Common C-ITS Service Definitions

Hazardous Locations Notification (HLN) Alert Wrong Way Driving

C-Roads Platform

Working Group 2 Technical Aspects

Taskforce 2 Service Harmonisation

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Publication History

Version	Date	Description, updates and changes	Status
0.1	16.10.2019	Input from France	Input
0.2	17.10.2019	Further editing, minor improvements	Draft
0.3	17.10.2019	Further input, Austria	Draft
0.4	25.10.2019	Use case descriptions improved according to TF2 telco, input from several C-road members	Draft
0.5	28.10.2019	Incorporated track changes into clean version	Draft
0.6	28.10.2019	Added TF3 link	Draft

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1 Functional Description of Hazardous Locations Notification (HLN - WWD)

1.1 <Alert Wrong Way Driving> service introduction

Service introduction	
Summary	The wrong way driver warning service on motorways is of high importance for road safety, the service is as follows: A vehicle has entered a motorway and is cruising in the wrong driving direction. (This is mostly on the left most lane for the wrong way driver, this means that it coincides with the lane with highest vehicle speeds for the correct driving direction => high relative speeds of over 200 km/h of the “approaching vehicles”, with very limited possibilities to prevent an accident for both vehicles involved*) - The vehicle is detected (by various fixed or mobile sensor systems) to drive in the wrong direction. - The Infrastructure operator generates a “warning message sequence” for the complete segment of the road involved. (for both driving directions – as long as the correct lane position and driving direction of the wrong way driver is not confirmed by a second information source.) - The infrastructure operator confirms the correct position and driving direction of the wrong way driver and sends out the detailed warning to upstream drivers on the correct driving direction to switch lane away from the lane used by the wrong way driver (in most cases switch to the next lane on the right) - If possible the infrastructure operator sends out a warning to the wrong way driver to stop immediately on the right border of the used lane, and wait for public forces to clear the dangerous situation. - The infrastructure operator sends a clearance message to the drivers driving in the other direction of the motorway (because initially they have been alerted of a possible wrong way driver, but now, with better information available regular traffic situation has been resumed) - Following the clearance of the wrong way driver situation a warning message is send to all drivers entering and exiting the road segment involved in the service. - The infrastructure operator generates a “message record” of the complete warning service sequence involved for statistics and future improvements of operational parameters of the warning. * - this described traffic situation is valid only for right lane driving countries, in e.g. UK the lane situation would be mirrored, but the resulting danger for all vehicles involved similarly high.
Background	In several European countries the wrong way driver warning service on motorways is of high importance for road safety even if the overall numbers in traffic statistics of this event are not high. But there are several aspects linked to this rare event which make it a high priority issue for road infrastructure operators and public authorities – it generates high risk situations on the road and is at the same time difficult to detect or even to prevent with current technologies. For these reasons the application of a combined C-ITS service were vehicles and infrastructure cooperate to quickly detect, and immediately warn nearby vehicles and drivers reaching to the “warning zone” could be of high positive impact for road safety. As the wrong way drivers occur at varying network positions, including motorway

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	entrances and exits the main limitation of current technologies is the low quality and slow detection of the vehicle involved, this can be improved by applying C-ITS and combining I2V and V2V applications.
Objective	Enhance road safety through the prevention of high speed and therefore very risky road accidents on motorways by faster detection and more precise location of the wrong way driver and activate a detailed warning sequence to all nearby and approaching drivers. This warning sequence will be updated in quality according to more precise and confirmed information available in the TMC. The target objective of the use case is the reduction of the time to alarm of the next approaching vehicles to the wrong way driving one to an absolute minimum. This warning sequence could be enhanced by direct V2V communication messages of service conform equipped vehicles. (To reach the objective the equipment of vehicles with a wrong way driver application and detection logic for the ego vehicle and for surrounding vehicles is of high importance)
Expected benefits	Reduce the number of accidents on motorways including entrance and exit sections and contribute to lower road safety casualties and persons injured. Reduce the number of follow up accidents by detecting high risk situations linked to wrong way drivers fast and efficiently and distribute the correct and precise warnng sequence of messages to all drivers approaching the risk area of driving.
Use Cases	For the wrong way driving alert at least two use cases should be defined depending from the confirmed status of information of the road operator, possibly the warning sequence in a single case can also consist of more than two, but linked use cases as follows. - Warning all approaching drivers to the risky area or segment of the transport network at early indications of a wrong way driver present (as long as exact location of the wrong way driver and driving direction is not confirmed). The WWD - alert informs drivers to drive only on the right lane and not to overtake (and therefore use the most left lane of the motorway) on both directions of the motorway. - If wrong way driver position, heading and lane is confirmed, alert all drivers approaching this respective road segment with correct driving direction to switch lane to drive on the right lanes. And at the same time alert drivers on the opposite driving direction of the motorway that WWD-A has been clarified and regular traffic conditions have been resumed. - The use case could in the future also be extended in urban road networks, were drivers are driving against the allowed driving direction of a single direction road, which is also mainly a V2V use case. - In a later stage of C.-ITS deployment this could be enhanced by warning the wrong way driver to stop immediately at the safe boarder of his current driving lane (and not to try to turn, deviate or perform other driving actions). - After clearance of the complete warning case inform all drivers involved that regular traffic condition have been resumed.

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1.2 Alert Wrong Way Driving

Type of road network	Road with separate carriageways (non urban) including entrance and exit segments.
Type of vehicle	All
Use case introduction	
Summary	The service is to warn a driver that he could encounter a vehicle that is driving in the wrong way. It is not the primary aim to alert the wrong-way driver that he is on the wrong way. (This V2V use case could be added to the warning sequence if detection quality and confirmed status of information is improved in the future)
Background	Today, the information about a wrong-way driver exists but is only broadcasted by radio and/or VMS. The detection rate, time and accuracy of information is initially low, even if the wrong way driver alert is, because of the high relative vehicle speeds involved between the approaching vehicles on the same lane, a high risk situation on the road motorway network. The added value of this use case is that potential directly involved drivers are informed faster and more accurately. Moreover, the service aims to inform more drivers than currently (not all drivers listen to the radio).
Objective	• The objective is to encourage the driver to adapt his driving lane, speed and his behaviour, in case of a wrong-way driver to minimise his risk. • Overall objective is the reduction of fatalities and injured drivers due to wrong way driving situations on motorways. • The aim is not to alert the wrong-way driver that he is on the wrong way. (can be an optional V2V message and possibly even an in vehicle application in the future)
Desired behaviour	Drivers receiving this information: • can adapt their speed and / or trajectory by driving at the most right (and mostly slowly travelling vehicles compared to left lanes on motorways, which are used to overtake or higher speed cruises) • and can put themselves in a safe place (rest area, motorway interchange, etc) • Pay more attention to their direct traffic surroundings
Expected benefits	Increased road safety by less accidents due to wrong way driving and less “horrible driving situations” for drivers involved in such a situation even without a direct accident.
Use case description	
Situation	• On a motorway, a vehicle takes a slip road (entrance or exit segment) in the wrong way, or turns back in the toll station / rest area and drives the motorway in the wrong way. • On a ring road with separate carriageways, the situation can be the same, but with slip roads / exits more regular. • Because the wrong way driver is entering the motorway segment he mostly uses the most left lane (which is for correct drivers the one with the highest travelling speed*) => high risk situation • In the urban environment, the use case is currently not regularly reported even if evidence shows that it could also be relevant, but is rarely detected. (Urban use case could be added in the future) .

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Logic of transmission	I2V Broadcast, enhanced by V2V (detection and message distribution)

Actors and relations	• Vehicle driver: the end-users of this service are drivers in their vehicle, exposed to the wrong way driving vehicle in their and in the opposite direction of driving at the beginning of the WWD-Alert.
	• Following the confirmation of WWD position, heading and driving direction including the lane only the vehicle drivers on the carriageway approaching the RWW are informed, the other driving direction gets a de-escalation or warning cancellation.
	• Road operator: the sender of the message is an operator in the TCC, using various detection sources of the wrong way driving vehicle:
	  ○ Automated wrong-way detector
	  ○ Camera's
	  ○ Phone call (field operator, police, drivers, radio).
	  ○ Other C-ITS equipped vehicles
	• Service providers, providing the message to the involved drivers and contributing the fast and precise detection of WWD cases.

Scenario	1. An operator in the TCC is alerted of the presence of a wrong way driving vehicle on a motorway segment. 2. The TCC broadcast the information in the relevant area for both directions. The subject of the message is "wrong-way driver on your way". No detailed recommendations will be given initially. 3. Vehicles receive the information. 4. If the information is relevant for a vehicle, information is displayed to the driver with a high priority. 5. Wrong way driver (details – as driving position, speed, heading, driving lane) are confirmed by second source of information to the road operator. 6. Vehicles receive the driving direction dependent updated information. 7. Updated information (for same traffic event and message) is displayed to the driver with a high priority. 8. message cancellation is transmitted after clearance of the WWD-A.
Display / alert principle	There are two main display possibilities: • A moderately intrusive alert to encourage the driver to adapt his behaviour (change lane to right as precaution) without risk of over reaction. • An intrusive alert to encourage the driver to adapt his behaviour in case of urgency. In both cases, the alert should be done enough in advance to give the drivers the time to adapt their behaviour.
Functional Constraints / dependencies	• For this particular use-case, the validity duration and the dissemination area of the information will need to be studied precisely. • The information will not be precise enough to manage an imminent emergency. ⇨ This use case would benefit from a future extension with V2V messages between vehicles and of an in vehicle application for all C-ITS Vehicles involved. (also ego vehicle detection)
Relation to C-Roads C-ITS Infrastructure Functions and Specifications	The DENM message for HLN use-cases are profiled in the C-ITS Infrastructure Functions and Specifications document (chapter 3.1.1.1 and 3.1.1.3). For this use-case, causeCode is 14 (wrongWayDriving) and subCauseCode is 2 (wrongDirection).

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	The relevance zone of the event is a linear which starts upstream the last known position of the WW Driving vehicle and ends downstream this last know position. Upstream and downstream has to be understand as the correct driving direction of the infrastructure concerned (and not in reference to the driving direction of the WW Driver). This linear of relevance is the eventHistory of the DENM. It results of this that the WW Driving vehicle is somewhere, along the eventHistory, between the eventPosition and the last point of the eventHistory. In case the WW Driver position is well known, the eventHistory can be shortened by the road operator. Anyway, the start of this linear event (i.e eventPosition) could be set by the road operator before the previous road connector. So that receiver-vehicles can choose to leave the carriageway to avoid any risk of accident. with the WW Driver This use case would benefit a lot if all C-ITS vehicles have a robust WWD-Detection logic on board for the EGO vehicle and for other vehicles in the surrounding traffic environment. Additionally if the WWD use case is active a specific V2V message forwarding in the opposite direction of the WWD would enhance the message distribution and to the correct drivers group (approaching the risky situation with the WWD.) ⇨ Discuss with C2C CC

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