

Informal document **GRVA-09-10**

9th GRVA, 1-5 February 2021

Provisional agenda item 4(a)



✔ Certification of Automated Vehicles

What to expect from Automated Vehicles?



Safety and security

Ensure functional/operational safety and cyber security during the development, production and post-production/in-use phase.



Compliance with all applicable traffic laws

Comply to the latest versions of road traffic legislation/rules of the road in the countries of operation.



Improved performance

Learn from field incidents, e.g. take into account new relevant scenarios and update cyber security.

How can a vehicle manufacturer ensure that?

By adequate management of the safety* and security related to ADS including the supply chain...

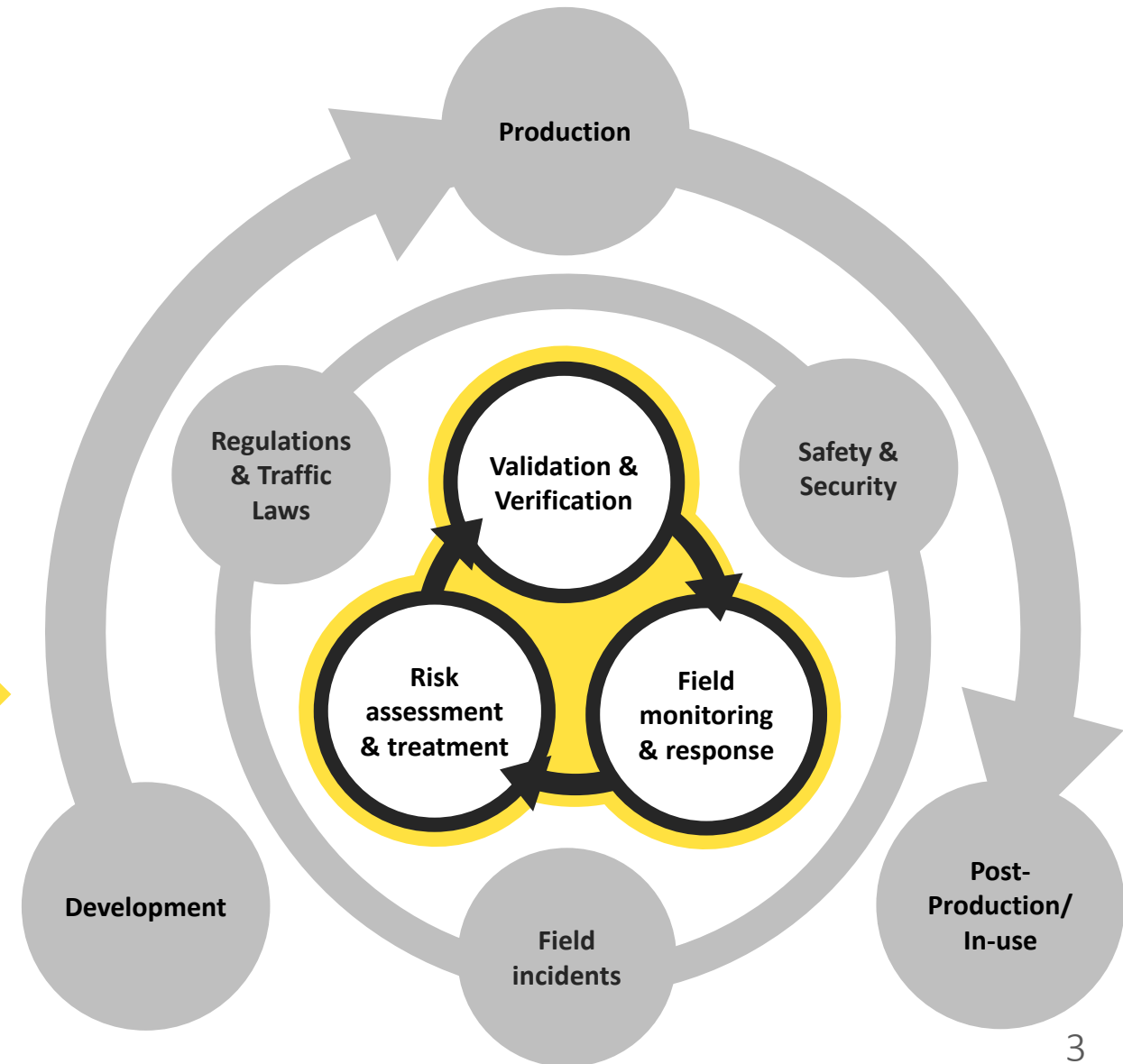
Risk Management ✓

V&V Management ✓

Field Management ✓

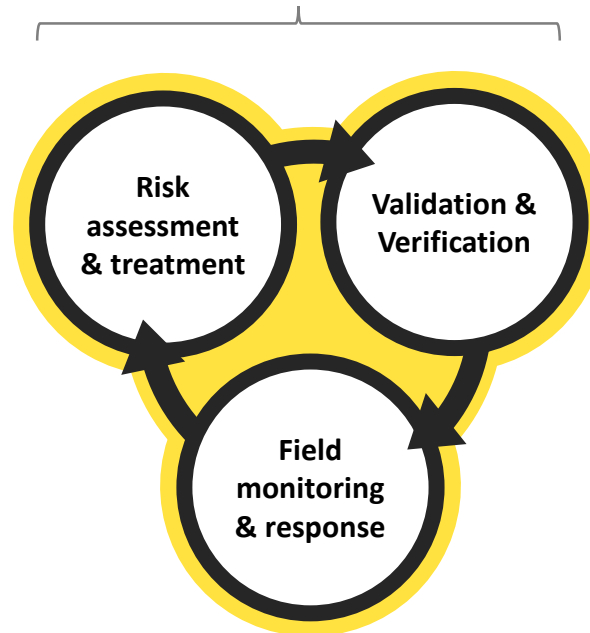
...using processes

*especially operational and functional



Which processes need to be considered?

Processes covering the **development, production** and **post-production/in-use phase** and the **entire supply chain** to manage the safety, especially operational and functional safety, and security related to ADS

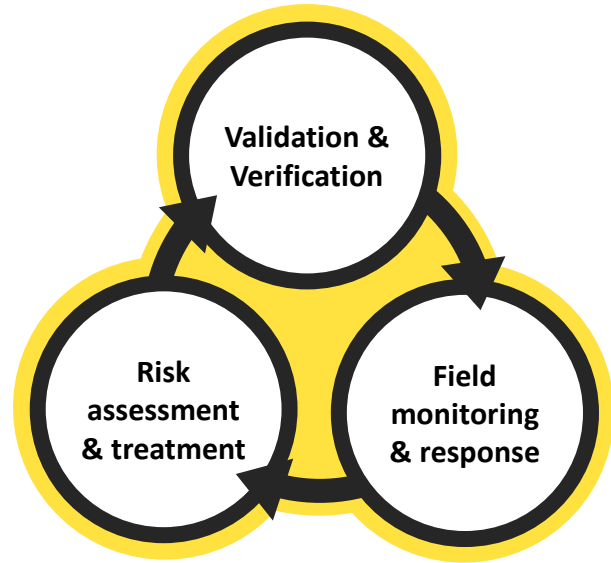


- Processes to identify risks related to ADS, incl. their assessment, categorization and treatment
- Processes to verify that the risks identified are appropriately managed and to ensure that the risk assessment is kept current

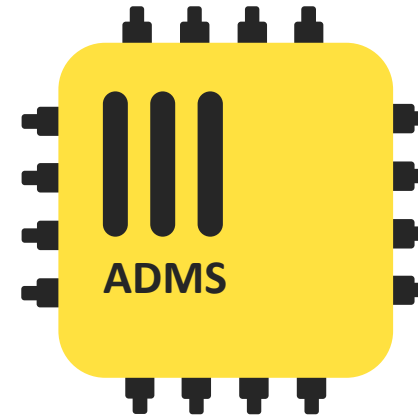
- Processes to validate the safety, especially operational and functional safety related to ADS/ADS-Features
- Processes to validate & verify the performance of ADS-Features and their integration/interactions in the ADS

- Processes to monitor the ADS in the field in order to detect and respond to safety issues
- Processes to monitor rules of the road/road traffic legislation of countries/regions where an ADS is operated or intended to operate, to detect and respond to changes in order to maintain compliance with such legal aspects

How to organize these processes efficiently?

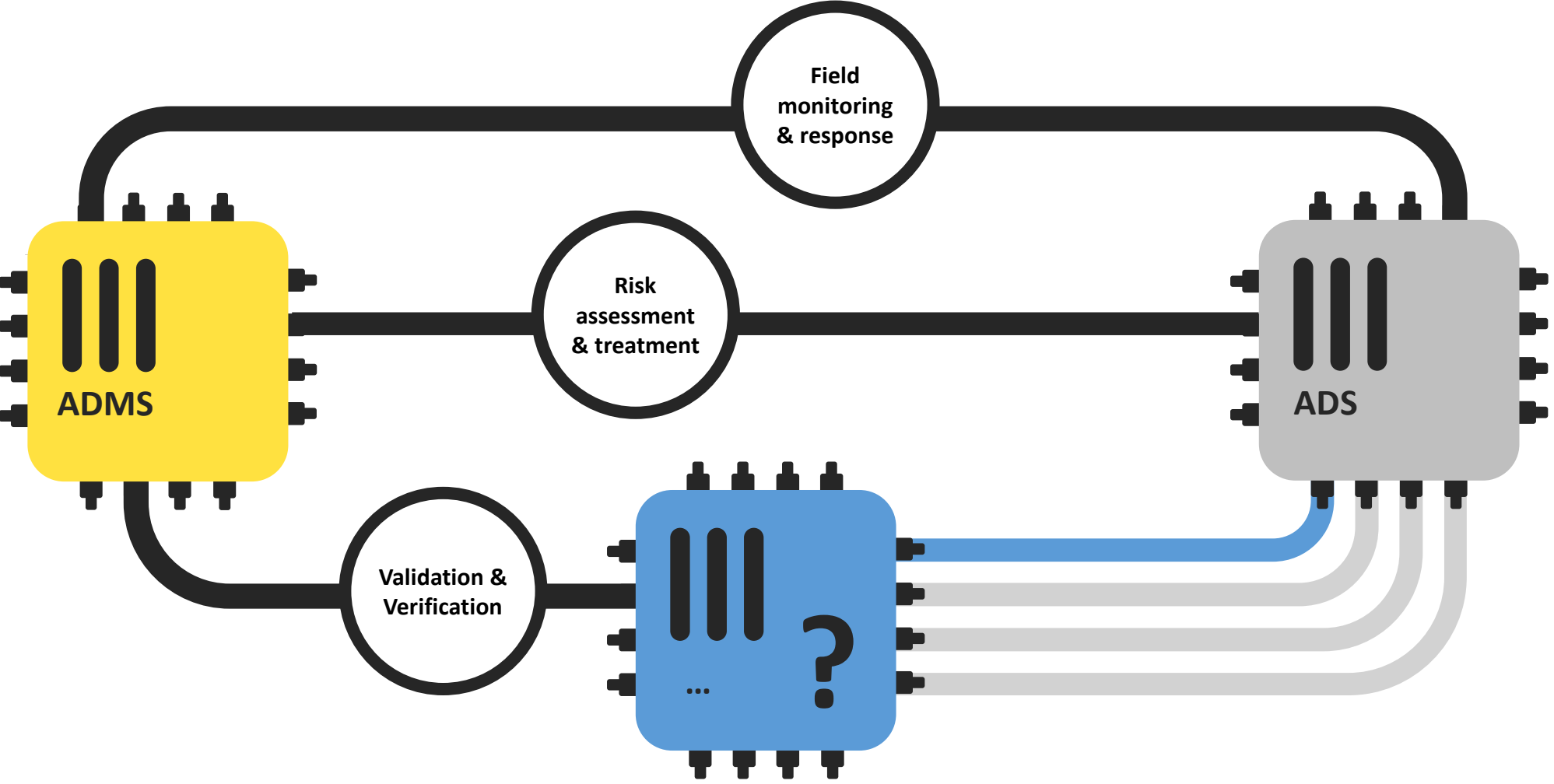


Processes

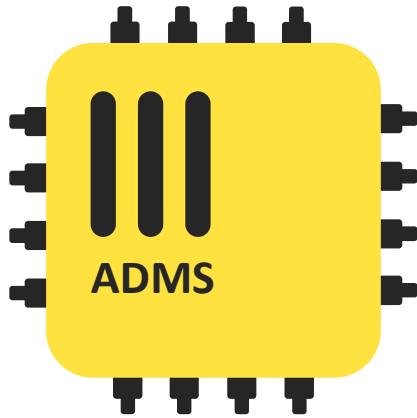


**Automated Driving
Management System**

How can these processes be used to certify an ADS?

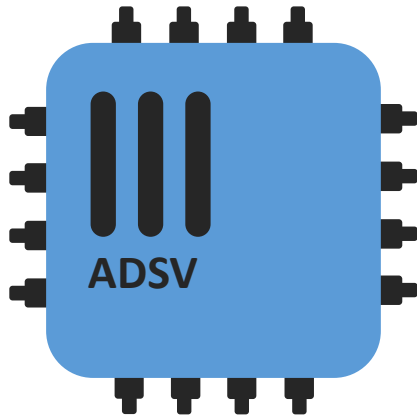


Concept: 2 Core Components/Toolboxes



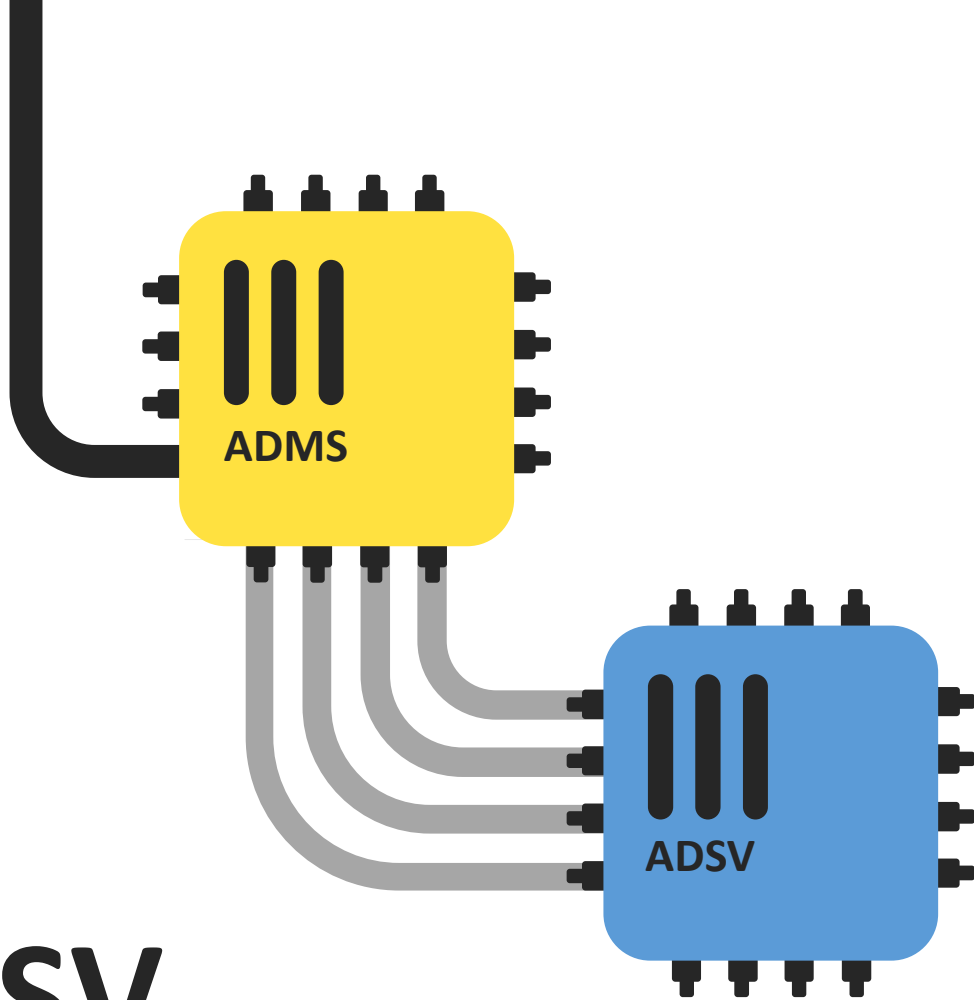
Automated Driving Management System

Safety management system anticipating the declared implementation of **core processes** to demonstrate the capability of a vehicle manufacturer to develop, validate, verify and maintain safe ADS in the field.



Automated Driving System Validation

Scenario based ADS **validation approach** with flexible testing configurations **using virtual, physical and real-world test methods as well as safety assessments** to cover the safety aspects of complex electronic ADS.

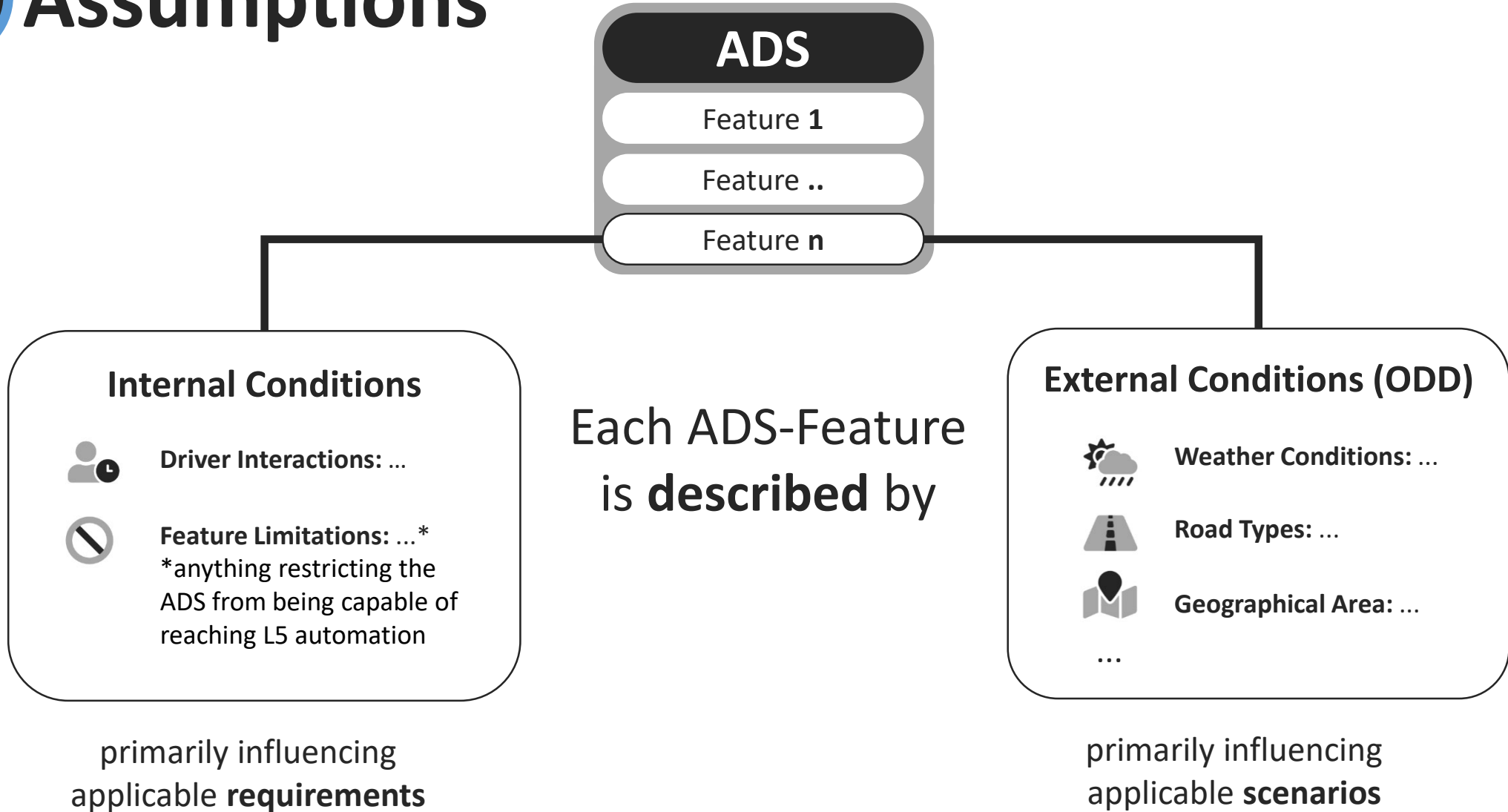


ADSV

Automated Driving System Validation

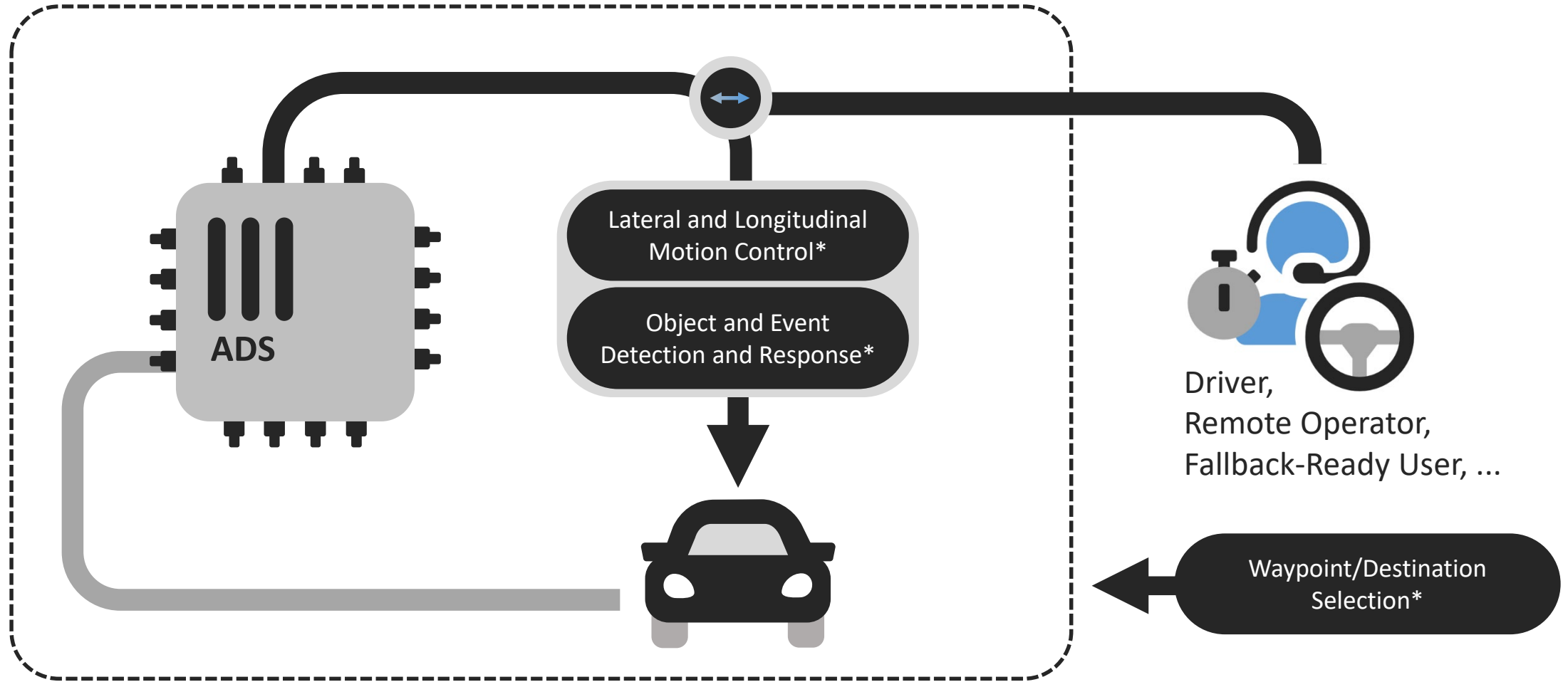


Assumptions

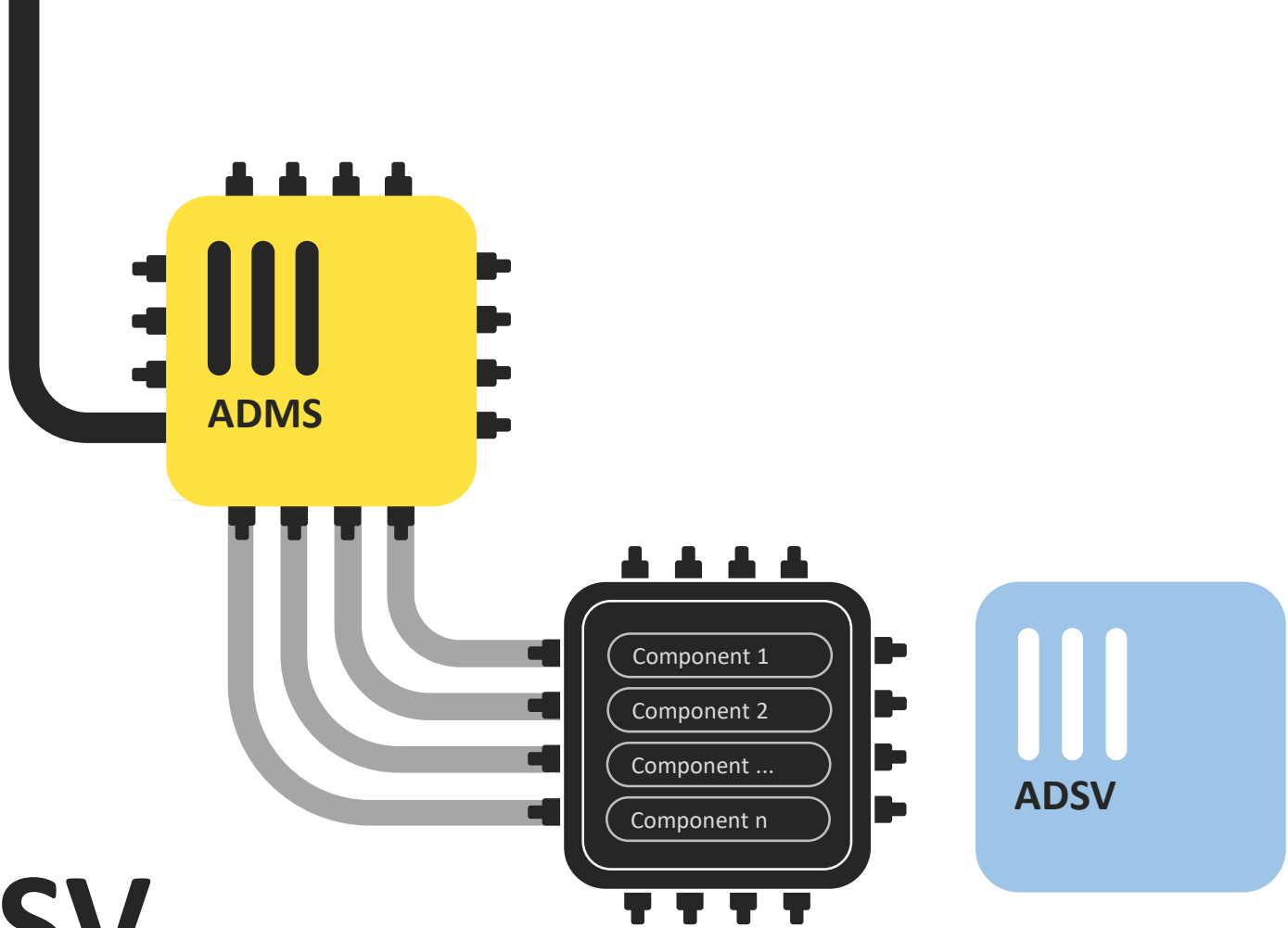


ADSV Scope

*as defined in SAE J3016



The ADSV² scope covers the **Dynamic Driving Task (DDT)** and a possible transfer of control between the ADS and other entities (if applicable).



ADSV

Sub-Components

ADSV Sub-Components



Technology neutral, non-design restrictive functional requirements...

...are filtered by a functional filter based on the internal and external conditions...

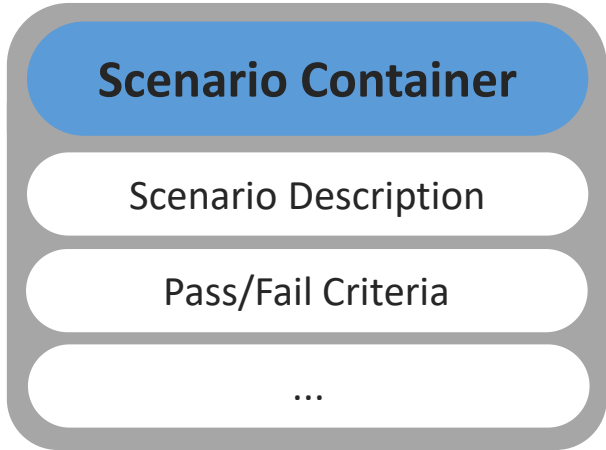
...resulting in ADS-Feature specific functional requirements.

Example	Functional Requirements	Functional Feature Requirements
L4 Driverless Shuttle	Transition Demand	not applicable
	ODD Recognition	ODD Recognition
	Minimal Risk Manoeuvre	Minimal Risk Manoeuvre

This exemplary level 4 driverless shuttle and features thereof will not issue a transition demand by design. Therefore requirements related to the transition of the dynamic driving task are not applicable.



Sub-Components

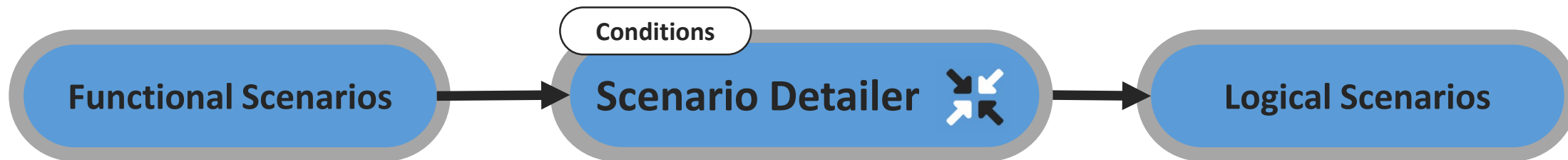


Contains at a minimum the scenario description (e.g. based on the PEGASUS¹ layers) and ADS-Feature specific **pass/fail criteria**, which can be derived from the (applicable) functional feature requirements, based on physical principles and/or human driving performance.

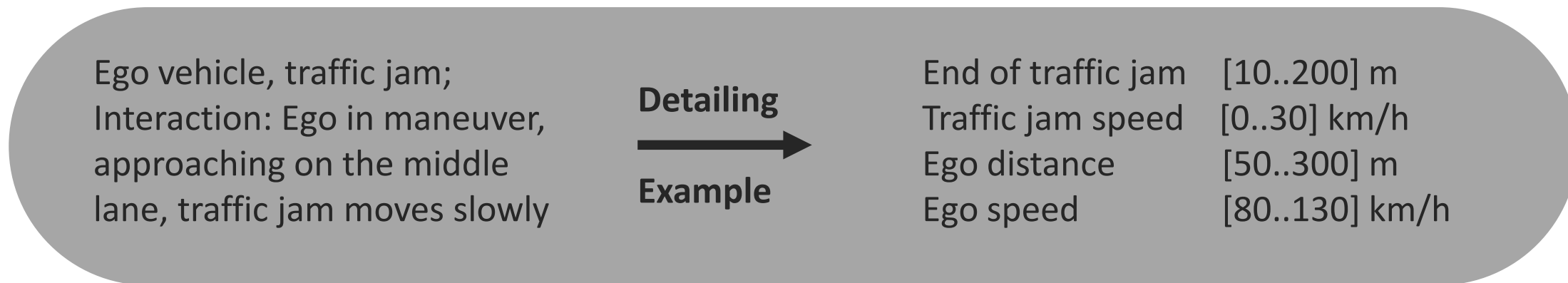
Scenarios are partitioned into three different abstraction layers, as defined in the PEGASUS project: **Functional, Logical and Concrete:**

Functional Scenario Description (Example)	Logical Scenario Description (Example)	Concrete Scenario Description (Example)
<u>Base road network:</u> three-lane motorway in a curve; 100 km/h speed limit indicated by traffic signs	<u>Base road network:</u> Lane width [2.3..3.5] m Curve radius [0.6..0.9] km Position traffic sign [0..200] m	<u>Base road network:</u> Lane width [3.2] m Curve radius [0.7] km Position traffic sign [150] m
<u>Stationary objects:</u> - <u>Moveable objects:</u> Ego vehicle, traffic jam; Interaction: Ego in maneuver, approaching" on the middle lane, traffic jam moves slowly	<u>Stationary objects:</u> - <u>Moveable objects:</u> End of traffic jam [10..200] m Traffic jam speed [0..30] km/h Ego distance [50..300] m Ego speed [80..130] km/h	<u>Stationary objects:</u> - <u>Moveable objects:</u> End of traffic jam 40 m Traffic jam speed 30 km/h Ego distance 200 m Ego speed 100 km/h
<u>Environment:</u> Summer, rain	<u>Environment:</u> Temperature [10..40] °C Droplet size [20..100] µm	<u>Environment:</u> Temperature 20 °C Droplet size 30 µm

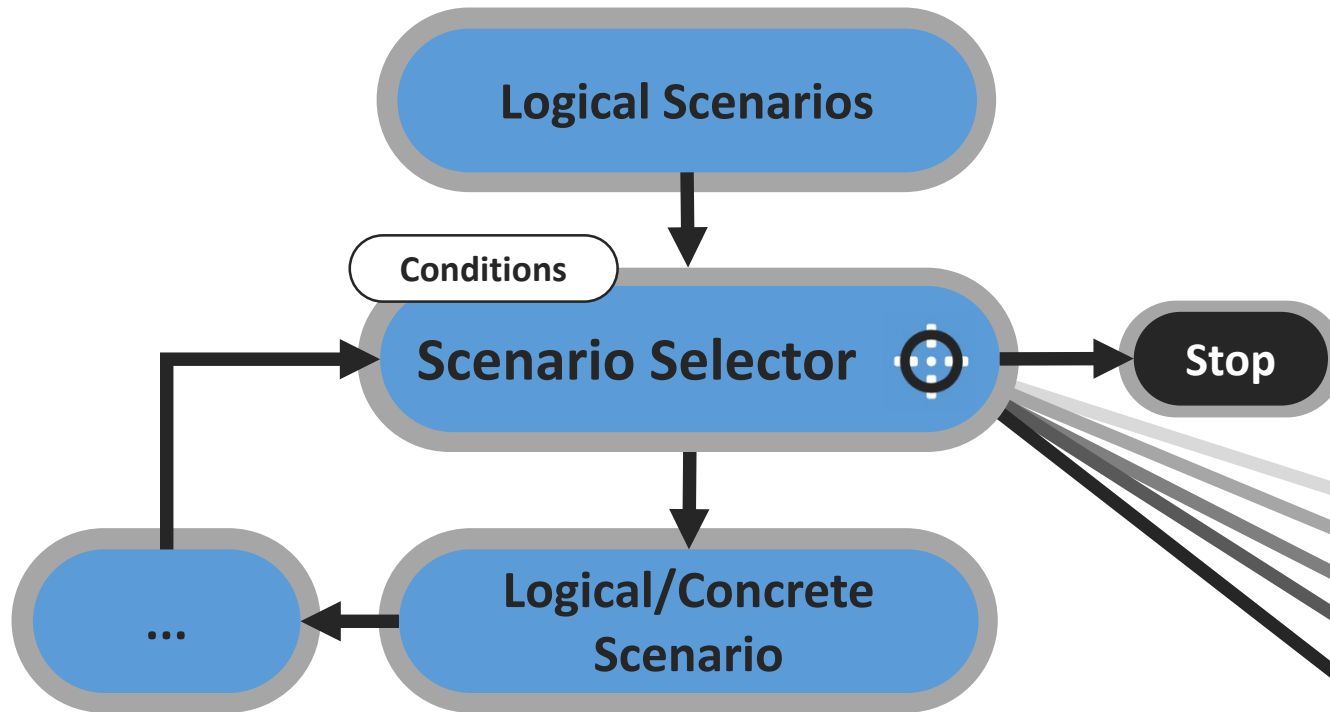
Sub-Components



The Scenario Detailer narrows the Functional Scenario space to the Logical Scenario parameter space taking the ADS-Feature conditions into consideration. The external conditions will primarily influence the applicable range for the parameters. The internal conditions may additionally influence the detailing procedure.

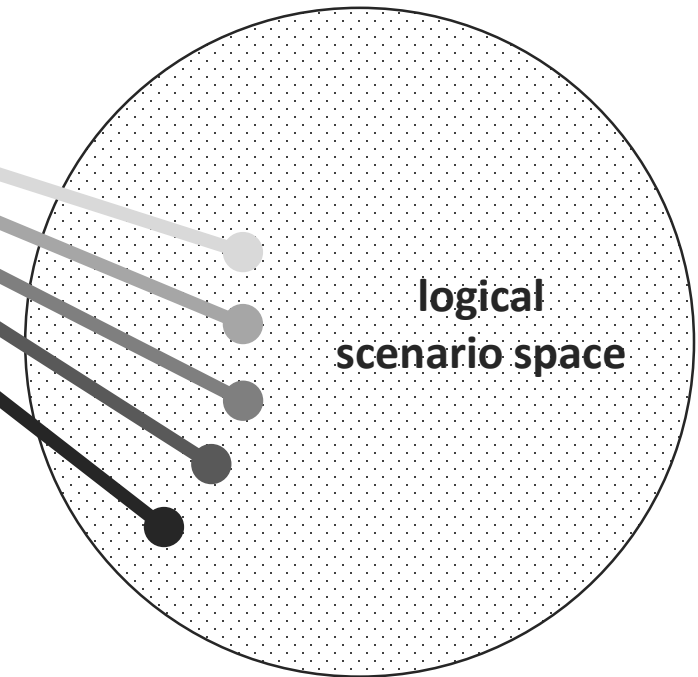


Sub-Components



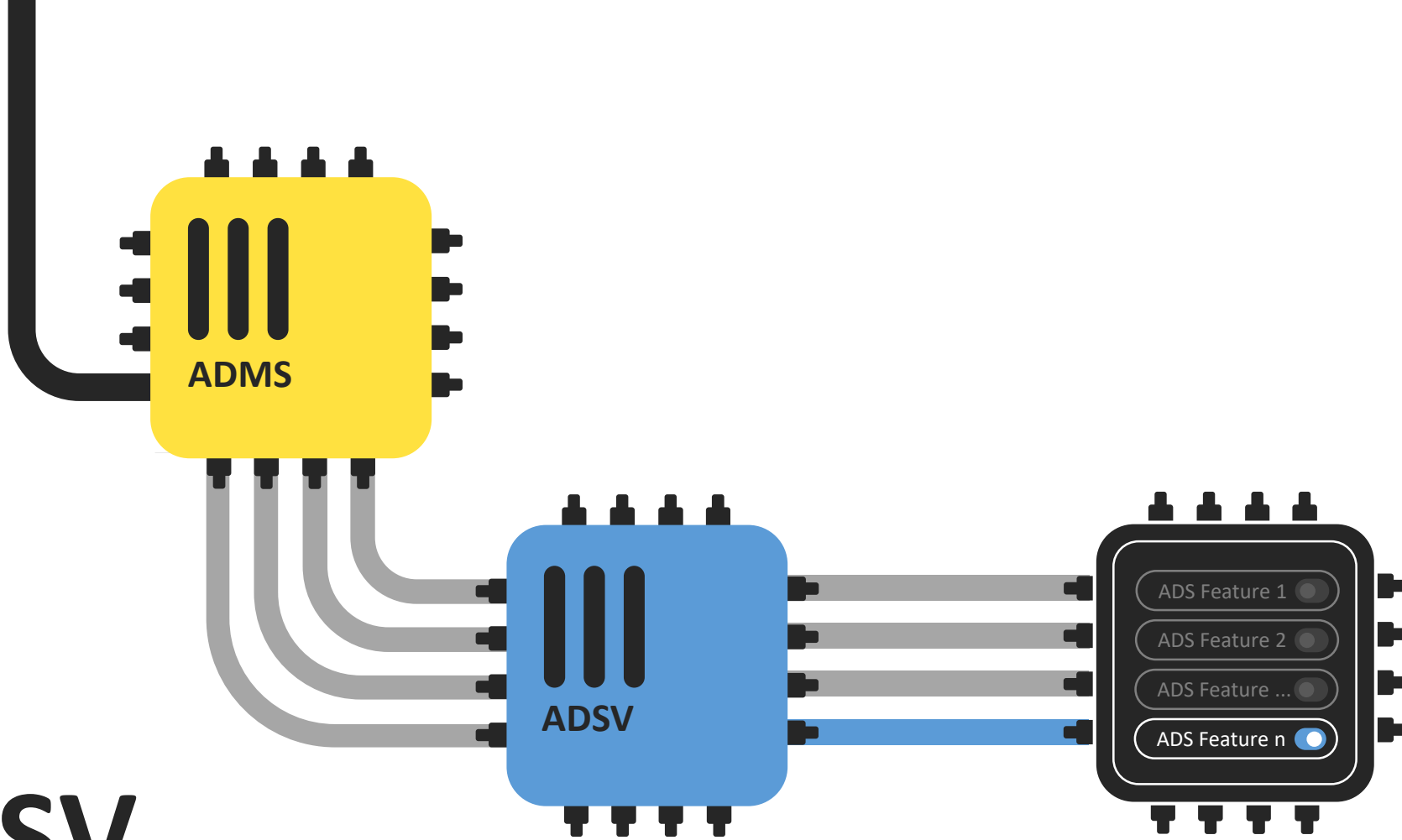
Selection algorithm examples

- 500 random scenarios
- 30 traffic accident scenarios
- 1 manually selected scenario (“human selector”) for re-testing
- ...



The Scenario Selector selects logical and/or concrete scenarios out of the continuous logical scenario space and outputs them consecutively for further processing¹ (...) until a sufficient coverage of the logical scenario space is achieved. The Scenario Selector is controlled by a selection algorithm which is influenced by the internal and external conditions of the ADS-Feature. These conditions have an impact on which and how many concrete/logical scenarios needs to be selected to reach a desired level of confidence.

¹virtual, physical and realworld test methods 15

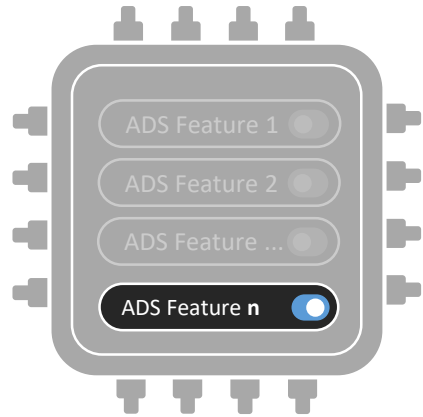


ADSV

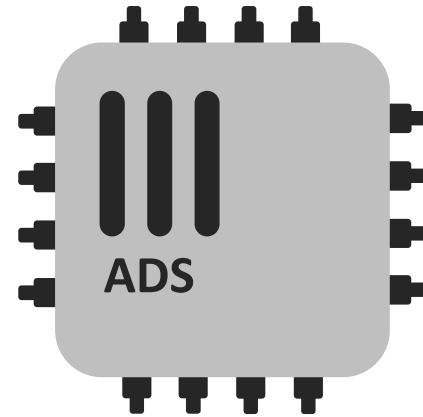
Validation Flows



Validation Flows

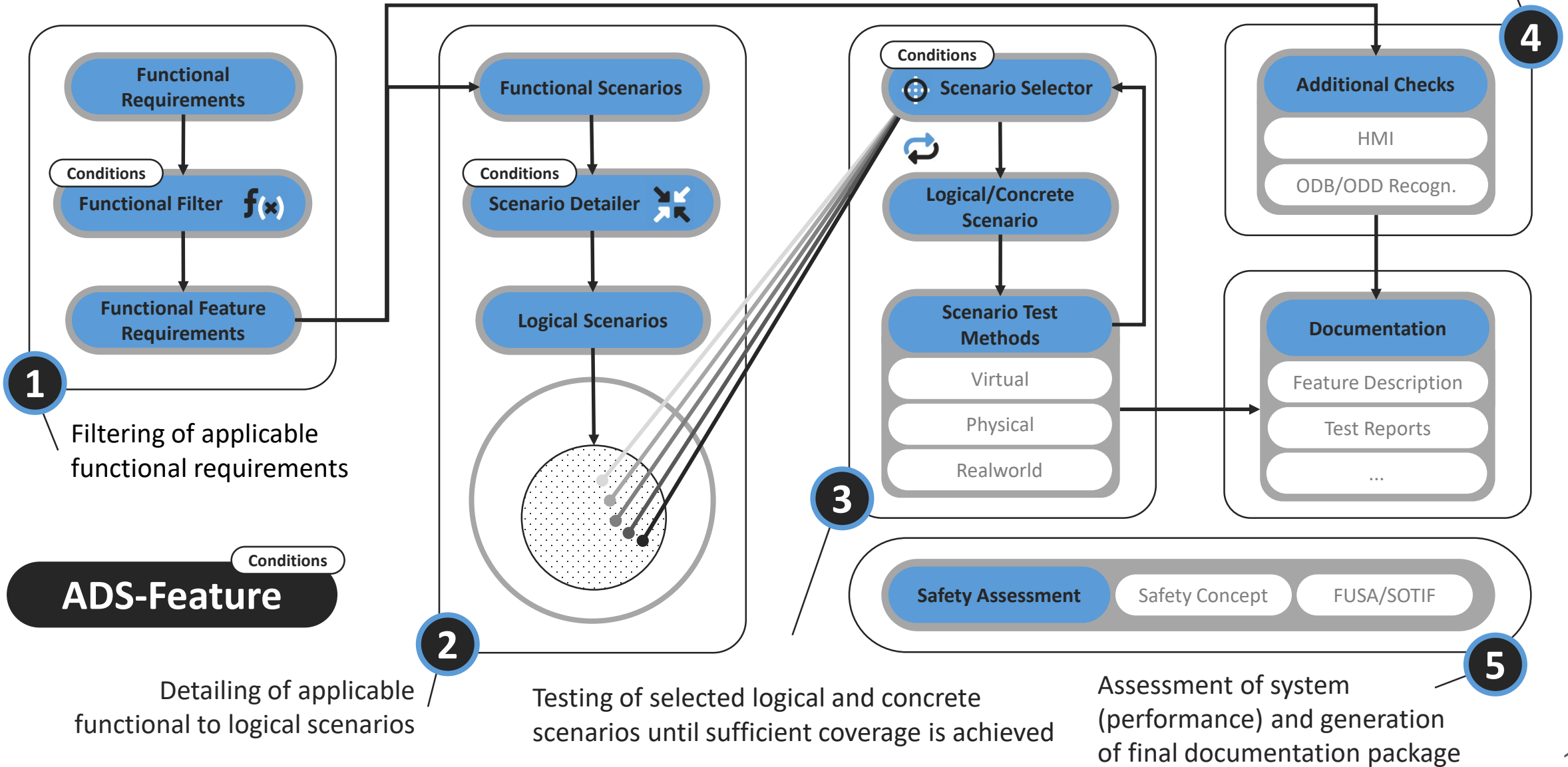


Feature
Performance

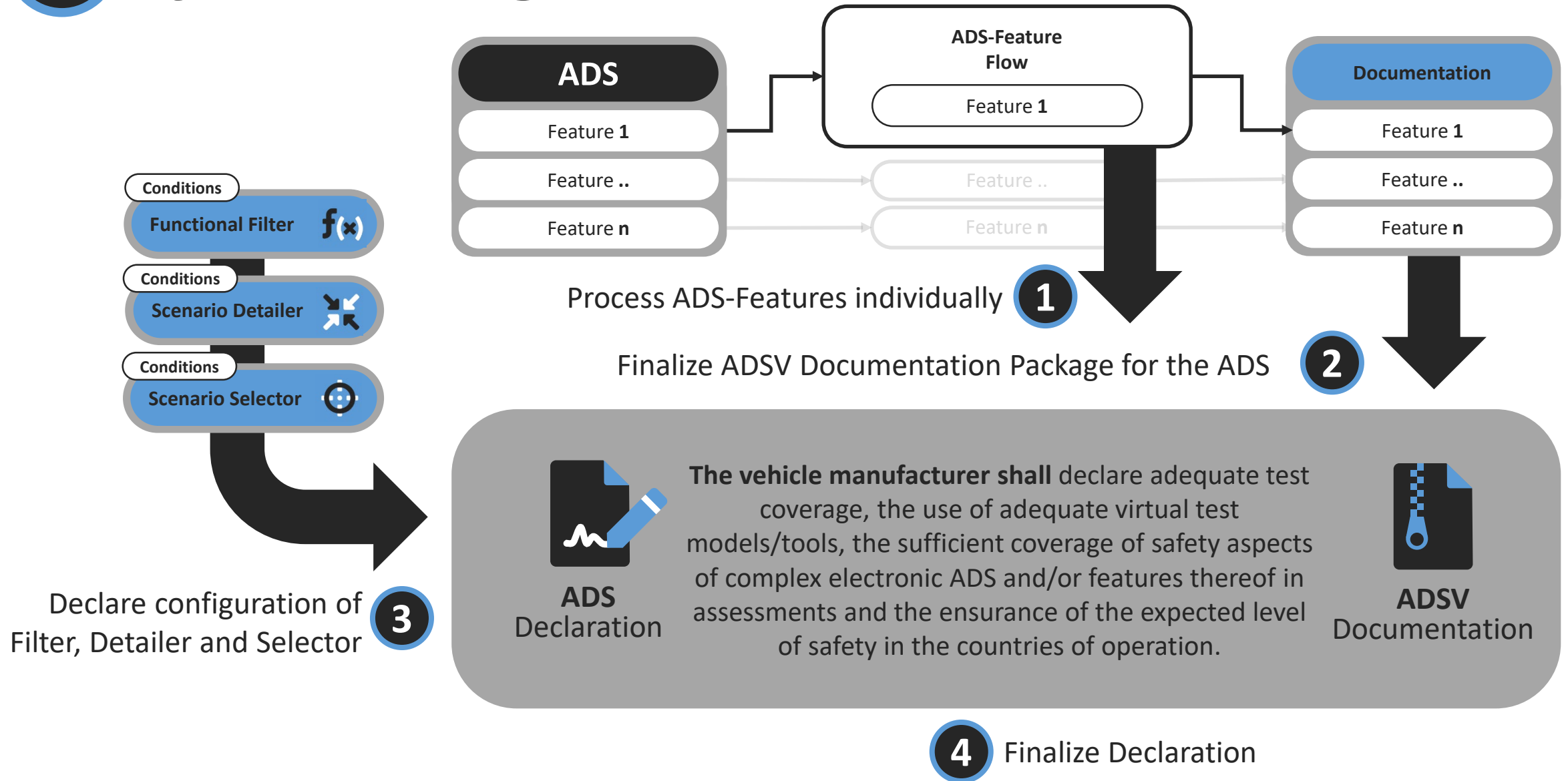


System
Integration

Feature Performance



ADSV System Integration



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