The future is here: winning carmakers balance metal and mobility
Key facts and main contents

✓ Seventh annual Digital Auto Report, developed by Strategy&
✓ Global study, with a focus on the U.S., the E.U. and China
✓ Quantitative market outlook based on detailed research
✓ Interviews with key industry executives at OEMs and suppliers, leading academics and industry analysts

Chapter 1
Market radar

Chapter 2
Mobility & connected service heads-up

Chapter 3
Capabilities for the road ahead

• When will connected, autonomous, electric and shared markets ramp up?
• What do consumers want?
• How will revenues and profits shift?
• How will policy and regulation influence progress?

• Overview of the mobility service market
• Which way-to-play captures the most value for OEMs?
• What are the new opportunities in connected car services?

• How can carmakers balance their traditional business with the new model of technology and services?
• What to do by when?
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

Chapter 2
Mobility & connected service heads-up

Chapter 3
Capabilities for the road ahead

Technology push
connected, electric, autonomous

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

Revenue and profit shift

Regulation impact
approvals, taxes, data privacy, infrastructure

Vehicle business

Connected services

Mobility services

Smart portfolio

Immersive channels

Hyper-local footprint

Fit-for-purpose technology

Ambidextrous organization
The mobility revolution is dawning and OEMs must stake their claim

- The market for shared on-demand vehicles (Mobility as a Service/MaaS) – in the U.S., the E.U. and China will be worth $1.4 trillion by 2030 (vs. $87bn in 2017) …

- Profitable mobility services will compensate for declining vehicle sales share: MaaS will account for 22% of automotive industry revenue by 2030, and 30% of profits, compared with 38% of revenue and 26% of profits for new car sales

- Millennials make up >50% of the global population – they expect their mobility experience to be personal, seamlessly integrated, multi-modal and on-demand. 47% of European and 79% of Chinese consumers would consider giving up their own cars once competitively priced robotaxis are available

- The gap is closing between the convenience customers want and the connected, electric, autonomous and shared mobility services available: the total cost of ownership for electric cars (volume and premium) with small battery capacity is already lower than petrol and diesel equivalents. 100% of new cars will be connected by ~2022 and the first level 4 autonomous vehicles will be used for specific use cases from 2021

- However policy rather than technology will drive the pace of change: governments have much to lose in the West (from fuel taxes and manufacturing jobs to transportation system control) and lots to win in the East (reduction of smog, battery technology leadership)

- Autonomous regulation is most favorable in the U.S., with the E.U. following slowly, because of different legal frameworks in member states

- Local bans on combustion engines in large cities, tax breaks and mandatory electric vehicle quotas push the transition to electric driving. Electric vehicles remain a minority of new cars until 2030, when they reach 50% in China, 44% in the E.U. and up to 20% in the U.S.

- The European MaaS market will be worth $451bn by 2030, compared with $25bn in 2017, but it will be clearly overtaken by China by 2030
To transform into next-generation mobility players, OEMs must act

- Traditional industry profit share could almost halve from 71% to 41% of traditional supplier business, vehicle sales and aftermarket by 2030. The biggest winners will be mobility platform providers: they will capture most of the share that previously went to owned vehicles.

- Therefore, OEMs must be ambidextrous: on the one hand today’s players will still be highly-efficient designers and producers of cars, and on the other, they must become flexible, agile digital services providers.

- OEMs have to manage a growing number of digital and physical customer channels beyond today’s retail structures and learn how to manage a drastically higher number of touchpoints and customer interaction.

- New hyper-local sites: moving from remote, low-cost production regions to high value metropolitan areas for mobility service operations.

- Faster innovation cycles require fundamental changes of IT; connected car services require completely new technology stacks around IoT.

Mastering both the old and the new world starts now – this year might be the last opportunity for traditional players to define their target position in mobility, in order to gain traction with new customer channels and expand their core technology platform in 2019. Global roll-out and partner integration at scale must start in 2020 to allow generating notable revenues from new mobility services in the near future.
01. Market radar
The mobility transformation will occur at different speeds in the E.U., U.S., and China

Mobility transformation, today until 2030

<table>
<thead>
<tr>
<th>I. Limited change</th>
<th>II. Electrification blooms</th>
<th>III. Autonomous reality</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEV and level 4/5 autonomy not advanced enough for broad adoption</td>
<td>ICE vs. BEV total cost of ownership (TCO) parity; first level 4/5 mobility services in use</td>
<td>BEV/PHEV transition well under way; fully autonomous vehicles viable at scale</td>
</tr>
</tbody>
</table>

Drivers of the mobility transformation

Consumers – Desire for alternative mobility options
Economics – TCO advantage over existing mobility options
Technology – Availability of in-vehicle technology and physical infrastructure
Regulation – Standards, legislation, incentives and taxes to support operations
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.

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

**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.

**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.

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

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\(^1\) Real-time traffic information, communication and advertising, news stream, music stream
Source: PwC Strategy& consumer research, 2018, n=3000 (EU, USA, CHN)
**Shared autonomous is expected to replace a sizable share of owned vehicles – willingness-to-pay might be lower than players hope**

### Autonomous robotaxi scenario

Chinese consumers most willing to give up own car once robotaxis are available

<table>
<thead>
<tr>
<th>Willingness to give up main car (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
</tr>
<tr>
<td>USA</td>
</tr>
<tr>
<td>CHN</td>
</tr>
</tbody>
</table>

#### Robotaxis could cover ~27% of daily commutes if priced aggressively

**Preferred mobility mode for daily commute (%)**

- **Personal car**
  - **today**
  - **in 5-10 yrs. (once robotaxis are widely available)**

<table>
<thead>
<tr>
<th></th>
<th><strong>today</strong></th>
<th><strong>in 5-10 yrs.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Taxi</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Public transport</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Car sharing</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>Robotaxi</td>
<td>54</td>
<td>82</td>
</tr>
</tbody>
</table>

#### Acceptable price range for robotaxis seen between car sharing and taxi

**Acceptable price range for 5 km city ride (€)**

- **Public transport**: 2.8 €
- **Car sharing**: 3.9 €
- **Taxi**: 12.3 €

**perceived fair robotaxi price**: 6.0 € (~1.2 €/km)

- **Public transport**: 2.4 €
- **Car sharing**: 5.3 €
- **Taxi**: 12.8 €

**perceived fair robotaxi price**: 6.9 € (~1.4 €/km)

- **Public transport**: 0.4 €
- **Taxi**: 3.4 €

**perceived fair robotaxi price**: 3.8 € (~0.8 €/km)

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1) assuming an aggressive robotaxi pricing scenario of 20% above mass transportation  
2) accepted robotaxi price ranges, fair price = good value for money (Median), other modes of transportation estimated from market price in reference cities

Source: PwC Strategy& consumer research, 2018, n=3,000 (EU, USA and CHN), assumption: scenario in 5 -10 yrs. once robotaxis are widely available, Germany as EU price reference.
Level 4 autonomous driving is expected to be available by 2021 with people movers and robotaxis on restricted roads and speed <50km/h

Autonomous driving availability (example of Germany)

**People mover**
- 7-12 seats

**Robotaxi**
- 2-6 seats

**Owned vehicle**
- 2-5 seats

### Key Terms
- **Level 3**: Max. speed
- **Level 4**: Area restriction
- **Level 5**: Construction area capable, Autonomous lane changes
- **Max. speed**: Speed limit
- **Area restriction**: Restricted areas
- **Construction area**: Areas under construction
- **Autonomous lane changes**: Autonomous lane management

### Timeline
- **2021**: Level 3
- **2023**: Level 4
- **2025**: Level 4
- **2027**: Level 5
- **2029**: Level 5
- **2031**: Level 5

**Full autonomy in all areas**
- Speed <130km/h
Solving the charging challenge is still key to wide e-mobility adoption and pushes diversified infrastructure development

### E-mobility infrastructure types

<table>
<thead>
<tr>
<th>Usage pattern</th>
<th>Typical power</th>
<th>Typical energy demand</th>
<th>Tolerable standing time</th>
<th>Required charging time</th>
<th>User perspective</th>
<th>Technology – E-Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>“My home/workplace – my charger”</strong></td>
<td>3-11kW AC 1-3 phase</td>
<td>10-20kWh</td>
<td>1…7h</td>
<td>4…14h</td>
<td>Fully satisfying</td>
<td>Critical charging induced extra standing time</td>
</tr>
<tr>
<td><strong>“Public curbside”</strong></td>
<td>3-11kW AC 1-3 phase</td>
<td>10-80kWh</td>
<td>4…14h</td>
<td>1…24h</td>
<td>Availability, parking rules and costs critical</td>
<td></td>
</tr>
<tr>
<td><strong>“Charge to attract”</strong></td>
<td>3-11kW AC 1-3 phase</td>
<td>5-10kWh</td>
<td>0.5…2h</td>
<td>0.5…3h</td>
<td>Nice to have feature</td>
<td></td>
</tr>
<tr>
<td><strong>“Electric filling station”</strong></td>
<td>50-350kW DC (in particular cases 22kW+ AC)</td>
<td>30-80kWh (full charge)</td>
<td>5-20min</td>
<td>10min…1.5h</td>
<td>Availability, charging time and costs critical</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** AC – alternating current

DC – direct current

Emerging E-Mobility Infrastructure Types
Total cost of ownership and powertrain challenges explained: TCO for BEVs with small battery capacity is favorable from 2018 onwards

Powertrain-specific development challenges

**ICE**
- Low degree of efficiency
- Pollution from exhaust gases

**PHEV**
- High system complexity and investment costs
- Limited full electric range
- Local emissions in ICE mode

**BEV**
- High investment costs
- Limited range
- Long recharge time

**FCEV**
- High investment costs
- Limited durability and lifetime

TCO of alternative powertrains vs. ICE until 2030

<table>
<thead>
<tr>
<th>Segment</th>
<th>Range</th>
<th>2018</th>
<th>2020</th>
<th>2025</th>
<th>2030 (\Delta) APT vs. ICE(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget</td>
<td>Short</td>
<td>-15%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>+1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Long</td>
<td>+15%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very long</td>
<td>+21%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume</td>
<td>Short</td>
<td>-17%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>-4%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Long</td>
<td>+7%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very long</td>
<td>+14%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premium</td>
<td>Short</td>
<td>-19%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>-11%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Long</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very long</td>
<td>+8%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) TCO difference of most competitive Alternative Powertrain (APT) in 2030 vs. ICE  
| range: low=150 km; mid=300 km; long=500 km; very long=800 km
The impact of legal frameworks, taxes and traffic control decisions will heavily impact the speed of mobility transition

Areas of regulatory involvement

Connected
- Price regulation for 4G/5G data services & network license fees
- Standardization of mobility data & access
- Machine-enabled data transmission across countries and regions
- License fees for usage of mobility data

Autonomous
- Legal framework for autonomous L4/5
- Autonomous testing standards
- Technical guidelines for L4/5 parts/systems
- Driving regulations regarding mixed traffic
- Harmonization of legal definitions for autonomous driving infrastructure

Shared
- Transport operator qualifications and respective liabilities
- Municipality charges for mobility providers (parking, exclusivity)
- Charges for driving a personal car alone to incentivize pooling, public transport, etc.
- Foreign provider restrictions to ensure full authority over national mobility

Electric
- Implementation of real drive emissions (RDE) and WLTP
- Further tightening of emission standards
- Mandatory alternative powertrain quotas and subsidies
- Buying incentives
- Urban ultra low/zero emissions zones
- Taxation of electricity for electric vehicles

... and beyond
- Data privacy and safety (e.g. for geospatial data)
- Data protection regulations on cyber crime robustness
- Cross-domain competition regulation (e.g. vehicle OS, batteries)
- Impact on public welfare and efficient use of assets (e.g. dynamic tolling)

1) potential for regulatory involvement on a local level
2) worldwide harmonized light vehicles test procedure
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

**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

**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

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
**When and where will the switch to electric, autonomous and shared mobility happen first?**

### Triggers towards new mobility (selection) …

<table>
<thead>
<tr>
<th><strong>Consumers</strong></th>
<th><strong>Economics</strong></th>
<th><strong>Technology</strong></th>
<th><strong>Regulation</strong></th>
</tr>
</thead>
</table>
| • Preference for vehicle ownership  
• Affinity towards new modes (shared, autonomous)  
• Relative willingness-to-pay (as % of income) | • TCO for existing and new mobility alternatives  
(purchasing price, incentive schemes, fuel/electricity cost, write-downs, penalties, etc.) | • Technology enabling autonomous driving (e.g. vehicle systems, V2X infrastructure)  
• Electric drive technology (e.g. powertrain, battery, charge points) | • Standards  
• Liability/legislation  
• Permissions/CO₂ targets |

### … and potential tipping points (examples)

<table>
<thead>
<tr>
<th></th>
<th>earlier</th>
<th>2030</th>
<th>later</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;50% people willing to give up own car?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEVs become cost competitive to ICE for mid-range (300km) volume segment?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autonomous cars drive at 80km/h, no route restrictions, good weather?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dense charging network in urban areas?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approval of autonomous people mover (8 seater, &lt;50km/h)?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95g CO₂/km (WLTP) target and urban access restrictions?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** V2X – vehicle-to-x

*Strategy& | PwC*
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 vehicles

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

Strategy& | PwC
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: 9% in L0-3 vehicles, 11% in L4/5 autonomous vehicles
- 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

Source: PwC AutoFacts
Shared-autonomous mobility will have strongest growth in China

Distribution of mobility types in road-bound personal mobility

Source: PwC AutoFacts, Strategy& analysis

1 in % of total person km “road” driven
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)

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** (in $bn)

- 2017: $5,315
- 2030: $8,931

**Profit distribution** (in $bn)

- 2017: $377
- 2030: $637

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

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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

Strategy& | PwC
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.
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)

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>47</td>
<td>170</td>
<td>250</td>
</tr>
</tbody>
</table>

CAGR 2017-30: +14%

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

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>25</td>
<td>198</td>
<td>451</td>
</tr>
</tbody>
</table>

CAGR 2017-30: +25%

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

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>15</td>
<td>201</td>
<td>656</td>
</tr>
</tbody>
</table>

CAGR 2017-30: +33%

Comments

- Global vehicle-based passenger travel shift to shared modes as key underlying driver
- Total (shared/traditional) price per distance travelled derived on a cost-plus view and historical household spending
- Price for shared mobility significantly decreases due to
  - reduced vehicle-related costs (efficiency, maintenance)
  - autonomous driving
  - intensification of sharing/pooling

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
Additional revenue sources, technical efficiency gains and regulatory changes will impact the profitability of autonomous mobility services

Upside potential and downside risk

- **Advertising and partnerships**
  - Provide advertising space
  - Offer products of ecosystem partners
- **In-vehicle experience**
  - Monetize customized vehicle space (e.g. office)
  - Offer audio-guided sightseeing tours
- **Excess capacity and transport**
  - Offer delivery services (e.g. parcels, food)
  - Support emergency services/public transport
- **Mobility analytics and data insights**
  - Monetize anonymized user/transportation data
  - Provide mobility/traffic data analytics services
- **Extended travel experience**
  - Bundle and sell mobility bundles (e.g. combining flights, rental cars, hotels)

**Technical efficiency**

- **Vehicle acquisition and operations**
  - Optimized fit-for-purpose vehicle design, incl. telematics/tech. for sharing in basic vehicle configuration
  - Access and ID management via centralized platform/from broader ecosystem
- **Mobility offering**
  - AI-based voice assistant customer service
  - Further commoditization of IT/cloud infrastructure

**Regulatory changes**

- **Taxes/tolls**
  - Taxes/toll on electric vehicles to compensate for decrease in mineral oil taxes
  - Street utilization fee on autonomous vehicles

Sizes are indicative, illustrative examples
Four ways to play in the mobility market:

**Mobility Advisor**
- **B2C**: focused offering in one area of the mobility system (e.g., routing)
- Narrow value block coverage and low value chain integration
- Broad mobility mode coverage and geographic reach to quickly scale specific service (e.g., public transport, train, air travel)
- Monetization commission-based (information, data), advertisement
- Open/API-based, information sharing, often **lower control over CX**

Examples include: Google, Apple, Here

**Specialized Mobility Enabler**
- **B2B**: focused offering in one area of the mobility system (e.g., data)
- Narrow value block coverage with high degree of specialization
- Independent of mobility mode coverage, quickly increasing geographic reach to benefit from network effects and operate efficiently
- Commission-based monetization or via **B2B fees** (information, data)
- Open/API-based, information sharing

Examples include: MotionTag, Streetlightdata, Inrix

**Mobility-as-a-Service Provider**
- **B2C**: “one-stop-shop” of a mobility services – owned or brokered
- Broad value block coverage and high value chain integration
- Focus on one/few mobility modes/use cases initially to reach critical density in one city/region and scale from there
- Monetization: **direct sales, commission fees, subscription fees**
- Semi-open/API-based for selected partners and control over CX

Examples include: Now Service Family, Uber, Didi Chuxing, Flixbus, Whim

**Operating System Provider**
- **B2B**: integrated technology solutions, e.g. IT backend, white label frontend, mobility analytics, roaming, **horizontal integration** (car, mobile device, IoT)
- Focus on value blocks that require scalable technology capabilities
- Independent of mobility modes
- License and **service fees**, data monetization
- API-based integration of platform partners into **(cloud) backend systems**

Examples include: Moovel on-demand, Siemens, IOKI, Splyt, Ford/Autonomic

Abbreviations: CX – customer experience  API – accessible programming interface
### Mobility-as-a-Service providers typically develop their business models along five use cases

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Micro mobility</th>
<th>City car sharing &amp; ride hailing</th>
<th>Daily commute</th>
<th>Mid-distance sharing, pooling, hailing</th>
<th>Long-distance travel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Micro mobility</strong></td>
<td>On-demand, short-distance mobility</td>
<td>On-demand sharing/hailing within cities</td>
<td>Pooling &amp; routing from suburban to city center</td>
<td>Connecting POIs outside city-centers/airports</td>
<td>Point-to-point mobility services between cities</td>
</tr>
<tr>
<td></td>
<td>Free-floating, light vehicles (e.g. scooters)</td>
<td>Free-floating or station-based, low cost vehicles</td>
<td>Curb-side pick-up and drop-off, commodity vans</td>
<td>„Hop on &amp; off“ shuttles or premium vehicles</td>
<td>Dynamically scheduled rides with larger vehicles</td>
</tr>
<tr>
<td></td>
<td>Competitive edge</td>
<td>Competitive edge</td>
<td>Competitive edge</td>
<td>Competitive edge</td>
<td>Competitive edge</td>
</tr>
<tr>
<td></td>
<td>availability</td>
<td>reliability</td>
<td>right price/value ratio</td>
<td>high convenience</td>
<td>price</td>
</tr>
<tr>
<td></td>
<td>seamless booking</td>
<td>fleet management</td>
<td>routing algorithm</td>
<td>specific needs (privacy)</td>
<td>travel experience</td>
</tr>
<tr>
<td></td>
<td>vehicle design</td>
<td>vehicle cleanliness</td>
<td>vehicle efficiency</td>
<td>safety</td>
<td>safety</td>
</tr>
<tr>
<td></td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Examples include:**
- Coup, Emmy, Mobike
- MyTaxi, Uber, Lyft, DriveNow, Car2Go
- UberPool, Waze Carpool, bla bla Lines, TwoGo
- Blacklane, Drivy
- Flixbus, bla bla Car
Successful mobility service providers are investing heavily into building the required 10 core capabilities

**Mobility platform capabilities**

<table>
<thead>
<tr>
<th>Mobility offering design, delivery, and enablement</th>
<th>Capability build-up guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer offering and go-to-market</td>
<td>• Which capabilities are differentiating in the market?</td>
</tr>
<tr>
<td>Brands building, customer acquisition, and growth</td>
<td>• Which capabilities provide control points that are critical to manage supply or demand?</td>
</tr>
<tr>
<td>Mobility service development and management</td>
<td>• Which capabilities to build vs. buy vs. partner?</td>
</tr>
<tr>
<td>Customer operations and customer service</td>
<td>• How will capability priorities shift with autonomous/electric drivetrain?</td>
</tr>
<tr>
<td>Traffic analytics and routing</td>
<td>• How does each capability impact revenue and cost?</td>
</tr>
<tr>
<td>Dynamic pricing, billing, and payment</td>
<td></td>
</tr>
<tr>
<td>Customer profile and identity management</td>
<td></td>
</tr>
<tr>
<td>Ecosystem partner management</td>
<td></td>
</tr>
<tr>
<td>Accounting, tax, HR, and legal</td>
<td></td>
</tr>
<tr>
<td>Technology operations and management</td>
<td></td>
</tr>
<tr>
<td>Technology operations and management</td>
<td></td>
</tr>
</tbody>
</table>

**Asset operations**

| Vehicle acquisition/leasing and disposal           | |
| Fleet steering and mobility utilisation analytics  | |
| Vehicle operations (dispatching, fueling/charging, repair and maintenance) | |

**Abbreviations: NBA – next best action**

Strategy& | PwC
Cost/km are expected to significantly drop with autonomous vehicles

Cost breakdown for offering a vehicle fleet – by business capability

1) Based on Strategy& “today” scenario, excl. tax and subsidies; without technical efficiency gains assumptions
2) Potentially prone to regulatory changes, e.g. introduction of road usage fees

1. Reduced driver costs as part of vehicle operations
2. Reduced vehicle acquisition costs due to fleet contracts
3. Costs for vehicle independence, incl.
   - Increase in telematics cost (access unit, data usage)
   - Vehicle relocation, cleaning, fuelling as separate service
   - Costs for development and operations

1. Increase in vehicle acquisition costs due to add. technology
2. Fixed cost reduction through increased vehicle utilisation and extension of vehicle fleet time till end of useful life
3. Decrease in vehicle operations costs, driven by
   - Reduction in fuelling costs (switch to electricity)
   - Reduction of parking needs
   - Reduction of vehicle relocation, cleaning, and charging effort

1. Key effects “car sharing model”
2. Key effects “vehicle autonomy”
Each mobility ecosystem player has a different set of opportunities

- **Mobility Advisor**
  - Ownership of mobility assets and access to vehicle-related data;
  - yet, limited service business capabilities

- **Mobility-as-a-Service Provider**
  - Fleet operations excellence and access to customer mobility data;
  - yet limited data analytics capabilities for B2B tech/data services

- **Specialized Mobility Enabler**
  - Deep customer insights beyond mobility, scalable technology infrastructure, digital service development & delivery capability;
  - yet limited integration into vehicle (limited to user interface as Apple Car Play, Alexa) and no expertise in providing own mobility solutions

- **Operating System Provider**
  - Access to personal mobility data; yet, build-up of mobility brand required
  - Access personal mobility data; yet, siloed user data without holistic perspective

- **Fleet operators**
  - Access to specific vehicle sensor data at scale (cross-OEM);
  - yet limited experience in data / software business beyond parts

- **Telco Providers**
  - Highly specialized & focused on one specific value proposition allowing superior customer experience & time-to-market;
  - yet, quick customer traction, access to capital funding and short-term amortization pivotal for survival

- **Digital Media & Technology Players**
  - Deep customer insights beyond mobility, scalable technology infrastructure, digital service development & delivery capability;
  - yet limited integration into vehicle (limited to user interface as Apple Car Play, Alexa) and no expertise in providing own mobility solutions

- **Start-ups**
  - Way-to-play opportunity based on existing assets & capabilities
  - Assets and capabilities required to expand into further ways-to-play

- **Suppliers**
  - Highly specialized & focused on one specific value proposition allowing superior customer experience & time-to-market;
  - yet, quick customer traction, access to capital funding and short-term amortization pivotal for survival
**Connected vehicles provide extra value opportunities from 5 digital service types**

### Digital service archetypes

1. **Vehicle feature as a service**
   - Extras on-demand, activated over-the-air, e.g. extra battery reach
   - Direct recurring monetization of user, e.g. pay-per-use
   - **Success factors**: amortization of pre-installed hardware; maintain good user experience despite repeat payments

2. **Vehicle-centric connected services**
   - Connected in-car services to 1) manage the vehicle, 2) assist while driving, 3) access the digital world
   - Direct user monetization, e.g. one-time, subscription; Indirect monetization, e.g. brand building, touchpoint experience improvement
   - **Success factors**: fast service innovation to avoid package price erosion; global service operations; user support via dealers

3. **5th screen services**
   - 3rd party services via vehicle "screen", e.g. music or coffee on the go
   - Commissions from reselling
   - **Success factors**: partner curation/selection; 3rd party service quality; partner mgmt.

4. **Beyond-vehicle services**
   - OEM branded services independent of the vehicle, e.g. chat bot travel assistant
   - Direct user monetization, e.g. paid app, in-app paym.; indirect monetization, e.g. for brand-building
   - **Success factors**: compete with global tech players/unicorns; alignment with brand and capabilities

5. **Data/insights services**
   - Leverage user insights to enhance own processes (e.g. R&D) or sell to 3rd parties (e.g. municipalities)
   - Cost savings from internal optimization; Direct B2B monetization, e.g. on road conditions
   - **Success factors**: pro-active GDPR & legal management; customer & internal acceptance; upfront potential quantification

Abbreviations: GDPR – general data protection regulation
# Connected services

**Connected car service development focuses on vehicle management, driving assistance and digital life interfaces**

## Vehicle-centric connected services

<table>
<thead>
<tr>
<th><strong>Vehicle management</strong></th>
<th>Data-based, vehicle-related services to minimize operating costs and necessary driver interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Autonomous) driving service</strong></td>
<td>Driving support through connectivity services to increase safety level and enable autonomous driving</td>
</tr>
<tr>
<td><strong>Digital life interface</strong></td>
<td>“Increase of the driver’s comfort and well-being by providing in-vehicle information and entertainment”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>over-the-air navigation updates</td>
</tr>
<tr>
<td>predictive vehicle maintenance</td>
</tr>
<tr>
<td>“track and trace”</td>
</tr>
<tr>
<td>stolen car recovery</td>
</tr>
<tr>
<td>over-the-air firmware update</td>
</tr>
<tr>
<td>driving enhancer</td>
</tr>
<tr>
<td>corner eye</td>
</tr>
<tr>
<td>driver monitoring</td>
</tr>
<tr>
<td>valet parking</td>
</tr>
<tr>
<td>driver health assistant</td>
</tr>
<tr>
<td>hazard warning</td>
</tr>
<tr>
<td>traffic jam assistant</td>
</tr>
<tr>
<td>freeway assistant</td>
</tr>
<tr>
<td>car sharing assistant</td>
</tr>
<tr>
<td>basic remote control</td>
</tr>
<tr>
<td>enhanced entertainment</td>
</tr>
<tr>
<td>connectivity assistant</td>
</tr>
<tr>
<td>smart home connection</td>
</tr>
</tbody>
</table>

**Current OEM priorities**

- **Integration**: OEMs offer as many digital service interfaces as possible to enable customers to smoothly integrate third party devices such as smart phones, home controls and wearables.

- **Monetization**: various complex monetization models from subscriptions to one-time fees can be found in the market as OEMs are testing which model suits their purposes best.

- **Automation**: with new, sophisticated ADAS OEMs and their partners (e.g. Nvidia, Intel) as well as players such as Uber and Tesla are pushing hard towards L3/L4 autonomy and related services.

---

**Abbreviations**: ADAS – advanced driver assistance systems

**Strategy& | PwC**
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)

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>USD</td>
<td>1.3</td>
<td>10.3</td>
<td>19.6</td>
</tr>
</tbody>
</table>

CAGR 2017-30: +23%

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

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>USD</td>
<td>0.8</td>
<td>8.6</td>
<td>16.7</td>
</tr>
</tbody>
</table>

CAGR 2017-30: +26%

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

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>USD</td>
<td>0.6</td>
<td>16.8</td>
<td>39.5</td>
</tr>
</tbody>
</table>

CAGR 2017-30: +38%

Comments

- Market growth driven by
  - higher connected car penetration
  - higher take rate due to better service quality & customer pull
- Overcompensating declining willingness-to-pay due to
  - commoditisation of service offerings, comparable to e.g. data plans in the telco industry
  - growing base of fleet operators as service customers

Note: based on Strategy& 2030 scenario
Source: expert interviews, PwC Autofacts, Strategy& analysis
5th-screen services create ~$50-60 p.a. potential per western premium household

Example 1: concierge services
Many OEMs offer concierge services to accompany customers during non-vehicle-related activities. Daimler, e.g. cooperates with start-ups Susi and James and Snips to automate natural language processing.

Example 2: ordering on the go
Ford enables e.g. ordering coffee from Starbucks or Pizza from Domino’s on the go via connecting their in-vehicle infotainment system to the larger commerce ecosystem, e.g. utilising Amazon Alexa.

Example 3: healthcare services
Faurecia developed a health-monitoring car seat using biometric sensing system built into the seat as a key pre-requisite for OEMs to offer connected healthcare services.

OEM gross margin potential: ~$50-60 p.a. per household
On top of vehicle-related connected car services, further value pockets can be addressed in 5th-screen/ecosystem plays.

• ~$28k addressable spend
• ~10% occurring during mobility via digital channel
• ~1-3% gross margin

2017 Western premium household expenditures (in USD)

2017 average Western “premium” household annual expenditures: USD 80,500

Food, apparel
Furnishing and housekeeping supplies
Healthcare
Gas
Public and other transportation
Entertainment (excl. hotels, restaurants)
Vehicle lease, finance, insurance, maintenance
Vehicle purchase, used

Vehicle purchase, new
Others

$6,800
$6,800
$3,600
$3,000
$4,000
$2,800
$1,500
$5,200
$14,400
$5,200
$3,600
$3,600
$5,200
$3,000
$4,000
$2,800
$1,500
$5,200
$14,400
$5,200
$3,600
$3,600
$5,200
$3,000
$4,000
$2,800
$1,500
$5,200
$14,400
$5,200
$3,600
$3,600

$30,400

Note: totals may not equal sums shown due to rounding
Source: Destatis; DIW; Eurostat; Trading Economics; U.S. Bureau of Labor Statistics; Strategy& analysis
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

- Direct customers
- Service excellence
- Remote updates

- Immersive channels
- Fit-for-purpose technology
- Ambidextrous organization

- Smart portfolio
- Hyper-local footprint

- Digital touchpoints
- Rapid development
- Real-time data & analytics

- Etc.
To serve customers’ future mobility needs, champions orchestrate a diverse portfolio of hardware, software, and services

Automotive mobility product portfolio

Implications

• **Alternative vehicle ownership** models are emerging as they allow OEMs to address new customer segments.

• **Portfolio complexity is growing** with increasing number of products and services.

• **Integrating 3rd party** offerings increases attractiveness of OEM portfolio, but requires new approach to IP and liability.

• **Services can have different value contribution** – ranging from additional revenues to higher car brand value.

• Adjusted **evaluation criteria and KPIs** are needed to prioritize investment allocation.

Abbreviations: IP – intellectual property
Faster innovation cycles require fundamental change in IT, incl. increased business orientation and best-of-breed integration

IT design parameters

Maturity stages of agile IT transformation

Trend 1 – Business integration:
close cooperation between business and IT functions to secure strong orientation towards end customer needs

Trend 2 – Best-of-breed integration:
transform legacy landscapes to integrated best of breed technologies, e.g. by leveraging ecosystem partners

Abbreviations: Ops – operations, BuDevOps – approach of business-aligned IT development and operations; SaaS – software as a service; SOA – service-oriented architecture; PaaS – platform as a service; IaaS – infrastructure as a service

Strategy& | PwC
During their journey to a digital service company, OEMs typically follow a transformation path along four phases

Phases of digital transformation

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

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

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

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

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

- **Mainly traditional**:
  - Production
  - Purchasing
  - Finance

- **Partly agile**:
  - R&D: agile development, agile interaction with connected services to combine long and short product lifecycles

- **Highly agile**:
  - IT: integrated with all departments to allow IT/business integration
  - Digital services (DS): short lifecycles of MaaS and connected services

### Ambidextrous organization

- **Act**: Finance, Purchase, R&D, Sales, IT
- **Lead**: Production, Digital team, Agile team

**Business unit/function**: Sales, R&D, Finance, Purchasing, Production

**Digital team**: Various stakeholders involved in digital initiatives

**Agile team**: Teams focused on fast execution and innovation

Strategy& | PwC
Transformation needs a comprehensive roadmap and clear priorities

Transformation roadmap

<table>
<thead>
<tr>
<th>2018 – Ignite</th>
<th>2019 – Accelerate</th>
<th>+2020 – Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Portfolio</strong></td>
<td>Way-to-pay positioning</td>
<td>Market entry</td>
</tr>
<tr>
<td></td>
<td>Opportunity landscape, positioning, value proposition, portfolio setup</td>
<td>Product &amp; service roadmap, business case, prototypes, product development, go-to-market</td>
</tr>
<tr>
<td><strong>Channel</strong></td>
<td>Channel mix</td>
<td>New channels</td>
</tr>
<tr>
<td></td>
<td>Customer touchpoints, channel target mix, online-to-offline journey design, new dealership model</td>
<td>In-vehicle HMI/app and online store as new direct channels, new digital dealership/showroom experience</td>
</tr>
<tr>
<td><strong>Footprint</strong></td>
<td>Footprint strategy</td>
<td>Location selection</td>
</tr>
<tr>
<td></td>
<td>Footprint assessment for new functions – service design, electronics R&amp;D, software development, service operations/delivery</td>
<td>Design/R&amp;D in digital hot spots, software development in near-shore/low cost markets, mobility service launch in city-by-city approach</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td>Technology stack</td>
<td>Build core stack</td>
</tr>
<tr>
<td></td>
<td>Business needs, technology capability requirements, IT target function, IT architecture design</td>
<td>Core platform build (e.g. ID, APIs), open source options, emerging tech application prototypes, internal/external interfaces</td>
</tr>
<tr>
<td><strong>Organization</strong></td>
<td>Target operating model</td>
<td>Lighthouses</td>
</tr>
<tr>
<td></td>
<td>Capability priorities, roles &amp; responsibilities, lean processes, agile way-of-working, culture change demand</td>
<td>Dedicated units/teams with new capabilities (e.g. analytics, service design), 360° feedback &amp; employee polls, project reviews</td>
</tr>
<tr>
<td><strong>Integration and partnering</strong></td>
<td></td>
<td>Transformation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New unit scale-up, new process roll-out, internal coaching, established agile teams, feedback for continuous improvement</td>
</tr>
</tbody>
</table>

Source: Strategy& analysis
# Postscript: disruption has no defined path

The pace of adoption of any new technology will vary widely depending on a long list of factors including cost, reliability, safety, performance, consumer preference, and a host of others. In some cases there could be a technological breakthrough that is nearly impossible to predict that could have a significant impact on the demand curve. There is also not an aligned path to global adoption. Rather, growth in each region & territory will be dictated based on their own unique factors such as market economics, infrastructure and regulatory policies. Because there are so many variables to consider, those participating in the new mobility ecosystem are best served to take a measured, scenario-based approach to these emerging technologies. Betting too big (or too small) can represent significant risk for your organization.

In this report, we provide a summary of the latest consumer feedback by market (US, EU, China) on a number of new mobility solutions. We also explore some of the aforementioned drivers of adoption related to electric and autonomous vehicles, including anticipated “breakthrough” targets by region. Finally, we offer a potential scenario for the adoption of electric, connected and autonomous vehicles, and the resulting impact on the vehicle parc. It is important to note, as previously discussed, that this highlights only one potential path to adoption and represents a largely unconstrained model where once total cost of ownership (TCO) parity is achieved for each technology, adoption will increase rapidly. It is easy to see a contrarian view where despite TCO parity the adoption rate could be much slower. There is little doubt that each of the variables discussed in this report are moving targets and must be closely monitored as technology develops.
Get in touch!

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