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ITU-T Focus Group on Driver Distraction

Report on Situational Awareness Management

Focus Group Technical Report

ITU-T

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FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The procedures for establishment of focus groups are defined in Recommendation ITU-T A.7. The ITU-T Focus Group on Driver Distraction (FG Distraction) was established further to ITU-T TSAG agreement at its meeting in Geneva, 8-11 February 2011. ITU-T Study Group 12 is the parent group of FG Distraction.

Deliverables of focus groups can take the form of technical reports, specifications, etc. and aim to provide material for consideration by the parent group in its standardization activities. Deliverables of focus groups are not ITU-T Recommendations.

SERIES OF FG DISTRACTION TECHNICAL REPORTS

Final Report

Report on Use Cases

Report on User Interface Requirements for Automotive Applications

Report on Situational Awareness Management

Report on Vehicle-to-Applications Communications Interface

ABSTRACT

This report from ITU-T FG Distraction on Situational Awareness Management describes system capabilities that are important for improving the safety of driver interaction with applications/services. An understanding of these system capabilities will be important during the development of standards on the underlying mechanisms. The main goal of this report is to support standardization efforts related to draft new Recommendation ITU-T G.SAM (Mechanisms for managing the situational awareness of drivers).

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1. Scope

This report describes *capabilities* of the Driver-Application system that have the potential to enhance the ability of drivers of road vehicles to safely interact with Information and Communications Technology (ICT) systems/applications.

These system capabilities are intended to apply to non-commercial road vehicles. Commercial road vehicles may have additional requirements not considered in this report. Advanced Driver Assistance Systems (ADAS) are considered out of scope.

2. References

[1] Recommendation ITU-T E.800 (1994). *Terms and definitions related to quality of service and network performance including dependability*.

[2] M. R. Endsley (1995). *Toward a theory of situation awareness in dynamic systems*. Human Factors 37(1), pp. 32–64.

[3] Adaptive Integrated Driver-vehicle InterfacE (AIDE) project (2008). http://www.aide-eu.org/

[4] Car Connectivity Consortium Driver Distraction Guidelines. http://www.mirrorlink.com/

[5] ETSI TR 102 762 V1.1.1 (2010): *Human Factors (HF); Intelligent Transport Systems (ITS); ICT in cars*. http://www.etsi.org/deliver/etsi_tr/102700_102799/102762/01.01.01_60/tr_102762v010101p.pdf

[6] ISO/TR 12204 (2012). *Road vehicles -- Ergonomic aspects of transport information and control systems -- Introduction to integrating safety critical and time critical warning signals*.

[7] ISO 15006 (2011). *Road vehicles -- Ergonomic aspects of transport information and control systems -- Specifications and compliance procedures for in-vehicle auditory presentation*.

[8] ISO/TS 16951. *Road vehicles – Ergonomic aspects of transport information and control systems – Procedures for determining priority of on-board messages presented to drivers*.

[9] SAE J2395 (2002). *ITS In-Vehicle Message Priority*.

[10] SAE J2397. *Integration of ITS In-Vehicle User Interfaces Standard*.

[11] UNECE WP.29. *Guidelines on establishing requirements for high-priority warning signals*. 154th session, Geneva, 21-24 June 2011.

3. Definitions

ADAS – Advanced Driver Assistance Systems are vehicle systems which have a primary function of helping the driver safely control the vehicle. Examples of such systems include lane departure warning systems and Adaptive Cruise Control (ACC).

Commercial road vehicle – a vehicle used by businesses or public transportation authorities which as a primary function other than personal transportation of individuals or small groups of individuals. Examples include tractor-trailers and buses. Such vehicles often require drivers to perform additional tasks while driving which may not have been adequately considered during the development of this report.

Driver-Vehicle Interface (DVI) – the integrated user interface in the vehicle. It includes visual displays, loudspeakers, microphones, manual input controls, etc.

External application/service – applications/services that were not integrated into the vehicle at the time of manufacture. Such applications/services include those that reside on a nomadic device brought into the vehicle, roadside station, or cloud-based server. Applications/services that do reside on the vehicle platform, but were not integrated at the time of manufacture (e.g., downloaded applications), are also considered "external applications/services" since they might not be fully integrated into the DVI.

Quality of Service (QoS) – the collective effect of service performances, which determine the degree of satisfaction of a user of the service [1].

4. Abbreviations

ADAS	Advanced Driver Assistance Systems
AIDE	Adaptive Integrated Driver-vehicle InterfacE
CCC	Car Connectivity Consortium
DVI	Driver Vehicle Interface
ETSI	European Telecommunications Standards Institute
G.SAM	Draft new Recommendation ITU-T G.SAM
ICT	Information and Communications Technology
ISO	International Organization for Standardization
ITU-T	Standardization sector of the International Telecommunications Union
QoS	Quality of Service
SA	Situational Awareness
SAE	Society of Automobile Engineers
SHRP2	Strategic Highway Research Program 2
TRB	Transportation Research Board
UNECE	United Nations Economic Commission for Europe

5. Introduction

Situational Awareness (SA) refers to "*the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future*" [2]. SA is a key element of a driver's ability to safely operate a vehicle. For instance, a driver must first detect a car has entered the roadway, and understand that its current trajectory will cause an accident, before an evasive manoeuvre can be performed to avoid an accident.

In order to mitigate driver distraction and workload, driver interaction with ICT systems/applications should be managed so that drivers are able to maintain SA. This can be achieved by enabling drivers, and/or intelligence about the driving situation, to control when and how ICT systems/applications are used by drivers during driving.

Figure 1 illustrates the major subsystems that are involved in SA management with ICT systems/applications. Although not explicitly labelled, the driver can also be considered a subsystem involved in SA management. This is because the driver makes real-time decisions on whether, when, and how to interact with ICT systems/applications, as well as how much attention to allocate to them.

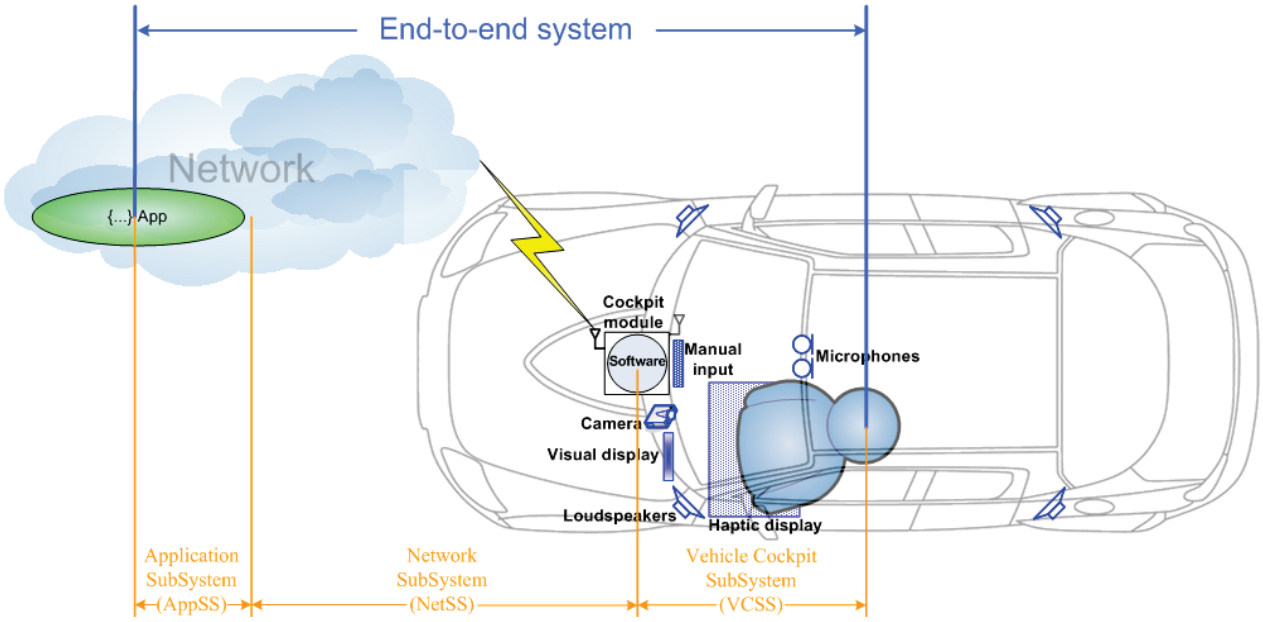

Figure 1. Example of multiple subsystems involved in management of situational awareness.

Standardization is desirable because it facilitates interoperability between the subsystems – which are likely created by different entities. They also provide guidance to designers and developers on the functional requirements for managing SA through user interface design and secondary mechanisms such as those being defined in G.SAM (if equipped).

The purpose of this report is to identify the Driver-Application system capabilities that are important for helping drivers to manage their SA. It is hoped this information will facilitate development of functional standards for ICT systems/applications. In particular, this report is intended to help facilitate development of the mechanisms being defined in draft Recommendation ITU-T G.SAM.

It is recognized that there will be a lag between the time such mechanisms are standardized, and the time there is a significant safety benefit. Therefore, other efforts should be pursued in parallel to positively affect road safety. Such efforts include educational programs and other technical solutions.

Section 3 of this report describes the system capabilities needed to help drivers manage SA while using ICTs. Section 4 discusses the next step of translating these capabilities into standards. Section 5 lists some existing works and related on-going activities that may be helpful in future standardization work.

6. System capabilities to manage Situational Awareness (SA)

This section describes the system capabilities that are useful to help drivers manage SA while interacting with applications.

6.1 Strategic capabilities

6.1.1 Communications provisioning QoS

Communications provisioning QoS refers to the ability for drivers to easily and automatically configure communications to external applications/services. Providing an easy and automatic means to connect the vehicle to external applications/services will provide greater likelihood that such systems will be used and the safety benefits from their use will be realized.

6.1.2 Application/system authorization

Application/system authorization refers to the ability to grant/revoke authorization of application/system to interact with the driver while driving.

The ability to only allow interaction with applications that have been judged to be safe to use while driving is an important capability for enhancing SA.

6.1.3 Communications QoS prediction

Communications QoS prediction refers to the ability to accurately predict the availability, reliability, and performance of driver-application communications during the time such communications is needed.

For example, a navigation application running entirely on a cloud-based server will need a communications link with high availability during the route that has been requested. Otherwise, navigation manoeuvres may not be delivered in time and potentially cause elevated levels of distraction and workload while the driver tries to figure out what went wrong and how to get back on route.

SA could be better managed in the above example if low availability of the communications network was predicted and the driver was simply told that navigation services were not available for the requested route.

6.1.4 Pause/resume application

Pause/resume application refers to the ability to easily suspend/resume interaction with an application.

When roadway demands increase, drivers need to be able to redirect their attention from the application to driving. However, if there is a high penalty for diverting attention away from the application, drivers may be reluctant to disengage from interacting with the application in order to attend to the primary task of driving. This can happen, for example, if failing to provide input within a timeout period will result in having to start again from the very beginning of a dialogue. SA can be facilitated by enabling the driver to better control the pace of interaction with an application, without imposing penalties for reasonably delayed input or response.

There are also situations where it may be beneficial for intelligence about the driving situation to suspend interaction with external applications/services. For example, if intelligence in the vehicle can determine that a vehicle several places ahead in a line of traffic has applied its brakes (e.g., through Vehicle-to-Vehicle communications) it could suspend interaction with an external application/service so that the driver can allocate full attention to the driving task.

6.2 Tactical capabilities

6.2.1 Communications status

Communications status refers to the ability to monitor, publish, and subscribe to the status of driver-application communications.

For example, round-trip latency of communications could be checked before starting a dialogue between a cloud-based application and the driver. If latency is large enough to cause the interaction to be distracting (e.g., unexpected application behaviour), then the dialogue could be deferred.

SA is managed by not engaging the driver when information cannot be transmitted in a timely and accurate manner.

6.2.2 Message scheduling

Message scheduling refers to the ability to time the deliver of messages so that they do not interfere with the primary driving task. This requires real-time monitoring of the driver, roadway, and vehicle conditions. It also includes making sure that messages which have expired are not delivered.

For example, if the driver is attempting to merge onto a busy highway, then the playback of an appointment notification message could be delayed until driving demands decrease.

SA is enhanced by making sure the driver is not distracted or overloaded by information from external applications/services at critical moments while driving.

6.2.3 Delay-tolerant driver input

Delay-tolerant driver input refers to the ability to handle tactical timing delays on input from the driver.

For example, if the driver is prompted for input by an application, short delays in responding (e.g., pausing to check traffic before crossing an intersection) should not cause the system to reset or reject previous inputs.

This will help drivers to manage SA by allowing them to switch attention to the driving task without penalty.

6.3 Operational capabilities

6.3.1 Communications quality

Communications quality refers to the ability to ensure that a specified QoS level for communications establishment, information transfer, and release is achieved.

Communications establishment QoS is largely determined by the time it takes to set-up the connection. For example, a cloud-based speech recognition service should respond to driver input within a couple of seconds to minimize distraction. However, if it takes more than 2 seconds to establish the connection to the server, then there will likely be long delays in responses to driver inputs as well, which may cause distraction and reduce the driver's SA.

Information transfer QoS is often characterized in terms of packet delay and loss. For example, if the packet loss ratio is high during the transmission of a speech prompt, then SA may be reduced because the driver has to devote more attention to trying to understand the degraded speech prompt.

Release QoS is largely determined by the time it takes to successfully terminate the connection. Long release times could negatively impact other functions that need a new connection.

Unexpected application behaviour and poor message comprehension can result when the requisite communications quality is not achieved. Therefore, guaranteeing expected communications quality is important for managing SA.

6.3.2 Communications repair

Communications repair refers to the ability to re-establish communications if disconnection occurs suddenly without the need for intervention by the driver.

For example, some have complained that it is distracting when their Bluetooth phone inexplicably disconnects from their car system and they have to pick-up their phone to re-establish communications.

This capability is important because it eliminates the need for manual intervention which can reduce SA.

6.3.3 Application management

Application management refers to the system features that enable a driver to manage interaction with multiple dialogues from different applications/systems in real-time.

For example, if multiple applications are active, the driver should be able to easily navigate among them and always be informed as to which application is associated with a given dialogue. Arbitration and integration policies for foreground/background application messages should also ensure that interactions are consistent with driver expectations.

Application management improves SA by reducing the time and effort needed to interact with applications.

6.3.4 Application output handling

Application output handling refers to system automated arbitration/integration of messages coming from multiple applications/systems, which set optimal timing and multi-modal message format based on current conditions.

An example of arbitration is when a navigation manoeuvre message arrives at the same time as a social media status update message. Both messages should not be played back simultaneously because it could cause distraction and thereby negatively affect SA. Instead, the messages should be played back sequentially based on importance. More specifically, playback of the social media status message should be delayed because the navigation manoeuvre message is more time sensitive and has a potentially greater impact on SA.

An example of integration is when a navigation manoeuvre message arrives while the driver is engaged in a phone call and is played simultaneously by spatially mixing it with the phone audio (e.g., the driver hears phone audio coming from directly in front of him/her, while s/he hears the navigation manoeuvre audible instruction coming from the right side of vehicle).

An example of setting optimal multi-modal message format based on current conditions is presenting an auditory message instead of a visual message when the visual message would otherwise be too long or complicated to comprehend during driving. . It should also be possible to select message modality based on user input (e.g., deaf driver setting). However, it may not always be possible to deliver the same amount or type of information in other modalities.

Application output handling helps manage SA by controlling how information gets presented to drivers.

6.3.5 Driver input handling

Driver input handling refers to the ability to accept multi-modal input from the driver.

For example, the driver may want to select an item from a list through speech or a manual knob; depending upon his or her familiarity with the list or with the roadway situation.

Giving drivers the flexibility to provide input in the manner that is easiest for them can help them to better manage their SA.

7. The next step: standardizing mechanisms

The success of technology-based solutions depends critically on figuring out which aspects to standardize – and which aspects not to standardize. For example, it may make sense to standardize how "driver state" is *represented by different vehicles or systems*, but not how it is *assessed*. The *representation* of driver state may need to be standardized to allow this information to be communicated across subsystems in a consistent manner (e.g., from vehicle to cloud-based application). On the other hand, it might not make sense to standardize how driver state is *assessed* by different vehicles or systems because each could have different sensors, and/or methods of assessing "driver state". Since it is desirable that manufacturers would remain motivated to innovate and improve such assessment hardware and methods, it would be counter-productive to standardize this.

For each of the high-level capabilities described in the previous section, the mechanisms that should and should not be standardized will need to be determined. It is anticipated that this will be one of the first orders of business as the work from FG Distraction is transitioned into ITU-T Recommendations.

8. Existing works and related on-going activities

There are several existing works and ongoing activities that should be considered during the standardization of mechanisms proposed in the previous section. They are more fully described in the following subsections.

8.1 Existing works

Below are some existing works that should be considered during the development of G.SAM mechanisms:

- **Adaptive Integrated Driver-vehicle InterfacE (AIDE)** [3] – This European project represents a previous attempt to do many of the things that G.SAM is attempting to address.
- **Car Connectivity Consortium (CCC) MirrorLink device specification** [4] – this specification defines mechanisms that have been developed to deliver some of the capabilities described in this report.
- **ETSI report on ICT in cars** [5] – technical report from ETSI on the factors important for safe interaction of drivers with ICT applications/systems. A summary of existing work in this area is also provided.
- **ISO/TR 12204:2012 (Introduction to integrating safety critical and time critical warning signals)** [6] – provides guidance on integration of safety critical and time critical warning signals into other messages.
- **ISO 15006:2011 (Specifications and compliance procedures for in-vehicle auditory presentation)** [7] – provides recommendations on the characteristics of auditory messages.
- **ISO/TS 16951 (Procedures for determining priority of on-board messages presented to drivers)** [8] – provides input on message priority.
- **SAE J2395 (ITS In-Vehicle Message Priority)** [9] – provides input on message priority.
- **SAE J2397 (Integration of ITS In-Vehicle User Interfaces Standard)** [10] – provides input on integrating external messages.
- **UNECE WP.29 high-priority warnings statement of principles (Guidelines on establishing requirements for high-priority warning signals)** [11] – this document provides guidelines on high-priority warning signals.

8.2 On-going activities

Below are some on-going activities that should be considered during the development of G.SAM mechanisms:

- **ITU-T Study Group 12 (Performance, QoS and QoE)** – Questions 17 and 13 of ITU-T Study Group 12 may be able to provide valuable input on network performance measurement and definition of network Quality of Service (QoS) classes.
- **ITU-T Study Group 17 (Security)** – ITU-T Study Group 17 may be able to provide valuable input on security aspects of G.SAM.
- **SAE Safety & Human Factors Steering Committee DVI committee** – this group is made up of subject matter experts on automotive HMI and well represented by academia and automakers. More information can be

found at: http://www.sae.org/works/committeeHome.do?comtID=TEITSSHF . They are actively working on guidelines and standards related to G.SAM including the following:

- **Task Force #4 (Prioritization of Distractions & Countermeasure approaches)** – this task force may be able to provide valuable input on the requirements for G.SAM mechanisms.

- **SHRP2 project** –Large scale naturalistic driving study being conducted by the Transportation Research Board (TRB) that is expected to provide insight into the factors contributing to near-crashes and crashes and how this relates to G.SAM mechanisms that are intended to mitigate such factors. More information can found at: http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-S05-RR-1.pdf.
- **UNECE WP.29 ITS informal group** – UNECE WP.29 is the UN agency dealing with international vehicle regulations. It plays a very similar role to that of the ITU-T – except that it deals with vehicle regulations instead of telecommunications standards. It may make sense to collaborate with the ITS informal group to ensure their warning principles are properly incorporated into G.SAM mechanisms. More information can be found at: http://www.unece.org/trans/main/welcwp29.html.

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