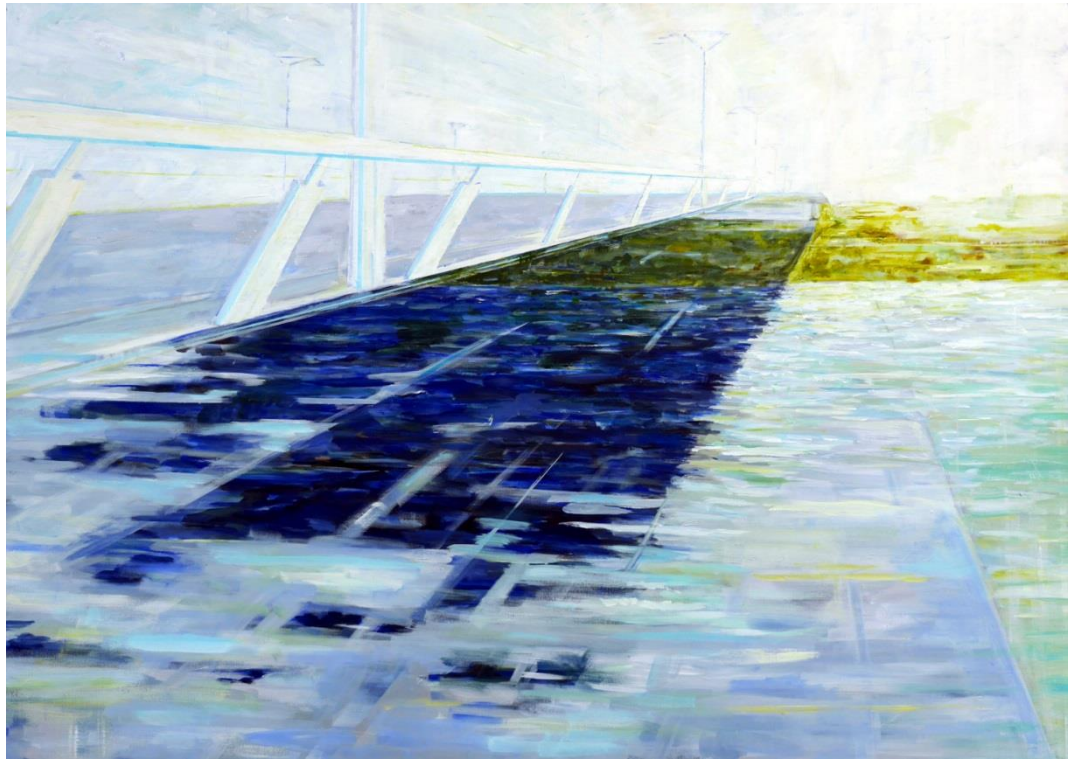
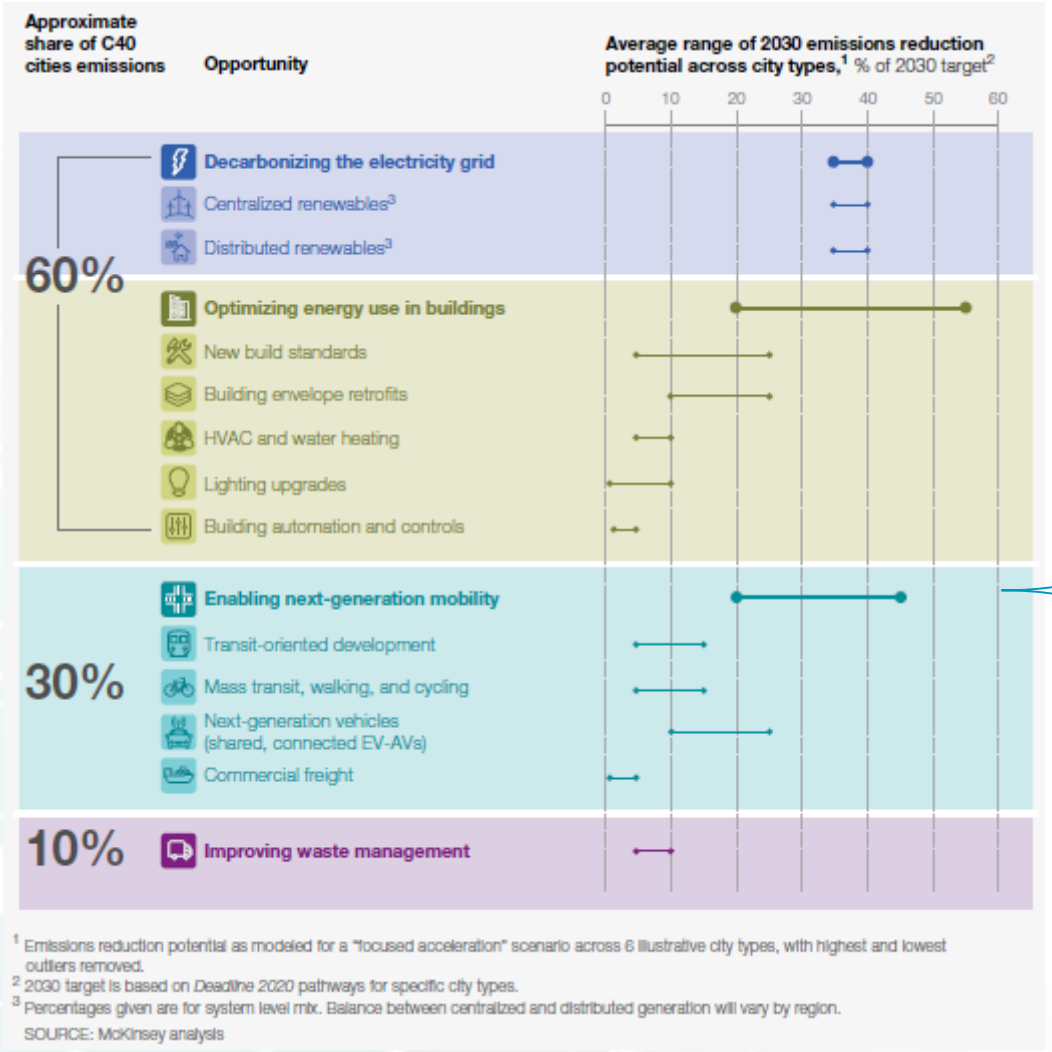
# THE NEW ROAD HAS MANY DIGITAL DIMENSIONS

Connectivity services

Digital technologies

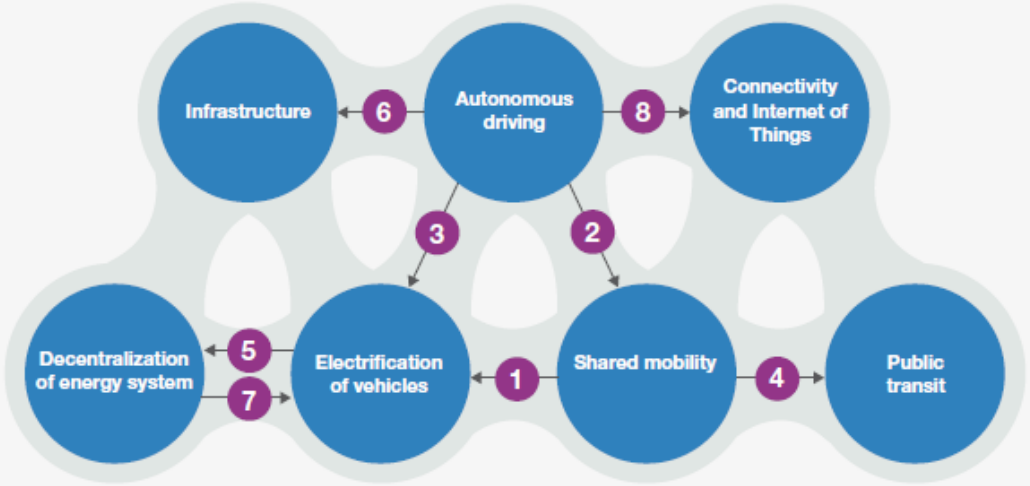


# ENABLING NEXT GENERATION MOBILITY ROAD HAS MANY DIGITAL DIMENSIONS




[1] Emissions reduction potential as modeled for a "focused acceleration" scenario across 6 illustrative city types, with highest and lowest outliers removed.
[2] 2030 target is based on *Deadline 2020* pathways for specific city types.
[3] Percentages given are for system level mix. Balance between centralized and distributed generation will vary by region.
SOURCE: McKinsey analysis

## Key trends




### Reinforcing effects

1. An update in shared mobility will accelerate electrification, as higher utilization favors the economics of electric vehicles.
2. Self-driving could merge shared mobility business models into a single proposition competitive with private car ownership and public transport.
3. Self-driving—private and shared—vehicles are likely to increase mobility consumption, in which case, electric vehicles offer lower total cost of ownership.
4. An update in shared mobility will affect public transit.
5. Electric vehicle production at scale would accelerate battery cost reductions, with multipe effects.
6. Self-driving electric vehicles will have different usage and hence requiring different requirements for charging infrastructure.
7. Increasing renewable power generation will make electric vehicles more attractive as a means to reduce the carbon intensity of the transport sector.
8. Self-driving vehicles might accelerate the uptake of IoT applications.

Source: Bloomberg New Energy Finance and Future of Mobility team analysis

# SMART CITY 3.0 ENVIRONMENT ROAD HAS MANY DIGITAL DIMENSIONS

*Wellbeing*

- work and sufficient income
- adequate and affordable housing, education, health care, and transport
- livable and healthy environment
- protection against extreme events and chronic problems
- lifelong and comprehensive education and development

*Circularity*

- circular growth based upon reuse of raw materials, sustainable energy and respect for nature
- availability of quality food, goods, and services
- disappearance of poverty and extreme wealth

*Justice*

- freedom
- democracy and self-government
- decreasing differences in income
- respectful cooperation
- sharing and where possible joint management of commodities

*Digital connectivity*

- general availability of ICT and other digital resources
- access to superfast and save Internet
- personalized ownership of data
- right to withdrawn data and of 'decoupling'
- alignment of technology and data with human interests

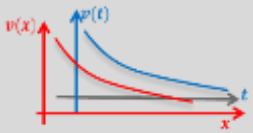
# CONNECTIVITY SERVICES AND DIGITAL TECHNOLOGIES MARKET TRENDS



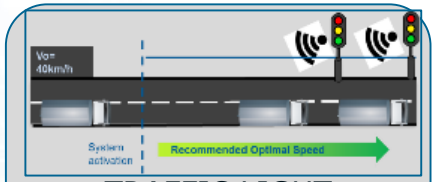
# AVL MOTIVATION

- Powertrain Designs have moved closer to the edge of optimum. Autonomous vehicle and mobility platforms to take momentum.
- Replacement of combustion engine by electrical powertrain don’t solve the mobility challenge of highly dense populated cities.
- Further reduction of CO2 and other emissions can only be achieved by connected operations and active balance of all traffic participants.
- Mobility quality needs to increase by clever combination of vehicles and sharing models. Digitalization can increase the efficiency but not replace the mobility concept or overcome physical limitations.
- Next generation mobility concept to be an open platform with secure and trusted data.

# FURTHER REDUCTION OF CO2 EMISSIONS BY CONNECTED OPERATIONS



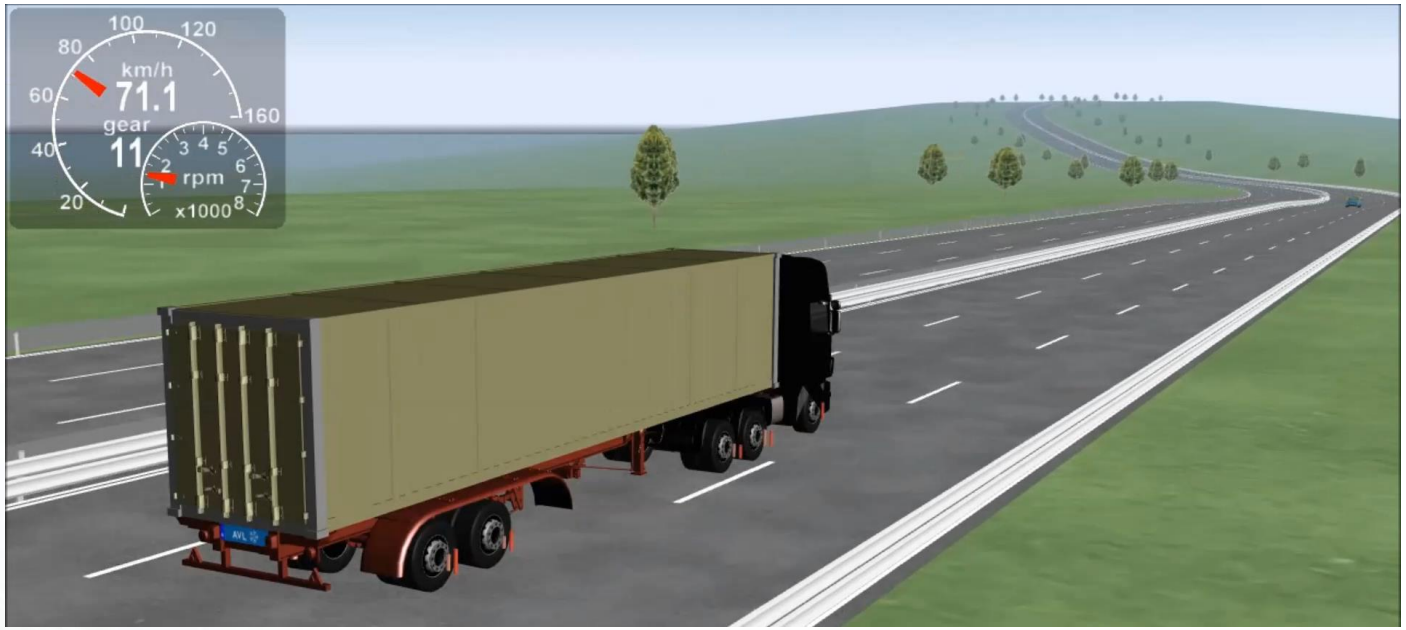
COASTING ASSISTENT




TRAFFIC LIGHT ASSISTENT

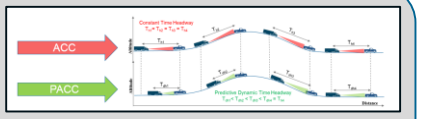
ECO ROUTING

ADAS/AD HMI

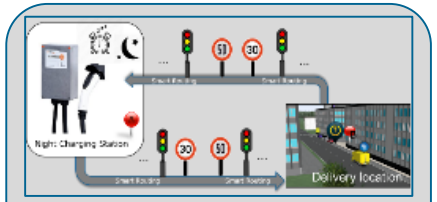



**PREDICTIVE FEATURES**

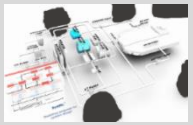
**SAVES AROUND 6-8% EMISSIONS**



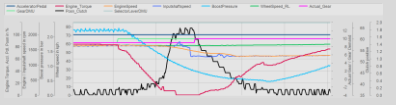

PREDICTIVE ADAPTIVE CRUISE CONTROL




PREDICTIVE CHARGING



PREDICTIVE THERMAL MANAGEMENT



PREDICTIVE SHIFTING



Sources: www, AVL

# REAL TIME CO2 AND NOX REDUCTION TRAFFIC MANAGEMENT

Tx/Rx Transportation

Tx/Rx Infrastructure

AVL

Sign sequence

APP Display

High NOx

Low NOx

Too Slow

Target Address and target time

Start time/Arrival time and route for most efficient driving

Nox Zone

Acceleration, Max Speed, Deceleration Set points

Vehicle route and real speed profile

Vehicle route and target speed profile

Nox Zone

**PROVIDE ROAD USERS CONTINUOUS REAL TIME DATA**

**PUBLIC TRANSPORTATION PRIORITY**

Virtual City Simulation or measurement Real Time

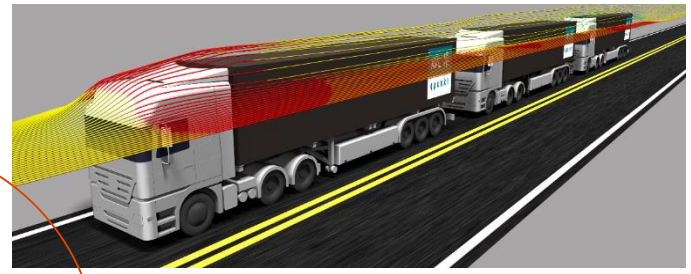
NOx Models traffic participants

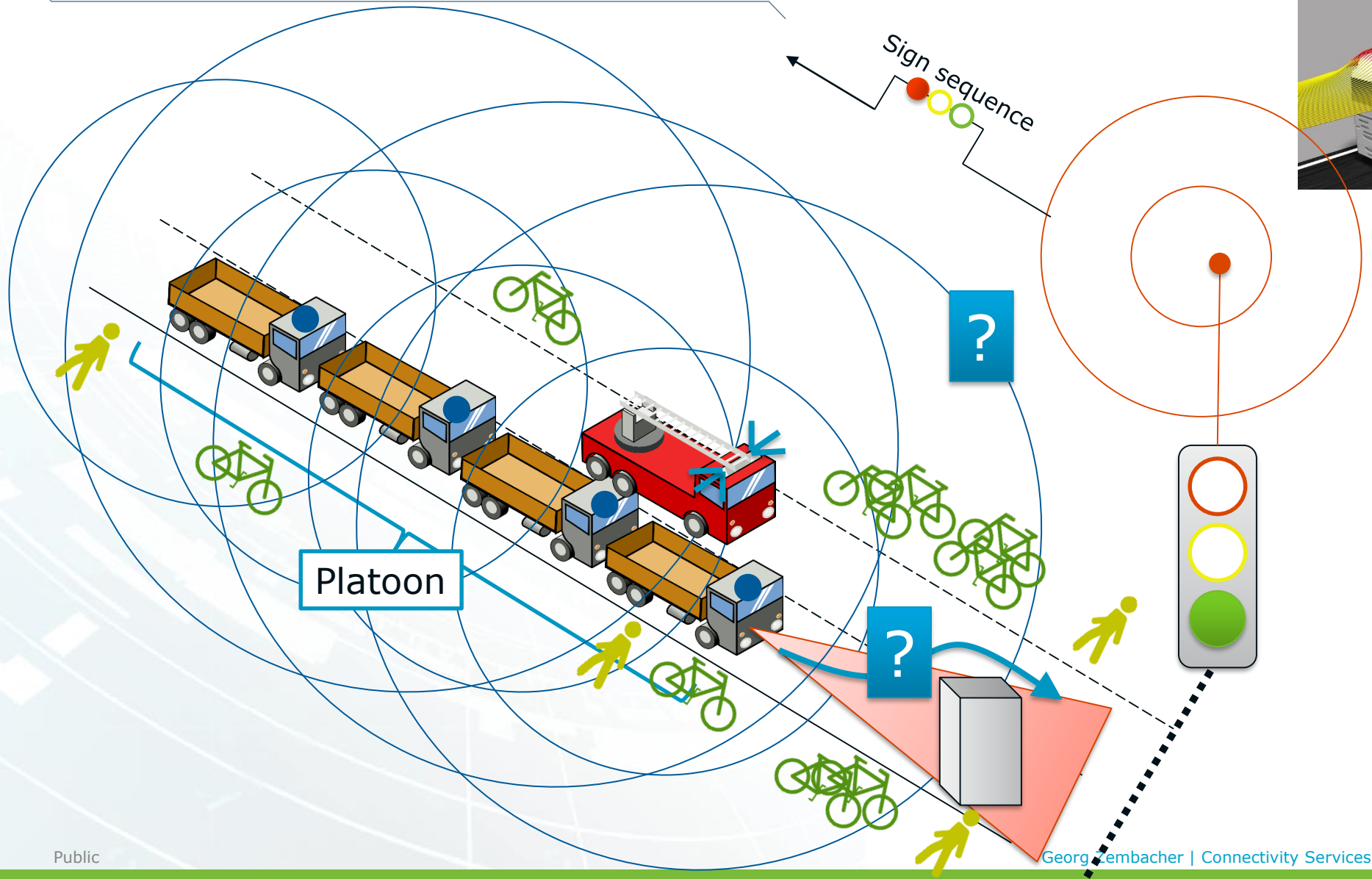
**CO2 + NOX REDUCTION TRAFFIC MANAGEMENT**

# COOPERATIVE DRIVING
# PLATOON MANAGEMENT

Tx/Rx Transportation

Tx/Rx Infrastructure



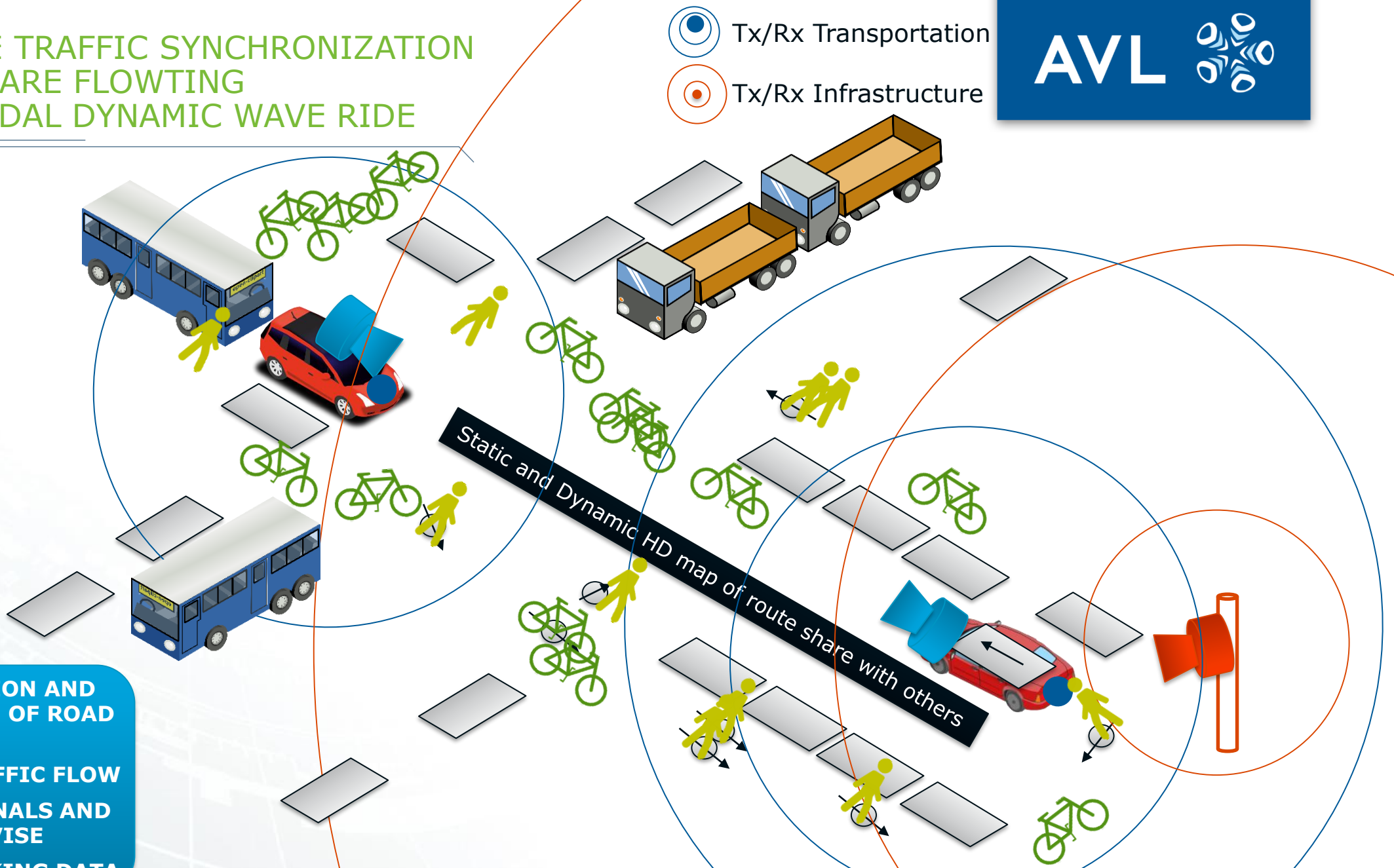



**TRAFFIC SAFETY INCREASE**

**ROAD SURFACE DURABILITY**

**TALKING TRAFFIC WITH PRIORITY DEFINITION, GREEN FLOW AND REAL TIME WARNING**

# REAL TIME TRAFFIC SYNCHRONIZATION
# BORDERS ARE FLOWTING
# MULTY MODAL DYNAMIC WAVE RIDE




**EARLY DETECTION AND CONSIDERATION OF ROAD USERS**

**OPTIMISTIC TRAFFIC FLOW**

**IN VEHICLE SIGNALS AND SPEED ADVISE**

**IN VEHICLE PARKING DATA**

# CITY MOBILITY QUALITY INCREASE SHARING MOBILITY

Tx/Rx Transportation

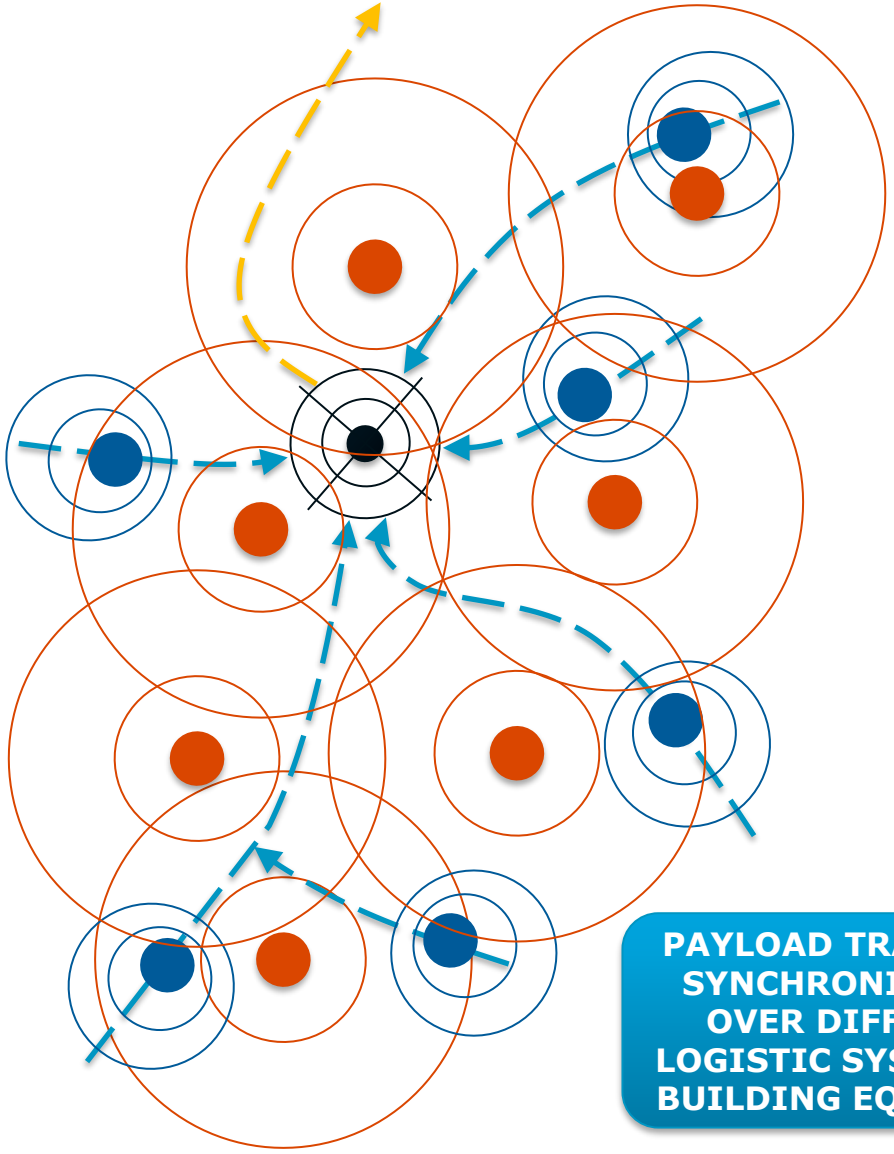
Tx/Rx Infrastructure


**COMBINATION OF DIFFERENT TRANSPORTATIONS**

# CITY MOBILITY QUALITY INCREASE
# PAYLOAD TRANSPORT SYNCHRONIZATION

Tx/Rx Transportation

Tx/Rx Infrastructure



**PAYLOAD TRANSPORT SYNCHRONIZATION OVER DIFFERENT LOGISTIC SYSTEMS OR BUILDING EQUIPMENT**


www.avl.com