Automated driving roadmaps
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<tr>
<th>EU country</th>
<th>Non EU country</th>
<th>Platforms</th>
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<th>Research/Projects</th>
<th>Public</th>
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<tr>
<td>Declaration of Amsterdam</td>
<td>Canada (2x)</td>
<td>Ertrac</td>
<td>CLEPA</td>
<td>SMART Study Report</td>
<td>AASHTO</td>
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<td>Australia (3x)</td>
<td>EPoSS</td>
<td>Robert Bosch</td>
<td>Austria Research, Development &amp; Innovation Roadmap for AV</td>
<td>GEAR 2030</td>
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<td>Germany</td>
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<td>iMobility Forum</td>
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Decision-making roadmaps and EU regulations are integral to the development and deployment of autonomous driving (AD) technology. This involves a collaborative effort from various organizations and regulatory bodies.

**Decision-making**
- EU regulations
- Knowledge / pre-deployment

**Research**
- EU C-ITS Deployment Platform (S&T)
- ISO/TC 204 (T&O)
- CEDR (N6) (T)
- INTERCOR (T)
- EU EIP (Facilitating A.D.) (T)
- UNECE (WP 1, WP 29) (S&T)
- Round Table Oettinger (S)

**EU Truck Platooning**
- (with ERTICO)

**Knowledge / pre-deployment**
- STRIA (DG RTD)
- ACEA
- GEAR 2030 (S)
- ERTICO (T&O)
- CARTRE
- EURO NCAP (S&T)
- UNECE (WP 1, WP 29) (S&T)

**International Transport Forum (OECD)**
- High Level Group on Road Safety

**World Economic Forum WG A.D. (S)**
- TRB/ SIP ADUS (congresses)
- TRB/ SIP ADUS (congresses)
- EU EIP (Facilitating A.D.) (T)
- CEDR (N6) (T)
- EURO NCAP (S&T)

**European Commission**
- (Horizon 2020/ CEF/INTERREG)
- Benelux (S&T)
- CLEPA
- IRF

**Automated Vehicles Symposium**
- ERTAC (T)
- Benelux (S&T)
- FIA

**International**
- USD Japan cooperation

**Decision-making EU regulations**
- Declaration of A'dam, High Level Structural Dialogue (S)
Roadmaps EU countries

- Declaration of Amsterdam
- UK
- Germany
- Finland
- Austria
- France
Declaration of Amsterdam

• Declaration of Amsterdam
• 14 April 2016
• Signed by the transport ministers of all 28 EU member states
Highlights (objectives)

• to work towards a coherent European framework for the deployment of interoperable connected and automated driving, which should be available, if possible, by 2019;

• to bring together developments of connected and automated driving in order to reach their full potential to improve road safety, human health, traffic flows, and to reduce the environmental impact of road transport;

• to adopt a “learning by experience” approach, including, where possible, cross-border cooperation, sharing and expanding knowledge on connected and automated driving and to develop practical guidelines to ensure interoperability of systems and services;

• to support further innovation in connected and automated vehicle technologies to strengthen the global market position of European industry; and

• to ensure data protection and privacy.

Declaration of Amsterdam
Roadmap

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

Declaration of Amsterdam
The focus of this review is to ensure the UK is at the forefront of the testing and development of the technologies that will ultimately realise the goal of driverless vehicles.
Highlights: very elaborate!

• Very elaborate!

• Part 1: setting the scene (introduction, definitions, international situation).

• Part 2: the review (driver testing and licensing, driver behaviour, other road users, product liability, standards for new vehicles, vehicle roadworthiness and maintenance, safe use of vehicles, vehicle tax, registration and licensing, road infrastructure standards, insurance, data protection and privacy, theft and cyber security).

• Part 3: delivering the pathway to driverless cars (options, action plan, summary

• Annexes (A: international situation, B: innovative personal transport, C: response to consultation, D: actions for government).
Roadmap

Timeline for the development of highly and fully automated vehicles

- **February 2019**: Stakeholder call for evidence
- **Spring 2019**: Review UK regulations
- **Summer 2017**: Publication of The Pathway to Driverless Cars
- **End 2018**: Publication of the Code of Practice for public road testing
- **End 2019**: Review and revise UK domestic regulations
- **Target for updating UK regulations**

**UK Government**
- **Engage with international partners regarding automated vehicles**
- **Negotiate and agree changes to vehicle standards**:
  - European Whole Vehicle Type Approval
  - ISO standards for symbols and driver warnings
  - Other legal and regulatory framework aspects
- **Target for updating international regulations**

**UK Government and international partners**
- **Research and development of highly and fully automated vehicle technologies**
  - Production and testing of automated vehicle prototypes on closed roads/test-tracks
  - Testing of automated vehicle technologies on UK public roads
  - Production of highly and fully automated road vehicles

**Industry**

Department for Transport, United Kingdom
The Pathway to Driverless Cars: A Code of Practice for testing

• Department for Transport, United Kingdom
• February 2015

• The publication of this Code of Practice is intended to help manufacturers and those organising testing of these technologies by providing clear guidelines and recommendations for measures that should be taken to maintain safety during this testing phase.

Highlights

• General requirements
  • Safety requirements
  • Insurance
  • Infrastructure and transport authorities
  • Engagement

• Test driver, operator and assistant requirements
  • Requirements to oversee testing
  • Licence requirements
  • Training
  • Test driver hours
  • Behaviour
  • Assistants

• Vehicle requirements
  • General
  • Maturity
  • Data recording
  • Data protection
  • Cyber security
  • Process for transition between automated and manual modes
  • Failure warning
  • Software levels

Department for Transport, United Kingdom
Strategy for Automated and Connected Driving

- Federal Ministry of Transport and Digital Infrastructure, Germany
- September 2015

The Federal Government has set itself three objectives:
- remain a lead provider
- become a lead market
- put automated and connected driving on the roads

https://www.bmvi.de/SharedDocs/EN/Publikationen/strategy-for-automated-and-connected-driving.pdf?__blob=publicationFile
Highlights: 5 action areas

- Infrastructure
  - Digital Infrastructure
  - Standards for intelligent roads
- Legislation
  - International regulatory framework
  - National regulatory framework
  - Driver training
  - Type approval and technical inspection
- Innovation
  - Digital Motorway Test Bed
  - Research funding
- Interconnectivity
  - Mobility data and spatial data
  - Interlinking of traffic signs
  - High-precision map systems
- Cyber security plus data protection
  - Standardization of cyber security
  - Data protection
Roadmap

Automated driving

- Assisted driving
- Partially automated
- Highly automated
- Fully automated
- Autonomous driving

Degree of automation

Federal Ministry of Transport and Digital Infrastructure, Germany
Road Map and Action Plan 2016–2020

- Finnish Transport Agency, Finland
- 2016

Highlights

• Action planning (incl. stakeholder workshops)

• Roadmaps

• Actions plans

Finland is a leading utiliser of automated road transport.

This means that in Finland, all stakeholders have good preconditions to develop, test and deploy automated driving.

This provides companies with opportunities to improve their expertise and competitiveness, and to create easy-to-use automated driving solutions and services for their customers.

Figure 14. Vision for road transport automatisation.
Roadmap: very elaborate!

Table 5. High-level political and strategic action cards. Legend: dark colour = actions/deployment and light colour = monitoring.

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Table 6. Transport infrastructure action cards. Legend: dark colour = actions/deployment and light colour = monitoring.

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<td>Mobile road infrastructure (e.g. roadworks, special events, etc.)</td>
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<td>Guidelines and verification of road network for automated driving</td>
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<td>Visibility and condition of road markings and traffic signs</td>
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<td>Harmonisation of road traffic control</td>
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Table 7. Traffic action cards. Legend: dark colour = actions/deployment and light colour = monitoring.

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<td>Identification of abnormal and hazardous transports</td>
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<td>Basic use of information in driving</td>
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<td>Access to vehicle resources and data</td>
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<td>Availability of data on vehicle features and equipment</td>
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<td>Provision of vehicle safety data to authorities</td>
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<td>Changes in inspection of vehicle\’s health/wellness</td>
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<td>Positioning of vehicle</td>
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<td>Personalisation of automated function parameters by users</td>
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<td>Environmental sensing</td>
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<td>Test vehicles and buses</td>
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<td>Right to drive and examination in transition phase</td>
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Table 8. Communication infrastructure action cards. Legend: dark colour = actions/deployment and light colour = monitoring.

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<td>30</td>
<td>Radio frequency allocations</td>
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<td>31</td>
<td>Availability of communication infrastructure</td>
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<td>Critical communications</td>
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Finnish Transport Agency, Finland
Automated - Connected - Mobile

- Action Plan Automated Driving - Executive Summary
- Federal Ministry of Transport, Innovation and Technology, Austria
- June 2016

http://www.smart-mobility.at/fileadmin/media_data/services/Thematisches/Actionplan_automated_driving.pdf
Highlights: deployment measures

• Enable & regulate Test Drives
• Development of a Code of Practice
• Initial Studies for the Construction of Test Environments
• Build up Test Environments
• Development of a Technology Funding Portfolio
• Ensuring the Digital Infrastructure as a Strength
• Ensuring Scientific Competencies
• Development of Evaluation Tools
• National Contact Point for Automated Driving
Roadmap (schedule)

Federal Ministry of Transport, Innovation and Technology, Austria
Objectifs de recherche Nouvelle France Industrielle Véhicule Autonome

• La Nouvelle France Industrielle – Véhicule Autonome, France

• 2015

Highlights

• Research subjects:
  • In-vehicle intelligence
  • Sensing and data fusion
  • Decision making
  • Positioning
  • Connectivity
  • Human factors and HMI
  • Security
Roadmaps non EU countries

• Canada (2x)
• Australia (3x)
• New Zealand
• United States (2x)
• Japan
• Korea
Automated vehicles

• The coming of the next disruptive technology
• The conference board of Canada
• January 2015

Highlights

• Status of Automated Vehicles and Trends
• The Impact of AVs on Canada’s Economy
• The Impact of AVs on Infrastructure
• The Automated Vehicle’s Impact on Our Wallets

• Five potential priorities for Canada:
  • Augment political leadership at the federal level, comparable with what we see in other countries, especially for the impact on vehicle standards, the technology sector, the auto industry, and the economy.
  • Enhance political leadership at the provincial and territorial level for transportation systems and regulations.
  • Boost leadership at the municipal level to incorporate the impact of AVs into urban planning, transit, and the design of infrastructure projects.
  • Measure the potential impact of AVs on Canadian businesses.
  • Encourage the creation of a Canadian ecosystem to compete for a share of the global market for AV software, parts, and components

• The cumulative potential benefits from the factors described above are $65 billion per year
• In total, the estimated cost savings are nearly $3,000 per household
The Roadmap for Autonomous (Self-Driving) Vehicles in Ontario, Canada

- Ontario Good Roads Association, Canada
- July 2015

https://www.ogra.org/.../Roadmap%20for%20AVs%20in%20Onta...
Highlights

• An ecosystem (of “hubs”) for success

• Being careful with personal data

• Integrating with the education sector

• Laws and regulations
National Policy Framework for Land Transport Technology

- Transport and Infrastructure Council, Australia
- August 2016

Highlights

• How Can Current and Emerging Transport Technologies Help?

• Key Issues for Government in Deploying New Transport Technologies
  • Safety, Security and Privacy
  • Digital Infrastructure
  • Data
  • Standards and Interoperability
  • Disruption and Change
## Roadmap: National Transport Technology Action Plan

<table>
<thead>
<tr>
<th>Action Item</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establish a regulatory framework for testing automated vehicles</td>
<td>Late 2017</td>
</tr>
<tr>
<td>Develop national operational guidelines to support the on-road use of automated vehicles</td>
<td>Late 2017</td>
</tr>
<tr>
<td>Undertake priority trials and research of Intelligent Transport Systems</td>
<td>2016-19</td>
</tr>
<tr>
<td>Develop a connected vehicle (Cooperative ITS) infrastructure road map</td>
<td>Mid 2017</td>
</tr>
<tr>
<td>Publish a connected vehicle (Cooperative ITS) statement of intent on standards and deployment models</td>
<td>Early 2017</td>
</tr>
<tr>
<td>Develop a nationally agreed deployment plan for the security management of connected and automated vehicles</td>
<td>Mid 2018</td>
</tr>
<tr>
<td>Investigate options to provide enhanced geo-positioning information to the land transport sector</td>
<td>Late 2017</td>
</tr>
<tr>
<td>Improve the availability of open data in the transport sector</td>
<td>2016-19</td>
</tr>
<tr>
<td>Explore options to increase the uptake of telematics and other technologies for regulatory and revenue collection purposes</td>
<td>Mid 2017</td>
</tr>
<tr>
<td>Evaluate low-cost technologies to improve safety at rail level crossings</td>
<td>Late 2017</td>
</tr>
<tr>
<td>Explore how data from telematics and other intelligent transport systems can be used to optimise operations and planning for port precincts and intermodal terminals</td>
<td>Mid 2017</td>
</tr>
<tr>
<td>Investigate options for interoperable public transport ticketing</td>
<td>Late 2017</td>
</tr>
<tr>
<td>Investigate the costs, benefits, and possible deployment models for Automatic Crash Notification</td>
<td>Mid 2017</td>
</tr>
<tr>
<td>Explore the merits of adopting new safety and traffic management technologies</td>
<td>2016-19</td>
</tr>
</tbody>
</table>
Automated Vehicles: Are we ready?

- Internal report on potential implications for Main Roads WA
- Main Roads Western Australia
- January 2015

Highlights

• Emerging issues with Automated Vehicles
  • Electronic control system safety
  • Human factors
  • Liability and insurance
  • Legislation
  • Privacy
  • Cybersecurity (vulnerability to hacking)
  • Public acceptance
  • Vehicle positioning accuracy

![Figure 3.1 How concerned are you about different issues with Level-4 AVs? - Responses from the Australian public. Source: Schellie and Suss (2019)](image)
Roadmaps: likely adoption rates and timelines

Table:

<table>
<thead>
<tr>
<th>Timescale</th>
<th>Potential Implementation</th>
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</thead>
<tbody>
<tr>
<td>Now - 2025</td>
<td>• Increasing automation of driving functions, even on affordable cars</td>
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<tr>
<td></td>
<td>• Vehicles park themselves</td>
</tr>
<tr>
<td></td>
<td>• Vehicle to vehicle communication</td>
</tr>
<tr>
<td></td>
<td>• Vehicles drive themselves in traffic jams or highways (adaptive cruise control)</td>
</tr>
<tr>
<td></td>
<td>• Early adopter entrepreneurs start to hire out AVs</td>
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<tr>
<td></td>
<td>• Taxi industry disruption</td>
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<td></td>
<td>• Standardisation of communication and technology protocols</td>
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<tr>
<td>2025 - 2035</td>
<td>• Car ownership declines - car sharing increases. Demand for parking starts to decline</td>
</tr>
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<td>• Bus service disruption - segregated or guided busways become fully electric, bringing costs down</td>
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<td></td>
<td>• Logistics industry disruption</td>
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<tr>
<td></td>
<td>• Vehicle to vehicle and vehicle to infrastructure communication technology matures</td>
</tr>
<tr>
<td>2035 - 2045</td>
<td>• Accidents/collisions significantly reduce</td>
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<td>2045 onwards</td>
<td>• Vehicle seat/weight emissions reduce. New vehicle platforms</td>
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<td>• Catalyst for alternative mass produced propulsion systems - electric</td>
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<td>• Catalysis for total intensives (load charging, pay as you go)</td>
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<td>• Urban road-space optimisation - narrower lanes, tighter intersections etc</td>
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<tr>
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<td>• Reduced need for urban parking - re-inventing/relocating car parks, on-street parking space reallocated for other road uses (walking, cycling, market stalls)</td>
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<td></td>
<td>• Vehicles on demand - no reduction in availability or quality of service</td>
</tr>
</tbody>
</table>

Figure 8.3: Potential 20-year implementation scenarios for AVs (adapted from Jacobs, 2013a)
Regulatory reforms for automated road vehicles

• National Transport Commission (NTC), Australia
• November 2016
• Recommendations approved by the Transport and Infrastructure Council
• This policy paper sets out transport and infrastructure recommendations for policy and regulatory reforms to support automated road vehicles in Australia.

Highlights [1/2]

• Supporting on-road trials
• Clarifying the meaning of *control* and *proper control*
• Safety assurance for vehicles that do not require a human driver
• Clarifying the meaning of *driver* and *driving*
• Vehicle design and standards
• Vehicle modification and in-service compliance
• Liability
• Data
  • Accessing data for enforcement and regulatory purposes
  • Accessing data to determine fault and liability
  • Protecting privacy
Highlights [2/2]

• Operational and investment issues
  • road manager commitment to, and investment in, vehicle-to-infrastructure connectivity
  • nationally-consistent road network infrastructure, including temporary and electronic road signage
  • access to accurate and timely road infrastructure data, such as temporary speed zone data
  • co-existence of automated vehicles with other road vehicles, including powered two wheelers and emergency vehicles
  • investment in satellite-based augmentation systems to improve the accuracy and integrity of global navigation satellite system (GNSS) location data
  • refuelling of automated vehicles.

• Broader societal issues
  • access equality – optimising mobility for older people and people with disabilities
  • education of end users, other road users and vulnerable road users
  • impacts on traffic and congestion and network planning
  • land use planning
  • urban parking
  • public transport demand
  • ridesharing and taxi reform
  • issues related to changing job opportunities
  • environmental impacts, including the potential for higher carbon emissions resulting from highly intensive on-demand passenger services.

• The vehicle can safely manage:
  • responding to temporary speed zones (such as roadworks)
  • responding to traffic controls (such as stop signs, variable speed signs and traffic lights)
  • all likely road conditions (such as unsealed roads)
  • all likely environmental conditions (such as dust storms or flooding)
  • interaction with trains and light rail (such as railway level crossings)
  • interaction with vulnerable road users (such as compliance with one metre clearance for cyclists)
Roadmap: near-term reforms (2017-2018)

- Government support of on-road trials of automated vehicles for all levels of automated driving
- Certainty for industry and governments as to:
  - (1) who is in control of an automated vehicle
  - (2) how enforcement agencies will apply the ‘proper control’ requirement in the road rules to all levels of driving automation
- A complete regulatory framework to support the safe commercial operation of automated vehicles
- A complete regulatory framework to support the safe operation of automated vehicles
- Regulation of government access to automated vehicle data to achieve road safety and network efficiency outcomes, efficient enforcement of traffic laws and sufficient privacy protections for users

National Transport Commission (NTC), Australia
Testing autonomous vehicles in New Zealand

- New Zealand Government, Ministry of Transport
- November 2016

- Invitation for testing in New Zealand
- Potentially, testing can take place on any part of the road network

Highlights

• General obligations for anyone wanting to test autonomous vehicles
• Insurance
• Testing and safety management plans
• Engagement
• Test vehicles
• Test vehicle operators
• Control of software and data security
ITS Strategic Plan

• Department of Transportation, United States
• Joint Program Office (JPO)
• December 2014

Highlights

• Strategic Priorities and Themes
  • Enable Safer Vehicles and Roadways
  • Enhance Mobility
  • Limit Environmental Impacts
  • Promote Innovation
  • Support Transportation System Information Sharing

• Automation program goals
  • Define the core elements and the performance criteria for automation (Research)
  • Test automation components in the CV Pilots, as well as in other test situations as available (Development)
  • Define the Federal role in facilitating and encouraging deployment of automated systems (Adoption)
**Roadmap [1/2]**

**U.S. DOT Automation Program Roadmap**

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<tbody>
<tr>
<td>2017</td>
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<td></td>
<td>Examine Control Systems and Vehicle Health Management Analysis</td>
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<td></td>
<td>Automated Vehicle Policy Based Evaluation</td>
</tr>
<tr>
<td>2018</td>
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<td></td>
<td>Functional Safety and Performance Requirements for AVs</td>
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<td></td>
<td>Automated Vehicle Policy Based Evaluation</td>
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<tr>
<td>2019</td>
<td></td>
<td></td>
<td>Cybersecurity Requirements for Automated Vehicles</td>
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<td>Automated Vehicle Policy Based Evaluation</td>
</tr>
</tbody>
</table>


Department of Transportation, JPO, US
### Table 4: Automation Research Questions that Guide the Detailed Programs

**Research**

<table>
<thead>
<tr>
<th>Question</th>
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<tbody>
<tr>
<td>What should be the role of the Federal government in automation research and development?</td>
</tr>
<tr>
<td>What policies are needed to harness benefits from automated vehicles?</td>
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<tr>
<td>What are the benefits from establishing connected automation?</td>
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<tr>
<td>What are users’ expectations for automated vehicles?</td>
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<tr>
<td>What are the security needs for various levels of automated environments?</td>
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<tr>
<td>What are the liability issues related to automation?</td>
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<tr>
<td>How to define characteristics for the automation environment?</td>
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<tr>
<td>What are the core elements and the performance criteria for automation?</td>
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<tr>
<td>What are the risks associated with automation applications?</td>
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<tr>
<td>What role will infrastructure play in an automated environment?</td>
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**Development**

<table>
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<tr>
<th>Question</th>
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<tbody>
<tr>
<td>What are the non-technical barriers to deployment of automated systems?</td>
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<tr>
<td>What automated vehicle applications can be demonstrated before 2019?</td>
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<tr>
<td>What technical challenges are barriers to deployment of automated systems?</td>
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<tr>
<td>What aspects of automated vehicles impact current law enforcement activities?</td>
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<tr>
<td>How does data produced from “opt in” systems or applications impact policy?</td>
</tr>
<tr>
<td>How do vehicle automation systems leverage connectivity to improve their performance and reliability?</td>
</tr>
<tr>
<td>What type of naturalistic testing should the USDOT support for automated vehicle systems?</td>
</tr>
<tr>
<td>Is there a consolidated focus between CV pilots and automation?</td>
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</table>

**Adoption**

<table>
<thead>
<tr>
<th>Question</th>
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<tbody>
<tr>
<td>What is the appropriate Federal role in facilitating and encouraging deployment of automated systems? Is this different at different levels of automation?</td>
</tr>
<tr>
<td>What is the role of early adopters (specialized drivers) in automation adoption and deployment?</td>
</tr>
</tbody>
</table>
Federal Automated Vehicles Policy

- Department of Transportation (DOT), United States
- National Highway Traffic Safety Administration (NHTSA)
- September 2016

As the Department charged with protecting the traveling public, we recognize three realities that necessitate this guidance.

First, the rise of new technology is inevitable.
Second, we will achieve more significant safety improvements by establishing an approach that translates our knowledge and aspirations into early guidance.
Third, as this area evolves, the “unknowns” of today will become “knowns” tomorrow. We do not intend to write the final word on highly automated vehicles here. Rather, we intend to establish a foundation and a framework upon which future Agency action will occur.

Tasks of facilitating the safe introduction and deployment of HAVs:

- Vehicle Performance Guidance for Automated Vehicles
- Model State Policy
- NHTSA’s Current Regulatory Tools
- New Tools and Authorities
Automated Driving Systems Activities

- Cross-Ministerial Strategic Innovation Promotion Program (SIP), Japan
- Presentation(s)
- SIP-adus: One of eleven SIP projects
  - Automated Driving for Universal Services

https://www2.unece.org/wiki/download/attachments/17760916/03_Japan%E2%80%99s%20views%20on%20Automated%20Driving%20rev.pdf?api=v2
https://drive.google.com/drive/folders/0BzVs7r9vCuRRTRlQWhtalJxUms?usp=sharing
Highlights

- 20-30 projects per year
Roadmap [1/2]
Roadmap [2/2]

Roadmap for Development of Auto Pilot System

Goal set out by the Government (Japan Revitalization Strategy)
Making a test installation of Automated Driving System

Scope

2013 - 2015
Drivers’ assists
- High condition
  - Traffic condition evaluation level
  - System type
  - Scope
  - Roadway

2020 - 2030
Extend scope area of vehicles’ assists (normally only driver monitoring, in emergency, driver takes control)
- High condition
  - Traffic condition evaluation level
  - System type
  - Scope
  - Roadway

Main issues

Vehicle side
- Combined Driver Assistance System (ACC-lane keeping assist)
- Driver system developed, commercialized
  (ACC, lane keeping assist, congested driving assist system, lane change assist system)
- Advanced Infrastructure Information
  Driver assistance by both vehicles and roads synchronously/during connection

Road side
- Real time Information (real time information and changes of controlled area)
- Information of details of Road structure and data
Automated Driving Development in Korea

- The Korea Transport Institute
- Presentation
- October, 2015

https://drive.google.com/drive/folders/0BzVs7yCuRRTRI4QWha1xUms?usp=sharing
Highlights

II. Main Activities for Deploying C-ITS Infra.

C-ITS Infrastructure

R&D → FOT → Pre-Deployment → Deployment

ITS Master Plan 2020 → ITS Master Plan 2020 (revision)

- Key committee: ITS committee with MOLIT
- Projects for proof of concept, FOT: u-Transportation, Smart Highway
- Projects for Pre-Deployment: Next-Generation ITS Pilot (’14~’17)
- Project for Pilot Deployment: C-AHS, Cooperative Automated Highway System (’15~’20)
- Focused mainly on V2I
Roadmap

II. Main Activities for Deploying C-ITS Infra.

C-ITS Infrastructure: Master Plan

- Long-term Strategies (tbd)
- V2I and V2V based on safety in metropolitan
- Equipped for commercial veh.
- Autonomous road and veh.
- Level 4 & 5
- Expressways National roads Urban roads
- 2014-2020: Introduction
- 2021-2025: Expansion
- 2026-2030: Maturity
- $3.6 billion
- Traffic accident death zero

III. Main Activities for Testing Automated Vehicles

Automated Driving with C-ITS: Key Roadmap

- 2015: Level 2
  - Law revision to make it possible to drive the AV for testing on the public roads
  - Improving GPS accuracy
  - Infrastructure (e.g., C-ITS Pilot)
  - Road designation for testing the AV (e.g., Expressways, National roads)

- 2018: Testing of Level 3
  - Lane-based road map
  - Cooperation between Infrastructure and the AV (e.g., C-AVHS)
  - Key services during the Pyeongchang Winter Olympic

- 2020: Product of Level 3

The Korea Transport Institute
Roadmaps EU platform

- Ertrac
- EPoSS
- iMobility Forum
Automated Driving Roadmap

• ERTRAC Task Force “Connectivity and Automated Driving”
• July 2015

Highlights: Key Challenges and Objectives

- Environmental Detection and perception
- Demonstrating Reliability, Safety and Robustness of Technology
- Legal and Regulatory Framework
- Users’ and Societal Acceptance
- Driver Attention and involvement
- Common validation procedures and Testing Requirements
- Infrastructure Requirements
- Industrialisation

ERTRAC Task Force
Roadmap [1/2]

Level 6 - Full automation
Level 5 - Full automation
Level 4 - High automation
Level 3 - Partial automation
Level 2 - Slew assistance
Level 1 - Automatic
Driver Level 0 - Driver Level 0

Vehicle path
Urban Environment Systems

ERTRAC Task Force
Roadmap [1/2]
European Roadmap Smart Systems for Driving

- European Technology Platform on Smart Systems Integration (EPoSS)
- April 2015
Highlights: challenges

- Challenges
  - Data security
  - Legal issues
  - Liability and safety
  - Rebound effects
  - Economic aspects
  - Validation aspects
  - Ethics
Figure 4: Development paths and milestones for Levels 3 and 4 of road vehicle automation until 2030 depending on velocity and complexity of the driving situation. The solid path represents the evolutionary scenario and the dashed line the revolutionary one. Both paths may eventually lead to the autonomous car which is indicated here as Level 5 of automation. The three milestones are indicated as years surrounded by frames. The full availability of the traffic jam chauffeur is to be expected for 2020 at the latest, while the availability of the highway chauffeur should follow right afterwards, around 2022. The highway autopilot as Level 4 is indicated as the second milestone which is to be reached in 2025. Undisturbed and safe driving in cities is considered to be the most complex task of the Level 4 automation for which full availability will be expected for 2030 in protected environments.
Roadmap [2/2]

- **ACTIVITY FIELDS**
  - Technology Inside Car
  - Infrastructure
  - Big Data
  - System Integration and Validation
  - System Design
  - Standardization
  - Legal Frameworks
  - Awareness Measures

- **2020**
  - R&D
  - Demo
  - Industry

- **2025**

- **2030**

- **MILESTONES**
  - Conditional automated driving (Level 3) for low velocities and in less complex driving environments
  - Highly automated driving (Level 4) on highways
  - Highly automated driving (Level 4) deployed in cities
Automation in Road Transport

• iMobility Forum, Working Group Automation in Road Transport
• May 2013

Highlights

• Impacts and concept areas
• Legal issues
  • Liability
  • Regulatory law
  • Standardisation
  • Certification and verification
• Research needs:
  • Perception
  • Cognition and human factors
  • Traffic management
  • Modelling
  • Fail safe actuation of the automated vehicle
  • Independent validation of high and full automated systems
  • Liability and legal aspects
Roadmap

• The roadmaps have a basic setup in which we discriminate between 3 phases with its subsequent TRL levels:
  • 1. Technological research;
  • 2. Piloting, large scale demonstrators;
  • 3. Industrialisation
Roadmap highway
Roadmap urban
Roadmaps industry

• CLEPA
• Robert Bosch
• Continental
• Groupe Renault
• JAMA
CLEPA Automated Driving Position Paper

- CLEPA, European Association of Automotive Suppliers
- October 2014

CLEPA companies are dedicated to transport sustainability by improving air quality, energy efficiency and road safety. The automation of the driving tasks is one of the emerging technical evolutions which will help in meeting these challenges while contributing to maintaining the technological leadership of the European Automotive Industry.

From a technological point of view, automated vehicles represent the evolution of advanced driver assistance systems, which we already have today. Research results reflect the feasibility of higher levels of automation as well as the beneficial effect on road safety, emissions reduction, fuel consumption and traffic congestion reduction. With regard to road safety, around 90% of all accidents are caused by human errors. A zero-accident approach must address the driver as main root cause.

Setting up an effective global regulatory framework is one of the vital pre-conditions for successful developments and market introduction.

The 1968 Vienna Convention on Road Traffic needs to be amended to allow automated driving. CLEPA welcomes the decision of the UN Working Party on Road Traffic Safety (WPI) taken in March 2014 and hopes national traffic laws will soon be amended accordingly. The necessity of further legislative amendments should be assessed to allow full implementation of automated driving systems in particular with respect to driver attention.

In parallel, the technical prescriptions of some UN Regulations under the 1968 Agreement also need some adaptations. In particular UN Regulations on steering, braking and lighting and light signaling need to be analyzed and CLEPA will prepare with the industry stakeholders the relevant draft amendments.

Another issue for a successful deployment of automated driving is user and societal acceptance. Therefore, it is essential to raise awareness and involve all stakeholders in an open communication on benefits and challenges of a higher level of driver assistance to reach a wide market acceptance.

This acceptance would need to be assessed and monitored. CLEPA is willing to contribute to this process.

CLEPA will support a stepwise approach towards higher levels of automated driving. CLEPA R&I roadmaps support this development with technological advancements in key innovation areas (i.e. safety and ITS). These include necessary progress and implementation of advanced safety technologies, communication, data handling, highly precise dynamic positioning, environmental recognition, human factors and human machine interaction, etc. Regarding communication CLEPA supports activities accelerating deployment of vehicle to vehicle (V2V) and vehicle to...
Highlights

• Setting up an effective global regulatory framework is one of the vital pre-conditions for successful developments and market introduction.

• Another issue for a successful deployment of automated driving is user and societal acceptance.

• CLEPA R&I roadmaps include necessary progress and implementation of advanced safety technologies, communication, data handling, highly precise dynamic positioning, environmental recognition, human factors and human machine interaction, etc.

• CLEPA supports activities accelerating deployment of vehicle to vehicle (V2V) and vehicle to 2 infrastructure (V2I) communication such as the development of an interoperable, open access, secured and standardised telematics platform.
The road towards automated driving

- Robert Bosch
- 2015
Highlights

• The communication protocols for data exchange between vehicles must also be standardized.

• A critical mass of vehicles that can communicate with each other (around 10 percent) is required for standard operation.

• In addition to the technical challenges, the legal framework must also be adjusted or recreated from scratch in order to pave the way for automated driving.

• In many countries, the law states that:
  • Any moving vehicle must have a responsible driver
  • The driver must constantly be able to control the vehicle
  • The driver must refrain from all other activities while driving the vehicle

• A major regulatory milestone towards the deployment of automated vehicle technologies was attained on 23 March 2016 with the entry into force of amendments to the 1968 Vienna Convention on Road Traffic. As of that date, automated driving technologies transferring driving tasks to the vehicle will be explicitly allowed in traffic, provided that these technologies are in conformity with the United Nations vehicle regulations or can be overridden or switched off by the driver.
From Assisted to Automated Driving

- Continental
- 2015
Highlights

Automated Driving
Motivations & Success Factors

**Motivation 1:**
Converting driving time to higher valued time

Success depends on **consumer** valued benefit/cost ratio

**Motivation 2:**
Accident-free driving, the prerequisite for Motivation 1 (boosting Vision Zero)

Success depends on **economic** valued benefit/cost ratio
(e.g. 174 bn. €¹ economic saving potential in EU should be motivation for politics)

## Roadmap

### Assist and Automation

<table>
<thead>
<tr>
<th>System</th>
<th>Fully AD</th>
<th>The driver need not (permanently) monitor the system</th>
<th>fail operational (redundant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Full Automation**
  - Level 5
  - >2025

- **Conditional, High Automation**
  - Level 3, 4
  - 2020

- **Partial Automation**
  - Level 2
  - 2013 (Mercedes S-Class)

- **Assisted**
  - Level 1
  - 1998 (Mercedes S-Class)

- **Driver Only**
  - Level 0
  - 1959 (Porsche 356)

---

**Abbreviations:**
- ABS: Anti-lock Brake System
- AD: Automated Driving
- ACC: Adaptive Cruise Control
- BA: Brake Assist
- DAS: Driver Assistance Systems
- ESA: Emergency Brake Assist
- ESC: Electronic Stability Control
- IHC: Intelligent Headlight Control
- LDW: Lane Departure Warning
- LKA: Lane Keeping Assist
- *DAS package*: ACC, Pre-SAFE, LDW, LKA, IHC

---

**Division:** Chassis & Safety

**Public:** 8 November 2015

**A. Eckert, © Continental AG**
France industry plan

• Groupe Renault
• 2015

• 3 ambitions for France:
  • a place for autonomous vehicle experimentation
  • a center of excellence for embedded intelligence technologies
  • a key player within critical system safety domain
Highlights

Regulations
- Vienna convention
- UNECE groups WP1&29

Global society
- Efficient mobility
- Safety
- Environment
- Space in cities

Customer values
- Safety & security
- Quality of life
- Freetime
- Mobility for all

Automobile and Connected Car

Conclusions for success

Standards
- Safety
- HWN principles
- Infrastructures
- Data platforms
- AD Central ECU

Technology
- Semantics
- Decision making
- Functional safety
- Data security
- Accurate and simple HW
- Interior design

Activity | TRL
--- | ---
Industrialisation | 9-6

--- | --- | --- | --- | --- | --- | ---
Regulation / standards
- For Level 3/4
- For Level 3/4
- For Level 3/4
- For Level 3/4
- For Level 3/4
- For Level 3/4
- Ready for AD applications

Pilot / large Experimentations | 6-5-6-7
Safety | 5-6-7

Demonstration

Call for projects

Technological research | 2-3-4

Safety and security design, SW, process, methods & tools
- HWN issues:
- Emotions/feedback
- Evaluation methodologies
- Impact assessment: legal barriers

Risk management
- Liability
- Responsibility

Partnerships
- Suppliers (new ones)
- Cities
- IT, Teleco, etc...

Business
- Product line-up
- Business model
- Marketing
- CRM

Lobbying
- Experiments: FOT funding
Roadmap

- Before 2020
  - Traffic Jam on highway Level 3/4
  - Highway Level 3/4
  - Intelligent parking and maintenance
  - Platooning on highway

- 2020 - 2030
  - Shared fleet
  - Shuttles platooning
  - Industrial sites
  - Platooning
  - Valet Parking Level 4
  - On demand transport

- > 2030
  - Every situation
  - Shared tasks
  - Delivery in all situations

Legend:
- Yellow: On private or industrial road
- Green: On open road

* SAE/OICA Level
On the road to automated driving

• Japan Automobile Manufacturers Association, Inc. (JAMA)
• February 2016

A “Strategic Innovation Program” is in fact underway in Japan, aimed at introducing next-generation road traffic systems and automated driving systems by the target year of 2020, when Tokyo is scheduled to host the Olympic and Paralympic Games.

Highlights
Roadmap
Roadmaps research / projects

- SMART Study Report
- Austria Research, Development & Innovation Roadmap for AV
- TNO – Truck Platooning
SMART study report

- Definition of necessary vehicle and infrastructure systems for Automated Driving
- Commissioned by: European Commission
- Prepared by: TNO, DLR, Frost & Sullivan, University Southampton, Tecnalia
- 2010
Highlights

Main conclusions:

- It is necessary to create a short- to long-term plan that could efficiently lead the gradual introduction of automated driving applications in groups, categorized according to specific criteria and fulfilling categories of requirements (for example, mandating a certain level of safety at intersections by means of V2V communication).

- Investments in the appropriate infrastructure are postponed or even denied until vehicle manufacturers take the lead to implement the related applications and the other way around. By acting in a more resolute manner at the legislative level it will be possible to break this issue into solvable situations, which could easily be agreed upon for the benefit of all participants in traffic, of the manufacturing industry, and of legislators as well.

- A more concrete standardization program will certainly help the industry, the regulators, and the road infrastructure owners to take the right decisions in due time and avoid thereby undesired costs introduced by uncertainties in their business models.

- Advanced automated driving will require more accurate global positioning of the vehicle along its path. Electronic components exhibits much lower development cycles compared to the renewability cycles in the conventional automotive industry. This inconsistency may lead to serious problems during the exploitation time of the vehicle.

- The legislators should embrace now the challenge of preparing in due time an adequate legislative framework that covers maybe more complex issues than liability alone, while allowing for sufficient innovation freedom to enable new technical developments and business models.
Roadmap
Research, Development & Innovation roadmap for AV

- Supported by bmvit, ITS Austria, ECSEL Austria, A3PS, AustriaTech, ASFiNAG, ÖBB, FFG, Austrian industry, and Austrian research & academia
- 2015

Highlights

• Wide range of areas, including aerospace, railways and waterways

• Five main task fields of activities (TF) have been identified as highly relevant for Austrian industry and thus constitute the backbone of the Austrian RDI Roadmap “Automated Vehicles”:
  • TF_1 System architecture,
  • TF_2 Hardware, Sensors, Actuators, Connectivity,
  • TF_3 Embedded SW & Cyber-Physical Systems,
  • TF_4 Integration, V&V, and Field Tests, and
  • TF_5 ADAS Applications.
Truck Platooning

- TNO
- February 2015
Highlights

DEVELOPERS
- Truck manufacturers, OEMs
- Tier suppliers

USERS
- Shippers
- Carriers/LSPs
- Platooning Service Providers

POLICY MAKERS
- Ministries
- Local government

REGULATORS
- Type approval authority
- Road infrastructure manager
- Inspection
- Customs
- Insurers

Fig. 8. Stakeholders influenced by the platooning innovation

BUSINESS VALUE
- Fuel consumption
- Driver efficiency optimisation
- Reduced truck idle time; enhanced efficiency
- Labour costs

SOCIAL VALUE
- Benefits of Truck Platooning
- Emission reduction
- Increased traffic efficiency
- Less congestion
- Reduced capacity optimisation
- >0% of accidents and damages caused by human error

Through mileage improvements 2.6 kg CO2/L diesel

>1st truck 6% @ 0.5s/2.0 L/100 km
>2nd truck 5.8% @ 0.3s/2.8 L/100 km

TNO
Roadmap

2014: Develop technical demo on A270, assess safety case.

2015: Towards technical feasibility; simulations on logistics & traffic impact; evaluate safety case; draft type approval method & legal framework.

2016: Up-scaling towards logistical exploration and validation in pilot, updated proposal type approval method & legal framework.

2017: Up-scaling towards implementation in pilot, multivendor interoperability analysis, final proposal type approval & legal framework.

2018: Towards commercial implementation; type approval and legal framework in place; commercial start Truck Platooning.

2019:

2020:
Roadmaps public

• AASHTO
• GEAR 2030
• CEDR
• ITFVHA
Connected/Automated Vehicle Research Roadmap for AASHTO

• American Association of State Highway and Transportation Officials, United States
• National Cooperative Highway Research Program (NCHRP), United States

• NCHRP 20-102 [Active]

Highlights: active tasks

LISTING OF TASKS

20-102(01) Policy and Planning Actions to Internalize Societal Impacts of CV and AV Systems into Market Decisions
20-102(02) Impacts of Regulations and Policies on CV and AV Technology Introduction in Transit Operations
20-102(03) Challenges to CV and AV Application in Truck Freight Operations
20-102(05) Strategic Communications Plan for NCHRP Project 20-102
20-102(06) Road Markings for Machine Vision
20-102(07) Implications of Automation for Motor Vehicle Codes
20-102(08) Dedicating Lanes for Priority or Exclusive Use by CVs and AVs
20-102(09) Providing Support to the Introduction of CV/AV Impacts into Regional Transportation Planning and Modeling Tools
20-102(10) Cybersecurity Implications of CV/AV Technologies on State and Local Transportation Agencies
20-102(11) Summary of Existing Studies on the Effects of CV/AV on Travel Demand
20-102(12) Business Models to Facilitate Deployment of CV Infrastructure to Support AV Operations
20-102(13) Planning Data Needs and Collection Techniques for CV/AV Applications
20-102(14) Data Management Strategies for CV/AV Applications for Operations

To create a link to this page, use this URL: http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.aspx?ProjectID=3824
Roadmap (starting 2015)
GEAR 2030 Discussion Paper

- European Commission
- Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

Roadmap on Highly Automated Vehicles

Recent developments in vehicle automation technology (e.g., automatic braking, lane keeping systems) are moving us closer to increasingly automated vehicles. This development complements the parallel development of connectivity in vehicles.

Automated and connected vehicles raise cross-cutting issues involving different departments within the Commission and Member States. The different issues on automated and connected vehicles mean that we will need to work closely with other DGs (mainly DG CONNECT, DG GROW, DG FINMA, DG JUST, DG MOVE, DG RTD etc.) in a coherent manner at EU level.

This is why some stakeholders have explicitly requested to consider an EU roadmap on highly automated vehicles in the framework of the GEAR 2030 (ex-CARS 2020 high level group) putting together all the automotive stakeholders (e.g., car industry, IT industry, insurers, interest groups etc.) and policy makers (Ministers, Commissioners). It is important for Europe to overcome silos to be a competitive player on automated and connected vehicles.

This note first presents the main challenges and opportunities for highly automated vehicles and then suggests a way forward for the GEAR 2030 roadmap.

1. AUTOMATED VEHICLES: AN EVOLUTION THAT COULD MAKE A REVOLUTION

Automated vehicles should come step by step. While the term “driverless” is often used, the reality is that entirely removing the need for a driver is a longer term goal for most vehicle types (See Annex 1) as the technical challenges for fully automated vehicles in any traffic conditions are still very high for manufacturers.

The concept of “automated vehicles” is also often associated with “connected vehicles”. However, the two concepts are different. On the one hand, partially automated vehicles are already available on the market and are able to sense their environment without necessarily being connected to a network, a road infrastructure or to other vehicles. On the other hand, connected vehicles available on the market (internet surfing, info traffic, GPS, eco-fu, vehicle-to-vehicle and vehicle-to-infrastructure short-range communication, etc.) do not carry out driving tasks for the driver (like automated vehicles). Contrary to automated vehicles, connected vehicles do need an interoperable communication network that, depending on the application, can either be a dedicated network (see C-ITS platform from DG MOVE) or can use a commercially available network like the cellular communication network.

All in all, the development of connected vehicles and automated vehicles will follow parallel routes which will have to converge to make full use of all the potential benefits of fully autonomous/driverless cars (see Annex 2) and therefore need coordination.

Highlights

• Preliminary review of the EU legislation
  • I - LARGE SCALE TESTING OF HIGHLY AUTOMATED VEHICLES
  • II- UP COMING INCREASINGLY AUTOMATED VEHICLES
    • Road safety, traffic rules, driver behaviour and other users, driving licence
    • Insurance, liability and defects
    • Vehicle approval legislation, vehicle roadworthiness and maintenance
    • Connected vehicles, data protection and security
    • Infrastructure requirements
      • This could include e.g. minimum standards for road signs and markings, digital mapping of speed limits, digital infrastructure for connectivity, common agreement for readability of temporary structures e.g. around road works, etc.
Roadmap

• This is the purpose of the GEAR 2030 roadmap. This roadmap should cover:
  • A shared vision of increasingly automated vehicles which should come step by step focusing first on very well defined and safe traffic conditions, e.g. automated driving on motorways with no crossroads, and including connectivity aspects as appropriate along the way (See Annex 1). The shared vision should also address issues of societal acceptance early on, in an inclusive process.
  • A list of actions covering: 1) the review of the existing legal and policy framework for highly automated and connected driving 2) Coordinated research, innovation, large scale tests and other financing tools 3) international co-operation action and competitiveness.

• The different issues on automated and connected vehicles mean that we will need to work closely with other DGs (mainly DG CONECT, DG GROW, DG FISMA, DG JUST, DG MOVE, DG RTD or) in a coherent manner at EU level.
CEDR Position on Road Vehicle Automation

- Conference of European Directors of Roads
- 2016

Background
Automated driving is becoming increasingly important, and will place demands on NRAs (National Road Authorities) in very near future, before 2020. While automated driving will bring about several benefits to NRAs, it will also come with costs and changes in the traditional roles of the NRAs. The cooperation with key stakeholders such as vehicle manufacturers, the telecommunications industry and the IT industry will intensify as a consequence. Closer collaboration with globally operating industries makes it necessary for NRAs to intensify their European and intercontinental cooperation (Americas, Asia-Pacific). The development will also bring a number of new challenges concerning legal issues, data security, and road safety, especially in the transition phase towards high automation. Coming to full automation, general mobility and interworking with other transport means will fundamentally change. Furthermore, totally new players are expected to enter the market.

In April 2016, the European Transport Ministers gave out a declaration on connected and automated driving, indicating strong EU and Member State support to developing and deploying road vehicle automation. A week later, the CEDR Governing Board discussed road vehicle automation in a dedicated workshop facilitated by CEDR Task Group "Unleising ITS for NRAs". This position paper reflects the GB view based on that workshop. In doing so, this position paper complements the CEDR ITS Position Paper (issued 2014).

CEDR view on road vehicle automation

- recognizes that automation is already happening now and is becoming increasingly important
- supports the European Transport Ministers’ Declaration of Amsterdam on connected and automated driving, and will work towards a common strategy for CEDR and NRAs with the aim of ensuring road safety, transport efficiency and sustainability in the process towards high level automation, including the transition phase
- recognizes the need to act right now. Since automation is disruptive, will affect NRA core business of network operation, is developing very fast, and only by being active CEDR and the NRAs will be able to promote their interests and ensure the benefits of data availability for both travelers and road operators.
- realizes that as all NRAs can act proactively, some NRAs need to take more active role than others. These active NRAs will benefit from “learning by experience” using a rapid learning cycle via piloting and test areas, and from open exchange of information between the NRAs involved in pilots and test areas.
- aims for a written policy on road trials that allow harmonization with other NRAs to enable cross border pilots and trials

Highlights

• Supports the European Transport Ministers’ Declaration of Amsterdam
• Recognizes the need to act right now since automation is disruptive
• Active National Road Authorities (NRAs) will benefit from “learning by experience” using a rapid learning circle via piloting and test areas
• Encourages strong liaison with European and national regulatory bodies in order to remove legal barriers
• Encourages public private cooperation with industry and service providers in the automotive, telecommunications, IT, mobility, and other relevant sectors in order to ensure required research and innovation, testing and piloting, evaluation, and deployment actions.
• Considers setting up a multi-stakeholder coordination group
• Highlights the importance of agreeing on the requirements of automated driving towards NRAs
Roadmap
International Task Force on Vehicle-Highway Automation

• ITFVHA 2016

• A forum to discuss government-industry roles in development and deployment of advanced driver assistance systems

• An informal group for exchange of information and strengthening global linkages

https://drive.google.com/drive/folders/0BzVsV7r9vCttRTRtQWhltaJxUms?usp=sharing
Highlights

• Overview of significant developments

• Overview of Key Issues for Next Three Years

• Perspectives:
  • Public & Media
  • Validation & Testing
  • Technology
  • Regulatory
  • Industry
  • Road Operations / Infrastructure
  • Standardization
  • Human factors
  • Benefits
  • Societal