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SYSTEM-LEVEL INTEGRATION: NEW CHALLENGES ON THE ROAD TO NETWORKED CARS

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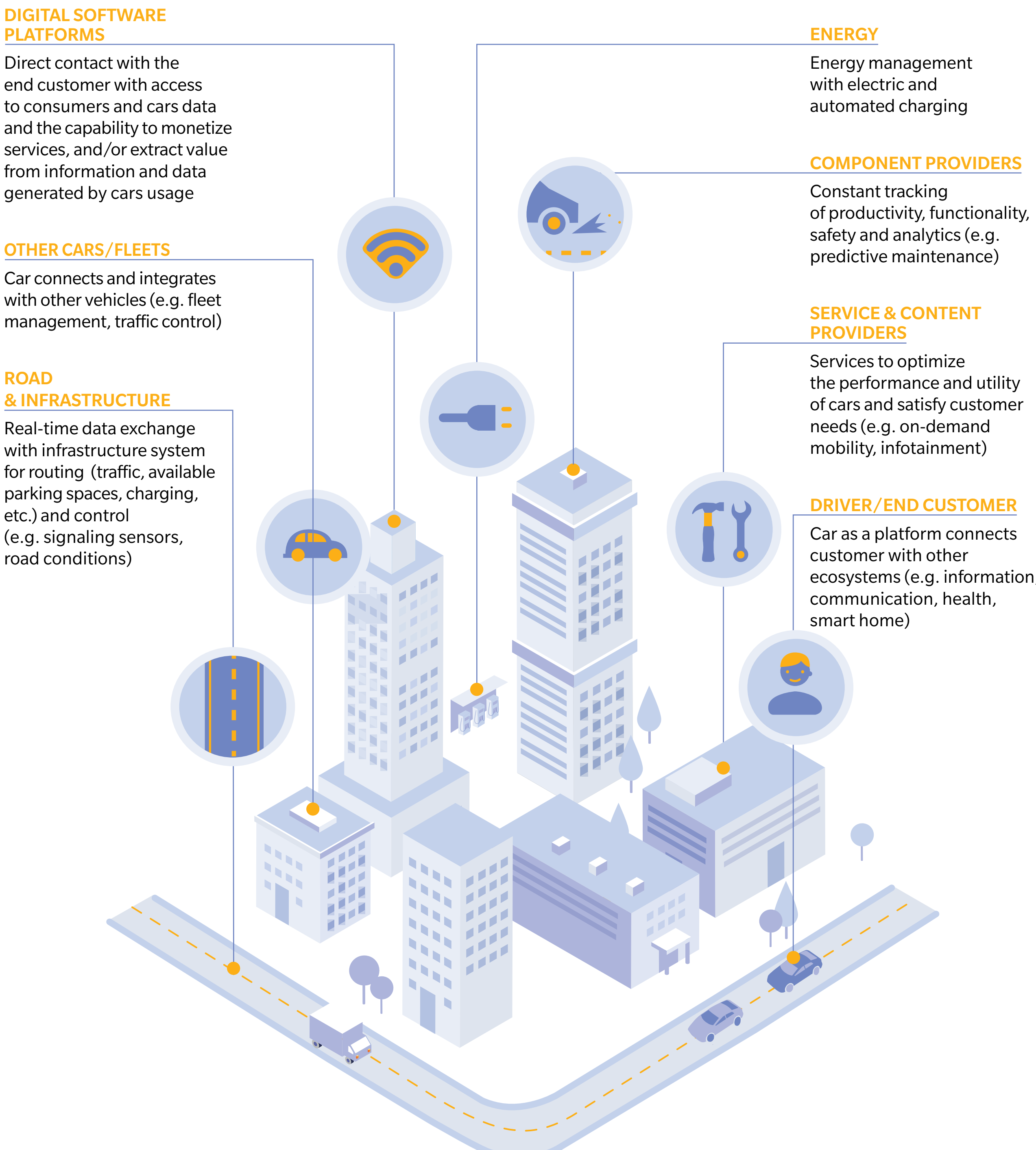
MAKING CARS PART OF THE MOBILITY NETWORK WILL REQUIRE AUTOMAKERS TO ADD A NEW LAYER OF SYSTEM ENGINEERING

In the past, the only network a typical car belonged to consisted of asphalt and had potholes, petrol stations and traffic lights. Now, technology has changed everything, with cars increasingly connected to the environment in inextricable ways; from signaling for a turn to finding a fuel station, your car will increasingly act by itself.

Digitization is already making it possible for cars to receive over-the-air (OTA) software updates from OEMs, while content providers constantly refresh infotainment systems, and soon, communications with external companies will help self-driving vehicles find parking spaces and other necessities. Sensors could make it possible for an automobile to interact with other traffic participants and to stop autonomously in dangerous situations, while electrification connects the car to new energy systems with automated charging. The car would thus move from a standalone entity to one that connects with a "system of systems" in the mobility landscape. (See Exhibit 1.) But there is a catch.

Exhibit 1: Cars are increasingly becoming integrated in mobility networks



"A system is a construct or collection of different elements that together produce results not obtainable by the elements alone." (INCOSE)

THE CAR IS ONE ELEMENT OF A LARGER SYSTEM: URBAN MOBILITY

Source: Oliver Wyman analysis

SYSTEM INTEGRATION: A NEW CHALLENGE FOR AUTOMAKERS

While the technology is increasingly available and new entrants are staking claims in the new networked car landscape, automakers as a group have yet to achieve meaningful mobility system integration. Rather than a simple lack of will, the challenge involves a complex set of technological, governance, and organizational hurdles.

For example, the close links and interactions that characterize mobility network integration impose new requirements on car design and manufacturing. Moving to connected vehicles requires companies to change their security paradigms, while autonomous driving requires reliable sensors and massive amounts of computing power, and the shift to electric power mandates changes in car architectures.

Recent industry news suggests automotive players have yet to meet these requirements. Two examples: One European premium OEM's vehicle autopilot system cannot operate at even 60 kilometers per hour due to limited computing power and the complexity of sensors and programing. Likewise, a mass-market OEM had to recall 1.4 million cars because its new infotainment system gave attackers an easy external hack that would enable them to control critical functions such as the brake system.

The consequences of these failures include exploding costs, lost future business, delays in development, and customer dissatisfaction. In the future, these challenges will become even greater due to three major ongoing trends. First, the value chain hierarchy is shifting, as automotive suppliers increasingly approach downstream fleet operators to understand end-customer needs. As a result, parts of the value chain will bypass the car manufacturers entirely, perhaps even forcing them to integrate "foreign" technology into their vehicles, the way train manufacturers integrate safety equipment for tier suppliers. Second, the connectivity inherent in advanced driver assistance system (ADAS) features, telematics, OTA updates, and leading-edge infotainment offerings requires new architectural designs, which can be tricky to integrate. And third, the need for increased local vehicle autonomy and the algorithms that provide it require deeper machine-learning capabilities, thus further complicating an already complex environment.

MAKING CARS PART OF THE MOBILITY SYSTEM

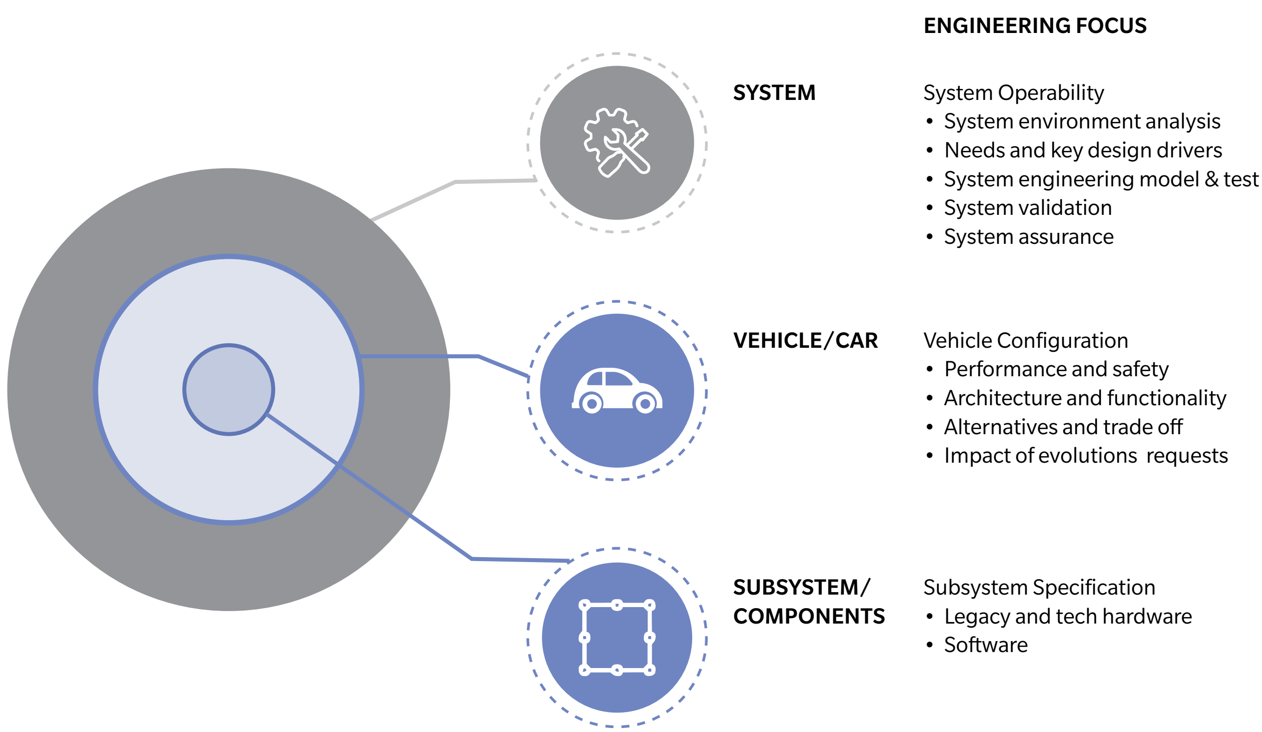
To achieve much of the promise of the mobility industry of the future, stakeholders need to integrate the car fully into the equation and make it part of the mobility system.

Other industries can provide insights as to what such integration requires. Trains, for example, physically mesh with the trackwork, civil engineering infrastructure (bridges and tunnels), energy systems and signaling technologies – by definition, this industry must think in terms of systems. Given that need, the railway industry reacts professionally regarding the need for system engineering – a discipline that considers the train as one element of the larger overall mobility system.

Elements of the rail industry's system engineering approach include a partnering strategy with system service providers and the vertical integration of support. It manifests itself in the form of a dedicated organization among the OEM's suppliers and systematic capability development, and includes a standardized portfolio of tools, software, and processes to ensure the system remains operable.

One way to think about this new system-level requirement is to add an additional layer to the vehicle engineering process as illustrated by the traditional industry "V-cycle" framework, which currently covers subsystem specifications and the vehicle configuration itself. (See Exhibit 2.) So far, the car itself has been the top layer, above components and parts. Now, an additional system layer at the top of "V" will define the ultimate mobility system requirements, which engineers then translate down to the vehicle and component levels. This new layer focuses on system-level operability, ensuring that the entire system meets customer needs for mobility.

Exhibit 2: Adding a system layer to the "V-model" vehicle engineering framework



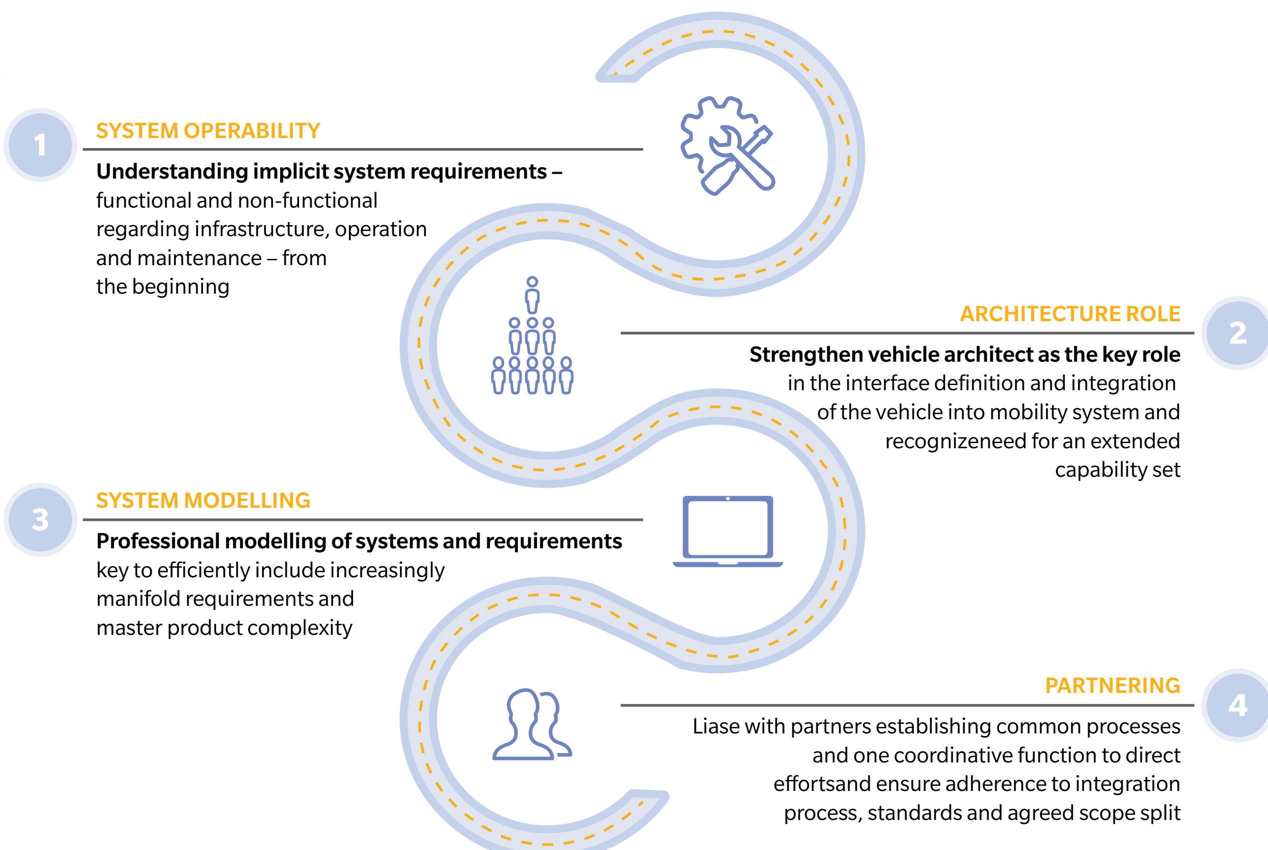
Source: Oliver Wyman analysis

EMBRACING THE NEW SYSTEM ENGINEERING MINDSET

The new V-cycle derives system requirements that determine the car specification and architecture. It will require a mindset-shift regarding the engineering needed and car manufacturing itself, which will likely have a significant impact on the company's organization, processes, and tools.

Examining how various industries deal with this new focus enabled us to uncover four key insights. (See Exhibit 3.) First, the requirements management process needs to ensure all involved parties gain a solid understanding of system requirements from the beginning and use a rigorous process from the system level down to the vehicle and components. Second, vehicle architects will play the key role in the interface definition and integration of the vehicle into the mobility system. They will need an extended capability set (including a new operability definition, system integration techniques, and testing and validation processes). Third, the professional modelling of systems and requirements will enable companies to include increasing numbers of requirements efficiently and thus master product complexity. The fourth insight involves the need for effective partnering, the definition of standards and common processes, and a clear scope split. All will play inevitable parts, given the broad spectrum of players in the mobility system.

Exhibit 3: Cars are increasingly becoming integrated in mobility networks



Source: Oliver Wyman analysis

KNOWING YOUR STARTING POINT

System engineering affects all aspects of an automaker's core business – its strategy, culture, organization, processes, and tools. And because every automaker is different – often significantly so – it is important for leaders to first understand where they are and what their focus is.

To begin, it makes sense to ask three questions. Who ultimately defines the requirements for your product and how do you integrate this into your organization? Have you defined required capabilities for system engineering, architecture, and requirements management? Do you use standard tools to model systems and/or "systems of systems," such as model-based systems engineering (MBSE) or systems modeling language (SysML)? Based on the answers to these questions, companies should define their direction and then move quickly.

ABOUT OLIVER WYMAN

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