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Intelligent transport systems — Information interface framework between automated driving systems and users

Systèmes de transport intelligents — Cadre d'interface d'information entre les systèmes de conduite automatisée et les utilisateurs

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Foreword

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Automated driving systems (ADS), which are expected to become increasingly popular in the future, can need to convey situation-specific information to or from users.

For example, when it becomes necessary to lower the level of driving automation or cancel it for a given reason, it is important to notify the user of this change and to prompt the user to monitor the surroundings or take a certain action. Additionally, when the system executes a certain function, it can be necessary for the user to confirm the intention.

ADS can receive supplementary information from users through nomadic devices (if these are paired to the ADS) in addition to onboard devices. As users of ADS level 3 or higher are allowed to use certain nomadic devices (such as smartphones) to perform secondary tasks while in the driver seat, a problem can potentially arise where the ADS needs to inform the user of a critical message through a nomadic device currently being used.

Examples of information exchanged between the ADS and the user include:

— ADS prompting action by the user;

— ADS informing the user about the need for action in the near future;

— ADS informing the user about a change in operational status;

— user's nomadic device informing ADS about the user's current condition.

NOTE 1 The user is primarily the person sitting in the driver's seat, but also includes the passengers in a driverless vehicle.

This document provides a review of ideas and policies on this subject that have gained international consensus. Information to be provided to the user is stratified and aspects such as priority and content are described. Within each classification, this document defines information attributes.

A primary classification of notifications to users is based on two broad criteria, which lead to differences in the type of information provided to users:

a) degree of safety criticality: the user needs to take action or provide a response, the user needs to be aware of a change, or user information is provided only for comfort or convenience;

b) time criticality.

ISO/SAE PAS 22736 discusses relevant terminology definitions as well as important concepts concerning ADS design.

NOTE 2 Several documents have been published concerning an ergonomic approach to transport information and control systems. See References [2], [3], [4] and [5].

Intelligent transport systems — Information interface framework between automated driving systems and users

1 Scope

This document describes the classification of notifications provided to and from users and automated driving systems (ADS) of level 3 or higher.

This document does not include recommendations on how to provide information.

This document also includes information on transmission between nomadic devices and ADS in the context where the user is concentrating on a device such as a smartphone, and the smartphone is able to monitor the user's condition.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Abbreviated terms

ADS automated driving system

DDT dynamic driving task

ODD operational design domain

FRU fallback ready user

MRM minimal risk manoeuvre

MRC minimal risk condition

5 System image

While the ADS system is used at automated level 3 or higher, the system asks the driver to take the wheel or perform some action, such as when the system is about to exit the ODD. In such cases ADS conveys some information or messages to users to prompt them for appropriate actions.

For notifications, it selects a means of transmission according to its purpose and considers the degree of importance/urgency and whether there is a user action request. In such cases, prompting messages are conveyed through various onboard visual, acoustic and haptic devices such as an instrument panel or navigation display.

If the user is immersed in a device such as a smartphone as shown in Figure 1, it is effective to transmit information not only through an onboard device installed in the vehicle but also a device that the user is watching.

If a nomadic device is paired to the vehicle, some information from it can potentially be utilized as a supplemental sensing function to confirm, for example, user's fallback readiness and vital conditions to support onboard driver monitoring devices.

Figure 1 — User in ADS mode

6 Classification of the information in ADS

6.1 General strategy for information classification

The information from ADS to users upon events are classified by strategy. Basic considerations are time-critical and safety-critical events.

Time/safety criticalities are considered on each fallback case described in ISO/SAE PAS 22736.

6.2 Fallback cases

Figure 2, 3, and 4 show the fallback cases of automated level 3 ADS and Figure 5, 6, and 7 show level 4 cases. These are the cases that this document takes into account.

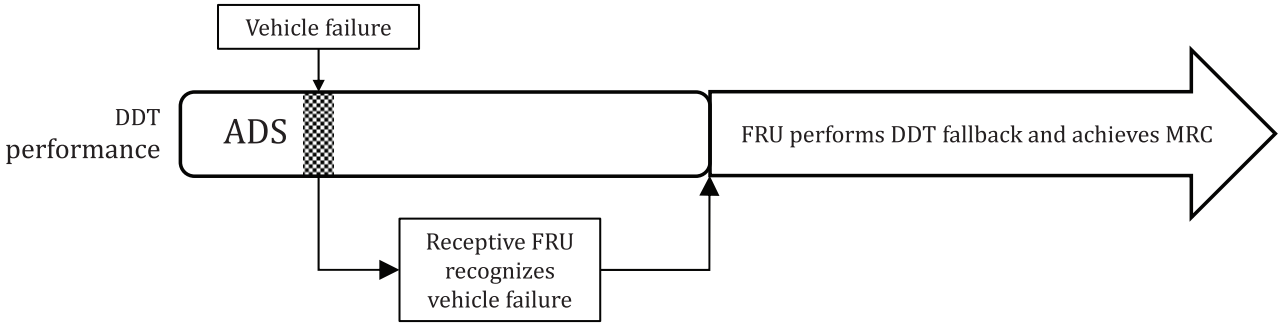


Figure 2 — User performs DDT fallback to MRC

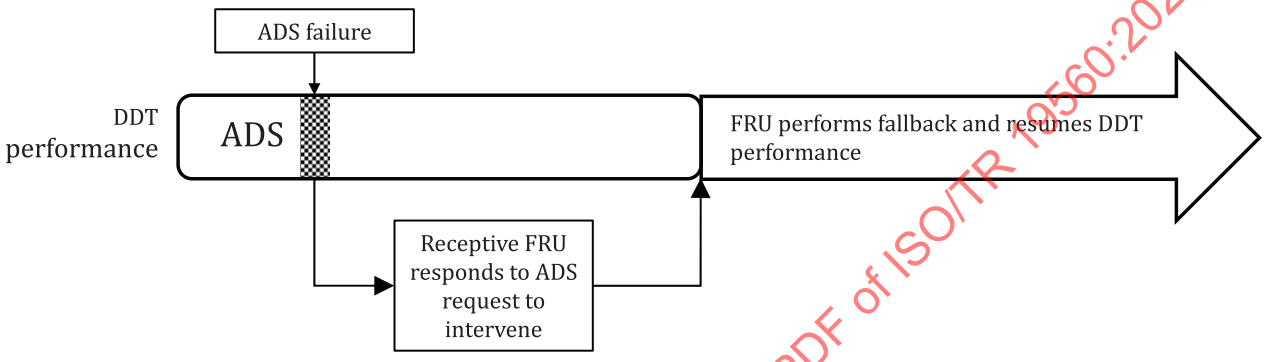


Figure 3 — User resumes DDT on ADS failure

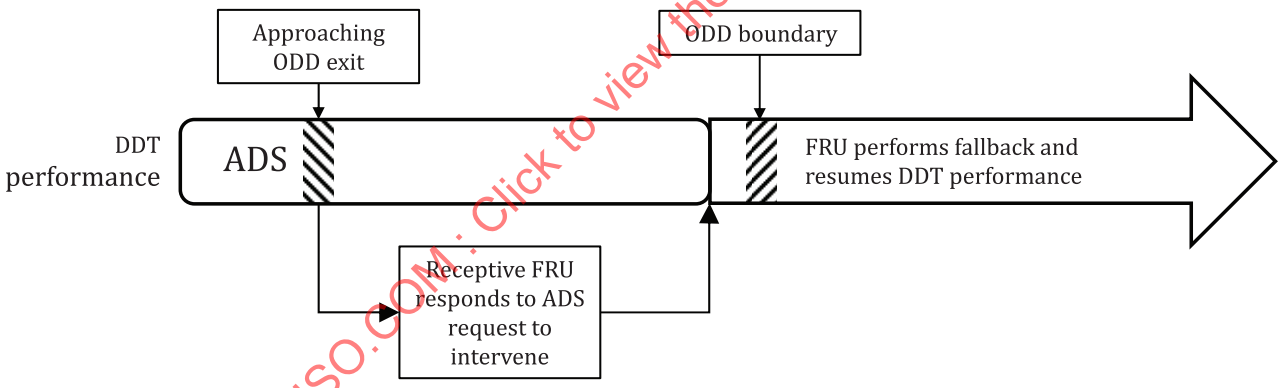


Figure 4 — User resumes DDT as ODD boundary is close

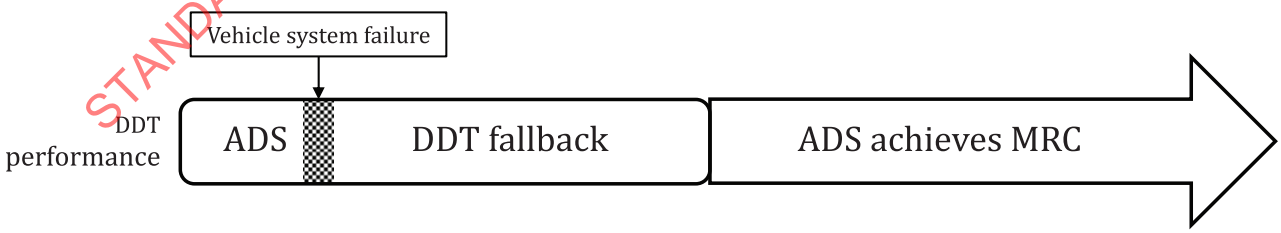


Figure 5 — ADS performs DDT to achieve MRC on vehicle failure

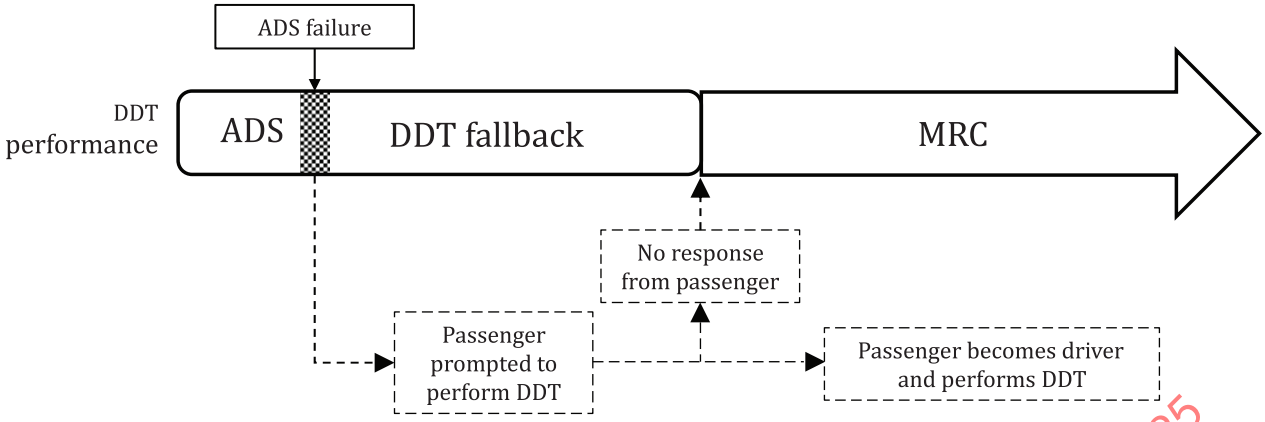


Figure 6 — ADS achieves MRC when user ignored the prompt from ADS on ADS failure

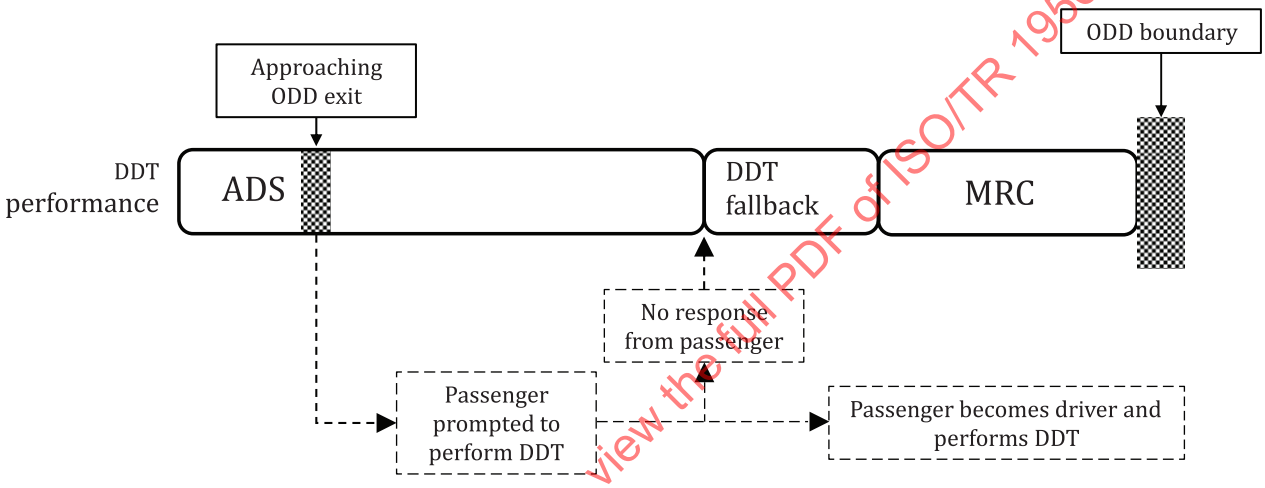
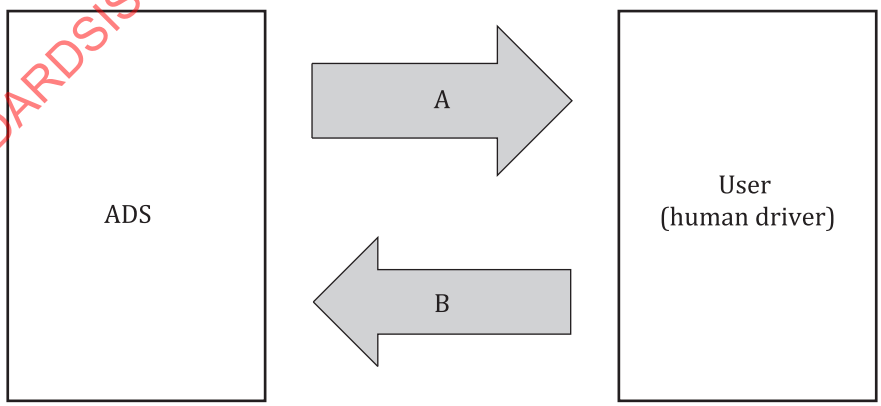


Figure 7 — ADS prompts user to fallback or ADS fallbacks if user ignores the prompt ADS achieves MRC when ODD boundary is close

6.3 Direction of the information

In this document the directions of the information flow are described as in Figure 8.



Key

A ADS to user (human driver)

B user (human driver) to ads

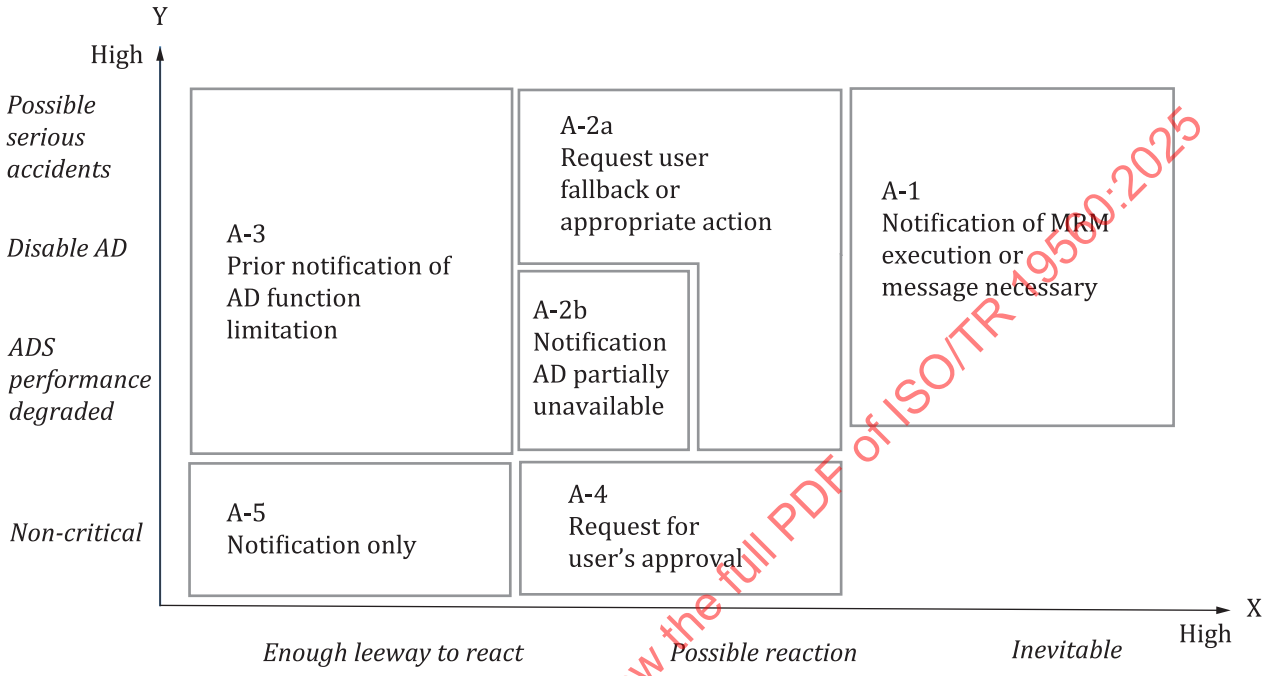
Figure 8 — Direction of information

6.4 Criticality assessment

6.4.1 General

The kinds of information to be transmitted in each direction are shown in Figure 9 (direction A) and Figure 10 (direction B).

6.4.2 Information from ADS to user (A)



Key

X time criticality

Y safety criticality

Figure 9 — Example events to be communicated from ADS to user (direction A)

The following 6 categories are presented in Figure 9.

— A-1 Notification of MRM execution or other time-critical, safety-critical information

In this case, both time and safety criticalities are high. The situation occurs due to sudden ODD violation or serious system malfunctions. There is not enough time for fallback user to react, so notification of the system decision, such as MRM execution, is the only action the ADS can perform.

— A-2a Request user fallback or appropriate action

In this case, the ADS requests the user to perform fallback when an ODD violation is encountered or a malfunction is detected that will disable automated driving, but the vehicle is still manually drivable.

— A-2b Notification AD partially unavailable

In this case, a device failure disables a partial system function. If driver monitoring failure is detected, it is impossible to detect the user's availability for fallback, but this would not require any specific action by the user.

— A-3 Prior notification of future AD function termination

In this case, the user has enough time to resume manual driving mode. For example, ADS notifies the user that after a certain amount of time (e.g. 2 – 3 min) the automated driving function will become unavailable.

This case generally represents the normal behaviour of the system when it approaches its ODD boundary as designed.

— A-4 User's approval request or only notification

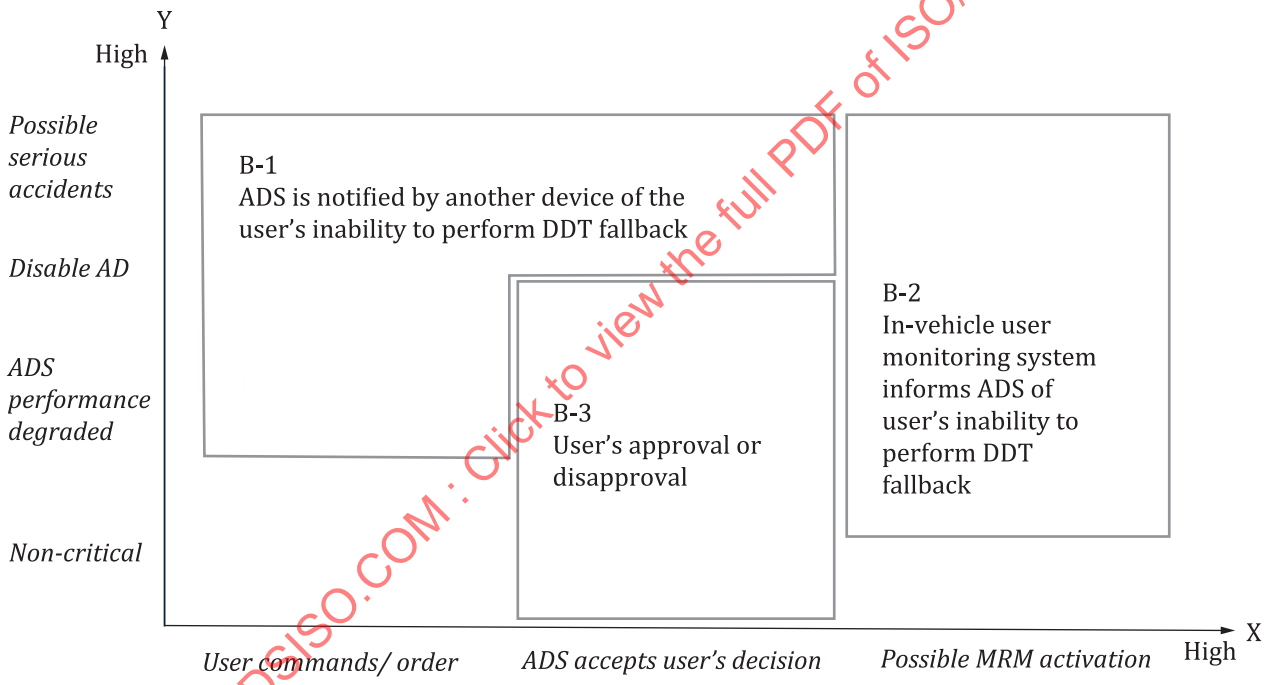
In this case, a message is sent optionally according to the concept of the system design.

Depending on the user's preferences and characteristics, the message is sent to request confirmation or approval from the user before the ADS performs a specific behaviour.

— A-5 Notification only

This case concerns information that is less urgent but useful for the user, such as remaining fuel/charge level and information on relatively distant routing decisions that will be needed. The time and safety criticality level are low.

6.4.3 Information from user to ADS (B)



Key

X operational criticality

Y safety criticality

Figure 10 — example events to be communicated from user to ADS (direction B)

The following 3 categories are presented in Figure 10.

— B-1 ADS is notified by another device of the user's inability to perform DDT fallback

In this case, the ADS is informed of the user condition (that they are not able to perform fallback) through monitoring devices, such as driver monitoring camera, smart watch or mobile phone.

EXAMPLE Information being monitored through monitoring devices can include elements of the driver's vital information, such as body temperature, blood pressure, pulse rate, skin electric resistance, and respiration rate.

Causes that can make the user unable to perform fallback vary in urgency and severity, for example:

— highly urgent: acute illness such as heart attack and stroke;

— moderately urgent: drowsiness, fatigue, digestive attack.

— B-2 In-vehicle user monitoring system informs ADS of user's inability to perform DDT fallback

In this case, an in-vehicle sensor monitors the user's movement and physical condition, and notifies the ADS when it estimates that the user will be unable to perform DDT fallback.

Conversely, it also notifies the ADS when the user's ability to perform DDT fallback is restored.

— B-3 User's approval or disapproval

In this case, as shown in A-4 in Figure 9, the user responds to messages sent from ADS to communicate the user's intentions or preferences when necessary.

6.5 Classification of information

Table 1 — Classification table

Classification	Type	Event	User action
A-1	Notification of MRM execution or other time-critical, safety-critical information	ADS disabled due to fatal malfunction Brake or steering system disabled Detected burst tire Severe surrounding environment condition (out of ODD) Lane keeping impaired (e.g. due to strong wind) Road flooded and impassable Detected close object	None
A-2a	Request user fallback or appropriate action	Surrounding environment condition (out of ODD) Detected emergency vehicle approaching Police regulating traffic, blocked roads Obstruction by aggressive drivers System malfunction, e.g. steering system disabled; insufficient acceleration because engine malfunction or overheat ADS control disabled by malfunction(s), e.g. main sensor stops functioning; map unmatch to actual road; no info transmission available due to device malfunction	Resuming manual driving mode or performing fallback to reach MRC
A-2b	Notification AD partially unavailable	Partial system malfunction, e.g. sensor performance degraded; ADS controller performance degraded; sensor degradation by dirty or fogged camera	Resuming manual driving mode or performing fallback to reach MRC
A-3	Prior notification of future AD function termination	ADS will encounter ODD violation in near future, e.g. obstacle on road at 10 km away; dense fog in 5 min; harsh weather in 10 min; severe rain in 10 min; road closing ahead; winter tyre/chain required ahead; road construction ahead ADS performance becomes impaired due to partial system failure (still operable by backed up: redundant design), e.g. insufficient information to ensure ADS is available; no road info available due to disabled communication	Driver needs to be prepared to intervene
A-4	User's approval request or only notification	Proposal from ADS: overtaking; passing; ADS automation level transition (UP); route selection (navigation cooperation)	Reply
A-5	Notification only	Fork road in 10 km away Low fuel/power Deceleration at toll gate	None
B-1	ADS is notified by another device of the user's inability to perform DDT fallback	User's declaration of fallback unable to change ADS to the mode with less possibility to fallback, e.g. lowering speed, changing lane to slower traffic	User provides notification (e.g. button press)