

LIDAR for Automotive

Patent Landscape Analysis – April 2018

From ADAS to autonomous and robotic vehicles, what are the LIDAR technologies and related IP of automotive industry players?



REPORT OUTLINE

- LIDAR for Automotive
- Patent landscape analysis
- April 2018
- PDF > 220 slides
- Excel file > 12,800 patents
- €6,490 for a multi-user license

REPORT'S KEY FEATURES:

- **IP trends**, including time-evolution of published patents, and countries of patent filings
- Patents' **current legal status**
- Ranking of **main patent assignees**
- **Promising technologies** IP analysis: VCSEL, LED, APD, SPAD, MEMS mirrors, flash LIDAR
- **Key patents** and granted patents nearing expiration, by technology segment
- **Key players' IP position** and **relative strength** of their patent portfolios
- **Newcomers IP profile:** Quanergy, Luminar Tech., Xenomatix, Hesai Photonics, Leishen Lidar, Robosense, Ricoh
- **Key players IP profile:** Velodyne, Denso, Bosch, Valeo, Toyota, Uber, Waymo
- **Excel database** containing all patents analyzed in the report, including technology segmentation

RELATED REPORTS

- [Sensors for Robotic Vehicles 2018](#) (Yole Développement)
- [LiDAR for Automotive and Industrial Applications 2018](#) (Yole Développement)
- [Continental SRL1: State-of-the-art LiDAR for Advanced Driver Assistance Systems](#) (System Plus Consulting)
- [LeddarVu8: The first off-the-shelf, solid-state high-definition LiDAR module from LeddarTech](#) (System Plus Consulting)

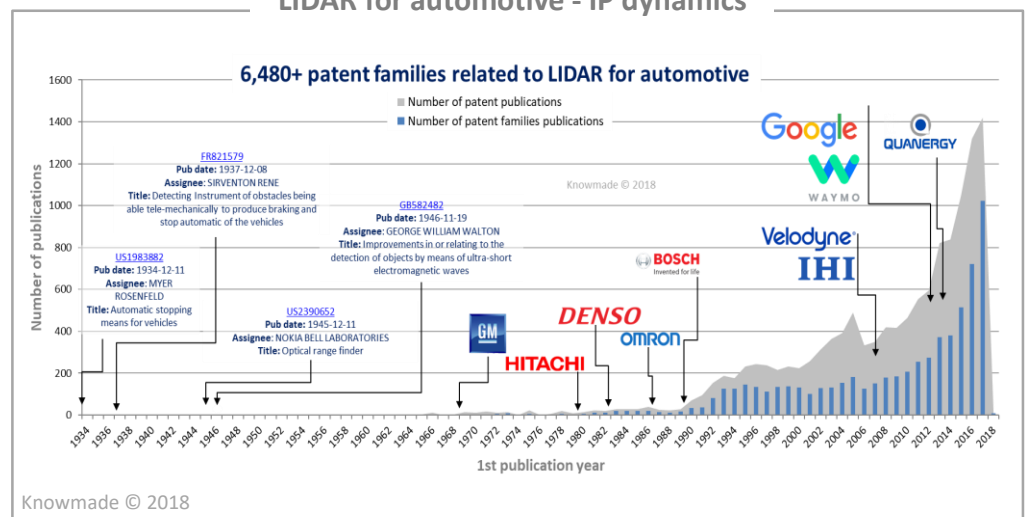
LIDAR FOR AUTOMOTIVE - IP DYNAMICS

The automotive sector is changing. After being crippled by the 2008 financial crisis, it has risen from the ashes and commenced its own revolution. Indeed, for more than 4 years the automotive industry has been discussing new mobility solutions based on autonomous vehicles, shared mobility, connectivity, and electrification. Among these four axes, autonomous vehicles (**i.e. driverless vehicles and robotic vehicles**) is the most disruptive technology. Indeed, with self-driving vehicles the road will be safer, the journey more comfortable, and traffic jams minimized. To achieve this goal, the industry is rapidly evolving. Driver assistance systems (ADAS) are today well-integrated, with partial automated driving already available and self-driving cars being tested in real-world environments. However, along with the trend towards self-driving come new technical challenges with regard to surround sensors, actuators, and the vehicle's electrical/electronic architecture.

LIDAR (*light detecting and ranging*) appears to be the best solution for these challenges. The technology has already proven its accuracy and reliability in ADAS applications. Moreover, LIDAR's increasing power and portability are being embraced as it is integrated into new, exciting functions like **3D mapping** and **car-surround sensors**.

Today, **LIDAR technologies** and new **automotive applications** are developing simultaneously. Thus the LIDAR market is linked to the development of ADAS and robotic vehicle applications. Both domains show high growth rates and tremendous enthusiasm. Consequently, the **LIDAR market** is one of the **automotive industry's fastest-growing sectors**, with an annual growth of 42% from 2018 - 2028 expected by Yole Développement.

LIDAR for automotive - IP dynamics



LIDAR-related patent activity began in the late '80s amongst Japanese automotive players. This first wave of IP players, composed of Japanese and European car manufacturers and suppliers, contributed to the development of LIDAR for ADAS applications. Since 2010, the **IP landscape related to LIDAR for automotive has seen a strong increase**. The swift development of autonomous vehicles has opened many opportunities, with the established/strongest IP players increasingly challenged by new pure players and international companies entering the IP landscape.

IP landscape - scope

REPORT'S SCOPE

Through January 2017, more than 30,000 inventions have been published worldwide. In this report, Knowmade has selected and thoroughly investigated the **6,480+ inventions related to LIDAR for automotive applications**. These patents were filed by more than 2,230 patent applicants.

This report also provides a deep analysis of patents related to **promising technologies and main players' IP portfolios**.

Examples	Selected	Related	Excluded	Illustration
Generic patents describing lidar devices without describing any specific applications	X			
Patents describing electrical or optical compound especially dedicated to lidar systems	X			
Patents describing lidar driving systems	X			
Patents describing method for driver assisted system		X		
Patents claiming the use of LIDAR, RADAR and other sensors in anti-collision or other ADAS systems		X		
Patent describing non-embedded lidar for vehicle traffic surveillance			X	
Patents describing lidar system for airborne, weather, laser guidance, industrial, robotic or surveillance applications			X	
Generic patents describing laser, optical components, detectors, etc. and non-directly related to lidar applications			X	

Knowmade © 2018

REPORT'S MAIN ASSETS

- Identifying the newcomers and evaluating their portfolios' strengths and weaknesses

In this report, Knowmade discusses the **more than 35 newcomers** that have entered the IP landscape in the last seven years. **Nine newcomer IP profiles** are analyzed within, based on their market position, portfolio size, and IP activity growth. **Links between patents and products** are also provided.

- Understanding the key players' patented technologies and current IP strategies

More than **2,200 patent applicants** are involved in the **LIDAR for automotive** patent landscape. This report reveals the **IP position of key players** through a detailed analysis of their patent portfolios. We also provide an understanding of these players' **patented technologies**, their **IP strategy**, and their **capability to limit other firms' IP activity and freedom-to-operate**. Moreover, we discuss the **relative strength of the top patent owners** as derived from their patent portfolio sizes, technological impact factors, geographic coverage, blocking potential, and most **valued patents**.

- Analyzing IP players' position on promising technologies and their main inventions

This report provides an understanding of **IP players' positions on promising technologies**. The corpus is segmented between VCSELs, LED, APD, SPAD, flash LIDAR, and MEMS mirrors-related patents. Each segment's **main IP players and key patents** are presented, along with an **understanding of the current technical challenges addressed in the patents**.

Main IP players involved in promising LIDAR technologies

	LIDAR systems claiming/describing the use of				Flash/Solid state LIDAR
	EEL	LED	VCSEL	APD and SPAD	
End users / automobile manufacturers	<i>All conventional players (Established technology)</i>				
Automobile suppliers					
Electronic and optic component manufacturers					
Others (sensor manufacturers, etc.)					

Note: All details are given in the report

USEFUL PATENT DATABASE

This report also includes an **Excel database** with the **>12,800 patents and patent applications** analyzed in this study. This useful patent database allows for **multi-criteria searches** and includes patent publication numbers, hyperlinks to the original documents, priority date, title, abstract, patent assignees, patent's current legal status, and **technological segments**.

COMPANIES MENTIONED IN THIS REPORT (NON-EXHAUSTIVE LIST)

DENSO, MITSUBISHI, ROBERT BOSCH, NISSAN, TOYOTA, SICK, DAIMLER, OMRON, GENERAL MOTORS, VALEO, FORD, HONDA MOTOR, HYUNDAI, CONTINENTAL, MAZDA MOTOR, SANYO, RICOH, BMW, DAIHATSU, WAYMO, HITACHI, VOLKSWAGEN, CONTITEMIC MICROELECTONIC, NEC, PANASONIC, GOOGLE, AUDI, NIKON, FUJITSU, CHANGAN UNIVERSITY, KANSEI, IBEO AUTOMOBILE, VOLVO, CHERY AUTOMOBILE, SHENZHEN LEISHEN INTELLIGENT SYSTEMS, SHARP, HOKUYO AUTOMATIC, SHINY TECHNOLOGY, UBER, VELODYNE, QUALCOMM, SHANGHAI SLAMTEC, BEIJING WANJI TECHNOLOGY, BASF, PHILIPS, FRAUNHOFER, ZOOX, QUANERGY SYSTEMS, APPLE, TEXAS INSTRUMENTS, LG INNOTEK, SCANIA, QINETIQ, LUMINAR TECHNOLOGIES, HESAI PHOTONICS, ROBOSENSE, and more.

TABLE OF CONTENTS

INTRODUCTION	45	POSITION OF MAIN IP PLAYERS INVOLVED	KEY PLAYERS' IP PROFILE	161
Market data		IN LIDAR DEVICES AND SYSTEMS	Newcomers	
Report scope		Methodology and segment overview	Company overview	
Report's key features		Segment analysis and position of main IP players	Portfolio overview	
Report's objectives		Main assignees	Detailed analysis of their patents	
		IP leadership	Main IP players	
METHODOLOGY	19	Blocking potential	Company overview	
Patent search, selection, and analysis		Reinforcement potential	Most valued patent families	
Search equations		IP strength index	Recent IP strategy and patent families analysis	
Mergers & acquisitions				
Terminologies for patent analysis				
		KEY TECHNOLOGIES	CONCLUSION	227
IP LANDSCAPE OVERVIEW	27	Emitters: LED, VCSELs		
Time evolution of patent publications		Detectors: APD, SPAD	KNOWMADE PRESENTATION	229
Main countries of filings		Scanning: MEMS mirrors, flash LIDAR		
Main patent assignees		Current technological trends		
Publication countries of main patent assignees				
Legal status of main IP players' patents		KEY PATENTS		
World mapping of patent applications		Seminal patents		
Time evolution of patent assignees		Blocking patents		
Main IP collaborations		Main cases		
NEWCOMERS TYPOLOGY	39	GRANTED PATENTS NEAR EXPIRATION		152

AUTHORS

Dr. Paul Leclaire works for Knowmade in the fields of MEMS, sensors, and RF & microwave technologies. He holds a PhD in Micro and Nanotechnology from the University of Lille, in partnership with IEMN in Villeneuve-d'Ascq and CRHEA-CNRS in Sophia-Antipolis.
paul.leclaire@knowmade.fr



Dr. Nicolas Baron is CEO and co-Founder of Knowmade. He manages the company's development and strategic direction, and personally leads the Electronics & Telecom department. He holds a PhD in Physics from the University of Nice Sophia-Antipolis and a master's degree in Intellectual Property Strategies and Innovation from the European Institute for Enterprise and Intellectual Property (IEEPI Strasbourg), France.
nicolas.baron@knowmade.fr

ABOUT KNOWMADE

Specialized in the analysis of patents and scientific information, **Knowmade** provides technology intelligence and IP strategy consulting services. The company supports the business development of R&D organizations, industrial companies, and investors by offering them a deep understanding of their IP environment and technology trends.

Knowmade operates in the following industrial sectors: compound semiconductors, power electronics, RF & microwave technologies, LED/OLED lighting & display, photonics, memory, MEMS & sensors, manufacturing & advanced packaging, battery & energy management, biotechnology, pharmaceuticals, medical devices, medical imaging, and agri-food & environment.

Knowmade's experts provide prior art search, patent landscape analysis, scientific literature analysis, patent valuation, IP due diligence, and freedom-to-operate analysis. The company also delivers litigation/licensing support, technology scouting, and IP/technology observation. **Knowmade's** analysts combine their technical and patent expertise with powerful analytics tools and proprietary methodologies, delivering invaluable patent analyses and scientific reviews.

ORDER FORM

LIDAR for Automotive

Patent Landscape Analysis – April 2018

Ref.:KM18005

SHIP TO

Name (Mr/Ms/Dr/Pr):

Job Title:

Company:

Address:

City:

State:

Postcode/Zip:

Country:

VAT ID Number for EU members:

Tel:

Email:

Date:

PAYMENT METHODS

Order online: [Click here](#)

Check

To pay your invoice using a check, please mail your check to the following address:

KnowMade S.A.R.L.
2405 route des Dolines, BP 65
06902 Valbonne Sophia Antipolis
FRANCE

Money Transfer

To pay your invoice using a bank money wire transfer, please contact your bank to complete the process. Here is the information you will need to submit the payment:

Payee: KnowMade S.A.R.L.
Bank: Banque Populaire Méditerranée, CAP 3000 Quartier du lac, 06700 St Laurent du Var
IBAN: FR76 1460 7003 6360 6214 5695 139
BIC/SWIFT: CCBPFRPPMAR

Paypal

To pay your invoice via PayPal, you must first register at www.paypal.com. You can then send money to KnowMade S.A.R.L. by entering our email address (contact@knowmade.fr) as the recipient, and entering the invoice amount.

RETURN ORDER BY:

Email: contact@knowmade.fr

Mail: KnowMade S.A.R.L. 2405 route des Dolines, BP 65 06902 Sophia Antipolis FRANCE

PRODUCT ORDER

- €6,490 – Corporate license
 €5,990 – Single-user license*

For the price in dollars, please use the current day's exchange rate. French customers, please add 20% for VAT.

Upon payment reception, all reports are delivered electronically in pdf format *

"Single-user license" means only one person at the company can use the report. Please be aware that the report is watermarked on each page, with the name of the recipient and the organization (the name mentioned on the PO). This watermark also reaffirms that report sharing is not allowed.

I hereby accept Knowmade's Terms and Conditions of Sale

Signature:

TERMS AND CONDITIONS OF SALES

Definitions

“Acceptance”: Action by which the Buyer accepts the terms and conditions of sale in their entirety. It is done by signing the purchase order which mentions “I hereby accept Knowmade’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 interests.

“Contracting Parties” or “Parties”: The Seller on the one hand and the Buyer on the other hand.

“Intellectual Property Rights” (“IPR”) means any rights held by the Seller in its Products, including any patents, trademarks, registered models, designs, copyrights, inventions, commercial secrets and know-how, technical information, company or trading names and 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.

“License”: For the reports and databases, 2 different licenses are proposed. The buyer has to choose one license:

1. Single-user license: a single individual at the company can use the report.
2. Corporate license: the report can be used by unlimited users within the company. Subsidiaries are not included.

“Products”: Reports are established in PowerPoint and delivered on a PDF format and the database may include Excel files.

“Seller”: Based in Sophia Antipolis (France headquarters), Knowmade is a technology intelligence company specialized in the research and analysis of scientific and technical information. We provide patent landscapes and scientific state of the art with high added value to businesses and research laboratories. Our intelligence digests play a key role to define your innovation and development strategy.

1. Scope

1.1 The Contracting Parties undertake to observe the following general conditions when agreed by the Buyer and the Seller. 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, SHALL BE WHOLLY INAPPLICABLE TO ANY SALE MADE HEREUNDER AND SHALL NOT BE BINDING IN ANY WAY ON THE SELLER.

1.2 This agreement becomes valid and enforceable between the Contracting Parties after clear and non-equivocal consent by any duly authorized person representing the Buyer. For these purposes, the Buyer accepts these conditions of sales when signing the purchase order which mentions “I hereby accept Knowmade’s Terms and Conditions of Sale”. This results in acceptance by the Buyer.

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 or to the Buyer’s address. In the absence of any confirmation in writing, orders shall be deemed to have been accepted.

2. Mailing of Products

2.1 Products are sent by email to the Buyer:

- within [1] month from the order for Products already released; 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 Some weeks prior to the release date the Seller can propose a pre-release discount to the Buyer.

The Seller shall by no means be responsible for any delay in respect of article 2.2 above, and including in cases where a new event or access to new contradictory information would require for the analyst extra time to compute or compare the data in order to enable the Seller to deliver a high quality Products.

2.3 The mailing of the Product will occur only upon payment by the Buyer, in accordance with the conditions contained in article 3.

2.4 The mailing is operated through electronic means either by email via the sales department. If the Product’s electronic delivery format is defective, the Seller undertakes to replace it at no charge to the Buyer provided that it 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 to 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 information to the Seller, even in case of delayed delivery. Any Product returned to the Seller without providing prior information to the Seller as required under article 2.5 shall remain at the Buyer’s risk.

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 expressed to be inclusive of all taxes. The prices may be reevaluated from time to time. 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 Knowmade, PayPal, or by electronic transfer to the following account:

Banque Populaire Méditerranée, CAP 3000 Quartier du lac, 06700 St Laurent du Var

BIC or SWIFT code: CCBPFRPPMAR

IBAN: : FR76 1460 7003 6360 6214 5695 139

To ensure payment, 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.

3.3 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 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. Our publications (report, database, tool...) are delivered only after reception of the payment.

3.4 In the event of termination of the contract, or of misconduct, during the contract, the Seller will have the right to invoice at the stage in progress, 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 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 loss, caused by 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 profits, business interruption and loss of programs or information) arising out of the use of 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 be modified by or substituted with similar Products meeting the needs of the Buyer. This modification shall not lead to the liability of the Seller, provided that the Seller ensures the substituted Product is similar to the Product initially ordered.

4.6 In the case where, after inspection, it is acknowledged that the Products contain defects, the Seller undertakes to replace the defective products as far as the supplies allow and without indemnities or compensation of any kind for labor costs, delays, loss caused or any other reason. The replacement is guaranteed for a maximum of two months starting from the delivery date. Any replacement is excluded for any event as set out in article 5 below.

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. If such deadlines are not met, it shall not lead to any damages or cancellation of the orders, 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 saleability and fitness for a particular purpose, with respect to the 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 the 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, labor difficulties, equipment failure, late deliveries by suppliers or other difficulties 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 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 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 therefore not use the Product for purposes such as:

- Information storage and retrieval systems;
- 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 the Product.

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

6.4 The Buyer shall define within its company point of contact for the needs of the contract. This person will be the recipient of each new report in PDF format. This person shall also be responsible for respect of the copyrights and will guaranty that the Products are not disseminated out of the company.

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 loss that may be borne by the Seller, following this decision.

7.2 In the event of breach by one Party under these conditions or the order, the non-breaching Party may send a notification to the other by recorded delivery letter upon which, after a period of thirty (30) days without solving the problem, the non-breaching Party shall be entitled to terminate all the pending orders, without being liable for any compensation.

8. Miscellaneous

All the provisions of these 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 those provisions against the Buyer.

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

The Seller may, from time to time, update these Terms and Conditions and the Buyer, is deemed to have accepted the latest 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 or linked to these Terms and Conditions or to any contract (orders) entered into in application of these Terms and Conditions shall be settled by the French Commercial Courts of Grasse, 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.