European Commission

Optimizing road transport through autonomous vehicles
The ART project

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Intelligent Transport Systems: a Tool or a Toy?

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY · ŽILINSKÁ UNIVERZITA V ŽILINE UNIVERSITAS SOLLERTIA · SK EU2016 · ERTICO ITS EUROPE

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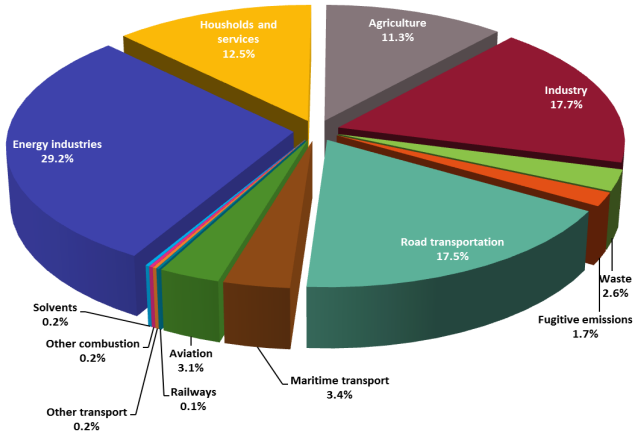
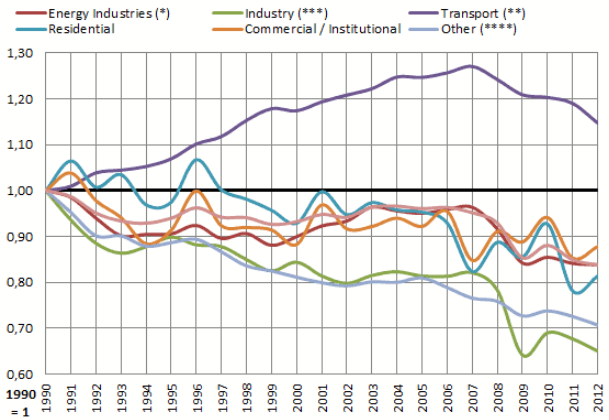
CO_2 emissions from Road Transport

- Road Transport:17.5% of EU CO_2
  - 800 M tonnes
  - 70% of which from pass cars
  - Transport only sector increasing after 1990
- On the road today about:
  - 208 M pass. cars
  - 1.3 M buses/coaches
  - 28.6 M Trucks





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European Objectives

- Target 60% GHG reduction by 2050 (Base 1990)
- 40% by 2030 (Base 1990)
- 30% reduction for non-ETS sector (Base 2005)
- Extensive Series of Regulations, Directives and Technical documents regulating emissions and CO_2 savings measures

- More info available:
  http://ec.europa.eu/clima/policies/transport/vehicles/cars/documentation_en.htm

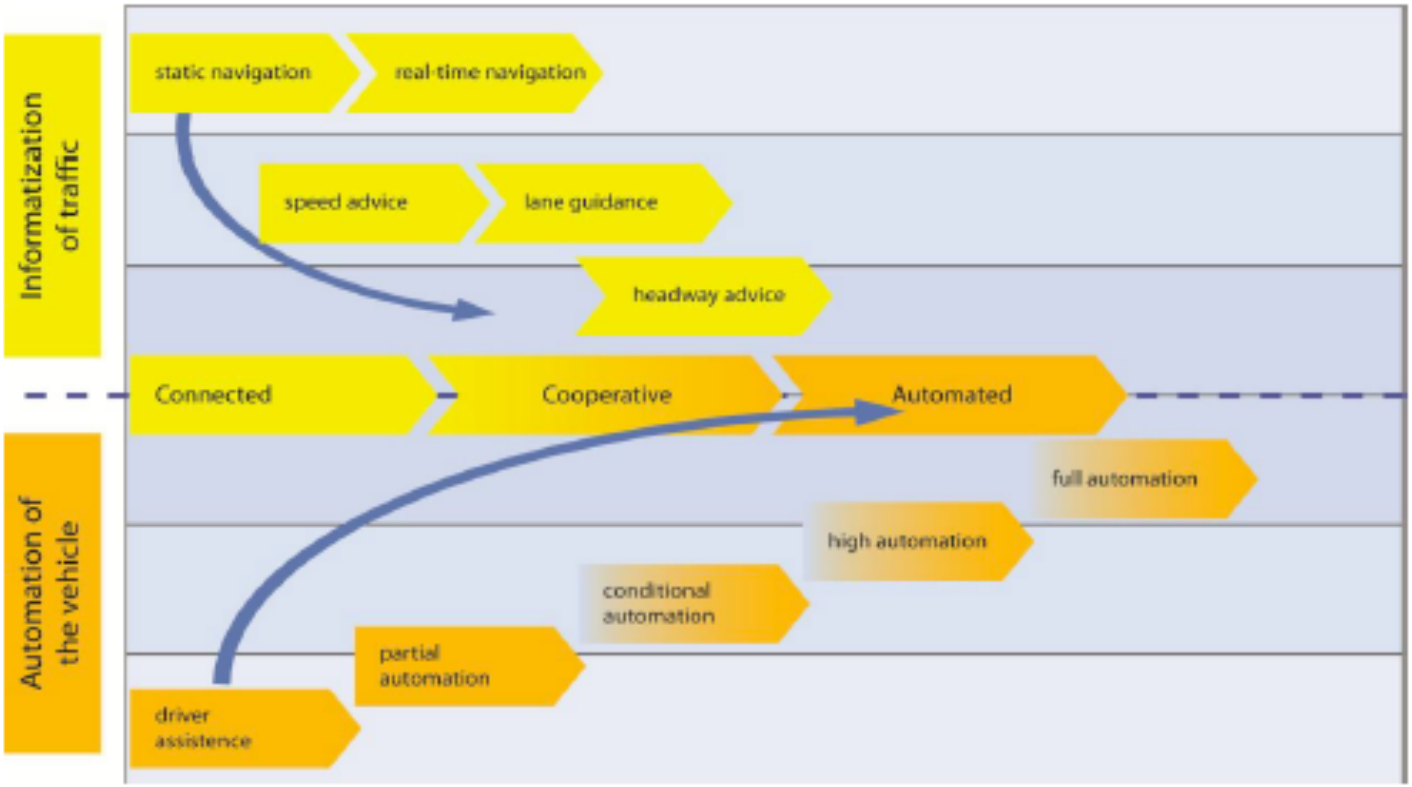
European Approach

- Commission Strategy for low emission mobility (2016) frames the initiatives that the Commission is planning in the coming years, and it maps the areas in which it is exploring options.

- The main elements of the Strategy:
  - **Moving towards zero-emission vehicles** (higher efficiency in ICE vehicles, PHEVs, BEVs, etc.)
  - **Speeding up the deployment of low-emission alternative energy for transport** (advanced biofuels, electricity, hydrogen, etc.)
  - **Increasing the efficiency of the transport system** (ITS, C-ITS, AVs, etc.)

Amsterdam declaration

- On April 14 2016, EU Members States, Commission and Industry signed a **cooperation agreement in the field of connected and automated driving**



Connected, cooperative and automated driving developments should come together to harvest societal benefits.

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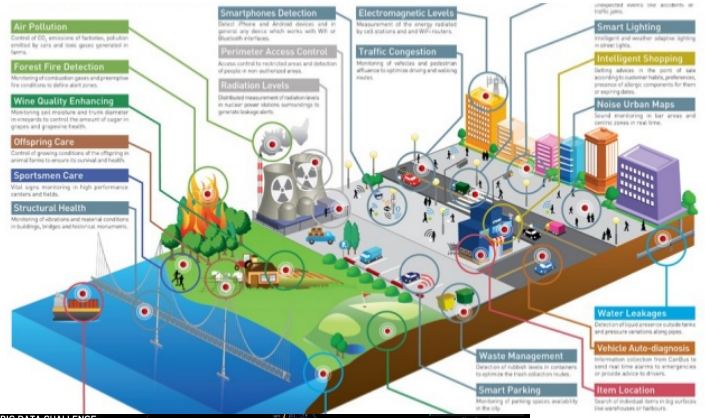
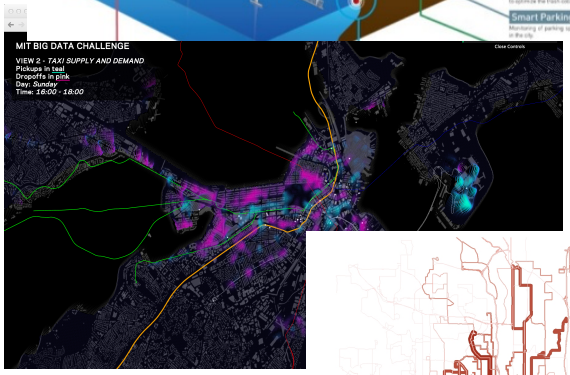
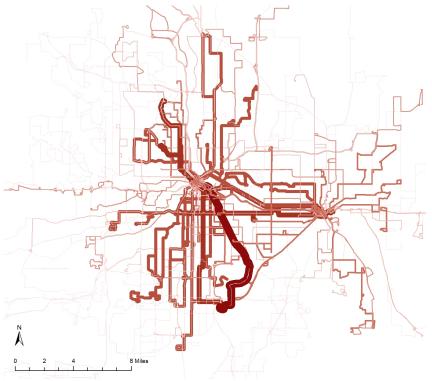
Reasons for change

- New technologies are reshaping our lives
- Today, everything we use acts as a detector of the world around us (internet of things)
- An unprecedented amount of information is constantly generated, shared and used
- In many fields the challenge is to use this amount of info in the best possible way
- The transportation system could take enormous benefits from these data







BIG-DATA

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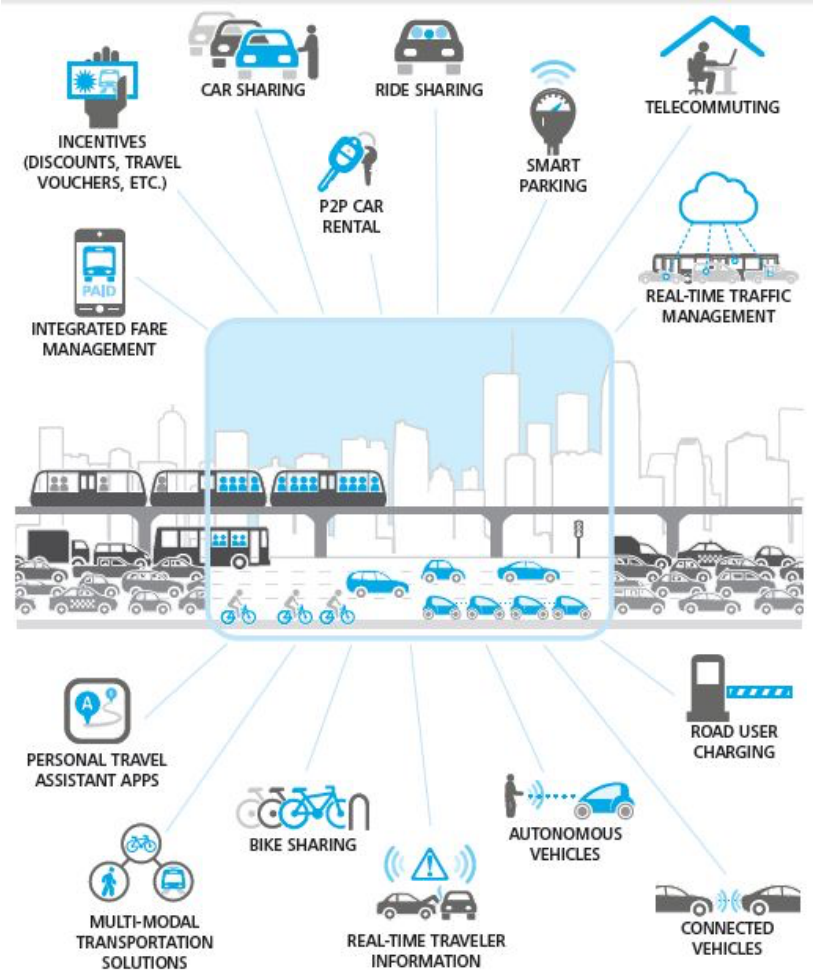
Big-data in transport

- **Accessing the potentially available information on the status of the transportation system *in real time* could enormously increase its efficiency**
- **Based on this idea, at the end of the 20th century the Intelligent Transportation Systems concept gained more and more importance (EC Directive 2010/40 on ITS)**

ITS



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Networked vehicles

=

More efficient transport

(less delays, cleaner,..)

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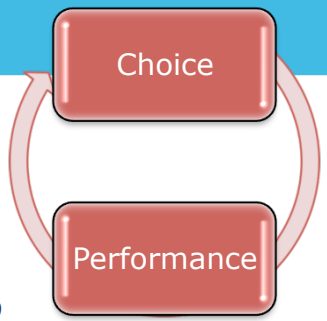

But…

- **The transportation system is a complex system: *the performance of the system depends on the choices of its users and the choice of the users depend on the performance of the system…***

- ***Unlike weather information (that do not affect weather), traffic information do affect traffic!***

- **Humans (especially drivers…) often do not follow fully rational rules to their choices and therefore information is not necessarily helpful!**

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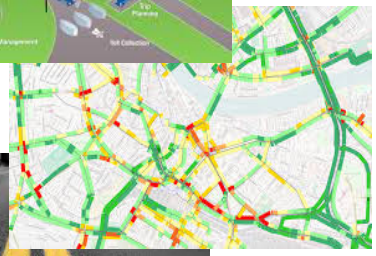
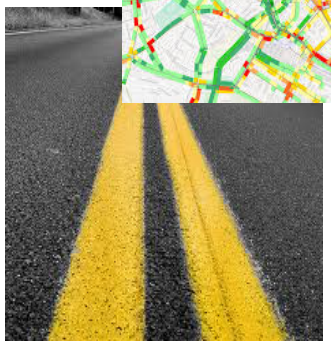
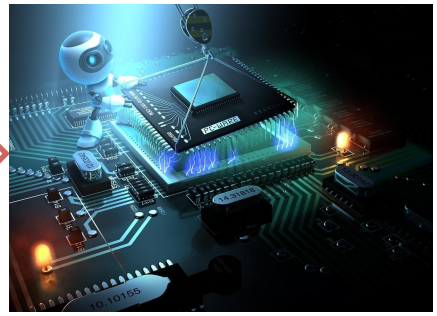
AV in support of ITS

Information







Reaction

From Information to Automation

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Autonomous vehicles

=

More efficient transport

(less delays, cleaner,..)

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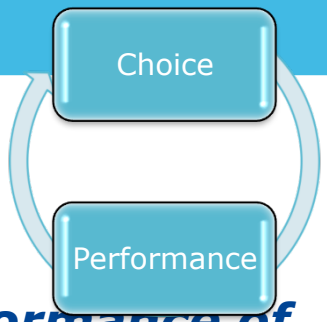

But…

- **The transportation system is still complex: *the performance of the system depends on the choices of its users and the choice of the users depend on the performance of the system…***
- ***Unlike humans, AVs are expected to react all in the same way, i.e. in a way that can be foreseen!***
- ***Are information sufficient? AVs will try to minimize individual travel time on the basis of the available information: they will all make the same choices…***
- ***Congestions peaks potentially increase!***

Summary

- **The positive impact of information on traffic is only potential.**
- **Information should be managed in the right way (*e.g if all the drivers will use the path that is the fastest at the time when the information is provided, it is likely that the same path will not be the fastest at the time in which it is actually used, etc.*).**

- **Without intelligence, the situation is likely to worsen with the increase of networked vehicles and even more with autonomous vehicles that will all follow the same indications!**

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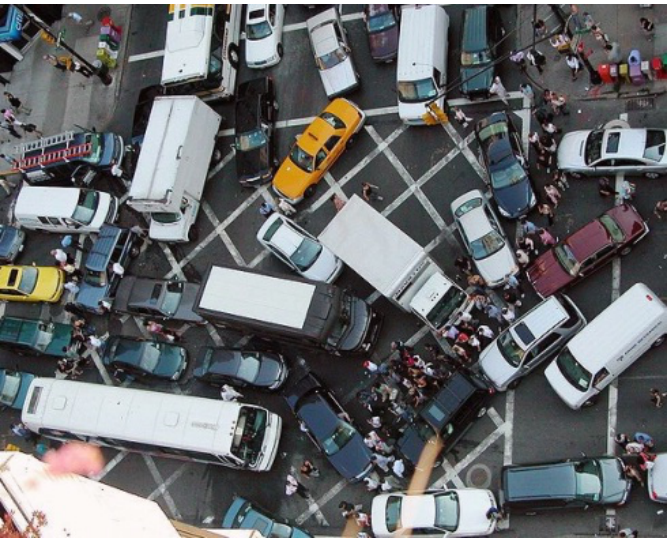
Increasing capacity

- **AV could increase road capacity by, e.g. reacting faster, moving closer, etc. But what about safety?**
- **Drivers accept a certain level of risk (the more congested the system the higher the risk) to save time. What will happen with a mixture of normal and full risk-averse drivers?**



- **Will the reduced reaction time be able to compensate for the impossibility to accept risk?**

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Risk acceptance and system management

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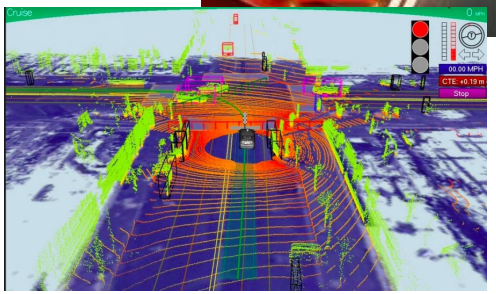
From AV to ART



From Automation to Coordination

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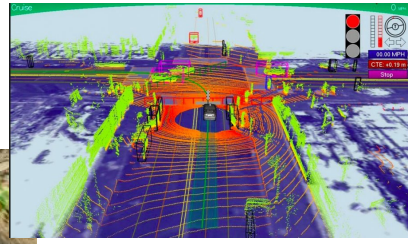
Future scenarios

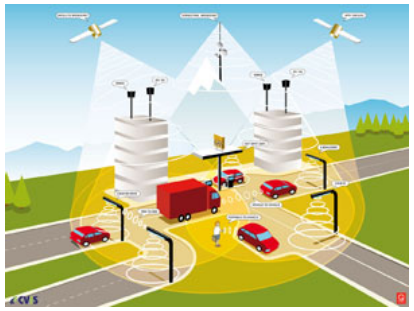
New opportunities are coming as they are pulled by industry (both traditional and new players)



Public institutions at first will act as enablers (contributing to building the necessary infrastructures and avoiding to introduce barriers)

At a later stage they will need to decide the role to play and how to regulate the interaction between vehicles and the system

- **From car-ownership to system access right**
- **Full control of autonomous vehicles for system optimization?**
- **…**



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The ART Project

Socio-economic issues

Policy needs
Ownership
Privacy
Responsibility
Governance
Barriers

Technical issues

System simulation
(traffic, emissions, environment, etc.)

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System simulation JRC, Technion, TSS

Simulation scenario

JRC.C4 Technion

- Ring-road in Python
- Motorway in Aimsun

Modified traffic models for AVs

JRC.C4 Technion TSS

- ACC
- CACC
- Interaction AV/nAV

Integration with emission model

JRC.C4 Technion

- Fuel consumption
- Pollutant emissions

Integration with dispersion model

JRC.C5

- Integration between Aismun and Sherpa model

System optimization loop

JRC.C6 JRC.C4

Simulation scenarios (JRC.C.4+Technion)

- The ring-road simulator is intended to simulate the mathematica properties of the modified vehicle algorithms
- The motorway scenario is created to assess the effect of automation on traffic and externalities
  - The scenario is implemented in Aimsun v.8
  - Antwerp ring-road is implemented (complex motorway network and congested traffic dynamics of light and heavy duty vehicles)

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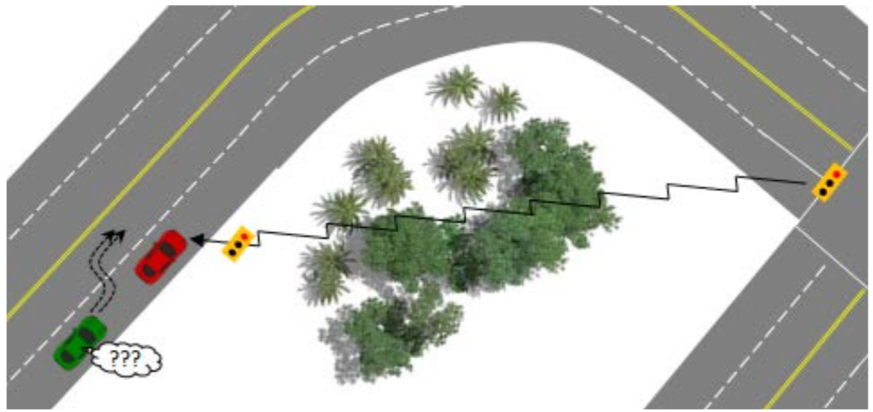
Modified traffic models for Avs (C.4 + Technion+TSS)

- Modified vehicle models for AVs concern the algorithms to govern longitudinal and lateral dynamics in:
  - Adaptive Cruise Control (ACC) systems, and
  - Cooperative Adaptive Cruise Control (CACC) systems
- Longitudinal control system embedded in both scenarios
- Lateral dynamics only implemented in the Antwerp scenario (via Aimsun Micro-SDK)
- Always mixed traffic will be considered and the interaction between AVs and nAVs will be attempted



Emissions from traffic (C.4+Technion)

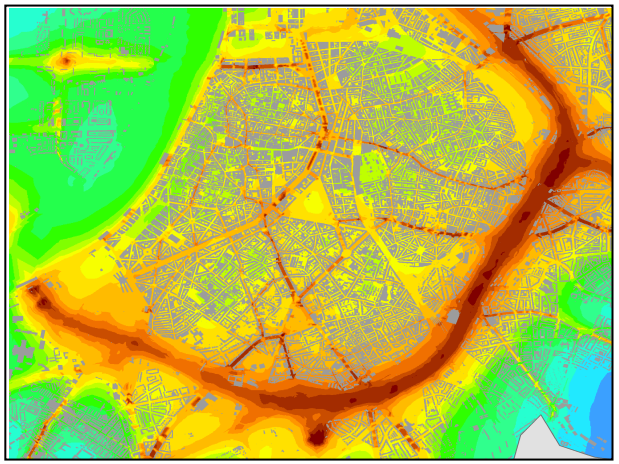
- In order to calculate emissions and fuel/energy consumption from road transport, Aimsun is integrated with:
  - CO2MPAS (JRC) to calculate fuel/energy consumption and CO2 emissions
  - GT-SUITE (Technion) to calculate pollutant emissions
- Integration is first attempted off-line
- At a later stage a full software integration will be carried out

Pollutant dispersion (C.2)

- The integrated traffic/emission model provides as input pollutant emission per road stretch and per time intervals of 15’
- Emissions are translated into concentrations using a modified version of the Sherpa model

SHERPA

Screening for High Emission Reduction Potential on Air



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System optimization (C.6+C.4)

- Final objective of the ART simulator is the development of an **optimization framework in which vehicles' parameters and choices are adapted to achieve an optimal configuration of the traffic system**
- System can be optimized to minimize travel time, emissions, energy consumption, concentrations, etc.
- The full deployment of the ART simulator is beyond of the scope of the project
- Identifying the needs in terms of data, control and optimization variables is the most plausible result to be expected

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