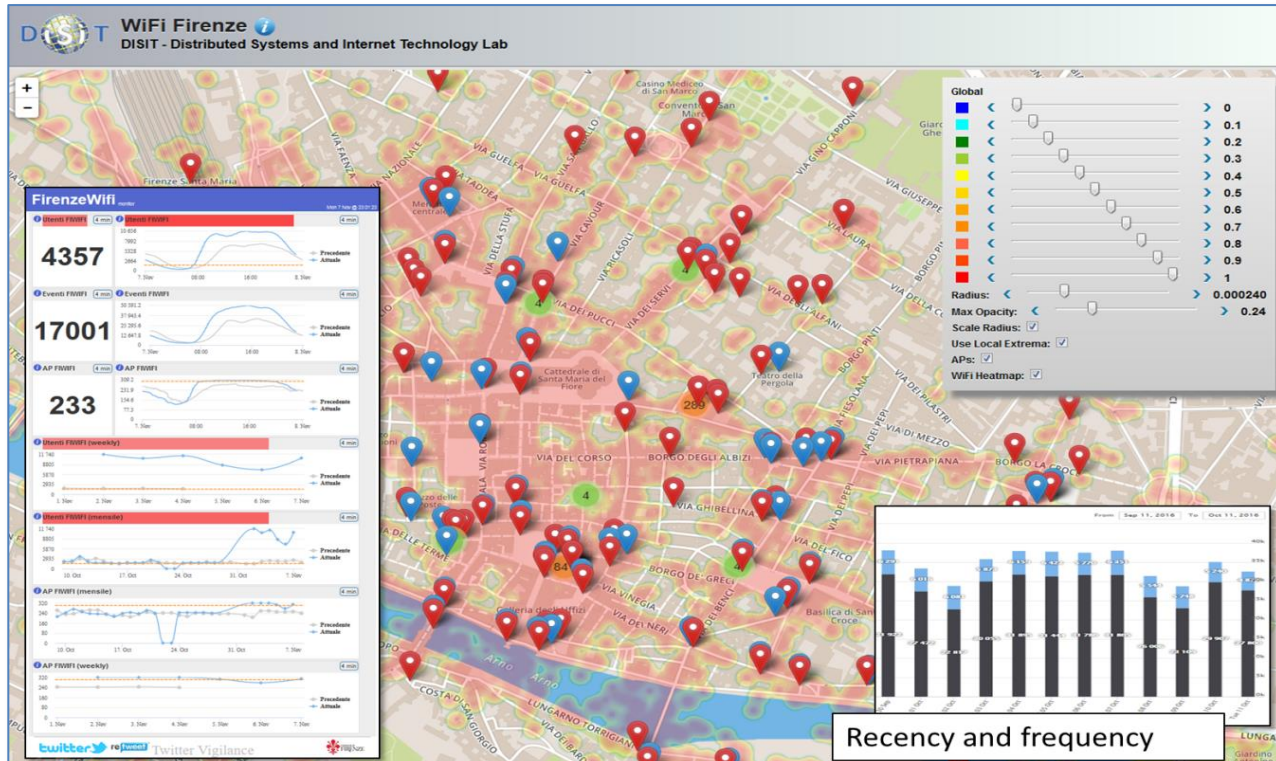


- **Prediction of people flows** on the basis of Wi-Fi data
- **Anomaly detection**
- **Resolute H2020**
- **Classification of city areas**

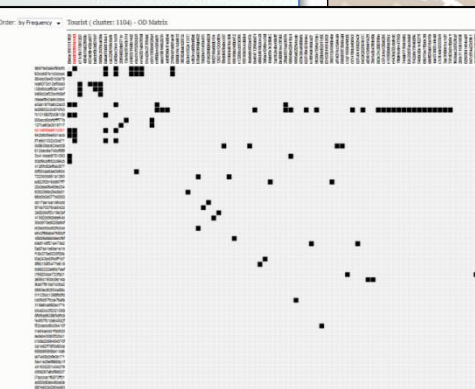
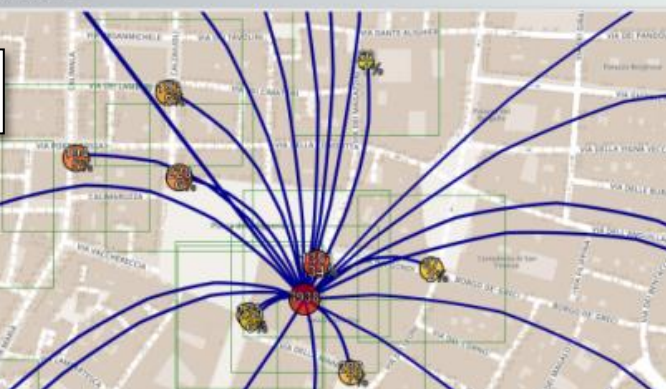


Origin Destination Matrix Estimation

Firenze - Saturday November 12 2016 20:11:59



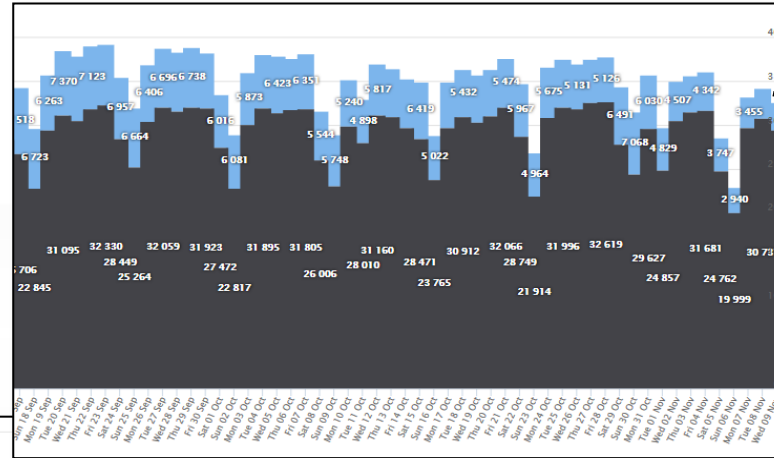
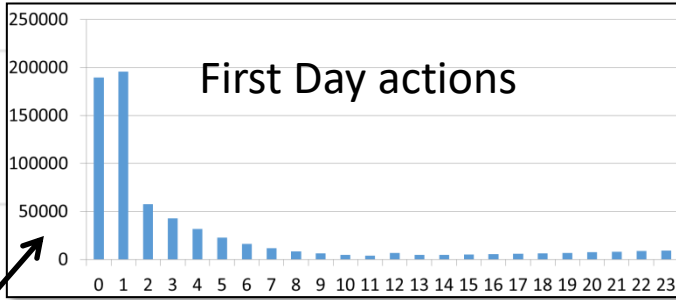
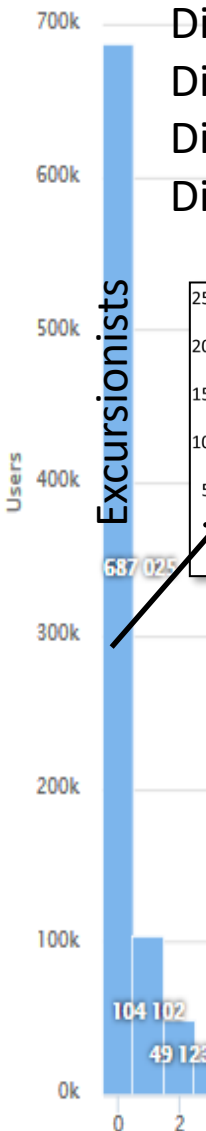
Wi-Fi based



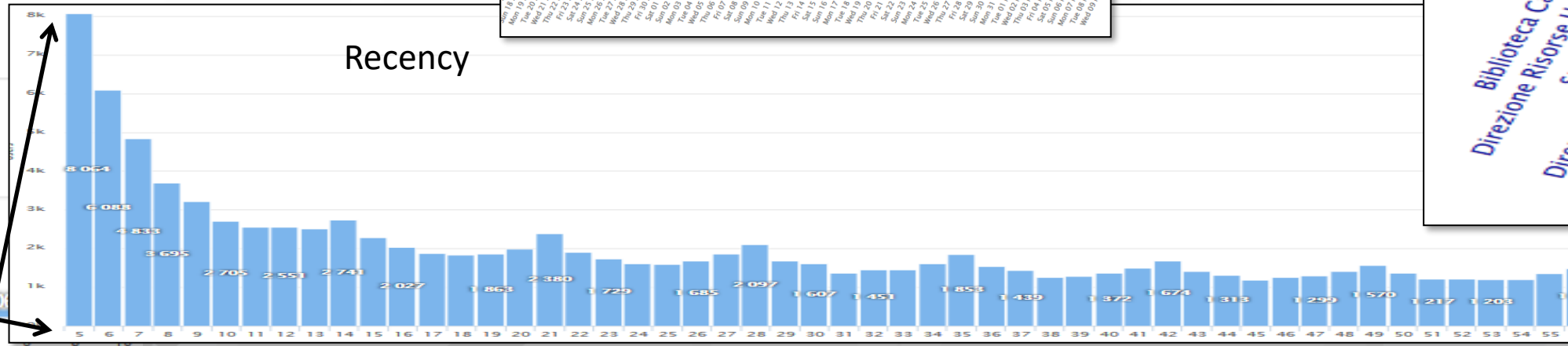
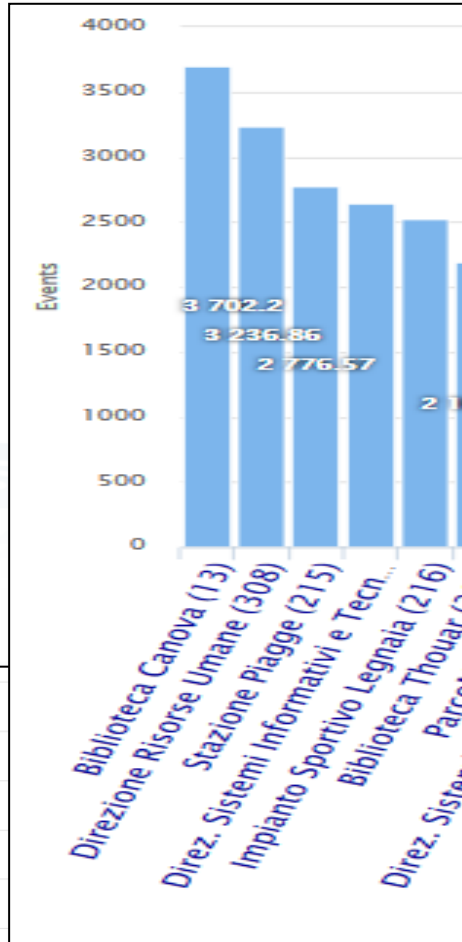
User Behaviour Analysis

Where

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



New City Users
VS
Returning



Tuscany Region

• Dashboards & Services:

- **Mobility:** public transport operators schedule and paths, traffic Fi-Pi-Li main road, parking status and predictions, traffic sensors, Origin Destination matrix, routing, multimodal routing, etc.

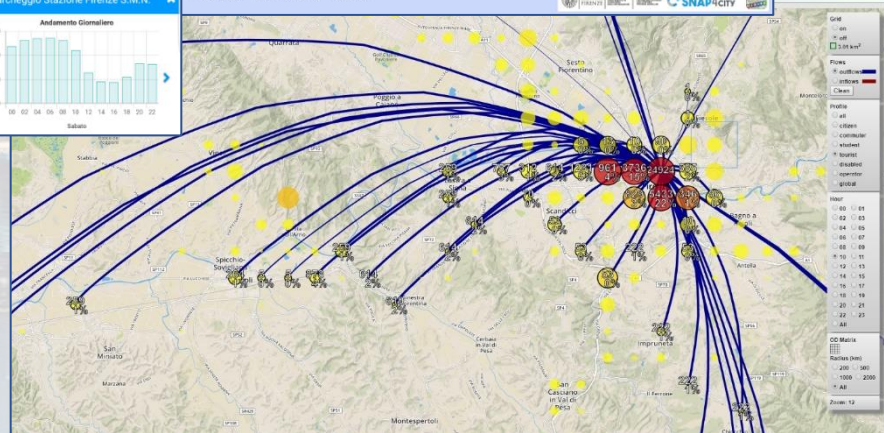
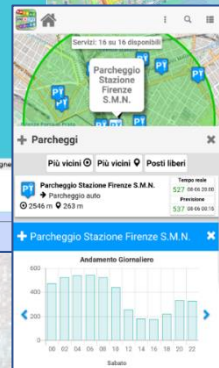
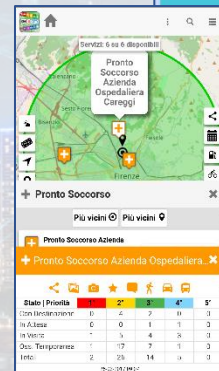
- **Social:** Hospitals and triage, etc.
- **Environment:** sensors, heatmaps, alerting,
 - **Pollution Forecast:** NOX, NO2
 - **Weather Forecast,**
- **Culture and Tourism**
- Etc.

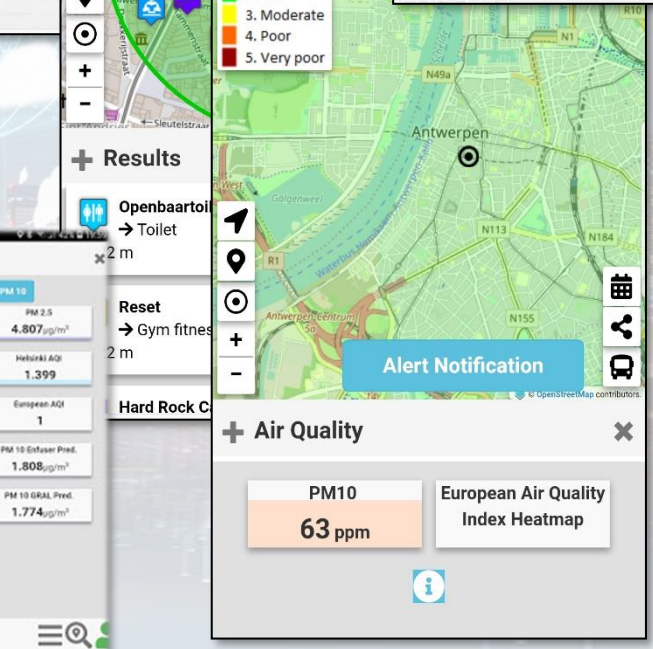
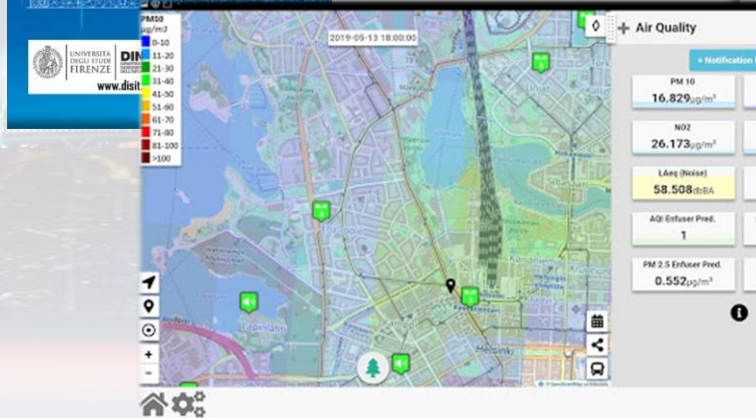
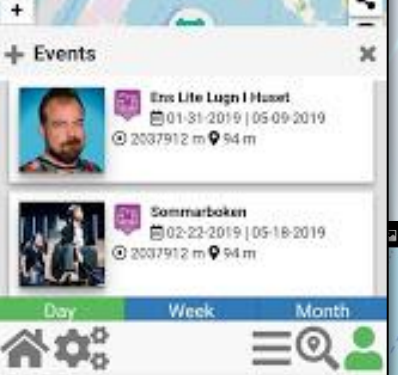
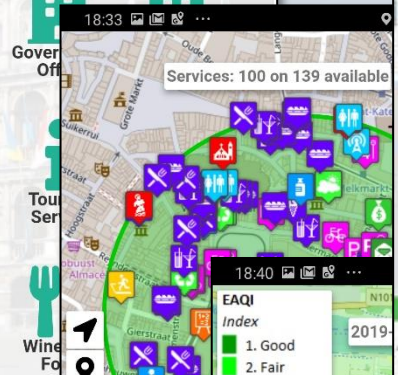
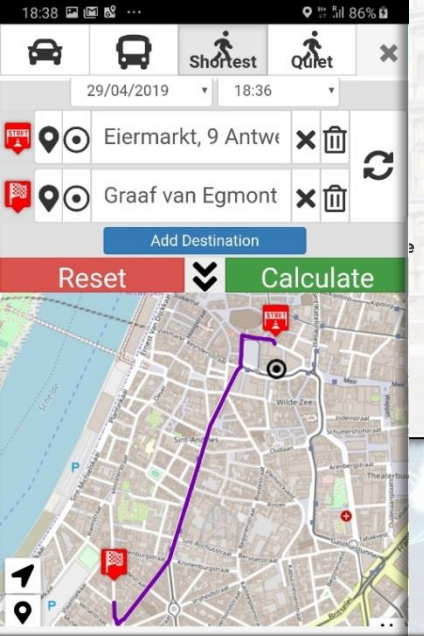
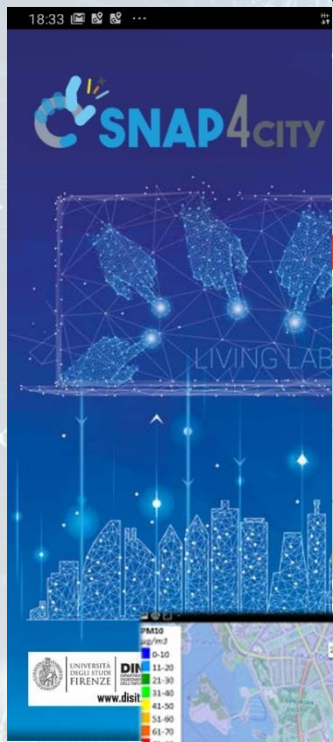
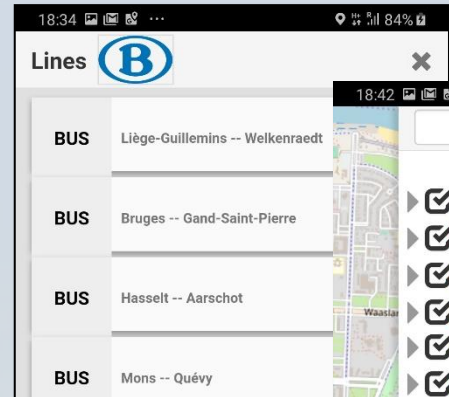
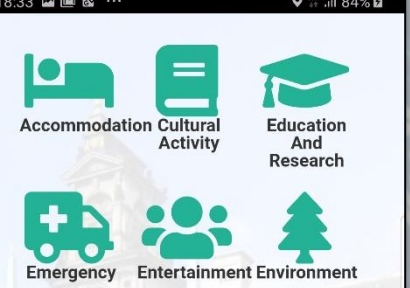
• Mobile App and MicroApplications:

- Tuscany in a Snap (all stores)
- Tuscany where what... km4city (all stores)

• Numbers: 1.5 M complex events per day

Snap4City (C), Sept. 2024







Citizen Engagement via Mobile Apps

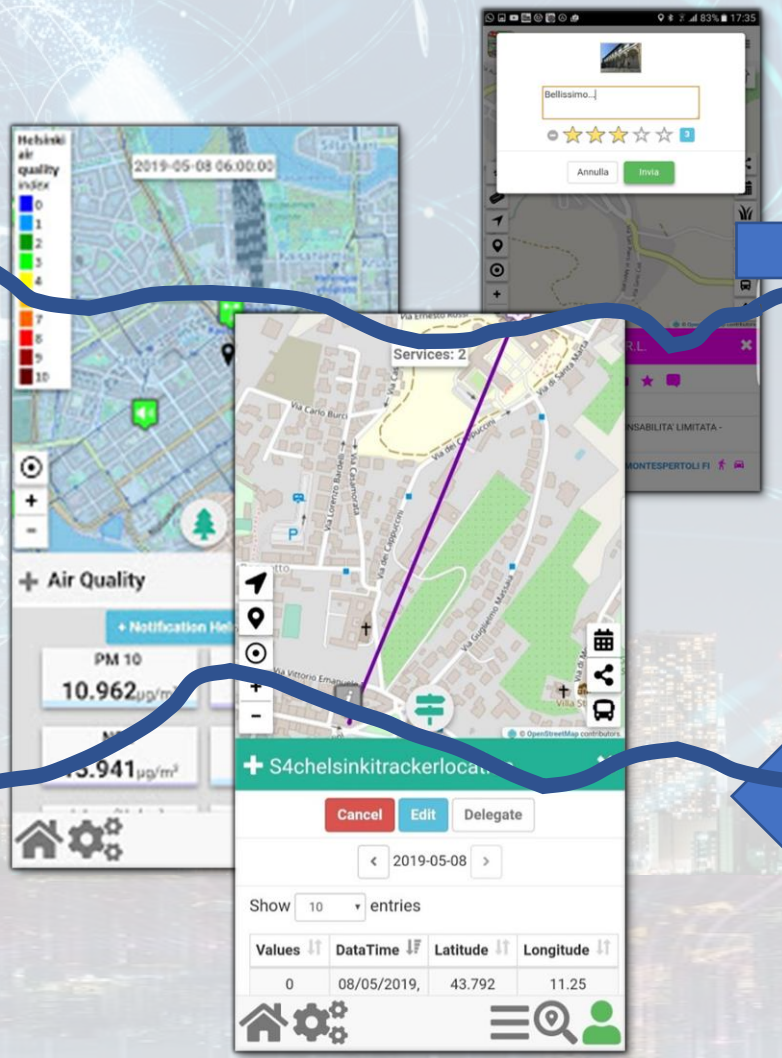
- GPS Positions
- Selections on menus
- Views of POI
- Access to Dashboards
- searched information
- Routing
- Ranks, votes
- Comments
- Images
- Subscriptions to notifications
-

Produced information

- Viewed ?
- Accepted ?
- Performed ?
- ...

Users

Snap4City (C), Sept. 2024



Derived information

- Trajectories
- Hot Places by click and by move
- Origin destination matrices
- Most interested topics
- Most interested POI
- Delegation and relationships
- Accesses to Dashboards
- **Cumulated Scores from Actions**
- Requested information
- Routing performed
-

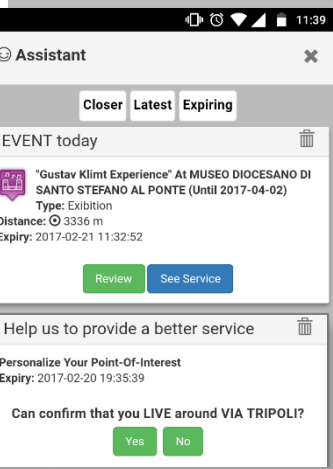
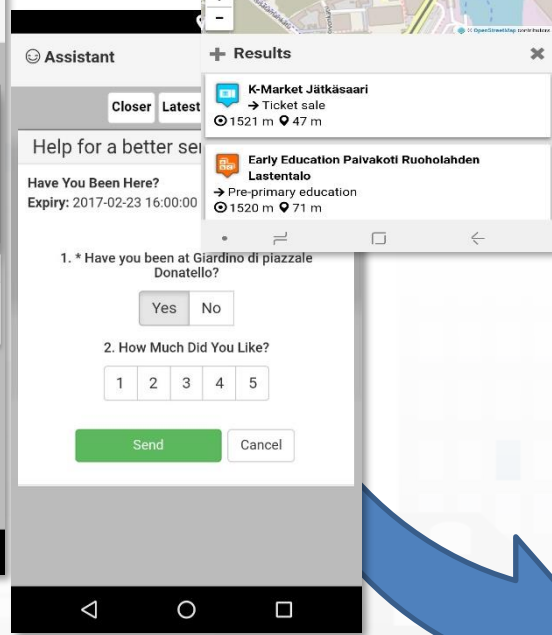
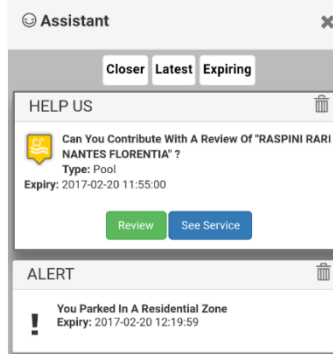
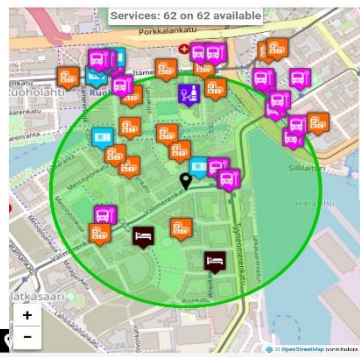
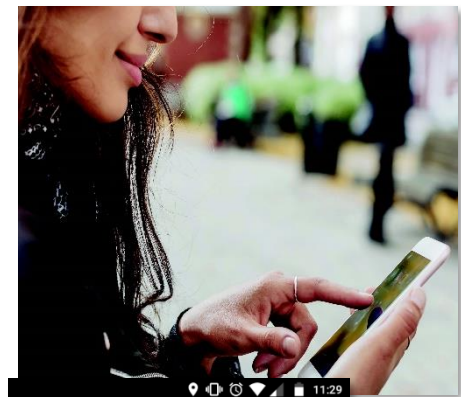


Produced information

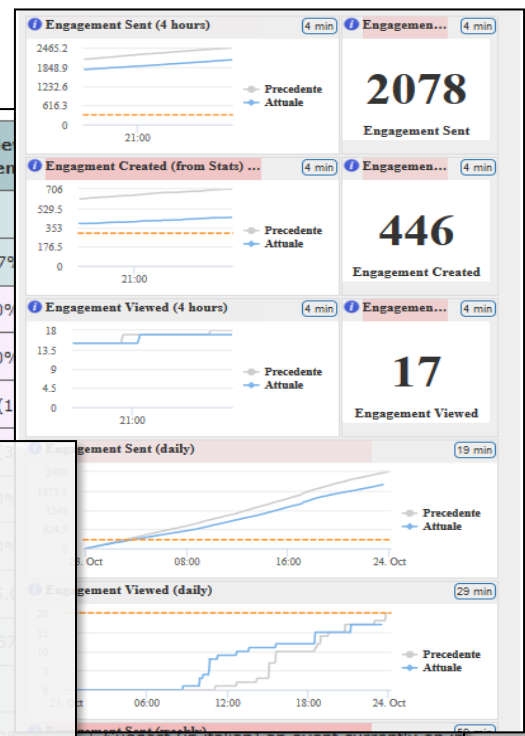
- Suggestions
- Engagements
- Notifications
- ...

System

Users' Engagement



Rule name	Type	#sent	#viewed	#viewed / #sent
daily_event_de	ENGAGEMENT	1 (0%)	0 (0%)	0%
daily_event_en	ENGAGEMENT	1720 (2.12%)	70 (7.1%)	4.07%
- commuter		5 (0.29%)	0 (0%)	0 (0%)
- student		14 (0.81%)	0 (0%)	0 (0%)
- tourist		1462 (85%)	25 (35.71%)	25 (17.1%)



Inform
Air Quality forecast is not very nice
You have parked out of your residential parking zone
The Road cleaning is this night
The waste in S.Andreas Road is full

Engage
Provide a comment, a score, etc.

Stimulate / recommend
Events in the city, services you may be interested, etc..

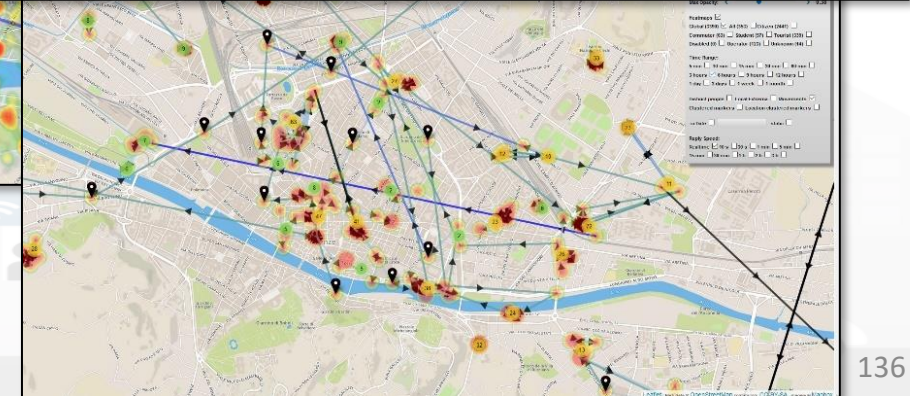
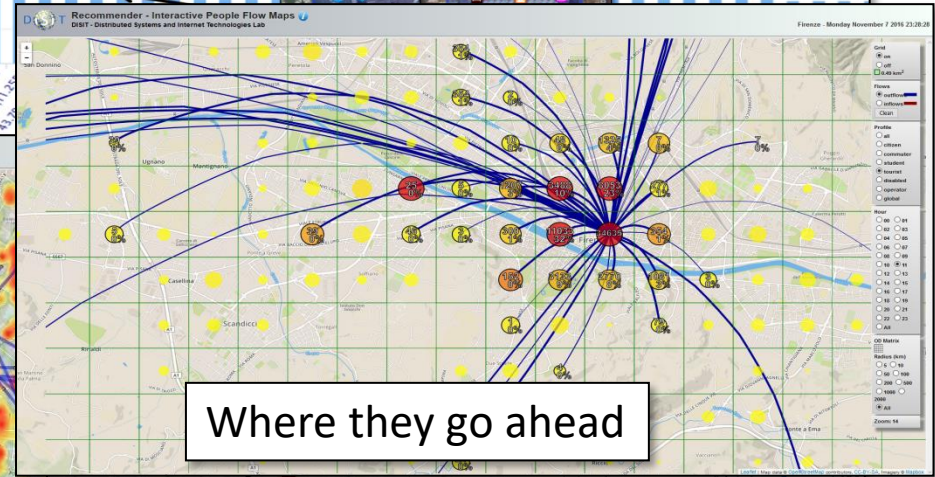
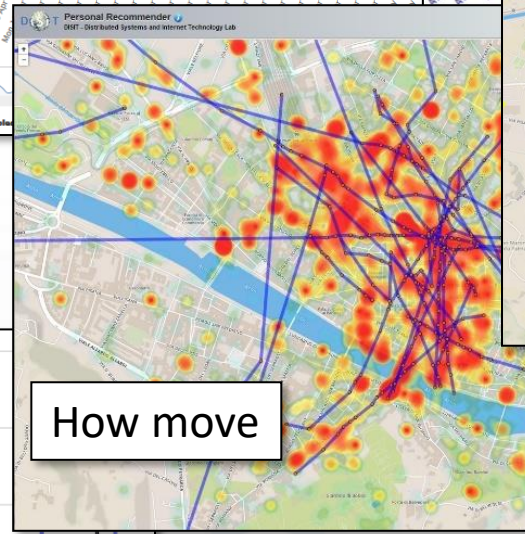
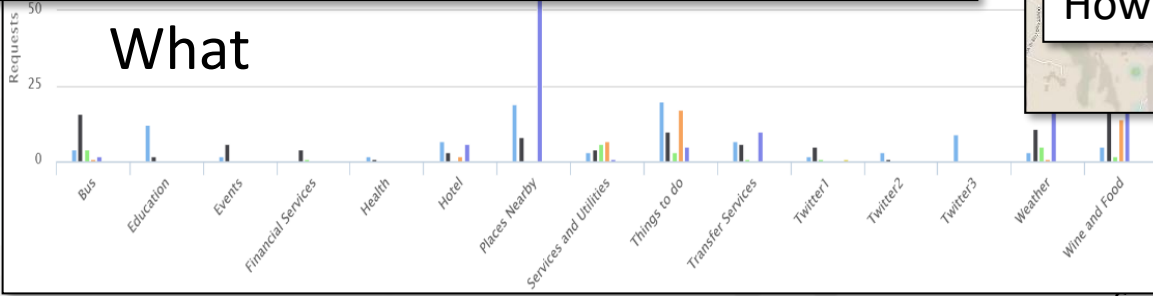
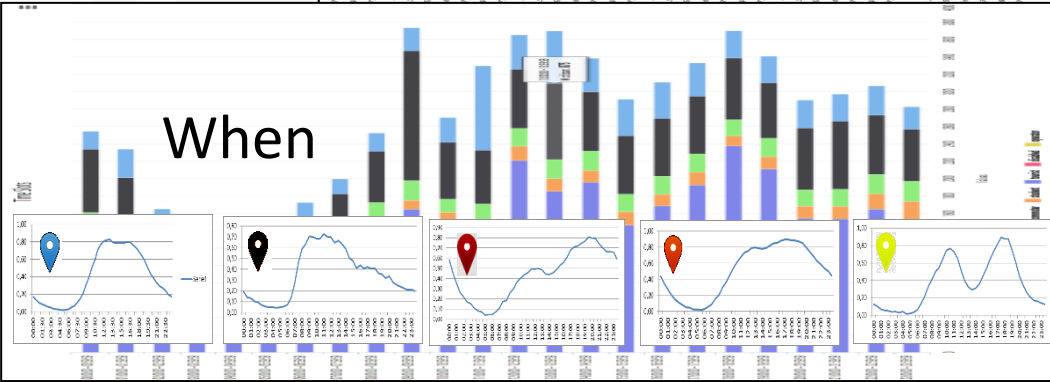
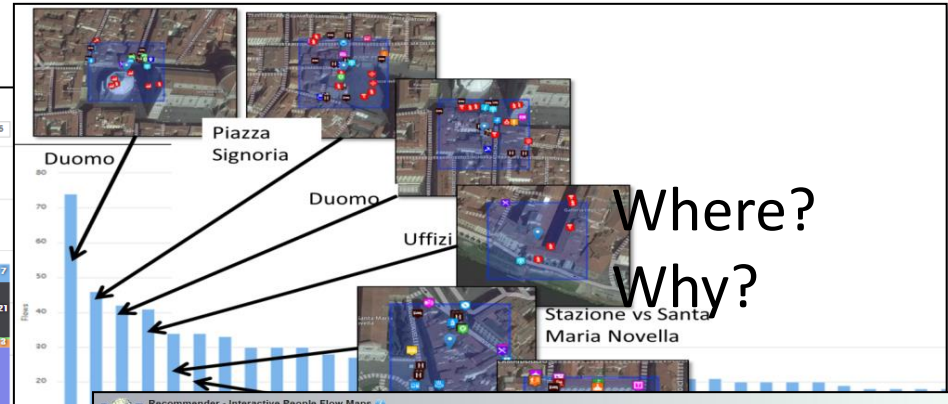
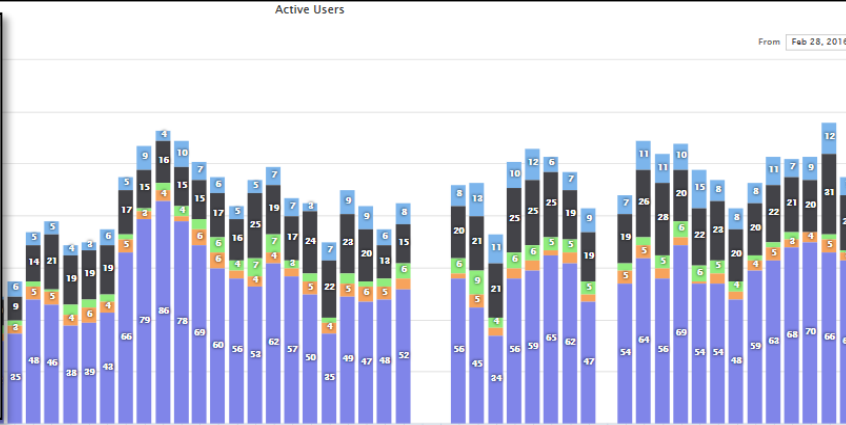
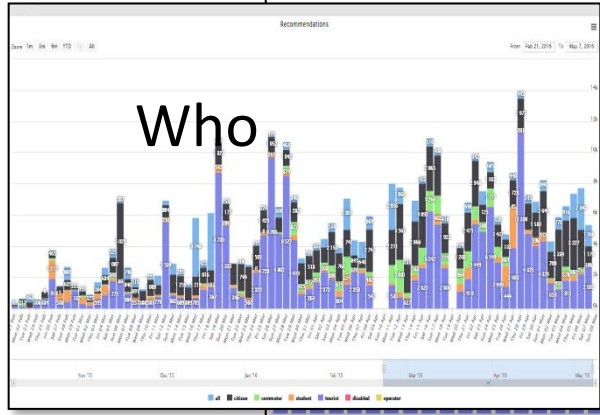
Provide Bonus, rewards if needed
you get a bonus since you parked here
We suggest: leave the car out of the city, this bonus can be used to buy a bus ticket

User context

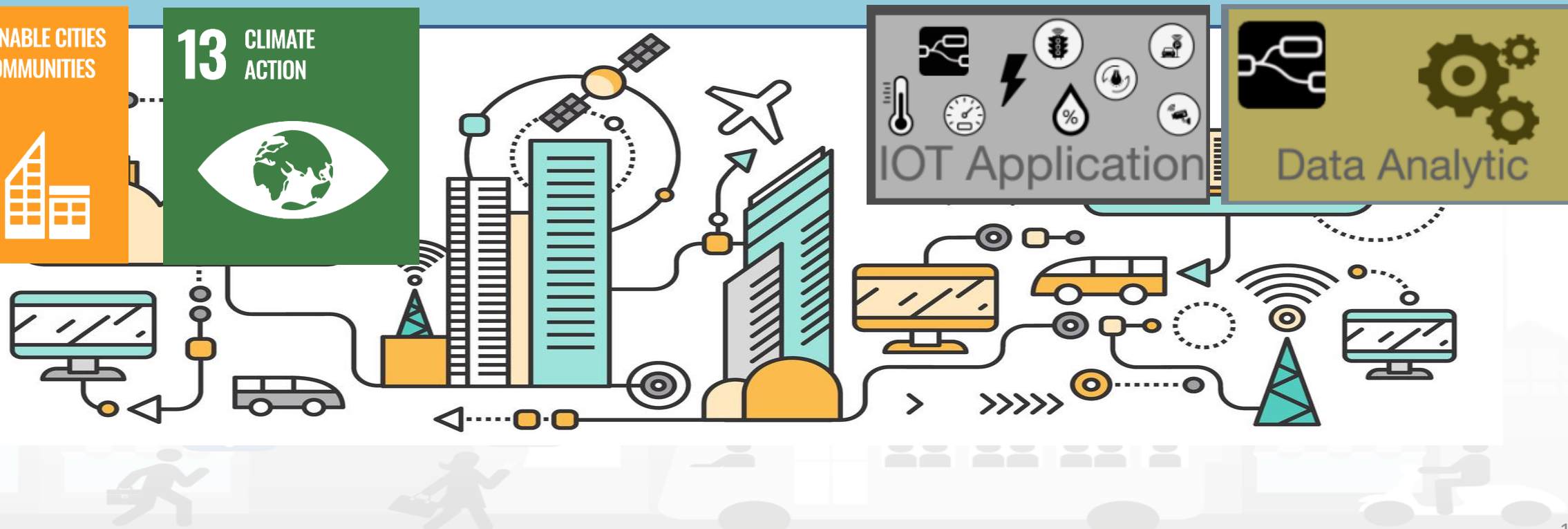
City context

Rules

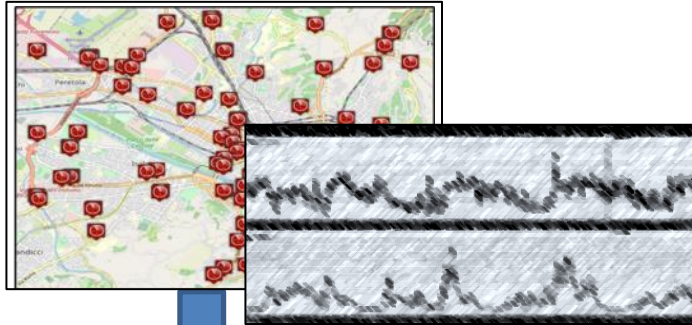
User Behavior Analyser for Collective Profiling



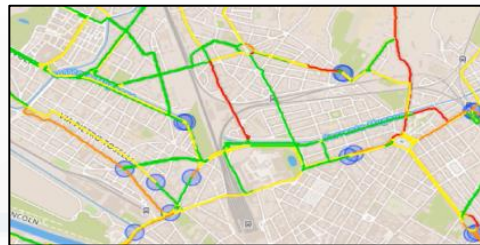
Computing / predicting CO₂/NO₂ from traffic Data



Estimating City Local CO2 from Traffic Flow Data



Computing Traffic Flow
into CO2 sensor area



Traffic Flow data

- Traffic Flow is one the main source of CO2 (**ton of CO2 x Km x Vehicle**)
 - **K1: Fluid Flow**
 - **K2: Stop and Go**
- **Dense estimation of CO2 into the city** is very useful to know to target EC's KPIs



Computing CO2 on the basis of
traffic flow data



CO2 estimation

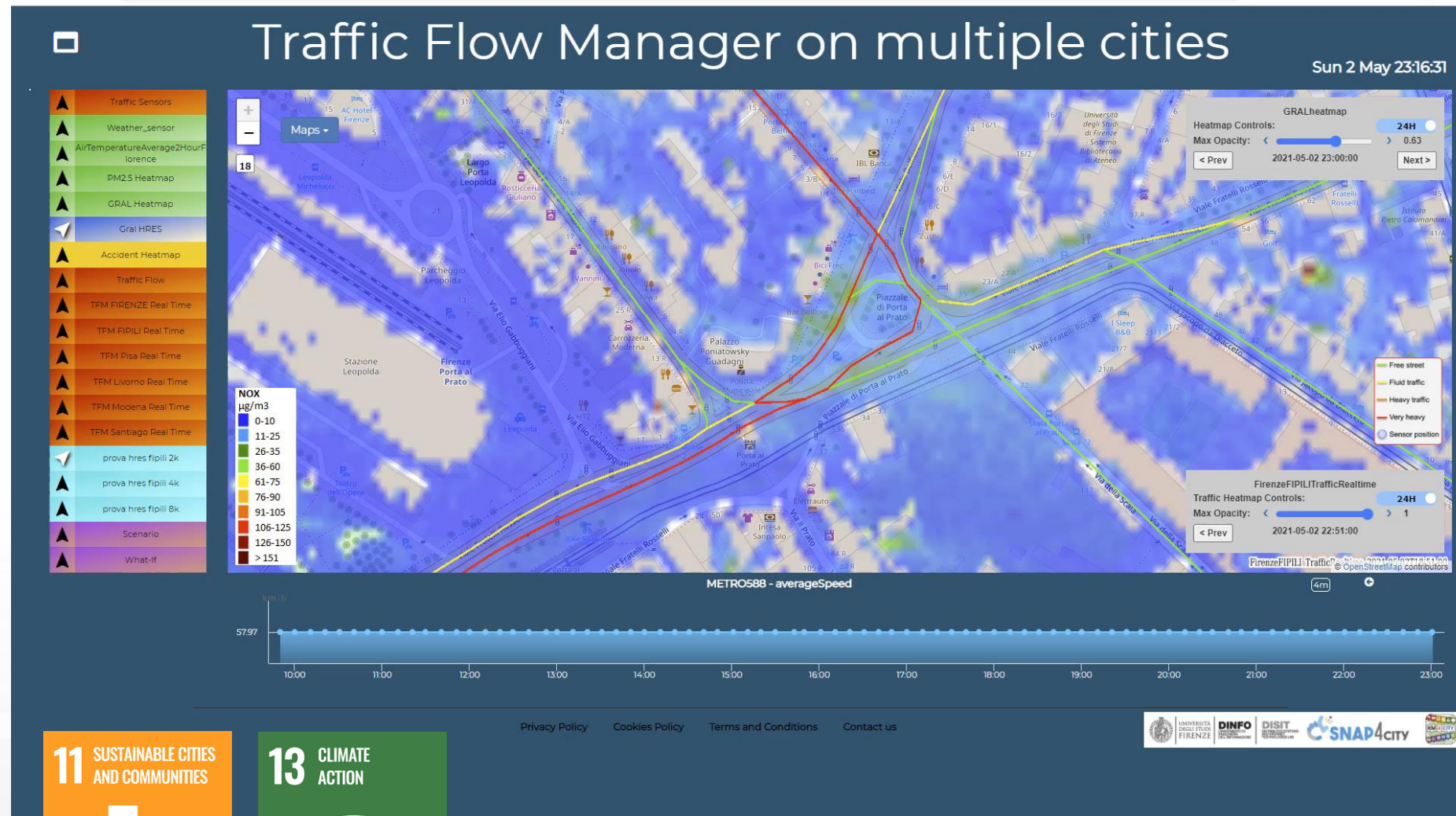
S. Bilotta, P. Nesi, "Estimating CO2 Emissions from IoT Traffic Flow Sensors and Reconstruction", Sensors, MDPI, 2022. <https://www.mdpi.com/1424-8220/22/9/3382/>

• Prediction

- **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
- **NO2 progressive average** (Long term)

• Project:

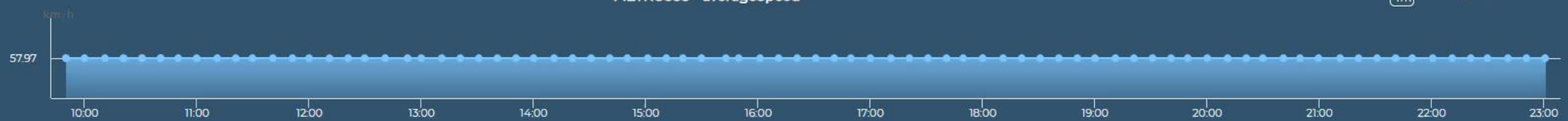
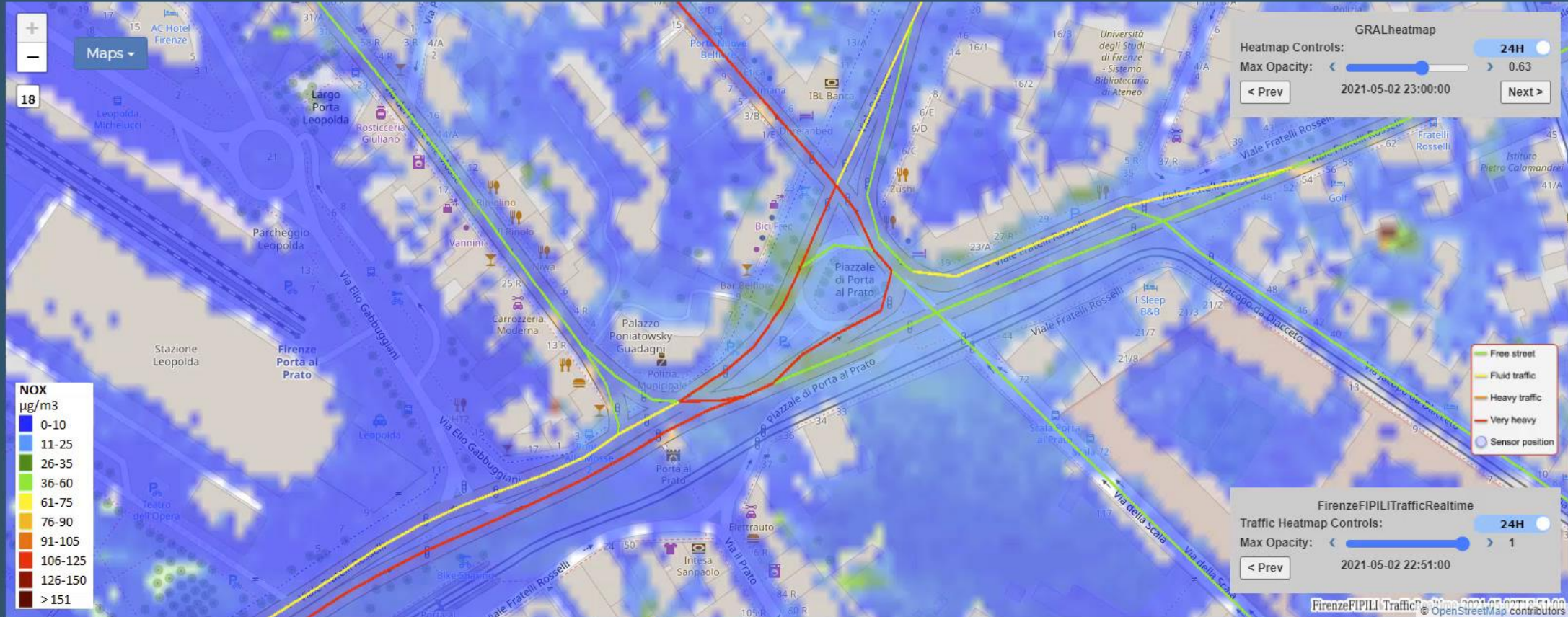
- **Trafair CEF EC**
- Mixed solutions of Fluidinamics modeling and AI



Traffic Flow Manager on multiple cities

Sun 2 May 23:16:31

- Traffic Sensors
- Weather_sensor
- AirTemperatureAverage2HourFlorence
- PM2.5 Heatmap
- GRAL Heatmap
- Gral HRES
- Accident Heatmap
- Traffic Flow
- TFM FIRENZE Real Time
- TFM FIPILI Real Time
- TFM Pisa Real Time
- TFM Livorno Real Time
- TFM Modena Real Time
- TFM Santiago Real Time
- prova hres fipili 2k
- prova hres fipili 4k
- prova hres fipili 8k
- Scenario
- What-if



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<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MzEyNg==>

TOP

References



booklets



- Smart City



https://www.snap4city.org/download/video/DPL_SNAP4CITY.pdf

- Industry

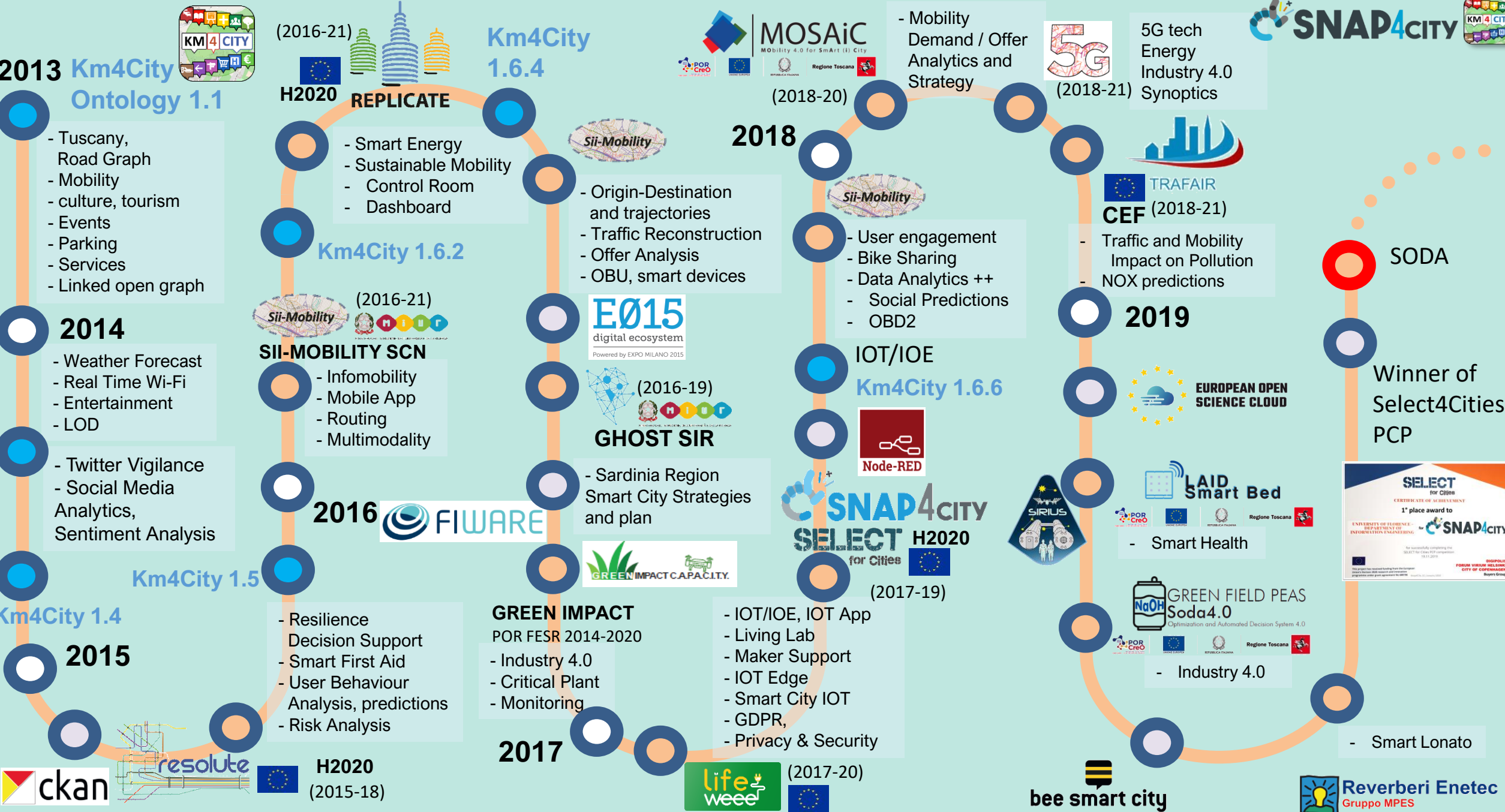


https://www.snap4city.org/download/video/DPL_SNAP4INDUSTRY.pdf

- Artificial Intelligence



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



2013 Km4City Ontology 1.1

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

2014

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

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015

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



(2016-21) H2020 REPLICATE Km4City 1.6.4

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

(2016-21) Sii-Mobility

SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

2016 FIWARE

Km4City 1.5

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

MOSAiC (2018-20) - Mobility Demand / Offer Analytics and Strategy

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

E015 digital ecosystem

Powered by EXPO MILANO 2015

(2016-19) GHOST SIR

Sardinia Region Smart City Strategies and plan

2017 GREEN IMPACT

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

(2017-20) life weee

- Smart Waste

2018

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

IOT/IOE Km4City 1.6.6

Node-RED

2019 SNAP4CITY SELECT for Cities H2020 (2017-19)

- Smart Health

bee smart city

5G tech Energy Industry 4.0 Synoptics

- Traffic and Mobility Impact on Pollution
- NOX predictions

2019 SODA

TRAFAIR CEF (2018-21)

EUROPEAN OPEN SCIENCE CLOUD

LAID Smart Bed

- Smart Health

GREEN FIELD PEAS Soda4.0

- Industry 4.0

Reverberi Enetec Gruppo MPES

DISIT lab roadmap vs model and tools' usage



2020



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



- Smart Mobility
- PISA, PUMS
- Living lab



Km4City 1.6.7

Smart Ambulance (2021-22)

Enterprise (2021-22)
Industry 4.0



2021

PC4City (2020-21)
Monitoring Terrain

Winner of Open Data Challenge of
enel x

CAPĒLON

- Smart Light
- Sweden

Almafluida Industry 4.0 (2021-22)

AMPERE (2021-22)
Industry 4.0

SYN-RG-AI
SmartCity



Industry 4.0

uni.systems

SmartCity, 2021-23



AXIS collab
SmartCity

2022



Asymmetrica Smart City, 2022-23



Contract, 2022-23

2023



Contract, 2022-23



2022-2023



Contract, 15min



Security and Risk



2024



Italferr, Smart City



Co-funded by the European Union



CN MOST, 2022-26



EI THE, 2022-26



G. Agile, 2021-23



2023-26



Finanziato dall'Unione europea NextGenerationEU

Merano, smart light

OceanRace, Genova, AWS

Cuneo, smart city

ELLIE IA 2025-2027



Contract, 2024-25

CAI4DSA



Rhodes, smart city

eShare UNIFI TUSS

AMMIRARE



PEN Test
Passed



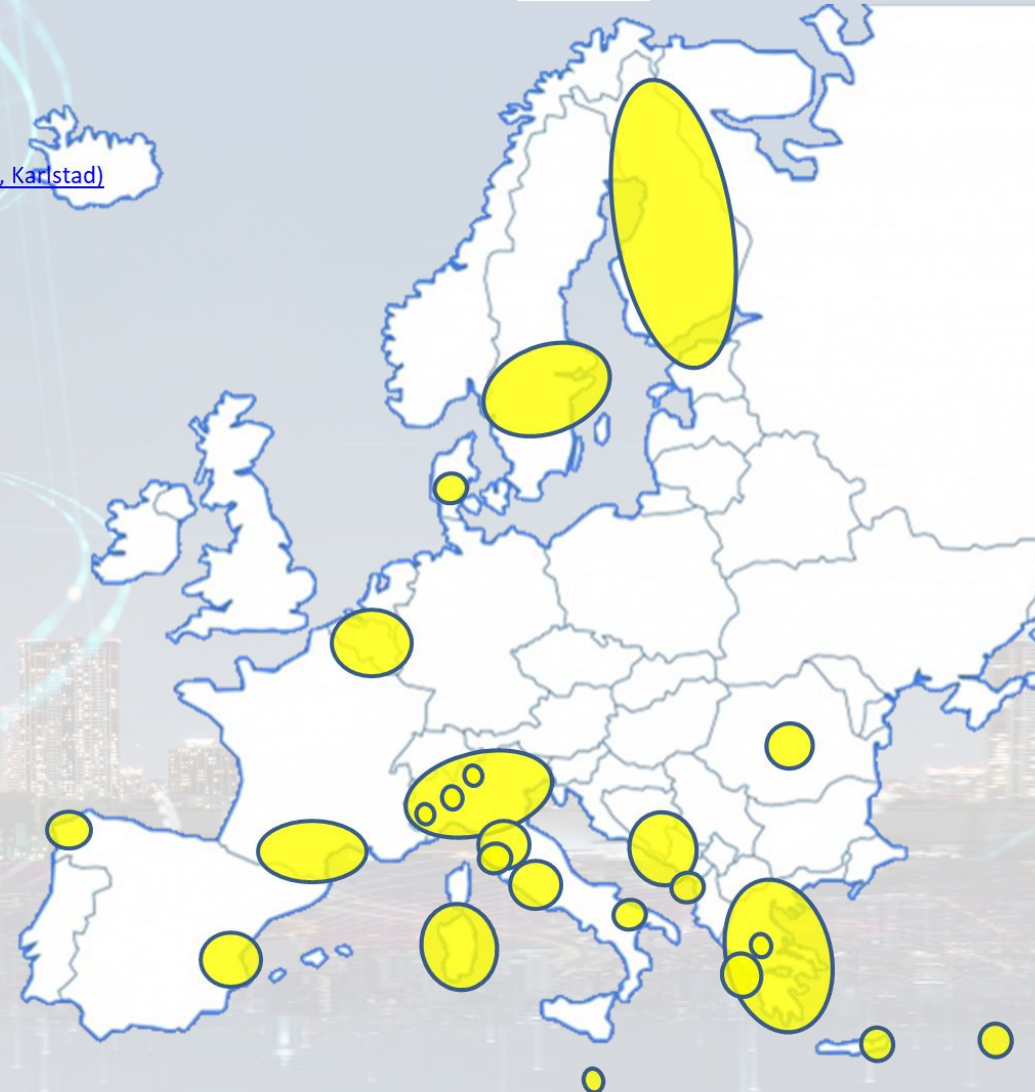
EU GDPR
COMPLIANT



- 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 \(Ro\)](#), by ICEBERG
- [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.

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

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 MOST** 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



Spoke 8

MaaS & Servizi Innovativi per la Mobilità

Centro Nazionale per la Mobilità Sostenibile

SASUAM - Solutions for Safe, Sustainable and Accessible Urban Mobility

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.



TOP



Be smart in a SNAP!



CONTACT

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