

# 3D IMAGING & SENSING 2018

Market & Technology report - June 2018

*The iPhone X initiated a trend. What happens next?*

## WHAT'S NEW

- Updated mobile adoption rate/ ASP/revenue forecasts through 2023
- Forecast analysis per sub-components
- Added scenario for mobile rear 3D camera
- Expected supply chains from the Android camp
- 3D imaging & sensing ecosystem update
- Updated trends for all markets
- Special technology focus on the iPhone X release
- Technology cost breakdown
- New technologies

## OBJECTIVES OF THE REPORT

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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

## KEY FEATURES OF THE REPORT

- Market forecast (in Munits and \$M) through 2023
- Ecosystem mapping
- Application trends - mobile and consumer, automotive, medical, scientific, space, and defense
- Technology trends - optical 3D/lidar/other

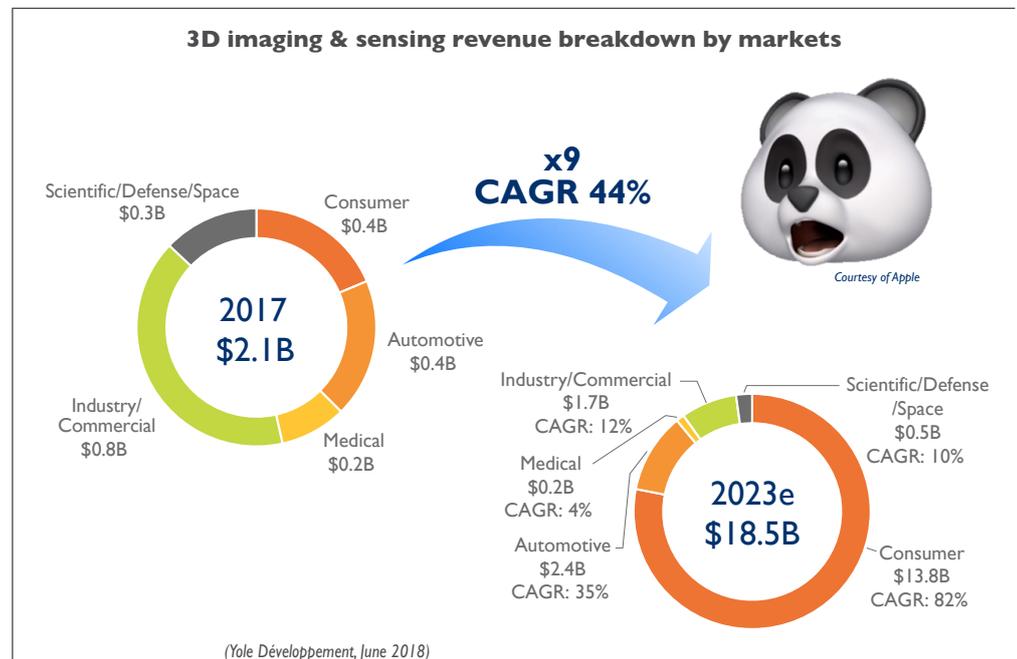
## A 3D IMAGING & SENSING MARKET REVOLUTION HAS BEGUN

With the introduction of the iPhone X in September 2017, Apple set the standard for technology and use-case for 3D sensing in consumer. Apple contrived a complex assembly of camera modules and light sources using structured light principles, along with an innovative NIR global shutter image sensor from STMicroelectronics. From our initial depiction of the market in March 2017, the main gap is in illumination ASP, which is greater than expected. High expenses in dot and flood illumination VCSELs from Lumentum/II-VI/Finisar, along with the dot illuminator optical assembly from ams, are the biggest technology surprises powering Apple's \$1,000 smartphone.

Yole Développement (Yole) expects the global 3D imaging & sensing market to expand from \$2.1B in 2017 to \$18.5B in 2023, at a 44% CAGR. Along with consumer, automotive,

industrial, and other high-end markets will also experience a double-digit growth pattern.

The transition from imaging to sensing is happening before our eyes. Artificial intelligence (AI)-powered devices and robotics are gaining a better understanding of their surroundings, and developing a new level of interaction with humans. 3D imaging & sensing technology is currently delivering on its early promises. Despite half-successful attempts like Xbox's Kinect technology and Leap-Motion hand controllers, 3D sensing is now tracking towards ubiquitousness. Technology providers of global shutter image sensors, VCSELs, injection-molded and glass optics, DOEs, and semiconductor packaging are all benefiting, and this latest edition of Yole's popular report offers you key insights for navigating the 3D imaging & sensing revolution.

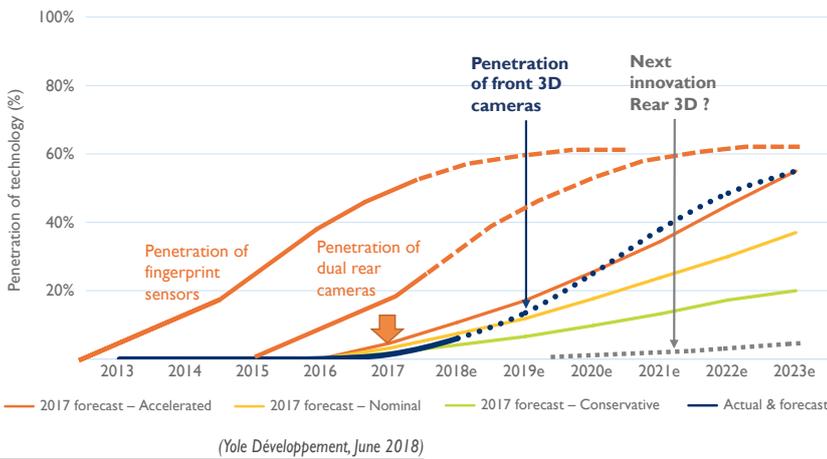


## WHAT'S NEXT?

In the consumer world, smartphone players are now quickly revising their own 3D sensing strategy. Oppo made the first announcement beginning of the year with Orbeec, while Xiaomi released the Mi 8 explorer edition with Mantis as a technology partner. We

expect Huawei to release its own solution soon, probably partnering with ams and Sunny Optical. 3D-enabled smartphones started off in-line with our previous forecast, which was conservative due to the solution's high cost. In fact, players like Himax are currently paying

### 2013-2023 penetration scenario for 3D cameras in smartphones



the price for a lower-performance offering and are struggling to get design-ins beyond AR/VR headsets for Microsoft.

Once the alternative supply chains for Android smartphones are in place, the adoption/attachment rate should accelerate and move from 13.5% in 2018 to 55% in 2023. The attachment on the phone's rear (world) face remains a key question, as AR/VR has yet to show proven sales momentum. Yole nevertheless forecasts an emergence of rear 3D camera, though with limited penetration. Other notable next steps should include expansion into other consumer devices, and in automotive. In particular, consumer robotics should highly benefit. The high-end markets, i.e. medical, industrial, and scientific, are already well-accustomed to the modality and will accelerate adoption.

### COMPLEX SUPPLY CHAIN CONSIDERATIONS

One of the key learnings from 2017 is the impressive complexity of consumer 3D imaging & sensing hardware and software. In 2016 we witnessed the sophistication of the Google Tango-enabled smartphone, the Lenovo Phab 2 Pro, which included a PMD time of flight sensor, an Omnivision NIR global shutter, and a Samsung RGB image sensor. The current implementations are not as simple as one would have initially thought; in fact, complexity has increased. This is not a first for Apple, which developed a similar strategy for smartphone cameras - one that saw

the company radically increase camera module complexity in early 2010's, and subsequently leave the competition behind.

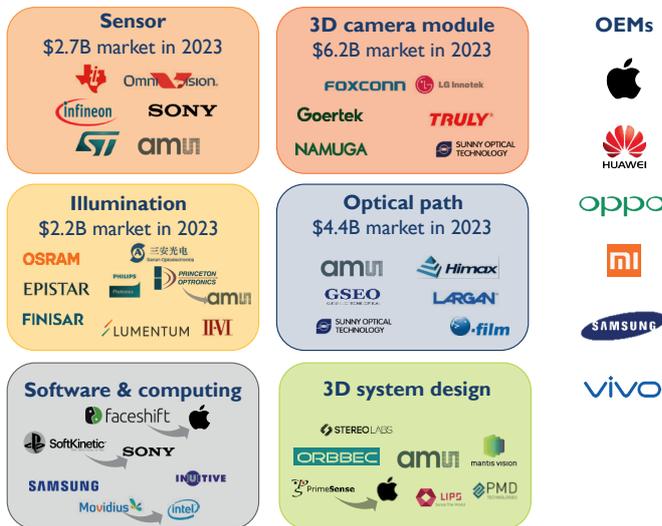
In this context, the ecosystem must adapt towards performance. Only a few players can actually deliver at the level of market demand. A few names of the supply chain:

- 1) Wafer and epiwafer manufacturers : SOITEC and IQE;
- 2) Sensor semiconductor companies : Sony, Samsung, Omnivision, STMicroelectronics, On Semiconductor, and Panasonic;
- 3) VCSEL suppliers : Lumentum, Finisar, II-VI, ams-Princeton Optronics, and Philips Photonics;
- 4) Packaging houses : Tong Hsing, Xintec;
- 5) Optical module companies : ams, Himax;
- 6) Module assembly players : LG Innotech, Sunny Optical, Semco, and O-Film.

Unlike previous sensing components, the responsibility of system design does not fall on the OEM - instead, a specialist is required, such as the Primesense team that Apple acquired in 2013, or other firms like Mantis, Orbbec, and ams, which want play the "specialist" role in the new 3D imaging & sensing ecosystem. Such players orchestrate the final solution while allowing room for the best in each sub-component category.

Is 3D imaging & sensing now ripe for disruption? Yole expects it will take at least 2 -3 years before any new solution start dramatically lowering total system cost.

### Mobile and consumer 3D sensing ecosystem in 2018-2023



### COMPANIES CITED IN THE REPORT (non exhaustive list)

II-VI, Abbott, ams, Anritsu, Apple, ASC, BAE Systems, Bioptigen, Bosello, Canon, Continental, Core Photonics, Crystalvue, Epcos, Faceshift, Fairchild, Faro, Finisar, First Sensor, Fujifilm, GE, Gestigon, IDS, Huvitz, IFM, IQE, iRobot, iRay, Hamamatsu, Heptagon, Hexagon Metrology, Himax, Hokuyo, Hologic, Honeywell, Lee, Infineon, Keyence, Konica Minolta, Kreon, LeddarTech, Leica, Linx, Lips, LMI, Lumentum, Mantis Vision, Medtech, Melexis, Namuga, Nidek, Nikon, Nordson Dage, Nsi, Oculus, On Semi, Opto, Optopol, Orbbec, Pebbles, Olympus, Panasonic, Perceptron, Philips Photonics, Pix4D, PMD, Quanergy, Sanan, Sensata, Samsung, Sensl, Sick, Siemens, Softkinetic, Soitec, Sony, St.Jude Medical, STMicroelectronics, Teledyne Dalsa, Tetravue, Topcon, Toshiba, Trixell, Trinamix, Valeo, Varex, Varian, Velodyne Lidar, Vieworks, Yxlon, Zimmer, Zeiss Meditech, and more.

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