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Intelligent transport systems — Cooperative ITS —

Part 10: Driver distraction and information display

Systèmes intelligents de transport — Systèmes intelligents de transport coopératifs —

Partie 10: Distraction du conducteur et affichage des informations

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

ISO 17427 consists of the following parts, under the general title *Intelligent transport systems — Cooperative ITS*:

— *Part 2: Framework Overview* [Technical Report]

— *Part 3: Concept of operations (ConOps) for 'core' systems* [Technical Report]

— *Part 4: Minimum system requirements and behaviour for core systems* [Technical Report]

— *Part 6: 'Core system' risk assessment methodology* [Technical Report]

— *Part 7: Privacy aspects* [Technical Report]

— *Part 8: Liability aspects* [Technical Report]

— *Part 9: Compliance and enforcement aspects* [Technical Report]

— *Part 10: Driver distraction and information display* [Technical Report]

The following parts are under preparation:

— *Part 1: Roles and responsibilities in the context of co-operative ITS architecture(s)*

— *Part 5: Common approaches to security* [Technical Report]

— *Part 11: Compliance and enforcement aspects* [Technical Report]

— *Part 12: Release processes* [Technical Report]

— *Part 13: Use case test cases* [Technical Report]

— *Part 14: Maintenance requirements and processes* [Technical Report]

This Technical Report provides an informative 'driver distraction and information display aspects' for Cooperative Intelligent Transport Systems (*C-ITS*). It is intended to be used alongside ISO 17427-1, ISO/TR 17465-1 and other parts of ISO 17465, and ISO 21217. Detailed specifications for the application context will be provided by other ISO, CEN and SAE deliverables, and communications specifications will be provided by ISO, IEEE and ETSI.

Introduction

Intelligent transport systems (*ITS*) are transport systems in which advanced information, communication, sensor and control technologies, including the Internet, are applied to increase safety, sustainability, efficiency, and comfort.

A distinguishing feature of '*ITS*' is its communication with outside entities.

Some *ITS* systems operate autonomously, for example, 'adaptive cruise control' uses radar/lidar/ and/or video to characterize the behaviour of the vehicle in front and adjust its vehicle speed accordingly. Some *ITS* systems are informative, for example, 'Variable Message Signs' at the roadside, or transmitted into the vehicle, provide information and advice to the driver. Some *ITS* systems are semi-autonomous in that they are largely autonomous but rely on 'static' or 'broadcast' data, for example, *GNSS* (2.5) based 'SatNav' systems operate autonomously within a vehicle but are dependent on receiving data broadcast from satellites in order to calculate the location of the vehicle.

Cooperative Intelligent Transport Systems (*C-ITS*) are a group of *ITS* technologies where service provision is enabled by, or enhanced by, the use of 'live', present situation related, dynamic data/information from other entities of similar functionality [for example, from one vehicle to other vehicle(s)], and/or between different elements of the transport network, including vehicles and infrastructure [for example, from the vehicle to an infrastructure managed system or from an infrastructure managed system to vehicle(s)]. Effectively, these systems allow vehicles to 'talk' to each other and to the infrastructure. These systems have significant potential to improve the transport network.

A distinguishing feature of '*C-ITS*' is that data are used across *application*/service boundaries.

It will be immediately clear to the reader that such systems present the possibility of driver *distraction* (2.4), both through visual overload (display presentation and visual or oral provision of information and/or via instructions or advice). The purpose of this Technical Report is to identify potential critical driver distraction and information display issues that *C-ITS* service provision may introduce, to consider how to control, limit or mitigate such issues.

Existing *rules* (2.12) govern the use of technology inside vehicles to reduce driver *distraction* (2.4). This Technical Report identifies and discusses how *C-ITS applications* may fit within these existing rules and discusses whether they may raise additional risks.

This Technical Report is a 'living document' and as our experience with *C-ITS* develops, it is intended that it will be updated from time to time, as and when we see opportunities to improve this Technical Report.

Intelligent transport systems — Cooperative ITS —

Part 10:
Driver distraction and information display

1 Scope

The scope of this Technical Report is, as an informative document, to identify potential critical driver *distraction* (2.4) and information display issues that *C-ITS* service provision may introduce, to consider strategies for how to identify, control, limit or mitigate such issues. The objective of this Technical Report is to raise awareness of and consideration of such issues and to give pointers, where appropriate, to existing standards deliverables that provide specifications for all or some of these aspects. This Technical Report does not provide specifications for solutions of these issues.

Existing *rules* (2.12) govern the use of technology inside vehicles to reduce driver distraction.

NOTE The issues of driver *distraction* (2.4) and information display affect the design of all aspects of *C-ITS* service provision and are a critical factor in *C-ITS* system design and instantiation. However, while the general issues that affect *C-ITS* system design and implementation and related issues of what and how data in a *C-ITS* assisted *application service* provides and is realized and is therefore developed within ISO TC 204/CEN TC 278, most of the detailed aspects of physical presentation and human factors within the vehicle are standardized within ISO TC 22.

2 Terms and definitions

2.1
application
software application

2.2
application service
service provided by a service provider accessing data from the *IVS* (2.7) within the vehicle in the case of C-ITS, via a wireless communications network, or provided on-board the vehicle as the result of software (and potentially also hardware and firmware) installed by a service provider or to a service provider's instruction

2.3
cooperative ITS
C-ITS
group of ITS technologies where service provision is enabled, or enhanced by, the use of 'live', present situation related, data/information from other entities of similar functionality [for example, from one vehicle to other vehicle(s)], and/or between different elements of the transport network, including vehicles and infrastructure (for example, from the vehicle to an infrastructure managed system or from an infrastructure managed system to vehicle(s))

2.4
distraction
something that draws the attention of a driver away from the driving task and/or divides or confuses the attention of the driver

2.5
global navigation satellite system
GNSS
several networks of satellites that transmit radio signals containing time and distance data that can be picked up by a receiver, allowing the user to identify the location of its receiver anywhere around the globe

2.6
guideline
principle put forward to set standards or determine a course of action; usually, but not always, as a recommendation or advice without the requirement of law but adherence to published guidelines may in some circumstances become a requirement of a regulation

2.7
in-vehicle system
IVS
hardware, firmware and software on-board a vehicle that provides a platform to support C-ITS service provision, including that of the *ITS-station* (2.9) (ISO 21217), the facilities layer, data pantry and on-board 'apps'

2.8
intelligent transport systems
ITS
transport systems in which advanced information, communication, sensor and control technologies, including the Internet, are applied to increase safety, sustainability, efficiency, and comfort

2.9
ITS-station
ITS-s
entity in a communication network [comprised of *application* (2.1), facilities, networking and access layer components] that is capable of executing ITS-S application processes, comprised of an ITS-S facilities layer, *ITS-S* networking and transport layer, *ITS-S* access layer, ITS-S management entity and ITS-S security entity, which adheres to a minimum set of security principles and procedures so as to establish a level of trust between itself and other similar ITS stations with which it communicates

2.10
jurisdiction
government, road or traffic authority which makes and enforce *regulations* (2.11)

EXAMPLE Country, state, city council, road authority, government department (customs, treasury, transport), etc.

2.11
regulation
order issued by a jurisdiction having the force of law

2.12
rule
authoritative *regulation* (2.11) or direction concerning method or procedure, as for a court of law, legislative body, game, or other human institution or activity, especially any body which may exert control (e.g. an employer, a jurisdiction, a school, etc.)

3 Abbreviated terms

C-ITS cooperative intelligent transport systems, cooperative ITS

ESOP European statement of principles

IHRA International Harmonized Research Activities

ITS intelligent transport systems (2.8)

IVS in-vehicle system (2.7)

NHTSA (US) National Highways Traffic Safety Administration

TR technical report

4 How to use this Technical Report

4.1 Acknowledgements

Much of the inspiration for this Technical Report and its considerations and content originate from the reports *"Cooperative ITS Regulatory Policy Issues"* and *"Cooperative Intelligent Transport Systems Policy Paper"* National Transport Commission, Australia. This source is acknowledged and thanked.[1][17]

Contribution from the EC project AIDE is acknowledged.

Contribution from various documents made available by UN-ECE (Nations Economic Commission for Europe) WP.29 is acknowledged and including contributions from US NHTSA.

See Bibliography for further details.

4.2 Guidance

This Technical Report is designed to provide guidance and a direction for those considering the issues concerning driver distraction and information display associated with the deployment of *C-ITS* service provision. It does not purport to be a list of all potential driver *distraction* (2.4) and information display factors which will vary according to the *application* (2.1) service being provided, the regime of the *jurisdiction* (2.10), the location of the instantiation, and to the form of the instantiation, nor does it provide definitive specification. Rather, this Technical Report discusses and raises awareness of the major driver distraction and information display issues to be considered and provides guidance and direction for considering and managing driver distraction and information display in the context of future and instantiation specific deployments of *C-ITS*.

4.3 ITS and 'driver distraction and information display'

Driver *distraction* (2.4) has become an increasing concern amongst road safety experts, with the increasing range of technologies within vehicles creating the potential for drivers to have their attention taken away from the driving task. *C-ITS* has the potential to create further distractions if not implemented appropriately.

Distraction (2.4) is when drivers divert their attention away from the driving task to focus on another activity instead. Distraction can come in several ways:[14][1]

— visual – eyes off the road (or focusing on the wrong part);

— manual – hands off the wheel;

— cognitive – mind off the road;

— biomechanical – requiring action on the part of the driver.

C-ITS have the potential to increase safety and, for example, collision warning systems will be designed to only notify a driver by exception (i.e. an alarm would be generated only when a crash was likely and the driver needed to take evasive action). These alarms should therefore not affect the general driving task the majority of time. However, designers will need to be careful to ensure that such warning alarms are sufficiently intuitive that drivers immediately know what to do; poorly designed alarms could decrease safety if they divert attention from the immediate risk or create confusion.

'Infotainment' *applications* may create more of an on-going *distraction* (2.4) risk; this is however already an existing risk with infotainment systems today. *C-ITS* channels may create new ways for this content to be shared with a vehicle but it is not expected that this will substantially change the risks involved associated with 'infotainment'.

Driver *distraction* (2.4) and information display is the subject of International *Regulation* and National Regulations and recommendations.

The reader's attention is again drawn particularly to the standards deliverables of ISO TC 22 especially, International Standards Organization ISO/TC 22/SC 13.

— Distraction metrics (measurement of distracting tasks) and design *guidelines* (2.6) (e.g. prioritization)

and the Society of Automotive Engineers (SAE) Safety and Human Factors Committee.

NOTE The following list is illustrative and does not claim to be a complete list.

Primarily:

— ESOP - Commission of the European Communities (2007) Commission Recommendation on Safe and Efficient In-Vehicle Information and Communication Systems; Update of the European Statement of Principles on Human Machine Interface;

— JAMA - Japan Automobile Manufacturers Association Guidelines for In-Vehicle Display Systems, Version 3.0, 2004;

— Alliance of Automobile Manufacturers (AAM) Statement of Principles, Criteria and Verification Procedures on Driver Interactions with Advanced In-Vehicle Information and Communication Systems, June 26, 2006;

— International Telecommunications Union ITU-T FG Distraction Recommendations:

  — P.UIA—ITU-T Recommendation on automotive user interface requirements;

  — G.SAM—ITU-T Mechanisms for managing the situational awareness of drivers;

  — G.V2A—ITU-T Recommendation on an automotive interface for *applications* external to the vehicle gateway;

— Car Connectivity Consortium:

  — Driver Workload Guidelines for MirrorLink™[1)] Mobile *Applications*;

  — "drive-ready" certification to MirrorLink™[1)] apps. that are deemed not to adversely affect driving;

  — Guidelines for developers are based on existing *distraction* (2.4) *guidelines* (2.6) (i.e. ESOP, JAMA and Alliance).

See also Annex A for a comparison of ESOP, JAMA and AAM considerations.

4.3.1 ESOP

4.3.1.1 ESOP scope

The principles apply primarily to in-vehicle information and communication systems intended for use by the driver while the vehicle is in motion.

Apply to systems and functionalities in OEM-, aftermarket-, and nomadic (portable) systems.

1) MirrorLink™ is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

4.3.1.2 ESOP principles

a) Installation

b) Information presentation

c) Interface with displays and controls

d) System behaviour

e) Information about the system

4.3.1.3 ESOP design objectives

— The system supports the driver and does not give rise to potentially hazardous behaviour by the driver or other road users.

— The allocation of driver attention while interacting with system displays and controls remains compatible with the attentional demand of the driving situation.

— The system does not distract or visually entertain the driver.

— The system does not present information to the driver which results in potentially hazardous behaviour by the driver or other road users.

— Interfaces and interface with systems intended to be used in combination by the driver while the vehicle is in motion are consistent and compatible.

4.3.2 US NHTSA distraction guidelines

Minimize driver *distraction* (2.4) from electronic devices by encouraging better driver-device interfaces.

Conformance is voluntary.

Guidelines (2.6) implementation in three phases:

— Phase 1 – Visual-manual interfaces for devices installed by vehicle manufacturers (2013);

— Phase 2 – Portable and aftermarket devices (future work);

— Phase 3 – Voice-based auditory interfaces (future work).

4.4 C-ITS driver distraction and overload issues in context

It is important that potential driver *distraction* (2.4) and display issues created by *C-ITS* service provision are not viewed in isolation. *C-ITS* service provision is simply yet another potential source of driver distraction of visual or audible overload. Indeed, designed wisely, *C-ITS* service provision may often be used to reduce such overloads.

The prime driver *distraction* (2.4) and visual display issues remain those described and addressed in 4.3. The principle context for C-IS is to ensure that

a) *C-ITS* service provision does not add to driver distraction/overload, and

b) *C-ITS* service provision, where possible, uses opportunity to reduce driver distraction/overload

5 What are the key driver distraction and information display issues

5.1 General

Existing *rules* (2.12) and guidelines (see 4.3) govern the use of technology inside vehicles to reduce driver *distraction* (2.4). An assessment is required of how *C-ITS applications* fit within these existing rules and whether they raise additional risks. Key findings indicate the following:

— Initial *C-ITS applications* are likely to require human recognition of the signals and timely and proportionate responses. This reliance on human factors (see 4.3) could increase risks in certain circumstances;

— *C-ITS*, including driver distraction and information display considerations, are not yet explicitly regulated in most countries;

— Relevant terms such as 'visual display unit' and 'driver's aid' are not precisely defined in the 'Highway Code/Driving Rules' of most countries. However, devices providing *C-ITS applications* would likely fall under the definition of a 'driver's aid' or similar and be allowable under the road rules;

— In addition to ensuring that *C-ITS* meets safety objectives, legislation may be required to ensure that legitimate *C-ITS* functions are legalized and that drivers using the technology are not caught by laws prohibiting the use of mobile phones while driving. Any required changes to the law will need to be addressed by *jurisdictions* on a national or state basis;

— Guidelines relating to the safety and ergonomic functionality of in-vehicle electronic devices have been developed to address this issue (see 4.3 and Bibliography).

C-ITS will provide more information to drivers to empower them to make better driving decisions, at least in its early development when *C-ITS* is expected to be, at least initially, largely based on advisory systems that require human recognition of the signals. The challenge for designers is to achieve this without overloading the driver's cognitive load. Messages shall be prioritized in order to ensure that the driver receives critical information at the critical time. Drivers should be able to distinguish a critical message from a host of other *in-vehicle systems* (2.7) competing for his or her attention.

Safety is a primary objective of *C-ITS* but there is a risk that its introduction will inadvertently compromise safety in certain scenarios. The challenge for manufacturers and *C-ITS* service providers is to provide more in-vehicle information or enable more selective prioritized presentation of information through new systems without unnecessarily distracting, overwhelming or confusing drivers.

The American Automobile Association Foundation for Traffic Safety defines driver *distraction* (2.4) as occurring:

"when a driver is delayed in the recognition of information needed to safely accomplish the driving task because some event, activity, object or person within or outside the vehicle compelled or tended to induce the driver's shifting attention away from the driving task."

It has alternatively been defined as "the diversion of attention away from activities critical for safe driving toward a competing activity."[4]

As stated above, *distraction* (2.4) can be visual, auditory, biomechanical, physical or cognitive.

Driver *distraction* (2.4) can be caused by the actions of the driver, for example, adjusting the radio, answering a phone or texting, or it might be caused by unexpected visual, auditory or haptic experiences that are outside the driver's control, such as a distracting billboard image or sudden in-vehicle high pitched tone or vibration.

It might also be caused by an active screen demanding attention, a visual or audible warning, or by an inappropriate warning. For example, if a forward collision warning system indicated a medium risk of collision that demanded the driver's attention looking ahead but there was an unannounced higher critical level situation of a side impact collision which was unnoticed because of the driver's attention being focused on the less imminent threat.

In-vehicle driver distraction outside the driver's control is particularly relevant to *C-ITS* and is the focus of this Technical Report.

At the same time, it should be borne in mind that *C-ITS* safety *application*s can also help protect against the results of *distraction* (2.4) by providing warnings of imminent collisions (such as rear-end collisions) that might be caused by distraction. Future technology could assist with managing distraction, for example, by varying the options and functions presented to a driver based on the driver's experience, vehicle speed, weather and current traffic conditions, in order to 'lock down' the technology in riskier situations.[5]

At issue is the loss of concentration that these acts might cause, and while driver *distraction* (2.4) data are difficult to measure and not as consistently collected as speed or alcohol data, driver distraction is acknowledged as a common source of crashes. Given the newness of *C-ITS,* there is even less empirical research about its impact on drivers than other forms of distraction. The scenario of most concern is nonetheless clear: where an in-vehicle *C-ITS* warning startles the driver and contributes to a collision. *C-ITS* does not function in isolation but requires human recognition of the signals and timely and proportionate responsiveness. This reliance on human factors could create risks. *C-ITS applications* providing traveller information to drivers could also prove a source of distraction.

As in-vehicle technologies increase, *C-ITS* will emerge in the marketplace to compete with a host of other information-providing systems and technologies. In-vehicle technology may include systems built into the vehicle, personal navigation devices or smartphones (or a combination of these devices). This could result in drivers ignoring the warnings produced by *C-ITS* or becoming distracted by the warnings. Alternatively, the package of *C-ITS* technologies could result in a range of warnings and signals competing for the driver's attention and could result in overwhelming the driver. Warnings need to be carefully timed and prioritized.

In addition to ensuring that *C-ITS* is designed to meet safety objectives, legislation will need to confirm that *C-ITS* devices are legal and not caught in the net of laws prohibiting the use of mobile phones while driving. It also remains an ongoing challenge to keep the laws, standards and guidelines up-to-date with changing technology: "it is important that standards addressing driver distraction be valid and applicable independent of type of device, manufacturer and level of experience of driver/user."[6]

Potential risks include the following:

— An increasing cognitive load on drivers: *C-ITS* will provide more information to drivers which should empower them to make better driving decisions. The risk is that they will be overloaded with information and decision-making will worsen in critical situations as a result;

— Prioritizing signals: with a greater volume of information and a range of signals competing for the driver's attention, messages shall be prioritized in order to ensure that the driver receives the critical information at the critical time and be able to distinguish that message from the host of others.

(ISO/TC 22/SC 13 and the SAE Safety and Human Factors Committee have produced standards for message prioritization, notably: SAE J2395 and ISO/TS 16951);

— Prioritizing systems: a critical *C-ITS* warning to a driver, perhaps involving both an audio and a visual message, could be undermined if competing with other *in-vehicle systems* (2.7) or example, the audio message may not be clear when the navigation system is providing turn-by-turn directions and the mobile phone is notifying the driver of new text messages and music is playing. Compatibility between systems that enable prioritization is possible when *C-ITS* is built into the vehicle but prioritizing systems is a much greater risk when *C-ITS* is based on after-market devices. The risk could also be higher in commercial vehicles that have additional in-vehicle systems. Significant work in this area has been undertaken in the aviation industry; however, that is a much more closely controlled environment;

— It is important to recognize that warnings are designed to get a person's attention, communicate the nature of the hazard, its severity, urgency and an appropriate response. Warnings are distracting by nature. Collision warning needs to be attention getting. However, prompts for location-based services may have some urgency but they are not safety critical.

Distraction reduces situation awareness and impairs driving performance. Risk increases with exposure to a hazard. With distraction, risk can vary with the following:

— type of distraction - visual, manual and cognitive;

— timing;

— duration;

— frequency;

— intensity.

5.2 Information display

Good design *rules* (2.12) and guidance (see 4.3 and Clause 7) can help detail the location and format of dashboard information display, including the placement of speedometers and odometers. But generally, existing design rules do not prescribe the location and format of additional information, such as changes to the speed limit, real-time traffic and roadwork advice or the location of approaching vehicles, nor prioritization between visual and audible warning. As early ITS *applications* have been introduced, screen displays and warnings current vary widely between auto-manufacturers.

As *C-ITS* generated information becomes available to drivers, the current information display regulations may require updating, more so if *C-ITS* information display becomes mandatory. The work of ESOP and AAM to achieve these objectives is discussed at length elsewhere in this Technical Report. Also the work of ISO/TC 22/SC 13 has put much effort in advice for integration of warnings (especially ISO/TR 12204) and should be taken into account. Current work at NHTSA is designed to provide a set of human factors design principles for driver-vehicle interfaces (DVIs), as well as basic human factors concepts in respect of safety messages in visual, auditory or haptic formats for light and heavy vehicles, and so NHTSA may provide additional resource for those considering these issues (www.nhtsa.gov).

5.3 In-vehicle technology and distraction

Most driving *regulations* (2.11) proscribe the use of in-vehicle televisions or visual display units (VDU) that are visible to the driver or could distract other drivers, unless the unit is part of a driver's aid and is either an integrated part of the vehicle design or is secured in a mounting affixed to the vehicle while being used. Relevant examples of driver's aids include the following:

— VDUs for closed-circuit security camera;

— VDUs for closed-circuit television reversing and blind spot cameras;

— dispatch systems;

— navigational or intelligent highway and vehicle system equipment;

— vehicle monitoring devices.

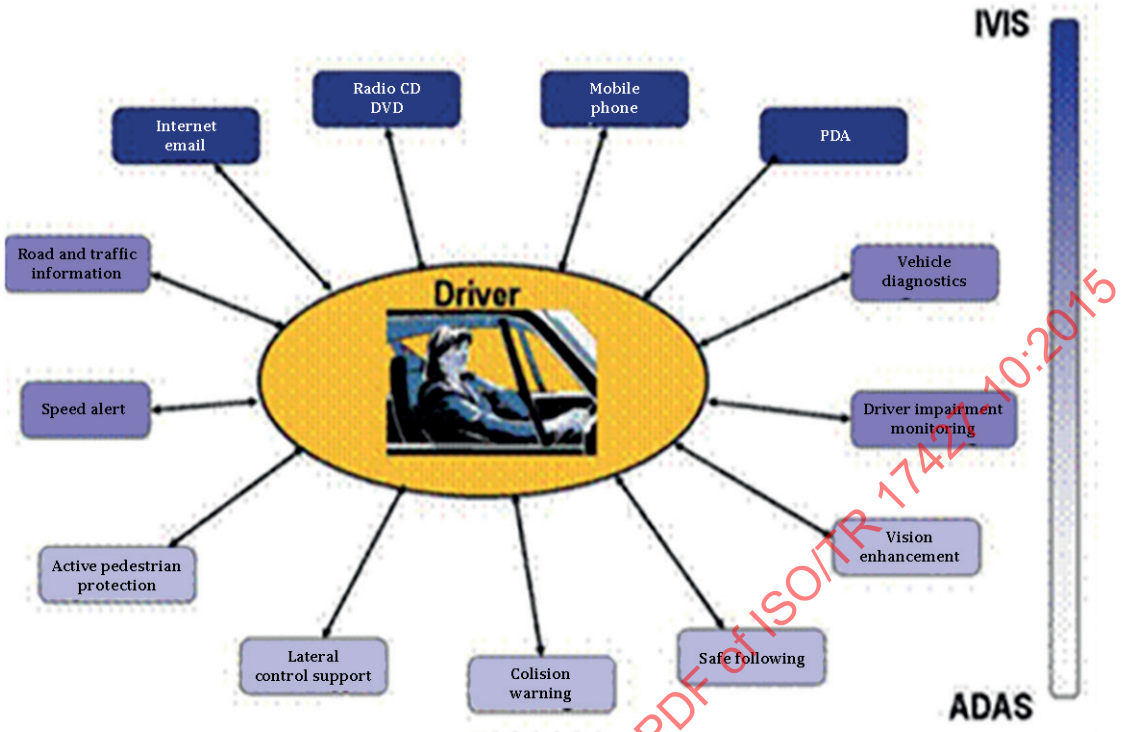

Figure 1 — Examples of various ADAS and IVIS interacting with the driver in a future vehicle1 (Source: EC Project AIDE)

Project AIDE[12] concluded "It is clear from Figure 1 that the various systems interacting with the driver cannot be implemented independently. The most obvious reason for this is that such a large number of separate HMI devices would simply not fit into the vehicle cockpit. Moreover, conflicting information from different systems could distract, overload, confuse and annoy the driver, thus causing problems that did not exist for the systems in isolation. Moreover, behavioural changes in response to a combination of systems may be very different from responses to the systems in isolation. Thus, there is a strong need for a unified human machine that integrates the different systems into functioning whole resolving conflicts between different functions and taking into account their aggregate effects. Some key features of such an integrated HMI would include the following:

— multimodal HMI devices shared by different systems (e.g. head-up displays, speech input/output, seats vibrators, haptic input devices, directional sound output);

— centralized intelligence for resolving conflicts between systems (e.g. by means of information prioritization and scheduling);

— seamless integration of nomad devices into the on-board driver-vehicle interface;

— adaptivity of the integrated HMI to the current driver state/driving context.

Most existing *regulations* (2.11) do not prescribe appropriate use of visual display units or driver's aids and do not regulate design interface or provide maximum time periods that a driver's attention should be taken from the road, although voluntary *guidelines* (2.6) such as the NHTSA-2010-0053 Visual-Manual NHTSA Driver Distraction Guidelines: For In-Vehicle Electronic Devices[16] and ESOP guidelines addresses these issues. However, most highway regulations prohibit the manual use of mobile phones while driving. Generally, a driver shall not make or receive a phone call while driving, unless the mobile phone is secured in a mounting affixed to the vehicle or is not being held by the driver, and does not require the driver, at any time while using it, to press or manipulate anything on the body of the phone, i.e in most countries, 'hands-free' operation is allowed, although there is a growing body of evidence that simply talking on the

phone creates an unacceptable level of driver distraction that has empirical evidence collated that is a contributory cause of vehicle accidents. Hands-free operation is generally allowed.

The position of whether a driver can receive a text or video or similar communication if the communication is received automatically by the phone and the message is not automatically visible on the screen of the phone (except for an indication that the communication has been received) is less clear in many countries. CB radio communications or other two-way radio devices (such as taxicab control systems) are generally allowed in most countries.

It may generally be said, in most countries, that the mobile phone usage regulations have not kept pace with developing mobile phone functions which could potentially be both a visual display unit and a driver's aid (especially, e.g. as a sat/nav device) The prognosis is worse for the future. Because much *ITS*/*C-ITS* service provision could well be carried into the vehicle via a USIM/cellular communications link, which is technically a mobile phone even if the *IVS* (2.7) does not look like one, and might need screen led responses by the driver. How the law will deal with this is unclear in most countries and revision (clarification) is urgently needed.

Current *regulations* (2.11) for driver *distraction* (2.4) were developed in now outmoded scenarios. There is not so much a need to use regulatory tools to set uniform standards, as to bring the existing regulations up to date. Standardization should, wherever possible, be a consensual process involving as many stakeholders as practicable. Wherever possible, regulatory tools should reference consensually developed standards.

5.4 International approaches

5.4.1 United States

Driver distraction *rules* (2.12) in the United States are largely set by state *jurisdictions*, resulting in a wide range of different *regulations* (2.11). However, driver distraction is also a particular concern of the US Department of Transportation and the National Highways Traffic Safety Administration (NHTSA).

Working with industry, the NHTSA recently proposed performance-based *distraction* (2.4) *guidelines* (2.6) for in-vehicle electronic device manufacturers, with the aim to

— reduce complexity and task length required by the device,

— limit device operation to one hand only (leaving the other hand to remain on the steering wheel to control the vehicle),

— limit individual off-road glances required for device operation to no more than two seconds in duration,

— limit unnecessary visual information in the driver's field of view, and

— limit the amount of manual inputs required for device operation.

The *guidelines* (2.6) distinguish between safety critical and other features of in-vehicle electronic devices and recommend disabling the operational capability of the following devices while driving:

— visual-manual text messaging;

— visual-manual Internet and social media browsing;

— visual-manual navigation system destination entry by address;

— visual-manual 10-digit phone dialling;

— displaying to the driver more than 30 characters of text unrelated to the driving task.[7]

There is an exception for devices intended for use by passengers so long as it cannot reasonably be accessed or seen by the driver or unless the vehicle is stopped and the transmission shift lever is in park.

While there has been some criticism of these *guidelines* (2.6), for example, they do not consider auditory distraction, they are perhaps a sensible starting place when thinking about what revised guidelines or a code may look like. The Phase 3 guidelines are expected to address auditory interfaces.

There has also been significant criticism from the automotive industry, who is concerned that the guideline is overly restrictive. Their concern is that too many functions are blocked while driving and a well-integrated OEM device might become unattractive for the driver. As a consequence, the driver will use nomadic devices which have no restrictions and the overall effect on safety will be negative.

It should be noted, however, that it is likely to be easier to incorporate into *in-vehicle* devices than into after-market devices.

See also Annex A for a comparison of ESOP, JAMA and AAM considerations.

5.4.2 Europe

Within the European Union, *distraction* (2.4) issues are generally governed at the member-state level.

As a result, there is a variety of regimes, for example, in regard to nomadic devices, states generally have either a behavioural focus or technical standards focus:

Table 1 — Different approaches to driver distraction in the EU

Behavioural focus – road traffic acts	**Technical focus – vehicle licensing and regulations**
Bans or user restrictions: — Technical (e.g. hands-free) — Situational (e.g. vehicle is moving) — Functional (e.g. texting prohibited) — Way of use (e.g. sound volume)	Bans or vehicle requirements: — Location of mounting position (e.g. position on windscreen of hands-free equipment) — Technical mounting (e.g. suction cup of hands-free equipment)

The 'European Statement of Principles (ESOP) on Human Machine Interface for In-Vehicle Information and Communication' was published by the European Commission (EC) in 1998 and updated in 2006 with the Commission Recommendation on safe and efficient in-vehicle information and communication systems.[17] The taskforce responsible for the statement was developed jointly with the automotive and vehicle technology sector and the principles provide guidance on the usability and safety aspects of the interface between in-vehicle information devices and the driver.

The statement includes a range of principles over the following areas: a) overall design; b) installation; c) information presentation; d) interaction with displays and controls; e) system behaviour.

Again, as with the development of US *regulations* (2.11) and *guidelines* (2.6), the EC principles take a pragmatic approach with the objective of safety and ergonomic suitability in mind. For example, the system should be designed to support the driver and should not present information that gives rise to potentially hazardous behaviour by the driver or other road users in such a way that the allocation of driver attention to the system displays remains compatible with the attention demand of the driving situation

— so as not to distract or visually entertain the driver,

— to be located and fitted in accordance with relevant *regulations* (2.11), standards and manufacturer's instructions for installing the system in vehicles,

— so that information relevant to the driving task is timely and accurate,

— so as not to produce uncontrollable sound levels liable to mask warnings from within the vehicle or outside,

— with provision for hands-free speaking and listening,

— to enable the driver to control auditory information where there is a likelihood of *distraction* (2.4) or irritation,

— to enable non-safety dynamic visual information to be capable of being switched off,

— to display current status of the system and any malfunction that is likely to have an impact on safety,

— so that in the event of a partial or total failure of the system, the vehicle should remain controllable or at least should be capable of being brought to a halt in a safe manner,

— with instructions that clearly state which aspects of the system are intended for use by the driver while driving and those aspects which are not intended to be used while driving, and

— to ensure that representations of system (e.g. descriptions, photographs and sketches) should neither create unrealistic expectations on the part of potential users nor encourage unsafe or illegal use.

The EC is again in the process of updating the statement of principles to make them more specific.

5.4.3 Australia

Australian Road Rule 300 restricts the use of mobile phones while driving. Generally, a driver shall not make or receive a phone call while driving unless the mobile phone is secured in a mounting affixed to the vehicle (in a manner intended by the manufacturer) or is not being held by the driver and does not require the driver at any time while using it to press or manipulate anything on the body of the phone.

But the nature of the examples provided, particularly reference to navigational or intelligent highway and vehicle system equipment, correspond sufficiently with *C-ITS* technology to suggest that it would be considered a driver's aid for the purposes of Rule 299. It is noted, however, that Rule 299 does not proscribe appropriate use of visual display units or driver's aids and does not regulate design interface or provide maximum time periods that a driver's attention should be taken from the road.

The NTC recently released the Australian Road Rules 10th Amendment Package Explanation of Amendments July 2013.65 Amongst the changes proposed is an amendment to Rule 299 "to create consistency by bringing rule 299 in line with rule 300 so that a visual display unit which comprises a driver's aid includes one which is operating on a mobile phone." This change would go some way to ensuring a "technology neutral" approach, by allowing a mobile phone to be used as a driver's aid, which would conceivably include *C-ITS applications*. However, there will remain a difference in treatment between the two, as a mobile phone used as a driver's aid cannot be touched while driving, while this is not the case for other driver's aids.

5.4.4 Japan

Japan's Road Traffic Act restricts the use of mobile phones while driving.

Generally, a driver shall not make or receive a phone call while driving, unless the mobile phone is secured in a mounting affixed to the vehicle or is not being held by the driver.

And, by the act, a driver is also prohibited to fix one's eyes on any display device such as car navigation system.

On the other hand, National Public Safety Commission gave notice of "a guideline for the provision of traffic information" in 2002.

In the guideline, traffic information providers (including equipment manufacturers) are requested not to provide a 'complex' information requiring driver's gaze and also requested to take possible actions to avoid a driver distraction.

5.4.5 Other countries

May be added in a later version of this TR.

5.4.6 Vienna convention on road traffic

The Vienna Convention on Road Traffic[9] was amended in 2006 to provide that:

A driver of a vehicle shall at all times minimize any activity other than driving. Domestic legislation should lay down rules on the use of phones by drivers of vehicles. In any case, legislation shall prohibit the use by a driver of a motor vehicle or moped of a hand-held phone while the vehicle is in motion.

The convention does not, however, specify uses of other technology.

6 Policy questions and options

A key question is the role of government and regulation in this area and how far the market should be left to innovate its own solutions.

6.1 Option 1: Continue current approach

Enable self-regulation within the industry: manufacturers and in-vehicle *ITS* service providers are generally aligned with government objectives to ensure that *C-ITS applications* minimize safety risks relating to driver distraction and market-led solutions and may be largely accommodated within existing *regulations* (2.11).

6.2 Option 2: Amend current road rules

Update the road/highway *rules* (2.12) to ensure that *C-ITS applications* are captured and set out in what circumstances, and how, *C-ITS* is permitted to be incorporated into vehicles.

There might be a need in many *jurisdictions* to remove ambiguities and distinguish between safety critical and non-safety critical systems or functions. This may extend to permitting the use of a mobile phone as a driver's aid when it is being used for that purpose. There are inherent challenges in enforcing provisions that allow particular devices to be used for one purpose and not another. An alternative may be to change the focus to the task demand on the driver rather than the technology; however, again, this approach is problematic for enforcement.

6.3 Option 3: Create guidelines or principles for manufacturers

As an alternative to regulation, there may be an opportunity to work with manufacturers in order to define safe interfaces, *in-vehicle systems* (2.7) and operations, as is being developed in the United States and Europe. In doing so, *guidelines* (2.6) or a statement of principles should not restrict technology innovation and take into consideration the international connectivity of in-vehicle technology development and multinational nature of the auto-manufacturing sector that will favour in-vehicle information standards that are consistent across *jurisdictions*.

The straightforward adoption of a revised version of ESOP or NHTSA guidelines may present a solution (both are under revision).

Guidelines (2.6) or a statement of principles should also take into consideration the challenge of after-market *C-ITS* devices and seek to manage and provide advice on how these devices can minimize driver *distraction* (2.4) when units may have multiple functions or be competing with a range of in-vehicle technologies, such as satellite navigation or phone communication. Separate guidelines may need to differentiate between technology built into the vehicle and after-market devices which could raise different risks.

6.4 Option 4: Examine technology options as they develop

There are already technology solutions emerging in the market that seek to minimize driver *distraction* (2.4). For example, in-vehicle cameras are being developed that track the driver's eyes in order to ensure that they are not looking away from the road for longer than a designated period. This technology is still in development, however, but should be watched for the opportunities it presents to minimize driver distraction and overload. In the meantime, *jurisdictions* may have a role ensuring that as anti-distraction technologies are developed, there are appropriate and agreed standards in place that are consistent with design objectives and meet ergonomic and safety *guidelines* (2.6).

7 Summary of findings

The following are the principal findings of this Technical Report:

a) Transport authorities, in conjunction with automotive manufacturers and providers of after-market products, need to develop verification processes for the installation of new technologies so that vehicle owners and potential purchasers can be ensured that the installation satisfies the design rules that apply in that *jurisdiction*;

b) There is a need for the development of safety standards, ratings, and labels for after-market devices.

   (After-market products do not benefit from the discipline and rigor of type approval testing, and may potentially add to driver distraction if allowed in uncontrolled circumstances. Conversely, after-market products can introduce safety measures that were not available or taken up at the time of manufacture of the vehicle. As vehicles now have an average life of 20+ years, these are likely to be significant. A separate regime is therefore required for after-market devices and their use in vehicles.);

c) Drivers need to be given

   1) awareness and education, and

   2) deterrence;

d) *Distractions* (2.4) need to be targeted specifically in respect of

   1) design (e.g. display legibility, no moving images),

   2) intelligent adaptive interfaces,

   3) performance (e.g. level of safe driving), and

   4) human factors design procedures;

e) Protecting distracted drivers.

For UNECE, IHRA identified a timeline for the types of protective measures against driver *distraction* (3.4). See Figure 2.

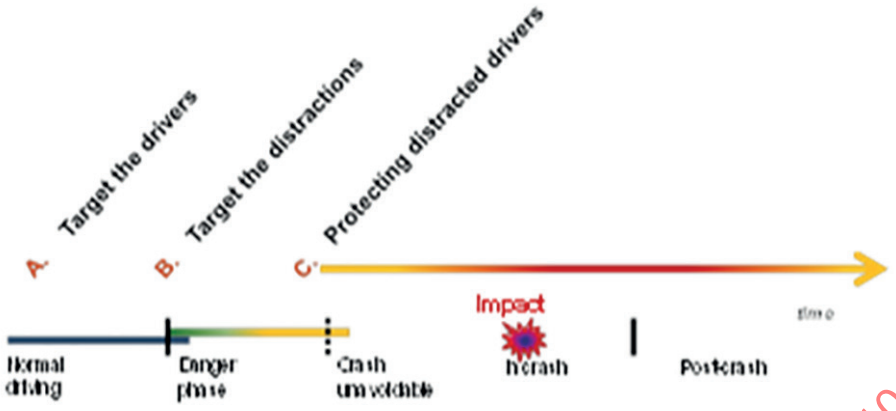

Figure 2 — Distraction timeline (Source: UNECE-IHRA[14])

In Figure 2, IHRA propose a distraction countermeasures strategy as follows:

A: Target the drivers

— Awareness and Education

— Deterrence

B: Target the distractions

— Design (e.g. display legibility, no moving images)

— Intelligent adaptive interfaces

— Performance (e.g. level of safe driving)

— Human factors design procedures

C: Protecting distracted drivers

US NHTSA offers a plan to eliminate crashes due to *distraction* (2.4). See Figure 3.

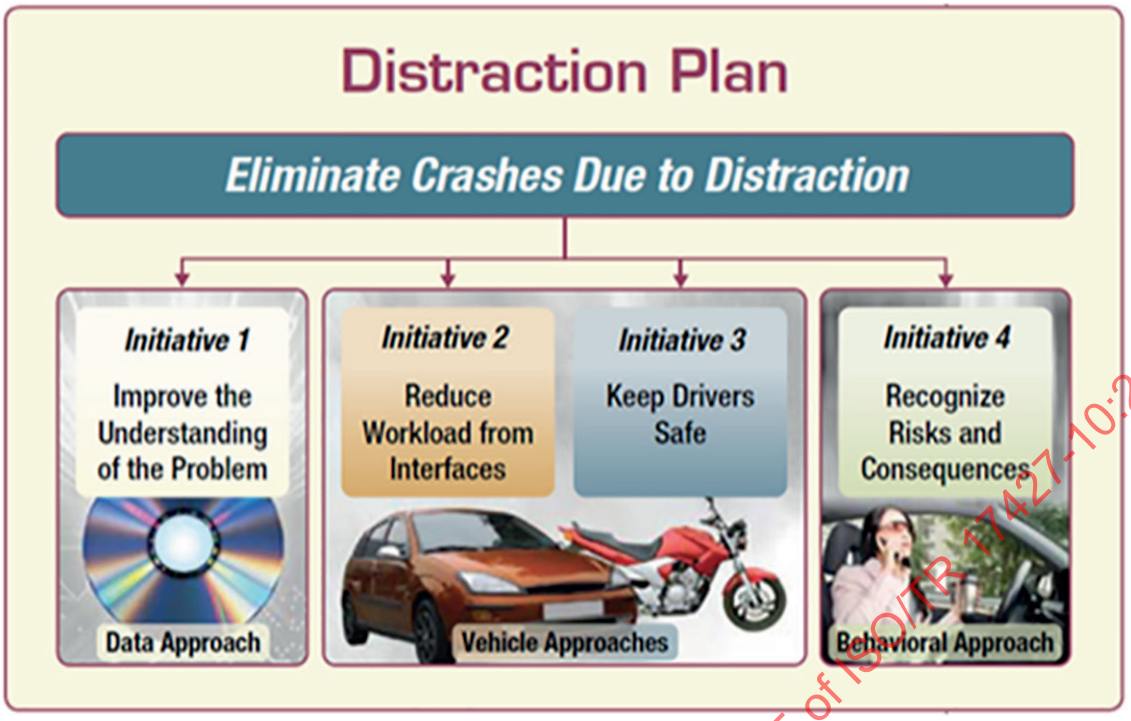

Figure 3 — NHTSA (US DoT) distraction plan[15]

US NHTSA (US DoT) offers the following fundamental principles:

— The driver's eyes should usually be looking at the road ahead;

— The driver should be abe to keep at least one hand on the steering wheel while performing a secondary task (both driving-related and non-driving-related);

— The distraction induced by any secondary task performed while driving should not exceed that associated with a baseline reference task (manual radio tuning);

— Any task performed by a driver should be interruptible at any time;

— The driver, not the system/device, should control the pace of task interactions;

— Displays should be easy for the driver to see and content presented should be easily discernible.

For details, the reader is referred to "Department Of Transportation National Highway Traffic Safety Administration Docket No. NHTSA-2010-0053 Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices".[16]

Perhaps the first important step towards minimizing driver *distraction* (2.4) safety risks is reaching agreement with industry on *guidelines* (2.6) that are broadly consistent with standards being developed (Option 3). Where new services are introduced that are not covered by existing guidelines, the auto-manufacturing and *C-ITS* service providers would most likely benefit from a uniform principle-based approach implemented across the sector. Furthermore, standardized formatting and prioritization *rules* (2.12) for information communication across all vehicle and *C-ITS* makes and models will accelerate consumer confidence in *C-ITS* and decrease the driver distraction risk.

As *C-ITS* services are implemented across the vehicle fleet, in both new vehicles and after-market systems, and as the technology begins to blur information display with entertainment and/or critical safety features, driving *rules* (2.12) are also likely to need review in most *jurisdictions* (Option 2). While the *applications* are, in many case, in the near to mid-term future, enough is known about their nature to start these revision processes now in order for them to be implemented in a timely manner. *Regulations* (2.11) should ensure that the principles of reducing driver *distraction* (2.4) extend to *C-ITS*

and the interplay with other in-vehicle functions, ideally without being technology specific or limiting further intelligent transport innovation.

However, given that *C-ITS application*s will still only be one technology communication function amongst a range of different in-vehicle and after-market systems, it may be that a wider review of *distraction* (2.4) is required, rather than focusing specifically on *C-ITS* and developing *rules* (2.12) or guidance that may be incompatible with other technology. *C-ITS* will therefore likely follow the lead of in-vehicle *regulations* (2.11) and standards (ISO TC 22) rather than lead these initiatives; however, it should make input into these processes.

A rigorous accreditation or certification process for *C-ITS* products and services conducted by an independent body against best practice standards may be considered to mitigate potential driver *distraction* (2.4) issues, and indeed, liabilities consequential thereof, because such products and services would be required to pass another point of scrutiny before going on the market. OEM equipment is normally covered by a mixture of type approval testing and self-regulation. As the potential of C-ITS systems are realized, it will remain to be seen and tested as to whether this already provides adequate measures, or whether further measures are required.

Smartphones have given consumers access to a growing number of indispensable applications anytime and anywhere but when it comes to driving, smartphone use is ill-advised and even the most advanced infotainment systems cannot match the breadth of functionality in even the most ordinary smartphones. Commercial solutions such as MirrorLink™[2)] offer to provide some control as to what applications can be accessed by the driver. Whether such systems meet the needs of regulators has to be ascertained and reviewed as the use of such tethered and bluetooth linked devices develops.

Good practice *guidelines* (2.6) should also be developed and issued where they do not already exist and will guide developers in new regulatory and non-regulatory *application*s. While many basic parameters such as not startling or *distraction* (2.4) of the driver might be general, many potential safety risks are likely to be specific to a particular *application* or service and many *ITS/C-ITS application service*s are novel and their paradigm and context likely to be unknown to regulators.

To address the new paradigm, C-ITS service developers should inform regulators and standards developers about new applications. Information, education and advice to regulators, and standards developers by *C-ITS application service* developers will therefore play an important role in getting the regime right and appropriate for the new paradigm. As *application*s are developed, new experience will be gained and new potential risks will become apparent. In the development of a new system, one should always be aware of the introduction of new potential safety risks and make best efforts to avoid or manage them.

The prime responsibility for developing International Standards concerning the HMI and in-vehicle display aspects associated with potential driver *distraction* (2.4) are developed by ISO/TC 22/SC 13 , and all HMI aspects of C-ITS systems should be developed in close coordination with this working group.

2) MirrorLink™ is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Annex A
(informative)

Extracts from "Fighting driver distraction — worldwide approaches"

The following description is taken from "Fighting driver distraction — worldwide approaches".

http://www-nrd.nhtsa.dot.gov/pdf/esv/esv23/23ESV-000290.PDF

Comparison of the regional guidelines

	Reference		
Content	**ESOP**	**AAM**	**JAMA**
Correct installation	2.1	1.1	3.1 (4)
Driver's field of view	2.2	1.2	3.1 (2)
Obstruction of displays and controls	2.3 4.5	1.3	3.1 (1)
Driving posture	-	-	3.1 (3)
Close to the driver's line of sight	2.4	1.4	3.2 Annex 1
Glare and reflections	2.5	1.5	3.2
Display at night			4.1 (3)
Short glances	3.1	2.1A	4.2 (1) 4.2 (2) 5(4) Ann. 2.1
Total glance time	3.1	2.1A	4.2 (1) 4.2 (2) 5 (3) Annex 3
Visual distraction/driving performance		2.1B	-
Symbols	3.2	2.2/1	4.1 (2)
Legibility			
- Contrast	3.2	2.2/2	4.1 (2)
- Size of characters	3.2	2.2/2	4.1 (2)
- Font dimensions	3.2	2.2/2	4.1 (2)
- Blinking	3.2	2.2/2	4.1 (2)
Audibility	3.2		4.1 (2)
Timeliness and accuracy of information	3.3	2.3	-
Prioritization 4)	3.4	-	-

	Reference		
Content	ESOP	AAM	JAMA
Information which impairs the safety and smooth flow of road traffic	-	-	4.1 (1)
No uncontrollable sound	3.5 4.6	2.4	4.3 (1) 4.3 (2)
At least one hand on the steering wheel	4.1	3.1	5 (1)
Chunkability	4.2	3.3	5 (5)
Resumeability	4.3	3.3	5 (6)
Driver paced	4.4	3.4	5 (8)
Hands-free speech	-	3.2	-
Timely feedback	4.7	3.5	5 (9)
Visual information can be switched off	4.8	3.6	5 (5)
No TV or scrolling text	5.1	4.1	4.2 (2) Ann. 2.3 Ann. 2.4
No functional interference	5.2	-	-
Locked during driving	5.3	4.2	4.2 (2) Ann. 2.2 5 (7)
Malfunction notification	5.4	4.3	-

The following extracts show the detailed comparison with differences and common elements.

Correct installation

The system should be located and fitted in accordance with relevant regulations.

While the ESOP focuses on stable mounting and passive safety, the AAM is more general. JAMA regulates the installation of retrofit systems.

Driver's field of view

The system should not obstruct the driver's view of the road scene.

The content of all guidelines is the same; AAM and ESOP also reference regional standards.

Obstruction of displays and controls

The system should not obstruct vehicle controls and displays required for the driving task.

Same content, in ESOP with reference to ISO 4040.

Driving posture

The system shall not cause the driver to be substantially displaced from the driving posture (JAMA only).

Close to the driver's line of sight

This principle limits the downward angle. JAMA defines a value of 30° for the projection of the line between display and JIS eye point on the xz plane. AAM applies, additionally, a 3D method that allows greater downward angles if the display is mounted on the passenger side. ESOP does not give a defined value for the downward angle.

Glare and reflections