C-ITS status in Europe and Outlook

Car 2 Car Communication Consortium

ITU Seminar
7th June 2018
Car 2 Car Communication Consortium
Communication Technology Basis – ITS-G5

- Dedicated Short-Range Communication for exchanging messages between vehicles, and between vehicles and road-side units
- NO communication costs to access the frequency band with equal access
- 5,9 GHz frequency band allocated in EU and US
- Enhancement of the IEEE 802.11 (802.11p) standard
- Standardized at ETSI (as ITS-G5)
  - Short range: specifically tailored for cooperative safety
  - Communication latency < 5 ms
  - Information dissemination rates up to 10 times-per-second (10 Hz), but prepared for rates of >50Hz, e.g. for platooning
  - Ad-hoc Sensor network – No repetitions – oversampling is used

  *C2C-CC is welcoming improvement of the access layer, either through technology upgrades and new technologies, as long as interoperability is ensured*
Political and Regulatory Framework

- Standardisation mandate M/453 for a set of interoperable standards which lead to current set of ETSI specification based on an access layer based on 802.11p
- November 2016 the EU Commission Communication COM(2016) 766 - A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility
- March 2018: EU Parliament approves ITS report

In summary the recommended way forward is using the already available technologies, to get started now (2019 target) and ensure that evolution is interoperable and backwards compatible
C-Roads Platform

- The C-Roads platform was set up by EU and member states to aid deployment of C-ITS
- The C-Roads Platform was set up with the aim of
  - linking all C-ITS deployments develop, share and publish common technical specifications (including the common communication profiles), planning intensive cross-testing to verify interoperability develop system tests based on the common communication profiles by focusing on hybrid communication mix, which is a combination of ETSI ITS G5 and operational cellular networks.
  - and by doing so C-Roads will pave the ground for making Cooperative, Connected and Automated Driving reality in Europe
- C-Roads and C2C-CC signed an cooperation agreement during the European ITS Conference in June 2017
- Profiles from C-Roads are publicly available at www.c-roads.eu

* Also the C2C-C profiles are publicly available for an administrative subscription fee contact@car-2-car.org
C-Roads Members

- Core Members 2016
  - Austria
  - Belgium/Flanders
  - Czech Republic
  - France
  - Germany
  - Slovenia
  - The Netherlands
  - UK

- Core Members 2017
  - Belgium/Wallonia
  - Denmark
  - Finland
  - Hungary
  - Italy
  - Norway
  - Portugal
  - Spain
  - Sweden

- Associated Members
  - Ireland
  - Switzerland

  - Australia
  - New Zealand
ITS-G5 deployment is happening in Europe

- VW Group has announced start of sales of ITS-G5 equipped cars from 2019
- Renault and PSA are selling cars with ITS-G5 (Dual channel) to customers as part of SCOOP@F (Limited numbers)
- SCOOP@F: Road Operators are deploying Road Side Units under the leadership of the French Ministry of Transport
- Original Corridor project - Austria, Germany and Netherlands have announced commercial tenders and already have equipment deployed
- Several other Member-States and non–Member-states are deploying - these deployments are accelerated by CEF support. C-Roads is initial deployment not just pilots

→ Conclusion: ITS-G5 deployment is happening now!
Vehicle communication and automation: an example of synergy

- ABS, ESP, ...
- Forward collision W, Blind spot detection, ...
- Automated reactions (e.g. braking), maneuvering (e.g. Overtaking), ...

Automation

Vehicle state monitoring

Environmental perception

Reaction/ maneuver execution/ planning

Maneuver coordination

Communication

- Warnings about situations detected by other cars' state sensors
- Automated reactions or maneuvering based on cooperative context awareness
- Cooperative maneuvering (Automated merging, intersection crossing, platooning, ...)

Warnings about situations detected by perception sensors of other cars/infra
Roadmap: Services & sample use cases

Take-over of the driving functions
- Fully Automated Driving
- Optimal Traffic Flow

Basic infrastructure support
- Short term Roadworks W
- Traffic light info
- In-vehicle information

Coop. awareness & decentralized notification
- Intersection Coll. W
- Emergency Vehicle W
- Dangerous Sit. W
- Stationary Vehicle W
- Traffic-Jam W
- Pre-/Post-Crash W
- Hazardous Loc. W
- Adverse Weather W
- Motorcycle Approach Info

Collective Perception
- Overtaking W
- Ext. Intersection Coll. W
- VRU W

Improved coop. awareness & decentralized notification
- Motorcycle-related W
- Cooperative ACC

Improved Infrastructure support
- Long term Roadworks W
- Special vehicle prioritization

Sensor data

Status data

Automation Level
- Phase 1 Awareness Driving
- Phase 2 Sensing Driving
- Phase 3 & 4 Cooperative Driving
- Phase 5 Accident-free Driving

Dissemination
- Coordination and Negotiation
- Trajectory/Maneuver sharing
  - Static platooning
  - Area reservation
  - Traffic light info optimizations
- VRU active advertisement
  - VRU safety

Intention & Coordination data

C-ITS penetration

07/06/2018
Day 2: CAM/DENM extensions

- Convey data non included in Day1 release

Examples:

**Cooperative ACC**

Rx vehicles analyze CACC status of tx vehicle/infra to modify communications & automation behavior (reduce gap/improve response to speed variations of preceding vehicle)

**Motorcycle Approach Warning**

Rx cars and motorcycles analyze motorcycle dynamics info (e.g. lean angle) to evaluate collision risk and possibly generate warnings
Day 2: Collective perception

- Sharing abstract descriptions of objects detected by vehicle or infrastructure sensors.
- Creates improved awareness even with low C-ITS penetration

Examples:

Overtaking Warning

Turning car analyses the rx info and warns the driver if necessary

VRU Warning

Overtaking car analyses the rx info and warn the driver if necessary
Day 3/4: Trajectory/maneuver sharing

- Sharing automated vehicles’ intended maneuvers and trajectories

Examples (from EU H2020 MAVEN project):

**Dynamic platooning**

- Based on intended maneuver at next intersection, vehicles assess the convenience of building small platoons, and keep them using exchanged trajectory

**Traffic light info optimization**

- Based on rx intended maneuver at intersection, infra calculates and suggests optimization info such as lane-specific GLOSA or lane change advices
Day 3/4: Coordination/negotiation sharing

- Enabling vehicular interaction for coordinated maneuver execution
- Examples (from IMAGinE project):

**Cooperative Merging on Highways**

Based on notification of intended merging, interested vehicles exchange info to coordinate gap opening and merging maneuvers with increased time spans.

**Cooperative Turning at Junctions**

Based on notifications of intended turning, interested vehicles exchange info to coordinate right of way and transit maneuvers with increased time spans.
Roadmap: Supporting technology

Phase 1
- Cellular licensed
- 60 GHz
- Simultaneous multi-channel
  - G5D-SC5+6
  - G5B-SC3+4
- +QoS, 5G
- +mmW-ITS
- +Enhanced IEEE 802.11p
- Coordinated multi-channel
  - G5A-SC1+2
- IEEE 802.11p
- Day1 CC
- Single-channel
- G5A-SC0
- Day1 CC
- Single-channel

Phase 2
- Hybrid comm. relays/redun. mgmt
- Segmentation/Reassembly
- Data Streaming
- Advanced FWD
- GN-Groupcast
- GN6
- GN/BTP + QoS
- GN-Unicast
- multi-channel-based apps priority mgmt
- Facilities layer CC
- multi-channel CC
- GN-GBC
- GN-SHB

Phase 3
- Risk Assessment
- Isolation mechanism
- Confidentiality
- Day2+ PC change rules
- Misbehaviour detection
- Crypto Agility
- Revocation
- Update mechanism Risk Assessment
- Day-1 PC-change rules
- Day-1 PKI
- Automated-driving Coordination Msgs
- I2V/V2I Coop. Msgs
- Streaming Msg
- Intention Msg (route/trajectory)
- Platoon Control Msg
- Platoon Management Msg
- Cooperative Positioning Msg
- VRU Msg
- Collective Perception Msg
- Collective Positioning Msg
- CAMV2, DENMv2
- SSEM, SREM, SAM
- SPAT, MAP, IVI
- DENM, CAM

Dissemination
- Automation Level

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Questions ?