Informal document **GRVA-14-35**
14th GRVA session, 26-30 September 2022
Provisional agenda item 4(a)

Informal Working Group on Functional Requirements for Automated Vehicles

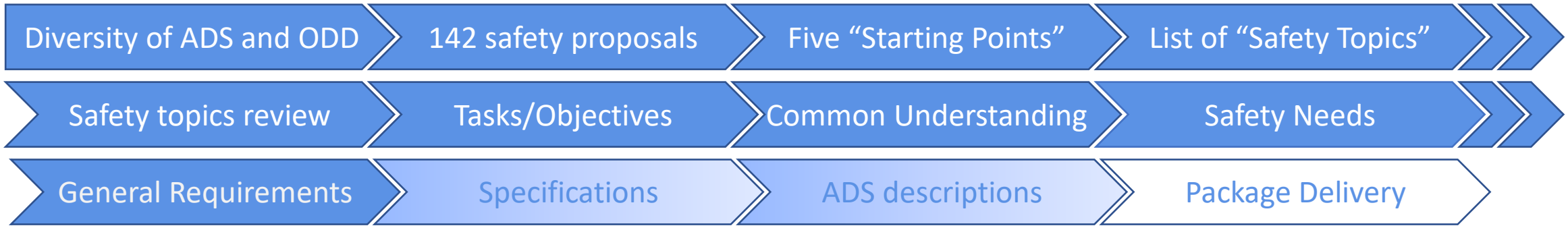
Status Report

14th GRVA Session

26-30 September 2022

FRAV

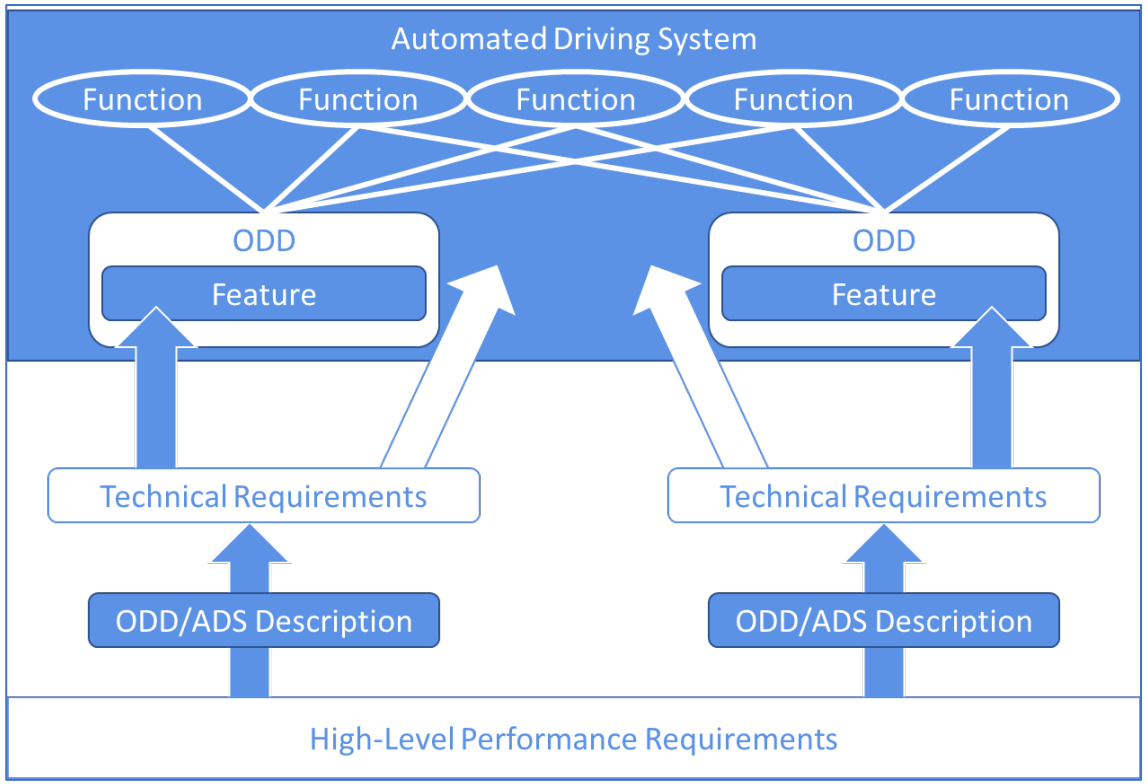
FRAV current status



1. Requirements applicable globally related to performance of the DDT
2. Traffic-rule conversions to address local requirements
3. Guidelines for documenting the ODD of ADS features
4. ODD-based framework to generate scenarios for assessing ADS performance
5. Safety models for assessing ADS responses under scenarios
6. Behavioural competencies to set verifiable performance criteria for scenarios
7. Safety requirements for ADS user HMI and interactions

What is an ADS? What to Assess?

Previously from FRAV…



Feature-based Assessment

The ADS must be capable of performing the entire DDT within the ODD of its feature(s) in accordance with the safety requirements.

- ADS is the hardware and software system.
- ADS functions enable performance of the DDT.
- ADS functions enable features specifically designed to operate within an ODD.

Diversity and complexity challenge

- Dynamic Driving Task
  - Broadly covers tactical (planning and perception) and operational (vehicle control) functions required to operate vehicle in traffic.
  - Assessing performance of DDT dependent upon traffic situations and involves thousands of possible subtasks.
- Operational Design Domain
  - Broadly involves definition of conditions that may impact performance of the DDT.
  - Application dependent upon traffic situations and involves thousands of possible combinations of conditions.

Key question is whether an ADS responds safely (DDT instance) under a given traffic situation (ODD instance).

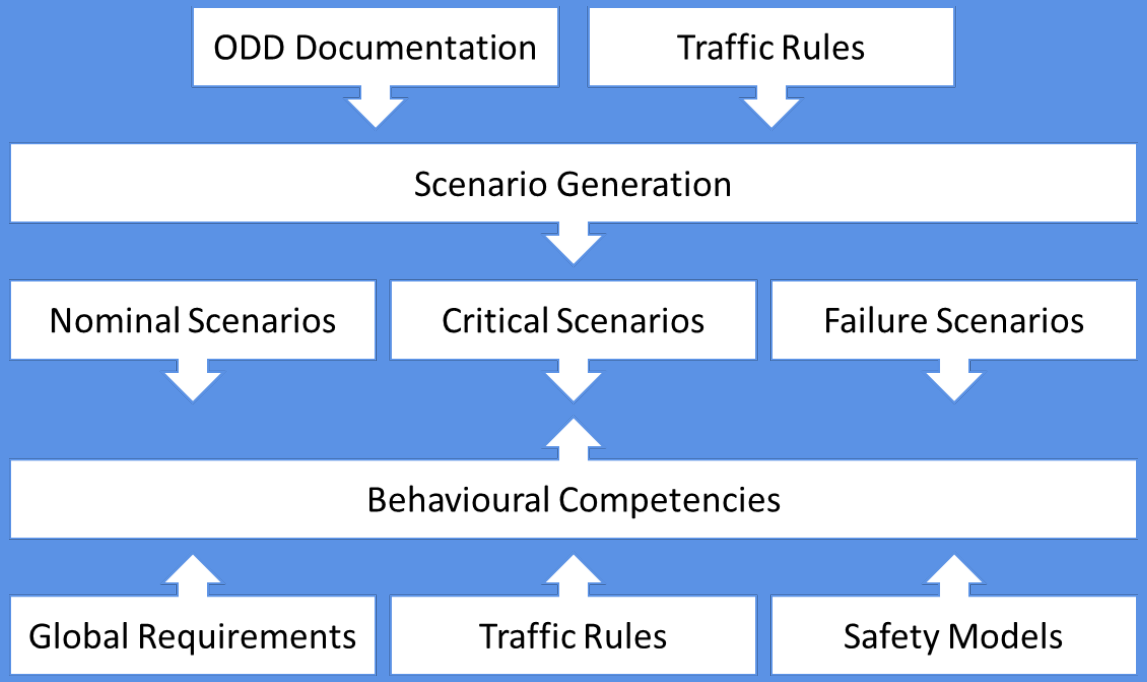
Scenarios and competencies

- *Scenarios* to describe traffic situations relative to ODD.
  - Generate scenarios covering performance of the DDT within the ODD of each ADS feature.
- *Behavioural competencies* to specify acceptable DDT responses to scenario conditions.
- Scenarios can be matched with behavioural competencies to provide verifiable criteria for assessing performance of the DDT.
  - Scenarios can be generated by analysing the ODD of an ADS feature.
  - Behavioural competencies can define expected and measurable response options linked to scenarios.

Behavioural competencies

- Behavioural competencies can be derived from global requirements and safety models.
- Global requirements cover safety goals applicable worldwide.
  - ADS shall not cause collisions or traffic disruption.
  - ADS shall avoid collisions where preventable.
  - ADS shall comply with traffic laws → local requirements
- Safety models provide boundaries and thresholds for assessment of ADS responses.
  - Verify that ADS response under scenario falls within model bounds.
  - Define thresholds between preventable and unpreventable collisions.
  - Several methodologies to generate models (e.g., human-driver, mathematical, technical feasibility analysis).

Snapshot of DDT Framework



1. Manufacturer provides ODD conditions and boundaries for each ADS feature in accordance with guidelines.
2. Traffic rule conversions provide ODD and other scenario elements and link traffic rules, ADS feature, and scenarios.
3. ODD descriptions and traffic rules are part of the ODD analysis used to generate scenarios.
4. Scenarios are matched with behavioural competencies describing expected responses.
5. ADS is required to demonstrate these behavioural competencies under scenario-based assessments.
6. Competencies are based on global requirements, performance limits from traffic rules, and safety models.

Categories and layers

- Nominal scenarios
  - Enable verification that ADS will not cause collisions or disrupt traffic.
- Critical scenarios
  - Enable verification that ADS will avoid collisions caused by other road users or road conditions where preventable.
- Failures scenarios
  - Enable verification that ADS will safely manage internal system failures.
- Scenarios and behavioural competencies can be defined at functional, logical, and concrete layers of abstraction (per VMAD recommendations).
  - Nominal performance may be at the functional layer (real-world testing).
  - Critical performance may be at the concrete layer (repeatable, reproducible track testing).

Key components

1. **Guidelines for ODD descriptions**
   Ensure coverage of ODD in measurable/verifiable terms.
2. **Methodology to generate traffic scenarios**
   Ensure test scenarios that cover DDT performance across the ODD.
3. **Global requirements**
   Establish high-level requirements for DDT performance applicable worldwide.
4. **Methodology for traffic-rule conversions**
   Extract local performance limits plus any ODD and OEDR elements for scenario generation.
5. **Methods for generating safety models**
   Enable quantifiable parameters for collision avoidance applicable across scenarios.
6. **Behavioural competencies**
   Define verifiable performance expectations across traffic scenarios (at layers of abstraction).

FRAV expectations

- Interim submission to WP.29 (June 2023)
  - Global requirements for DDT performance
  - Safety principles for interactions between ADS and users
  - Descriptions of key components in determining verifiable criteria
    - ODD documentation
    - Traffic-rule conversions
    - Scenario generation
    - Behavioural competencies
    - Safety model methodologies
- Final submission to WP.29 (June 2024)
  - Refinements as may be beneficial including integration with VMAD outcomes
  - Procedures for defining verifiable criteria under scenarios with proof of concepts (examples)
  - Future-proof framework to enable further work (scenario catalogue, safety models, conversions of traffic rules, etc.) applicable under WP.29 Agreements

External ADS vehicle signalling

- FRAV does *not* recommend mandatory requirements for additional light-signalling devices under WP.29 beyond those requirements established for manually driven vehicles.
- Use of existing light-signalling devices may be suitable (if permitted) to signal an automated fallback to place the ADS vehicle in an MRC.
- FRAV recommends establishment of uniform provisions for a light signal to communicate the operational status of the ADS *if fitted on an ADS vehicle and under certain conditions* (i.e., address risk-benefit trade-offs).
- FRAV notes that means other than light-signalling may be suitable to achieve safety needs (e.g., telecommunications).
- FRAV recommends monitoring research into ADS signalling and the safety of interactions between other road users and ADS vehicles.

FRAV near-term work plan

- Next FRAV session in November
  - Submit external signalling position to AC.2—consider further comments, if any, prior to submission.
  - Further consideration of draft recommendations (“Document 5").
- FRAV session in Tokyo during week of 12 December
  - Consolidation of draft recommendations and consensus decisions on scope and content of interim submission to WP.29.
  - Anticipate session in conjunction with VMAD session—consider eventual final submission(s) to WP.29 June 2024 session.
- January-March: Drafting and finalisation of FRAV submission to June 2023 WP.29 session.