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NAVIGATING THE AUTOMOTIVE REVOLUTION: INSIGHTS INTO THE FUTURE OF AUTOMOTIVE OPERATING SYSTEMS

AOS

AUTOMOTIVE OPERATING SYSTEM

in the sense of a software platform and development framework, ranging from core services (e.g. hypervisor) to middleware (e.g. communication interfaces) and platform services (e.g. vehicle status)

In the landscape of the automotive industry, an enormous transformation is underway. The very essence of vehicles is being redefined, not under the hood, but in lines of code and algorithms. Automotive Operating Systems (AOS) have emerged as the catalysts for this revolution, promising a future where software dictates the driving experience. In our in-depth survey conducted among industry experts spanning OEMs, Tier-1 suppliers, Big Tech players, and engineering service providers, a tapestry of insights has been woven, illuminating the path forward.

1 DEFINING AOS: A CALL FOR STANDARDIZATION

At the heart of AOS challenges lies the lack of standardization. With an average approval rate across all respondents of 4.2 on a scale from 1 to 5, it seems clear that there's no universally accepted definition for Automotive Operating Systems. This lack of standardization inflates costs as suppliers are forced into crafting bespoke solutions for each OEM.

Despite there not being an agreement of the one definition for an AOS, our survey uncovered a crucial consensus with average approval rate of 4.0 across participants: due to decoupling of Hardware, Software and Middleware layers, Middleware must evolve into a domain-agnostic

platform, allowing seamless integration across various automotive domains. However, the dream of a fully domain-agnostic platform faces a reality check due to specialized needs in areas like Infotainment and Advanced Driver-Assistance Systems (ADAS). These specific requirements will most likely necessitate domain-specific extensions to the platform.

Standardization in this regard is not merely a convenience; it's a strategic necessity. By establishing clear guidelines on AOS components, the industry can foster innovation, enhance collaboration, and pave the way for a harmonized future in automotive software development.

2 THE INEVITABLE CONVERGENCE

As the race for AOS supremacy intensifies, industry experts foresee a future where the market will inevitably coalesce around 3-5 dominant AOS solutions. At its core, convergence is the industry's response to a fundamental challenge: the demand for a substantial number of vehicles to justify the heavy financial investments poured into AOS solutions. For developers, this critical mass represents a fertile ground—an attractive market where third-party developments can thrive and find widespread adoption.

Our survey also outlined a glimpse into what the potential AOS landscape could look like: with an average approval rating of 4.1, there is a strong consensus among participants that open-source solutions will play a pivotal role, fostering collaboration and driving innovation.

Additionally, participants largely agree on geopolitical strategies and data security concerns being likely to bolster the prominence of a Chinese OS platform.

When it comes to the success of Big Techs in the AOS space, participants are slightly more divided. With an average approval rating of 3.8, the majority nevertheless believe that players such as Amazon and Google will play an important role in the AOS market.
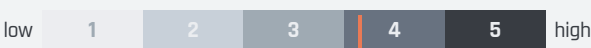
While the concept of standardization has been a beacon, current efforts are under scrutiny. The surveyed participants cast doubt on the feasibility of adaptive AUTOSAR, further fueled by a wave of exploration of alternatives among new OEM startups and Chinese manufacturers. Amidst this skepticism, a sobering reality emerges: the hundreds of millions of dollars currently poured into AOS development might face the risk of obsolescence. The industry stands at the precipice of a pivotal moment. Considering these uncertainties, OEMs face a pressing obligation: a critical self-assessment of their product value proposition and the role AOS plays within it. Investments made today must be future-proof, aligning with long-term value-add strategies and ensuring sustained growth.
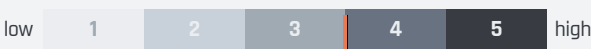
HYPOTHESIS / EXPERT APPROVAL

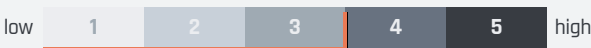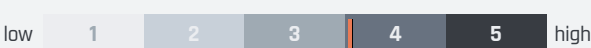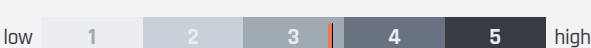| HYPOTHESIS	EXPERT APPROVAL
There is no „one" market definition for an Automotive Operating System (in thesense of a Car Software Platform)	low 1 2 3 4 5 high
Decoupling of Hardware, Software and Middleware layers will require Middleware to step-wise evolve towards a domain-agnostic platform	low 1 2 3 4 5 high
Due to high effort/invest in building a car Software platform and limited possibilities of differentiation in between them, there will be a consolidation to around 3-5 Automotive OS platforms	low 1 2 3 4 5 high
Open-source will play an important role in Automotive OS platforms of the future	low 1 2 3 4 5 high
AOS platforms will be able to adapt to regional specifics, with China likely being an exception due to political / social reasons	low 1 2 3 4 5 high
Big Tech will be successful in the Automotive OS market	low 1 2 3 4 5 high
The viability of adaptive AUTOSAR is unclear	low 1 2 3 4 5 high

DECODING OEM STRATEGIES IN THE AOS LANDSCAPE

Navigating the complex AOS landscape, OEMs find themselves at a strategic crossroads: to go solo or to collaborate. Our survey reveals a fascinating paradox – while there is strong consensus among respondents regarding the importance for an OEM to control the product ecosystem and customer interface, there is also a the strongly shared belief that there will never be a uniform software strategy among OEMs.

For many OEMs, a significant challenge emerges: they lack the capabilities and resources to develop the entire AOS stack independently and competitively –which is confirmed by an average approval rating of 4.3 in our study. This realization has led to a paradigm shift in their approach. OEMs are now exploring collaborations and partnerships, acknowledging the importance of specialization and strategic alliances. In this shifting landscape, the industry is witnessing a transformation—from competition to collaboration, from silos to synergies.

However, amidst this collaborative spirit, outliers emerge. A handful of OEMs, particularly the new disruptors, tread a different path. These industry rebels are akin to the Apple of smartphones, aiming for nothing short of complete control over their ecosystems. In their pursuit, they challenge the status quo, emphasizing the importance of an integrated approach from hardware to software. The OEM landscape, therefore, presents a diverse panorama— traditional players forging partnerships, seeking synergies, and adapting to the changing dynamics, while the pioneers chart their course toward vertical integration, mirroring the likes of tech giants in other domains. In this ever-shifting paradigm, the lesson is clear: adaptability is the key. OEMs must be agile, open to collaboration, and yet strategic in their pursuit of control. It's not just about crafting a strategy for today; it's about laying the foundation for a future where flexibility, innovation, and strategic vision reign supreme.
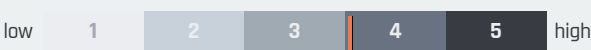
HYPOTHESIS

EXPERT APPROVAL

Controlling an ecosystem and a customer interface with sufficient reach will be a major success factor for an OEM

low | 1 | 2 | 3 | 4 | 5 | high
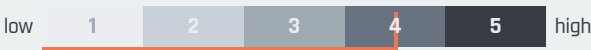
There is not and will not be one common software strategy across OEMs (it will always vary in e.g., partnership dependencies, own value-add, ecosystem ownership)

low | 1 | 2 | 3 | 4 | 5 | high

OEMs trying to build their own AOS currently lack needed capabilities and resources and therefore rely on cooperations for certain parts of the stack or even complete stacks

low | 1 | 2 | 3 | 4 | 5 | high

4. REDEFINING THE AUTOMOTIVE VALUE CHAIN

As the market matures, modularity is the new mantra. Our survey uncovered a resounding consensus, with an average approval rate of 4.1 among participants: the market is fervently seeking modular stacks with exchangeable components, driven by the need to avoid vendor lock-in. Furthermore, our study reveals that OEMs are expected to increasingly source hardware and software separately. The implications of this shift are profound, reshaping industry dynamics in multiple ways.

This shift, however, could have repercussions for Tier-1 suppliers, potentially relegating them to pure hardware providers – a statement to which participants of our study show an average approval rate of 4.1. This would put them in direct competition with electronics contract manufacturers armed with streamlined processes and leaner organizations, capable of thriving on narrower profit margins.

Simultaneously, other industry players are exploring ways for expansion, both vertically and horizontally. Big Tech entities are descending down the stack, exemplified by Google's foray into Infotainment systems. Concurrently, silicon providers are diversifying their offerings, providing pre-integrated software stacks to broaden their service portfolio. These strategic moves are emblematic of the industry-wide consensus: the priority to expand coverage and enhance capabilities. In this transformative landscape, a critical imperative echoes: every player must meticulously assess their capabilities and operating models to align with their desired business models. This assessment, far from being a mere formality, is an urgent mandate. Timely adjustments are not just advantageous; they are essential for survival.

5. BEYOND ONES AND ZEROS: A HOLISTIC APPROACH TO AOS

The success of AOS extends beyond mere lines of code; it encompasses the very framework enabling its creation. In our study, experts share strong agreement on the importance of a frictionless development toolchain for the success of an AOS. Consequently, a large majority of experts expect an Automotive OS not only to comprise of a software platform but also the corresponding development framework.

An example of a this can be seen in the Eclipse Foundation's SDV working group, an open-source initiative that tries to establish an open technology platform that will include open-sourced, modular software components and frameworks that are fully integrated into a modern developer experience.
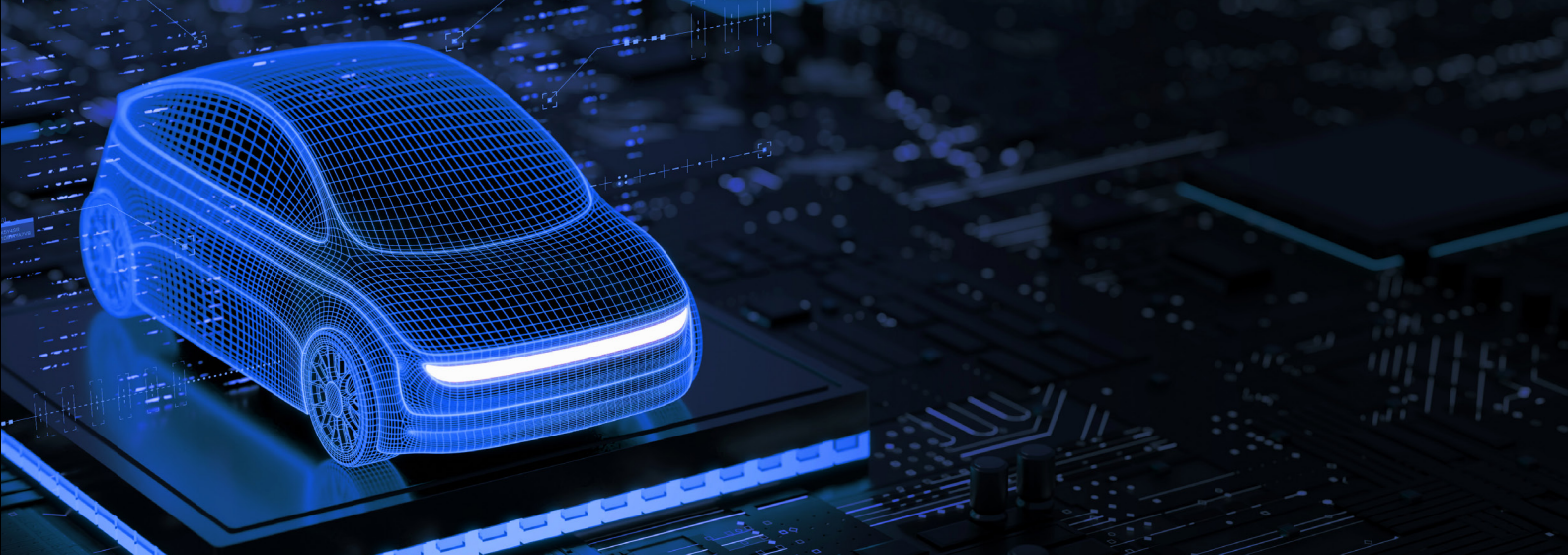
HYPOTHESIS — EXPERT APPROVAL

In the medium term, OEMs that have HW and SW separated, will tend to integrate the SW themselves to keep control, while in the long run, when there are end2end integration tools, they will outsource integration
low | 1 | 2 | 3 | 4 | 5 | high

Tier 1s can in some cases be degraded to pure Hardware suppliers, with application/integration sourced elsewhere
low | 1 | 2 | 3 | 4 | 5 | high

Silicon providers are increasingly pushing pre-integrated SW stacks or Open Source SW stacks into the market
low | 1 | 2 | 3 | 4 | 5 | high

The key to success is a frictionless development toolchain enabling e.g., addition and maintenance of cloud-centric apps within the car
low | 1 | 2 | 3 | 4 | 5 | high

The Automotive OS combines a software platform and development framework to reduce software variants across the complex vehicle network of ECUs
low | 1 | 2 | 3 | 4 | 5 | high

CHARTING THE COURSE AHEAD

In this whirlwind of change, proactive strategies are not just advantageous – they are imperative. Stakeholders across the automotive spectrum must take the following three steps:

1. Evaluate the Impact:

Undertake a comprehensive analysis of how AOS influences your business model. Identify the opportunities it presents and the risks it entails.

2. Embrace the Inevitable Consolidation:

Prepare for the imminent consolidation of software platforms. Align your operations with this transformative shift, ensuring your organization is poised to thrive amidst this industry evolution.

3. Strategic Planning:

Develop a robust strategic roadmap that encompasses diverse scenarios. Anticipate risks and devise strategies to mitigate them. Identify emerging opportunities and position your organization to capitalize on them.

In conclusion, the adoption of Automotive Operating Systems marks an epochal shift, one that propels the industry towards a more customer-centric, flexible, and innovative future. This journey, though challenging, is pregnant with possibilities.

APPENDIX:
FURTHER SURVEY RESULTS

HYPOTHESIS

EXPERT APPROVAL

	low	1	2	3	4	5	high

Multibrand OEMs lack PMT (Processes, Methods, Tools) in their product development

low | 1 | 2 | 3 | 4 | **5** | high

There is an increasing need for solutions for virtualization (tooling, simulation, automation)

low | 1 | 2 | 3 | 4 | **5** | high

The sourcing behavior of OEMs depends on their background (e.g. SDV pioneers seek to source HW & SW separately and do integration themselves while other players seek a pragmatic approach and keep the traditional sourcing model)

low | 1 | 2 | 3 | 4 | **5** | high

Some OEMs will move from SOP driven to continuous life cycle management

low | 1 | 2 | 3 | 4 | **5** | high

Players tend to increase their coverage over the stack

low | 1 | 2 | 3 | 4 | **5** | high

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