Report of the Sixth Meeting of the Informal Working Group on Functional Requirements for Automated Vehicles (IWG FRAV)	
Venue	Web conference
Date	29 October 2020
Documents	Submissions for the session can be found on the [FRAV-06 UNECE wiki page].
Status: Draft	

Agenda and previous session report adopted.	With the US co-chair presiding, FRAV adopted the draft agenda (FRAV-06-01-Rev.2) without change; however, an error in the link to join the session was noted. FRAV also provisionally adopted the draft report of the previous session (FRAV-05-02) without revision. Adoption of the report will be confirmed during the 7th session to allow additional time for any comments.
FRAV reviewed the group's status and consensus to date.	On behalf of the FRAV co-chairs (China, Germany, USA), the presiding co-chair presented a review of the FRAV working consensus to date (FRAV-05-03). The co-chair noted the addition of the performance requirement starting points agreed during the last session to the list of consensus items. Per the standing FRAV practice, stakeholders were invited to inform the secretary of any questions or disagreements with the list.
FRAV received an updated version of Document 5. Stakeholders were asked to provide comments for the next FRAV session.	Pursuant to the previous discussions, FRAV received an updated version of the group's tracking tool, Document 5 (FRAV-06-05). The secretary reviewed the changes and new items for FRAV consideration: • Updated chronology of FRAV discussions to FRAV 5th session • Proposes definition of ADS "function" (based on DDT) • Proposes definition of Dynamic Driving Task (DDT) • Proposes to integrate DDT into ADS definition • Removes "System Safety" chapter per FRAV-04 decision • Proposes "ADS Safety Requirements" introductory chapter • Proposes to consolidate eventual performance requirements under "ADS Performance Requirements" chapter. The definitions respond to comments received during the 5th session regarding the need to define "function" and the frequent references to DDT in discussing ADS functions. The ADS Safety Requirements text aims to explain the FRAV strategy (see FRAV-05 report and orientation slides) and describe "system safety" in line with the consensus reached during the 4th and 5th sessions. FRAV stakeholders were requested to review the changes and communicate comments or concerns to the secretary before the 7th session.

Japan presented its views on ODD.	Japan presented its views on the scope of ODD descriptions, stating that the ODD specifies the range of conditions under which the ADS operates and the circumstance where the ADS would transfer control to the [human] driver (FRAV-06-09-Rev.1). Although ADS may have multiple features, Japan suggested that the basic performance requirement is for the ADS to transfer control whenever it encounters an ODD limit. Japan noted two exceptions for transfers of control: under conditions with a high risk of collision and in response to an ADS internal failure (where failure responses would be addressed separately from ODD considerations). Japan proposed ODD-related requirements: • ADS should meet requirements within its ODD • All conditions that would trigger a transition should be declared • ADS should provide adequate warning of an impending ODD exit • ADS should provide continued support if adequate warning cannot be provided (e.g., in the case of an unplanned ODD exit) • The ADS warning should continue until the user has transitioned to full control of the vehicle or an MRM has been initiated • The ADS should initiate a transition or MRM whenever it encounters a condition, including an internal failure, that prohibit safe operation • The ADS should not activate if there is a risk that the ODD conditions are not fulfilled and/or there is a risk of failing to operate normally • The ADS should inform the user via an optical signal if there is a risk of failure to operate normally • The ODD should be described in the user manual, and • The ADS should detect all ODD boundaries.
FRAV discussed the concept of ODD elements as boundaries that would trigger transitions of control to the user.	SAE interpreted Japan's remarks as saying that the FRAV definition of ODD would remain the same; however, the ADS description would in addition explain how the transition should or must occur, etc. This additional explanation would not be part of the ODD but would be relevant to how the ADS responds to an ODD exit. SAE noted that inclusion of the "driver's condition" under item 2 of their document in the description of the ODD is contrary to J3016 and the interpretation agreed by FRAV (i.e., ODD refers to external environmental conditions). SAE added that lane-changing would not be a feature of an ADS but rather a function. ADS are Level 3 and above systems where the ADS must perform the entire DDT. In the expert's view, lane-changing would be part of the DDT functions regarding the capability to control lateral and longitudinal motion.
FRAV agreed that the principles for ODD element definitions would follow the identification of these elements pursuant to the elaboration of safety requirement objectives.	The expert from ITU expressed a different understanding of the ODD. The expert viewed ODD as defining conditions the ADS could handle and the conditions that would trigger a transfer of control. In his interpretation, the ODD could include events such as an abrupt cut-in or abrupt deceleration of the lead vehicle because these events would trigger a transfer. The presiding co-chair noted that FRAV would need to reconcile the different interpretations. The secretary noted the previous FRAV decision to further address ODD after having identified elements to be addressed in the description of an ADS. FRAV agreed to define these elements while defining individual performance requirements. As a result, FRAV would reconsider the ODD chapter once the group has identified a sufficient set of elements.

FRAV discussed the terminology to describe the human being interacting with the ADS with a preference for "user" that may require additional precision.	FRAV discussed different terms referring to the human being interacting with the ADS such as driver, user, and operator. For consistency, FRAV was asked for views on the preferred term. CLEPA preferred the term "user" to cover a human with control over the DDT either in the vehicle or outside the vehicle. The UK explained its use of the term "user-in-charge" as the person who activates and/or deactivates the ADS and therefore has control over performance of the DDT. CLEPA recalled that some ISO standards may also use this term. SAE added that SAE J3016 has a definition of user as a generic reference to the human and uses the term in allocating roles and responsibilities. The presiding co-chair noted general support for the term "user". The secretary requested any information the UK might wish to share on the definition of "user-in-charge".
FRAV discussed the elaboration of the five starting points for defining performance requirements. *Japan proposed to consolidate the 142 candidate proposals from the January session under the starting points. FRAV agreed to further consider this work at its next session.* *Japan proposed distinguishing between Level 3 and Level 4 ADS in separate steps.*	Japan presented document FRAV-06-06 summarizing an assessment of the five starting points for performance requirements against the 142 candidate requirements collected during FRAV-02 (detailed in document FRAV-06-07). Based on the assessment, Japan believes that the five starting points are good enough to cover ADS safety. Japan noted three candidate items relating to Level 4 Mobility as a Service applications that could not be classified under the starting points. Therefore, Japan proposed developing safety requirements in two steps, starting with Level 3 ADS before proceeding to Level 4 ADS. For the first step, Japan proposed that FRAV reconcile the raw list of candidate items to produce a consolidated list while refining the five starting points to address interactions with other road users and ODD. Japan also suggested interaction with WP.1 on traffic laws. CLEPA noted similar work and suggested a need to eliminate overlaps and redundancies in the raw list. The FRAV co-chair from Germany suggested that document FRAV-06-07 provided a good basis for elaborating the five starting points. The presiding co-chair encouraged stakeholders to review FRAV-06-07 and provide comments to the secretary prior to the next FRAV session. The co-chair also accepted CLEPA's proposal for collaborate with Japan on a joint proposal based on their respective work.
Japan noted its initial work on external signaling of an ADS.	Japan explained that under its national law, ADS vehicles are required to display a special symbol (i.e., a sticker affixed on the rear of the vehicle) to indicate to other road users that the vehicle can operate in automated mode. In particular, the sticker enables police to know whether a vehicle has an ADS. However, Japan noted the limitations of this approach in communicating the status of the ADS and requested FRAV attention towards improving the external communication. In this regard, the co-chair from Germany recalled discussions in WP.29 and GRE regarding dynamic signaling of an ADS vehicle status to other road users. WP.29 agreed at the time that FRAV should first consider this issue and then, if needed, seek GRE support related to the use of light-signaling for this purpose.

The Netherlands stressed the importance of approaching requirements from the standpoint of the user and human factors, especially to ensure reasonable uniformity in HMI.	The expert from the Netherlands presented document FRAV-06-10 regarding human factors performance requirements. The expert recommended that FRAV address human factors engineering aspects of ADS (i.e., ensuring that an ADS can be operated safely by users). The expert noted previous discussions and references in the AV Framework Document to HMI, proposing that human factors aspects can be address under the FRAV starting point 2 (ADS should interact safely with the user). The expert explained that each user constructs a mental model of the ADS that influences the user's expectations, attention, and decision-making. Harmonized and simple user interfaces, transparent information, and effective user training foster more uniform mental models across all users. The better and more accurate the mental models are, the lower the risks of misuse. Uniformity can be promoted by addressing challenges (e.g., transitions, mode confusion, misuse) based on the needs of the ADS user (transparency, simplicity, saliency, etc.). CLEPA suggested that specific examples for simple, effective user interfaces would be helpful to further discussion.
Germany proposed revisions and clarifications to the safety requirements OICA/CLEPA derived from national/regional guidelines and other sources. *Germany urged FRAV to develop a more precise definition of "foreseeable" collisions an ADS should be able to avoid.*	The expert from Germany (BMVI) presented document FRAV-06-11 commenting on document FRAV-06-04 (elaboration of safety requirements). The expert noted frequent use of the term "foreseeable" and suggested a need to define this concept. Germany emphasized the high-level requirement that an ADS should not itself cause a collision due to its driving behavior. Germany disagreed with certain passages in FRAV-06-04 and proposed clarifications and improvements to the text. Germany requested the FRAV stakeholders to review its comments. CLEPA expressed general agreement with Germany's proposals; however, the expert noted that the statement "the ADS should not cause traffic accidents that are reasonably foreseeable and preventable" recognizes that some situations cannot be avoided by an ADS. The expert expressed concern that the proposed revisions related to this concept would remove this understanding. Japan was unable to accept the deletion of "The nominal operation of the ADS shall result in equal or safer performance than a human driver, i.e. achieve a neutral or positive risk balance" given the importance attached to achieving this minimum overall performance level. Japan proposed to further consider the German proposals and submit comments for the next session. The presiding co-chair accepted Japan's proposal and urged stakeholders to consider proposals for improving document FRAV-06-04. The secretary provided additional background concerning the starting points. In particular, the secretary noted that "the ADS should drive safely" concerns behavior under the control of the driver while "the ADS should manage safety-critical situations" address responses to the behavior of other roads (i.e., driving aspects outside the control of the driver).

JRC explained its research into the performance of systems such as ACC in traffic. JRC urged attention to string stability to reduce risks of traffic perturbations due to ADS responses to deceleration of lead vehicles.	JRC proposed that FRAV consider "string stability" in formulating ADS performance requirements. String stability refers to the impact of a vehicle's driving behavior on other vehicles, especially related to a "string" of vehicles following one another in a lane of travel. Braking and accelerating behaviors are known to contribute to traffic congestion and the "accordion effect". JRC described string stability as "the capability of the ADS to react to a perturbation in the speed profile of the leading vehicle with a perturbation in its speed profile of lower or equal absolute magnitude independently from the driving conditions". In other words, achieving an ADS response to a lead vehicle deceleration in a way that would not amplify the deceleration leading to "stop and go" patterns in dense traffic. JRC presented the results of research undertaken on public roads and test tracks to quantify the effects of automated behavior (based on adaptive cruise control and related ADAS). This research demonstrated how such adaptive systems, depending upon the settings, can cause and/or exacerbate accordion effects and traffic flow congestion. The expert from JRC directed stakeholders to the research paper (provided for convenience as FRAV-06-15) and to the data sets from these experiments. The expert from CLEPA noted ISO standards recommending headway time gaps for adaptive cruise control (ACC), but suggested that an ADS performance requirement would be stipulated in terms of compliance with traffic regulations. Road traffic regulations generally stipulate longer headways. For example, ISO uses about 0.8 seconds for a shorter time gap and 1.2-2.0 seconds for a longer time-gap setting. The expert referred to the ALKS regulation (UN R157) that propose far longer time gaps than the ISO ACC shorter setting. As a result, an ADS would have longer time gaps than a typical ACC on a shorter setting that would seem to reduce risks for traffic perturbation. The JRC expert acknowledged that longer headways help string stability but do not guarantee string stability. JRC noted that headways prescribed in traffic laws are often not respected in human driver traffic patterns. Therefore, the expert urged FRAV to consider real-world traffic flows and driver behaviors towards limiting perturbations. Longer headways may ensure string stability, but the expert proposed that FRAV include provisions to address this issue in order to achieve the desired real-world outcomes. The expert from CLEPA offered that other factors such as ADS reaction times could influence driving interactions. The JRC expert agreed, noting that anticipatory responses play an important role in maintaining string stability. In the experiments, drivers could adapt their behavior by observing vehicles further ahead in the string of vehicles. To the extent that ADS can detect the behavior of such vehicles, ADS could similarly adapt their driving to minimize perturbations. JRC suggested providing a high-level performance requirement where manufacturers would be free to develop solutions to address the risk of perturbations. SAE asked whether the Commission had plans to regulate ACC in addition to the suggestion to address ADS in FRAV. The expert from JRC explained the role of his agency to provide research to support decisions by the Commission, so he was not in a position to comment on Commission responses to the research.

FRAV continued its discussion of methods for determining performance limits. *FRAV agreed to consider the methods based on Japan's proposal for a matrix of criteria.* *FRAV requested stakeholders to provide further information on the methods and their application in reaching consensus on performance limits.*	The presiding co-chair turned the discussion to the next agenda item on approaches to setting performance limits. In order to meet the session time constraints, the co-chair requested brevity while allowing for further discussion at the next session if desired. The co-chair noted the discussions from the previous FRAV session where stakeholders suggested that the different approaches might be complementary and used in combination to justify decisions on performance limits. Japan elaborated on its concept for criteria by which to determine appropriate principles and methods for setting performance limits (FRAV-06-08). In response to stakeholder requests, Japan provided more information on the proposed criteria and its matrix for considering the various approaches. Japan requested stakeholders to review the document and provide feedback on the criteria and matrix proposal. The secretary explained that FRAV would be discussing the different methods for justifying performance limits during the next few sessions. FRAV's immediate task is to define an initial set of high-level performance objectives. After these objectives have been agreed, FRAV would turn to developing measurement and/or verification criteria as needed. Therefore, the secretary suggested that stakeholders interested in presenting methods use Japan's criteria as a means to inform the group on the application of the methods to ADS performance requirements. Germany supported the secretary's proposal and would use the criteria to elaborate its explanations on state-of-the-art based criteria. However, Germany requested further information regarding Japan's proposal to based limits on a careful and competent human driver model. Germany requested Japan to provide a presentation on this approach, recalling an earlier presentation provided to the ACSF group.
JRC proposed a method combining Japan's driver model approach with mathematical safety envelope methods.	JRC provided a condensed presentation of its views regarding performance levels (FRAV-06-12). JRC emphasized two safety aspects of complying with traffic laws and avoiding collisions, recalling the ALKS regulation specifications for following distance and equation regarding time-to-collision and collision avoidance. The expert from JRC recalled Japan's model for establishing performance levels based upon the behaviors of an attentive driver and the proposed standard that ADS performance should be equal to or better than such a driver. Japan's approach enabled the definition of boundaries between avoidable and unavoidable collisions. Although Japan's approach has substantial merits, JRC identified some weaknesses, especially in capturing the additional contributions of state-of-the-art ADS to road safety. Therefore, JRC considered approaches complementary to Japan's proposal. The "safety envelope" approach provides a mathematical model to create a dynamic space around the vehicle (e.g., NVIDIA Safety Force Field, Intel Responsibility-Sensitive Safety). The safety envelope approaches provide clear mathematical formulas based on physics and technological properties that can be updated as ADS capabilities progress. However, JRC sees risks that the approach could limit OEM options and fixed parameters could hinder innovation. Therefore, JRC proposed to consider the safety envelope approach to develop avoidable/unavoidable limits for scenarios but not in establishing driving behavior requirements. JRC characterized the former as "performance requirements" and the latter as "behavioral requirements".

JRC found that the driver model and safety envelope method outcomes suggest an optimal "positive risk" balance based on defining the unavoidable boundaries where neither method determines a collision is avoidable.	In its presentation, JRC compared the results of Japan's driver model, the ALKS time-to-collision method, and the Intel RSS approach. JRC applied modest performance parameters under the RSS mathematical models to ensure a reasonable comparison. This comparison allowed JRC to overlay the performance ranges of the methods in terms of where they determine the avoidable/unavoidable collision boundaries. JRC found that the ALKS TTC and Japanese driver models produced similar results. The RSS approach, however, resulted narrower or smaller ranges for unavoidable collisions (alternatively, the range of avoidable collisions was greater) in many instances. As a result, JRC concluded that a combination of Japan's approach with a mathematical safety envelope method based on ADS capabilities would enable definition of unavoidable collisions based on whether neither method would result in avoidance. Ultimately, this combined approach would result in a positive risk balance where ADS performance would consistently equal or exceed human driver performance. Therefore, the next step for FRAV would be to agree on the requisite driver models and safety envelope parameters to underpin performance requirements. SAE stressed the importance to reach consensus on appropriate parameter values in applying the safety envelope methods. In addition, the use of approaches based on fault should be considered for whether they are sufficient in a regulatory context. CLEPA agreed with SAE on the need to further explore the proposal but praised the JRC work as a way to consolidate the work done so far on the various methods. CLEPA raised a concern that driver models may not be applicable across all driving environments, resulting in complex "models within models" that may be difficult to implement. The CLEPA expert noted work under IEEE to define harmonized driving policies around the world during the past 18 months that had yet to arrive at a conclusion. Rather than harmonizing policies, the IEEE work has turned to work on harmonizing the assumptions on driver behaviors used in the policies. The expert raised concern over the time available and the time required to reach consensus decisions on parameters for the safety envelope formulas. JRC agreed with the observation but stressed the need to be pragmatic. FRAV needs to start from somewhere to avoid prolonged discussion of methods without significant progress towards defining performance requirements.
RDW urged caution to avoid over-emphasis of collision scenarios based on human performance given that ADS may consistently avoid such situations.	Japan appreciated the JRC presentation but stressed that the immediate objective concerned the reaching consensus on the concept of the safety level to be achieved by ADS (rather than agreeing on the method for validating performance limits). Japan asked whether JRC views the safety envelope method as a method to define the basic safety level or to define specific limits for validating ADS performance. JRC replied that they used the safety envelope for the same purpose as the driver model to define performance requirements, not behavioral requirements. RDW noted the JRC focus on collision scenarios and suggested that ADS performance should also be considered in terms of avoiding such situations in the first place. The ADS may not encounter such dangerous circumstances with the same frequency as human drivers which could lead to excessive attention to situations that may occur relatively rarely for an ADS.

Next FRAV session scheduled for 17 November. *Primary focus on elaborating list of safety objectives to enable elaboration of high-level requirement descriptions and identification of ODD elements for ADS descriptions.*	The next FRAV session is scheduled for 17 November. The timing of the session may be adjusted given the time zones and shift to standard daylight time. The presiding co-chair reminded the stakeholders of FRAV's short-term objective to deliver a list of ADS safety objectives and ADS description elements to WP.29 (along with the agreed strategy for applying these two aspects to assess individual ADS) for the March 2021 session. FRAV stakeholders are requested to contribute proposals towards reaching consensus on the safety objectives derived from the five starting points. This baseline will enable the group to elaborate performance requirements and the ODD elements and other constraints that may impact performance. FRAV will also continue to discuss the approaches to defining desired ADS performance behaviors and performance limits. The co-chair encouraged stakeholders to continue informing the group on these approaches and their application to FRAV's work. The leadership plans to continue these discussions through its last 2020 session scheduled for 8 December with the aim to reach consensus on the group's internal methodology for elaborating the performance requirements from January 2021.