

STATUS OF THE CMOS IMAGE SENSOR INDUSTRY 2018

Market & Technology report - September 2018

Proliferation of cameras for imaging and sensing is driving CMOS image sensor (CIS) growth.

KEY FEATURES

- 2017 CIS revenue breakdown by market
- 2017 CIS revenue ranking by player
- 2017 CIS production ranking by foundry
- CIS volume shipment forecast by application 2011-2023
- CIS revenue forecast by application 2011-2023
- CIS average selling price forecast by application 2011-2023
- CIS wafer production forecast by application 2011-2023

WHAT'S NEW

- 2017-2023 Forecast
- 2017 M&A activity
- Ecosystem update
- Dual and 3D camera trends for mobile
- Mobile applications and technology
- Consumer applications
- Technology update

OBJECTIVES OF THE REPORT

Ecosystem identification and analysis:

- Determination of the application range
- Technical market segmentation
- Market trends and forecasts
- Key players, by market and analysis

Analysis and description of markets and technologies involved:

- Detailed applications per market segment
- Major global actors
- Technology trends
- Main technical challenges

YOLO DÉVELOPPEMENT IS INCREASING ITS FORECAST FOR CMOS IMAGE SENSORS AGAIN

2017 saw aggregated CIS industry revenue of \$13.9B. We now forecast a 9.4% compound annual growth rate (CAGR) for the next five years. Year-on-year (YoY) growth hit a peak at 20% due to the exceptional increase in image sensor value, across almost all markets, but primarily in the mobile sector. The market has benefited from the operational recovery of leading CIS player Sony, which captured 42% market share. The CIS industry is able to grow at the speed of the global semiconductor industry, which also had a record year, mainly due to DRAM revenue growth. CIS have become a key segment of the broader semiconductor industry, featuring in the strategy of most key players, and particularly the newly-crowned industry leader Samsung. Mobile, security and automotive markets are all in the middle of booming expansion, mostly benefiting

ON Semiconductor and Omnivision. These markets are boosting most players that are able to keep up with technology and capacity development through capital expenditure. The opportunities are all across the board, with new players able to climb the rankings, such as STMicroelectronics and Smartsense. Technology advancement and the switch from imaging to sensing is fostering innovation at multiple levels: pixel, chip, wafer, all the way to the system. CIS sensors are also at the forefront of 3D semiconductor approaches. They are a main driver in the development of artificial intelligence. We can foresee new techniques and new applications all ready to keep up the market growth momentum. This report is aimed at giving the best possible snapshot of the current status of the CIS industry in order to proactively benefit from the next wave of innovations.

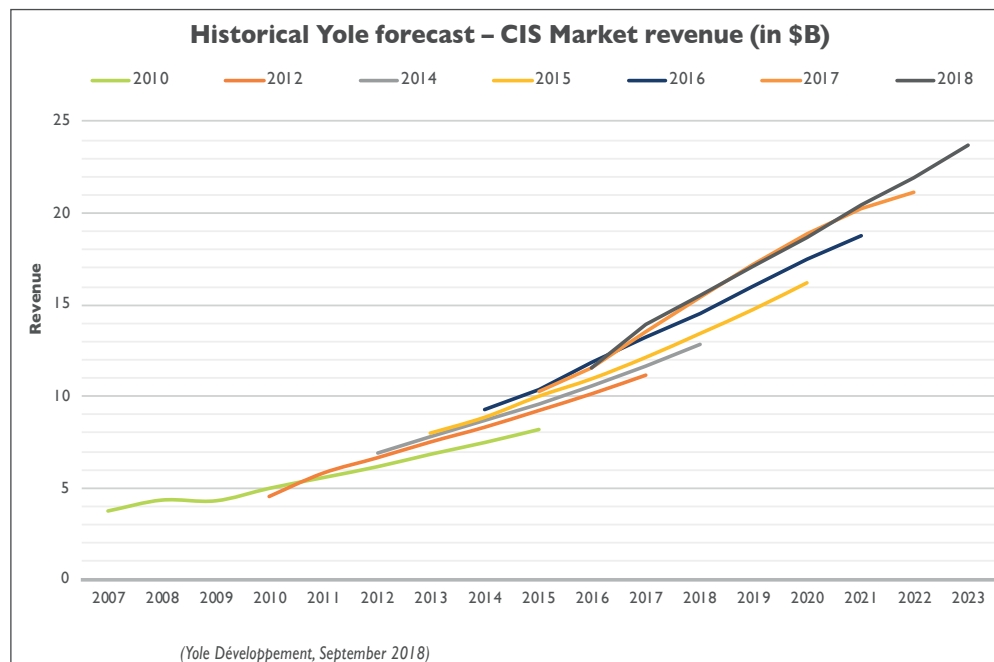
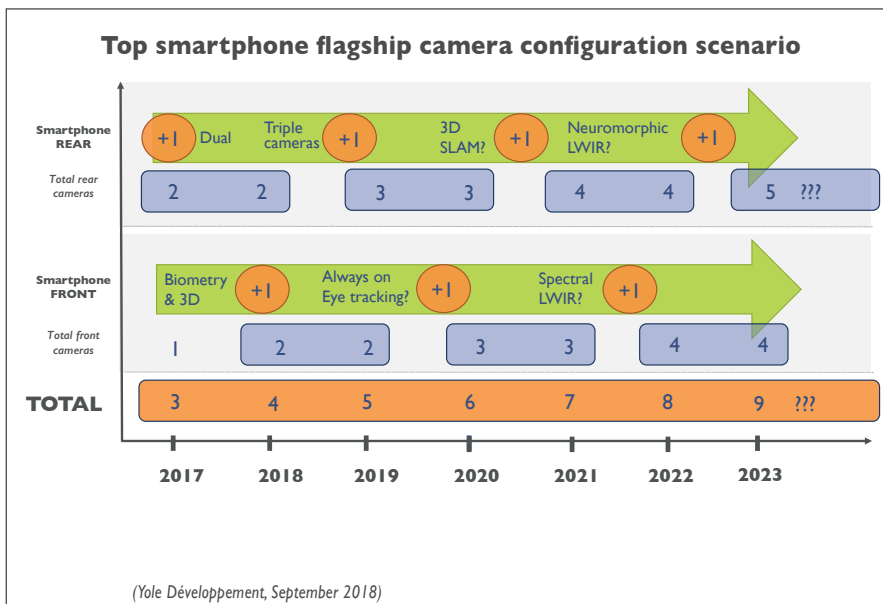


IMAGE SENSOR PROLIFERATION IS BENEFITING BOTH VOLUME AND REVENUE GENERATION

The key takeaway from 2017 has been the rapid deployment of dual camera approaches in the mobile sector. The market has quickly adopted dual cameras on the rear of the phones, serving photography either to improve resolution and low light performance or to provide optical zoom capabilities. Dual camera approaches have

also been deployed on the front side, mostly serving biometric face or iris recognition, but also 3D sensing in the Apple iPhone X. Competition and differentiation between mobile device manufacturers is deeply linked to CIS implementation. CIS has therefore benefited from ever-increasing dollar content per smartphone,

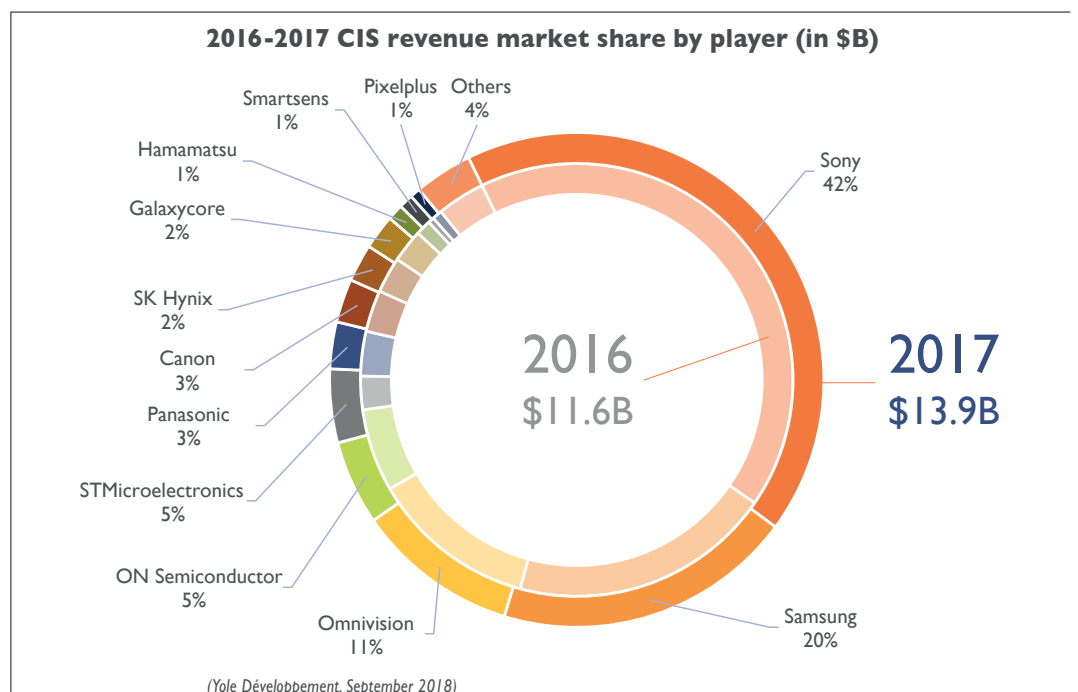


compensating for the mobile market slowdown. Security is now one of the most active markets, tightly connected to Chinese involvement in the industry. Hikvision and Dahua are the two new leading OEM manufacturers, having capitalized very quickly on internet protocol (IP) camera technology, cloud computing and artificial intelligence. The number of cameras per security system isn't limited by human monitoring any more, which is a paradigm shift for surveillance. In automotive the same is occurring, as rear back-up cameras have become mandatory in the US. Also, the move toward ever-increasing numbers of cameras per car, either to serve front Advanced Driver Assistance System (ADAS) collision avoidance or 360° parking assist cameras, is worldwide. The number of cameras increases at the same time as quality increases, which has a multiplier effect on revenue generation. The CIS industry sector is clearly in the middle of a golden age.

THE RISING MARKET TIDE IS BUOYING THE ENTIRE ECOSYSTEM

Sony is the unchallenged industry leader market and technology-wise. It benefited from the operational recovery of the Kuamoto foundry after the major earthquake of 2016. This helped Sony's market share increase, on top of the CIS market's rapid growth. Samsung is also maintaining its growth, and is now able to match most of Sony's technology advancements in 3D stacking. This mostly serves Samsung's handset division, but it's increasingly supporting Chinese OEMs in a constrained environment for high-end Mobile CIS. Omnivision seems to have completed its transition toward continental China, with HLMC now producing one third of its products, and is capturing good revenue in automotive. The next logical step would be to expand its early successes in the near-infrared (NIR) Global Shutter device designed into the Intel Realsense products, which unfortunately suffered from shrinking computing business. STMicroelectronics stole the show at

the end of 2017 by capturing the slot in the newly released iPhone X with an innovative NIR Global shutter based on a silicon-on-insulator (SOI) substrate. ON Semiconductor has become the key player in automotive despite growing competition from Sony and Samsung. Growth in its Industrial division helped mitigate decreasing volumes of action and drone camera products. On the CIS foundry side, HLMC has benefited from the production transfer from Omnivision and TPSCo similarly from ON Semiconductor. Hynix is apparently locked in a conundrum prioritizing DRAM over CIS. SMIC similarly has to invest in the next generation technology and is in transition. Probably the last key aspect of this year's status of CIS is China's positive progress. Having built a consistent ecosystem incorporating CIS foundries, CIS vendors and high growth system manufacturers, China CIS ecosystem will become more important in the future.



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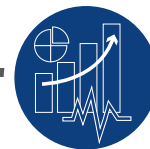
since 2014. He is part of the Photonics, Sensing and Display team. He has been part of the imaging industry since 1999 by holding several positions at Thomson TCS, which became Atmel Grenoble in 2001 and e2v Semiconductors in 2006 (now Teledyne e2v). In 2012 he founded Vence Innovation (now Irllynx) to bring to market an infrared sensor technology for smart environments and interactions. Pierre holds an MSc from UTC Compiègne and Virginia Tech and graduated from GEM MBA in 2011.

Since 1966 **Jean-Luc Jaffard** has made invaluable contributions



to imaging activity at STMicroelectronics, working at the forefront of this business's emergence and impressive growth. At STMicroelectronics' Imaging Division, Jean-Luc was appointed Research Development and Innovation Director, managing a large multidisciplinary/multicultural team. Soon after, he was promoted to Deputy General Manager and Advanced Technology Director, in charge of identifying and developing breakthrough imaging technologies and transforming them into innovative, profitable products. In 2010 he was appointed STMicroelectronics' Intellectual Property Business Unit Director, and in January 2014 he created Red Belt Conseil's Technology and Innovation branch.





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