WI-CCAD Project description template

Rationale:

The workitem Connected and Cooperative Automated Driving (WI CCAD – RD) aims to collect and classify existing research in this field, whether in research projects, demonstrations or in basic research. This template is a means to allow comparable information on these items and will be used to collect existing work, identify generics and to summarize and harmonize concepts and approaches in the field in a whitepaper. This is a basis for a recommendation to a harmonized approach of the Car 2 Car Communication Consortium.

This whitepaper will serve as basis for decision making and potential standardization approach.

How-To:

- Please fill out the template to the best of your knowledge.
- If a category is missing or hard to interpret, please give feedback to CCAD at oliver.sawade@fokus.fraunhofer.de (rapporteur) to improve the template.
- If you have missing knowledge on the project please try to contact project responsible, if necessary with help of the rapporteur.
- You can leave out unmatching/unkown fields – a partially filled template is better than no template

Template History

Date	What	Who
2018-12-20	Created initial version for review at CCAD meeting in January	Oliver Sawade Bernd Schäufele
2019-01-07	Updated fields in preparation of CCAD meeting	Oliver Sawade
2019-02-06	Modified template after CCAD meeting in C2C-Week1-2019	Oliver Sawade
2019-02-06	Finalized template in CCAD telco	CCAD group
2019-03-07	Added results section and privacy check	CCAD group

Project details

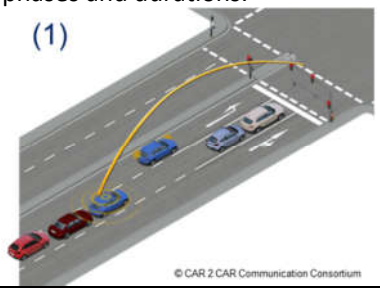
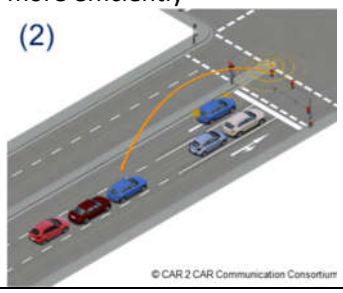
Field	Input	Remarks
Editor	Michele Rondinone, Hyundai Motor Europe Technical Center - HMETC (Germany), mrondinone@hyundai-europe.com	Please give your name and email
Project title	H2020 MAVEN (Managing Automated Vehicles Enhances Network), http://maven-its.eu/	Project title
Project lead	Robbin Blokpoel, Dynniq (NL), robbin.blokpoel@DYNNIQ.COM	Please give name and email
Consortium	DLR (DE), Dynniq (NL), Hyundai Motor Europe Technical Center (DE), Czech technical University Prague (CZ), TomTom (DE), Polis (BE), Helmont city (NL), Greenwich borough (UK), Map Traffic Management (NL)	Please list additional involved entities
Abstract	The objective of MAVEN is to deliver C-ITS-assisted solutions for managing Cooperative Automated Vehicles (CAVs) at signalized intersections and intersection corridors with the aim of increasing traffic efficiency and safety.	Short project description
Framework	H2020 EU programme	Please list framework for publicly funded projects or

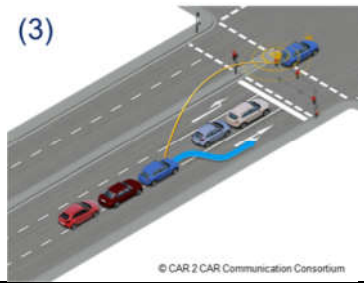
		mention “company activity” or “own research”
Duration	36 Months (Sept 2016 – August 2019)	Please list project duration for temporary activities

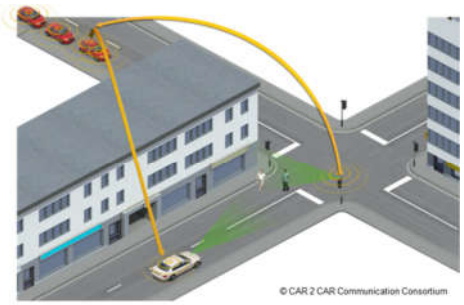
Use-cases & Facilities

Here, you can list use-cases and technologies addressed in the project. A use-case is an intended way, in which a function interacts with users. You can alternatively also list functions directly, if the use-case is obvious (e.g., the use-case of a CACC function is cooperative longitudinal control).

A facility represents an underlying functionality in a cooperative system, which enables functions and use-cases, but has no direct relation to the user. Thus, a facility might be the LDM of a day-1 implementation. In CCAD, known facilities are e.g. Cooperative Perception, Negotiation modules, Lower-layer facilities (in the ISO-OSI stack) etc. Feel free to add new facilities.

Field	Input	Remarks
Use-Case 1	**Traffic light info optimization via V2I:** In proximity of urban signalized intersections, isolated CAVs and/or CAVs organized in CACC strings continuously transmits information describing intentions (like planned route at intersection) or vehicle/string characteristics (like desired speed, string size, etc.). By collecting this explicit probing V2I information, the traffic light controller updates its queue models and calculates more efficient traffic light phases and durations. 	CAV: Cooperative Automated Vehicle CACC: Cooperative Adaptive Cruise Control
Use-Case 2	**Automated adaptation to GLOSA and Lane change advices:** Thanks to the collected V2I information, the traffic light controller can compute lane-specific GLOSA and lane change advices that CAVs can apply to pass the intersection more efficiently 	GLOSA: Green Light Optimal Speed Advice

Use-Case 3	**Automated adaptation to GLOSA and Lane change advices with I2V negotiation:** CAVs and/or CAVs strings communicate if the GLOSA and Lane change advices can be executed by updating their own transmitted messages. This feedback can be used by the traffic light controller to further refine the traffic light phase and time algorithms (e.g. to put priority at the phases whose GLOSA advices that can be applied, e.g. ensure a long enough and stable time to green for a big string of CAVs to pass the stop line before the next red starts. (3)  	
Use case 4	**Urban CACC string (MAVEN urban platooning):** CAVs form and drive in small and flexible platoon formations, where flexible means implementing cooperative methods for forming, joining, travelling in, leaving, and breaking a platoon. MAVEN platooning is a mix between a distributed and centralized scheme (Figure 3). Based on common distributed algorithms and V2V exchanged information, individual CAVs form platoons, manage their operation (joining, leaving, etc., see Figure 3 (1)), and control their motion (both longitudinal and lateral). In this sense, the MAVEN platooning approach can be seen as an extended Cooperative ACC (CACC strings), where every vehicle closely follows its preceding vehicle by still controlling its speed, distance, and possible emergency reactions. Yet, the platoon leader has the central role of communicating platoon properties/features to the infrastructure according to the above mentioned I2V negotiation process, see figure below.  	
Use Case 5	**Cooperative detection of-/reaction to conventional traffic and VRUs:** Isolated CAVs and/or CAVs in CACC string (in red) are	VRU: Vulnerable road user

	heading towards the same intersection equipped with C-ITS and detection capabilities. Conventional traffic or VRU in dangerous positions can be detected only by a subset of the approaching CAVs and by the intersection. On the contrary, other CAVs cannot detect the risk (e.g. in the figure, the platoon of red CAVs is not capable to detect the pedestrians since they are hidden around the corner). Knowing about the presence of hidden obstacles would give CAVs more information for planning paths in a safer way (e.g., in the figure, if the platoon needs to turn right). In fact, with this additional information, CAVs might decide to slow down if, once in proximity of the stop line, the hidden obstacle would still represent a risk. In order to let CAVs aware of VRUs and other unequipped vehicles that cannot be locally detected, collective perception is used at both vehicles and infrastructure side.  	

Field	Input	Remarks
Facilities 1	At the vehicle side: extensions of the standard ETSI ITS Cooperative Awareness Message (CAM) service allowing CAVs to explicitly communicate the planned intentions to the infrastructure and provide feedbacks on the compliance to advised speeds or lane changes (explicit probing). CAM extensions reuse CCD and SAE J2735 semantics and are backward compatible	For UC1/UC3 in such a way that CAVs can indicate the planned route and compliance to infra advices using C-ITS semantics
Facility 2	At the infrastructure side: I2V standard SPAT/MAP services profiled for enabling lane-specific glosa	For UC2
Facility 3	At the infrastructure side: a brand new Lane Change advice service enabling lane change advices for individual CAVs reusing CCD and SAE J2735 semantics	For UC2
Facility 4	At the vehicle side: other specific extensions of the standard ETSI ITS Cooperative Awareness Message (CAM) supporting MAVEN platooning. CAM extensions for detecting platoon initialization opportunities are appended to Day1 CAMs (CCH). CAM extensions for managing platoon management (form, join, leave, break-up, etc.) and controlling car-following functionalities are transmitted in separate CAMs on one of the SCHs.	For UC4

	CAM extensions reuse CCD and SAE J2735 semantics and are backward compatible	
Facility 5	At the vehicle and infrastructure side: Collective perception service	For UC5
Facility 6	At the vehicle side and infra side: Extended LDM including an underlying HD map representation of the intersection where HD map features (lane groups) can be associated C-ITS features (SAE SPAT/MAP intersectionID, LaneID, SignalGroup, etc)	For UC1/UC3 in such a way that CAVs can indicate the planned route and compliance to advices using C-ITS semantics; For UC4 in such a way that the position of a detected obstacle at the intersection can be associated to a C-ITS representation (e.g. LaneID, distance to stop line, etc.)
Facility 7	At the vehicle side and infra side: Extended LDM capability to properly fuse and track information received via C-ITS (CAMs, CPMs) with information detected via local sensors	For UC4 and UC5

Addressed challenges

Projects often focus on specific challenges, advancing state of the art in them. Thus, a project developing CACC might focus on string-stability, on UI or on transmission methods. If possible, list here specific issues, which are in focus of the project.

Field	Input	Remarks
Challenge 1	Fusion and tracking of C-ITS info combined with local sensor detected info. If not done properly negatively affects the performance of platooning and cooperative detection/reaction applications	Add a short description
Challenge 2	Definition of object quality/confidence for its inclusion in CPM message. If not harmonized, can lead to misuse at receiving side	

Communication

This WI is focused on cooperative automated driving, thus a form of communication is implied for projects. Here, specifics to the communication can be listed. If applicable you can distinguish between addressed use-cases.

Field	Input UC1	Input UC2	Input UC3	Input UC4	Input UC5	Remarks
Scope of communication	- Transmission of ego motion - Transmission of ego-plans (route at intersection) - Transmission of ego features (desired speed, platoon size, etc)	- Transmission of GLOSA and lane change advices	- Transmission of ego compliance to infra advices	- Transmission of ego motion - Transmission of ego-plans (route at intersection for identifying platoon initialization opportunities; planned trajectory for vehicle lateral and longitudinal following) - Transmission of ego features (states of platoon state machines to manage joining, leaving, break-up, etc.	Transmission of detected object (both cars and infra)	Please list the main scope of communication here (e.g. transmission of ego motion, negotiation, ..)
Used technology	ETSI ITS-G5 cch	ETSI ITS-G5 cch	ETSI ITS-G5 cch	ETSI ITS-G5 cch + sch	ETSI ITS-G5 cch OR sch	E.g. ETSI ITS-G5
Used standards	ETSI CAM, CDD	ETSI TS 103301 + SAE 2735	ETSI CAM, CDD	ETSI CAM, CDD	ETSI CPM	Please list standard and version, if applicable
Additional messages	MAVEN extensions (backwards compatible)	MAVEN LAM	MAVEN extensions (backwards compatible)	MAVEN extensions (backwards compatible)		Please describe shortly messages used if deviating/extending from standard (e.g. CPM)
Additional protocols						Please list used protocols if deviating/extending from standard (e.g. negotiation protocols)

Working assumptions

In this section, we collect prerequisites for the addressed functions.

Field	Input UC1	Input UC2	Input UC3	Input UC4	Input UC5	Remarks
Automation in sending vehicle	Level 3-5	-	Level 3-5	Level 3-5	Level 2-5	Which SAE level is addressed
Automation in receiving vehicle	-	Level 3-5	-	Level 3-5	Level 3-5	Which SAE level is addressed
Used/necessary roadside infrastructure	necessary	necessary	necessary	Not used, but infra advices can indirectly induce platoon forming or splitting	Used, not necessary	Please describe, if roadside infrastructure (sensors, communication, …) is used or necessary
Used/necessary central infrastructure	Might be used for high level optimization (green wave + GLOSA at corridor)	Might be used for high level optimization (green wave + GLOSA at corridor)	Might be used for high level optimization (green wave + GLOSA at corridor)	-	-	Please describe, if central / cloud infrastructure is used or necessary

Results

In this section please add expected/measured technical or scientific results by the project, if applicable. This could for instance be an improvement in ttc for a collision warning function.

Field	Expected	Measured	Remarks
Result UC1	Explicit probing improves TLC planning efficiency	Demonstrated in simulation (SUMO) on large scale, demonstrated on small scale with real CAV and infra on real roads	TLC= traffic light controller
Result UC2	GLOSA and lane advice better serve traffic demands at intersections	To be demonstrated in large scale simulations (SUMO). Proof of concept demonstrated with real CAVs on test tracks and real infra on real roads	
Result UC3	I2V negotiation further increase TLC planning for better traffic demands serving at intersections	To be demonstrated in large scale simulations (SUMO). Proof of concept demonstrated with real CAV and infra on real roads	
Result UC4	Platooning application allows better traffic demands serving at intersections	To be demonstrated in large scale simulations (SUMO). Platooning functionalities demonstrated in AD Simulation environments. Proof of concept demonstrated with real CAVs and infra on test track and on real roads. Real road tests demonstrate the high dependency from sensor fusion performance	AD: Automated Driving
Result UC5	Cooperative detection allows safer planning at road intersection to take into account hidden obstacles	Platooning functionalities demonstrated in AD Simulation environments. Proof of concept demonstrated with real CAVs on test track. Real road tests will be performed to test against real infrastructure.	

Additional details

Please find more information on the current and future MAVEN deliverables available at http://maven-its.eu/

Please remark here, if we may use the above information in C2C-CC publications.

[YES] – we hereby allow to use the above information in publications