



European Commission

# Optimizing road transport through autonomous vehicles The ART project



1939 GM Futurama Exhibit, New York



## Joint Research Centre

the European Commission's  
in-house science service

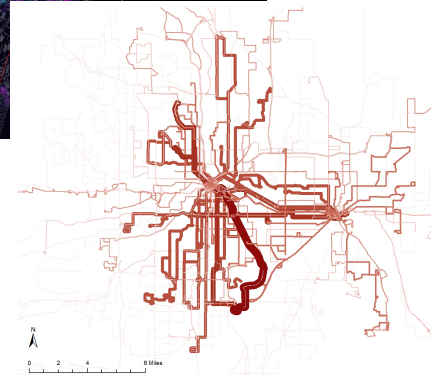
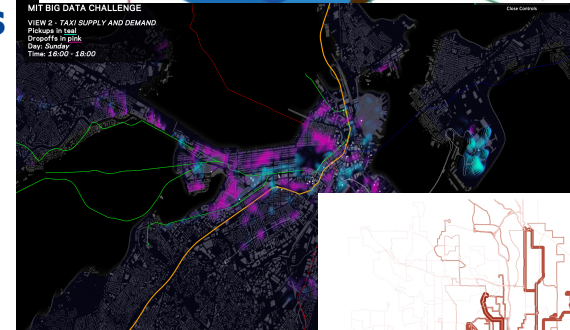
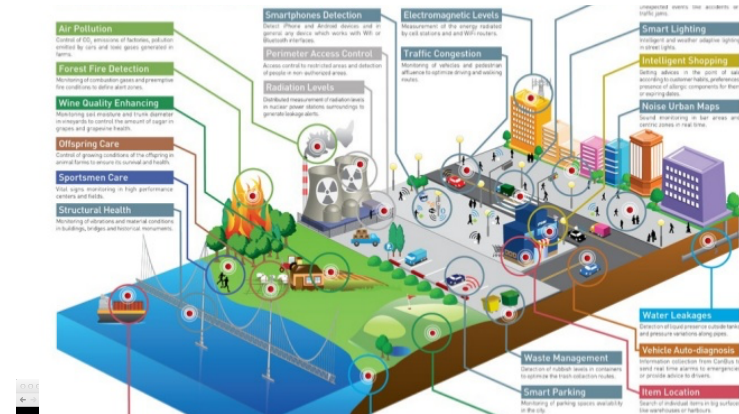


**B. Ciuffo**  
**TAPPS Project Workshop**

**Ispra, May 10, 2017**

# Big-data in transport

- 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

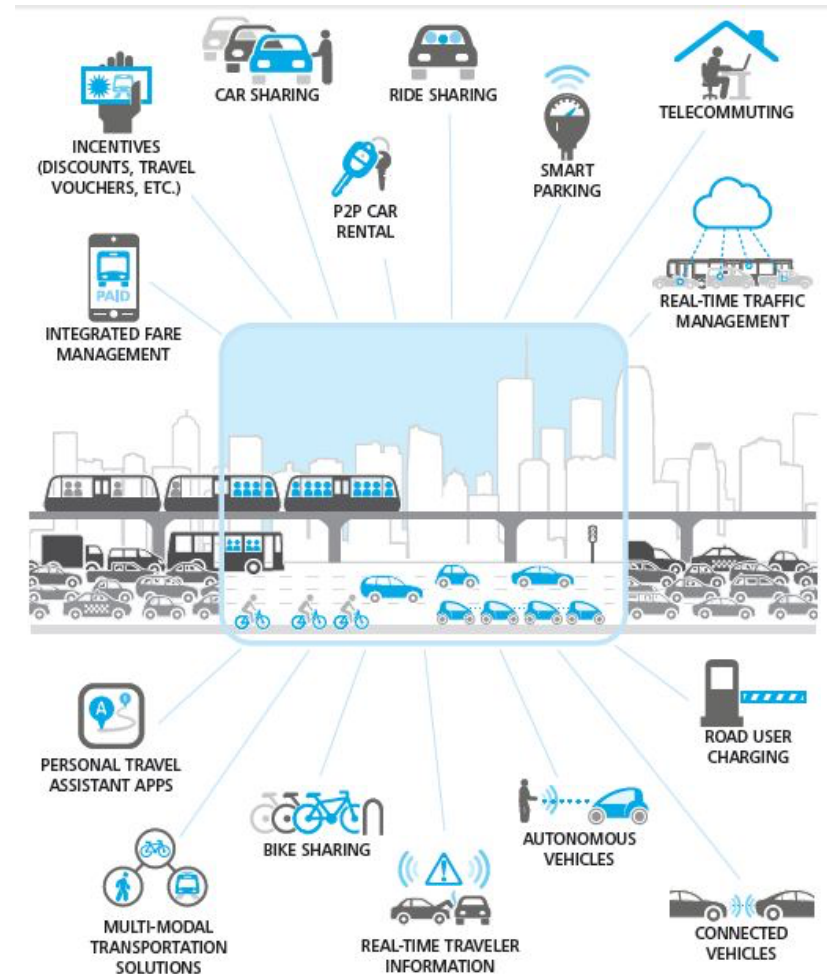


# BIG-DATA

# 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 20<sup>th</sup> century the **Intelligent Transportation Systems** concept gained more and more importance (EC Directive 2010/40 on ITS)

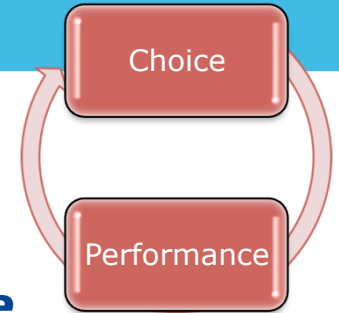
# ITS



# Networked vehicles

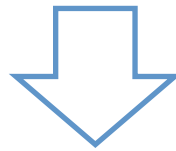
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More efficient  
transport  
*(less delays, cleaner,..)*



## 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...*

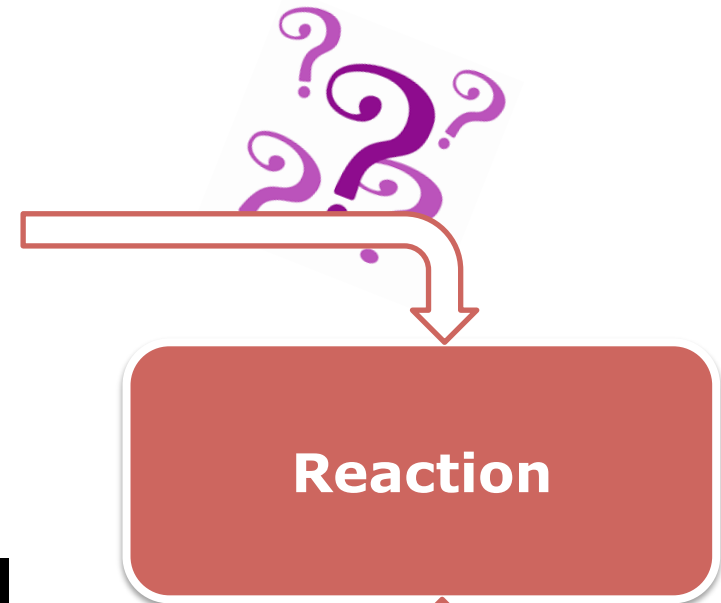
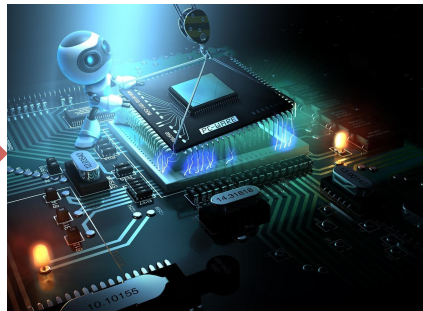
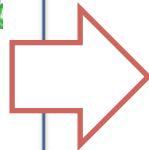
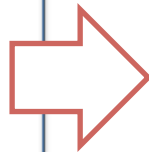


- *Unlike weather information (that do not affect weather), traffic information do affect traffic!*
- **Humans** (especially drivers...) often do not follow fully rational rules to their choices and therefore information is not necessarily helpful!



# AV in support of ITS

## Information

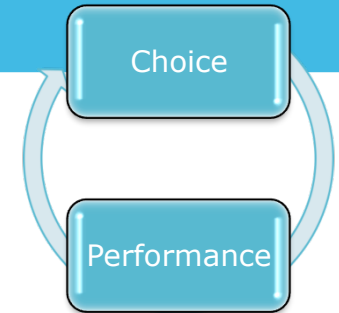


*From  
Information to  
Automation*

# Autonomous vehicles

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More efficient  
transport  
*(less delays, cleaner,..)*



## 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 costs on the basis of the available information: they will tend to make similar 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.).

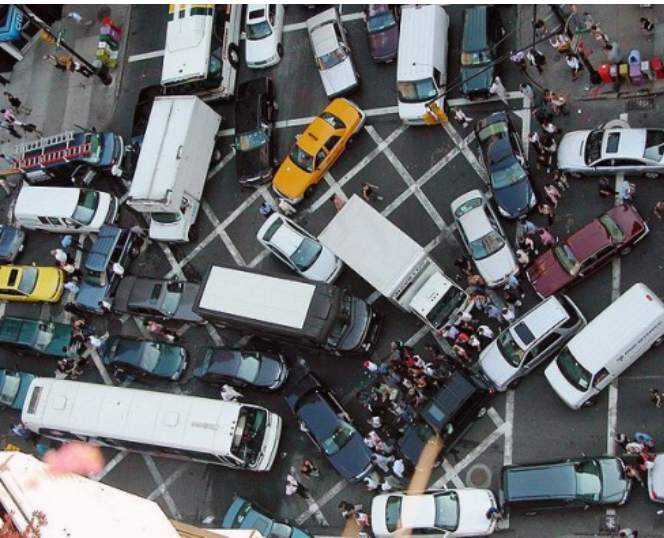


- **Without intelligence, the situation is likely to worsen** with the increase of networked vehicles and even more with autonomous vehicles that will all follow the same indications!



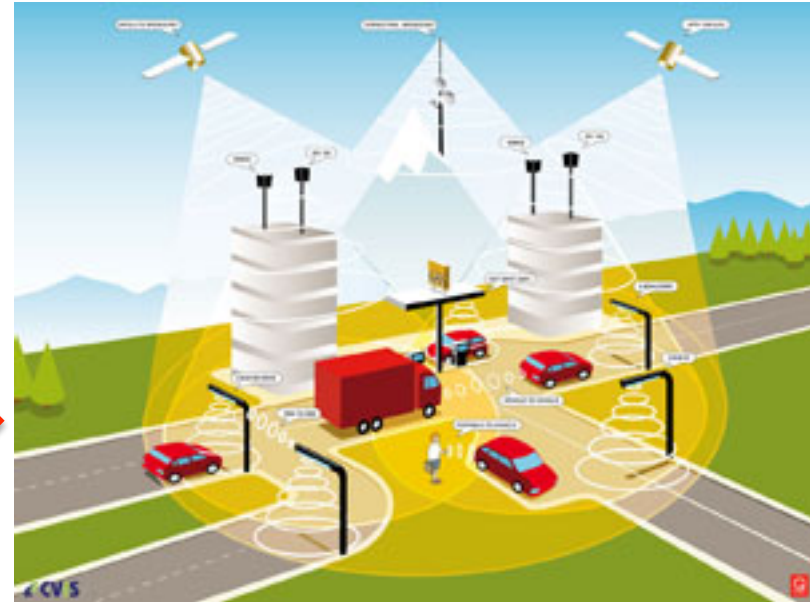
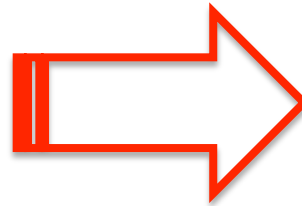
# Increasing capacity

- **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?**

# From AV to ART



*From Automation  
to Coordination*

# ART

# From AV to C-ART

The need for a ***centrally managed automated road transport*** is slowly being recognized by many actors as a possible way to exploit the full potential of vehicle automation and to avoid many problems connected to the interactions of vehicles.

- Several scientific authors are starting to refer to some sort of **“network” manager** without explicitly specifying its role.
- Interestingly, just recently, the **CEO of Renault** has publicly expressed his **perplexities on the impact of autonomous vehicles on traffic** (<http://fortune.com/2017/01/20/autonomous-vehicles-traffic/>) and the possible future need to implement a sort of **“air traffic control for the roads”**.

# Future scenarios

New scenarios 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) but 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?*
- ...



In any case this will require a deep transformation in the way vehicles are produced and managed. CPSs are therefore expected to play a very important role in this transformation.

# Uptake of vehicle automation

The path towards the full automation of road transport is still very long (2050 at least)

- In the coming years, vehicles will start to appear with a combination of **Level 2 automation** [1] features (ACC, lane keeping systems, collision avoidance systems, etc.)
- **Level 3** (advanced automation with driver supervision) systems will probably **never appear** due to the need to regulate the transition of responsibilities from the vehicle to the driver
- **Level 4** (advanced automation without driver involvement in specific conditions) will probably be the next step in **10 years** time. With the introduction of Level 4 vehicles, the need for local network managers will arise.
- **Level 5** (full vehicle automation) will require high penetration of AVs to be possible. Central network managers will take care of the optimization of road transport

# Summary

- In the next decades **road transport** will see the **biggest transformation** since the introduction of internal combustion engines
- **Communication and automation technologies** will drive this transformation
- The **path** to achieve the full potential of new technologies seems **still very long** though (at least 2050 for a full road automation)
- An important role can be played by the introduction of a **central controller** with the role to **optimize the behavior of automated vehicles**
- **A central controller and its interaction with vehicles will require totally new systems in place. CPS are expected to play a very important role in this transformation**



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