Semiconductors supporting the evolution of automotive systems

Michael Anfang

Executive Vice President Sales and Marketing EMEA
STMicroelectronics
STMicroelectronics

- Among the world’s largest semiconductor companies
- Serving over 100,000 customers across the globe
- 2018 revenues of $9.66B, with year-on-year growth of 15.8%
- Listed: NYSE, Euronext Paris and Borsa Italiana, Milan
- Signatory of the United Nations Global Compact (UNGC), Member of the Responsible Business Alliance (RBA)

- ~46,000 employees worldwide
- ~ 7,400 people working in R&D
- 11 manufacturing sites
- Over 80 sales & marketing offices

As of December 31, 2018
Application Approach

Leverage broad and deep knowledge of automotive systems to develop solutions optimized for targeted vehicle subsystems

- Chassis & Safety
- ADAS
- Powertrain for ICE
- Electro-mobility
- Body & Convenience
- In-vehicle Infotainment
- Telematics & Networking
- Mobility Services

Market Approach

Partnerships with Car Manufacturers, Tier 1’s and technology leaders

Partnerships with Distribution Including full kit solutions

Partnerships for long-term success in China

ST Strategy

- Investment in technology, product and manufacturing capabilities to support leadership objectives
- Leverage Silicon Carbide disruption to lead the car electrification transformation
- Leverage car architecture change through advanced Automotive domain controllers (MCU)
- Partnership with ADAS and V2X Leaders
- Continue leadership in traditional areas thanks to product and technology roadmap
Automotive Semiconductor Market

Strong Existing Positions – Building in New Areas

<table>
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<tr>
<th>Rank</th>
<th>Logic</th>
<th></th>
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<tbody>
<tr>
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<tr>
<td>10</td>
<td>STMicroelectronics</td>
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</table>

Source: Strategy Analytics

CAGR 8%

$35.2B to $44.4B

2018 to 2021
Automotive Market
Content and Volume Growth

Vehicle Production (Million Units)

<table>
<thead>
<tr>
<th>Year</th>
<th>TRIAD</th>
<th>China</th>
<th>ROW</th>
<th>Total</th>
</tr>
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<tr>
<td>2018</td>
<td>46</td>
<td>27</td>
<td>22</td>
<td>95</td>
</tr>
<tr>
<td>2019</td>
<td>46</td>
<td>27</td>
<td>22</td>
<td>96</td>
</tr>
<tr>
<td>2020</td>
<td>47</td>
<td>23</td>
<td>28</td>
<td>99</td>
</tr>
<tr>
<td>2021</td>
<td>47</td>
<td>30</td>
<td>24</td>
<td>101</td>
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CAGR 2018-2021: +2.3%

Semiconductor Content ($)

<table>
<thead>
<tr>
<th>Year</th>
<th>TRIAD</th>
<th>China</th>
<th>ROW</th>
<th>World AVG</th>
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<tbody>
<tr>
<td>2018</td>
<td>$282</td>
<td>$339</td>
<td>$296</td>
<td>$309</td>
</tr>
<tr>
<td>2019</td>
<td>$296</td>
<td>$361</td>
<td>$319</td>
<td>$317</td>
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<tr>
<td>2020</td>
<td>$309</td>
<td>$389</td>
<td>$309</td>
<td>$389</td>
</tr>
<tr>
<td>2021</td>
<td>$319</td>
<td>$417</td>
<td>$417</td>
<td>$417</td>
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</table>

CAGR 2018-2021: +5.1%

TRIAD: Europe-US-Japan

Source: Strategy Analytics
Electrification & Digitalization
Driving Growth

Car Digitalization & Car Electrification
Growth driven by silicon pervasion, with smaller impact from growth of car volumes

Automotive Legacy Electronics
Growth linear with the car volumes
Exposed to market cycles

Source: Strategy Analytics
Car Electrification

ST Leading with Disruptive Technologies

**Mild Hybrid 48V**
Low-end entry level electrification

- 48V-12V DC-DC Converter
- Electric Starter/Generator
- Battery Management

**Battery Electric Vehicle**
High-end battery-based full electric car

- On-Board Charger
- DC-DC Converter
- Traction Inverter
- Charge Station
- Battery Management

**Electric Cars**

<table>
<thead>
<tr>
<th>Year</th>
<th>Electric Car Production (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>7.5</td>
</tr>
<tr>
<td>2023</td>
<td>25.4</td>
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</tbody>
</table>

$\text{Average Content per BEV/HEV} = \frac{396}{493}$

**Powertrain Electrification**

<table>
<thead>
<tr>
<th>Year</th>
<th>ST SAM</th>
<th>CAGR 20%</th>
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<tbody>
<tr>
<td>2018</td>
<td>$2.6B$</td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td>$6.5B$</td>
<td></td>
</tr>
</tbody>
</table>

Includes: BEV, mild hybrid, plug-in hybrid, fuel cell electric vehicle, full hybrid

Source: Strategy Analytics
**ST Silicon Carbide**

### Silicon Carbide: Business Status

- **SiC MOSFETS /Diodes** Revenues in 2018
  - $>100^M$
  - 2019 Projection
  - $>200^M$

- **>10** OEM in production with ST SiC MOSFET

- **8 European Car-Makers** ramping-up by 2019-20

- Partnering with **Renault Nissan Mitsubishi** on several SiC projects

- Cooperating with **Hyundai Kia Motor** on several **SiC MOSFET & Diodes**

### ST Strategy and Execution

- **SiC Supply Chain**
  - Vertical Integration Norstel AB

- **Extended and Secured** Supply Chain capability through Multi-Year supply agreement with **Cree-Wolfspeed**

- **Next Gen**
  - **Trench Technology**

- **1st Gen.**
  - **2nd Gen.**
  - **3rd Gen.**
  - **x2 shrink**
  - **x4 shrink**
Silicon Power Innovation

Electrification Beyond Silicon Carbide

**Battery Management up to 800V to support the Chinese electrical mobility market**

Innovative cell monitoring architecture in cooperation with ~10 Chinese car makers and IMECAS as part of “China 2025” national program

**Lithium cell monitoring**  
**Devices per Vehicle**  
Suitable for **Hybrid** and **Full** Electrical vehicles

**IGBT for EV applications**

> 15 OEMs in production in ‘19

Agrate Fab

**Investing** in new Facilities to sustain **Power Silicon** solution growth

**Solution for Mild-Hybrid vehicle (48V)**

Tailored Low Voltage **MOSFET suitable for 48V systems**

→ Already in production in multiple Hybrid Cars with Top Car Makers in EU, US and Asia

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Projected Volume

<table>
<thead>
<tr>
<th>2019</th>
<th>2021</th>
<th>2023</th>
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<tbody>
<tr>
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<td></td>
<td><strong>x3</strong></td>
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Life augmented
ST Leading with Disruptive Technologies & Partnerships

ADAS System Penetration

% Penetration vs Car Production

<table>
<thead>
<tr>
<th>Year</th>
<th>Level 2+</th>
<th>Level 4+</th>
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<tbody>
<tr>
<td>2018</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td>53%</td>
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</table>

Average ADAS Content per Car

- Level 2+: $350
- Level 4+: $900

ADAS includes: distance warning, drowsiness monitor, eCall, LDWS, night vision, occupant detection, Parking and other ADAS functions

ADAS Growth

CAGR 16%

ST SAM

<table>
<thead>
<tr>
<th>Year</th>
<th>2018</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$3.6B</td>
<td>$7.7B</td>
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Automotive MCU Growth

CAGR 8%

32-bit MCU

<table>
<thead>
<tr>
<th>Year</th>
<th>2018</th>
<th>2023</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>$6.0B</td>
<td>$7.8B</td>
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Source: Strategy Analytics
Active Safety and Autonomous Driving

Leading Vision-based system with Mobileye

EyeQ5
1st product designed for Automotive in 7nm FinFET suitable for both ADAS and Autonomous Driving market

Moving towards autonomous vehicles with Auto-parking ability

- Advanced solution for mobility and Autonomous Parking
- Co-development leveraging ST Expertise in designing safe and secure Automotive SoCs and Panasonic leadership in image manipulation and system design
ADAS Beyond Vision
Leading Innovation with 5G Cellular V2X and High Precision GNSS

Market 1st dual-mode solution supporting 5G Cellular V2X

Cellular (Automotive low latency 5G)

&

Wi-Fi 11.p (for Automotive)

Single Ics Solution

TESEO APP: Precise Positioning enhancing Assisted and Autonomous Driving

Full Production

Sub-meter positioning

Ramp-up by 2020

Multi-Band ASIL-D

Autotalks solution awarded for production:

• 4 of the top 10 automakers deploy Autotalks V2X solution
• > 10 Tier1s selected the chipset
• Volume production by 2020

• Sub-meter positioning for Assisted Driving
• Multi-constellation(*) system including now Indian System (NAVIC) with 3 customers certified with ST solution (1st in the market)
• Enabling ADAS (Tolling, Insurance Box, Assisted Driving...)

(*) GPS, Galileo, Glonass, Beidou, NAVIC, QZSS
Car Digitalization: New Architectures

2017

Distributed Architecture: 9k DMIPs per Car

- Local Control Units with up to 130 ECUs/Car (with 8-16-32-bit MCUs)
- Limited connectivity and in-vehicle data flow (up to 10 Mbit/s)
- Heavy and expensive harness
- Extremely complex car software management
- No car functionality upgrade

202X

Integrated Real-time Domain Architecture: 90k DMIPs per Car

- ~5 Domain-Control Units with higher power computation: +30% Silicon Value
- Autonomous Driving Super-computer (MPU ext. Memory) ~100 Trillion Operations per/s.
- Architecture simplification, SW rationalization, harness drastic reduction
- Easy car functionality reconfiguration and SW upgrades
- High-speed in-vehicle communication
- Over-the-Air Software upgrade capability

ST “Stellar” automotive MCUs

- With multiple Arm® Cortex®-R52 cores embedded Phase-Change Memory (PCM)
Israeli partners and customers in Automotive applications

ADAS

Security

Communication

Mobileye

Karamba Security

Valens

ADASky

ARILOU

Autotalks
• **ST is an enabler for the automotive industry**: strongly focused on the two megatrends disrupting the design and manufacturing of cars – **electrification, digitalization**.

• **Partnerships and cooperation with very innovative Israeli companies** in key areas: co-design and/or industrialization and manufacturing of their designs, joint marketing.

• **Ramp-up of ST-Up hardware accelerator program in Tel-Aviv to help Israeli startups scale faster**; smart mobility is key.