Automotive Packaging: Market and Technologies Trends 2019

Market and Technology Report 2019
Mario IBRAHIM

is a Technology & Market Analyst - Advanced Packaging and a member of the Semiconductor & Software division at Yole Développement (Yole). Mario engages in the development of technology & market reports and the production of custom consulting studies. He is also deeply involved in test activities business development within the division.

Prior to Yole, Mario was engaged in test activities development for LEDs at Aledia, and oversaw several advanced packaging R&D programs. During his five-year stay, he developed strong technical and managerial expertise in different semiconductor fields.

Mario also spent three years at STMicroelectronics (Grenoble) within the Imaging division, where he contributed to test benches park automation within the Test & Validation team.

Mario holds an Electronics Engineering degree from Polytech Grenoble (France).

Contact: mario.ibrahim@yole.fr
Over 100 companies are cited in this report

# TABLE OF CONTENTS

## Part 1/2

- **Glossary**
  - P2
- **Table of contents**
  - P3
- **Report scope & objectives**
  - P5
- **Report methodology**
  - P6
- **About the authors**
  - P7
- **Companies cited in this report**
  - P8
- **What we got right, What we got wrong**
  - P9
- **What electronic devices are considered in the report**
  - P10
- **3 pages summary**
  - P11
- **Executive Summary**
  - P14
- **Introduction**
  - P67
    - The major news since 2018
    - Automotive market, trends and changes
    - Automotive packaging, trends, changes and challenges
- **Vehicle electrification**
  - P87
    - Trends, market & challenges
- **Vehicle autonomy**
  - P97
    - Trends, market & challenges
- **Automotive packaging**
  - P104
    - Automotive packages evoked in this report
    - Automotive packaging landscape & global market
    - Automotive electronic chips in a car, 2019 vs 2024 comparison
    - Automotive electronic chips packaging ASP, 2018 vs 2024 comparison
    - Automotive packaging, mainstream vs advanced packaging
    - Automotive packaging market repartition by application
- **Automotive packaging per application**
  - P117
    - Trends & markets:
      - CIS
      - LiDAR
      - Radar & Connectivity
      - MEMS & Sensors
      - LED lighting
      - Computing
      - Memory
      - Power devices
# TABLE OF CONTENTS

## Part 2/2

- **Automotive ecosystem & supply chain**  P229  
  - Ecosystem by application  
  - Automotive industry mutation  
  - Automotive supply chain possible change scenarios  
    - Short-term scenario  
    - Mid-term scenario  
    - Long-term scenario  
  - IDM vs OSAT automotive packaging battle  
    - IDM vs OSAT packaging market share  
    - Top automotive OSAT packaging revenue & market share  
- **Report conclusions**  P253  
- **Appendix**  P254  
- **About Yole Développement**  P269
## GLOSSARY

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD</td>
<td>Autonomous driving</td>
<td>FPGA</td>
<td>Field-Programmable Gate Array</td>
</tr>
<tr>
<td>ADAS</td>
<td>Advanced driver-assistance systems</td>
<td>GaN</td>
<td>Gallium Nitride</td>
</tr>
<tr>
<td>AFLS</td>
<td>Adaptive Front Light System</td>
<td>GDP</td>
<td>Gross domestic product</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
<td>GNNS</td>
<td>Global Navigation Satellite System</td>
</tr>
<tr>
<td>AiP</td>
<td>Antena in package</td>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>ASIC</td>
<td>Application-Specific Integrated Circuit</td>
<td>GPU</td>
<td>Graphics Processing Unit</td>
</tr>
<tr>
<td>ASP</td>
<td>Average Selling Price</td>
<td>HPC</td>
<td>High Performance Computing</td>
</tr>
<tr>
<td>BEV</td>
<td>Battery Electric Vehicle</td>
<td>HVM</td>
<td>High Volume Manufacturing</td>
</tr>
<tr>
<td>BGA</td>
<td>Ball Grid Array</td>
<td>I/O</td>
<td>Inputs/Outputs</td>
</tr>
<tr>
<td>BOM</td>
<td>Bill of materials</td>
<td>iBGA</td>
<td>Interstitial Ball Grid Array</td>
</tr>
<tr>
<td>CAGR</td>
<td>Compound Annual Growth Rate</td>
<td>IC</td>
<td>Integrated Circuit</td>
</tr>
<tr>
<td>CHMSL</td>
<td>Center High-Mount Stop Light</td>
<td>IDM</td>
<td>Integrated Device Manufacturers</td>
</tr>
<tr>
<td>CIS</td>
<td>CMOS Image Sensor</td>
<td>IGBT</td>
<td>Insulated Gate Bipolar Transistor</td>
</tr>
<tr>
<td>CLCC</td>
<td>Ceramic Leadless Chip Carrier</td>
<td>IMU</td>
<td>Inertial Measurement Unit</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
<td>ISP</td>
<td>Image signal processor</td>
</tr>
<tr>
<td>CSP</td>
<td>Chip Scale Packaging</td>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>DRAM</td>
<td>Dynamic Random Access Memory</td>
<td>LGA</td>
<td>Land Grid Array</td>
</tr>
<tr>
<td>DRAM</td>
<td>Dynamic random-access memory</td>
<td>LiDAR</td>
<td>Light Detection And Ranging</td>
</tr>
<tr>
<td>DSRC</td>
<td>Dedicated Short Range Communications</td>
<td>LTCC</td>
<td>Low Temperature Co-fired Ceramic</td>
</tr>
<tr>
<td>ECU</td>
<td>Electronic Control Unit</td>
<td>LTE</td>
<td>Long-Term Evolution</td>
</tr>
<tr>
<td>ED</td>
<td>Embedded Die</td>
<td>LV</td>
<td>Low Voltage</td>
</tr>
<tr>
<td>EPROM</td>
<td>Erasable programmable read-only memory</td>
<td>LWIR</td>
<td>Long Wave Infrared</td>
</tr>
<tr>
<td>EV/HV</td>
<td>Electrical Vehicle/Hybrid Vehicle</td>
<td>MCB</td>
<td>Metal Core Printed Circuit Board</td>
</tr>
<tr>
<td>FC</td>
<td>Flip Chip</td>
<td>MCU</td>
<td>MicroController Unit</td>
</tr>
<tr>
<td>FCC</td>
<td>Federal Communications Commission</td>
<td>MEMS</td>
<td>Micro-Electro Mechanical Systems</td>
</tr>
<tr>
<td>FCCSP</td>
<td>Flip Chip Scale Package</td>
<td>MOSFET</td>
<td>Metal Oxide Semiconductor Field-Effect Transistor</td>
</tr>
<tr>
<td>FCEV</td>
<td>Fuel cell electrical vehicle</td>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
</tr>
<tr>
<td>Fi</td>
<td>Fan-In</td>
<td>OSAT</td>
<td>Outsourced Semiconductor Assembly and Test</td>
</tr>
<tr>
<td>FO</td>
<td>Fan-Out</td>
<td>PHEV</td>
<td>Plug-in Hybrid Electric Vehicle</td>
</tr>
<tr>
<td>PMIC</td>
<td>Power Management Integrated Circuit</td>
<td>QFN</td>
<td>Quad flat No lead package</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSAT</td>
<td>Outsourced Semiconductor Assembly and Test</td>
</tr>
<tr>
<td>PHEV</td>
<td>Plug-in Hybrid Electric Vehicle</td>
</tr>
<tr>
<td>PMIC</td>
<td>Power Management Integrated Circuit</td>
</tr>
<tr>
<td>QFN</td>
<td>Quad flat No lead package</td>
</tr>
<tr>
<td>RCL</td>
<td>Rear Combination Lamp</td>
</tr>
<tr>
<td>RDL</td>
<td>Redistribution Layer</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>SiC</td>
<td>Silicon Carbide</td>
</tr>
<tr>
<td>SiP</td>
<td>System in Package</td>
</tr>
<tr>
<td>SMD</td>
<td>Surface Mount Die</td>
</tr>
<tr>
<td>SO/SOIC</td>
<td>Small Outline Integrated Circuit</td>
</tr>
<tr>
<td>SoC</td>
<td>System on chip</td>
</tr>
<tr>
<td>SRR</td>
<td>Short-Range Radar</td>
</tr>
<tr>
<td>SSOP</td>
<td>Small Outline Integrated Circuit</td>
</tr>
<tr>
<td>TO</td>
<td>Transistor Outline</td>
</tr>
<tr>
<td>TPMS</td>
<td>Tire Pressure Monitoring System</td>
</tr>
<tr>
<td>TSOP</td>
<td>Thin Small Outline Package</td>
</tr>
<tr>
<td>V2X</td>
<td>Vehicle to anything</td>
</tr>
<tr>
<td>VPU</td>
<td>Vision processor unit</td>
</tr>
<tr>
<td>WB</td>
<td>Wirebond</td>
</tr>
<tr>
<td>WB BGA</td>
<td>Wirebond Ball Grid Array</td>
</tr>
<tr>
<td>WBG</td>
<td>Wide Band Gap</td>
</tr>
<tr>
<td>WLCS</td>
<td>Wafer Level Chip Scale Package</td>
</tr>
<tr>
<td>WLP</td>
<td>Wafer-Level packaging</td>
</tr>
<tr>
<td>OSAT</td>
<td>Outsourced Semiconductor Assembly and Test</td>
</tr>
<tr>
<td>PHEV</td>
<td>Plug-in Hybrid Electric Vehicle</td>
</tr>
<tr>
<td>PMIC</td>
<td>Power Management Integrated Circuit</td>
</tr>
</tbody>
</table>
REPORT SCOPE & OBJECTIVES

• This report is an update of the 2018 “Trends in Automotive Packaging” report
• The scope of this report is to present the actual mega trends & trends, their impact on automotive industry, its packaging technologies and platforms
• This report’s objectives are to:
  • Offer a global overview of the automotive market and trends
  • Show the impact of automotive mega-trends, and trends in the automotive semiconductor ecosystem
  • Provide an overview of automotive electronics and packaging
  • Furnish updated market data & forecasts for different automotive applications, and their packaging (units & revenue):
    • CIS / LiDAR / radar / connectivity / MEMS & sensors / memory / computing / power / LED
  • Identify the key players and their automotive ecosystems
  • Discuss the possible scenarios for the automotive supply chain’s future evolution
  • Compare the packaging market share of IDMs vs. OSATs
Yole’s market forecast model is based on the matching of several sources:

**Comparison with existing data**
- Monitoring of corporate communication
- Using other market research data
- Yole analysis (consensus or not)

**Comparison with prior Yole reports**
- Recursive improvement of dataset
- Customer feedback

---

**Preexisting information**

---

**Top-to-bottom approach**
- Aggregate of market forecasts
  - System level

**Bottom-up approach**
- Ecosystem analysis
  - Aggregate of all players’ revenue
    - System level

---

**Top-to-bottom approach**
- Aggregate of market forecast
  - Semiconductor device level

**Bottom-up approach**
- Ecosystem analysis
  - Aggregate of key players’ revenues
    - Semiconductor device level

---

**Market**
- Volume (in Munits)
- ASP (in $)
- Revenue (in $M)

---

**Semiconductor foundry activity**
- Capacity investments and equipment needs

---

**Primary data**
- Reverse costing
- Patent analysis
- Annual reports
- Direct interviews

---

**Secondary data**
- Press releases
- Industry organization reports
- Conferences

---

**Information Aggregation**
### WHAT ELECTRONIC DEVICES ARE CONSIDERED IN THE REPORT

<table>
<thead>
<tr>
<th>Application</th>
<th>Details</th>
<th>Quantified</th>
<th>Not included</th>
</tr>
</thead>
<tbody>
<tr>
<td>General analog, analog IC, infotainment electronics</td>
<td>MCU/MPU/VPU/Fusion Platform, ISP/FPGA/Infotainment AI SoC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computing</td>
<td>Electronics drivers, other infotainment computing units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power (numbers are mostly for EV/HEV vehicles)</td>
<td>Discrete (IGBT/Bipolar/Mosfet [LV/HV/SiC] SiC diode/GaN) PMIC (body &amp; convenience/ADAS/others; Infotainment; power train) Power modules (HV IGBT, LV bipolar &amp; mosfet, SiC module)</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thyristor, rectifier, power diode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connectivity</td>
<td>DSRC, PCS, hybrid, LTE, 5G, GNSS (single/Dual band) modules</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>MEMS &amp; sensors</td>
<td>Pressure/phone/Accelerogram/Gyro/Magnetometer/Optical MEMS/bolometer/Oscillator/Env sensor</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>CIS</td>
<td>ADAS, driver monitoring, gesture recognition, surround, mirror replacement, night vision, dash camera</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Radar</td>
<td>24.77.79 GHz</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>LiDAR</td>
<td>Laser, photodetector, Micro mirror</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>LED</td>
<td>Exterior (Headlamps and DRL, RCL, CHMSL)</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interior</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Memory</td>
<td>DRAM, NAND</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• Since 2018, the global cars & light trucks sales are decreasing. This trend will continue in 2019 and will bounce back in 2020 reaching similar volumes as in 2018.

• Many factors are shaping the market, among them the push toward ecology that strengthens in Europe and the unpredictable global policies:
  • Political & economic stability: it is difficult to predict the stability of a region for the coming 10 years. Many examples can be given as the USA/China trade war, the tensions between China/Hong Kong & the mutual restrictions between Japan & South Korea. Those political and economic tensions can have a direct impact on the automotive market.
  • Ecology: difficult environment conditions are forcing to reconsider the way of living. In Asia, the electrification of the cars is pushed to solve pollution threat. In Europe, frequent restriction on automotive circulation and models are applied to try to counter punctual pollution peaks. A change in the population's way of thinking and moving is ongoing in Europe. We don’t see specific moves in USA.
AUTOMOTIVE TRENDS

Two megatrends enabled by a multitude of devices

Today’s car… Boring

New automotive era

The car of tomorrow… Exciting

*Can be boring if no infotainment 😊

Mega Trends

Electrification

Autonomy

Connectivity

Computing

Power management

Comfort

How?
Driven by the two megatrends, automotive sector is changing, or said in a different way, is finally open for changes.

Known as a conservative industry, automotive today is at a certain point forced to change if it’s willing to follow the innovation. They are also constrained to counter attack the offensive coming from the so called “new comers” in automotive industry as Waymo, Uber, Lyft that are threatening their business model.

Car makers can no more wait the typical 5 years before adopting a new technology especially when it’s related to ADAS computing, this time is too much of constraints. They need to quickly move on a new ADAS computing technology. Once adopted, the technology, die and package will still have to pass the long and harsh automotive qualifications.

A mentality change is shown in this graph, where it’s predicted that the automotive adoption time will be reduced from 5-8 years till 2014 to 6-12 months by 2019-2020 for the latest technologies. We believe this trend is only relevant, as for the moment, for ADAS computing and some power applications. Automotive industry will still need more time to accelerate the technology adoption for the other automotive applications.

**Automotive Adoption of Process Technology**

*Source: BMW, Audi Presentations at AEC Rel Workshop Oct 2018, ITRS Roadmap, Intel*
Both megatrends are also pushing the automotive industry to adopt new types of packages to better answer the requirements. This also comes alongside material development and innovation for specific automotive applications.

One challenge for vehicle electrification is the increase of a car’s autonomy time. This passes through a better battery efficiency. One way to increase it, is to have a higher efficiency power conversion systems and a better heat management. Embedded die is a new type of package that is expected to enter the automotive market firstly in the 48V vehicles. Infineon partnering with Schweizer have developed a new technology using power MOSFET chip embedding. Continental will be the first player to adopt this technology.

ADAS is also at the origin of new packages adoption in automotive. The ADAS requirements in terms of performance and I/O pushed some advanced packaging platforms from consumer into automotive:

- Fan Out: largely used for automotive radar transceivers especially the 77 & 79 Ghz radars. The performances delivered by this type of package helped settling it as favorite package for this kind of devices in replacement of QFN and CSP packages.
- FC BGA: dominant package for ADAS processor and computing units. Those applications require a high number of I/O (>300 for some processors) in addition to a better heat management that only a FC BGA package can answer.
- WB BGA is still dominant for MCU/MPU.

The use of this kind of advanced packages in automotive is relatively new and still for limited applications. Thus the volumes are still very low versus conventional automotive packaging. But there is a beginning for everything.
HOW TO REACH VEHICLE ELECTRIFICATION & AUTONOMY? [2/2]

By implementing more and more electronic systems ...
AUTOMOTIVE PACKAGING, LEGACY & ADVANCED PACKAGING FUTURE

2018
(The beginning of advanced packaging)

Legacy packages

2024
(Advanced packaging market evolution)

Legacy packages

Advanced packages

>2024
(Advanced packaging market confirmation)

Legacy packages

Advanced packages

% Market share
% size of total automotive packaging market

Revenue size
**EV/HEV CLASSIFICATION**

**CO₂ reduction compared to thermal vehicles in %.**

**HEV/EV**
- **Energy saving**
  - No battery charging from the grid

**New Energy Vehicles (NEV)**
- Battery charging from the grid
- Electric motor only (Zero-emission vehicle)
- High-voltage battery (except for the 48V EV)

**Internal Combustion Engine (ICE)+ electric motor**
- Mitsubishi Outlander
- Tesla Model S
- Toyota Mirai

**Car examples**
- **Mild HEV + Mild H48V**
  - BMW X1
  - Full HEV
  - Toyota Prius
- **PHEV**
  - 50-100%
  - 20-50Km
  - 48V EV
  - 100Km
- **BEV**
  - 100-300Km
- **High end BEV or FCEV**
  - 300-500Km

**Level of electrification**
- PHEV: Plug-in Hybrid EV
- BEV: Battery EV
- FCEV: Fuel Cell EV or hydrogen EV

**Autonomy range**
- Volkswagen Golf
- Thermal vehicle (Taken as reference)
AN IDEA ON THE EV/HEV MARKET

EV/HEV sales by electrification type (Mu)

- In 2018: only 7% of the total sold light vehicles are EV/HEV
- By 2024, between 25-30% of the total sold light vehicles will be EV/HEV accounting for almost 30M in total
- A swift EV/HEV car sales growth is expected over the 5 years
AUTONOMOUS VEHICLE

2 different business models: ADAS & Robotic vehicles

**ADAS vehicle**

- **ADAS vehicles** are consumer cars. Me, you, anyone can buy an ADAS car in exchange of a price depending on its ADAS level
- ADAS vehicle is and will operate on the roads. The driver is still behind the wheel to rectify an error caused by ADAS nonfunctioning. Most of the cars today are level 1-2, only Audi & Tesla have cars with ADAS level 3 as an option
- These cars are produced by conventional car manufacturers like Audi, Volkswagen, Toyota, Ford, Porsche, Mercedes, Tesla... They implement step by step more sensors & systems in order to increase the autonomy level
- Few $K < Vehicle price range < $100K (dependent of the manufacturer, ADAS level and vehicle type (standard, luxury...))

**Robotic vehicle**

- **Robotic vehicles** are not consumer cars. They are used as service vehicles (taxis and shuttles). These vehicles are made to be used almost non-stop (24/7, around 350 days/year)
- They are and will, at least for the coming years be mainly used in designated places (campus, airports ...). Some of these robotic vehicles are already operational in some states in the USA but still very low volumes
- These cars are produced by a so called new comers in automotive like Uber, Lyft, Baydu, Waymo, Navya... They chose to directly implement ADAS level 5 (no driver)
- Very high vehicle price: ~$200K
AUTONOMOUS VEHICLE MARKET

Car sales forecast by autonomy level (Mu)

- It’s obvious that sales of cars without any ADAS features will decrease. On the other hand those with will increase.
- ADAS level 1 & 2 are the actual big sales volumes for cars with ADAS features.
- ADAS level 3 is already a reality, but the volumes still low. Regulations on who is responsible in case of an accident are a potential roadblock for level 3 sales as for the moment. It also seems that the reliability of ADAS level 3 is still questionable.
- No level 4 or 5 on the road before 2024.
- Few robotic vehicles are already running, the volumes will still be low vs consumer ADAS vehicles.
WHICH PACKAGE IS USED FOR WHICH AUTOMOTIVE APPLICATION [1/2]

A kind of an organized labyrinth

Automotive packages

Lead frame

Ceramic

Power module

LGA

aCSP

Epoxy with glass window

Computing (MCU/MPU) QFN/P

Memory (NAND) TSOP

Power (SiC/power modules) Different kinds of packages

MEMS & sensors (Press/phone/Acc/Gyro/IMU/Env)

LED (high power)

LiDAR (photodetector)
WHICH PACKAGE IS USED FOR WHICH AUTOMOTIVE APPLICATION [2/2]

A kind of organized labyrinth

Automotive packages

- WB BGA
- CIS (All the auto cameras) iBGA
- Fan Out
- FC BGA
- ED
- WL CSP
- MEMS & sensors (Env)
The automotive total packaging market will grow from $5.1B in 2018 to around $9B in 2024 exhibiting 10% of CAGR over the forecast period.

This is mainly due to the automotive mega trends, electrification & autonomy but also the connectivity and comfort trends that are multiplying the number of electronics needed in a car.
ELECTRONIC CHIPS IN A CAR

**2019**
- **ASP:** 35 000$
- **Electronic chips/car:** 400-700$
- **Electronic chips value/car:** 600-700$
- **Electronic chips packaging value/car:** 60-90$

**2024**
- **ASP:** 41 000$
- **Electronic chips/car:** 600->1 000$
- **Electronic chips value/car:** 850-1 000$
- **Electronic chips packaging value/car:** 90-150$
AUTOMOTIVE CHIP PACKAGING ASP

Package ASP by application

- The plotted ASP are average ASPs of different chips in each application.
- This graph gives a very global overview on how to situate the packages in terms of average ASP. It does not give detailed ASP per device for each application. For example an LGA package for pressure sensors does not have the same ASP as the one for accelerometers. According to the application, the device and the functionality, a same package family can have a different size, a different complexity, a different qualification grade … and thus a different ASP.

---

* CIS average package ASP does not include any ED package ASP in 2018
** Power applications average package ASP does not include the HV power module packages’ ASP that is on average around 26$ per package
*** MEMS & Sensors average package ASP does not include the microbolometer ceramic packages’ ASP that is around 35$ per package
**** LiDAR ASP is the average ASP for the laser, photodetector and micro mirror devices and not the ASP of a LiDAR system.
Mainstream versus advanced packaging

- Advanced packaging presence in automotive can still be considered as a shy one
- Based on the reported automotive electronic packages, advanced packages will quadruple their revenue in 5 years. They will consist of 6% of the total automotive packaging revenue in 2024. This percentage is expected to be even higher if we count all the computing units in a car. In addition, even if it’s not yet the case, but several electronic applications can use advanced packaging platforms in the future > 5 years, contributing in potential a higher growth.
GLOBAL AUTOMOTIVE PACKAGING MARKET

Market repartition by automotive application based on our calculated packaging revenue

**CIS:** Driver monitoring, Gesture recognition, rear view, 360° surround, Mirror replacement, Forward ADAS, Night vision, Dash Camera

**Radar & connectivity:** 24/77/79GHz & LTE/5G, V2X (DSRC/PCS/hybrid modules), GNSS (single and dual band modules)

**MEMS & Sensors:** Pressure sensors, Microphones, Accelerometers, Gyroscopes, Magnetometers, IMUs, Optical MEMS, Micro bolometers, Oscillators, Environmental sensors

**LED:** Low power (interior lighting / RCL / CHMSL), Mid power (interior lighting / RCL / CHMSL / Headlamps), High power (Headlamps)

**Computing:** General computing (MCU / MPU / Standalone ISP), ADAS computing (VPU / Fusion platform / FPGA), Infotainment (AI based SoC)

**Memory:** DRAM, NAND

**Power:** Discrete (IGBT / Bipolar / Mosfet (LV/HV) / SiC Mosfet / SiC diode / GaN), PMIC (body & convenience / Chassis & safety / Infotainment / Power train), Power module (IGBT / Bipolar / Mosfet / SiC modules)
## AUTOMOTIVE IMAGING – APPLICATION & TECHNOLOGY SEGMENTATION

<table>
<thead>
<tr>
<th>Application</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver monitoring</td>
<td>Camera</td>
</tr>
<tr>
<td>Gesture recognition</td>
<td>3D camera</td>
</tr>
<tr>
<td>3D perception</td>
<td>3D LiDAR</td>
</tr>
<tr>
<td>Forward ADAS</td>
<td>Camera</td>
</tr>
<tr>
<td>Night vision</td>
<td>Thermal camera</td>
</tr>
<tr>
<td>Mirror replacement</td>
<td>Camera</td>
</tr>
<tr>
<td>360° surround</td>
<td>Camera</td>
</tr>
<tr>
<td>Rearview/backup</td>
<td>Camera</td>
</tr>
<tr>
<td>Dash/blackbox</td>
<td>Camera</td>
</tr>
</tbody>
</table>
## CIS AUTOMOTIVE PACKAGING & TRENDS BY APPLICATION

<table>
<thead>
<tr>
<th>Application</th>
<th>Ceramic</th>
<th>iBGA</th>
<th>ED</th>
<th>aCSP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Used</td>
<td>Used</td>
<td>Used</td>
<td>Used</td>
</tr>
<tr>
<td></td>
<td>Trend</td>
<td>Trend</td>
<td>Trend</td>
<td>Trend</td>
</tr>
<tr>
<td>Driver monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gesture recognition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rear view</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>360° surround</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mirror replacement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward ADAS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Night vision</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dash Camera</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**

- ✗ Package not yet used in 2019
- ✗ ❫ Package not yet used in 2019 but will be in the future
- ✔ Package used with standstill trend
- ✔ ❫ Package used but with decreasing % trend
- ✔ ❪ Package used but with increasing % trend
More than 70% of the automotive CIS packages are and will be using iBGA package.

Ceramic will continue to be used for certain CIS applications in the car especially in the high end cars (luxury).

Embedded die will enter the CIS automotive packages in 2019, it’s expected to grow in terms of volumes and revenue in the future, getting shares essentially from aCSP package that will start to decrease starting from 2022.

Total automotive CIS packaging market is expected to exceed $286M in 2024.
LiDAR for ADAS vehicles – Integration roadmap

Today, only available in Audi A8 and A7. Valeo is the only tier-1 having automotive grade as for this time. The typical use case is a traffic-jam assistance. OEM programs integrating LiDAR into mass production vehicles are expected to start from 2020-2021.

In this high automation configuration, short-/mid range LiDARs will be necessary and should be integrated in the corners of a vehicle. In this case, the vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.

In this full automation configuration, the vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.
### AUTOMOTIVE LIDAR PACKAGING & TRENDS BY COMPONENT

<table>
<thead>
<tr>
<th>Component</th>
<th>Lead frame / TO</th>
<th>Ceramic</th>
<th>Epoxy with glass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Used</td>
<td>Trend</td>
<td>Used</td>
</tr>
<tr>
<td>Laser</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Photodetector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>μMirror</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- ✗ Package not yet used in 2019
- ✗ ➡ Package not yet used in 2019 but will be in the future
- ✔ Package used with standstill trend
- ✔ ➡ Package used but with decreasing % trend
- ✔ ⬆ Package used but with increasing % trend
The automotive LiDAR packaging is expected to be dominated by ceramic packaging. This is due to the used components and their stringent requirements in terms of heat management and hermeticity. Nevertheless, the ceramic package is relatively expensive. Thus, ceramic can be challenged in the future, by any new package development reaching comparable performances with lower cost.

Almost a $120M packaging revenue by 2024, with ceramic accounting for 95% of this revenue.
AUTOMOTIVE RADAR & CONNECTIVITY SEGMENTATION & THEIR PACKAGING IN THIS REPORT

Radar & connectivity

Radar
- 24GHz
- 77GHz
- 79GHz

Connectivity
- LTE/5G modules
- V2X modules
- GNSS modules

The segmentation retained for this report
# AUTOMOTIVE RADAR & COMMUNICATION PACKAGING & TRENDS BY APPLICATION

<table>
<thead>
<tr>
<th>Application</th>
<th>Type</th>
<th>Lead frame</th>
<th>Fan Out</th>
<th>Ceramic</th>
<th>FC BGA</th>
<th>WL CSP</th>
<th>WB BGA</th>
<th>LGA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Used</td>
<td>Trend</td>
<td>Used</td>
<td>Trend</td>
<td>Used</td>
<td>Trend</td>
<td>Used</td>
<td>Trend</td>
</tr>
<tr>
<td>Radar</td>
<td>24GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>77-79GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connectivity</td>
<td>LTE/5G</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>V2X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GNSS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**

- ✓ Package used with standstill trend
- ✓ 🔫 Package used but with decreasing % trend
- ✓ 🔫 Package used but with increasing % trend

- ✗ Package not yet used in 2019
- ✗ 🔫 Package not yet used in 2019 but will be in the future
• Fan Out & FC BGA packages will grow in terms of volumes and market, with a domination of FO platforms for automotive radar
• QFN & WL CSP packages are still used, especially QFN.
AUTOMOTIVE MEMS & SENSORS AND THEIR PACKAGES STUDIED IN THIS REPORT
## AUTOMOTIVE MEMS & SENSORS PACKAGING & TRENDS BY APPLICATION

<table>
<thead>
<tr>
<th>Application</th>
<th>Lead frame</th>
<th>LGA</th>
<th>Ceramic</th>
<th>WL CSP</th>
<th>WB BGA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Used</td>
<td>Trend</td>
<td>Used</td>
<td>Trend</td>
<td>Used</td>
</tr>
<tr>
<td>Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microphones</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accelerometers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gyroscopes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnetometers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMUs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optical MEMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micro bolometers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oscillators</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental sensors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Legend:

- ✗ Package not yet used in 2019
- ✗ ↗ Package not yet used in 2019 but will be in the future
- ✔ Package used with standstill trend
- ✔ ↘ Package used but with decreasing % trend
- ✔ ↗ Package used but with increasing % trend
• A peak in pressure sensors units will occur in 2020 due to the Chinese regulations where TPMS will become mandatory in the new produced cars
### AUTOMOTIVE LED PACKAGING & TRENDS BY APPLICATION

<table>
<thead>
<tr>
<th>Application</th>
<th>FC with ceramic substrate</th>
<th>FC with other substrate</th>
<th>WB with ceramic substrate</th>
<th>WB with other substrate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Used</td>
<td>Trend</td>
<td>Used</td>
<td>Trend</td>
</tr>
<tr>
<td>Low Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- ✖️ Package not yet used in 2019
- ✖️ ➡️ Package not yet used in 2019 but will be in the future
- ✔️ ✔️ Package used with standstill trend
- ✔️ ➡️ Package used but with decreasing % trend
- ✔️ ➡️ Package used but with increasing % trend
LED units are still dominated by low power LED units. This trend will change starting 2021 where Mid power LEDs will be the largest automotive volumes. This will have an impact on the LED packaging where ceramic is more used for mid/high power LEDs and not for low power.
AUTOMOTIVE COMPUTING AND THEIR PACKAGES STUDIED IN THIS REPORT

- General computing
  - MCU/MPU
  - Standalone ISP
- ADAS computing
  - VPU/Fusion platform
  - FPGA
- Infotainment computing
  - AI based SoC

The segmentation retained for this report
# Automotive Computing Packaging & Trends by Application

<table>
<thead>
<tr>
<th>Computing type</th>
<th>Hardware</th>
<th>QFN/P</th>
<th>WB BGA</th>
<th>FC BGA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Used</td>
<td>Trend</td>
<td>Used</td>
</tr>
<tr>
<td>General computing</td>
<td>MCU/MPU</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ISP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADAS computing</td>
<td>VPU/Fusion platform</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FPGA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infotainment computing</td>
<td>AI based SoC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- ✗ Package not yet used in 2019
- ✗ ↗ Package not yet used in 2019 but will be in the future
- ✓ Package used with standstill trend
- ✓ ❏ Package used but with decreasing % trend
- ✓ ✗ Package used but with increasing % trend
• Automotive computing market is largely dominated by WB BGA & QFN/P packages. This is due to the huge volumes that

• The important thing to point out is the continuous adoption of FC BGA package for ADAS computing. The future seems to be heading towards one complex calculation unit with function split vs the different sensors. This may reduce some of the basic computing volumes.
AUTOMOTIVE MEMORY AND THEIR PACKAGES STUDIED IN THIS REPORT

- Memory
  - DRAM
  - NAND

The segmentation retained for this report
# AUTOMOTIVE MEMORY PACKAGING & TRENDS BY APPLICATION

<table>
<thead>
<tr>
<th>Computing type</th>
<th>WB BGA</th>
<th>FC BGA</th>
<th>Lead frame</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Used</td>
<td>Trend</td>
<td>Used</td>
</tr>
<tr>
<td>DRAM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAND</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**

- ✗ Package not yet used in 2019
- ✗ 🔺 Package not yet used in 2019 but will be in the future
- ✔ Package used with standstill trend
- ✔ ❯ Package used but with decreasing % trend
- ✔ ⬇ Package used but with increasing % trend
AUTOMOTIVE MEMORY TOTAL PACKAGING MARKET

By package type

Automotive Memory units by package type (Mu)

Automotive Memory packaging revenue by package type ($M)
Most of the discrete device & power module volumes are volumes for EV only, except for MOSFET (it's EV and other vehicle types).
### AUTOMOTIVE POWER DEVICES PACKAGING & TRENDS BY APPLICATION

<table>
<thead>
<tr>
<th>Application</th>
<th>Lead frame (WB)</th>
<th>Lead frame (Copper clip)</th>
<th>Power module</th>
<th>WB BGA</th>
<th>Embedded die</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Used</td>
<td>Used</td>
<td>Used</td>
<td>Used</td>
<td>Used</td>
</tr>
<tr>
<td></td>
<td>Trend</td>
<td>Trend</td>
<td>Trend</td>
<td>Trend</td>
<td>Trend</td>
</tr>
</tbody>
</table>

**Legend:**

- ❌ Package not yet used in 2019
- ❌ ↘ Package not yet used in 2019 but will be in the future
- ✓ Package used with standstill trend
- ✓ ↘ Package used but with decreasing % trend
- ✓ ↗ Package used but with increasing % trend
• Automotive power packaging is dominated by the lead frame (WB) packages. Copper clip lead frame package is growing at a 7% CAGR 2018-2024 faster than the WB lead frame. This is due to the fact that power intensity of the new power devices is higher and thus a wire bond interconnection may no more be adapted.

• Embedded die entry to the automotive packaging market is expected in 2019. The volumes will still be low as this infant technology will need to prove its utility for automotive devices.

• Power modules, and even if the volumes are relatively low compared to the other packages, will exhibit a revenue of $1.1B by 2024. This is due to very high ASP for the high power modules vs the traditional packages (low power). Big part of the high power package cost today is due to the external parts used to build the package (baseplate, cover, housing …)

• Global automotive power devices automotive packaging will be around $2.4B in 2024 with a CAGR of 8% over the forecast period.
**AUTOMOTIVE SUPPLY CHAIN**

- Tesla have the willingness to control the supply chain down to component manufacturing. Others are partnering with the lower stages of this pyramid.

*Non-exhaustive list*
Based on this report’s total automotive packaging market, IDMs are still dominating the automotive packaging market with more than 65% of market share accounting for more than $3.3B in 2018. OSATs share is around 35% = $1.8B

The trend in terms of packaging and due to higher volumes and more package diversity and complexity, is more packaging subcontracting from IDMs towards OSATs (test will follow but with much slower pace)

By 2024 it’s expected that the automotive packaging revenue repartition will be close to 50/50 between both business models
The top 7 OSATs in automotive packaging account for 94% of the OSATs automotive packaging revenue, reaching $1.8B.

Amkor is the incontestable leader with more than 47% of the OSATs market share accounting for around $840M. ASE is following but is far behind Amkor.

UTAC is closing the podium with more than $140M of revenue followed by Carsem & StatsChipPac / KYEC & Kingpak.
Today’s automotive industry is transforming in preparation for the vehicles of tomorrow. Vehicle autonomy and electrification trends, along with comfort and safety, are driving these changes, which are occurring on every front: supply chain, business models, players, and technologies, down to packaging and materials, etc.

This report focuses on automotive packaging, presenting the different packages used by in-car applications. The total calculated packaging market will exhibit a +10% CAGR 2018-2024, growing from $5.1B in 2018 to around $9B in 2024.

Traditionally a conservative industry, automotive players have begun adapting their approach to today's quickened technology pace. Packaging is one of the fields where changes are manifesting, and affirming the growth of advanced packaging usage. In 2018, advanced packages accounted for only 3% of automotive packaging revenue: the other 97% was attributed to legacy packaging. But in 2024 advanced packaging will double its share, reaching 6% of the total accessible market and accounting for $550M (4x its 2018 revenue). Despite the obvious domination of legacy packaging, advanced platforms will continue their breakthrough into automotive - driven by autonomy applications like ADAS computing, along with vehicle electrification’s need for new advanced packages, i.e. embedded die.

Automotive packaging is application-dependent. In areas like MEMS, low-power, and most CIS, legacy packaging is sufficient - whereas other applications, i.e. computing, require advanced packaging. In fact, advanced packaging’s growth in automotive is directly linked to advancements in autonomy levels, vehicle electrification, and their adoption.

This report details the packages used for various applications: CIS, LiDAR, radar, connectivity, MEMS and sensors, LED lighting, computing, memory, and power devices.

### THE AUTOMOTIVE INDUSTRY'S EVOLUTION, AND ITS IMPACT ON PACKAGING

Today’s automotive industry is transforming in preparation for the vehicles of tomorrow. Vehicle autonomy and electrification trends, along with comfort and safety, are driving these changes, which are occurring on every front: supply chain, business models, players, and technologies, down to packaging and materials, etc.

This report focuses on automotive packaging, presenting the different packages used by in-car applications. The total calculated packaging market will exhibit a +10% CAGR 2018-2024, growing from $5.1B in 2018 to around $9B in 2024.

Traditionally a conservative industry, automotive players have begun adapting their approach to today's quickened technology pace. Packaging is one of the fields where changes are manifesting, and affirming the growth of advanced packaging usage. In 2018, advanced packages accounted for only 3% of automotive packaging revenue: the other 97% was attributed to legacy packaging. But in 2024 advanced packaging will double its share, reaching 6% of the total accessible market and accounting for $550M (4x its 2018 revenue). Despite the obvious domination of legacy packaging, advanced platforms will continue their breakthrough into automotive - driven by autonomy applications like ADAS computing, along with vehicle electrification’s need for new advanced packages, i.e. embedded die.

Automotive packaging is application-dependent. In areas like MEMS, low-power, and most CIS, legacy packaging is sufficient - whereas other applications, i.e. computing, require advanced packaging. In fact, advanced packaging’s growth in automotive is directly linked to advancements in autonomy levels, vehicle electrification, and their adoption.

This report details the packages used for various applications: CIS, LiDAR, radar, connectivity, MEMS and sensors, LED lighting, computing, memory, and power devices.

### THE AUTOMOTIVE PACKAGING LANDSCAPE: AN “IDM VS. OSAT” BUSINESS

The automotive industry of the future will require more in-vehicle electronics systems, implying higher packaging volumes. Historically, automotive packaging was mostly done in-house by IDMs. Today however, with higher volumes and OSATs’ extensive packaging expertise, IDMs are more frequently subcontracting packaging to OSATs, or at the very least producing part of their legacy package needs in-house and subcontracting the rest. Most IDMs are not willing to invest in new packaging lines - especially not for automotive advanced packaging, which requires a substantial investment in terms of tools, qualification, and workforce. In 2018, 65% of the $5.1B total calculated for automotive packaging was generated by IDMs, led by NXP and followed by Infineon and Renesas. In the future, Infineon, due to its acquisition of Cypress, may challenge NXP’s leading position.
Automotive trends, the introduction of new systems like high-performance computing units and the need for higher in-car cyber security, are few reasons behind potential supply chain changes in the future. Conventional car makers like Audi, Toyota, and Volkswagen will lead the consumer automotive business, while so-called “service providers” like Uber, Lyft, Waymo, and Baidu will spearhead the robotic vehicle supply chain.

Besides car makers, if we descend the supply chain pyramid we find system makers that can also be module makers - for example, Denso and Delphi. Component and module makers, which include companies like Infineon, NXP, Bosch, and others, are the next link in the supply chain, following companies offering manufacturing and packaging services: TSMC, Amkor, ASE, and UTAC.

Different supply chain scenarios are possible. Manufacturing and service companies will be less impacted, since car makers will continue relying on them. One possible mid-term scenario calls for expanded involvement of car makers in the supply chain, bypassing system makers and working directly with component and module makers. This scenario is supported by the need for a smaller supply chain, with higher engagement in developing the hardware for specific applications directly linked to vehicle security. This is similar to what Toyota is doing with Denso, and what Audi is researching.

Another approach is one where the car maker integrates the entire supply chain in-house, with the exception of manufacturing and packaging. Tesla is trying to create this scenario by internally developing some of the hardware and software for its cars. This path is risky and costly, and should only be attempted either through very close partnerships and/or M&A. In the short-term, the automotive supply chain will not change drastically - but we should become more aware of some business models than others, based on future activities.

More details are provided in this report, along with an analysis of ecosystems, by application.
REPORT OBJECTIVES

- Offer a global overview of the automotive market and trends
- Show the impact of automotive mega-trends, and trends in the automotive semiconductor ecosystem
- Provide an overview of automotive electronics and packaging
- Furnish updated market data & forecasts for different automotive applications, and their packaging (units and revenue): CIS / LiDAR / radar / connectivity / MEMS and sensors / memory / computing / power / LED
- Identify the key players and their automotive ecosystems
- Discuss the possible scenarios for the automotive supply chain’s future evolution
- Compare the packaging market share of IDMs vs. OSATs

COMPANIES CITED IN THE REPORT (non exhaustive list)


TABLE OF CONTENTS (complete content on i-Micronews.com)

- Table of contents
- Report scope and objectives
- What we got right, what we got wrong
- What electronic devices are considered in the report
- Executive summary
- Introduction
- Automotive electronic chips packaging ASP, 2018 vs 2024 comparison
- Automotive packaging, mainstream vs advanced packaging
- Automotive packaging market repartition by application
- Automotive packaging per application
- Trends and markets: CIS, LiDAR, radar and connectivity, MEMS and sensors, LED lighting, computing, memory, power devices
- Automotive ecosystem and supply chain
- Ecosystem by application
- Automotive industry mutation
- Automotive supply chain possible change scenarios (short - mid - long-term scenarios)
- IDM vs OSAT automotive packaging battle
- IDM vs OSAT packaging market share
- Top automotive OSAT packaging revenue & market share
- Report conclusions
- Yole Développement presentation

AUTHOR

Mario Ibrahim is a Technology & Market Analyst - Advanced Packaging, and a member of the Semiconductor & Software division at Yole Développement (Yole). Mario engages in the development of technology & market reports and the production of custom consulting studies. He is also deeply involved in test activities business development within the division. Prior to Yole, Mario was engaged in test activities development for LEDs at Aledia, and oversaw several advanced packaging R&D programs. During his five-year stay, he developed strong technical and managerial expertise in different semiconductor fields. Mario also spent three years at STMicroelectronics (Grenoble) within the Imaging division, where he contributed to test benches park automation within the Test & Validation team. Mario holds an Electronics Engineering degree from Polytech Grenoble (France).

RELATED REPORTS

Benefit from our Bundle & Annual Subscription offers and access our analyses at the best available price and with great advantages

- Status of the Advanced Packaging Industry 2019
- Status of Advanced Substrates 2019
- Imaging for Automotive 2019
- LiDAR for Automotive and Industrial Applications 2019
- Artificial Intelligence Computing for Automotive 2019
- Radar and Wireless for Automotive: Market and Technology Trends 2019

Find all our reports on www.i-micronews.com
ORDER FORM
Automotive Packaging: Market and Technologies Trends 2019

BILL TO
Name (Mr/Ms/Dr/Pr):
Job Title:
Company:
Address:
City:
State:
Postcode/Zip:
Country:
*VAT ID Number for EU members:
Tel:
Email:
Date:

PAYMENT

BY CREDIT CARD
○ Visa ○ Mastercard ○ Amex
Name of the Card Holder:
Credit Card Number:
Card Verification Value (3 digits except Amex: 4 digits):
Expiration date:

BY BANK TRANSFER
BANK INFO: HSBC, 1 place de la Bourse, F-69002 Lyon, France,
Bank code: 30056, Branch code: 00170
Account No: 0170 200 156 87,
SWIFT or BIC code: CCFRFRPP,
IBAN: FR76 3005 6001 7001 7020 0156 587

RETURN ORDER BY
• MAIL: YOLE DÉVELOPPEMENT, Le Quartz,
  75 Cours Emile Zola, 69100 Villeurbanne/Lyon - France

SALES CONTACTS
• Western US & Canada - Steve Laferriere:
  + 1 310 600-8267 – laferriere@yole.fr
• Eastern US & Canada - Chris Youman:
  +1 919 607 9839 – chris.youman@yole.fr
• Europe & RoW - Lizzie Levenez:
  + 49 15 123 544 182 – levenez@yole.fr
• Japan & Rest of Asia - Takashi Onozawa:
  +81-80-4371-4887 – onozawa@yole.fr
• Greater China - Mavis Wang:
  +886 979 336 809 – wang@yole.fr
• Korea - Peter OK:
  +82 10 4089 0233 – peter.ok@yole.fr
• Specific inquiries: +33 472 830 180 – info@yole.fr
(1) Our Terms and Conditions of Sale are available at
www.yole.fr/Terms_and_Conditions_of_Sale.aspx
The present document is valid 24 months after its publishing date: November 7, 2019

PRODUCT ORDER - Ref YD19050
Please enter my order for above named report:
[ ] One user license*: Euro 5,990
[ ] Multi user license: Euro 6,490
* The report will be ready for delivery from November 22, 2019
For price in dollars, please use the day's exchange rate. All reports are delivered electronically at payment reception. For French customers, add 20% for VAT
I hereby accept Yole Développement’s Terms and Conditions of Sale
Signature:

[ ] One user license means only one person at the company can use the report.

SHIPPING CONTACT
First Name: ____________________________
Last Name: ____________________________
Email: ________________________________
Phone: ________________________________

ABOUT YOLE DEVELOPPEMENT
Founded in 1998, Yole Développement (Yole) has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services and well as IP and patent analysis. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 120 collaborators worldwide covering MEMS and image sensors, Compound semiconductors, RF Electronics, Solid-state lighting, Displays, Software, Optoelectronics, Microfluidics & Medical, Advanced Packaging, Manufacturing, Power Electronics, Batteries & Energy Management and Memory.
The “More than Moore” market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO, KnowMade and Blumorpho, supports industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business.

CONSULTING AND ANALYSIS
• Market data & research, marketing analysis
• Technology analysis
• Strategy consulting
• Reverse engineering & costing
• Patent analysis
• Design and characterization of innovative optical systems
• Financial services (due diligence, M&A with our partner)
More information on www.yole.fr

MEDIA & EVENTS
• i-Micronews.com website, application & related e-newsletter
• Communication & webcast services
• Events: TechDays, forums…
More information on www.i-micronews.com

REPORTS
• Market & technology reports
• Patent investigation and patent infringement risk analysis
• Structure, process and cost analysis and teardowns
• Cost simulation tool
More information on www.i-micronews.com/reports

CONTACTS
For more information about :
• Consulting & Financial Services: Jean-Christophe Eloy (eloy@yole.fr)
• Reports & Monitors: David Jourdan (jourdan@yole.fr) & Fayçal Khamassi (khamassi@yole.fr)
• Marketing & Communication: Camille Veyrier (veyrier@yole.fr)
• Public Relations: Sandrine Leroy (leroy@yole.fr)
Yole Développement

From Technologies to Market
**YOLE DEVELOPPEMENT – FIELDS OF EXPERTISE WITHIN 3 MAIN DOMAINS**

**Photonics & Sensing**
- Photonics
- Lighting
- Imaging
- Sensing & Actuating
- Display

**Semiconductor & Software**
- Semiconductor Packaging and Substrates
- Semiconductor Manufacturing
- Memory
- Computing and Software

**Power & Wireless**
- RF Devices & Technologies
- Compound Semiconductors & Emerging Materials
- Power Electronics
- Batteries & Energy Management
4 BUSINESS MODELS

- **Consulting and Analysis**
  - Market data & research, marketing analysis
  - Technology analysis
  - Strategy consulting
  - Reverse engineering & costing
  - Patent analysis
  - Design and characterization of innovative optical systems
  - Financial services (due diligence, M&A with our partner)

- **Syndicated reports**
  - Market & technology reports
  - Patent investigation and patent infringement risk analysis
  - Teardowns & reverse costing analysis
  - Cost simulation tool [www.i-Micronews.com/reports](http://www.i-Micronews.com/reports)

- **Monitors**
  - Monthly and quarterly update
  - Excel database covering supply, demand, and technology
  - Price, market, demand and production forecasts
  - Supplier market shares

- **Media**
  - i-Micronews.com website and application
  - i-Micronews e-newsletter
  - Communication & webcast services
  - Events: TechDays, forums,…

[www.i-Micronews.com](http://www.i-Micronews.com)
6 COMPANIES TO SERVE YOUR BUSINESS

Yole Group of Companies

**Yole Développement**
- Market, technology and strategy consulting
  - [www.yole.fr](http://www.yole.fr)

**SystemPlus Consulting**
- Manufacturing costs analysis
- Teardown and reverse engineering
- Cost simulation tools
  - [www.systemplus.fr](http://www.systemplus.fr)

**KnowMade**
- IP analysis
- Patent assessment
  - [www.knowmade.fr](http://www.knowmade.fr)

**Piseo Photonics**
- Design and characterization of innovative optical systems
  - [www.piseo.fr](http://www.piseo.fr)

**Blumorpho**
- Innovation and business maker
  - [www.blmorpho.com](http://www.blmorpho.com)

**Yole Finance**
- Due diligence
  - [www.yole.fr](http://www.yole.fr)
OUR GLOBAL ACTIVITY

40% of our business
Yole Deutschland
Paris
Nantes
Vénissieux

30% of our business
Yole Korea
Seoul
Yole Japan
Tokyo
Greater China office
Hsinchu

30% of our business
Yole Inc.
Cornelius
Palo Alto
ANALYSIS SERVICES - CONTENT COMPARISON

- Technology and Market Report
- Leadership Meeting
- Q&A Service
- Meet the Analyst
- Custom Analysis

Depth of the analysis vs. Breadth of the analysis

High | Low
---|---
Technology and Market Report | Leadership Meeting
Q&A Service | Meet the Analyst
Custom Analysis |
Our analysts provide market analysis, technology evaluation, and business plans along the entire supply chain.

Integrators, end-users and software developers

Device manufacturers

Suppliers: material, equipment, OSAT, foundries...

Financial investors, R&D centers
SERVING MULTIPLE INDUSTRIAL FIELDS

We work across multiple industries to understand the impact of More-than-Moore technologies from device to system.
Over the course of more than 20 years, Yole Développement has grown to become a group of companies. Together with System Plus Consulting and KnowMade, we now provide marketing, technology and strategy consulting, media and corporate finance services, reverse costing, structure, process and cost analysis services and well as intellectual property (IP) and patent analysis. Together, our group of companies is collaborating ever closer and therefore will offer, in 2019, a collection of over 125 reports, 10 new monitors and 120 teardowns. Combining respective expertise and methodologies from the three companies, they cover:

- MEMS & Sensors
- RF devices & technologies
- Medical technologies
- Semiconductor Manufacturing
- Advanced packaging
- Memory
- Batteries and energy management
- Power electronics
- Compound semiconductors
- Solid state lighting
- Displays
- Software
- Imaging
- Photonics

If you are looking for:

- An analysis of your product market and technology
- A review of how your competitors are evolving
- An understanding of your manufacturing and production costs
- An understanding of your industry’s technology roadmap and related IPs
- A clear view supply chain evolution

Our reports and monitors are for you!

Our team of over 70 analysts, including PhD and MBA qualified industry veterans from Yole Développement, System Plus Consulting and KnowMade, collect information, identify trends, challenges, emerging markets, and competitive environments. They turn that information into results and give you a complete picture of your industry’s landscape. In the past 20 years, we have worked on more than 2,000 projects, interacting with technology professionals and high-level opinion makers from the main players of their industries and realized more than 3,000 interviews per year.

WHAT TO EXPECT IN 2019?

In 2019 we will extend our offering with a new ‘monitor’ product which provides more updates on your industry during the year. The Yole Group of Companies is also building on and expanding its investigations of the memory industry. Moreover, in parallel, the Yole Group reaffirms its commitment to a new collection of reports mixing software and hardware and is increasing its involvement in displays, radio-frequency (RF) technology, advanced substrates, batteries and compound semiconductors. Last but not least, System Plus Consulting is developing its teardowns service providing 120+ offers related to phones, smart home, wearables and connected devices. Discover our 2019 program right now, and ensure you get a true vision of the industry. Stay tuned!
18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

**Market – Technology – Strategy – by Yole Développement**
Yole Développement (Yole) offers market reports including quantitative market forecasts, technology trends, company strategy evaluation and indepth application analyses. Yole will publish more than 55 reports in 2019, with our partner PISEO contributing to some of the lighting reports.

The Reverse Costing® report developed by System Plus Consulting provides full teardowns, including detailed photos, precise measurements, material analyses, manufacturing process flows, supply chain evaluations, manufacturing cost analyses and selling price estimations. The reports listed below are comparisons of several analyzed components from System Plus Consulting. More reports are however available, and over 60 reports will be released in 2019. The complete list is available at www.systemplus.fr.

**Patent Reports – by KnowMade**
More than describing the status of the IP situation, these analyses provide a missing link between patented technologies and market, technological and business trends. They offer an understanding of the competitive landscape and technology developments from a patent perspective. They include key insights into key IP players, key patents and future technology trends. For 2019 KnowMade will release over 15 reports.

**The markets targeted are:**
- Mobile & Consumer
- Automotive & Transportation
- Medical
- Industrial
- Telecom & Infrastructure
- Defense & Aerospace

Linked reports are dealing with the same topic to provide a more detailed analysis.
OUR 2019 REPORTS COLLECTION (1/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

MEMS & SENSORS

- **MARKET AND TECHNOLOGY REPORT**
  - Status of the MEMS Industry 2019 - Update
  - Status of the Audio Industry 2019 - New
  - Uncooled Infrared Imagers and Detectors 2019 – Update
  - Consumer Biometrics:Technologies and Market Trends 2018
  - MEMS Pressure Sensor Market and Technologies 2018
  - Gas & Particle Sensors 2018

- **STRUCTURE, PROCESS & COST REPORT**
  - MEMS & Sensors Comparison 2019
  - MEMS Pressure Sensor Comparison 2018
  - Particle Sensors Comparison 2019
  - Miniaturized Gas Sensors Comparison 2018

- **PATENT REPORT**
  - MEMS Foundry Business Portfolio 2019 - New
  - Miniaturized Gas Sensors 2019 - New

PHOTONIC AND OPTOELECTRONICS

- **MARKET AND TECHNOLOGY REPORT**
  - Silicon Photonics and Photonic Integrated Circuits 2019
  - LiDARs for Automotive and Industrial Applications 2019 - Update

- **PATENT REPORT**
  - Silicon Photonics for Data Centers: Optical Transceiver 2019 - New
  - LiDAR for Automotive 2018

RF DEVICES AND TECHNOLOGIES

- **MARKET AND TECHNOLOGY REPORT**
  - 5G’s Impact on RF Front-End Module and Connectivity for Cell Phones 2019 – Update
  - 5G Impact on Telecom Infrastructure 2019 - New
  - Radar and Wireless for Automotive: Market and Technology Trends 2019 - Update
  - Passive & Active Antenna Systems for Telecom Infrastructure 2019 - New
  - RF Standards and Technologies for Connected Objects 2018

- **STRUCTURE, PROCESS & COST REPORT**
  - RF Front-End Module Comparison 2019 - Update
  - Automotive Radar RF Chipset Comparison 2018

- **PATENT REPORT**
  - Antenna for 5G Wireless Communications 2019 - New
  - RF Front End Modules for Cellphones 2018
  - RF Filter for 5G Wireless Communications: Materials and Technologies 2019
  - RF GaN 2019 – Patent Landscape Analysis
OUR 2019 REPORTS COLLECTION (2/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

**IMAGING**
- MARKET AND TECHNOLOGY REPORT
  - Status of the CIS Industry 2019: Technology and Foundry Business - Update
  - Imaging for Automotive 2019 - Update
  - Neuromorphic Sensing and Computing 2019 - Update
  - Status of the Camera Module Industry 2019 - Focus on Wafer Level Optics – Update
  - 3D Imaging & Sensing 2018
  - Machine Vision for Industry and Automation 2018

- STRUCTURE, PROCESS & COST REPORT
  - Compact Camera Modules Comparison 2019
  - CMOS Image Sensors Comparison 2019

- PATENT REPORT
  - Facial & Gesture Recognition Technologies in Mobile Devices 2019 - New
  - Apple iPhone X Proximity Sensor & Flood Illuminator 2018

**MEDICAL IMAGING AND BIOPHOTONICS**
- MARKET AND TECHNOLOGY REPORT
  - X-Ray Detectors for Medical, Industrial and Security Applications 2019 - New
  - Microscopy Life Science Cameras: Market and Technology Analysis 2019
  - Ultrasound technologies for Medical, Industrial and Consumer Applications 2018

- STRUCTURE, PROCESS & COST REPORT
  - Piezoelectric Devices from Bulk to Thin Film 2019 - New
  - Inkjet Functional and Additive Manufacturing for Electronics 2018

- PATENT REPORT
  - Optical Coherence Tomography Medical Imaging 2018

**MICROFLUIDICS**
- MARKET AND TECHNOLOGY REPORT
  - Status of the Microfluidics Industry 2019 - Update
  - Organs-on-chips Market and Technology Landscape 2019 - Update
  - Point-of-Need Testing Application of Microfluidic Technologies 2018
  - Liquid Biopsy: from Isolation to Downstream Applications 2018
  - Chinese Microfluidics Industry 2018

- PATENT REPORT
  - Microfluidic Manufacturing Technologies 2019 – New
  - Nanopore Sequencing 2019 - New

**INKJET AND ACCURATE DISPENSING**
- MARKET AND TECHNOLOGY REPORT
  - Inkjet Printheads - Dispensing Technologies & Market Landscape 2019 - Update
  - Emerging Printing Technologies for Microsystem Manufacturing 2019 - New
  - Piezoelectric Devices from Bulk to Thin Film 2019 - New
  - Inkjet Functional and Additive Manufacturing for Electronics 2018

- STRUCTURE, PROCESS & COST REPORT
  - Piezoelectric Materials from Bulk to Thin Film Comparison 2019
OUR 2019 REPORTS COLLECTION (3/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

BIOMEMS & MEDICAL MICROSYSYTEMs

- MARKET AND TECHNOLOGY REPORT
  - Medical Wearables: Market & Technology Analysis 2019 - New
  - Neurotechnologies and Brain Computer Interface 2018
  - BioMEMS & Non-Invasive Sensors: Microsystems for Life Sciences & Healthcare 2018

- PATENT REPORT
  - 3D Cell Printing 2019 - New
  - Circulating Tumor Cells Isolation 2019 - New

SOFTWARE AND COMPUTING

- MARKET AND TECHNOLOGY REPORT
  - Artificial Intelligence Computing For Automotive 2019 - New
  - Artificial Intelligence Computing for Consumer 2019 - Update
  - Image Signal Processor and Vision Processor Market and Technology Trends 2019
  - xPU (Processing Units) for Cryptocurrency, Blockchain, HPC and Gaming 2019 – New
  - Artificial Intelligence for Medical Imaging 2019 - New

- PATENT REPORT
  - Artificial Intelligence for Medical Diagnostics - New

MEMORY

- MARKET AND TECHNOLOGY REPORT
  - Status of the Memory Industry 2019 - New
  - MRAM Technology and Business 2019 - New
  - Emerging Non Volatile Memory 2018

- STRUCTURE, PROCESS & COST REPORT
  - Memory Comparison 2019

- PATENT REPORT
  - Magnetoresistive Random-Access Memory (MRAM) 2019 - New
  - 3D Non-Volatile Memory 2018

ADVANCED PACKAGING

- MARKET AND TECHNOLOGY REPORT
  - Fan Out Packaging Technologies and Market Trends 2019 - Update
  - 2.5D/3D TSV & Wafer-Level Stacking:Technology & Market Updates 2019- Update
  - Advanced RF SiP for Cellphones 2019 - Update
  - Status of the Advanced Packaging Industry 2019 - Update
  - Status of the Advanced Substrates 2019 - Update
  - Automotive Packaging Market & Technology Trends 2019 - New
  - Trends in Automotive Packaging 2018
  - Thin-Film Integrated Passive Devices 2018
  - Die Attach Equipment Trends 2019 en Semiconductor Manufacturing - New

- STRUCTURE, PROCESS & COST REPORT
  - Advanced RF SiP for Cellphones Comparison 2019

Update: 2018 version still available

About Yole Développement | www.yole.fr | ©2019
OUR 2019 REPORTS COLLECTION (4/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

**SEMICONDUCTOR MANUFACTURING**

- **MARKET AND TECHNOLOGY REPORT**
  - Nano-Imprint Technology Trends for Semiconductor Applications 2019 - New
  - Equipment and Materials for Fan Out Packaging 2019 - Update
  - Equipment for More than Moore: Thin Film Deposition & Etching 2019 - New
  - Wafer Starts for More Than Moore Applications 2018
  - Polymeric Materials at Wafer-Level for Advanced Packaging 2018
  - Bonding and Lithography Equipment Market for More than Moore Devices 2018

- **STRUCTURE, PROCESS & COST REPORT**
  - Wafer Bonding Comparison 2018

- **PATENT REPORT**
  - Hybrid Bonding for 3D Stack 2019 – New

**SOLID STATE LIGHTING**

- **MARKET AND TECHNOLOGY REPORT**
  - Status of the Solid-State Lighting Source Industry 2019 - New
  - Edge Emitting Lasers (EELS) 2019 - New
  - Light Shaping Technologies 2019 – New
  - Automotive Advanced Front Lighting Systems 2019 - New

- **DISPLAY**
  - **MARKET AND TECHNOLOGY REPORT**
    - Next Generation 3D Displays 2019 - New
    - Next Generation Human Machine Interaction (HMI)in Displays 2019 - New
    - MicroLED Displays 2019 - Update
    - MiniLED 2019 - Update
    - Displays & Optical Vision Systems for VR, AR & MR 2018

- **PATENT REPORT**
  - MicroLED Displays: Intellectual Property Landscape 2018

- **VCSELs – Market and Technology Trends 2019 - Update**
  - IR LEDs and Laser Diodes – Technology, Applications, and Industry Trends 2018
  - UV LEDs - Technology, Manufacturing and Application Trends 2018
  - LiFi: Technology, Industry and Market Trends 2018

- **STRUCTURE, PROCESS & COST REPORT**
  - VCSEL Comparison 2019

- **PATENT REPORT**
  - VCSEls 2018

Update: 2018 version still available
OUR 2019 REPORTS COLLECTION (5/5)
18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

POWER ELECTRONICS

- MARKET AND TECHNOLOGY REPORT
  - Power SiC: Materials, Devices and Applications 2019 - Update  
  - Power Electronics for EV/HEV and e-mobility: Market, Innovations and Trends 2019 - Update  
  - Status of the Power Electronics Industry 2019 - Update  
  - Discrete Power Packaging : Material Market and Technology Trends 2019 - New  
  - Status of the Power ICs Industry 2019 - Update  
  - Status of the Power Module Packaging Industry 2019 - Update  
  - Wireless Charging Market Expectations and Technology Trends 2018  
- STRUCTURE, PROCESS & COST REPORT
  - Automotive Power Module Packaging Comparison 2018  
  - GaN-on-Silicon Transistor Comparison 2019  
  - SiC Transistor Comparison 2019  
- PATENT REPORT
  - Power SiC : Materials, Devices and Modules 2019 - New  
  - Power GaN : Materials, Devices and Modules 2019 – Update  

BATTERY & ENERGY MANAGEMENT

- MARKET AND TECHNOLOGY REPORT
  - Status of the Rechargeable Li-ion Battery Industry 2019 - New  
- PATENT REPORT
  - Battery Energy Density Increase: Materials and Emerging Technologies 2019 - New  
  - Solid-State Batteries 2019 - New  
  - Status of the Battery Patents 2018  

COMPOUND SEMI.

- MARKET AND TECHNOLOGY REPORT
  - Emerging Semiconductor Substrates: Market & Technology Trends 2019- New  
  - InP Wafer and Epiwafer Market - Photonic and RF Applications 2019- New  
  - GaAs Wafer and Epiwafer Market: RF, Photonics, LED and PV Applications 2018  
- PATENT REPORT
  - GaN-on-Silicon Substrate: Materials, Devices and Applications 2019 - Update  

BIOTECHNOLOGIES

- MARKET AND TECHNOLOGY REPORT
  - CRISPR-Cas9 Technology: From Lab to Industries 2018  
- PATENT REPORT
  - Personalized Medicine 2019 – New
OUR 2019 MONITORS COLLECTION (1/2)

Get the most updated overview of your market to monitor your strategy

Yole Développement, System Plus Consulting and KnowMade, all part of the Yole Group of Companies, are launching a collection of 10 monitors in 2019. The monitors aim to provide updated market, technology and patent data as well dedicated quarterly analyses of the evolution in your industry over the previous 12 months. Furthermore, you can benefit from direct access to the analyst for an on-demand Q&A and discussion session regarding trend analyses, forecasts and breaking news. Topics covered will be compact camera modules (CCMs), advanced packaging, compound semiconductors, microfluidics, batteries, RF and memory.

MARKET MONITOR by Yole Développement

A FULL PACKAGE:
The monitors will provide the evolution of the market in units, wafer area and revenues. They will also offer insights into what is driving the business and a close look at what is happening will also be covered in it.

The following deliverables will be included in the monitors:
  • An Excel database with all historical and forecast data
  • A PDF slide deck with graphs and comments/analyses covering the expected evolutions

- ADVANCED PACKAGING – NEW
  This monitor will provide the evolution of the advanced packaging platforms. It will cover Fan-Out Wafer Level Packaging (WLP), Fan-Out Panel Level Packaging (PLP), Wafer-Level Chip Scale Packaging (WLCSP), Flip Chip packaging platforms, and 2.5D and 3D Through Silicon Via (TSV) integration. Frequency: Quarterly, starting from Q4 2019

- COMPOUND SEMI. – NEW
  This monitor will describe how the compound semiconductor industry is evolving. It will offer a close look at GaAs, InP, SiC, GaN and other compounds of interest providing wafer volumes, revenues, application breakdowns and momentum. Frequency: Quarterly, starting from Q 2019

- CMOS IMAGE SENSORS – NEW
  This monitor will provide the evolution of the imaging industry, with a close look at image sensor, camera module, lens and VCM. Volumes, revenues and momentum of companies like Sony, Samsung, Omnivision and OnSemi will thus be analysed. Frequency: Quarterly, starting from Q3 2019

- MEMORY – UPDATE
  For the memory industry you can have access to a quarterly monitor, as well as an additional service, a monthly pricing. Both services can be bought separately:
  • DRAM Service: Including a quarterly monitor and monthly pricing.
  • NAND Service: Including a quarterly monitor and monthly pricing.

REVERSE TECHNOLOGY MONITOR by System Plus Consulting

- SMARTPHONES – NEW
  To stay updated on the latest components, packaging and silicon chip choices of the smartphone makers, System Plus Consulting has created its first Smartphone Reverse Technology monitor. This year, get access to the packaging and silicon content database of at least 20 different flagship smartphones – more than five per quarter. Starting at the beginning of 2020, the monitor will include an Excel database report for each phone and a quarterly comparison.
OUR 2019 MONITORS COLLECTION (2/2)

Get the most updated overview of your market to monitor your strategy

PATENT MONITOR by KnowMade

A FULL PACKAGE:
Starting at the beginning of the year, the KnowMade monitors include the following deliverables:

- An Excel file including the monthly IP database of:
  - New patent applications
  - Newly granted patents
  - Expired or abandoned patents
  - Transfer of IP rights through re-assignment and licensing
  - Patent litigation and opposition

- Quarterly report including a PDF slide deck with the key facts & figures of the quarter: IP trends over the three last months, with a close look to key IP players and key patented technologies.

- GaN for Power & RF Electronics
  Wafers and epitwafers, GaN-on-SiC, silicon, sapphire or diamond; semiconductor devices such as transistors, and diodes, devices and applications including converters, rectifiers, switches, amplifiers, filters, and Monolithic Microwave Integrated Circuits (MMICs), packaging, modules and systems.

- GaN for Optoelectronics & Photonics
  Wafers and epitwafers, GaN-on-sapphire, SiC or silicon; semiconductor devices such as LEDs and lasers; and applications including lighting, display, visible communication, photonics, packaging, modules and systems.

- Li-ion Batteries
  Anodes made of lithium metal, silicon, and lithium titanate (LTO); cathodes made of Lithium Iron Phosphate (LFP), Nickel-Manganese-Cobalt (NMC), Lithium Nickel Cobalt Aluminium Oxide (NCA), Lithium Nickel Metal Dioxide (LiNiM02), Lithium Metal Phosphate (LiMPO4), and Lithium Metal Tetroxide (LiMO4); electrolytes including liquid, polymer/gel, and solid inorganics; ceramic and other separators; battery cells including thin film/microbattery, flexible, cylindrical and prismatic; and battery packs and systems.

- Post Li-ion Batteries
  Battery technologies including redox-flow batteries, sodium-ion, lithiumsulfur, lithium-air, and magnesium-ion, and their supply chains, including electrodes, electrolytes, battery cells and battery packs/systems.

- Solid-State Batteries
  Supply chain including electrodes, battery cells, battery packs/systems and electrolytes, including polymer, inorganic and inorganic/polymer, inorganic materials, including argyrodites, Lithium Super Ionic CONductor, (LISICONs), Thio-LISICONs, sulfide glasses, oxide glasses, perovskites, anti-perovskites and garnets.

- RF Acoustic Wave Filters
  Including Surface Acoustic Wave (SAW), Temperature Compensated (TC)- SAW, Bulk Acoustic Wave- Free-standing Bulk Acoustic Resonator (BAWFBAR), BAW-Solidly-Mounted Resonator (BAW-SMR), and Packaging.

- RF Power Amplifiers
  Including Low Noise Amplifiers, Doherty Amplifiers, Packaging, and Millimeter-Wave technology.

- RF Front-End Modules

- Microfluidics
  From components to chips and systems, including all applications.
To meet the growing demand for market, technological and business information, i-Micronews Media integrates several tools able to reach each individual contact within its network.

We will ensure your company benefits from this

### Online
- **i-Micronews e-newsletter**
- **i-Micronews.com**
- **FreeFullPDF.com**

**Unique, cost-effective ways to reach global audiences.**

Online display advertising campaigns are great strategies for improving your product/brand visibility. They are also an efficient way to adapt with the demands of the times and to evolve an effective marketing plan and strategy.

- **#15,800+ monthly unique visitors** on i-Micronews.com
- **#10,900+ weekly readers** of i-Micronews e-newsletter

### Onsite
- **Events**

**Brand visibility, networking opportunities**

Today’s technology makes it easy for us to communicate regularly, quickly, and inexpensively – but when understanding each other is critical, there is no substitute for meeting in-person. Events are the best way to exchange ideas with your customers, partners, prospects while increasing your brand/product visibility.

- **#110 attendees on average**
- **#7+ key events planned for 2019 on different topics**

### Inperson
- **Webcasts**

**Targeted audience involvement equals clear, concise perception of your company’s message.**

Webcasts are a smart, innovative way of communicating to a wider targeted audience. Webcasts create very useful, dynamic reference material for attendees and also for absentees, thanks to the recording technology.

- **#380 registrants per webcast on average**

### Contact:
Camille Veyrier (veyrier@yole.fr), Marketing & Communication Director
CONTACT INFORMATION

○ CONSULTING AND SPECIFIC ANALYSIS, REPORT BUSINESS
  • North America:
    • Steve LaFerriere, Senior Sales Director for Western US & Canada
      Email: laferriere@yole.fr - +1 310 600-8267
    • Chris Youman, Senior Sales Director for Eastern US & Canada
      Email: chris.youman@yole.fr - +1 919 607 9839
  • Japan & Rest of Asia:
    • Takashi Onozawa, General Manager, Asia Business Development (India & ROA)
      Email: onozawa@yole.fr - +81 34405-9204
    • Miho Ohtake, Account Manager (Japan)
      Email: ohtake@yole.fr - +81 3 4405 9204
    • Itsuyo Oshiba, Account Manager (Japan & Singapore)
      Email: oshiba@yole.fr - +81-80-3577-3042
  • Korea: Peter Ok, Business Development Director
      Email: peter.ok@yole.fr - +82 10 4089 0233
  • Greater China: Mavis Wang, Director of Greater China Business Development
      Email: wang@yole.fr - +886 979 336 809
  • Europe: Lizzie Levenez, EMEA Business Development Manager
      Email: levenez@yole.fr - +49 15 123 544 182
  • RoW: Jean-Christophe Eloy, CEO & President, Yole Développement
      Email: eloy@yole.fr - +33 4 72 83 01 80

○ FINANCIAL SERVICES (in partnership with Woodside Capital Partners)
  • Jean-Christophe Eloy, CEO & President
    Email: eloy@yole.fr - +33 4 72 83 01 80
  • Ivan Donaldson, VP of Financial Market Development
    Email: ivan.donaldson@yole.fr - +1 208 850 3914

○ CUSTOM PROJECT SERVICES
  • Jérome Azémar, Technical Project Development Director
    Email: azemar@yole.fr - +33 6 27 68 69 33

○ GENERAL
  • Camille Veyrier, Director, Marketing & Communication
    Email: veyrier@yole.fr - +33 472 83 01 01
  • Sandrine Leroy, Director, Public Relations
    Email: leroy@yole.fr - +33 4 72 83 01 89 / +33 6 33 11 61 55
  • Email: info@yole.fr - +33 4 72 83 01 80

Follow us on