Common C-ITS Service Definitions

SAE Level Guidance

C-Roads Platform

Working Group 2 Technical Aspects

Taskforce 2 Service Harmonisation

Publication History

Version	Date	Description, updates and changes	Status
0.1	31.01.2020	Converted input from Austrian document where applicable into the C-Roads template	Draft
0.2	15.02.2020	Additional input provided by Austria on the use case description part	Draft
0.3	23.03.2020	Improvements based on WG2 review + comments to be addressed	Draft
0.4	05.05.2020	Revision of single elements of the draft according to TF2 Telco discussions and feedback, General outline and specific changes in the description.	Draft
1.7.0.TF.5	12.05.2020	Smaller adjustments, editorial improvements, setting the Service Name to Automated Vehicle Guidance and incorporated new template	Draft

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1 Functional Description of SAE Level Guidance

1.1 Automated Vehicles Guidance service introduction

Service introduction	
Summary	For automated vehicles at various technical levels of automation the guidance and information given by road operators with C-ITS can be additional and specific to certain types of road networks and dynamic traffic conditions, but also for vehicle types and their characteristics. The information given can hereby be a simple speed recommendation, for a segment or a lane of a road, but also an advice for a specificly automated vehicle category to drive in groups at a lane (e.g. platooning guidance for trucks). The detailed scenarios of this use cases will be defined at a later point in time and added to the specification.
Background	Road operators have the challenge to be responsible at the same time for an uninterrupted operation of their networks and dynamically adapt this network to the future needs of the users and travellers. This is particularly true for the introduction of automated vehicles in the transport network, with long periods of mixed vehicle fleets. (traditional, connected and automated vehicles operating in parallel for many years on the same road networks). Therefore is it of high interest for the road operator to use all options of connected vehicle communication and C-ITS messages to support this transition to automated vehciels with highly dynamic use cases and scenarios targeted to the specific vehicle groups on their roads.
Objective	To enhance road safety and traffic efficiency on road networks by giving specific advice to various vehicle types and groups based on current traffic conditions. Support the introduction of automated vehicles in the transport system by extending the communication capabilities to all types of vehicles by different standard messages that can be interpreted in a uniform way by all passing vehicle types and be used for safer and more efficient travel.
Expected benefits	More uniform and dynamically adapted transport flows on the road networks. Overall higher energy efficiency and reduced energy consumption, as well as reduced numbers of accidents and delays in transport operations.
Use Cases	SAE Level Guidance (at SAE Level 2, 3, 4) Platoon support for automated vehicles Additional Use cases will be deffined and added.

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1.2 SAE Level Guidance (at SAE Level 2, 3, 4)

Type of road network	Highways
Type of vehicle	Automated Vehicles (at SAE levels 2, 3, 4)
Use case introduction	
Summary	The purpose of the use case is to give guidance (in the form of information or even regulation if legally possible) to partly automated vehicles in different categories within a specific road segment or lane segment of a motorway. . The results could be that vehicles adapt their driving plans or trajectories to the received information from the road operator via I2V messages. , resulting in an increase / decrease in what is required from the automated vehicle and a corresponding decrease/increase in what is required from the driver, based on traffic situation. .
Background	Infrastructure based and vehicle SAE automation level related information is expected to provide improvements to the efficiency of traffic flows as well as road safety by guiding automated vehicles with additional information. This will be especially useful / necessary in the transitional phase towards automated driving, which will include conventional vehicles, connected vehicles as well as autonomous vehicles, in order to enhance road safety as well as traffic flow efficiency.
Objective	- Guide and inform vehicles about the currently valid SAE driving automation levels in a specific road segment or lane (regulated lane clearance) - Inform vehicles about the applicable zone of the regulated lane clearance: - specific road segment - specific lane - specific vehicle type - Inform vehicles about the start position of the regulated lane clearance - Inform vehicles about the end position of the regulated lane clearance
Desired behaviour	- Automated vehicle driver/operator is informed about a change in recommended SAE automation level - Vehicles adapt their driving plans (e.g. lane specific) or trajectories to the information, advice received and overall adhere better to the guidance received - Automated vehicle adjusts its SAE automation level according to the information received Hence, the use case describes the lane guidance and information provided to automated vehicles at a specific road segment and traffic condition. It does not describe the behaviour of the automated vehicle at the end of clearance lane (how to switch automated levels, guiding the vehicle to a safe place, …)
Expected benefits	<u>Drivers of conventional vehicles</u> Drivers of conventional vehicles experience safer traffic conditions through the SAE-level regulation of automated vehicles, including (optional) speed limits on affected road segments or lane segments. By combinations with other use cases they can be informed of specific "automation related" rules active in this section of the road. <u>Automated vehicles</u> The automated vehicle receives information about a recommended SAE automation level in specific road segments or lane segments and (optional) speed limits. With this information, automated vehicles are able to perform an adjustment of their driving plans and trajectories as well as the activated automation functions. Additionally, they are able to inform their drivers in time about the adjustment of driving-requirements. <u>National Economy</u>

The gradual introduction of automated driving will save life and transport costs by reduction of accidents. This service will facilitate the introduction of autonomous vehicles through specific guidance provided to different categories of vehicles travelling on the same road segment with comparative traffic circumstances………

Road operator
- Enable the gradual introduction of automated driving on tested and C-ITS equipped road segments and/or lanes.
- Ensure of traffic safety in the transitional phase towards automated driving.
- Ensure of traffic flow efficiency in the transitional phase towards automated driving.
- Reduction of costs related to accidents.
- Possibility to adapt TMC´s to mixed vehicle traffic (in terms of vehicle characteristics) and their information needs and guidance step by step.
- Reduction of congestion due to accidents

Use case description

Situation	- The road operator monitors the situation on the road and gives guidance and advice on the proposed SAE automation level under current traffic conditions in the specific road segment. - Following changes in traffic and therefore driving conditions (as a result of accidents, congestion, weather, etc.), a reassessment of the given advice e.g. SAE automation level is required. - If the assessment leads to a change of the allowed SAE automation level, the vehicle and the road user need to be informed. - Therefore the infrastructure distributes an updated and appropriate next message.
Logic of transmission	I2V
Actors and relations	Actors: Road operator - Road users/their vehicles are the end users of this use case.
Scenario	- Due to current traffic and road conditions on the following stretch of the road the guidance is that vehicles (of type x.y, e.g. weight higher than 3.5 tons) driving automatically should use lane 2. - The SAE automation level on a specific part of a road is set to e. g. 3. Due to the rush hour and an accident on one lane, the allowed SAE automation level will be reduced to 1. - … (similar scenarios possible)
Display / alert principle	The information is sent to the vehicle and shall be displayed to the driver, if the proposed SAE automation level is reduced and therefore additional driver interaction is required. Overall the principles of in-vehicle interactions and alerts are under complete responsibility of the vehicle manufacturer or operator of the automated vehicle. This includes the responsibility to make the driver aware in time to be able to take needed actions to comply to a given road specific advice.
Functional Constraints / dependencies	There is a need to display information to the driver if the SAE automation level will be reduced. The transition between road sections with different SAE automation levels (related to the specific ODD – Operational Design Domain) and the communication of the change of SAE automation levels on one road section to the vehicles are not yet defined.

Interoperability Requirements

Message profile requirements	For this use case the message format IVI shall be used. The IVI profile (including its extension: automated vehicle container) for this use case is specified in section 3.2.2.3 in Infrastructure functions and specifications.

Security and data protection requirements	
Communication technology requirements	
Test and validation requirements	

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