ASAM OpenODD Concept Project Overview V1.0.0 Standardisation Proposal Kickoff workshop

Dr Siddartha Khastgir Head of Verification & Validation, Intelligent Vehicles, WMG, University of Warwick, UK ASAM OpenODD Concept Project Lead

14 March 2022

Online





Association for Standardization of Automation and Measuring Systems

ASAM OpenODD Motivation



Some Challenges for CAVs

11 Billion miles¹

To demonstrate with 95% confidence that AVs are 20% better than human drivers



Some Challenges for CAVs

11 Billion miles¹

To demonstrate with 95% confidence that AVs are 20% better than human drivers

100,000 lives²

Saved (in the next 30 years) if AVs which are 10% better than human drivers are introduced



Why is ODD important?

Number of miles driven?

Types of scenarios experienced?







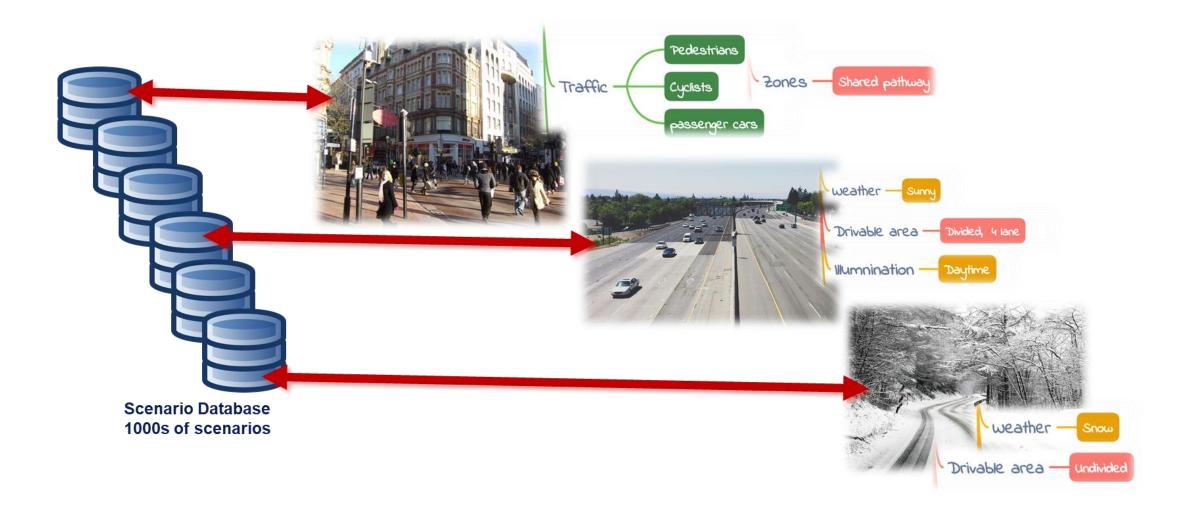
Why is ODD important?







Scenario mapping to ODD





ODD considerations



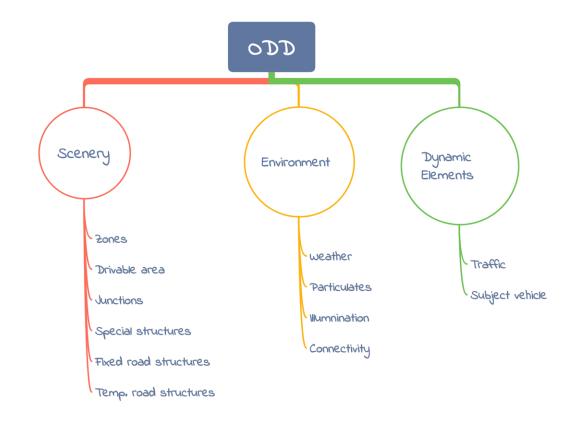
What is an ODD?

"Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics."

- SAE J3016 (2021)



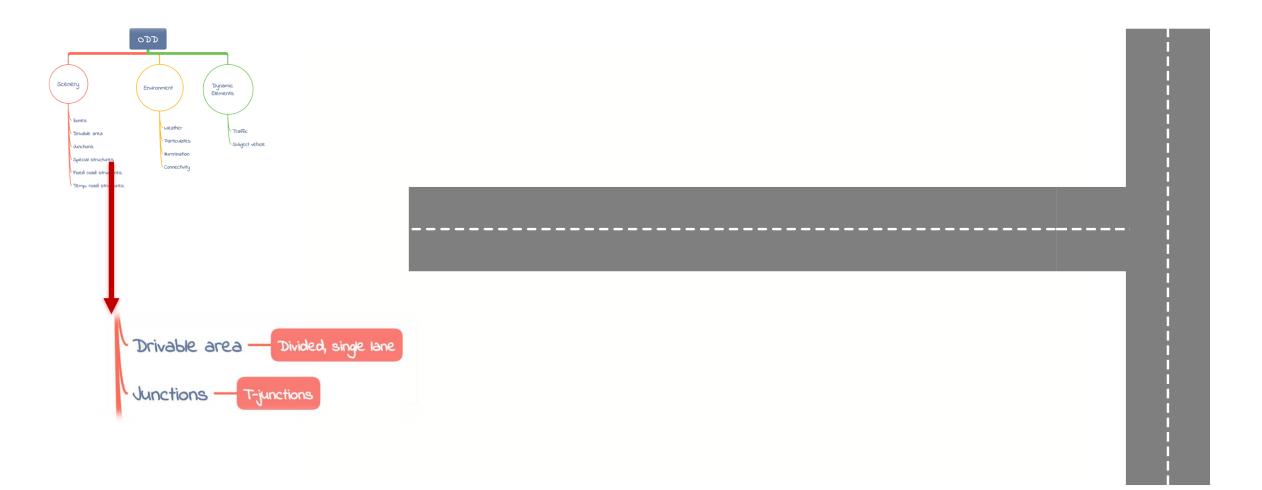
What is an ODD?



ODD Taxonomy as per BSI PAS 1883

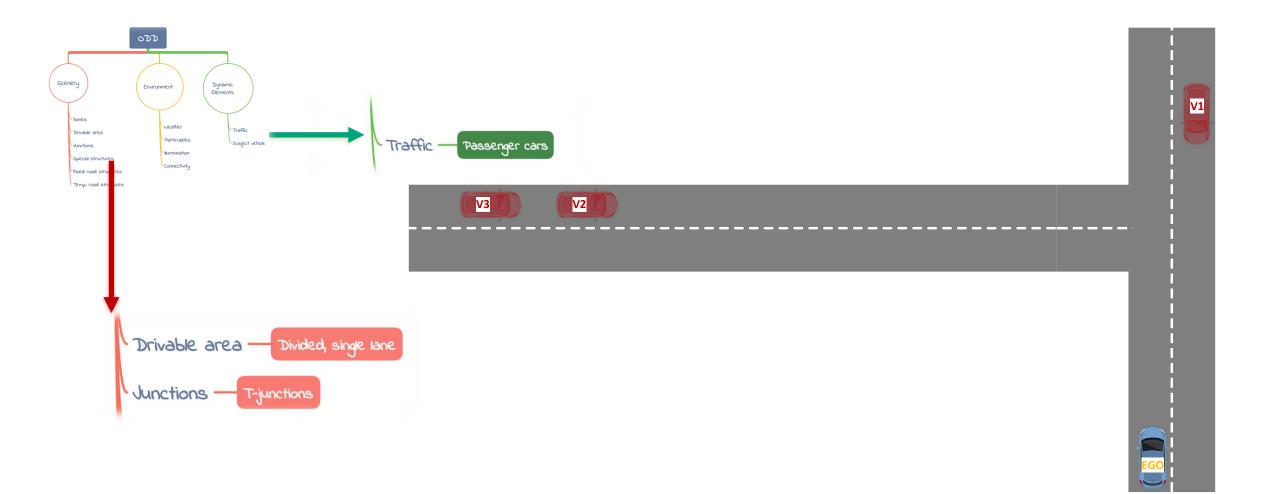


ODD and Scenario



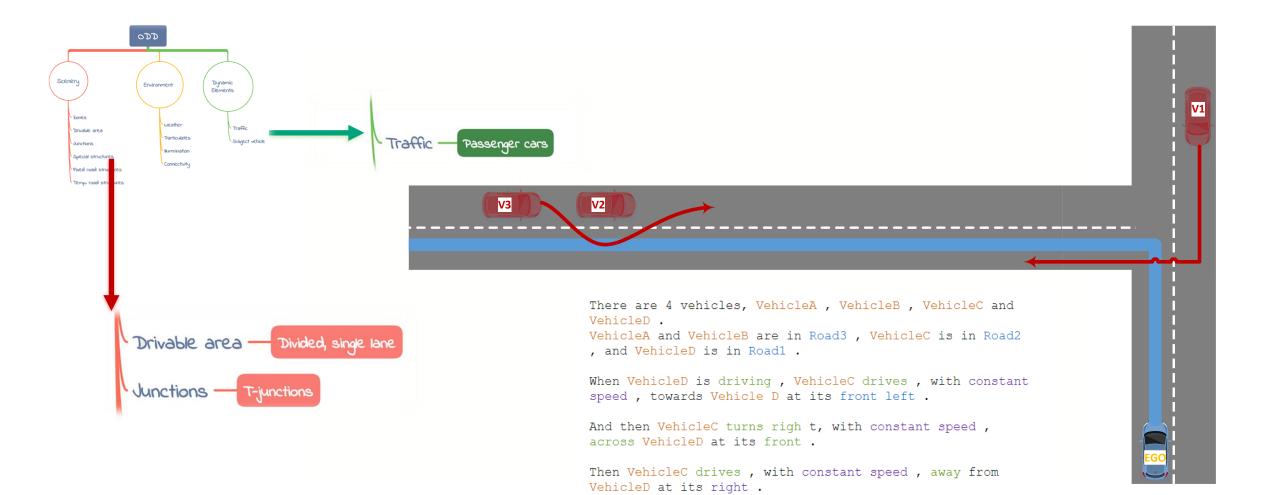


ODD and Scenario





ODD and Scenario



ODD attributes awareness - Rainfall

What does rainfall rate mean?

■ How do we measure rainfall rate?

Can the CAV measure it via on-board sensing only?

How do we address local variability issues?

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





Other standardization activities

- Need for common understanding
- Need for collaboration
- Crowded landscape

Major activities

- BSI (UK): PAS 1883: ODD Taxonomy
- SAE: ORAD (J3259), AVSC: ODD Lexicon
- ISO: ISO 34503: ODD Taxonomy and definition format
- ASAM: OpenX family of standards







ASAM OpenODD Concept Project Scope and Objectives



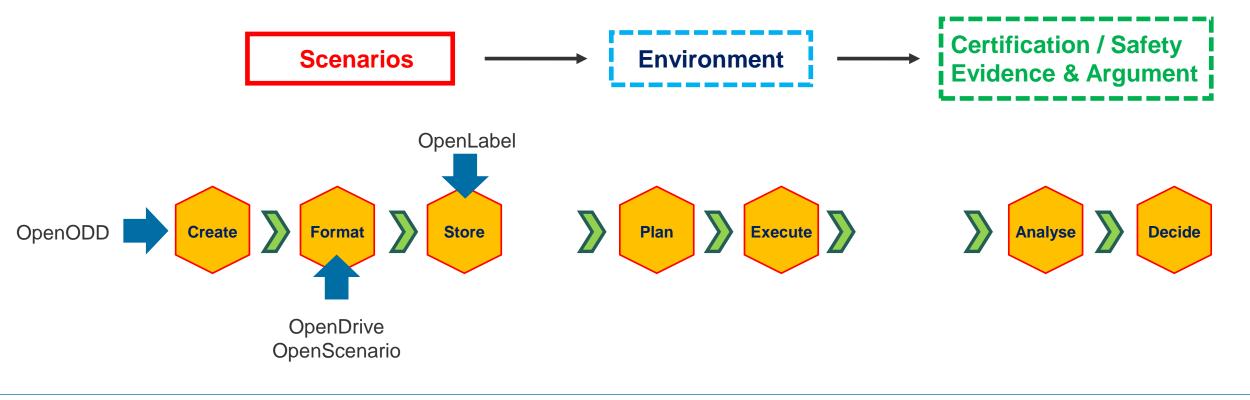
ASAM OpenODD Concept Project: Scope and Objectives

The aim is to provide a format that is capable of representing a defined Operational Design Domain for connected automated vehicles (CAV) for *simulation based testing*.



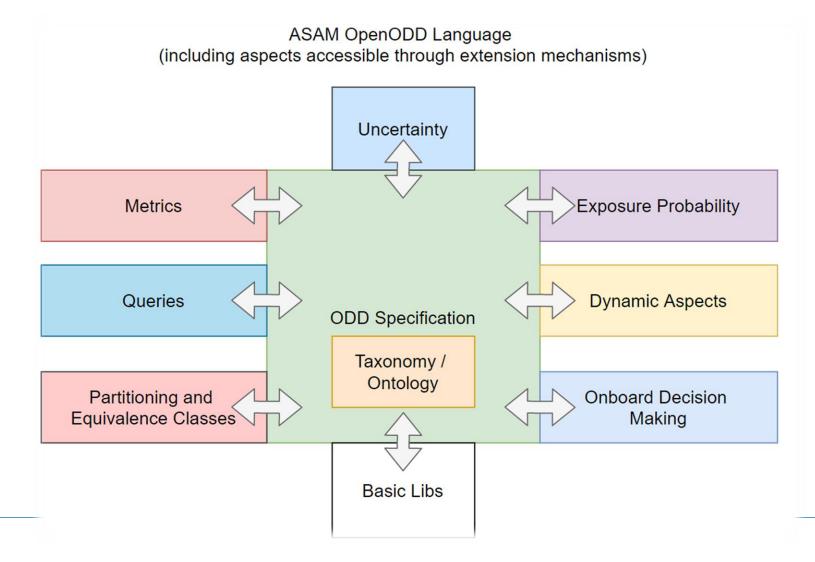
ASAM OpenODD Concept Project: Scope and Objectives

The aim is to provide a format that is capable of representing a defined Operational Design Domain for connected automated vehicles (CAV) for *simulation based testing*.





ASAM OpenODD Concept Project: Scope and Objectives





ASAM OpenODD Concept Project: work packages

Four work packages

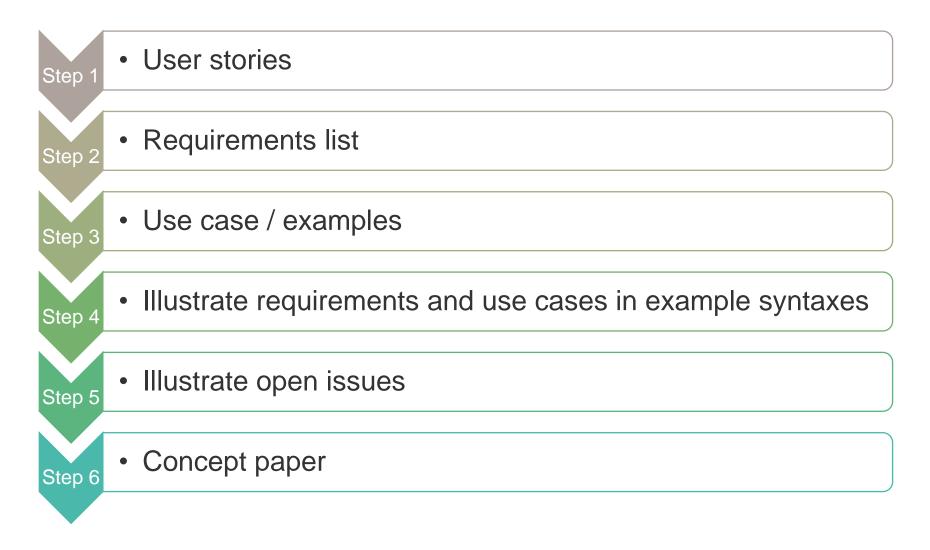
- Work Package 1: Attributes:
 - Ensure alignment with BSI PAS 1883, ISO 34503, and the ongoing ASAM OpenXOntology Project

■ Work Package 2: Specification/format

- Describe the semantic and syntactic description of the ODD description for format for simulation execution
- Work Package 3: Metrics / Measurement
 - Define and describes Metrics associated with ODD
- Work Package 4: Uncertainty
 - Define and describes uncertainty attributes associated with ODD



ASAM OpenODD Concept Project: workflow





ASAM OpenODD Concept Project: Requirement & Syntax illustration

REQUIREMENT: Human and machine readability

Example Use case:

An example ODD states that motorway is only suitable when there is no rain, up slope is not suitable as the vertical geometry.

Syntax 1

keep(road_type == motorway => odd_5.weather.rain == none)
keep(geometry.vertical != up_slope)

Syntax 2

SUITABLE Motorway EXCEPT WHEN Rain UNSUITABLE Up_slope



Deliverables OpenODD Concept project.

What was Released

Concept Paper

- Documentation
- Illustration in 2 example syntaxes

Ontology Web App

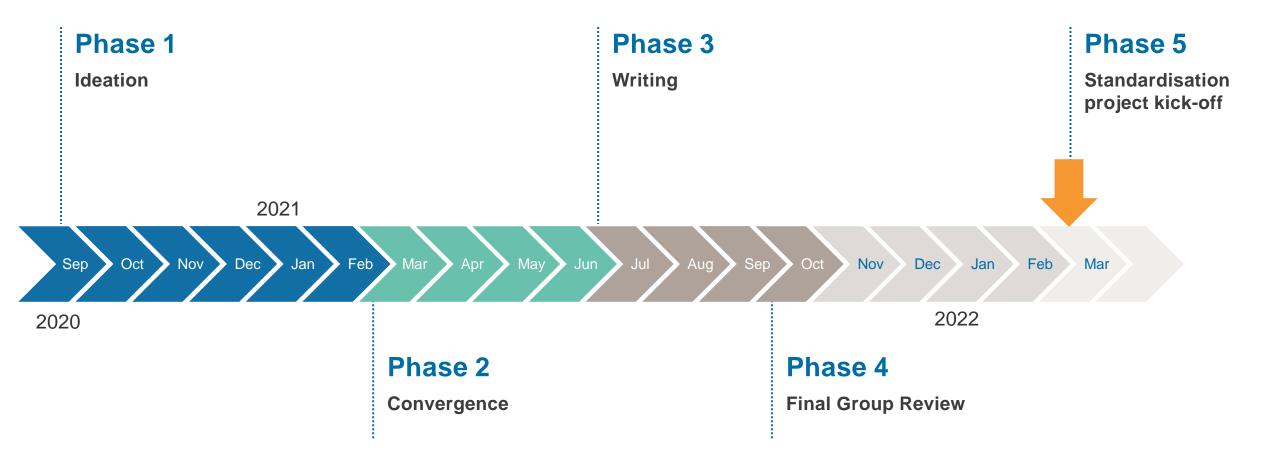
 Online portal with detailed ODD attributes and their ontological relationships



Ontologies Classes Object Properties Data Properties Annotation Properties Individuals Datatypes Clouds	Ontologies Classes Object Properties Data Properties Annotation Properties Individuals Datatypes Clouds openODD_WP1_Draft
Contents	http://www.semanticweb.org/nicolacroce/ontologies/2021/4/openODD_WP1_Draft
openODD_WP1_Draft	Loaded from file:/Users/nicolacroce/Desktop/ASAM_guick/ODD/OpenODD_WP1_draft1.2.owl
Classes (166) Object Properties (2)	Annotations (1)
Data Properties (2) Annotation Properties (3)	
Datatypes (2)	rdfs.comment "This is a work in progress draft for openOOD WP1 on ODD taxonomy"
OWL HTHL inside	References
	Classes (166)
	Object Properties (2) Data Properties (2)
	Annotation Properties (3) Datatypes (2)
Ontologies Classes Object Properties Data Properties Annotation Properties Individuals Datatypes Clouds	OWLNTHL inside
Entitles (172)	
owl:Thing Agent Type	
Alligator Cracks	
Artificial_Illumination Automatic Access Control	
Barriers on Edges	
Bridges Buffer	
Building	
Bus_Lane	
Cellular Cloudiness	
Communication	
Compact_Roundabout Connectivity	
Contractivity Construction Site Detours	
Cracks	
Crossroads Curb	
Curves	
Cycle_Lane Damp	
- Day	
Dedicated Lane	
Density_of_Agents Direction_of_Travel	
Distributor_Roads	
Divided	
Double_Roundabout Down-Slope	
Drivable_Area	
Drivable_Area_Edge	
Drivable_Area_Geometry Drivable_Area_Lane_Specification	
Drivable_Area_Signs	
Drivable_Area_Surface Drivable_Area_Surface_Features	
Drivable_Area_Surface_Features Drivable_Area_Surface_Induced_Surface_Conditions	
Drivable_Area_Surface_Type	



ASAM OpenODD Concept Project Timeline

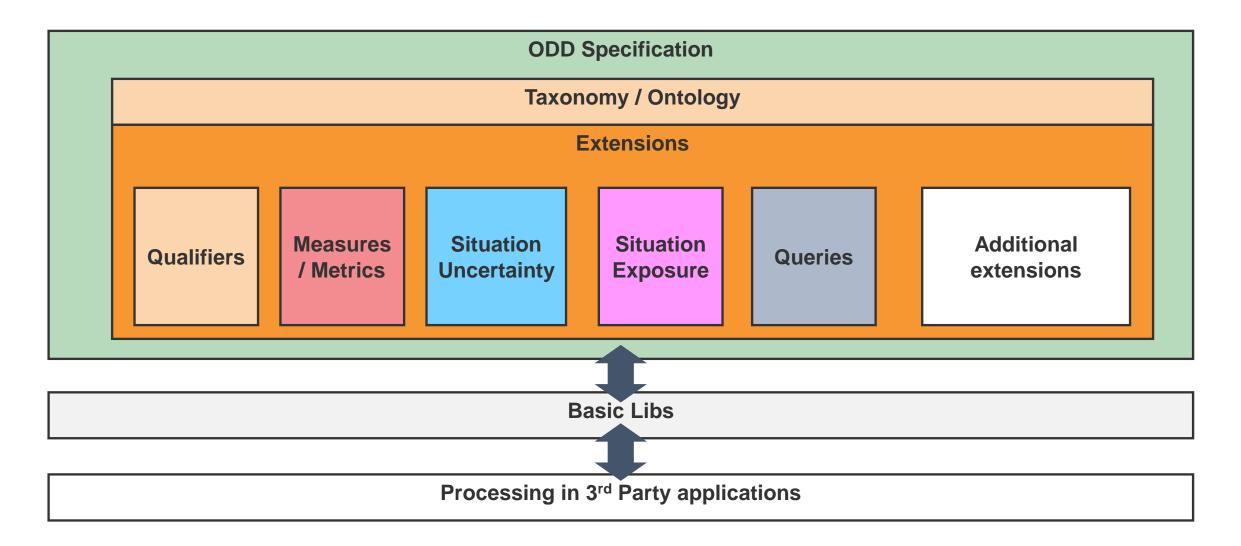




ASAM OpenODD V1.0.0 Standardisation Project Key Next steps

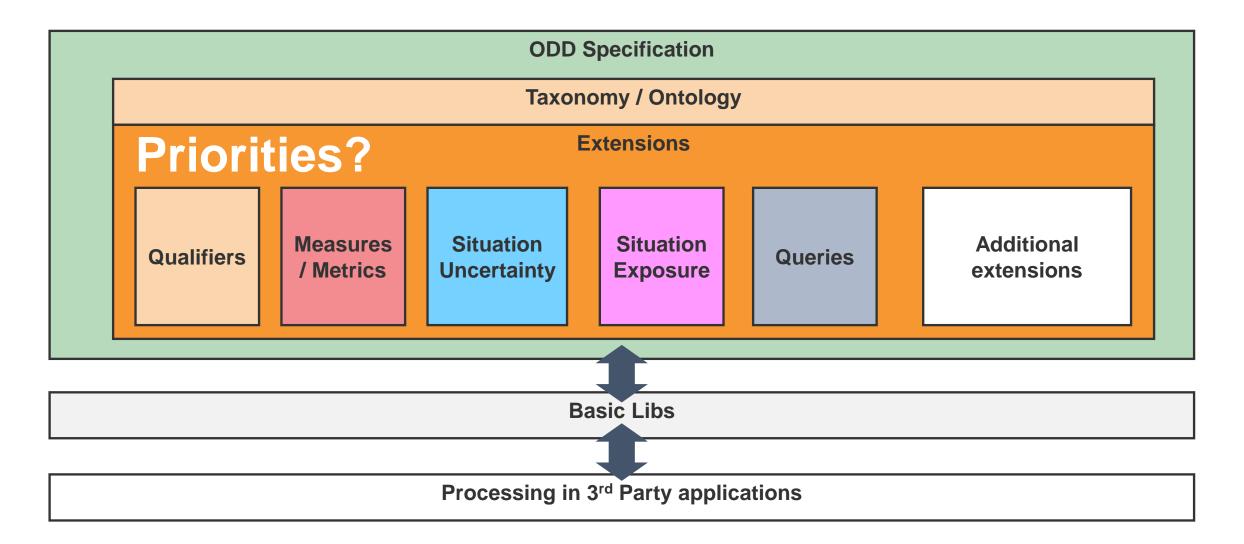


ASAM OpenODD V1.0.0 Standardisation Scope





ASAM OpenODD V1.0.0 Standardisation Scope





ASAM OpenODD V1.0.0 Standardisation Project: Proposed Work Packages

- Work Package 1: Syntax
- Work Package 2: Semantics
- Work Package 3: Extensions
 - Prioritise which extensions and decide on additional "extension" focussed WPs
- Work Package 4: Applications



Thank you for your attention!

Dr Siddartha Khastgir Head of Verification & Validation, Intelligent Vehicles, WMG, University of Warwick, UK ASAM OpenODD Concept Project Lead

Phone: +44 7881 267502 Email: S.Khastgir.1@warwick.ac.uk



