

Automation in Road Transport

V2X connectivity sub-group

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V2X connectivity

- Definition: Vehicles using wireless technologies to achieve real-time two-way communication among them (V2V) and with the infrastructure (V2I)
- Connectivity is an important element of **automated vehicles** especially *secure* V2X communication requiring *low latency*
- The **convergence** of sensor-based solutions (current ADAS) and V2X connectivity will promote automated driving.

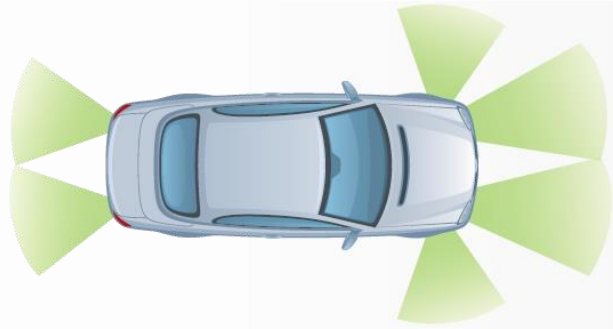


Why V2X?

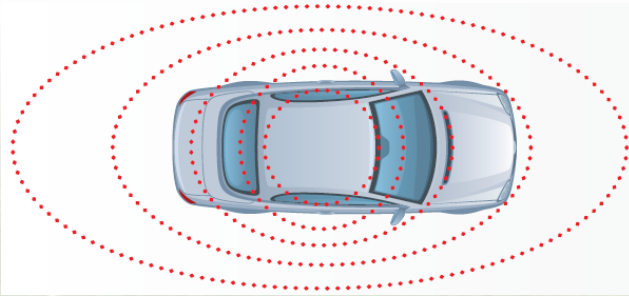
- Reasons for information sharing between automated vehicles
 - Identify hidden objects not directly in the line-of-sight of in-vehicle sensors
 - Insufficient accuracy of sensor data in the long range → Limited planning ability
 - Cost of sensors



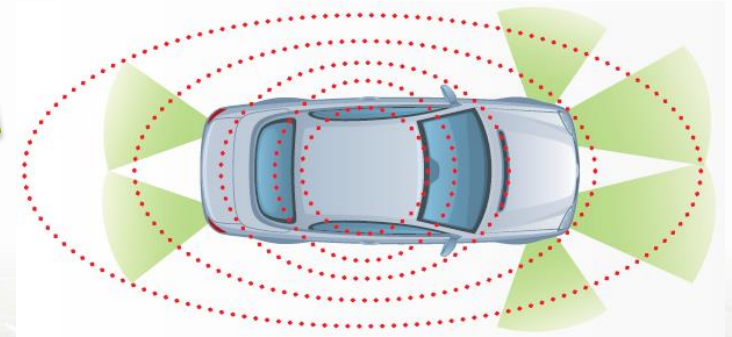
Connected & Automated vehicles



Automated vehicle
(sensors only)



Connected vehicle
(communication only)



Connected and
automated vehicle
(convergence)

*Source (images): KPMG report, Self-driving cars - The next revolution



Progress of V2X sub-group

- Several physical (& virtual) meetings since the establishment of the sub-groups
- The main outcome so far:
 - 2 pager available incl. definition, vision, subtopics of interest, possible collaboration with EU-US-Japan, relevant stakeholders etc.
 - Recommendations for WP 2016-2017 regarding connectivity



**[Mobility Working Group Automation in Road Transport
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V2X Connectivity (ICCS)

PARTICIPANTS

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VISION

Connectivity is an important element of the automated vehicles especially secure V2X communication requiring low latency.

DEFINITION

Vehicles using wireless technologies to achieve real-time two-way communication among them (V2V) and with the infrastructure (V2I). The convergence of sensor-based solutions (current ADAS) and V2X connectivity will promote automated driving.

• **Subtopics that should be also discussed:**

- o Communication technologies for both V2V & V2I: V2V-ITS G5/DSRC, V2I-LTE/4G, other technologies and seamless transitions between different communication technologies; UC-1¹ / UC-2² / UC-3³
- o Deployment issues in the different regions, continents; UC-1 / UC-2
- o Cross-border issues of V2X; UC-1
- o Regulatory issues; UC-1 / UC-2 / UC-3
- o Legal and liability issues; UC-1 / UC-2 / UC-3
- o Spectrum issues (differences in US-EU-JP), current controversy in FCC spectrum allocation for 802.11ac;
- o Robustness and reliability issues (e.g. fusion of different sources of information); UC-1/ UC-2
- o Interaction and interoperability with the rest of the road users (infrastructure, VRUs, digital maps) / UC-2 / UC-3
- o (Cyber)security & privacy; UC-1/ UC-2 / UC-3
- o Consensus protocols for V2V and V2I decision makings; UC-2
 - Negotiation between vehicles –standardisation
 - Transmission of intentions
- o Use of novel concepts and technologies (e.g. cloud connectivity, crowd sourcing, big data analytics...); UC-2

• **What should be done in EU/international level?**

- o Common standards
- o Interoperable equipments (both OBUs & RSUs)
- o Quality of service

¹ UC-1: Automated Highway Driving (Highway Pilot)

² UC-2: Smart Intersection Control

³ UC-3: Freeway Platooning

- o Performance requirements
- o Common applications (application layer)
- o Common framework (or method) for testing and validation (something like FESTA focused on V2X)
- o Extended floating car data & vehicle management systems (collecting data from CAN-bus and the infrastructure side)
- o Integration with ADAS systems
- o Value chain, stakeholders and business model

• **What should we collaborate on?**

- o Communications architecture (e.g. ETSI architecture)
- o Could connectivity and computing
- o Standardisation activities
- o (Cyber)security and privacy aspects
- o Specification, simulation and verification of consensus protocols
- o Definition and specification of the decisions that can be performed by V2X communication
- o Common methodology for testing and validation (including simulation and emulation of V2X)
- o Refined definition of requirements for automation taking into account progressive deployment scenarios (and prospective on communication technology 4G and after ...)
- o Fusion with other information sources to improve robustness and precision
- o Local and extended dynamic maps

• **Who are the contributing projects/activities/people?**

- o C2C-CC
- o Other organisations such as the Amsterdam Group (CEDR – ASECAP – POLIS and C2C-CC)
- o Ongoing/Past EU projects: SAFESPOT, CVIS, COOPERS, DRIVE C2X, TEAM, MOBINET, Compass4D, AdaptIVe, AutoNet2030, iGAME, COMPANION etc.
- o National activities e.g. simTD (German project), DITGM (Netherlands), SCORE@F (France)
- o ETSI/CEN working groups on standardization of V2X

• **List of relevant references**

- o KPMG report: Self driving cars the next revolution (<https://www.kpmg.com/US/en/issuesAndInsights/ArticlesPublications/Documents/self-driving-cars-next-revolution.pdf>)
- o ETSI communications architecture (http://www.etsi.org/deliver/etsi_en/302600_302699/302665/01.01.01_60/en_302665v010101p.pdf)
- o CAR 2 CAR Communication Consortium Manifesto (http://www.car-to-car.org/index.php?elD=tx_nawsecured&u=0&file=fileadmin/downloads/C2C-CC_manifesto_v1.1.pdf&t=1389272310&hash=6ffcfd240483615310bc6703f2078864868eeb32)
- o US DoT Research planning: http://www.its.dot.gov/presentations/CV_PublicMeeting2013/PDF/Day2_Automation.pdf
- o Self-Driving the New Auto Industry Paradigm, MORGAN STANLEY RESEARCH
- o "Preparing a Nation for Autonomous Vehicles, Opportunities, Barriers and Policy Recommendations", Eno Center for Transportation, Oct 2013
- o "Autonomous Vehicle Technology A Guide for Policymakers", James M. Anderson et Al., RAND corporation, Jan 2014

STAKEHOLDERS



Recommendations WP 2016-2017

- **Large scale pilots** which test the technical maturity and security aspects of V2X in order to assess if the requirements posed by cooperative automated driving and safety critical applications are covered by the current technology and which specific issues should be addressed (e.g. Interoperability, low latency, increased throughput, congestion strategies, data verification and data integrity)
- Enable **reliable and secure communication** by seamless and transparent integration of different communication technologies (e.g. 4G / 5G / WiFi / 802.11p) and develop and improve data fusion algorithms to combine V2X information with on-board sensor information
- **Big Data** management, analytics and privacy to support V2X connectivity incl. **Vehicle-to-cloud** communication



Next steps

- Clarify the target of the sub-groups within the next period
- Harmonize our work with other sub-groups (check for inconsistencies/interdependencies)
- Integrate/consider inputs from ongoing EC Projects (iGAME, AutoNet2030, AdaptIVe, COMPANION) or worldwide activities (mainly US and Japan)??

