

Extended Updated Proposal for an Approach to Defining Rules of the Road: United Kingdom Proposal

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UNECE FRAV 27th Session
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Motivation

FIRST PART: ADS Safety Topics

FRAV DDT Workstream

The ADS should drive safely

1. The ADS should be capable of performing the entire Dynamic Driving Task (DDT)
2. The ADS should recognize the ODD conditions and boundaries of the ODD of its feature(s)
3. The ADS should detect and respond to objects and events relevant for the DDT
4. The ADS should comply with traffic rules
5. The ADS should interact safely with other road users

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3. The ADS should detect and respond
4. The ADS should comply with
5. The ADS should interact safely

FRAV ORU Workstream

3	<p>The ADS should respond in line with traffic laws to markings and signals used to identify the functions and authorizations of ORUs.</p>	<ul style="list-style-type: none"> • The ADS should respond in accordance with traffic rules upon the operational status or dedicated signals displayed by emergency/enforcement vehicles. 	<p>Scenario/Virtual test/Track test:</p> <ul style="list-style-type: none"> • Object: Emergency/Special vehicle with visual signal (flash/painting), ego vehicle; • Case: 2-lane road, an emergency vehicle moves at low speed (in operational state) ahead while test vehicle drives in the same lane. 	
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FRAV DDT Workstream

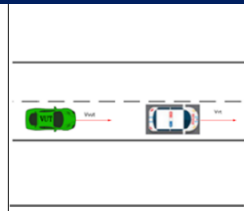
FRAV ORU Workstream

The ADS should respond in line with traffic laws to markings and signals used to identify the functions and

• The ADS should respond in accordance with traffic rules upon the operational status or dedicated signals displayed by

Scenario/Virtual test/Track test:

- **Object:** Emergency/Special vehicle with visual signal (flash/painting), ego vehicle;
- **Case:** 2-lane road, an emergency vehicle moves at low speed (in



5.1.2. The activated system shall comply with traffic rules relating to the DDT in the country of operation.

4.1.1. Verification of the function of "The System"

The Type approval authority shall verify "The System" under non-failure conditions by testing on a track a number of selected functions from those described by the manufacturer in paragraph 3.2. above, and by checking the overall behaviour of the system in real driving conditions including the compliance with traffic rules.

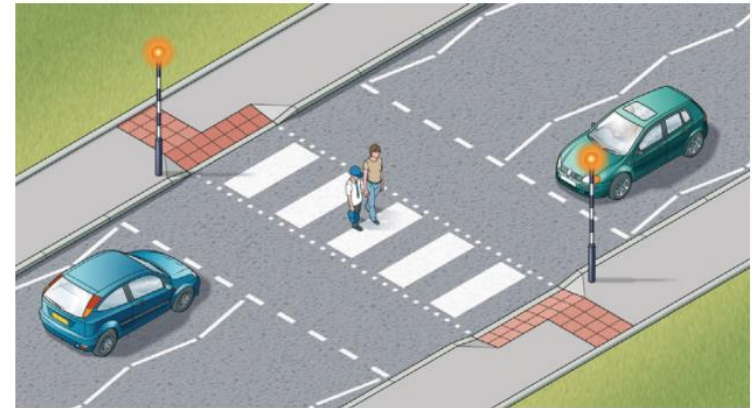
UNECE Reg 157

Motivation

- To create **verifiable** requirements
- **Verifiable** requirements can then be used by VMAD SG1 to create **relevant** scenarios
- **Enabling** a **concrete** and **usable link** between FRAV and VMAD SG1

UK Highway Code: Rule 195

“As you approach a zebra crossing: look out for pedestrians waiting to cross and be ready to slow down or stop to let them cross; you MUST give way when a pedestrian has moved onto a crossing”



Rule 19: Zebra crossings have flashing beacons

How long to wait?

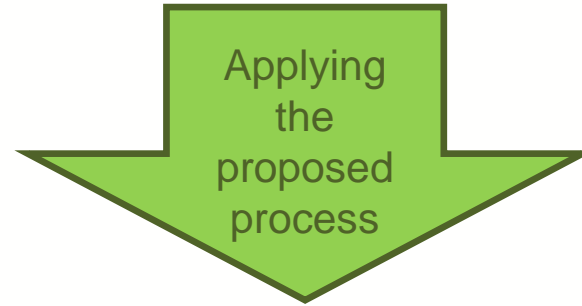
Behaviour

ODD

Assumptions

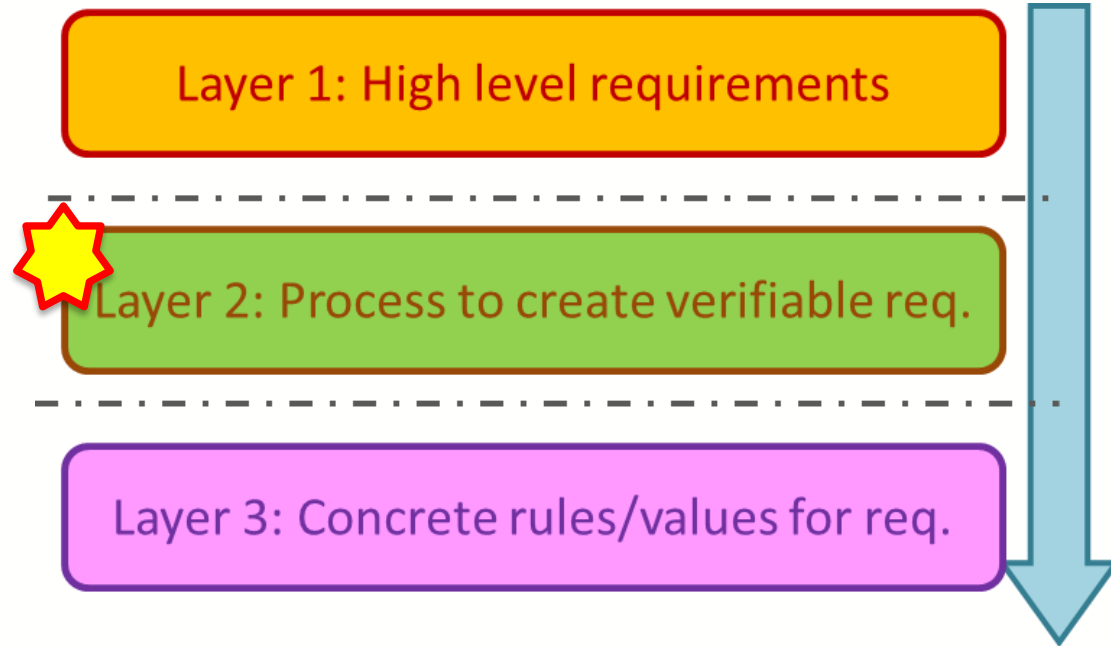
ODD based Codified Rules of the Road **PROCESS**

*Current Rules of Road
(for human drivers)* = $f(\text{Operating condition, Behaviour competency, Assumptions})$



*Codified
Rule of the Road* = $f(\text{Operating condition, behaviour competency, driving characteristics})$

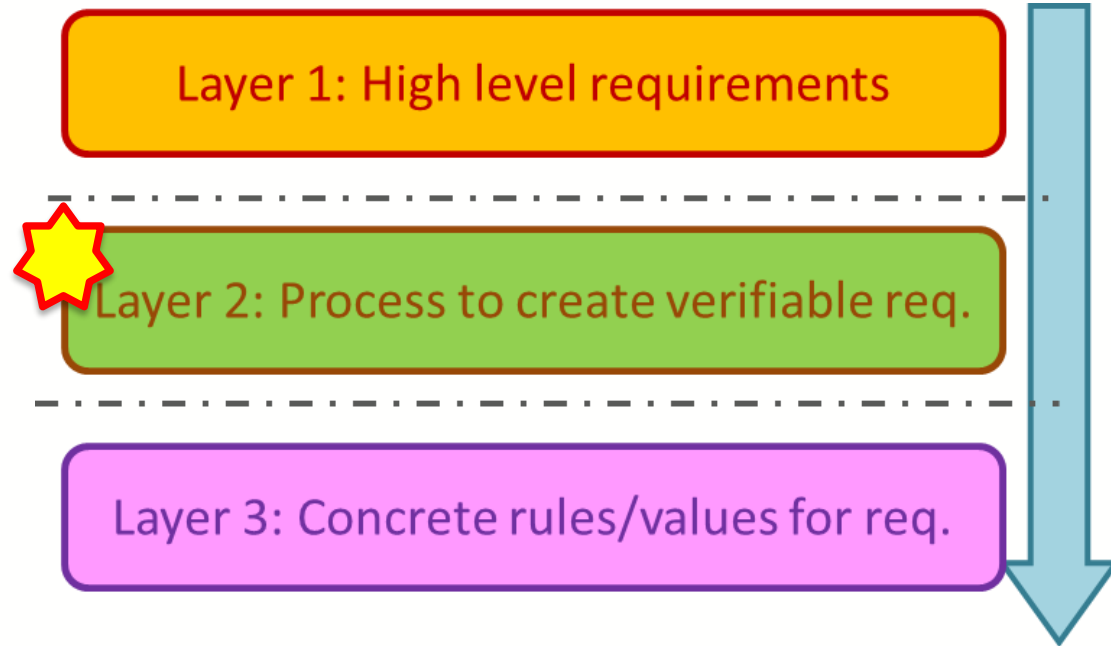
Focus for FRAV: Process for deriving requirements



Understanding links between UNECE groups



Focus for FRAV: Process for deriving requirements



Deriving Requirements from Rules of Road

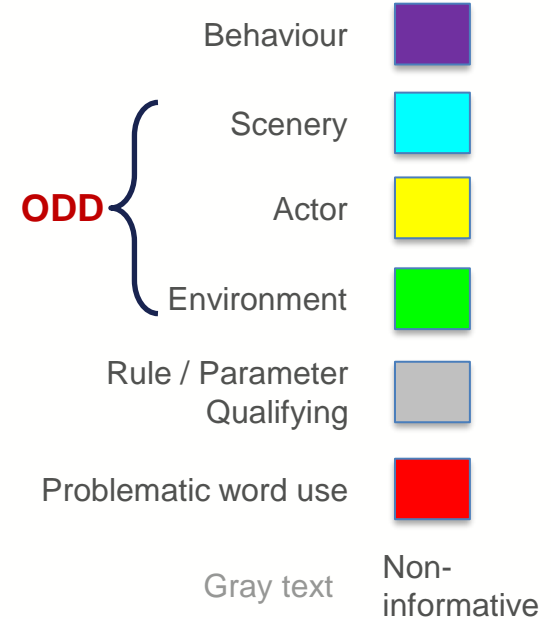
UK Highway Code Rule 125

- The speed limit is the absolute maximum and does not mean it is safe to drive at that speed irrespective of conditions. Driving at speeds too fast for the road and traffic conditions is dangerous. You should always reduce your speed when:
 - the road layout or condition presents hazards, such as bends
 - sharing the road with pedestrians, cyclists and horse riders, particularly children, and motorcyclists
 - weather conditions make it safer to do so
 - driving at night as it is more difficult to see other road users.

Deriving Requirements from Rules of Road

UK Highway Code Rule 125

- speed limit is absolute maximum and does not mean safe speed. reduce speed when:
 - road layout or condition hazards, bends
 - sharing the road pedestrians, cyclists and horse riders, particularly children, and motorcyclists
 - weather conditions make it safer
 - driving at night



Deriving Requirements from Rules of Road

UK Highway Code Rule 125

- speed limit is absolute maximum and does not mean safe speed. reduce speed when:
 - road layout or condition hazards, bends
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 - weather conditions make it safer
 - driving at night

- ▶ $\text{isVehicle}(x) \rightarrow \text{speed}(x) < \text{limit}(\text{speed})$
- ▶ $\text{isVehicle}(x) \wedge (\text{isAtHazard}(x) \vee (\text{near}(x, a_1) \wedge \text{isPedestrian}(a_1)) \vee (\text{near}(x, a_2) \wedge \text{isCyclist}(a_2)) \vee (\text{near}(x, a_3) \wedge \text{isHorseRider}(a_3)) \vee (\text{near}(x, a_4) \wedge \text{isChildren}(a_4)) \vee (\text{near}(x, a_5) \wedge \text{isMotorcyclist}(a_5)) \vee \text{isUnsafeWeather}(\text{env}) \vee \text{isNight}(\text{tod})) \rightarrow \text{action}(\text{reduceSpeed})$

Define “near” ;
“hazard” ;
“UnsafeWeather”

$(\text{near}(x, a_1) \wedge \neg \text{isVehicle}(a_1))$

We define vehicle to be anything that is a four wheeler or larger

Need to define what reduceSpeed means
What would an acceptable “slow” speed mean?

Codification of Vienna Convention Rules of Road

Chapter II

RULES OF THE ROAD

PART I

CONVENTION ON ROAD TRAFFIC
DONE AT VIENNA ON 8 NOVEMBER 1968

(Consolidated version)*

* Including the amendments to the Convention which entered into force on 3 September 1993 (marked in the margin with a single line) and the amendments which entered into force on 28 March 2006 (marked in the margin with a double line).

Codification of Vienna Convention Rules of Road

ARTICLE 7

General rules

3. Drivers shall show **extra care** in relation to the most vulnerable road-users, such as pedestrians and cyclists and in particular children, elderly persons and the disabled.
4. Drivers shall take care that their vehicles **do not inconvenience road-**users or the occupants of properties bordering on the road, for example, by causing noise or raising dust or smoke where they can avoid doing so.

Codification of Vienna Convention Rules of Road

Chapter II - Rules of the Road – Article 11 (Overtaking)

ARTICLE 11

Overtaking and movement of traffic in lines

1. (a) Drivers overtaking shall do so on the side opposite to that appropriate to the direction of traffic.

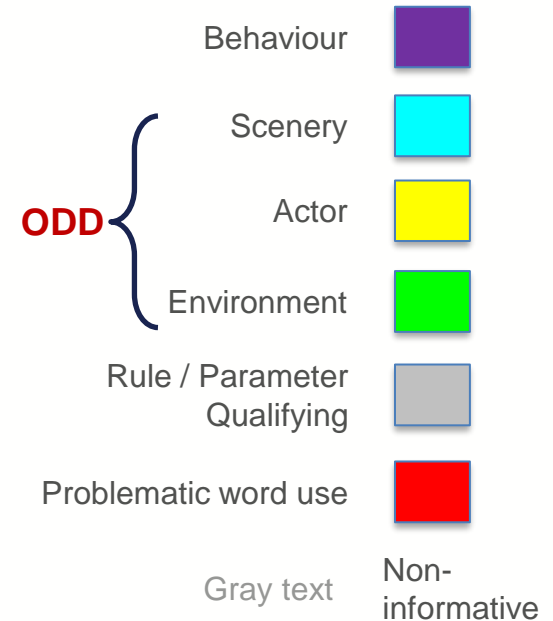
4. When overtaking, a driver shall give the road-user or road-users overtaken a sufficiently wide berth.

9. A vehicle shall not overtake another vehicle which is approaching a pedestrian crossing marked on the carriageway or signposted as such, or which is stopped immediately before the crossing, otherwise than at a speed low enough to enable it to stop immediately if a pedestrian is on the crossing. Nothing in this paragraph shall be construed as preventing Contracting Parties or subdivisions thereof from prohibiting overtaking within a prescribed distance from a pedestrian crossing, or from imposing stricter requirements on a driver of a vehicle proposing to overtake another vehicle stopped immediately before such a crossing.

Codification of Vienna Convention Rules of Road

Chapter II - Rules of the Road – Article 11 (Overtaking - 4)

When **overtaking**, a driver shall give the **road-user** or **road-users** **overtaken** a **sufficiently wide berth**.



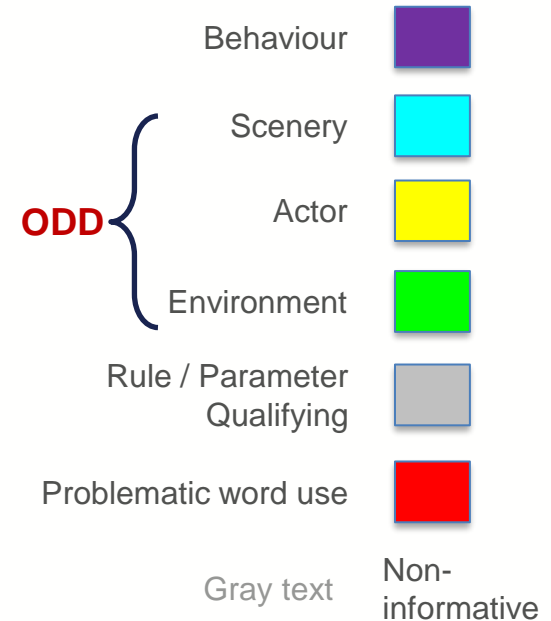
Codification of Vienna Convention Rules of Road

Chapter II - Rules of the Road – Article 11 (Overtaking - 4)

When **overtaking**, a driver shall give the **road-user** or **road-users** **overtaken** a **sufficiently wide berth**.

$\text{isVehicle}(x) \wedge \text{onRoad}(x,r) \wedge$
 $\text{roadUser}(y,r) \wedge$
 $\text{isOvertaking}(x,y) \wedge$
 $\text{lateralDistance}(x,y,z)$

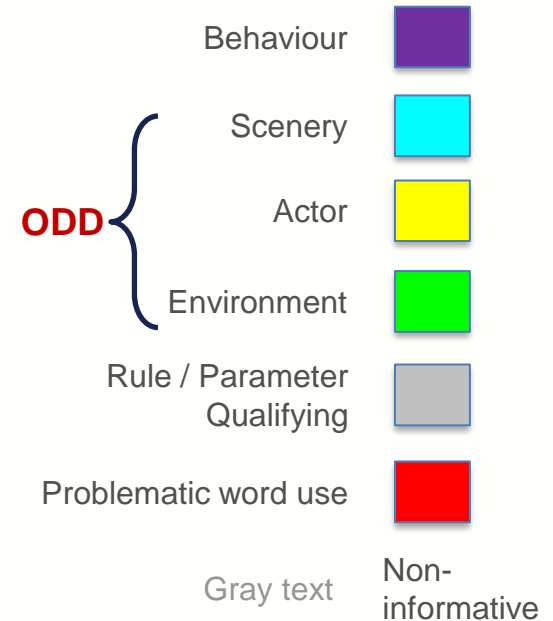
→ $\text{sufficientlyWideBerth}(z)$



Codification of Vienna Convention Rules of Road

Chapter II - Rules of the Road – Article 11 (Overtaking - 11)

*A vehicle shall not **overtake** **another vehicle** which is **approaching** a **pedestrian crossing** marked on the **carriageway** or **signposted** as such, or which is **stopped** immediately before the **crossing**, otherwise than at a **speed** low enough to enable it to **stop** immediately if a **pedestrian** is on the **crossing**.*



Codification of Vienna Convention Rules of Road

Chapter II - Rules of the Road – Article 21 (Behaviour of drivers towards pedestrians)

ARTICLE 21

Behaviour of drivers towards pedestrians

2. Without prejudice to the provisions of Article 7, paragraph 1, Article 11, paragraph 9, and Article 13, paragraph 1, of this Convention, where there is on the carriageway a pedestrian crossing signposted as such or indicated by markings on the carriageway:

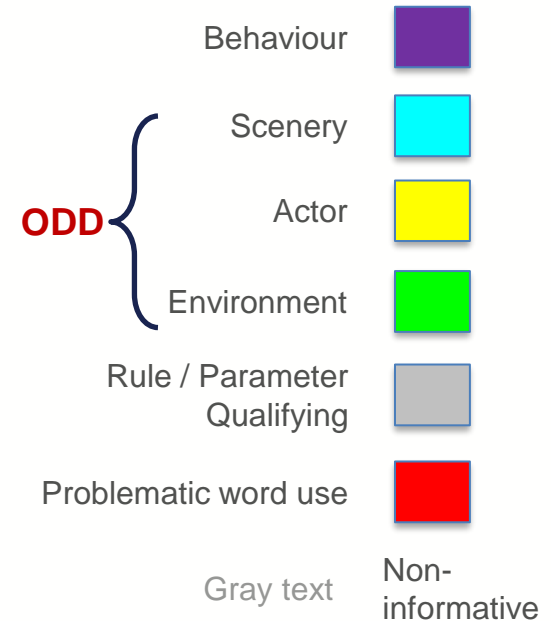
(a) If vehicular traffic is regulated at that crossing by traffic light signals or by an authorized official, drivers forbidden to proceed shall stop short of the crossing or the transverse markings preceding it and, when they are permitted to proceed, shall not prevent or obstruct the passage of pedestrians who have stepped on to it; drivers turning into another road at the entrance to which there is a pedestrian crossing shall do so slowly and give way, if necessary stopping for this purpose, to pedestrians already using, or about to use, the crossing;

(b) If vehicular traffic is not regulated at that crossing by traffic light signals or by an authorized official, drivers shall approach the crossing only at a speed low enough not to endanger pedestrians using, or about to use, it; if necessary, they shall stop to allow such pedestrians to cross.

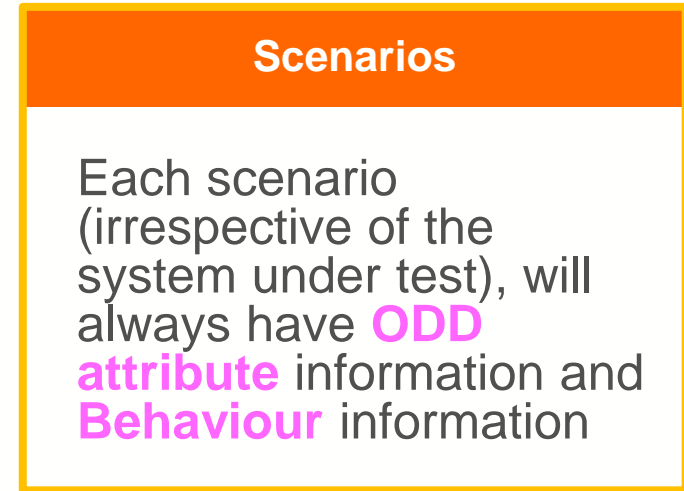
Codification of Vienna Convention Rules of Road

Chapter II - Rules of the Road – Article 21 (Behaviour of drivers towards pedestrians)

If **vehicular traffic** is not regulated at that **crossing** by **traffic light signals** or by an **authorized official**, drivers shall **approach** the **crossing** only at a **speed** low enough not to endanger **pedestrians** **using, or about to use,** it; if necessary, they shall **stop** to allow such **pedestrians** to **cross**.

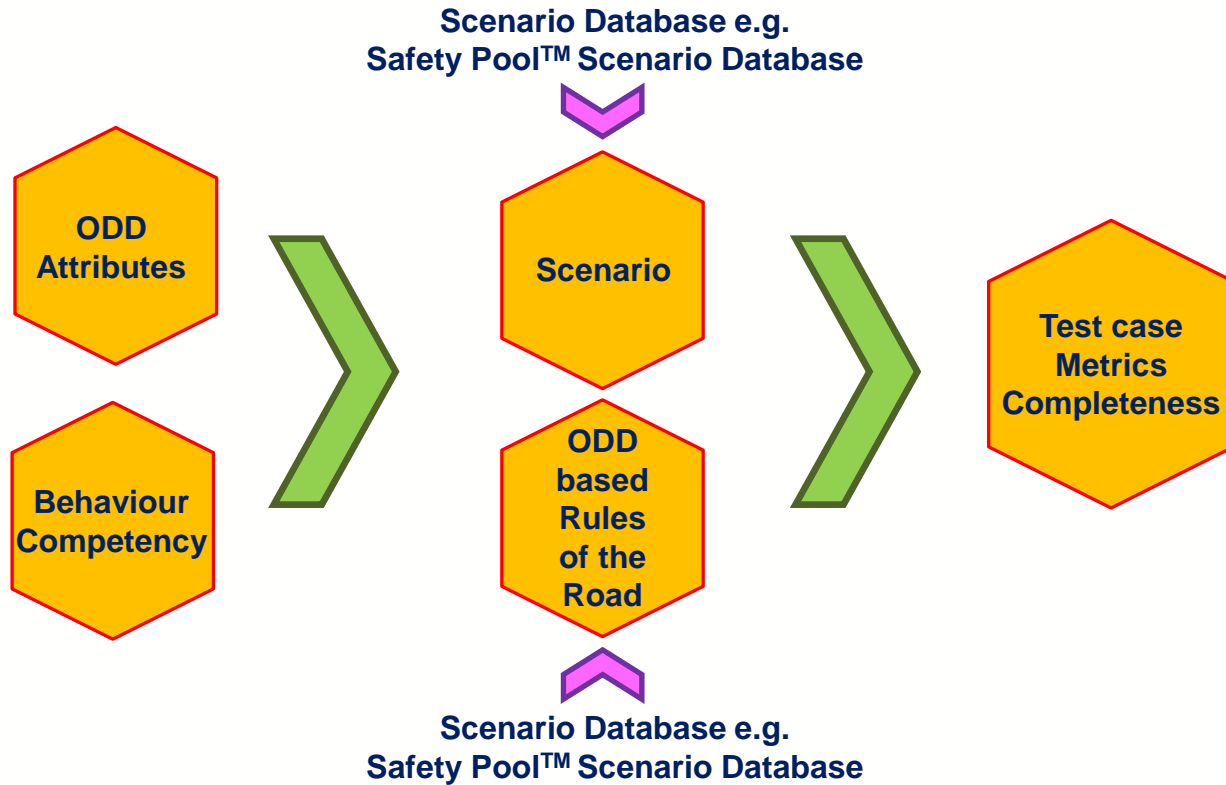


Using **ODD Based** Rules of Road in wider Safety Assurance

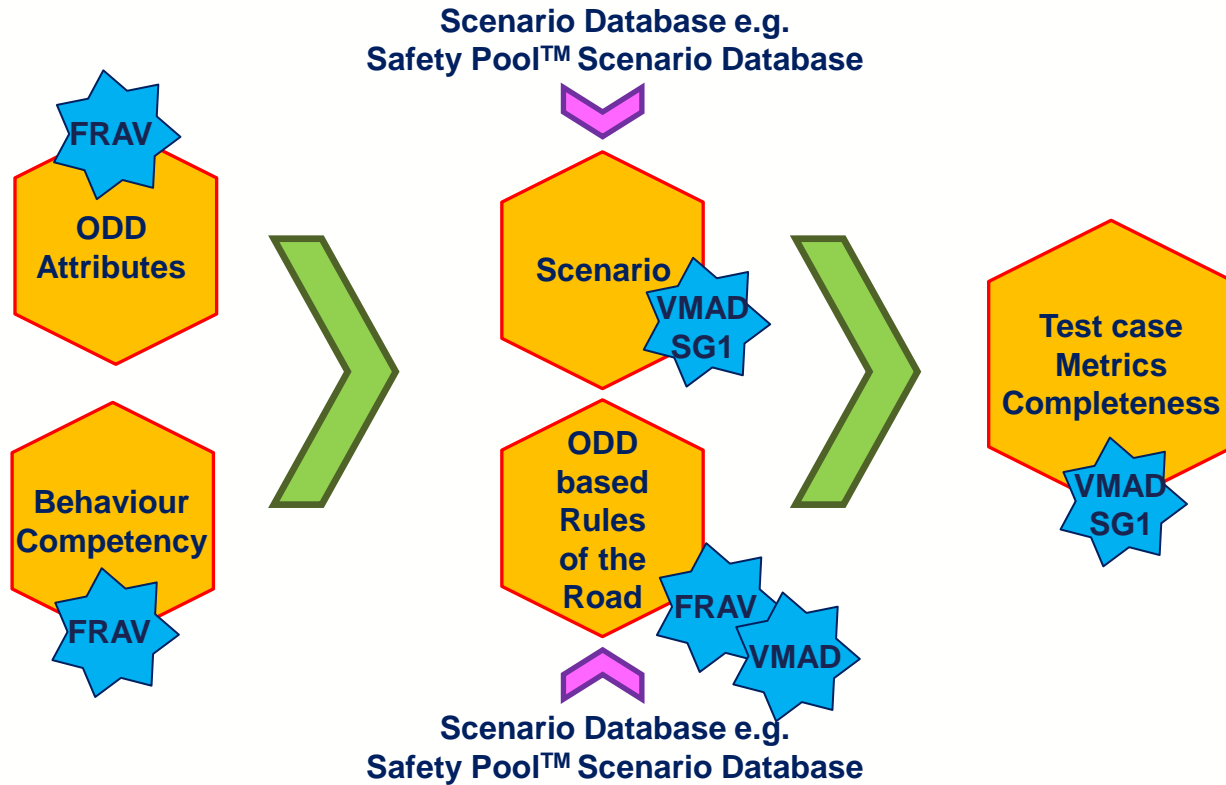


Mapping using labels / tags

Using **ODD Based** Rules of Road in wider Safety Assurance



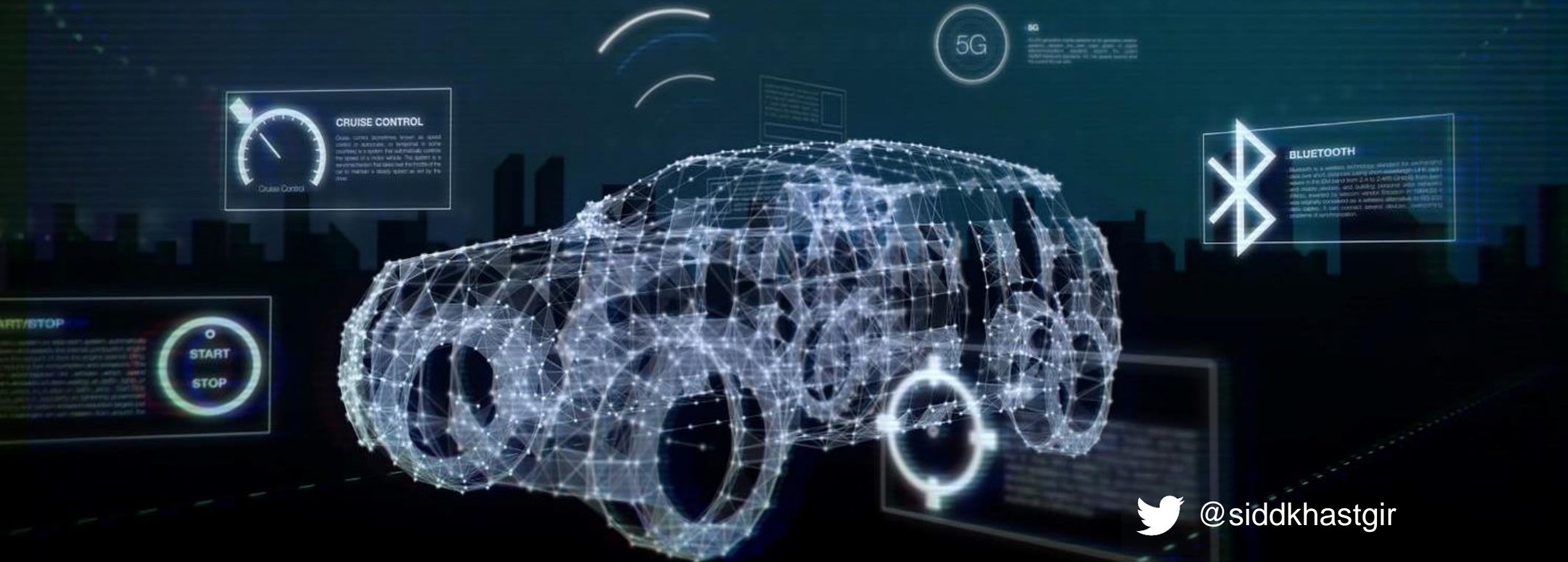
Using ODD Based Rules of Road in wider Safety Assurance



Next steps

- Provide draft text for the “FRAV document 5” to cover the methodology (process of converting rules of road to **verifiable** rules of road)
- Provide a **process** to link between **verifiable** rules of road (FRAV) and **scenarios** (VMAD SG1)
- Implementing the process of creating verifiable rules of road is a responsibility for each CP

Thank you... Discussions...



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