# Introduction to Intelligent Transportation Systems

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# Forecasting 2020

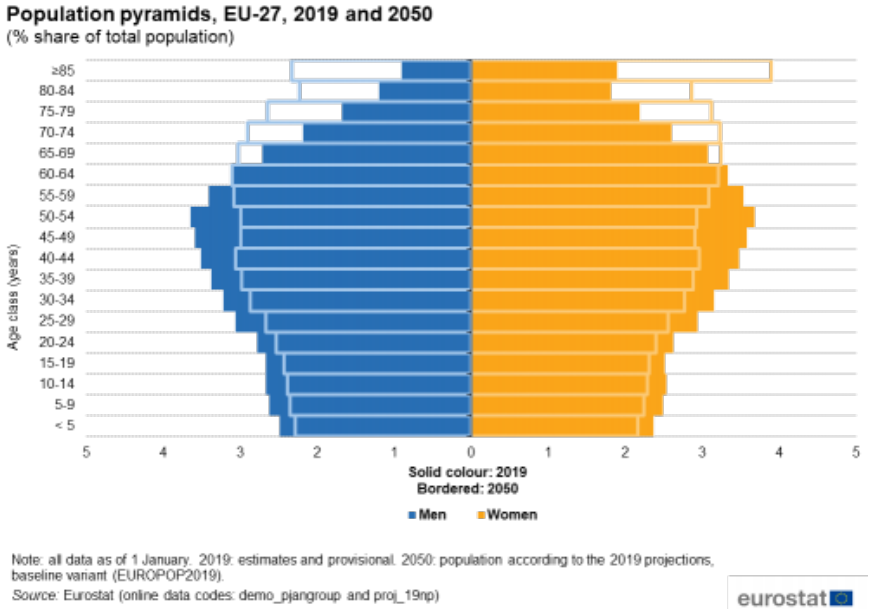
by Prof Jorgen Randers

***2052*: A Global Forecast for the Next Forty Years**

- More than 80% of population will live in urban areas.
- The CO2 emmission will increase by 33%.

# *2052*: A Global Forecast for the Next Forty Years

- The number of cars in traffic will increase 20%.
  - Saturation of the transportation infrastructures due to the growing number of vehicles over the last five decades.
- More elderly people in the road
  - in need of health services
- More complicated services to handle.
  - Unexpected disaster management




# New Challenges and Needs for ITS in Smart Cities

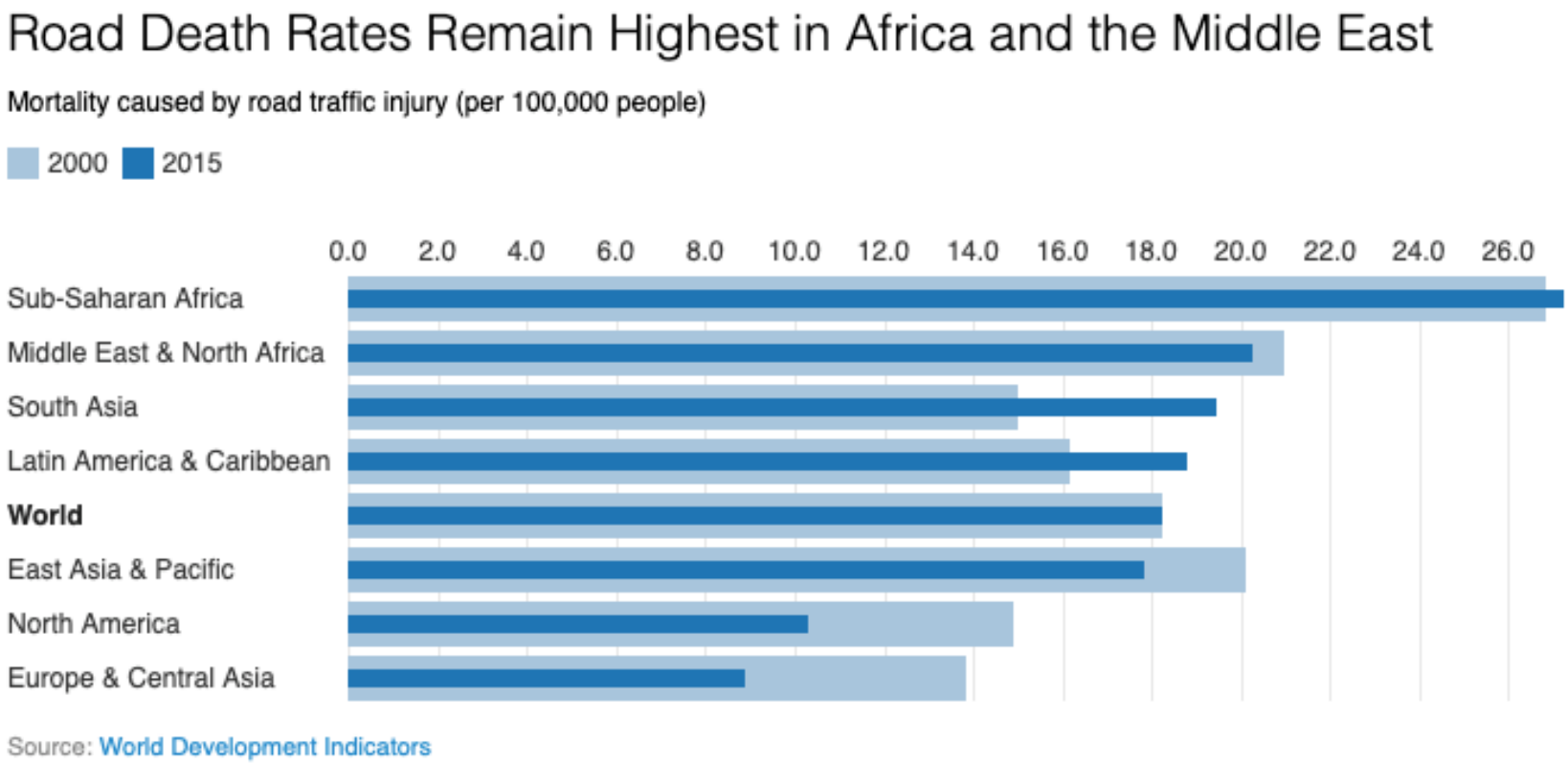
- Next decade: **new societal challenges** in transportation and mobility (smart devices)


- 1.3 million people are killed on world roads every year (+3,500/day)
  - ….90% in developing countries
- **Affects our lives** particularly in the urban areas, while people needs, more and more, to move rapidly between different places.

  - A 9-day traffic jam (100KM) in China in 2010, drivers stuck in the traffic jam for several days.

# 1.25 million people killed each year

- 20-50 million seriously impacted by road traffic injuries.
- Sub-Saharan Africa, Middle East and North Africa still see over 20 deaths per 100,000 people every year.



# New Challenges and Needs for ITS in Smart Cities

Traffic congestion, accidents, transportation delays and larger vehicle pollution emissions.

- More roads to reduce traffic congestion is not the "right" solution
  - Very expensive, considerable environmental impact.
  - A large space, limitation within urban areas.

But improvement of the transport infrastructure essential for economical development.

A compromise solution must be implemented.

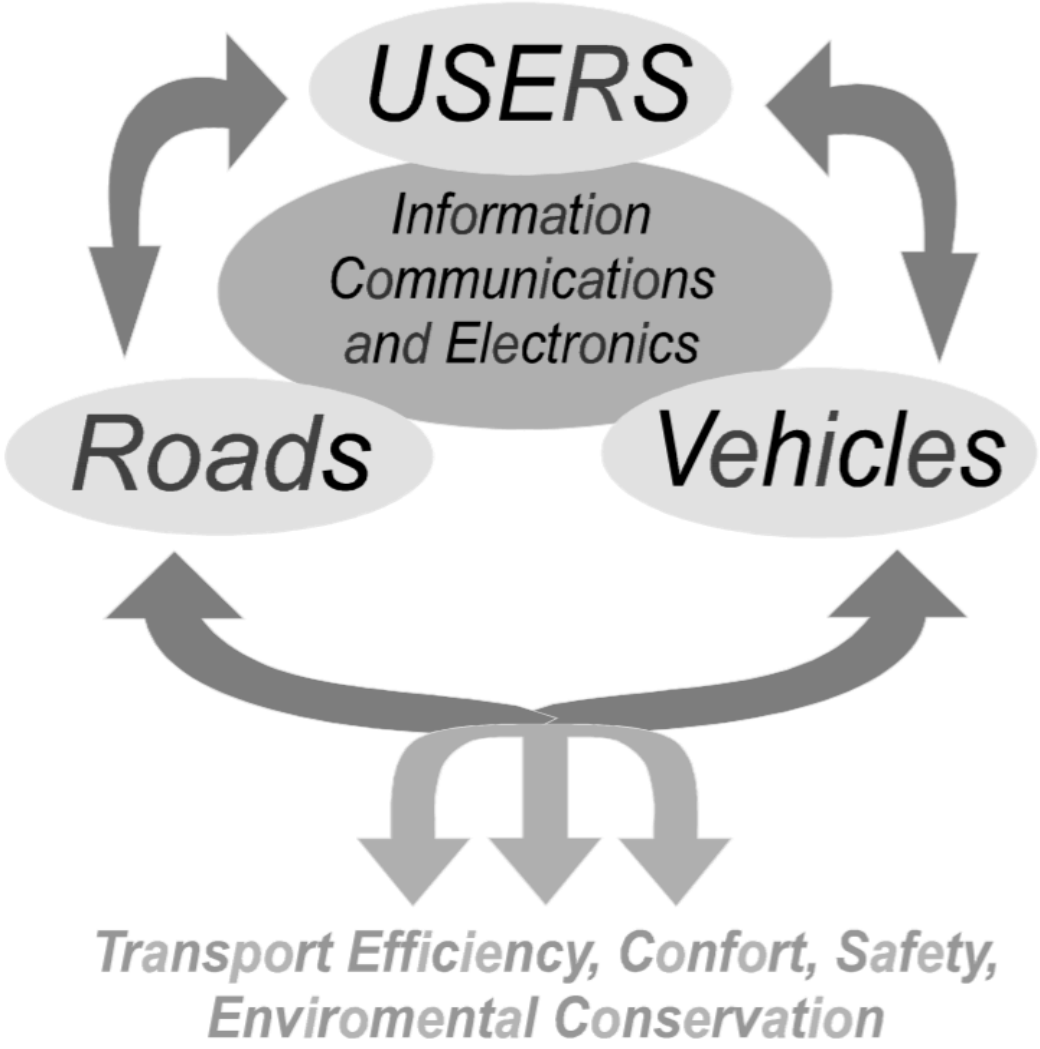
# What are ITS ?

- ITS : Technologies and the scientific aspects
- Aim: Develloping new systems capable of solving some of the problems.
- Exploiting emerging ITS technologies:
  - Road-vehicle systems safer,
  - More efficient and more environment friendly.
  - ITS technology assists human operators
    - Conventional road-vehicle systems depend entirely on human drivers,

# What are ITS ?

- ITS: Many different areas (multidisciplinary) electronics, control, communications, sensing, robotics, signal processing, logistics and information systems.
  - Increases the problem' s complexity,
  - Requires knowledge transfer and cooperation among different areas (ICT, social sciences, logistics, Urban dev policy, economy, .)
- ITS global phenomenon, worldwide interest from transportation prof, automotive indus. and political decision makers.

# What are ITS ?




Take advantage of the appropriate technologies to create "more intelligent" roads, vehicles and users.

# Smart cities
# Sustainable mobility and transportation

**Future mobility requirements can only be met with intelligent, eco-friendly, secure and efficient technologies**

•Design of new approaches for **gathering data** from # **heterogeneous sources**: sensors, web services, user behavior

- •Provide users with **useful information** on real-time traffic conditions, cost and $CO^2$ emissions, location of resources: charging stations for FEV, influence their behavior

# Intelligent Transportation Systems
# ITS : Benefits

- Security & Safety :
  - Example : Inform drivers of potential hazards (accident, fog …)
  - Comfort : Facilitate driving
- Flow efficiency :
  - Optimize traffic flow (cooperative driving) and reduce pollution
- Productivity and cost reduction,
  - Facilitate driving
- Environment benefits.

# ITS Types

## 3 types of Services for ITS

**Communication**

**Localization**


**Detection (Accident avoidance)**

# MAJOR CATEGORIES OF ITS

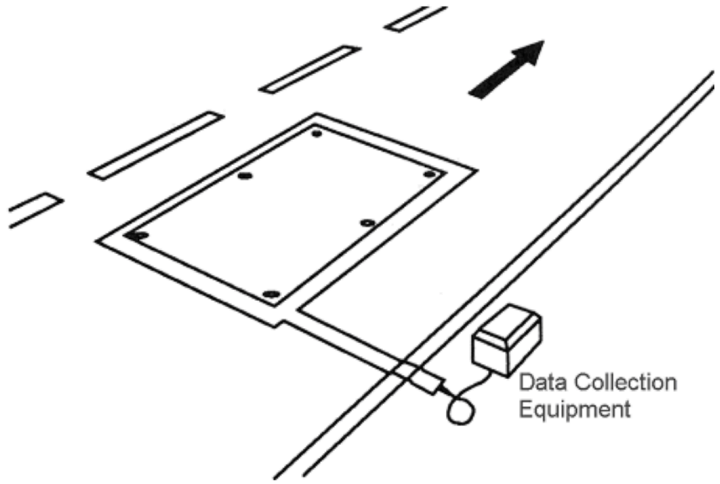
- *Advanced Traffic Management Systems (ATMS)*
- *Advanced Travellers Information Systems (ATIS)*
- *Commercial Vehicles Operation (CVO)*
- *Advanced Public Transportations Systems (APTS)*
- *Advanced Vehicles Control Systems (AVCS)*

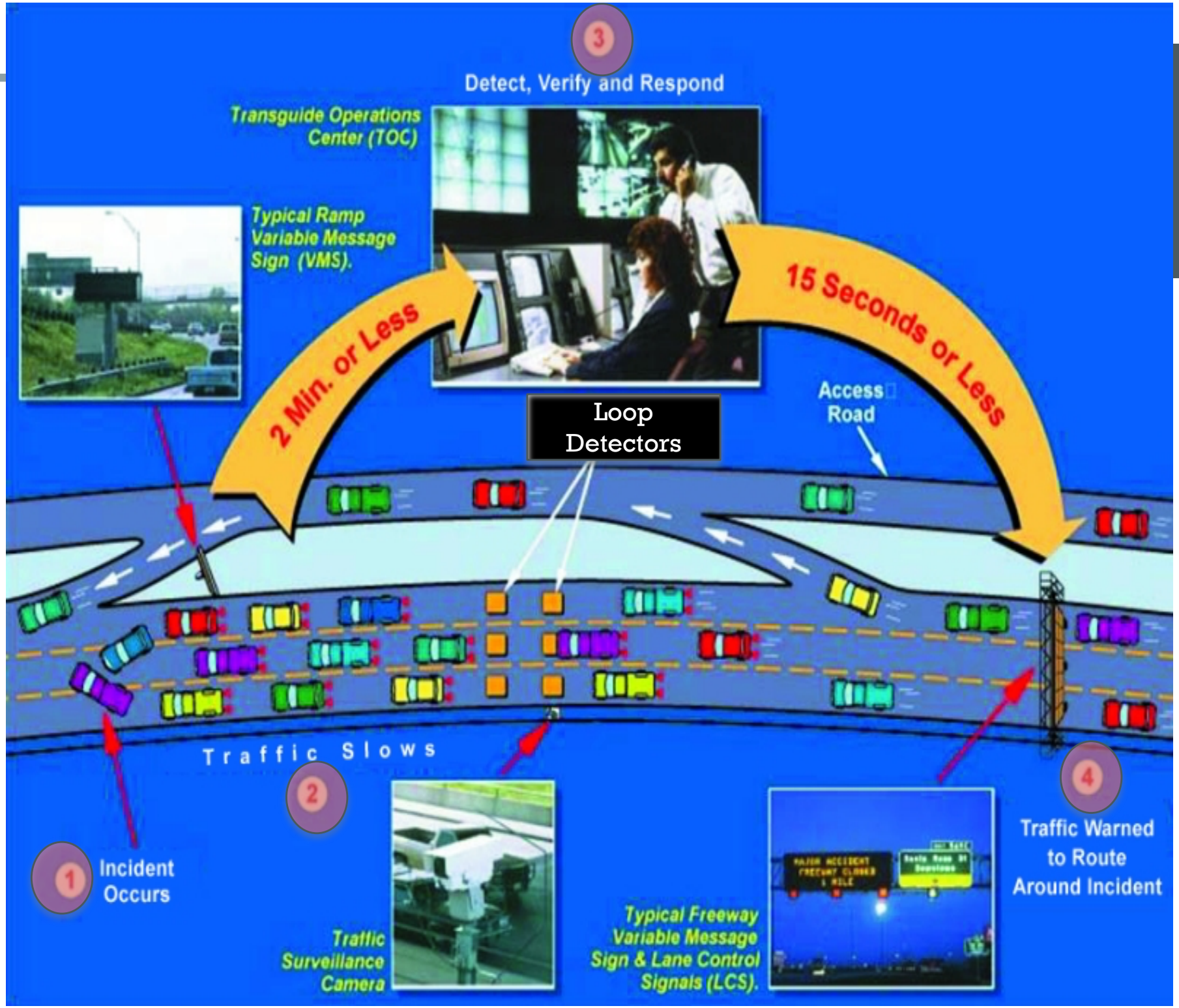
# Advanced Traffic Management Systems (ATMS)

- **Purpose: Improve traffic service quality and reduce traffic delays**

- Operates with video and *roadway loop detectors*, variable message signs, network signal, ..
  - **Inductive loop detector**: placed in a roadbed to detect vehicles
    - Used to count the number of vehicles during a unit of time (ex 60 sec) pass over the loop. Speed, length, and class of vehicles and the distance between them can also be collected.

- Real time traffic control systems: use the information provided by previous elements to change semaphores, send messages to electronic displays and control highway access



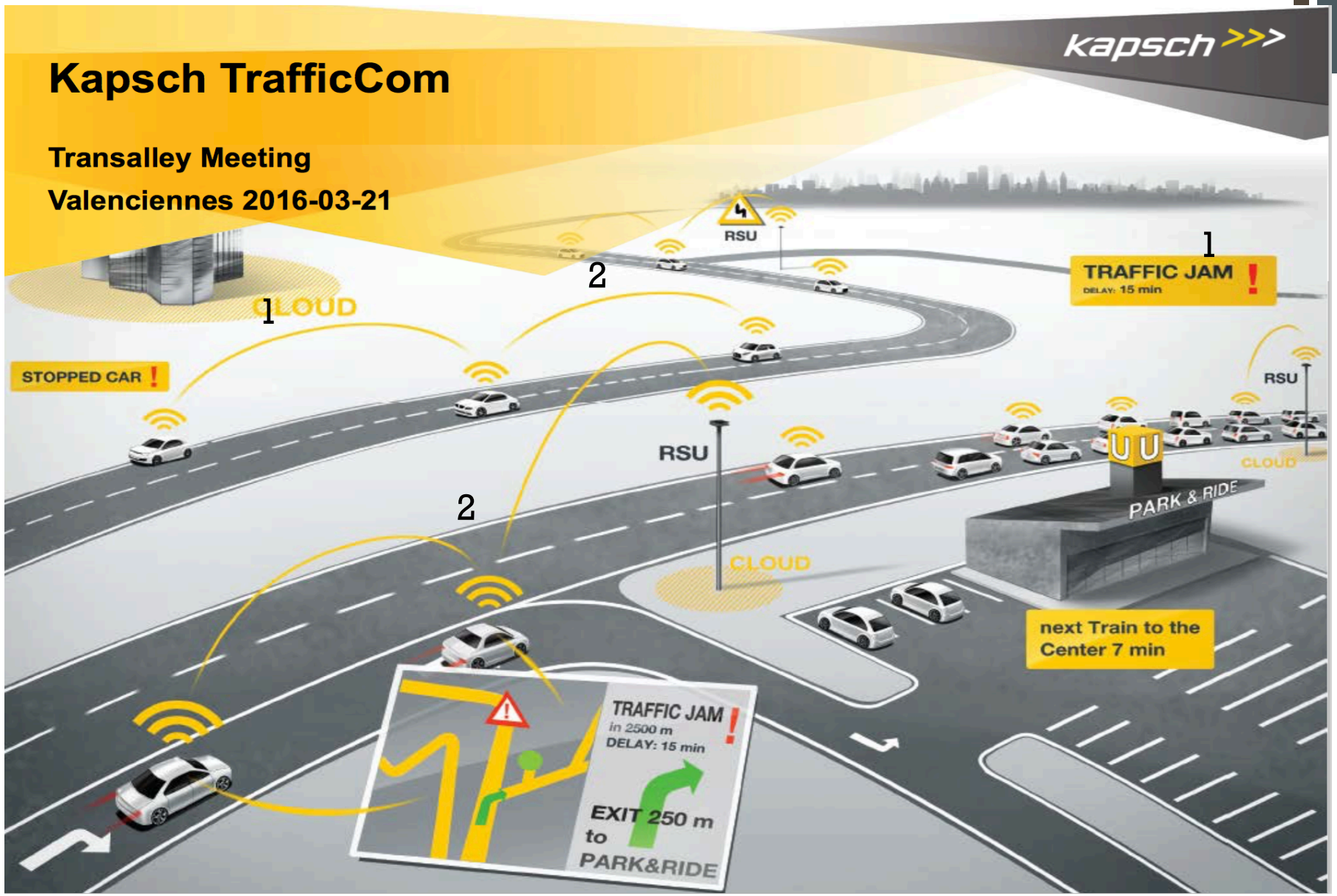

3
Detect, Verify and Respond
Transguide Operations Center (TOC)
Typical Ramp Variable Message Sign (VMS).
2 Min. or Less
15 Seconds or Less
Loop Detectors
Access Road
Traffic Slows
2
1
Incident Occurs
Traffic Surveillance Camera
Typical Freeway Variable Message Sign & Lane Control Signals (LCS).
4
Traffic Warned to Route Around Incident

# *Advanced Travellers Information Systems (ATIS)*

- **Supply real time traffic information to the travellers**
- ATIS is more general than ATMS
- Users or Drivers make a better use of the system:
  - Reduction of congestions, optimising the traffic flow and reducing pollution.
  - Driver decides:
    - the most advantageous road to reach its destiny,
    - the most favourable transportation service and
    - the most appropriate schedule to adopt.

Info provided through electronic panels, portable systems connected to the Internet or in-vehicles systems

# + Advanced Travellers Information Systems (ATIS)



# *Advanced Public Transportations Systems (APTS)*

- Use electronic technologies to improve the operation and public transports (buses and trains)
- Improve the mass transport service, allowing route information, travel schedules and costs, and real time information about changes in transport systems.
- Actuate on the traffic lights in order to give priority to the public transportations.

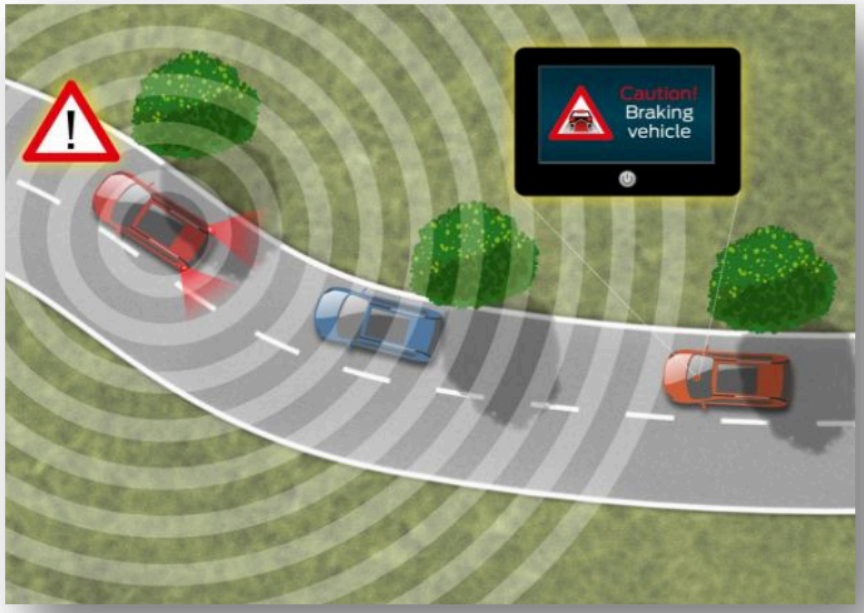
# Commercial Vehicles Operation (CVO)

- Increase safety and efficiency of commercial vehicles and fleets.
- For large and medium companies, commercial fleets,
  - Management of all the vehicles,
  - Controlling speed and stopping-place times, fulfilling the destination.
- Increase speed of goods delivery, patient transport and reduction of costs operation.
- Example: Every 15 min the computer transmits where the truck has been. The digital radio service forwards the data. A computer system in the central office manages the fleet in real time under control of a team of dispatchers.

# *Advanced Vehicles Control Systems (AVCS)*

- Use sensors, computers and control systems to assist and alert drivers or to take part of vehicles driving.
- Increase safety, decrease congestions on roads and highways, improve road systems productivity.
- Driver can receive visual and hearing information about traffic, dangers and all vehicle situations: in-vehicle sensors.
- **Automatic control** to react in danger situations, faster and effective way, ex : braking or acceleration systems, useful for aged drivers or drivers with less practice.

# *Advanced Vehicles Control Systems (AVCS)*




# Advanced Vehicles Control Systems (AVCS)


**Green Light Optimal Speed Advisory**

Vehicles are advised about optimal speed in order to avoid stopping at traffic lights

- Day 1 application
- Infrastructure to Vehicle (I2V)
- Up to 13% fuel savings for buses
- 6.5% increase of average speed

**Platooning**

Primarily commercial vehicles driving in close formation to save fuel. In the continuation an important building block for Autonomous highway traffic

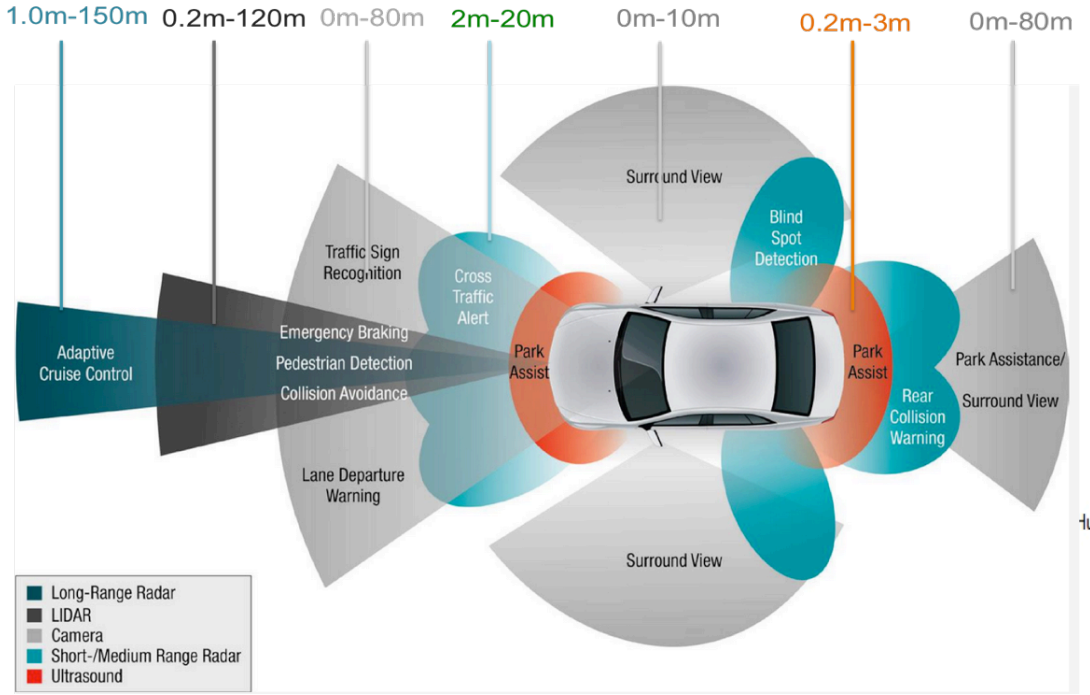
- Day 2 application
- Session based direct Vehicle to Vehicle (V2V)
- Up to 20% fuel saving (8% for first vehicle)

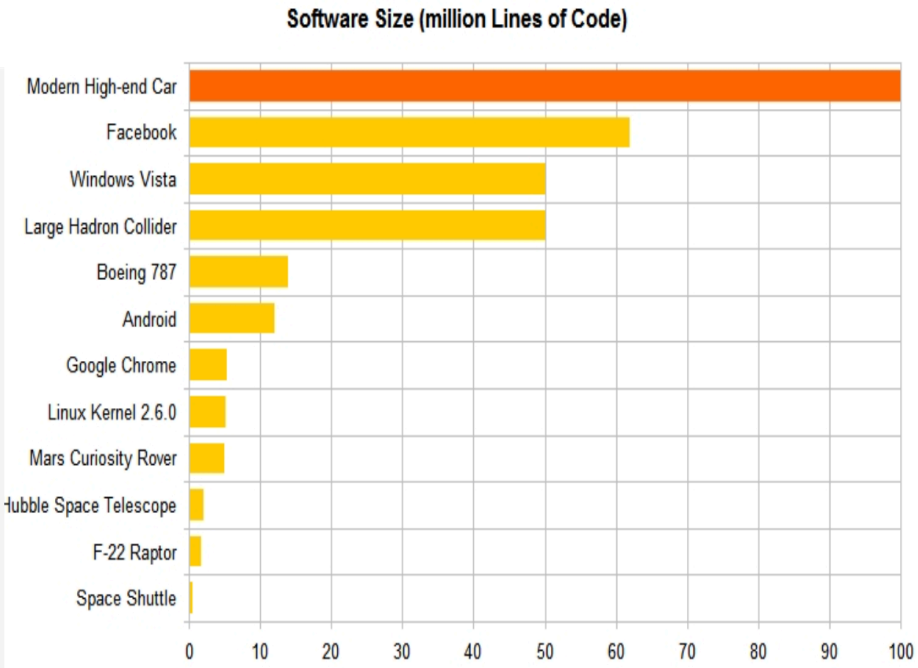
https://www.youtube.com/watch?v=Sn4UupR_duQ&ab_channel=KOREANOW

https://www.youtube.com/watch?v=rtfC3Fj068o

# Chalenges in Next Generation Automotive

- Number of sensors in automotive systems increasing:
  - Cameras, Radars, Lidars, V2V, V2I, .. (Autonomous cars)
- The challenges are:
  - processes the data? Extract useful info? communicate? …



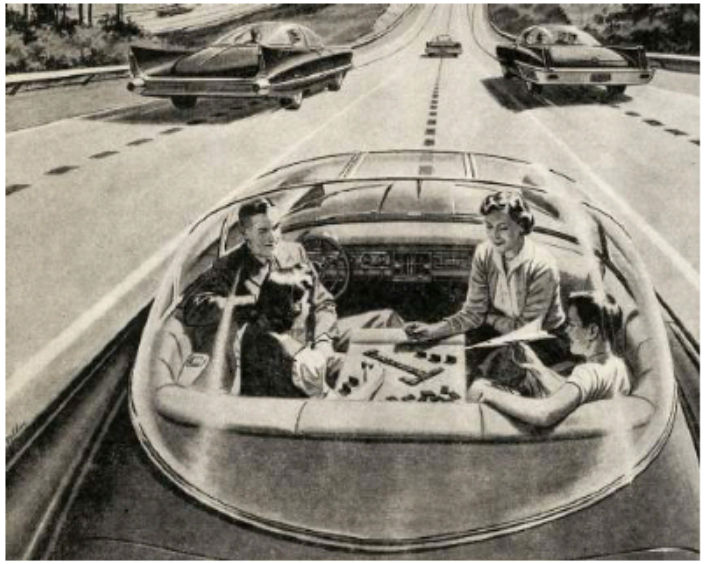
# ADAS & Autonomous Driving


| Full Driver Control | Function-Specific Automation | Combined Function Automation | Limited Self-Driving Automation | Full Self-Driving Control |
|---|---|---|---|---|
| The driver is in complete control of the car, and responsible for all roadway monitoring | The driver is assisted by V2V technology, which is used primarily in emergency situations. It usually assists in either steering or braking/throttle controls (but not both). Car function-specific systems include cruise control, automatic braking, and lane keeping. | The driver is supported by "active cruise control," where the car can take over non-emergency driving tasks such as a controlled speed limit, and a safe distance from cars. | The driver is expected to be seated by the controls, and expected to take over driving at any time. | The driver inputs a destination and takes a role in driving a vehicle at any time. |

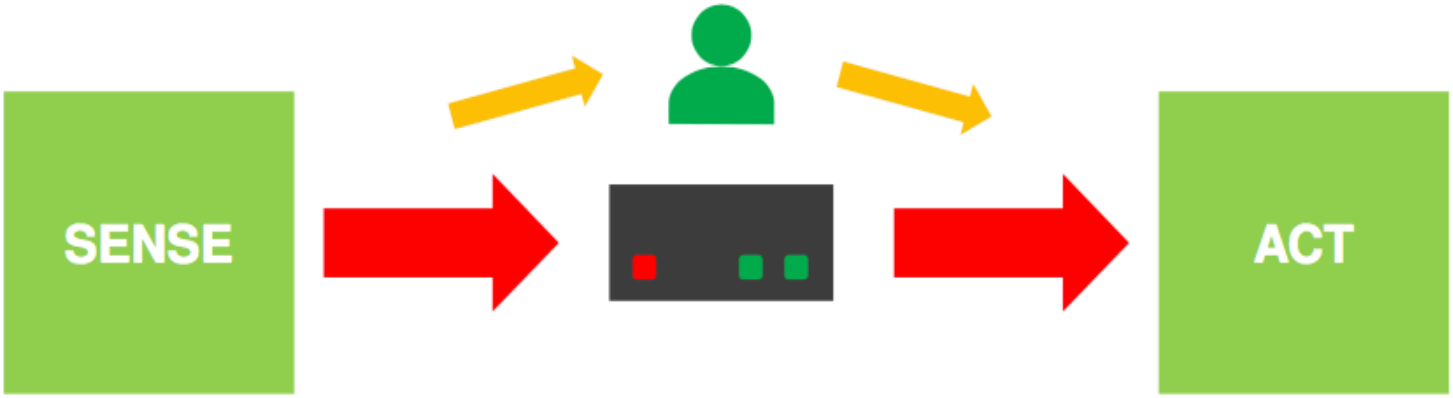
# Autonoumous Cars


The vehicle once was a **passive platform**, completely piloted by the human driver.

# What a vehicle will be

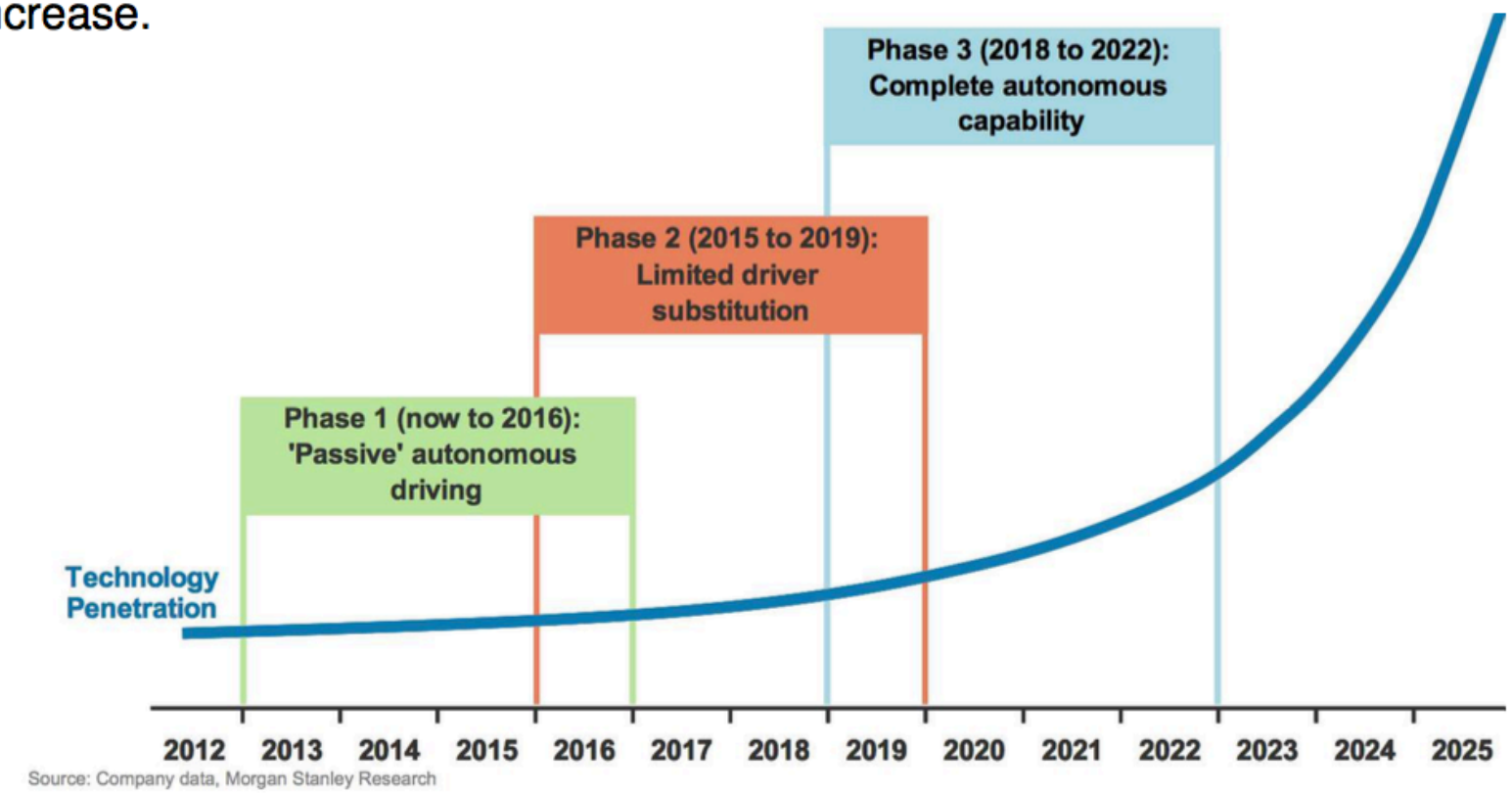


In the future, more and more functions of car driving will be **automatic**.



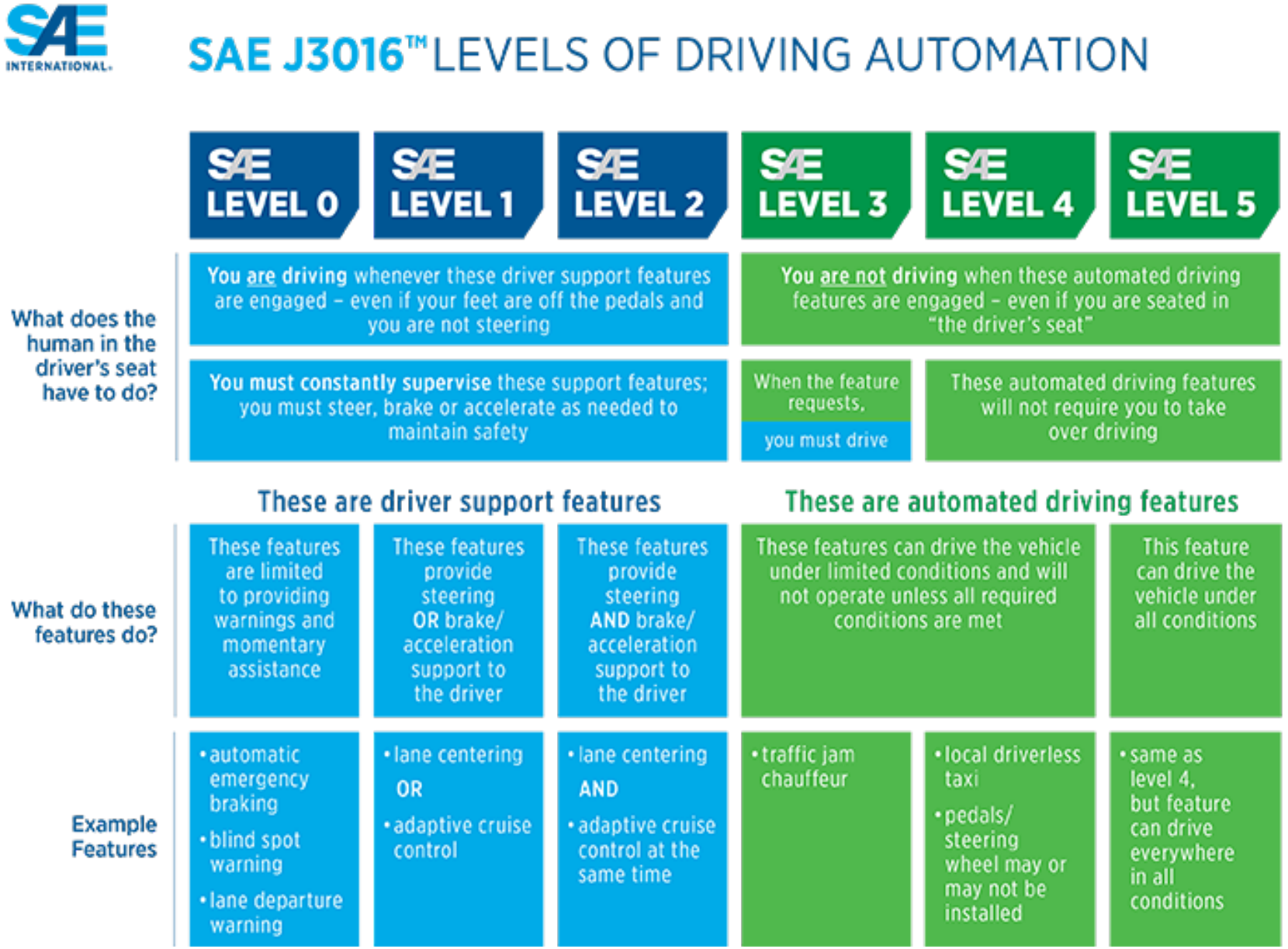
# Autonoumous Cars

The depth of control over driving functionalities will increase.




Source: Company data, Morgan Stanley Research

# Society of Automotive Engineers (**SAE**) **Automation Levels**



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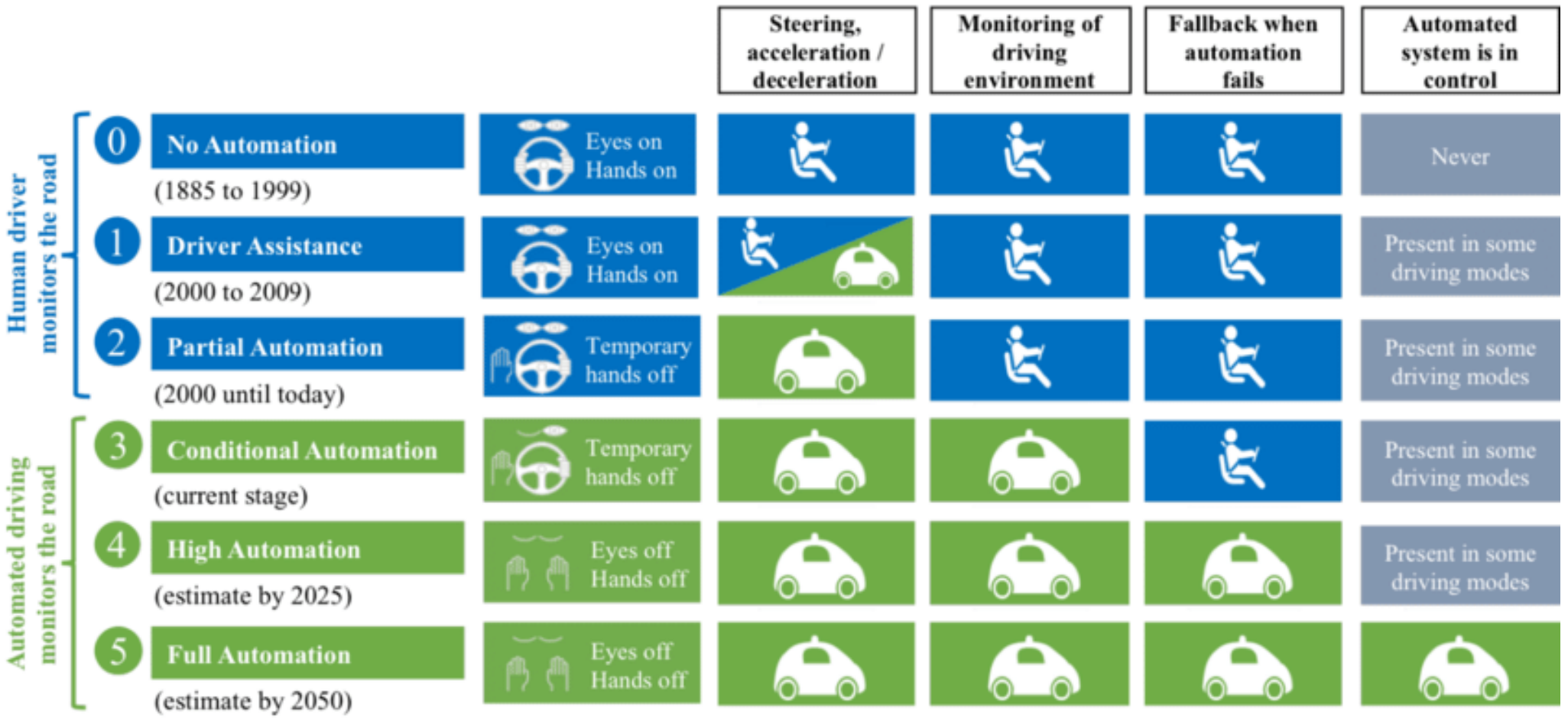

# Readings

- Intelligent Transport Systems Department Faculty of Transport and Traffic Sciences University of Zagreb, Sadko Mandžuka, https://bib.irb.hr/datoteka/801261.ITS_Selected_Lectures_Mandzuka.pdf