In collaboration with the
Boston Consulting Group

WORLD ECONOMIC FORUM

Centre for the Fourth Industrial Revolution

Advancing Industry Collaboration in Vehicle Software

BRIEFING PAPER

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The Automotive in the Software-Driven Era community

The automotive industry is undergoing its most challenging transformation in over a century. The role of software in this transformation is so prominent that the new generation of vehicles are being referred to as "software-defined vehicles" (SDVs) – see Box 1 for an overview of this transformation. To better understand this transformation, the World Economic Forum launched the Automotive in the Software-Driven Era community. This community brings together leaders from the automotive and tech industries and fosters collaboration to ensure a safe, resilient and innovative sector.

The community previously worked on a simplified tech stack for the software-defined vehicle and focused on one of its key layers, the vehicle software platform (the "brain" of the car). The briefing paper, Unlocking Safety and Innovation in Vehicle Software, gives an overview of the key characteristics of the vehicle software platform target picture and a timeline. The current publication, *Advancing Industry Collaboration in Vehicle Software*, builds on the earlier paper and provides a **path to better streamline existing industry work on the vehicle software platform.**

The need: Enhancing collaboration in the vehicle software platform

The need for collaboration to advance the transition to the software-defined vehicle is well-acknowledged by the industry. This is especially the case when it comes to the vehicle software platform. There are two key reasons why collaboration is sought after when it comes to the vehicle software platform:

1. Its complexity

The development of end-to-end car platforms requires involvement of multiple stakeholders and collaboration among them. Such collaborations address the interlink among different components of the final software platform, as well as regulatory standards and requirements, such as safety ones. To add to the complexity, standards and requirements vary across geographies. Multiple industry consortia, each of which with their own set of objectives, structures and stakeholder composition, have been formed to address these challenges – but a unified direction for such industry collaboration consortia has not yet been set.

2. Its potential to unlock the full value of the software-defined vehicle

While the market size of software-defined vehicles has been estimated at approximately $320 billion by 2023 and $660 billion by 2030, only around 2% of this market is expected to be linked to the vehicle software platform (see Figure 1). A safe, efficient and innovative vehicle software platform is, however, vital for the software-defined vehicle success – it drives the decoupling of software and hardware (a prerequisite for its scaled development) and unlocks the full ecosystem value and functionality. Collaboration is thus key.

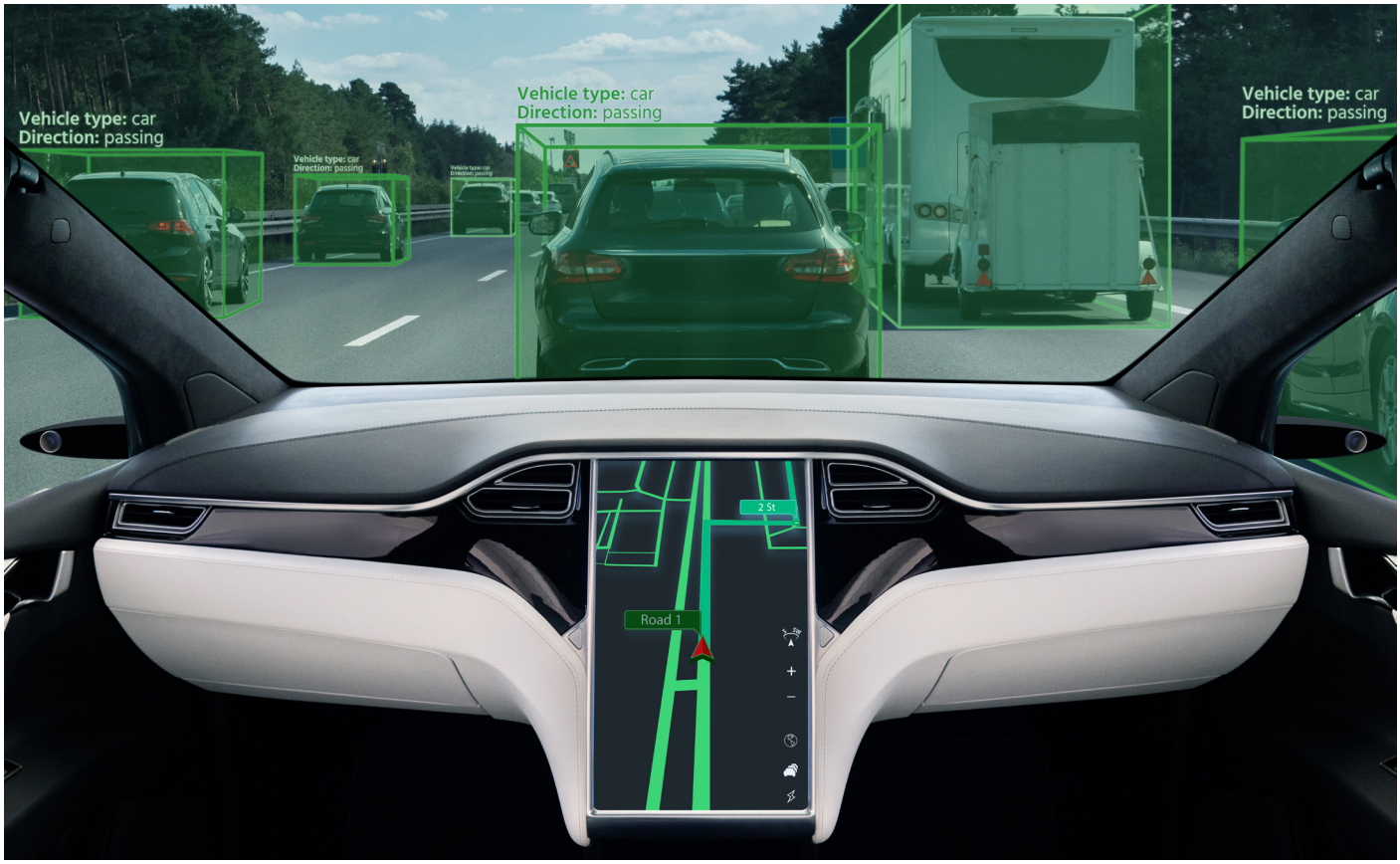

FIGURE 1 | **SDV market development**

Source: BCG market model

Different industry consortia have been created to collaboratively advance the vehicle software platform. These include the ECLIPSE SDV working group, SOAFEE, COVESA, AUTOSAR and others. These consortia have a multitude of projects, some of which have a conflicting or overlapping scope. Recent collaboration efforts among consortia have also emerged, such as the creation of the SDV Alliance, which aims to tackle some of these issues.

This briefing paper aims to contribute to current efforts on collaboration in the vehicle software platform by:

- Providing a simplified overarching structure of the key areas needed for industry collaboration
- Outlining key industry deliverables for each of the areas, as well as their current progress stage
- Suggesting next steps to maximize the existing synergies to solve the related challenges

BOX 1 | **The journey towards the software-defined vehicle**

The journey of software-defined vehicles can be outlined in four fundamental development stages (see Figure 2). Each stage involves changes in all layers of the tech stack. Software plays a key role in the related strategic decisions that need to be taken to advance in these stages.

Noting that the four stages of the journey towards the SDV should not be confused with the six levels of vehicle autonomy outlined by SAE International. While the former considers the journey of the vehicle transformation, the latter focus is on the vehicle autonomy journey exclusively. Also, even if legacy OEMs seem to be taking an iterative approach in their journey towards the SDV, stages could be skipped – this can be of special relevance for new OEMs.

FIGURE 2 | **SDV development phases**

Note: 1. HPC – High Performance Computing; **2.** SoC – System-on-a-Chip

Six key areas for industry consortia collaboration

The collaboration needed in the vehicle software platform includes different aspects – from creating unified approaches for auto software development and unified standards to facilitating shared testing or aligning on a joint architecture. The World Economic Forum and Boston Consulting Group, in collaboration with the Automotive in the Software-Driven Era community and their expert groups, identified six broad areas for collaboration in the vehicle software platform (see Figure 3).

Areas 1 to 5 include the key components of the vehicle software platform. These five areas are distinct in the key elements they aim to deliver, yet they share others, namely (a) functional safety and security; and (b) tooling. Area 6 targets the overarching alignment and governance of the other five areas and it is responsible for ensuring a clear allocation of efforts among the consortia in the other five areas – efforts that should contribute to a shared SDV vision.

FIGURE 3 **Six broad areas of collaboration in the vehicle software platform**

Area	1 Syntax and protocols	2 Semantics	3 App development	4 Operating environment	5 Integration	6 Alignment and governance
Description and key elements	The „grammar“ of software (i.e., what rules and protocols are used for transferring the data	The “vocabulary" of software (i.e., which namespace is used)	The tooling/UI in which the features and user-functions are developed and continuously upgraded and deployed	The encapsulation and separation of the different user-functions, which ensures there is no negative interference	The logical alignment of all the different user functions to an overall vehicle behaviour	The coordination and management of key software initiatives to ensure unified objectives and deliverables.
Potential collaboration areas (not exhaustive)	Communication middleware Vehicle data abstraction Messaging, incl. open standards Basic platform services	Semantic signal abstraction Digital twin API definitions	Configuration management Development monitoring	OS Hypervisors Containers Non-differentiating vehicle core services SW update management	Combination and deployment of multiple applications	Continuous review and alignment of initiatives scope Reference implementations

Two additional aspects that span five areas:

Functional safety and security

Tooling

The challenge that industry consortia face is identifying the key deliverables needed from each area. This challenge is even more prominent given the limited participation of some industry segments (e.g., OEMs) in some of the leading existing consortia. Figure 4 identifies key deliverables required for each area, as well as their current progress state. As illustrated in the figure, efforts around syntax and protocols are in an advanced state; other areas need more progress, notably the integration area. The following section suggests next steps to streamline and further advance consortia efforts.

FIGURE 4 | **Deliverables and progress pertaining the six areas of collaboration**

Area	1 Syntax and protocols	2 Semantics	3 App development	4 Operating environment	5 Integration	6 Alignment and governance
Deliverables What is industry expecting from consortia?	IP opening for API (i.e., open use of some IP and ArXML)	Interoperability tooling Open interface standard API (e.g., openAPI)	Extension CI/CD pipeline for ASIL[1] and real-time performance	Scaling to multiple hardware architectures Further standardization of non-differentiating vehicle core services	Joint testing environment Test tooling Definition of "done" (e.g., automated validation)	Identification of clear scope allocation on a regular basis Alignment of regional aspects (e.g., Japan, China) Reference implementations
Current state To what extent is the area covered by existing efforts?	 Good coverage Currently covered by AUTOSAR, yet speed of new items development could be improved	 Partially covered Partially covered by COVESA (VSS)	 Partially covered Missing collaboration on ASIL[1] (current collaboration focused on QM)	 Significant gaps Scaling for other hardware architectures missing	 Significant gaps Currently not covered by any of the initiatives. Not sufficient industry collaboration	 Partially covered Newly formed alliance can be leveraged to improve long-term collaboration

Note: 1. ASIL – Automotive Safety Integrity Level, part of ISO 26262

Ensuring success on the way forward

In order to advance the different areas successfully, there needs to be clarity in the roles and responsibilities of the different consortia, as well as a unified direction that maximizes synergies among the existing efforts. The following outlines four recommendations for the way forward:

1. Agree on the collaboration framework

There is general agreement about the need for streamlined collaboration on the vehicle software platform to enable a faster, more efficient and safer transition to fully scaled software-defined vehicles. The first step for such streamlined collaboration is agreeing on the overarching collaboration framework.

This briefing paper contributes to this first step of providing a collaboration framework by highlighting six key working areas and their high-level deliverables. The framework has been developed in collaboration with leading industry players, yet, in order to maximize its impact, it needs to be adopted across the automotive value chain and different geographies.

2. Ensure a holistic approach to governance

Different bodies and/or industry consortia can add value to the same area, yet it is unlikely all of them would drive the agenda in the same direction. To ensure consistency, it is of value that there is a "lead" consortia/body for each area, with other related consortia contributing to the industry directions set by these leads.

Special attention should be given to ensuring a clear lead for area 6 (alignment and governance) given its overarching role in ensuring a shared vision and efficient decision-making processes and in steering the direction of the other areas. Recently, the SDV Alliance has been created by ECLIPSE SDV, SOAFEE, COVESA and AUTOSAR to fulfil this goal and it includes representatives from the four mentioned consortia. While this collaborative approach may facilitate compliance with the overarching decisions (and how they feed in the other five areas), the governance challenges of running an "alliance of alliances" should not be underestimated.

3. Ensure consistent industry representation

While the leading vehicle software consortia have a wide range of industry support, they have varying levels of engagement from OEMs and other key industry bodies. To ensure continuous alignment, it is crucial to have consistent engagement of these players in the consortia leading the different areas.

Consistent representation from key industry groups will ensure that the work done in the different areas is well aligned with industry capabilities and needs. At times, industry players may have diverging priorities. The consortia leading the different areas will, thus, also have to reconcile the different inputs in a meaningful industry direction. This will be of especial importance, but not only, for the consortium/body leading area number 6.

4. Accelerate collaboration in the "*operating environment*" and "*integration*" areas

As outlined in Figure 4, the level of progress differs across the six areas – area number 4 (operating environment) and area number 5 (integration) being the ones with larger gaps. Joint efforts to achieve progress on both areas will be critical to progressing in the vehicle software platform.

Progress in the *operating environment* area could be made by achieving deeper collaboration between existing initiatives, since some consortia have the capabilities to extend their scope and address current gaps (e.g., ECLIPSE SDV or SOAFEE). Identifying a way forward for the *integration* area is a more challenging task, since there is currently no industry consortium covering this topic sufficiently.

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