S&P Global
Mobility

NIO

Featured Interview with NIO

The Shift to Software-Defined Vehicles

May 2024

Background

S&P Global Mobility

Continuing our series of interviews with leading suppliers of SDV solutions, we spoke to NIO.

Software-defined vehicles (SDVs) use software to govern operations, incorporate new features and facilitate the integration of novel functionalities. This concept marks an advancement in the automotive industry, laying the foundation for autonomous driving and vehicle connectivity technologies.

The evolution of SDVs entails separating software and hardware development, like smartphones. Original equipment manufacturers are establishing “walled gardens” for applications. This shift encompasses continuous agile software development, heightened computing requirements for data processing, a modular service-oriented architecture and fortified security measures against cyberthreats.

The automotive industry is rapidly advancing toward SDVs, with the promise of improved comfort, safety and customization. As collaborations between OEMs and tech companies flourish, SDVs present additional challenges such as cybersecurity risks and design intricacy.

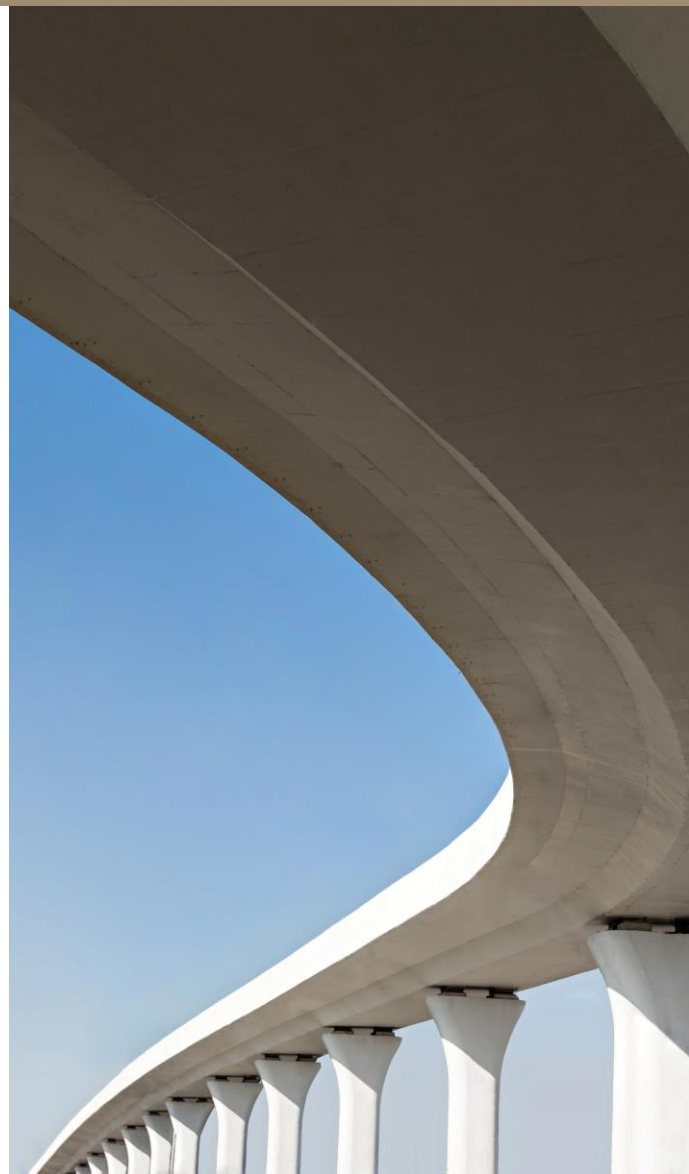
The transition from domain to centralized architecture is also progressing, converting vehicles into mobile data centers. In this transformative journey, standards, collaborations and digital twin technology stand out as critical components, promising a future where software dictates the driving experience.

To delve deeper into this transformation, S&P Global Mobility initiated discussions with leading players in the SDV market, including NIO. To learn more, we spoke to Lucas Huang, NIO’s senior director and senior expert of Digital Program Management. NIO has eight smart electric models in its lineup, including the sport utility vehicle (SUV) ES8, coupe SUV EC7, mid-large SUV ES7, sedan ET7, SUV ES6, coupe SUV EC6, midsize sedan ET5 and midsize tourer ET5 Touring. In December 2023, the ET9 made its global debut, and the delivery is expected to start in 2025.

Key Takeaways

S&P Global Mobility

- The automotive industry is undergoing a transition from domain architecture to centralized compute units (CCUs) in SDVs. This shift is accompanied by the increasing software component in vehicles, which requires more powerful chips and a focus on software architecture.
- The transition to CCUs presents opportunities for customization, infotainment and user interaction in SDVs. The vehicle operating system (OS) plays a crucial role in ensuring software stability and reusability, enabling efficient software upgrades and enhancing the user experience.
- Challenges in SDV design include aligning software development with hardware and OS changes, ensuring functional safety and cybersecurity, and effectively managing software-related changes. OEMs are actively engaging in the development process and exploring new collaboration models with suppliers to deliver high-quality products and enhance ecosystem integration.



Question 1

S&P Global Mobility

S&P Global Mobility:

Could you give us your thoughts on the architectural transformations that SDVs are undergoing, specifically the shift from domain architectures to centralized ECUs [electronic control units], and the potential impact on vehicle operations?

NIO:

"The automotive industry is undergoing a transition from domain architecture to CCUs, with companies like [NIO] at the forefront of this shift. This change is accompanied by the growing software component in vehicles, which requires more powerful chips.

As software complexity continues to increase, the role of the operating system (OS) becomes increasingly crucial. It goes beyond just the Android infotainment OS and includes embedded OS to serve as key layers that abstract the physical hardware capability. The industry is recognizing the growing importance of software architecture, which often follows a layered approach similar to smartphone software.

This transition involves integrating or consolidating small ECUs into larger ECUs, making the vehicle software more prominent. Computing power sharing among multiple function domains ([for example,] smart cabin and autonomous drive) will become common in the future. The software within these ECUs is becoming more powerful and complex, underscoring the significance of the operating system. As software architecture becomes more intricate, there is a greater emphasis on software modularization and usability. These changes collectively signify the industry's shift towards a software-centric architecture in cars."

Question 2

S&P Global Mobility

S&P Global Mobility:

We are interested in how SDVs are reshaping the in-vehicle experience. Could you elaborate on the opportunities and challenges this presents for customization, infotainment and user interaction?

NIO:

"[NIO], a user-centric enterprise, places a strong emphasis on prioritizing the user experience in their vehicles. As the automotive industry undergoes a transition from domain-centric to centralized or SDV architectures, there is an increasing focus on software. However, regardless of the architecture, the user experience remains a top priority.

The vehicle OS plays a critical role in ensuring software stability and reusability. It enables the abstraction of hardware capabilities and the reuse of software modules, reducing the cost of adapting to hardware changes. This means that hardware modifications no longer necessitate rewriting the software, leading to greater efficiency.

The industry is also actively promoting software component reuse, similar to building multiple vehicle modules on a single platform with similar designs and segments. This approach reduces production costs for new vehicles and encourages the reuse of software components. The introduction of service-oriented architecture (SOA) facilitates better cross-domain function interaction, increasing reusability. These advancements in software architecture and integration ultimately contribute to an enhanced user experience in SDVs."

Question 3

S&P Global Mobility

S&P Global Mobility:

What challenges have you encountered in SDV design, including system architecture, security, safety and failure prevention? How are these challenges being tackled?

NIO:

“In the automotive industry, one of the significant challenges we face is the simultaneous evolution of hardware, operating systems and software in new architectures. This presents a unique challenge compared to traditional software development for vehicles. To improve delivery efficiency, it is essential to address the simultaneous technology changes occurring in different layers, such as hardware, operating systems (OS), and software modules. However, this poses challenges in aligning the software/hardware development and delivery processes. For instance, the introduction of new chips or smart hardwares necessitates software change and could also impact the OS compatibility. To effectively manage these changes, the delivery team must undergo process and organizational structure adjustments [and] adapt their capabilities to suit the evolving landscape. These adaptations are vital for ensuring the efficient and seamless delivery of software updates and enhancements.”

Question 4

S&P Global Mobility

S&P Global Mobility:

How do you perceive the automotive industry's response to the increased risks of safety-related software crashes and remote cyberthreats in SDVs?

NIO:

“To effectively address cyberthreats in the automotive industry, it is important to prioritize both functional safety and cybersecurity. This can be achieved by having professionals in the safety/security department who specialize in ensuring the safety/security of every phase of the product life cycle, including functional design, development, testing, validation and even post-deployment operation. These dedicated experts play a vital role in mitigating cyberthreats and ensuring the safety and security of automotive products.

Given the evolving nature of software-related challenges, continuous efforts are being made to tackle these issues effectively. The automotive industry is committed to addressing cyberthreats and safeguarding the integrity and security of its products.”

Question 5

S&P Global Mobility

S&P Global Mobility:

Could you provide some insight into the division of software development between the OEM and suppliers?

NIO:

“One such model involves delivering black box hardware and software together, providing a comprehensive solution.

To foster deeper interaction and collaboration, some OEMs are moving away from the traditional black box approach and actively engaging in the development process. This includes sending personnel to conduct process checks and review intermediate deliverables, ensuring adherence to quality standards throughout the development process.

Looking ahead, there is potential for new collaboration models, such as suppliers adopting OEMs' operating systems, [developing] software and [enhancing] their hardware offerings. This indicates a significant evolution in ecosystem integration.”

Question 6

S&P Global Mobility

S&P Global Mobility:

How do you see large language models (LLMs) transforming the automotive industry and its business models? What potential applications could we anticipate in the automotive sector?

NIO:

“The integration of LLM AI ChatGPT in new car models in Greater China is expected to bring new features and enhance the user experience. LLM enhances user experience such as a voice assistant and smart companion within the vehicle, with the potential to provide exciting experiences that have yet to be discovered. While Greater Chinese companies are currently experimenting with the adoption of LLM in cars, it is still too early to determine their exact impact. These adoptions are likely in the experimental stage, and the ultimate value they will bring to vehicle users is yet to be fully understood. The broader impact of LLM in vehicles remains unknown.”

Question 7

S&P Global Mobility

S&P Global Mobility:

What is your perspective on SDVs and the key factors that differentiate OEMs in the future?

NIO:

“OEMs play a critical role in the automotive industry as key differentiators. They distinguish themselves by building robust software architectures and integrating innovative technologies to provide a user-centric experience. Their focus is on meeting the specific needs and preferences of users, particularly in the development of autonomous drive and smart cabin experience for SDVs. By excelling in these software capabilities, OEMs can deliver innovative features that enhance the overall user experience.

As someone with a software background, I understand the increasing significance of software in vehicles. The domain-centralized architecture already incorporates a substantial amount of software, especially in the smart cabin and autonomous driving domains. However, the emphasis on software has grown because we recognize that the entire vehicle, beyond just autonomous driving and smart cabin aspects, relies heavily on software. This growing importance and reliance on software enable better functionality of smart vehicles and greater efficiency.

Nevertheless, the shift towards software presents challenges for OEMs in terms of software capabilities and managing software-related changes. It requires OEMs to enhance their software capabilities and effectively manage software-related changes to meet the evolving demands of the industry.”

Moderator

Matthew Beecham

**AutoTechInsight Research Manager,
Supply Chain & Technology,
S&P Global Mobility**

Matthew Beecham is a research manager for
S&P Global Mobility's AutoTechInsight platform.

Matthew brings almost three decades of industry knowledge and an extensive network to his role. His expertise spans ATI domains, providing shop floor insights and conducting high-level interviews.

He has worked for GlobalData plc, Just Auto, HORIBA MIRA, Economist Intelligence Unit (EIU), McKinsey, AT Kearney, and Supplier Business, a predecessor of ATI.

Matthew's academic credentials include a PhD in Automotive Technology Transfer from Cranfield University.

Fanni Li

**Principal Research Analyst,
Automotive Supply Chain & Technology,
S&P Global Mobility**

Fanni is Principal Research Analyst focused on Connected Car and related technology at S&P Global Mobility. Her responsibilities include China market research and analysis of digital cockpit and connected car, as well as global market analysis of over the air updates, connected services and vehicle software paid updates.

Fanni has more than 10 years working experience in automotive industry with engineering background. Prior to joining S&P Global, she worked for global OEM engineering centre in China for several years focusing on project management and product development of infotainment domain products.

Fanni holds a Master of Engineering in Mechatronic System from University of Technology of Compiegne in France, along with an MBA from University of Canberra.

Partner

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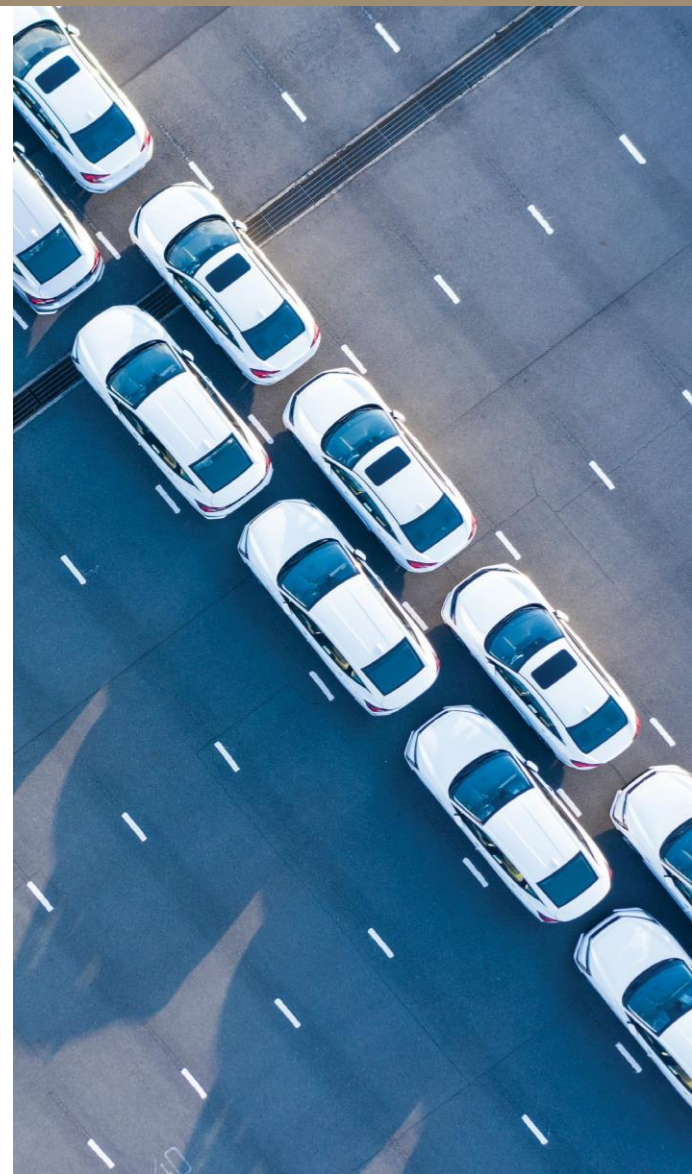
Lucas Huang

Senior Director and Senior Expert of Digital Program Management

NIO

Mr. Huang is an agile software R&D expert and former McKinsey digital expert. In the past 10+ years, he has helped several Fortune 500 companies in finance, telecom, SaaS, Internet and other industries to transform from traditional R&D model to user-centric agile R&D organization, as well as digital business innovation.

Currently at NIO, he is responsible for whole vehicle software delivery and R&D systemization efficiency improvement.



Corporate Profile

S&P Global
Mobility

S&P Global Mobility

S&P Global Mobility enables customers to anticipate change and make decisions with conviction.

We help them to optimize their businesses, reach the right consumers, and shape the future of mobility. Leveraging technology and data science, we provide unique insights, forecasts and advisory services spanning every major market and the entire automotive value chain—from product planning to marketing, sales and the aftermarket.

With a legacy dating back to the 1920s when R. L. Polk published the first vehicle registration reports, our solutions are used by nearly every OEM, more than 95% of tier one suppliers, media agencies, governments, insurance companies, and financial stakeholders to provide actionable insights that enable better decisions and better results.

NIO

NIO is a global smart electric vehicle company. Founded in 2014, NIO has been committed to shaping a joyful lifestyle by offering high-performance smart electric vehicles and ultimate experience. Nine years into establishment, NIO is one of the leading companies in the global premium smart electric vehicle market, and also the first car company listed on the NYSE, HKSE and SGX.

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