Driven by consumer and automotive applications, the CMOS image sensor market is forecasted at $16B in 2020 with a CAGR of 10.6% over the 2014-2020 period.
What we get right, What we get wrong
Technology & Market forecast challenge

- Over the years Yole Développement has managed to keep consistent forecast.
- Looking back, we have slightly undervalued global CIS market. As we research over time the same market, some new applications such as Tablets impact the growth.
When Yole Développement presented its first report in 2010, The imaging industry was at a turning point as CMOS image sensor revenues were breaking the 50% threshold in respect to CCD.

Since this first report, Yole documented the rise of a new CIS technology called BSI. In 2015, the 50% revenue threshold is also broken for BSI technology.

Mobile and tablets are currently the key applications for CIS, they are demanding in term of volume and performance therefore keeping price at a good level for the top notch technology. The industry has reached $8.9B in 2014 and with 10.6% CAGR forecasted for the 2014-2020 period, it will reach $16.2B in 2020.

Currently the most dynamic CIS market is Automotive. New features and performance are needed to serve this new market. Are we shifting from vision for Imaging to vision for Sensing? One thing is certain, every one in the industry is working on it.
Image Sensors: Triple Disruption History

Technology x Market Penetration

1865 80 years 1945 40 years 1985 20 years 2005 10 years 2015 5 years 2020

First color pictures from emulsion plates in 1860’s

Era of Film Photography

Tube technology Never took over Film

Era of Digital Photography

CCD technology Took over Film in the 2000’s

CMOS technology Took over CCD in 2010

Era of Mobile Photography

Acceleration: The speed in technology changes doubles every technology shift

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CMOS Image Sensor Applications

Mobile is currently driving the market of CIS

- Smartphone secondary camera adoption made Mobile sub-segment very significant. It should take an even greater importance in the future as their ASP increase.
- Tablets appear to be part of computing, even tough the technology came from Mobile.
CMOS Image Sensor Ecosystem
The industry is currently consolidating

2014 activity

Foundry
- TSMC
- SMIC
- UMC
- Dongbu HiTek
- TowerJZ
- LFoundry
- Hynix

Fabless
- OmniVision
- GalaxyCore
- PLUSPIXEL
- CMOSIS
- Aptina
- TrueSense
- SiliconFile

Fab-lite

IDM
- Sony
- Samsung
- Canon
- TOSHIBA
- Panasonic

For Sale?
IPO?
• Revenues are dominated by Mobile, Consumer and Computing which represent 91% of all CIS revenues in 2014. Mobile alone represent 60%.

• From 2014 to 2020, global revenue growth will remain at ~10.6% CAGR 2014-2020.
2014 CIS Revenue Market Breakdown
Market by Player

Market breakdown analysis in specific application segments
Mobile Market Trend
Smartphone Thickness vs. Camera Module Specification

Smartphone Thickness Trend - Top 10 Brands Flagship

- **Cybershot S006**
  - Sony
  - 16Mp 1.12µm
  - 9.5x9.5x8.0

- **Lumia 920**
  - Nokia
  - 8.7Mp 1.4µm
  - 12.5x12.5x6.0

- **Galaxy S2**
  - Samsung
  - 8Mp 1.4µm
  - 8.5x8.5x6.0

- **Iphone 4S**
  - Apple
  - 8Mp 1.4µm
  - 8.4x8.4x6.0

- **Iphone 6**
  - Apple
  - 8Mp 1.5µm
  - 10.6x9.3x5.8

January 2015 • Courtesy of System Plus

Yole Développement © January 2015
Mobile Market Trend
Main rear Camera & Sub Front Camera Roadmap

Size constraints & Drive for better images & Features:
→ More pixels
→ Smaller modules
→ Image Stabilization (OIS)
Automotive Market Trend
From feature to key enabling technology

**ADAS**

- Collision avoidance
- Pedestrian detection
- Adaptive speed control
- Highway line keeping

- Night vision
- Cross traffic detection
- Fatigue Warning
- Headlight control
- Traffic sign recognition
- Line departure warning
- Blind spot detection

**Feature**

- 360° surround view
- Dash camera recorder
- Rear view camera

**Semi-auto**

- 10+ years adoption rate

**Assist**

- 7 to 10 years adoption rate

**Feature**

- 3 to 5 years adoption rate

2010  2015  2020  2025
CMOS Image Sensor Technology
Penetration of BSI in respect to FSI

- Back Side Illuminated (BSI) sensors were initially introduced for smart phones, which asked for higher resolution with same camera module footprint than the pre-existing mobile phones (now called “feature phones”) that had conventional Front Side Illuminated (FSI) sensors.

- BSI transition is not a disruption like the CCD to CMOS transition. As an incremental improvement over FSI it is no surprise that a key industry player like Omnivision and Sony were instrumental in bringing this technology to market. The iPhone 4 launch in 2010 was the key turning point for massive BSI adoption.

- BSI technology is now following the same path as basic FSI CIS. As performance improvements get valorised in higher end markets, we can easily forecast a brilliant future of BSI in most market segments.
Main Technology trend in CIS
From FSI to BSI to 3D stacked BSI – Pixel Level

Front-Side illuminated (FSI)

Backside illuminated (BSI)

3D Stacked BSI

Silicon Bulk

<2010

2010

2012
Main Technology trends in CIS
The 3D Stacked BSI could use Hybrid bonding in a short future.

3D Stacked BSI

3D Hybrid BSI

Connection within pixels become possible
About the Authors of This Report

• Pierre Cambou
  o In 1999 Pierre Cambou joined the imaging industry at a time when the CCD to CMOS paradigm shift was occurring. He had earned an Engineering degree from Université de Technologie de Compiegne doubled by a Master of Science from Virginia Tech in 1998. More recently he graduated from Grenoble Ecole de Management's MBA. Pierre occupied several positions at the Thomson TCS factory which became Atmel Grenoble in 2001 and e2v Semiconductors in 2006. In 2012 he founded the start-up Vence Innovation (now called Ir lynx) in order to bring to market a disruptive Human to Machine interaction technology. He joined Yole Développement as Imaging Activity Leader in 2014.
  o Contact: cambou@yole.fr

• Jean-Luc Jaffard
  o From 1966 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 was successively appointed Research Development and Innovation Director managing a large multidisciplinary and multicultural team and later on promoted Deputy General Manager and Advanced Technology Director in charge of identifying and developing breakthrough Imaging Technologies and to transform them into innovative and profitable products. In 2010 he was appointed STMicroelectronics Intellectual Property Business Unit Director. In January 2014 he created the Technology and Innovation branch of Red Belt Conseil.
Fields of expertise

Yole Développement’s 30 analysts operate in the following areas:

- Imaging
- Photonics
- MEMS & Sensors
- Compound Semi.
- LED
- PV
- Power Electronics
- MedTech
- Manufacturing
- Advanced Packaging
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  - Patent assessment
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Our global activity

- 30% of our business is in North America
- 40% of our business is in EU countries
- 30% of our business is in Asia

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Yole Japan
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Serving the entire value chain

Yole Développement analysts provide market analysis, technology evaluation, and business plan along the entire value chain.
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Related reports

Information in this presentation is extracted from the following reports:

• 6 and 9-Axis Sensors Consumer Inertial Combo Sensors
  Released in Nov. 2014 – More info. [here](#).

• 6 and 9-Axis Sensors Consumer Inertial Combo Sensors
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Status of the CMOS Image Sensor Industry report

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Date:

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Credit Card Number:
Card Verification Value (3 digits except AMEX: 4 digits):
Expiration date:

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Account No: 0170 200 1565 87,
SWIFT or BIC code: CCFRFRPP,
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• MAIL: YOLE DÉVELOPPEMENT, Le Quartz,
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ABOUT YOLE DEVELOPPEMENT

Founded in 1998, Yole Développement has grown to become a group of companies providing marketing, technology and strategy consulting, media in addition to corporate finance services. With a strong focus on emerging applications using silicon and/or micro manufacturing (technology or process), Yole Développement group has expanded to include more than 50 associates worldwide covering MEMS, Compound Semiconductors, LED, Image Sensors, Optoelectronics, Microfluidics & Medical, Photovoltaics, Advanced Packaging, Manufacturing, Nanomaterials and Power Electronics. The group supports industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to develop their business.

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(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: January 28th, 2015.
Definitions: “Acceptance”: Action by which the Buyer accepts the terms and conditions of sale in its entirety. It is done by signing the purchase order which mentions “I hereby accept Yole’s Terms and Conditions of Sale”.

“Buyer”: Any business user (i.e. any person acting in the course of its business activities, for its business needs) entering into the following general conditions to the exclusion of consumers acting in their personal, family or non-commercial/intellectual activities.

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“Intellectual Property Rights” (“IPR”) means any rights held by the Seller or any of its patentees, trademarks, registered designs, models, inventions, commercial secrets and know-how, technical information, company or trading name or any other intellectual property rights or similar in any part of the world, notwithstanding the fact that they have been registered or not and including any pending registration of one of the above mentioned rights.

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2. Mailing of the Products

2.1 Products are sent by email to the Buyer:

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b) no return of the Products and in no case can the Buyer obtain prior information to the Seller, even in case of delayed delivery. Any Product returned to the Seller without providing prior information will be deemed to be the one applicable at the time of the order.

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2.3 Payments due by the Buyer shall be sent by cheque payable to Yole Développement, credit card or by electronic transfer to the following account:

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Branch code: 0107
Account no.: 0107 200 1565 87
IBAN: FR76 3005 6001 7001 7020 0156 587
To ensure the payments, the Seller reserves the right to request down payments from the Buyer. In this case, the need of down payments will be mentioned on the order.

2.4 Payment is due by the Buyer to the Seller within 30 days from invoice date, except in the case of a particular written agreement. If the Buyer fails to pay within this time and fails to contact the Seller, the latter shall be entitled to invoicing interest in arrears based on the annual rate of the «BCe» + 7 points, in accordance with article L. 441-6 of the French Commercial Code. In such circumstances, the following expenses, too, are delivered only after receipt of the payment:

3. IN CASE OF TERMINATION OF THE CONTRACT, OR OF MISCONDUCT, during the contract, the Seller will have the right to invoke the stage in progress, and to take legal action for damages.

4. LIABILITY

4.1 The Buyer or any other individual or legal person acting on its behalf, being a business user buying the Products for its business activities, shall be solely responsible for choosing the Products and for the use and interpretations he makes of the documents it purchases, of the results he obtains, and of the advice and acts it deduces thereof.

4.2 The Seller shall only be liable for (i) direct and (ii) foreseeable pecuniary losses. If the Products or arising from a material breach of this agreement.

4.3 In no event shall the Seller be liable for:

a) damages of any kind, including without limitation, incidental or consequential damages (including, but not limited to, damages for loss of business, interruption and loss of business information) caused by the Buyer’s or inability to use the Seller’s website or the Products, or any information provided on the website, or in the Products;

b) any claim attributable to errors, omissions or other inaccuracies in the Product or interpretations thereof.

4.4 All the information contained in the Products has been obtained from sources believed to be reliable. The Seller does not warrant the accuracy, completeness adequacy or reliability of such information, which cannot be guaranteed to be free from errors.

4.5 All the Products that the Seller sells may, upon prior notice to the Buyer from time to time by reference or substitute with similar Products meeting the needs of the Buyer. This modified version of the licensor, providing that the Seller ensures the substituted Product is similar to the Product initially ordered.

4.6 After any legal and statistical inspection, it is acknowledged that the Terms and Conditions of Sale, the Seller undertakes to replace the defective products as far as the suppliers allow and without indemnities or compensation of any kind for labor costs, delays, interest and any other reason. Replacement is guaranteed for a maximum of two years starting from the delivery date. Any replacement is excluded for any event as set out above.

4.7 The deadlines that the Seller is asked to state for the mailing of the Products are given for information only and are not guaranteed. The Seller shall not be liable for any delays, for any damages or cancellations of the order, except for non-acceptable delays exceeding 4 months from the stated deadline, without information from the Seller. In such case, only, the Buyer shall be entitled to ask for a reimbursement of its first down payment to the exclusion of any further damages.

4.8 The Seller does not make any warranties, express or implied, including, without limitation, those of sale ability and fitness for a particular purpose, with respect to the Products. Although the Seller shall take all reasonable care in the selection of Products for infection of viruses, worms, Trojan horses or other codes containing contaminating or destructive properties before making Products available to the Buyer, the Seller cannot guarantee that any Product will be free from infection.

5. FORCE MAJEURE

5.1 The Seller shall not be liable for any delay in performance directly or indirectly caused by or resulting from acts of nature, fire, flood, accident, riot, war, government intervention, embargoes, strikes, labor difficulties, equipment failure, late deliveries by suppliers or other situations which are beyond the control, and not the fault of the Seller.

6. PROTECTION OF THE SELLER’S IPR

6.1 All the IPR attached to the Products are and remain the property of Yole Développement, a research and development consultancy company, facilitating market access for advanced technology, and the Buyer on the other hand.

6.2 The Buyer agrees to disclose, copy, reproduce, redistribute, resell or publish the Product, or any part of it, to any other party other than employees of its company. The Buyer shall have the right to use the Products solely for its own internal information purposes. In particular, the Buyer shall not use the Product for purposes such as:

a) Information storage and retrieval systems;

b) Recordings and re-transmissions over any network (including any local area network);

c) Use in any timesharing, service bureau, bulletin board or similar arrangement or public display;

6.3 The Buyer shall be solely responsible towards the Seller of all infringements of this obligation, whether this infringement comes from its employee or any person to whom this sends the Products and shall personally take care of any related proceedings, and the Buyer shall bear related financial consequences.

6.4 The Seller shall define its company’s point of contact for the needs of the contract. This person will be the recipient of each report or invoice. The Buyer will be responsible for all correspondence with the Seller.

6.5 In the event of any dispute between the Seller and the Buyer the Seller shall be entitled to ask for a reimbursement of all the fees charged to the Buyer, even in case of delayed delivery. The Seller agrees to produce sufficient evidence of such defects. .

7. TERMINATION

7.1 If the Buyer cancels the order in whole or in part or postpones the date of mailing, the Buyer shall indemnify the Seller for the entire costs that have been incurred as at the date of notification by the Buyer of such delay or cancellation. This may also apply for any other direct or indirect consequential damages.

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8.1 All Sales Terms and Conditions are for the benefit of the Seller itself, but also for its licensors, employees and agents. Each of them is entitled to assert and enforce these provisions against the Buyer.

8.2 Any modification of these Terms and Conditions shall be in writing. They shall be effective upon receipt by the other Party. The Seller may, from time to time, update these Terms and Conditions. The Seller reserves the right to change and/or update this version of these terms and conditions, provided they have been communicated to him in due time.

9. GOVERNING LAW AND JURISDICTION

9.1 Any dispute arising out of or linked to these Terms and Conditions or any contract between the Seller and the Buyer, shall be settled by the French Commercial Courts of Lyon, which shall have exclusive jurisdiction upon such issues.

9.2 French law shall govern the relation between the Buyer and the Seller, in accordance with these Terms and Conditions.