

2021 POLIS CONFERENCE

1-2 December, Gothenburg

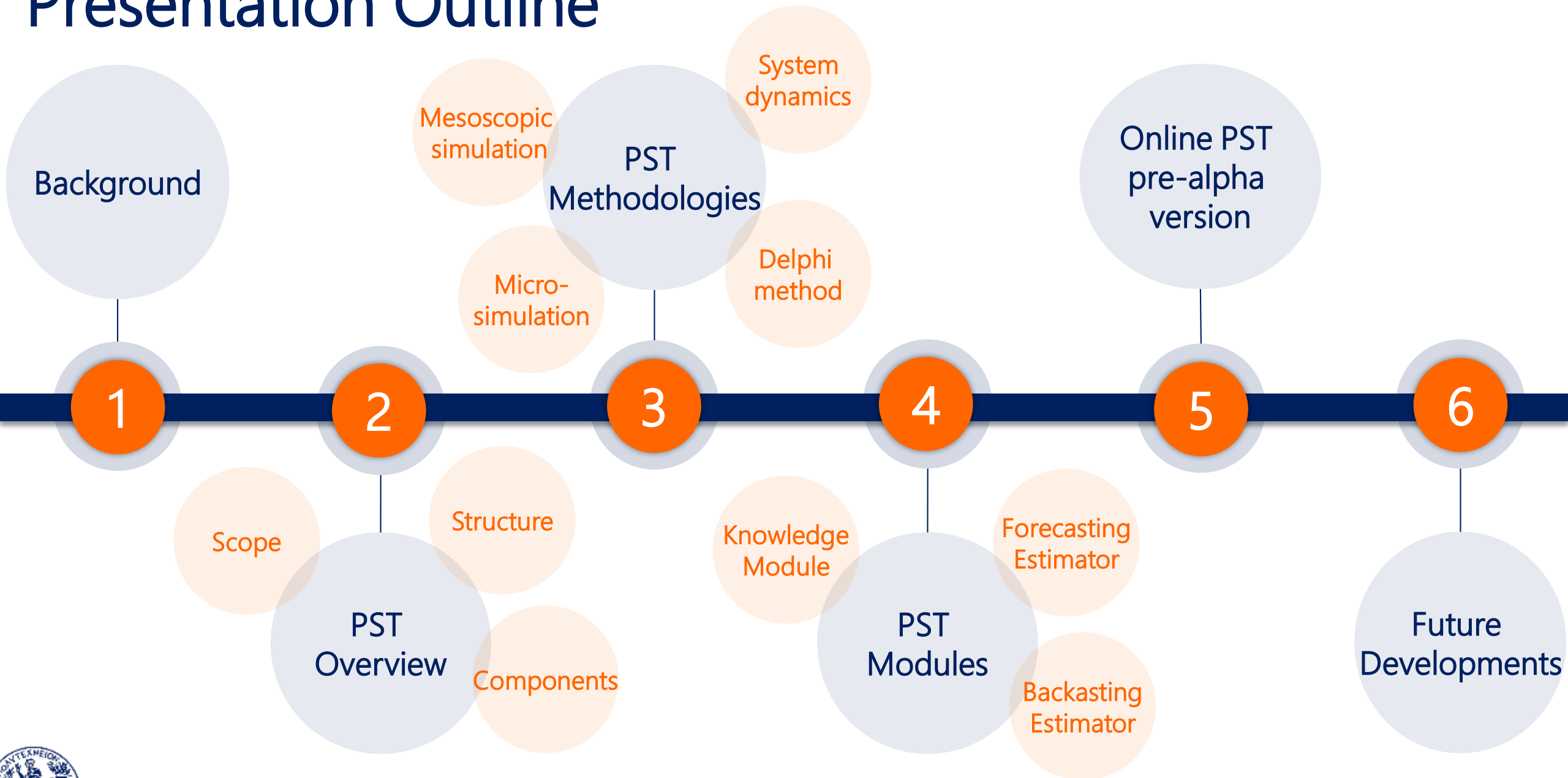
The Levitate Connected and Automated Transport Systems Policy Support Tool

**Apostolos Ziakopoulos,
Maria Oikonomou,
Julia Roussou,
George Yannis**

National Technical University of Athens
Department of Transportation Planning and Engineering



Presentation Outline

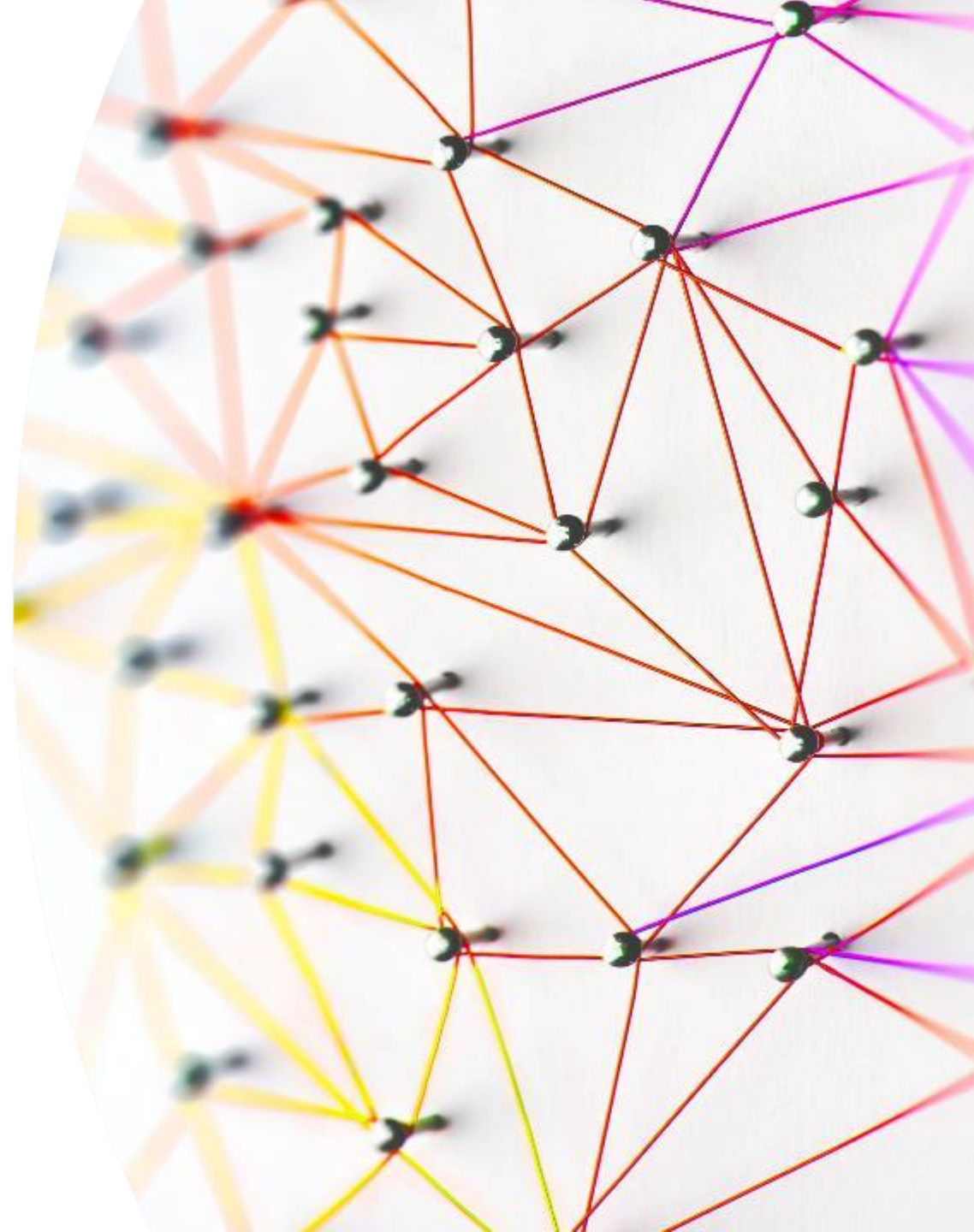


Background

- 
- Introduction
 - The Levitate Project

Introduction

- Rapid technological advances leave **limited margins** for the preparation of cities in order to receive Connected and Automated Transport Systems (CATS).
- Automation technologies are expected to roll out in a **rapid pace in all transport domains**, including land transport modes such as passenger cars, urban public transport and freight transport.
- The Levitate project endeavors to develop an **open access web-based Policy Support Tool (PST)** targeting Decision makers at all levels: Municipalities, Regional Authorities & National Governments.

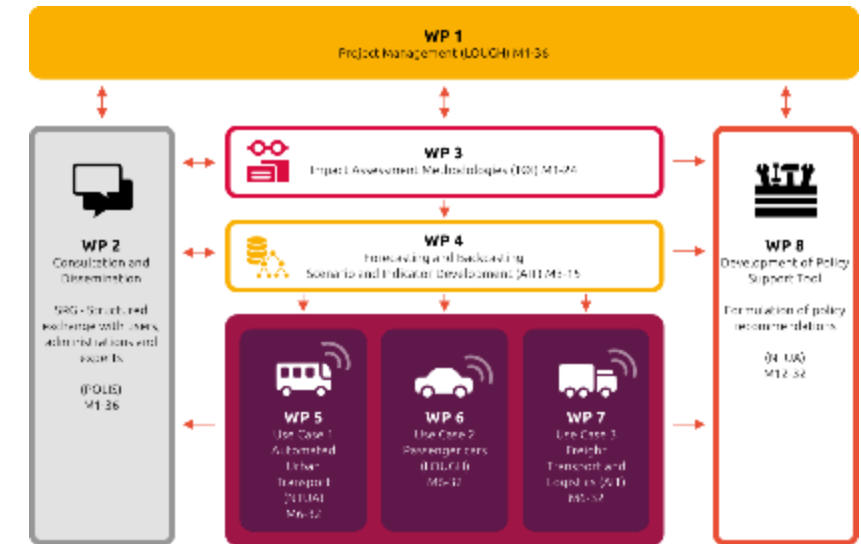


The Levitate Project

- Levitate focuses on the development of a new impact assessment framework, in order to enable policymakers to manage the **introduction of connected and automated transport systems**, maximise the benefits and utilise the technologies to achieve societal objectives
- **Project partners:** LOUGH (UK), AIT (AT), AIMSUN (ES), NTUA (EL), POLIS (BE), SWOV (NL), TOI (NO), TfGM (UK), City of Vienna (AT), QUT (AU), TJU (CN), UMTRI (US)
- **Duration of the project:** 36 months (December 2018 - December 2021)
- **Framework Program:** Horizon 2020 - The EU Union Framework Programme for Research and Innovation - Mobility for Growth



levitate



PST Overview

- Scope
- Components
- Structure

Scope

- To consolidate the outputs of different methods into an **overall framework** for the assessment of impacts, benefits and costs of CATS, for different automation and penetration levels and on different time horizons.
- To **analyze user needs** for a decision support tool aiming to assist in the analysis of urban policy scenarios and targets.
- To develop and implement a **toolkit and a decision support tool**, allowing the testing of various policy scenarios on the basis of the needs of relevant stakeholders, incorporating both **forecasting and backcasting** approach.
- To provide **policy recommendations**.



Components

- **Three automation use cases** are considered:
 - Passenger cars
 - Urban transport
 - Freight transport
- **Twenty examined impacts** are considered, classified into three distinct categories:
 - Direct impacts,
 - Systemic impacts and
 - Wider impacts

- **Four scenarios of automation penetration** are established:
 - No automation base scenario
 - Pessimistic base scenario
 - Neutral base scenario
 - Optimistic base scenario
- **Four different methods** used to provide inputs:
 - Microsimulation
 - Mesoscopic simulation
 - System dynamics
 - Delphi method



Structure

- Static
- Searchable
- Components:
 - Bibliography
 - Results
 - Tools
 - Guidelines and policy recommendations



Policy Support Tool (PST) - release 5 [June 2020]

Knowledge Module

Bibliography



Levitate results



- use case results
- predefined impact assessment scenarios

Tools Documentation



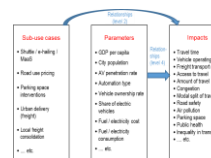
Guidelines



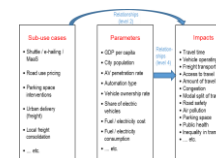
Estimator Module

Forecasting sub-system

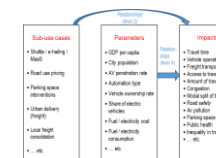
Sub-use case 1



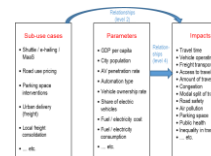
Sub-use case 2



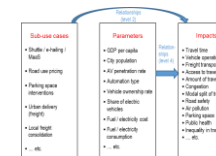
Sub-use case 3



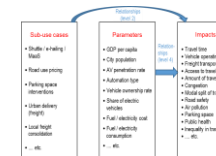
Sub-use case 4



Sub-use case 5



Sub-use case



Backcasting sub-system

Employment of forecasting in an iterative process ("goal seek"), testing alternative policy interventions until the desired impact - policy goal is obtained
TO BE DEFINED

- Dynamic
- Interactive
- Javascript Design
- Sub-systems:
 - Forecasting
 - Backcasting

PST Methodologies

- Microsimulation
- Mesoscopic simulation
- Systems dynamics
- Delphi method

Microsimulation

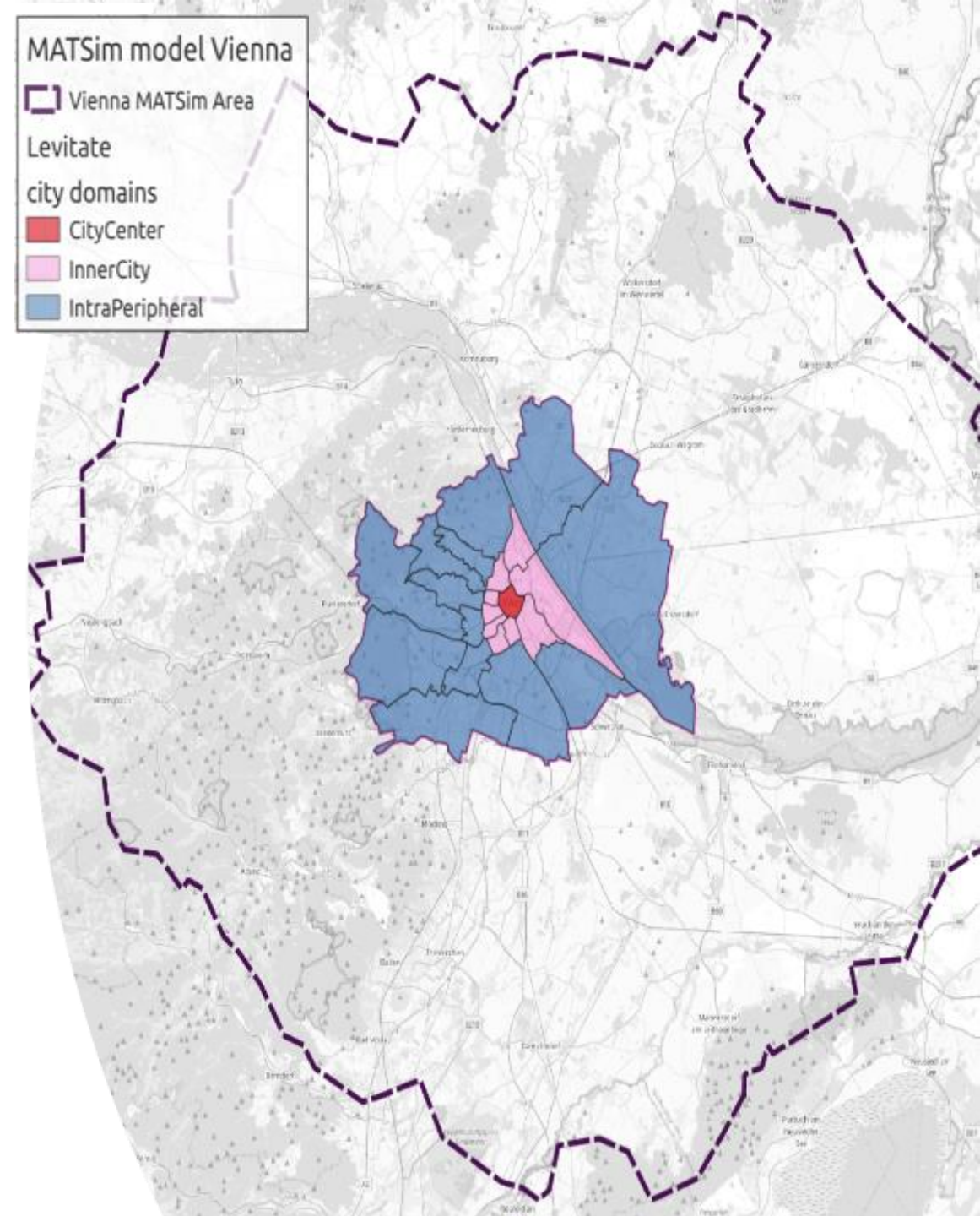
- **Impacts of CATS on traffic:** travel times, flows, traffic emissions and road safety under several simulation scenarios.
- Influence of different **CAV penetration rates** on a microscopic level.
- **AIMSUN software** is used within Levitate, with inputs including road geometry and design, traffic volume, modal split, O-D matrices etc.



Mesososcopic simulation

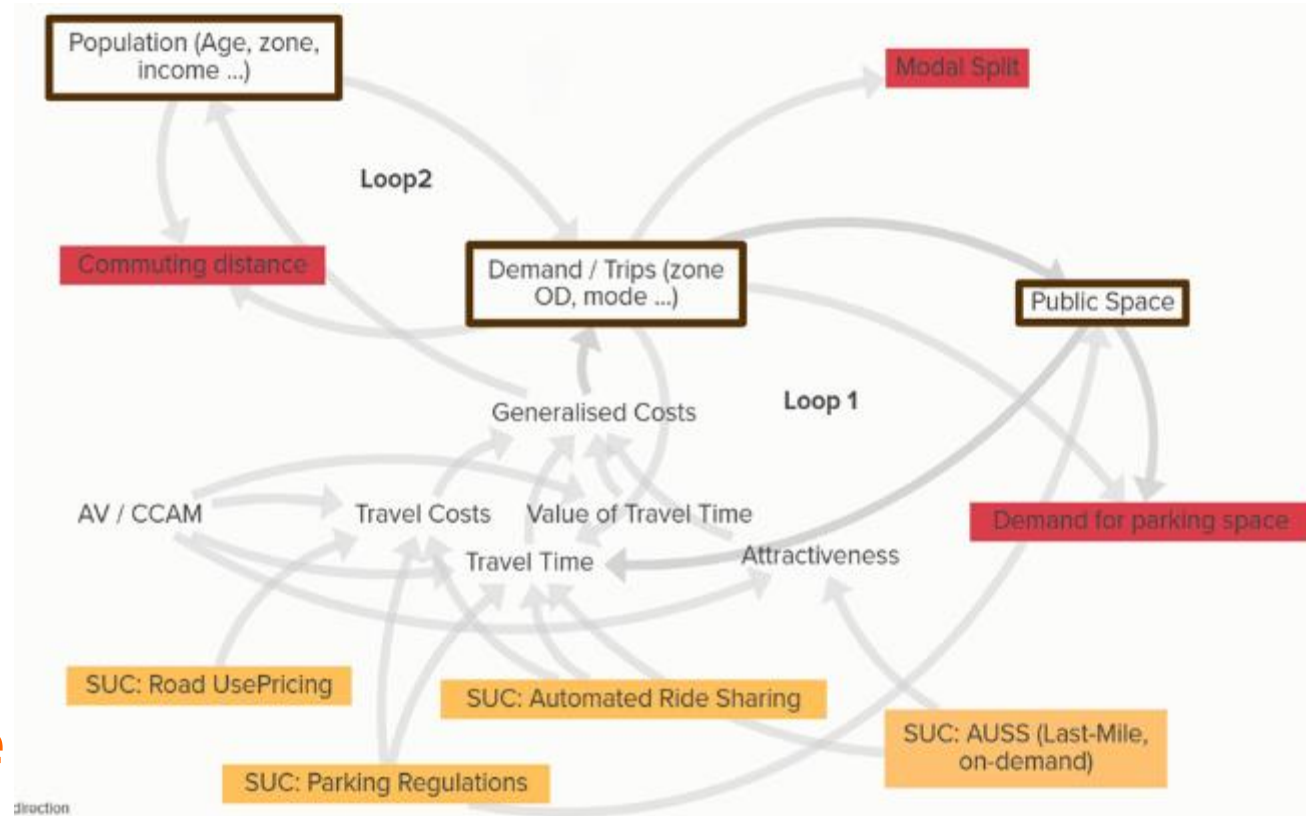
The mesoscopic mobility simulation of agents and their plans of activities is used as a method to estimate:

- **Travel time** of an average 5 km trip within the inner city.
- **Modal splits and modal shifts** (i.e. changes in modal split) of active (walking or cycling) and public transport modes of travel.
- **Total distance traveled** within the inner city.



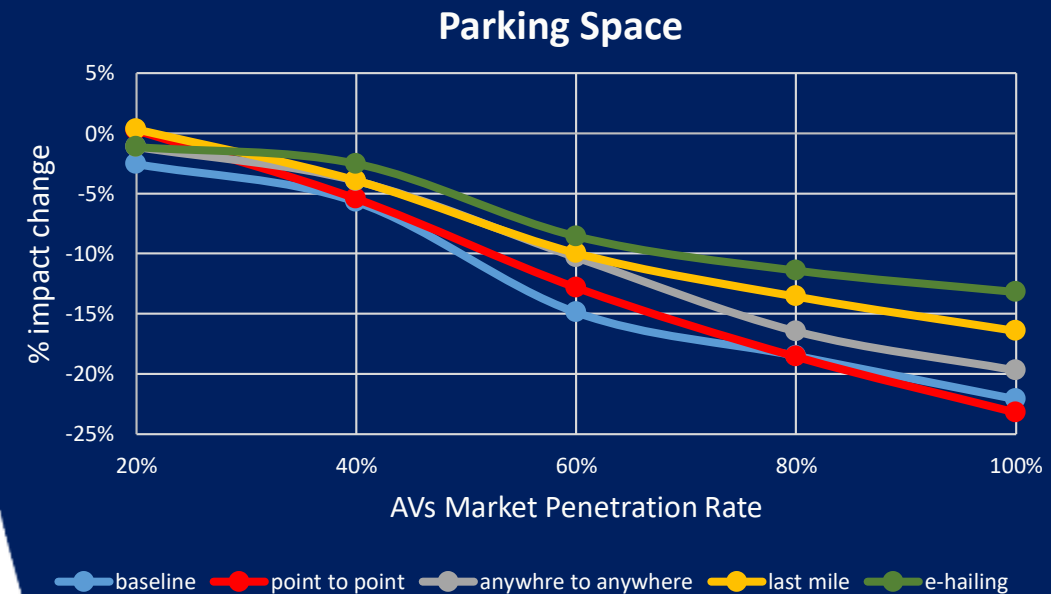
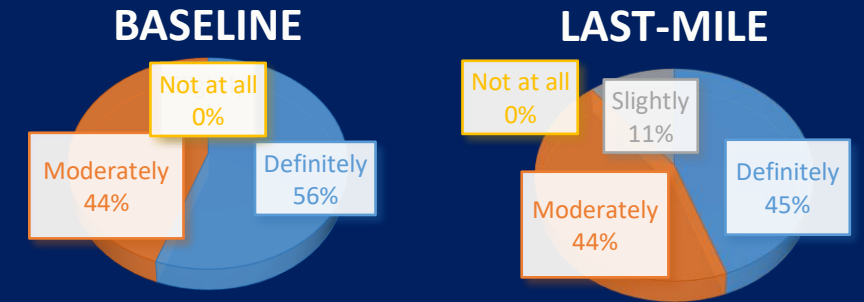
System dynamics

- **Transportation systems** that are undergoing transformation are considered.
- Assess **impacts of policy interventions** (e.g., road use pricing/last-mile shuttles) during a transition period of increasing AV percentage.
- Impacts are typically **commuting distances, modal split and parking space** as a function of MPR per scenario.



Delphi method

- A process used to arrive at a collective, aggregate group opinion through an **expert panel**.
- Used to obtain impacts that **cannot be calculated** by other quantitative methods.
- **Two-round** 45-min questionnaires, regarding 2 to 4 automation interventions based on expertise.
- Answers were aggregated as **percentage change coefficients**.



PST Modules

- Knowledge Module
- Forecasting Estimator
- Policy Intervention Combination
- Backasting Estimator

Knowledge Module

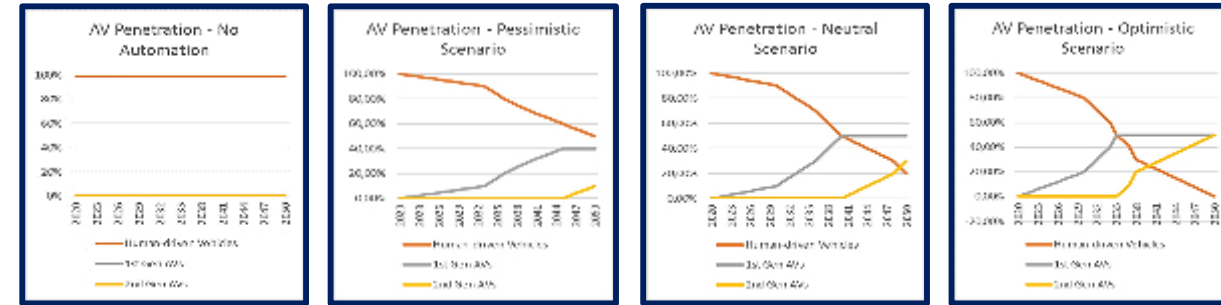
- **Bibliography:** Relevant literature concerning impact assessments of CATS
 - Systematic literature review across the project and one per use case
 - The documentation of each sub-use case
 - Short synopsis summarizing each use-case/sub use-case
- **Project results:** Case studies, impact assessments
 - For each case study:
 - Information regarding the scenarios and baseline conditions
 - Assumptions and limitations relevant to each case study
 - Showcasing of case study results

- **Documentation of tools:** Toolbox of methods
 - For each methodology:
 - Information regarding the methodological background
 - Assumptions and limitations relevant to each methodology
- **Guideline excerpts:** Guidelines and policy recommendations regarding CATS
 - Explanations and tutorials on the use of the PST Estimator modules
 - Overall recommendations to cities from project results
 - Additional recommendations from literature or other inputs



Forecasting Estimator

- **Step 1:** Selection of Use Case:
- **Step 2:** Definition of initial values
- **Step 3:** Definition of base scenario:
- **Step 4:** Details of sub use-case and policy intervention
- **Step 5:** Details of sub use-case implementation
- **Step 6:** Details of economic situation of agents
- **Step 7:** SUC impact estimation – presentation of results



User interface: Inputs

PASSENGER CARS

no.	Description	Unit of Measurement	Default Initial Value (can be changed by user)
1	GDP per capita	€	17,000
2	Annual GDP per capita change	%	1.50%
3	Inflation	%	1.00%
4	City Population	million persons	3.000
5	Annual City Population change	%	0.50%
6	Urban shuttle fleet size	no. of vehicles	300
7	Freight vehicles fleet size	no. of vehicles	100
8	Average load per freight vehicle	tones	3
9	Average annual freight transport demand	million tones	1.5
10	Human-driven Vehicles	%	100%
11	1st Gen - Cautious AVs	%	0%
12	2nd Gen - Aggressive AVs	%	0%
13	Fuel cost	€ / lt	1.50
14	Electricity cost	€ / KWh	0.10
15	Fuel consumption	lt / 100Km	8.00
16	Electricity consumption	KWh / 100Km	13.00
17	VRU Reference Speed (Typical on Urban Road)	km/h	40.00
18	VRU at-Fault accident share	%	30.00

SCENARIO 2 - PESSIMISTIC

Dynamic city toll

2021

[illegible][illegible]

1.42857142

0.95



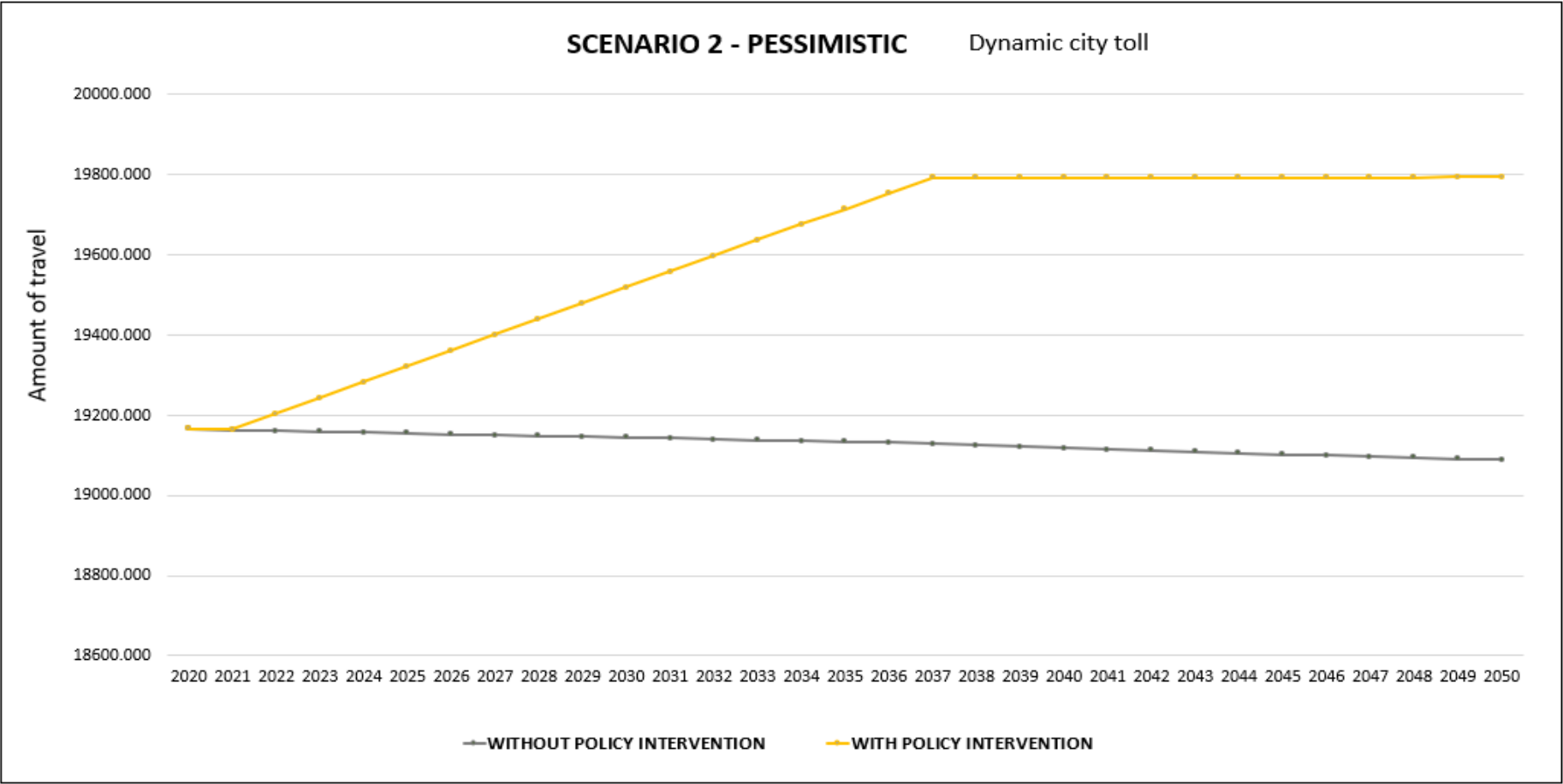
	no.	Impact	Description / measurement	Unit of Measurement	Initial Value
Direct impacts	1	Travel time	Average duration of a 5Km trip inside the city centre	min	15.0
	2	Vehicle operating cost	Direct outlays for operating a vehicle per kilometre of travel	€/Km	0.3
	3	Freight transport cost	Direct outlays for transporting a tonne of goods per kilometre of travel	€/tonne.Km	0.3
	4	Access to travel	The opportunity of taking a trip whenever and wherever wanted (10 points Likert scale)	-	5
Systemic impacts	5	Amount of travel	Person kilometres of travel per year in an area	person-km	19165.40
	6	Congestion	Average delays to traffic (seconds per vehicle-kilometer) as a result of high traffic volume	s/veh-km	197.4
	7	Modal split of travel using public transport	% of trip distance made using public transportation	%	0.4
	8	Modal split of travel using active travel	% of trip distance made using active transportation (walking, cycling)	%	3%
	9	Shared mobility rate	% of trips made sharing a vehicle with others	%	4%
	10	Vehicle utilisation rate	% of time a vehicle is in motion (not parked)	%	8%
	11	Vehicle occupancy	average % of seats in use (pass. cars feature 5 seats)	%	25%
Wider impacts	12	Parking space	Required parking space in the city centre per person	m ² /person	0.9
	13	Energy efficiency	Average rate (over the vehicle fleet) at which propulsion energy is converted to movement	%	0.25
	14	NO _x due to vehicles	Concentration of NO _x pollutants as grams per vehicle-kilometer (due to road transport only)	g/veh-km	1.80
	15	CO ₂ due to vehicles	Concentration of CO ₂ pollutants as grams per vehicle-kilometer (due to road transport only)	g/veh-km	2500.00
	16	PM ₁₀ due to vehicles	Concentration of PM ₁₀ pollutants as grams per vehicle-kilometer (due to road transport only)	g/veh-km	0.20
	17	Public health	Subjective rating of public health state, related to transport (10 points Likert scale)	-	5
	18	Inequality in transport	To which degree are transport services used by socially disadvantaged and vulnerable groups, including people with disabilities (10 points Likert scale)	-	5
	19	Commuting distances	Average length of trips to and from work (added together)	Km	20.00
	20	Unmotorized VRU crash rates	Injury crashes with unmotorized VRUs per vehicle-kilometer driven	injury-crashes/veh-km	2.20
	21	Road safety motorized	Number of crashes per vehicle-kilometer driven	crashes/veh-km	1.40
	22	Road safety total effect	Road safety effects when accounting for VRU and modal split	crashes/veh-km	0.85

User interface: Results

RESULTS

Enter Impact no:

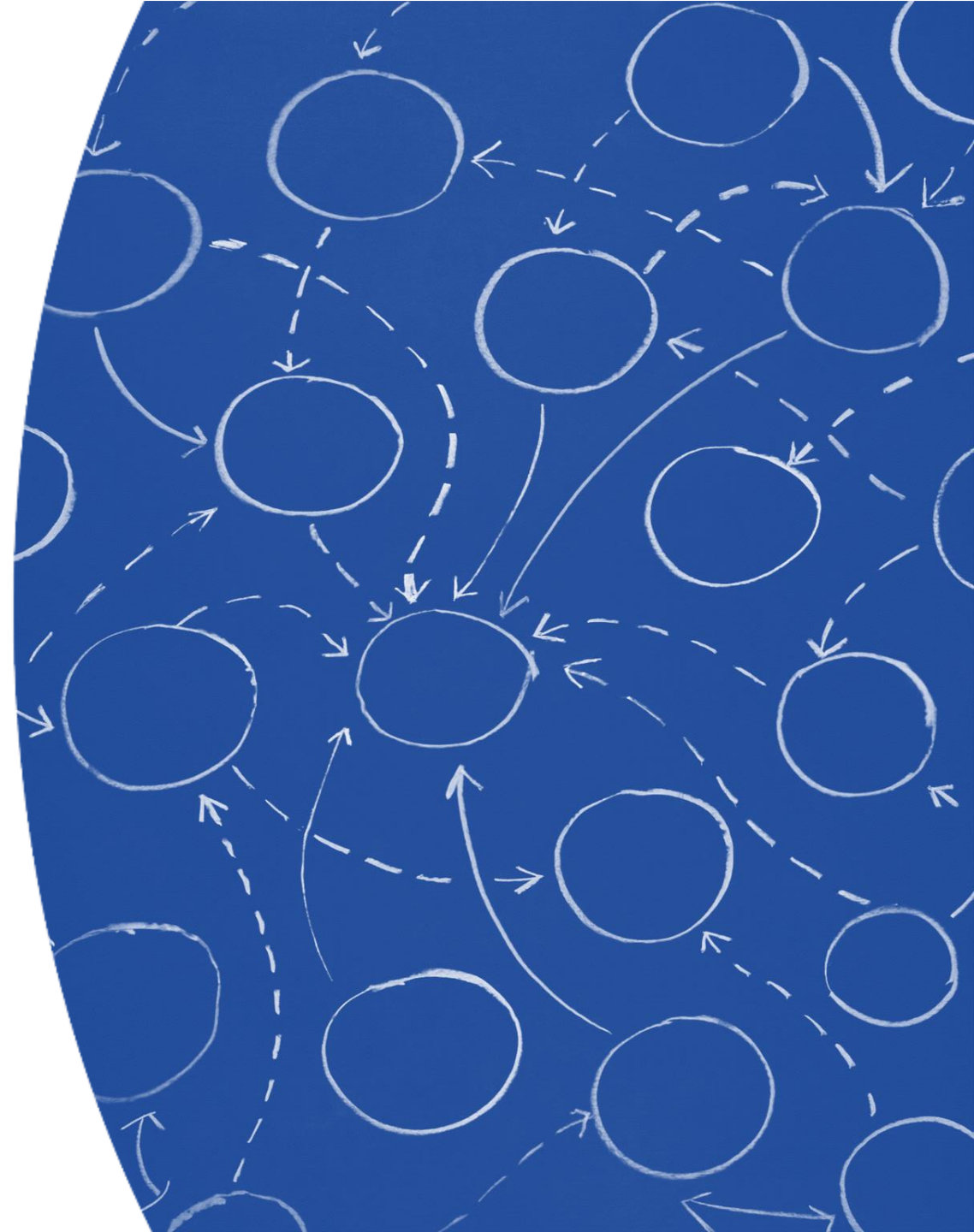
5



Policy Intervention Combination

The creation of Impact Modification Factors (IMFs) and their combinations in pairs drawing from the US FHWA HSM philosophy for CMFs

- **Additive method:**
$$\text{IMFc} = 1 - [(1 - \text{IMF}_1) + (1 - \text{IMF}_2)]$$
- **Multiplicative method:**
$$\text{IMFc} = \text{IMF}_1 * \text{IMF}_2$$
- **Dominant effect method:**
$$\text{IMFc} = \min(\text{IMF}_1, \text{IMF}_2)$$
- **Dominant common residuals method:**
$$\text{IMFc} = (\text{IMF}_1 * \text{IMF}_2)^{\min(\text{IMF}_1, \text{IMF}_2)}$$
- **Amplificatory method (not existing in FWHA):**
$$\text{IMFc} = [\text{IMF}_1 * \text{IMF}_2]^2$$



Backcasting Estimator

- **Functionality:** The backcasting process is envisioned to be the inverse of forecasting, i.e.: Set a vision, investigate how it can be reached.
- **Projection:** Are the selected measures enough or not?
- If not, define **best possible** attainable outcome.
- **Measure combination:** Using combined Impact Modification Factors (IMFs).
- **Measure change:** Option to substitute a measure for another midway once in the PST (e.g. Measure 1 performs better in low MPR, and Measure 2 performs better in high MPR).

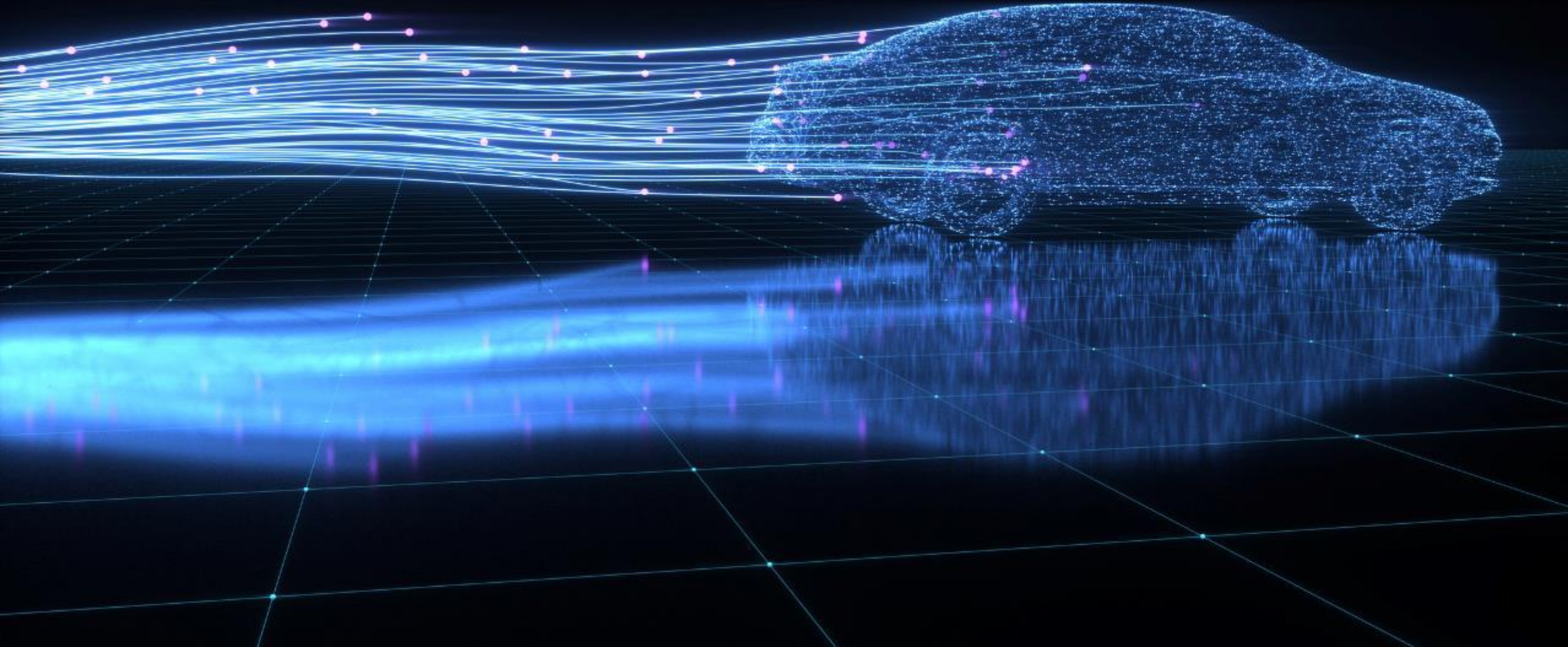


Online PST pre-alpha version

<http://34.248.215.136/>

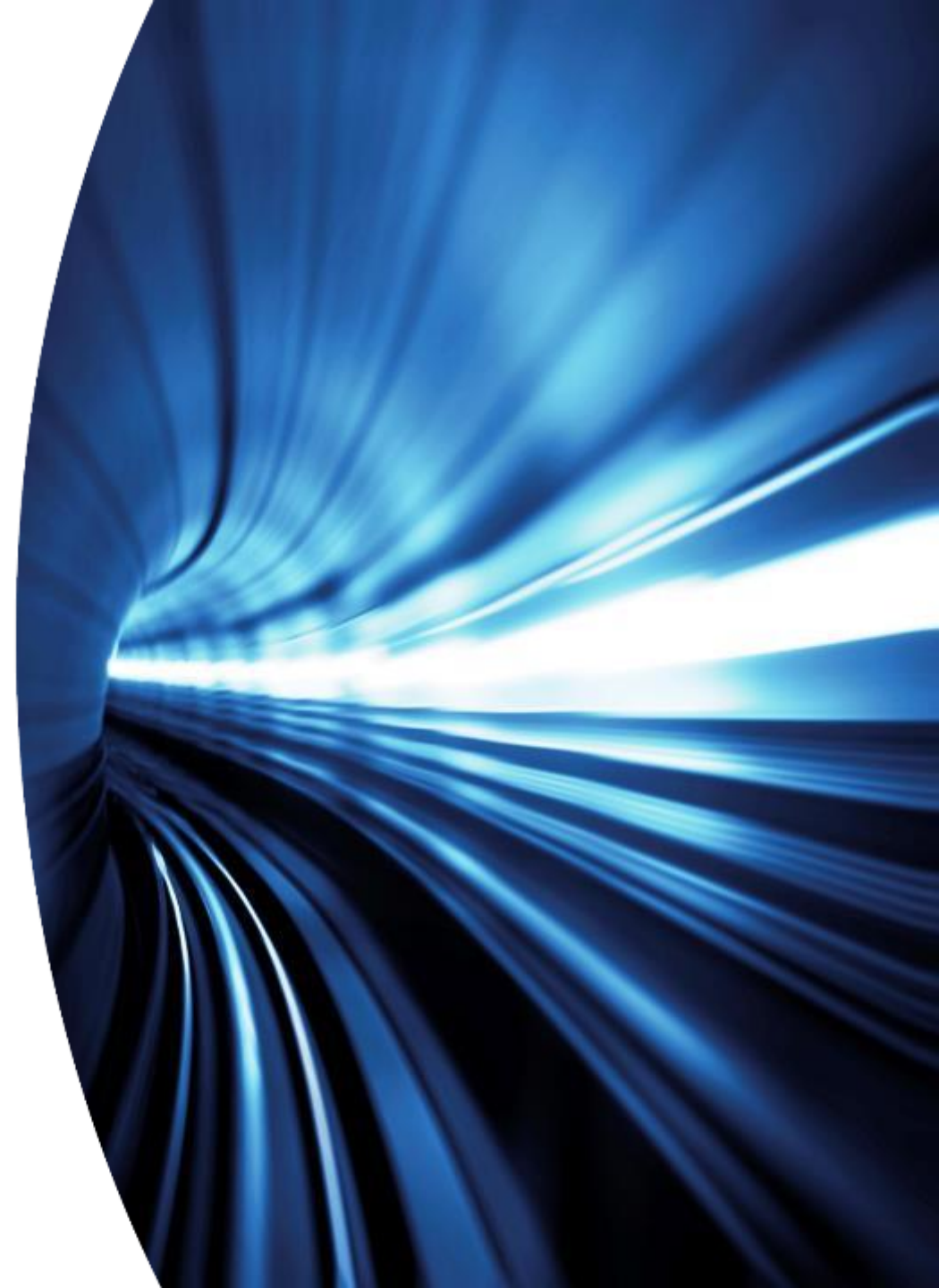


Future Developments



Future Developments

- As the Levitate project moves forward, **additional results and functionalities** will be available for the PST user.
- **CBA capabilities** are already being examined as an extension of the forecasting module database in order to monetize costs and benefits induced from the overall transformation of the transport networks.
- Overall, the Levitate PST aspires to become the go-to, one-stop-shop tool for the **calculation of societal impacts of automation** by experts, authorities, stakeholders and any other interested party.



2021 POLIS CONFERENCE

1-2 December, Gothenburg

The Levitate Connected and Automated Transport Systems Policy Support Tool

**Apostolos Ziakopoulos,
Maria Oikonomou,
Julia Roussou,
George Yannis**

National Technical University of Athens
Department of Transportation Planning and Engineering

