Software-driven Mobility

Deliver the new mobility experience

Capgemini

Executive summary

Two-thirds of automotive respondents to a recent survey regard software as critical to their future product/service strategy and roadmap. For the automotive industry, that means it is vital to succeed at software-driven mobility (SDM*) – and do so via a rapid, yet controlled, process of software-driven transformation (SDT*) delivering software-defined vehicles (SDVs*) and associated mobility services.

SDVs, SDT, and SDM are pressing imperatives for several reasons, including the following:

- Due in part to familiarity with new mobility models such as ride-sharing, micromobility, and subscription-based services, today's end-customers increasingly expect seamless mobility experiences rather than focusing on individual vehicle ownership. These expectations can only be met through SDM, which lays the foundation for delivery of new services to create attractive mobility experiences.
- SDT provides powerful control over existing product complexity. Via SDVs, it becomes possible to drastically standardize and efficiently manage the complexity of vehicle architecture, and simplify electrical/electronic (E/E) hardware.
- Increased use of software abstraction* in SDVs increases flexibility and maintainability, and smoothly bridges onboard and offboard environments. Customers can still be given plenty of choice and personalization via software.
- SDT and SDM bring immense revenue potential for the OEM, for example in terms of continuously offering relevant new services and keeping them up to date throughout the vehicle lifecycle, as well as via data monetization.
- SDT helps with sustainability by simplifying the implementation of targeted services (for example, measuring the influence of driving style on energy consumption), as well as facilitating the collection of data needed for these services.

*defined on page 5

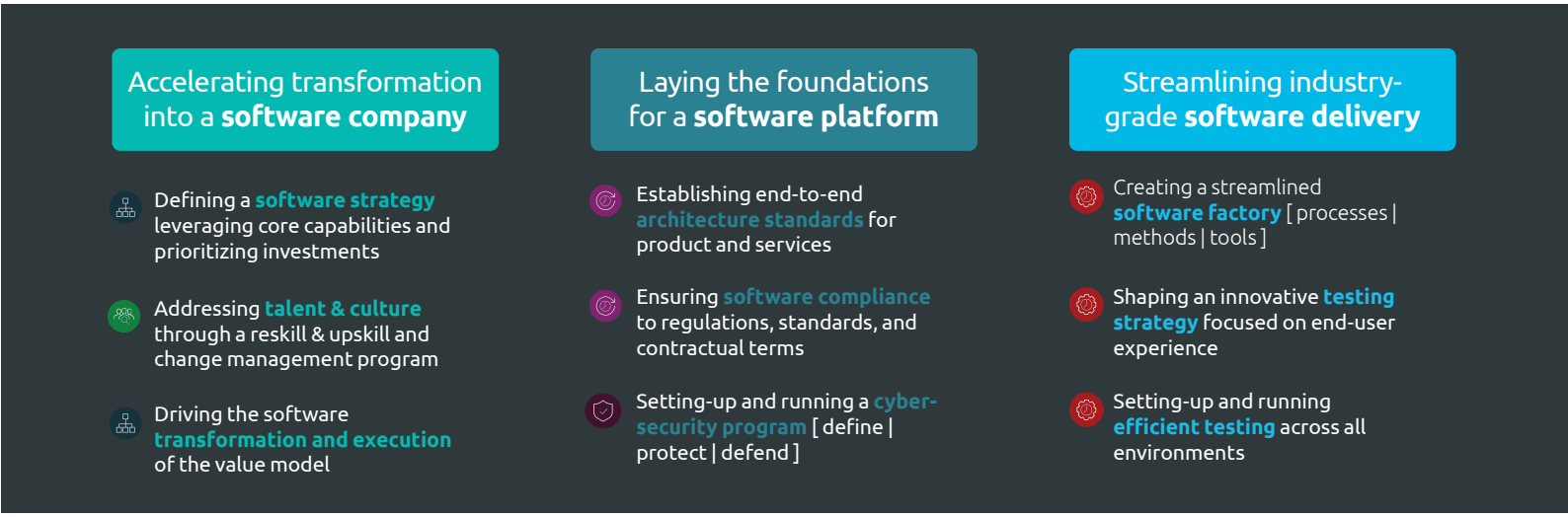
More because of their culture and practices than their technology legacy, traditional OEMs are typically finding it difficult to catch up with digital-native newcomers in the race to SDM. Although they acknowledge software as an enabler of future success and profitability, they often try to carry out their SDT incrementally and in-house – an approach that has proved unable to deliver at the necessary pace.

Now, however, established players are realizing that they can only achieve the necessary speed of transformation through collaboration with the wider mobility ecosystem, and with the right specialist partners.

To regain the lead, traditional OEMs need two things: a structured approach and collaboration within the mobility ecosystem*.

The **structured approach** should enable the company to leverage both its proven strengths and those associated with digital natives. It must combine the skills and practices of established IT with new digital ones, and also with those of manufacturing and vehicle engineering.

There are three key enablers of transformation to SDM. These are: accelerating transformation into a software company, laying the foundations for a software platform, and streamlining industry-grade software delivery.



Effective collaboration with the mobility ecosystem – with the right frameworks and controls in place – enables an OEM to make a wide range of facilities available to customers in a short amount of time. Partners should include specialists that can fill any shortfalls in in-house skills and capabilities and that help customers integrate their digital life.

Although this journey requires significant preparation, steps can be taken now to rapidly address current or imminent pain points, for example:

- A maturity assessment against market baselines
- A roadmap to guide the company to its desired future
- A skills analysis to identify gaps that need filling

By adopting the right structured approach and fully leveraging the mobility ecosystem, traditional OEMs can deliver the mobility experience that users expect. That way, they can catch up with – even overtake – new market entrants.

*defined on page 5

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01 Definitions of terms used in this report

Abstraction:

An operational construct within a system that, for a given set of services, hides implementation details that do not need to be known to use those services.

For example, if users of postal services know two abstractions – addresses and mailboxes – they needn't understand how letters or parcels are processed, sorted, and distributed.

Abstraction enables software engineers to process highly complex solutions while keeping individual components reasonably simple. It also becomes possible to correct or upgrade systems with minimal disruption (in the postal example, a processing center can be changed without affecting customers' processes).

Application Programming Interfaces (APIs) are practical implementations of abstraction, which is also central to object-oriented programming, service-oriented architecture / micro-services, and the services making up the Internet.

Mobility ecosystem:

The totality of entities across (and sometimes beyond) the global mobility industry, working together to help move people, goods, or any combination of these, and with the connections between them enabled by software. Collaboration can exist without a formal partnership; for example, an OEM may provide frameworks, standards, and safeguards enabling any third-party service provider to offer their services to the OEM's customers.

Software-driven mobility (SDM):

The provision of mobility products and services within the new environment of the mobility ecosystem. Everything that happens within this environment is enabled and integrated by software.

Software-driven transformation (SDT):

The change that the industry and individual companies need to undergo to fully realize SDM, including the strategy, skills, culture, and so on that are required.

Software-defined vehicles (SDVs):

Vehicles for which most of the capabilities previously delivered by electronic hardware are implemented in software, providing the ability to continuously evolve, integrate with a wider mobility ecosystem, and better manage complexity.

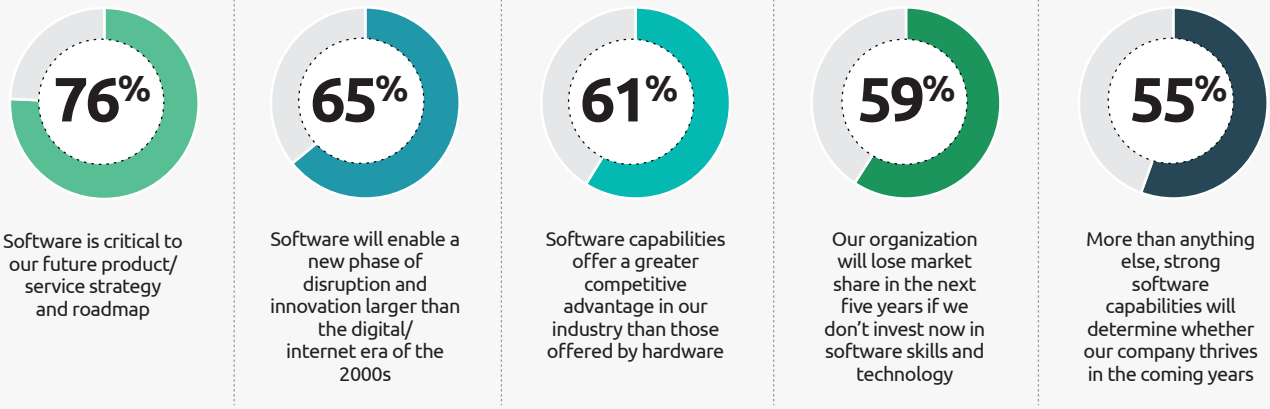
As well as hardware consolidation, SDVs are characterized by software application abstraction, where software infrastructure handles deployment, roll-out, and roll-back for code, and components provide abstraction for transparent communication, both onboard and offboard. SDVs are the building blocks of SDM.

02

Introduction: Why software-driven mobility, and why now?

Software is redefining the automotive industry. Automakers now largely share this conviction, with 76% of automotive industry respondents to a recent survey[1] saying that software is critical to their future product/service strategy and roadmap.

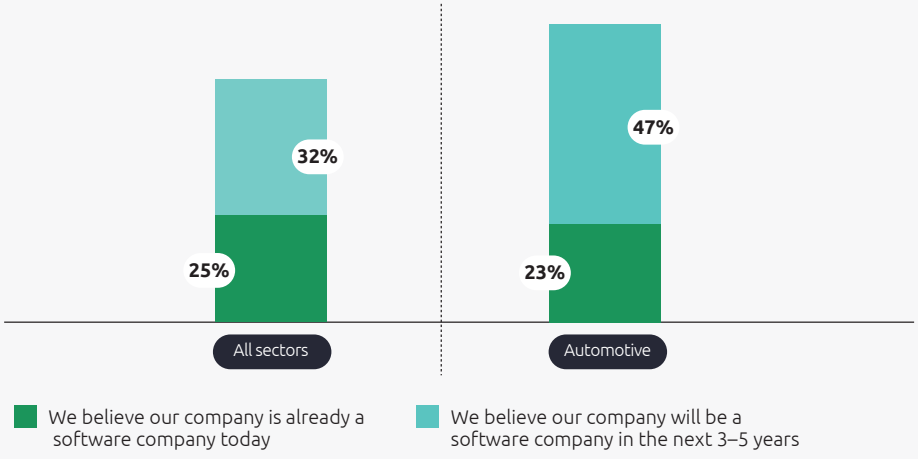
% of automotive organizations agreeing to the statements below



Based on these expectations, automotive organizations are striving to reinvent themselves as software companies – i.e. they are reconstructing their business models around software and, in doing so, transforming their business processes, organizational structures, and revenue models. They are investing in this area, too, though probably not as much as they should. Currently, 19% of automotive companies' R&D spend goes toward software.

Their confidence about achieving these goals is sometimes limited, however. Less than half (47%) of automotive companies believe they will be a software company within the next three to five years, and just 23% believe they already are one.

% of organizations agreeing to the statements below



For the automotive industry, meeting the aim of becoming a software company boils down to one thing: a shift to SDM.

[1] Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023

> *We are… on a journey to become a software company. We will put supercomputer-like performance into every single Mercedes.*
>
> **Ola Källenius,**
> CEO, Mercedes-Benz.[2]

What do we mean by software-driven mobility?

Increasingly, the automotive industry's end-customers expect mobility experiences, not just products. As a result, we are moving toward a world where an ecosystem of providers collaborate to offer complementary products and services that move people and goods seamlessly to where they need to be, with all processes enabled, fueled, and orchestrated by software. SDVs are a key element of this SDM.

Pivoting to SDM is essential to future success and profitability for automakers. This pivoting process is called software-driven transformation.

Currently, however, the leaders in SDM are new market entrants who are digital natives, and know how to work with the wider ecosystem. Their leadership extends to both setting the new standards for customer experience, and providing the solutions to deliver them. Most traditional automakers are trying to achieve transformation incrementally and largely in-house – an approach that has proved unable to deliver in the required timeframe.

Traditional OEMs can forge ahead of the newcomers if they accelerate their SDT. To do so, they need:

- A structured approach that combines the skills and practices of established vehicle engineering with new digital ones.
- Effective and open collaboration across the mobility ecosystem, including with specialist partners that can fill any shortfalls in in-house skills and capabilities required for delivery of SDM.

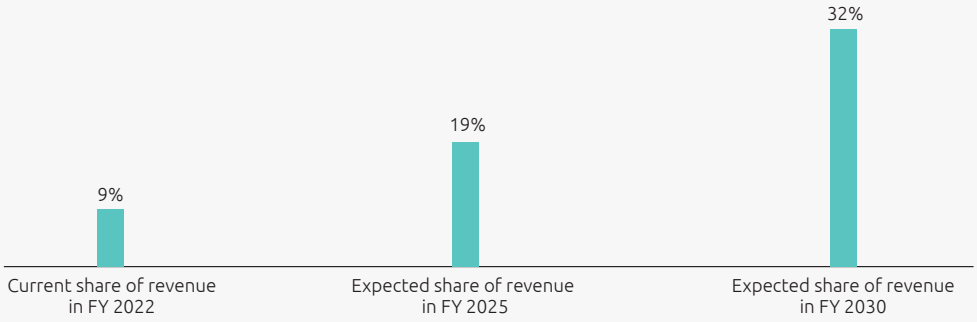
[2]Source: The software report, "Already a leading car maker, Automotive sector Mercedes-Benz wants to be an innovative software company," May 2, 2023.

Automakers can realize dramatic bottom-line improvements

Providing SDM has immense revenue potential, mainly because customer interactions move from one-off purchases to full lifecycle engagement. Virtually every journey will bring significant new selling opportunities, from better car-sharing to ADAS features to support specific driving conditions such as mountainous terrain.

It is not surprising, therefore, that by 2029 software is expected to represent 32% of revenue, compared with 9% currently, according to our recent survey.

Automotive organizations' software-based revenue is expected to grow to around 32% by 2030



There is also the potential to monetize the data gathered from SDVs, both by using it to offer new services and (subject to privacy considerations) by sharing it with third parties.

These opportunities should more than offset any losses of revenue in the evolving business environment, such as a decline in vehicle sales arising from shared mobility models.

Some automotive organizations are already reaping significant benefits

Companies are seeing benefits right across the value chain from reorienting around software. As many as 90% of respondents to our survey have achieved new revenue streams based on software-defined products, with faster R&D of existing products and services mentioned by 74%, and other advantages close behind.

90% **New revenue streams based on** *software-defined* **products**

74% *Faster R&D* **for existing products and services**

61% **Competitive** *advantages* **(e.g. increase in market share)**

61% **Improved** *customer experiences*

But they know there's much more to be done. Drawing on experience and research from across Capgemini, this report proposes a way to accelerate the process, reduce risk, and maximize benefit.

03 Rapid action on software-driven mobility is imperative

> *Stakeholders in this industry face huge investments in relation to electrification and the move to software-defined vehicles. Those pressures, together with constraints arising from sustainability concerns and geopolitical conflicts, mean that optimization is required. But this is already a highly optimized industry, and so it's essential to add value as well. And that means adding services – which realistically can only be achieved by refurbishing the vehicle's entire software architecture.*

Alexandre Audoin,
Global Head of Industries,
Sales & Portfolio
Capgemini Engineering

Diverse mobility solutions are needed to meet new customer expectations

Leading automakers are realizing that they need to move on SDM right now if they are to safeguard their long-term success.

The introduction pointed to several reasons for this realization, but the most fundamental one is the need to adjust to a new environment – one where customers have completely different expectations than those of ten or even five years ago. Where have these new expectations come from?

First of all, we have seen the emergence of diverse mobility solutions such as ride-sharing and ride-hailing, shared and subscription-based fleets, and micromobility facilities such as electric scooter hire. In the commercial vehicle sphere, there's a range of goods delivery options, both general and specialized.

Such solutions provide experiences that are intuitive and easy to use, hyper-personalized, seamlessly integrated, and always up to date. In addition, users are able to balance service quality against environmental impact considerations.

As a result of exposure to these mobility solutions, when customers invest in a vehicle, they expect a new kind of experience: a reliable, frictionless mobility experience that will be sustained over time. This observation is particularly true of digital-native users, who have grown up with this kind of solution.

This expectation about experience comes with others. For example, the experience needs to be consistent across all the relevant interfaces, whether in-vehicle, mobile, or web. And users also want advanced driving assistance to reduce accident risks, and to enable them to engage safely and legally in in-vehicle activities that are not directly related to mobility. That is part of a wider expectation that high standards of safety and reliability will be enforced, along with privacy and end-to-end cybersecurity.

The key to meeting all these expectations is software, because it is the key to putting today's customer expectations at the heart of the mobility experience.

It follows that OEMs can only meet all those new user expectations by pivoting – much faster than most of them are currently doing – toward working with the wider mobility ecosystem, in a way that ensures software is always up to date and seamlessly integrated. This is the only way to ensure continued success with SDM, and to sustain the value of the vehicle to the user and to the market.

The mobility ecosystem exists already, but until now traditional OEMs have not been able to exploit it fully, whereas new entrants have been, in general, more successful. That is because such collaborative working is business as usual in the digital world from which these new players have emerged.

Software-driven mobility supports multiple goals

Clearly, SDM is vital because it is the only way to give today's end-customers the experience they want while efficiently managing complexity – whether it already existed or is caused by these new expectations. But there are other reasons why OEMs need to achieve SDM, and quickly.

Software-driven mobility supports customer-centricity (and vice versa)

> *Increasingly, customers are viewing the vehicle as just another place of operation, like their home and workplace. They want to be able to move between all of these places reliably and seamlessly. They also want to switch instantly between their different devices – their car and their smartphone, for example. Giving customers that experience depends, above all, on software. The industry needs to undergo a radical transformation before it can truly claim to be putting customer expectations at the heart of the mobility experience – and software will enable that transformation. So I believe it's no exaggeration to say that excellence in developing, maintaining, and running software will be the number one determinant of future success in automotive.*

Jayashree Ravichandran,
Vice-President,
Automotive Software,
Capgemini Engineering

SDM and customer-centricity are strongly interdependent. SDM will only succeed when OEMs move their emphasis from building products to delivering customer experiences.

This shift of emphasis represents a major cultural challenge for automakers whose work was historically centered on designing, building, and selling products. But the challenge must be accepted because, to be blunt, future success, and even survival, depends on providing customers with the experiences they want – because new entrants are already able to deliver these experiences, at a price point that is becoming highly competitive.

Of course, product innovation remains as essential as it ever was, but it must always be planned and evaluated in the light of customer experience: experience that is delivered through products and services, but also at any touchpoint in the user journey. (It makes sense to think in terms of a user rather than a customer, because of the shift in focus from the moment of purchase to the full experience.)

That requires a culture change from a product mindset to a service mindset: Instead of understanding innovation in terms of products, companies need to focus on providing a better overall experience. Expecting to succeed without this culture change is like thinking you can transform a health service just by buying better thermometers and MRI equipment.

(As an aside, technological innovation need not always involve major inventions – it can often be a question of finding new and better ways to use what we already have to support customer experience. The modern software practices we are recommending to traditional automakers are certainly not new – they have been developed over the past four decades at least. Tesla and other relative newcomers got ahead in this area by disregarding current automotive industry software approaches and standards in favor of those from their digital-native pasts.)

Success with SDM depends on making customer experience the focus, but equally, delivering the right customer experience depends on the move to SDM. That is because SDM can make an OEM's brand into an essential part of the customer's digital universe, creating new levels of loyalty.

Moving to SDM is likely to involve deploying a microservice-based architecture coupled with a unified service layer that, together, continuously transfer data and integrate services. This type of architecture makes it straightforward to tailor digital services to customer preferences, and also to integrate the customer's apps and devices, creating a unified user experience that extends well beyond the vehicle. In addition, the architecture supports OTA updates, which can be used to safeguard the integrity and satisfaction of the unified customer experience. And that maximizes long-term value for both customer and supplier.

Software-driven mobility makes complexity manageable

> *We urgently need to simplify the way we make cars. Currently, vehicles have multiple control units and complex architectures, and the complexity will continue to escalate rapidly if left unchecked. Software-driven mobility – combined with abstraction – has the power to tame complexity. That's one of the main reasons why SDM is a strategic priority for the industry.*

Jean-Marie Lapeyre,
Executive Vice-President
& Chief Technology and Innovation Officer,
Global Automotive Industry, Capgemini

In recent years, OEMs have been grappling with burgeoning complexity owing to rapid increases in the number and sophistication of vehicle services, augmented with connected features. This complexity demands a wide range of tools, skills, capabilities, and mindsets that pose management challenges of their own.

In truth, the intrinsic complexity of SDM is even higher, but it comes with architecture patterns, abstractions, and tools that dramatically improve the management of this complexity. Consolidation, de-duplication, factorization, and standardization of hardware or software are key properties associated with software-defined approaches, and have already supported transformation in other industries such as telecom.

With approaches like these, uncontrolled and unnecessary complexity decreases and the company gains the ability to deliver a more sophisticated value proposition, faster. In addition, SDM simplifies the management of customer experience – even when software is provided by third parties – because shared standards can be more easily propagated and enforced.

Let's consider just two examples of SDM's ability to control complexity. First, new services can be rolled out by simply sending OTA updates to vehicles. The mechanisms for managing updates entail additional complexity, but huge benefits come from an infinitely better ability to react to issues that were impossible to deal with efficiently before. As a result, an OEM might even be able to avoid the major costs and disruptions associated with some large-scale recalls.

As a second example, the complexities of supply chain management can be addressed more easily, for instance by tweaking designs to accommodate different chips when the preferred ones are unavailable – as seen in Tesla's agile response to the chip shortages during and after the pandemic.

Such improvements are strongly linked to the rise of SDVs with a unified hardware architecture differentiated by their software configurations. As well as being easier to control than today's array of ranges and models, this unified architecture brings the opportunity for direct-to-consumer sales or leasing and support, associated with better margins.

Software-driven mobility supports sustainability

> *Automakers have been building cars for years. They have put in place very efficient processes and ways of working, but these are now being disrupted by the introduction of software at the very heart of cars. It's a radical transformation that they must carry out in a very short time, and that impacts not only vehicle architecture (the software-defined vehicle) or even engineering, but the entire company. The challenge is to integrate digital culture into its DNA so that it can think and act like a digital-native company. The implementation of standardized, industrial software development capabilities is key to ensuring complete fluidity in the customer experience, inside and outside the car. In the end, the entire business model is transformed, with an increasing share of the value coming from connected services. It's a real reinvention of the automobile industry that is underway – and it's exciting.*

Reza Hariri,
Vice-President
Business Technology,
Capgemini Invent

SDT and SDM support another major goal: that of automotive sustainability. One way they do this is to simplify implementation of targeted services – for example, one such service might provide the customer with feedback on how their driving style is affecting energy consumption, helping them to correct it. SDT also makes it easier to collect the internal and external data needed to provide a service like this.

Using the software within software-defined vehicles to configure them to meet multiple customer requirements means that OEMs can standardize their hardware, ultimately perhaps to a single platform for all models within a range (or multiple ranges). This standardization reduces waste in R&D processes, accelerates manufacturing efficiency, and cuts time to market – improvements that complement the decrease in vehicle emissions achieved by moving to electric vehicles.

This move toward SDVs also facilitates the move to a circular economy, in part because it means OEMs can easily update a vehicle before resale simply by updating the software. In addition, standardization makes individual parts easier to reuse or recycle thanks to the increased clarity about how they have been made. As well as increasing sustainability, this alignment with circular economy principles can reduce costs, increase customer loyalty, and facilitate regulatory compliance.

How new entrants have taken the lead

Where are these new industry standards and expectations coming from? Overwhelmingly, they are being set by new entrants to the industry – digital natives like Tesla and a number of new Chinese OEMs.

From the customer perspective, these new entrants offer innovative products and services that deliver a fresh mobility experience. They rely on, and enable, a full range of other entities across the mobility ecosystem to help them provide these products and services and to manage them after purchase, from suppliers of mapping apps and data to power companies.

From an industry perspective, new entrants provide products and services that are built on modern software, providing fast go-to-market, flexibility, and efficient management of complexity.

Apart from their digital knowhow, how are the newcomers achieving all this?

Capgemini Research Institute in their research shows that, compared with traditional OEMs, digital-native OEMs offer:

- Three times the computing power, improving user experience and enabling it to evolve faster
- Four times the density of electronics, enabling greater flexibility with less complexity
- Nine times the frequency of updates, so that the experience is always up to date and offers sustained value

Behind the scenes, digital natives have code that is three times simpler – an important factor in higher maintainability and faster go-to-market.

OEMs know software is key to their future success

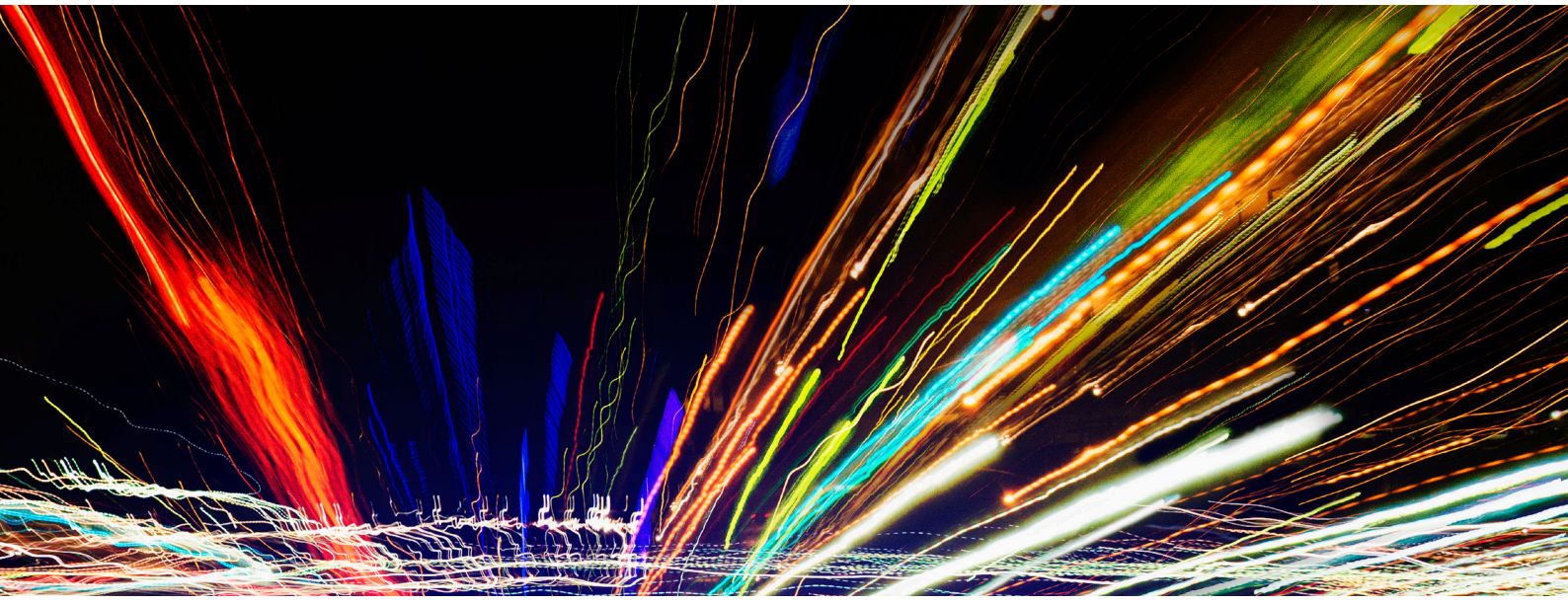
OEMs understand the crucial role of software in all these achievements. They also know that they cannot draw level with these digital natives unaided – never mind overtake them. They do not have the in-house capabilities to manage all the complexity that is needed to achieve radical change – only, at best, to move forward incrementally.

> *It's so difficult for car companies to get software right. We have about 150 modules across the car, developed by 150 different companies, written in more than 100 different languages, that don't talk to one another… And we can't even understand it all.*

Jim Farley,
CEO, Ford.[3]

More than that, though, they are hampered by their culture and practices – exemplified in particular by a reluctance to share information with outsiders, a mindset focused on products rather than services, and a stress on structured processes rather than agility.

Let's now see what can be done to overcome current challenges.



[3] https://c2a-sec.com/ford-ceo-its-very-difficult-for-car-companies-to-get-software-right/

04 OEMs can still draw level with, and overtake, the new entrants

> *Vehicle buyers today expect a reliable, safe, and frictionless mobility experience throughout the life of the car. A prerequisite for meeting that expectation is to enforce end-to-end cybersecurity that keeps up with the fast pace of technological change. The end-to-end aspect is critical. For instance, securing the data collected by a vehicle is of no use if enterprise systems are insecure, and vice versa. Everything needs equal protection. And, with 5G-enabled use cases proliferating rapidly, ad hoc or silo-based cybersecurity approaches won't cut it any longer – cybersecurity protection must be holistic.*

Aarthi Krishna,
Global Head of Industry Cybersecurity, Capgemini

Five gaps to fill

So how can traditional OEMs close up the gap between themselves and newer competitors, and realize the potential of SDM?

To catch up with and overtake the new entrants, traditional OEMs need to tackle five areas where historic practices often limit their flexibility and their ability to innovate and scale rapidly.

Culture and talent

OEMs need to contribute to – and interact openly with – the mobility ecosystem. They must attract and develop teams of software talent, and mesh key automotive knowledge with software skills.

Organization and processes

A set of appropriate software practices needs to be established as a backbone for the whole company; this will help to break down silos. In particular, agile at scale should be adopted for all software product development, since this will accommodate mixed cycles far better than waterfall approaches can.

Consistency and value over time

It is important to enforce a consistent end-user experience company-wide, and to define and use a single software architecture across the full range. With these in place, it becomes feasible to issue frequent software upgrades, and thus to deliver value continuously throughout the lifecycle.

Reliability and dependability

Automakers must be able to react in a timely manner so that they can promptly correct – or preferably prevent – defects. State-of-the-art cybersecurity practices and tools should be fully and deeply integrated into organizational processes.

Flexibility and efficiency

To meet customer expectations, OEMs have to be able to deliver software efficiently, and to ensure that software is of top quality, with no duplication or inconsistency. They must be adept at using abstraction to control complexity.

Undeniably, overcoming these challenges adds up to a daunting task, and it is certainly not one that most OEMs can tackle on their own. But by working with the right partners with the right structured approach, traditional OEMs can achieve SDT much faster than they currently imagine.

Let's see what needs to be done.

05 A structured approach to software-driven mobility

> *For a few years now, automotive OEMs have been seeing their margins shrink, with mounting software development costs as one of the major factors. What's more, new revenue streams haven't nearly tapped their full anticipated potential. Now, the market is open to new entrants positioning themselves closer to their customers and users. They take advantage of innovative approaches and tools that both drive down costs and ensure that new products and services hit the mark. These approaches are mainly supported by custom software development and can easily be adopted by the classical OEMs as well. Now we need to further transform their way of working and thinking so that it delivers customer value and return on investment.*
>
> **Michael Tenschert,**
> Global Automotive Industry Lead – Cloud & Custom Applications, Capgemini

The SDT needed for OEMs to pivot to SDM requires a structured approach – one that combines the skills and practices of established vehicle engineering with new digital ones, and also with those of manufacturing and vehicle engineering.

At a high level, the approach can be structured around three enablers that facilitate custom software development across all environments, in addition to helping the organization to make best use of existing software and services, in-house or third-party.

Accelerating transformation into a **software company**

- Defining a **software strategy** leveraging core capabilities and prioritizing investments
- Addressing **talent & culture** through a reskill & upskill and change management program
- Driving the software **transformation and execution** of the value model

Laying the foundations for a **software platform**

- Establishing end-to-end **architecture standards** for product and services
- Ensuring **software compliance** to regulations, standards, and contractual terms
- Setting-up and running a **cyber-security program** [define | protect | defend]

Streamlining industry-grade **software delivery**

- Creating a streamlined **software factory** [processes | methods | tools]
- Shaping an innovative **testing strategy** focused on end-user experience
- Setting-up and running **efficient testing** across all environments

We'll now describe each of these actions in more detail.

Accelerating transformation into a software company

> *Software development needs to be addressed holistically, with onboard and offboard development merged. That requires a paradigm shift for onboard to embrace principles like agile DevOps which are long established for the offboard world and enterprise IT. But backend development needs to evolve as well, for example to support OTA updates of vehicles on the road. All of this implies a dramatic culture change to harmonize development activities. It also requires skills that are often scarce within automotive companies.*

Fergus Duncan,
Senior Architect,
Automotive Software,
Capgemini Engineering

Leading OEMs acknowledge that they need to rethink their entire businesses in terms of software rather than vehicles involves several steps.

Define a software strategy: First, identify your core capabilities for software value creation, and define a software strategy that leverages these capabilities to build competitive advantage. This strategy will help you to prioritize investments. It is vital to allocate sufficient resources to activities that will bolster the core capabilities that differentiate the company. Of course, you still need to invest in essential capabilities that do not directly contribute to differentiation, but the strategy will ensure that this is done efficiently.

Address talent and culture: Foster the shift to a software-native culture with enterprise-wide HR and change management programs to attract, develop, and retain software talents. Aside from recruitment, reskilling and upskilling should be used to build a software engineering workforce. Choose the right training courses and tools to equip everyone for an evolving workplace.

Steer software-driven transformation: Rethink the enterprise operating model to support delivery of software products and services. Set up a dedicated program management and value office to manage and support all aspects of your program for SDT.

> *What we realized over the last few years is the enormous difficulty for incumbent existing auto manufacturers to develop their own full stack software.*

RJ Scaringe
Founder & CEO,
Rivian.[4]

Example: *A tier 1 supplier decided to create its own software house to accelerate its journey to SDM by onboarding software capabilities and leveraging best-in-class software engineering practices. The company worked with a specialist partner to infuse a new software culture and create the necessary knowhow and capabilities. The new software house built nearshore capabilities in multiple countries, which helped it to rapidly begin servicing all the company's product lines.*

[4] https://finance.yahoo.com/news/rivian-founder-tells-investors-why-134239247.html

Laying the foundations for a software platform

> *It's critical that organizations implement a composable architecture for their products and services – one incorporating end-to-end standards that can be applied across all relevant environments. The architecture should support features like continuous and seamless data streaming between car, customer, and ecosystem, and connectivity from edge to cloud, including enterprise IT.*

Jean-Baptiste Courmont,
Vice-President,
Head of Automotive Business
Technology Solutions, Capgemini

A standardized software platform will reduce the effort involved in future software development while increasing the quality and reliability of the outputs. By "platform," we mean a blueprint with associated pre-defined components and tools, on which full products and services can be based.

The steps required are as follows.

Establish architecture standards: Design a composable architecture with end-to-end standards for products and services, to work across all your environments. Objectively assess your EE solutions and software strategy architecture and improve them as needed. Seek benchmarks and best practices to support design and build of a composable, reliable, and scalable infrastructure foundation.

Ensure software compliance: Find ways to simplify the process of demonstrating formal compliance to regulations, standards, and contractual terms. First, run gap analysis to find out where your current process may fall short; then, based on your current maturity, define a roadmap for reaching your compliance goals. Work out how you will manage realization of the roadmap and deploy the new process. An important aspect of this step is ensuring that evidence of compliance is correctly produced and managed.

Set up and run a cybersecurity program: Your program should have the right "define," "protect," and "defend" elements at all stages of the automotive lifecycle. To make sure it does, evaluate the current maturity of your cybersecurity and reassess your current and future cyber risks. Make sure you have the right expertise available in areas like security architecture, design, and implementation. Also, establish the right structures for managing security operations, such as 24x7 vehicle security operating centers.

> *I think we are… seeing a paradigm shift of how we approach software and the electronic architecture in a vehicle.*

Ola Källenius,
CEO, Mercedes-Benz.[5]

Example: *When a French OEM was developing a new urban electric vehicle, it also needed to create a software platform to support the first-ever high-performance compute/zonal architecture leveraging service-oriented architecture (SOA). System and software engineering capabilities from five countries were harnessed to design, build, and integrate this platform, which also supports a novel EE hardware architecture.*

[5] https://www.theverge.com/23172839/mercedes-benz-ceo-ola-kallenius-electric-vehicles-self-driving-luxury-tech-g-class

Streamlining industry-grade software delivery

Software-driven mobility requires a much more proactive approach to testing, otherwise you risk finding out too late that when you add one service to a vehicle, another service stops working. By using virtualization, digital twins, automation, and so forth, you can detect those problems early on and solve them fast. But these approaches have to be applied organization-wide, not just within silos.

Franck Desaulty,
Solution Director,
Software-Driven Transformation Automotive,
Capgemini Engineering

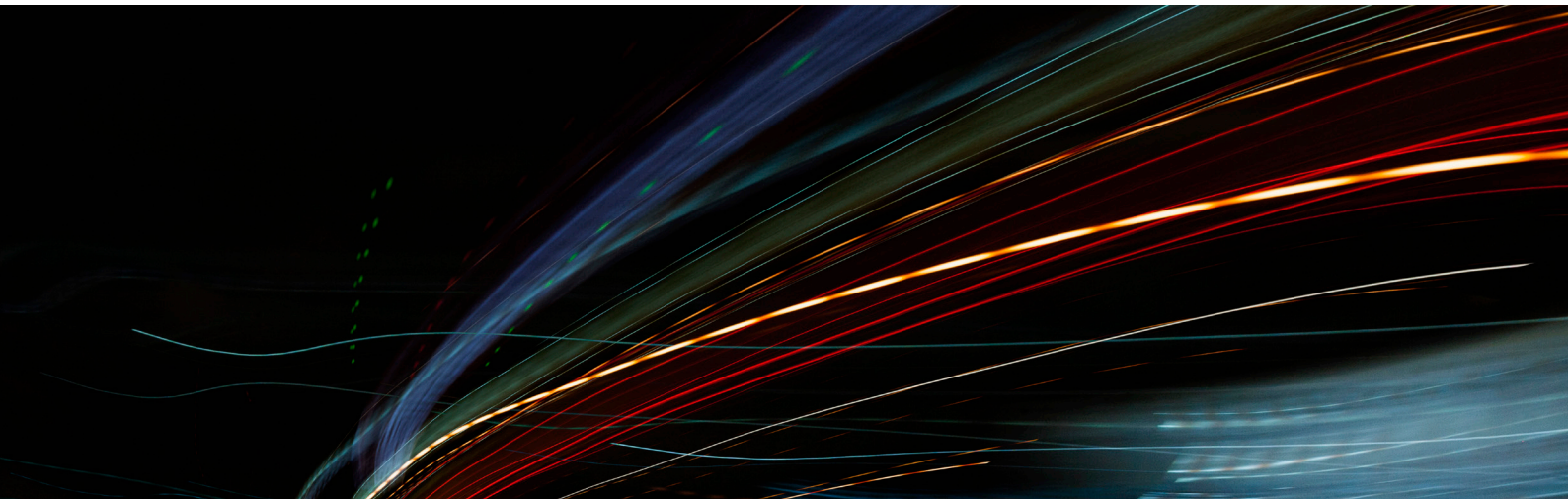
Adding standardized processes to the software platform will further increase efficiency and quality. That can be achieved with the following steps.

Create a streamlined software factory: Design, build, and run your own integrated in-house software factories, leveraging industry-leading practices via technology benchmarks and use cases, and possible patterns. Integrate processes, methods, and toolchains for code generation and test automation.

Shape a test strategy: Optimize all testing activities, with a focus on customer value and experience. Develop a strategy and roadmap. Strive for innovation, including the use of GenAI to create test data, and virtual testing using digital twins.

Run efficient testing: Accelerate and execute end-to-end software testing at scale, with methods that can be used across all your environments. Consider the use of frameworks such as HIL, and AI-enabled automation. Plan what should be done where, including the possible use of offshore or nearshore facilities.

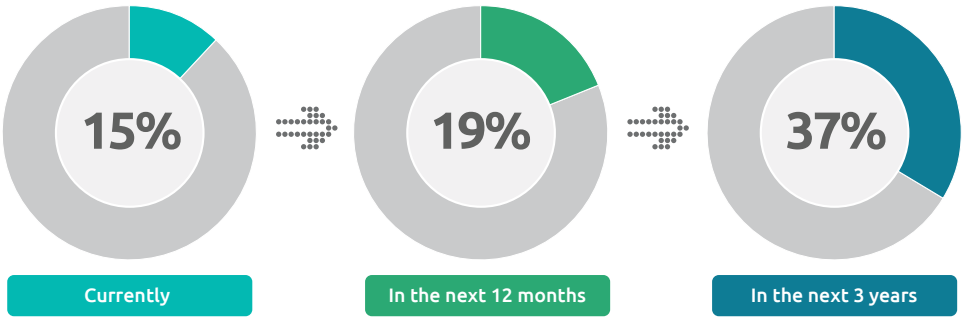
Example: *A premium OEM based in Germany decided to restructure the way it manages software updates, so that it can smoothly upgrade vehicle software over the air. It established structures for delivering upgrades at any point in the software lifecycle from a single source. The result is a continuous flow of data, streamlined and load-balanced for high scalability and reliability across the value chain. The OEM can now easily keep vehicle software up to date and sell new features in the digital aftermarket.*



Generative AI will accelerate software transformation, among other benefits

GenAI will accelerate SDT both by improving products and services, and by helping to create the actual software. Regarding the latter, recent Capgemini research found that around 15% of the automotive industry's code was already being written with the help of GenAI; this proportion could reach 19% in a year and 37% in three years.

Percentage of code generated by GenAI in the automotive industry



Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023

The research also revealed that organizations foresee huge gains in developer productivity resulting from the use of GenAI in coding. The proportion of tasks supported by GenAI is expected to increase from 15% currently to 42% in three years' time.

While coding assistance is the best-known example of GenAI use in software engineering, this technology will probably have even more impact on software design, documentation (direct and retrospective), impact analysis, testing, and so on.

Regarding the use of GenAI to improve products and services, it is harder to predict specific applications at this stage. However, perhaps one of the most obvious uses is the potential to "humanize" and personalize the computer side of the human-computer interface, and to use each interaction with an individual to personalize subsequent interactions. For example, as ADAS features become ubiquitous and critical enablers of SDM, their interfaces must be as intuitive to use as possible – and as personalized. GenAI could make all the difference between a copycat app and a highly individualized one that really fits the customer's needs.

Consider early virtual in-car assistants that coach people who have acquired a new car on how to use the different features of their vehicle, and help them to create personalized settings. Imagine how much more effective these assistants will be if they speak to the user in a language that they understand, taking account of the questions that they have asked earlier in the dialogue.

06 Collaboration is key

> *App stores such as public Google Play are an important part of software-driven transformation in automotive. That's partly because of users' desire to move seamlessly between the different aspects of their digital lives. But it's also because an upgradable software-defined vehicle platform makes it much easier for car manufacturers and third-party developers to contribute new apps and services, continuously enriching customer experience and adding value throughout the life of the vehicle.*

Anthony Faucogney,
Automotive Android Architect,
Capgemini Engineering

Fully leveraging the mobility ecosystem

SDT needs a wide range of capabilities – a range that nobody, not even a digital-native company, is going to be able to develop and offer alone and unaided.

Even if an OEM could gather enough in-house capabilities to satisfy user expectations about SDM, it would not be ideal, because users want to integrate their digital lives. For example, they will probably prefer to carry on using the navigation and hotel-booking apps that they are already familiar with. So it is preferable that these are provided from a range of app and service suppliers, whose activities are enabled by a development and delivery framework provided by the OEM.

As noted earlier, the mobility ecosystem exists, and digital-native OEMs are already successfully using it, thanks to their heritage in digital where this type of collaboration is second nature. Now it is time for traditional OEMs to turn the mobility ecosystem to their advantage. This requires careful consideration of the players to collaborate with, and the best way to work with them.

What type of players will be your main collaborators in the mobility ecosystem? The list is long but is likely to include third-party software and service providers, power companies, and many more.

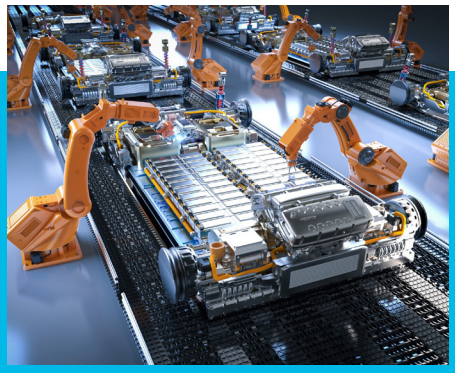
The specialist in software-enabled transformation: a key member of the ecosystem

One type of partner is likely to be particularly crucial: the kind that can combine the skills and practices core to software-enabled transformation in automotive. Such a partner should have the experience and assets to undertake a wide range of activities, including software design, development, and testing for enterprise, digital, industrial, and vehicle. They should offer strong business transformation capabilities specifically for the automotive industry, ideally backed by knowledge of best practices in other industries. Other essentials include excellence at innovation and sustainability, plus global coverage and a people-centric approach.

Specific skills that this SDT specialist should offer include both system integration and custom software development. For custom software, a range of capabilities are needed, for example:

- The ability to provide a continuous flow of high-quality software to the end-user, maximizing automation.
- The development of highly integrated software regardless of hardware boundaries, via simulation of functions and services across the whole fleet and across many generations, at any point in the lifecycle.
- Flexibility and adaptability in design to accommodate internal and external disruptions to the requirement such as new regulations or technologies or unforeseeable events.
- The use of a reliable, modern technology stack to minimize the risk of systems and services becoming outdated, and to create a homogeneous and future-proof IT landscape.
- Orchestration of IT/OT/IoT, Cloud, and Edge along value streams to break down technical islands and create streamlined, transparent continuity of services driven by value streams.
- Tearing down silos and extending the use of the ecosystem by using modern IT capabilities to open new business models and customer-centric services, increasing product value and revenue.

Skills like these will result in efficient, effective custom developments that produce long-lived results and that fit seamlessly into the overall technology landscape.



Example: *A UK OEM wanted to establish its next-generation EE architecture. It decided to collaborate with a specialist partner on building a vehicle-wide SOA, to be deployed on a telematic unit and with multi-ECU EE architecture. The result, believed to be the first SOA for a production vehicle, required the establishment of a co-innovation model leveraging a variety of expertise and capabilities from across Europe.*

07 Recommendations

> *Modern embedded software must exhibit real-time performance, high reliability, robust safety mechanisms, and dependable security to cyber threats, all within an optimal energy footprint. A robust architecture is the foundation and prerequisite for realizing these goals while also providing scalability to accommodate new and evolving features, as well as interoperability with various hardware and software systems. To efficiently deliver these software intensive systems, new development paradigms must be embraced including cloud native, virtual development, integration, and test automation, and containers with mixed criticality orchestration – all the while ensuring compliance with relevant industry standards and certifications. Bringing these elements together will help ensure that the software meets end-user demands for a safe, secure, and reliable mobility experience.*

Michael Welsh,
Chief Technology Officer,
Automotive Software &
Electronics, Capgemini
Engineering

Clearly, managing and accelerating the journey to SDM is a sizable task, albeit one that already has proven methodologies, technologies, and techniques available. For a quick start, we suggest focusing on three areas where significant progress can be made in a few weeks or months.

Maturity assessment

An initial maturity assessment can lay the foundations for your transformation to SDM. This should involve an objective assessment of strengths and weaknesses in the software transformation to date, using current market performance as a baseline. With the current level of maturity better understood, it becomes possible to define a target state and timetable for reaching it.

Roadmap

It is worth taking time to define your desired future – i.e. your vision and goals for software transformation. That definition plus the maturity assessment makes it possible to build a realistic SDM roadmap for your transformation to SDM. Most organizations establish a software-driven transformation office, which monitors progress against the roadmap to ensure it stays on track.

Skills analysis

Analyze the skillsets you have available for software transformation, again comparing them with market baselines to pinpoint strengths and weaknesses. Once you know about the gaps, you can start identifying the best ways to fill them, for example through recruitment, upskilling via a "software academy," collaboration with the ecosystem, or some combination of these.

08 How Capgemini helps

> *The value of good architecture is not defined by size, fanciness, or hype. What matters is fitness for purpose along the journey to its long-term future. Thus, it's important to define and verify architectures with real-life use cases. This way we ensure that our clients achieve the business outcomes they need to accelerate their journey to software-driven mobility.*

Holger Cermann,
Chief Architect for Global OEM,
Enterprise Architect Director,
Capgemini

Capgemini is uniquely positioned to help with SDT, because it is an expert in both system integration and custom software development. That expertise spans software for products, for services, and for the enterprise.

Capgemini is also:

- A service partner rooted in software and products, and so understands the business transformation from products to services that your organization needs to undergo.
- A specialist in the convergence of software and business skills and practices across products, services, and enterprise, and can help you achieve the interdisciplinary culture you need now.
- Positioned to mobilize global software talents at scale, and so can quickly help you fill any gaps in capabilities needed to achieve SDM.

Already, we have delivered business outcomes to major clients in all aspects of their SDM journey, from creating service-oriented architecture and structuring software delivery teams to implementing OTA updates.

Our proposition is underpinned by strong assets that accelerate the software transformation. These include code libraries and toolsets, business APIs, and reference architecture – all specifically created for the automotive industry.

In addition, we know exactly how to combine your own strengths as an established automaker with those of digital natives. We understand your client base and the loyalty enabled by your reputation and brand image. We respect your industry knowledge and experience. But we also know first-hand about digital natives' successful innovation strategies, culture, and skills.

We will work with you to ensure that you achieve your SDM goals while minimizing the risk of disruption. We'll help you identify and seize high-value opportunities that open up when you have responsive, dynamic offers.

Make Capgemini your SDM partner and you'll gain maximum value from mobility services and data. Remember, software-based features and services are predicted to treble in value between now and 2031 to a point where they will account for almost a quarter of revenues. You'll also see higher residual values for your products.

Get in touch today to find out about Capgemini's capabilities and achievements in this area, and discover our new Software-Driven Mobility offer, bringing together both new and established products and services for the automotive industry.

09 Contacts

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About Capgemini

Capgemini is a global business and technology transformation partner, helping organizations to accelerate their dual transition to a digital and sustainable world, while creating tangible impact for enterprises and society. It is a responsible and diverse group of 340,000 team members in more than 50 countries. With its strong over 55-year heritage, Capgemini is trusted by its clients to unlock the value of technology to address the entire breadth of their business needs. It delivers end-to-end services and solutions leveraging strengths from strategy and design to engineering, all fueled by its market leading capabilities in AI, cloud and data, combined with its deep industry expertise and partner ecosystem. The Group reported 2023 global revenues of €22.5 billion.

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