Session 2: Automotive Artificial Intelligence Explainability and Standards for Connected, Cooperative, Automated Mobility (CCAM)

Future Networked Car Symposium

14th March 2023

AI for Good
Global Summit
An **ITU** experience

FG-AI4AD Proposal 28th May 2019

ITU-T SG16:
Multimedia for ITS
and Automated Driving

FG-AI4AD Approval 17th Oct 2019

AI for Autonomous and Assisted Driving
ITU Focus Group

FG-AI4AD Active Jan 2020 - Sept 2022
350+ participants

ITU-T SG16:
Multimedia for ITS
and Automated Driving

FG-AI4AD Proposal for new
ITU Recommendation 17th Oct 2022

How safe is safe enough?

Authorisation and monitoring

Predictability +

Authorisation of
intended behaviour
evidenced by
testing and simulation

Explainability

In-use monitoring of
actual behaviour
evidenced by
on-road operations

Motivating Safety Case

The Molly Problem for Self-Driving Vehicles

A young girl called Molly is crossing the road alone and is hit by unoccupied self-driving vehicle.

There are no eye-witnesses.

How can the AD Software explain what happened?

The Molly Problem

Explainability

Situational Awareness

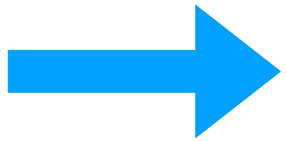
Did the AD understand the circumstance and situation?

Hazard Awareness

Did the AD understand the hazards?

Mitigating Action

Did the AD execute the risk mitigating action for the hazards successfully?



Outcome

Did the AD behaviour ***endanger the public or property***?

AD Behaviour Explainability

AD Behaviour Safety Assessment

Situational Awareness

99% expect recall of the ***time*** of the collision

99% expect recall of the ***location*** of the collision

98% expect recall of the ***speed*** at point of the collision

The Molly Problem: A young girl called Molly is crossing the road alone and is hit by unoccupied self-driving vehicle. There are no eye-witnesses. What should happen next?

Hazard Awareness

96% expect recall of ***when*** the collision risk was identified

93% expect recall of ***if*** Molly was detected

96% expect recall of ***when*** Molly was detected

91% expect recall of ***if*** Molly was detected as a ***human***

90% expect recall of ***when*** Molly was detected as a ***human***

The Molly Problem: A young girl called Molly is crossing the road alone and is hit by unoccupied self-driving vehicle. There are no eye-witnesses. What should happen next?

Mitigating Action

98% expect recall of ***whether*** mitigating action was taken

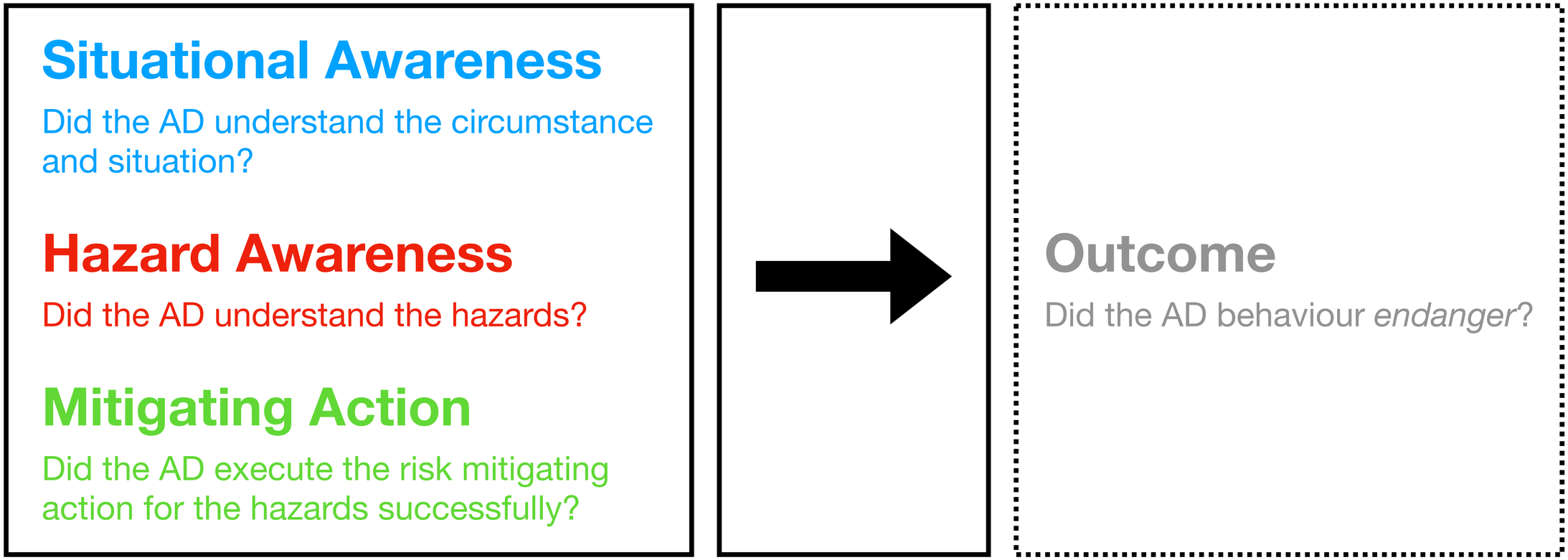
97% expect recall of ***when*** mitigating action was taken

96% expect recall of ***what*** mitigating action was taken

The Molly Problem: A young girl called Molly is crossing the road alone and is hit by unoccupied self-driving vehicle. There are no eye-witnesses. What should happen next?

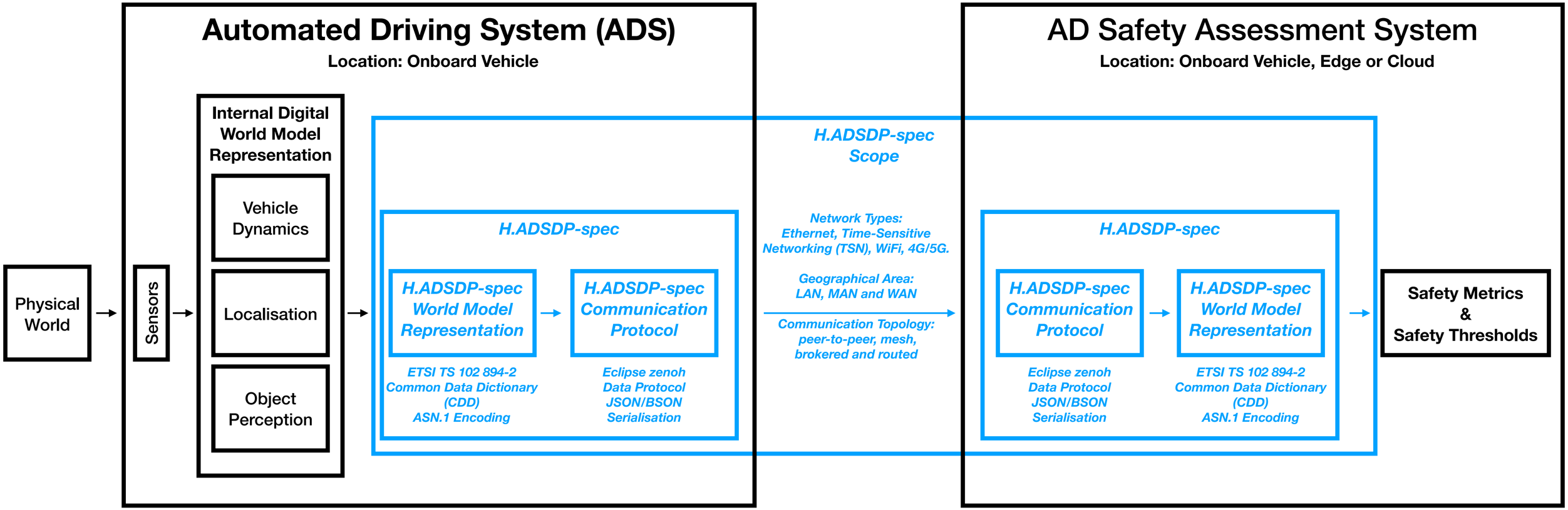
FG-AI4AD Technical Report 01 Scope

World Model Representation & Communication Protocol



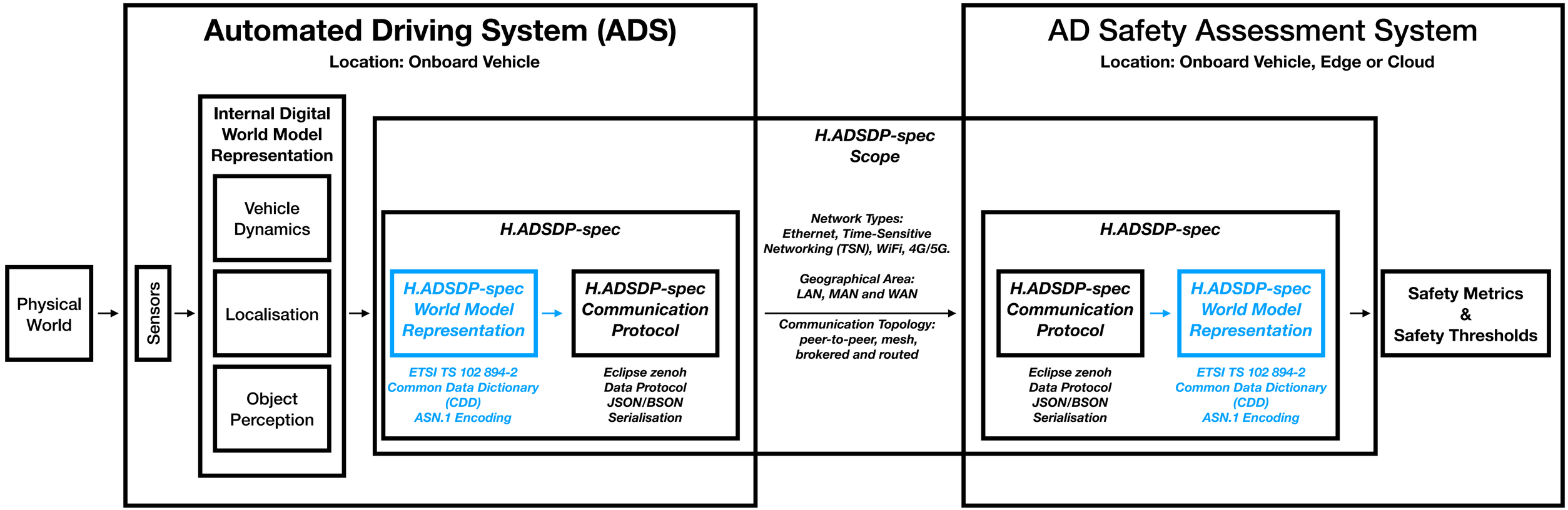
FG-AI4AD Technical Report 01

Proposed H.ADSDP-spec



Proposed H.ADSDP-spec

World Model Representation



Proposed H.ADSDP-spec

World Model Representation

- A world model is an abstract digital representation of the spatial and temporal dimensions of the physical world.
- It enables the AD software to understand where the vehicle is located relative to road infrastructure and other road users.
- The world model representation is the foundation to the AD software decision making and the resultant vehicle behaviour in the physical world.
- FG-AI4AD specifies a common format in which the AD software should communicate it’s world model representation for the purpose of behavioural safety assessment.

H.ADSDP-spec World Model Representation

ETSI TS 102 894-2 Common Data Dictionary (CDD)

- The FG-AI4AD world model representation uses data frames (DF) and data elements (DE) defined by ETSI TS 102 894-2 Common Data Dictionary (CDD).
- This alignments ensures future compatibility with cooperative, connected, automated mobility (CCAM) solutions and compatibility with ETSI V2X standards including;
    - ETSI EN 302 637-2 Cooperative Awareness
    - ETSI TS 103 300-3 Vulnerable Road User (VRU) Awareness
    - ETSI TR 103 562 Collective Perception

H.ADSDP-spec World Model Representation

Vehicle Data and Other Road User Data

- **Ego vehicle** high frequency data (Cooperative Awareness Message)
  - Heading, speed, driving direction, accelerations (longitudinal, lateral, vertical), vehicle dimensions (length, width), curvature, yaw rate, steering wheel angle, lane position.
- **Other road** user data (Collective Perception Message)
  - Object ID, Time, XYZ coordinate, XYZ velocity, XYZ acceleration, Roll/Pitch/Yaw (angle, speed acceleration), object dimensions, object ref point, object age, object confidence, classification

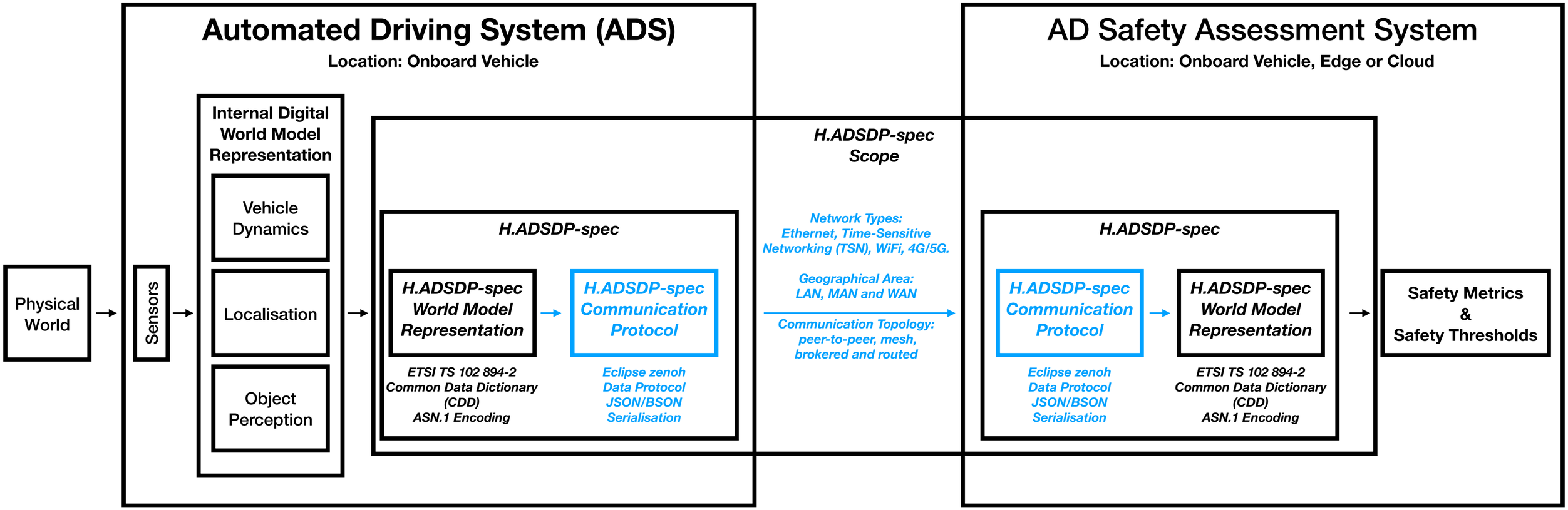
H.ADSDP-spec World Model Representation

Output

- The output of the World Model Representation stage is as ASN.1 encoding of the relevant data to ETSI TS 102 894-2 Common Data Dictionary (CDD).
- All AD Software systems using the H.ADSDP-spec would convert their internal world model representations into this standardised output format.
- NOTE: the use of ETSI TS 102 894-2 does prevent or restrict the use of alternative internal world model representations within the AD software.

Proposed H.ADSDP-spec

Communication Protocol



Proposed H.ADSDP-spec

Communication Protocol

- The H.ADSDP-spec communication protocol defines a standardised way for the world model representations to be shared for the purposes of AD safety assessment against future metrics and thresholds.
- The communication protocol enables the AD safety assessment to be executed in a range of different locations to provide flexibility in future international and domestic regulation;
  - On the same operating system as the AD Software
  - On the same compute hardware as the AD Software
  - On the same vehicle as the AD Software but using different compute hardware
  - On remote compute resources at a distributed wireless network edge
  - On remote compute resources in a centralised public or private cloud data centre

H.ADSDP-spec Communication Protocol

Eclipse zenoh Data Protocol JSON/BSON Serialisation

- The FG-AI4AD Communication Protocol uses Eclipse zenoh (0.6.0)
- Zenoh is a communication middleware suitable for use over Ethernet, Time Sensitive Networking (TSN), WiFi and 4G/5G networks commonly used for cooperative, connected, automated mobility (CCAM) solutions.
- Zenoh enables world model data “published” by the AD Software to be “subscribed” to by the AD Safety Assessment System.
- Zenoh also enables the AD Safety Assessment System to “query” world model data on the geo-distributed sources (vehicles, edge or cloud) and trigger local computations making data transmission more efficient.

H.ADSDP-spec Communication Protocol

Output

- The output Communication Protocol stage is a JSON/BSON encoding of the world model representation according to the Eclipse zenoh (0.6.0) standard.
- All AD Software systems using the H.ADSDP-spec would publish the standardised world model representations according to the zenoh middleware protocol for subscription/query by the AD Safety Assessment System.
- NOTE: the use of zenoh does prevent or restrict the use of alternative internal communication protocols within the AD software.

UNECE WP.29 GRVA Explainability

Alignment with VMAD New Assessment/Test Method (NATM)

10.3 The three main purposes of ***in-service monitoring and reporting*** is to use retrospective analysis of data from manufacturers and other relevant sources to:

(a) demonstrate that the initial safety assessment (residual risk) in the audit phase before the market introduction is confirmed in the field overtime (***safety confirmation***).

(b) to fuel the common scenario database with important new scenarios that may happen with automated vehicles in the field (***scenario generation***)

(c) to derive safety recommendations for the whole community by sharing learnings derived from key safety accidents/incidents to allow the whole community to learn from operational feedback, fostering continuous improvement of both technology and legislation (***safety recommendations***).

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THANK YOU. STAY SAFE. STAY HEALTHY.

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