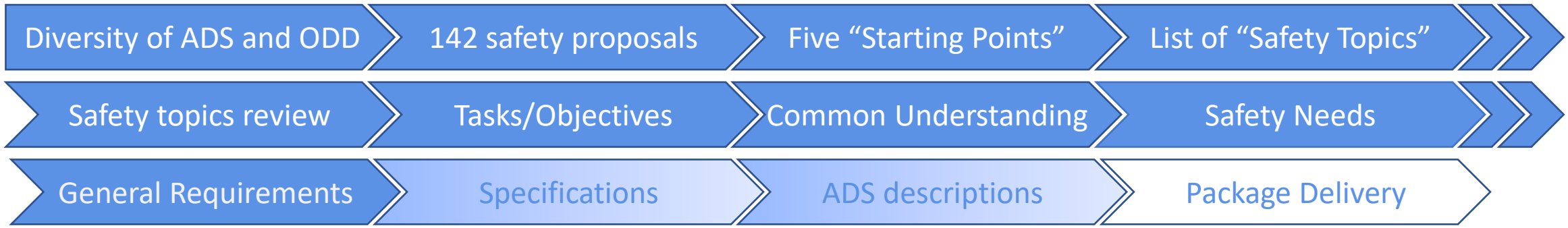
Document FRAV-29-07
Submitted by the DDT workstream leader
29th FRAV session, 15 June 2022

Informal Working Group on Functional Requirements for Automated Vehicles

Activities Planning

14 June 2022

FRAV current status



Status-quo

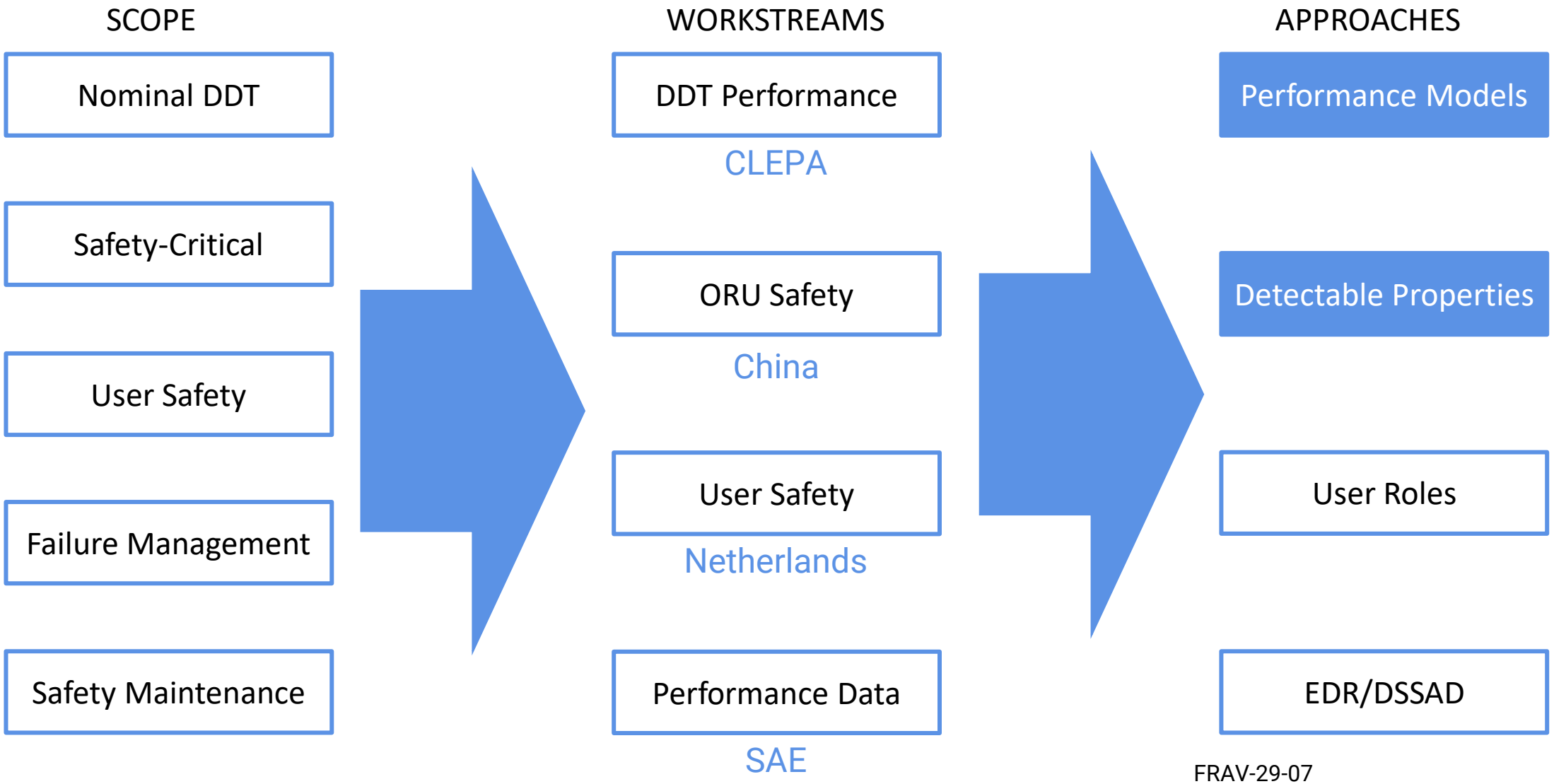
- GRVA accepted a 2 year extension of FRAV mandate (June 2024)
  - First step to consolidate FRAV deliverables by June 2023
  - Second Step to integrate FRAV/VMAD work into a unicum
  - OICA/CLEPA proposed roadmap to drive AC.2 decision in June (GRVA-13-18)

General overview of activities

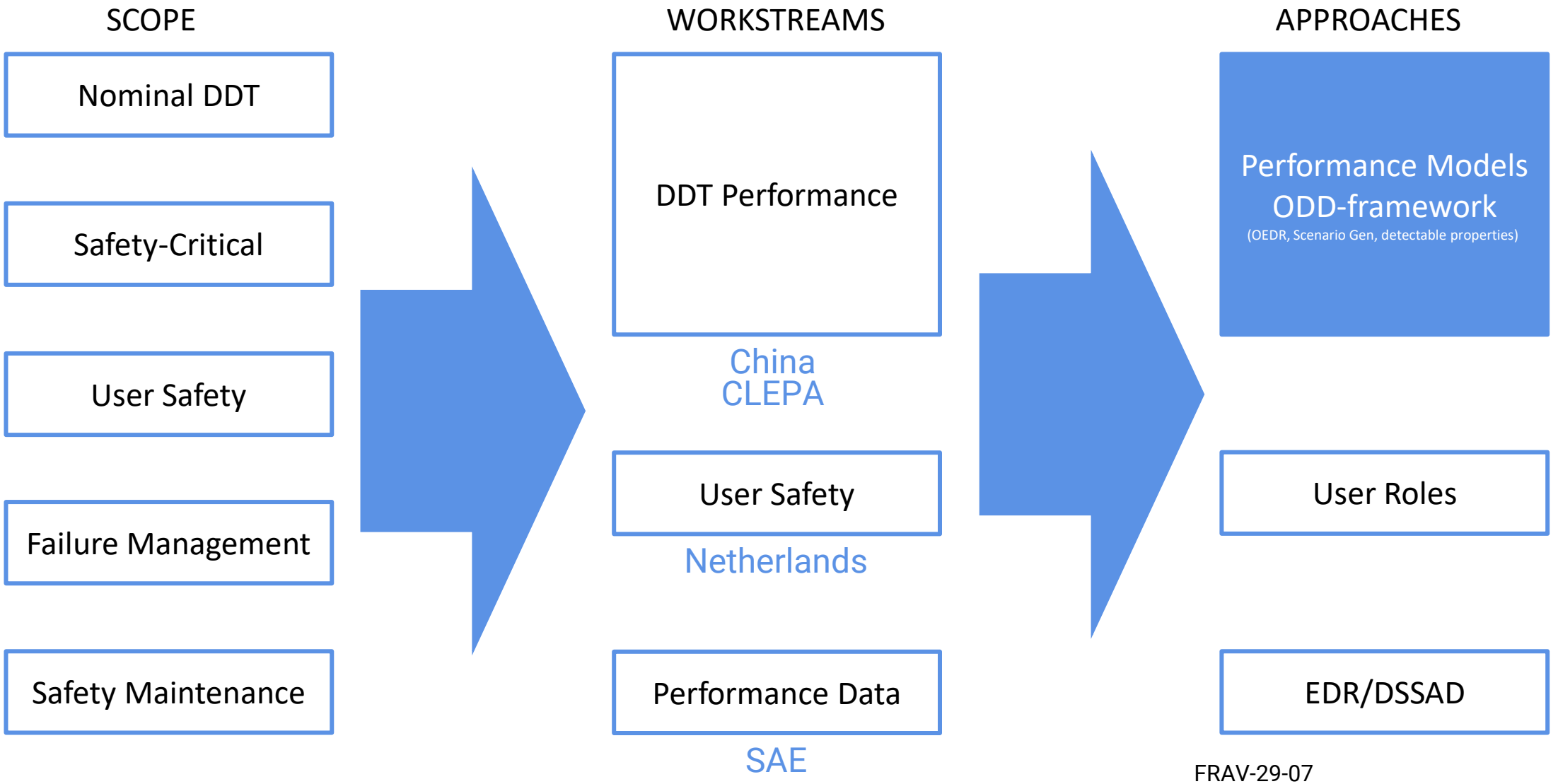
FRAV

SCOPE	WORKSTREAMS	APPROACHES
Nominal DDT	DDT Performance CLEPA	Performance Models
Safety-Critical	ORU Safety China	Detectable Properties
User Safety	User Safety Netherlands	User Roles
Failure Management		
Safety Maintenance	Performance Data SAE	EDR/DSSAD

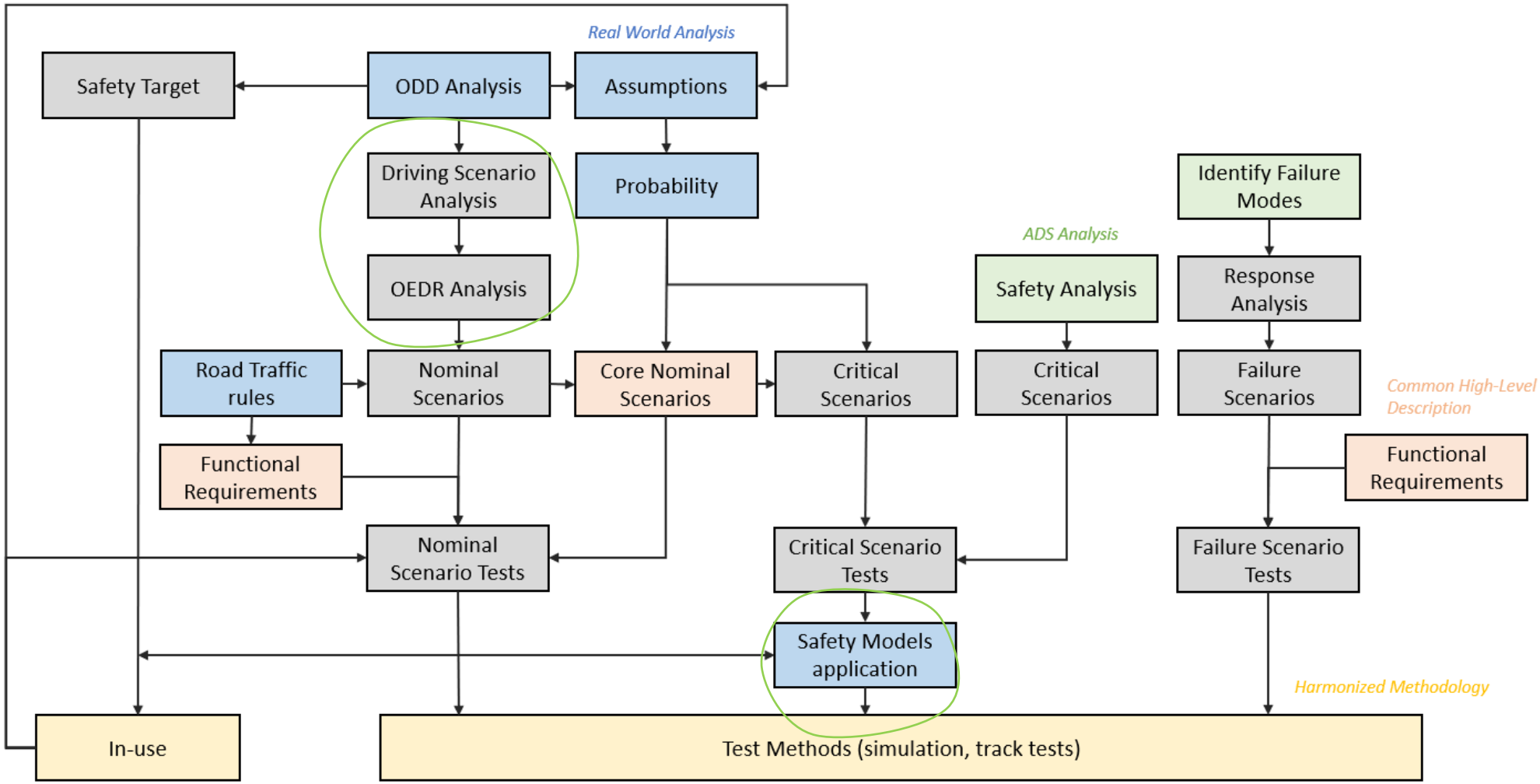
General overview



General overview



General overview



Driving Analysis

- It aims to address ORU/Objects safety by ensuring that ADS will respond appropriately to roadway objects
- Detectable properties to differentiate and classify ORU and relevant objects
- OEDR-based detection, recognition, and classification

Objects	Events/Interactions
Vehicles (e.g., cars, light trucks, heavy trucks, buses, motorcycles)	**Lead vehicle decelerating (frontal), lead vehicle stopped (frontal), lead vehicle accelerating (frontal), changing lanes (frontal/side), cutting in (adjacent), turning (frontal), encroaching opposing vehicle (frontal/side), encroaching adjacent vehicle (frontal/side), entering roadway (frontal/side), cutting out (frontal)**
Pedestrians	**Crossing road – inside crosswalk (frontal), crossing road – outside crosswalk (frontal),** walking on sidewalk/shoulder
Pedalcyclists	**Riding in lane (frontal)**, riding in adjacent lane (frontal/side), riding in dedicated lane (frontal/side), riding on sidewalk/shoulder, **crossing road – inside crosswalk (frontal/side), crossing road – outside crosswalk (frontal/side)**

Objects	Events/Interactions
Animals[5]	Static in lane (frontal), moving into/out of lane (frontal/side), static/moving in adjacent lane (frontal), static/moving on shoulder
Debris[6]	**Static in lane (frontal)**
Other dynamic objects (e.g., shopping carts)	**Static in lane (frontal/side), moving into/out of lane (frontal/side)**

Objects	Events/Interactions
Traffic signs[7]	Stop, yield, speed limit, crosswalk, railroad crossing, school zone
Traffic signals[7]	Intersection, railroad crossing, school zone
Vehicle signals	Turn signals

Table 1 – Dynamic elements and their properties

OEDR Analysis : Behaviour Competency Identification

- ADS safety recommendations for interactions with subsets of ORU
- Behaviour competences that can be applied to the events characterizing the ODD to ensure compliance with the applicable regulatory and legal requirements

Event	Response
Lead vehicle decelerating	Follow vehicle, decelerate, stop
Lead vehicle stopped	Decelerate, stop
Lead vehicle accelerating	Accelerate, follow vehicle
Lead vehicle turning	Decelerate, stop
Vehicle changing lanes	Yield, decelerate, follow vehicle
Vehicle cutting in	Yield, decelerate, stop, follow vehicle
Vehicle entering roadway	Follow vehicle, decelerate, stop
Opposing vehicle encroaching	Decelerate, stop, shift within lane, shift outside of lane
Adjacent vehicle encroaching	Yield, decelerate, stop
Lead vehicle cutting out	Accelerate, decelerate, stop
Pedestrian crossing road – inside crosswalk	Yield, decelerate, stop
Pedestrian crossing road – outside of crosswalk	Yield, decelerate, stop
Pedalcyclist riding in lane	Yield, follow
Pedalcyclist riding in dedicated lane	Shift within lane[9]
Pedalcyclist crossing road – inside crosswalk	Yield, decelerate, stop
Pedalcyclist crossing road – outside crosswalk	Yield, decelerate, stop
Lead vehicle decelerating	Follow vehicle, decelerate, stop
Lead vehicle stopped	Decelerate, stop
Lead vehicle accelerating	Accelerate, follow vehicle

Table 2 – Behaviour competences for given events

General overview

Safety Models

- Propose multiple modeling methodologies. (safety envelopes, scenario-based, driver modeling, technology state-of-the-art, etc.)
- Compare ADS performance against benchmarks for expected behavior (e.g., ADS performance vs model performance)
- Address collision-avoidance/crash-mitigation boundaries

Verifiable Criteria

- Global requirements with verifiable criteria established via an ODD-based approach
- DDT performance requirements will not be prescriptive
- Approach allows for local constraints and parameters
- Performance acceptable if satisfies model expectation
- Example for Lane-Keeping in FRAV-25-11

Summary

Proposal

- Need to streamline the process and improve efficiency
- Merge similar workstreams to focus on deliverables
  - Safety Models + ORU workstream + (SG1 Scenario Generation?)
  - All covered by the ODD-framework approach
- Other workstream working in parallel (User Role, EDR/DSSAD, …)
- Ensure verifiable criteria deliverables by June 2023
- FRAV+VMAD editorial merging into a single document post June 2023

Back-up

Safety models for DDT

- Challenge of local variables and assumptions.
  - Local operating conditions cannot be harmonized: Traffic laws, signs, signals, markings, languages, driver education and behaviors, etc.
  - Safe driving depends upon adaptation to local conditions and assumptions.
- Verifiable metrics can be derived from the application of an ODD-based approach.
  - Allow application of local variables and assumptions
  - Propose multiple modeling methodologies. (safety envelopes, scenario-based, driver modeling, technology state-of-the-art, etc.)
  - Compare ADS performance against benchmarks for expected behavior (e.g., ADS performance vs model performance)
  - Address collision-avoidance/crash-mitigation boundaries.

Safety models for DDT

- Global requirements with verifiable criteria established via an ODD-based approach.
  - DDT performance requirements will not be prescriptive.
  - Approach allows for local constraints and parameters.
  - Performance acceptable if satisfies model expectation.
- FRAV analyzing various models.
  - Aim to propose various models that result in safe driving actions.
  - May result in multiple models that may be used to demonstrate performance.
  - Models can address nominal driving and collision avoidance/mitigation.
- Expectation to furnish global specifications with annexes providing methods for establishing verifiable criteria.

ORU properties-based approach

- Objects and other road users (ORU) have attributes detectable by an ADS.
  - These attributes enable differentiation.
- OEDR involves detection, recognition, and classification.
  - At the most basic level, an ADS must detect safety-relevant objects in and around the roadway.
  - Subsets of objects must be recognized to enable correct ADS evaluations and responses (e.g., car, truck, bus, motorcycle, cyclist, pedestrian, animal).
  - In some cases, subsets may need to be further classified (e.g., police car, fire truck, road worker).

ORU properties-based approach

- The properties-based approach aims to address ORU safety by ensuring that ADS will respond appropriately to roadway objects.
  - Detect the attributes that enable differentiation.
  - Recognize and classify objects in accordance with differences in the safety needs and ADS responses.
- This approach relates to issues surrounding ADS communications or signaling in ORU interactions.
  - Some, but not all, ORU may need information from the ADS.
  - For example, law enforcement may need to know if an ADS is operating a vehicle. However, this information could adversely impact ORU behaviors (e.g., increase in higher-risk behaviors based on predictability of ADS responses).

ORU properties-based approach

FRAV

- ORU workstream building out OEDR-based framework.
  - Detectable properties to differentiate and classify ORU.
  - OEDR-based detection, recognition, and classification.
  - ADS safety recommendations for interactions with subsets of ORU.
- ORU workstream developing FRAV response to AC.2 mandate regarding external light-signaling.
  - Identify safety-relevant needs for external communication/signaling, if any.
  - Evaluate possible solutions to meeting needs.
  - Define nature of light-signaling solutions, if any.
  - Particular attention to communicating ADS operational status.
  - Deadline set for November 2022.