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Urban Transport Services

Webinar

11/06/2020

LEVITATE has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 824361.

Agenda

- The LEVITATE project
- Urban transport sub-use cases
  - Point to point automated urban shuttle connecting two modes of transport
  - Point to point automated urban shuttle in a large scale network
  - Autonomous mobility on demand shuttle service (AMoD)
- Policy Support Tool
- Conclusions and Future steps

LEVITATE

Societal Level Impact of Connected and Automated Vehicles

€ 6,4 million project funded by the European Commission under the Horizon 2020 research framework programme

Project coordinator:	Loughborough University
Start date:	1/12/2018 – 30/11/2021
Partners:	12 – from 10 countries

The LEVITATE project

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)

Operation Program:

- European Union’s “Horizon 2020” research and innovation program

Why LEVITATE

High expectations about CATS in terms of **safety, mobility, environment and prosperity**

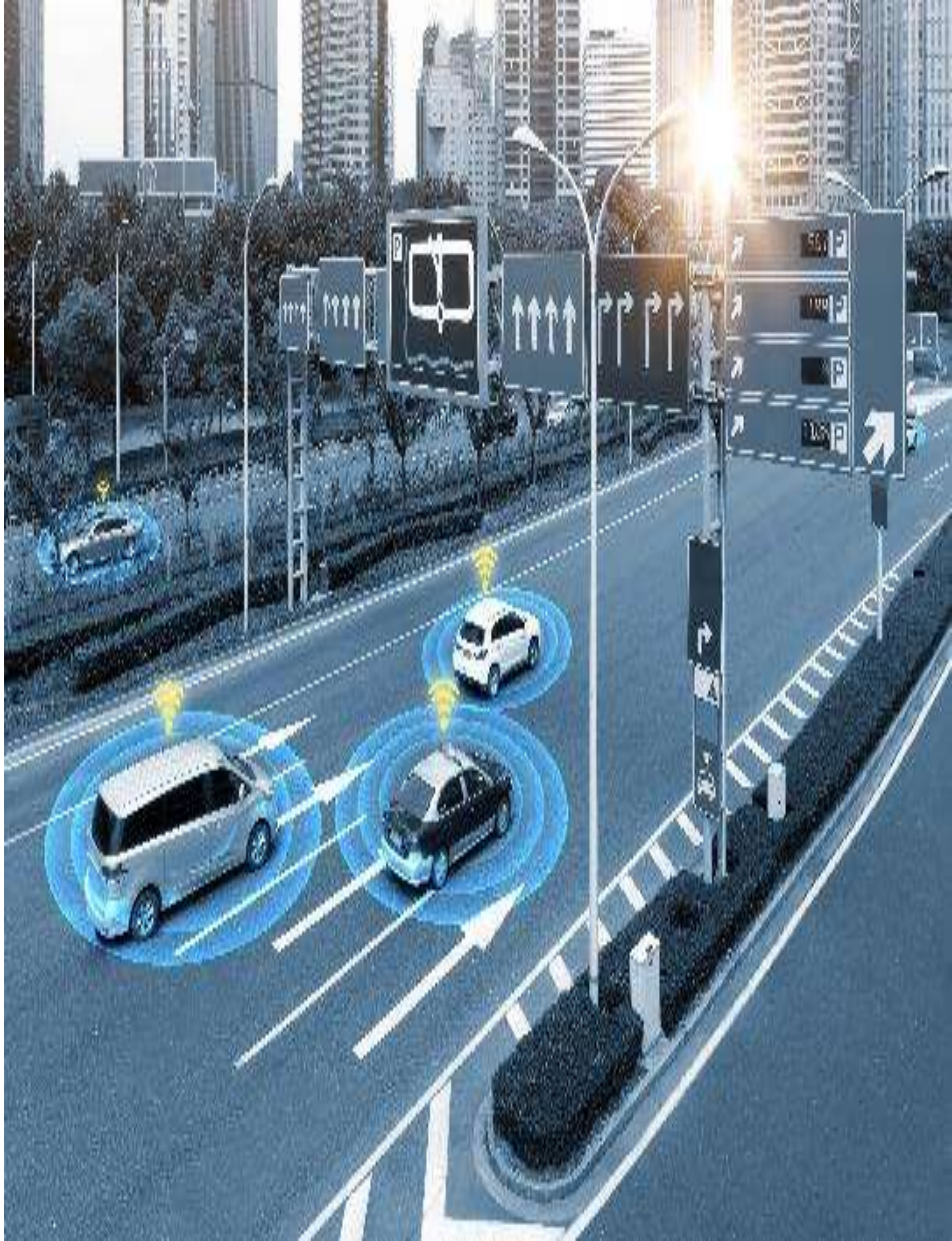
The need to measure the impact of existing systems as well as forecasting the impact of future systems represents a **major challenge**

The **dimensions for assessment** are wide including safety, mobility and environment, with many sub-divisions adding to the complexity of future mobility forecasts

LEVITATE…

is building tools to help **European cities, regions and national governments** prepare for a future with increasing levels of automated vehicles in passenger cars, urban transport services and urban logistics.

The aim is to develop an **impact assessment framework** to enable policymakers to manage the introduction of CATS, maximise the benefits and generally harness the technology to achieve societal objective.



Challenges

Research questions

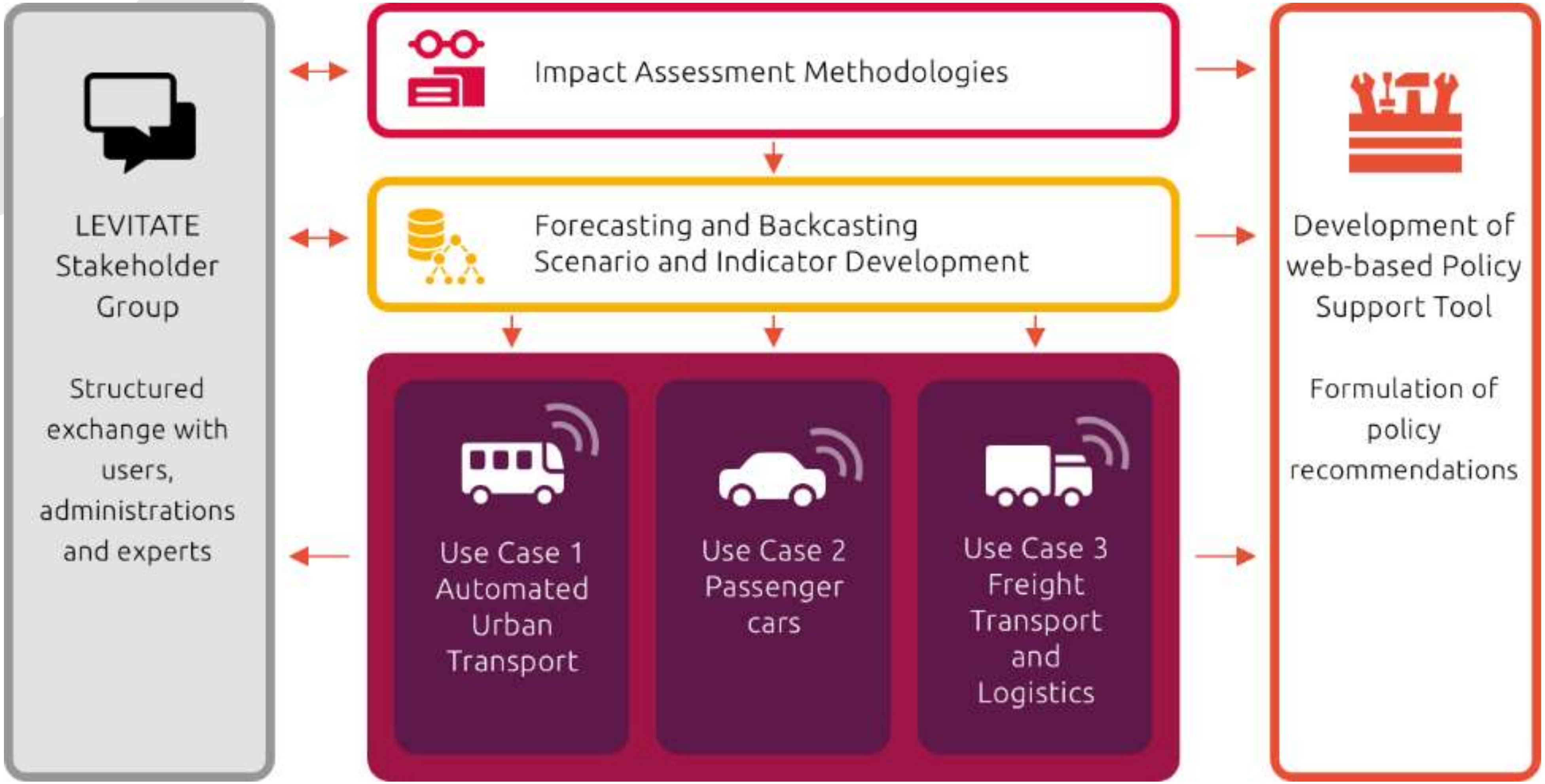
- How will autonomous vehicles improve safety, congestion, economy and the environment?
- What are the key policy decisions to maximize these benefits?

→ **Focus on cities**

Challenges

- Provide rigorous forecasts of impacts for many years ahead
- Wide range of impacts
- Wide range of forecasting methods
- Wide range of city types

Levitate overview



Use Cases in Levitate

Passenger cars

Road use pricing
- Empty km pricing
- Static toll on non-AVs
- Static toll on all vehicles
- Dynamic toll on non-AVs
- Dynamic toll on all vehicles

Automated ride sharing

Parking space regulation
- Parking price
- Replace long-term parking

Dedicated lanes for AVs

Urban transport

Automated shuttles
- Point to point shuttle connecting two modes of transport
- Point to point shuttle in a large scale network
- Autonomous mobility on demand shuttle service (AMoD)

Freight Transport

Automated urban delivery
- Semi-automated delivery
- Fully-automated delivery

Local freight consolidation
- Automated delivery via white label city-hubs

Hub to hub automated transfer

Highway platooning
- Platooning on city highways
- Access control for bridges on city highways

Urban transport sub-use cases

1. Point to Point Automated Urban Shuttle Service (AUSS) connecting two modes

2. Point to Point AUSS in a large-scale network

- **Shuttle service connecting urban zone and the suburbs (not served by standard bus service)**
- **Anywhere to anywhere urban shuttle service**
- **Last-mile shuttle service**
- **E-hailing**

3. Autonomous mobility on demand shuttle service (AMoD)

1. Point to point AUSS connecting two modes

Route:

- 3.4 km length
- Signalized arterial and Secondary streets

Characteristics:

- Cautious AV - connected
- 5.00 m length
- 2.50 m width
- 10 passengers total capacity
- 40.0 km/h max operating speed
- 25.0 km/h mean speed
- 15 min service frequency

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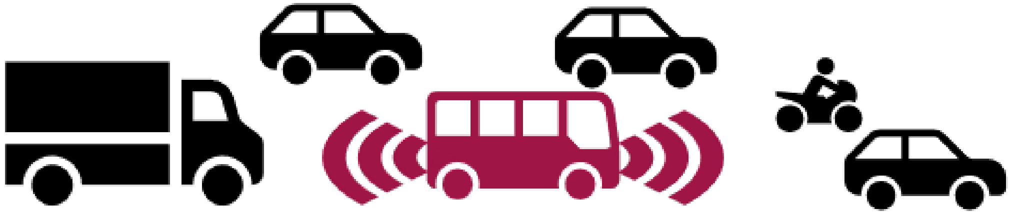
Scenarios Specifications

A. Scenarios on the shuttle bus route level:

- Included or not the shuttle bus service in 2021
- During peak and off peak hour

B. Scenarios on network level:

- During peak and off peak hour
- For different mobility scenarios
- At the emergence of an incident on the shuttle route
- Operating on a dedicated lane or with the rest of the traffic

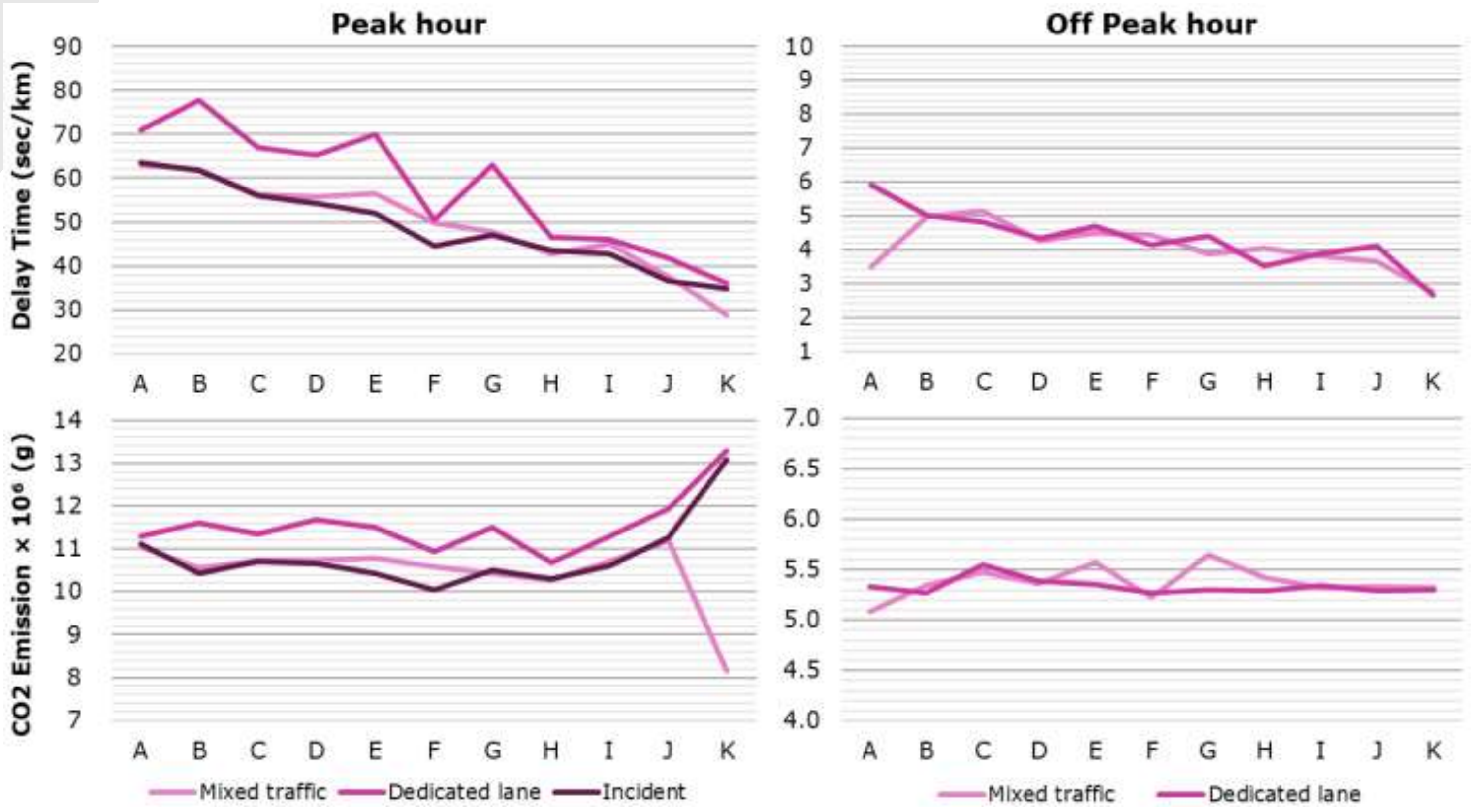


On the shuttle bus route level results

Traffic condition	Street type	Speed variance (km/h)	Delay Time (sec/km)			CO2 Emission (kg)		
			No Shuttle service	Shuttle service	Change	No Shuttle service	Shuttle service	Change
Peak hour	Signalized Arterial	34	130	130	0%	476,6	487,9	2%
	Secondary Street	13	246	252	2%	672,7	729,8	8%
Off Peak hour	Signalized Arterial	45	8	14	63%	256,1	318,4	24%
	Secondary Street	26	8	10	24%	135,5	132,8	-2%

- The **speed variance** of the Shuttle bus gets higher values during off peak hour than peak hour.
- The shuttle bus leads to **increased delay times** on its route, especially on the signalized arterials.
- Shuttle bus service **affects traffic only during off peak hour**, when the traffic is much lower and stochastic.

Preliminary results (1/3)



- Delay time gets lower values when more automated vehicles exist in the network.
- In mixed traffic automation decreases CO_2 emissions during peak hour conditions, while no change in CO_2 levels is observed during off peak hour.

Preliminary results (2/3)

Impacts	Scenarios		A	B	C	D	E	F	G	H	I	J	K
Delay Time (sec/km)	Peak hour	Mixed traffic	63	62	56	56	56	50	48	43	45	38	29
		Dedicated lane	71	78	67	65	70	51	63	46	46	42	36
		Incident	64	62	56	54	52	44	47	44	43	36	35
	Off Peak hour	Mixed traffic	3	5	5	4	5	4	4	4	4	4	3
		Dedicated lane	6	5	5	4	5	4	4	4	4	4	3
CO2 Emission (kg)	Peak hour	Mixed traffic	11.042	10.557	10.732	10.736	10.790	10.582	10.418	10.266	10.715	11.181	8.155
		Dedicated lane	11.288	11.608	11.358	11.669	11.498	10.930	11.501	10.691	11.302	11.945	13.293
		Incident	11.104	10.435	10.699	10.660	10.428	10.056	10.503	10.312	10.612	11.280	13.079
	Off Peak hour	Mixed traffic	5.078	5.346	5.477	5.366	5.571	5.221	5.644	5.419	5.323	5.335	5.318
		Dedicated lane	5.335	5.263	5.552	5.384	5.357	5.273	5.300	5.286	5.339	5.289	5.297
Total conflict change (%)	Peak hour	Mixed traffic	-	11%	9%	19%	21%	21%	20%	22%	23%	17%	-81%
		Dedicated lane	-	18%	16%	28%	27%	20%	30%	10%	24%	16%	8%
		Incident	-	14%	12%	23%	15%	7%	23%	14%	25%	16%	19%
	Off Peak hour	Mixed traffic	-	6%	7%	1%	12%	14%	16%	18%	22%	26%	27%
		Dedicated lane	-	-54%	-50%	-66%	-49%	-3%	8%	-53%	-32%	3%	-53%

- If the shuttle bus uses a dedicated lane, both **delay time and CO2 emissions are increased** during off peak and peak hour.
- An **incident occurrence** on the shuttle service route was not observed to affect traffic delays and CO2 emissions.
- If the shuttle bus uses a **dedicated lane**, the number of conflicts is reduced during off peak hour and for other occasions it seems to be increased.

Preliminary results (3/3)

- Automation seems to lead to decreased numbers of crossing conflicts.
- If the shuttle bus uses a dedicated lane, the number of lane change conflicts is higher.
- The number of rear end conflicts is increased if an incident occurs on the shuttle bus route.

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2. Point to Point AUSS in a large-scale network

Aim:

Impacts of automated urban shuttle buses complementing public transport in the city of Athens

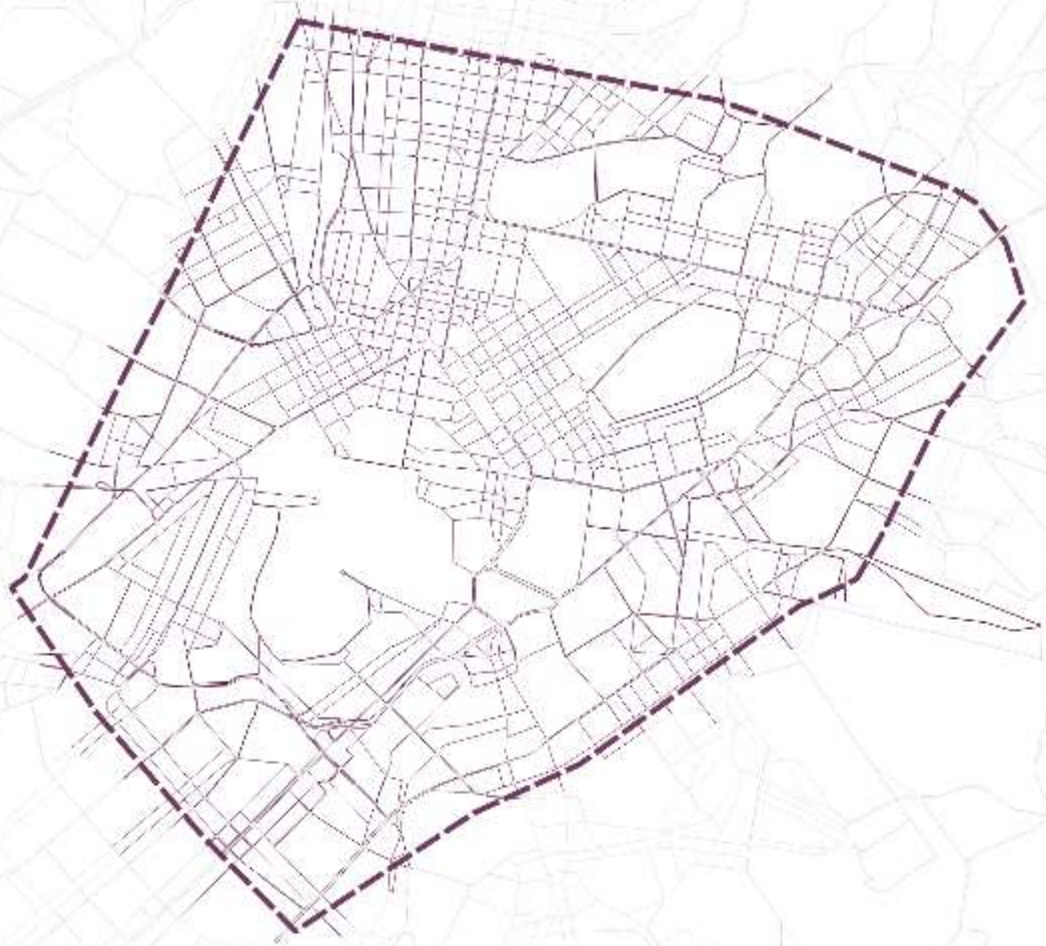
Service Characteristics:

- Parallel operation with the existing transit service
- Intermediate stations
- Connecting various destinations
- Connecting areas with low transit coverage

2. Point to Point AUSS in a large-scale network

The city of Athens in AIMSUN

- 290×290 OD Matrices
- 2.580 Sections
- 1.137 Nodes



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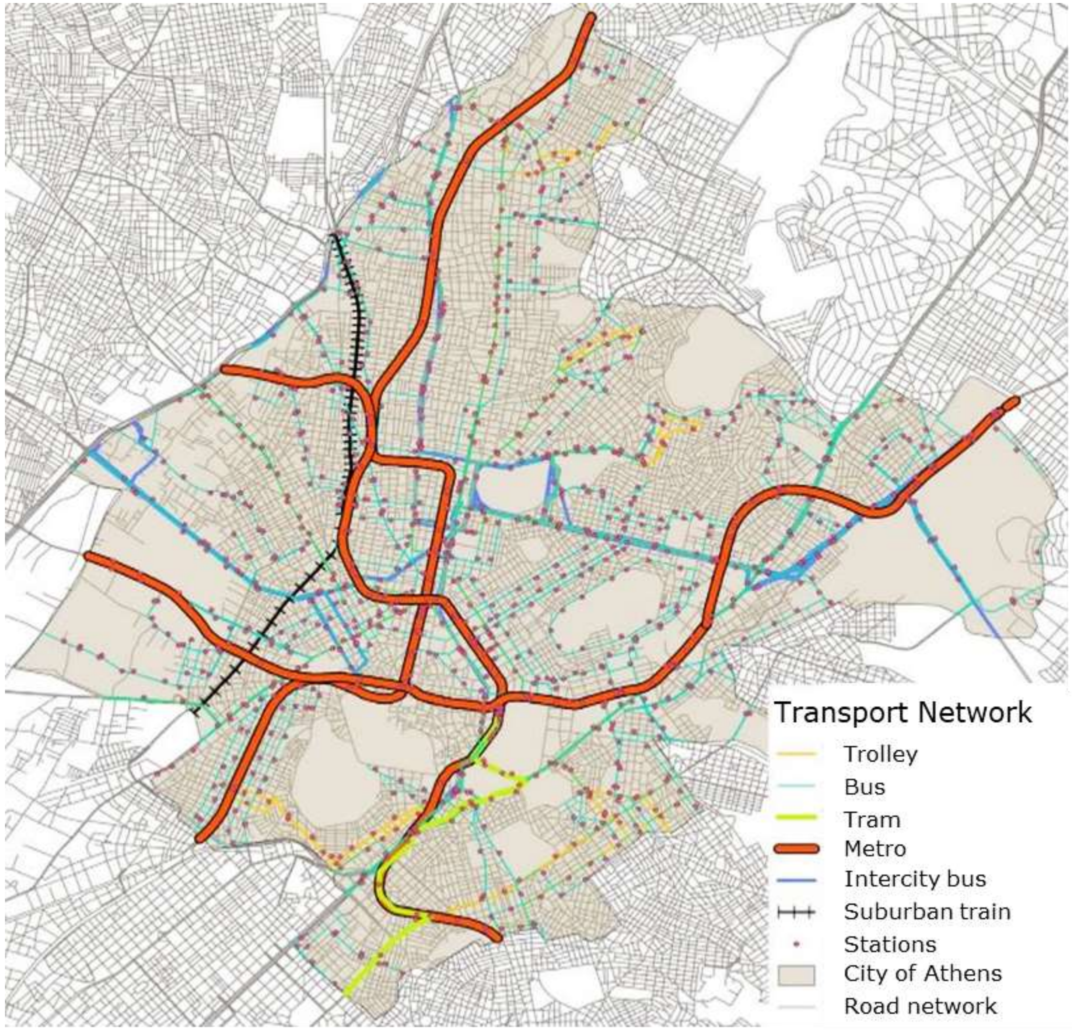
2. Point to Point AUSS in a large-scale network

Athens transport network

- 170 public transport lines
  - 95 bus lines
  - 14 trolley lines
  - 4 metro lines
  - 2 tram lines
  - 5 suburban lines
  - 50 intercity bus lines
- 1.030 public transport stations



Proposed Shuttle bus lines

Line 1:

Connecting the metro station “Viktoria” (A) with the metro station “Panormou” (B)

Line 2:

Connecting the National Garden (A) and Greek Parliament with the National Archeological Museum (B)

Line 3:

Connecting Omonoia Square (A) with Acropolis - Parthenon (B)

Line 4:

Connecting metro station “Rouf” (A) with metro station “Neos Kosmos” (B)

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2. Point to Point AUSS in a large-scale network

Other Specifications

- Provision for dedicated lane
- Extreme conditions (e.g. incident)
- Frequency of service, with intermediate stops

Methodologies:

- Macro-simulation: Traffic impacts - Travel time, Distance, Trips, etc.
- Meso-simulation: Environment impacts – CO_2, NO_x Emissions
- Micro-simulation: Road safety impacts
- Meta-analysis
- Delphi

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3. AMoD shuttle service

Service Specifications

- Fixed routes → completely free routing
- Fixed timetables → on-demand real-time requests
- Physical stops→ stop anywhere
- Fleet type: small shuttles
- Rides offered disconnected from existing public transport service

3. AMoD shuttle service

Assumptions

- Part of the demand will be assigned to the new mode. The demand shift will be estimated based on the new mode choice model of Athens.

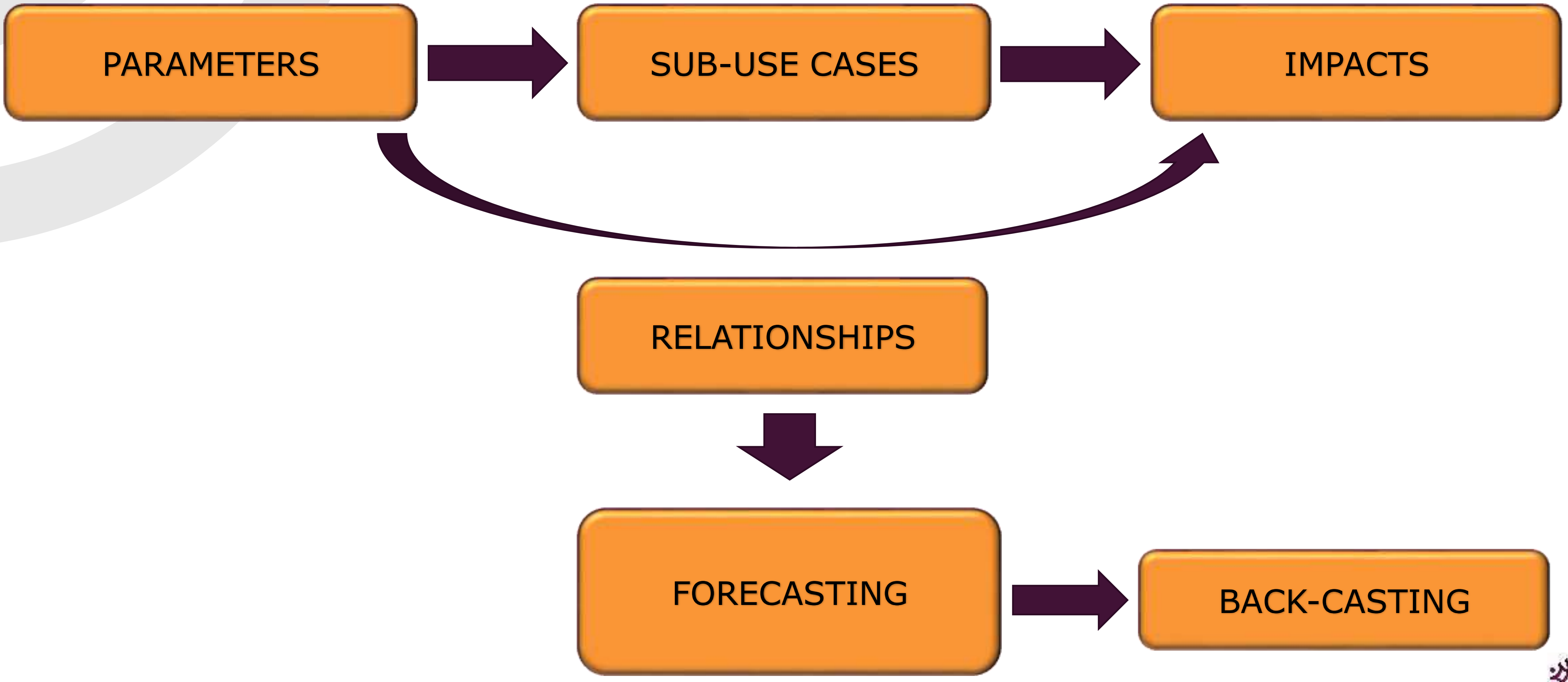
or

- Demand is generated dynamically during the simulation period …

How this demand will be served from the new mode?

- Identify the trips
- Optimization algorithm to assign vehicles to demand
- Monitor the impact to the network

PST Overview



Policy Support Tool (PST)

Knowledge Module

Bibliography

Levitate results

- use case results
- predefined impact assessment scenarios

Tools Documentation

Guidelines

Estimator Module

Forecasting sub-system (per use case)

Relationships (level 2)

Sub-use cases

- Shuttle / e-hailing / MaaS
- Road use pricing
- Parking space interventions
- Urban delivery (freight)
- Local freight consolidation
- .... etc.

Relation-ships (level 1)

Relation-ships (level 3)

Parameters

- GDP per capita
- City population
- AV penetration rate (per SAE Level)
- Automation type
- Vehicle ownership rate
- Share of electric vehicles
- Fuel / electricity cost
- Fuel / electricity consumption

Relation-ships (level 4)

Relation-ships (level 5)

Impacts

- Travel time
- Vehicle operating cost
- Freight transport cost
- Access to travel
- Amount of travel
- Congestion
- Modal split of travel
- Road safety
- Air pollution
- Parking space
- Public health
- Inequality in transport
- .... etc.

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

Conclusions and Future Steps

Point to point shuttle

- Delay time gets lower values when more automated vehicles exist in the network.
- Under our assumptions, CAV introduction will decrease emissions and conflicts during peak hours

Future sub-use cases in urban transport

- which challenges will arise for on-demand shuttle service?
- What will be the economic benefits of introducing these sub-use cases in urban environment?

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For more information:
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