

Ottimizzazione Semaforica e di Infrastruttura. Ottimizzazione del Trasporto Collettivo



Prof. Paolo Nesi, UNIFI DISIT



Decongestion



Safety



Accessibility



Cost Reduction



Decarbonization



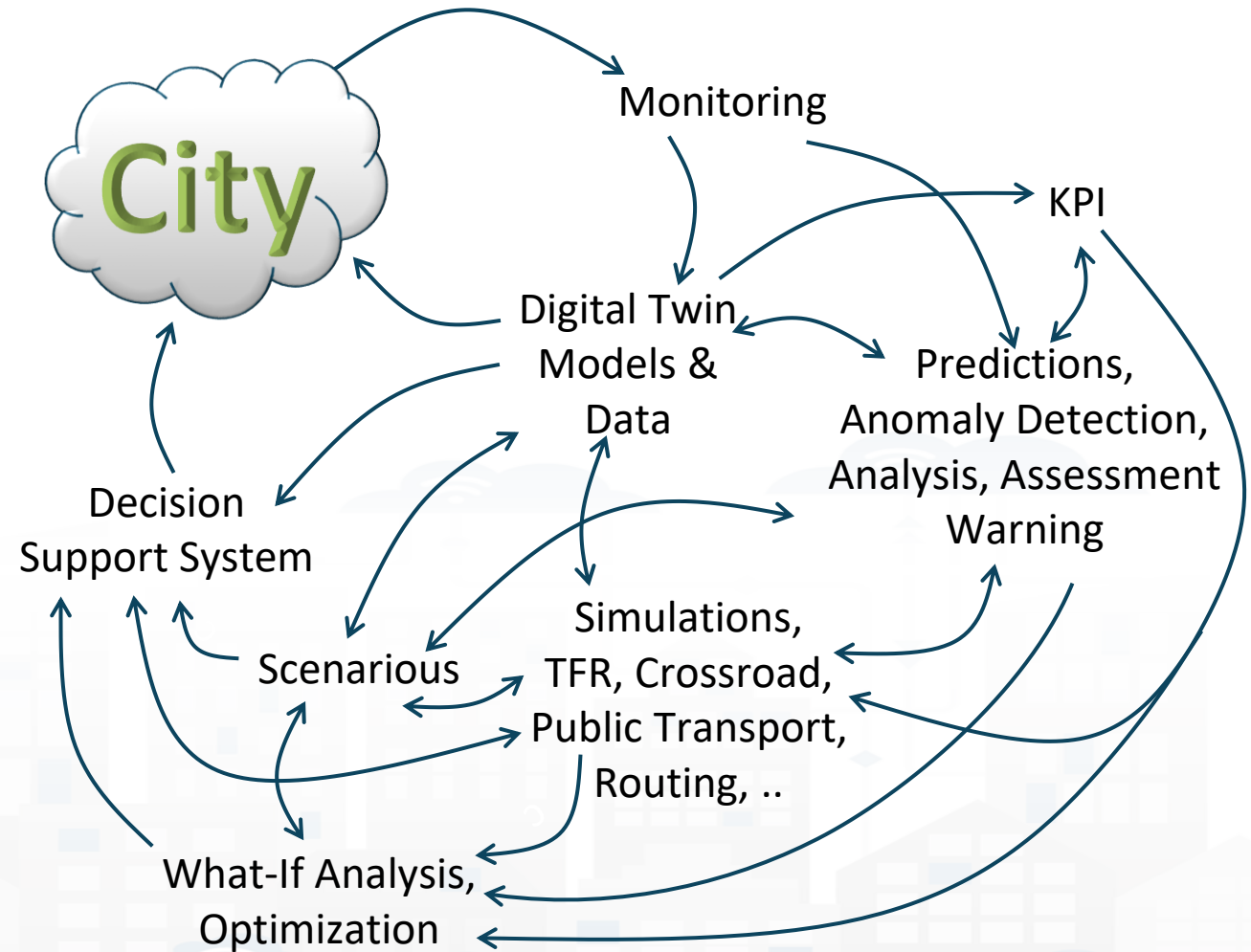
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INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB

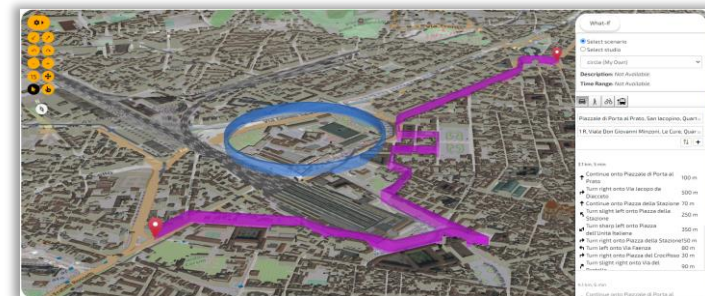


- **Controlling Status: management, and operational**
 - Monitoring via KPI
 - Predictions vs KPI
 - Anomaly detection
 - Neuro-Symbolic analysis
 - Risk assessment
 - Early warning on critical conditions
 - Fast What-if analysis
- **Making plan: tactic and strategic, medium and long range, micro/macro**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

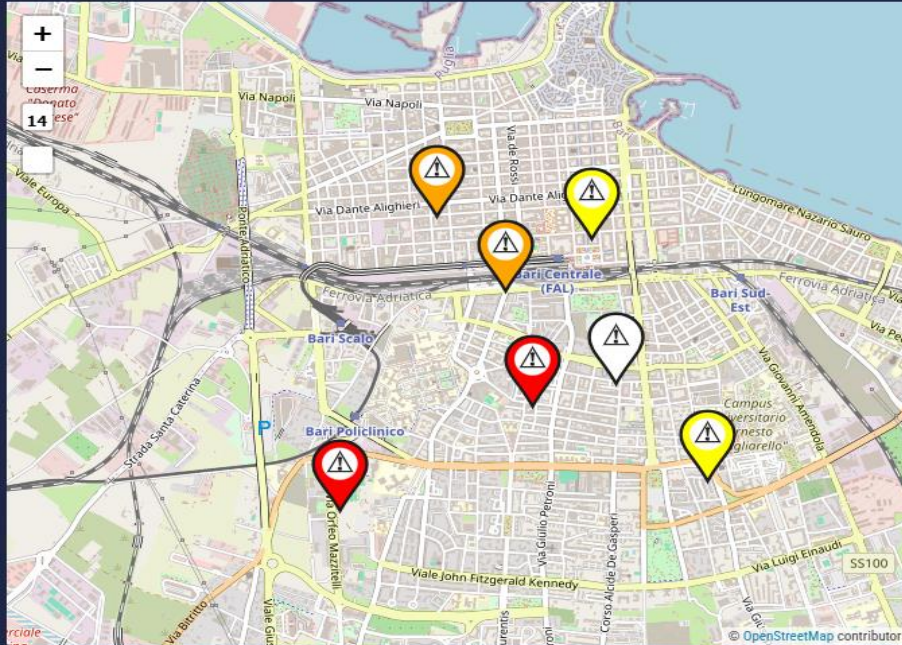


Mobility & Transport

- **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 plans, infrastructure**
 - **Reduction:** travel time, waiting time, # stops, CO2 emissions, consume fuel, travel time for tramways and busses
- **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.



- Home
- Traffic Monitoring
- Smart Parking
- 15 minuti index
- Urban Security



Road Monitoring

Media congestioniC	Nr. congestioniC	Picco congestioniC	Riduzione Co2 ZTLC	Emissioni medie CO2 C	Emissioni totali CO2 C
28.4 %	17	18:27	-5.2 %	282 ppm	846 ppm

Traffico in ingresso



Tot. veicoli in ingresso C	Velocità media C
12105 Veicoli	27 km/h

Traffico in uscita



Tot. veicoli in uscita C	Veicoli totali C
11703 Veicoli	7825 -

Pannello Rischi Meteo

MINIMO	BASSO	MEDIO	ALTO
Rischio Idraulico	MINIMO	Rischio Idrogeologico	MINIMO
Rischio Temporali	MINIMO	Rischio Neve	MINIMO
Rischio Ghiaccio	MINIMO	Rischio Vento	MINIMO

Viabilità

INCIDENTI	3
Chiusura Traffico	2
Chiusura Lavori	0
Limitazioni Traffico	4
Limitazioni Lavori	0
SEGNALAZIONI	7

Trasporto Pubblico

Tempo medio di attesa C	
5.9 sec	
Ritardo autobus C	
0 %	

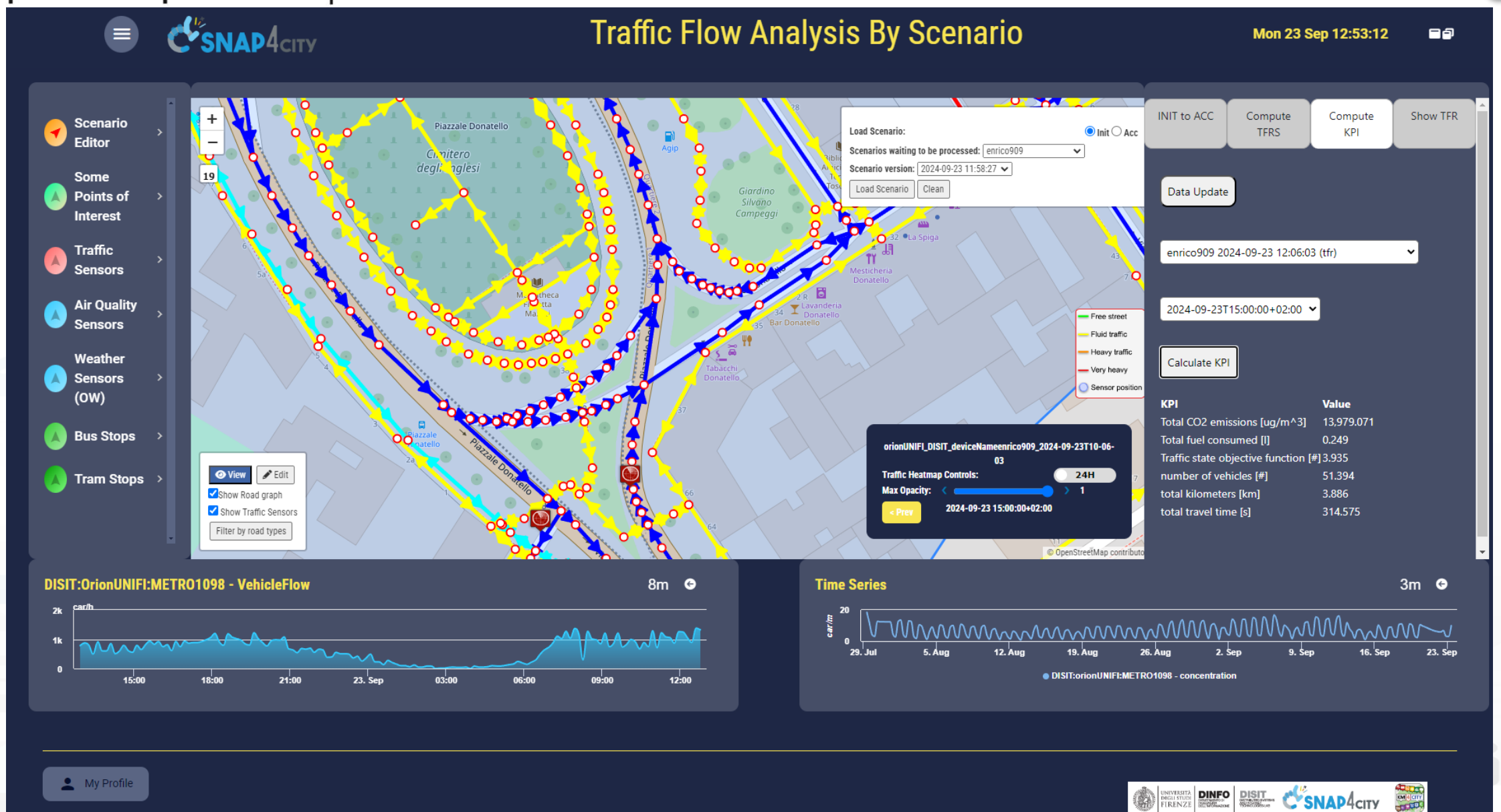
Attesa Media Fermate

Linea 50	12 sec
Linea 11	10 sec
Linea 33	6 sec
Linea 02/	5 sec
Linea E	5 sec
Linea 19	4 sec

Sensori

15	3
Semafori	
22	0
Videocamere	
4	1
Sensori	

What-if on TFR





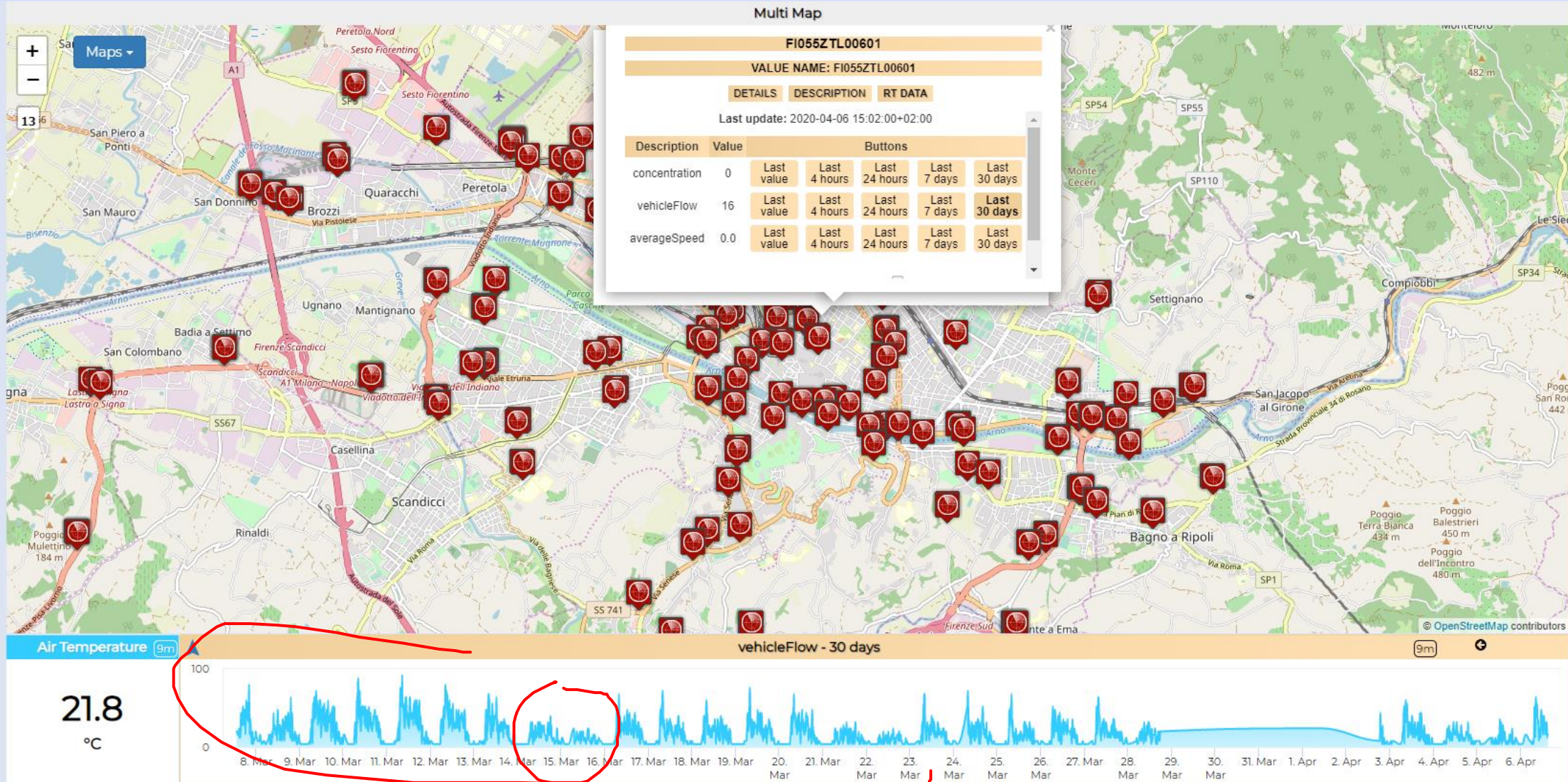
Firenze - Trafair - AirQuality Heatmaps



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

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



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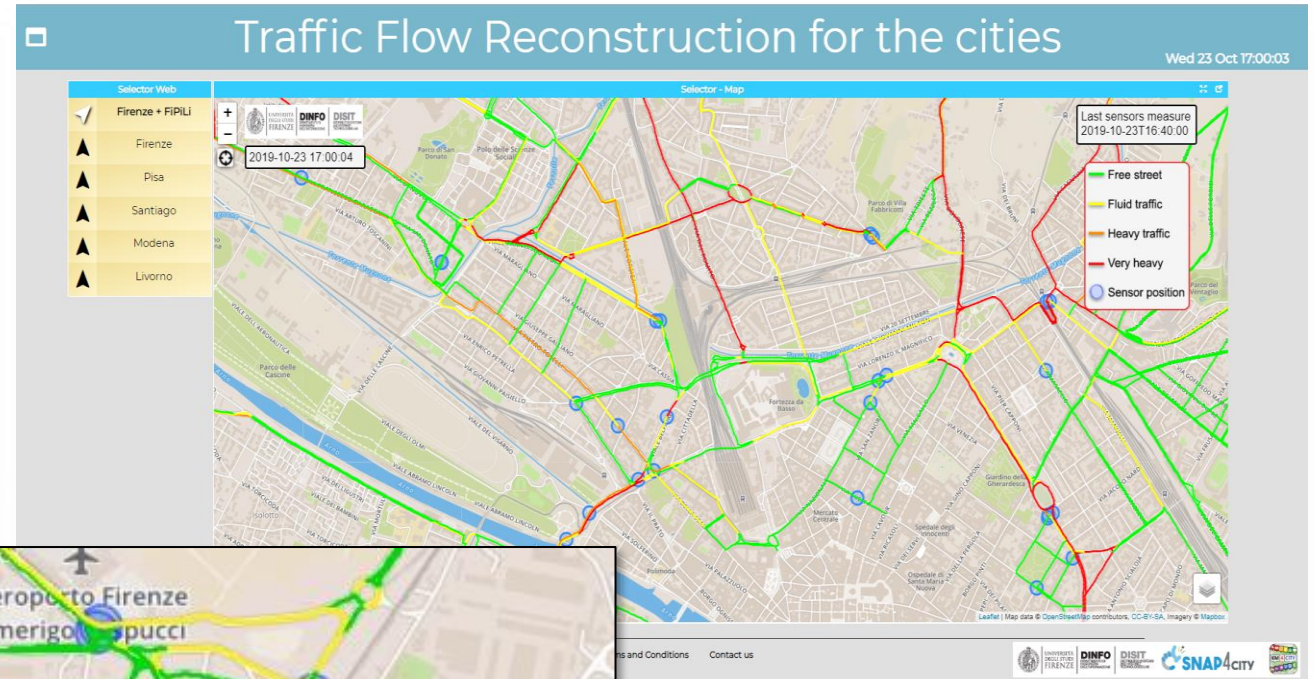
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SNAP4CITY



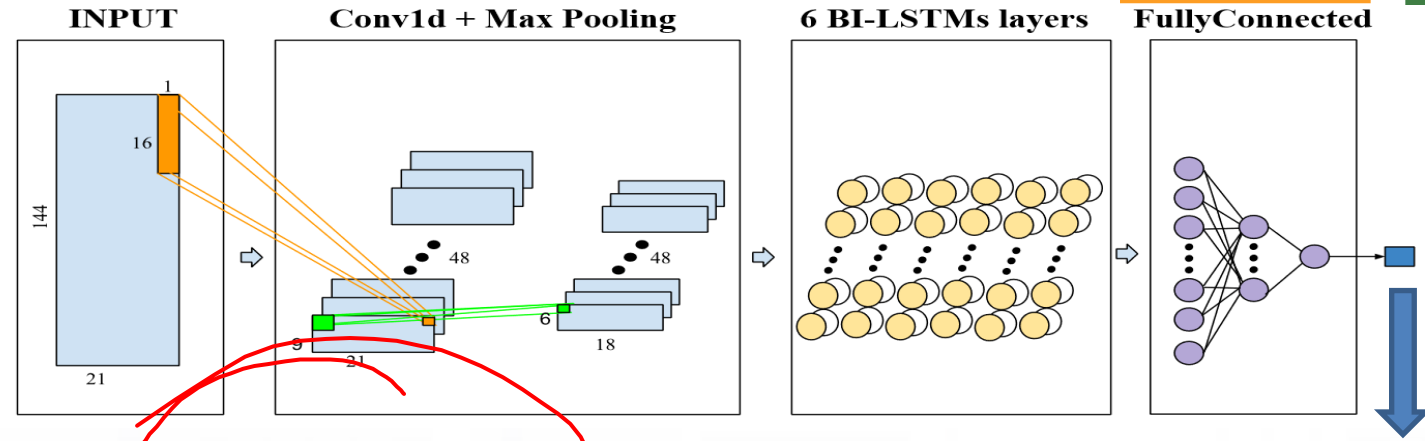
Why Dense Traffic Flow Reconstruction ?

- 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?iddashboard=MTc5NQ==>

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



Urban data:

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

RF

XGBOOST

DNN

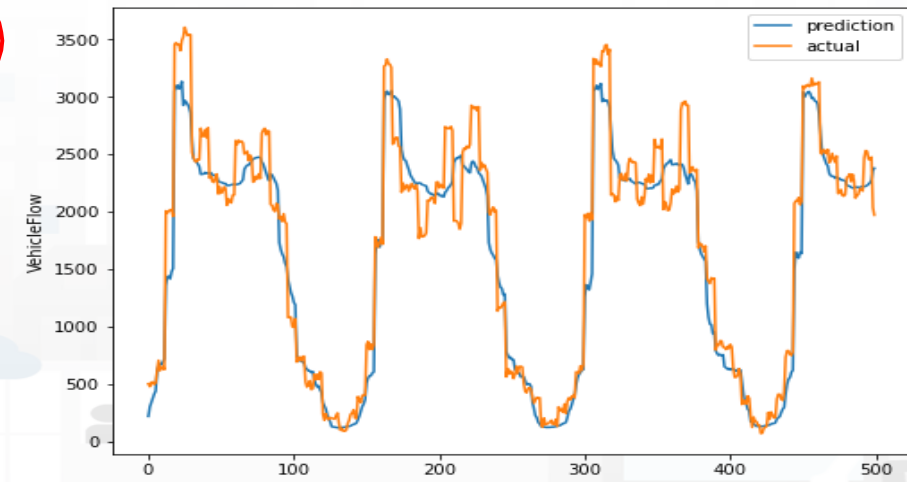
LSTM

BI-LSTM

Autoencoder BI-LSTM

Attention CONV-LSTM

CONV-BI-LSTM



Routing Optimization

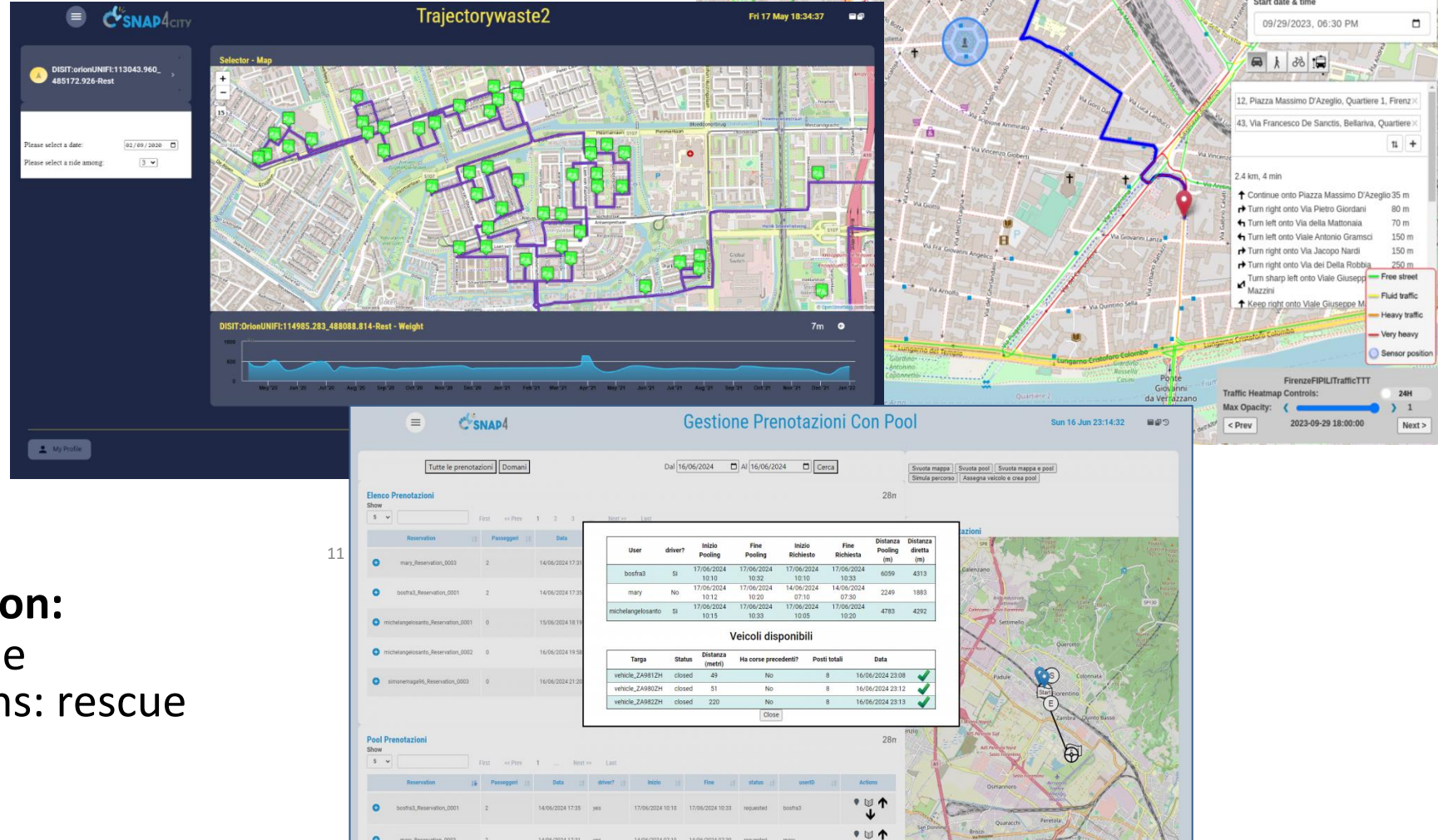
Goals on planning:

- Reduction of costs on plan
- **waste collection** optimization, Reduction of Km
- **car pooling trajectories** optimization for maximize the pool usage
- **delivering optimization**, reduction of travel time, reduction of Km
- etc.

SNAP4City (C), October 2025

Dynamic Routing on operation:

- React in operation to define immediate routing solutions: rescue teams, ambulance, etc.
- Recovery from failure



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Routing Facilities

- **modal routing: private vehicles, bikes, pedestrian**
 - with start, end and multiple intermediate points
 - selecting: shorter, faster, quitter, etc..
 - dynamic conditional routing taking into account the effective traffic flow status, or typical traffic flow status
 - dynamic conditional routing taking into account eventual blocked areas (by scenario) for example for street working, restoring, etc. (what-if cases and analysis)
- **multimodal routing** for the city users to walk and take the public collective transport
- **modal routing for public administrations** (ambulance, fire brigade, police, busses, etc.) exploiting the reserved lanes, etc.
- **a combination of cases.**
- **Full API for exploitation from your applications**

Some Routing Service Capabilities

Routing Modal And Multimodal With What-If

Tue 10 Jun 10:30:28

Selector

- Monuments
- Parks
- Scenario
- Scenario Editor

Map

What If - Routing

Scenario **Studio**

Select scenario
Choose a scenario

Save as studio

Weighting
Fastest

Start date and time
10/06/2025 10:29

Show alternatives?

Modal **Multimodal**

Pedestrian Bicycle

Private Transport Service Vehicles

Clear

Instructions

Main route
5 min (3.21 km)

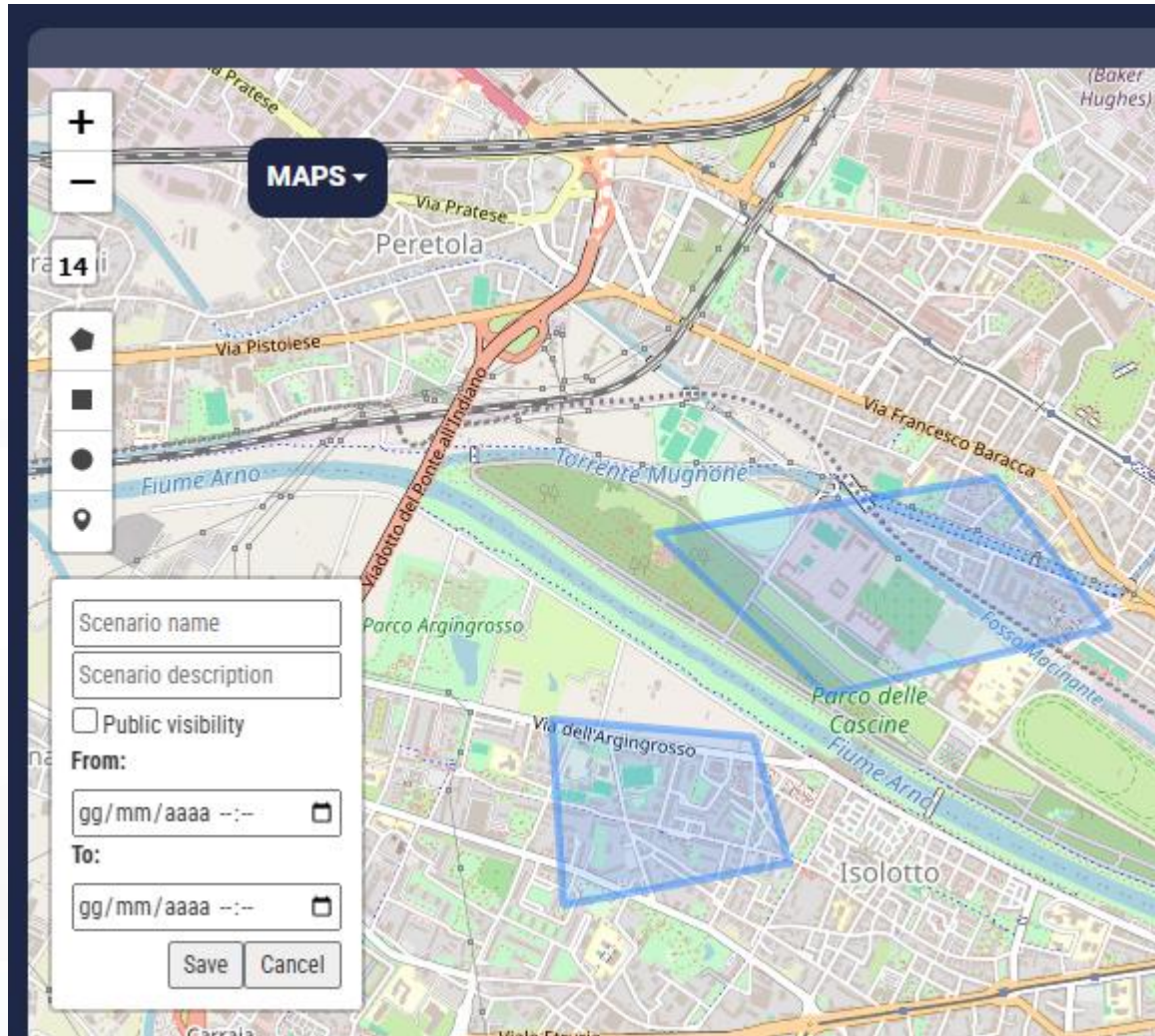
- Depart from 21, Piazza 0 sec (0 m)
- Continue onto Via Giovi 0 sec (1 m)
- Turn right onto Piazza 1 23 sec (194 m)
- Continue onto Via Silvio 11 sec (94 m)
- Turn sharp right onto Vi 5 sec (91 m)
- Make a U-turn onto Vial 2 min (1.45 km)
- Keep right onto Piazza 28 sec (348 m)
- Turn left onto Viale Spa 2 sec (16 m)
- Turn right onto Via Sant 2 min (993 m)
- Turn left onto Piazza de 2 sec (20 m)
- Arrive at destination 0 sec (0 m)

My Profile

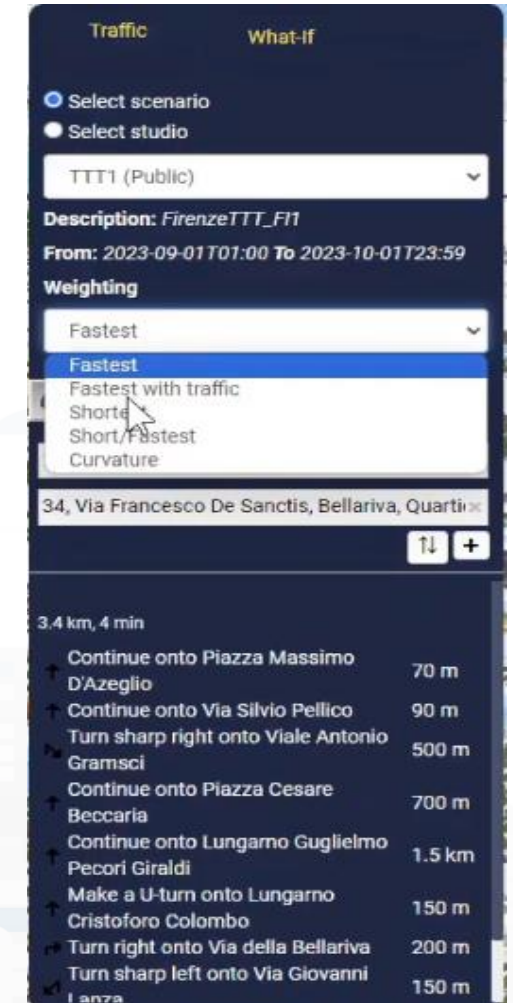
Snap4City (C), October 2025

13

What you can do with advanced tools



- **Basic Scenario editor**
 - Single and multiple blocked areas, which can be shared among users
- **What-if analysis tool**
 - Ready to use tools for exploiting Basic Scenarios as blocked areas and simulating/
 - computing in real time routing, in different traffic conditions

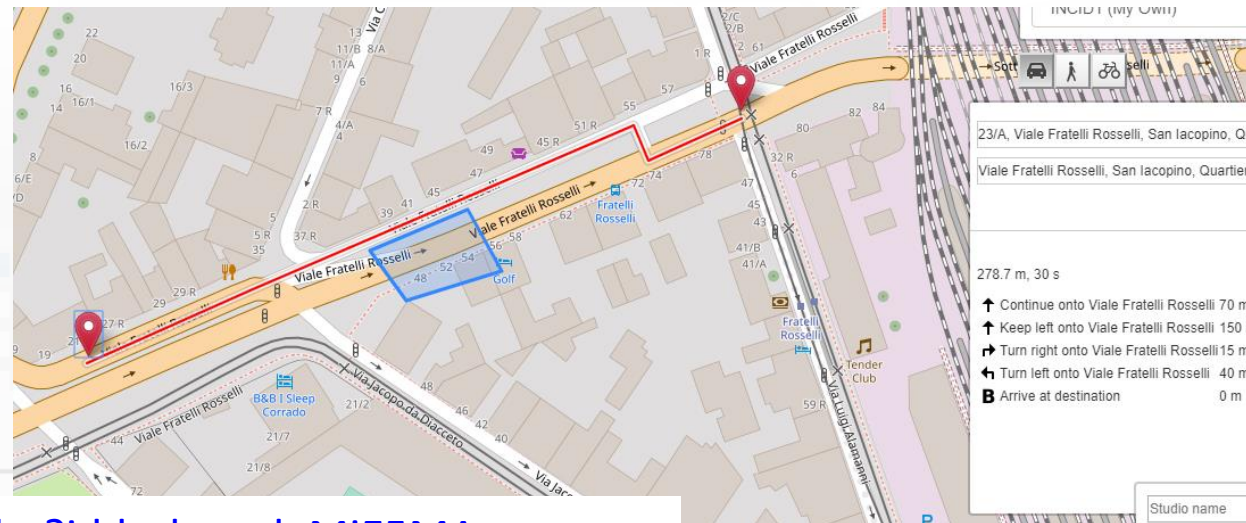
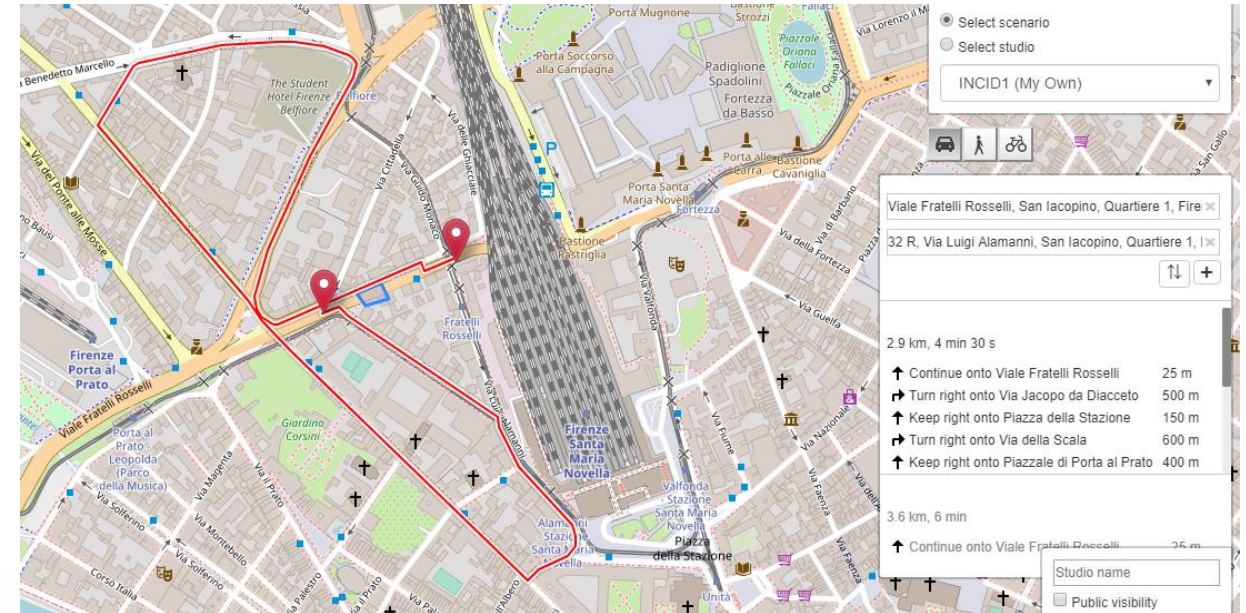


Accidents and elements blocking Points and Shapes taken into account for:

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

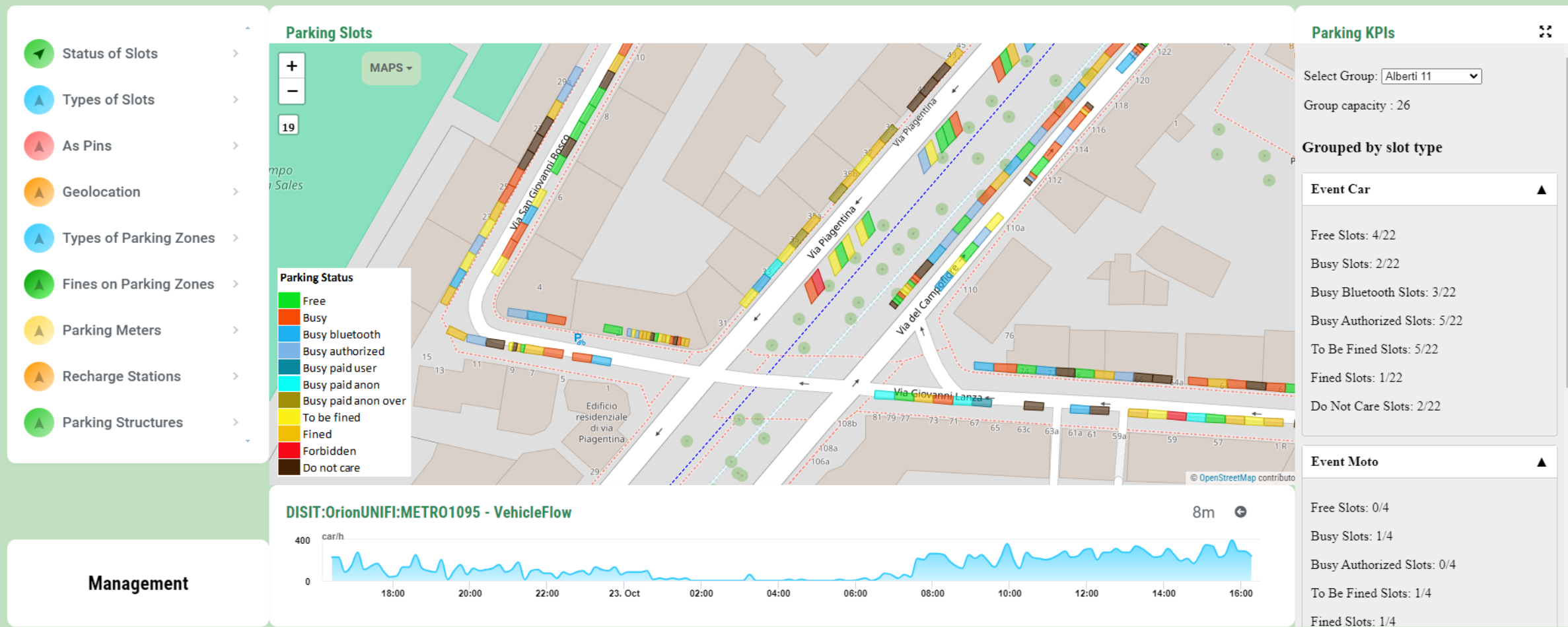
Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment

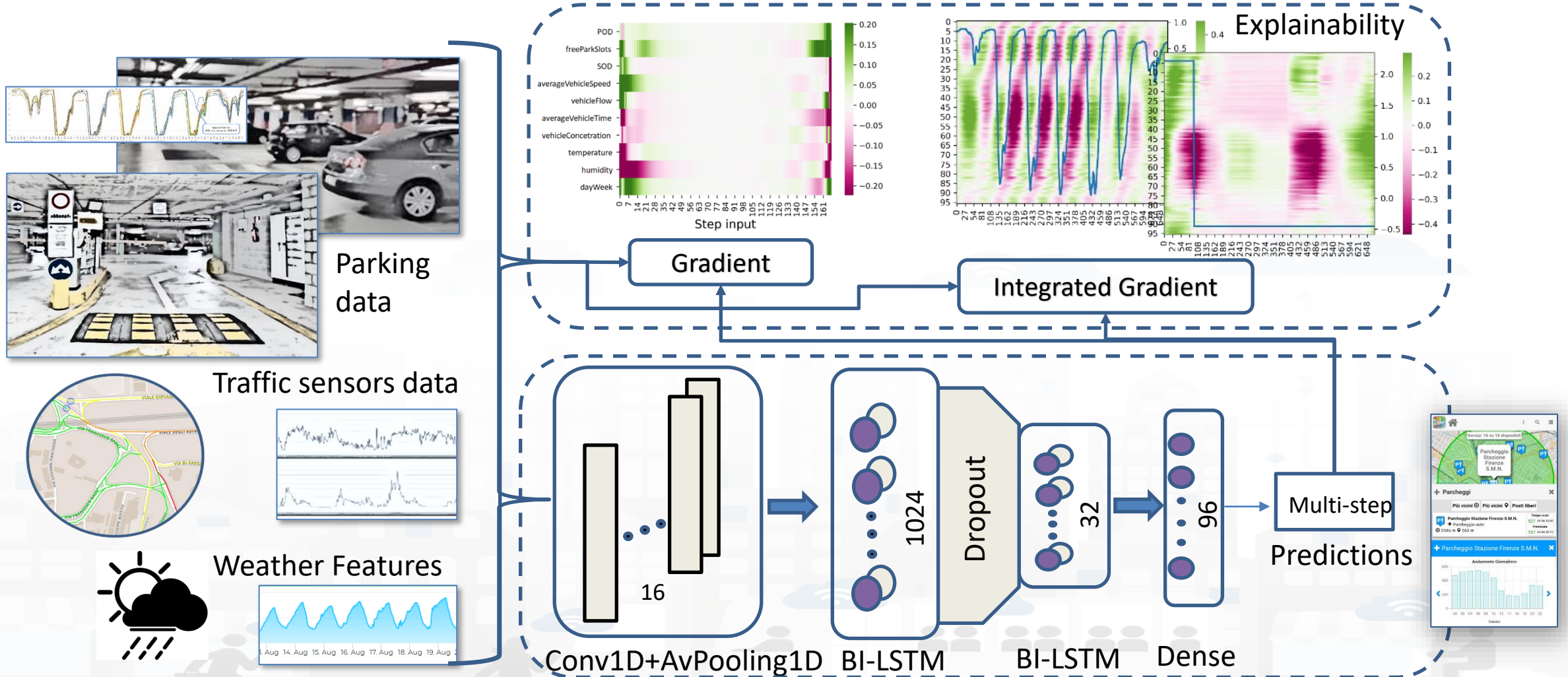


Parking Conditions Monitoring

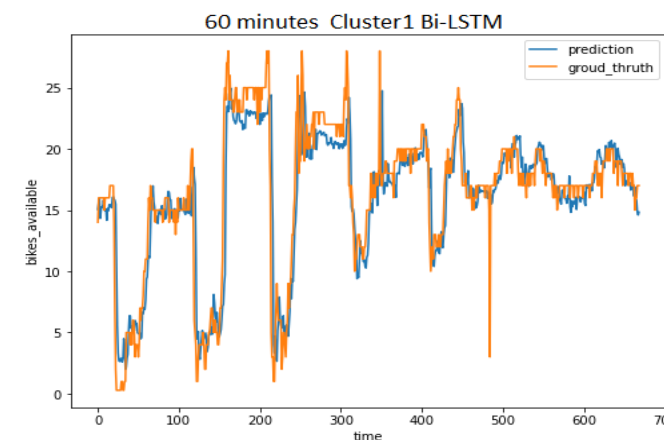
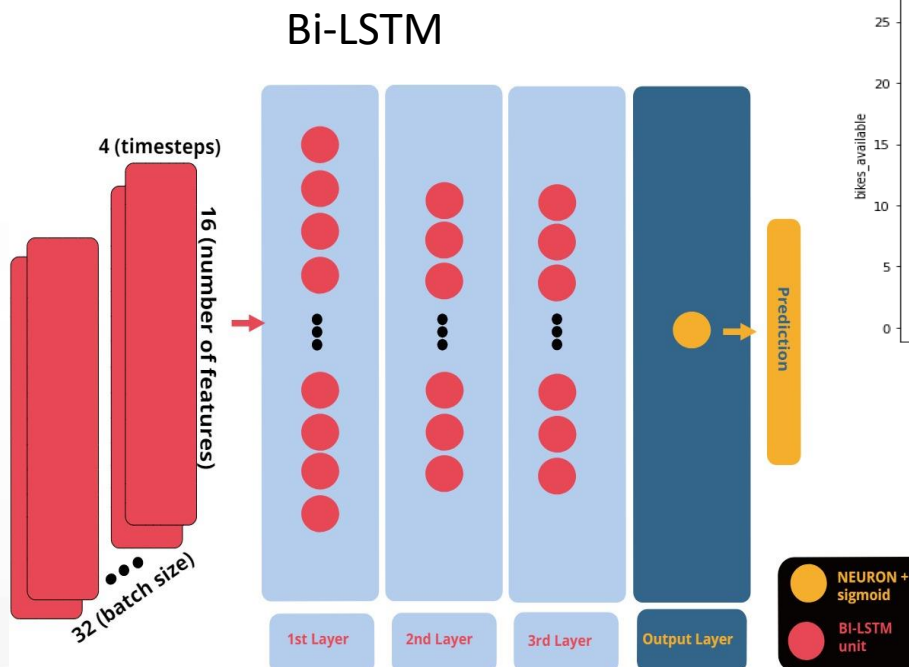
Wed 23 Oct 16:24:41



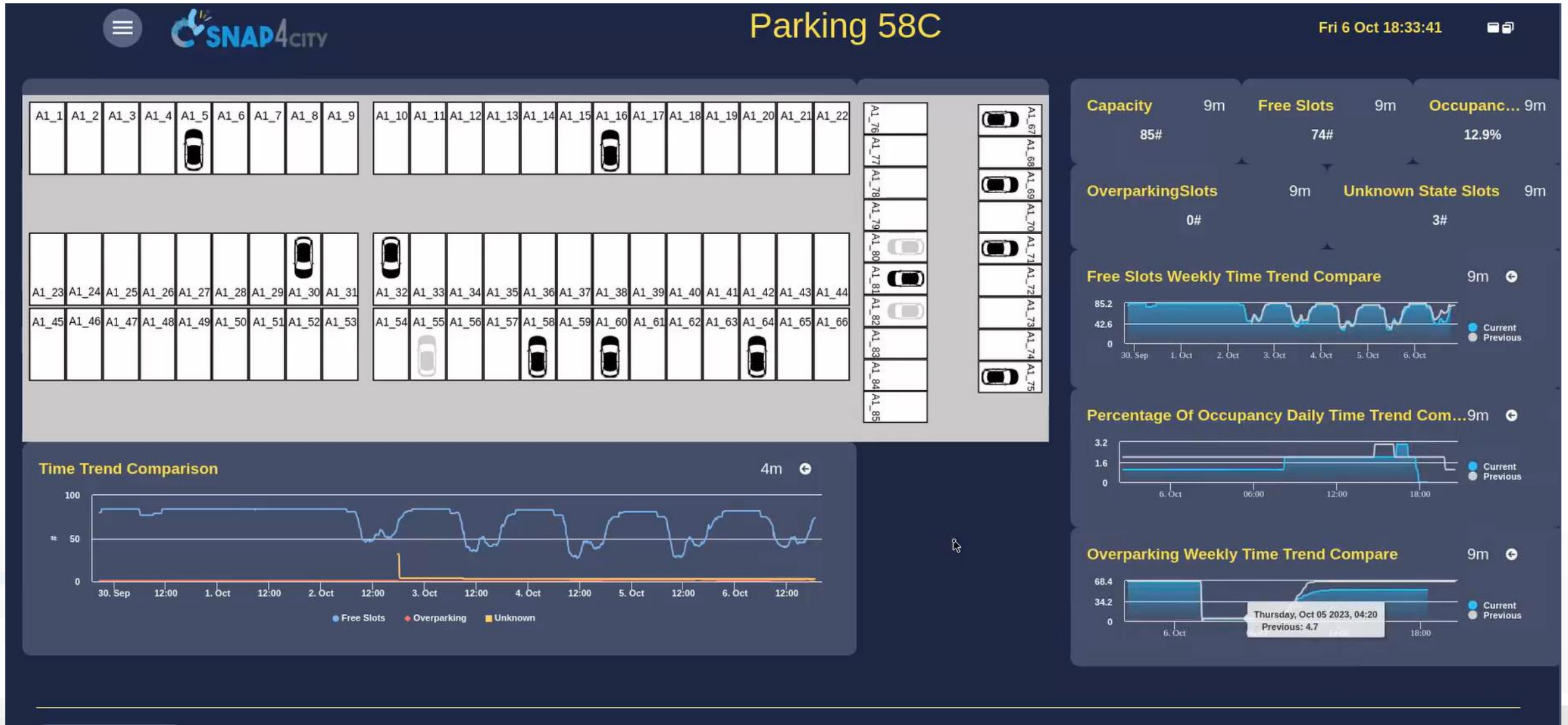
Deep Learning AI to surely Park!



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



Snap4ISPRA Parking: ISPRA JRC



Smart Parking

- payments, profiles
- Fines
- mobile for parking

Dash8 - To Be Fined Management

Fri 19 Sep 12:46:24

Fines Show Search: 10 First << Prev 1 Next >> Last

device	dateObserved	groupid	sensorId	slotType	vehicleType	Actions
parkingSlotOffRoad_9	2025-09-10T14:16:34.344Z	alberti_offRoad	offRoad_sensor_9	handicap	car	
parkingSlotOffRoad_8	2025-09-10T14:16:14.340Z	alberti_offRoad	offRoad_sensor_8	handicap	car	
parkingSlotOffRoad_7	2025-09-10T14:15:54.338Z	alberti_offRoad	offRoad_sensor_7	handicap	car	
parkingSlotOffRoad_3	2025-09-10T14:14:34.329Z	alberti_offRoad	offRoad_sensor_3	recharge_car	car	

Fine Form

* Parking ID: parkingSlotOffRoad_8

* City: Limassol * Area: area_4

* Datetime: 19/09/2025 12:45:23

Vehicle brand: Suzuki Vehicle model: Sport

Vehicle color: red * Vehicle plate: AA456BB * Vehicle Type: Moto

Infraction Codes

- ☐ P001 - No parking zone
- ☒ P002 - Double parking
- ☐ P003 - Blocking driveway
- ☐ P004 - Expired meter
- ☐ P005 - Fire hydrant zone

* Infraction Points Deducted: 0

* Vehicle Stop Status: REMOVED

* Amount to be Paid (Euro): 43

Upload Evidence

Click or drag files here

Submit Cancel

Dash3 - Policy Area Management

Fri 12 Sep 15:38:29

Search Area Careggi 1

☒ Show area ☒ Show slots

View mode

☒ Shape ☐ Pin

Slot/Area List

- parkingSlot_193593
- parkingSlot_193594
- parkingSlot_193595
- parkingSlot_193596
- parkingSlot_193597
- parkingSlot_193598
- parkingSlot_193599
- parkingSlot_193600
- parkingSlot_193601
- parkingSlot_193602
- parkingSlot_193603
- parkingSlot_193604
- parkingSlot_193663
- parkingSlot_193664
- parkingSlot_193665
- parkingSlot_193666
- parkingSlot_193667
- parkingSlot_193668
- parkingSlot_193669
- parkingSlot_193670
- parkingSlot_193671
- parkingSlot_193672
- parkingSlot_193673
- parkingSlot_193674
- parkingSlot_193822
- parkingSlot_193823
- parkingSlot_193824
- parkingSlot_193825
- parkingSlot_193826
- parkingSlot_193828
- parkingSlot_193829

Parking Type

- Bus
- Cargo
- Event car
- Event moto
- Forbidden
- Free car
- Free moto
- Mixed car
- Org car
- Org moto
- Recharge car
- Recharge moto
- Resident
- Taxi
- Timed car
- Timed moto
- Women car

Group free

- >40
- 25 - 35
- 10 - 24
- 0 - 9

Free Slots Of Careggi_01

8m

Manage Area Policy

policy_0

permissionBus

12:00-13:00

Calendar

settembre 2025

dom	lun	mar	mer	gio	ven	sab
1	2	3	4	5	6	
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Policy price range

€/hour

- 0 - 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- 1.20 - 1.50
- 1.50 - 1.80
- 1.80 - 2.10
- 2.10 - 2.40
- 2.40 - 2.70
- 2.70 - 3.00
- > 3.00

Set policy to selected area

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- Home
- Traffic Monitoring
- Smart Parking
- 15 minuti index
- Urban Security

- Posto auto
- Posto auto per tipologia parcheggio
- Posto auto per tipologia veicolo



Disponibilità parcheggi

Liberi

20

stalli

Occupati

26

stalli

Non disponibili

0

stalli

Tipologia parcheggio

Gratuiti

3

stalli

A pagamento

35

stalli

Residenti

0

stalli

Prioritari

4

stalli

Disabili

4

stalli

Carico/Scarico

0

stalli

Tipologia veicolo

Auto

46

stalli

Moto

0

stalli

Bici

0

stalli

Camion

0

stalli

Camper

0

stalli

eSharing and Pooling

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA
AND C
KNOW
MANA

TWITTER
VIGILANCE SOCIAL
MEDIA ANALYSIS

SNAP4CITY
AND KM4CITY
PROJECTS

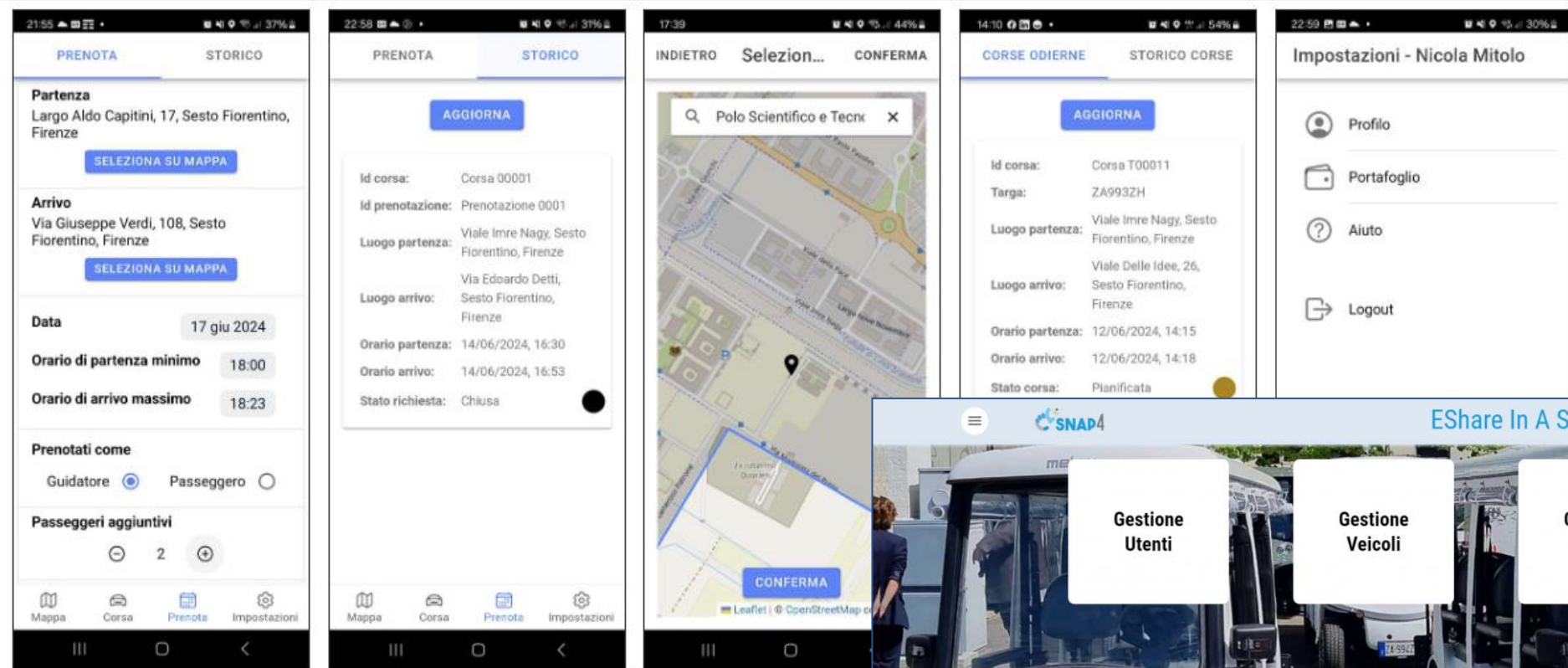
HOW TO ADOPT
SNAP4CITY, AND
ROADMAP

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS



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



SNAP4

Gestione Veicoli

Sun 16 Jun 23:09:13

VehiclesDeviceTable

Show

5

First

<< Prev

1

2

Next >>

Last

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

Time Trend Batteria

3m

11 Jun 12 Jun 13 Jun 14 Jun 15 Jun 16 Jun

vehicle_ZA993ZH - batteryLevel

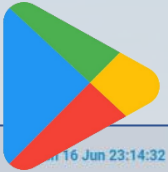
Time Trend Velocità

11 Jun

Ricerca tutti i veicoli

show area

Selector - Map



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

SNAP4

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

Show

5

First

<< Prev

1

2

3

Next >>

Last

Reservation	Passeggeri	Data
mary_Reservatio_0003	2	14/06/2024 17:31
bosfra3_Reservatio_0001	2	14/06/2024 17:35
michelangelosanto_Reservatio_0001	0	15/06/2024 18:19
michelangelosanto_Reservatio_0002	0	16/06/2024 19:58
simonemaga96_Reservatio_0003	0	16/06/2024 21:20

Pool Prenotazioni

Show

5

First

<< Prev

1

Next >>

Last

Reservation	Passeggeri	Data	driver?	Inizio	Fine	status	userID	Actions
bosfra3_Reservatio_0001	2	14/06/2024 17:35	yes	17/06/2024 10:10	17/06/2024 10:33	requested	bosfra3	
mary_Reservatio_0003	2	14/06/2024 17:31	yes	14/06/2024 07:10	14/06/2024 07:30	requested	mary	

Veicoli disponibili

User	driver?	Inizio Pooling	Fine Pooling	Inizio Richiesto	Fine Richiesta	Distanza Pooling (m)	Distanza diretta (m)
bosfra3	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

Targa

Status

Distanza (metri)

Ha corse precedenti?

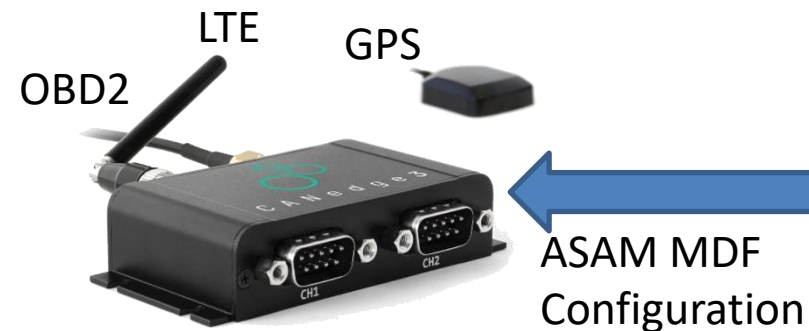
Posti totali

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	✓

Close

Fleet Monitoring and Management



CAN Logger

<https://www.csselectronics.com/>



Snap4Fleet Logger

Data
Lake

Decoder MDF
Decoder CAN (DBC)

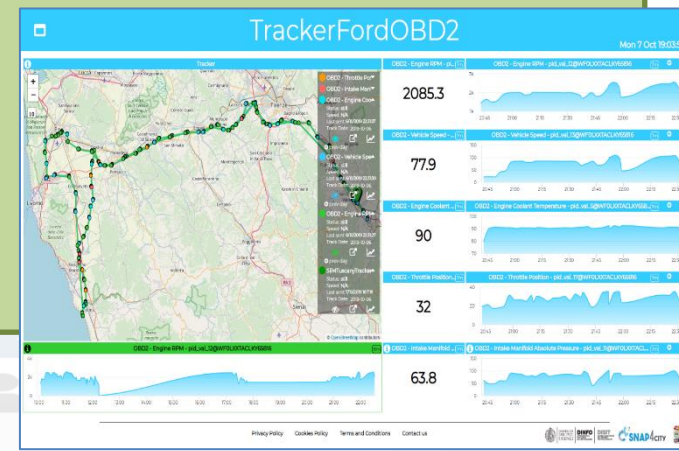
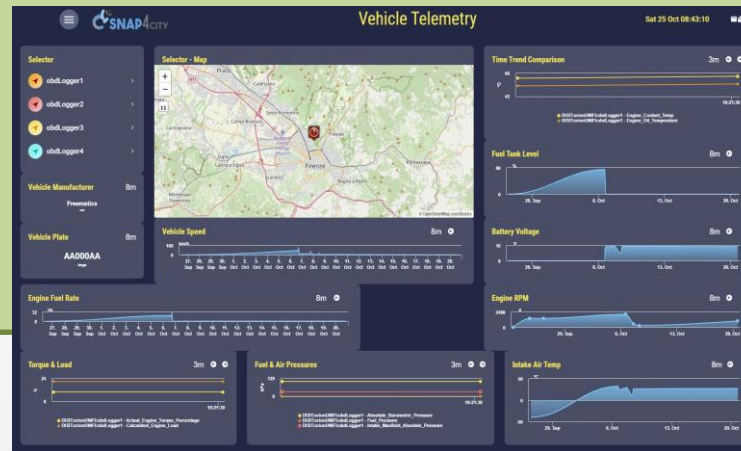
IoT App/Proc.Logic
Snap4City Edge



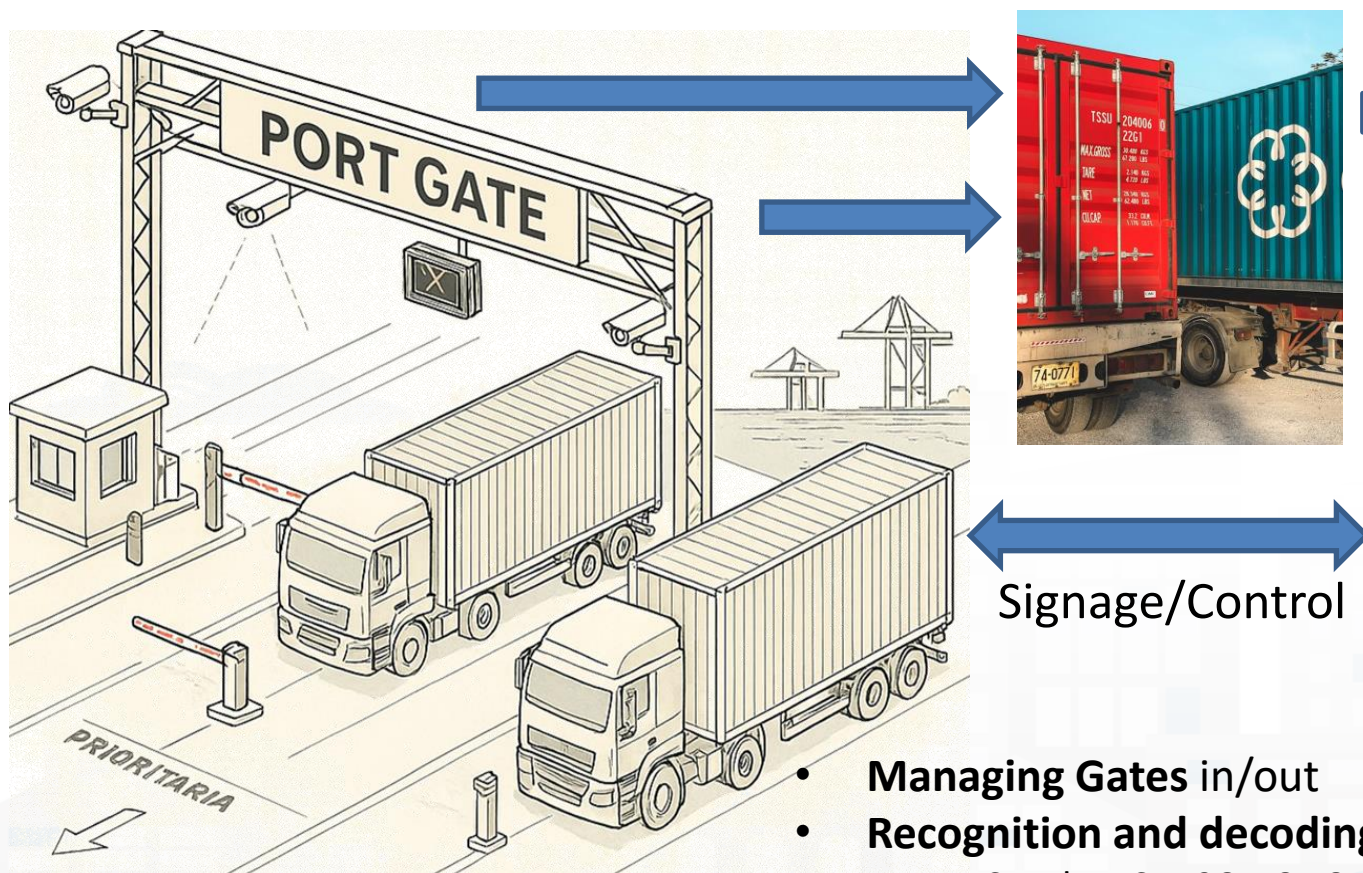
- Configuring data logger
- Selecting parameters
- Decoding and pushing data on Snap4City Platform AI enabled platform
- Toward the Snap4Fleet Manager

Snap4Fleet Manager

on Snap4City Platform

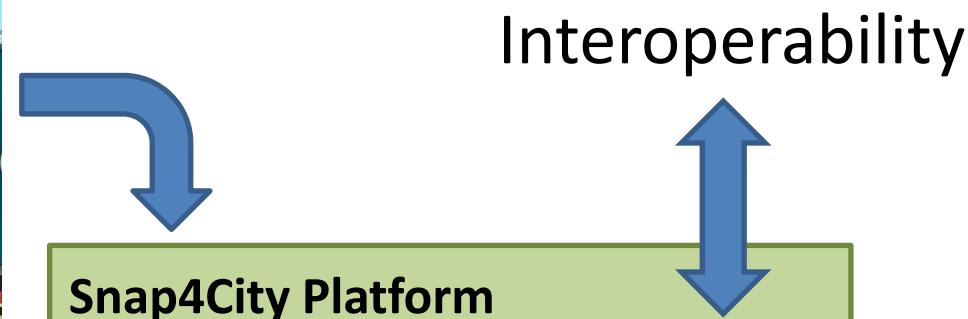


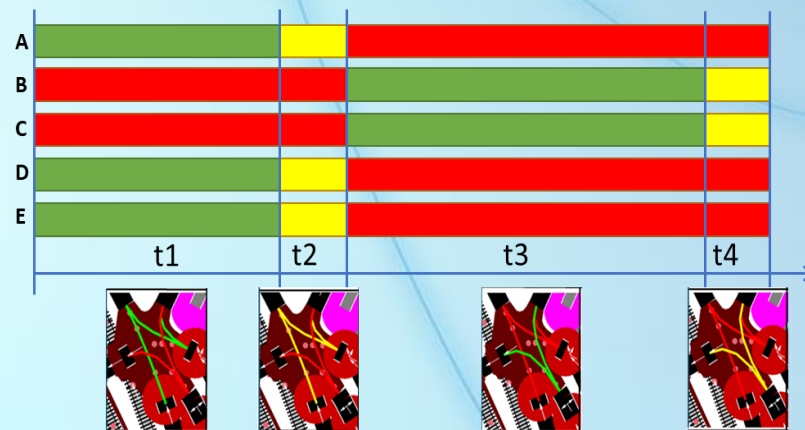
Trucks' Plates and Container ID Recognition



- **Managing Gates in/out**
- **Recognition and decoding**

- BIC code: FCIU 964484 8
- ISO code: 45G1
- Seal status: on/off
- Multi-national Plates: EX 398AE





IL FUTURO DELLA MOBILITA'
INTELLIGENTE E SOSTENIBILE

Ottimizzazione Semaforica

Prof. Paolo Nesi, UNIFI DISIT



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



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Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANTO NAZIONALE
DI SOSTENIBILITÀ

MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

Traffic Light Optimisation

- **Traffic Light Plan:**

- General construction of Traffic Light Plans for the area
- TLP are loaded on the basis of the expected conditions: football game, ferial and festive, school period, morning and afternoon, etc.
- Single Junction TLP can be:
 - adjusted exploiting local data, on demand signals, etc.
 - Actuated on the basis of the measures of traffic

- **Issues:**

- Making multijunction synchronization to keep under control of quality of Service for TRAMWAYS and/or Busses Rapid Transit, BRT/HRB



Select map

Zoom

New Scenario

Editing

Drag & drop

Split & Join

Delete

Do and Undo

Edit Road
Segment

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

35

Traffic Light Plan Optimisation, Digital Twin

- **Match Multiple Objectives and Synchronization:**

- public and private traffic, tramway priority
- Micro and Macro Scales

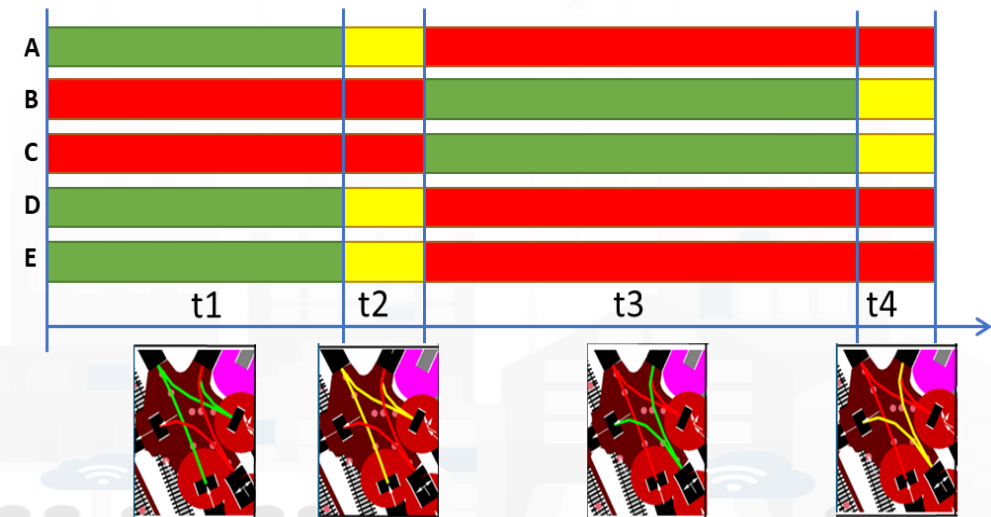
- **AI: Genetic Algorithms, Deep Reinforced Learning**

- 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%**



Traffic Light Plan Editor

Traffic Light Plan Generator

Wed 23 Oct 18:50:03

Traffic Light Plan Editor

Query radius:

Semaphore name:

Directions:

Time cycle:

Save Traffic Light

debug

Clear

View Mode

	Via Ve...	Via Fr...	Via Ve...
Via Ve...	1	0	0
Via Fr...	2	0	3
Via Le...	0	4	5

1 : Via Venti Settembre - Via Venti Settembre

2 : Via Francesco Crispi - Via Venti Settembre

3 : Via Francesco Crispi - Via Venti Settembre

4 : Via Leone Decimo - Via Francesco Crispi

5 : Via Leone Decimo - Via Venti Settembre

Selector - Map

Load Scenario:

Scenarios waiting to be processed: dbologna_scenario2

Scenario version: 2024-02-21 17:20:42

Load Scenario Clean

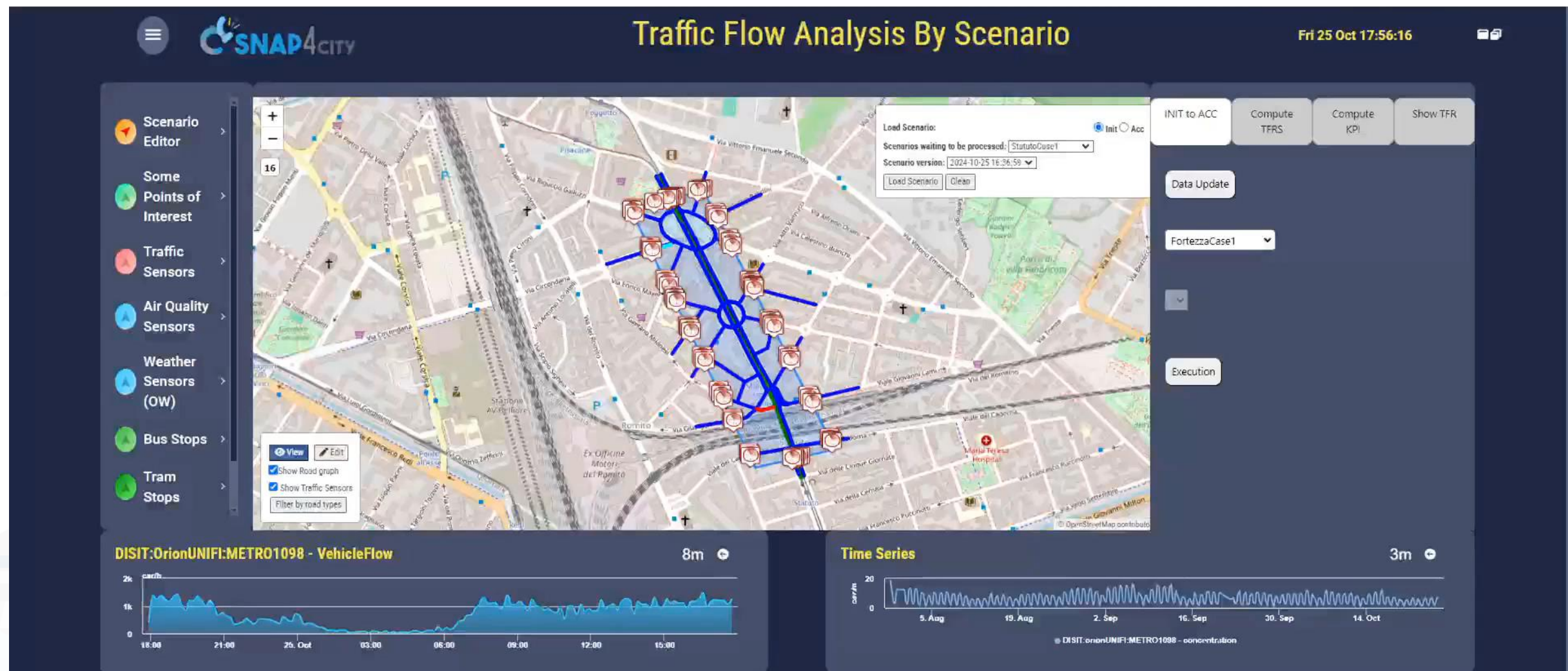
View Edit

Show Road graph

Show Traffic Sensors

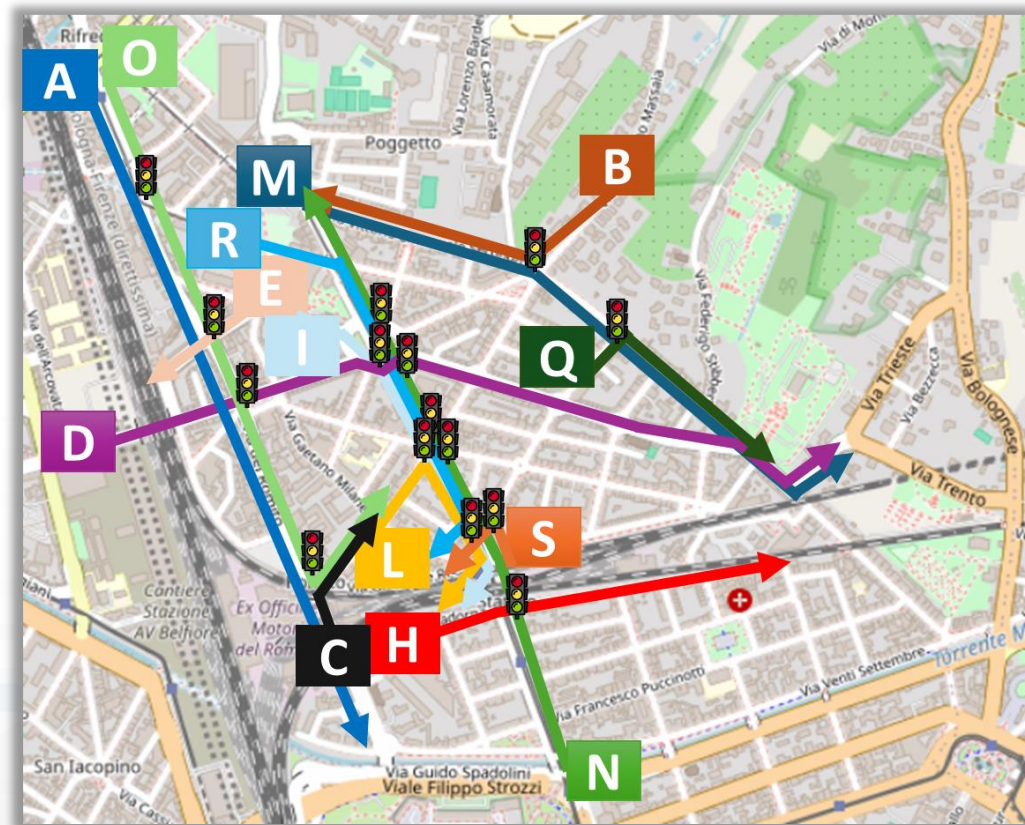
Filter by road types

Optimization of Traffic Light Plan



Optimization Drivers

- **MTT, Mean Travel Time** on
 - Multiple Directions or globally
 - For specific service
- **MWT, Mean Waiting Time** on
 - specific direction or globally
 - For specific service
- **MNS, Mean Number of Stops** on
 - specific direction or globally
 - For specific service



GA based: 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

-5%

-8%

-45%

-3%

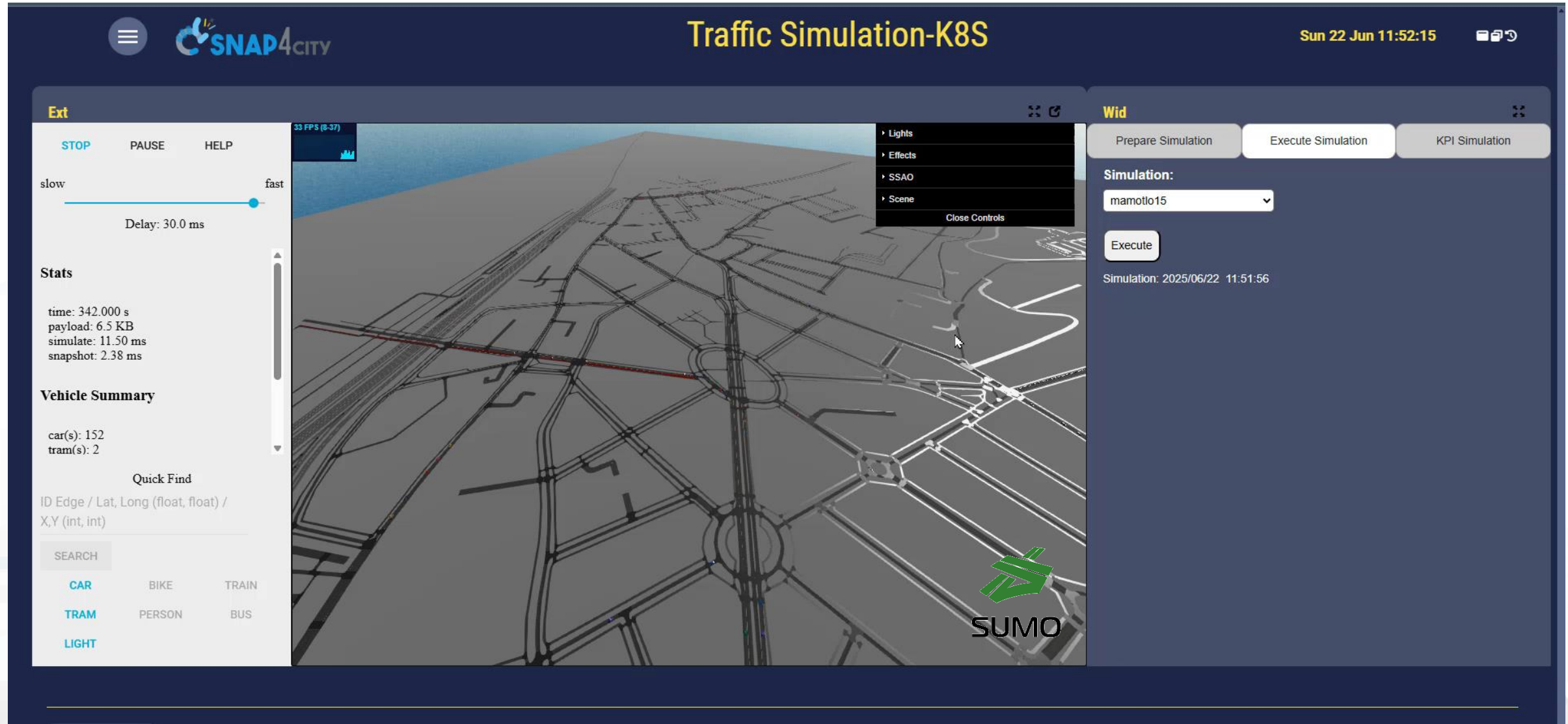
-6%

-4.5%

Reductions of Travel time of 3-45% and elimination of the #stops for the tramways

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

S. Bilotta, Z. Fereidooni, L.A. Ipsaro Palesi, P. Nesi, "Macroscopic GA-based Multi-Objective Traffic Light Optimization Prioritizing Tramways", Applied Soft Comp. Journal, Elsevier, 2025.



The screenshot displays the SNAP4CITY Traffic Simulation-K8S interface. The main window shows a 3D perspective view of a city street network with a tram line highlighted in red. The interface includes several control panels:

- Ext Panel (Left):**
 - Buttons: STOP, PAUSE, HELP
 - Speed slider: slow to fast, Delay: 30.0 ms
 - Stats:**
 - time: 342.000 s
 - payload: 6.5 KB
 - simulate: 11.50 ms
 - snapshot: 2.38 ms
 - Vehicle Summary:**
 - car(s): 152
 - tram(s): 2
 - Quick Find:**
 - ID Edge / Lat, Long (float, float) / X,Y (int, int)
 - SEARCH input field
 - Vehicle type filters: CAR, BIKE, TRAIN, TRAM, PERSON, BUS, LIGHT
- Wid Panel (Right):**
 - Buttons: Prepare Simulation, Execute Simulation, KPI Simulation
 - Simulation:**
 - Dropdown menu: mamotio15
 - Execute button
 - Simulation timestamp: 2025/06/22 11:51:56
- Top Bar:**
 - Menu icon, SNAP4CITY logo
 - Title: Traffic Simulation-K8S
 - Date/Time: Sun 22 Jun 11:52:15
 - Icons for window management
- Bottom Right:**
 - SUMO logo

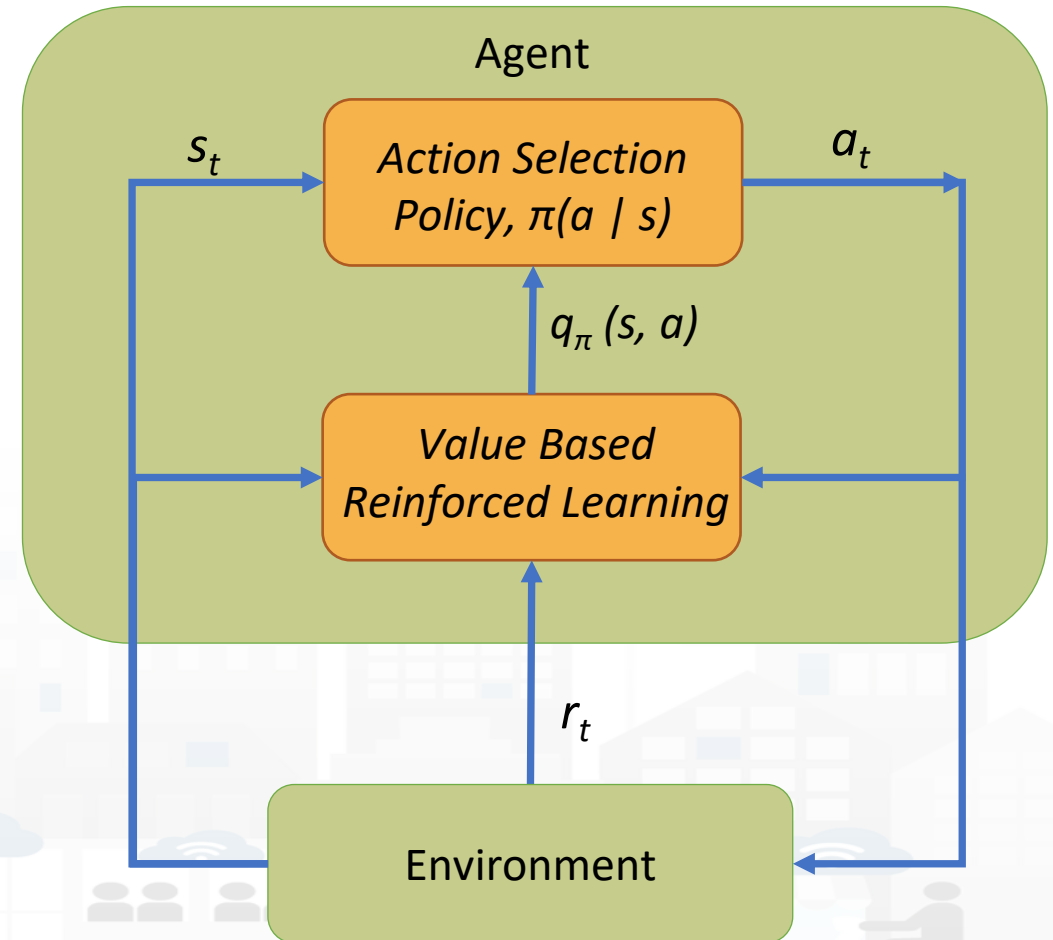
Multi Agent Reinforced Learning

- **Single Actuated**

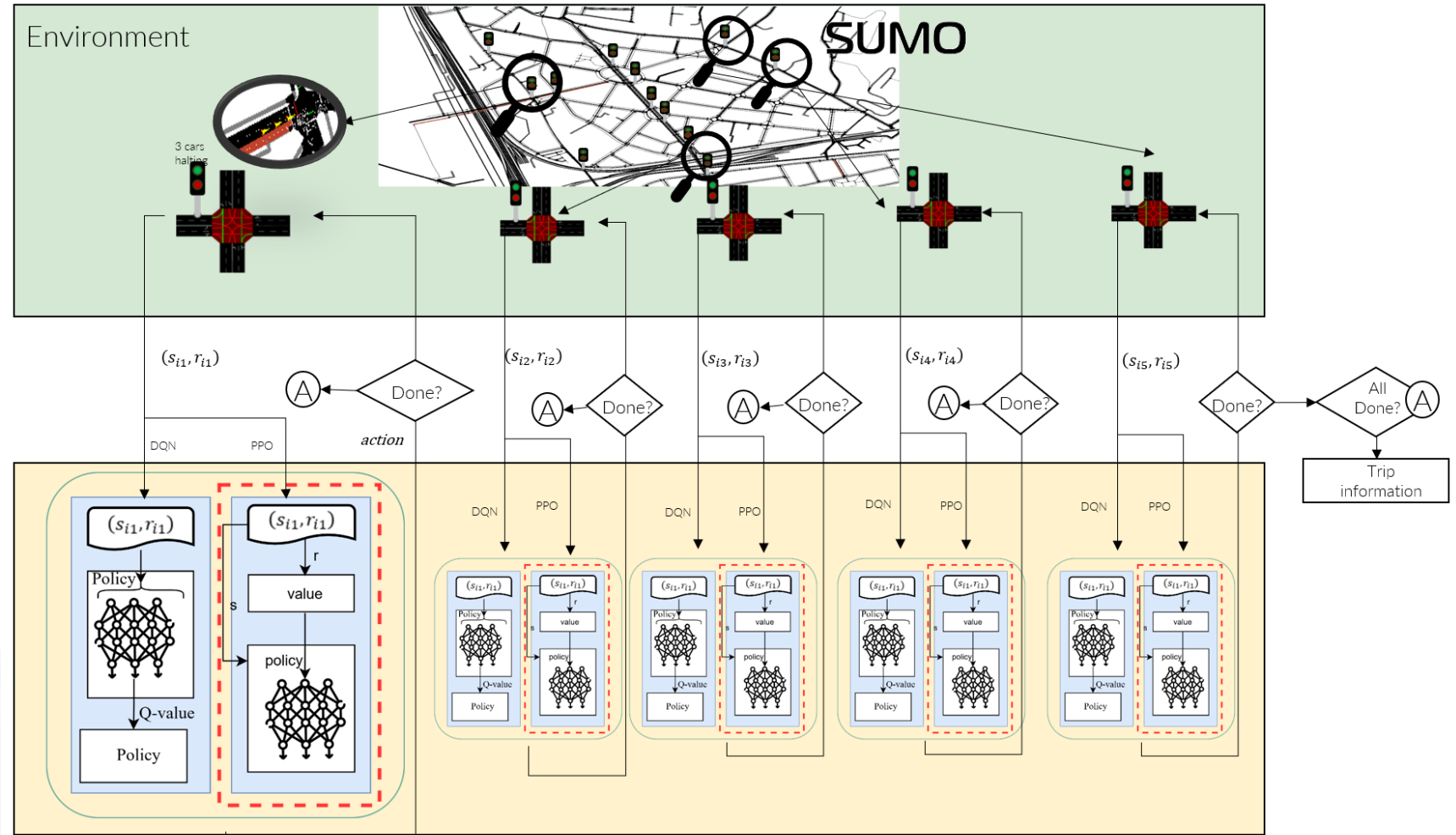
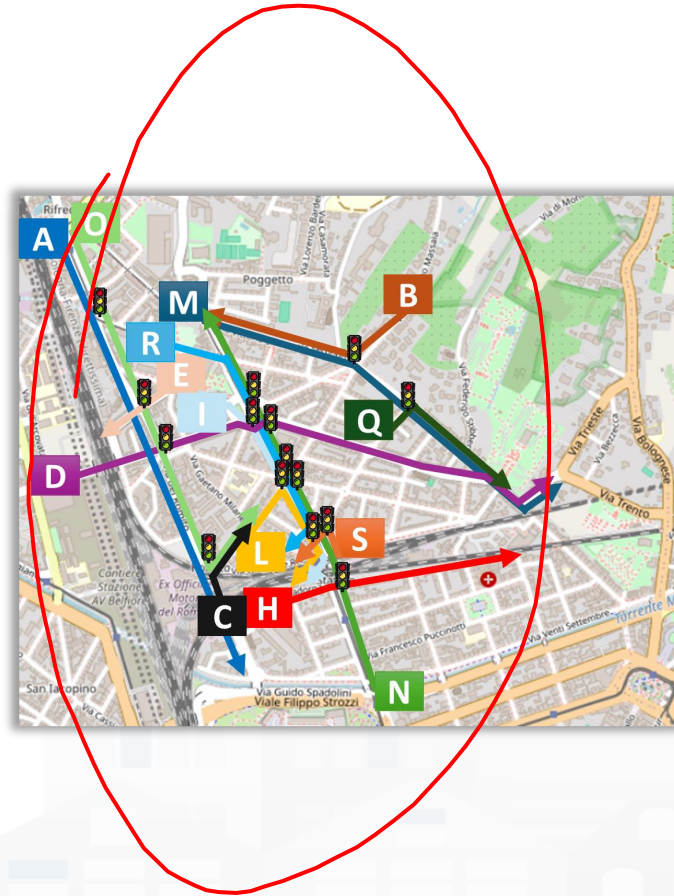
- Taking into account the status of each traffic source of each Junction
- Computing the best compromise of G/R ratio
- Act on the next cycle

- **Multi Agent**

- As Single Actuated
- Taking into account synchronization, as condition and travel time of main specific travel means



Multi Agent DRL



MTT for Multi Agent DRL for TLP

Model	TL	all	dir_N	dir_M	dir_A	dir_D	Careggi	Costanza
4TWD-NTNS-MWD-A	1	3013.85	176.93	233.75	194.46	237.65	436.00	427.00
4TWD-NTNS-MWD-P-A	1	3013.85	176.93	233.75	194.46	237.65	436.00	427.00
SUMO Actuated	1	2935.41	249.60	209.77	202.42	270.86	486.73	478.36
Webster	1	5188.87	211.66	242.32	205.46	562.31	984.00	427.00
Webster A	1	2968.90	183.50	242.67	201.27	251.76	482.27	427.00
SARL-FC DQN	1	2834.93	206.68	244.78	199.21	243.26	486.72	485.00
SARL-FC DQN A	1	2760.12	206.35	244.63	198.00	244.76	436.00	427.00
MADRL-FC DQN	1	3089.20	188.29	220.91	205.07	248.06	485.00	445.00
MADRL-FC DQN A	1	2983.69	189.11	220.70	187.00	248.79	436.00	427.00
MARL-FC PPO	1	2910.76	200.38	235.41	198.14	237.78	547.00	445.00
MARL-FC PPO A	1	2855.12	200.93	235.53	196.39	237.97	436.00	427.00
SMART A	1	2599.13	182.14	200	188.28	235.11	436.00	427.00

Ottimizzazione Trasporto Collettivo

Prof. Paolo Nesi, UNIFI DISIT



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MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

In the large

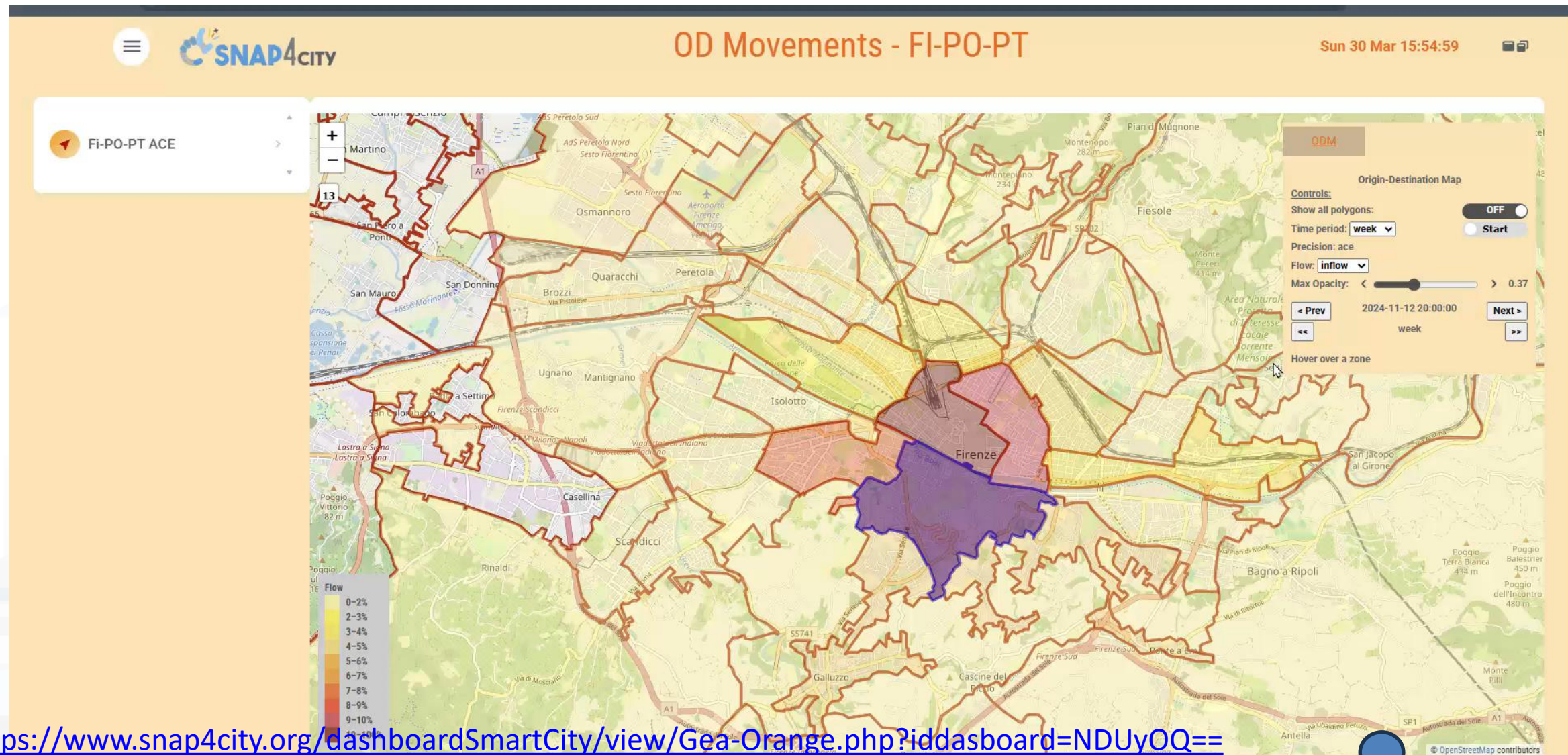
- **Mobility Demand → ODM:**

- Telecom Operator ODM, all movements on ACE Area
- Reduction on local actual percentage and behaviour distributions
- Matching on MGRS 200 mt, exploiting presence data of Telecom Operators

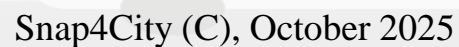
- **Transportation offer**

- Road graph
- GTFS/NeTex, transmodel
- Bike sharing, carsharing, scooters, etc.

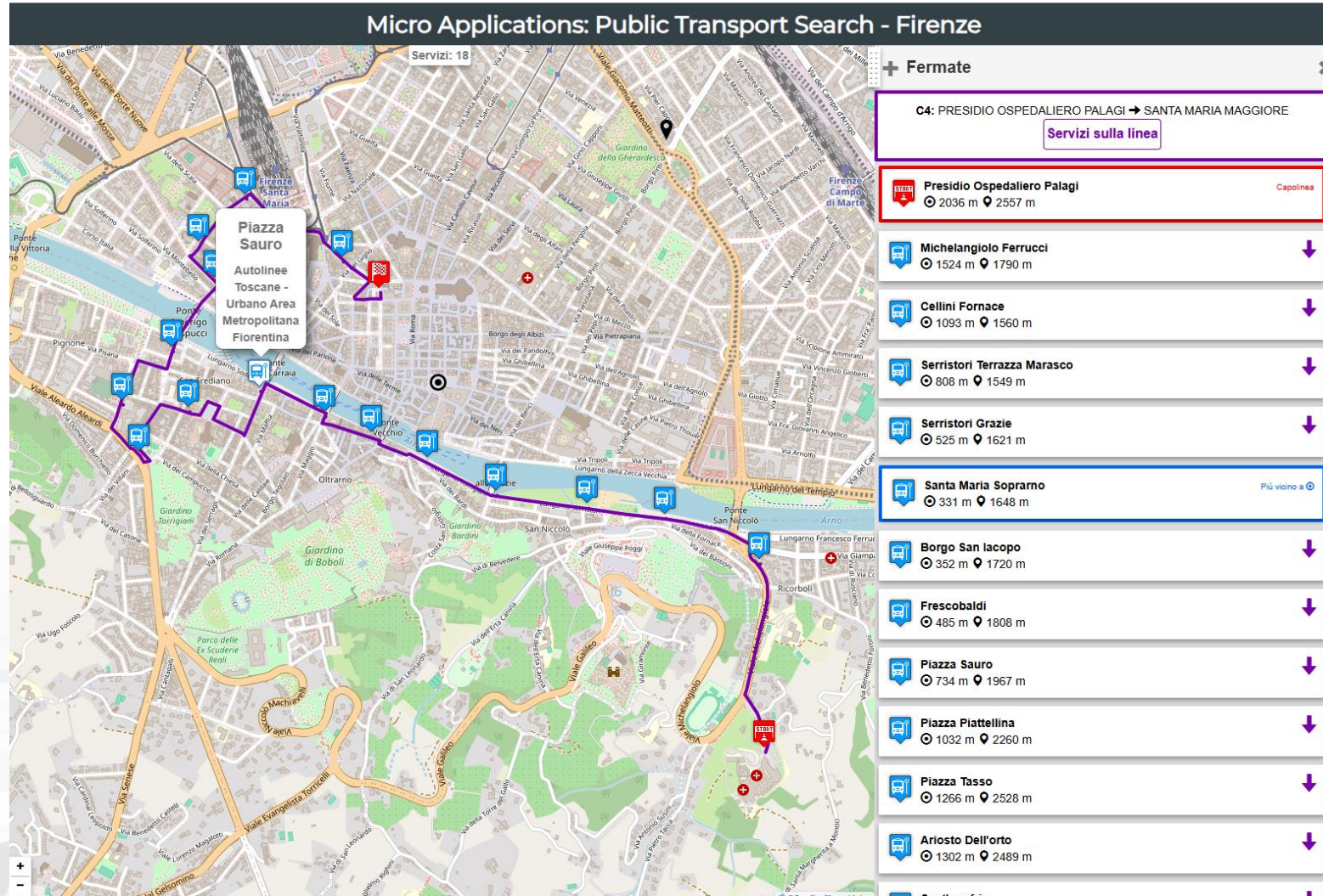
Origin Destination Matrices: Mobility Demand



Presences From Mobile Operator Data



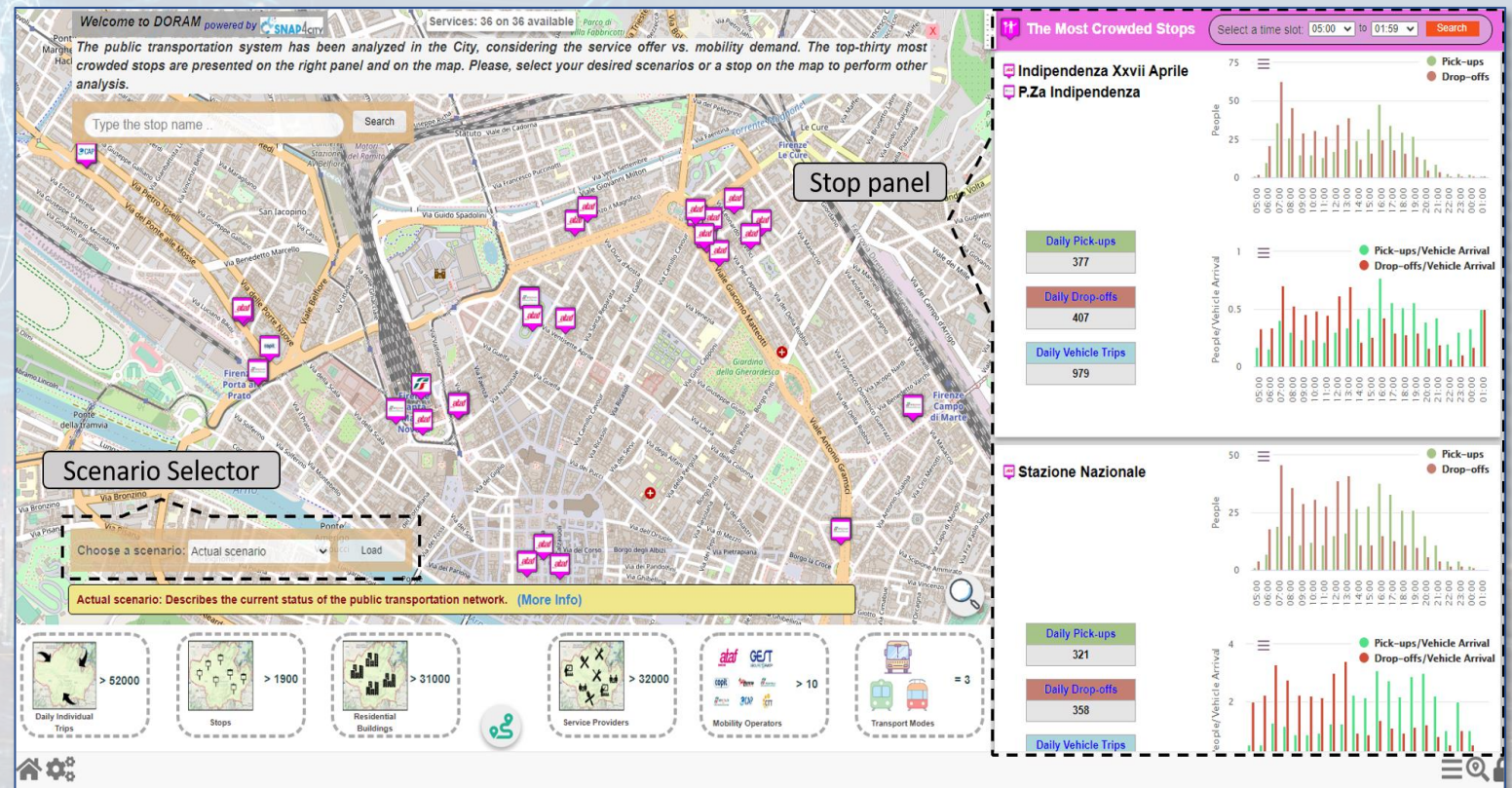
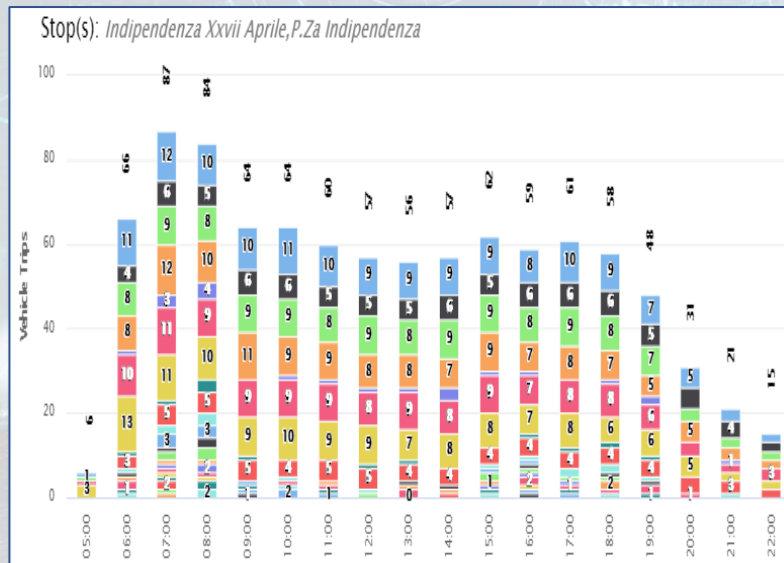
Offer of Transportation, GTFS, for example

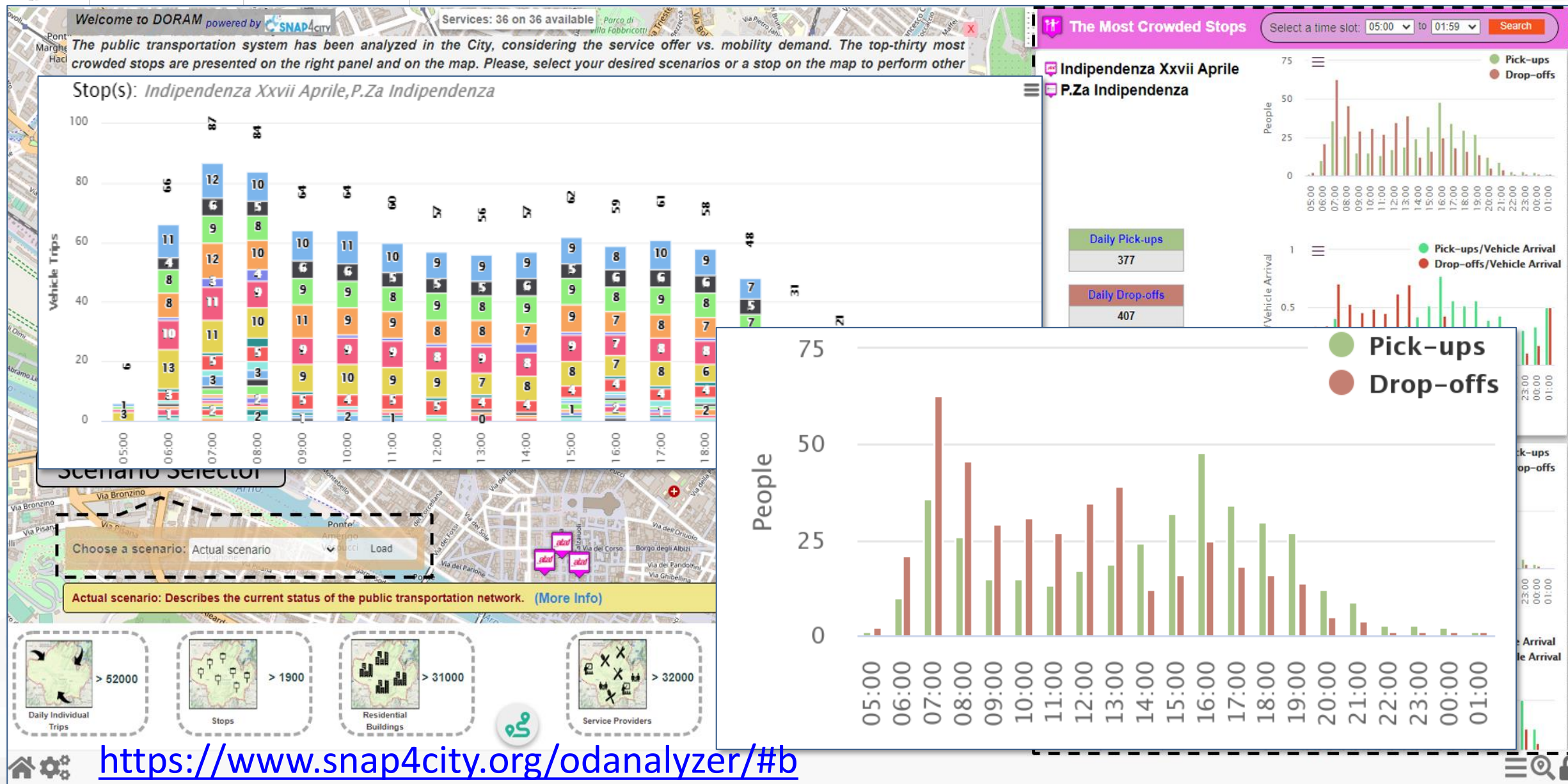


What-if Analysis on Collective Transport: DORAM

- Simulation / analysis of Mobility Demand wrt Transportation Offer
 - GTFS/TranSmodel vs ODM, taking into account road graph and services
- Definition of scenarios impact on
 - Traffic, Pollutant, parking, public transport, private flows, etc.
 - KPI analysis

Public Services







Traffic Simulation-K8S

Sun 22 Jun 11:53:30



Ext

STOP

PAUSE

HELP

26 FPS (17-26)

slow

fast

Delay: 30.0 ms

Stats

time: 0.000 s
payload: 0.0 KB
simulate: 0.00 ms
snapshot: 0.00 ms

Vehicle Summary

Quick Find

ID Edge / Lat, Long (float, float) /
X,Y (int, int)

SEARCH

CAR

BIKE

TRAIN

TRAM

PERSON

BUS

LIGHT

▸ Lights

▸ Effects

▸ SSAO

▸ Scene

Close Controls

Wid

Prepare Simulation

Execute Simulation

KPI Simulation

Simulation:

firenzeodbus

Execute

Simulation: 2025/06/22 11:53:27

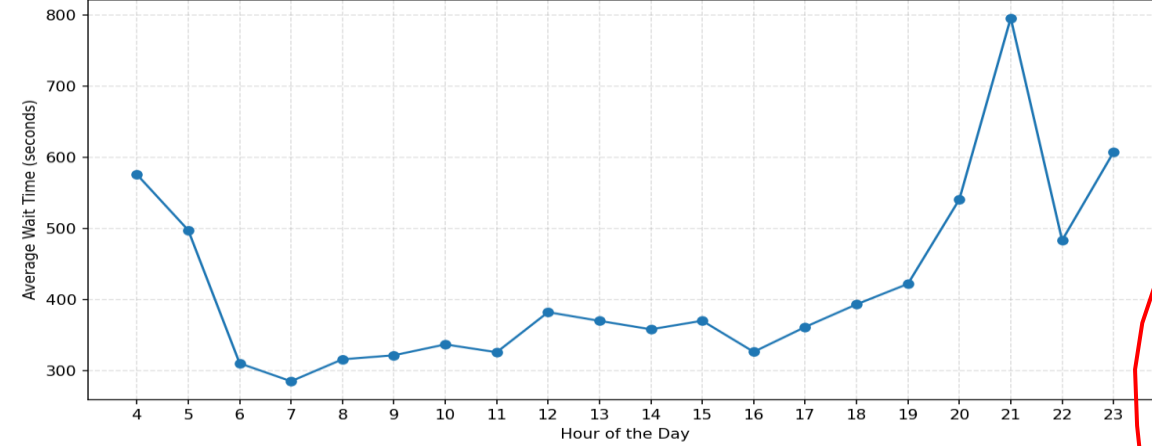


KPI on Match D-O of Collective Transport

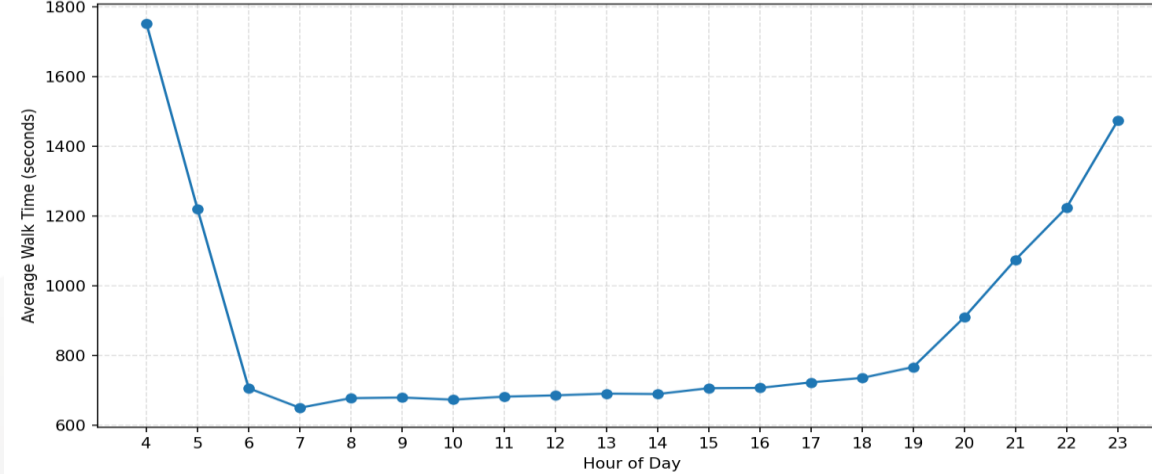
- **On users**
 - **Unmet Demand**
 - Number of passengers who could not board their planned bus
 - **Average Walk Time**
 - The average time spent by passengers during walking before and after taking a ride from source to destination of their trip.
 - Etc.
- **On Service performance**
 - **Average Ride Wait Time**
 - The average amount of time spent by passengers at bus stops while waiting for their desired vehicle.
 - **Average Ride Duration**
 - The average time spent by passengers in a vehicle taking a ride from source to destination of their trip.
 - **Average Vehicle Occupancy**
 - The average number of people boarded in vehicles of different bus lines at different timestamps of a day.
 - **Critical Bus Lines**
 - Bus lines for which the load factor of a bus line exceeds the threshold value of 15 in the service hours.
 - **Critical Bus Stops**
 - Bus stops where the crowding ratio is highest at top 20 bus stops served by different bus lines.
 - **Average Vehicle Depart Delay**
 - Vehicles which depart later than their expected time from the bus stops.
 - Etc.

The typical working day

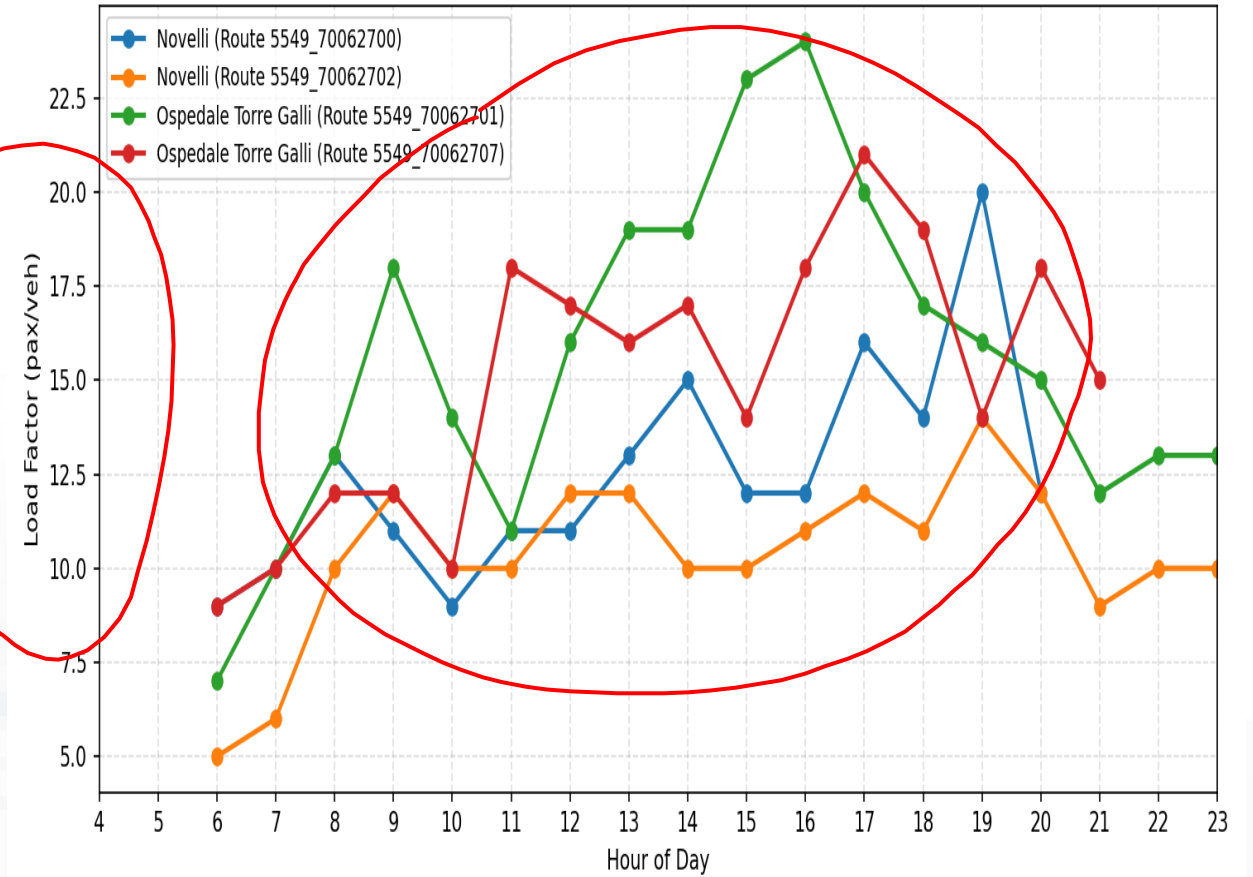
Average Hourly Ride Wait Time (Hour 04:00–23:59)



Average Hourly Walk Time (Hours 04:00–23:59)

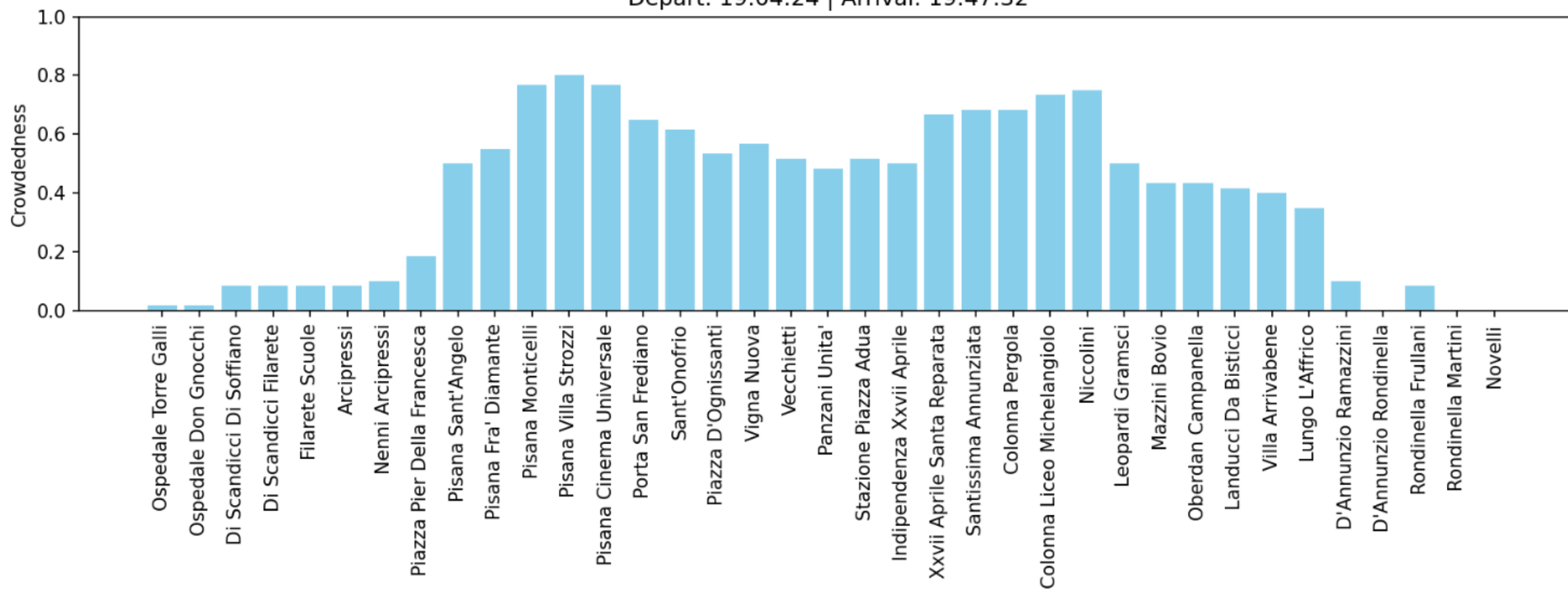


Line 6



Crowdedness

Trip 5549_70062700 | Line 6 - Novelli
Depart: 19:04:24 | Arrival: 19:47:32



Registrazione	10:00 - 10:30	Registrazione e Welcome Coffee Saluti
Avvio Lavori	10:30 - 10:40	- Prof. Paolo Nesi , UNIFI DISIT Lab/Snap4City - Franco Prampolini , Head of R&D and Innovative Industry Solutions Lutech Group
CN MOST SPOKE 8	10:40 - 11:00	Presentazione generale e obiettivi di OPTIFaaS - Mauro Starinieri , Head of Smart City & Mobility Solutions CoE Lutech Group
Overview OPTIFaaS	11:00 - 11:30	Presentazione dell'infrastruttura - Prof. Paolo Nesi , UNIFI DISIT Lab/Snap4City
Strumenti OPTIFaaS	11:30 - 11:50	Ottimizzazione del Traffico - Prof. Luigi Pariota , Università degli Studi di Napoli
Scenario OPTIFaaS	11:50 - 12:10	Ottimizzazione Semaforica e di Infrastruttura. Ottimizzazione del Trasporto Collettivo - Prof. Paolo Nesi , UNIFI DISIT Lab/Snap4City
Scenario OPTIFaaS	12:10 - 12:40	MaaS e OPTIFaaS: potenziali integrazioni con TPL e Micromobilità per una mobilità come servizio più interconnessa ed efficiente - Prof. Luigi Pio Prencipe , Politecnico di Bari
Q&A	12:40 - 13:00	Sessione aperta
Light Lunch (offered)	13:00 - 14:00	
Incontri 1:1	14:00 -	Incontri 1:1 con i referenti di Snap4City/ OPTIFaaS (in presenza)



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