

CAMERA MODULE INDUSTRY 2017

Market & Technology report - November 2017

New technologies and applications have restructured the Compact Camera Module industry.

WHAT'S NEW

- 2016-2022 forecast
- Ecosystem update
- Penetration of autofocus (AF) & Optical Image Stabilization (OIS) technology
- Penetration of dual and 3D cameras technology
- Automotive camera market growth
- Security camera market growth

OBJECTIVES OF THE REPORT

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To provide market data on key CCM metrics & dynamics

- CCM revenue forecast, volume shipments and component share
- Market share with detailed breakdown by player.
- Application focus on key areas of growth for CCM: mobile and automotive

To provide in-depth understanding of the CCM value chain, infrastructure & players

- Who are the CCM players (CIS manufacturers, CCM manufacturer, optics manufacturer..) and how they are related?
- Who are the key suppliers to watch and more generally how will the camera module industry evolve.

To provide key technical insight & analysis about future technology trends and challenges

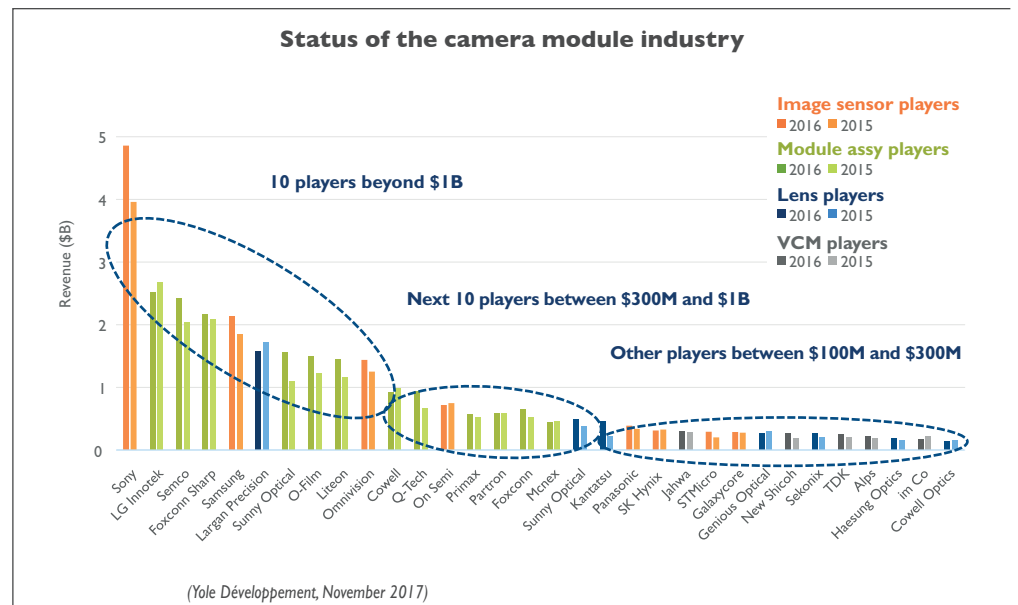
- Manufacturing technologies: design structure
- Device technologies: CCM application across markets.
- Technology focus on game changing areas such as OIS and WLC.

AT 12.2% CAGR FOR THE NEXT FIVE YEARS, THE COMPACT CAMERA MODULE (CCM) INDUSTRY IS A GROWTH POWERHOUSE WITH NUMEROUS LARGE COMPANIES THRIVING IN A DYNAMIC MARKET

In 2015, Yole Développement published its first report on the camera module industry and mentioned the immaturity of the ecosystem with numerous small players especially for module assembly. Now the dust has settled and giant camera module players have emerged such as LG Innotek, Semco, Foxconn Sharp, O-Film and Sunny Optical. This 2017 edition is giving you the insights into the trajectory of the industry and of more than 30 players serving mobile and other applications such as automotive and security.

Historically one could differentiate the faith of camera module market from the sub parts such as the image sensor, the lens and the autofocus or optical image stabilization system (Voice Coil Motors - VCM). It seems that differentiated growth has now ended and every

sub segment is enjoying almost equal benefit from the rising market tide. This convergence is in part due to the end of quasi-monopoly from Sony in the image sensor sub-segment now joined by Samsung and Omnivision. The story is very similar for Largan Precision in the lens set sub-segment which is now facing renewed competition from Sunny Optical, Kantatsu and Genius Optical. The last sub-domain of our interest in this report is VCMs. The growth of VCM companies has been undercut by dire structuration efforts. We had mentioned the inability of the VCM to serve the demand in the mobile market. Price pressures have changed the face of competition with competitors such as Mitsumi and Shicoh which were forced out and new players such as New Shicoh and Jawha to take center stage.



NEW TECHNOLOGIES ARE SERVING DEMANDING APPLICATIONS IN A MARKET HUNGRY FOR TECHNOLOGY PERFORMANCE

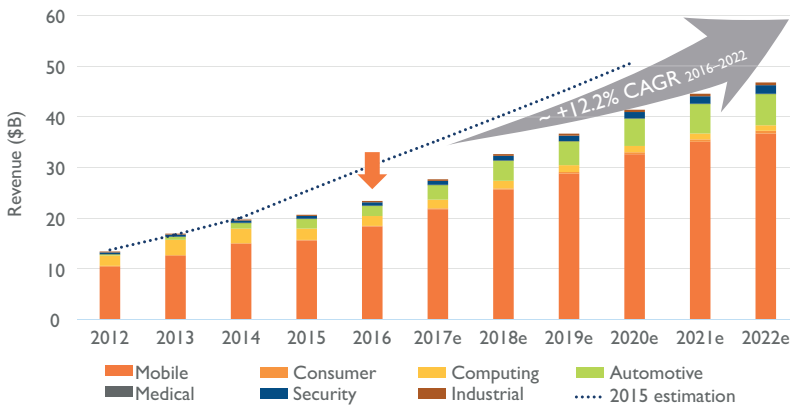
Mobile rear photography camera is still the main driver of the camera module industry that reached \$23.4 Billion in 2016 and that will reach \$46.8 Billion by 2022. In 2015 optical image stabilization (OIS) was the VCM technology differentiator introduced by Apple. While competition and the whole ecosystem was struggling to incorporate this

innovation, the dual camera approach has been an elegant solution from LG and Huawei to recycle old module designs into state of the art systems. Those two innovations have collided and resulted into the impetus to provide dual rear cameras with dual OIS which is only happening end of 2017.

On the mobile front camera side, the impact of selfies has been increasing the performance and cost of camera devices. Now Apple and

Samsung are coming out with dual front camera setup incorporating biometric capability and also adding a 3D sensing user interface for Apple. Those innovations are game changing as they explain the enormous increase in camera module content per smartphone. While 2 cameras were needed few years ago, now the new normal in the high end of mobile is to have 4 cameras, 2 on both sides. With a gross average cost of \$6 per camera it is quite easy to understand we left a world of \$12 per smartphone (in 2015) and have entered a world in the range of \$24 worth of camera module per smartphone.

2012-2022 Compact Camera Module revenue forecast



(Yole Développement, November 2017)

AUTOMOTIVE CAMERA MODULES ARE REACHING \$2 BILLIONS IN REVENUE AND ARE NOW WELL BEYOND EMERGENCE

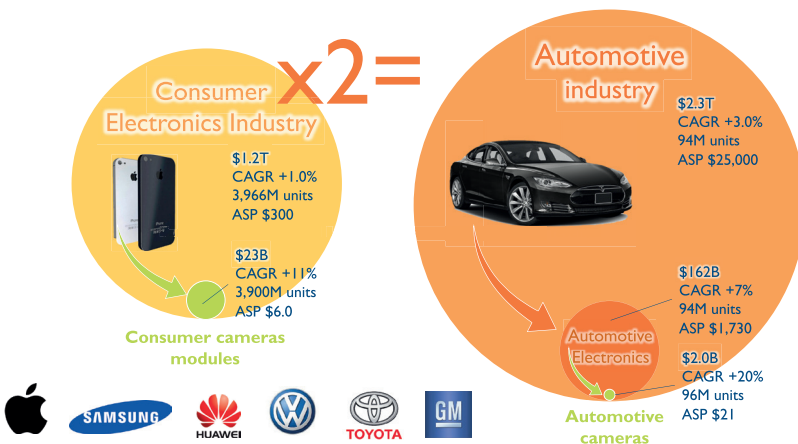
While 2016 has been a crazy year for automotive camera modules as it paused for a quarter and ended with the \$15B purchase of Mobileye by Intel. The “explosive” growth pattern is maintained with 20% CAGR predicted for 2016-2022. In this context, the balance of power has gradually switched from the camera module makers who may have discussed directly with the OEMS,

now replaced by the tier ones such as Bosch, Continental and Autoliv that do not necessarily manufacture the camera module themselves. Most camera module makers are in fact part of this game as tier twos.

Automotive cameras are part of a bigger picture of automotive electronics, ADAS and automated driving. They have hugely benefited from the infrastructure left by Digital Still Camera (DSC) manufacturers and the know-how developed from mobile camera modules. The direct consequence has been the dramatic decrease in average selling prices (ASP) as we expect it to cross the \$20 line in 2017.

Technology wise we do also see much more maturity in the way automotive camera modules are build. As standardization is fostering competition, we expect more players to enter the fray. Today we are witnessing a duopoly on the image sensor side from ON Semiconductor and Omnivision. The link between image acquisition and image analysis is very strong in ADAS where ultimately all automotive cameras will be categorized. One of the big question is the future compatibility of vision processors and the evolution in market dominance of vendors such as Intel Mobileye.

Mobile camera modules vs. automotive camera modules



(Yole Développement, November 2017)

COMPANIES CITED IN THE REPORT (non exhaustive list)

AAC Technologies, Ability Opto, AGC, Alps, Apple, Asia Optical, Brigates, BYD Microelectronics, Calin Technology, Cammsys, Cha Diostech, Chicony, Continental, Cowell Optics, Cresyn, Crystal-Optech, Ddk, DJI, Foxconn, Fujifilm, Fujinon, Fujitsu, Galaxycore, Genius Optical, Google, Gopro, Haesung Optics, Himax, Hirose, Hoya, Huawei, IM, Intel, Jawah, JSR, Kantatsu, Kinko Optical, Kolen, Kyocera, Largan, Lenovo, LG Innotek, Liteon, Magna, Materion, Mcnex, Microsoft, Mitsumi, Mobileye, Nalux, New Shicoh, Nidec, NTK, O-Film, Omnivision, On Semiconductor, Optis, Panasonic, Parrot, Partron, Pixart, Pixelplus, Powerlogic, Primax, Q-Tech, Ricoh, Samsung, Schott, Semco, Sharp, Sekonix, SK Hynix, Softkinetic, Sony, ST Microelectronics, Sunny Optical, Sunex, Superpix, Suyin, TDK, Toshiba, Truly, Valeo, Viavi, Volvo, Xiaomi, Xperi, Zeiss, Zeon, Zte and more...

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Pierre Cambou joined the imaging industry in 1999. Following an engineering degree from Université de Technologie de Compiègne in parallel to a master of science from Virginia Tech in 1998, as well as graduating from Grenoble Ecole de Management's MBA, Cambou took several positions at Thomson TCS, which became Atmel Grenoble in 2001 and e2v Semiconductors in 2006. In 2012 he founded Vence Innovation, now called Irlynx, in order to bring to market a disruptive man-to-machine interaction technology. He joined market research and strategy consulting company Yole Développement as imaging activity leader in 2014.



From 1996 to 1999 **Jean-Luc Jaffard** paved the way of imaging activity at STMicroelectronics being at the forefront of the emergence and growth of this business. At STMicroelectronics Imaging division he has been appointed Research Development and Innovation Director managing a large multidisciplinary and multicultural team and was later on promoted Deputy General Manager and Advanced Technology Director in charge of identifying, sourcing or developing the breakthrough Imaging Technologies and Applications to transform them into innovative and profitable products. In 2010 he was appointed STMicroelectronics Intellectual Property Business Unit Director. In 2014 he created the Technology and Innovation branch of Red Belt Conseil, to support High Tech actors like SME, Research Institutes, Start-ups, Analysts, Investors and public authorities. Jean-Luc Jaffard owns multiple patents in semiconductor and Imaging domains and has been invited speaker in many conferences worldwide. He studied Electronic and Microelectronic and has been graduated from Ecole Supérieure d'Electricité of Paris in 1979.

KEY FEATURES OF THE REPORT

- 2016 camera module market share (in %)
- 2016 sensor for CCM market share (in %)
- 2016 lens for CCM market share (in %)
- 2016 autofocus & OIS for CCM market share (in %)
- CCM volume shipment forecast by application 2012-2022
- CCM average selling price forecast by application 2012-2022
- CCM revenue forecast by application 2012-2022

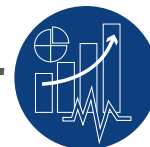
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The "More than Moore" market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO and KnowMade, support industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business.

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