



Accelerate cooperative mobility

## Deliverable D26.1

# DRIVE C2X vehicle integration and interoperability check report

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## Executive summary

This document reports on work package 26 tasks and the results achieved.

Work package 26 provides the integration of enhanced DRIVE C2X system prototypes into vehicles and road-side equipment.

Various communication units, 802.11p protocol stack implementations and other components were provided by previous work packages. The different partitioning of necessary functions forced the development of a reference block diagram. This diagram summarizes all functional blocks of a DRIVE C2X reference system on an abstract level.

The work package 26 partners needed to form their real implementation of the "reference" DRIVE C2x system on that base. It is in the domain of the partners to put these systems into cars or motorcycles as reference VIS or as reference RIS into road side cabinets or weather proof housings. Beside the mechanical and electrical integration of the systems the software adaptation to vehicle sensors or roadside infrastructure, like traffic lights is a task that belongs to the partner specific domain.

Various real live problems like timing synchronization of the components or sensor data availability were solved by the partners during the individual integration work. Reception problems caused by antenna mounting were also problems that partners had to tackle.

In more detail, Chapter 2 documents the integration of the DRIVE C2X reference system into selected vehicles. At first the common reference block diagram is introduced. Vehicle providers can select of a variety of available communication units. The vehicle provider has the role of the system integrator. It is their responsibility to select the components, build these components into the vehicle and take care about the software of their reference system.

The description of the reference block diagram is followed by the challenges that needed to be solved by the individual reference system integration.

Finally for all selected vehicles the individual flavour of the DRIVE C2X reference system implementation is described by the OEMs. The intention is to provide an overview of the individual implementation addresses certain common aspects of the reference system. It is not meant as a detailed guide how a reference system was built into the selected vehicle.

In Chapter 3 the integration of the DRIVE C2X reference system into selected road side units is documented. First the common reference block diagram is introduced. Then the description of the reference block diagram is followed by the challenges that needed to be solved by the individual reference system integration. Finally, an overview of the reference system realization is given.

In Chapter 4 the prerequisite for work package 26 system integration and interoperability tests was that the components were laboratory tested and achieved a certain level of CAM and DEN interoperability. Beside the tests during software integration also the ETSI plug tests assured these prerequisite.

For calibration and alignment of the equipped vehicles and the reference road side units initial interoperability tests were performed on a proving ground and the STS Helmond. Calibration of the vehicles enables to share the work in WP 34 (Piloting) sending only a limited number (not all) of interoperability checked vehicles to the test sites for pre-test and piloting.

Initial interoperability tests were executed during face-to-face meetings. The first meeting was held in cw11 with vehicles from Audi, CRF, Daimler, Fokus, Ford, Opel and Volvo at Daimler premises in Ulm. The second meeting was held on the system test site in Helmond during week 15. In cw16 during the third meeting in Helmond the interoperable systems could be further optimized and demonstrated for an EU project review. The fourth workshop in Helmond in cw21 was used for system stabilization final interoperability tests and preparation of the first validation tests.

In Chapter 5 the focus was on interoperability testing. The system description in this document can be used for test fleet acquisition (and build) at the test sites as well as for a call for tender of RSU installation at the test sites. To decide on the equipment for a test site the interoperability of the components is of high importance. The system set-ups from different partners, as described in chapter 1 and 2, have been tested for interoperability to other ITS stations at the system test site Helmond. A huge number of drives in CW25 and CW27 including the manual validation of the applications by the co-driver have been performed in parallel to the analysis of the collected log files.

In this way the system set-ups for vehicle stations and road side stations have demonstrated their interoperability and together with the installed applications the functionality of the DRIVE C2X system.

Continuing the interoperability testing as described in chapter 3 the exchanged messages have been analysed in more detail and more from an application layer perspective.

To conclude, after work package 26 there are now several reference DRIVE C2X systems in vehicles, motorcycles and road side equipment available.

These systems proved to work together. Interoperability of these systems is achieved.

The descriptions of the various implementations will be a beneficial for building further system to be used at the different test sites. The now available DRIVE C2X reference systems will be the base to test these further systems regarding interoperability. By this it will be assured that the DRIVE C2X system rolled out in the next months are interoperable across Europe.

Aspects that are important for the execution of field tests were not in the focus of work package 26. Some examples of those aspects are the overall system stability, correct logging of data and controllability over the test control. Nevertheless, test control and logging were used during some interoperability tests. A good base for the field test execution is available. Now it is the time to continue with the field test piloting.

Work packages with the focus on field test execution will obviously trigger further stability improvements and one or the other correction of functions. Overlapping validation tasks with the focus on field test execution already triggered system improvements.

The ticket system that was introduced to follow up changes between workshops showed a good acceptance by the developers. This is a reliable way to follow-up necessary changes beyond SP2 work.