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A Stakeholder Analysis of Operational Design Domains of Automated Driving Systems

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***Abstract*—Developing an automated driving system (ADS) involves collaboration between various stakeholders. To support this process, the concept of operational design domain (ODD) has emerged. Nonetheless, stakeholders require variable levels of information from an ODD. A thorough investigation has identified eight main stakeholder categories. Furthermore, a stakeholder analysis is used to assess their expectations, interests, and influence. These findings briefly summarise all necessary ODD engineering requirements and deliverables for all ODD stakeholders.**

***Index Terms*—Operational Design Domain, Automated Driving Systems, Stakeholder, Requirements, Data Management**

I. Introduction

Automated driving systems (ADS) with the Society of Automotive Engineers (SAE) level 4 are anticipated to enhance urban mobility. However, challenges include technological limitations, legal and regulatory barriers, and societal acceptance. To accelerate the development of an ADS, the operational design domain (ODD) concept has been established. It defines the operating environment and conditions for which an ADS is specifically designed to function [1]. The information content of an ODD is essential for effective collaboration between stakeholders. This paper analyzes stakeholders to identify necessary ADS and ODD engineering requirements and deliverables. Most ODD papers focus on a single stakeholder, whereas this paper offers a brief overview of different ODD stakeholders and their impact.

II. Stakeholders Using Operational Design Domain

ADS development requires collaboration and co-ordination of stakeholders using ODD. This section examines stakeholder categories and their respective roles in ADS development, with input from research of related work and ADS experts.

- **Vehicle-Base Developer (VBD):** building the vehicle platform that serves as the foundation for an ADS.
- **Self-Driving System (SDS) Developer:** developing software and (third-party) hardware for automated driving.
- **Verification & Validation (V&V):** methodology to ensure that an ADS meets its intended functionality and fulfills requirements and specifications.
- **Business Case Management (BCM):** planning mobility service with an ADS fleet, while analysing the cost/benefit ratio to ensure economic viability.
- **Regulatory (REG):** providing approval for nonautomated vehicles and ADS before operating on public roads.
- **Fleet Operator (FOP):** managing the entire ADS fleet in a given service area.
- **Mobility Service Provider (MSP):** serving as an interface between the fleet operators and customers using a communication platform.
- **Public (PUB):** using an ADS service as customers who might be interested in requesting a simplified representation of the operating limits before starting the journey.

III. Analysis of the ODD-Stakeholder

To optimize the functionality of an ADS, it is crucial to identify stakeholders who require an ODD definition while considering their unique needs. Stakeholder analysis is an effective way to achieve deeper insights into this topic [2]. This analysis includes the main stakeholder categories outlined in Section II. To derive the following results, we have conducted structured interviews with colleagues and experts from relevant domains. In the case of the public stakeholder, we have anticipated the classical news situation and the public's mindset.

Initially, the experts were asked general questions about their awareness of ODD. Except for the public stakeholder, everyone was aware of the concept of ODD or had a basic understanding of it. The public stakeholders needed more information due to its novelty, but they were interested in learning about the operational limits of an ADS. SDS developers, vehicle-base developers, and V&V stakeholders already use ODD in their work. However, all other stakeholders needed to be informed about ODD's purpose, but they could see themselves using ODD in the future.

Fig. 1 shows the results of the stakeholder analysis concerning six analysis parameters (1-6) within an Eisenhower matrix. The x-axis shows the settling degree (1), which indicates the attitude towards an ODD. The y-axis describes the degree of influence or power (2) a stakeholder has to make changes and new demands on an ODD. Each stakeholder's main category is given its position within the Eisenhower matrix. In addition, the shapes describe which stakeholders are impacted by the concept of an ODD given their level of interest and stake (3). The colour shows the degree of integration (4), which shows the extent to which the stakeholder is involved in creating an ODD

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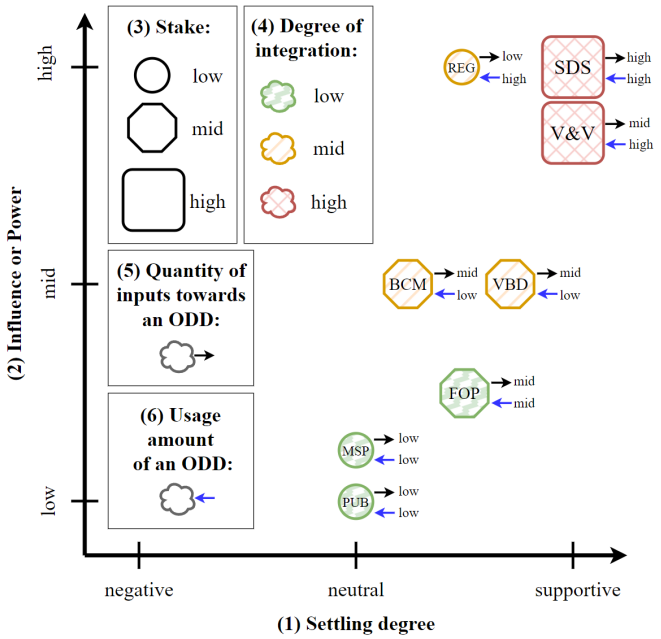

Fig. 1. Eisenhower matrix for the ODD stakeholders from Section II including six analysis parameters

and its further development. Finally, the entering and leaving arrows describe respectively the delivery (5) and usage amount (6) of an ODD.

According to the analysis, all stakeholders involved in the ODD had a neutral to supportive attitude. None of the stakeholders interviewed had a negative attitude towards the concept. Notably, the SDS Developer and V&V stakeholders stand out in the upper right quadrant, having the highest values across all evaluated categories. Thus, they are the most significant stakeholders in terms of their influence, integration, stake, and settling degree using the ODD concept. Both parties require a complete understanding of the ODD. The SDS developer must establish clear operational conditions for the SDS system during development and implementation. V&V requires the ODD to systematically check the ADS for proper functionality and compliance. Both stakeholders require a comprehensive and detailed ODD definition as input for their respective tasks. The SDS developer can supply in-depth information as input for ODD engineering including the operational boundaries. In contrast, V&V can provide feedback on whether the overall ODD can be validated or whether changes are necessary due to ADS capabilities that cannot be validated.

The regulatory stakeholder sets the legal requirements for an ADS for homologation giving it a high level of impact to define an ODD. Regulatory bodies should be involved and kept informed throughout the process of developing or revising an ODD. The primary focus is to use the ODD to compare and check the operational conditions within the existing legal framework. Regulatory bodies can specify the required format of an ODD and legal minimums for an ADS including its ODD as an output for ODD engineering. Therefore, it is essential to provide regulatory bodies with a comprehensive, state-of-the-art ODD as input for final homologation.

Stakeholders in charge of designing the vehicle base and overseeing the business case have a moderate level of involvement and stake in ODD engineering. The developers of the vehicle base do not need a complete ODD; only selective extracts as input for their work. ODD-related information about the road, such as lane count and roadside objects, is not essential to develop a vehicle base. Therefore, their involvement in shaping the overall ODD is limited to a subset. Nonetheless, they can provide crucial details to an ODD, such as the vehicle's size and top speed. To fully understand the performance of an ADS service, the business case management must consider more than a predefined road network that is aligned with the corresponding ODD. Other significant factors include, for example, development costs, the operational area of an ADS, or the mobility behaviour of potential customers. Business case management can offer insights into the impact of ODD constraints including cost feedback compared to the value added by the final ADS service. Alternatively, it may suggest creating value-enhancing ODD extensions and offering input on new operating areas to develop new capabilities for the ADS.

As a fleet operator, it is crucial to clearly understand the operational boundaries of an ADS. The ODD can help by providing a clear view of currently suitable roads and those that can be planned for the future. From the interviews conducted, it became clear that fleet operators have a favourable view of the ODD and can slightly influence it based on their experience during operations. However, the overall level of influence and integration on the ODD is rather low.

The mobility service provider and public stakeholders have a neutral position towards an ODD. While they see the potential benefits of a comprehensive overview at some point in the future, they are not extensively involved or committed to an ODD, which is considered more of an optional concept.

Overall, the ODD stakeholder can receive and provide various input and output types to ODD engineering. The analysis identified the input for the stakeholders as the ODD including its taxonomy in different levels of detail and the processed geodata enriched with ODD taxonomy elements. The identified outputs from the stakeholders towards ODD engineering may include requirements for an ADS, data that drive its development, communication from the V&V process, minimum legal requirements, or new research insights. It is planned to provide a more detailed explanation of the respective ODD inputs and outputs in a future publication.

IV. Conclusion

This paper presents a stakeholder analysis of the ODD stakeholder covering the life cycle process of an ADS. The analysis shows that the ODD is more important than just a development tool and should be considered a vital component in the life cycle of an ADS. Moreover, some stakeholders may only need fragments or converted representations of ODD for their respected tasks.

References

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