(R)Evolution of Automotive Electronics

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Agenda

• Automotive electronics and semiconductor market trends
• ADAS architectures towards automated driving
  – Current state of ADAS sensor architectures
  – Key technologies enabling next-gen ADAS architectures
  – Key Takeaway
Automotive market trends
Vehicle production rises slowly with various degrees in emerging and established markets.
Average value of electronic systems per car to touch $1600 by 2022

Automotive electronics system revenue forecast

Source: IHS Markit

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Automated driving, connectivity and electrification fueling automotive semiconductor growth

Automotive semiconductor revenue forecast

Source: IHS Markit

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Automated driving, connectivity and electrification fueling automotive semiconductor growth

Automotive semiconductor revenue forecast

- Microcomponent IC
- Optical Semiconductors
- Memory IC
- Logic IC
- Discretes
- Sensors & Radars
- Analog IC

Source: IHS Markit

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Current state of ADAS architectures
Growing ADAS content towards meeting NCAP guidelines

ADAS electronic system content by vehicle segment on 2017 European OEM production platforms

Number of ADAS modules on car platforms

Source: IHS Markit

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Redundancy and reliability driving next-generation ADAS architectures

Typical ADAS module content on automated driving platforms

<table>
<thead>
<tr>
<th>ADAS Module</th>
<th>Average per L3</th>
<th>Average per L4</th>
<th>Average per L5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Fusion</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Exterior Camera</td>
<td>5</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Interior Camera</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Short/Mid-range Radar</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Long-range Radar</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Long-range LIDAR</td>
<td>1</td>
<td>1-2*</td>
<td>1-2*</td>
</tr>
<tr>
<td>Short-range LIDAR</td>
<td>2*</td>
<td>2-4*</td>
<td>4</td>
</tr>
</tbody>
</table>

**Architectures based on existing pilot car platforms from BMW, Volvo, Audi, Nissan, Tesla, etc.**
Source: IHS Markit

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Key technologies enabling next-generation ADAS architectures
Addressing the gaps in automotive LIDAR technology

Typical gap in LIDAR specifications

Current Standard

Required Performance

Source: IHS Markit
Key technologies enabling next-generation automotive LIDAR

Key silicon technologies for next-generation LiDAR

Emitter
- Lasers (8xx-9xxnm)
- Lasers (> 14xxnm)
- VCSELs
- CO₂ Lasers
- Mechanical
- MEMS
- Electro-optical
- Flash*

Detector
- PIN Diodes
- APDs
- SPADs
- SiPMs
- CMOS Imagers
- Time of Flight (TOF)
- Active TOF
- Optical Phase Array
- FMCW

Range
- Resolution
- Eye-safe
- Automotive Qualified
- Reliability
- $$$ LIDAR $$$

Beam Steering

Notes: Add notes here or delete
Source: IHS Markit
Who will prevail in the supply chain?
Pure solid-state technology to dominate LIDAR space by 2026

Revenue forecast for LIDAR system and semiconductor

CAGR (2020-26) and market size in 2026 by different technologies

Source: IHS Markit © 2017 IHS Markit
AI, Machine Learning, Neural Net, Deep Learning

Major differences in the same “intelligent” family

Source: IHS Markit
Sensor fusion modules – Growth in semiconductor value for safety-critical functions

• System Level:
  – **Challenge**: Software for enabling AD via machine vision, deep learning, sensor fusion and etc.
  – **Opportunity**: Universities, technology labs and start-ups working on unconventional technologies (deep learning, machine vision, etc.)

• Chip level:
  – **Challenge**: High performance processors meeting traditional automotive requirements (power consumption, functional safety, temperature, life-time, etc.)
  – **Opportunity**: Suppliers with high-performance computing platforms at lower power consumption and smaller die size.
Key Takeaway
Supply Chain increases in entropy
Space for new players through partnership

(R)Evolving automotive supply chain?

Source: IHS Markit

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Past

Future
Thank You!

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