

# COMPOUND SEMICONDUCTOR QUARTERLY MARKET MONITOR 2021

Compound Semiconductor Service - October 2021

*3D sensing and LiDAR will drive another round of GaAs and InP growth and investments.*

## WHAT ABOUT THE COMPOUND SEMICONDUCTOR QUARTERLY MARKET MONITOR ?

### A full package:

The Compound Semiconductor Market Monitor includes the following deliverables:

- Excel database with quarterly update on historical and forecast data
- PDF slide deck with graphs and comments/analysis covering expected evolutions
- **Direct access to a Yole Développement analysts for one year, providing an opportunity for on-demand Q&A and discussions regarding trends, analyses, forecasts, and breaking news**

### Frequency:

Receive every quarter the updated Market Monitor documents

Get the sample of the monitor on [www.i-Micronews.com](http://www.i-Micronews.com)

## NEW GAAS AND INP PHOTONICS MODULE COMPLEMENTS EXISTING CS MONITOR MARKETS

The newly released Compound Semiconductor (CS) Quarterly Market Monitor Module III contains data related to semiconductor photonics. It includes GaAs vertical cavity surface emitting lasers (VCSELs), edge emitting lasers (EELs). The Monitor also includes various InP-based lasers, from Fabry-Pérot (FP), and Directly Modulated Lasers (DMLs) to advanced Electro-Modulated Lasers (EMLs) and InP in silicon photonics (SiPh). It includes a complete analysis of supply chain movements. The Monitor provides a market forecast with a quarterly basis and five-year time frame. The forecast reflects impacts of recent design wins and announcements in the dynamic consumer and automobile markets. At different levels of the supply chain, Module III covers the market data for wafers, epiwafers and bare dies. It dives deep into end systems in consumer and mobile, telecom and infrastructure, automotive, industrial, medical and other applications. There's also a special focus on the developing Chinese supply chain.

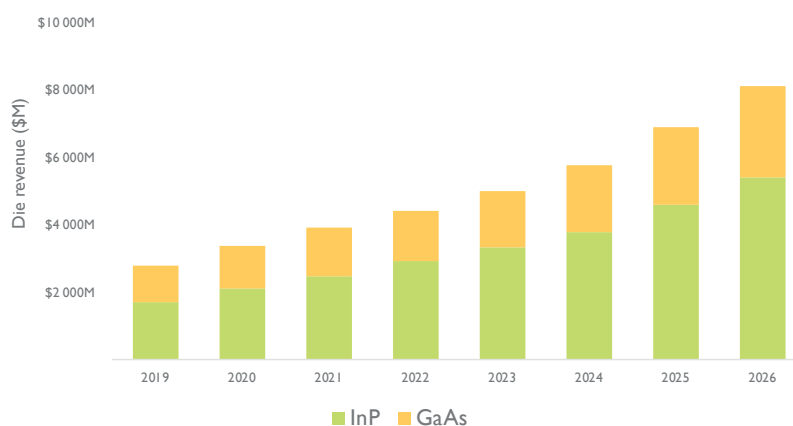
Yole Développement follows key actors and new players across the supply chain within

photonics GaAs and InP industries. The top players deeply engage in both industries, such as Lumentum and II-VI at the device and module level, IQE at epiwafer level and Sumitomo Electric at wafer level. Meanwhile, some players focus on one of the industries, acquiring significant market share, for example ams, Landmark, VPEC, Freiberger and AXT. This CS Quarterly Market Monitor provides a detailed revenue analysis of key players at different levels of the supply chain. It features market share, capacity, business model analysis and company profiles.

The Monitor also includes the following deliverables:

- Excel database with all historical and forecast data
- PDF slide-deck with graphs and comments/analysis regarding expected evolution
- Direct access to Yole analysts for one year, providing an opportunity for on-demand Q&A and discussions regarding trends of market and technology, forecast, and breaking news.

### 2019 - 2026 GaAs and InP photonics die market revenue forecast – In US\$M



(Yole Développement, October 2021)

## 3D SENSING IS DRIVEN BY APPLE AND ITS TWO MAJOR SUPPLIERS

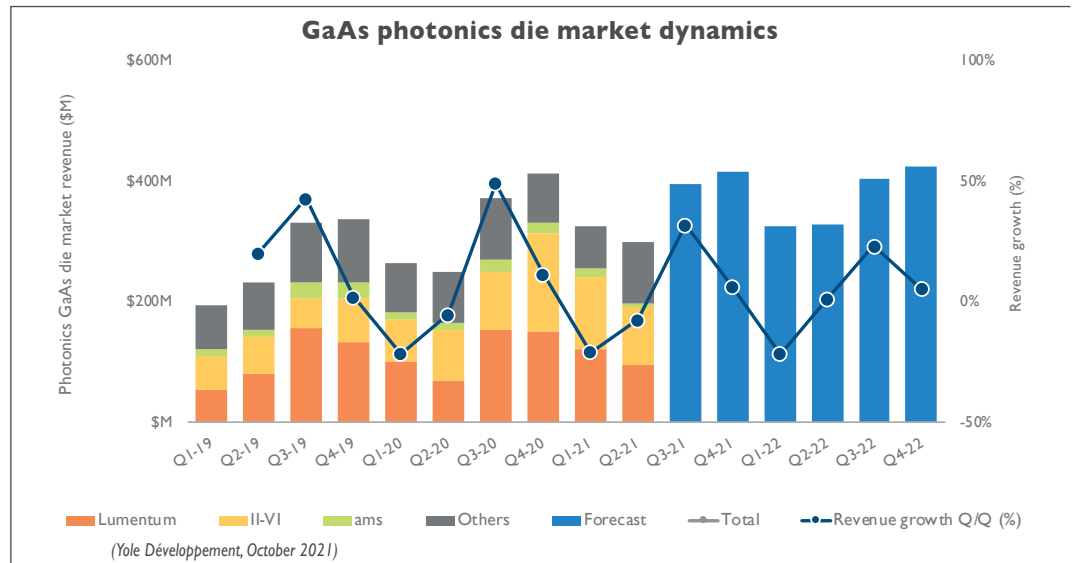
GaAs photonics has been driven by data communications (datacom) for long time, until demand from 3D sensing boomed thanks to Apple's iPhone X in 2017. In 2018, VCSELs for 3D sensing become the biggest application for GaAs photonics. The total annual die market is worth \$1.4B in 2021 and will double by 2026 in Yole's estimation. The ramp-up of VCSELs in consumer and mobile segments started a new wave of

technology development and investments. Manufacturers have adapted to 6-inch GaAs wafers to deal with high-volume shipments, in order to address greater demands on cost and capacity compared to the datacom era.

The competition of two business models in GaAs photonics directly reshapes the supply chain. There are two major suppliers to Apple. One,

Lumentum, built partnerships with epitaxy houses and foundries. II-VI implemented vertical integration through mergers and acquisitions (M&A). This

further impacted the open epiwafer market. IQE became the major epiwafer supplier with the biggest market share after II-VI acquired Finisar in 2019.



### NEW INP OPPORTUNITIES IN EMERGING SENSING APPLICATIONS

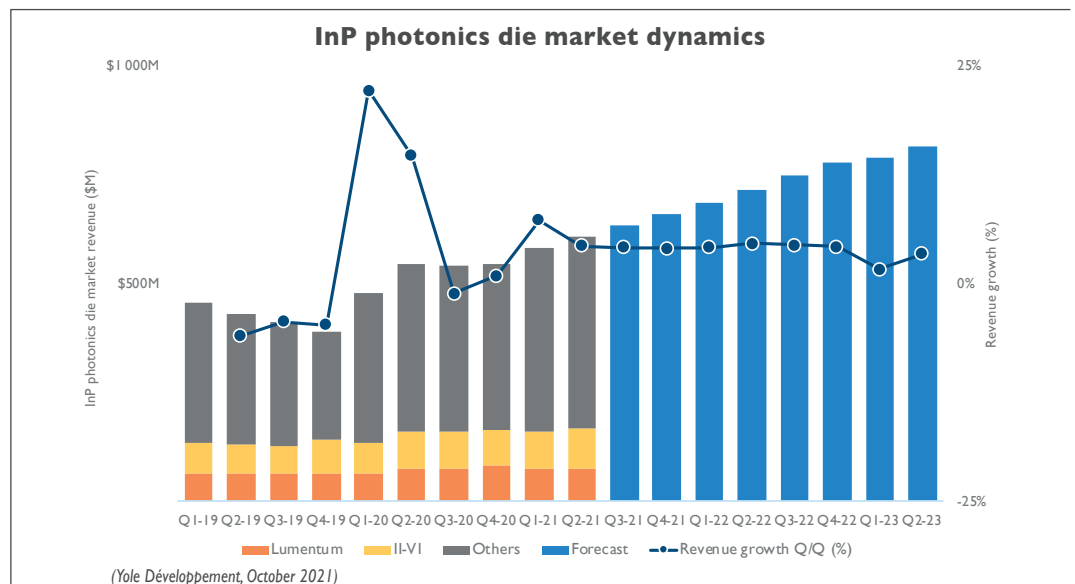
The InP industry is fragmented, with numerous players at the device level. Two American players lead the InP market: II-VI and Lumentum. Both have increased their market share and strengthened their positions thanks to strategic M&A. Their combined bare die market share is around 30%.

As of 2021, the main market drivers for InP remain datacom and telecom, thanks to the unique properties of InP photonic devices to reach high bandwidth and data rates and long reach in optical transceivers. However, there is growing interest in emission and detection at wavelengths around 1300nm and 1500nm for sensing applications. We are likely to see attractive health monitoring, 3D sensing and LiDAR applications creating new opportunities and a second wave for InP photonic devices. In Q3-21, Rockley Photonics went public through a Special Purpose Acquisition Company (SPAC) merger at a valuation of \$1.2B. Apple is interested in working with Rockley Photonics to develop SiPh modules

that can measure healthcare biological parameters for smartwatch consumer applications. For LiDAR applications, InP could be promising, enabling eye safety at longer wavelengths. Players such as Volvo, ZF, Continental, and Daimler are interested in adopting InP-based LiDAR.

For smartphones, manufacturers interested in removing the camera notch on their screens and integrating 3D-sensing modules under OLED displays are considering moving to longer wavelengths, replacing current GaAs VCSELs with InP EELs. Even though this trend is currently in an early R&D phase, we see strong interest from several players, such as AMS, Infineon, STMicroelectronics, II-VI, and Lumentum.

*Android phone makers are now returning to 3D sensing, so how will this change the GaAs photonics market? Will LiDAR become another battleground between GaAs and InP? Find out the latest trends in the industries in this monitor.*



Will GaAs and InP compete in 3D sensing for handsets and LiDAR for automotive? What are the device players' strategies in GaAs and InP photonics? Can InP leverage GaAs processes?

Yole provides answers to these questions and detailed profiles and analyses of the main suppliers on a quarterly basis. This Monitor addresses all

the dynamic markets in the CS industry, from SiC and GaN power to GaAs and GaN RF to GaAs and InP photonics, covering wafer and epiwafer market sizes, as well as bare die and device, updated quarterly. Yole Développement also addresses COVID-19 and trade tension impacts on these markets.

**KEY FEATURES**

- COVID-19 impact analysis
- Quarterly update of the data
- Market forecast from 2019 to 2026 in M\$US for devices, wafers and epiwafers and units for wafers and epiwafers for Power SiC, Power GaN, RF GaAs, RF GaN, GaAs photonics and InP photonics applications
- Market forecast through 2026 by market segment including automotive, consumer, telecom and energy in M\$US revenue
- Market forecast breakdown by technology including discrete, module and wafer size

**COMPANIES MONITORED IN THE PRODUCT (non exhaustive list)**

STMicroelectronics, Wolfspeed, ROHM, Infineon, Onsemi, Mitsubishi Electric, Showa Denko, II-VI, EPC, Power Integrations, Transphorm, GaN Systems, Navitas, Innoscience, IQE, Skyworks, Qorvo, Murata, Broadcom, VPEC, Freiberger Compound Materials, SiCC, Sumitomo Electric, AXT, Sumitomo Electric Device Innovations (SEDI) Lumentum, ams, Landmark and more.

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

**Module I, II and III market overview**

- > Device, open epiwafer and wafer market dynamics
- > Open epiwafer and wafer shipment
- > Open epiwafer and wafer pricing
- > Device, open epiwafer and wafer market revenue

**Module I, II and III market application segment**

- > Device market forecast per segment and share
- > Open epiwafer market per segment and share
- > Wafer market per segment and share

**Module I, II and III technology**

- > Device market projection by device type (\$M)
- > Bare die device market projection by technology (\$M)
- > Wafer market projection by wafer size (\$M and Units)
- > Open epiwafer market projection by wafer size (\$M and Units)

**Power SiC market players**

- > STMicroelectronics, Wolfspeed, ROHM, Infineon, Onsemi, Mitsubishi Electric- Power SiC device revenue
- > Wolfspeed, Showa Denko- Power SiC epiwafer revenue
- > Wolfspeed, II-VI- Power SiC and wafer revenue

**Power GaN market players**

- > Infineon, EPC, Power Integrations, Transphorm, GaN Systems, Navitas, Innoscience - power GaN device revenue
- > IQE - Power GaN epiwafer revenue

**RF GaAs market players**

- > Skyworks, Qorvo, Murata, Broadcom - RF GaAs die revenue
- > IQE, VPEC - RF GaAs epiwafer revenue
- > Freiberger Compound Materials, Sumitomo Electric, AXT - RF GaAs wafer revenue

**RF GaN market players**

- > SEDI, Qorvo, Wolfspeed- RF GaN device revenue
- > IQE, Wolfspeed - RF GaN epiwafer revenue
- > II-VI, Wolfspeed, SiCC- Semi-insulating SiC wafer revenue
- > SiCC - Semi-insulating SiC wafer revenue

**Photonics GaAs market players**

- > Lumentum, II-VI, ams - GaAs Photonics device revenue
- > IQE, VPEC - GaAs photonics epiwafer revenue
- > Sumitomo Electric, Freiberger Compound Materials - GaAs photonics wafer revenue
- > Trumpf - GaAs photonics device
- > Win Semiconductor - GaAs photonics foundry

**Photonics InP market players**

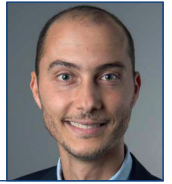
- > II-VI, Lumentum - InP photonics bare die revenue
- > LandMark, IQE - InP photonics epiwafer revenue
- > Sumitomo Electric, AXT- InP photonics wafer revenue

**RELATED REPORTS, MONITORS & TRACKS**



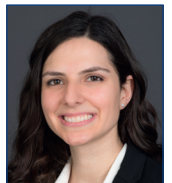
- GaN Power 2021: Epitaxy, Devices, Applications and Technology Trends
- Power SiC: Materials, Devices and Applications 2020
- GaAs Wafer and Epiwafer Market: RF, Photonics, LED, Display and PV Applications 2020
- GaN RF Market: Applications, Players, Technology, and Substrates 2021

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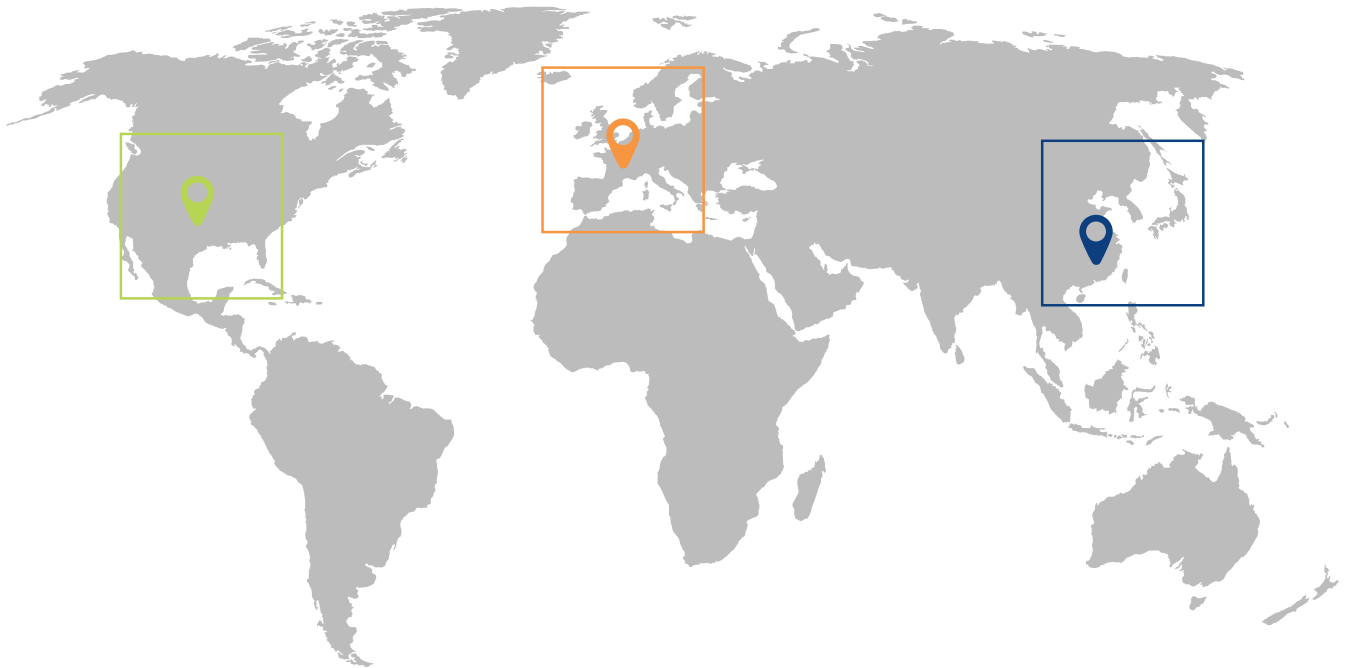


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## ABOUT YOLE DEVELOPPEMENT

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 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
- Design and characterization of innovative optical systems
- Financial services (due diligence, M&A)

More information on [www.yole.fr](http://www.yole.fr)

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- Market & technology reports
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- Cost simulation tool

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- Marketing & Communication: Brice Le Gouic ([brice.legouic@yole.fr](mailto:brice.legouic@yole.fr))



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**“Buyer”**: Any business user (i.e. any person acting in the course of its business activities for its business needs) placing an order pursuant to these General Terms and Conditions of Sale, with the exclusion of any individual consumer acting for his/her sole personal interest.

**“Seller”**: Headquartered in Villeurbanne (France), Yole Développement provides marketing, technology and strategy consulting, media and corporate finance services, reverse engineering/costing services as well as IP and patent analysis. With dedicated teams of technology & market analysts, Yole Développement operates worldwide with the key industrial companies, R&D institutes and investors to help them understand the market and technology trends.

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Monitors are established and delivered in Excel. An additional PDF can also be added. Q&A with an Analyst is possible for each monitor (except where specified otherwise). Frequency of the release vary according to the monitor or service (quarterly and monthly). All monitor products are eligible for a Corporate License.

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1.1 Both Contracting Parties undertake to comply with these General Terms and Conditions of Sale.  
**ANY ADDITIONAL, DIFFERENT, OR CONFLICTING TERMS AND CONDITIONS IN ANY OTHER DOCUMENTS ISSUED BY THE BUYER AT ANY TIME ARE HEREBY OBJECTED TO BY THE SELLER, ARE DEEMED WHOLLY INAPPLICABLE TO ANY SALE MADE HEREUNDER, AND SHALL NOT BE BINDING IN ANY WAY ON THE SELLER.**

1.2 These General Terms and Conditions of Sale shall be deemed valid and enforceable between the Contracting Parties after acceptance of an order from the Buyer by the Seller pursuant to Article 1.3 below. For such purpose, the Buyer, when signing the purchase order which mentions “I hereby accept Yole Développement’s Terms and Conditions of Sale” is deemed to have fully and unequivocally accepted these Terms and Conditions of Sale.

1.3 Orders are deemed to be accepted only upon written acceptance and confirmation by the Seller, within [7 days] from the date of order, to be sent either by email. In the absence of any confirmation in writing, no order shall be deemed to have been accepted.

## 2. MAILING OF THE PRODUCTS

- 2.1 Products are sent by email to the Buyer after Seller’s confirmation:
  - Within a few days from the Seller’s confirmation of the order for Products already released and paid; or
  - Within a reasonable time for Products ordered prior to their effective release. In this case, the Seller shall use its best endeavours to inform the Buyer of an indicative release date and the evolution of the work in progress.
- 2.2 The Seller shall by no means be responsible for any delay pursuant to Article 2.1 above, in particular in cases where a new event or access to new contradictory information would require the Seller analyst to dedicate extra time to compute or compare the data in order to enable the Seller to deliver a high quality Product.
- 2.3 The mailing of the Product will occur only upon payment by the Buyer, in accordance with the conditions contained in Article 3 above.

2.4. The mailing is operated through electronic means either by email via the sales department or automatically online via an email/password. The Buyer is responsible for ensuring that the Buyers platform has the required capacities and authorisations to receive the Product(s) emailed by the Seller. If the Product’s electronic delivery format is defective, the Seller undertakes to replace it at no charge to the Buyer provided that the Seller is informed of the defective formatting within 90 days from the date of the original download or receipt of the Product.

2.5 The person receiving the Products on behalf of the Buyer shall immediately verify the quality of the Products and their conformity with the order. Any claim for apparent defects or for non-conformity shall be sent in writing to the Seller within 8 days of receipt of the Products. For this purpose, the Buyer agrees to produce sufficient evidence of such defects.

2.6 No return of Products shall be accepted without prior written notification from the Buyer to the Seller, even in case of delayed delivery. Any Product returned to the Seller without the Buyer providing prior notification to the Seller as required under Article 2.5 above shall remain at the Buyer’s risk. In no event shall the Seller incur any liability for Products erroneously ordered by the Buyer, or for any request from the Buyer to replace a Product previously ordered by a different Product.

## 3. PRICE, INVOICING AND PAYMENT

3.1 Prices are given in the orders corresponding to each Product sold on a unit basis or corresponding to annual subscriptions. They are deemed to be inclusive of all taxes applicable in the country where the Seller is based (except for France where VAT will be added). The prices are re-evaluated from time to time by the Seller. The effective price is deemed to be the one applicable at the time of the order.

3.2 Payments due by the Buyer shall be sent by cheque payable to Yole Développement, or made by credit card or by electronic transfer to the following account:  
HSBC, 1 place de la Bourse 69002 Lyon France  
Bank code: 30056  
Branch code: 00170  
Account n°: 0170 200 1565 87  
BIC or SWIFT code: CCFRFRPP  
IBAN: FR76 3005 6001 7001 7020 0156 587

To secure the payments due to the Seller, the Seller reserves the right to request down payments from the Buyer. In such case, the need for a down payment will be mentioned on the corresponding order.

3.3 Payment is due by the Buyer to the Seller within 30 days from invoice date, except as otherwise specifically agreed in writing by the Buyer and the Seller. If the Buyer fails to pay at the due date and fails to request and obtain from the Seller a payment extension, the latter shall be entitled to invoice interest in arrears based on the annual rate Refi of the “BCE” + 7 points, in accordance with article L.441-6 of the French Commercial Code.

3.4 The Seller publications (reports, monitors, tracks...) are due for delivery only after receipt by the Seller of any payment due by the Buyer prior to delivery.

3.5 In the event of termination of the contract by the Seller attributable to Buyer misconduct during the contract, the Seller will have the right to invoice all work performed at the time of termination, and to take legal action for damages.

## 4. LIABILITIES

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 the choice of the Products purchased as well as for the use and interpretations the Buyer makes of the documents it purchases, of the results the Buyer obtains, and of the advice and acts the Buyer bases thereon .

4.2 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 profits, business interruption and loss of programs or information) arising out of the use of a Product or the use of or the inability by the Buyer to use the Seller’s website, or any information provided on the website, or contained in a Product;  
b) Any claim attributable to errors, omissions or other inaccuracies in a Product or interpretations thereof.

4.3 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.

4.4 Any Product that the Seller sells may, upon prior notice to the Buyer from time to time be modified by Seller or substituted with a similar Product meeting the needs of the Buyer. Such modification shall not lead to any liability of the Seller, provided that the Seller ensures the substituted Product is similar to the Product initially ordered.

4.5 In the case where, after inspection, it is acknowledged that a Product contain defects, the Seller undertakes to replace the defective product to the extent reasonably feasible and without indemnification or compensation of any kind for labour costs, delays, loss caused or any other reason being due by the Buyer . This undertaking from the Seller shall be effective for a maximum of two months starting from the delivery date but shall not be applicable in the event of force majeure as described in Article 5 below.

4.6 The deadlines that the Seller is asked to provide for the mailing of a Product are given for information purposes only and are not guaranteed. If such deadlines are not met, this shall not, without the agreement of the Seller lead to any claim for damages or right of cancellation of one or more orders by the Buyer, except for non-acceptable delays exceeding [3] months from the stated deadline. In such case only i.e. only in the event of a delay exceeding (3) months from the stated deadline the Buyer shall be entitled to ask for a reimbursement of any down payment previously made to the Seller, to the exclusion of any other damages.

4.7 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 any Products. Although the Seller shall take reasonable steps to screen Products for infection of viruses, worms, Trojan horses or other codes containing contaminating or destructive properties before making Products available, the Seller cannot guarantee that any Product will be free from infection.

## 5. FORCE MAJEURE

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, labour difficulties, epidemics, major health event (e.g. Corona virus), equipment failure, late deliveries by suppliers or other difficulties which are beyond the control, and not attributable to the fault of the Seller.

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6.1 All the IPR attached to the Products are and remain the property of the Seller and are protected under French and international copyright law and conventions.

6.2 The Buyer agreed not to disclose, copy, reproduce, redistribute, resell or publish a Product, or any part of it to any other party other than employees of the Buyer Company (and only in the country of the Primary User for Multi-User Licenses). The Buyer shall have the right to use Products solely for its own internal information purposes. In particular, the Buyer shall therefore not use any Product for purposes such as:

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- Recordings and re-transmittals over any network (including any local area network);
- Use in any timesharing, service bureau, bulletin board or similar arrangement or public display;
- Posting any Product to any other online service (including bulletin boards or the Internet);
- Licensing, leasing, selling, offering for sale or assigning a Product or any derivative thereof.

6.3 If the Buyer would like to use data coming from a Product for presentations, press announcements and any other projects, the Buyer needs to contact Yole Développement’s Public Relations Director (info@yole.fr) to get an official authorization and confirm that the data are up to date. In return the Seller will make sure to provide up-to-date data under a suitable public format.

6.4 The Buyer shall be solely responsible towards the Seller for any infringement of the obligation described in Article 6.3 above, whether such infringement originates from the Buyer’s employees or any person to whom the Buyer has sent the Products. Furthermore, the Buyer shall initiate and personally take care of any related proceedings in coordination with the Seller, and the Buyer shall bear the related financial consequences in their entirety.

6.5 The Buyer shall define within its Company an identified user who shall serve as a contact person for the License purchased by the Buyer. This person will be the recipient of each new report. This person shall also be responsible on behalf of the Buyer, for compliance with all copyrights and other obligations relating to the protection of the Seller’s IP rights and general compliance with the terms of the License purchased by the Company. In the context of Bundle and Annual Subscriptions, the contact person shall decide within the Buyer which person(s) shall be entitled to receive the protected link that will allow the Buyer to access the Products.

6.6 It is acknowledged and accepted by the Buyer that whether purchased in the form of Bundles or Annual Subscription, all unselected reports will be deemed cancelled and lost after a period of 12 month following acceptance of the corresponding order by the Seller in accordance with provisions of Article 1.3 above .

6.7 It is further acknowledged and agreed by the Buyer that any investor in the Buyer Company, any external consultant of the Buyer Company or any joint venture done with a third party in which the Buyer Company is involved , is not entitled to use a Product, without paying to the Seller the full price for a license to the required Product..

## 7. TERMINATION

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 loss that may be incurred by the Seller, pursuant to such cancellation or postponement.

## 8. MISCELLANEOUS

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

Any notices under these Terms and Conditions shall be given in writing and shall be effective upon receipt by the other Party.

8.2 The Seller may, from time to time, update these General Terms and Conditions of Sale, and the Buyer, shall be deemed to have accepted the latest version of such General Terms and Conditions of Sale, once they have been duly communicated to the Buyer by the Seller.

## 9. GOVERNING LAW AND JURISDICTION

- 9.1 Any dispute arising out or linked to these General Terms and Conditions of Sale or to any Licenses or Products purchased in application thereof shall be submitted to the French Commercial Court of Lyon, which shall have exclusive jurisdiction upon such issues.
- 9.2 French law (without reference to any applicable conflict of law provisions) shall apply to these General Terms and Conditions of sale and any agreement between the Buyer and the Seller made pursuant thereto.