Data & Technology

A necessary but not sufficient condition for sustainable mobility

Prof. Francesc Soriguera

Barcelona Innovative Transport

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Presentation overview

- Sustainable urban mobility: Identifying the problem
- Is **data** the solution?
- Will **technology** solve the problem?
  - Autonomous Vehicles (AV)
  - Electric Vehicles (EV)
  - Vehicle Sharing
  - Flying cars
  - Hyperloop
  - Teleportation?

Demand for mobility

- Who wants to move?
  - The potential demand for mobility is “infinite”…
  - Smart Cities: The end of distance?

    The answer is **NO**

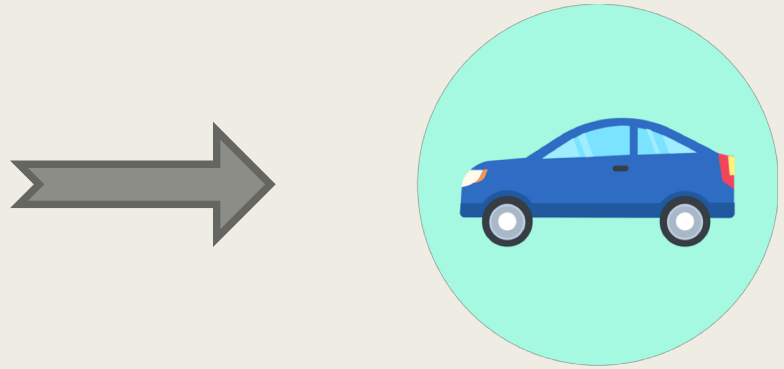


- Why we do not move more?
  - Because it costs TIME and MONEY (perceived costs)
  - Direct relationship between WEALTH and MOBILITY



Mobility: what we want?

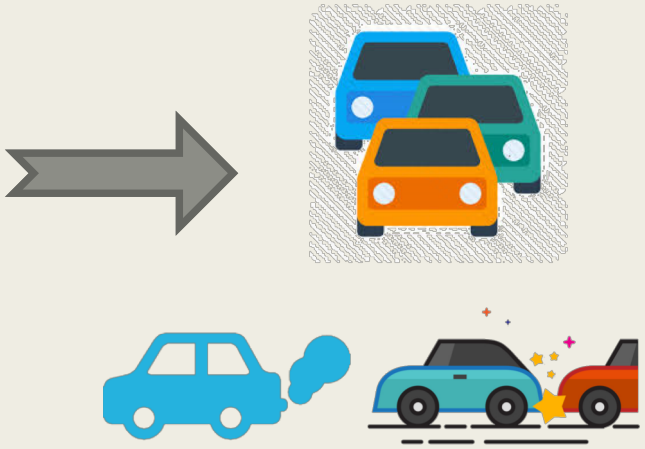
- Travel where we want => Door-to-door travel
- Travel when we want => At any time
- Travel fast, safe and cheap
- Travel comfortably and privately



But the **car** turns to be highly **inefficient**

…in dense demand environments

- Large **vehicle fleets** most of the time unused (sharing ?)
- Large **space consumption**, while space is a scarce resource
- Opposing flows (**intersections**) generate huge loss of capacity
- **Inefficient** and **selfish** human driving



- **Individual transportation** alternatives:



The alternative is **collective transportation**

PROS

- Efficient space consumption
- Smaller fleet
- Easier flow management
- Economies of scale

CONS

- Time consolidation => Wait
- Space consolidation => Access
- Lost time => Stops
- Infrastructure & operative costs

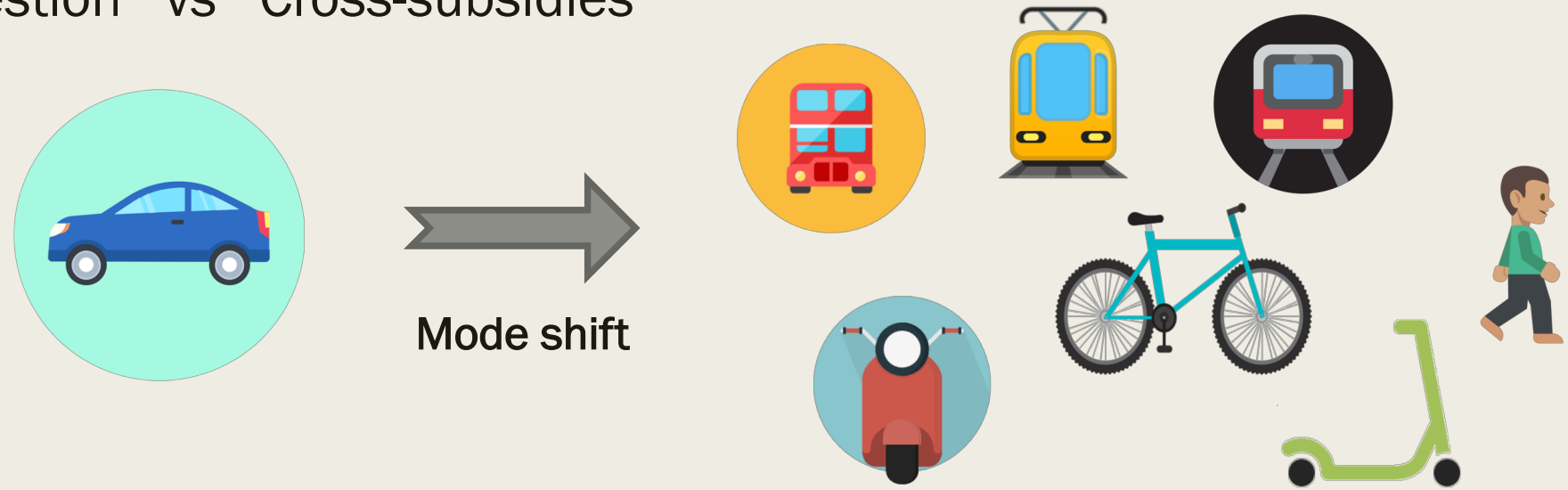


NEEDS

- High demand
- Efficient design & operation

Sustainable urban mobility – Equilibrium

- Congestion vs Cross-subsidies



- Intermodality





DATA

Is **data** the solution?



- **Seduced** by data availability

Before the impulsive data consumption, ask yourselves:

- **Why** we need this data?
- Which **level of detail** we need?
- **How** are we going to use these data (data treatment)

Many times there is **not a clear answer**

Data treatment

The more detailed data and computational power

The less attention paid to **data treatment** and **fundamental knowledge**



- Units
- Significant digits and truncation errors
- Aggregation and averaging
- Temporal and spatial alignment
- …

But data means **information**…



- Information to **users**
  - Perfect information leads to **user equilibrium.** Remember **Wardrop**?
  - **Not optimal**. Few may penalize many.
  - Information has not implied a more efficient transportation system

- Information to **agencies/operators**
  - Should be used to support **control** and **management strategies** => **System optimal**
  - Restrict few to benefit many
  - Today lots of information lead to **very little action**.
    - Traffic? Metering, lane-changing, DSL, HOV lanes, tolling, parking…
    - Collective transportation? Vehicle pairing, ticketing, lost times, transfer coordination, priority, …
    - Sharing? Rebalancing, empty/full zones

Microscopic modelling



- Racing towards more **data avid** models
- More detail (and errors) in the huge amount of inputs
- Many **parameters and calibration** required
- Most transportation models are **uncertain**, or even **unpredictable**, at individual level.

"Increasing model precision can reduce accuracy of results"

(Daganzo, 1987)

Macroscopic modelling



- Do not disregard the **macroscopic** (aggregated) approach
- **Few** aggregate inputs, **few** parameters, **few** calibration
- **Robust** aggregate models are available
  - LWR – Freeway traffic
  - MFD – Urban traffic control
- **Easily implemented** control systems

So… is **data** the solution?



- **Fundamental knowledge** comes first. Data comes next.
- **Data helps**, but it is not enough.
- Not always more detailed data is better.

- Incentives/attractiveness to implement latest technologies and obtain data
- **Fear** to apply transportation engineering principles and move towards a sustainable mobility.
- **Society is ready**. What about policy makers?

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Thank you for your attention

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UPC
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TECHNOLOGY

Technology is seen as the **final objective**

- Is **technology** the future solution to mobility problems?
  - Autonomous vehicles (AVs) ?
  - Electric vehicles (EVs) ?
  - Vehicle sharing ?
  - Flying car ?
  - Hyperloop ?
  - Teleportation ?



Autonomous vehicles



- Vehicle centric research
- Comfort and safety => Conservative parameters
- Uncoordinated behavior (e.g. car following, route guidance, lane assignment)

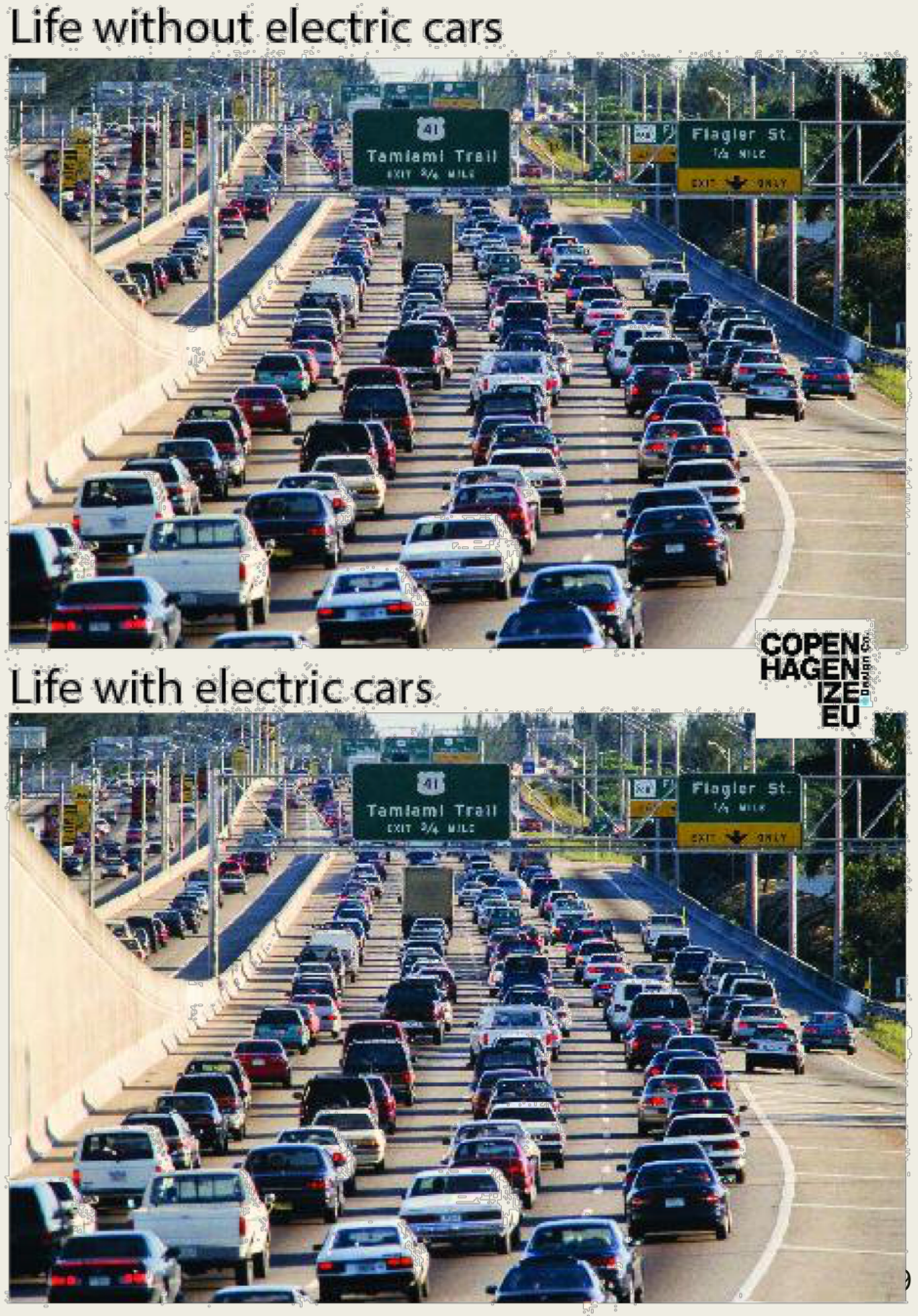
→ **Detrimental in terms of traffic efficiency**

- **Traffic management** will be even more necessary than today, and **easier**
- Coordination => platooning, route/lane coordinated guidance
- Mixed traffic strategies

Electric vehicles

- ↓ local **pollutant emissions**
- **Range anxiety** and **price** of batteries
- Availability of fast **charging stations**
- **Battery recycling** and availability of raw materials
- Primary source of **electric power**

And still a car



Vehicle sharing

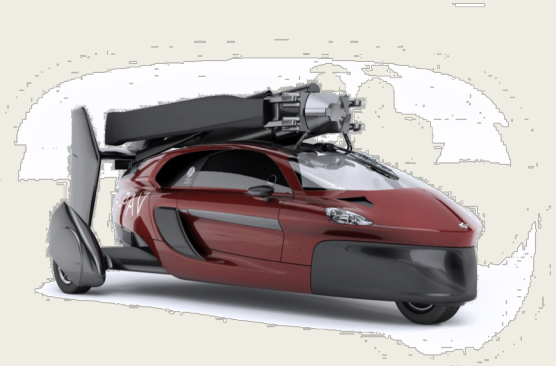


- Optimal **system design** => free-floating vs station-based
- **Profitability** => Users vs Agency costs
- **City wide** systems => Interoperability amongst operators
- In **competition** with walking, biking and collective transportation
- **Induced demand**
- Still restricted to a **niche of society**
  - Lack of spatial coverage
  - Lack of technical skills
  - Loss of comfort and privacy
  - Displeasure with cleanliness
  - Inclination to ownership

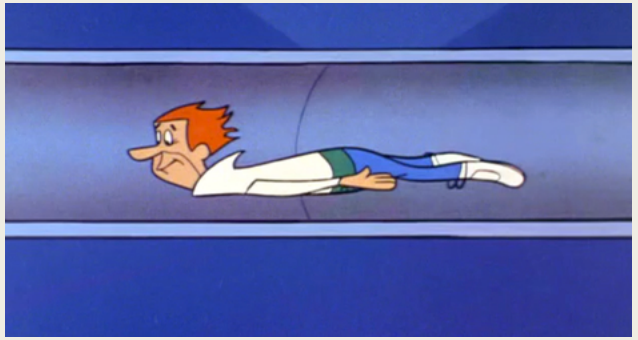
Flying car

- Highly sensitive to **weight and weather**
- Battery **power** restrictions
- **Price**
- Pilot **license**
- Traffic **regulations**
- **Take-off & landing** => Infrastructure & Operation
- All the **problems** of traditional cars + others





Urban hyperloop





- Magnetic levitation in a low pressure tube at high speeds
- Many small stations underground

But…

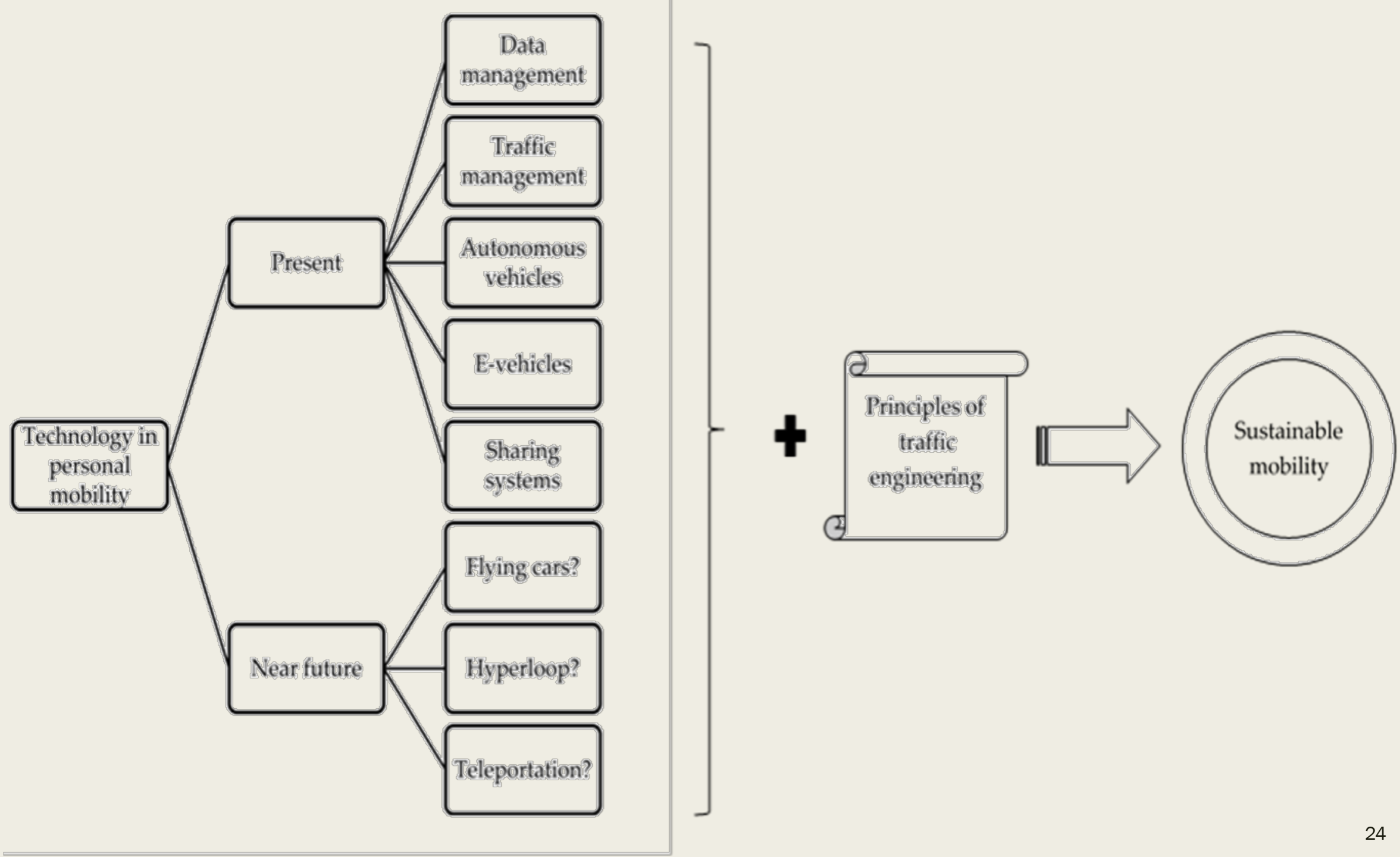
- Is this technically feasible?
- This is a subway with small vehicles and high maximum speed
- Door-to-door speeds not very sensitive to maximum technological speed:
  - Stops: Trade-off between accessibility and riding time
  - Lost times at stops determines the commercial speed of the system
  - Transfers allow spatial coverage

Teleportation

- Physically possible?
- Quantum teleportation
- Transmit information not the object itself…






Technology in personal mobility
Present
Near future
Data management
Traffic management
Autonomous vehicles
E-vehicles
Sharing systems
Flying cars?
Hyperloop?
Teleportation?
Principles of traffic engineering
Sustainable mobility

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