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POV

Transforming the Auto Industry with Software-Defined Vehicles

Overview

Automotive innovation has accelerated over the past decade, reshaping the traditional OEM-centric 'Tiered Model' value chain. The entry of digital-born companies and evolving customer preferences have shifted the focus toward a customer-centric ecosystem. This shift necessitates full digitization of the end-to-end value chain.

Automakers are now adopting innovative strategies to meet higher customer expectations, deliver feature-centric products, and manage cost pressures. This requires a resilient supply chain, rapid prototyping, agile product development, and over-the-air feature deployment.

To provide customer-centric features, automakers need a scalable, integrated, and resilient architecture with software at its core. This enables the management of diverse data, industrialization of AI/ML at scale, democratization of insights, and transformation of business models and processes.

The concept of a software-defined vehicle, popularized by TESLA's subscription-based offerings and OTA updates, has become a differentiator. While some OEMs have adopted a platform-based approach, others remain cautious. The transition to a software-defined product is challenging, but the upcoming sections will explore its building blocks, the emerging ecosystem, and new business models.

Evolution of major automotive trends

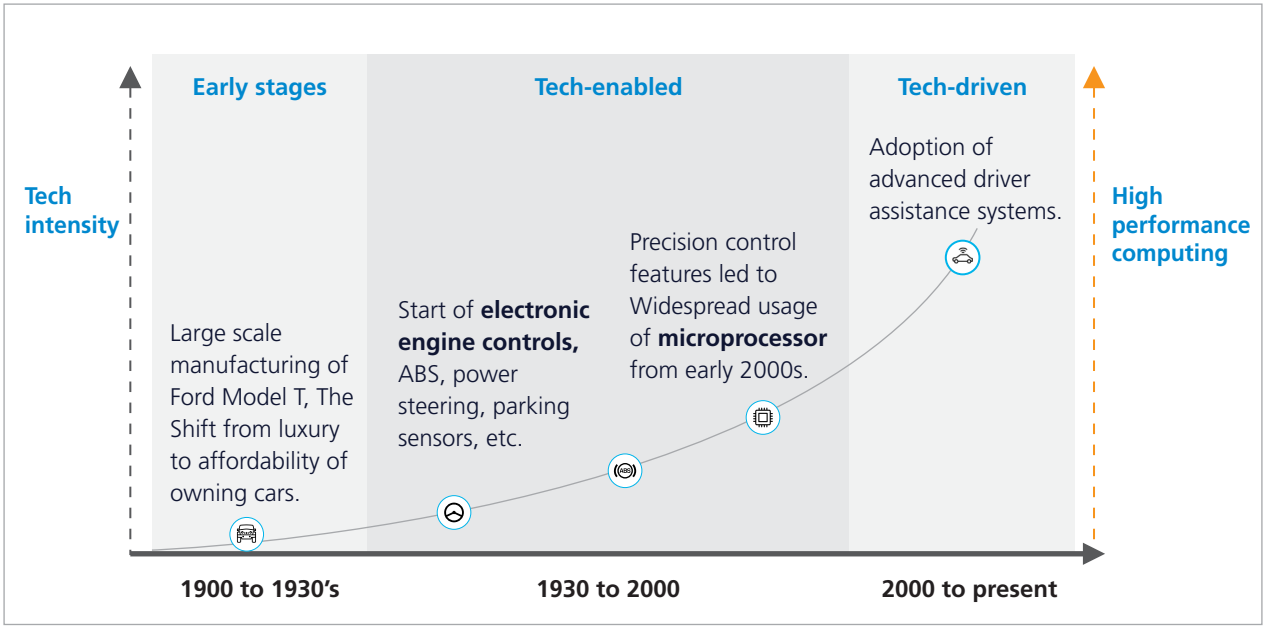

Figure 1: Evolution of major automotive trends

Technology is accelerating at a breakneck pace, transforming vehicles into 'Supercomputers on Wheels.' What was once a luxury, such as - a vehicle with 100 ECUs running 100 million lines of code, is now a necessity in modern vehicles.

As vehicles evolve into digital platforms, OEMs face immense pressure to reinvent their business models. The shift towards service or subscription-based models, driven by changing customer expectations and experiences, poses significant challenges for traditional OEMs.

But what sparked this shift from horsepower (BHP) to gigahertz (GHz), or to put it another way, the digital experience? Let's delve into that.

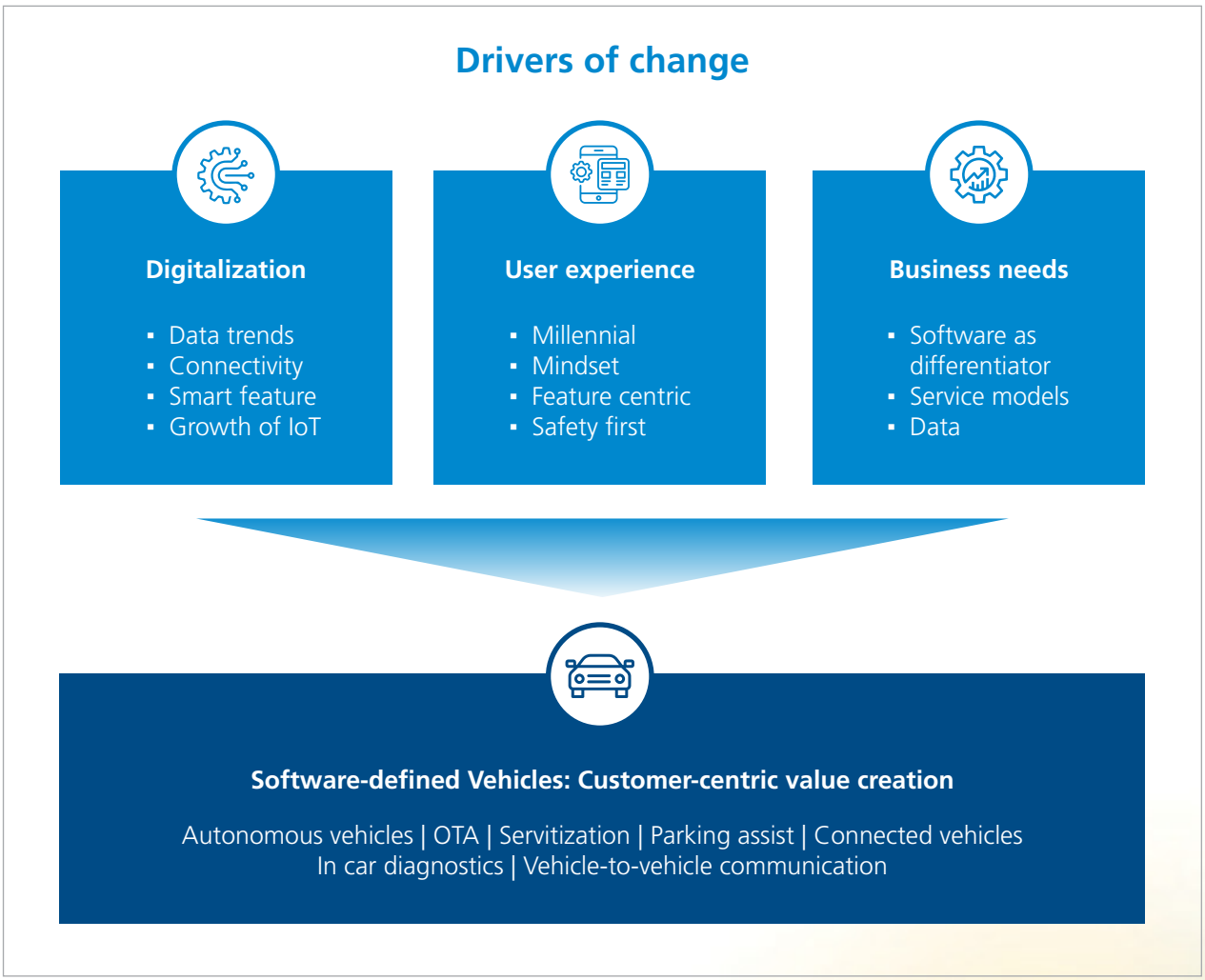

Figure 2: Drivers of change: shift from horsepower (BHP) to gigahertz (GHz)

Changing value stream in software-defined vehicles

Tech players have a significant role in shaping the value chain of automobiles. The emergence of new players and startups focused on the research and development of new digital products etc., will now have a major share in the automotive world along with OEMs. This has enabled new scenarios that OEMs have or are contemplating the following options:

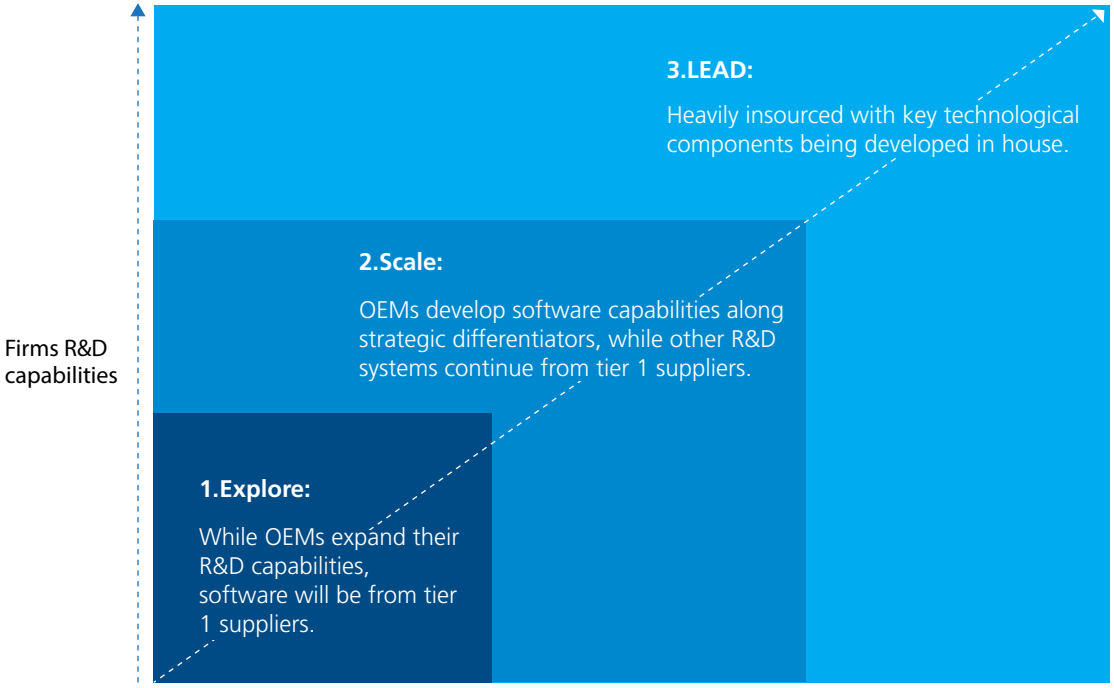

Figure 3: New scenarios for OEMs

Scenario 1- Explore:

OEMs may require time to evaluate and set up their in-house software capabilities. They will first explore by collaborating with tech giants or emerging startups while they actually develop their internal ecosystem. To begin with we can quote the example of Blackberry QNX, the most popular software integrated into many OEM vehicles.

Scenario 2- Scale:

Moving away from the Tier 1 suppliers and starting to build your own platform, which will be the differentiator in the near future. In this process, OEMs may also carve out software units that will accelerate software development and create unique experiences for customers. Toyota has announced the launch of its own software platform, Arene, which was developed and maintained by Woven Planet Holdings. Toyota has plans to monetize its vehicle OS and open Arene to developers.

Scenario 3- LEAD:

TESLA, the decade's leading self-driving car, developed its software and powertrains in-house. Despite challenges, this vertical integration, with software at its core, was a conscious decision. The Self-Driving Vehicle (SDV) ecosystem, teeming with various tech players, will continue to expand. As new business models emerge, collaboration and fresh participants will shape the future, gradually phasing out the traditional tiered supply model.

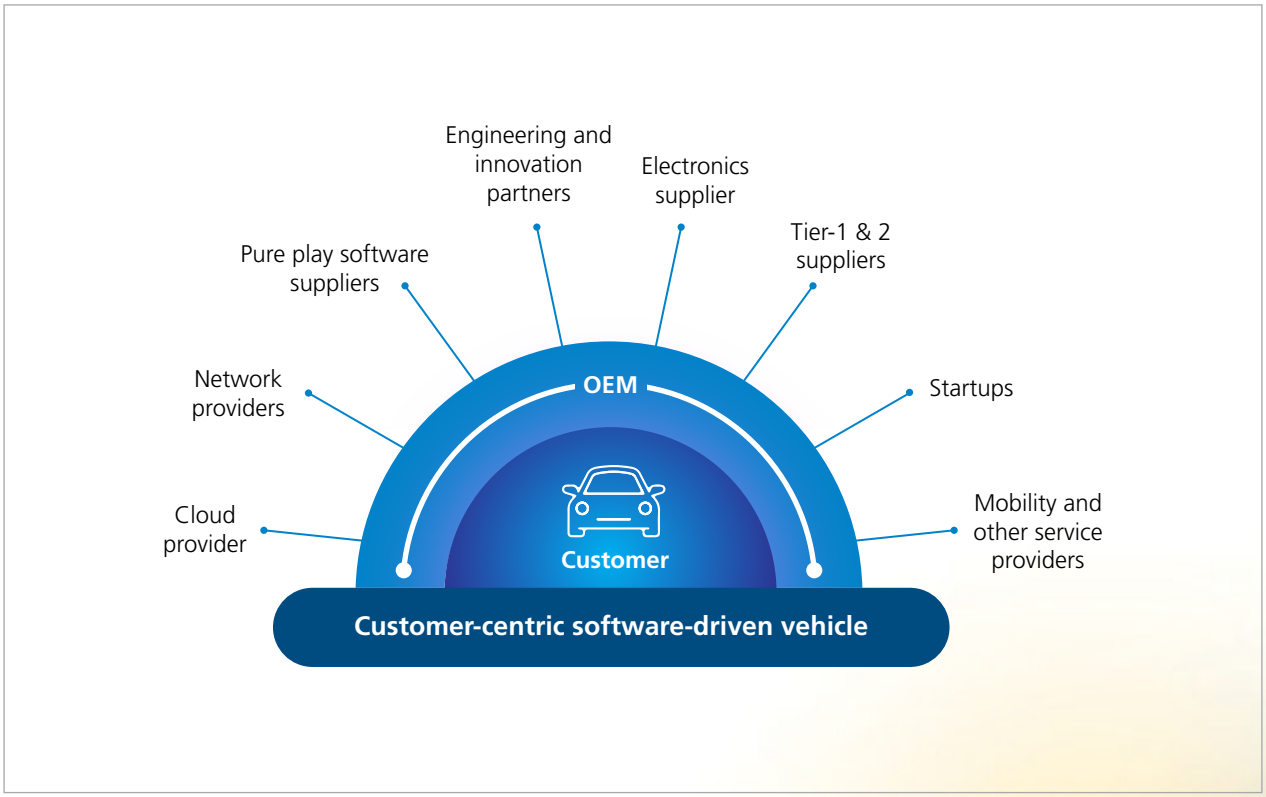

Figure 4: Customer-centric software-driven vehicle

Software-oriented architecture: The differentiator going forward

The evolving ecosystem in the automotive has to be backed up by a compatible electrical/electronics (E/E) architecture. The need for increased computing power, simplified E/E architecture, self-driving capabilities, etc., has set the foundation for the transition toward a software-driven architecture. The following figures will highlight the evolution of E/E architecture towards software-defined.

Stage 1: Distributed systems architecture: Group of function-specific ECUs connected via a central BUS.

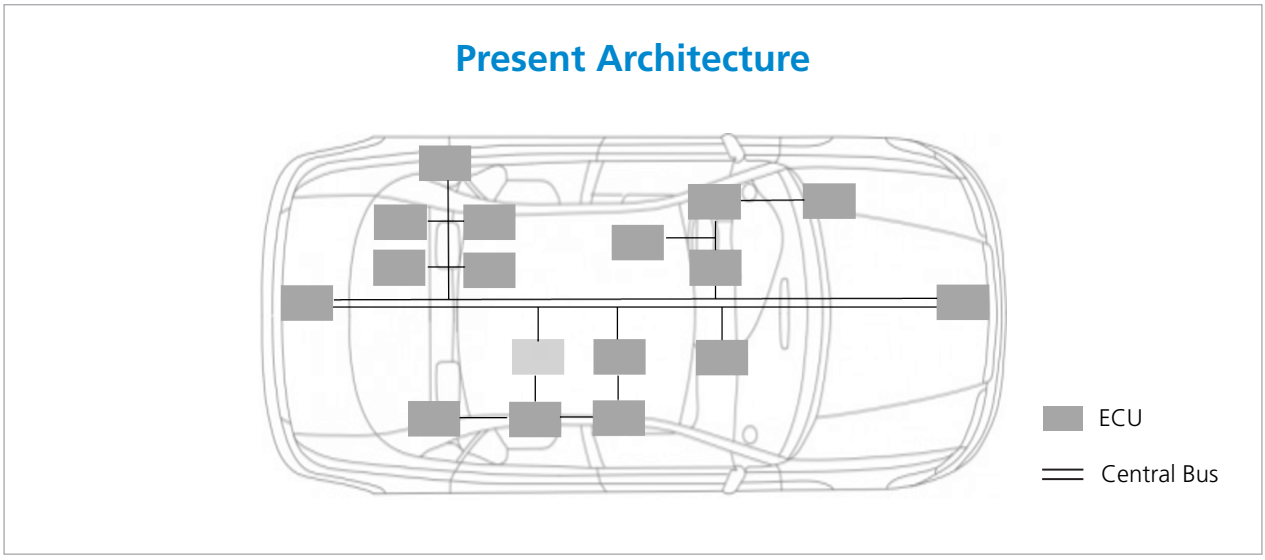

Figure 5: Distributed systems architecture

The distributed architecture connects the individual ECU via a central bus. The embedded systems are not completely integrated and are not scalable for cloud-based applications and V2X communications leveraging 5g networks. As the requirements increased, the number of ECUs also increased, making the systems much more complex and leading to the evolution of domain-based Architecture.

Stage 2: Domain-led functional architecture: Function-specific ECU connected to the domain controller

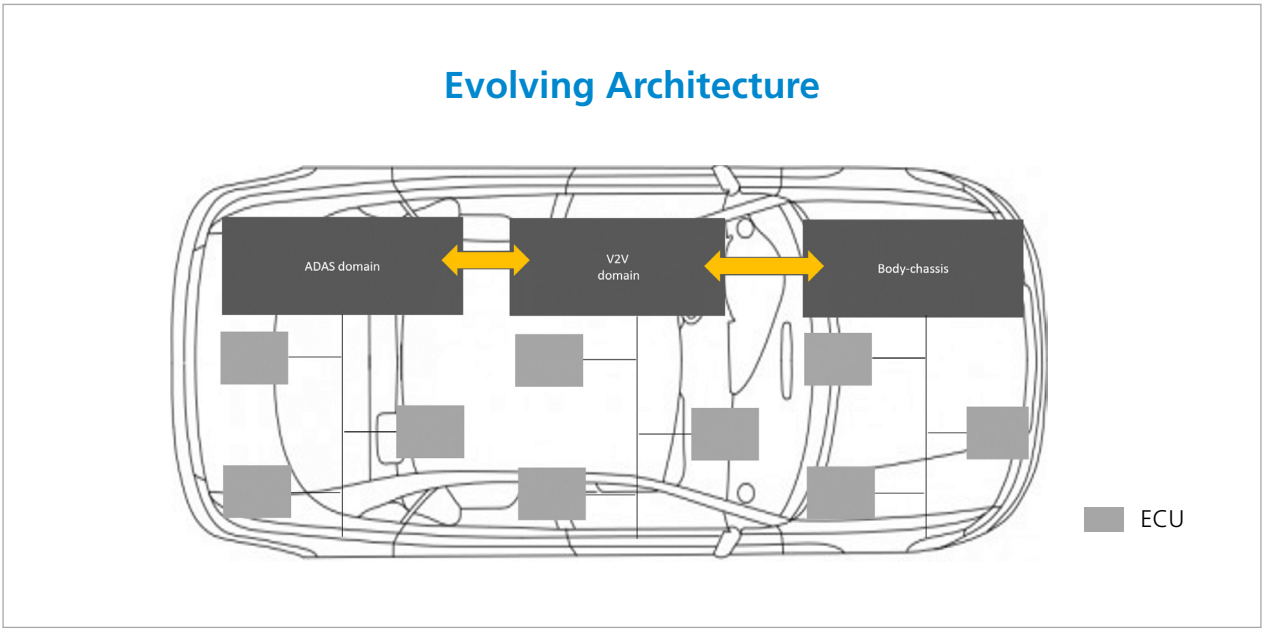

Figure 6: Domain-led functional architecture

The grouping of functional ECUs into a domain reduced the complexities involved in the distributed architecture. This enabled OEMs to reduce the vehicle's weight, use sensors and allied components, and partially solve the integration capabilities. However, as demand increased for sensors and actuators, interdependencies between domains also increased, leading to a centralized computing system.

Centralized software-defined zonal architecture

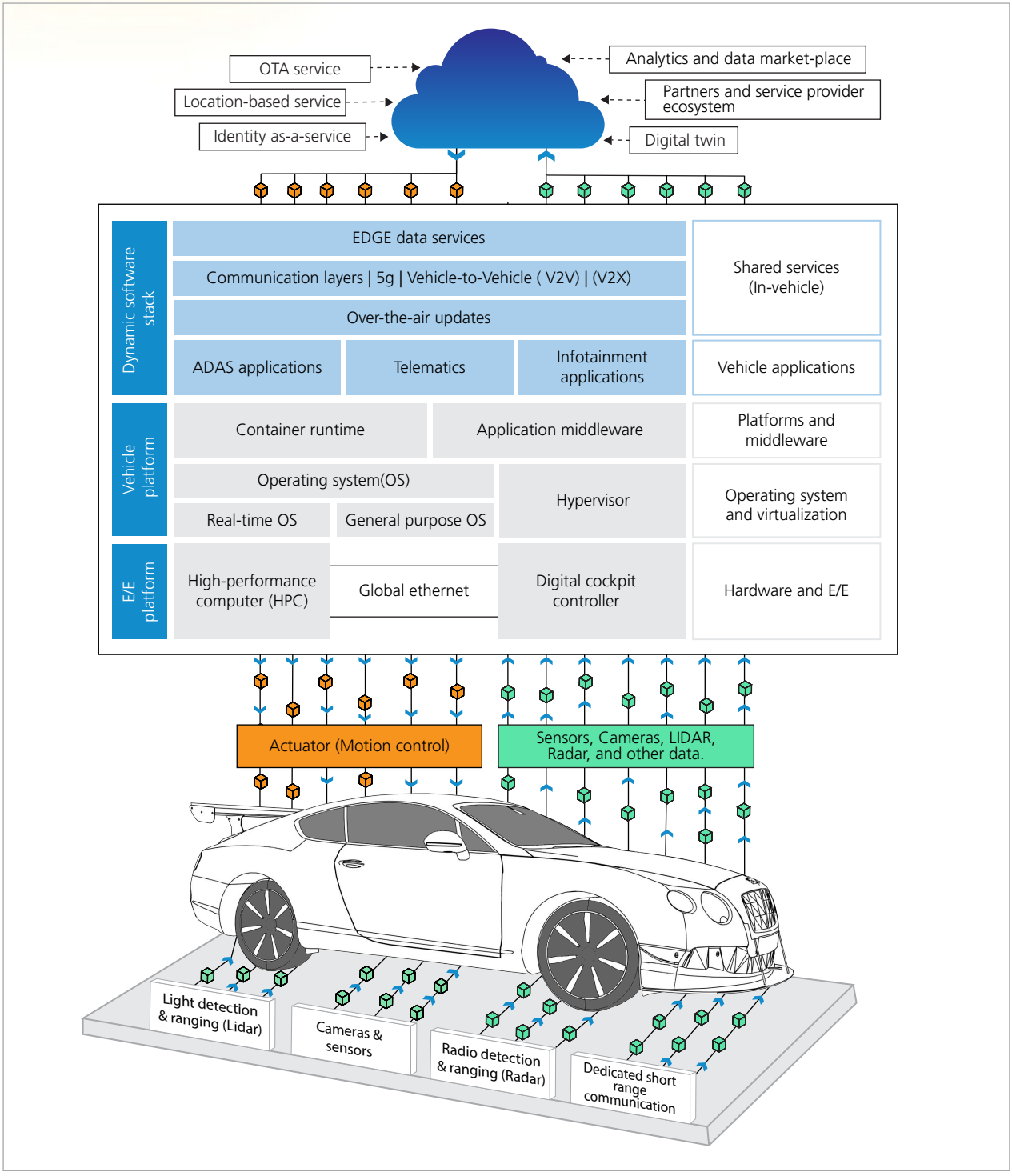

Figure 7: Centralized software-defined zonal architecture

Why would the automakers move towards zonal architecture?

The vehicles are divided into zones, while the allied sensors and actuators are based on proximity, thereby enabling minimal processing of sensor data and realizing the corresponding actuator functions for motion control. This enables minimal wiring as zones are connected via high-speed ethernet, which transfers data to a central computer- a high-performance computing platform. Also, Hypervisors enable multiple operating systems to run simultaneously on a single system on a chip (SoC).

This architecture is better suited to leveraging cross-functional aspects across multiple domains and software layers. This helps automakers increase the reusability of developed software components (no worries about hardware-software computability), develop rapidly, deploy via OTA, improve continuously, etc.

Role of the cloud in continuous software development

As OEM focus shifts to faster adoption of technology and more convenience for its customers, cloud-based development and deployment will be more suited. Consider the below user journey of a software-intensive vehicle architecture:

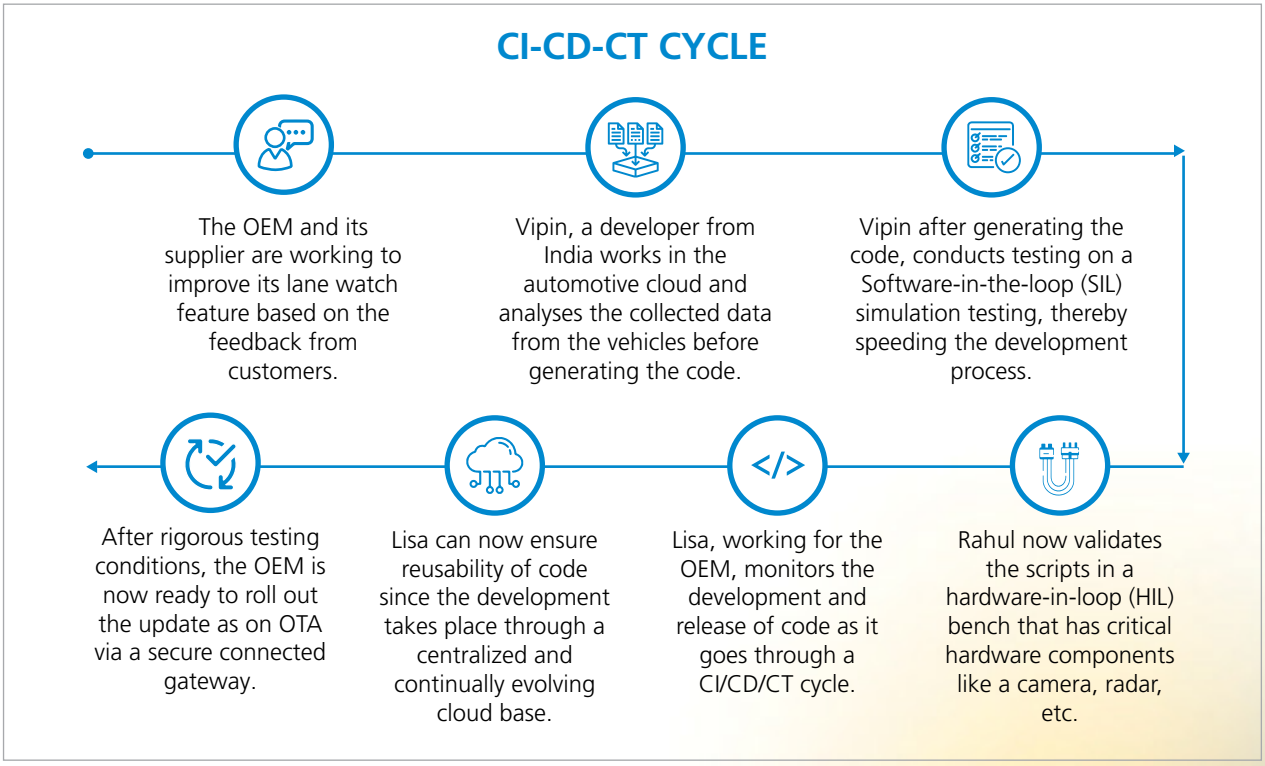

Figure 8: User journey of a software-intensive vehicle architecture

Software platform enables differentiated service offerings

With OEMs' increased focus on differentiation with the SDV platform, subscription services will become a major contributor to revenues. Soon, OEMs will target an increased share of revenue from paid OTAs or optional service packages.

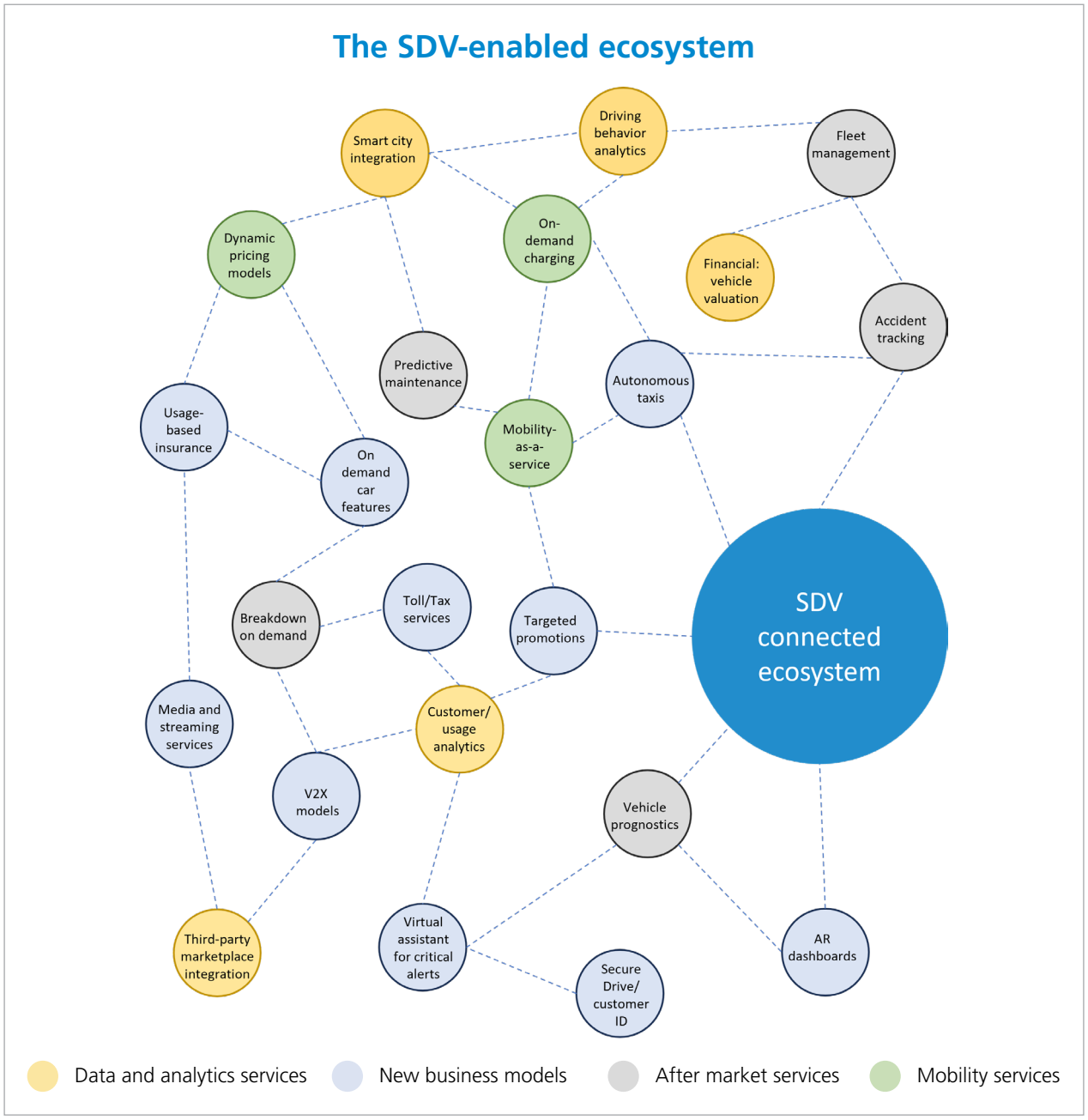

Figure 9: SDV-connected ecosystem

The future of the automotive Industry: Software-enabled vehicles

Technological disruption is reshaping the automotive sector. Software's role in product development is pivotal, involving diverse players and startups. Established and emerging players will adopt unique approaches towards Software-Defined Vehicles (SDVs). This dynamic landscape demands robust changes, with software architects playing key roles in decision-making. Empowered leadership and strategic roadmaps are essential to navigate these changes, with a focus on customer needs. The industry's reinvention will be driven by both existing OEMs and digital-born newcomers, heralding a software-enabled future.

Author bio

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Arvind Ragu is a seasoned professional with over nine years of multifaceted experience in the manufacturing sector. He has held key positions in Automotive OEMs, contributing significantly to their growth. His expertise spans Lean manufacturing, new product development, digitalization, and product engineering. He holds a management degree from the prestigious IIM Calcutta. After his graduation, he has been deeply engaged in providing solutions and consulting services to our automotive clients. His work focuses on digitalization, generative AI, and other disruptive trends shaping the automotive industry.

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