



Cooperative ITS facilities for automated driving

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AutoNet2030 overview

Project full title: Co-operative Systems in Support of Networked Automated Driving by 2030

Coordinator: Andras Kovacs / BroadBit

Project partners:



Starting Date: November 1, 2013

Ending Date: October 31, 2016

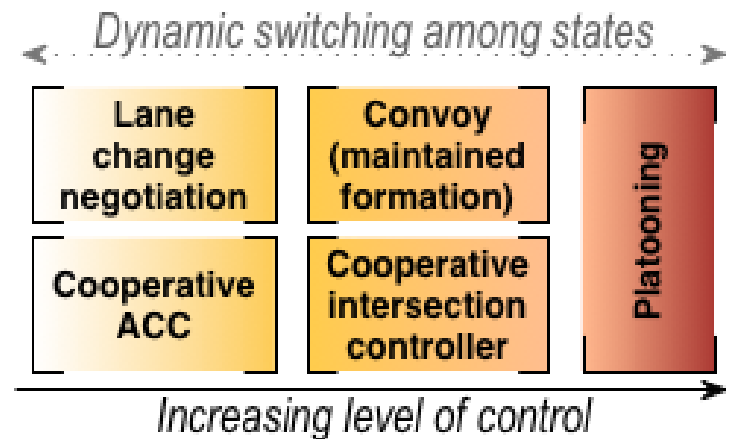
Budget Total/Funding: 4.6M EUR / 3.3M EUR

AutoNet2030 mission statement

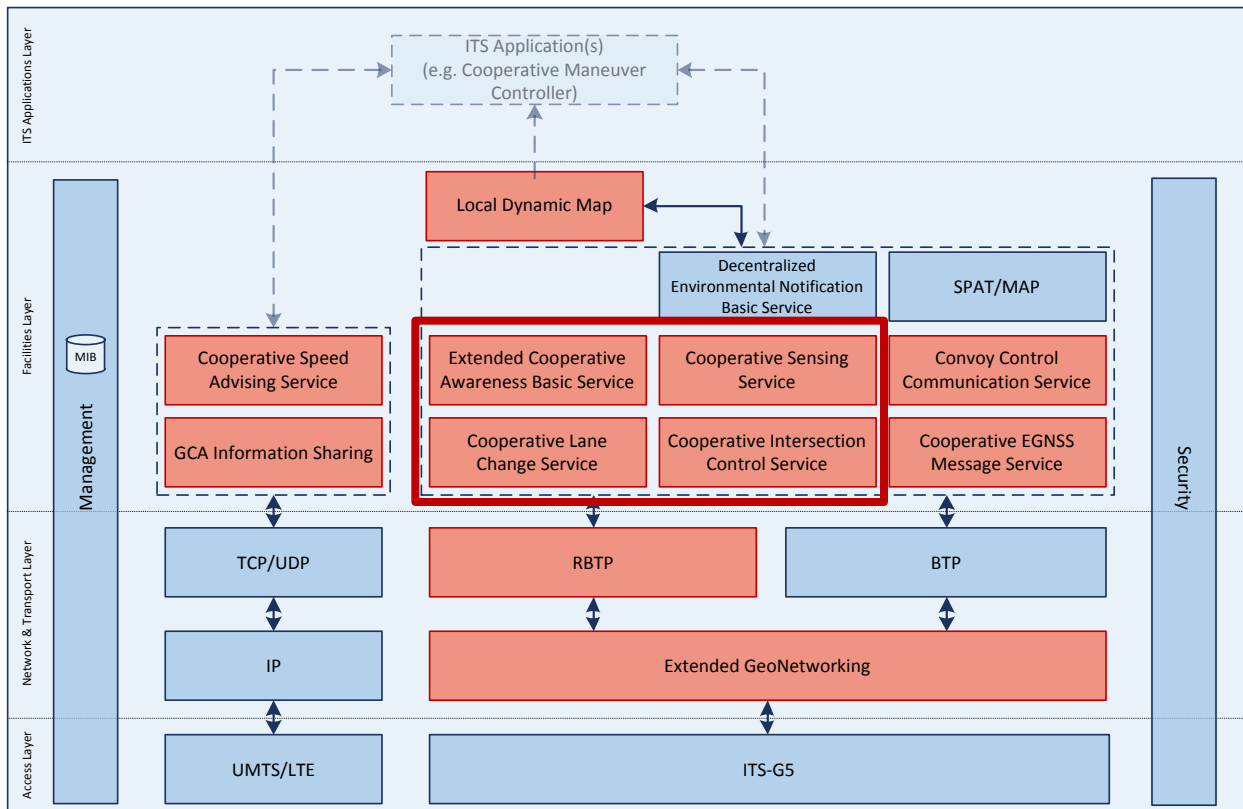
Specific project objectives:

- * *Standardized use of 5.9 GHz V2V communications in service of automated driving*
- * *A path for cost-optimized automated driving technology, making it more widely deployable*
- * *Demonstration of inherently safe cooperative maneuvering control algorithms*

Specification of cooperative communication protocol standards, which are required in order to support the AutoNet2030 automated driving use-cases.



AutoNet2030 Architecture



Scope of this presentation

Relevant ETSI ITS work items

AutoNet2030 plans to contribute to the ongoing standardization work or potential standard revisions in ETSI TC ITS:

AutoNet2030 specifications	ETSI TC ITS Wis
Extended CABS (for automated driving)	EN 302 637-2: CA basic service TR 103 298: Platooning pre-standardization TR 103 299: Cooperative ACC pre-standardization
Cooperative Lane Change Service	Potential new WI
Cooperative Intersection Control Service	TS 101 539-2: Intersection collision risk warning
Cooperative Sensing Service	TS 103 324: Cooperative Observation Service
Convoy Control service	TR 103 298: Platooning pre-standardization TR 103 299: Cooperative ACC pre-standardization
Cooperative EGNSS Message Service	TS 102 890-3: Position and Time
All message format specifications	TS 102 894-2: Common Data Dictionary

Proposed CAM extensions - 1/3

Main standardization proposal is the extension of the Cooperative Awareness Messaging (CAM) for automated driving support. The AutoNet2030-AdaptIVe projects proposes jointly the following extensions:

- ❖ Increase CAM transmission frequency to 10Hz for high awareness
- ❖ Dual-channel transmission on CCH and SCH (SCH6?).
- ❖ Introduce two new containers:
 - *automatedVehicleHighFrequencyContainer* as subset of *basicVehicleHighFrequencyContainer* to limit the CAM size.
 - *automatedVehicleLowFrequencyContainer* with new fields (see next slide)

Proposed CAM extensions - 2/3

Field	Description	Transmission Frequency
Driving Mode	The driving mode engaged by the vehicle that sent the CAM.	2 Hz
Automated Control	Lists the automated vehicle control systems engaged by the vehicle that sent the CAM.	2 Hz
Braking Capacity	The maximum braking capacity and its confidence of the vehicle that sent the CAM.	2 Hz
Target Speed	The target speed of the vehicle that sent the CAM.	2 Hz
Target Longitudinal Acceleration	The target longitudinal acceleration of the vehicle that sent the CAM.	2 Hz
Target Distance to Preceding Vehicle	The target distance between the front bumper of the vehicle that sent the CAM and the rear bumper its preceding vehicle in the same lane.	10 Hz
Target Distance to Following Vehicle	The target distance between the rear bumper of the vehicle that sent the CAM and the front bumper of its following vehicle in the same lane.	2 Hz
Predicted Path	The predicted future trajectory of the vehicle that sent the CAM.	2 Hz
Group Identifier	The platoon of convoy identifier in which the vehicle that sent the CAM is driving.	2 Hz
Group Speed	Target speed of the convoy or platoon the vehicle is driving in	2 Hz

Proposed CAM extensions - 3/3

```
HighFrequencyContainer ::= CHOICE {
    basicVehicleContainerHighFrequency BasicVehicleContainerHighFrequency,
    rsuContainerHighFrequency RSUContainerHighFrequency,
    ..., -- further type specific RSU containers might be added as extensions
    [[
        -- extension for automated driving
        automatedVehicleContainerHighFrequency AutomatedVehicleContainerHighFrequency
    ]],
    ...
}

LowFrequencyContainer ::= CHOICE {
    basicVehicleContainerLowFrequency BasicVehicleContainerLowFrequency,
    ..., -- further type specific RSU containers might be added as extensions
    [[
        -- extension for automated driving
        automatedVehicleContainerLowFrequency AutomatedVehicleContainerLowFrequency
    ]],
    ...
}

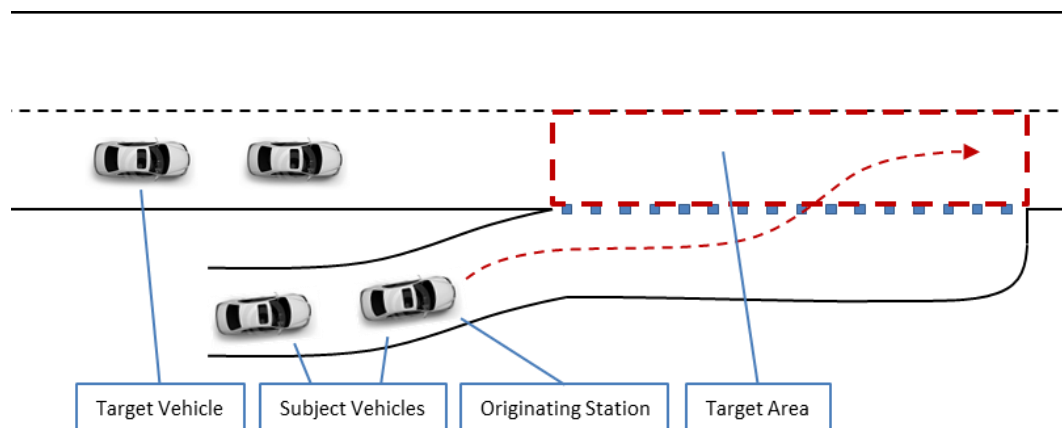
AutomatedVehicleContainerHighFrequency ::= SEQUENCE {
    heading Heading,
    speed Speed,
    longitudinalAcceleration LongitudinalAcceleration,
    lateralAcceleration LateralAcceleration,
    verticalAcceleration VerticalAcceleration,
    distanceToPrecedingVehicle Distance OPTIONAL
}

AutomatedVehicleContainerLowFrequency ::= SEQUENCE {
    drivingMode AutomatedDrivingMode,
    automatedControl AutomatedControl,
    targetSpeed SpeedValue,
    targetLongitudinalAcceleration LongitudinalAccelerationValue,
    brakingCapacity BrakingCapacity,
    targetDistanceToPrecedingVehicle DistanceValue(0..509) OPTIONAL,
    targetDistanceToFollowingVehicle DistanceValue(0..509) OPTIONAL,
    pathPrediction PathPrediction OPTIONAL,
    groupID GroupID OPTIONAL,
    groupSpeed SpeedValue OPTIONAL
}
```


Cooperative Lane Change Service 1/2

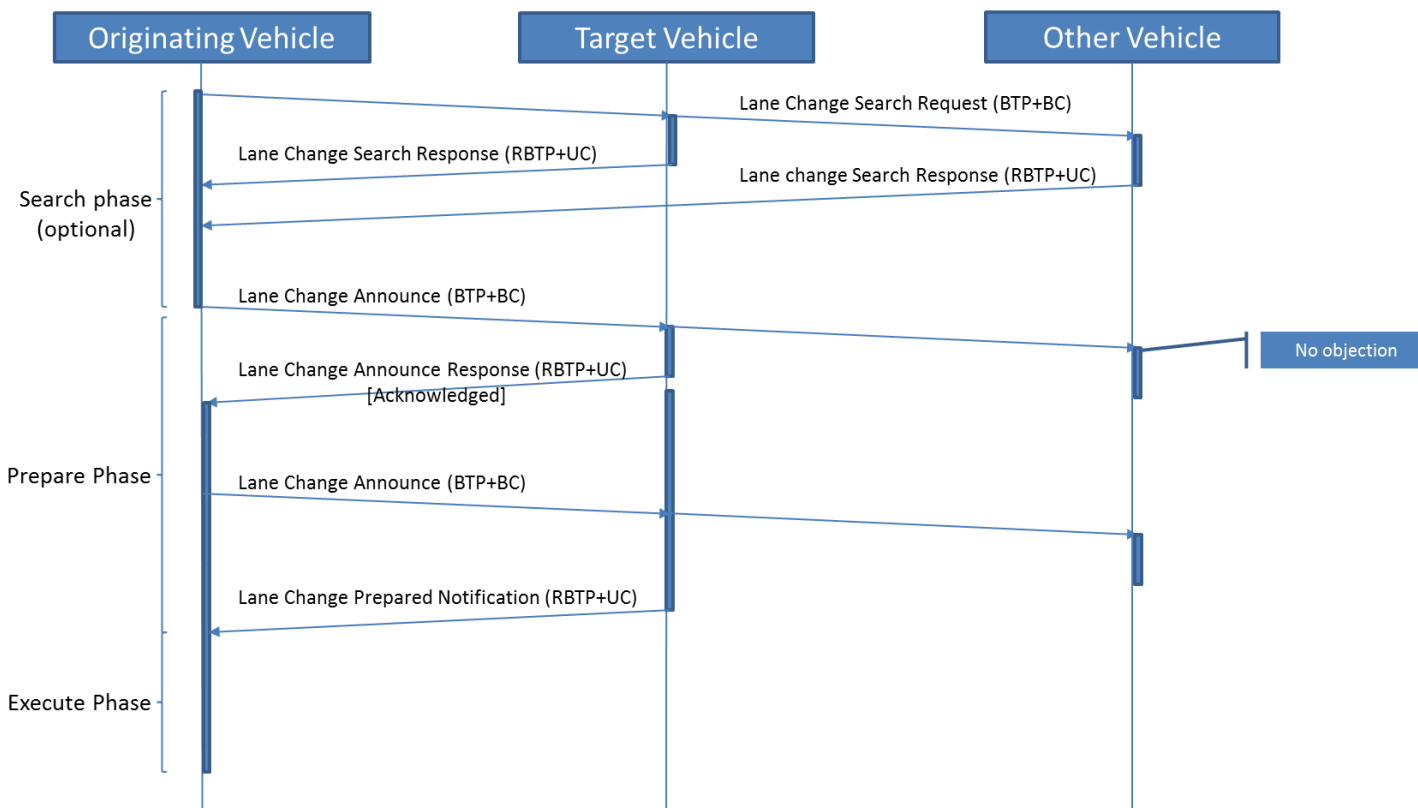
Communication facility to support a cooperative lane change of a single or group of vehicles. A Cooperative lane change is executed in three phases:

- ❖ **Search Phase (optional):** finding the right target vehicle in case awareness of potential target vehicles is insufficient.
- ❖ **Preparation Phase:** longitudinal adjustment of subject and target vehicles.
- ❖ **Execution Phase:** lateral lane change of subject vehicles.



Cooperative Lane Change Service 2/2

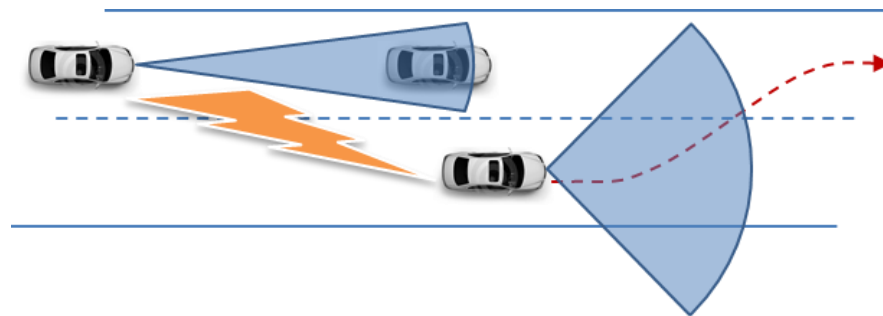
Interaction diagram example between three vehicles:



Cooperative Sensing

Communication facility for cooperative sharing of sensed objects to:

- ❖ Improve perception and redundancy as virtual sensor in addition to traditional on-board sensors (e.g. radar, LIDAR, camera, etc.).
- ❖ Broadcast with 1Hz perceived objects by ego-vehicle



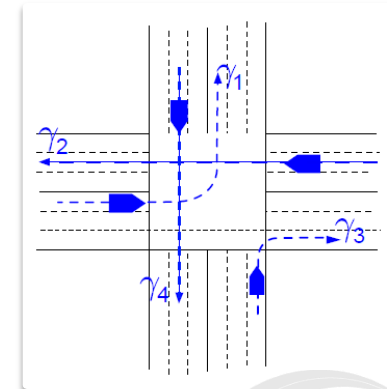
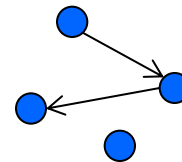
Field	Description
Object Position	Position of the detected object and its confidence
Object Type	Classification using <i>DE_StationType</i> of TS 102 894-2 (Common Data Dictionary)
Object Speed	Speed of the detected object and its confidence
Object Heading	Heading of the detected object and its confidence

Cooperative Intersection Control Service

Communication facility to support priority-based intersection coordination as described in [1]. Procedure:

- ❖ Arriving vehicles request intersection access to an intersection controller
- ❖ Intersection controller generates and broadcasts a priority graph.
- ❖ Automated Vehicles shall give priority to all other vehicles with higher priority.

AutoNet2030 considers CICS as addition to SPAT and MAP to handle mixed traffic situations (i.e. cooperative and non-cooperative).



[1] Qian, Xiangjun, Jean Gregoire, Fabien Moutarde, and Arnaud De La Fortelle.
"Autonomous Intersection Management for Mixed Traffic Flow." arXiv preprint arXiv:1407.5813 (2014).

Thank you for the attention

Further information about the AutoNet2030 project and deliverable D3.2
“Specifications for the enhancement to existing LDM and cooperative communication protocol standards” can be found on our webpage:

<http://www.autonet2030.eu>

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