FROM SENSOR INTEGRATION TO SENSOR FUSION

FIRST SENSOR’S LIDAR AND CAMERA STRATEGY FOR DRIVER ASSISTANCE & AUTONOMOUS DRIVING
FRAMEWORK CONDITIONS

Intensified interest in driver assistance & autonomous driving

<table>
<thead>
<tr>
<th>Market</th>
<th>Society &amp; Politics</th>
<th>Competition</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Demand for driver assistance systems for special &amp; commercial vehicles significantly increased</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Higher interest in self-driving vehicles, in particular commercial vehicles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– New players in the automobile sector: Connection with environment &amp; other vehicles (e.g. Google, Apple)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Increasing electrification is changing the market: Consolidation, M&amp;A &amp; technology boom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Customer requirements (especially with regard to comfort &amp; security) force development of new products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Legal requirements for commercial vehicles: Optional ADAS equipment becomes new standard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger cars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Cameras: Tier1 with own design; produced in-house or by EMS provider</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Complete systems provided by Tier 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special &amp; commercial vehicles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Smaller Tier1 (Customers / competitors)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– Cooperation opportunities with system development</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The camera & LIDAR market is expected to reach $52.5B in 2032.
OVERALL OBJECTIVES

Provider of innovative sensors and sensor systems in vehicle business

Positioning as focused provider of innovative sensors and sensor systems in OEM & Tier 1 vehicle business

1. Expanding product portfolio and increase of added value in the LiDAR and cameras segments

2. Market expansion
   Market entry into special & commercial vehicles with selected applications and systems

3. From sensor to system
   Camera, LIDAR >> advanced driving assistance systems (ADAS) & sensor fusion
1. EXPANDING OUR PRODUCT PORTFOLIO

For autonomous driving a combination of sensors is necessary.
1. EXPANDING OUR PRODUCT PORTFOLIO

We concentrate on LiDAR and camera applications

**Mid range LiDAR**
- Accident avoidance & reduction
- Pedestrian protection
- Distance measurement

**Front View**
- Sign recognition
- Pedestrian detection
- Lane keep assist

**Mirror replacement**
- Blind spot detection
- Avoid mirrors

**Rear View**
- Park assist
- Collision warning

**360° Area View System**
- Park assist
- Blind spot detection
- Driver information

**Driver monitoring**
1. EXPANDING OUR PRODUCT PORTFOLIO

LiDAR: We differentiate through 8 key respects

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20+ years experience in APD production</td>
</tr>
<tr>
<td>2</td>
<td>Customizing capability for die, package and modules in-house</td>
</tr>
<tr>
<td>3</td>
<td>ISO TS 16949 certified production and testing</td>
</tr>
<tr>
<td>4</td>
<td>Sensor only company</td>
</tr>
<tr>
<td>5</td>
<td>Lowest noise</td>
</tr>
<tr>
<td>6</td>
<td>Highest sensitivity for 905nm</td>
</tr>
<tr>
<td>7</td>
<td>AEC-Q 101 qualified APD arrays</td>
</tr>
<tr>
<td>8</td>
<td>Innovative roadmap</td>
</tr>
</tbody>
</table>
LIDAR

We have a long standing experience and expertise

- Single APD with amplifier
- DARPA Urban Challenge; First Sensor APDs in all winning teams
- Industrial hybrids (APD+TIA in one package)
- Few Pixel APD-Array in SMD package for ACC / AEC-Q 101 qualified by FIS

- 12 Pixel APD-Array in ceramic package for ACC
- Gesture recognition with 64 pixel APD-Array
- Receiver module with APD-Array, HV, TIA, MUX, Timing discriminator
- Receiver module with APD and electronics integrated in one package
LIDAR

Next steps: Securing and further developing our competitive advantage

1. “First LiDAR”: Crossfunctional tiger team for enhanced impact
   Marketing/Sales/Solution/Development

2. Alliances with complimentary suppliers for extended reach
   Solutions/Development

3. Innovative product roadmap and forward integration to ensure market leadership
   Solutions/Development

4. Cost down to meet future requirements of volume markets
   Production
LIDAR

Our activities are aimed at automotive and industrial applications

- Safety, comfort and cost reduction infrastructure drive development of partly or fully autonomous vehicles
- First adaptation: special vehicles
- Large volume: passenger car

- Mix of mature and emerging applications
- Industrial area applications include
  - Unmanned guided vehicles (UGV)
  - Security scanners
  - Mapping applications
  - Range finding (Point measurement)
1. EXPANDING OUR PRODUCT PORTFOLIO
Camera: We differentiate through 8 key respects

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Long-standing camera experience</td>
<td>2</td>
<td>Automotive network in new markets</td>
</tr>
<tr>
<td>3</td>
<td>Specialist for harsh environment and low-light applications</td>
<td>4</td>
<td>Tailor maid solutions also possible in small-scale production</td>
</tr>
<tr>
<td>5</td>
<td>New industrialized “Blue Next” camera generation</td>
<td>6</td>
<td>Camera to system concept</td>
</tr>
<tr>
<td>7</td>
<td>Embedded ECU platform for sensor fusion</td>
<td>8</td>
<td>Production and development “Made in Germany”</td>
</tr>
</tbody>
</table>
CAMERA

Our volume production of a new camera generation has started.
CAMERA

Next steps: Increase market presence

1. Expand “Blue Next” camera family
   Development and industrialization of “Blue Next” camera solutions

2. Worldwide sales offensive
   Enter identified target customers

3. Potential in related markets
   Use existing market position in industrial area
2. MARKET EXPANSION

Today, car OEM & Tier 1 account for the majority of sales
From sensor integration to sensor fusion: First Sensor’s LiDAR and Camera Strategy for driver assistance & autonomous driving

## 2. MARKET EXPANSION

We can develop further potential with commercial & special vehicles

<table>
<thead>
<tr>
<th>Segments</th>
<th>LIDAR</th>
<th>Cameras</th>
<th>Camera Systems</th>
<th>ADAS Systems Multiple Sensors Sensor Fusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car OEM &amp; Tier 1</td>
<td>Components</td>
<td>Customized cameras</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Commercial &amp; Special vehicles OEM &amp; Tier 1</td>
<td>Components, Subsystems and Manufacturing services</td>
<td>Standard cameras, tailor made solutions</td>
<td>Surround view, Mirror replacement, Blind spot detection</td>
<td>Turn assist, Break assist, Platooning, Pedestrian recognition, Autonomous driving</td>
</tr>
</tbody>
</table>
2. MARKET EXPANSION

Our focus is on target customers & leads with significant annual sales

1. Focus on defined target clients
2. Leads with potential annual sales > €500,000 per project / product

- Car OEM & Tier 1
- Trucks
- Bus
- Special vehicles (agriculture, mining machines, fork lifters)
2. MARKET EXPANSION

We focus on the European truck market

- Mediocre annual growth of Truck sales 3 % p.a.
  BUT double digit growth of revenue expected
- Focus on innovations; trend to fully or partly autonomous driving
- European key manufacturers: ~50% market share

Daimler Trucks
(500 Tsd / a)

VOLVO Group
(200 Tsd / a)

VW Group
(450 Tsd / a)

PACCAR
(150 Tsd / a)
2. MARKET EXPANSION

Next steps: Target market for commercial & special vehicles

1. Expand products experience with car OEM & Tier 1
   Offer products for trucks, buses and special vehicles

2. Initial focus on European market
   Sales team targets key manufacturers

3. Innovate according to market specific requirements
   Basis for future orders

4. Sensor fusion and system expertise
   Groundwork for long term market presence
## 3. FROM SENSOR TO SYSTEM

The trend is towards the fusion of different sensors

<table>
<thead>
<tr>
<th>Autonomous Level</th>
<th>Level 1 Assisted Driving</th>
<th>Level 2 Partly Automated</th>
<th>Level 3 Highly Automated</th>
<th>Level 4 Fully Automated</th>
<th>Level 5 Driverless</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functionality</strong></td>
<td>Active Cruise Control (ACC) Lane departure warning system (LDWS)</td>
<td>Lane Keep Assist (LKA) Park Assist (PA)</td>
<td>Automatic Emergency Brake (AEB) Driver Monitoring (DM) Traffic Jam Assist (TJA)</td>
<td>Autopilot on Highway (AP)</td>
<td>Autopilot everywhere</td>
</tr>
<tr>
<td><strong>Sensors</strong></td>
<td>Ultrasonic Radar (long range) Front Camera</td>
<td>Surround Camera</td>
<td>Radar (short range) Driver Camera Lidar</td>
<td>SENSOR Fusion</td>
<td>SENSOR Fusion</td>
</tr>
</tbody>
</table>
3. FROM SENSOR TO SYSTEM

The sensor fusion has already begun

**Camera Platform:**
- Blue Next Family
- LVDS, ETH, 2 WE ETH ...

**Camera Systems**
- Surround View
- Virtual Mirror

**Camera Systems & object recognition:**
- Lane departure
- Sign recognition
- ...

**ADAS Systems & Sensor fusion**
- Turn Assist
- Night Vision

**BLUE NEXT** – Camera generation based on modular platform designed for volume production, ASIL-conform

**ECU Platform:**
Multi purpose
- Embedded System for various applications
- Scalable processor family ASIL-conform

**Software Platform:**
Base software with application specific modules:
- Area view
- Object recognition
- ...

**Sensor fusion:**
Camera, Radar, LiDAR, US
3. FROM SENSOR TO SYSTEM
We are taking part with our Embedded ECU

Sensor Fusion
- Camera
- Radar
- Ultrasonic
- LiDAR

Target Applications
- Area View
- Mirror Replacement
- Turn Assist
- Object/Sign Recognition
### 3. FROM SENSOR TO SYSTEM

Next steps: We lay the foundations for sensor fusion

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>Extend software capabilities</td>
<td>Form a dedicated software team</td>
<td></td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>Entry into systems market</td>
<td>Strategic customers worldwide</td>
<td></td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Partnerships with customers and suppliers</td>
<td>Identify and strengthen alliances</td>
<td></td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>Development of software platform</td>
<td>Modular software on system-, com- and application-level</td>
<td></td>
</tr>
</tbody>
</table>
OUR STRATEGY FOR DRIVER ASSISTANCE & AUTONOMOUS DRIVING

Summary

1. For autonomous driving a combination of sensors is necessary

2. Expanding our product portfolio: We concentrate on LiDAR and camera applications

3. Market expansion: We focus on the commercial and special vehicles market

4. From Sensor to System: We develop our own software platform

5. Our LiDAR and camera sales will increase significantly in the upcoming years
FROM SENSOR INTEGRATION TO SENSOR FUSION: FIRST SENSOR’S LIDAR AND CAMERA STRATEGY FOR DRIVER ASSISTANCE & AUTONOMOUS DRIVING

Capital Market Day
March 22, 2018
Martin Kümmel
First Sensor AG
www.first-sensor.com

This presentation contains forward-looking statements. This presentation does not represent any solicitation to purchase shares of First Sensor AG. Rather it is intended exclusively for information purposes with regard to possible future developments at the company. All future-oriented information in this presentation was produced on the basis of probability-based planning and represents statements regarding the future which cannot be guaranteed. Rounding differences may occur.