



Vision for FRAV final steps

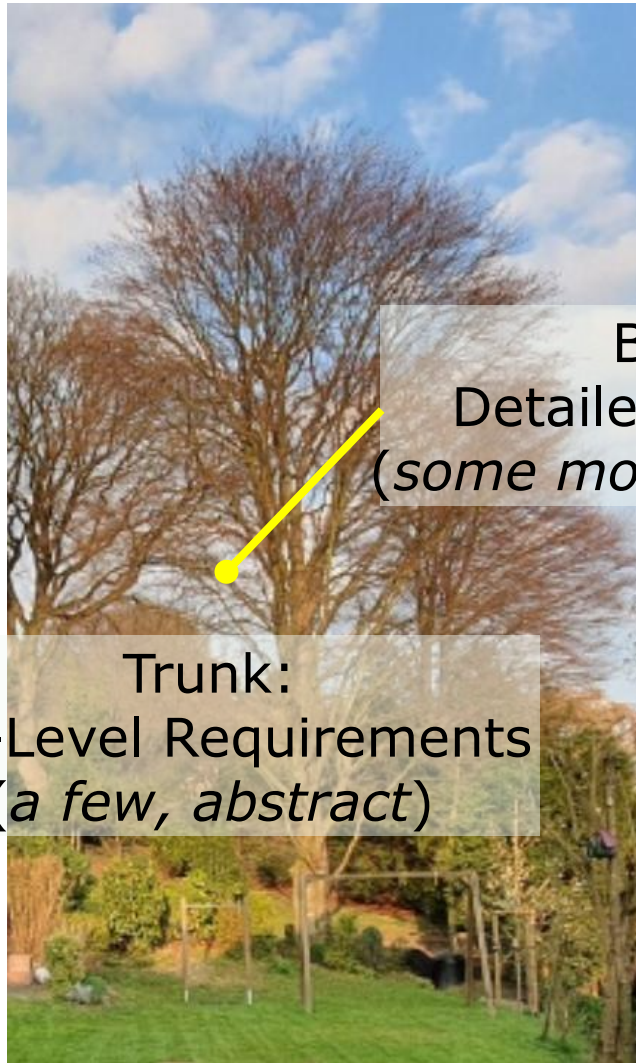
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“Necessary for [FRAV&VMAD] to start from high level and work down towards necessary level of specificity” (FRAV-01-15-rev.1, Berlin 2019)



Trunk:
Top-Level Requirements
(*a few, abstract*)



Branches:
Detailed Requirements
(*some more, more concrete*)



Leaves:
Verifiable Requirements
(*many, concrete*)

FRAV complexity:

- ➔ Pass-Fail req
- ➔ For All ODDs
- ➔ For All Non-PTW Vehicles
- ➔ Test Agnostic

Complexity Lever:

- ➔ Necessary level of specificity



Overview & Motivation

- ➔ Current FRAV status (FRAV-24-05) could already be considered as a guideline, providing definitions and superior requirements
- ➔ However, FRAV-24-05 still lacks important verifiable pass-fail-requirements (*loose ends*)
- ➔ FRAV's results would be more valuable if those *loose ends* could be filled
- ➔ Framework Document also expects FRAV to deliver detailed requirements
- ➔ This presentation proposes a solution on how this can be achieved within 2022

Current Requirements List – from FRAV-24-05



	Safety Recommendations	Detailed Provisions (under discussion)	Measurable / Verifiable Criteria (Final Result from FRAV)
The ADS should drive safely.			
1.	The ADS shall be capable of performing the entire Dynamic Driving Task (DDT) within the ODD of its feature(s).	<ul style="list-style-type: none"> • The capability of the ADS to perform the entire DDT should be determined in the context of the ODD of the ADS • As part of the DDT, the ADS should be able to: <ul style="list-style-type: none"> ○ Operate at safe speeds. ○ Maintain appropriate distances from [other road users] by controlling the longitudinal and lateral motion of the vehicle. ○ Adapt its behaviour to the surrounding traffic conditions (e.g., by avoiding disruption to the flow of traffic). ○ Adapt its behaviour in line with safety risks (e.g., by giving all road users and passengers the highest priority). 	?
3.	The ADS shall detect and respond to objects and events relevant to its performance of the DDT.	<ul style="list-style-type: none"> • Objects and events might include, but are not limited, to: <ul style="list-style-type: none"> ○ Vehicles, motorcycles, bicycles, pedestrians, obstacles ○ Road accidents ○ Road safety agents / enforcement agents ○ Emergency vehicles • The ADS shall detect objects in and around its path of travel that exceed a minimum size. • The ADS shall recognize objects as static or mobile. • The ADS shall recognize markings and signals used to indicate priority vehicles within the ODD of its feature(s). • The ADS shall classify priority vehicles within the ODD of its feature(s) in accordance with the relevant traffic law(s). • The ADS shall yield the right of way to priority vehicles in service in accordance with the relevant traffic law(s). 	?
4.	The ADS shall comply with safety-relevant traffic laws according to the ODD of the feature in use.	<ul style="list-style-type: none"> • ADS should comply with the traffic laws in nominal conditions, except when in specific circumstances or when necessary to enhance the safety of the vehicle’s occupants and/or other road users. 	?
5.	The ADS shall interact safely with other road users.	<ul style="list-style-type: none"> • The ADS shall avoid collisions with safety-relevant objects where possible. • The ADS shall signal intended changes of direction. • The ADS shall signal its operational status (active/inactive) as needed. 	?

Where are we? - Maturity of requirements:

- ➔ **Verifiable**, pass/fail criteria can be evaluated for all possible situations (*Leaves*)
 - Example: „*The ADS shall comply with safety-relevant traffic laws according to the ODD of the feature in use.*”
- ➔ **Verifiable with assumptions** → The *concept* of the ADS reaction is clear, but the calculation of pass/fail criteria requires further information (*Branches*)
 - Example: „*Maintain appropriate distances from [other road users] by controlling the longitudinal and lateral motion of the vehicle.*”
- ➔ **Not verifiable**, it is unclear how the ADS should react (*Trunk*)
 - Example: „*The ADS shall avoid collisions with safety-relevant objects where possible.*”

Making "not verifiable requirements" verifiable

Not verifiable

„The ADS should not do this when that“

verifiable
w/assumptions

Model(s) for possible vehicle behavior

Parameters

Verifiable

„In sit. X, the ADS shall not collide until a speed of Y“

Models

- ➔ Simple
- ➔ Based on a) physics, b) mathematics, c) logic
- ➔ Not prescriptive for vehicle behavior, but tool to identify pass/fail-criteria
- ➔ Modules: different models for different situations

4 models presented at FRAV are existing so far:

- ➔ Careful & Competent Driver (*FRAV-07-12, JP*)
- ➔ State-of-the-Art characteristics (*FRAV-05-05, DE*)
- ➔ Fuzzy Logic Approach (*FRAV-06-12, EC*)
- ➔ Responsibility Safety Sensitive Model „RSS“ (*FRAV-02-04*)

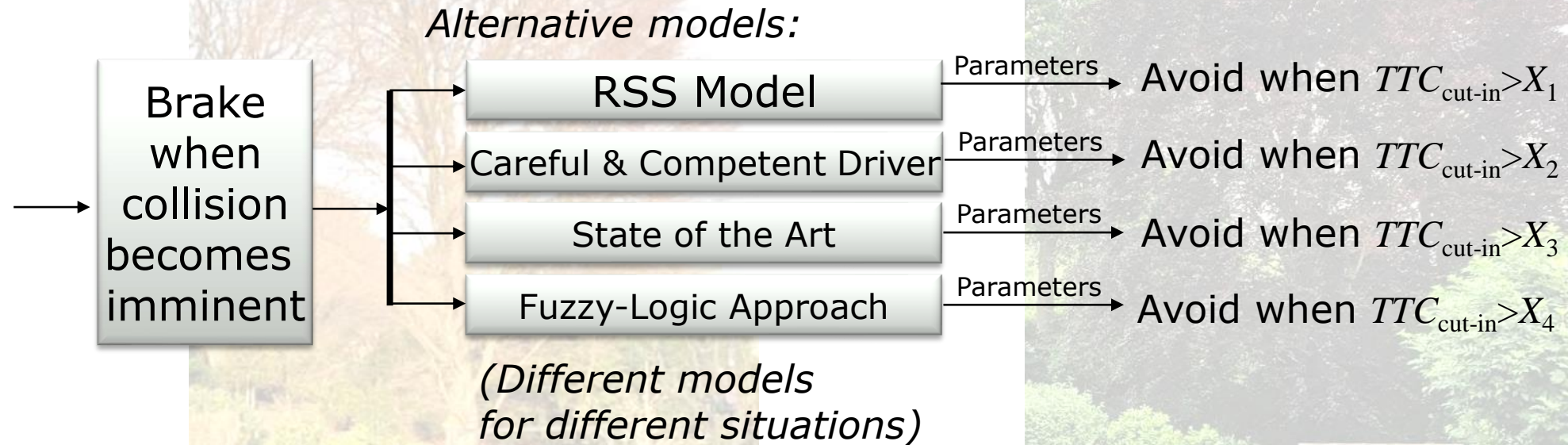
Making requirements verifiable

Not verifiable

„The ADS shall avoid collisions in cut-in situations where possible“

verifiable
w/assumptions

Verifiable



Making requirements verifiable

Not verifiable

„The ADS should not do this when that“

Possible FRAV guidelines?

verifiable
w/assumptions

Model(s) for possible vehicle behavior

Possible FRAV guidelines?

Parameters

Verifiable

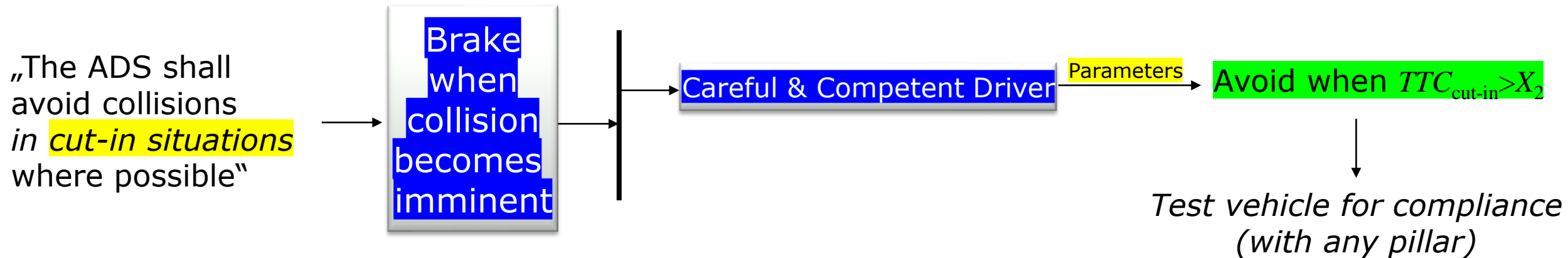
„In sit. X, the ADS shall not collide until a speed of Y“

Possible FRAV guidelines?

Specificity & Complexity & Effort increase

Cooperation FRAV-VMAD

- ➔ **VMAD question**: Lane keeping with other vehicle
- ➔ **FRAV answer**: avoid **cut-in** up to **parameters** as specified by one of the models
- ➔ Parameter ranges *a)* from VMAD scenario, *b)* vehicle characteristics
- ➔ Rulemaking: defines **verifiable pass-fail criteria**



Where Are We in the Requirements List



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3.	The ADS shall detect and respond to objects and events relevant to its performance of the DDT.	<ul style="list-style-type: none"> Objects and events might include, but are not limited, to: <ul style="list-style-type: none"> Vehicles, motorcycles, bicycles, pedestrians, obstacles Road accidents Road safety agents / enforcement agents Emergency vehicles The ADS shall detect objects in and around its path of travel that exceed a minimum size. The ADS shall recognize objects as static or mobile. The ADS shall recognize markings and signals used to indicate priority vehicles within the ODD of its feature(s). The ADS shall classify priority vehicles within the ODD of its feature(s) in accordance with the relevant traffic law(s). The ADS shall yield the right of way to priority vehicles in service in accordance with the relevant traffic law(s). [Missing] Expected response?
4.	The ADS shall comply with safety-relevant traffic laws according to the ODD of the feature in use.	<ul style="list-style-type: none"> ADS should comply with the traffic laws in nominal conditions, except when in specific circumstances or when necessary to enhance the safety of the vehicle's occupants and/or other road users.
5.	The ADS shall interact safely with other road users.	<ul style="list-style-type: none"> The ADS shall avoid collisions with safety-relevant objects where possible. The ADS shall signal intended changes of direction. The ADS shall signal its operational status (active/inactive) as needed.

Not verifiable

verifiable w/assumptions

Verifiable

How far to go with guidelines?

