5G and the Automotive Transformation

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Socioeconomical drivers

— Road safety and transportation efficiency are huge social, economical and environmental issues for society

— 25000 lost lives/year in EU, especially younger drivers and older pedestrians

— European transportation sector emissions decreasing slower than other sectors
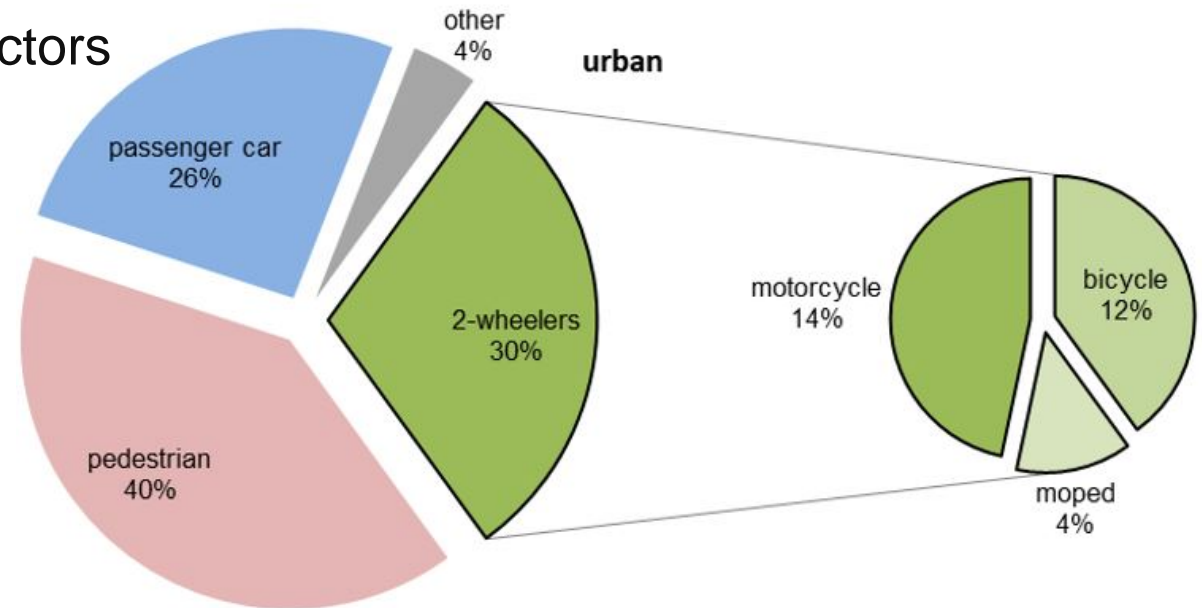
Percentage of road fatalities on urban roads by means of transport in 2017

Socioeconomical drivers — trends

Figure 2.3: EU road fatalities and targets, 2001–2020 [Source: EU Community Road Accident Database,[11] 2017]
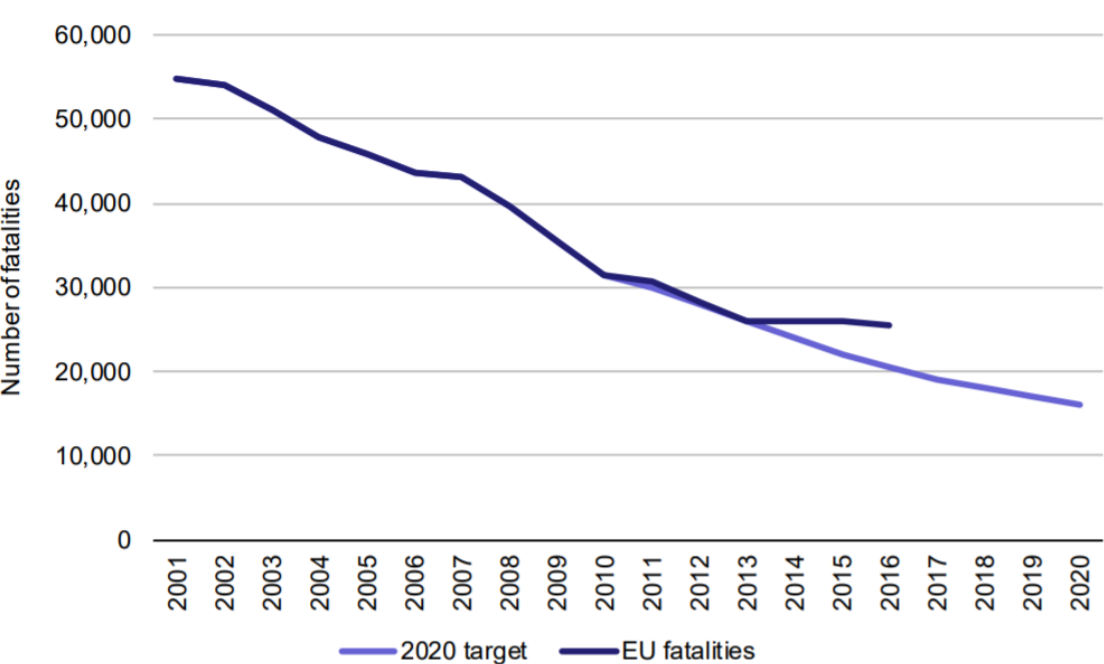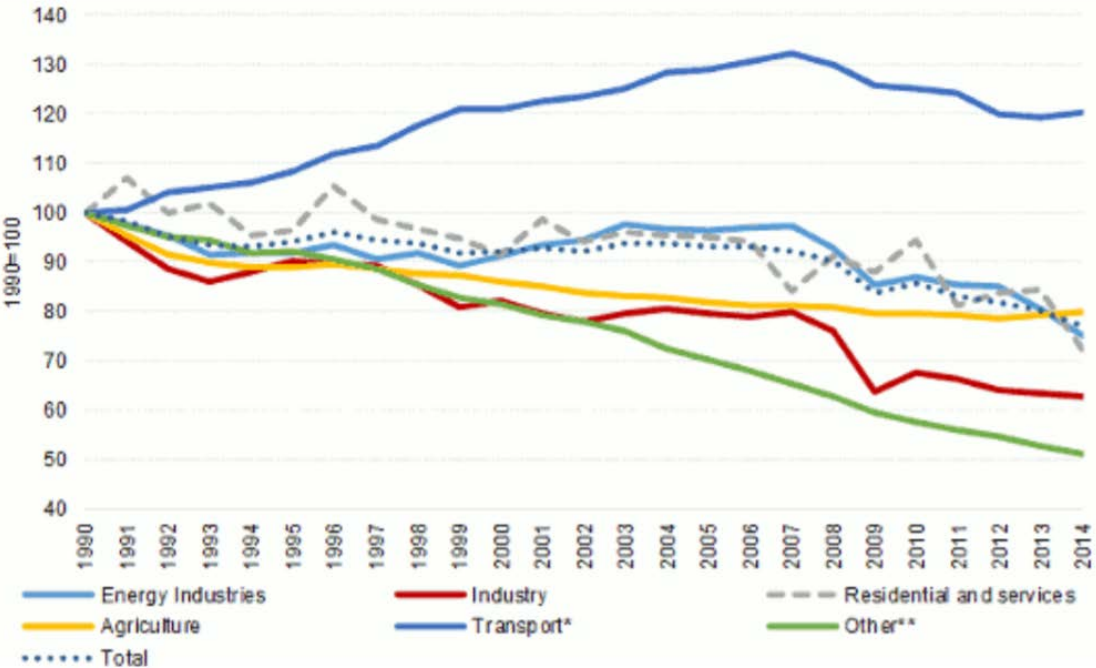

Figure 2.2: Evolution of CO_2 emissions (1990=100) [Source: European Commission, 2017]

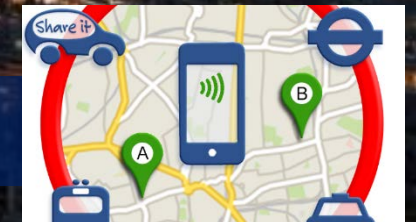# Trends in Automotive and Transport
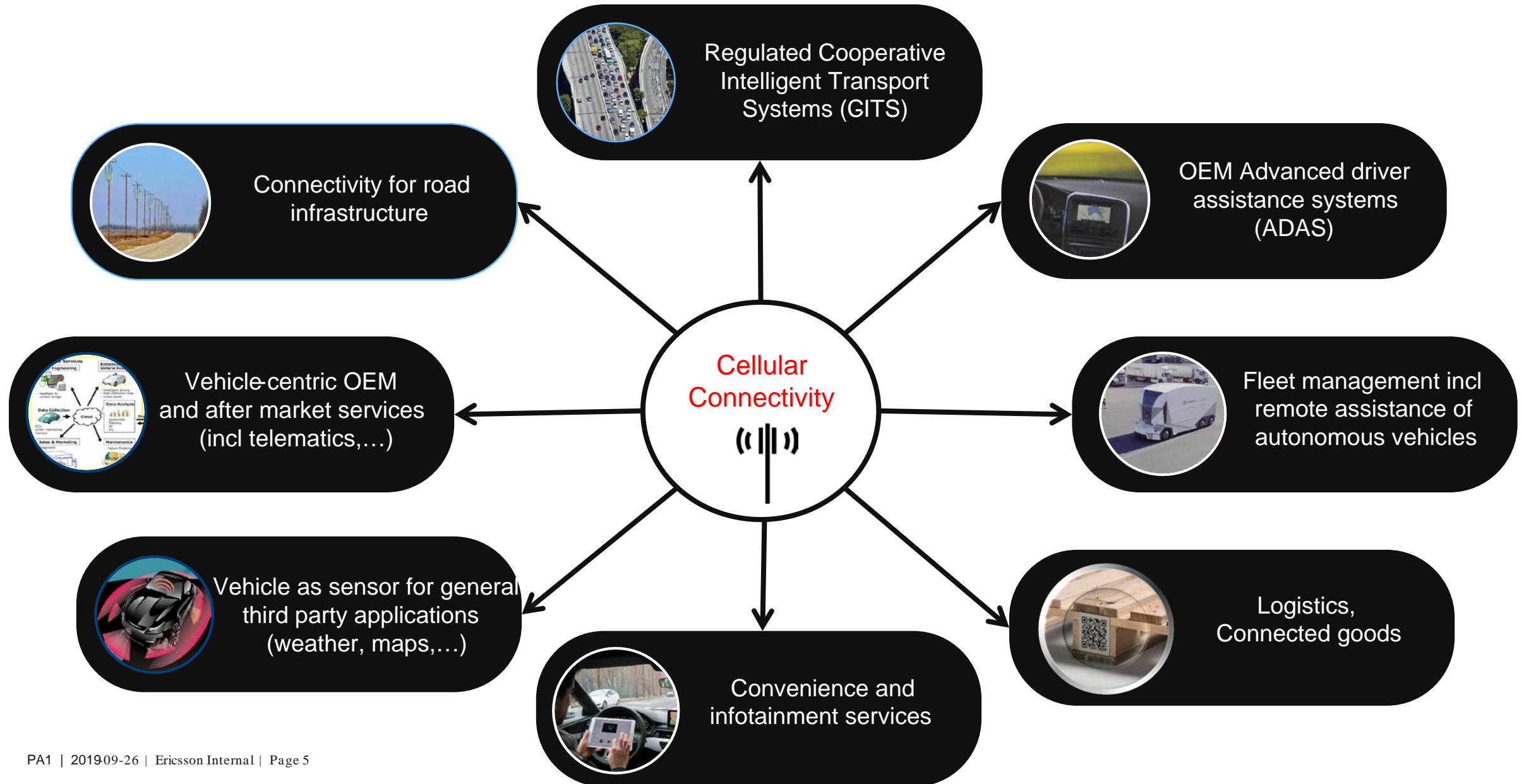
Connected

Electrified

Automated

Shared

Mobility as a service

Cellular connectivity along roads as a service enable

Regulated Cooperative Intelligent Transport Systems (GITS)

OEM Advanced driver assistance systems (ADAS)

Connectivity for road infrastructure

Cellular Connectivity

Vehicle-centric OEM and after market services (incl telematics,...)

Fleet management incl remote assistance of autonomous vehicles

Vehicle as sensor for general third party applications (weather, maps,...)

Convenience and infotainment services
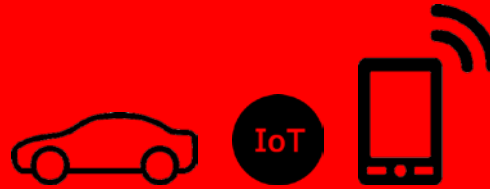
Logistics, Connected goods

The 5G connected vehicle enablers

New Radio and Core

Ecosystem Scale

Slicing and Networks Federation

Cloud Distribution and Network Virtualization
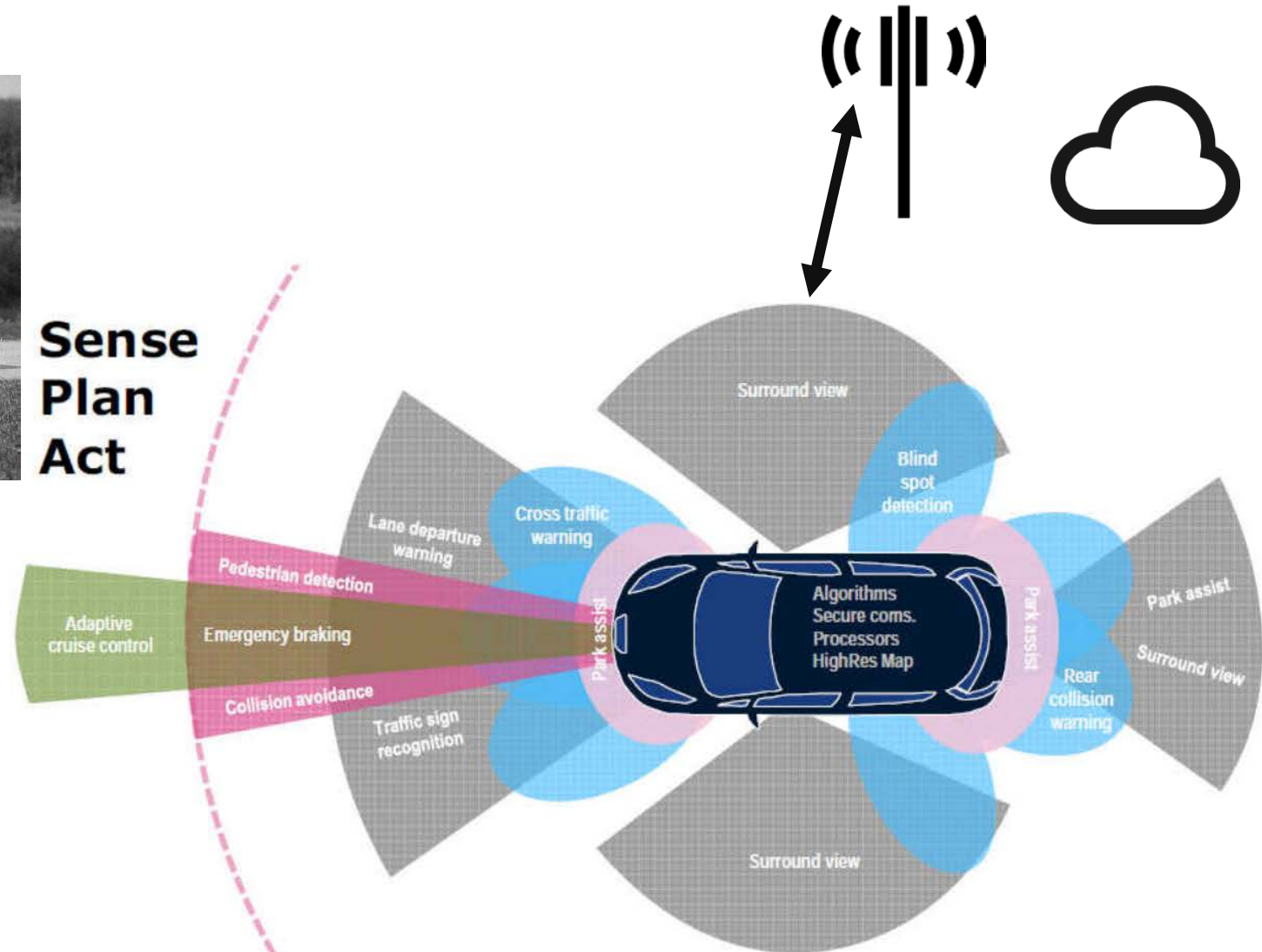
Ad-hoc and cellular complementary access

Security

"Vehicle" redefined

Sense
Plan
Act

Long-range radar | LIDAR (laser scan) | Camera | Short/medium-range radar | Ultrasound

Source: OECD/ITF

The connected transport ecosystem

Backend

IoT

Parking

Edge Cloud

4G/5G

Traffic
lights,
roadside
infrastructure

Vulnerable
road
users

IoT

V2V

V2V

Local sensors

Local sensors
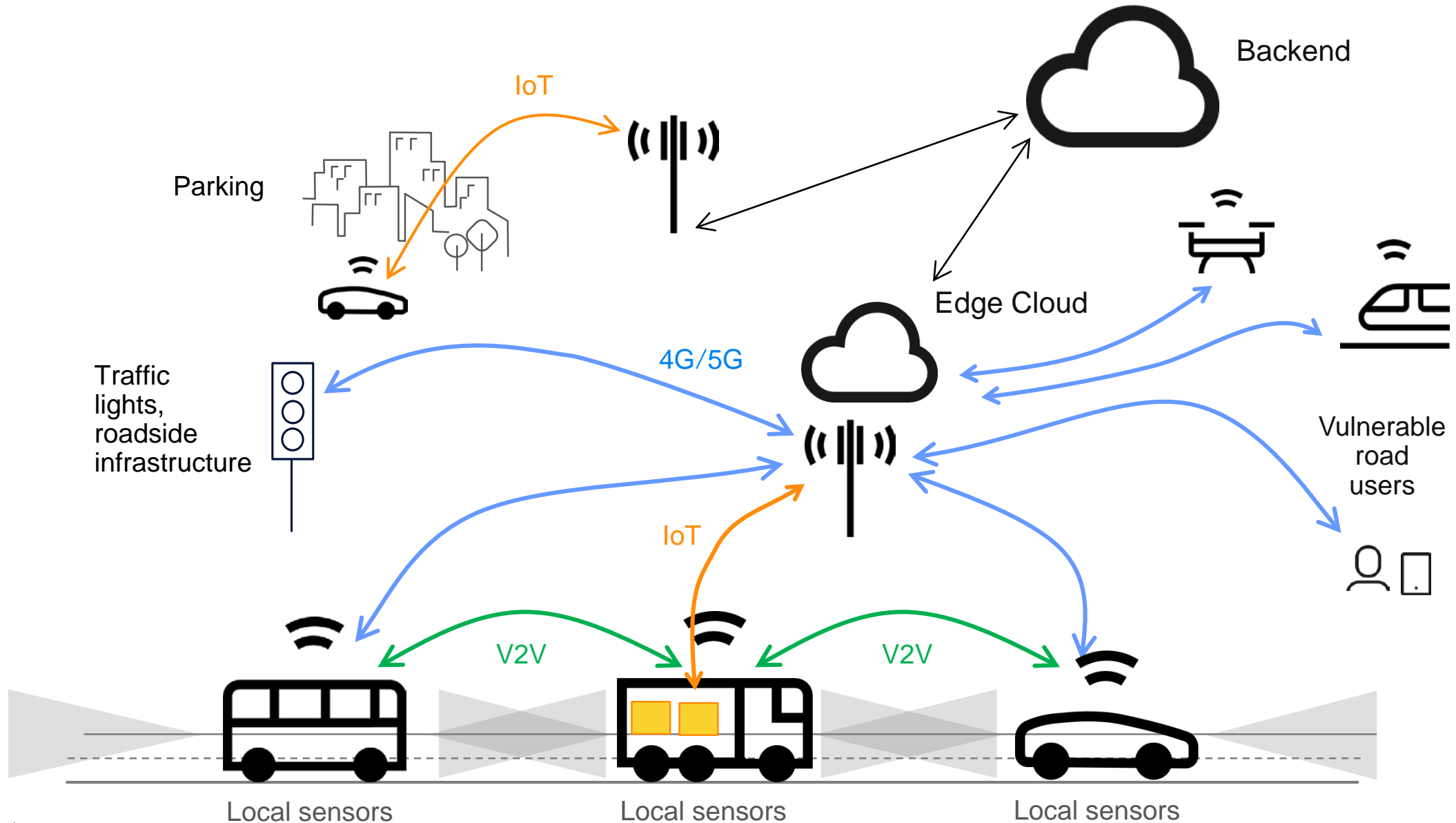
Local sensors

Autonomous Driving Evolution
From independent vehicles to a truly cooperative ecosystem

— The first autonomous vehicles rely on-board sensors and local computation
  — Expensive approach with limitations in operative domain, scalability and performance

— In the future, a paradigm shift is needed:
  — Remote supervision, central coordination
    — → Improved safety, performance and comfort
  — Vehicles as cooperative sensors
    — → Machine Learning and continuous improvements
  — Integration of pedestrians and road infrastructure
    → urban AD, multi-mode Mobility aaS
  — Progressive virtualization of processing (from vehicle to "cloud")
    → cost reduction, scalability, extended life-cycle

Autonomous Driving and cellular communication: a symbiotic evolution

AD implementation →

— **Phase 1:**
  — Communication complements on-board sensors
  — Non-latency-critical computations are offloaded to the cloud
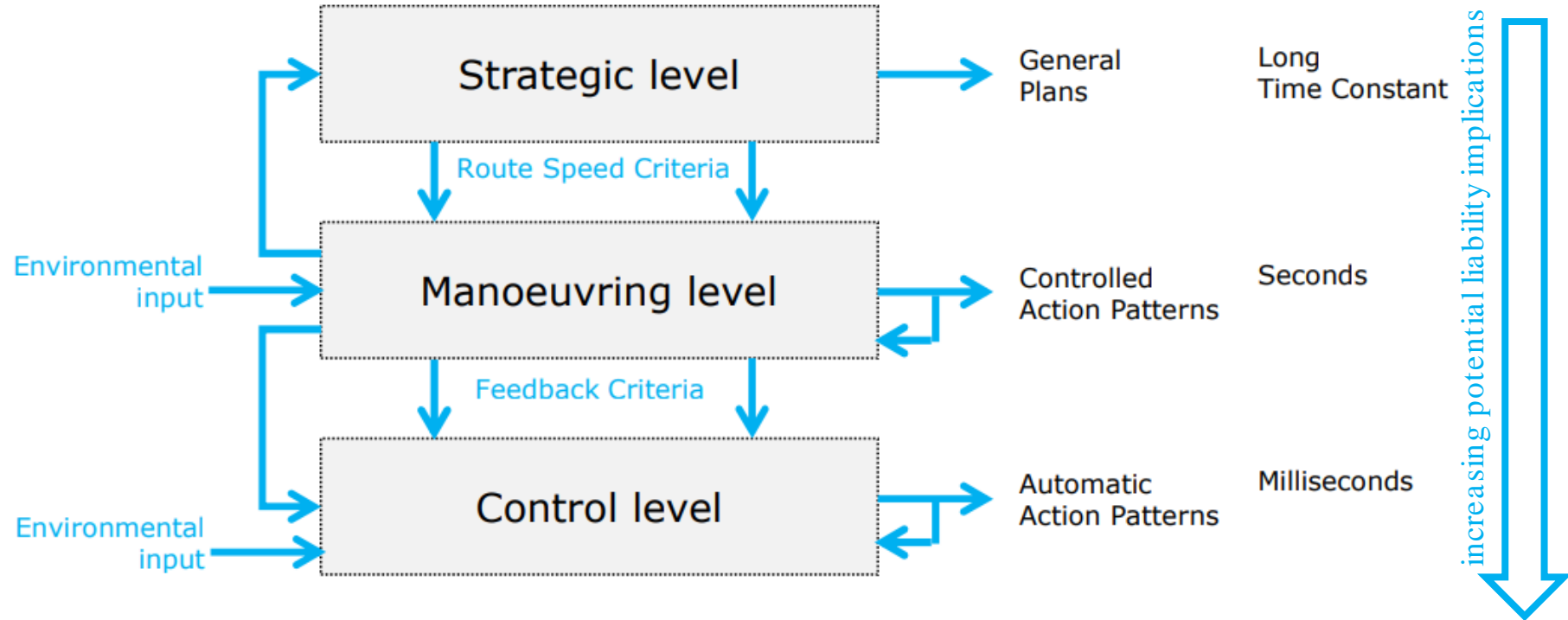 — Network-aided positioning

— **Phase 2:**
  — Cloud-augmented sensor and intentions sharing, processing, validation, including VRUs
  — Cloud supervision of AD and remote takeover in case of emergency

— **Phase 3:**
  — Some advanced AD functionalities are fully virtualized and rely on cloud-based processing

Network capabilities →

AD driving and communication roles

— Currently, communication contributes to the strategic level (e.g., route planning)
— The **manouvering** level is a near-future growth area for communication
— Using communications for the **control** level on open roads is an explorative area with important challenges

The role of Artificial Intelligence

— (Semi)-autonomous vehicles are one of the first massively deployed systems where consumers will directly interact with advanced AI

— Human-Machine-Interface:
  — New interaction paradigms
  — Create trust before progressively delegating control

— Data availability:
  — Differentiating asset for large fleets

— Long vehicles life cycle:
  — Increasingly diverse legacy to deal with

— New philosophical and ethical dilemmas created by AI

— Programmable ethics and conflict of interest
  — Is ethical AI possible at all?

A glimpse into the future
Last week, in Torino, Italy

— 5G-based ADAS with cyber-tires and Augmented Reality

— Pedestrian protection with off-the-shelf 5G smartphones

— Eye-tracking triggered, cloud-based real-time information

— Event-based augmented video feed to Road Authorities

A futuristic proof-of-concept running on a commercial 5G network!

Some technical challenges and opportunities

Low/medium frequency spectrum availability

— New higher frequency bands?
— Problem of "legacy" devices, especially in unlicensed spectrum
— Increased (radio) efficiency

Deterministic network performance

— Combination of radio enhancements and AI-based prediction

Deployment cost

— New topologies
— New types of network nodes, including flying ones

Liability implications

— Regulatory framework revision
— Improved real-time performance monitoring and secure logging of network performance

Key take aways

— The Automotive sector is in the middle of a deep technology-driven transformation

— Connectivity and AI play crucial roles

— The technical challenge for communication is to evolve from "informational" to safety-critical behaviour "control"

— Innovation will first be deployed in closed areas and later spread to open roads

— Connected vehicles penetration will impose new technical research challenges in the evolution of 5G and beyond