Autonomous driving: The short-term impact
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Agenda

Where are we now?

Enabling technologies

Component pricing

Market dynamics

2017?

Q&A
The big picture
So where are we now?

- **L0**: No automation
- **L1**: Single function automation
- **L2**: Combined function automation
- **L3**: Limited self-driving automation
- **L4**: Autonomous mode with driver controls
- **L5**: No driver controls

Timeline:
- 2005: L0
- 2015: L1
- 2017: L2
- 2025: L3
- 2035: L4/L5

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Enabling technologies
The autonomous ecosystem comes together

- Cloud
- Device
- Driver

- Connecting

- Actuating
- Steering
- Braking
- Accelerating

- Sensing
- LIDAR
- Camera
- Radar

- Computing
- Software
- Central electronic control unit (ECU)
- Cloud

- Localizing
- Maps
- LIDAR
- Road geometry

- Learning
- Machine learning
- Artificial intelligence

Current expertise

New frontier
Developments in autonomy to shape user interface

HMI Component Technologies
- Individual hardkeys, buttons, and knobs
- Multi-function controllers
- Haptic force feedback
- Speech recognition
- Proximity sensing
- Gesture recognition
- Augmented Reality
- Curved / free-form display
- Eye tracking

Automated Driving Levels
- L0
- L1
- L2
- L3
- L4

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Human-centric inputs

- Speech recognition
- Gesture recognition
- Driver monitoring

Display applications

- Rearview e-Mirrors
- Side-view e-Mirrors
- HVAC, passenger, door, etc.

Display technologies

- Curved displays
- AMOLED displays
- Augmented reality head-up display
Facial monitoring world fitment rate

Assessing drivers’ mental states, cognitive loads, and attention levels will become increasingly important.

Regionally, Japan is forecast to see the highest fitment rates of facial monitoring, followed by North America.
Advanced driver assistance systems (ADAS) growing rapidly

<table>
<thead>
<tr>
<th>ADAS Unit Growth: CAGR 2017–22</th>
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</thead>
<tbody>
<tr>
<td>Overall ADAS market excluding park assist</td>
</tr>
<tr>
<td>Park Assist</td>
</tr>
<tr>
<td>Autonomous Park Assist</td>
</tr>
<tr>
<td>Blind Spot Detection</td>
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<tr>
<td>Adaptive Cruise Control</td>
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<tr>
<td>Surround View</td>
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<tr>
<td>Driver Monitoring</td>
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<tr>
<td>Collision Warning &amp; Avoidance</td>
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<tr>
<td>Lane Departure Warning</td>
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<tr>
<td>Side &amp; Rear Mirror Camera</td>
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<tr>
<td>Autopilot</td>
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Source: IHS Markit

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High-performance solid-state LIDARs: A key to system cost reduction

Typical cost

- Mechanical Scanning LIDAR
- Basic Flash LIDAR
- High Resolution Flash LIDAR
- Solid-state scanning LIDAR
Wider change
Mobility manifesting

• Automaker subbrands become the home for new technologies
  • BMW i
  • Mercedes-Benz EQ
  • Volkswagen ID concept vehicles

• Companies establish stand-alone mobility units
  • Google Waymo
  • General Motors Maven
  • BMW ReachNow
  • Volkswagen Moia
  • Daimler car2go
  • PSA Group Free2Move
## Testing and pilot schemes

<table>
<thead>
<tr>
<th>Location</th>
<th>Initiated by</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom–Milton Keynes</td>
<td>Government</td>
</tr>
<tr>
<td>United Kingdom–London “Gateway project”</td>
<td>Government</td>
</tr>
<tr>
<td>United States–Pittsburgh</td>
<td>Uber</td>
</tr>
<tr>
<td>Sweden–Gothenburg</td>
<td>Volvo</td>
</tr>
<tr>
<td>Germany–Autobahn</td>
<td>BMW, Audi, Mercedes-Benz</td>
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### Adaptation of infrastructure
- Dedicated autonomous driving lanes
- Road signals and signs

### Education of drivers
- Addressing safety concerns
- How to interact with autonomous vehicles
# Forms of testing

<table>
<thead>
<tr>
<th>Key information</th>
<th>Comment</th>
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<tbody>
<tr>
<td><strong>Ride-hailing</strong></td>
<td></td>
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<tr>
<td>State-sponsored pilots</td>
<td>Singapore (Delphi, NuTonomy)</td>
</tr>
<tr>
<td>Private research and development and testing</td>
<td>Pittsburgh (Uber, Delphi)</td>
</tr>
<tr>
<td><strong>Special routes</strong></td>
<td></td>
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<tr>
<td>Simple and fixed city trips</td>
<td>Las Vegas—January 2017 (Navya)</td>
</tr>
<tr>
<td>Campus fixed trips</td>
<td>Santa Clara University (Auro)</td>
</tr>
<tr>
<td>Airport shuttle (two-year test)</td>
<td>New Zealand (Navya)</td>
</tr>
<tr>
<td>Between train stations</td>
<td>Paris (EasyMile)</td>
</tr>
<tr>
<td><strong>Self driving—only zones</strong></td>
<td></td>
</tr>
<tr>
<td>Small city section at first</td>
<td>Campus, military base, airport</td>
</tr>
<tr>
<td>Urban mega-centers</td>
<td>China, likely as low-emission zones</td>
</tr>
<tr>
<td><strong>Low-speed driving</strong></td>
<td></td>
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<tr>
<td>Urban or closed communities</td>
<td>To limit and avoid crashes</td>
</tr>
<tr>
<td><strong>Route- or lane-specific</strong></td>
<td></td>
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<tr>
<td>Commuter routes</td>
<td>Replace current ride-sharing routes</td>
</tr>
<tr>
<td>High-occupancy vehicle lane for self-driving</td>
<td>Seattle-Vancouver proposal</td>
</tr>
</tbody>
</table>
Market dynamics
Strategic partnerships

Technology companies

Mapping companies and tier-1 suppliers

OEMs

Ride-hailing, rental, and car-sharing companies
Recent strategic partnerships/acquisitions

- Uber and Volvo
- HERE—expanded consortium of ownership
- Autoliv/Volvo–Zenuity
- Nvidia/multiple OEMs
- Bosch/TomTom
- Intel/Mobileye
**Regulations**

Regulatory activity is already influential, but it becomes one of the most important market forces for ADAS

<table>
<thead>
<tr>
<th>New Car Assessment Program (NCAP)</th>
<th>Voluntary agreements</th>
<th>Standards and guidance</th>
<th>Sharing economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>US NCAP adding 7+ new ADAS in 2018</td>
<td>US commitment for standard AEB by 2022</td>
<td>ISO 26262 + Automotive Safety Integrity Level</td>
<td>Open question everywhere today</td>
</tr>
<tr>
<td>Euro NCAP continues to move forward on new automatic emergency braking (AEB) features</td>
<td>Will effectively make AEB standard everywhere in a few years, with rare local model exceptions</td>
<td>New automated vehicle guidelines expected in the United States</td>
<td>Even China allowed ride-hailing services in legal gray zone</td>
</tr>
<tr>
<td>Little-to-no activity from other countries</td>
<td>What is next?</td>
<td>Steady progress on cybersecurity and driver distraction guidance in the United States</td>
<td>Regulation likely to be defined by the current market</td>
</tr>
</tbody>
</table>

Guidance will shape the future of automotive technology; regulatory decisions will affect how the sharing economy evolves
2017 automotive technology foresight

**Autonomy & artificial intelligence**
- Sensor advances, artificial intelligence, innovative interiors, and platform development toward public deployment

**Autonomous, Connected, Electric, and Shared (ACES)**
- Creation of further subbrands and further development of stand-alone mobility units

**Collaboration and mergers and acquisitions**
- OEMs acquiring new competencies; more supplier consolidation possible, achieving scale in data and services

**Electronic architectures**
- Sensor fusion ECUs and central ADAS domain controllers will drive further advances in autonomy, reduce cost, and save weight

**New automotive user experience (UX)**
- Developments in user interface technologies, design, or service models aim to reinvent the automotive UX

**Disruptors**
- Mobility providers and start-ups push OEMs and suppliers to diversify products and business models
Thank you!