Ministerie van Infrastructuur
en Waterstaat

Innovations in Mobility

Jan van der Waard

KiM - Netherlands Institute for Transport Policy Analysis

KiM
Netherlands Institute for Transport Policy Analysis

- Established in 2006
- Provides knowledge inputs for the preparation of mobility policy at the Ministry of Infrastructure and Watermanagement
- KiM carries out our own research and collects the results of studies conducted elsewhere. KiM ensures that the ministry is able to develop policy with a sound knowledge base

Organisation KiM

Employees

- +30 people
- Many different research disciplines

Products and services

- **On demand** researchprojects into strategic policy questions

  www.kimnet.nl

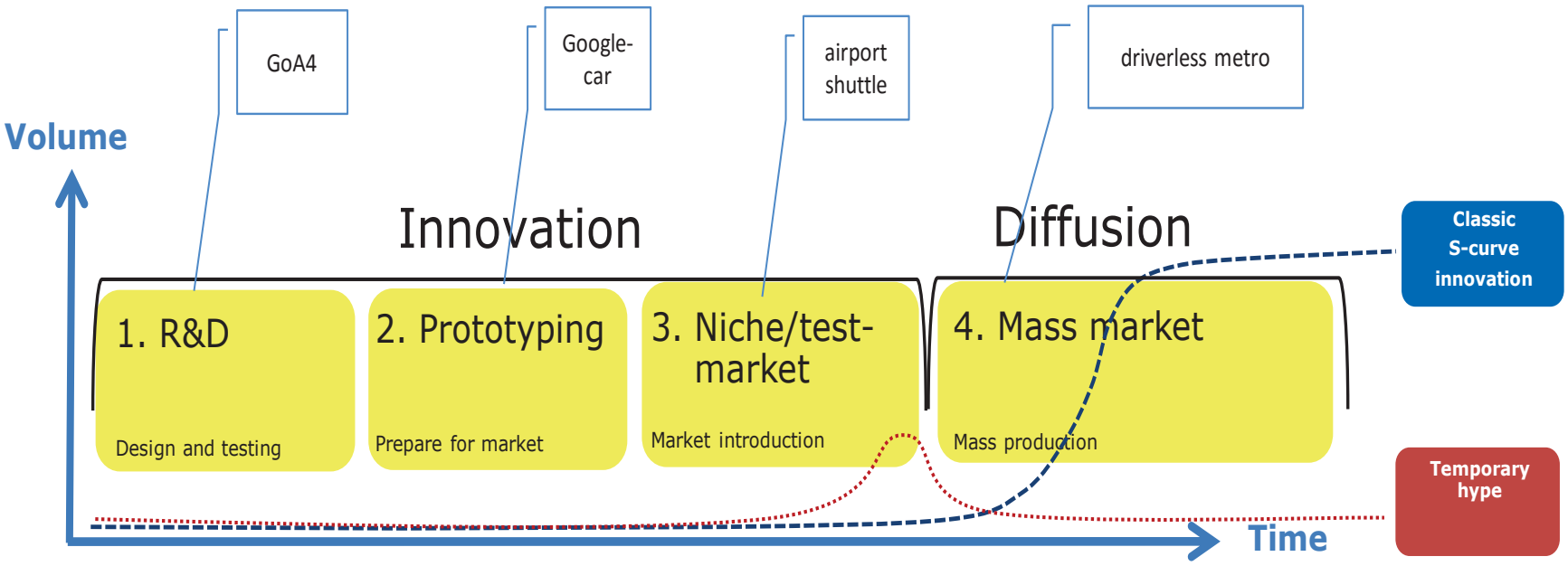
- **'Knowledge-at-the-table'**

- Internal **signaling** on our initiative

Transport innovations

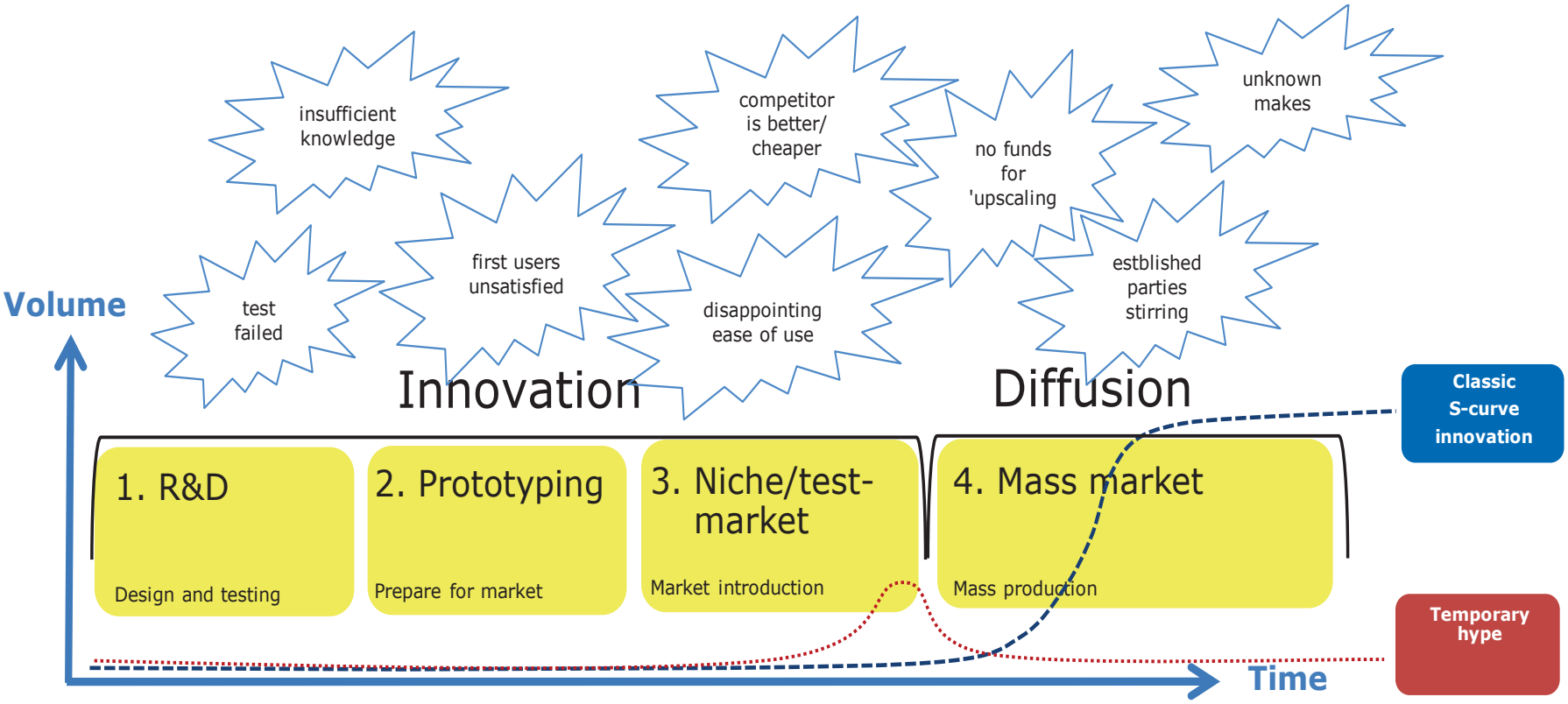
- Innovation in general / innovations in public transport
- Electric bicycle
- Smart mobility
  - Self-driving vehicles

Innovation is a development proces……



……in which many things can go wrong….

….which leads to no reaching the diffusion phase

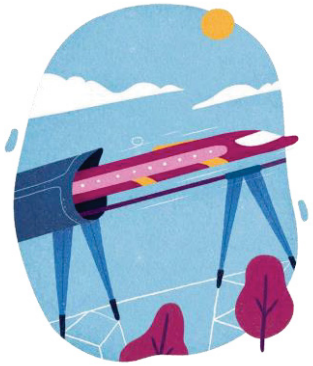


Not always a garanteed succes.....

33 public transport innovations in 7 categories

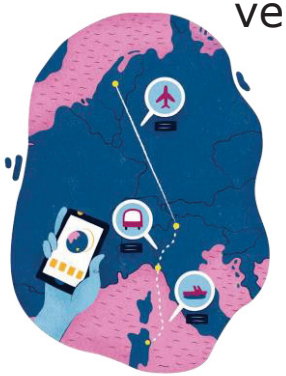
Automated road vehicles

Automated rail vehicles



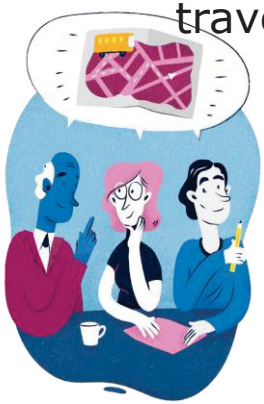
New types of infra (+ vehicles)

Payment syst. travel assistance



Travelplanners

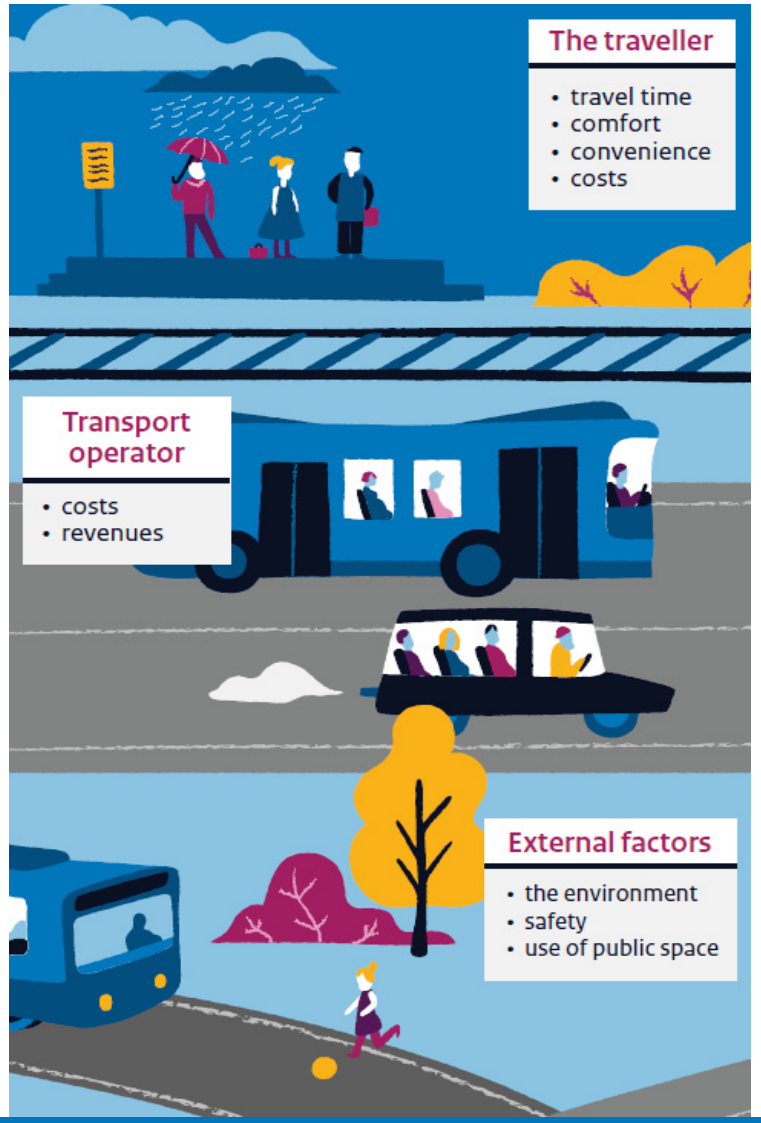
Demand responsive systems



Organisational innovations

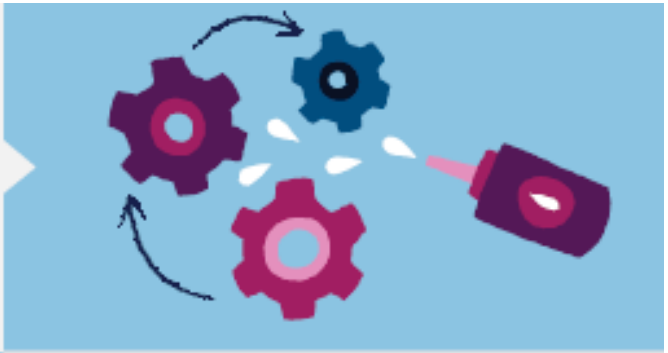
Market effects of public transport innovations

appraisal framework



Findings (1)

At present, innovations primarily involve minor improvements and the roll-out of that which is already underway.



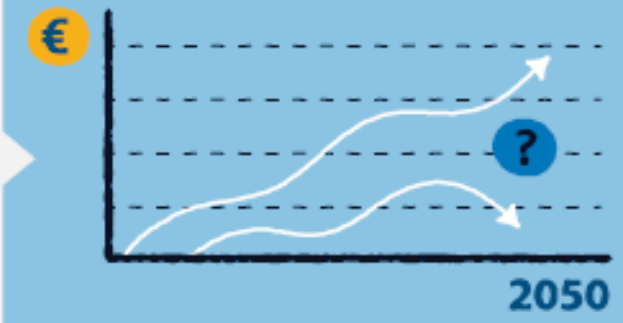
The focus in literature pertaining to public transport innovations is on vehicle technology, payment and information systems, and demand-responsive transportation.

The traveller benefits most from innovations that substantially improve door-to-door travel times. 'Travel time' pertains to both the actual clock time and the perceived travel time.

Findings (2)

Innovation is a process that includes obstacles. Hence, many innovations fail to secure a large-scale place in the market.

It is often uncertain whether an innovation will also be profitable over the longer term. Consequently, it is seemingly difficult to find an operator.



Innovations that require new, expensive infrastructure and large amounts of space are still deemed to be unrealistic.

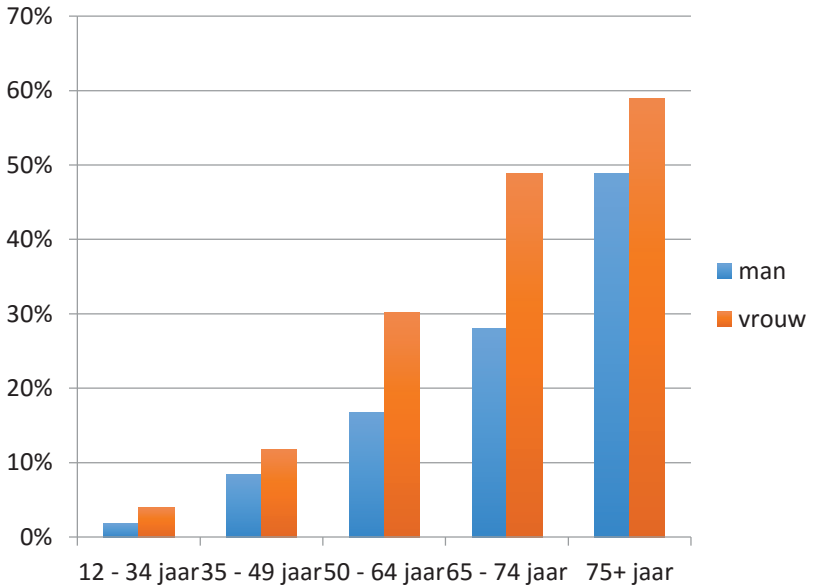
BMWBLOG
M EV 332E
M CP 872E
M EV 338E

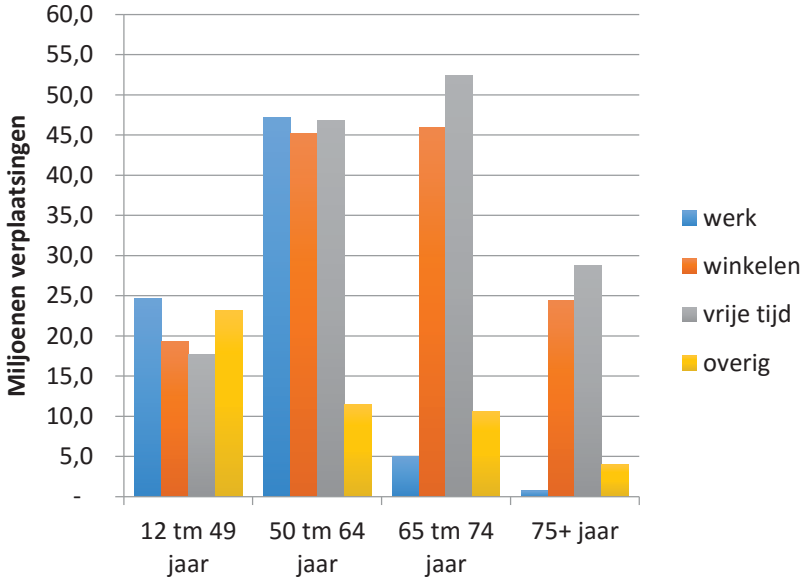
BMW Cruise e-bike

Audi e-bike

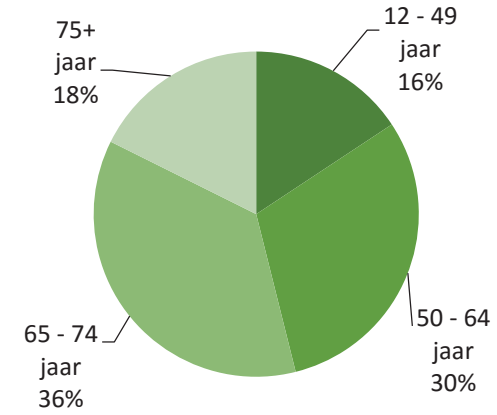
Electric bicycle...

Adopted by older people



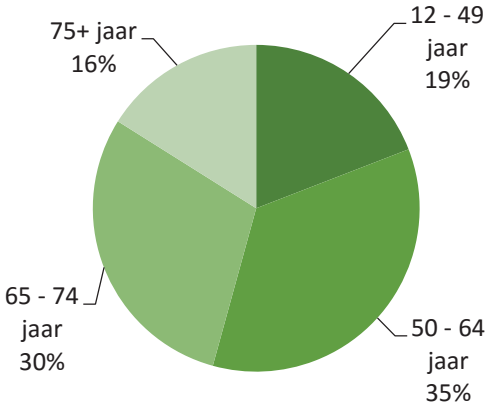


But increasingly used by younger people



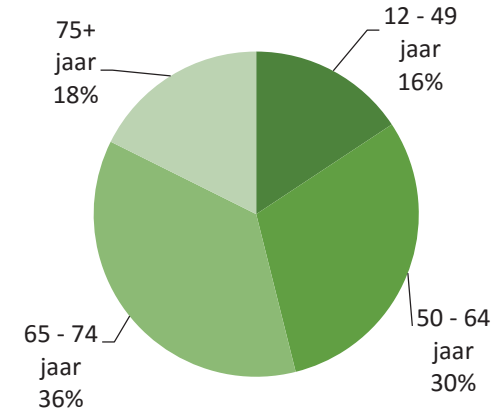
2013

Shares in kilometers by e-bike

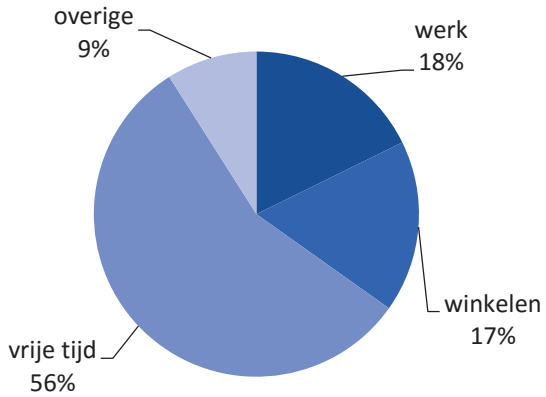


2016

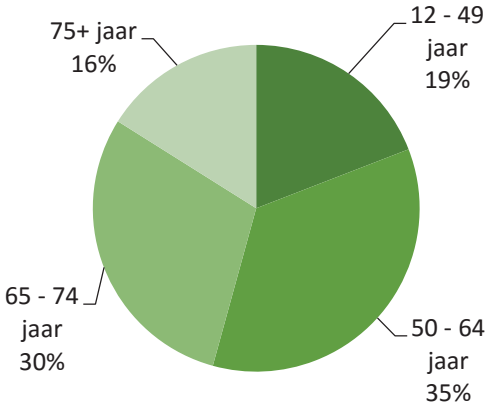
But increasingly used by younger people and for commuting and shopping



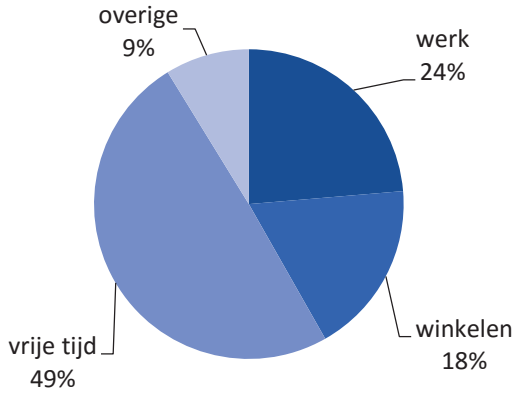
2013



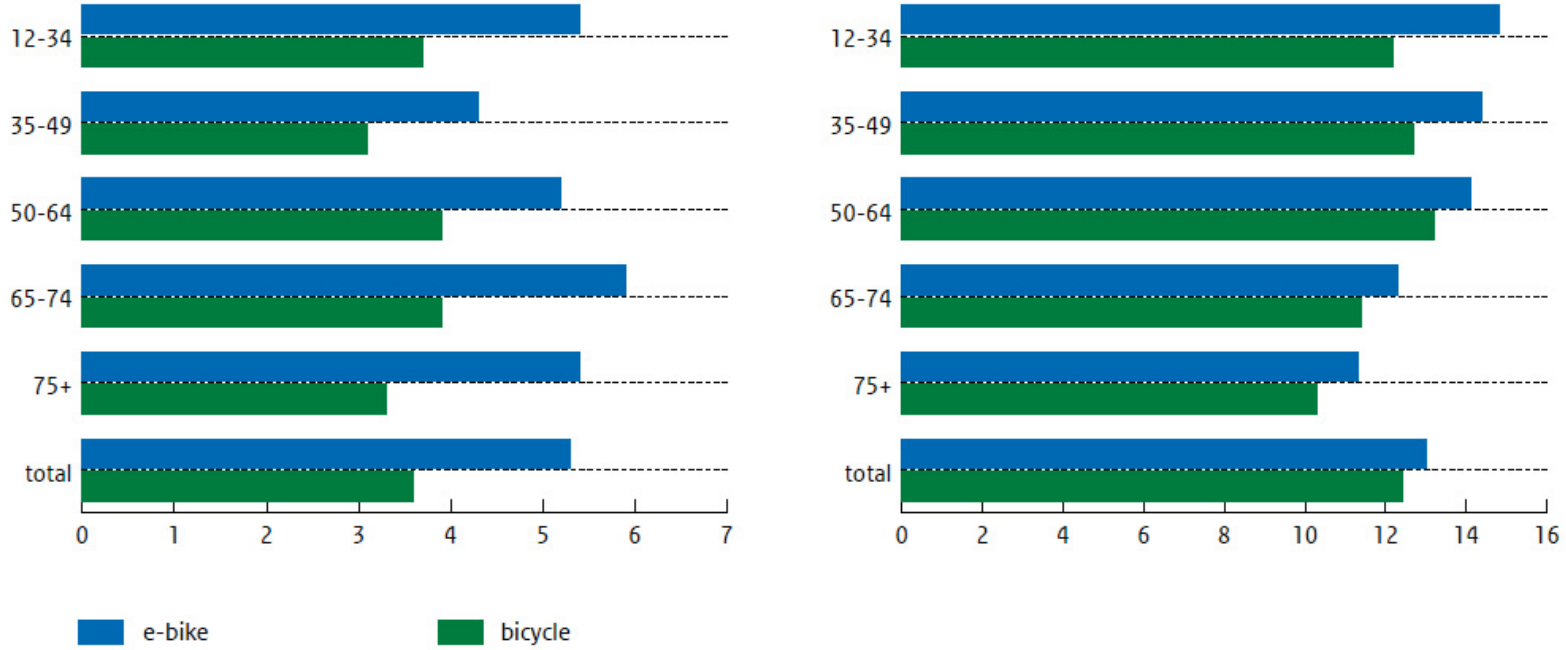
Shares in kilometers by e-bike



2016

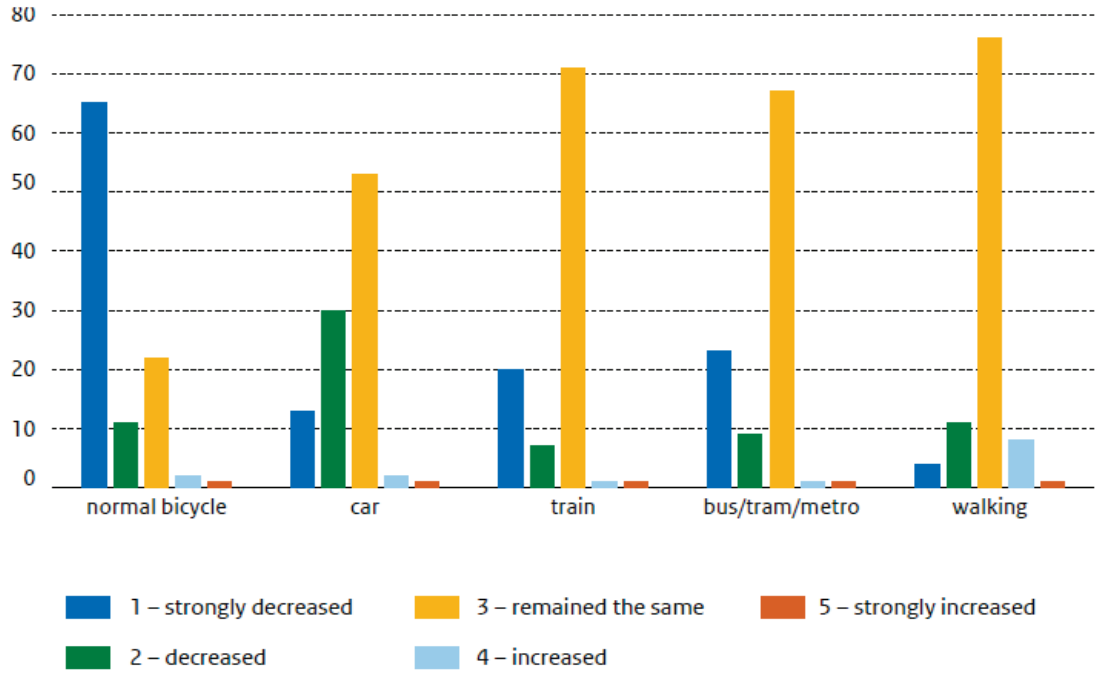


Range of electric bicycles one and a half that of normal bicycles



Trip length in kilometres (left) and average speed in kilometres per hour (right) for e-bikes and 'normal' bikes by age group, averaged for the years 2013, 2014 and 2015. Source: CBS OviN (2013-2015); calculation by KiM.

E-bike owners travelled less frequently by car and public transport and, above all, made less use of normal bicycles



Impact of e-bike ownership on travel by other transport modes (expressed in shares of e-bike owners who reported making lesser or greater use of other transport modes), 2016. Source: Beleving en beeldvorming van mobiliteit (2016); calculation by KiM.

Smart/intelligent mobility

- Intelligent Mobility: The discipline of smart apps to travel faster from A to B or to transport goods, the discipline of cooperative technology and the self-driving vehicle.

Automation of vehicles

(car, truck, vessels, drone)

Informatization of traffic

(data, connectivity, platforms)

Mobility on demand

(sharing/mobility without ownership)

Electrification of traffic

(car, truck, vessels, drone)

Drones

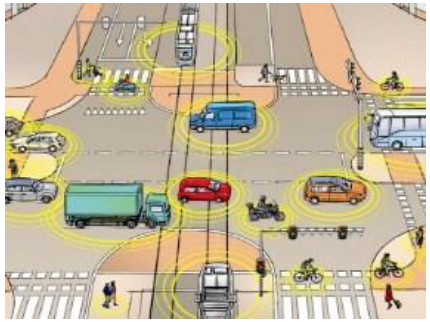
Connected en cooperative driving

- **Vehicle-to-vehicle communication (V2V)**
  - Hazardous location warning
  - Slow vehicle warning (for instance agricultural vehicles)
  - Stationary vehicle warning
  - Emergency Brake Light
  - Emergency vehicle warning (ambulance, police, firebrigade)
  - Motorcycle approaching indication (for instance in a traffic jam)
- **Vehicle-to-infrastructure communication (V2I, V2C)**
  - Road works warning
  - In-vehicle signage/information
  - Signal phase and timing of traffic lights
  - Probe vehicle data (Floating Car Data); information on traffic levels
- **Car sensor information; ECU's (Electronic Control Units); large scale use**
  - Better estimation of traffic congestion
  - Estimation of driver behaviour (e.g. agression, measured through accelerator dynamics)
  - Early warning of accidents
  - More fuel efficient driving
  - Safer driving in dangerous curves

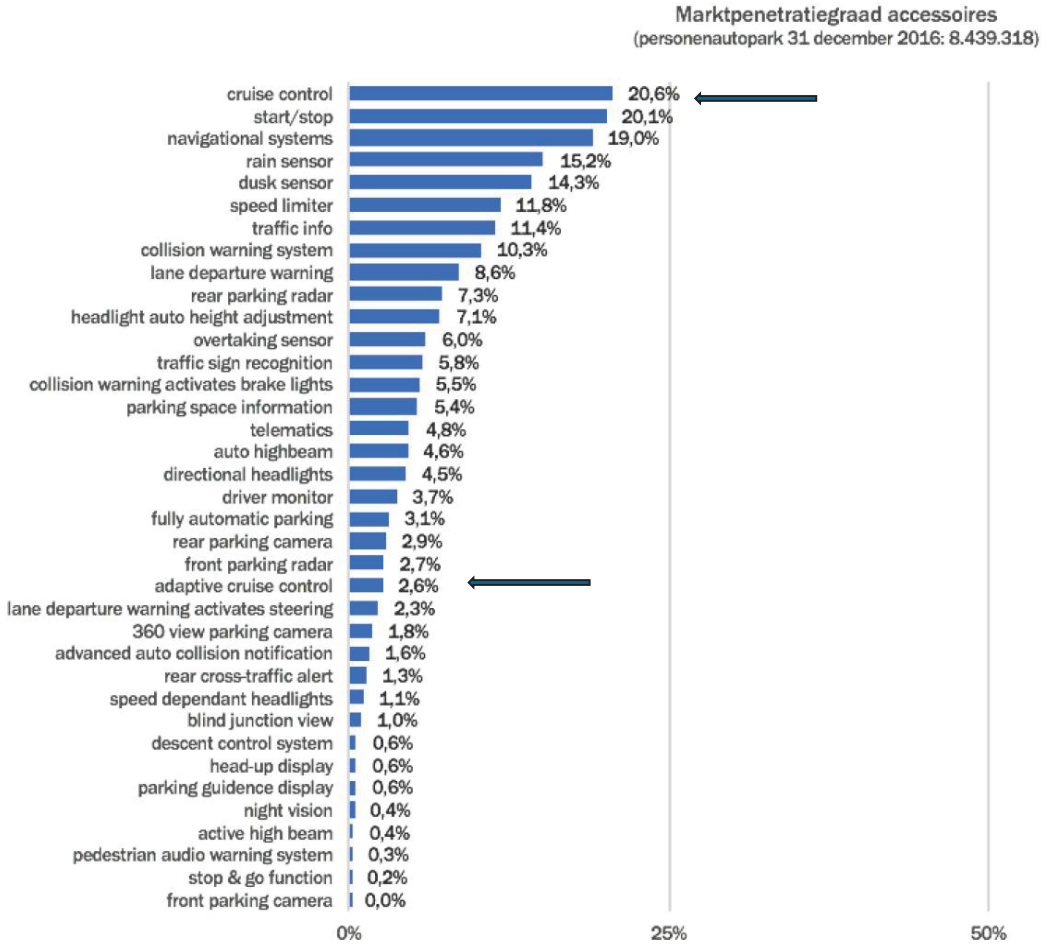
Privacy?

What can we expect?

- Travel information: further integration of traditional navigation-/information systems, navigation apps and connected and cooperative technology. More and more real time and indivdualised information regarding:
    - traffic situation/congestion
    - lane advise
    - Incident/accident information and advice
    - parking (reservation) advice
    - traffic sign/light advice/smart traffic lights
    - instant multimodal advise (MAAS)
- Self-driving vehicles (public transport and car)



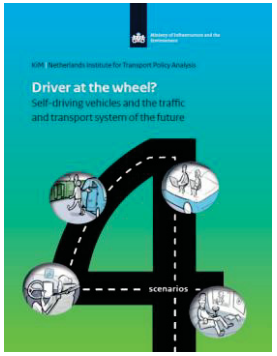
Technology vs. penetration

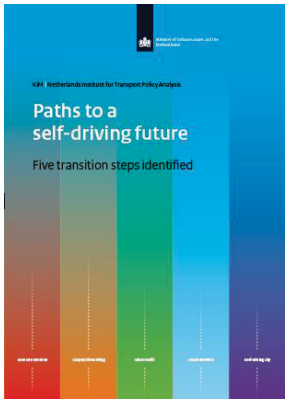


Self driving future – KiM research program

1. '*Driver at the wheel?*'
   - four scenarios for a future traffic and transport system with automated vehicles

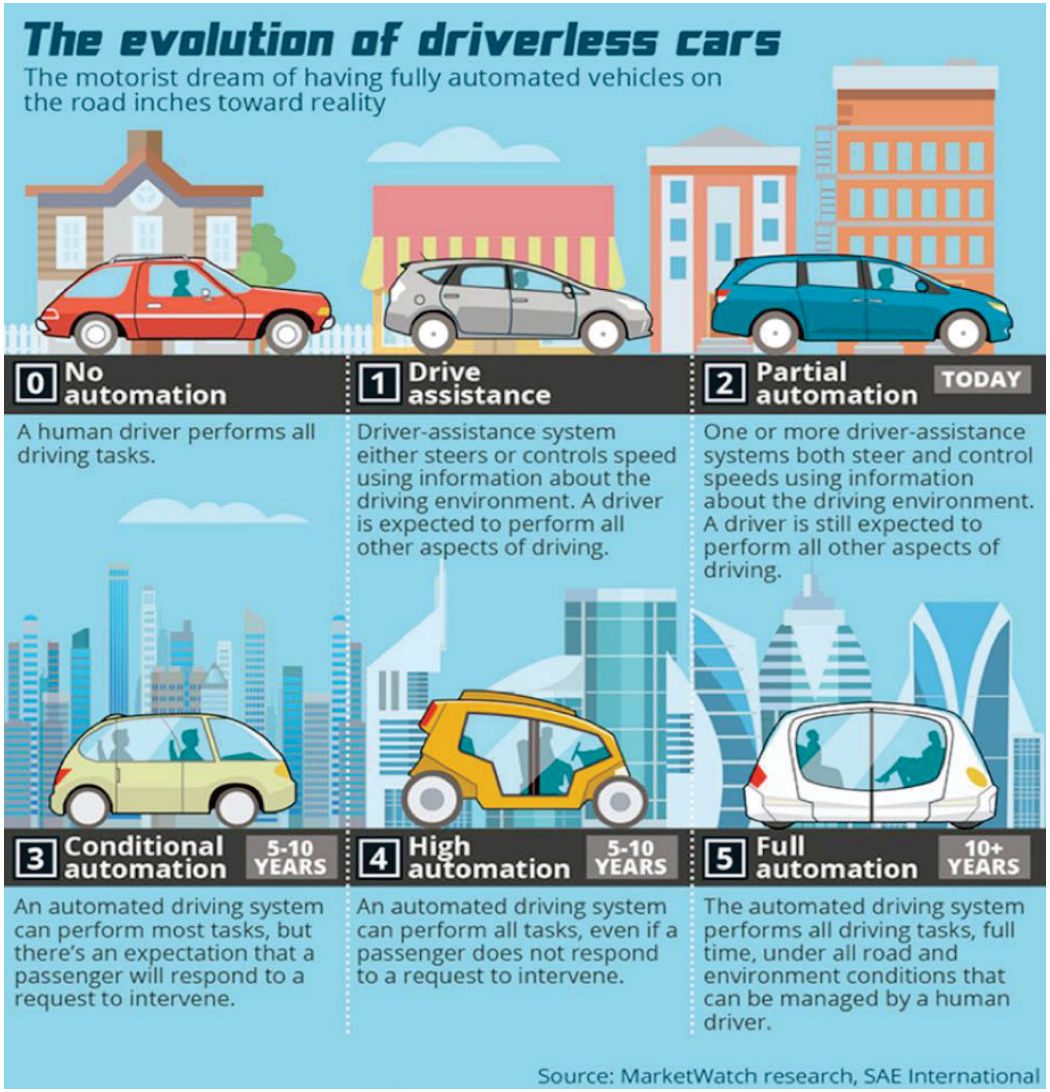
2. *Paths to a self-driving future*
   - Transition paths towards the scenario's
   - Perspective on policy options



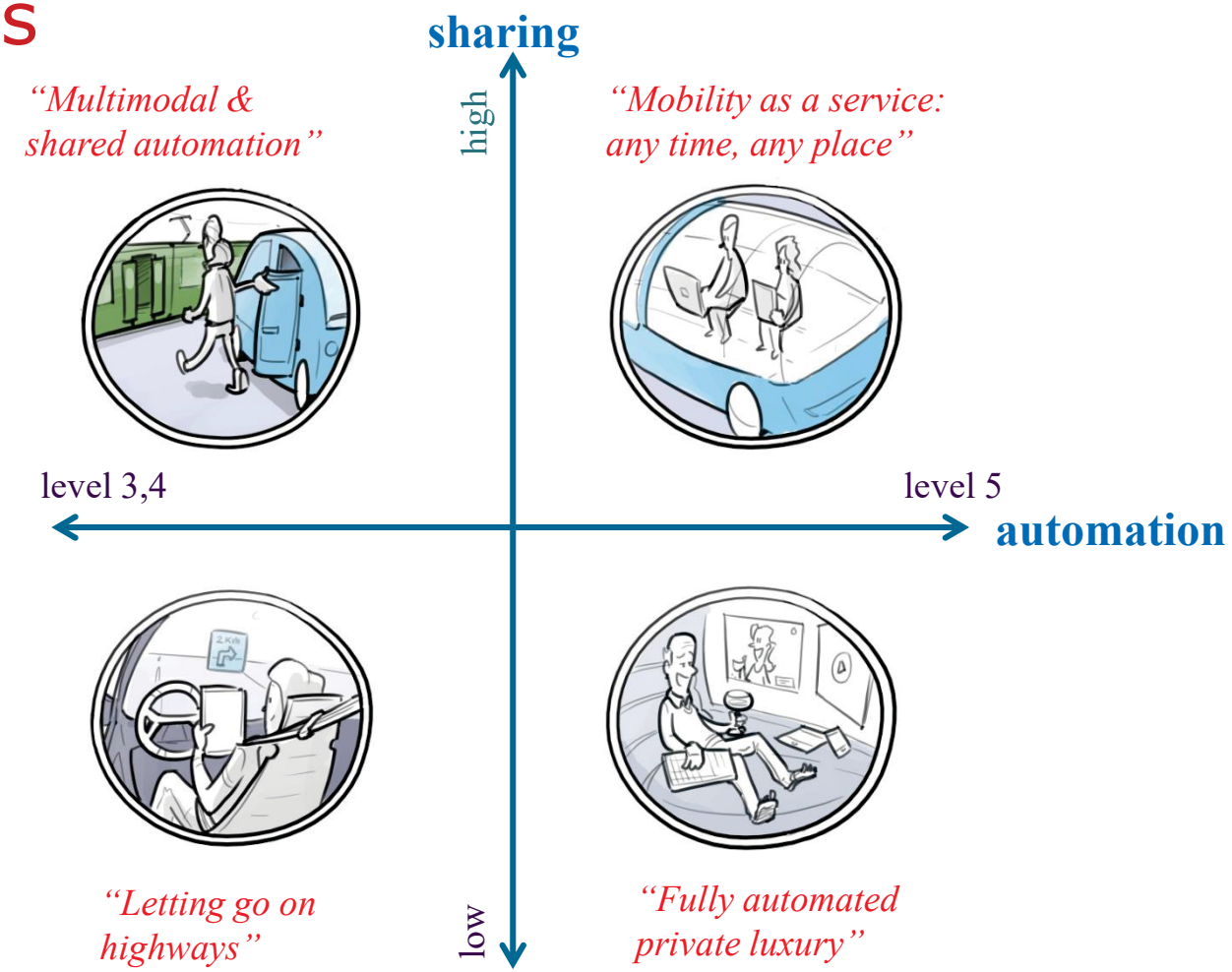


Definition: SAE-levels of automation

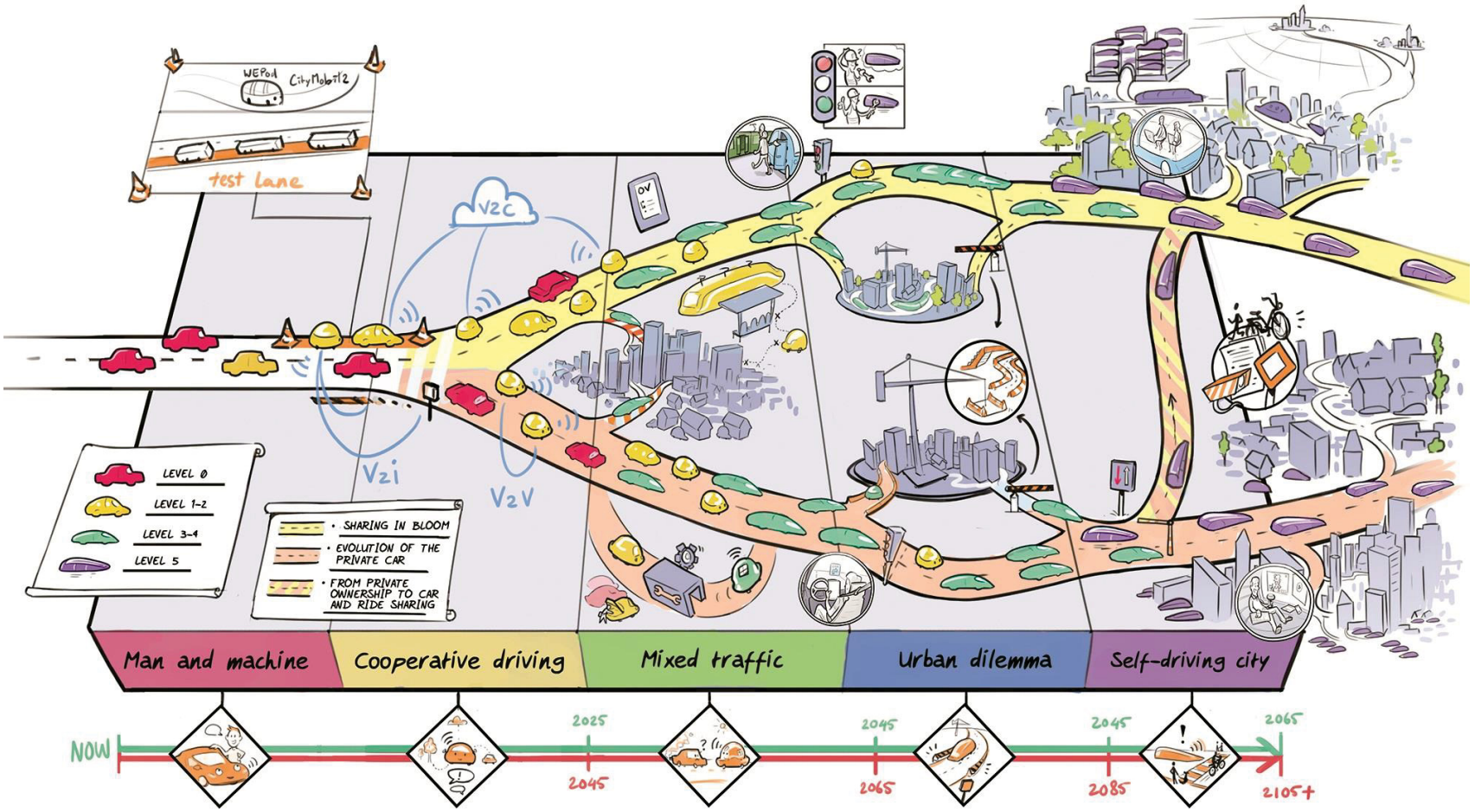
Level	Name	Example
Human driver monitors the driving environment		
0	No automation	Lane Departure Warning
1	Driver assistance	Adaptive Cruise Control
2	Partial automation	Parking Assistance
Automated driving system monitors the driving environment		
3	Conditional automation	Highway Chauffeur
4	High automation	Parking Garage Pilot
5	Full automation	Robot Taxi


The evolution of driverless cars
The motorist dream of having fully automated vehicles on the road inches toward reality
0 No automation
A human driver performs all driving tasks.
1 Drive assistance
Driver-assistance system either steers or controls speed using information about the driving environment. A driver is expected to perform all other aspects of driving.
2 Partial automation
TODAY
One or more driver-assistance systems both steer and control speeds using information about the driving environment. A driver is still expected to perform all other aspects of driving.
3 Conditional automation
5-10 YEARS
An automated driving system can perform most tasks, but there's an expectation that a passenger will respond to a request to intervene.
4 High automation
5-10 YEARS
An automated driving system can perform all tasks, even if a passenger does not respond to a request to intervene.
5 Full automation
10+ YEARS
The automated driving system performs all driving tasks, full time, under all road and environment conditions that can be managed by a human driver.
Source: MarketWatch research, SAE International

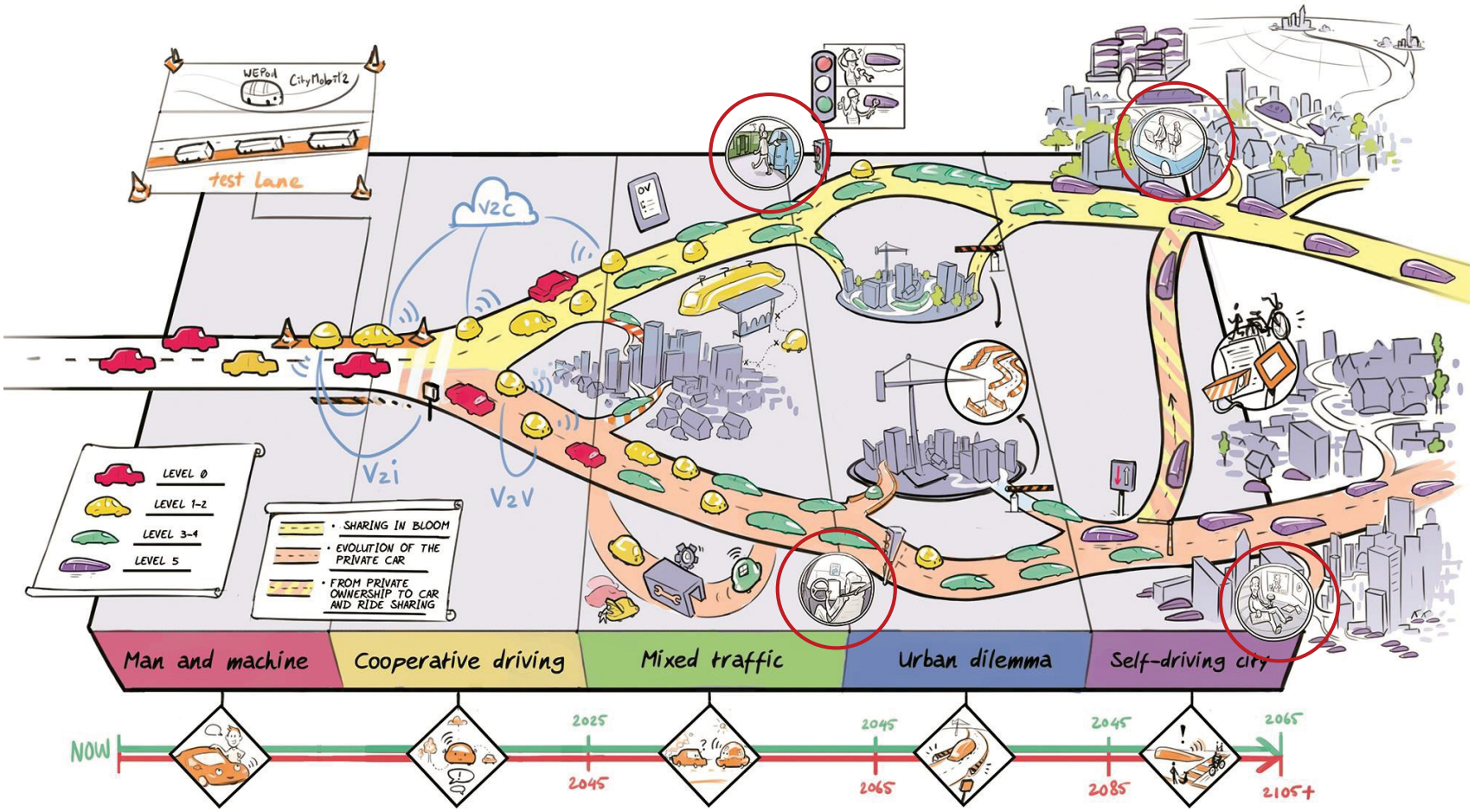
Driver at the wheel? Uncertainties and four scenarios



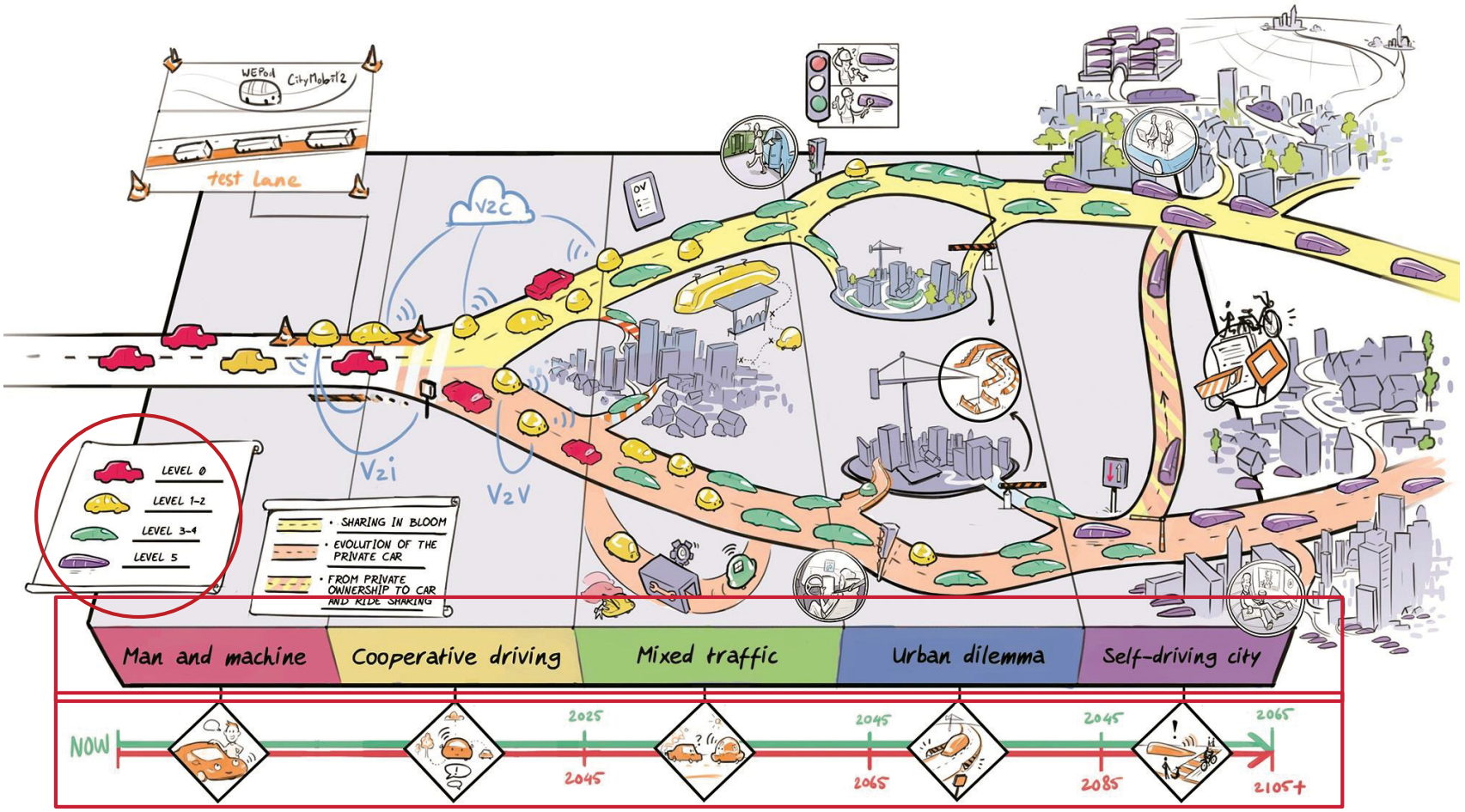
Transition paths: the story line



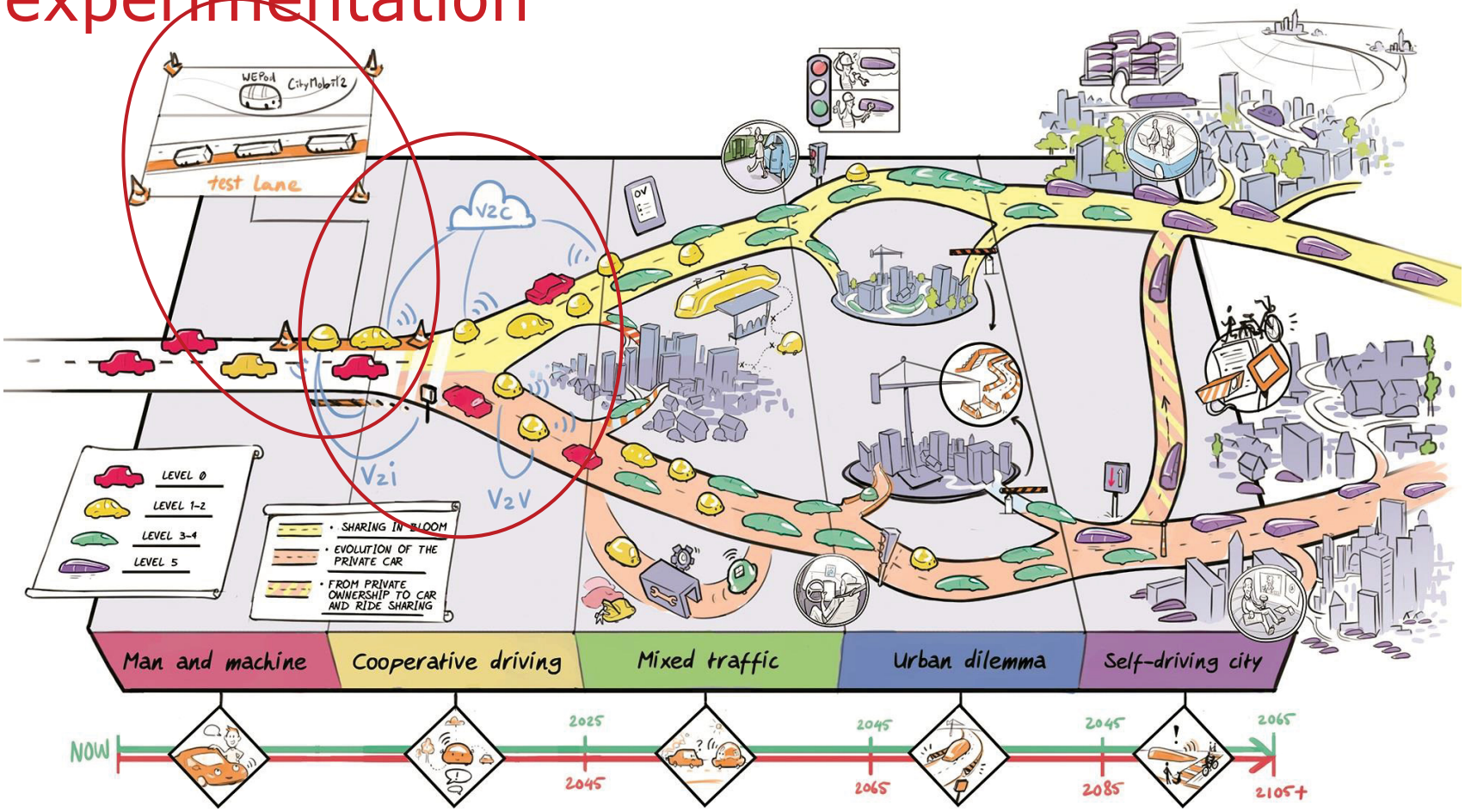
The four scenarios along the transition paths



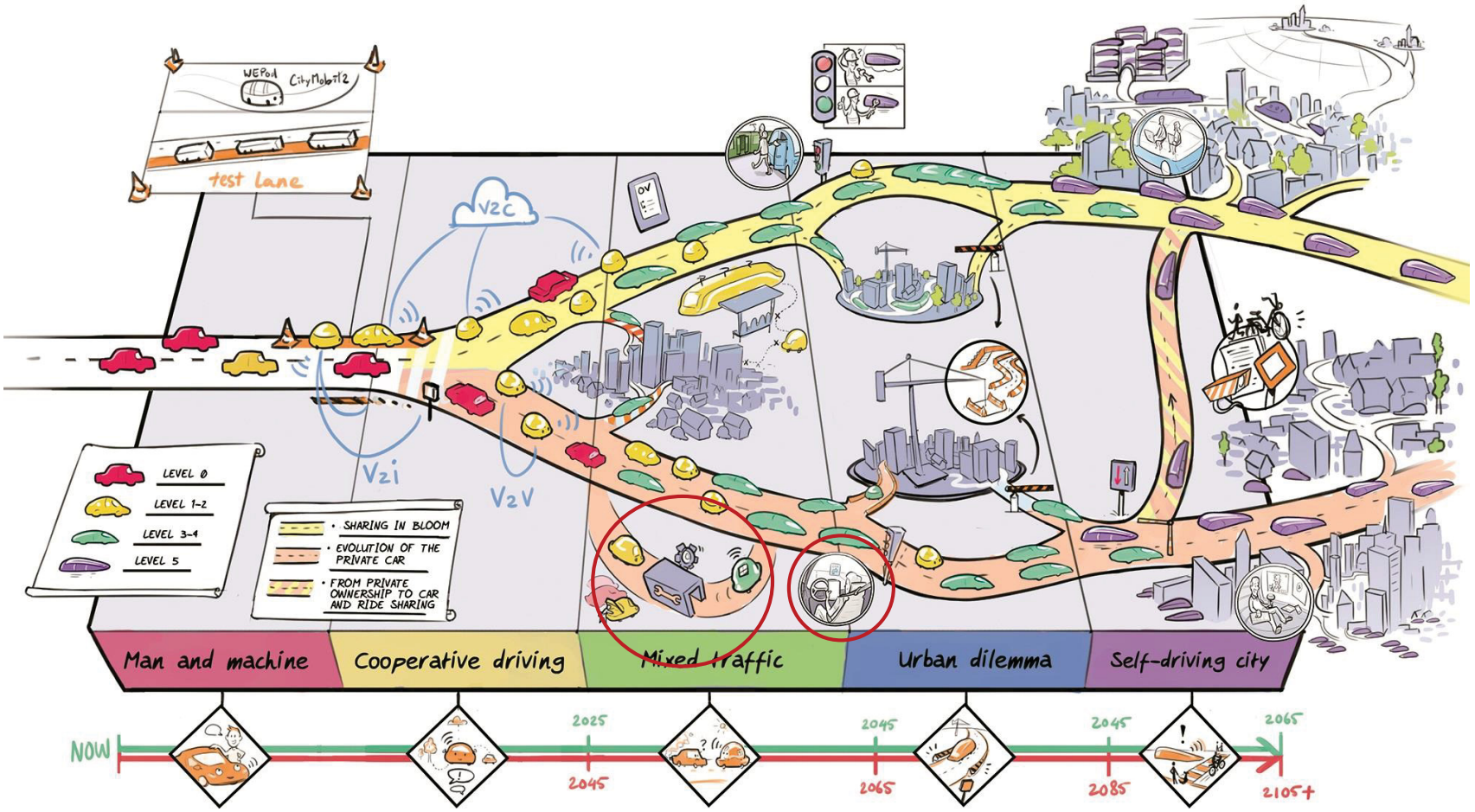
Evolving cars, transition steps, and a time line



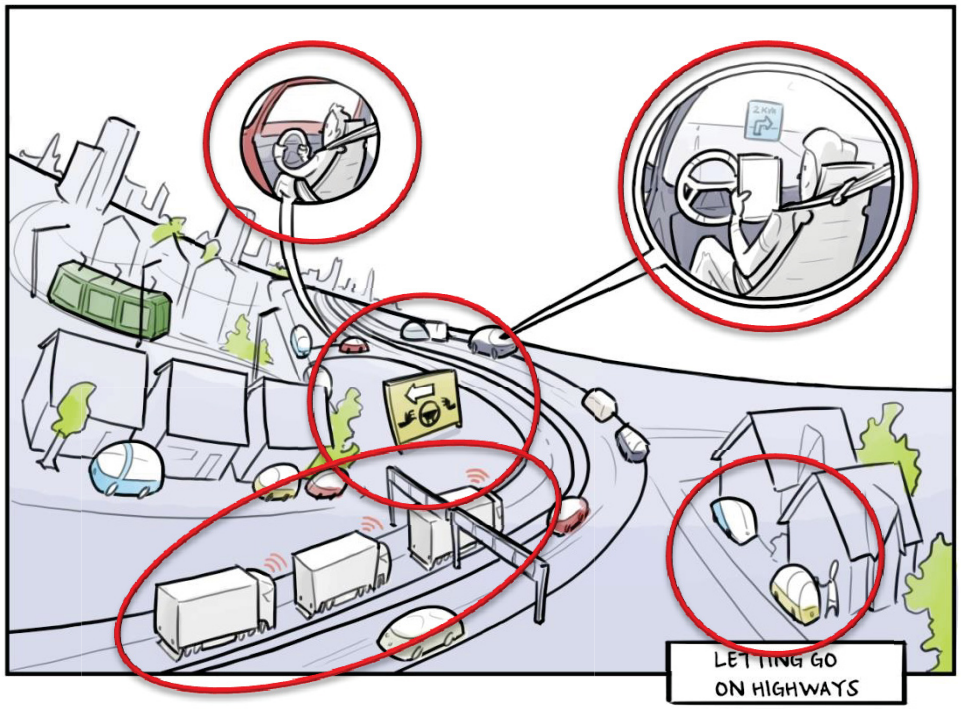
First steps: experimentation and communication



Evolution of the private car

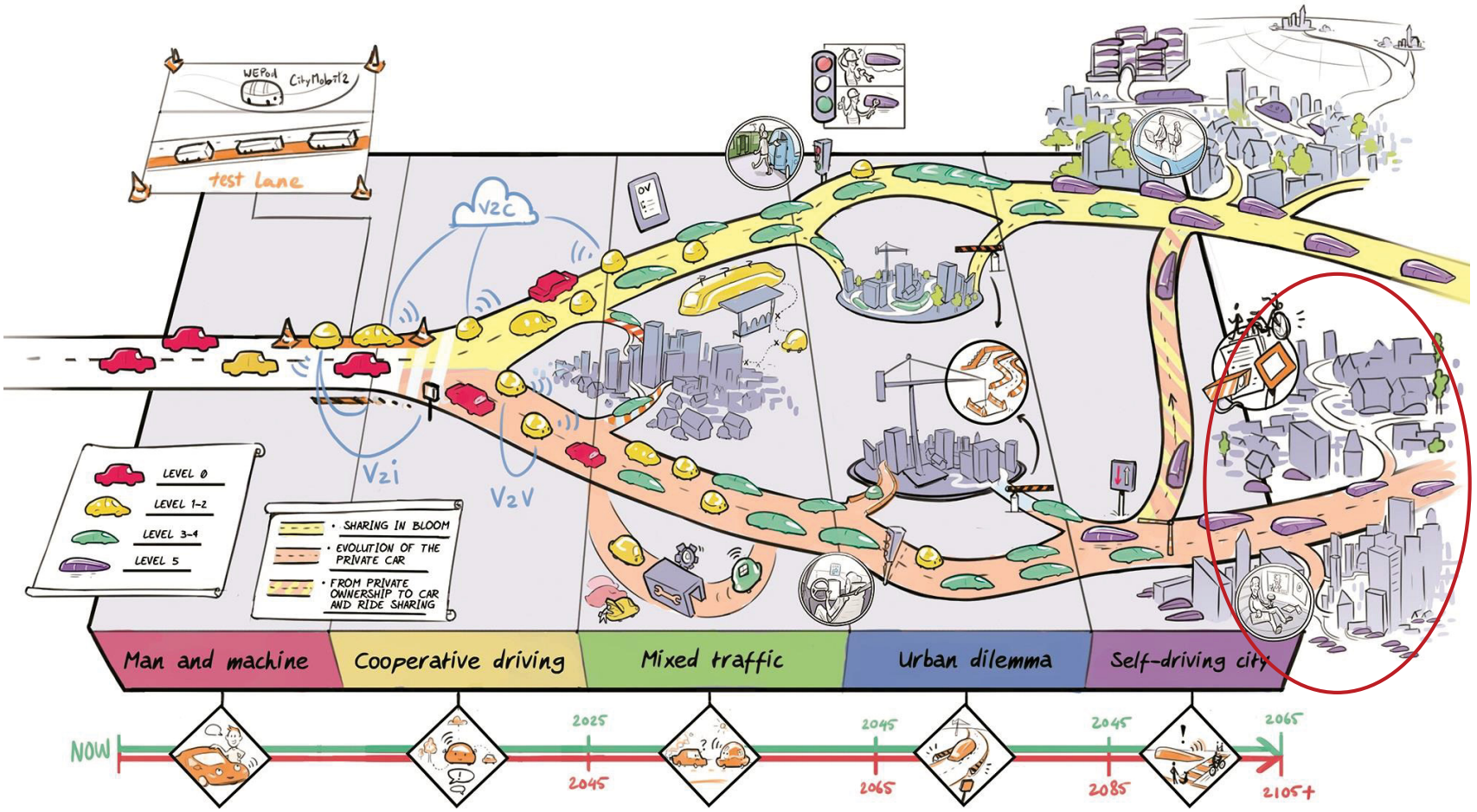


Letting go on highways

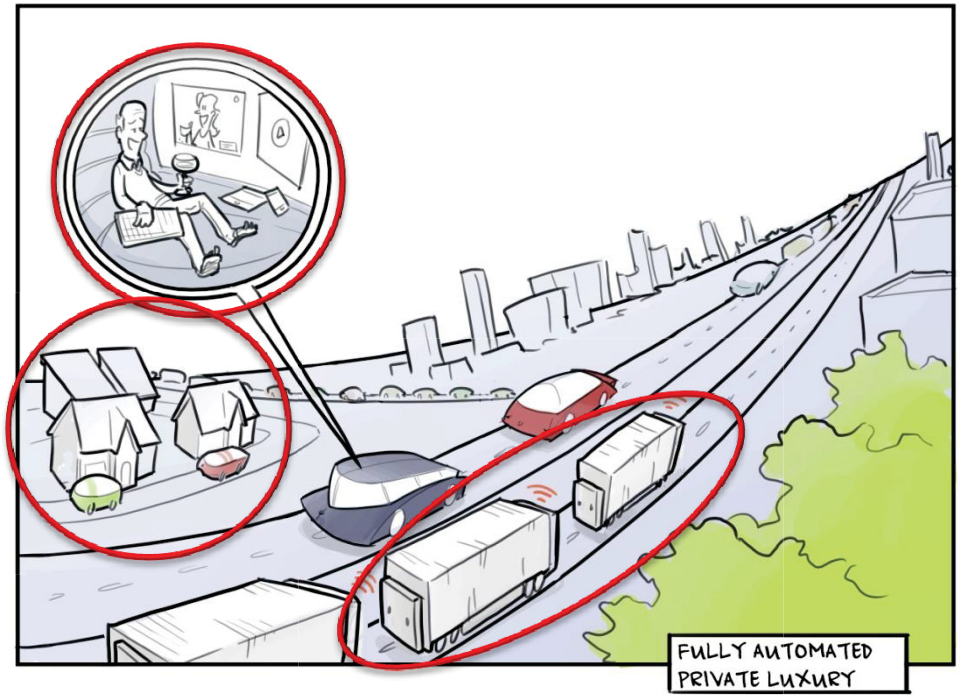


- 'No hands' on highways (level 3/4)
- 'Hands on' within the city, driver assistance systems available (level 1)
- 'Transition zone' from highway to city
- Automated parking in car parks
- Cars parked in front of the door
- Truck platoons on highways; drivers can rest

Evolution of the private car

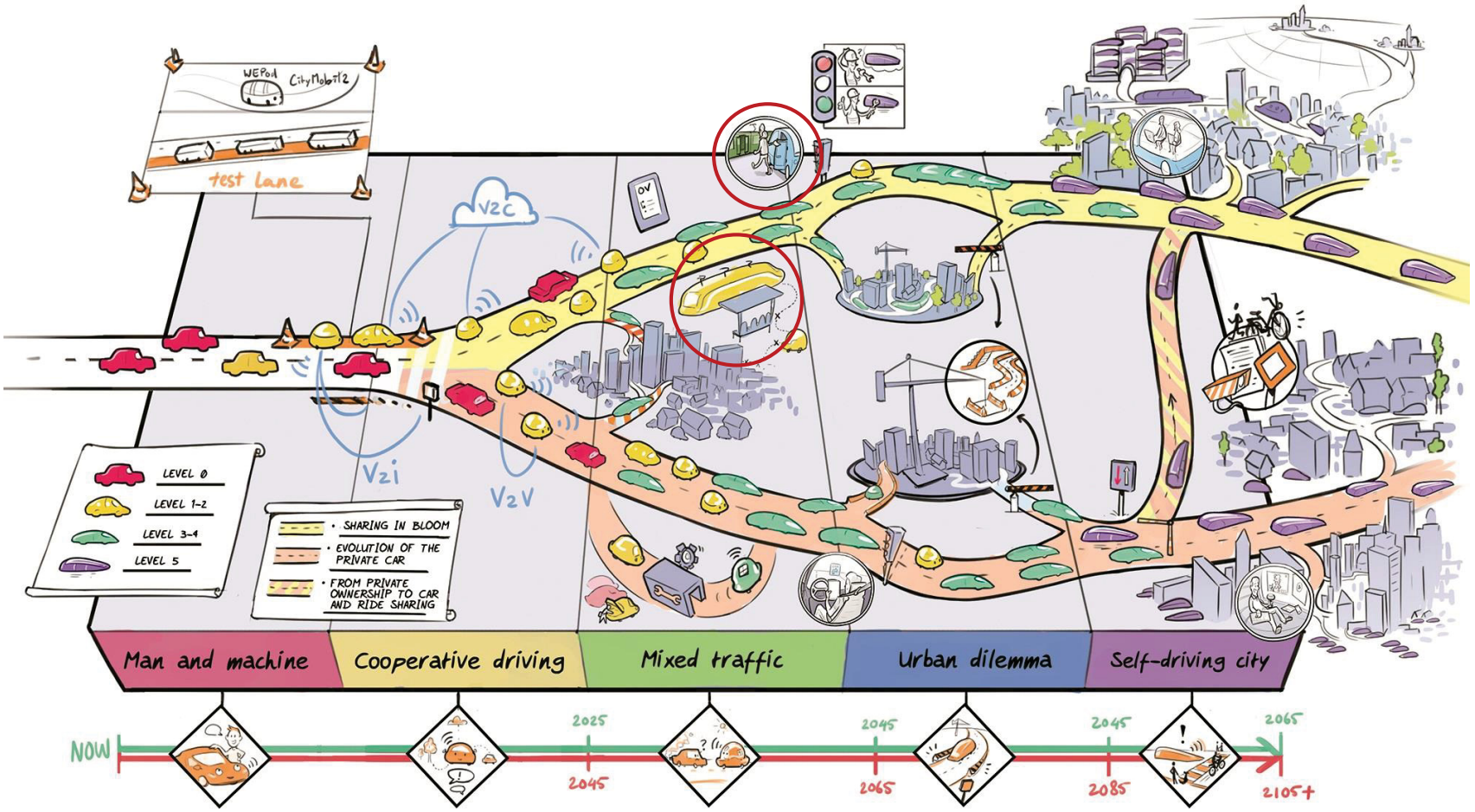


Fully automated private luxury

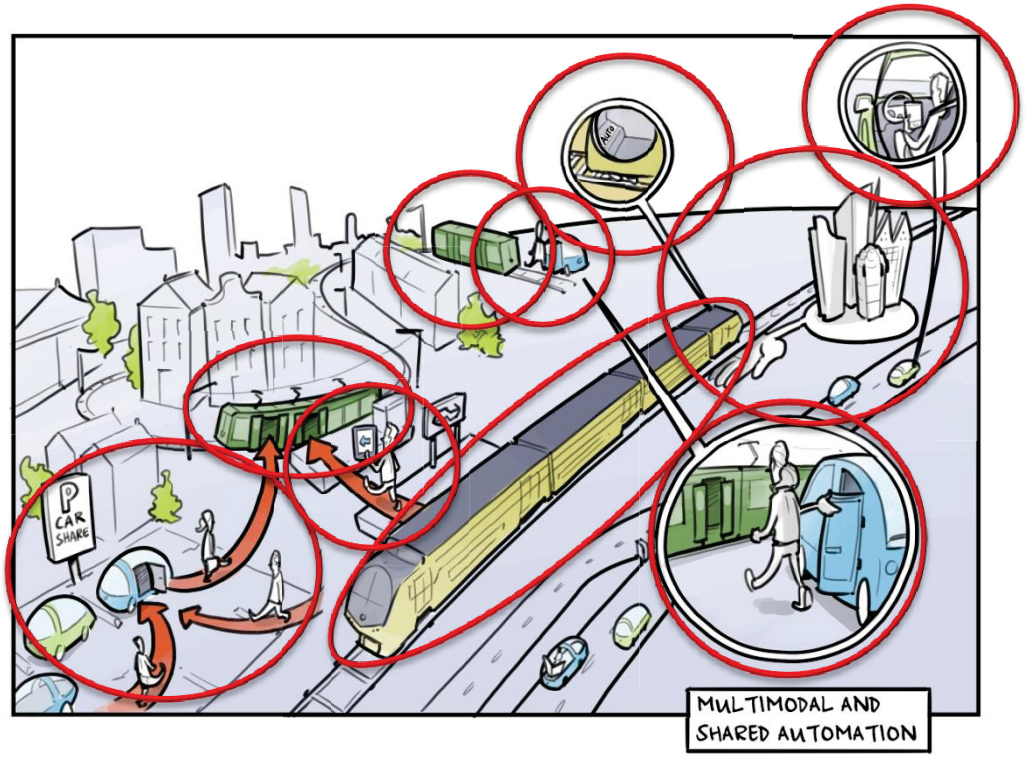


- ‘Fully connected’ cocoon, without a steering wheel
- Sharing car and rides only within household
- Most traditional public transportation abolished
- Uber-like system for people with no car
- Cars parked in front of the door
- People buy cars at car dealers
- Truck platoons on highways; no compartments for drivers

Sharing in bloom

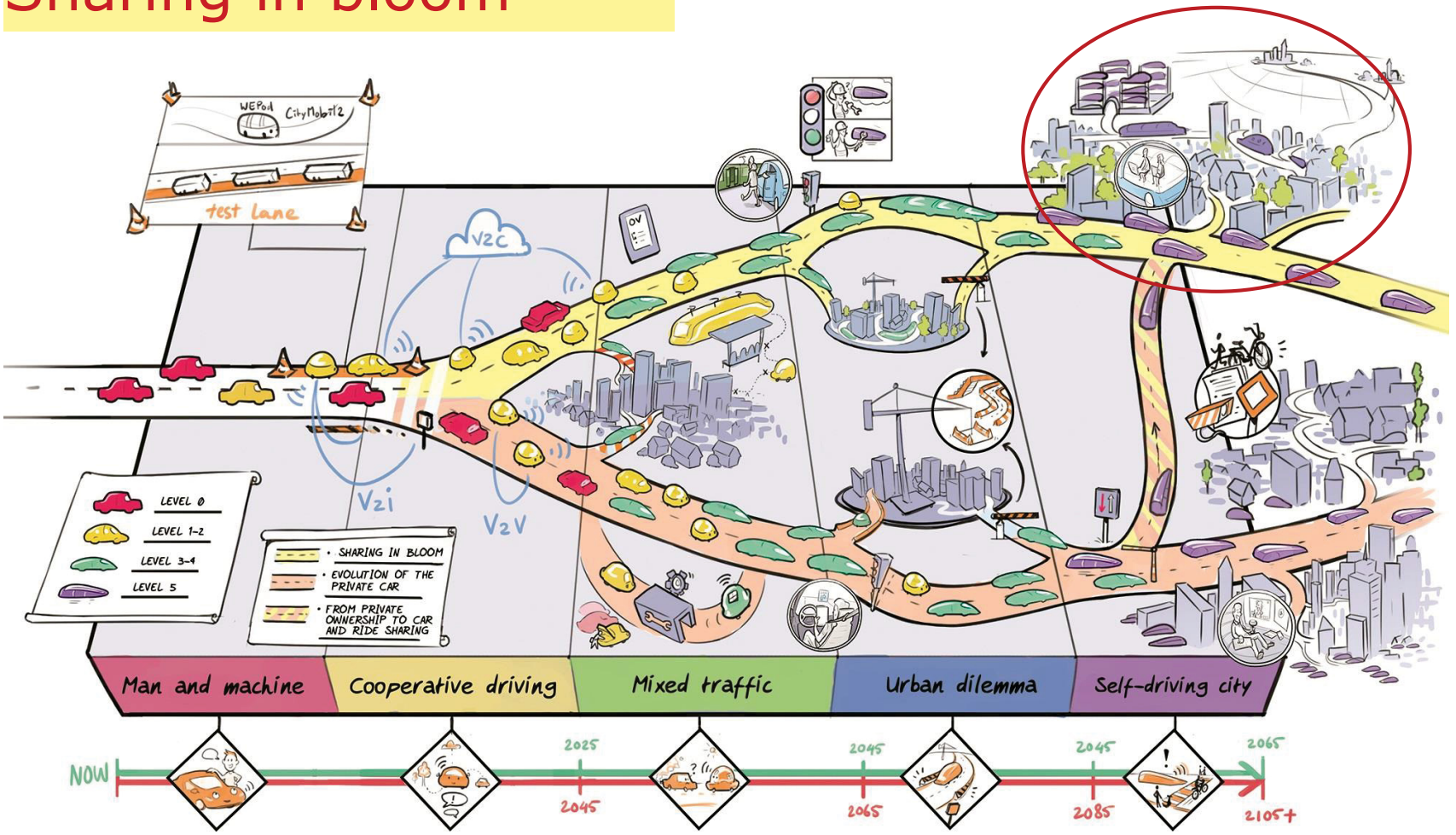


Multimodal and shared automation

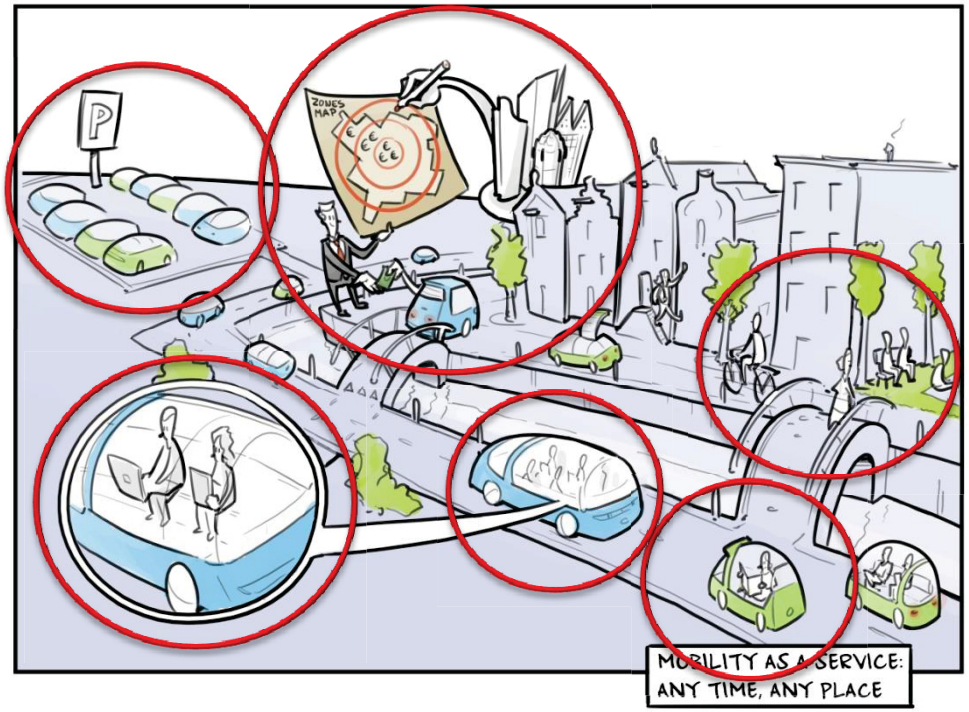


- 'No hands' on highways (level 3/4)
- High level of sharing (cars and rides)
- Public transportation popular
- Trains/trams/metros without a driver and high frequency
- Government supports large-scale public transport in the city
- Efficient multimodal trips and transfers
- Digital travel assistant arranges the journey

Sharing in bloom

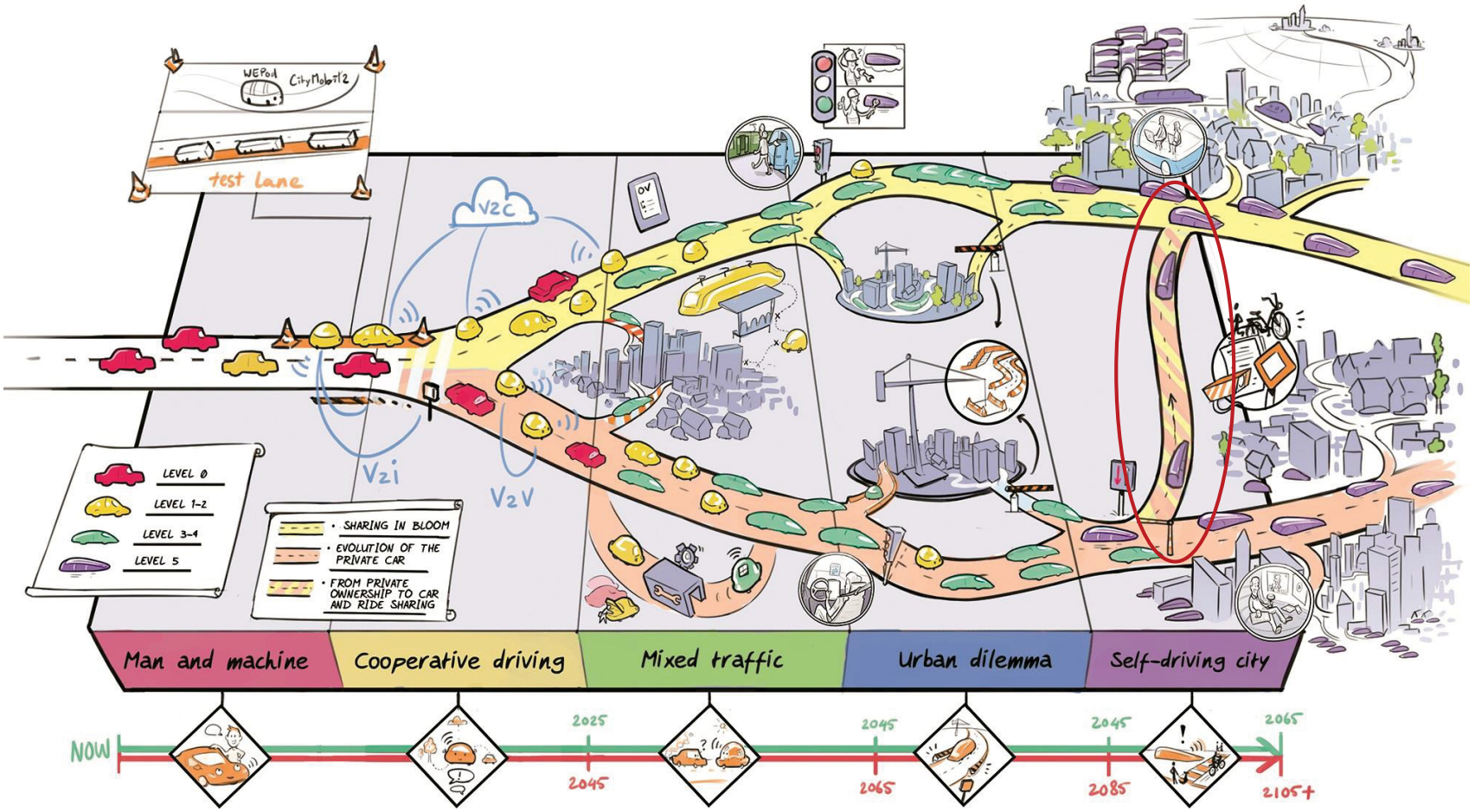


Mobility as a service: Any time, Any place



- Door to door travel by automated people movers
- Sharing flourishes: car ownership (large fleet owners) and rides
- Most traditional public transportation abolished
- Cars park themselves in parking areas on the outskirts of the city
- People opt to walk and cycle whenever possible
- Price/km within the city increases

Sharing in bloom

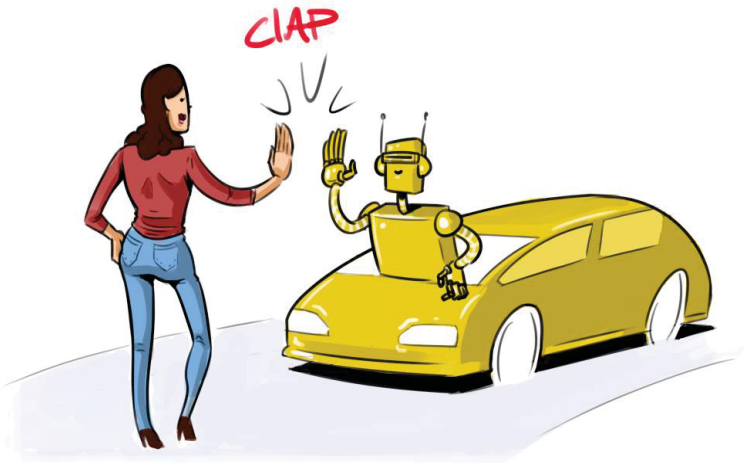


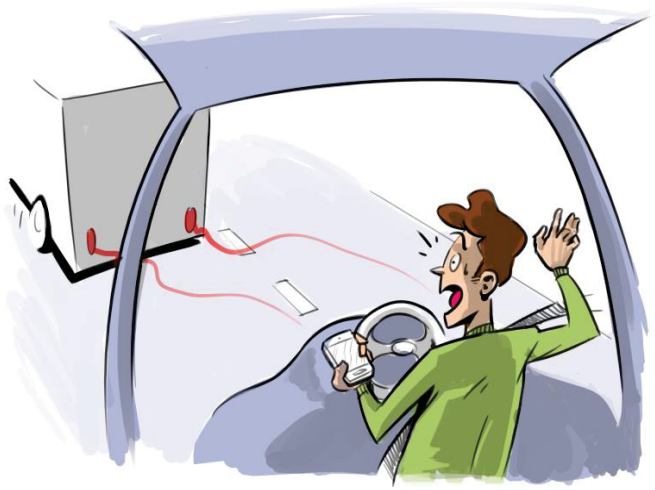
Five transition steps

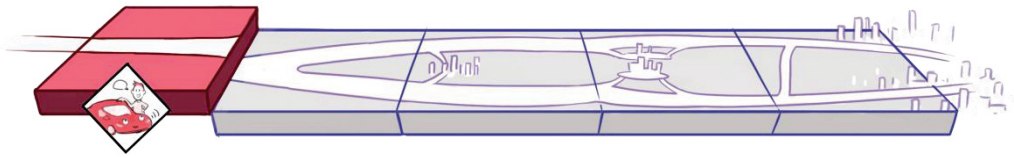
Man and machine (I 1/2)

- Best of two worlds?
  - human beings excel in complex unexpected circumstances
  - technology supports driver
  - higher traffic safety
  - improved traffic flow

- Or not?
  - driver looses attention: accidents
  - trust in technology undermined



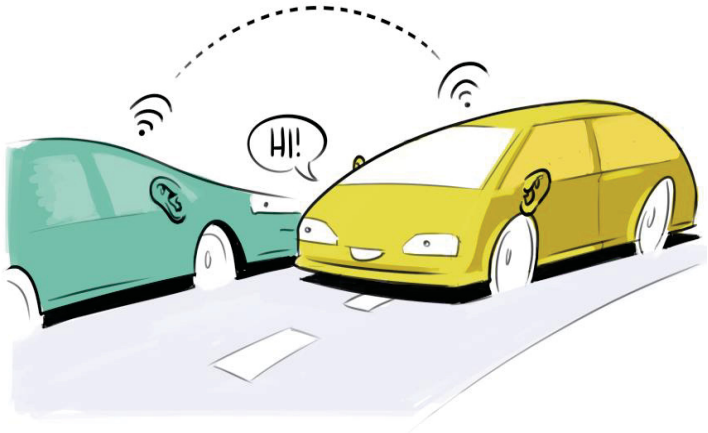


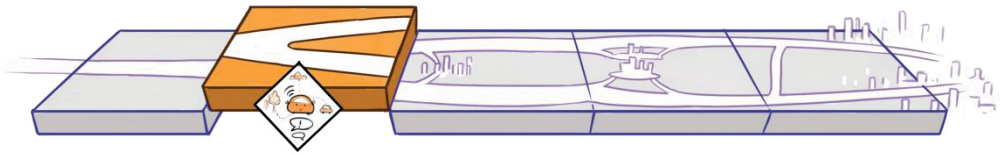


Cooperative driving (I 1/2)

- Holy grail?
  - Efficient road use
  - Higher traffic safety
  - Less congestion
  - Less CO_2

- Or bridge too far?
  - Sensor and software reliability
  - Cyber security: hacks, privacy

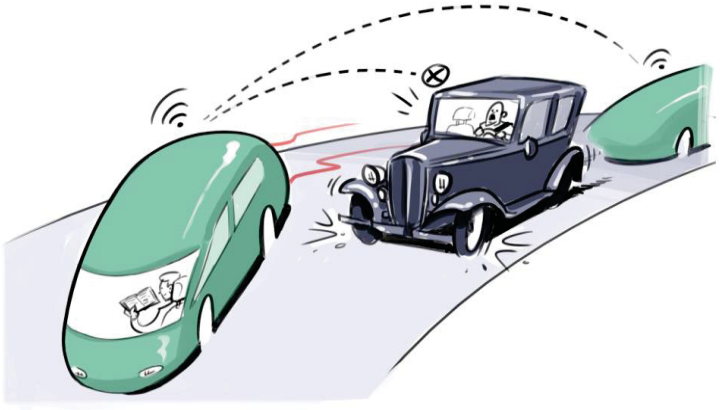




Mixed traffic (I 3/4)

- Solves itself?
  - consumers appreciate safer traffic and efficient road use
  - investments in transition zones between highway and city

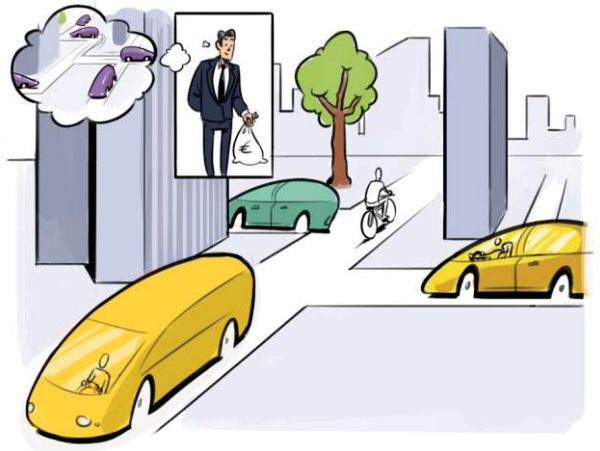
- Or showstopper?
  - consumer prefers to be in control
  - dangerous interaction

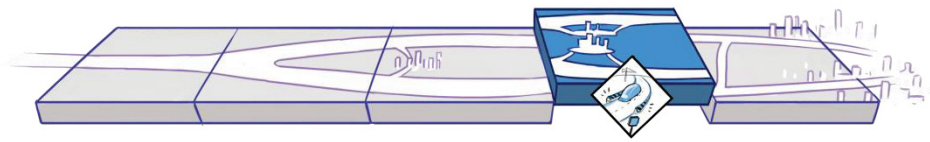


Urban dilemma (I 3/4)

- Separate modes?
  - I5 technology far away
  - Adjust city infrastructure
  - I 3/4 lanes

- Or driver in control?
  - I5 technology nearby
  - Separate modes too costly

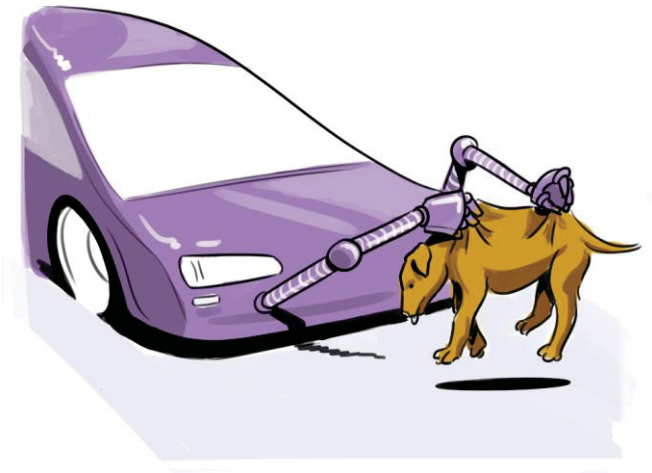


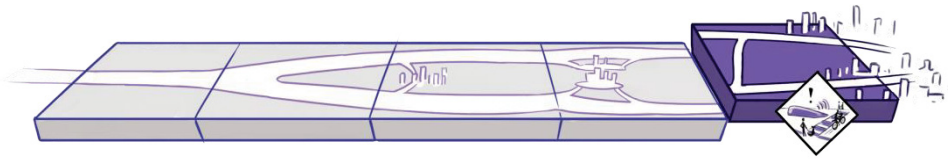


Self driving city (l 5)

- Contested space?
  - bikers and pedestrians take the road
  - car traffic comes to a standstill

- Or flexible interaction?
  - physical separation
  - technology
  - ‘pushy’ automated vehicle
  - culture





Towards automated vehicles (AV): main conclusions

- Long run: AV yield many positive effects for society
- Highways and cities filled with fully AV still far away (2060 – 2100)
  - Yet, first steps are already being taken
- Path towards sharing: major shift on short and medium term
  - Probable on long term
- Transition is crucial and determines how the future will look like
  - Implications for society differ considerably in the two paths
- Transition consists of five major steps:
  - man and machine, cooperative driving, mixed traffic, urban dilemma, self-driving city
- Transition in each step may progress smoothly or bumpy
- In each step adaptive policy is key

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