

ODD journey in the Automated Driving ecosystem: A UK perspective

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Verification & Validation Methods (VVM) Project Final Event
22 November 2023

ODD journey...

ODD Journey...



ODD Journey...

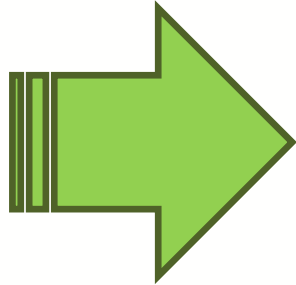


Our Journey: A very UK perspective...

bsi.

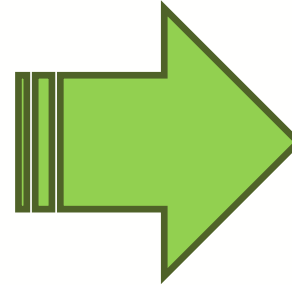


Started May 2019
Published Aug 2020
(UK experts only)



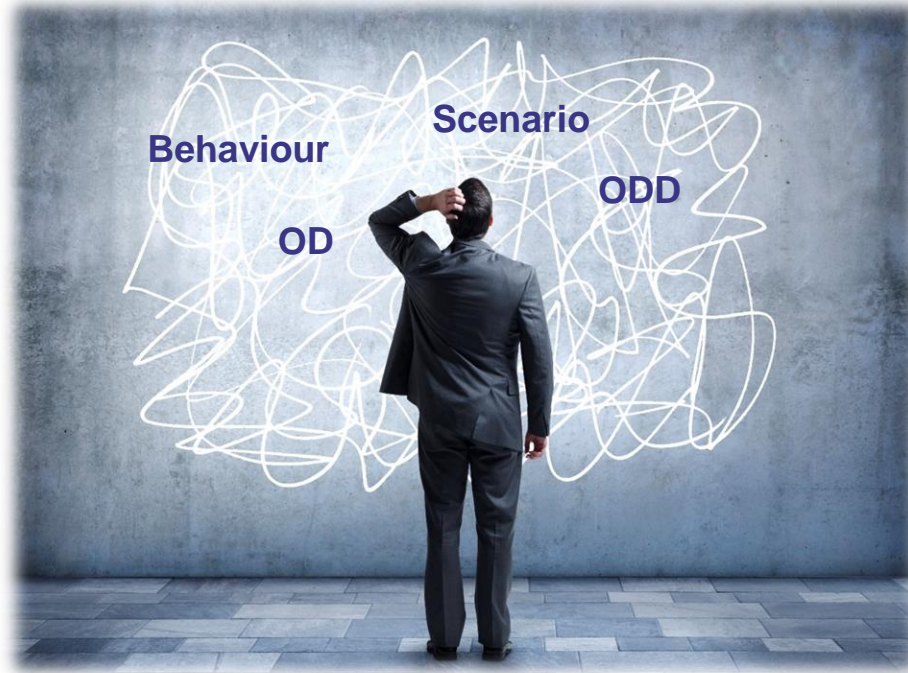
ISO Work Item
with **international**
group of experts

Sep 2019



Published Aug 2023

ODD and the confusion...



For more on
Curious case of ODD: <https://bit.ly/CuriousCaseODD>

ISO 34503: Doc structure

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ISO 34503: Doc structure

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ISO 34503: Doc structure

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ODD Format

12 ODD definition format

ISO 34503: ODD Definition Format

■ Definition Format Type

- Permissive
- Restrictive
- Default (don't care)

■ Human readability

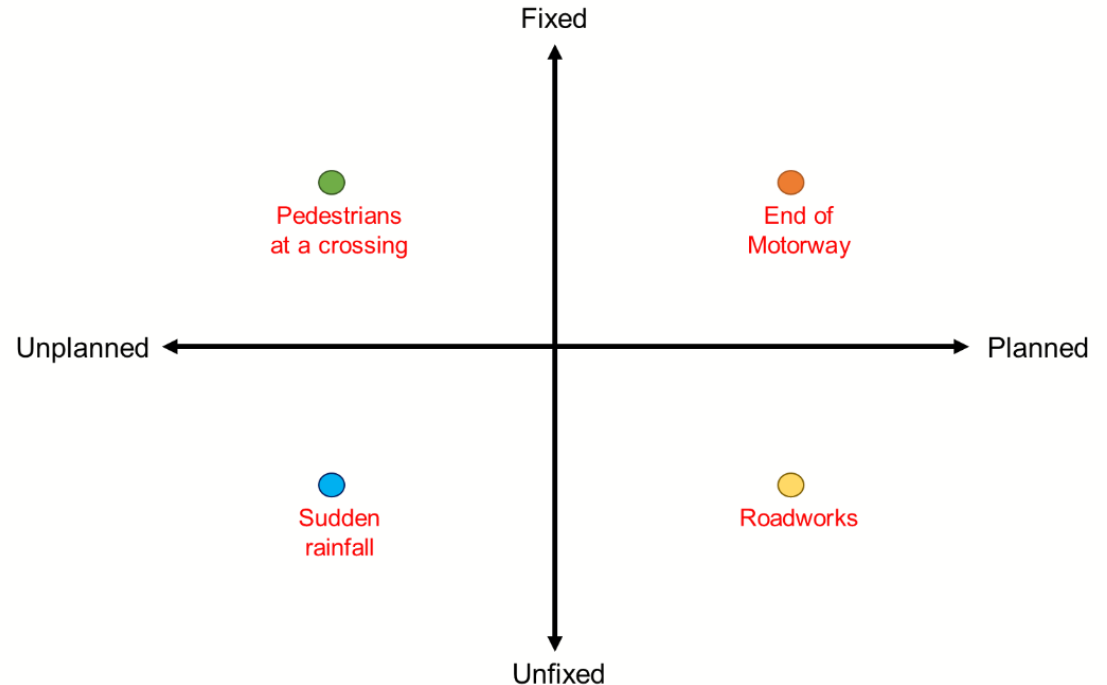
■ Qualifiers (include, exclude and conditional)

```
#Composition statements
Include geofenced areas is [predefined route]
Include regions or states is [Ottawa Canada]
Include zones are [regions or states, geofenced areas]
Cond_1 Conditional drivable area type are [minor roads, parking, shared space]
Cond_2 Conditional horizontal plane is [curved roads]
Exclude transverse plane is [divided]
Include types of lane together is [traffic lane]
```

```
#Conditional statements
Cond_1 Include speed of subject vehicle for [minor roads] is [0,15 km/h]
Cond_1 Include speed of subject vehicle for [parking, shared space] is [0,10 km/h]
```

Understanding ODD Boundary

- Two types of ODD departure conditions:
 - **Predictability** based
 - **Location** based



Understanding ODD Boundary

```
#Composition statements
Cond_1 Conditional drivable area type is [motorway, radial roads, distributor roads]
Cond_2 Conditional drivable area type is [median crossover]
Included number of lanes is [1,∞]
Included lane dimension is [3.7,∞]
Excluded roundabouts are [all]
Excluded intersections are [grade separated]
Cond_3 Conditional horizontal plane is [curved roads]
Excluded special structures are [all]
Included direction of travel is [right hand drive]
Included lane type is [traffic lane]
Included drivable area surface type is [asphalt, concrete]
Excluded fixed road structures are [buildings]
Excluded drivable area edge is [None]
Excluded transverse plane is [pavements]
Included temporary road structures are [road signage]
Cond_4 Conditional temporary road structures are [refuse collection, road works]
Excluded rainfall is [light rain, medium rain, heavy rain]
Excluded snowfall is [heavy snow]
Excluded particulates are [mist and fog]

#'Conditional' statements
Cond_1 Included speed of subject vehicle for [motorway, radial roads, distributor roads] is
[0,15 km/h]
Cond_2 Included drivable area signs for [median crossover] are [yield, stop, one-way, do not
enter]
Cond_3 Excluded radius of curved_road is [0,13 m]
Cond_4 Excluded location of [refuse collection, road works] is [in lane]
```

Understanding ODD Boundary

```

#Composition statements
Cond_1 Conditional drivable area type is [motorway, radial roads, distributor roads]
Cond_2 Conditional drivable area type is [median crossover]
Excluded drivable area edge is [None]
Excluded transverse plane is [pavements]
Included temporary road structures are [road signage]
Cond_4 Conditional temporary road structures are [refuse collection, road works]
Excluded rainfall is [light rain, medium rain, heavy rain]
Excluded snowfall is [heavy snow]
Excluded particulates are [mist and fog]
Excluded temporary road structures are [road works]
Excluded drivable area edge is [None]
Excluded transverse plane is [pavements]
Included temporary road structures are [road signage]
Cond_4 Conditional temporary road structures are [refuse collection, road works]
Excluded rainfall is [light rain, medium rain, heavy rain]
Excluded snowfall is [heavy snow]
Excluded particulates are [mist and fog]

# 'Conditional' statements
Cond_1 Included speed of subject vehicle for [motorway, radial roads, distributor roads] is
[0,15 km/h]
Cond_2 Included drivable area signs for [median crossover] are [yield, stop, one-way, do not
enter]
Cond_3 Excluded radius of curved_road is [0,13 m]
Cond_4 Excluded location of [refuse collection, road works] is [in lane]

```

Understanding ODD Boundary

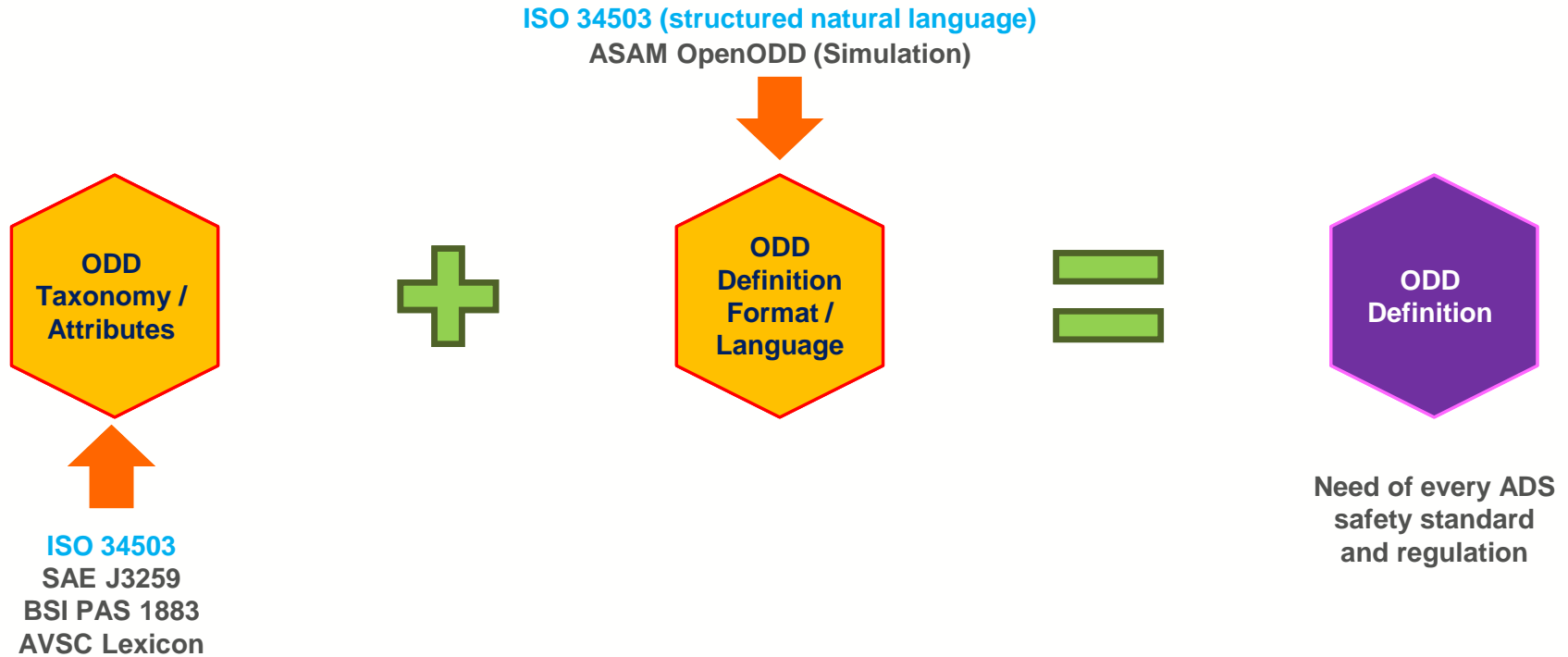
```
#Composition statements
Cond_1 Conditional drivable area type is [motorway, radial roads, distributor roads]
Cond_2 Conditional drivable area type is [median crossover]
Excluded drivable area edge is [None]
Excluded transverse plane is [pavements]
Included temporary road structures are [road signage]
Cond_4 Conditional temporary road structures are [refuse collection, road works]
Excluded rainfall is [light rain, medium rain, heavy rain]
Excluded snowfall is [heavy snow]
Excluded particulates are [mist and fog]
```

```
Excluded drivable area edge is [None]
Excluded transverse plane is [pavements]
Included temporary road structures are [road signage]
Cond_4 Conditional temporary road structures are [refuse collection, road works]
Excluded rainfall is [light rain, medium rain, heavy rain] FOR > 30 seconds
Excluded snowfall is [heavy snow]
Excluded particulates are [mist and fog]
```

Adding Temporal aspect

```
Cond_2 Included drivable area signs for [median crossover] are [yield, stop, one-way, do not enter]
Cond_3 Excluded radius of curved_road is [0,13 m]
Cond_4 Excluded location of [refuse collection, road works] is [in lane]
```

ODD Definition: Bringing things together...



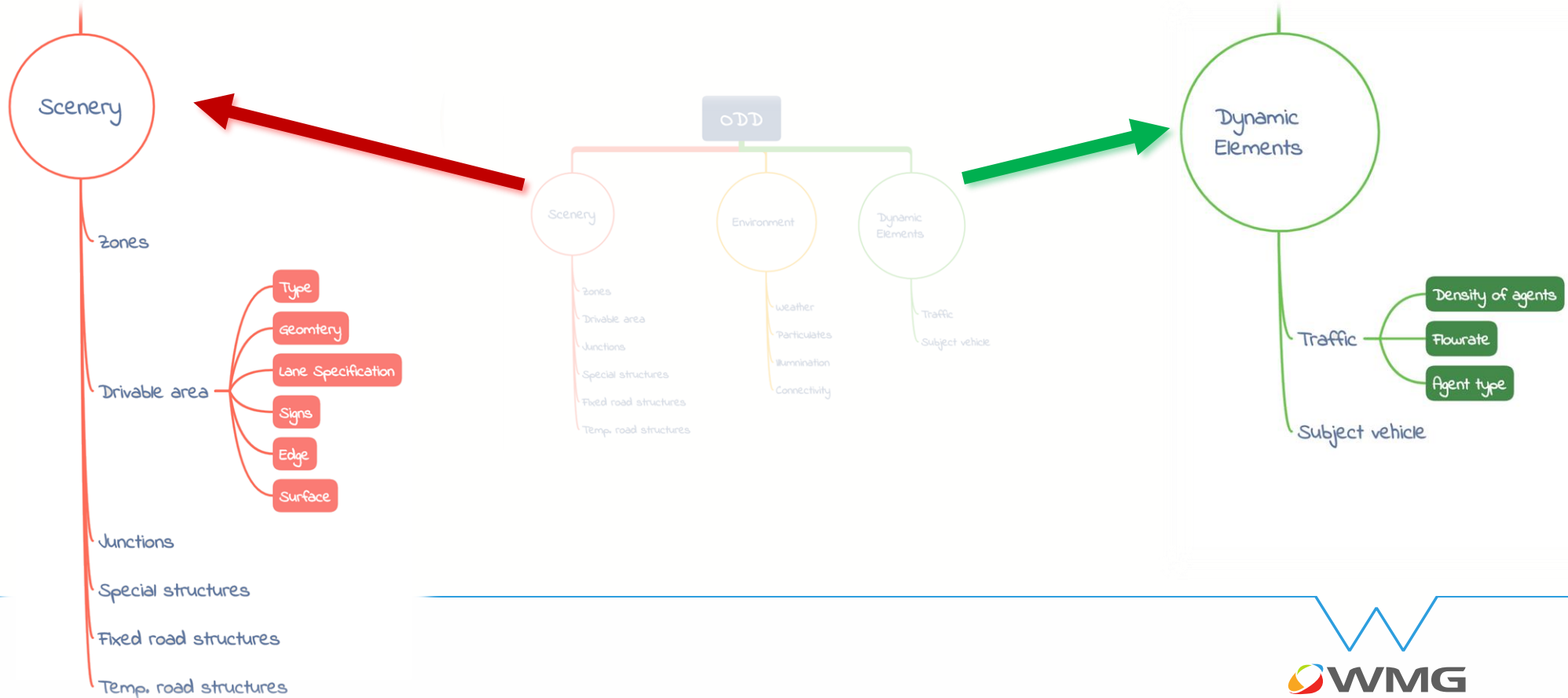
Some Qualifications / Clarifications

- Certain terms in discussion in a new **ISO Technical Report TR 17720** on “**ODD Boundary**” and the updated ISO/SAE 22736 (SAE J3016)

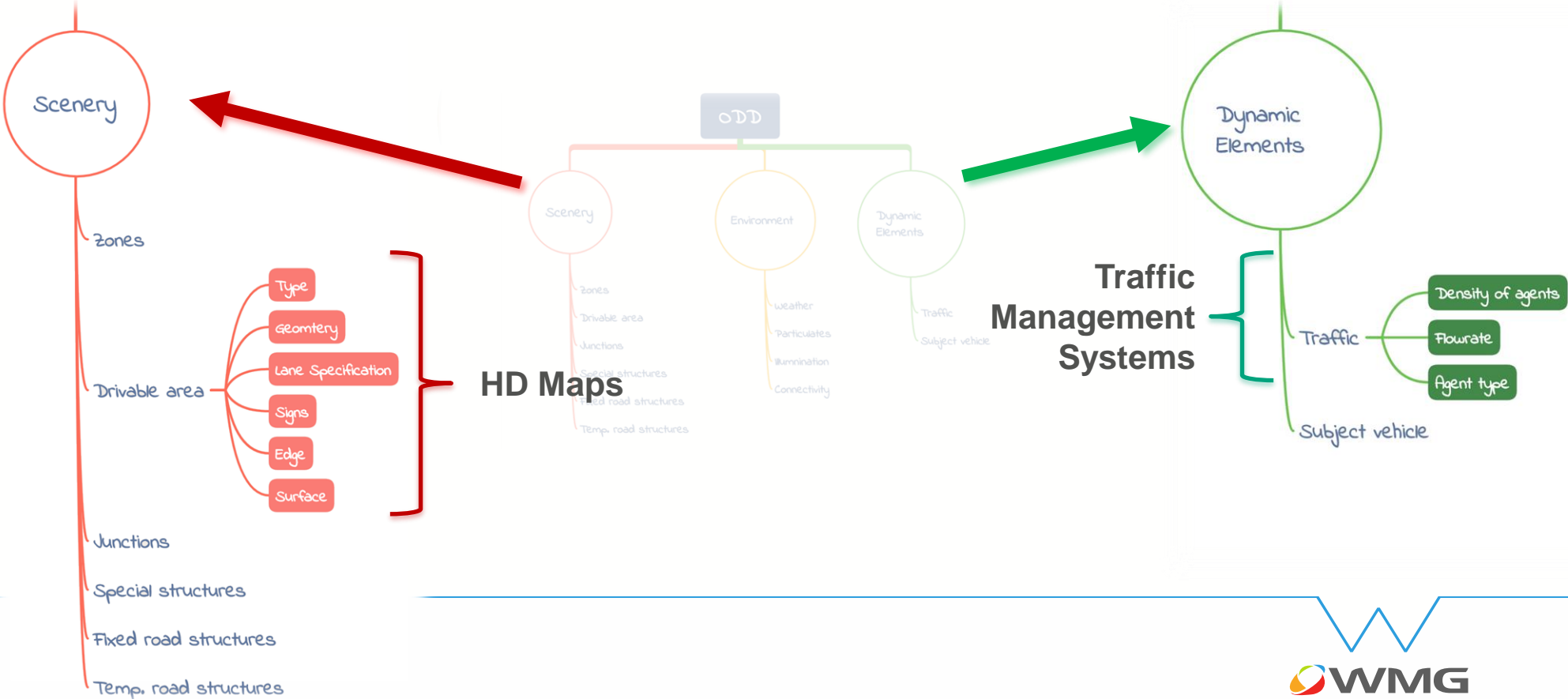
Some Qualifications / Clarifications

- Certain terms in discussion in a new **ISO Technical Report TR 17720** on “**ODD Boundary**” and the updated ISO/SAE 22736 (SAE J3016)
 - Target Operational Domain and Current Operational Domain
 - Quirks of **American English!**
- Concept remains the **same**. Terms “*may*” change.

ODD attribute Value Awareness



Distributed ODD attribute Value Awareness (DOVA)

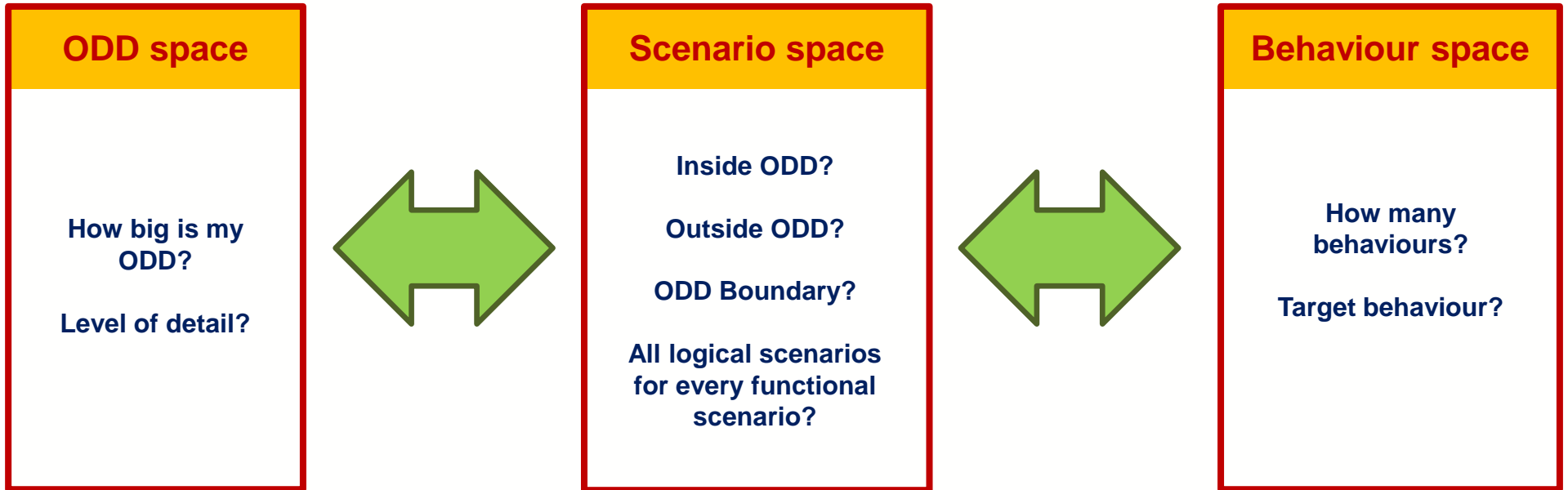


Distributed ODD attribute Value Awareness (DOVA)

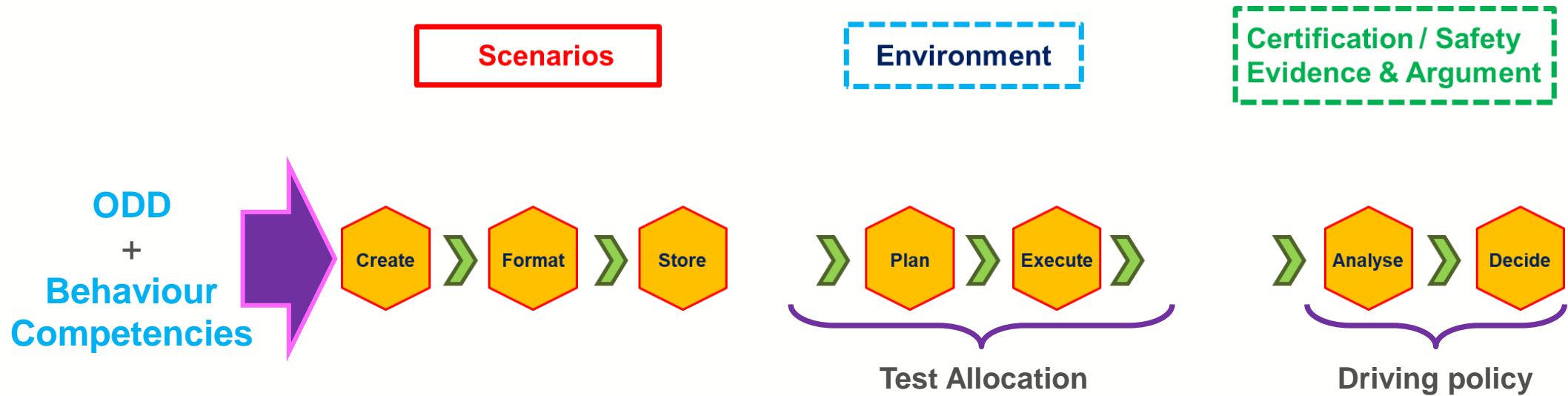
- Road works (planned)
- Road closures
- How do we address the **temporal aspect** of their existence?
- Can an ADS measure by **on-board sensing only**?



Understanding Coverage...

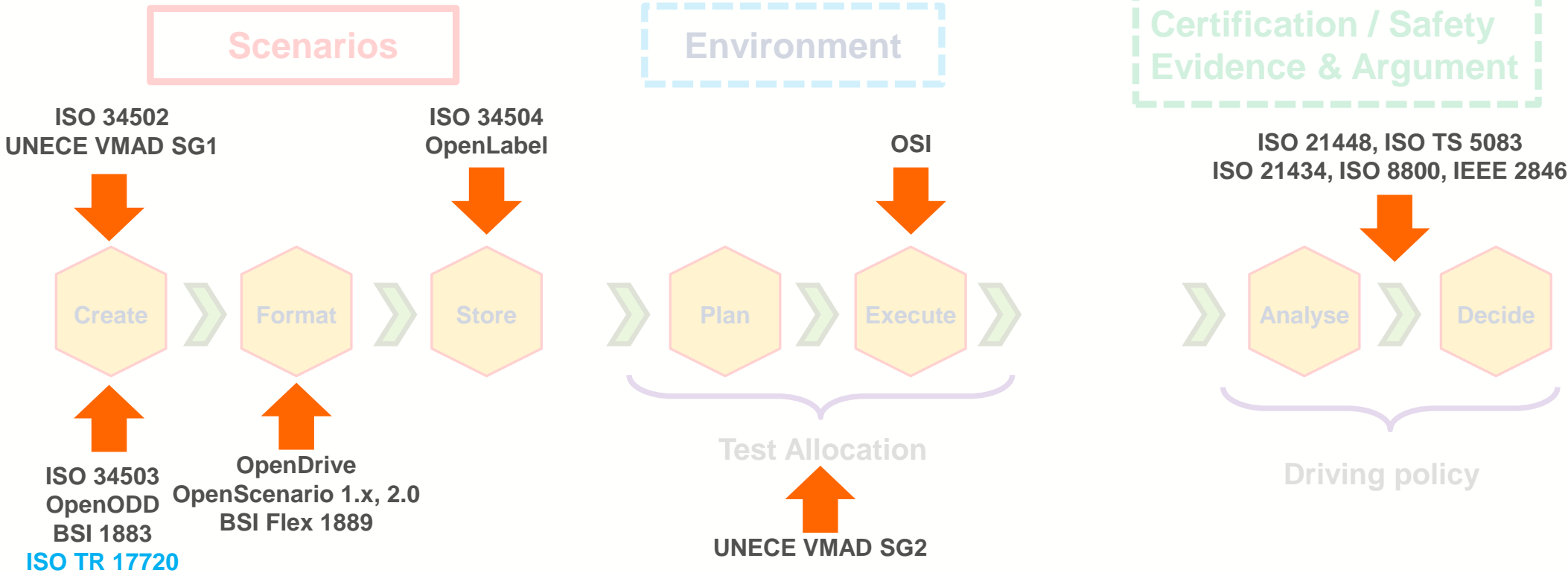


Understanding Coverage...

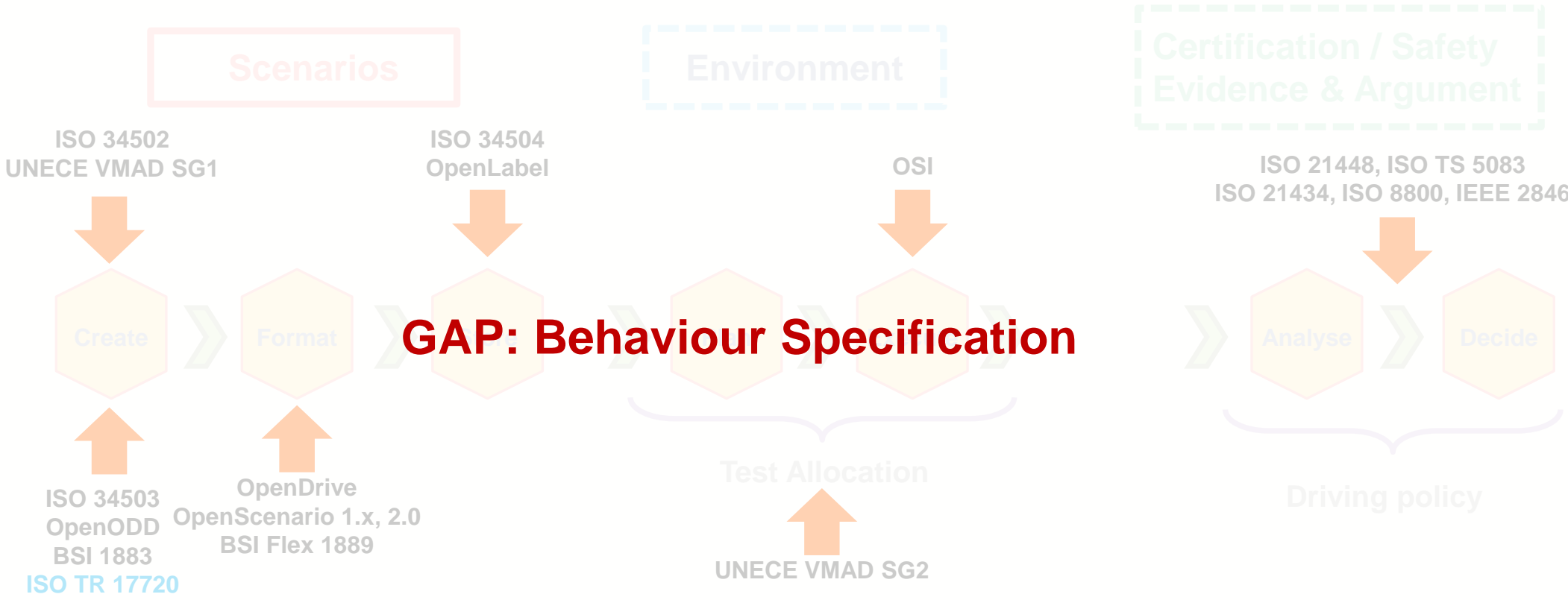


Standards and Tools!

Understanding Coverage...



Understanding Coverage...



Summary

Each aspect of testing framework of Automated Driving Systems needs to understand & act on its relationship with ODD!

ODD and scenarios are related **but not the same**.

ODD departures could be **planned/unplanned** or **fixed/unfixed**. ODD Boundary is binary but could have a **temporal aspect**.

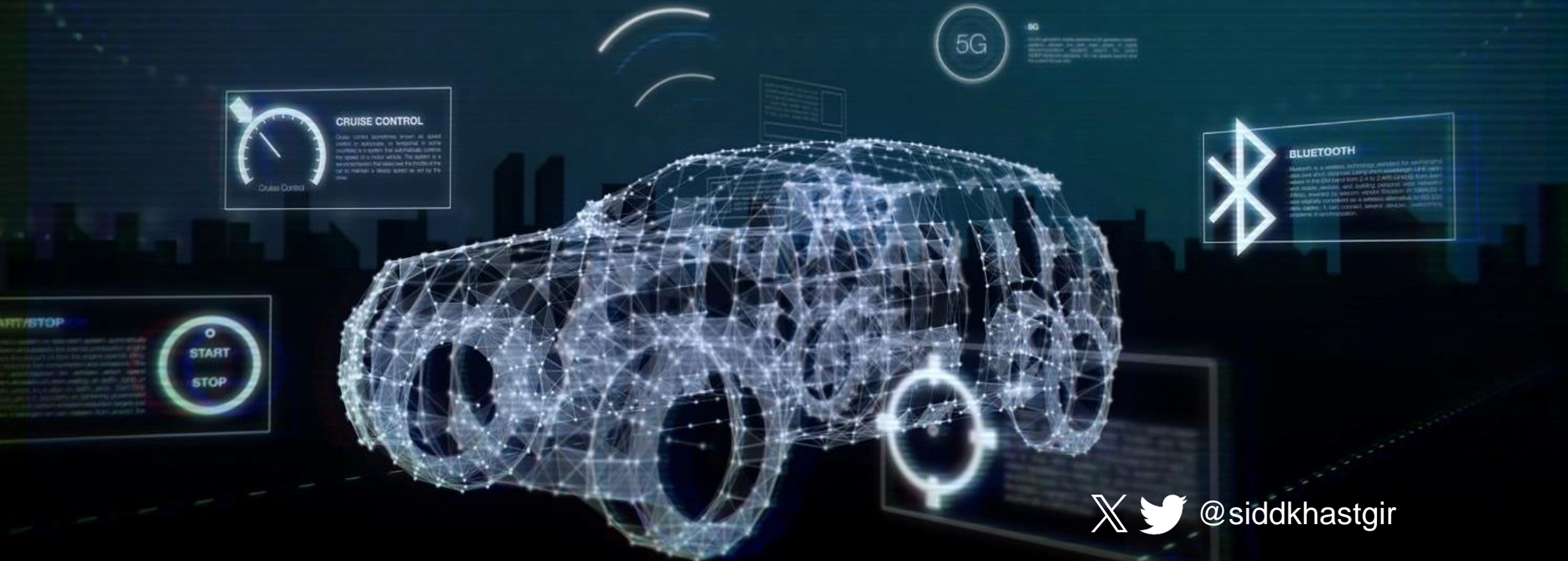
ODD Attribute Value Awareness concept needs to be implemented.

Coverage based on both ODD and Behaviour.

Success will be dependent upon suitable collaboration and data sharing, and **common understanding** nationally and internationally.



Thank you... Discussions...



X  @siddkhastgir

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