strategy&

Challenges and Trends in the Automotive Industry 2019

Ehningen , Capital Market Day 2019

pwc

Management Engineers

Autofacts®

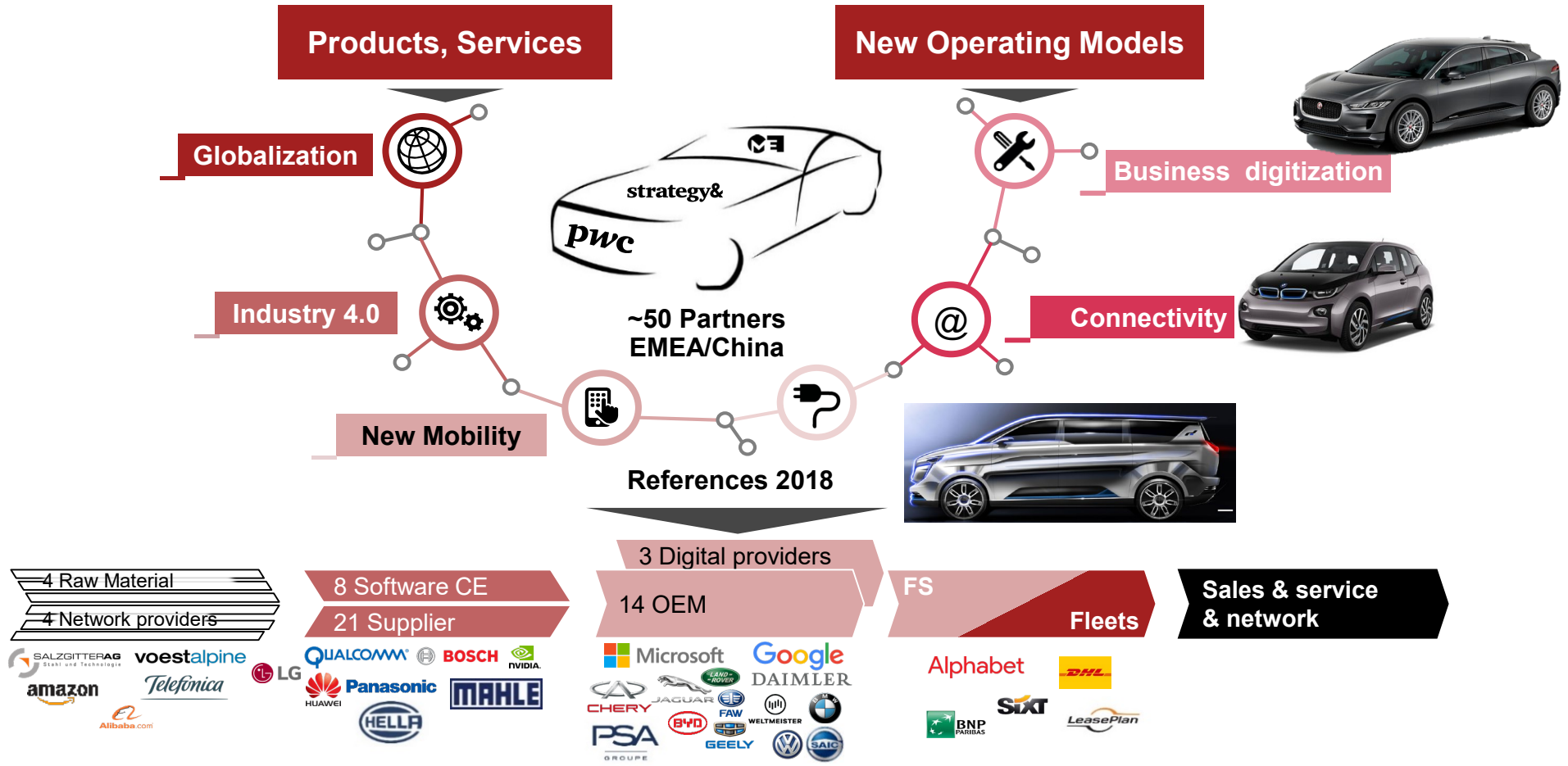
bertrandt

S&PwC supports the whole value chain transformation – Experts from Industry for Consulting

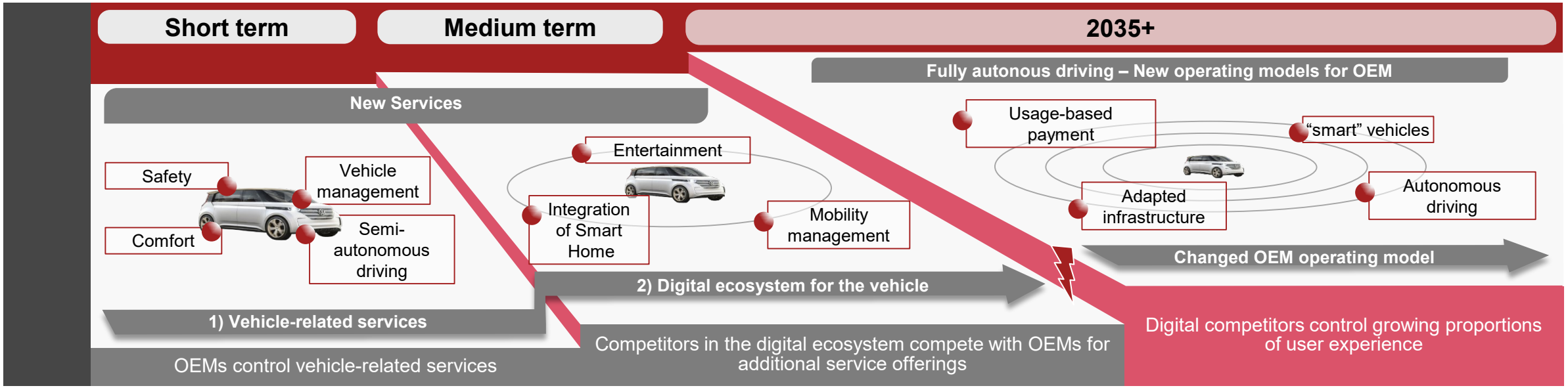
Strategy
- Portfolio Capability
- Operating Models

Competitiveness
- Product Cost
- CAPEX
- Productivity

Organization
- Benchmarking
- Best Practice
- Implementation



New technologies and customer requirements lead to fundamental transformation of the automotive industry and its players



Challenges for OEMs and suppliers

Robust quality processes

- Increasing complexity and number of variants
- Validation of new technologies and shorter life cycles/ market launches
- Regulatory framework conditions
- Increasing modularization
- Increasing demand for tests and validations
- High flexibility and responsiveness to changes
- Knowledge about laws and regulatory framework
- High level of responsibility through use of individual modules

Source: PwC Strategy& analysis

Reality of E-Mobility in Germany Today – 2019

Goal of the Federal Government's Electromobility Initiative 2012 was 2.0 million e-mobiles by 2020.

Industry claims : E-Mobility mass production will start right now

Volkswagen MEB Platform is planned to be manufactured 1,0 m units p.a. as of 2022

Vision and Demand of Our Industry 2020

Demanding:

Productivity wins
by Robotic for
Compatitiveness
throughout demografic
change

Our digital dashboard helps to navigate the future as both carmaker and mobility service provider

Digital dashboard with key transformation areas

Chapter 1
Market radar

Technology push
connected, electric, autonomous

Customer pull
on-demand, shared, multi-modal mobility

Revenue and profit shift

Regulation impact
approvals, taxes, data privacy, infrastructure

Chapter 2
Mobility & connected service heads-up

Vehicle business

Connected services

Mobility services

Chapter 3
Capabilities for the road ahead

Smart portfolio

Immersive channels

Hyper-local footprint

Fit-for-purpose technology

Ambidextrous organization

01.
Market radar

Consumers expect mobility services that are convenient, personalized, multi-modal and connected

Multi-modal

74% of consumers opt for the most convenient way to get from A to B – including the combination of multiple transport modes

Ubiquitously connected and integrated

34% of European consumers expect to seamlessly receive connected car services[1)] – so does a ***89%*** share of Chinese customers

On-demand

47% of European consumers would consider giving up their own car in favor of widely available and adequately priced autonomous robotaxi services

Shared

70% of Chinese vehicle owners could imagine earning money from sharing their car via a peer-to-peer platforms, while only ***28%*** would do so in Europe

Personalized

70% of consumers expect mobility offers to be personalized – reflecting their personal needs and mobility patterns

Subscription-based

The majority of consumers would be willing to pay up to ***$250*** for a monthly subscription of unlimited rides within town

Experience-driven

When traveling fully autonomous, music streaming with ***46%*** and video streaming with ***42%*** are considered most relevant by consumers to enhance their experience

1) Real-time traffic information, communication and advertising, news stream, music stream
Source: PwC Strategy& consumer research, 2018, n=3000 (EU, USA , CHN)

Electric and autonomous vehicles are subject to volatile regulatory frameworks across the E.U., China and the U.S.

Regulatory trends

USA

Electric

- Target controversy between „CARB“ states and EPA
- Gap between CARB’s ZEV sales targets and EPA’s emission standards freeze
- OEMs anxious about disparate US regulations

Autonomous

- Individual legislation in each state → fast ratification
- AVs on public highways permitted in selected states (Florida, Nevada, Virginia,..)
- Michigan and California allow driverless vehicle tests

EU

Electric

- Local focus on NOX & particles
- Credits for EVs to avoid CO2 non-compliance penalties
- Inner-city bans of ICE planned

Autonomous

- AVs receive only test vehicle status, driver mandatory for testing on public roads
- L3 mode allowed in Germany, yet unclarity about certification

China

Electric

- Licensing privileges for BEVs and PHEVs in many cities
- Mandatory EV quota planned for 2019
- Stepwise reduction of vehicle subsidies until 2022

Autonomous

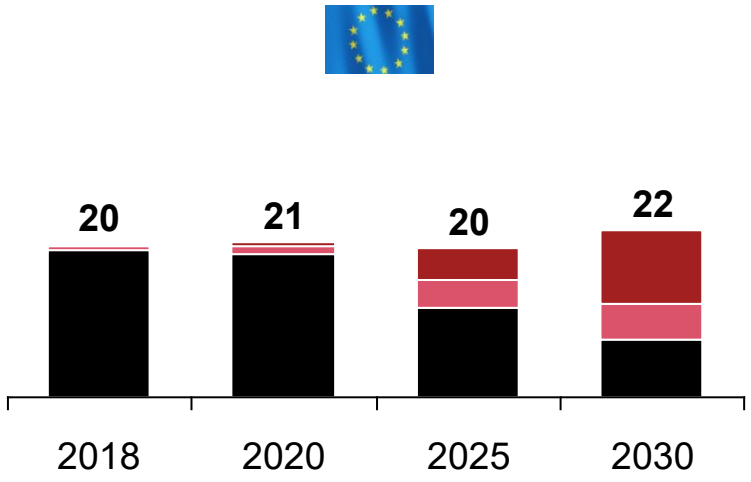
- Legal initiatives for AVs on the political agenda, no nationwide regulations issued yet
- Test vehicle registrations for public highways in 7 cities (incl. Beijing and Shanghai)
- Many players already testing with local regulations of certain cities

Regulator as (1) accelerator (2) inhibitor (3) or neutral

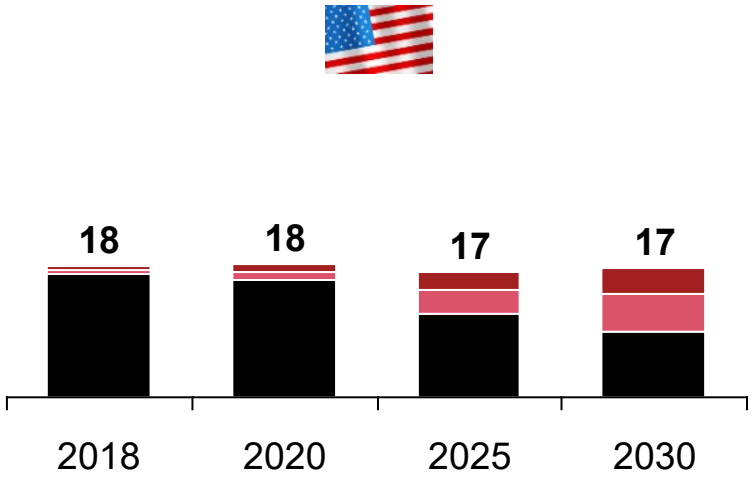
Abbreviations: CARB – states that have adopted the California Emission Standards; EPA – US Environmental Protection Agency; ZEV – zero emission vehicle; EV – electric vehicle; AV – autonomous vehicle

Electric vehicle sales will be boosted by legislation especially in China and E.U. after 2020

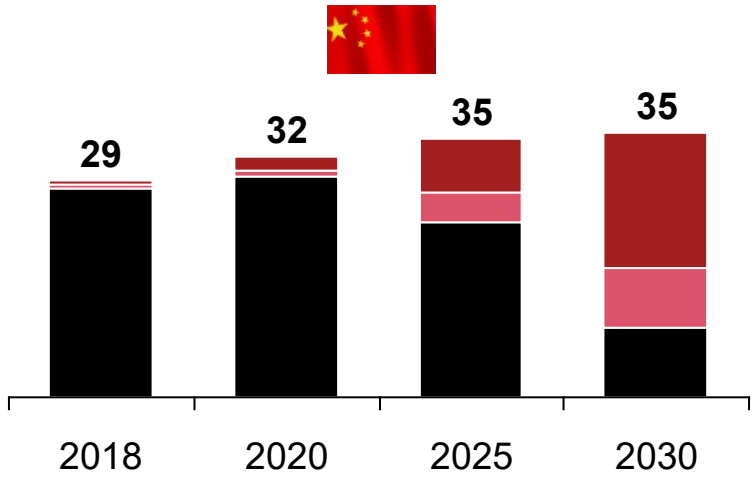
Electric vehicles (in total new vehicle sales) (E.U., U.S., China; in millions)



- 44% share of electric in 2030
- Strong legislative push from 2020 on
- Sufficient public charging infrastructure ~2025
- Cost of operations tipping point differs by segment and use pattern



- 20% share of electric in 2030
- As mobility patterns are not expected to change notably until 2030, EV technologies follow conventional S-curve adoption paths based on relative cost advantages



- ~50% share of electric in 2030
- Strong legislative push from June 2018 on
- Integrated charging infrastructure ~2025
- Cost-of-operations advantages by segment and use pattern already evident

Combustion Hybrid Electric

Source: PwC AutoFacts

Commercial applications will be first; China is far ahead

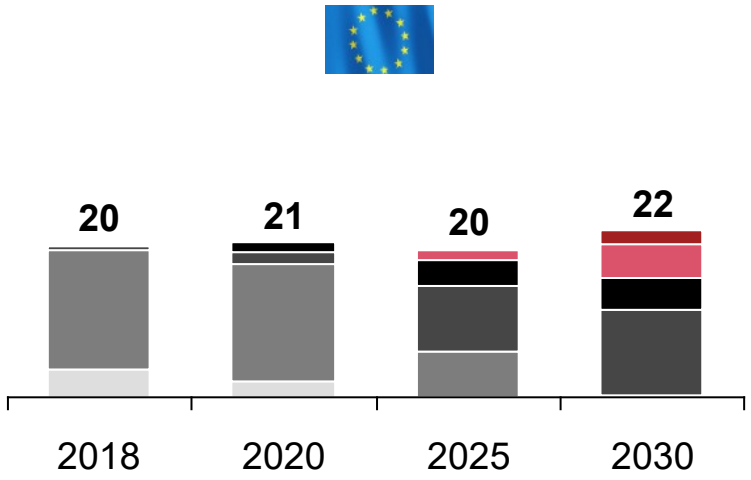
Robo Intralogistic

Robotaxis

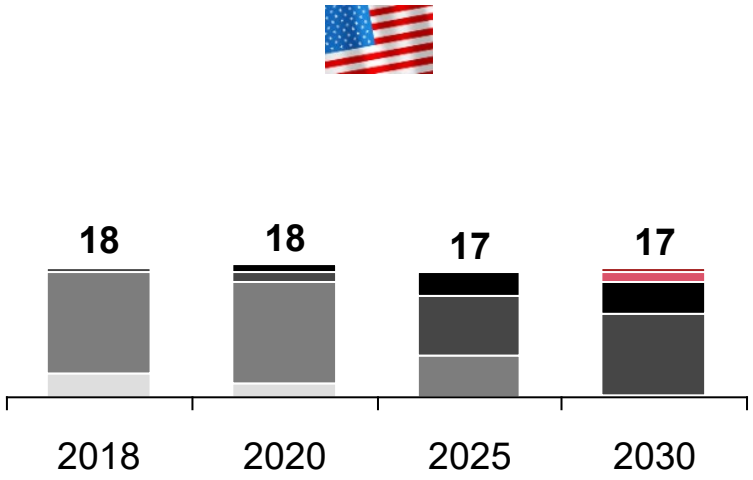
Robo-Last Mile

Autonomous vehicles could be used in significant numbers after 2025

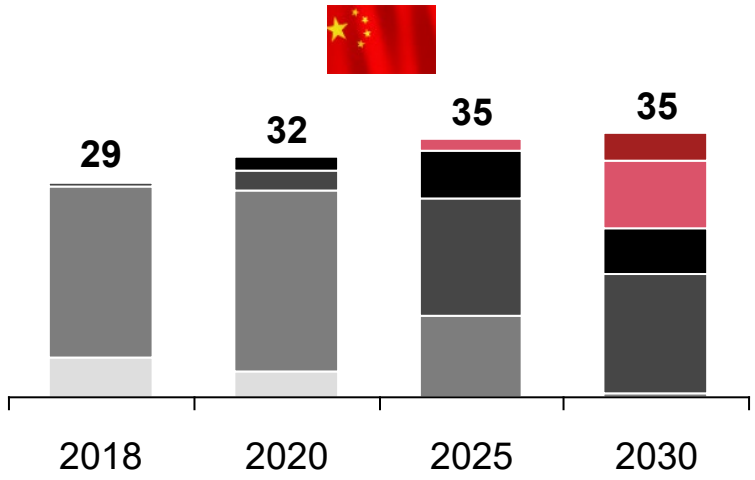
Autonomous vehicles (in total new vehicle sales) (E.U., U.S., China; in millions)



- ~25% of new cars with level 4/5 in 2030
- Assuming tech will allow level 4/5 adoption from 2028 onwards & regulation in place
- Robotaxis driving on specific routes / defined areas from 2025 onwards



- Share of level 4/5 up to ~10% in 2030 – point of inflection expected after 2030
- Assuming a slower transformation in the US, as mobility behavior is driven by lower TCO of traditional cars than elsewhere



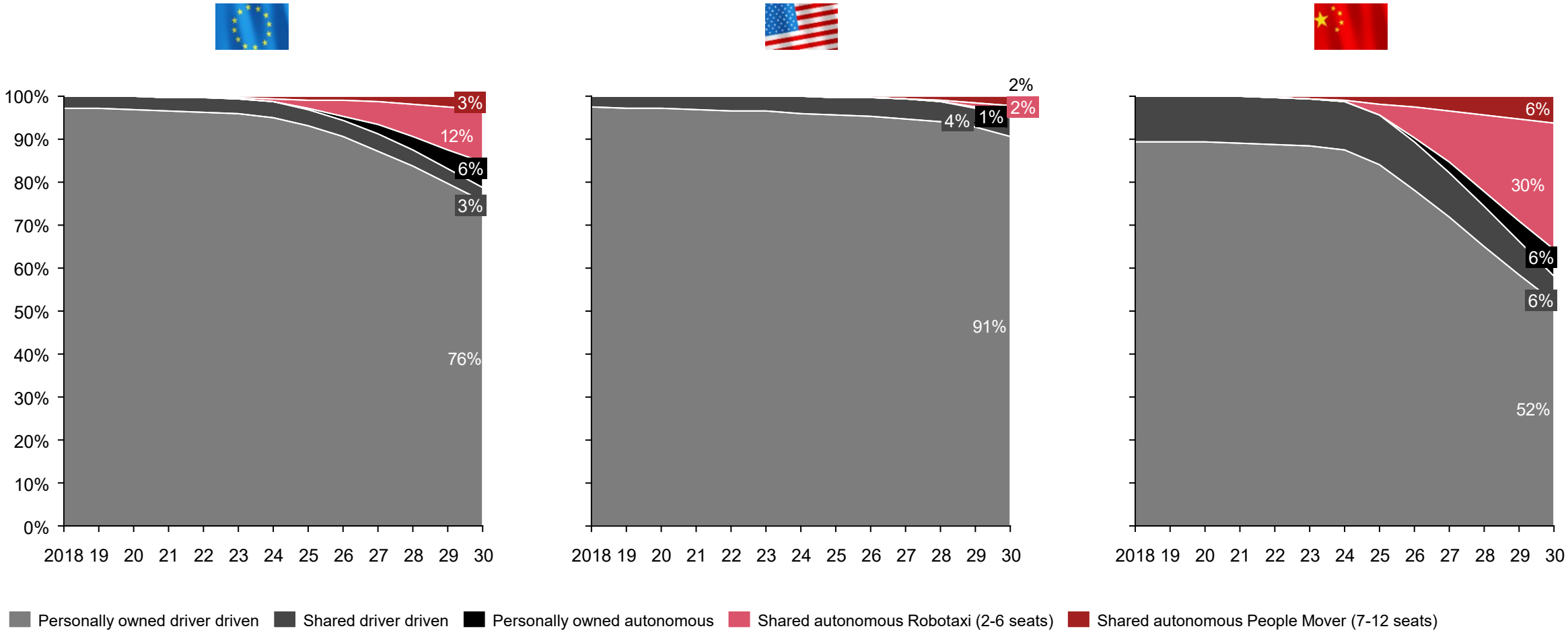
- ~35% share of level 4/5 in 2030
- Assuming tech will allow level 4/5 adoption from 2028 onwards & regulation in place
- Growing middle class open for new mobility modes and pushing demand for autonomous

Level 0 Level 1 Level 2 Level 3 Level 4 Level 5

Abbreviations: TCO – Total Cost of Ownership
Source: PwC AutoFacts

Shared-autonomous mobility will have strongest growth in China

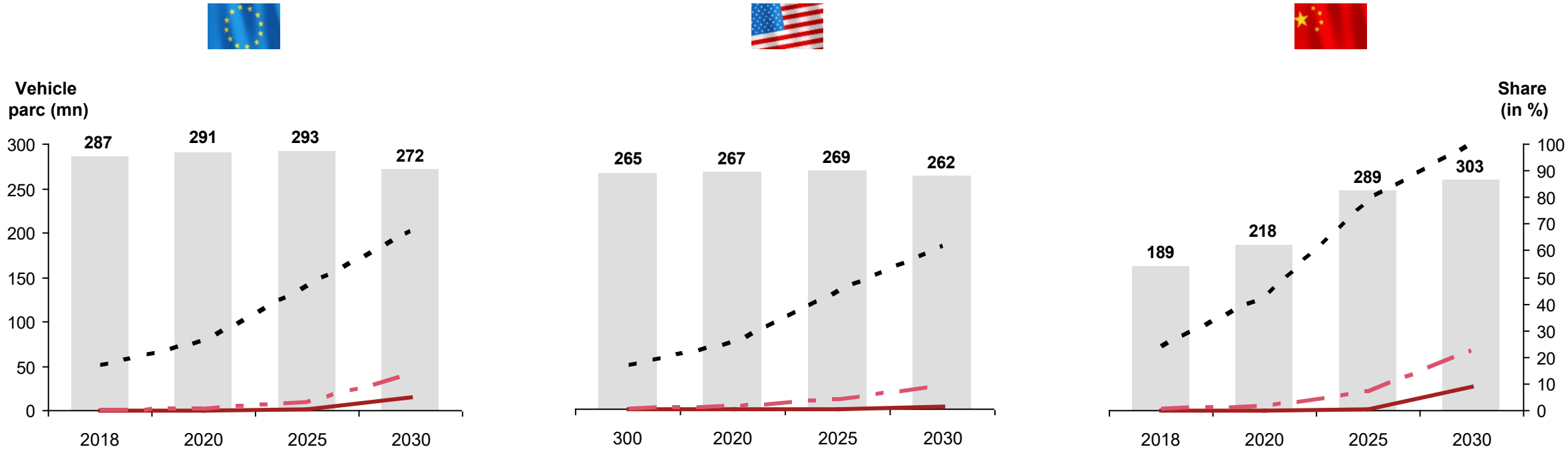
Distribution of mobility types in road-bound personal mobility[1]



1. in % of total person km "road" driven
Source: PwC AutoFacts, Strategy& analysis

Vehicle parc expected to decline in Europe, followed by the U.S. – yet, still growing in China

Total vehicle parc (in millions, auton./electr./connected, in % of total vehicle parc)



- Uptake of connected, electric and autonomous after policy and technology breakthroughs
- Overall increase of distance driven and strong growth in relative share of vehicle-based mobility (China in particular)
- Increased vehicle utilization and turnover due to sharing/pooling resulting in declining vehicle base
- China: increase of new vehicle sales as new mobility modes become more affordable (larger customer base)

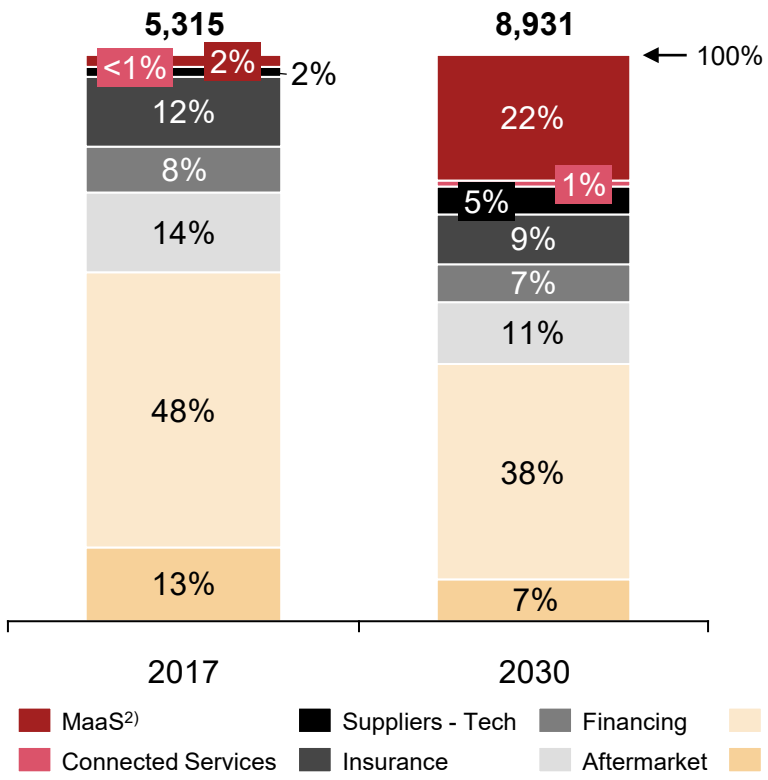
Autonomous Cars Electric Cars Connected Cars Total Parc

Source: PwC AutoFacts

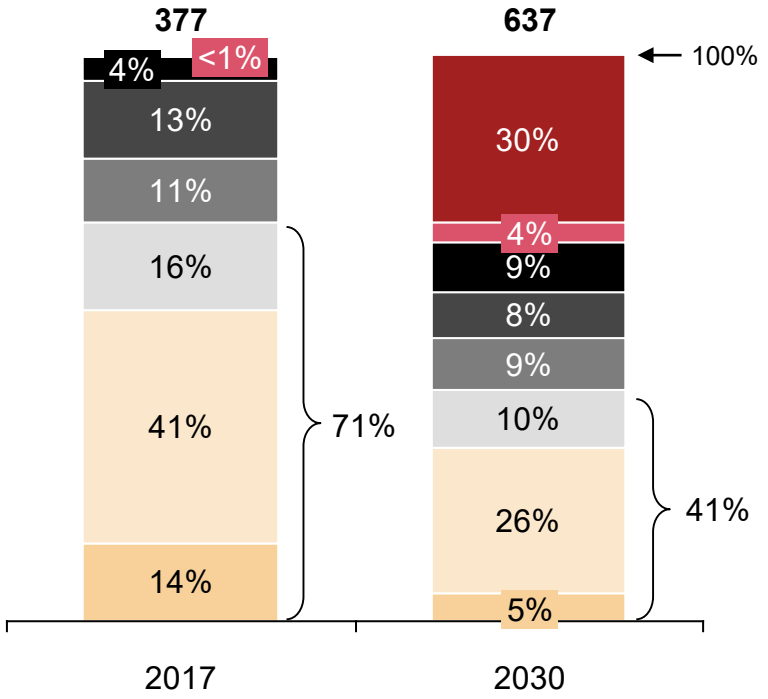
Industry profit share of traditional suppliers, OEM vehicle sales and aftermarket could almost halve to 41% by 2030

Global automotive value pool shifts

Revenue distribution[1] (in $bn)



Profit distribution[1] (in $bn)



Key levers

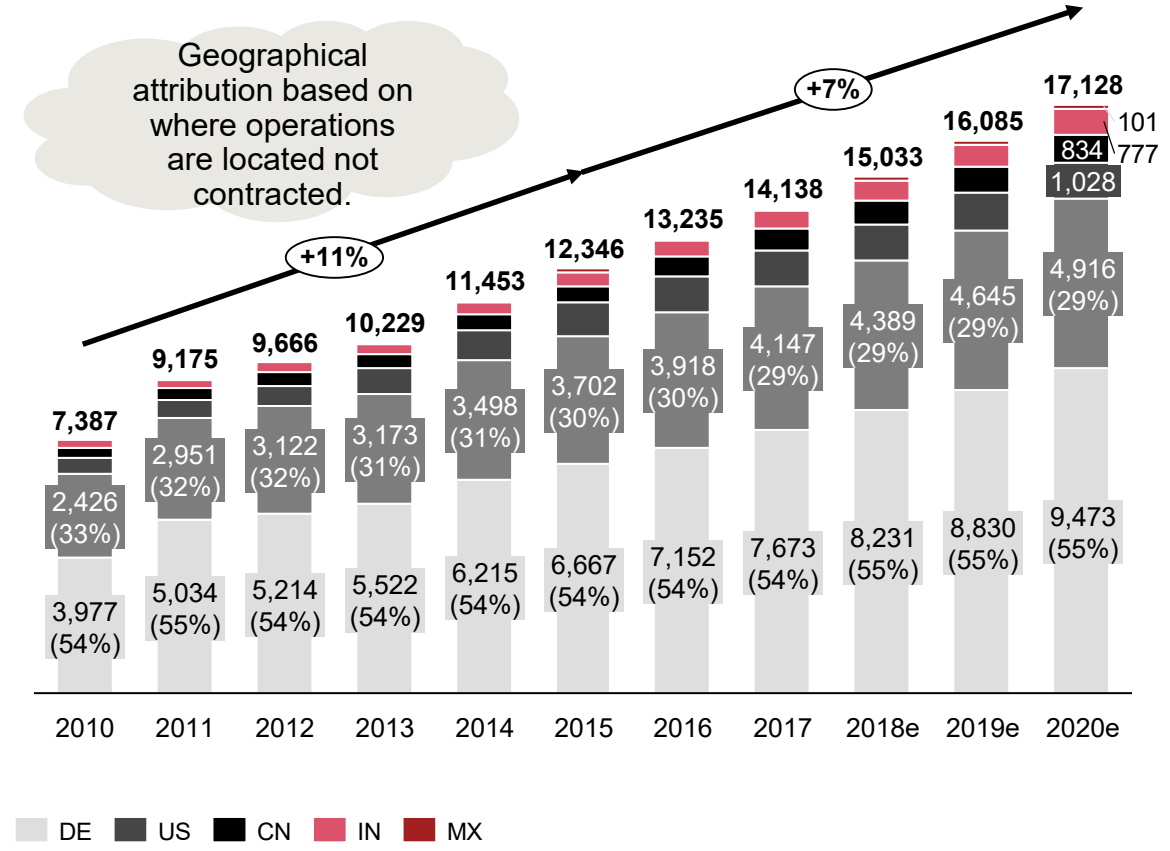
- MaaS increases **vehicle utilization** and respective vehicle wear/tear → higher vehicle related sales, but declining vehicle base
- MaaS **fleet owners** emerge as growing buyer segment with higher bargaining power → lower margins in aftermarket, financing, and insurance
- **Autonomous** increases technical vehicle complexity/value provided by new tech suppliers, but reduces collisions → shift in insurance business and aftersales
- Vehicle **electrification** reduces power train complexity, vehicle maintenance need, and traditional supplier contribution → reduced traditional supplier revenues

1) based on Strategy& 2030 Scenario. Totals may not equal sums shown due to rounding; 2) Vehicle-based mobility as a service, incl. “shared autonomous” & “shared driver-driven”
Note: consolidated view; supplier value pools not eliminated from vehicle/aftermarket/MaaS revenues to show full industry value pools; Source: PwC Autofacts, IHS, HBR, Technavio, Thomson Reuters, Oxford Economics, OEM Reports, Strategy& Analysis

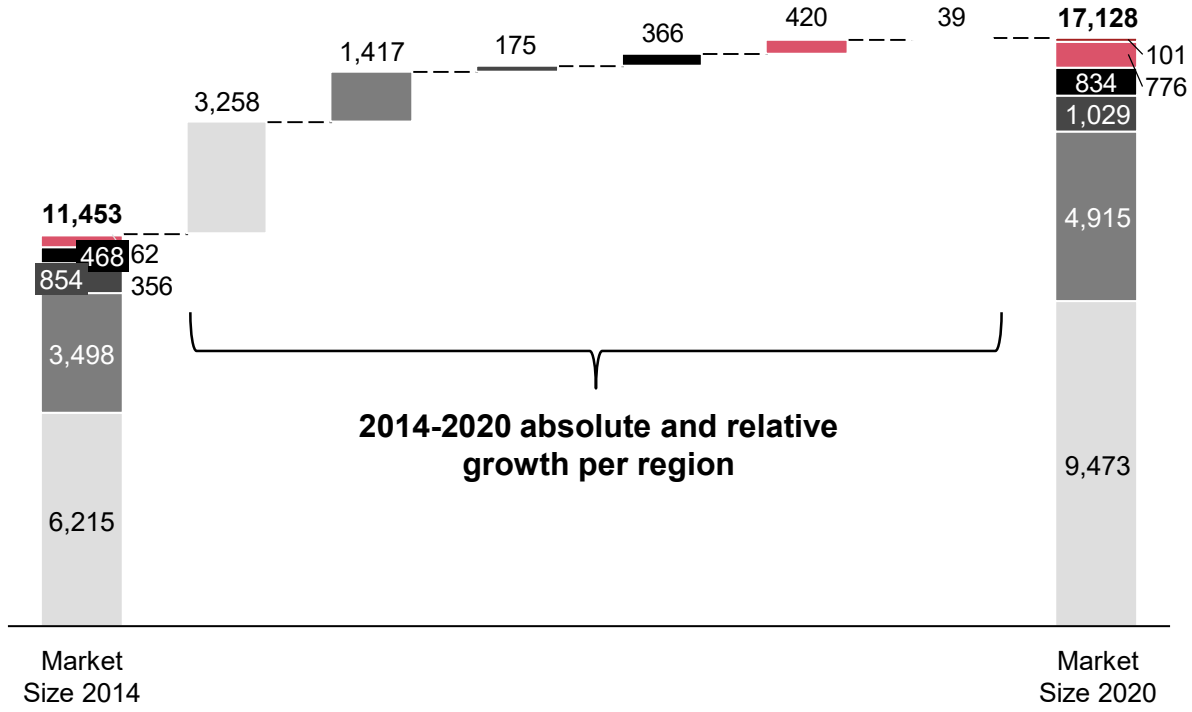
The engineering supplier market is expected to grow with a CAGR of approx. >6%

ESO market per region (EUR Mio.)

ESO market developement per region



ESO market growth per region



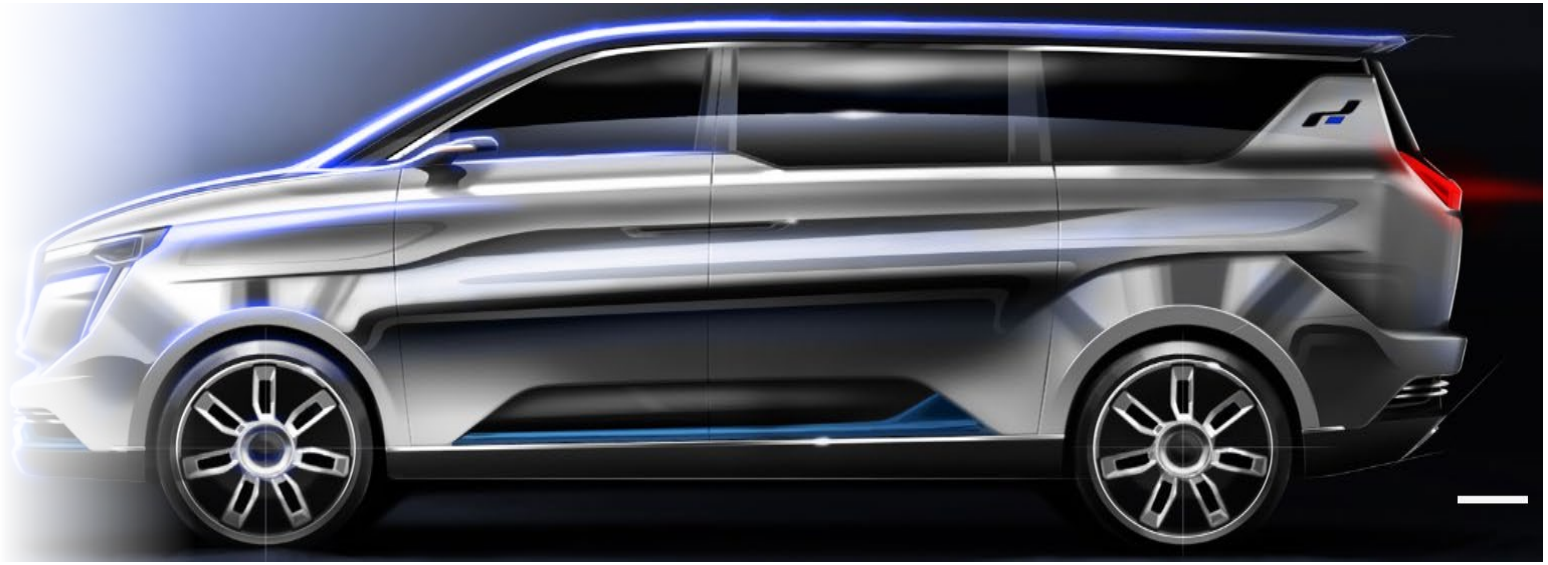
ESO: Engineering service Offering. RoE = Rest of Europe (excluding Germany)
Sources: Strategy& analysis, Market Model

Forward-looking concepts with a completely new structure and new functions are already in place

Example – Iconiq

Styling Trends

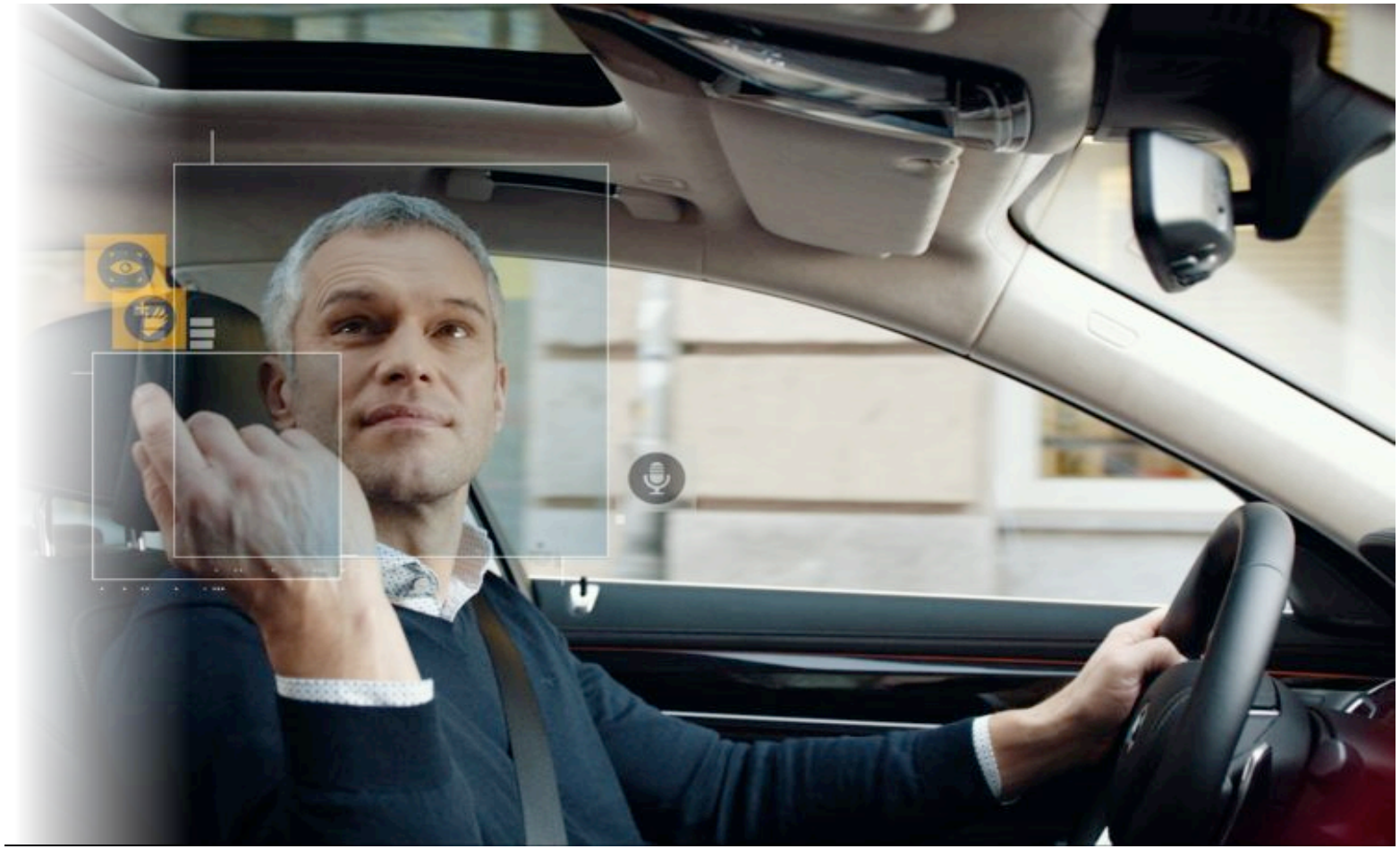
- Big screens, bigger,…..
- Under Body LED
- Exterior Lighting (in blue)
- Night View Sealing
- Useability in new dimensions



Natural Interaction will be a real challenge for OEM, suppliers and customers

Many technical solutions upcoming

Gaining for customer acceptance

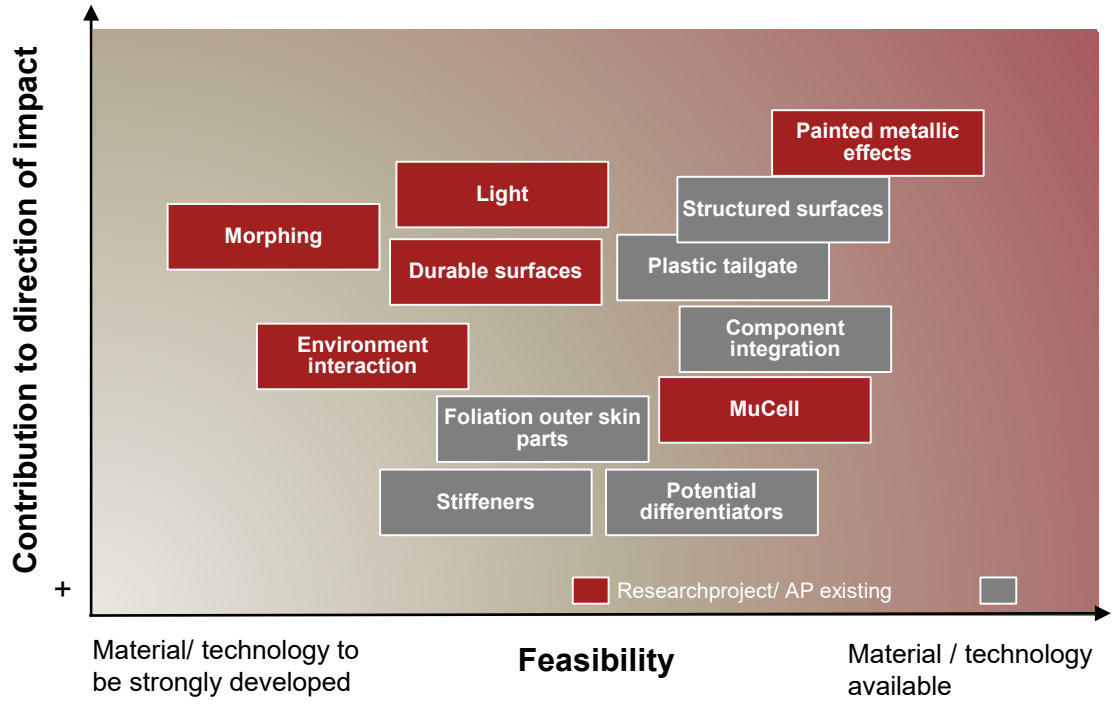


New interior solutions will differentiate the new mobility

Clean, Robust, Unlimited Functionality For Shared Mobility

EXAMPLE

New Technologies have to be rolled out with a strong strategic orientation to visibility and functional impact



Need for action

- **High feasibility**
  - Technical solution / material available in the market
  - Suppliers established
  - Process blueprint available
  - → Painted metallic effects, Plastic tailgate, Structured surfaces, MuCell
- **Medium-term feasibility**
  - Basic solutions available
  - Concrete strategy
  - VE projects / supplier exploration
  - → Component integration, Stable surfaces, Stiffeners, Foiled bumpers
- **Long-term horizon**
  - Development of concepts and fields of application
  - → Environment interaction, Morphing

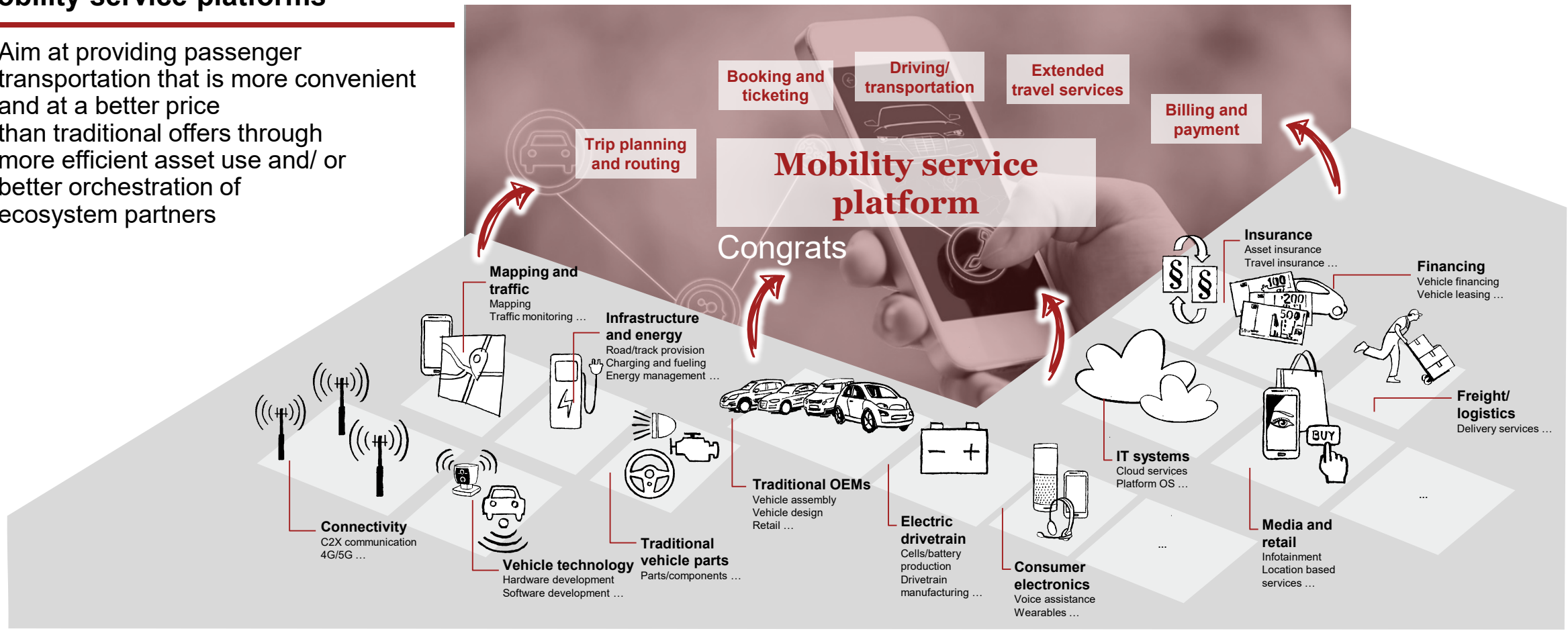
Feasibility of metallic effects, tailgates and structured surfaces can be classified as short-term implementation. Future topics can be implemented with a longer time horizon.

02.
Mobility and connected service heads-up

Mobility platforms beat traditional transportation offerings in choice, convenience, and price

Mobility service platforms

- Aim at providing passenger transportation that is more convenient and at a better price than traditional offers through more efficient asset use and/ or better orchestration of ecosystem partners

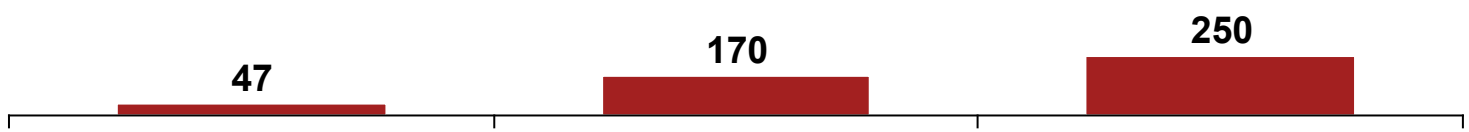


Abbreviations: OS – operating system

We see four Ways-to-play in the mobility market with different scope

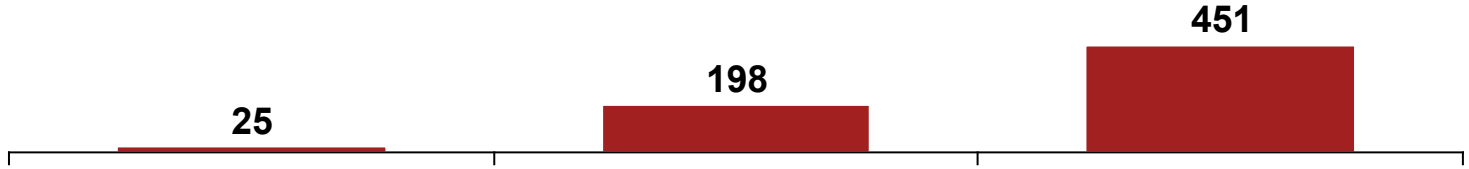
The value of MaaS is expected to grow at a combined 25% p.a. from 2017 to 2030 to reach ~USD 1,400 billion in the US/EU/China

Estimated MaaS market size development, U.S.
(in USD billions)

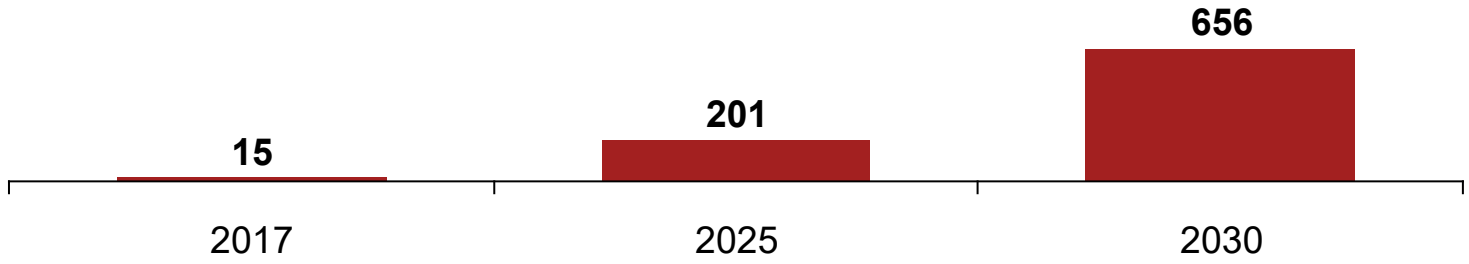


CAGR 2017-30

Estimated MaaS market size development, E.U.
(in USD billions)



Estimated MaaS market size development, China
(in USD billions)

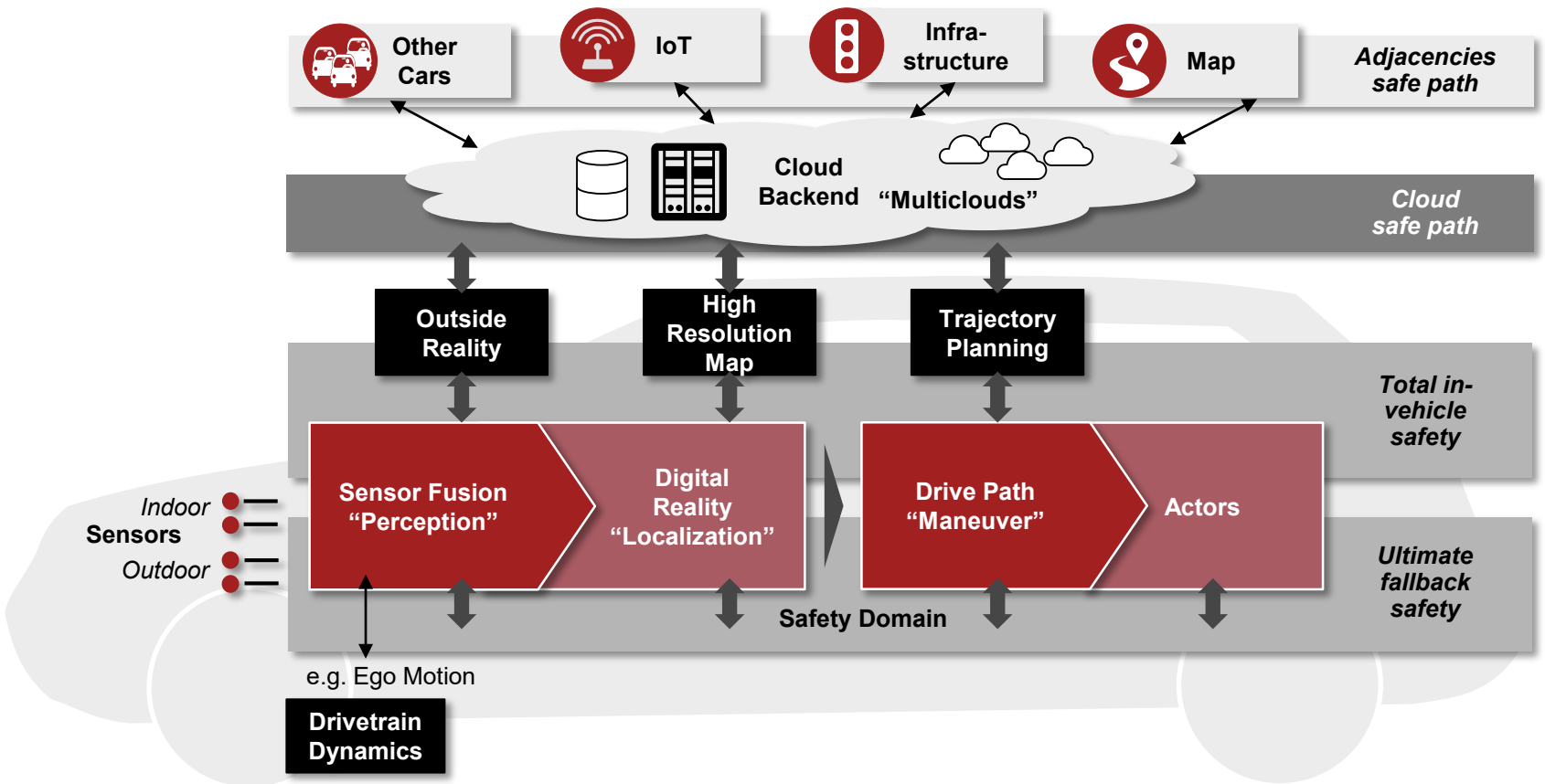


Note: vehicle-based mobility as a service, incl. “shared autonomous” and “shared driver-driven”. based on Strategy& 2030 scenario
Source: expert interviews, PwC Autofacts, Strategy& analysis

EXAMPLE

The domain ADAS /AD is subject to most significant and most complex technological change and a good example for distributed safety

High-level view on domain ADAS / AD – Distributed safety



Expected Impact

- **New concepts for safety- and fallback paths** are required
- **In-vehicle approach** for autonomous driving is **highly integrated**
- Multiclouds enable bringing **adjacent safety**
- Level 5 autonomous driving will most likely be enabled by a **cloud backend with AI**
- **Various designs and architectures** will emerge
- **Safety transforms** from individual ECU to all functions and layers and must be reflected in organization

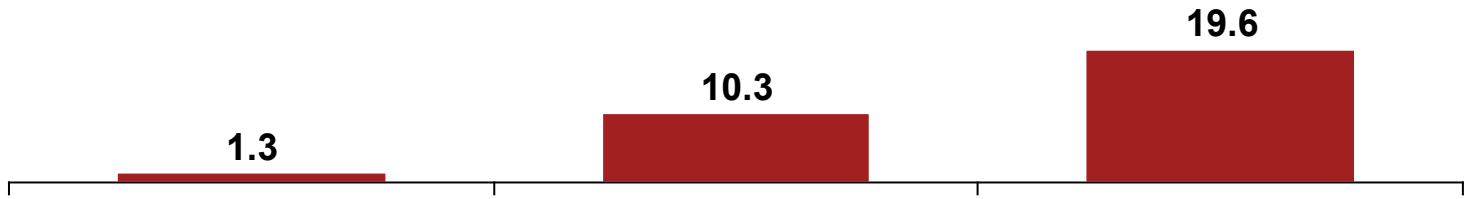
There are so many uncertain drive situations

… trap for autonomous cars ;)

The value of connected services will grow at a combined 28% p.a. from 2017-2030 to reach USD76 billion in the US/EU/China

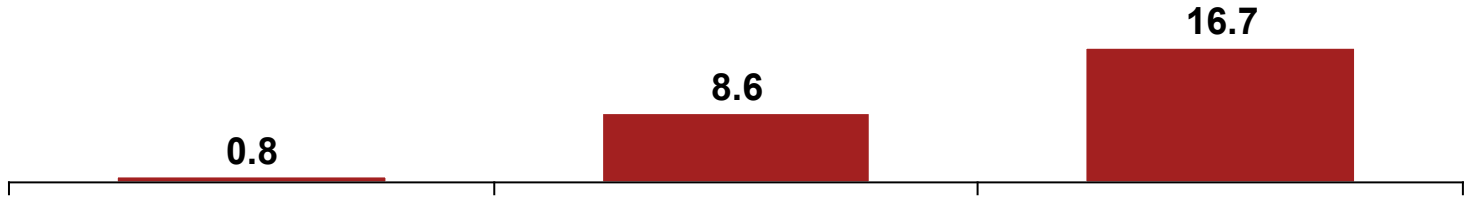
Vehicle-centric connected services – Market potential

Estimated connected services market size development, U.S.
(in USD billions)

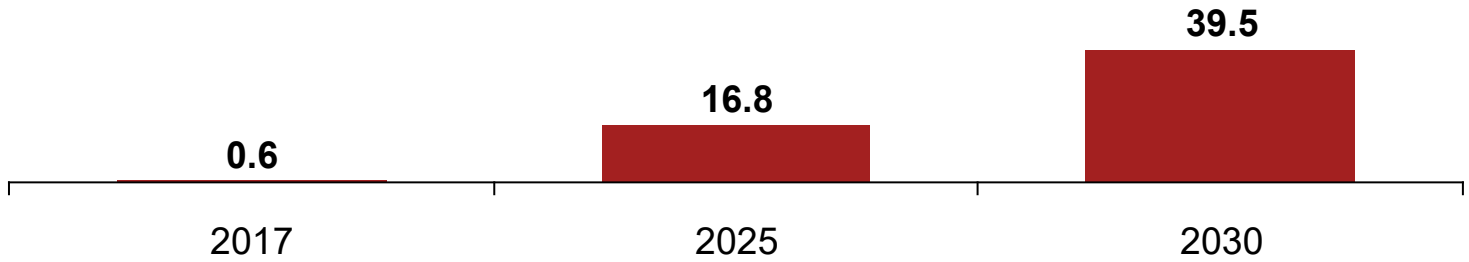


CAGR 2017-30

Estimated connected services market size development, E.U.
(in USD billions)



Estimated connected services market size development, China
(in USD billions)



Note: based on Strategy& 2030 scenario
Source: expert interviews, PwC Autofacts, Strategy& analysis

Fifth screen will be the new point of sales

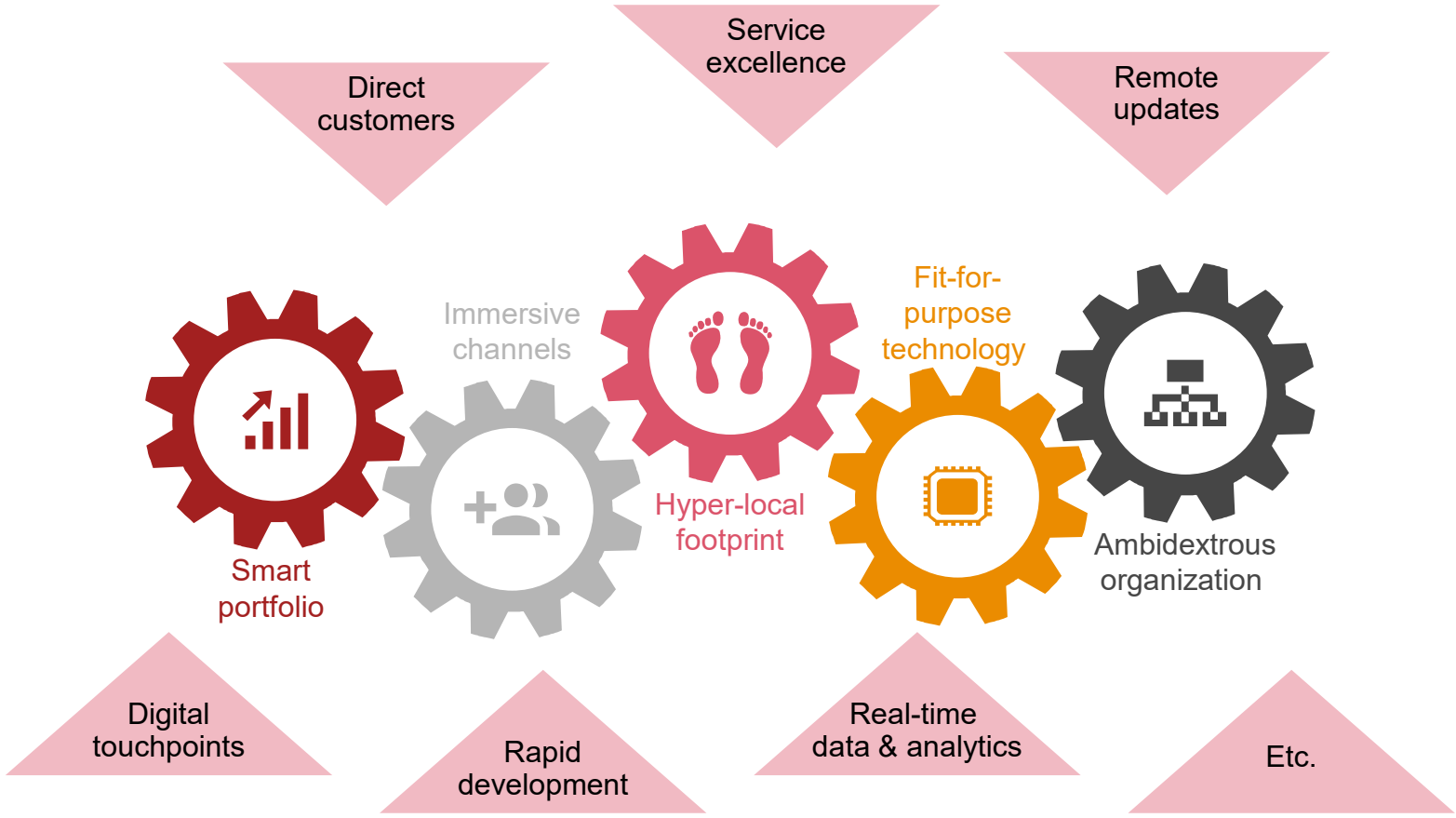
New technologies enable usability and driver focus for connected services

03.
Capabilities for the road ahead

Winners will shift gears in 5 areas to meet future of mobility demands

New paradigms in automotive …

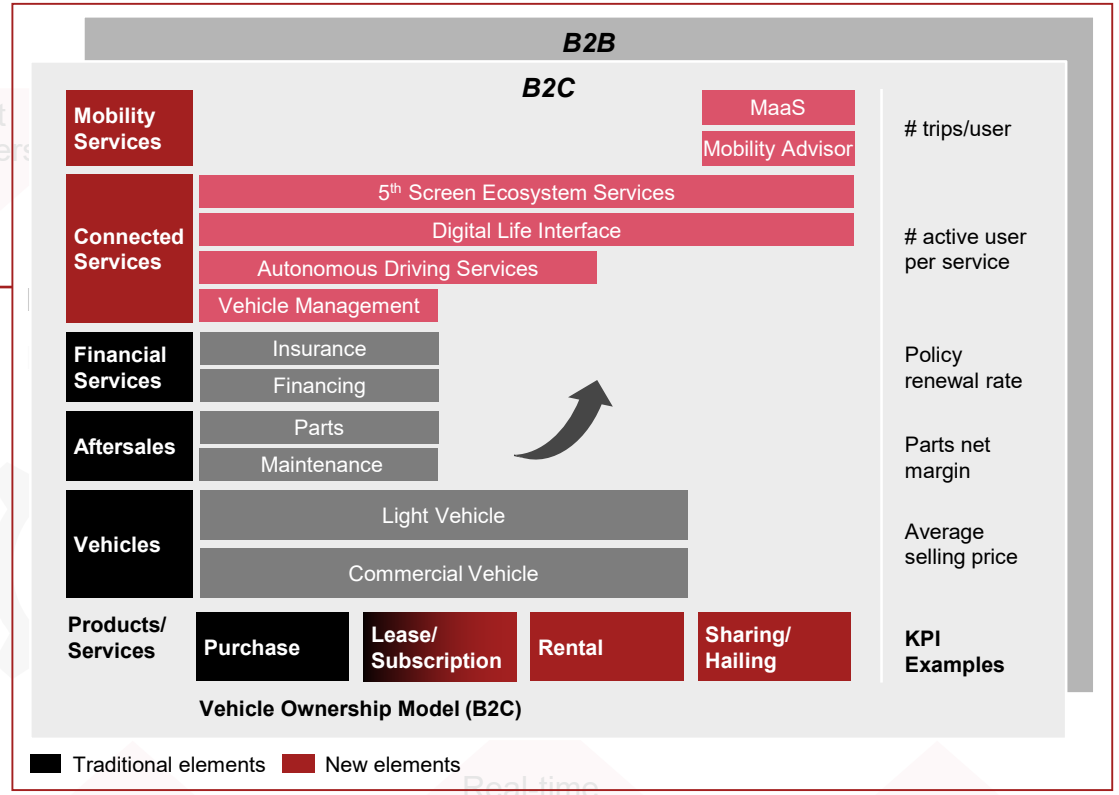
… ask for gears to be shifted



Operating models and workshare is shifting

New paradigms in automotive …

… ask for gears to be shifted



Take away No. 1: The customer group is growing for ESO

New working environment will lead to new organizations

New paradigms in automotive …

Phases of digital transformation

Digital maturity

4. Embedded: digital embedded across the company – small digital CoE possible; digital activities in sync with business unit operations and "agile" where suitable

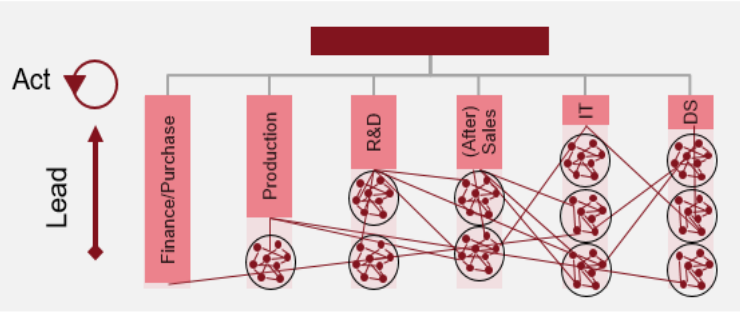
3. Central steering and incubation: central digital team with full steering, plus potential incubator and digital factory; clear governance ensuring fast execution

2. Central coordination: coordinator team as innovation lab to test and prototype; high alignment efforts with limited process standards; no home for new digital business

1. Explorative: independent generation and testing of isolated digital ideas in Bus; uncoordinated activities triggered by business or technology, often sub-scale

Business unit/function Digital team Agile team

Zoom-in "embedded": agile in auto



Depending on complexity and scope of projects, decision on working agile or traditional needs to be taken

Remote updates

Fit-for-purpose technology

Real-time

Ambidextrous organization

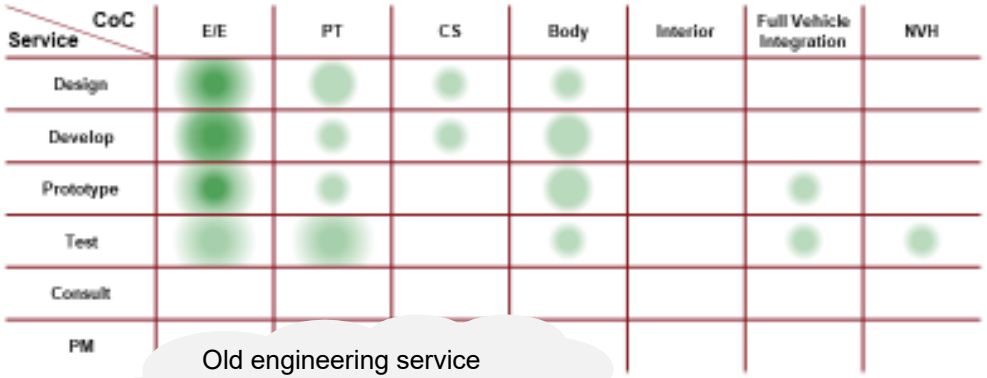
Take away No. 2: Organizations will change, buying center of clients is transforming

Engineering service providers have made high investments in electronic capability development; competition is intensifying as a result

Investments in "competence" development

Current investment focus for the development of competencies in the area of E/E...

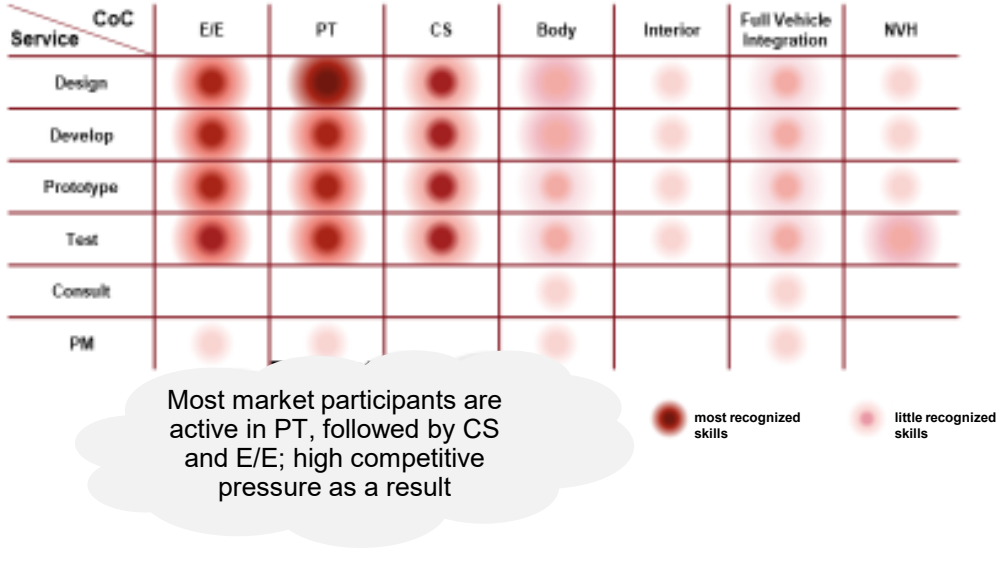
Engineering service provider investments



Sources: Strategy& analysis, Bloomberg, annual reports, expert interviews, company websites, international media

... will significantly intensify future competition in E/E

Detailed product portfolio



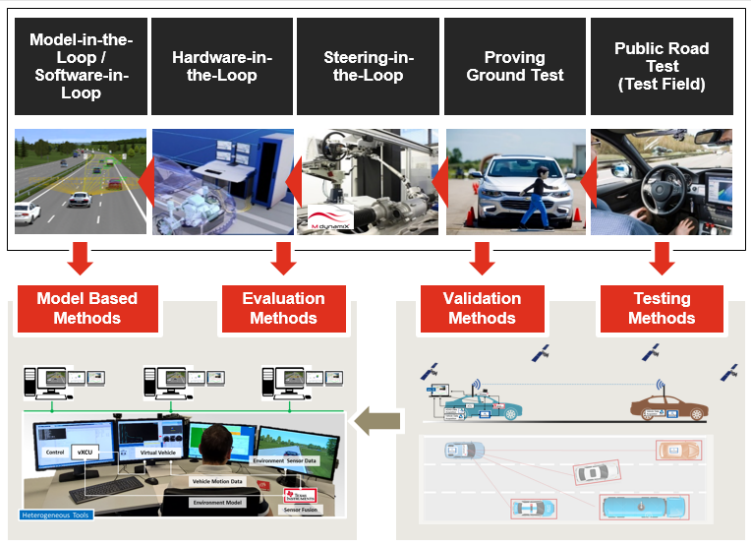
Sources: Strategy& analysis, Bloomberg, annual reports, expert interviews, company websites, international media

Take away No. 3: The ESO market is already moving to advanced capabilities

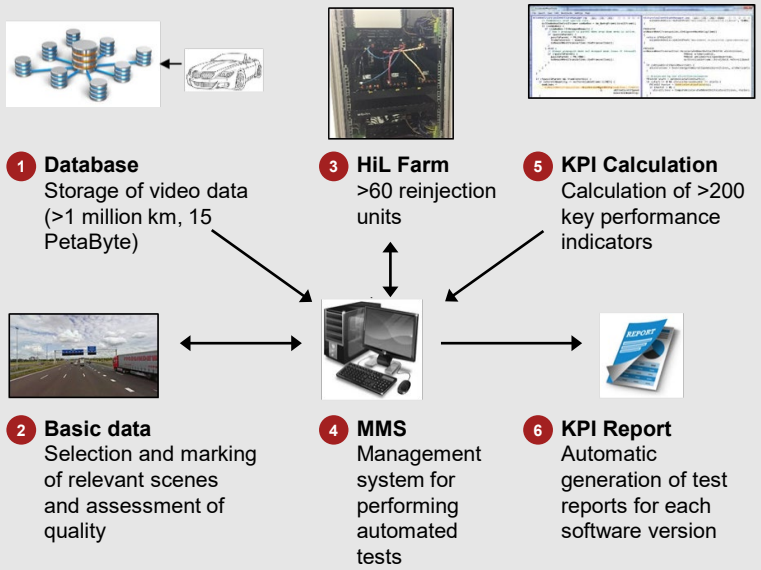
Source: Strategy& analysis, Bloomberg, annual reports, expert interviews, company websites, international media

Testing and validation is an essential part of software development and is often ~ 50% of the workload

Example: Autonomous/assisted drive test environment



Subproject for the planning and execution of software tests and the verification of compliance requirements parallel to the software development



Establishment of complex databases and controls for automatic testing of HiL, SiL and MiL systems parallel to the software development process

Test environment

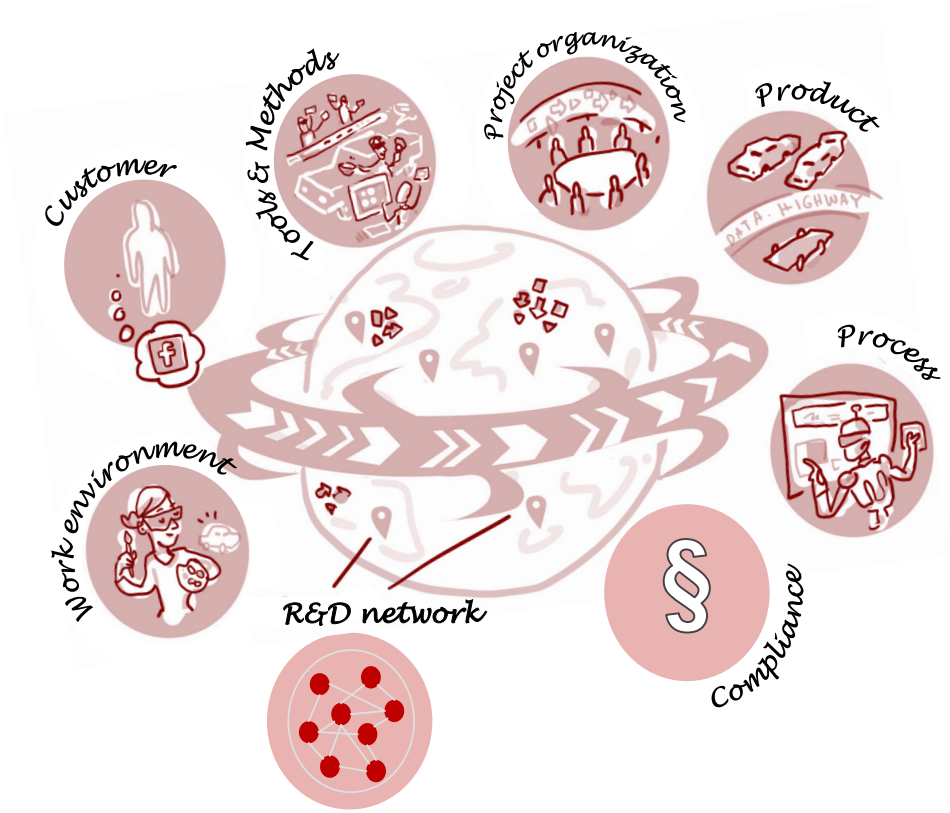
- Setup of a test environment for the **automatic validation** of camera functions and performance tests by Tier-1 Supplier
- Approximately **50% of the development** costs were needed to set up and run the test environment
- Strong **underestimation of the complexity** of the required IT infrastructure and special test software
- Autonomous Drive requires one of the **most complex test infrastructures**

Take away No. 4: Testing is the key issue for sustainable products

Source: Strategy& analysis, Tier-1 Supplier; KPI=Key Performance Indicator; HiL=Hardware in the Loop; SiL=Software in the Loop

ESO will prepare for a holistic transformation to build the necessary competencies and skills

Necessary skills



- Organizations foster **innovation**, **recognize customer needs, and enable** continuous after-sales improvement (on-air updates)
- Ensure best-in-class **technology/differentiating skills** (e. g. architecture design, agile software development, testing, artificial intelligence)
- Organizations work **decentralized with central know-how in modern, function-related areas**
- **Development organizations** with **strong profiles** and **conscious location** decisions (Best Cost Country vs. Best Capability Country) are necessary
- Organizations plan to have sufficient **for protection**
- **Cross-functional competency building** and **scalable project setups** (e. g., campus concept)
- Organizations promote **"Digital Change Culture"** within the company

Realignment & Balancing Organization

Take away No. 5: Next level ESO transformation starts right now

strategy & Impact