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TORINO, 12 - 16 NOVEMBRE 2018

**CONTRADDIZIONI E SFIDE  
CONTRADICTIONS AND CHALLENGES**



**Quale evoluzione e soluzioni tecnologiche per i  
trasporti terrestri sostenibili**

*Which evolution and technological solutions for  
sustainable land transport systems*

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Politecnico di Torino, Dip. DIATI-Trasporti

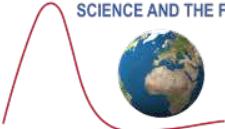
## RÉSUMÉ

1. How are **mobility and traffic are evolving**, in general?
  2. What do mobility and logistics **ask for** today, in terms of general trends?
  3. Which are the **constraints** – namely in terms of sustainability (CC) - for transport systems in this 1<sup>st</sup> half of XXI century?
  
  4. The expected **solutions** for transport within **urban contexts**
  5. The expected solutions for **extra-urban transport systems**
- ☞ The **conclusions** resume the **technological solutions** that can be expected according to the premises, therefore *compliant with present and expected environmental constraints and goals*.

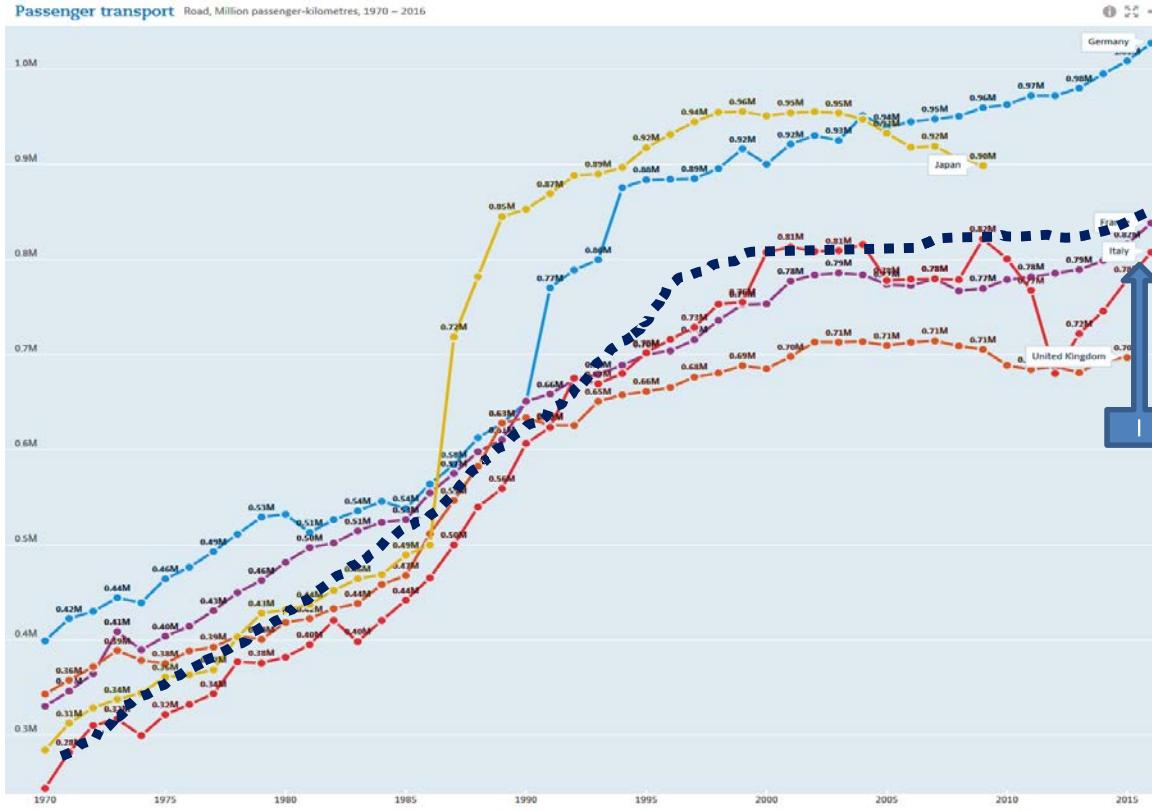


# 1/6 How are mobility and traffic evolving?

- Trends during last century and beginning of the XXI
- Motionless communications
- Daily use of automobiles



Passenger transport Road, Million passenger-kilometres, 1970 – 2016



Trends  
in daily  
mobility

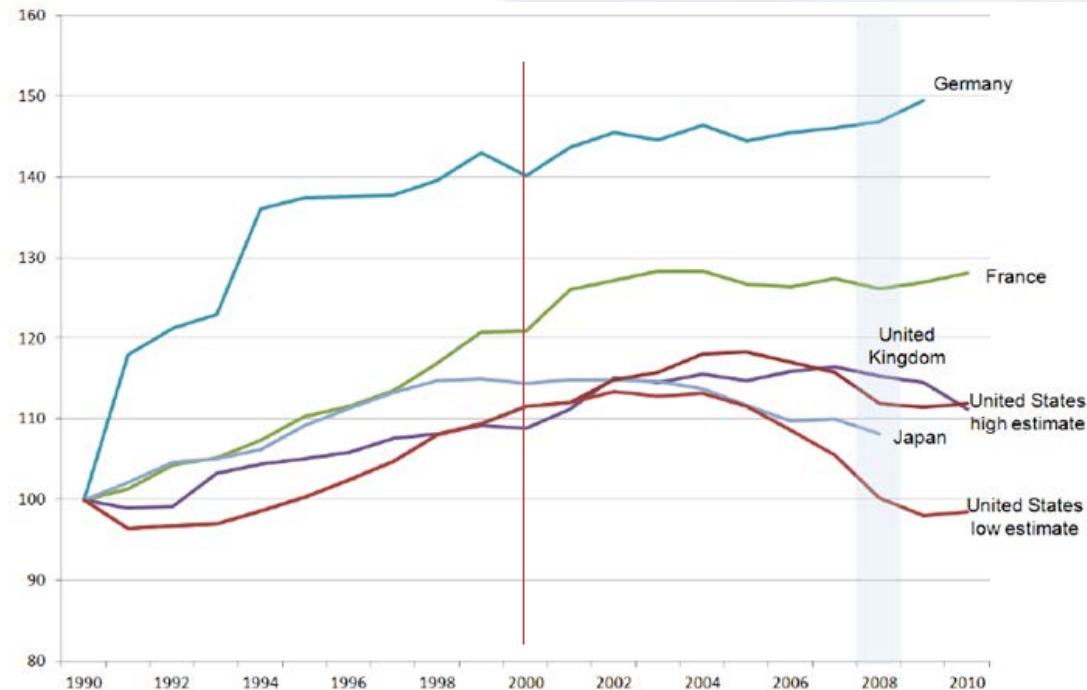
Million passenger  
kilometres travelled by  
road, passenger transport,  
1970-2015 (OECD, 2018).

- Population
- Supply: road, rail transport

1970

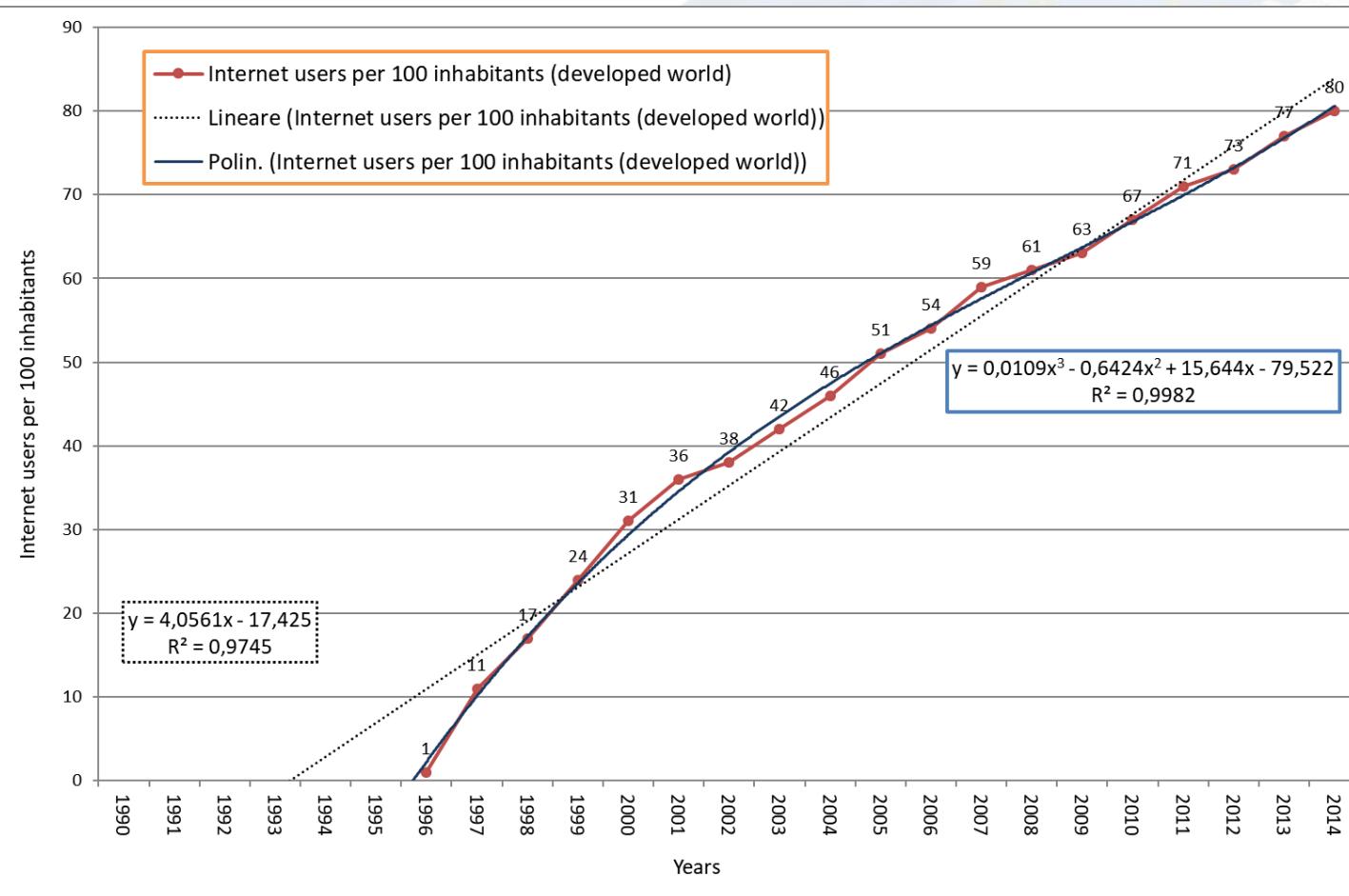
2000

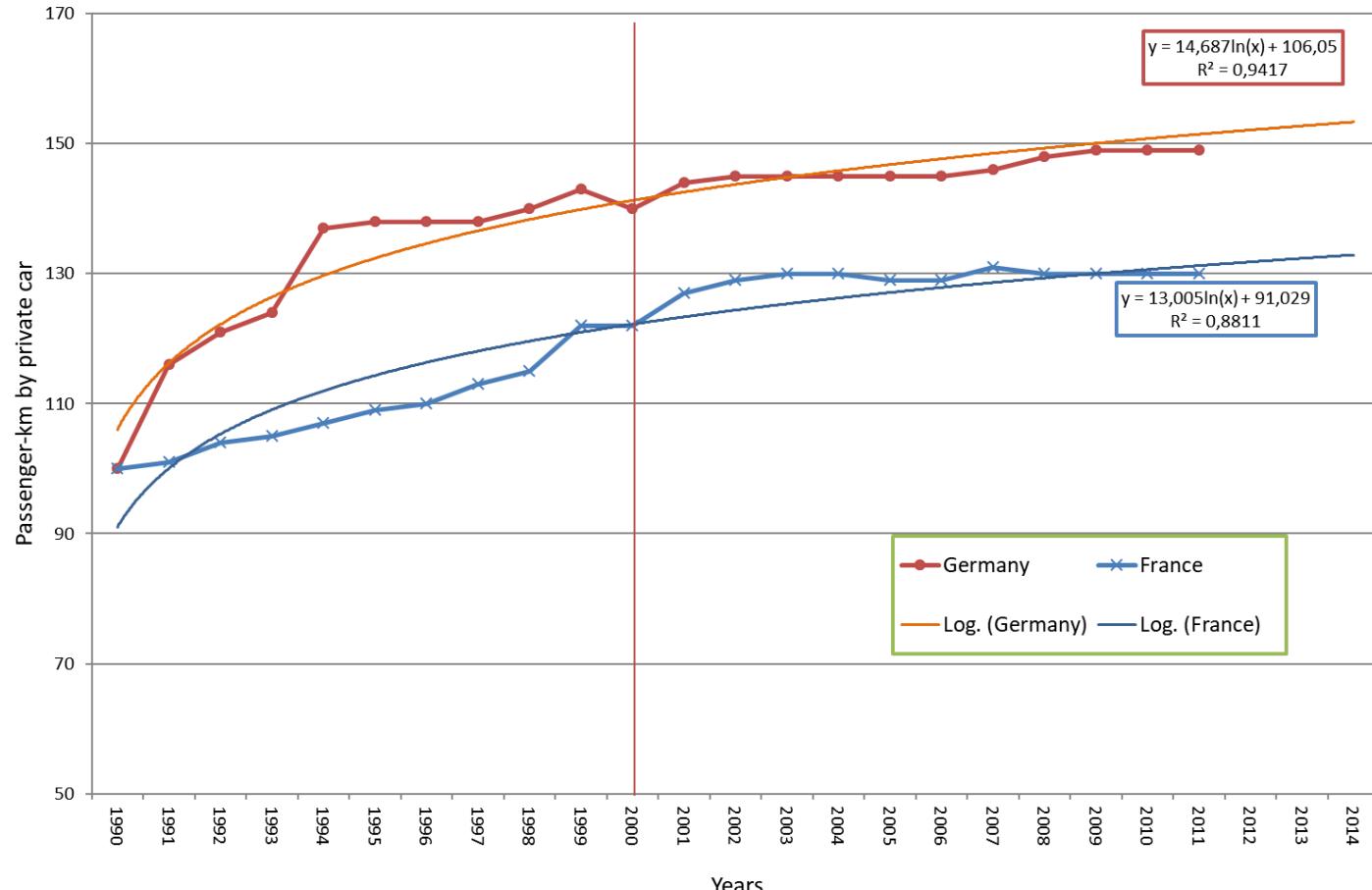
2015



Source: ITF statistics; the high estimate for the USA assumes car occupancy rates remain at the level measured in 2001, and the low one that they decline as of 2001 to the level observed in the most recent household travel survey.

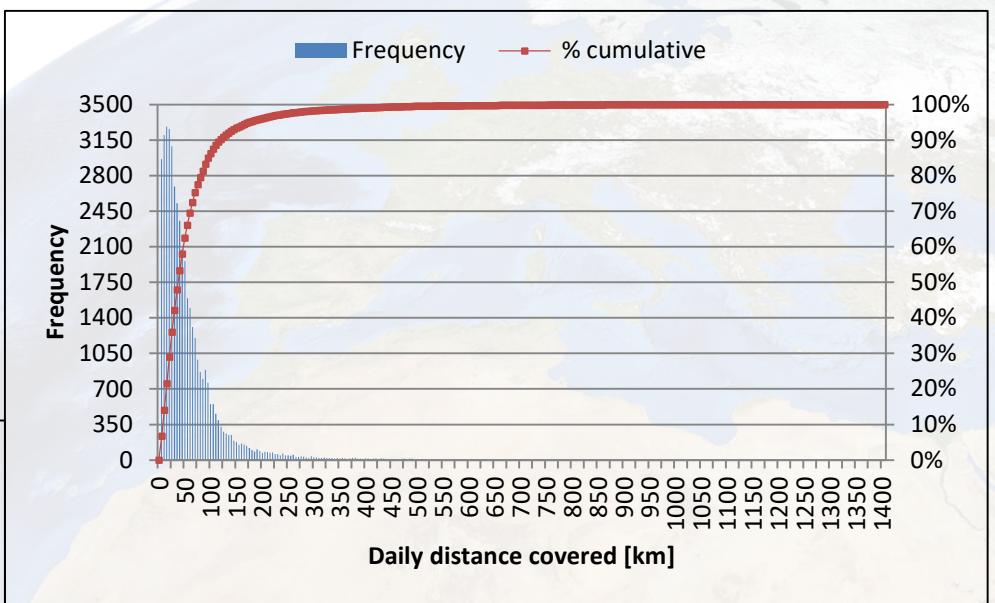
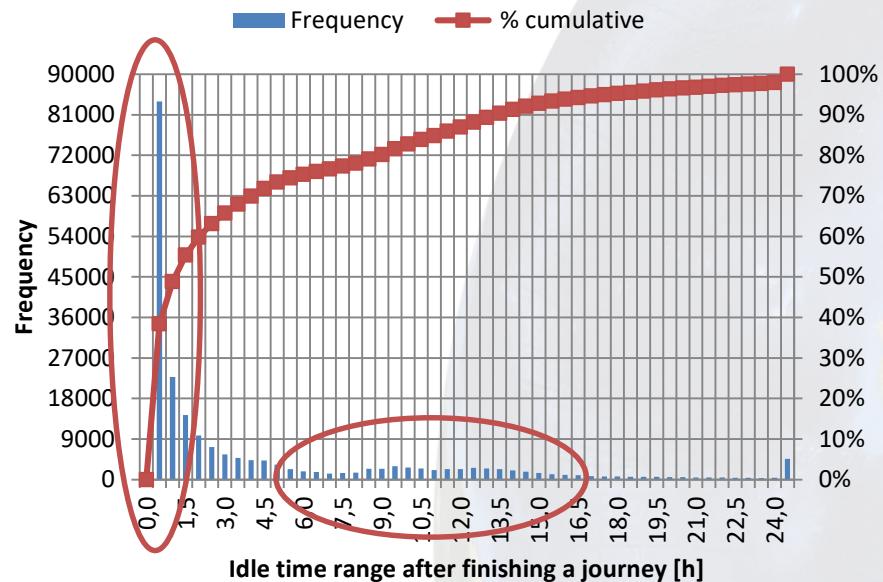
**Trends  
in daily  
mobility**







### Idle time after finishing a trip for all the driving cycles.



Frequency [#days] of the daily distance covered over all the driving cycles (contexts) for all the trips.



## 2/6 What do mobility and logistics ask for today



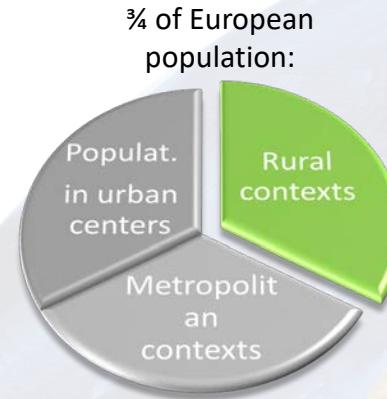
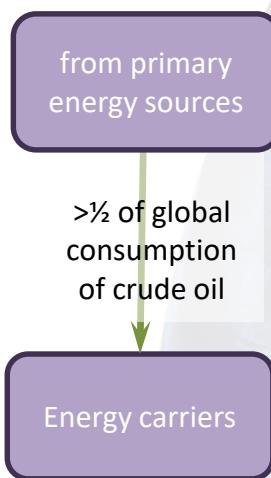
Climate change



- Efficiency
  - “Green” (hybridisation, decarb./electrif., well used PT)
- Quality
  - Connected vehicles, flexible modal choice
- Safety-security
  - Assisted driving, transport systems operating on fixed guideways



for transport:  
94% toe from  
crude oil in  
EU



¼ emissions from  
human activities  
→ 1/3 in 2018

*Transport and energy use*



## 3/6 Constraints for transport systems in this 1<sup>st</sup> half of XXI century

- European, in general
- European, automotive
- European, urban pollution



## Transport and emissions: general situation EU in various fields (not only transport systems)



CO<sub>2</sub>

-40% on 1990  
levels by 2030



Renewables  
27% by 2030  
(some inputs also on 30%)

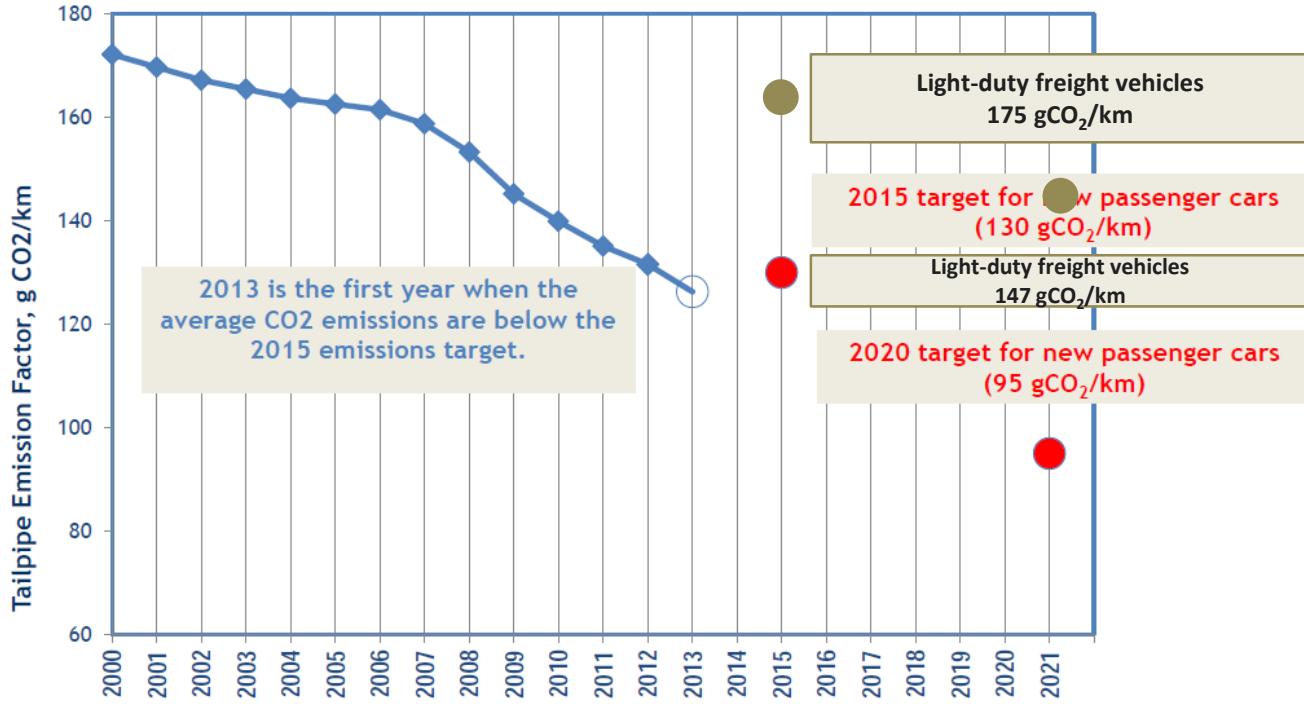


Energy efficiency  
27% by 2030  
(some inputs up to 38% at 2050)





UE - Emissioni medie CO<sub>2</sub> delle vetture nuove immatricolate  
EU - Monitoring CO<sub>2</sub> emissions from new passenger cars



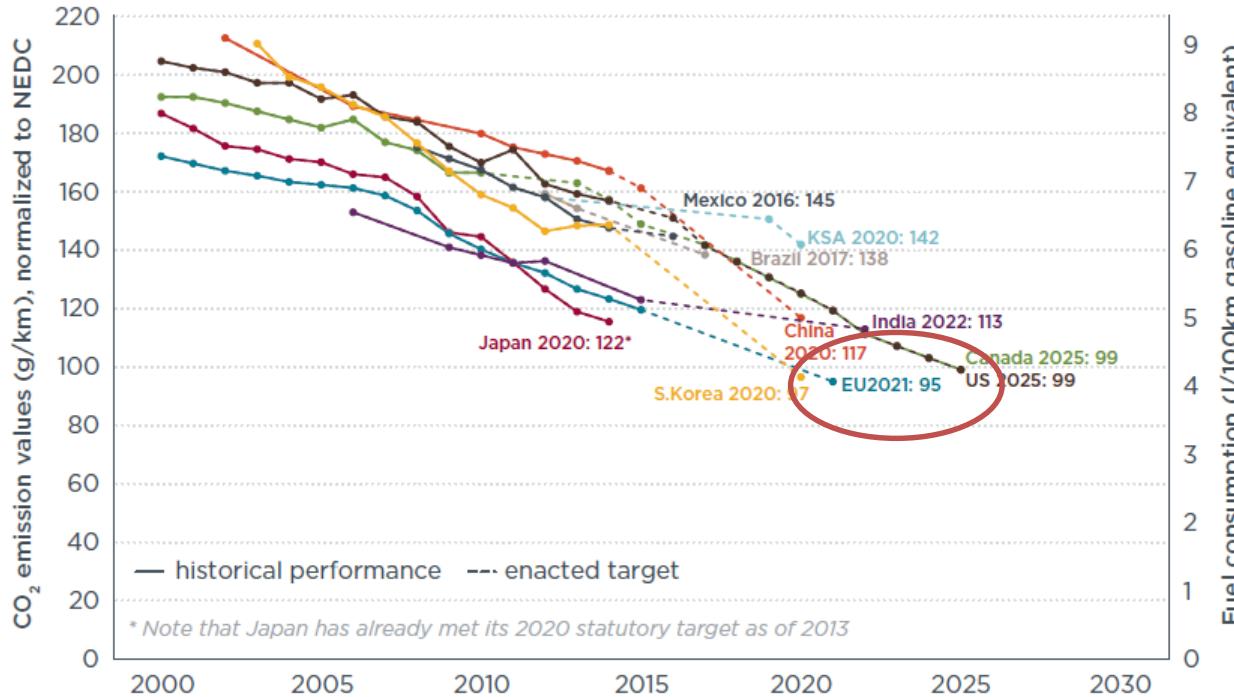
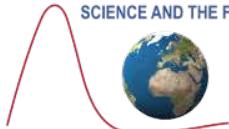


Figure 3. Comparison of global CO<sub>2</sub> regulations for new passenger cars.<sup>8</sup>



| <b>Pollutant</b>                    | <b>Concentration</b>  | <b>Averaging period</b>   | <b>Legal nature</b>   | <b>Permitted exceedences each year</b> |
|-------------------------------------|---|---------------------------|---|--|
| Fine particles (PM2.5)              | 25 µg/m <sup>3</sup> ***  | 1 year                    | Target value entered into force 1.1.2010<br>Limit value enters into force 1.1.2015  | n/a                                    |
| Sulphur dioxide (SO <sub>2</sub> )  | 350 µg/m <sup>3</sup>   | 1 hour                    | Limit value entered into force 1.1.2005   | 24                                     |
|                                     | 125 µg/ m <sup>3</sup>  | 24 hours                  | Limit value entered into force 1.1.2005   | 3                                      |
| Nitrogen dioxide (NO <sub>2</sub> ) | 200 µg/ m <sup>3</sup>  | 1 hour                    | Limit value entered into force 1.1.2010   | 18                                     |
|                                     | 40 µg/ m <sup>3</sup>   | 1 year                    | Limit value entered into force 1.1.2010*  | n/a                                    |
| PM10                                | 50 µg/m <sup>3</sup>  | 24 hours                  | Limit value entered into force 1.1.2005**   | 35                                     |
|                                     | 40 µg/m <sup>3</sup>  | 1 year                    | Limit value entered into force 1.1.2005**   | n/a                                    |
| Lead (Pb)                           | 0.5 µg/m <sup>3</sup>   | 1 year                    | Limit value entered into force 1.1.2005 (or 1.1.2010 in the immediate vicinity of specific, notified industrial sources; and a 1.0 µg/m <sup>3</sup> limit value applied from 1.1.2005 to 31.12.2009) | n/a                                    |
| Carbon monoxide (CO)                | 10 mg/m <sup>3</sup>  | Maximum daily 8 hour mean | Limit value entered into force 1.1.2005   | n/a                                    |
| Benzene                             | 5 µg/m <sup>3</sup>   | 1 year                    | Limit value entered into force 1.1.2010**   | n/a                                    |
| Ozone                               | 120 µg/m <sup>3</sup>   | Maximum daily 8 hour mean | Target value entered into force 1.1.2010  | 25 days averaged over 3 years          |
| Arsenic (As)                        | 6 ng/m <sup>3</sup>   | 1 year                    | Target value enters into force 31.12.2012   | n/a                                    |
| Cadmium (Cd)                        | 5 ng/m <sup>3</sup>   | 1 year                    | Target value enters into force 31.12.2012   | n/a                                    |
| Nickel (Ni)                         | 20 ng/m <sup>3</sup>  | 1 year                    | Target value enters into force 31.12.2012   | n/a                                    |
| Polycyclic Aromatic Hydrocarbons    | 1 ng/m <sup>3</sup><br>(expressed as concentration of Benzo(a)pyrene) | 1 year                    | Target value enters into force 31.12.2012   | n/a                                    |



## 4/6 Expected transport solutions for urban contexts



## Some European cities, 1900



Victorian London's © David's



Milan



Paris



## Same cities, today



A REACHED AIM  
OF THE EUROPEAN  
SOCIETY

DIFFUSED  
MOTORIZATION

Nowadays frequently  
REGULATED, CONTROLLED  
ELECTRIFIED (fixed guideway)



## Some EU cities, today



## Technological solutions

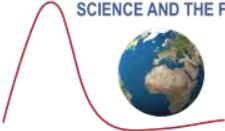
### FUTURE AIMS OF SOCIETY

QUALITY,  
SAFETY,  
SECURITY,  
EFFICIENCY

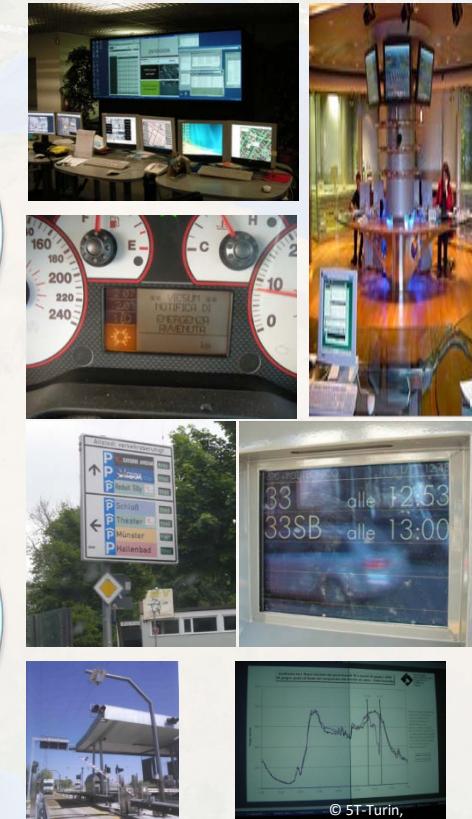
Automated  
Undergrounds  
( $> \sim 10 \text{ k pp/h x d}$ )  
and People Movers  
( $< \sim 10 \text{ k pp/h x d}$ )

Flexible mobility  
through  
Intelligent transport  
systems (ITS)

More oil-  
independent  
vehicles and green  
motor vehicles  
*including sharing*



## urban contexts



Some EU trends in cities

## Practical example: VAL Torino (ex. for the effects of the lengthening of the line of the attracted traffic)

Passengers :

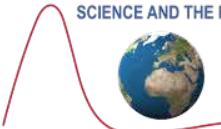
- **2006 (Fermi-XVIII Dicembre): 7 million 880 k pp**
- **2007 (extension to Porta Nuova from Oct.): 12 million 433 k pp**
- **2008: 20 million 509 k pp**
- **2015: 41 million 119 k pp**

Source GTT, 2018: <http://www.gtt.to.it/cms/notizie-eventi-e-informazioni/2443-2006-2016-10-anni-di-metropolitana-a-torino-3>





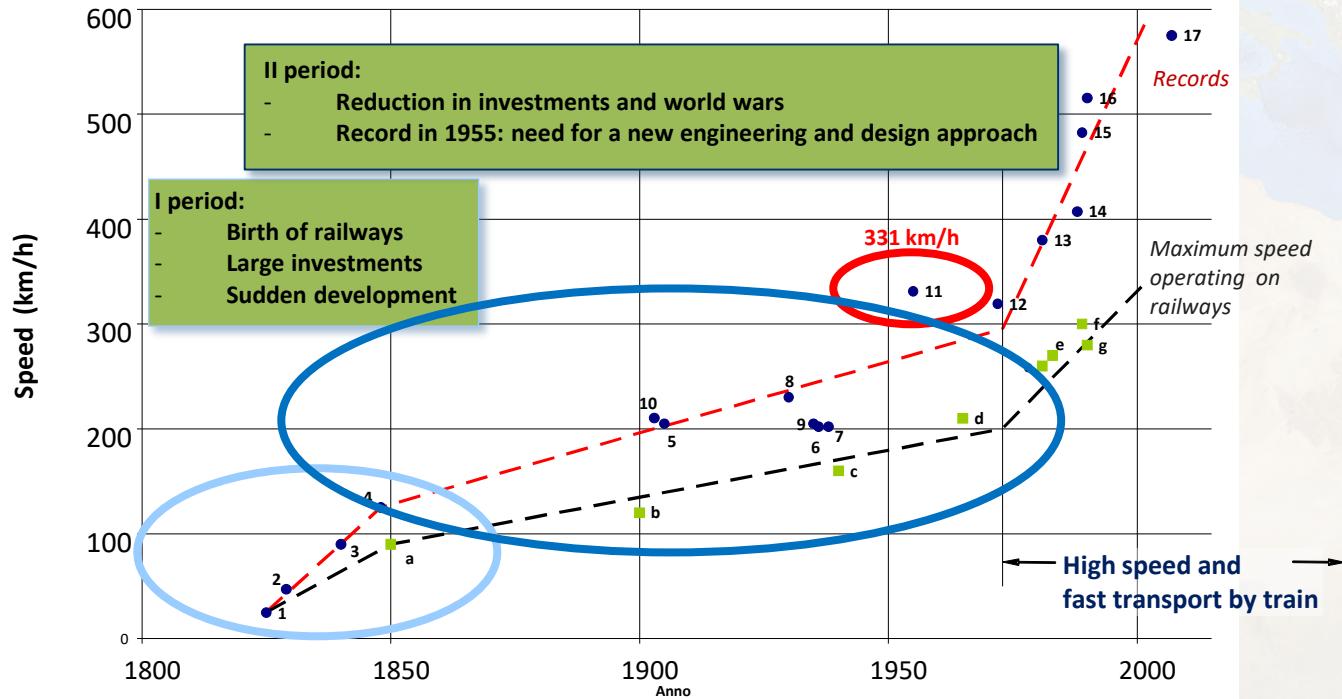
## 5/6 Expected transport solutions for extra-urban contexts



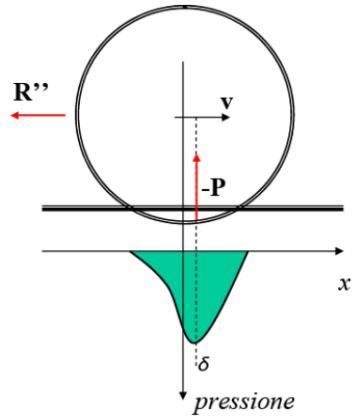
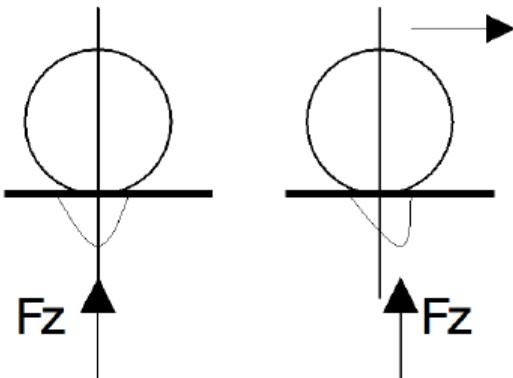
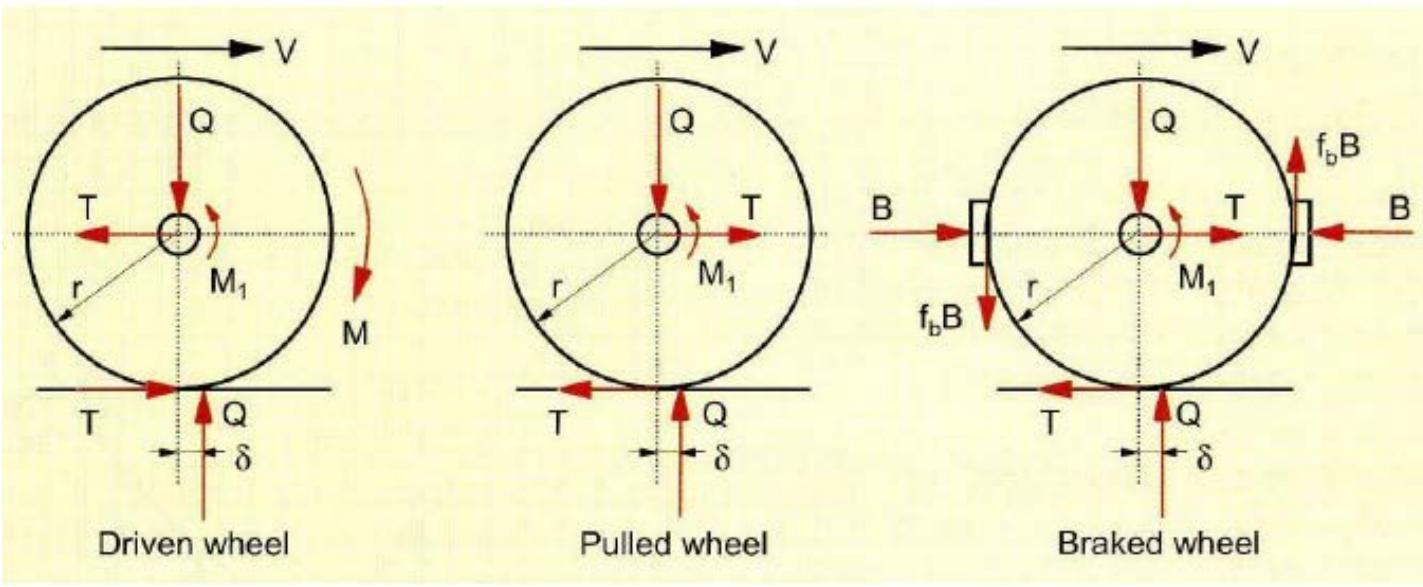
## Records and maximum speeds on railways

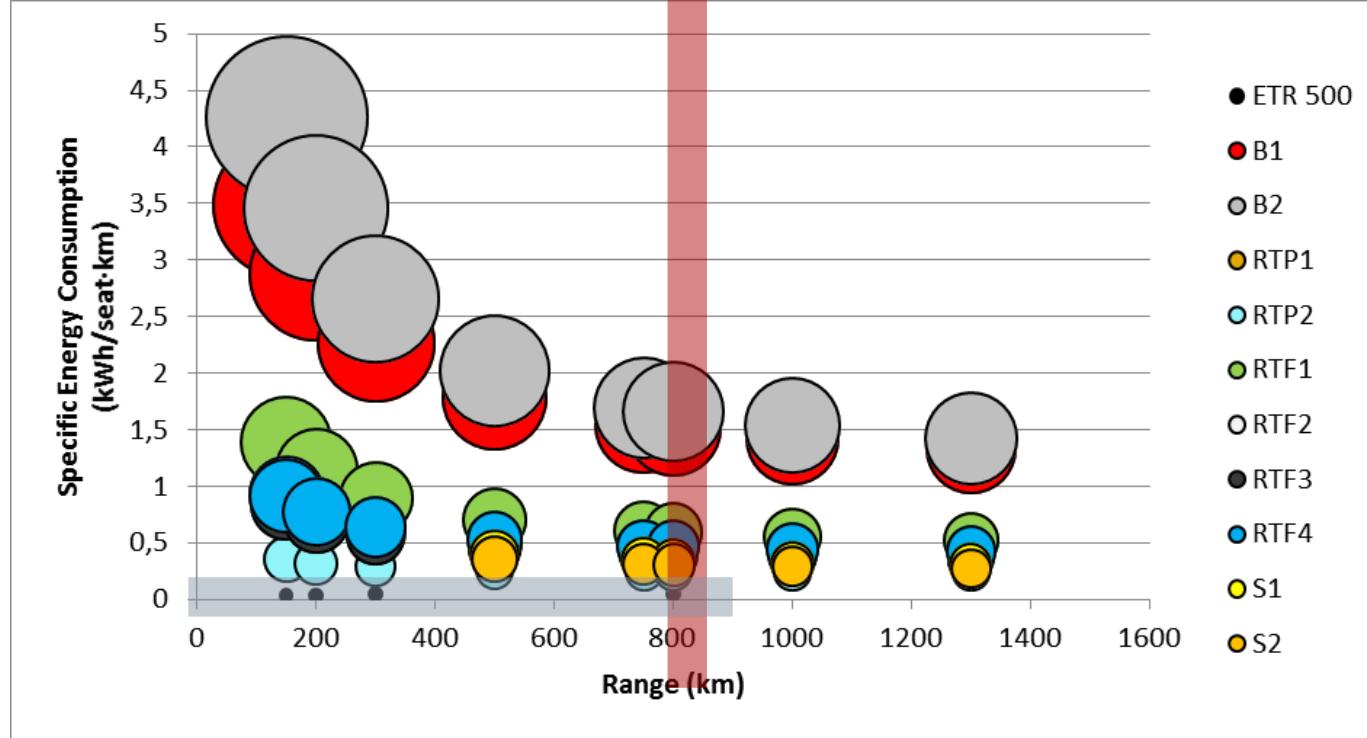
Territories

574.8 km/h (2007)



© Dalla Chiara B., Cornaglia L.; Deflorio F., A macro-analysis of the evolution of motorised mobility and relationships with the development of motionless communication systems, IET Intelligent Transport Systems, DOI: 10.1049/iet-its.2016.0083, Volume 10, Issue 9, November 2016, p. 613 – 621





Specific energy consumption HSR (**High speed Rail**) vs air transport for different route lengths (PASSENGERS)

LA LGV PARIS-LYON AUJOURD'HUI

# UN AXE EUROPÉEN MAJEUR



LA LIGNE  
**LA PLUS CIRCULÉE**  
D'EUROPE

**1/3** DU TRAFIC national français

Des liaisons transeuropéennes importantes avec **l'Espagne**  
**l'Italie & le nord de l'Europe**

**240**

TRAINS PAR JOUR  
en moyenne sur le tronçon  
le plus chargé, dans les 2 sens

**44,4**

MILLIONS  
de voyageurs en 2017

plus de  
**460**

KM de voies

**37**

ANS DE SERVICE  
depuis 1981

Extra urban context:  
a practical example

LA LGV PARIS-LYON

## UN AXE MAJEUR

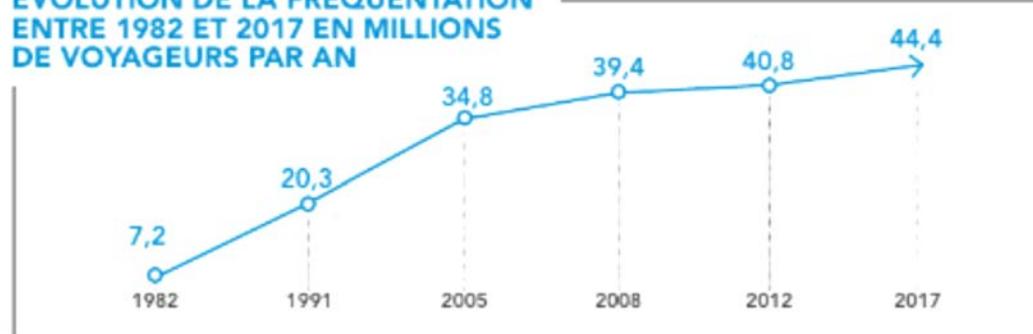


**1/3** DU TRAFIC national français

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**240**  
TRAINS PAR JOUR  
en moyenne sur le tronçon  
le plus chargé, dans les 2 sens

### ÉVOLUTION DE LA FRÉQUENTATION ENTRE 1982 ET 2017 EN MILLIONS DE VOYAGEURS PAR AN



Source SNCF Réseau

**44,4**

MILLIONS  
de voyageurs en 2017

plus de  
**460** KM de voies

**37**  
ANS DE SERVICE  
depuis 1981

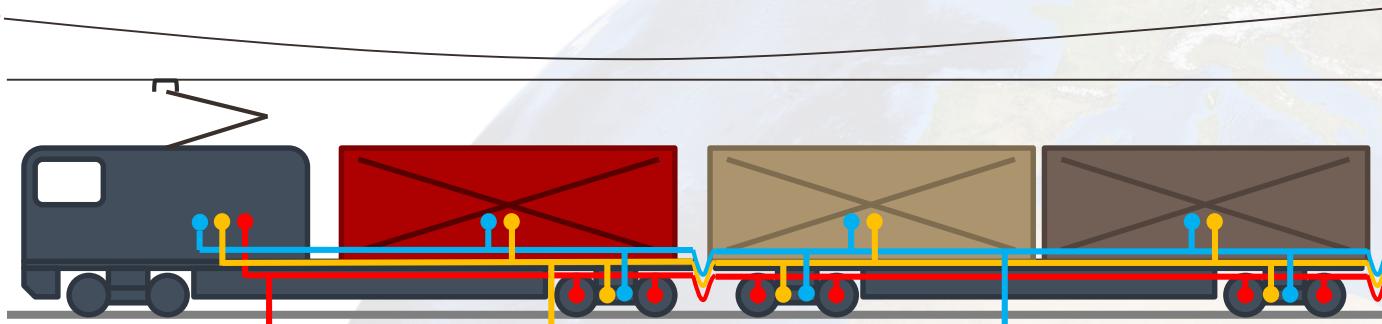
Extra urban context:  
a practical example

## Torino-Milano, HSR (ex. for the effects of the lengthening of the rail line AV on the supply and demand)

- **December 2009 – 7 couple of HST in week days**  
4 of these continuing towards Rome, with stop in Milan Porta Garibaldi, the others at Milan Centrale. On Saturdays 3 couples, 5 on Sundays
- **Today (Sept 2018): 28 couples for Trenitalia, 21 for NTV/Italo.**



# Distributed-power freight trains – “freight EMUs”



Power link

- Distributed traction power:**
- More power with the same axle load
  - Better traction control
  - Longer and heavier trains (35 wagons – 750 m, even on steep lines)

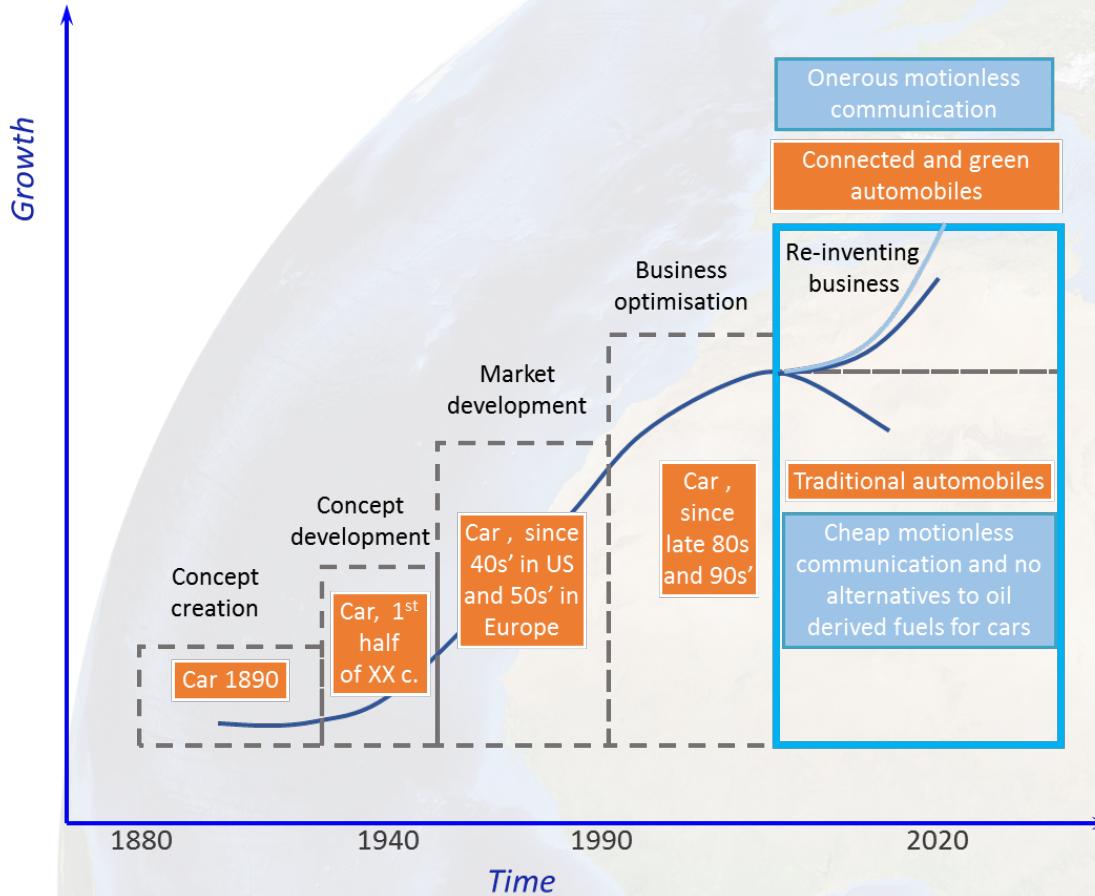
Control link

- Active control of the whole train:**
- Active traction control
  - Braking control and modulation
  - Control and power supply of secondary devices and plants besides cargo (refrigeration)

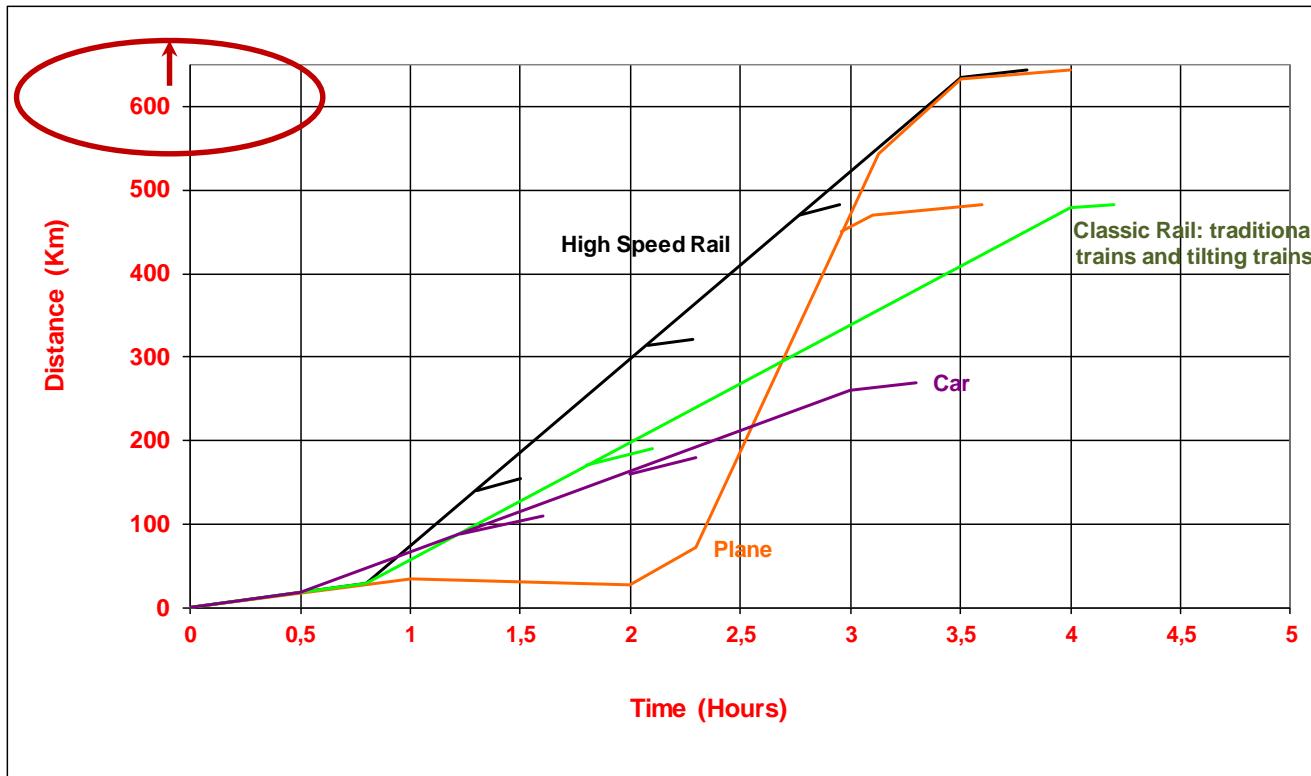
Supervision link

- Supervision of the whole train:**
- Supervision of the wagons sub-systems
  - Supervision of the traction and braking sub-systems
  - Wheelset supervision

- Higher speed with the same load
- Possibility to be used on HS/HC lines besides traditional railways (long trains)
- Better energy performances (better running profiles)
- Supervision of the electrical, mechanical and pneumatic sub-systems (improved maintenance)
- Cargo supervision
- Cargo refrigeration

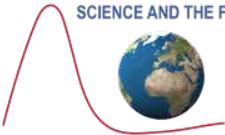


## Door-to-door travel time



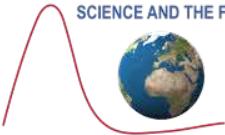


# 6/6 Therefore... (Conclusions)



## A. A European rail network of medium-big cities in a hierarchical co-modal EU network

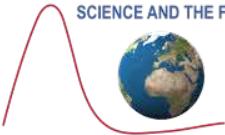
- **Mega-cities**
  - burn land
  - depreciate land already used
- “Stop” to the use of land for constructions
- A HSL rail network for medium-cities
- Air/train HUBs for VLD by airplane



## B. A EU network of rail terminals (inland-ports-industries)

- **freight EMUs**
- **HDV with ICE and PHEV/HEV for mixed use**





## C. Flexible co-modality in cities

(1<sup>st</sup> feasible step against global warming)

- **PHEV (Plug-in hybrid electric automobiles)**
- **Electric vehicles when each night the depot or parking is fixed**
- **Sharing (PT included); bikes**
- **MAAS**



TORINO, 12 - 16 NOVEMBRE 2018

**CONTRADDIZIONI E SFIDE  
CONTRADICTIONS AND CHALLENGES**



**Grazie per l'attenzione  
Thank you**

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