ÓBUDAI EGYETEM


# Vehicle Informatics
# (Vehicle System Informatics)

## Lectures
## Part 07

(V2X Solutions,
Connected_Cooperative_Mobility)

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# Cooperative Connected Automated Mobility

# Topics

- Big Pain Points of Road Traffic
- Expected benefits of C-ITS
- Networked and cooperative infrastructure
- Launching C-ITS in EU countries, phase 1
- Day 1 and Day1’5 services
- V2X communication
- In-Vehicle data
- Communication V2X
- Way to CCAM (Cooperative, Connected and Automated Mobility)

# Road Traffic

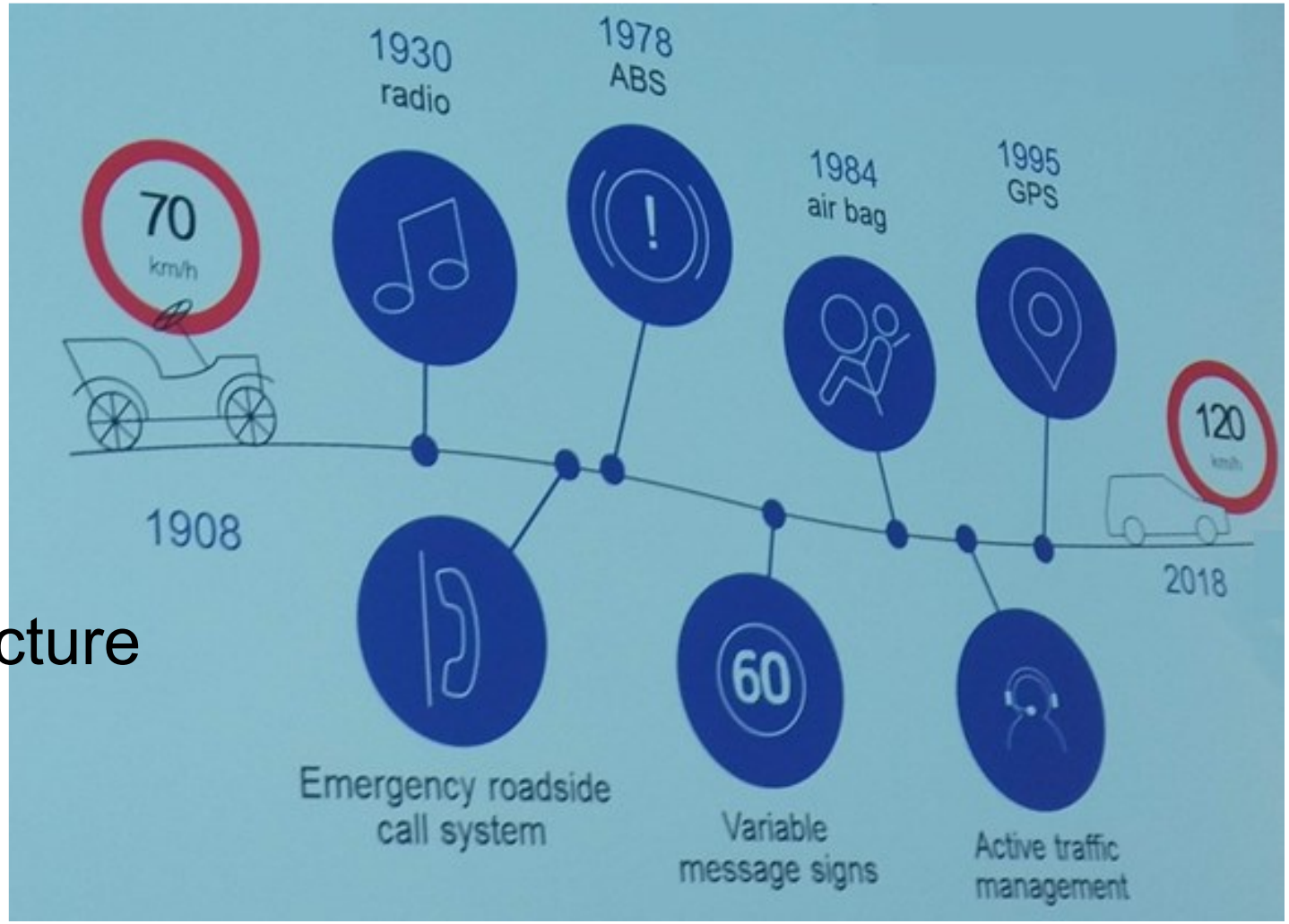

- „If I had asked people what they wanted, they would have said faster horses”

(Henry Ford)

# Classic Innovations on Road Traffic

– Automotive innovations

– Traffic infrastructure innovations




Nokia

# Automative innovations

# Road Traffic Problems

- Congestion and Pollution
  - $ 1 Trillion cost (estimated cost of air pollution in OECD countries due to road transport)
  - 6.9 Billion hours (estimated hours of traffic delays caused by congestions only in the US in 2014)
  - +66% vehicles by 2035
- Road fatalities
  - 1.25 Million fatalities (estimated road traffic related fatalities worldwide in 2013), (25.600 fatalities 130.000 seriously injured in the EU in 2016)
  - 90% error (90% of road fatalities caused by human error)

# Expected Benefits and Potential Services

- V2I safety
  - Red light violation warning
  - Curve speed warning
  - Stop sign gap assist
  - Spot weather impact warning
  - Reduced speed/work zone warning
  - Pedestrian in signalized crosswalk warning
- V2V safety
  - Emergency electronic brake lights (EEBL)
  - Forward collision warning (FCW)
  - Intersection movement assist (IMA)
  - Left turn assist (LTA)
  - Blind spot/Lane change warning (BSW/LCW)
  - Do not pass warning (DNPW)
  - Vehicle turning right in front of bus warning (Transit)

# Expected Benefits and Potential Services

- Environment
  - Eco-Approach and departure at signalized intersections
  - Eco-traffic signal timing
  - Eco-traffic signal priority
  - Connected eco driving
  - Wireless inductive/resonance charging
  - Eco lanes management
  - Eco-speed harmonization
  - Eco-cooperative cruise control
  - Eco-traveller information
  - Eco-ramp metering
  - Low emission zone management
  - AFV charging/fuelling information

# Expected Benefits and Potential Services

**Mobility**

- Advanced Traveler Information System
- Intelligent Traffic Signal System (I-SIG)
- Signal Priority (transit, freight)
- Mobile Accessible Pedestrian Signal System (PED-SIG)
- Emergency Vehicle Preemption (PREEMPT)
- Dynamic Speed Harmonization (SPD-HARM)
- Queue Warning (Q-WARN)
- Cooperative Adaptive Cruise Control (CACC)
- Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)
- Incident Scene Work Zone Alert for Drivers and Workers (INC-ZONE)
- Emergency Communications and Evacuation (EVAC)
- Connection Protection (T-CONNECT)
- Dynamic Transit Operations (T-DISP)
- Dynamic Ridesharing (D-RIDE)
- Freight-Specific Dynamic Travel Planning and Performance
- Drayage Optimization

# Expected Benefits and Potential Services

**Agency Data**

- Probe-Based Pavement Maintenance
- Probe-Enabled Traffic Monitoring
- Vehicle Classification-Based Traffic Studies
- Connected Vehicle-Enabled Turning Movement and Intersection Analysis
- Connected Vehicle-Enabled Origin-Destination Studies
- Work Zone Traveler Information

**Road Weather**

- Motorist Advisories and Warnings (MAW)
- Enhanced Maintenance Decision Support System (MDSS)
- Vehicle Data Translator (VDT)
- Weather Response Traffic Information (WxTINFO)

**Smart Roadside**

- Wireless Inspection
- Smart Truck Parking

# Networked and cooperative infrastructure

SWARCO V2X | Connecetd and Cooperative intrastructure | Andreas.Schmid@swarco.de

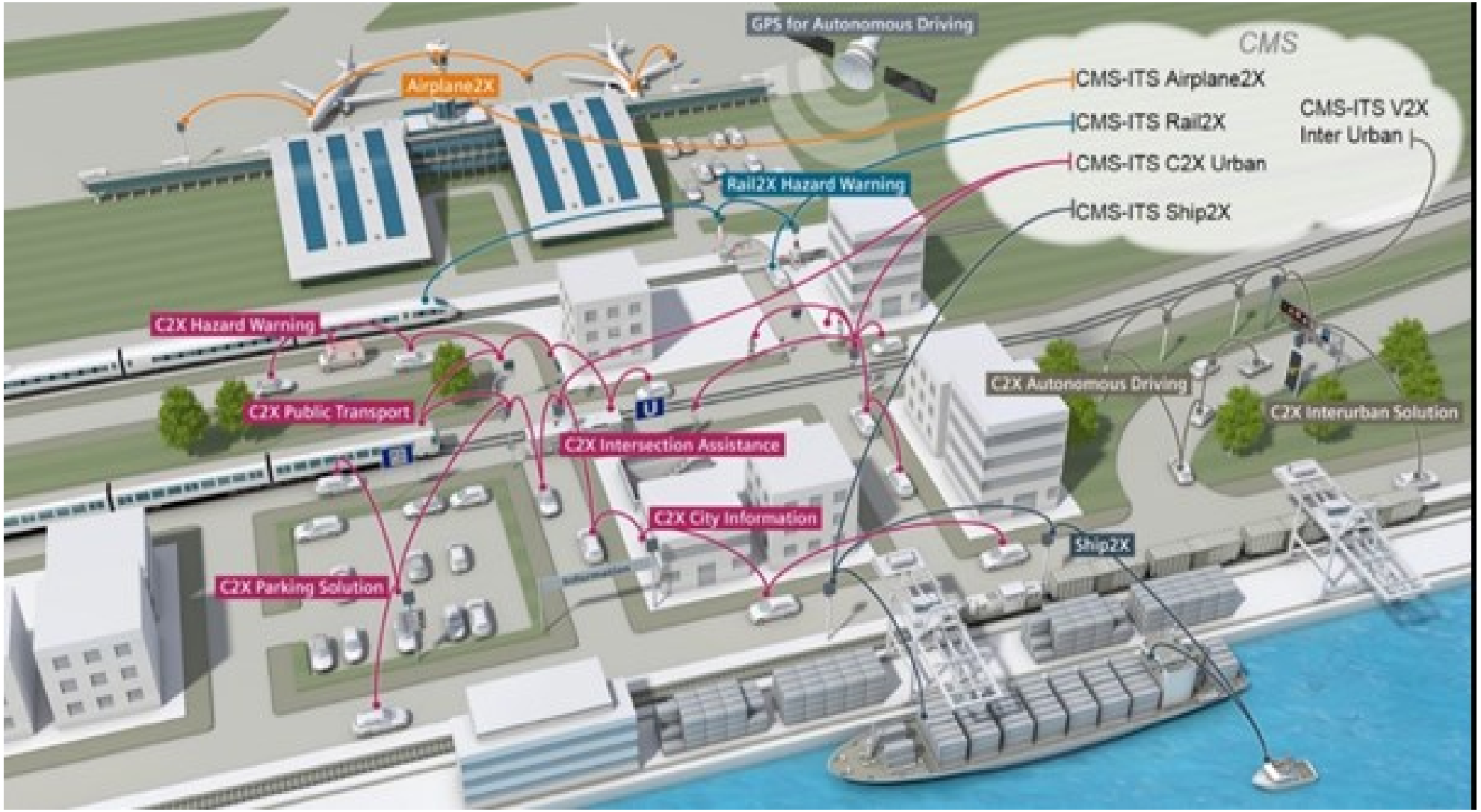
# Networked and cooperative infrastructure

Siemens

# Networked and cooperative infrastructure

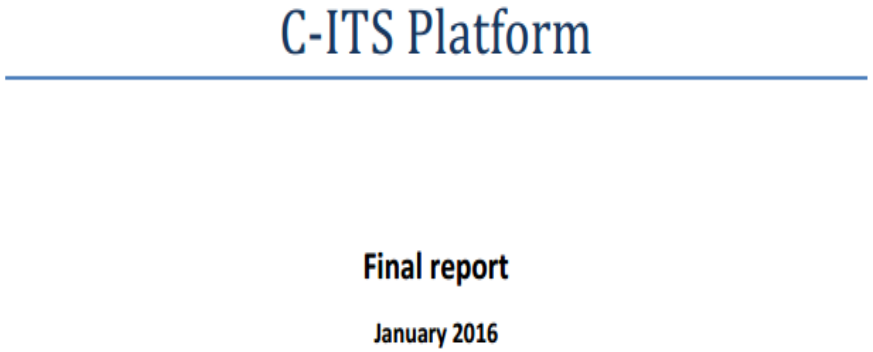

HR_Groep Holland

# Cooperative Intelligent Transport Systems



# C-ITS Platform First Phase

- The Platform for the Deployment of Cooperative Intelligent Transport Systems in the European Union (C-ITS Platform) was created by the European Commission services (DG MOVE) in November 2014
  - Delivered in its first phase (November 2014 – January 2016) its contribution towards a shared vision on the interoperable deployment of Cooperative Intelligent Transport Systems in the European Union.
  - To support the emergence of a common vision across all actors involved in the value chain.
  - The C-ITS Platform, which gathers public and private stakeholders, represents all of the key stakeholders along the value chain including
    - public authorities,
    - vehicle manufacturers,
    - suppliers,
    - service providers,
    - telecom companies



# C-ITS Platform First Phase

- Addresses the issues related to the following aspects:
  - A common technical framework is necessary for the deployment of C-ITS
  - The legal questions related to C-ITS
  - The "legitimacy" of the deployment of C-ITS, i.e. the fact that the deployment of C-ITS can be justified and fostered at all levels
  - International cooperation

# The Common Technical Framework

- List of Day1 services
  - Hazardous location notifications:
    - Slow or stationary vehicle(s) & Traffic ahead warning
    - Road works warning
    - Weather conditions
    - Emergency brake light
    - Emergency vehicle approaching
    - Other hazardous notifications

# The Common Technical Framework

- List of Day1 services (continued)
  - In-vehicle signage
    - In-vehicle speed limits
    - Signal violation / Intersection Safety
    - Traffic signal priority request by designated vehicles
    - Green Light Optimal Speed Advisory (GLOSA)
    - Probe vehicle data
    - Shockwave Damping (falls under ETSI (Europian Telecommunication Standard Institute) Category “local hazard warning”)

# The Common Technical Framework

- List of Day 1’5 services
  - Information on fueling & charging stations for alternative fuel vehicles
  - Vulnerable Road user protection
  - On street parking management & information
  - Off street parking information
  - Park & Ride information
  - Connected & Cooperative navigation into and out of the city (1st and last mile, parking, route advice, coordinated traffic lights)
  - Traffic information & Smart routing

# Security and Certification

- Security is paramount to the deployment of C-ITS in the EU. No security, no C-ITS.
- One common standardized C-ITS trust model and certificate policy all over the EU to support full secure interoperability of C-ITS Day 1 services at the European level
- International cooperation beyond the EU to discuss how interoperability of other domains (outside Europe) with the single EU trust domain can be realized

# Security and Certification

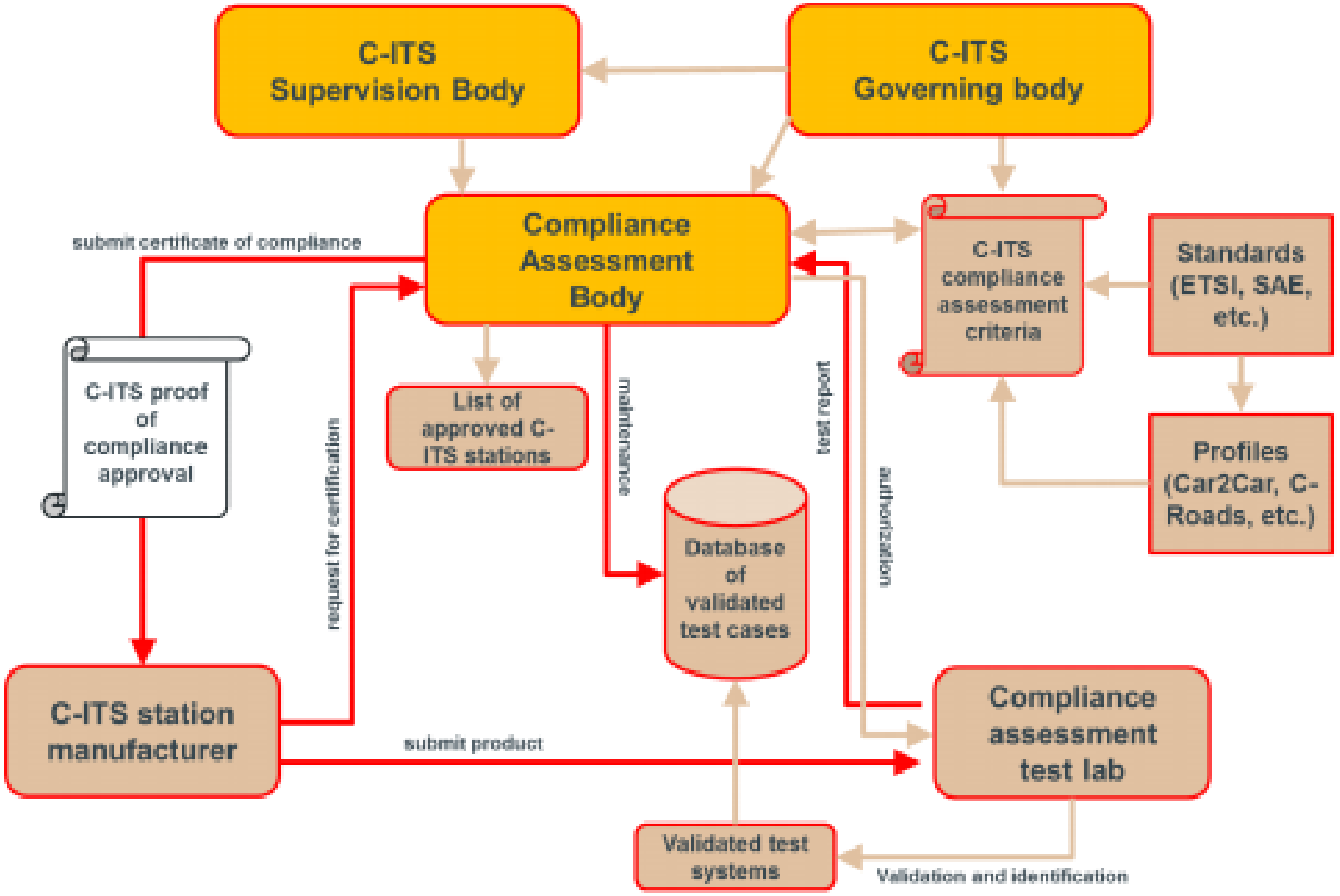



Figure 1: Overview of the compliance assessment process

# Radio Frequency and Hybrid communication

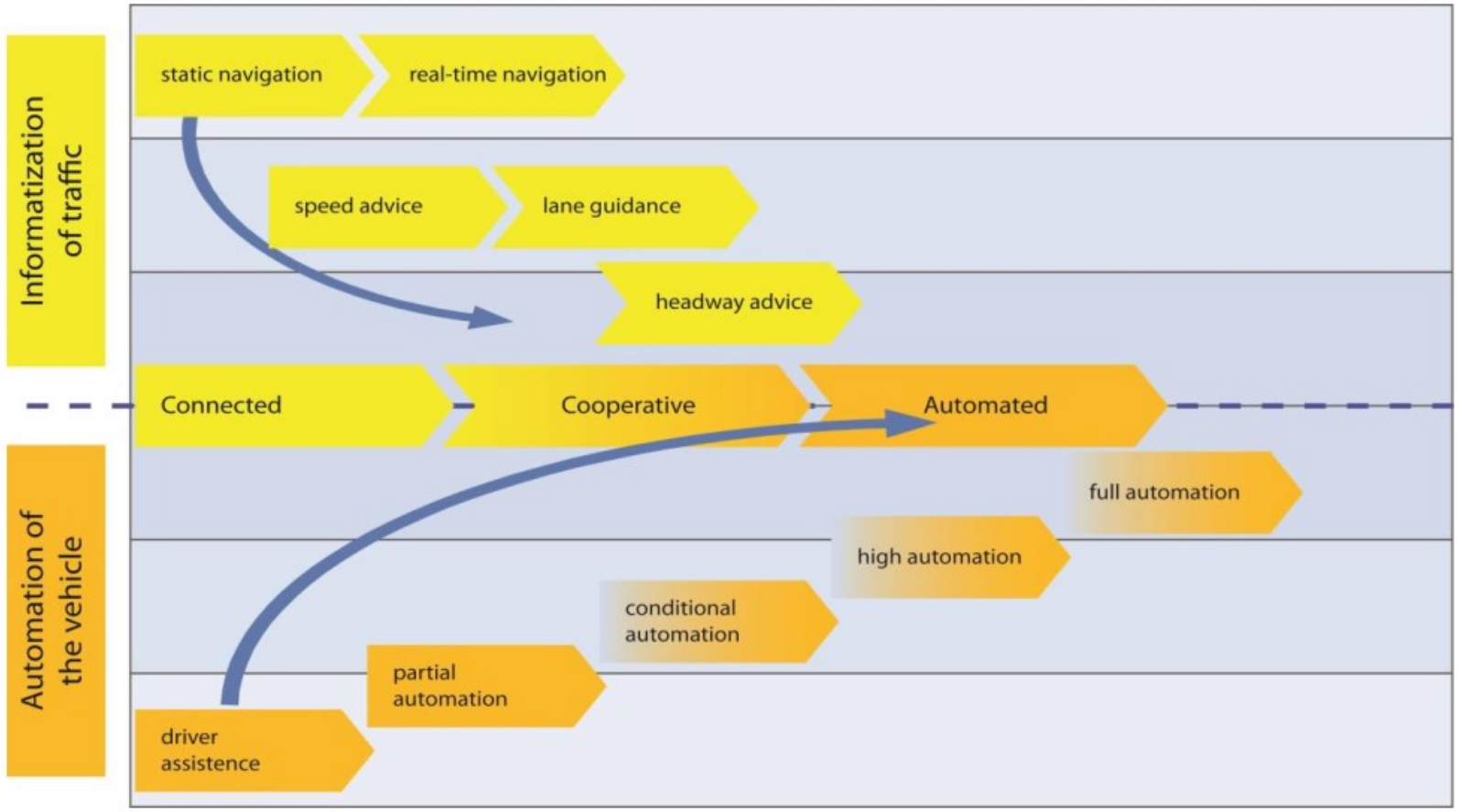
- The C-ITS Platform recommends that for short-range communications in the 5.9 GHz band initially the communication system to be used is IEEE802.11p/ETSI ITS-G5,  (WiFi Standard amendment)
- Through existing cellular communications (4G/LTE) infrastructure, and therefore foster uptake of C-ITS services
- Cellular 5G isn’t yet there
- Ensure coexistence between 5.8 GHz tolling DSRC and 5.9 GHz ITS applications

# Access to In-vehicle Data and Resources

- Three technical solutions have been identified for this access to in-vehicle data and resources:
  - the on-board application platform,
  - the in-vehicle interface and
  - the data server platform
- Five guiding principles that shall apply when granting access to in-vehicle data and resources
  - Data provision conditions: Consent
  - Fair and undistorted competition (equal position for all service providers)
  - Data privacy and data protection
  - Tamper-proof access and liability (use of in-vehicle data and resources should not endanger the proper safe and secure functioning of the vehicles)
  - Data economy (standardised access favours interoperability between different applications, and the common use of same vehicle data and resources)

# Declaration of Amsterdam

- In the Declaration of Amsterdam12 in April 2016, European transport ministers urged the European Commission to develop a European strategy on cooperative, connected and automated vehicles.




*Connected, cooperative and automated driving developments should come together to harvest societal benefits.*

# What is the motivation for C-ITS developments?

- **International competition in innovation pushes automotive industry towards automated driving**
  - Apparent industry activities and (funded) political support
  - Driver for Innovation and economic growth of a region
- Promising benefits
  - Driver experience / Competitive advantage
  - **Savings in fuel and environmental pollution** often emphasize motivation for cooperative and connected mobility
  - Car to car communication is the key for **Safety and Efficiency** in many applications (e.g. electronic brake lights, truck-platooning, hazard warning)
- Gain in safety (for automated vehicles) and efficient traffic flow simultaneously is **not possible without infrastructure communication**
- Always failure-free recognition of traffic light status and mandatory (dynamic) signs not fast and safe enough if vehicle based only
- Statements at EU level: ….see. next slides

**„Sensitive“ aspects**:

***Connected***
*Is there communication with each other?*

***Cooperative***
*Is there co-operation between vehicle(s) and infrastructure?*

***(Highly) automated***
*when exactly is the driver still responsible/ where is the control fully with the vehicle? (→ SAE J3016)*

***Autonomous***
*does a vehicle drive independently i.e. exclusively based on its own, on-board sensors?*

# Why V2X?

## C-ITS Platform 2015 – final report:

- Dominant benefits
  - Reduced travel times/ increased efficiency (66%)
  - reduced accident rates (22%)
  - Fuel consumption savings (11%)

- June 2015: Rupert Stadler, Berliner Wirtschaftstag: “If all traffic lights in Germany would be connected, 900 m litre fuel could be saved per year. Thi equivalents more than two million t le CO2."

http://ec.europa.eu/transport/themes/its/c-its_en.htm

A first overall conclusion is thus that the benefits of deploying C-ITS services are very large indeed but they will not appear in the short-term.

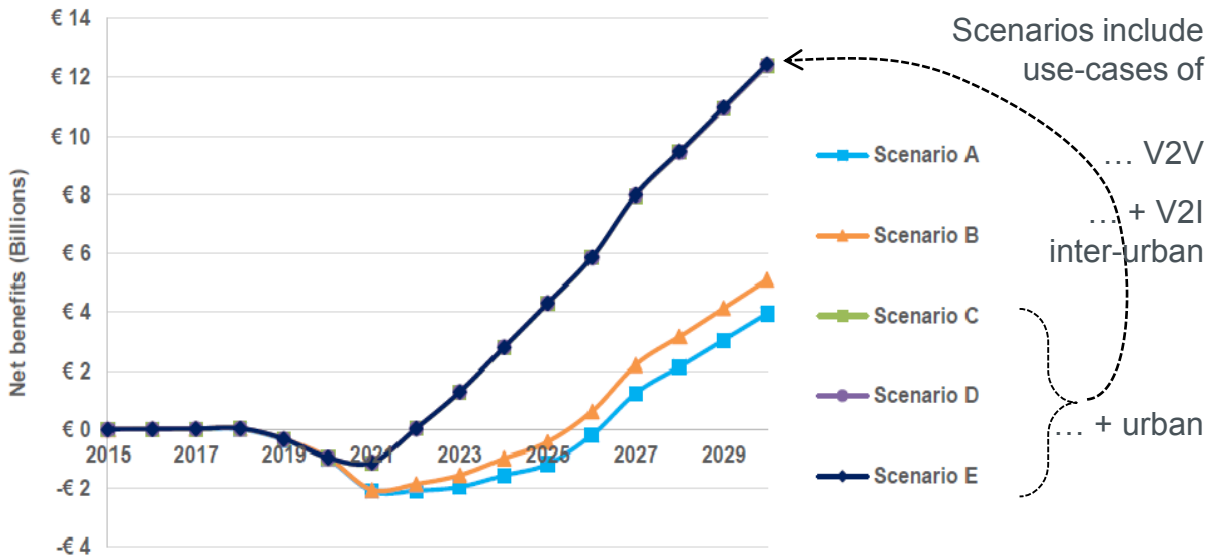



Figure 3: Net Benefits from C-ITS

# Who pays?

- C-ITS Platform 2015 – final report

http://ec.europa.eu/transport/themes/its/c-its_en.htm

  - Dominant costs
    - Hardware in vehicles (86%)
    - Aftermarket devices (10%)
    - Rest - incl. Infrastructure (4%)
- i.e.
  - Vehicle Industry will have to bear main extra-costs …and therefore will be a key driver

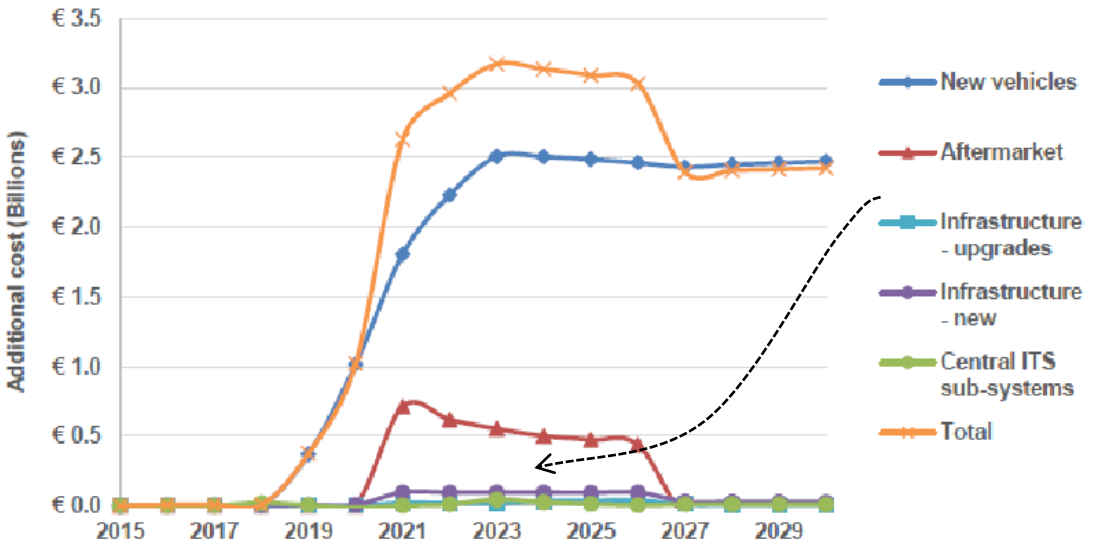
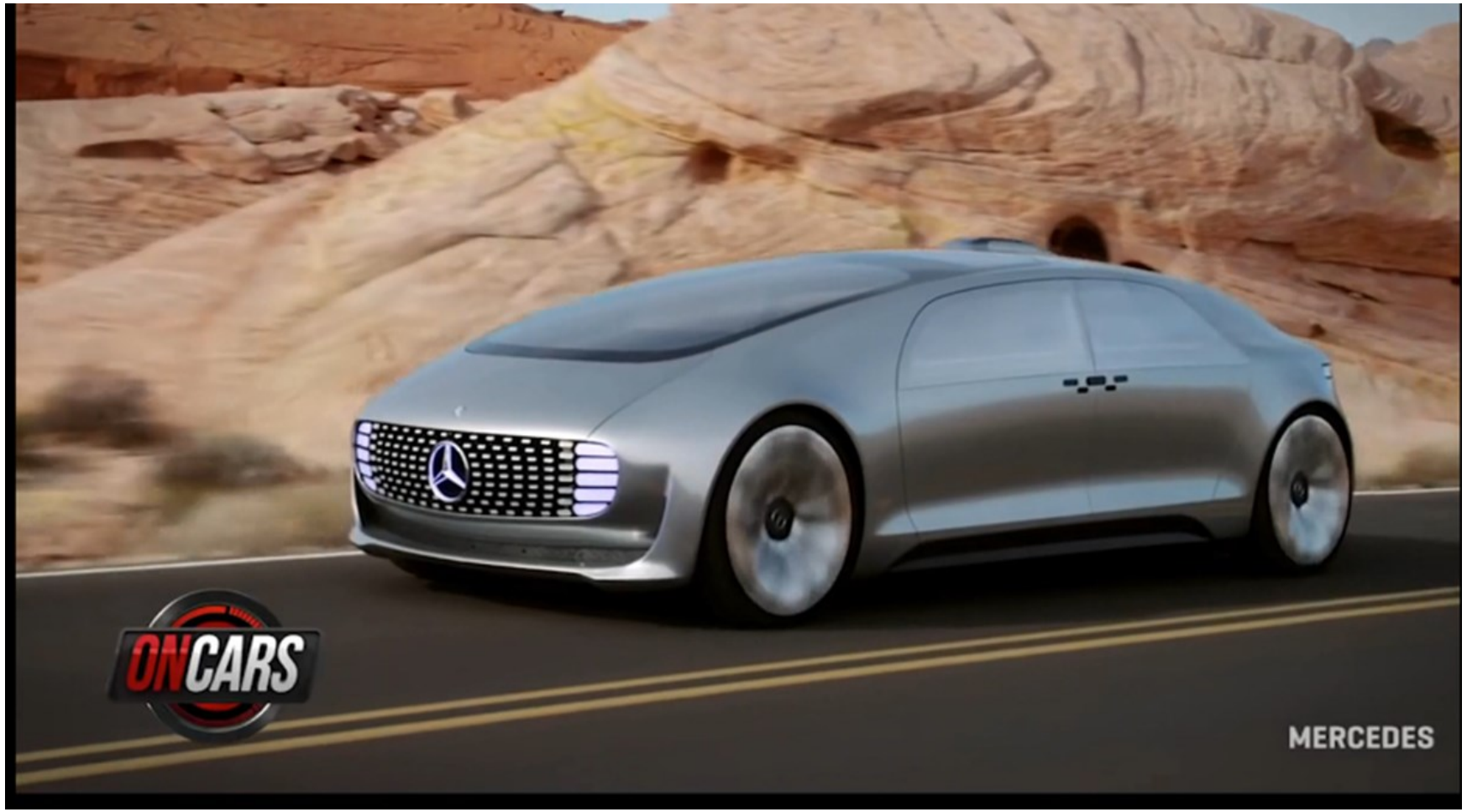


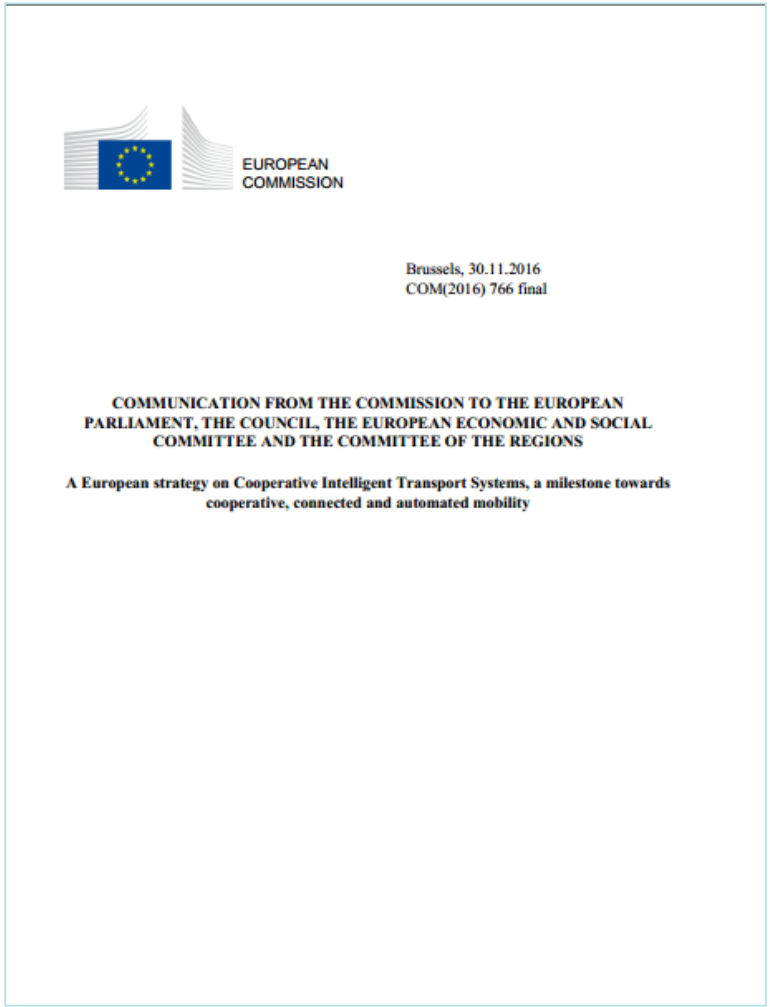

Figure 4: Costs for C-ITS deployment

# Car of the CCAM Times

- 

# Report to the EU Parliament (end of 2016)

- Day 1 C-ITS services – when deployed in an interoperable way across Europe – will produce a benefit cost ratio of **up to 3 to 1** based on cumulative costs and benefits from 2018 to 2030. This means that every euro invested in Day 1 C-ITS services should generate up to three euro in benefits.
- Rapidly deploying as many services as possible will also mean they break even more quickly and will lead to higher overall benefits, mainly due to the network effect (which means that slow initial uptake rates would result in relatively long periods with few benefits).
- Based on this work, the Reporting Commission considers that a list of technologically-mature and highly-beneficial C-ITS services should be deployed quickly so that end-users and society at large can benefit from them as soon as possible. This early deployment list is Day 1 C-ITS services list.
- In a second phase, the Day 1.5 C-ITS services list would be deployed. This is a list of services for which full specifications or standards might not be completely ready for large scale deployment from 2019, even though they are considered to be generally mature.



EUROPEAN COMMISSION

Brussels, 30.11.2016
COM(2016) 766 final

**COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS**

**A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility**

# Second phase of the C-ITS platform (July 2016 – September 2017)

C-ITS Platform Phase II

chaired by the

European Commission

- (July 2016 – September 2017)
- Progress towards the definition of implementation conditions for topics discussed during the first phase
- Recognizes and further investigates the mutual benefits that future C-ITS services will bring in terms of automation.
- The ultimate goal is the full convergence of all developments under Cooperative, Connected and Automated Mobility (CCAM)

# C-ITS

- Next time upcoming: V2X happens
- Thank you for your kind attention!