Understanding ODD: What it is and isn't!
ISO 34503 perspective

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THE UNIVERSITY OF WARWICK

ISO 34503: Motivation

Full title:

Road Vehicles - Taxonomy for Operational Design Domain for an Automated Driving System

Why is ODD important?

- Number of miles driven?
- Types of scenarios experienced?

≠

ISO 34503: Background and Current Status

Full title:

Road Vehicles - Taxonomy for Operational Design Domain for an Automated Driving System

ISO 34503: Background and Current Status

Full title:

Road Vehicles - Taxonomy for Operational Design Domain for an Automated Driving System

- Under the aegis of ISO TC22 SC33 WG9
- Sep 2019 Kick-off
- **Experts from all over the world**
- **DIS stage** – Draft International Standard (publicly available)

ISO 34503: Scope

*"This document specifies the **requirements for the hierarchical taxonomy** for specifying operating conditions which enable the definition of an Operational Design Domain (ODD) of an Automated Driving System (ADS). This document also specifies **requirements for the definition format** of an ODD using the taxonomy. The ODD comprises specific conditions (which include the static and dynamic attributes) within which an ADS is designed to function…."*

ISO 34503: Scope

*"This document specifies the **requirements for the hierarchical taxonomy** for specifying operating conditions which enable the definition of an Operational Design Domain (ODD) of an Au… req… tax… the… des…*

*"….for use by organizations taking part in developing safety cases for automated vehicle, …, for organizations **conducting trials, testing and commercial deployment**…. also for use by **manufacturers of Level 3/4 ADS** to define the ADS' operating capability.*

ISO 34503: Scope

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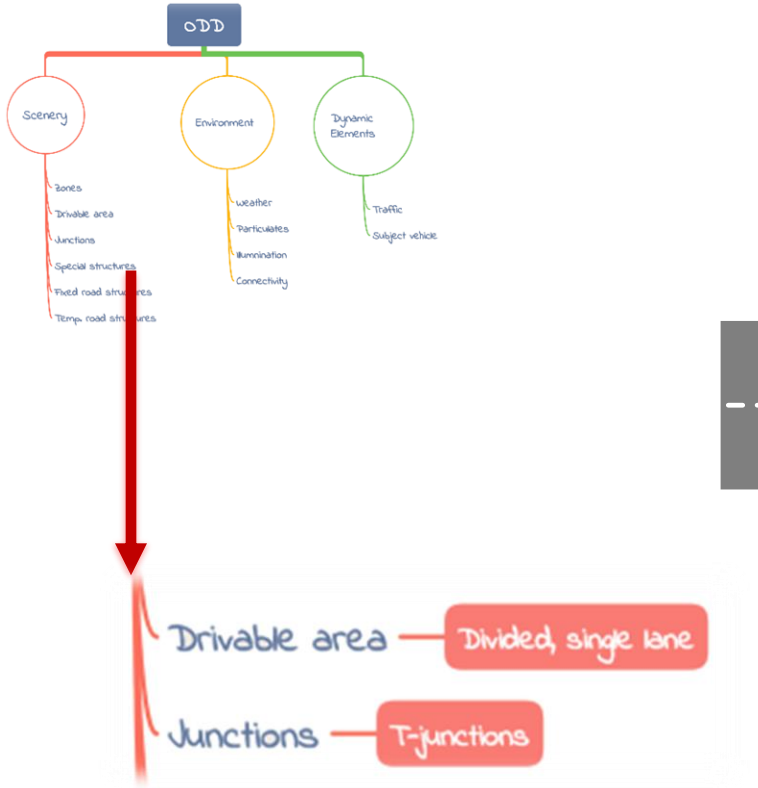
*"….for use by organizations taking part in developing safety cases for automated vehicle, …, for organizations **conducting trials, testing and commercial deployment**…. also for use by **manufacturers of Level 3/4 ADS** to define the ADS' operating capa…*

*"….It is also of interest to **insurers, regulators, service providers, national, local and regional governments** to enable them to understand possible ADS deployments and capabilities…."*

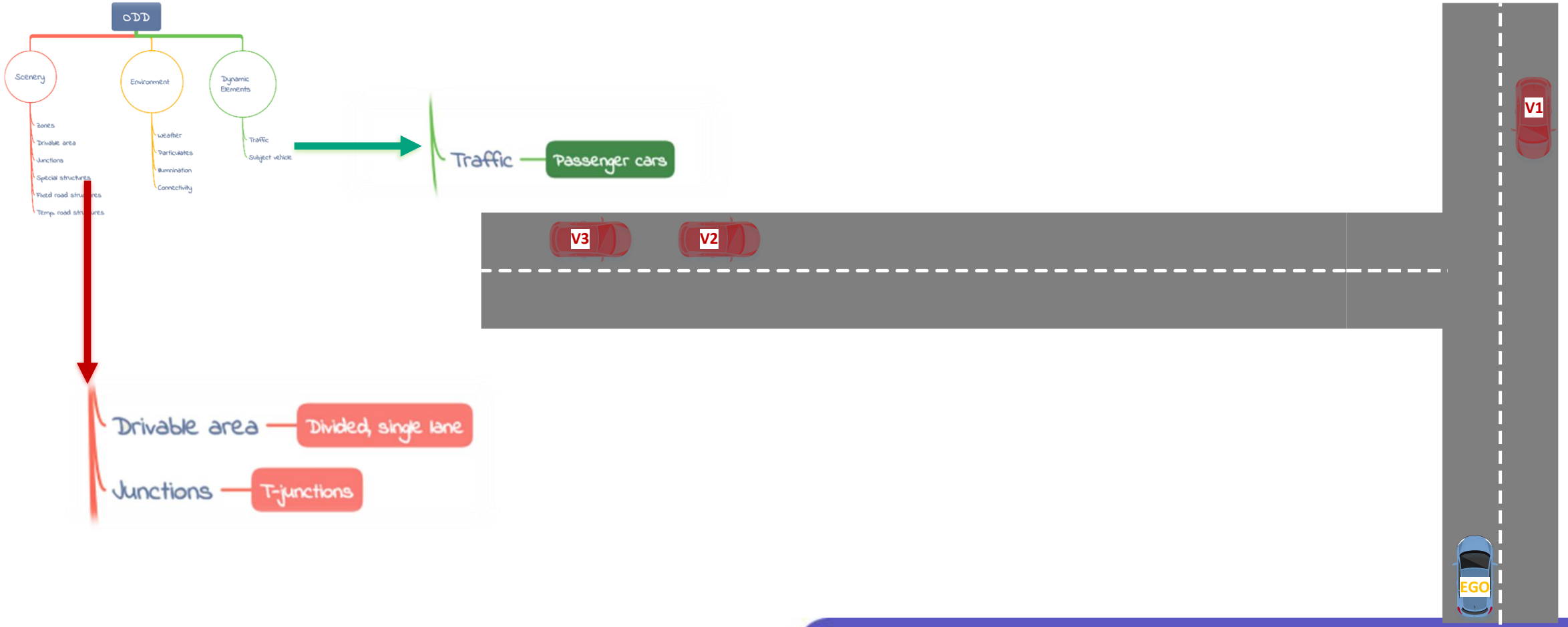
ODD, Scenarios and more…

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

ISO 34503: ODD and Scenario



ISO 34503: ODD and Scenario



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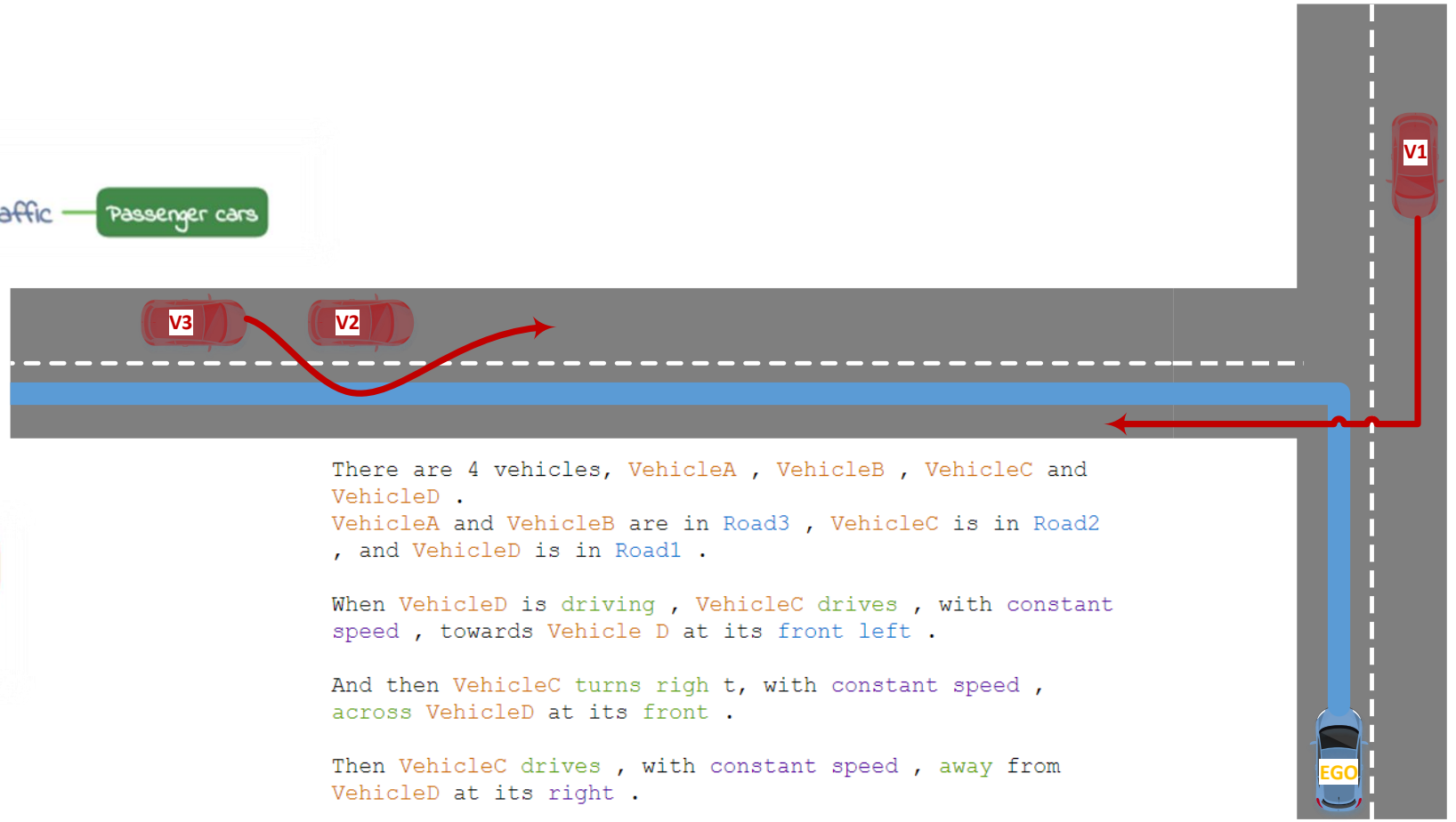


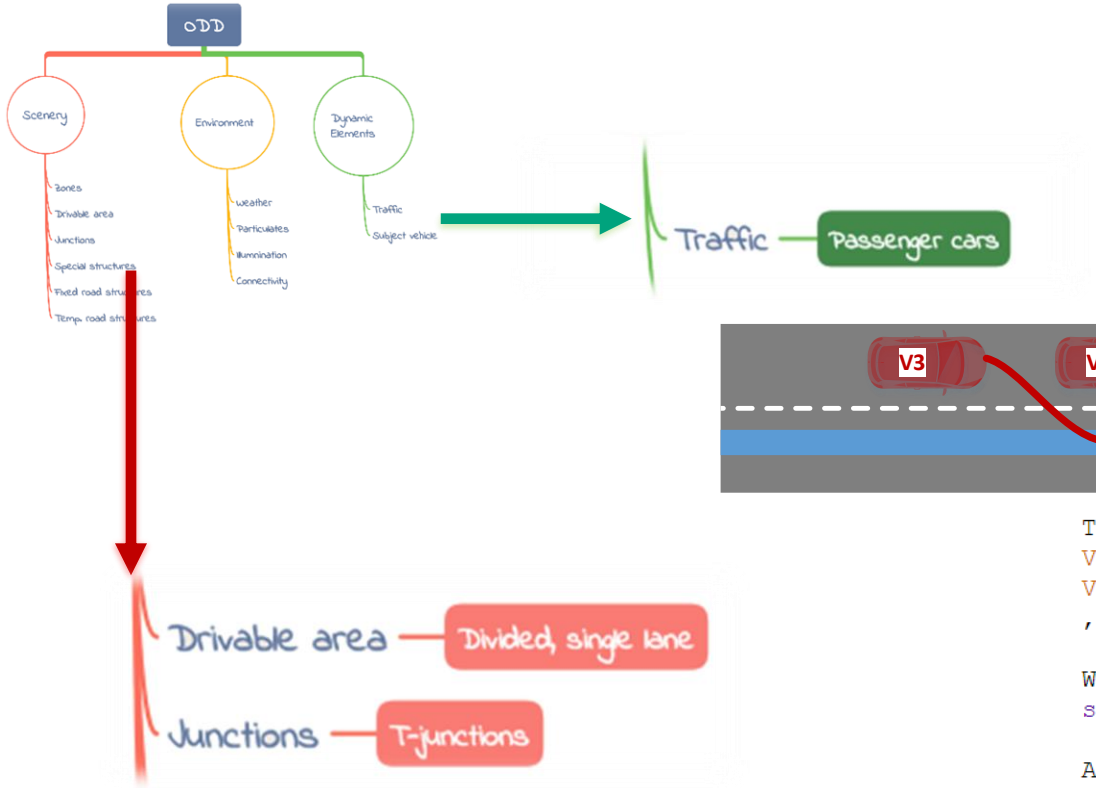
There are 4 vehicles, VehicleA , VehicleB , VehicleC and VehicleD .
VehicleA and VehicleB are in Road3 , VehicleC is in Road2 , and VehicleD is in Road1 .

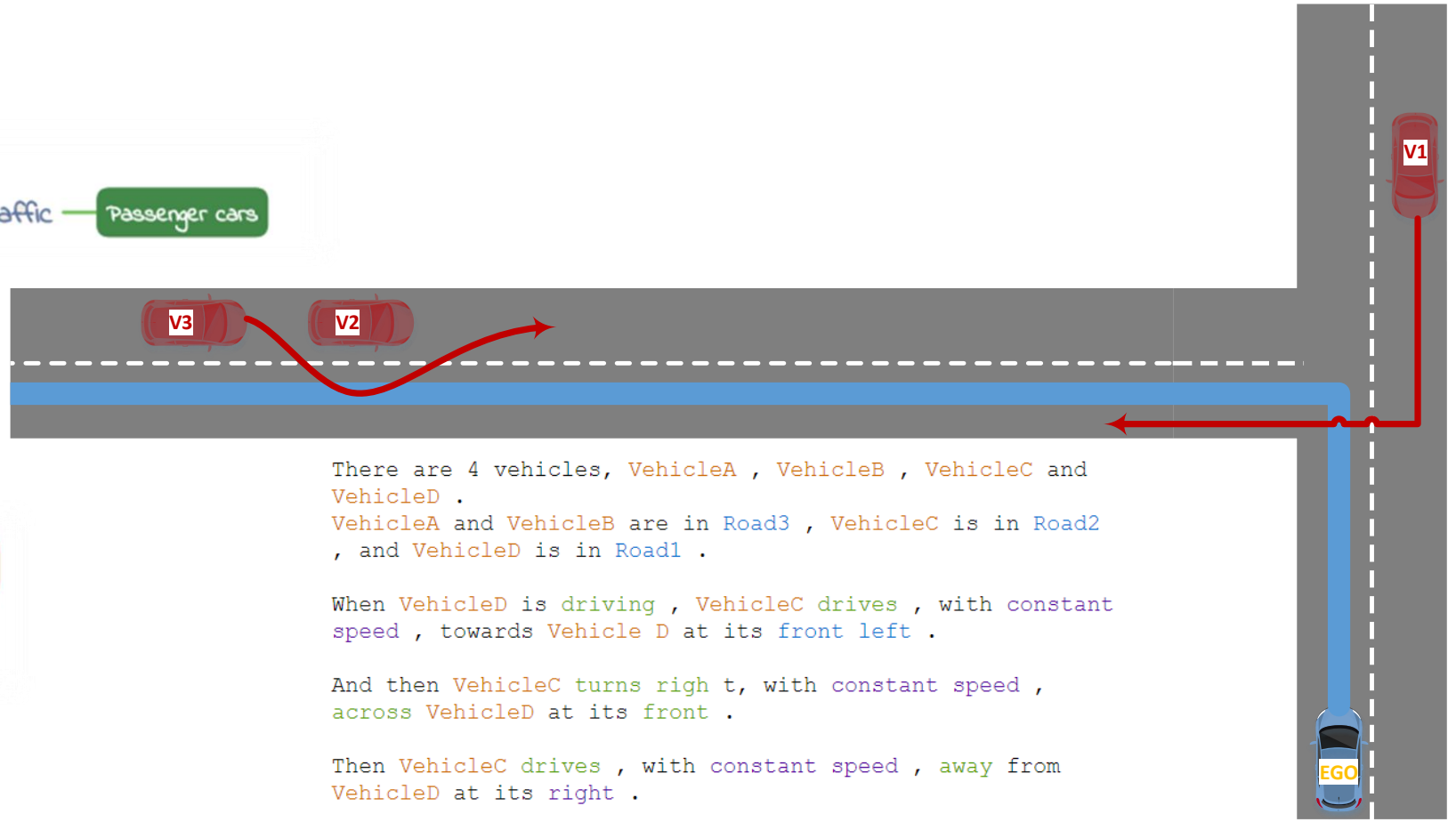
When VehicleD is driving , VehicleC drives , with constant speed , towards Vehicle D at its front left .

And then VehicleC turns righ t, with constant speed , across VehicleD at its front .

Then VehicleC drives , with constant speed , away from VehicleD at its right .

ISO 34503: ODD and Scenario





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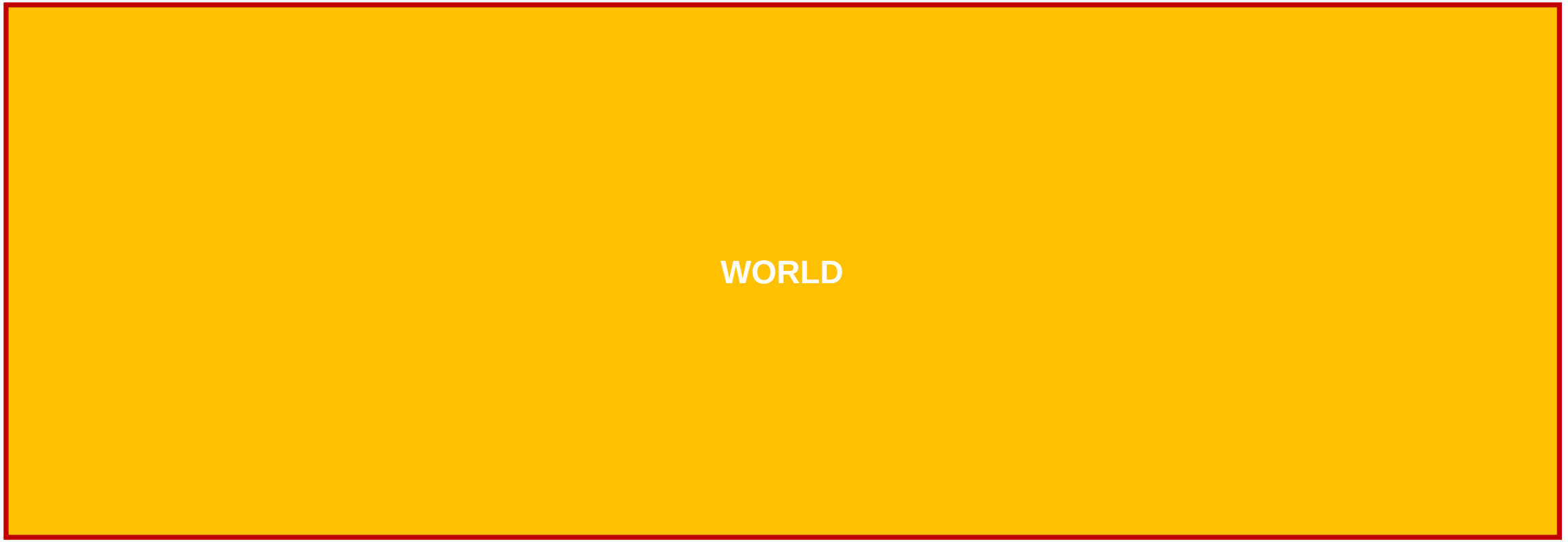
ODD and Operational Domain (OD)



ODD and Operational Domain (OD)

ODD and Operational Domain (OD)

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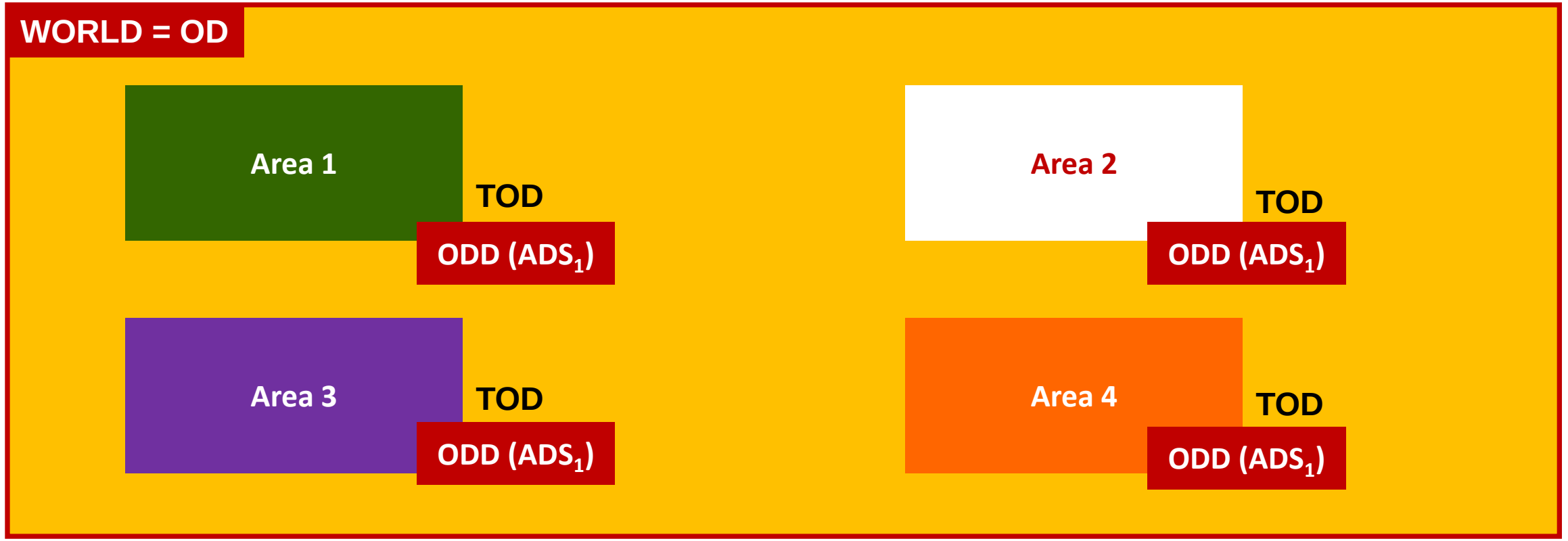
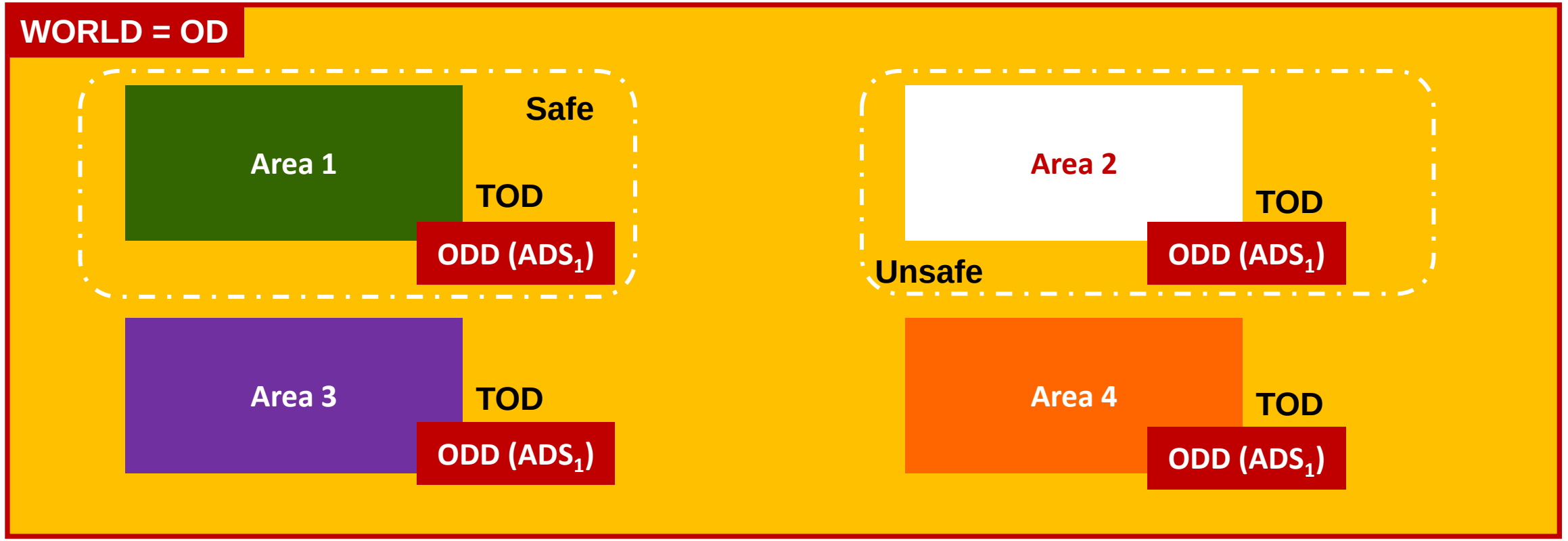


ODD (ADS$_1$) = Safe

ODD and Operational Domain (OD)



ODD (ADS_1) = Safe

ISO 34503: Doc structure

Contents

Foreword

Introduction

1 Scope

2 Normative references

3 Terms and definitions

4 Symbols (and abbreviated terms)

5 Operational Design Domain (ODD) and Target Operational Domain (TOD)

6 ODD and scenario relationship

7 ODD requirements and application

8 ODD Taxonomy

9 Scenery elements

10 Environmental conditions

11 Dynamic elements

12 ODD definition format

ISO 34503: Doc structure

Contents

Foreword .....

Introduction .....

1 Scope .....

2 N

3 T

4 S

5 O

6 O

7 ODD requirements and application .....

8 ODD Taxonomy .....

9 Scenery elements .....

10 Environmental conditions .....

11 Dynamic elements .....

12 ODD definition format .....

ODD & Scenario Concepts

5 Operational Design Domain (ODD) and Target Operational Domain (TOD) .....

6 ODD and scenario relationship .....

7 ODD requirements and application .....

ISO 34503: Doc structure

Contents

Foreword

Introduction

1 Scope

2 N

3 T

4 Sy

5 O

6 O

7 ODD req

8 ODD Tax

9 Scenery

10 Environ

11 Dynamic elements

12 ODD definition format

5 Operational Design Domain (ODD) and Target Operational Domain (TOD)

6 ODD and scenario relationship

7

ODD Taxonomy

8 ODD Taxonomy

9 Scenery elements

10 Environmental conditions

11 Dynamic elements

ISO 34503: Doc structure

Contents

Foreword

Introduction

1 Scope

2 N

3 T

4 Sy

5 O

6 O

7 ODD req

8 ODD Tax

9 Scenery

10 Environm

11 Dynamic elements

12 ODD definition format

5 Operational Design Domain (ODD) and Target Operational Domain (TOD)

6 ODD and scenario relationship

7

8 ODD Taxonomy

9 Scenery elements

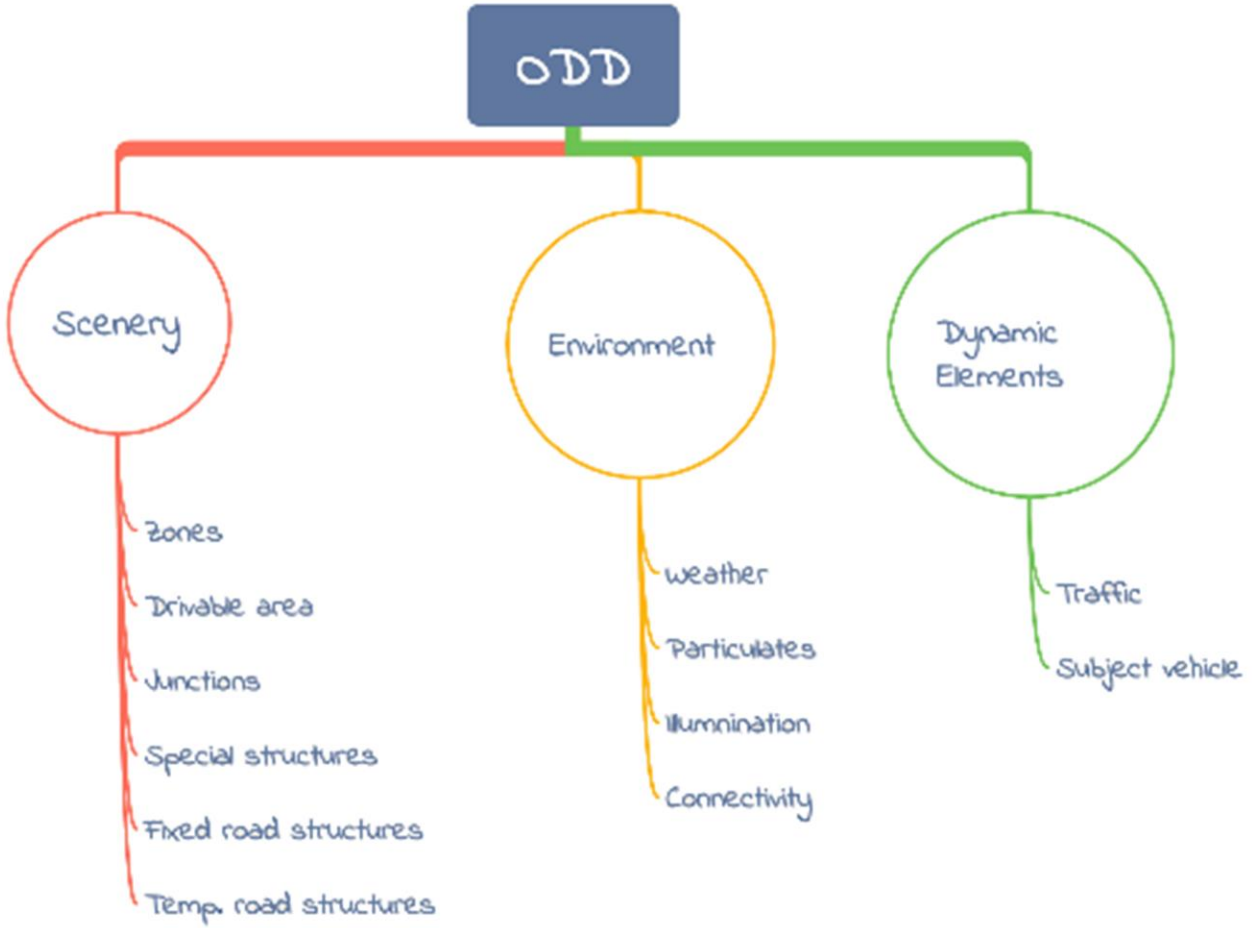
10 Environmental conditions

11 Dynamic elements

ODD Format

12 ODD definition format

ISO 34503: Taxonomy



ISO 34503: Format

- **Definition Format Type**
  - Permissive
  - Restrictive
  - Default (don’t care)
- **Human readability**
- **Qualifiers** (include, exclude and conditional)

ISO 34503: Format

- **Definition Format Type**
  - Permissive
  - Restrictive
  - Default (don't care)

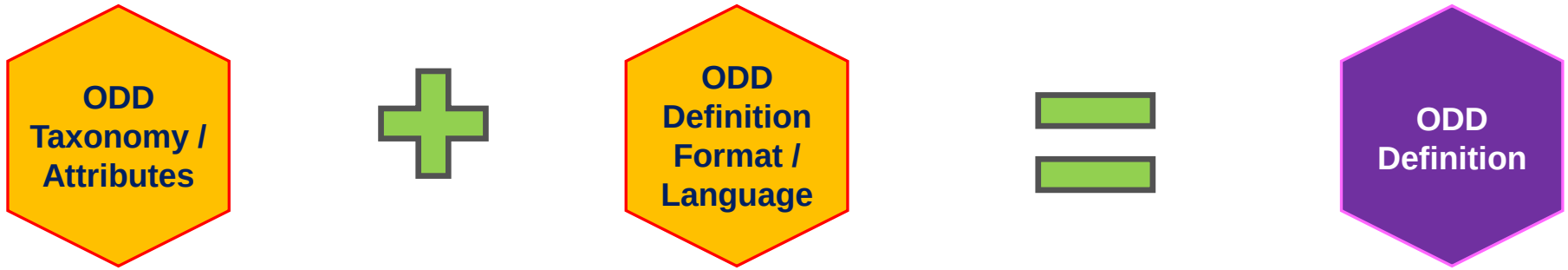
```
#Composition statements
Include geofenced areas is [predefined route]
Include regions or states is [Ottawa Canada]
Include zones are [regions or states, geofenced areas]
Cond_1 Conditional drivable area type are [minor roads, parking, shared space]
Cond_2 Conditional horizontal plane is [curved roads]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

```
#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]
```

- **Human readability**

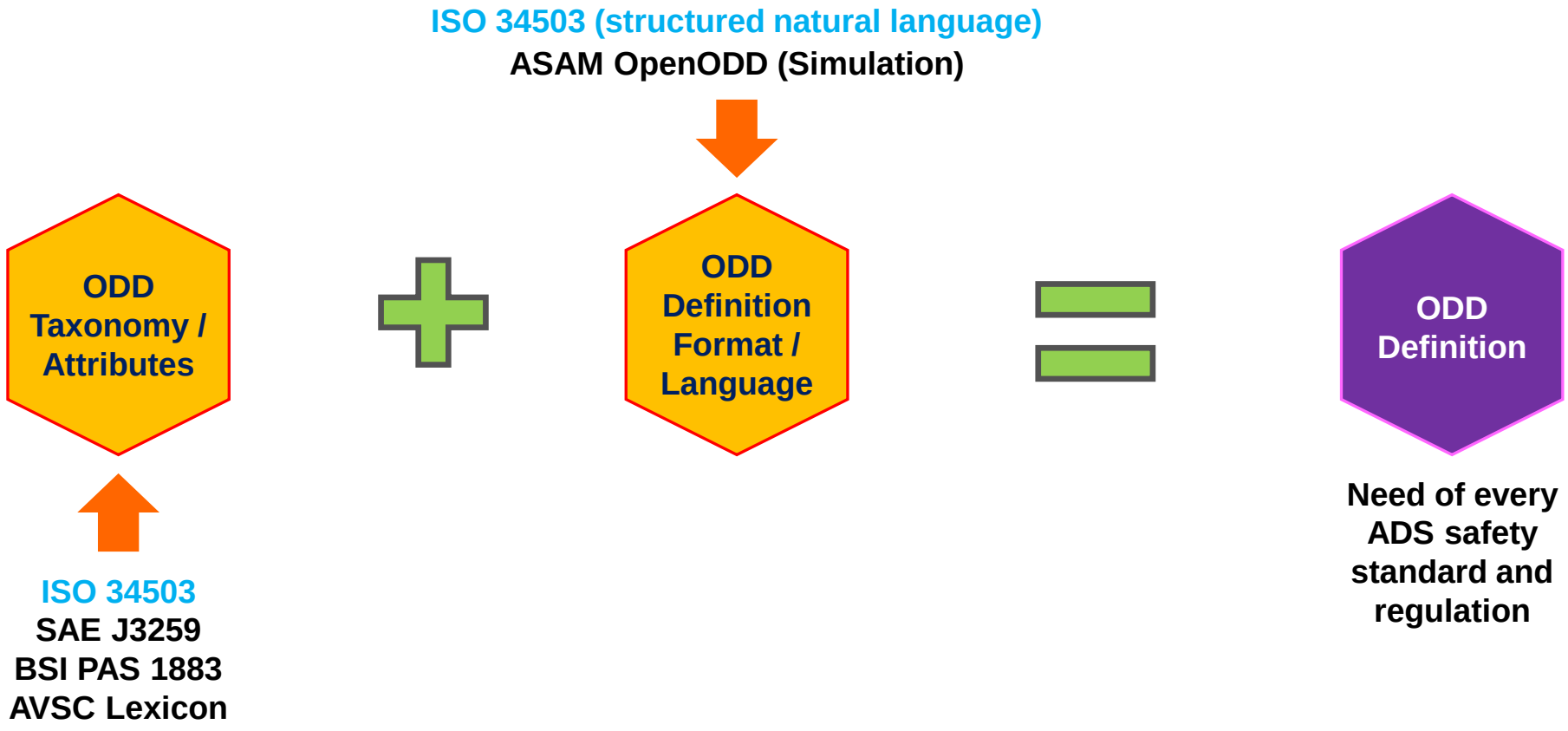
- **Qualifiers** (include, exclude and conditional)

ODD Definition: Bringing things together…



Need of every ADS safety standard and regulation

ODD Definition: Bringing things together…



Summary

- Each aspect of safety assurance of ADS needs to consider its relationship with ODD.

- ISO 34503 will provide:
  - A **hierarchical taxonomy** for ODD definition
  - **Structured natural language format** for ODD definition
  - Clarification on **difference between ODD and scenarios**

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

Thank you…
Discussion…

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ODD based Safety Assurance for Automated Driving Systems

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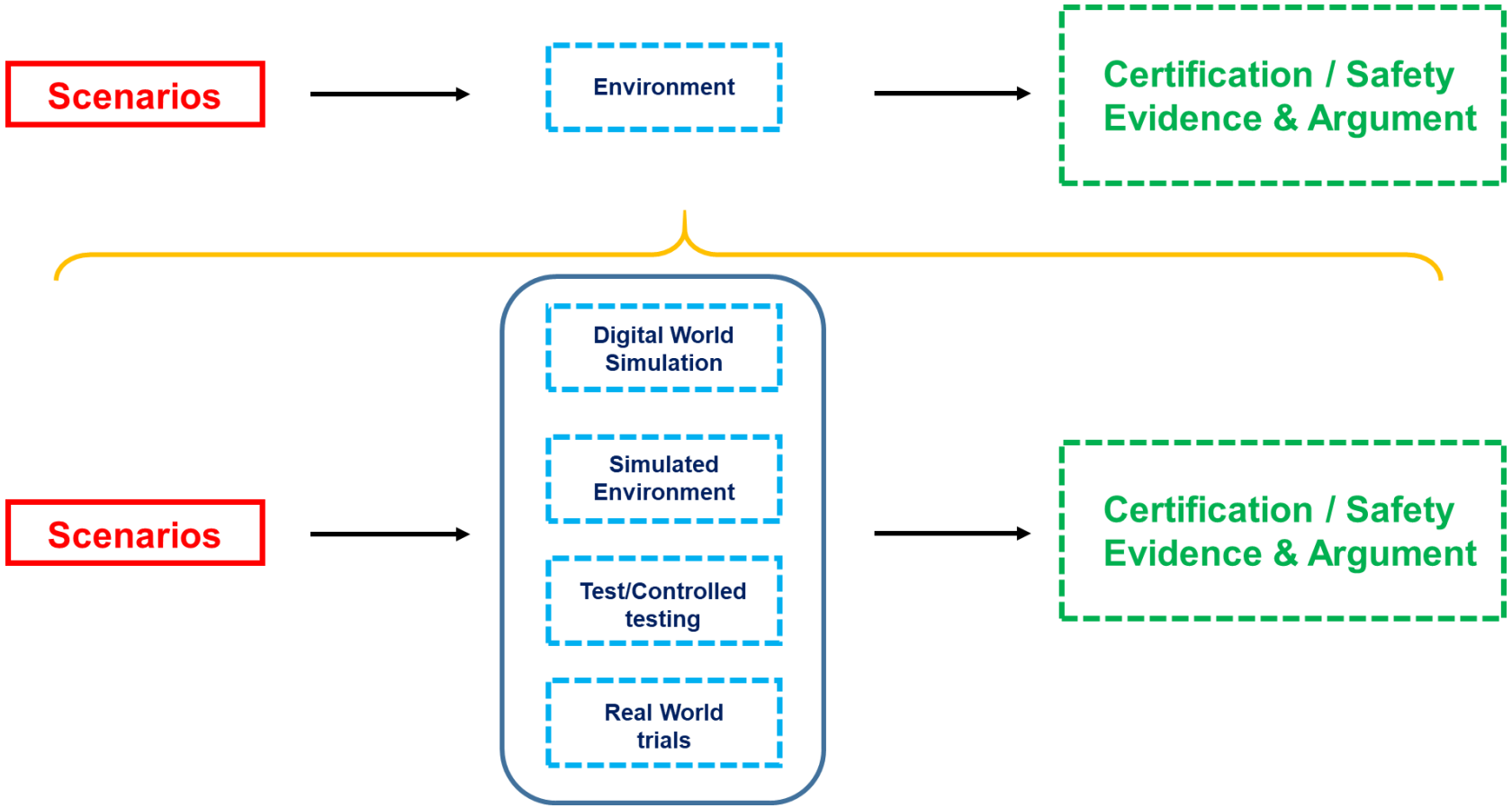
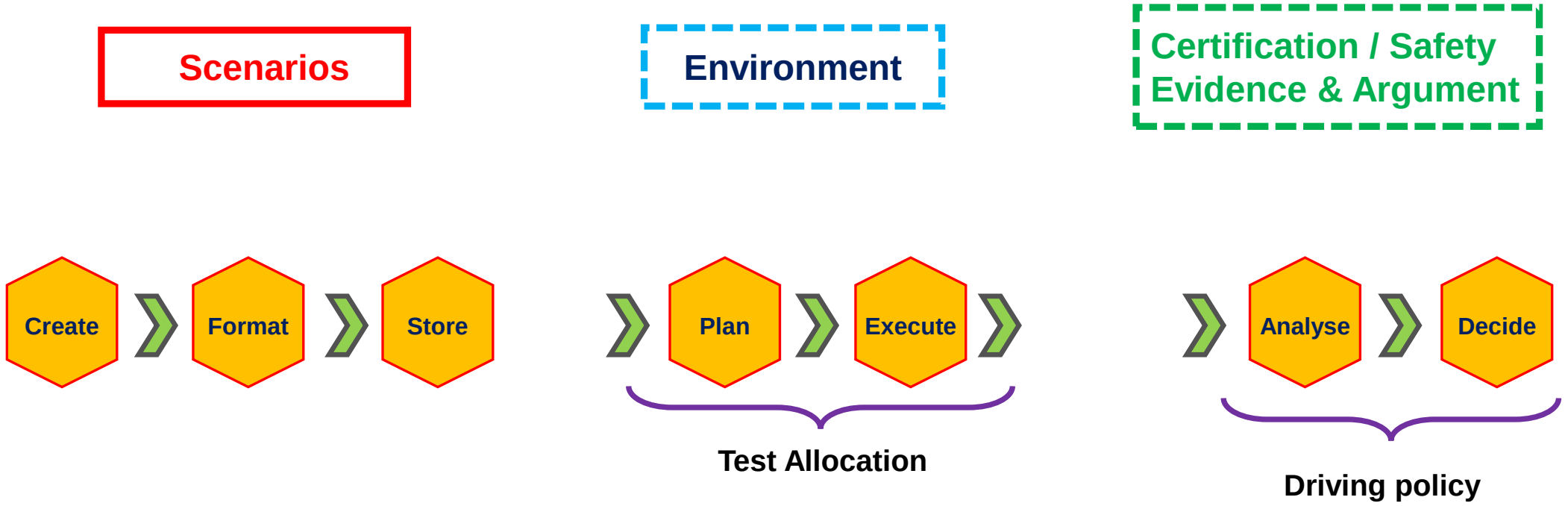
THE UNIVERSITY OF WARWICK

Evaluation Continuum

Evaluation Continuum



Evaluation Continuum



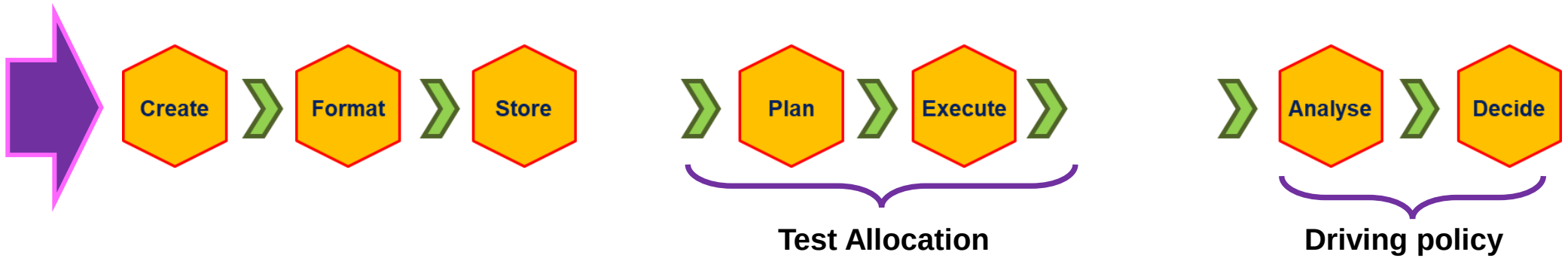
ODD Based Scalable Safety Assurance Framework

Scenarios

Environment

Certification / Safety Evidence & Argument

ODD
+
Behaviour Competencies



Evaluation Continuum

Scenarios

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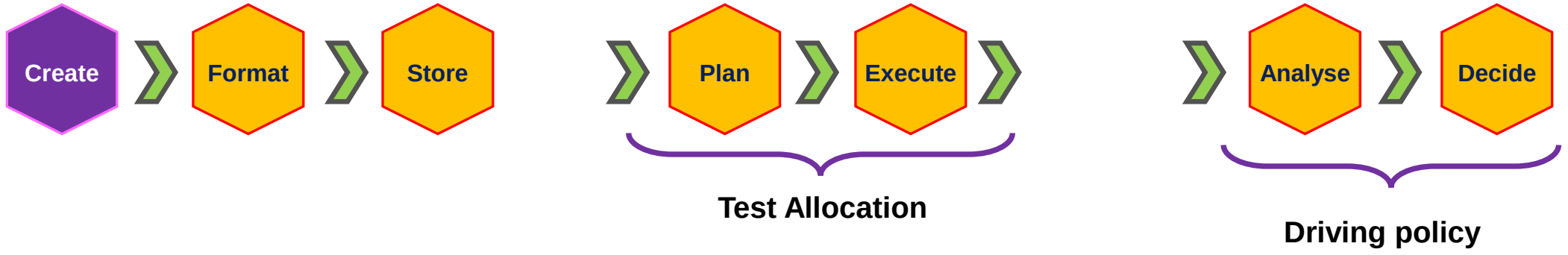
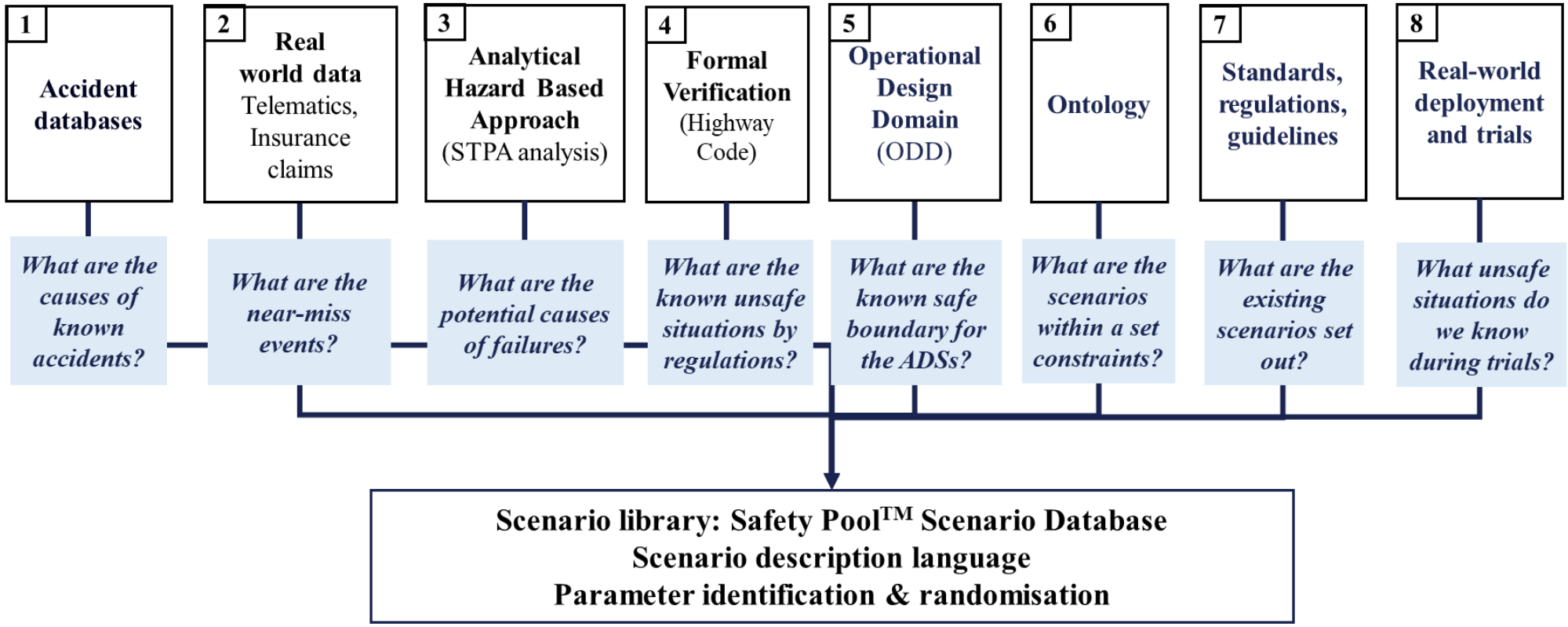
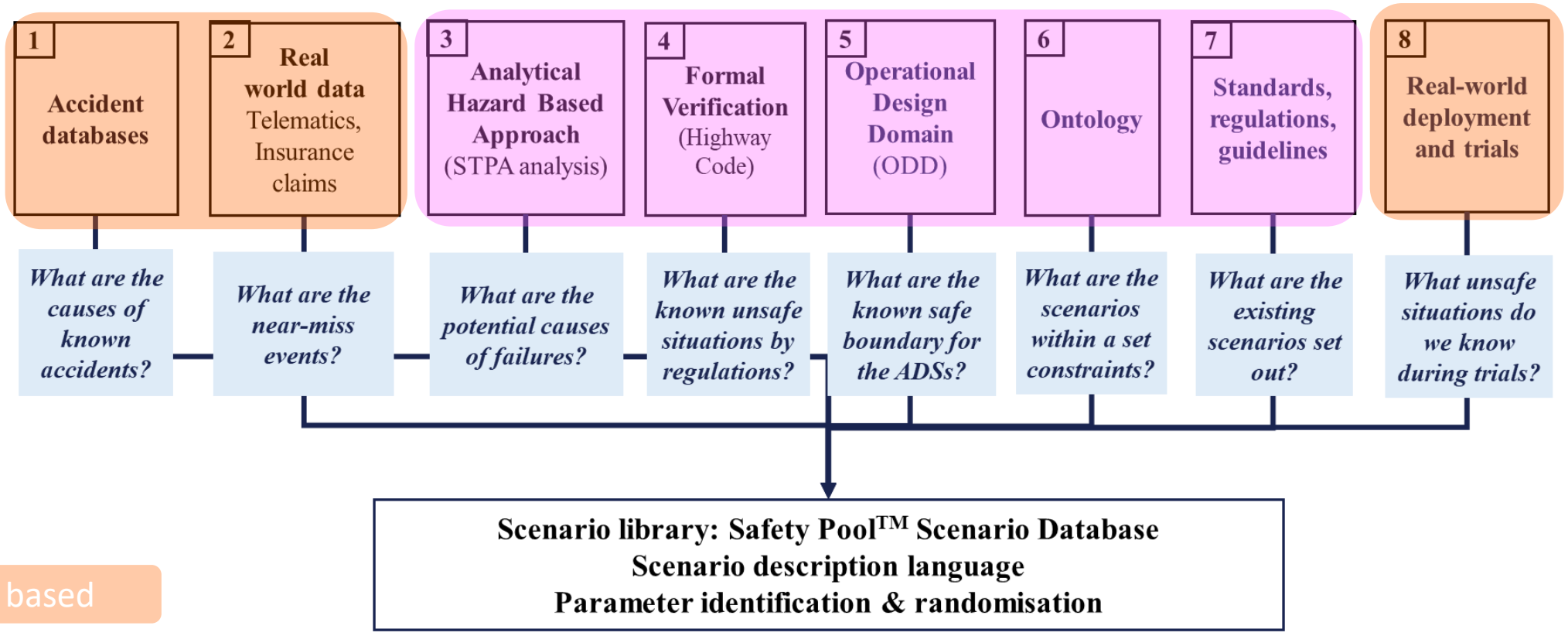
Certification / Safety Evidence & Argument



Scenario: Create



Scenario: Create



Data based

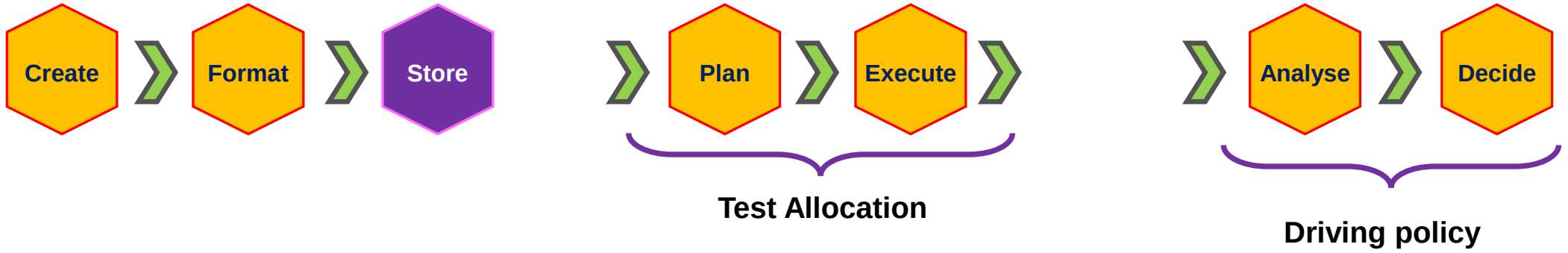
Knowledge based

Evaluation Continuum

Scenarios

Environment

Certification / Safety Evidence & Argument



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WMG

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- Libraries
- Test Suites
- Testbeds
- Users
- Roles
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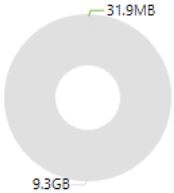

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Quota used: 0%

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Maximum Active Users

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File Storage Quota

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- Scenarios
- Libraries
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- Settings
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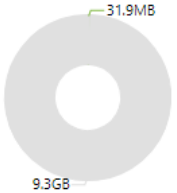

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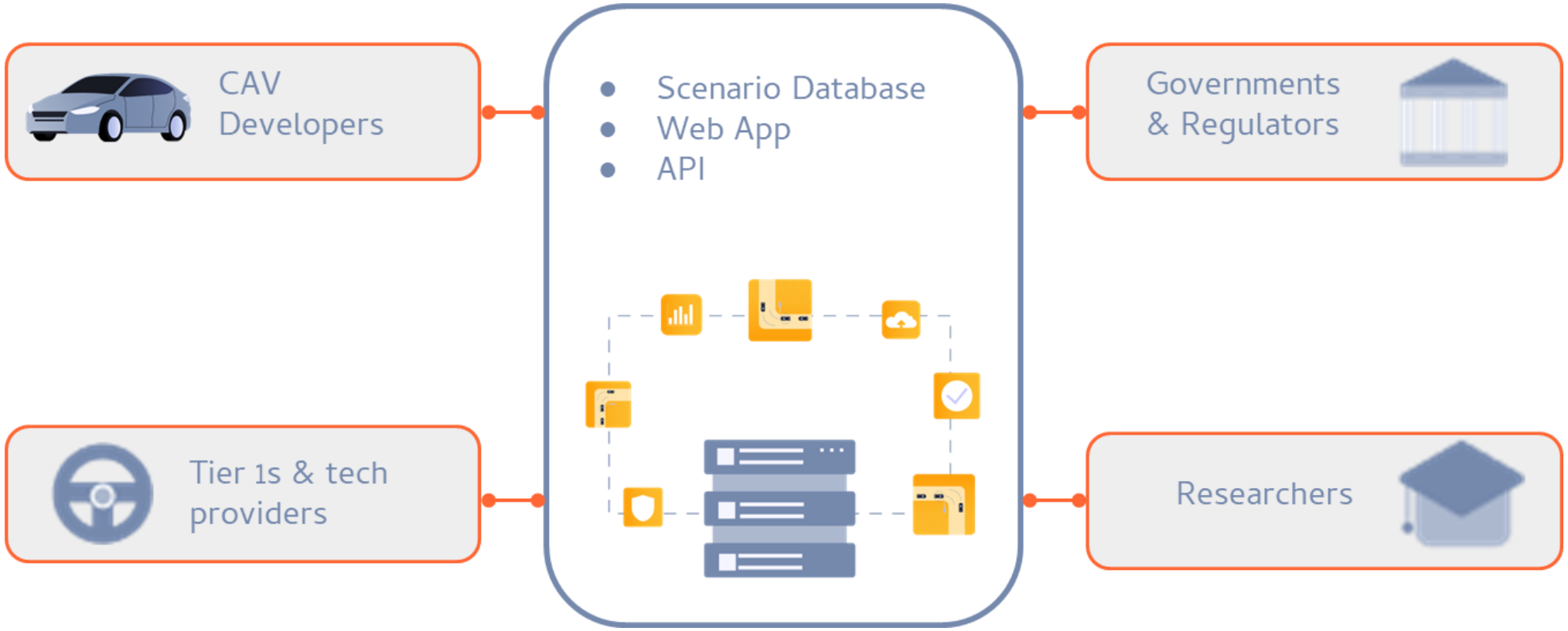
What is the Safety Pool™ Scenario Database?



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- Home
- Scenarios
- Libraries
- Test Suites
- Testbeds
- Users
- Roles
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- Audit Log

← Scenario

Download | Add to Test Suite

stat19_1_82482

Tags | Definition | Files | Route Locations | Versions

Scenery

- Broken line
- Contaminated
- Drive on left
- Lane dimensions [Width (m): 3.4 to 3.7]
- Level plane
- Normal roundabout
- Number of lanes [Lanes: 2]
- Radial road
- Shoulder (grass)
- Straights
- Traffic lane
- Undivided road
- Uniform surface

Environmental Conditions

- Cloudiness [Cloud cover (okta): 0 to 1]
- Day
- Sun elevation [Angle (degree): 10 to 30]
- Sun to the right
- Wind [Speed (m/s): 10.8 to 13.8]

Agents

- Cut-in
- Lane change left
- Vehicle

Meta Data

- Fatal collision

General

URN

d025e967-a9eb-452e-bd13-af66ec99a318

Library

STATS-19

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Version

1.0

Home
Scenarios
Libraries
Test Suites
Testbeds
Users
Roles
Settings
Audit Log

← Scenario

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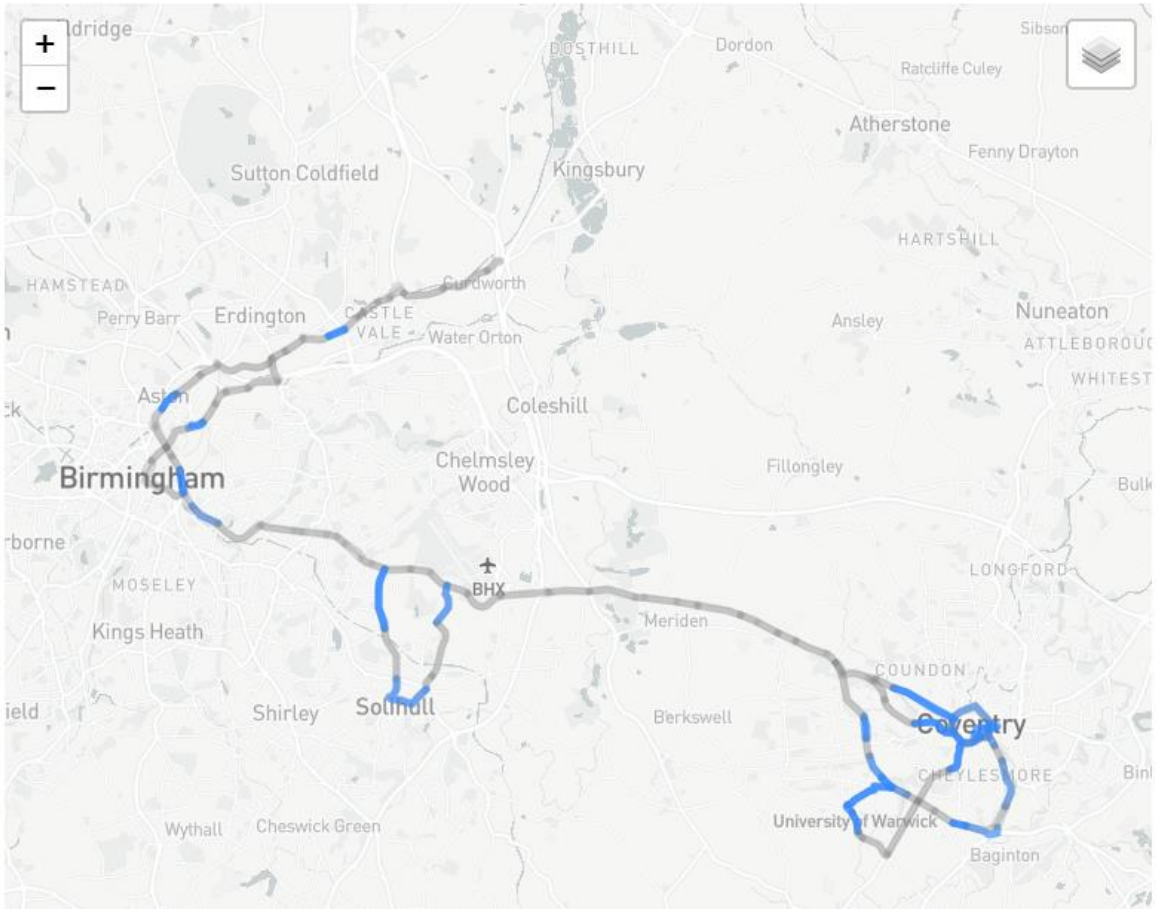
stat19_1_82482

Tags | Definition | Files | Route Locations | Versions

Midlands Future Mobility | Search | 38 possible testing locations found

This testbed does not support all of the tags for this scenario



General

URN

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Library

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1.0

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WMG

- Home
- Scenarios
- Libraries
- Test Suites
- Testbeds
- Users
- Roles
- Settings
- Audit Log

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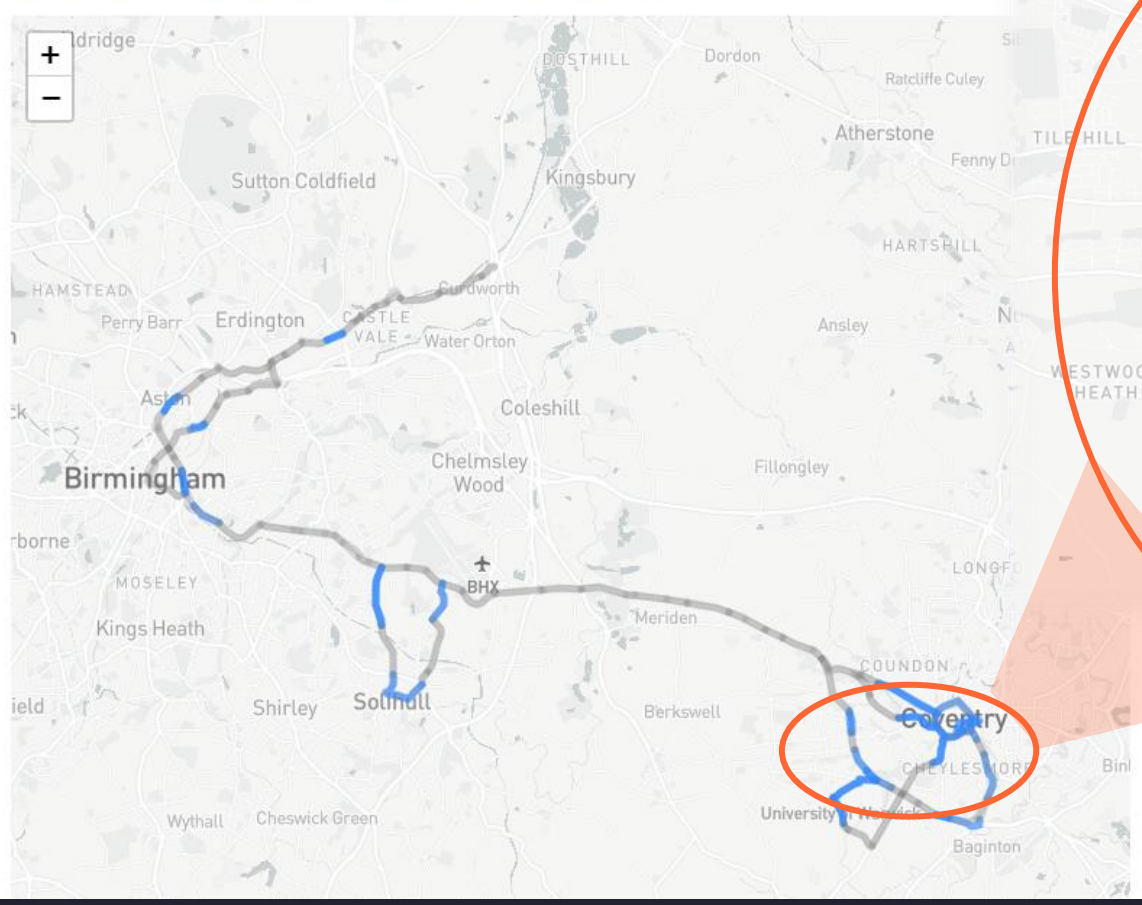

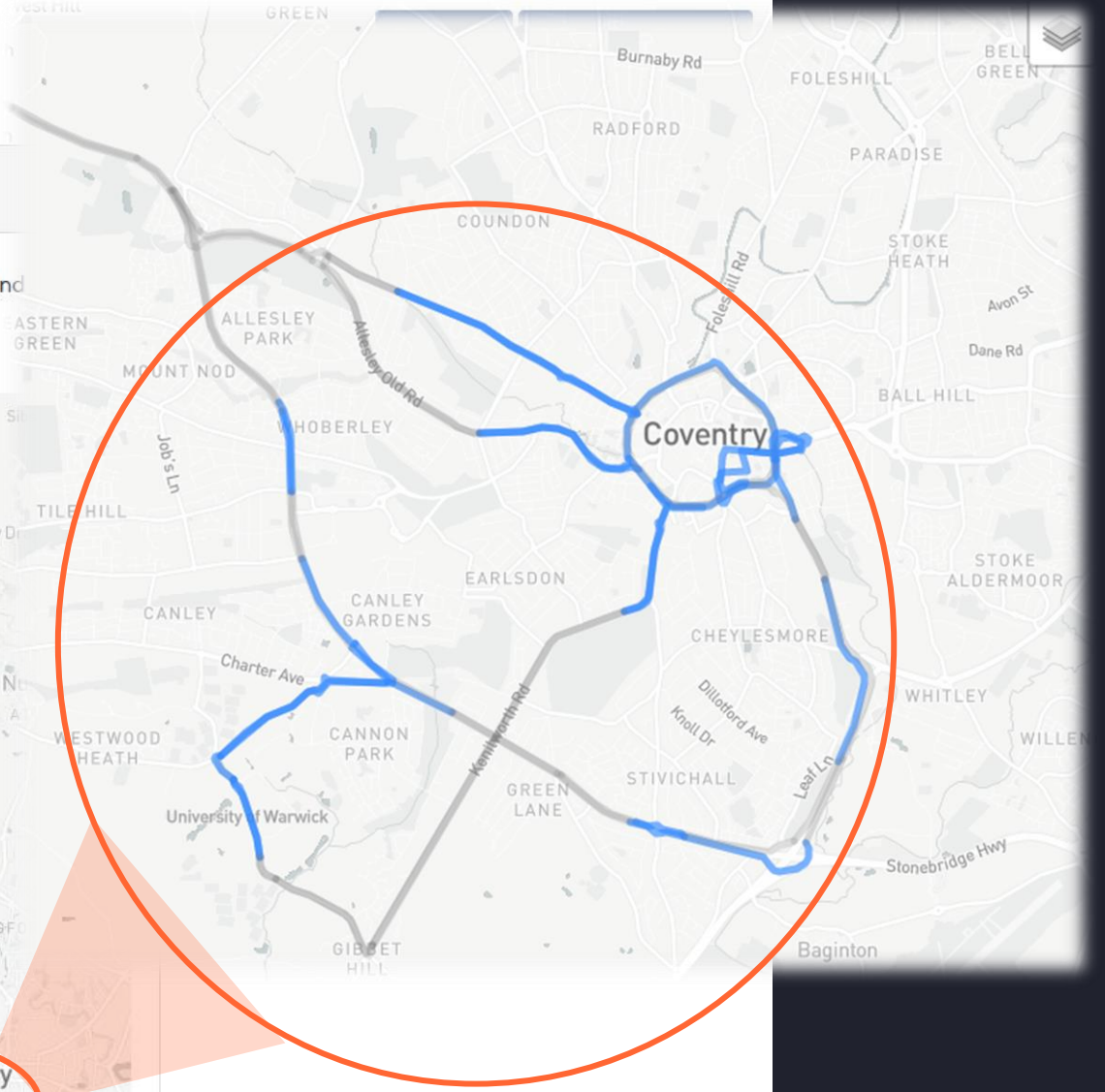

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- Home
- Scenarios
- Libraries
- Test Suites
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- Users
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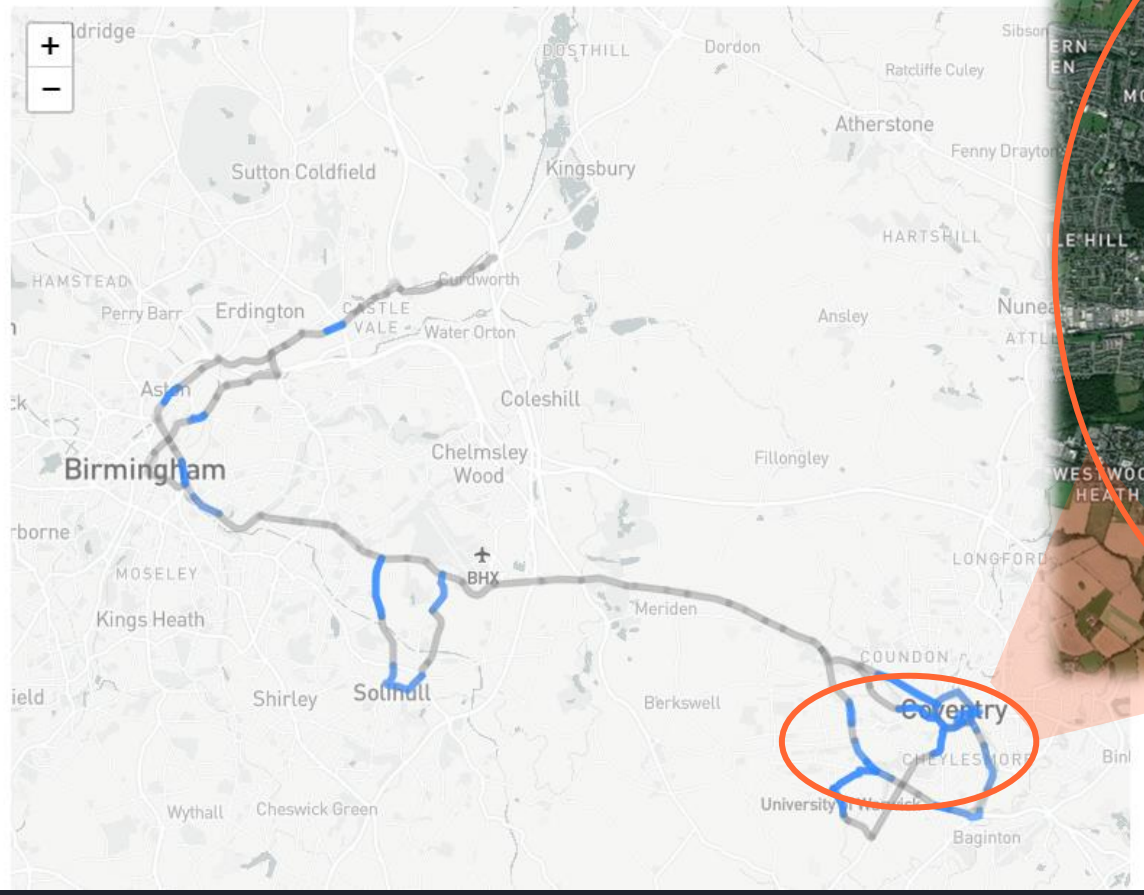

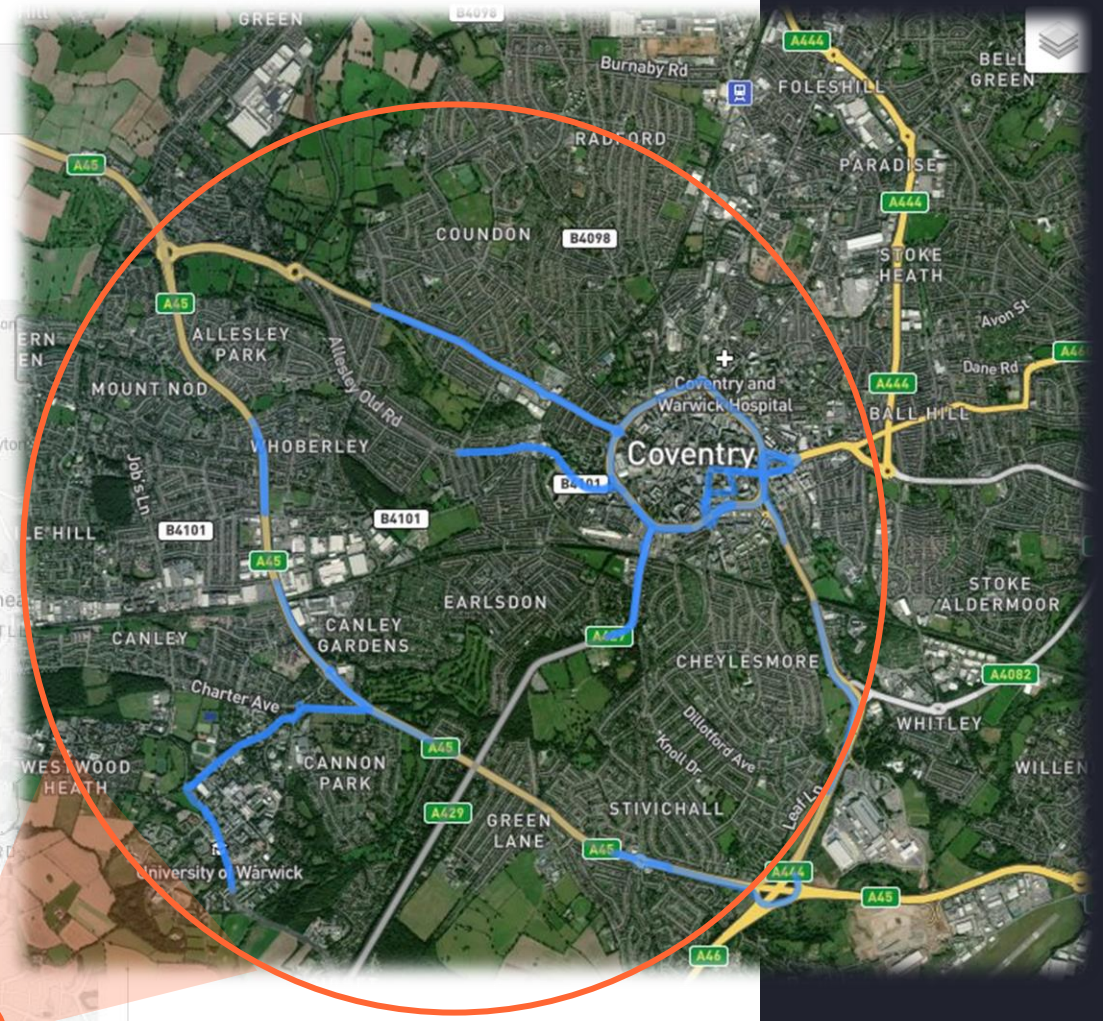

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- Home
- Scenarios
- Libraries
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Midlands Future Mobility | Search | 38 possible

This testbed does not support all of the tags for this scenario

5NW

Gibbet Hill Road/Lord Bhattacharyya Way to Kirby Corner Road/Gibbet Hill Road

- Bus stop
- Curves
- **Number of lanes [Lanes: 1 to 2]**
- Roundabout
- **Shoulder (grass)**
- Shoulder (paved or gravel)
- **Signalised normal roundabout**
- **Splitting lanes**
- **Straights**
- Traffic island
- Uncontrolled crossing
- Vegetation

* matched scenario tags are in **bold**

Street View

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Version

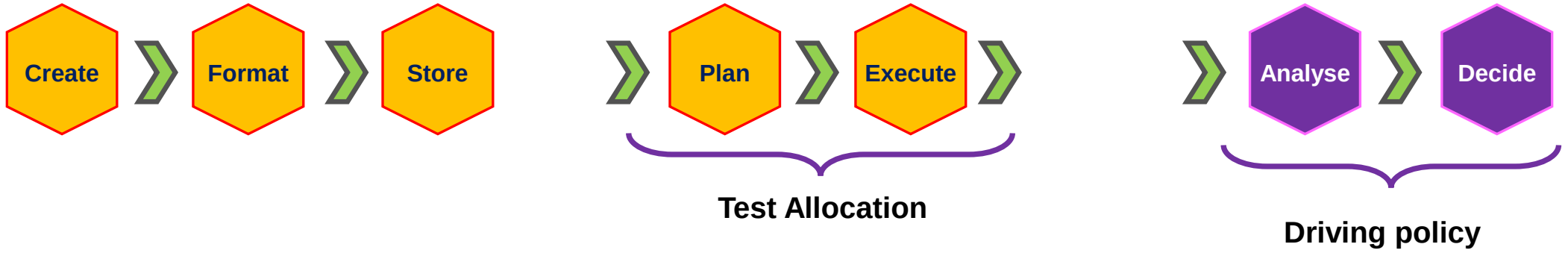
1.0

Evaluation Continuum

Scenarios

Environment

Certification / Safety Evidence & Argument



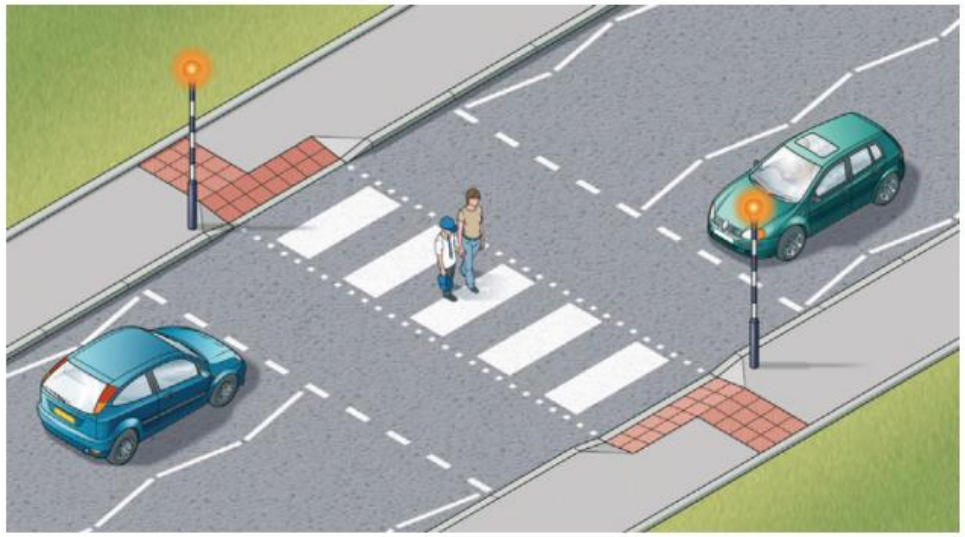
Rules of the Road (for human drivers)

- UK Highway Code (for human drivers) rule defines:
  - Doing some behaviour somewhere
  - NOT doing some behaviour somewhere

- Doing / NOT doing: behaviour competency library
- Somewhere: ODD instantiation

UK Higway 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

Behaviour

ODD

UK Higway Code: Rule 195

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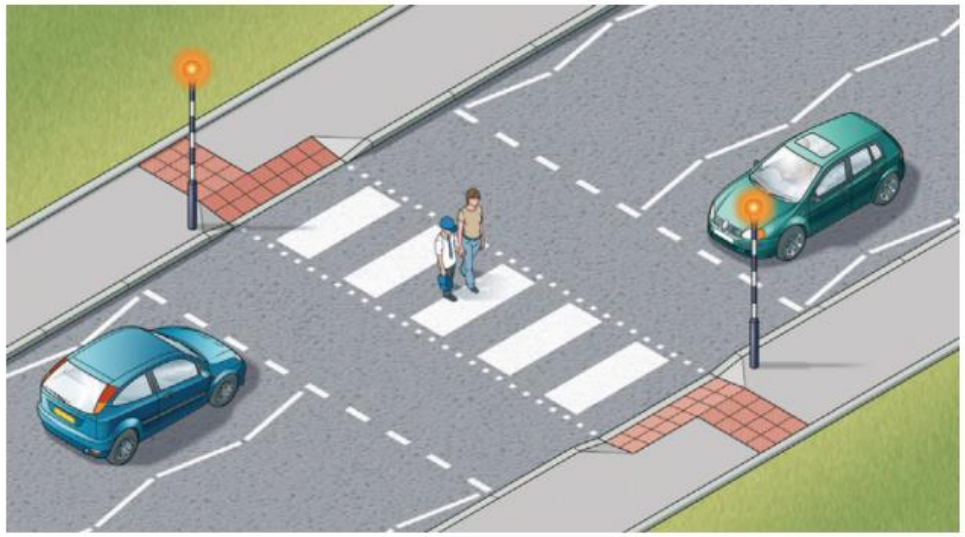


Rule 19: Zebra crossings have flashing beacons

How long to wait?

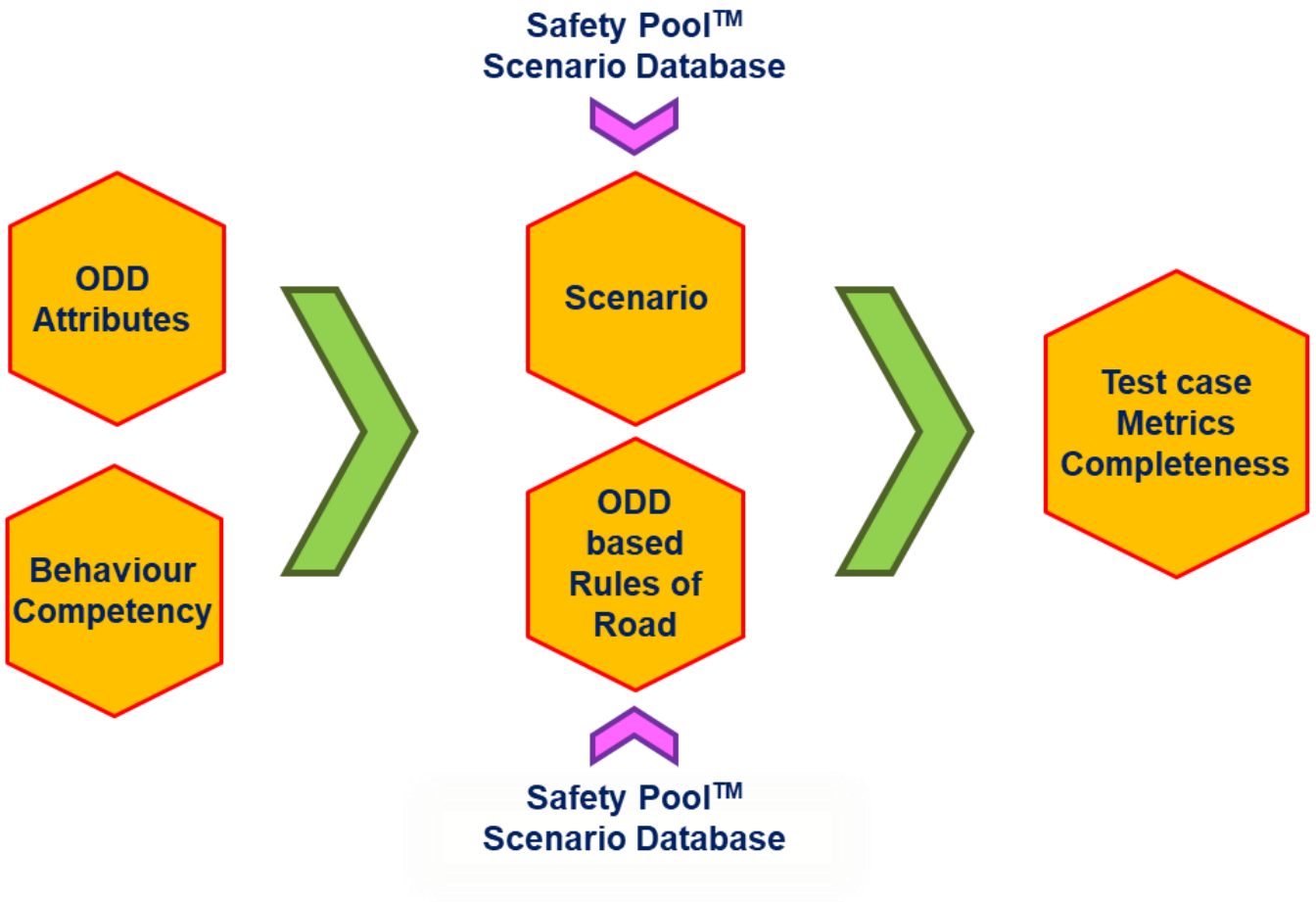
Behaviour | ODD | Assumptions

ODD Based Codified Rules of the Road

Current Rules of Road (for human drivers) = *f(Operating condition, Behaviour competency, Assumptions)*

Codified Rule of the Road = *f(Operating condition, behaviour competency, driving characteristics)*

ODD Based Scalable Safety Assurance Framework



Minimum ODD definition

ODD Definition 1

Motorways

ODD Definition 2

4 lane motorway,
Lane width min. 3m
Sunny days only
Daytime only

Summary

- Each aspect of safety assurance of ADS needs to consider its relationship with ODD.
- Scenarios need to be a function of their ODD. **Safety metrics** need to be a function of ODD.
- Need for concrete tools and methods to convert philosophical concepts into implementation.
- Success will be dependent upon suitable collaboration, data sharing and **common understanding**, nationally and internationally

Thank you…
Discussion…

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