

STA Presentation

Shifting Gears – How to ride the wave of change in the automotive industry?

by Christian Koehler, Strategy Engineers GmbH & Co. KG, Munich, Germany

June 7th 2017

Riding the wave of change in the automotive industry....

Introduction

Carlos Ghosn said at the opening of last year's New York International Auto Show:

“I expect the global auto industry to see more changes in the next five years than it has in the last twenty”.

He continued by saying:

“Because for those open to new ideas and new ways of doing things, the opportunities for our industry to grow and better serve society's needs has never been greater.”



The automotive industry is facing the biggest change in history due to several trends caused by legislation, society, technological developments

Key automotive trends 2017ff

Technology Trends

1

Electrification

- Increased penetration of electrified powertrains
- Electrical power becomes scarcer and tightly managed
- Range vs. functions trade-off
- New styling freedom in purpose-built xEV



Connectivity

- Increased connectivity in vehicles
- Increased data exchange (car2car, car2infrastr., car2x)
- Increased digital services in the automotive eco system



2

Autonomous Driving

- Increasing levels of autonomous driving from hands-off to mind-off
- Based on superior hardware for sensors and artificial intelligence
- Enabled through new software for object recognition, trajectory planning and actuation



Business Changes

Mobility as a service

- Decreasing attractiveness of traditional car ownership model
- Lease- or opportunity-based usage models
- Multi-modal transport solutions
- Cross-OEM and cross-modal solutions
- Digitals as new entrants



Changing Industry

- New vehicles, new markets
- New players and business models
- Changed volume structure (e.g. less cars due to Robotaxis)
- Changed price structure (e.g. decreasing margins due to xEV)



3

Digitalization

- Internet of Things / Industry 4.0
- Agile strategy and business processes
- End consumer driven

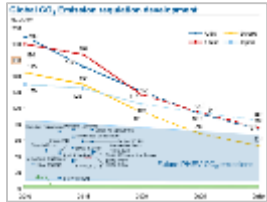


Riding the wave of change in the automotive industry

- **Electrification**
- Autonomous Driving
- Digitalization

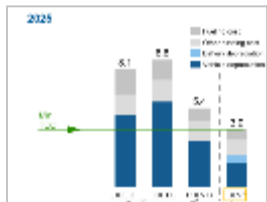
Four major drivers will lead to increasing xEV market shares beyond 2020 – CO₂ regulation, TCO, electrical range and increasing charging infrastructure

Drivers for increasing xEV market share



1 Legislation and stricter CO₂ targets

The increasing pressure to reduce pollutant emissions and CO₂ emissions and introduction of real driving emissions creates the need for pure EVs



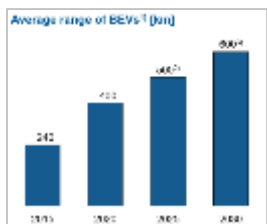
2 Competitive total-cost-of-ownership (TCO)

When the total cost of ownership for EVs reaches break even, electric vehicles become increasingly attractive for a larger number of costumers



3 Increasing electric range

Increasing pure electric ranges will soon meet customer demand

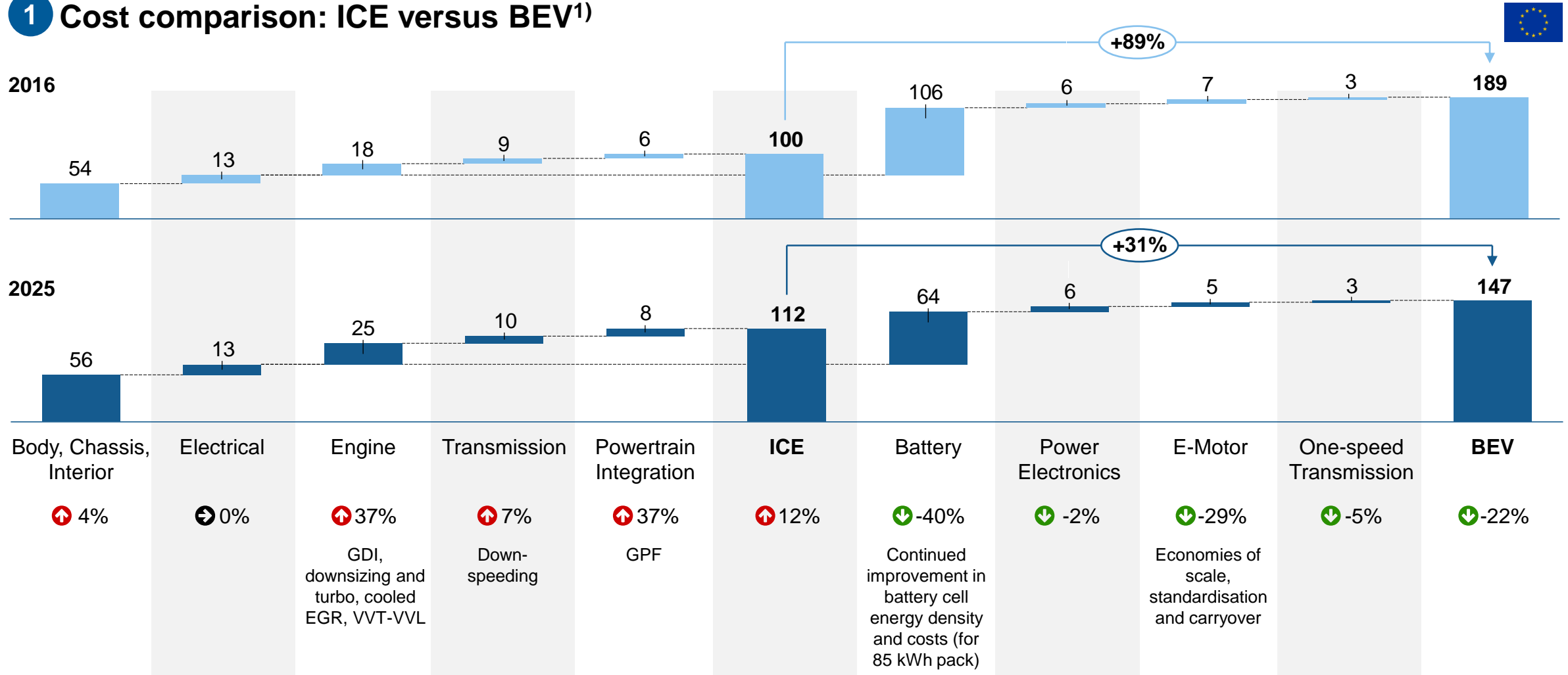


4 Increasing availability of charging infrastructure

Increasing charging options to secure customers' demand

BEVs will gain a solid material cost advantage over ICEs soon – Point of cost parity depends on battery cost decrease

1 Cost comparison: ICE versus BEV¹⁾



Source: USABC, SAE, IKA, Strategy Engineers analysis and estimates // ¹⁾ Europe C segment vehicle; 2016, Costs module incl. Battery management system: 120 €/kWh – 2016. 80 €/kWh - 2025

OEMs employ different strategies when it comes to engineering and manufacturing of xEV systems

1 OEM engineering and manufacturing strategies

ILLUSTRATIVE

More OEM Control: In-House



Less OEM Control: Out-sourcing

Manufacturing

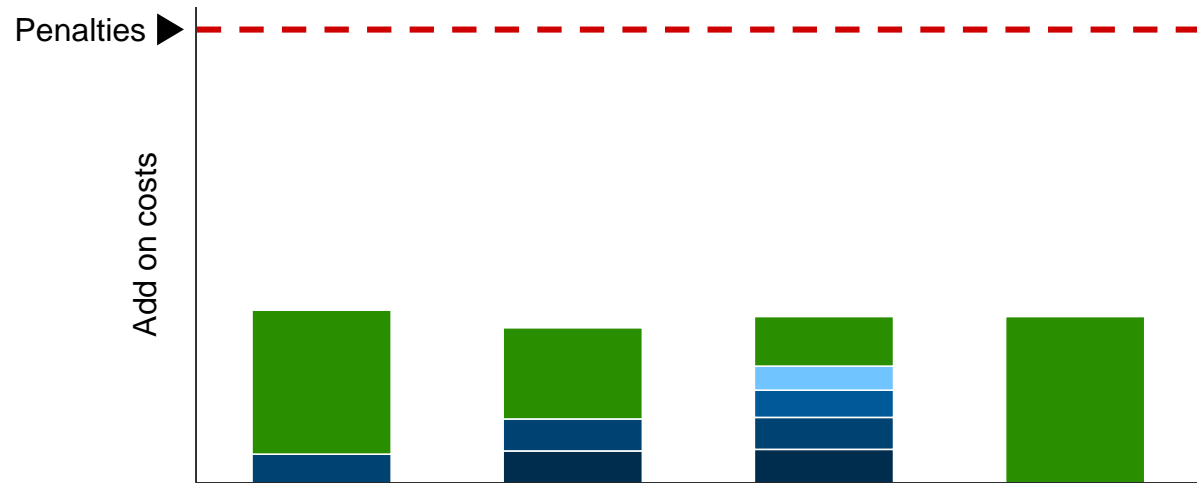
More OEM Control: In-sourcing

From a strategic and financial viewpoint, exposure to the risk of penalty costs is not feasible – xEV vehicles must be pushed onto the market

1 CO₂ reduction strategies simulation

CLIENT EXAMPLE

Simulated scenarios



	Most likely	Most efficient	Least risky	Least complex
Cost	◐	◑	◐	◐
Complexity	◐	◑	●	◑
Risk	◐	◐	○	●

- Gasoline ■ 48 V MHEV ■ PHEV
- 12 V MHEV ■ 48 V FHEV ■ BEV

Comments

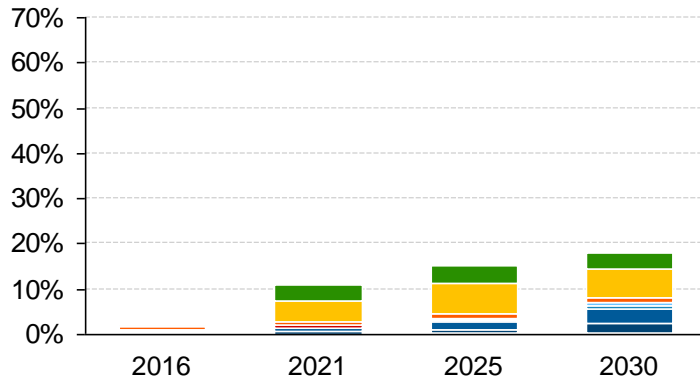
- Penalty → worst option: **always** much more expensive
- **BEVs necessary** to achieve CO₂ fleet targets 2021/2025
- Betting only on **BEVs** is too risky: the required market share needs **high subsidies**
- **Hybrid technology** is a valuable complementary solution
- Further **improve ICE technologies** for Gasoline to reduce required share of xEVs
- Keep the **portfolio mix complexity low** to avoid an overload for the R&D effort and reduce the risk of project delays

xEV customer demand (pull) is strongly dependent on OEM pricing decisions

1 xEV customer demand (pull)

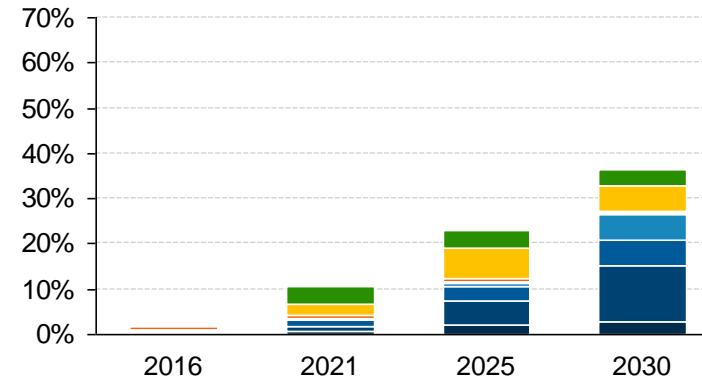
Conservative scenario

OEM markup on			
Battery pack	50%	Other components	50%



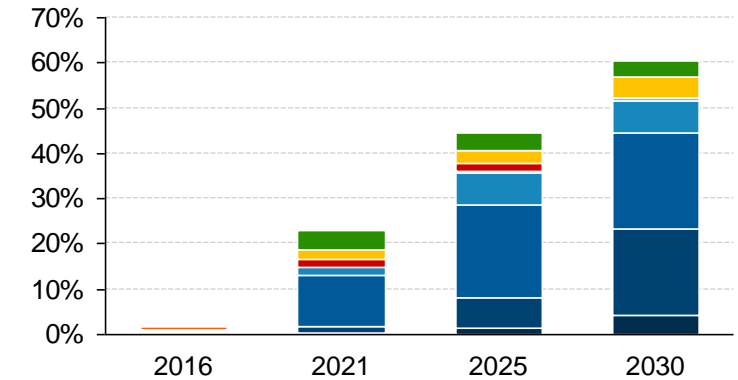
Mild scenario

OEM markup on			
Battery pack	25%	Other components	50%



Aggressive scenario

OEM markup on			
Battery pack	0%	Other components	50%



Figures indicative

OEM decisions in term of gross margin are crucial for the diffusion of xEVs

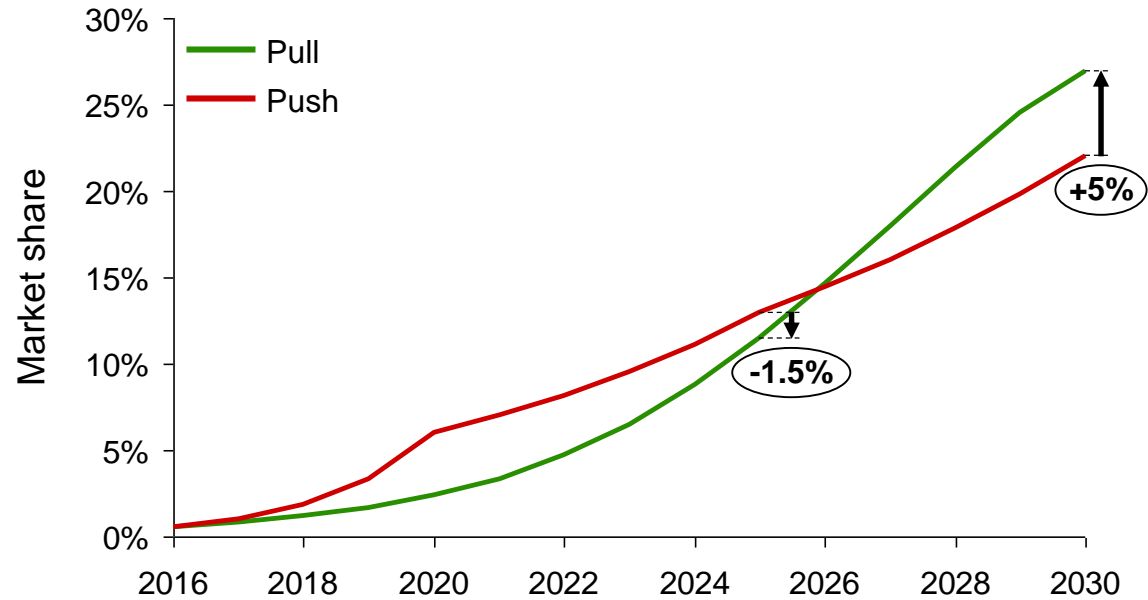
- **Aggressive scenario** to be considered only if fast BEV diffusion is required by CO₂ emission regulations (battery pack R&D and production costs need to be covered by alternative funding)
- **Conservative scenario** is to be considered only if government will strongly support BEV sales by introducing high economic incentives

■ A BEV
 ■ B BEV
 ■ C BEV
 ■ D BEV
 ■ E/F BEV
 ■ A PHEV
 ■ B PHEV
 ■ C PHEV
 ■ D PHEV
 ■ E/F PHEV

BEV pull is aligned with push forecasts, whilst PHEV diffusion is expected to slow down by 2030

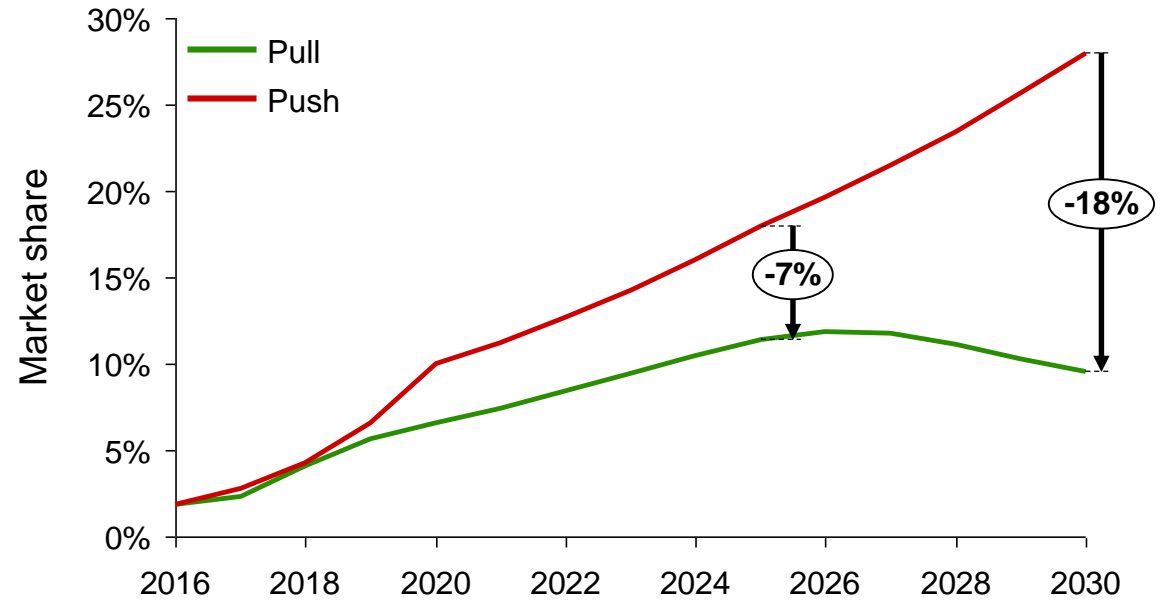
1 Push vs. pull model (mild scenario)

BEVs



Pull demand of BEVs is aligned with market push to comply with CO₂ emission regulations

PHEVs

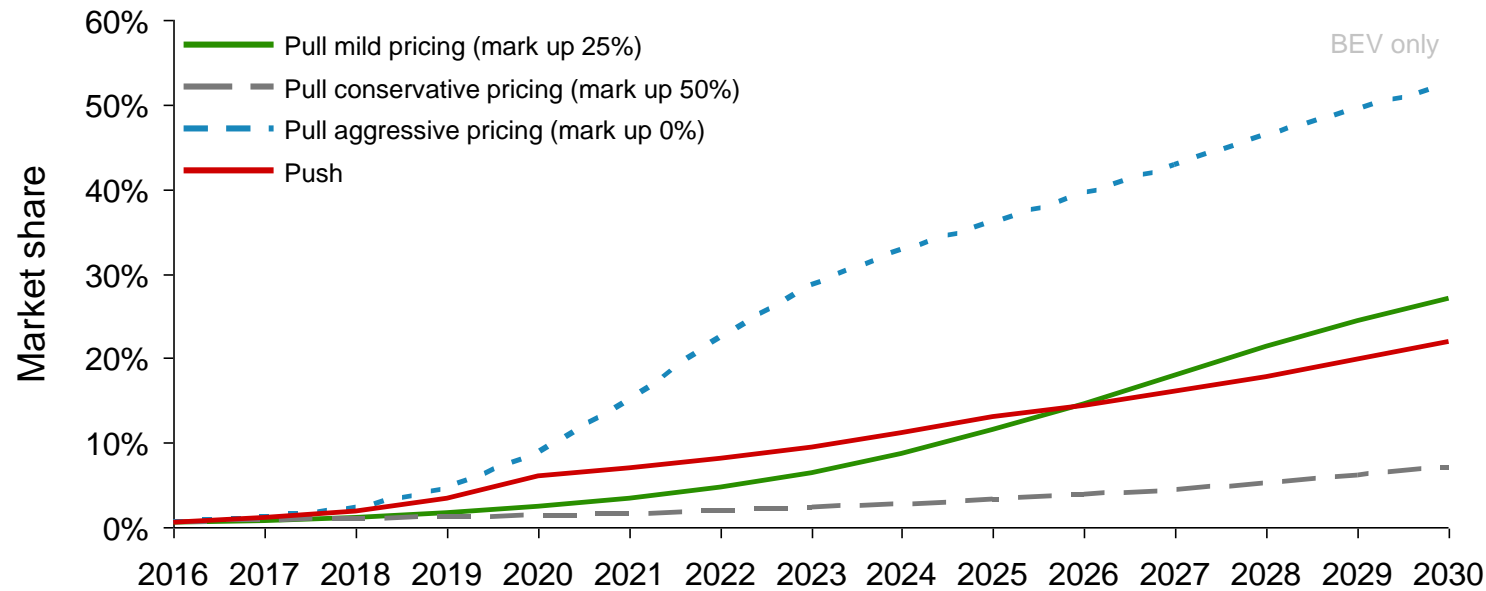


PHEV technology is too expensive for penetrating the market as much as needed by the CO₂ emission requirements

According to different pricing strategies, customer demand presents high variation

1 Push vs. pull model

Pull effect according to different pricing strategies (BEV)



Comments

- According to different pricing strategies, customer willingness to buy (pull) can be strongly influenced
- Pricing strategies must take regional and local subsidies into account, to keep the pull demand as close as possible to the required push
- In case the pricing strategy is too aggressive, the financial stability of the automotive industry can be threatened
- A too conservative pricing strategy can lead to a low diffusion of BEVs, leading to the payment of penalties

Pricing assumptions

Mark-up on components cost (excl. battery pack) for all scenarios		50%	
Mark-up on battery pack cost	0% (aggressive)	25% (mild)	50% (conservative)

A winning pricing strategy must be defined

Pure electric vehicle sales are expected to take off once attractive products become available – aggressive pricing and discounts will lower margins

1 Summary Electrification

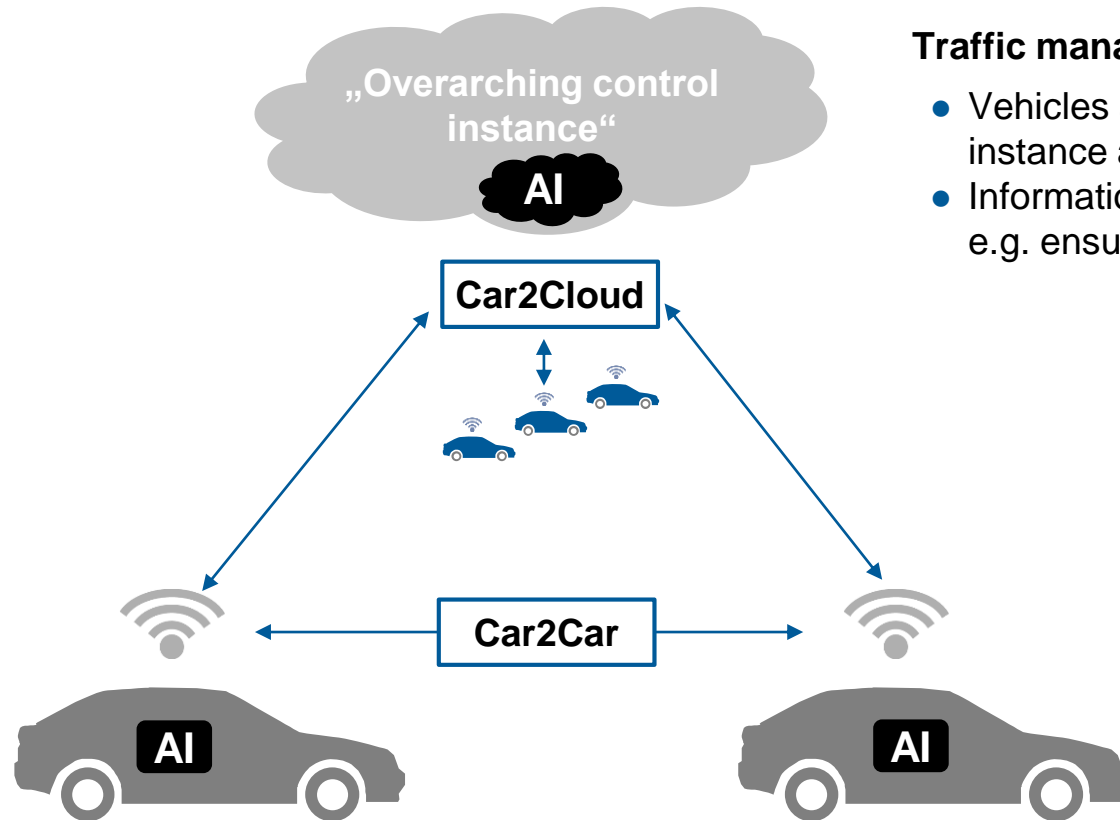
- **Legislation** in Europe (but also China and US) will demand **fleet electrification** from 2020 onwards
- Key for OEMs will be the **most cost-effective powertrain mix** in balance with **customer demand**
- **Prerequisite for customer demand** is an attractive product offer, most importantly a **reasonable electric range** and **competitive cost** compared to conventional ICEs, i.e. a price-competitive volume EV with an electric range above 400km
- **Hybrid powertrains** are a **bridging technology** to facilitate the transition from conventional powertrains to EVs; hybrids lack a superior value proposition over EVs to justify a long-term market success
- Hence, **conventional powertrain improvements**, the introduction of **MHEV in small segments** and the launch of **multiple BEV vehicles** are the most likely option
- Electric powertrains will become **needed** as a consequence, with radical changes for OEM **engineering processes, value chains and manufacturing footprint**
- OEMs need think about **pricing strategies to fulfil needed EV quotas** – **Aggressive pricing and discounts** are likely required to achieve targets and avoid penalties

Riding the wave of change in the automotive industry

- Electrification
- **Autonomous Driving**
- Digitalization

Stand-alone „driving robots“ cannot guarantee full safety and efficiency – they have to be integrated into a comprehensive traffic network system

2 Connectivity as condition for autonomous driving



Traffic management - Car2Cloud connection

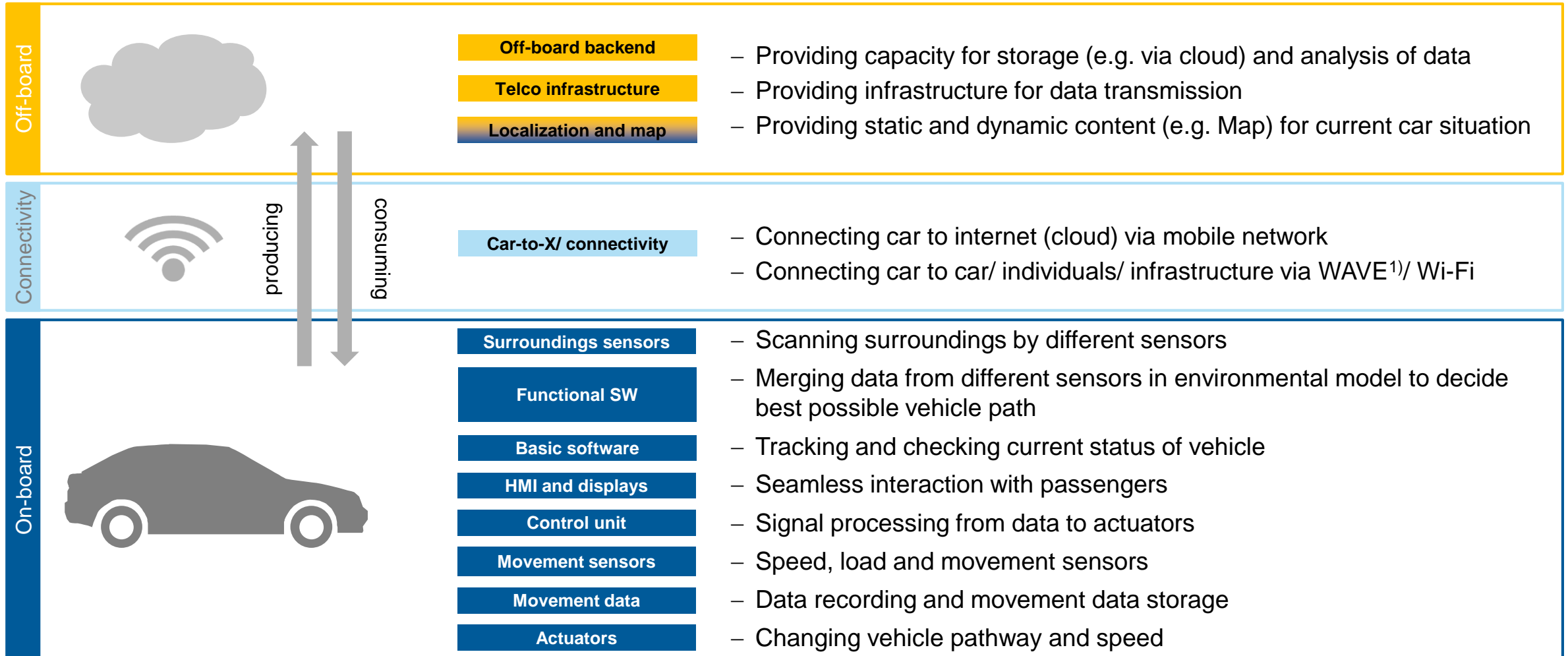
- Vehicles are permanently communicating with overarching control instance and act as actuator and sensor at the same time
- Information is selectively distributed across traffic system in order to e.g. ensure homogeneous free-flow traffic

Time critical adaption of driving strategy → Ad hoc (local) connectivity:

- Vehicles communicate directly in suddenly occurring (dangerous) situations
- Indirect cloud communication is skipped for time reasons

Technologies of autonomous and connected vehicles can be divided into three clusters with several layers in each cluster

3 Technology layers of autonomous and connected vehicles

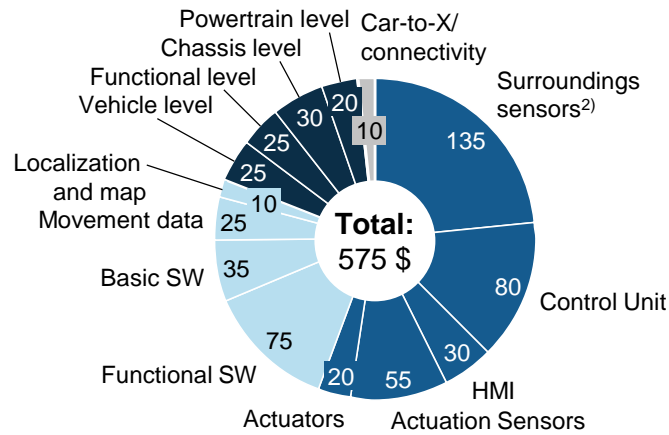


Source: Strategy Engineers // 1) Wireless access in vehicular environments, WiFi-standard exclusively for cars and infrastructure

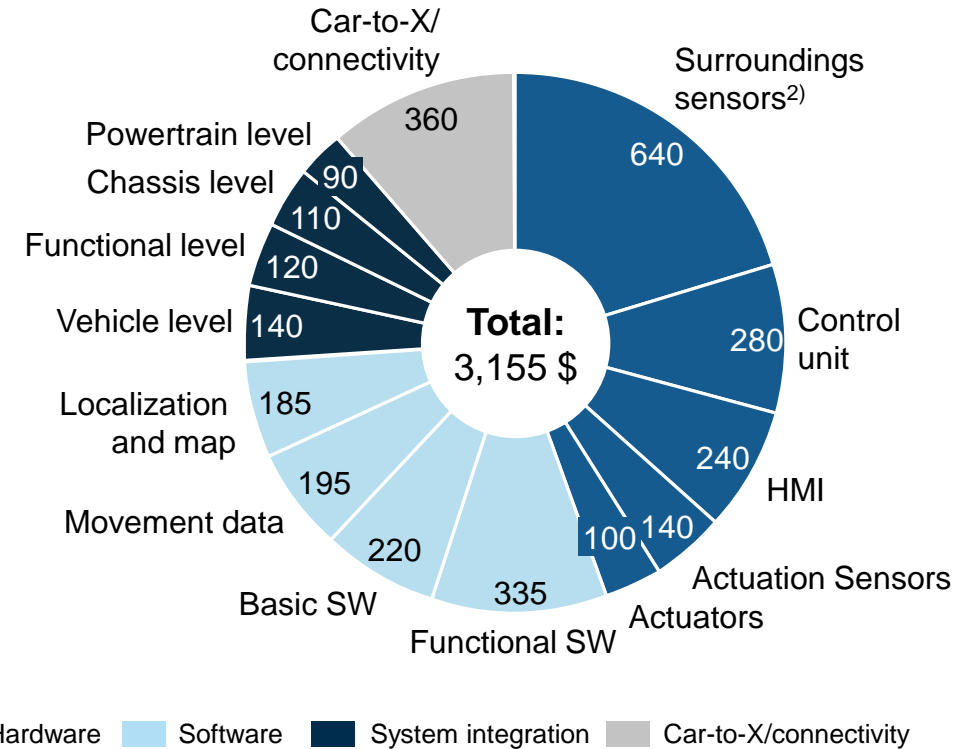
In order to facilitate connectivity to on- and off-board systems, the total costs of car-related system is expected to rise by ca. 450% from 2016-25

2 Car-related automated vehicle value chain¹⁾ – cost development [\$/ % per car]

Segment costs partially automated (2016)



Segment costs autonomous systems (2025)



+ 449%

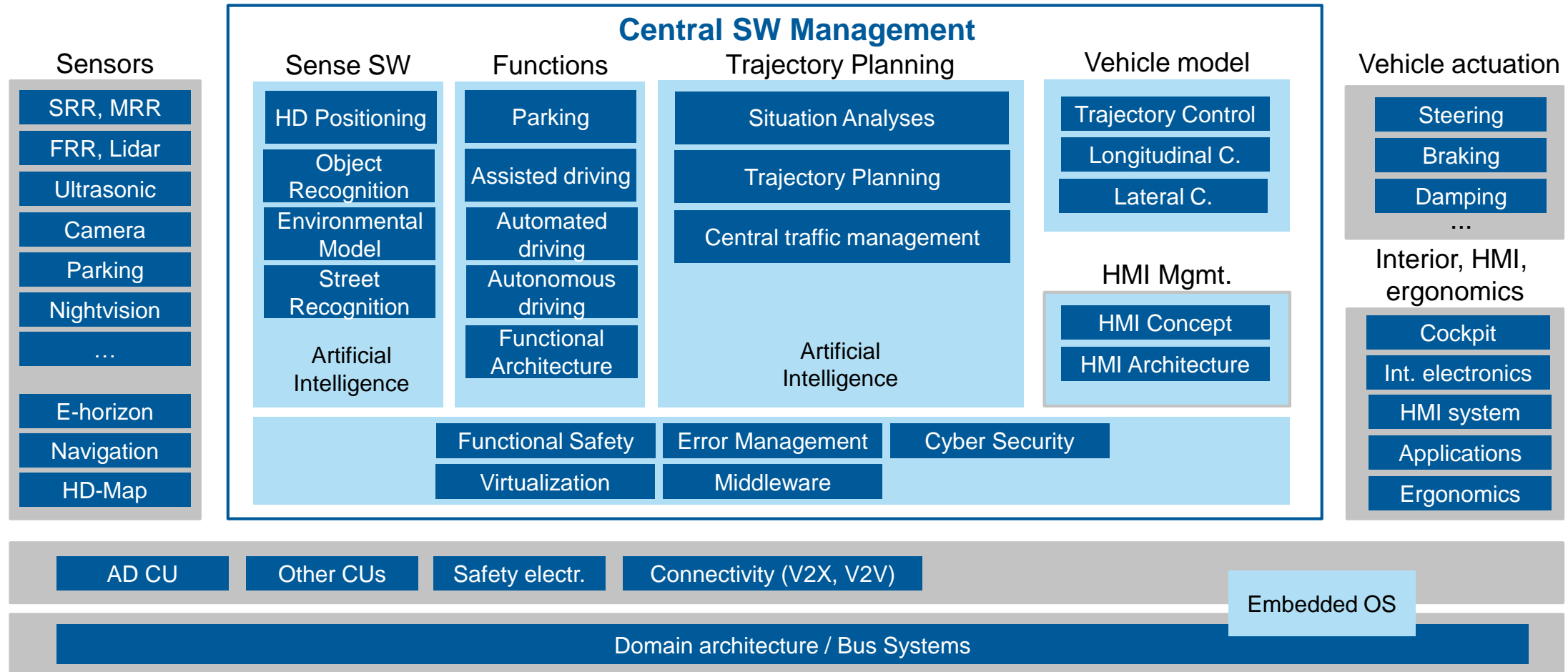
	2016	2025
HW ³⁾	320 \$ (56%)	1,400 \$ (44%)
SW	145 \$ (25%)	935 \$ (30%)
System integration	100 \$ (17%)	460 \$ (15%)
Car-to-X/ connectivity	10 \$ (2%)	360 \$ (11%)

¹⁾ Does not include off-board content (telco infrastructure, off-board backend)

²⁾ Sensor costs may vary strongly dependent on combination of cameras and radar (shown) vs. lidar (ca. + 335 \$), ³⁾ Hardware

Autonomous driving requires central SW management and HW platforms to interpret sensor data for path planning and automated control

2 Functional and system architecture



HW-Platform

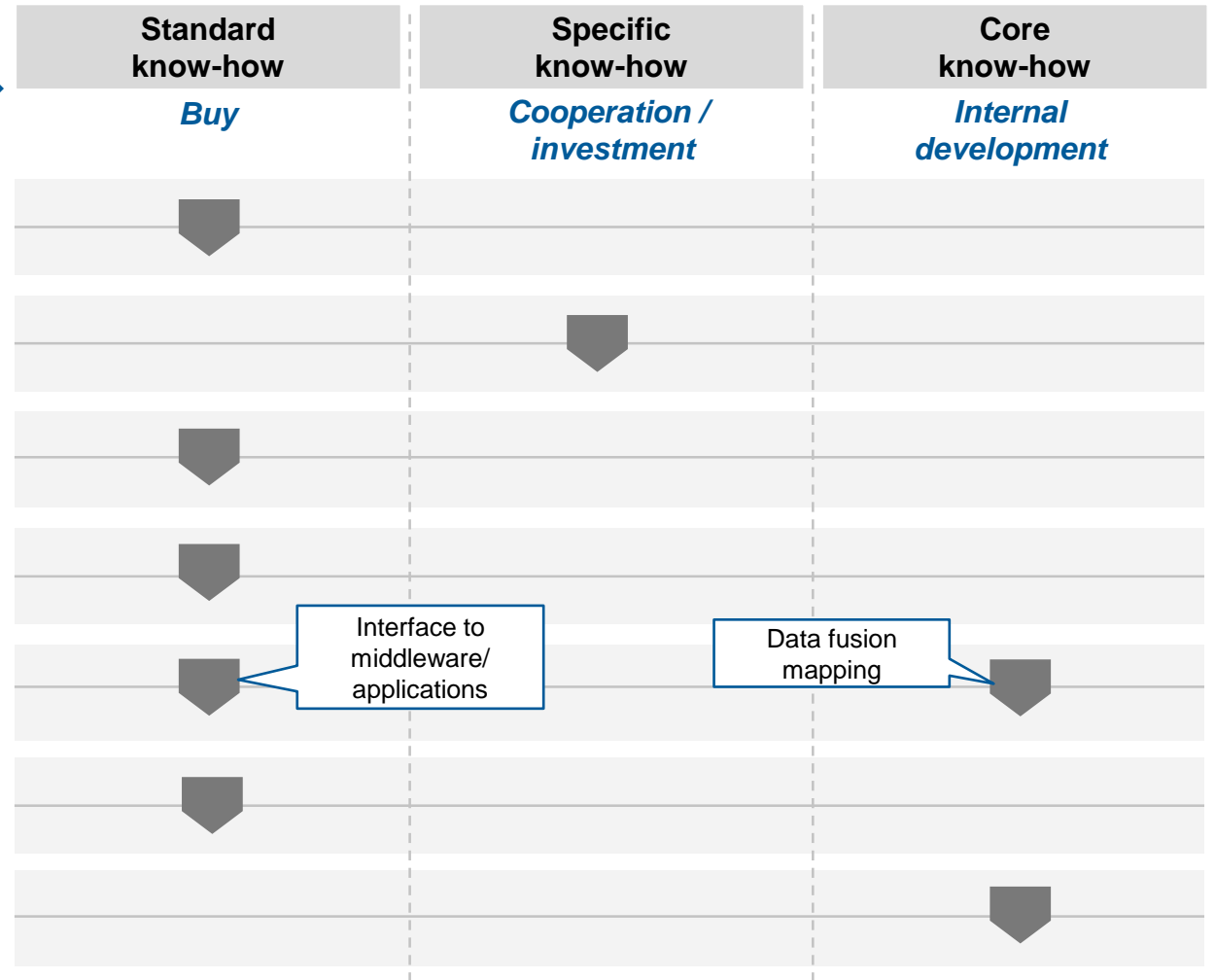
The resulting horizontal value chain will comprise several layers, whereas every layer will have own standards and own market leaders

2 Horizontal value chain (1/2) – Architecture-related

INDICATIVE

Horizontal layers

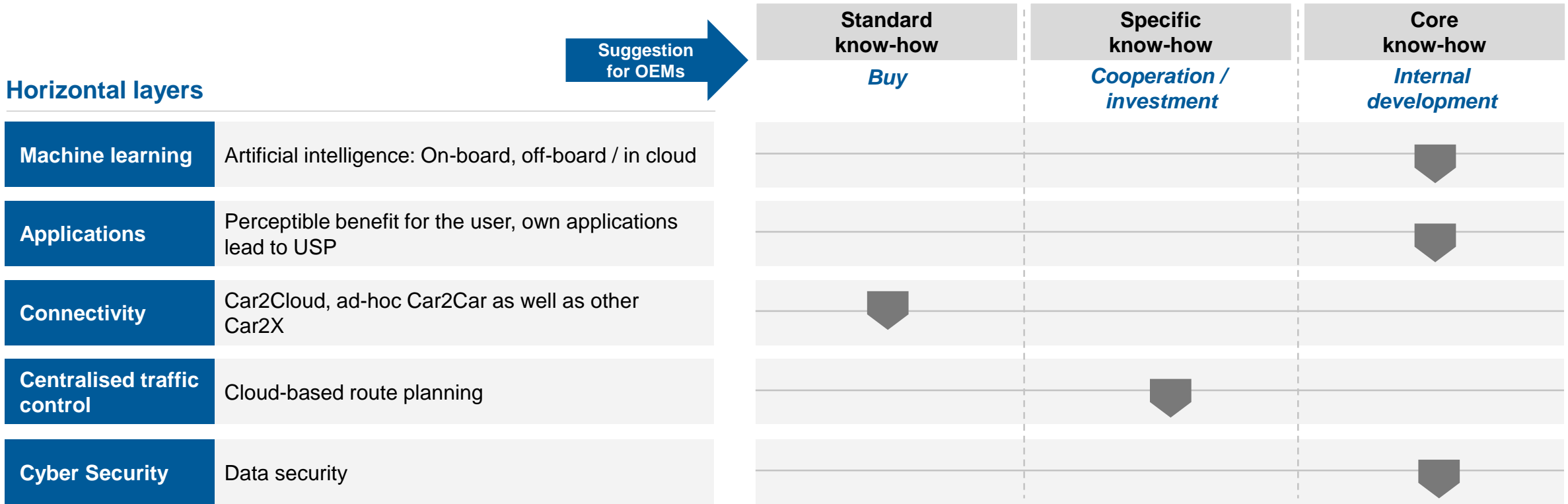
HW platform	CPU and complete ECU
Virtualisation	Special embedded kernels below operating system level for access/ functional safety requirements
Operating system	Embedded operating system, increased standardisation in the future (e.g. AUTOSAR)
Middleware	Standardisation (e.g. AUTOSAR) or quasi-standard solution
Sensor data fusion	Interface to middleware/ applications as well as data fusion mapping
Sensors	Sensors incl. GPS, maps and drivers
Safety	Functional safety



OEMs will need to acquire core know-how in artificial intelligence, customer-related functions, user interface and device design

2 Horizontal value chain (2/2) – Customer functions and enablers

INDICATIVE



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Seven key challenges are essential for OEMs to master Level 3 to 5 autonomous driving

2 Seven key challenges for the development of autonomous vehicles

			Enabler	Differentiator
Organi- sation	1. Working structure	<ul style="list-style-type: none"> Project team organization, cross-functional decision rights Agile SW development aligned with HW development 		
	2. Vertical integration/ cooperation	<ul style="list-style-type: none"> Cooperation development, management and IP rights Alignment of diversity of geographies, time zones, company/ industry cultures and work infrastructures 		
Competency clusters	3. System architecture	<ul style="list-style-type: none"> Overall architecture (re-)definition and implementation Centralized domain and CU-architecture Modular systems ("scalability") Upgradeability and OTA updateability 		
	4. Integration and validation	<ul style="list-style-type: none"> Continuous integration as part of agile development Continuous and virtual HiL/ SiL validation Statistic/ scenario-based testing of total system 		
	5. Functional safety and IT security	<ul style="list-style-type: none"> Multi-processor HW High priority on IT security and protection, SW and HW protection ("security by design") Domain and gateway security 		
	6. Autonomous driving functions	<ul style="list-style-type: none"> AI, machine/ deep learning 3D object recognition, data fusion Trajectory planning ("driving strategy") Big data processing, Backend-based services 		Crucial for competition with digitals
	7. HMI / User Experience	<ul style="list-style-type: none"> Utilization of whole car as UI Seamless integration of consumer electronics 		

Autonomous driving functions need to become much better to gain driver's acceptance

2 ACC Comparison – Auto, Motor und Sport

Assessment



	Volvo V60	BMW X1	VW Passat	Mercedes C-Klasse	Audi A4
Scope of functions	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★
Precision ACC	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★
Precision lane keeping	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★
Handling	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★
Price* [€]	2,150	1,400	1,590	2,499	1,640
Total score	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★

Summary

Ambiguous result

- In many situations supporting effect on the driver can be achieved
- Nevertheless, he or she always needs to be attentive
- None of the models tested could shine in all driving situations; especially lane keeping needs improvements
- Naturally, ACC functions are more sophisticated, as they have been on the market for >15 years by now
- Therefore, manufacturers' plans to release fully automated vehicles in a few years seem highly ambitious

👍 Best 👎 Worst *no effect on assessment

Source: Auto, Motor und Sport

SE17_(SE_AVL_STA)_20170607_Handout.PPTX

OEMs can beat Digitals on their home turf by taking advantage of being the designer of the “vehicle ecosystem” and the integrator of all of its elements

2 Summary Autonomous Driving

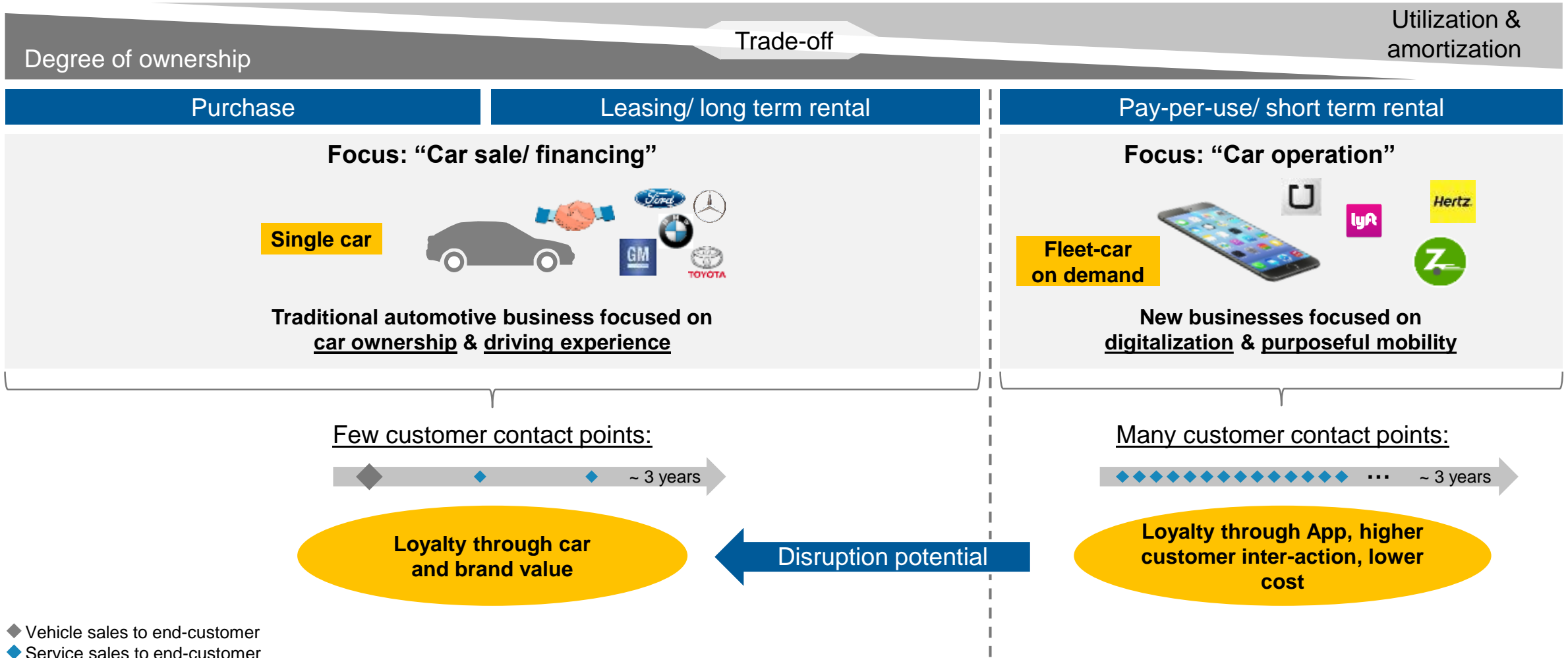
- Superior autonomous vehicles will be **differentiated by their functionality and user experience**. The best vehicles will make their passenger feel **comfortable, safe and secure**
- The **future value chains will become horizontalized** and will require OEMs to make deliberate choices about where they need to build own strengths and where they rely on partners
- If OEMs want to better digital players they need to refocus and build strong competencies in the following areas:
 - **User Interface and Experience**
 - **Applications / Functionalities for autonomous Driving**
- OEMs need to be build **own core competencies** in these areas plus the following:
 - **Machine Learning / Artificial Intelligence**
 - **Sensor Data Fusion**
 - **Functional safety and cyber security**
- **All other required capabilities need to be acquired** through strategic alliances and stable supplier relationships.
- This requires **new organizational models** which ensure stringent execution and decision making. **New development processes** are needed as well as **new project management** roles and responsibilities

Riding the wave of change in the automotive industry

- Electrification
- Autonomous Driving
- **Digitalization**

Digital businesses, which conveniently facilitate the use and billing of shared cars, bear the potential to disrupt the traditional automotive industry

3 Mobility business models and drivers for customer loyalty



◆ Vehicle sales to end-customer
 ◆ Service sales to end-customer

Source: Strategy Engineers

SE17_(SE_AVL_STA)_20170607_Handout.PPTX

Automotive digital offers based on C2X-applications can be classified into three main clusters: “Car-integrated”, “car-related” and “beyond car”

3 Automotive digital products and services

Offers	Description
Car-integrated products and services	<ul style="list-style-type: none"> ● Definition: Enrichment of the driving experience by integrating digital content into the car ● Examples: Navigation, infotainment, augmented reality, mobile apps (incl. remote car control)
Car-related services	<ul style="list-style-type: none"> ● Definition: (More convenient) fulfilment of customer demands related to daily car-usage ● Examples: Parking services, public charging of EVs, location-based services and update/ “tuning” services (incl. remote SW-updates)
Beyond car services	<ul style="list-style-type: none"> ● Definition: Fulfilment of general mobility, social, cultural and lifestyle demands beyond customers’ own cars ● Examples: Car and ride sharing, intermodal travel services, event bookings/ “concierge services”

***Automotive digital offers follow mobility and socio-cultural trends:
Scope goes beyond pure car-integrated products to services, which improve also non-car mobility and make life more comfortable***

Basis for changing mobility needs are consumer pain points with intensifying urban traffic and eMobility limitations, e.g. parking

3 Consumer pain points



Information

- Time management
- Traffic info
- Navigation
- Delays/malfunctions
- Location search
- Choice of means of transport
- Best routes
- Navigation/Re-Routing in case of traffic jam

Intermodal Travel

- Ticketing
- Public transport
- Selection of connection
- Comfort
- Security

eMobility

- Limited driving range
- Charging station search
- High cost of batteries
- Home charging facility
- Uncertainty about EV's conservation of value
- Uncertainty regarding EV technologies

Parking

- Parking payment
- Parking security
- Localisation of car
- Search for parking lot
- Action of parking
- Parking information

Flexible Use

- Booking
- Car sharing
- Pick up
- Car return
- Ride-sharing
- Taxi
- Help in case of breakdown

■ In-car ■ Car-related ■ Car-independent

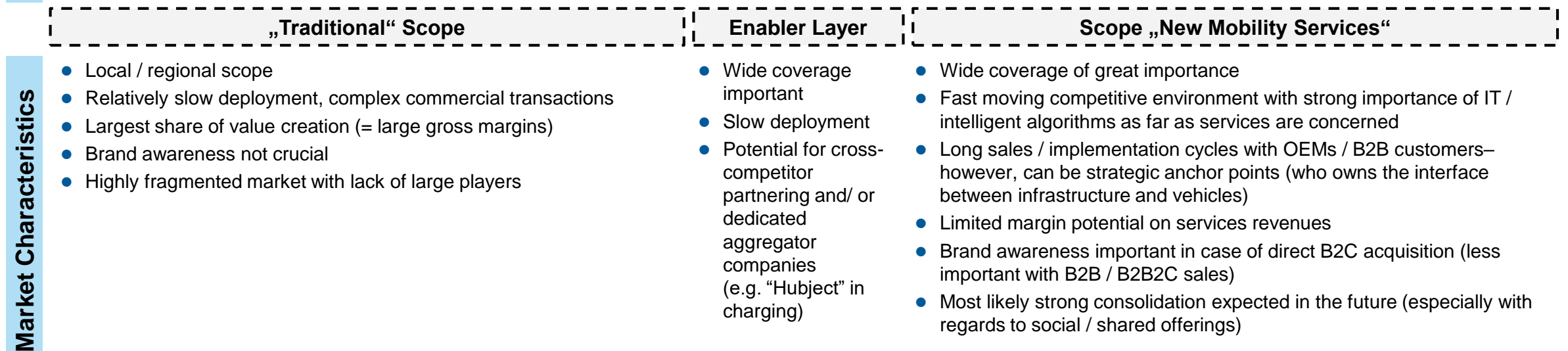
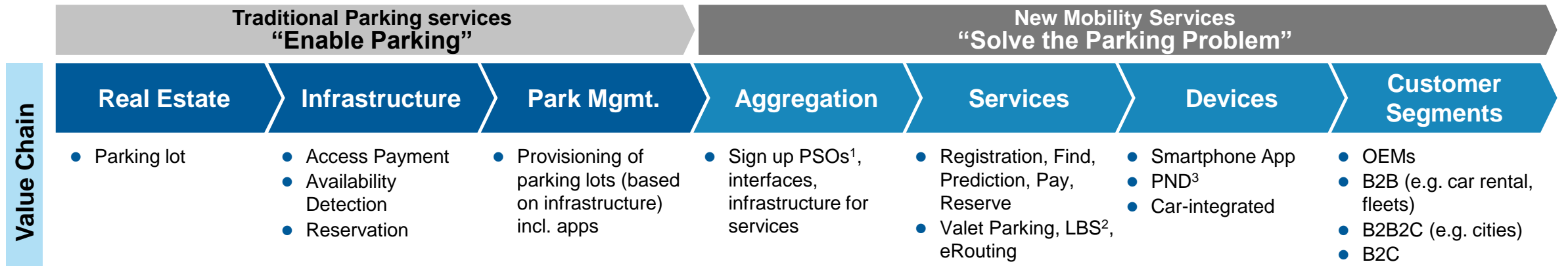
Source: Strategy Engineers

SE17_(SE_AVL_STA)_20170607_Handout.PPTX

The development of parking services will comprise of “aggregation” of services with cross-device support and a variety of customer segments

3 Parking market value chain and market characteristics

ILLUSTRATIVE



Source: Strategy Engineers Research // ¹⁾ parking space operators, ²⁾ location-based services, ³⁾ personal navigation device

„Future parking“ is an innovative topic area with different players who can boost unexploited potentials by collaborating

3 Automated parking: Players and products

ILLUSTRATIVE

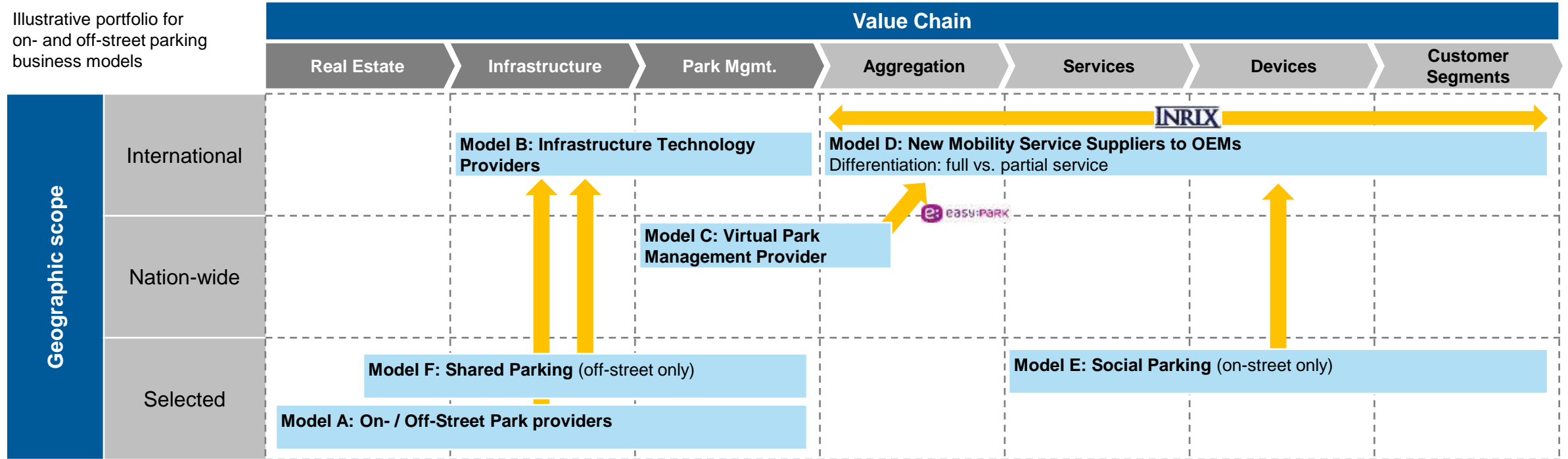


Various business models have established / arisen along the value chain with strong dynamics to expand / alter focus of value creation

3 Scope of different business models for on-/off-street parking services

ILLUSTRATIVE

Illustrative portfolio for on- and off-street parking business models

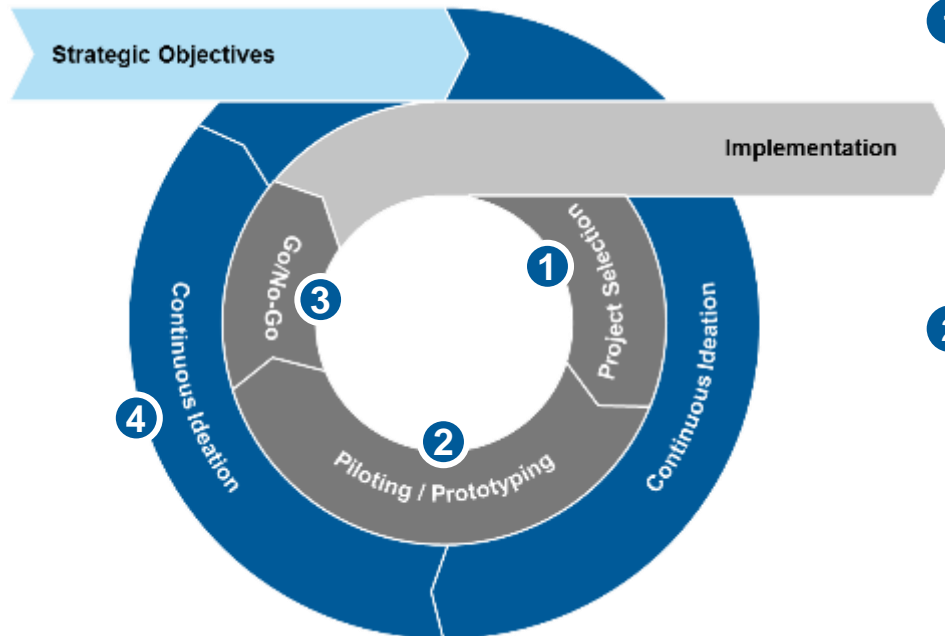


- Business model analysis: How do the key players in the industry position themselves?
- Potential: identification of blue ocean scenarios, anticipation of future developments

The definition and piloting of strategic initiatives at level 3 is the heart of the agile digital strategy processes, enabling quick and decisive actions

3 Level 3 – Strategic Initiatives: Process

Agile strategy development process (“TurboCharger”)



1 Project Selection

- Strategy and new product linkages
- Governance of new initiatives
- Tracking and definition
- Project approval decision-making processes
- Use of advanced valuation methodologies

2 Piloting, Prototyping

- Disciplined and effective stage/ gate process
- Time to market
- Bottleneck elimination and identification of project “congestion”
- Parallel planning of work steps
- Resource allocation

3 Continuous Ideation

- New product and technology ideas
- New business concepts and opportunities
- Consumer insights
- Trend analysis and anticipation
- New to the world and extensions of existing ideas

4 Go/No-Go

- Marketing and investment planning
- Consumer profiling and segmentation
- Competitive response and timing
- Advertising and promotion decision-making
- Product tracking

The strategy TurboCharger ...

- ... is an agile process
- ... is a continuous process
- ... uses parallel processes
- ... utilizes frequent and short review cycles
- ... is driven by short decision intervals
- ... builds a back-log of initiatives
- ... re-assess and re-prioritizes activities/back-log frequently and rapidly

Riding the wave of change in the automotive industry requires to reinvent the way cars are made, new types of cars and new businesses

1 3 Summary

1 Starting point: Take stock, prepare and enable

- Describe company vision and direction for new value creation
- Discover existing value creation areas
- Set new value business case framework
- Develop ideas about new value opportunities
- Develop and approve action plan

2 New carmaking

Optimize within current boundaries

- Scan entire supply chain for new value opportunities
- Investigate sustainability along entire value chain
- Maximize scale in components and systems
- Adjust footprint to global business requirements (Locations, Organization, Processes, etc.)
- Increase process efficiency (throughput) in planning, engineering, and purchasing

3 New cars

Plan, engineer, launch new vehicle types

- Accelerate simultaneous development cycles
- Decouple vehicle and electronics development cycles
- Improve trade-off decisions between weight – cost – performance to reduce weight
- Improve planning decisions balancing regional requirements and global standards
- Investigate mission and country specific derivatives

4 New business

Enter and excel in new business areas

- Drive extended value creation through new usage models for cars (Energy storage, rental, etc.)
- Use connected car models for partnering with service providers
- Increase service sales
- Install corporate ventures
- Enhance partnering with suppliers and dealers

Questions?



Christian Koehler
Partner

Strategy Engineers
GmbH & Co. KG

Prinz-Ludwig-Straße 7
80333 Munich

phone +49 89 4161 7235
fax +49 89 4161 7237
mobile +49 172 8986465
www.strategyengineers.com

cjk@strategyengineers.com

www.strategyengineers.com

Four years in a row!

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This statistical evaluation was conducted by Brand eins and Statista on the performance of 15,000 consultancies in total. With more than 3,200 questioned clients, executives, project leaders and partners this survey represents the biggest one within the German consultancy market.

