

# ANTENNA FOR 5G AND 5G-RELATED APPLICATIONS

Patent Landscape Analysis

April 2019



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# The authors



## Dr. Paul Leclaire

Paul works for Knowmade in the field of RF technologies, Wireless communications and MEMS sensors. He holds a PhD in Micro & Nanotechnology from the University of Lille (France), in partnership with the IEMN of Villeneuve-d'Ascq and the CRHEA-CNRS of Sophia-Antipolis.

Contact: paul.leclaire@knowmade.fr



## Dr. Nicolas Baron

Nicolas is CEO and co-founder of Knowmade. He manages the development and strategic orientation of the company and personally leads the Semiconductors department. He holds a PhD in Physics from the University of Nice Sophia-Antipolis, and a Master of Intellectual Property Strategies and Innovation from the European Institute for Enterprise and Intellectual Property (IEEPI Strasbourg), France.

Contact: nicolas.baron@knowmade.fr

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## Understanding the **competitive landscape** and **technology developments** from a **patent perspective**

- Know the **key IP players**, their **key patents**, their IP/technology **strategy** and their **future intents**
- Identify **new entrants**, their **technology** and **market areas** of interest
- Follow the **technology trends** and identify **emerging technologies**
- **Benchmark** patent portfolios and know competitors' **strengths** and **weaknesses**
- Identify the **key patents** (seminal, blocking, valuable) and the **key technical solutions** that address hot technical issues
- Identify **free technologies** which can be used safely and mitigate the **risks of patent infringement**
- Identify **technologies to acquire** and potential **R&D partners**



### Very complementary to market research

Links between patents and

- Key market players
- Supply chain
- Technology Readiness Levels (TRL)
- Market product
- Emerging technologies/applications
- Forecast

# Scope of the report

## SCOPE OF THE REPORT

- This report provides a detailed picture of the patent landscape for **Antenna for 5G and 5G-related applications**.
- This report covers **patents published worldwide up to January 2019**. We have selected and analyzed more than **3,540 patents and patent applications** grouped in more than **2,180 patent families** relevant to the scope of this report.

Example	Selected patents		
	Relevant patents	Related patents	Excluded
Patents related to Antenna and mentioning 5G applications	X		
Patents related to Antenna array, Massive MIMO, Beamforming and beam steering and related to 5G applications	X		
Patents related to mm Waves antenna and dedicated to mobile phones, LTE or 5G	X		
Patents published after 2014 related to Antenna devices and mentioning 5G or next generation applications	X		
Patents related to 5G network or infrastructures and that claim the use of specific antenna		X	
Patents related to Antenna for mobile devices but that do not mention 5G or next generation applications			X
Patent related to antenna for all other applications (3G, 4G, IoT, etc.)			X

## SCOPE OF THE REPORT

Examples of patents included in the report

Included in the report as antenna devices and systems

Antenna devices      Antenna array      Antenna network

- CN208127423**: Antenna assembly and the electronic device GUANGDONG OPPO MOBILE TELECOMMUNICATIONS
- CN109149069**: Agg antenna system and a mobile terminal AAC TECHNOLOGY
- US20190020114**: Millimeter wave patch antennas APPLE
- CN109149128**: Large-scale array antenna of a 5G WUHAN HONGXIN TELECOMMUNICATION TECHNOLOGIES
- CN108448239**: Millimeter wave antenna array and mobile terminal VIVO MOBILE COMMUNICATION
- US20180366809**: Base station including antenna having two-way tilting structure SAMSUNG ELECTRONICS
- US20180287667**: Backhaul link for distributed antenna system AT&T

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## SCOPE OF THE REPORT

Examples of patents excluded of the report

Not included in the report

- DE102012204488**: Solar module installed in building, has antenna structure whose major surfaces are mounted at spacing, recess or edge region of solar cells and are provided with line radiator, non-radiative lead, detour phase line and radiator element ROBERT BOSCH
- US20110267311**: Touch panel having hidden antenna TEN MONI TECHNOLOGY
- US20190007785**: Wireless network enhancements via inductance loops as antennas AT&T
- US20180166405**: Structure and formation method of chip package with antenna element TSMC
- US20170278603**: Magnetic composites, method of making the same, and antenna device comprising the magnetic composites SAMSUNG ELECTRONICS
- CN109167168**: MIMO antenna array, MIMO antenna and the security system TSINGHUA UNIVERSITY

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# Understanding the main trends

Who, When and where?

SAMPLE

## IP LANDSCAPE OVERVIEW

Time evolution of patent publications

More than 3,540 patents grouped in more than 2,480 patent families\* have been published worldwide

1800 ■ Number of patent publications

## IP LANDSCAPE OVERVIEW

Leading patent applicants according to the number of their patent families

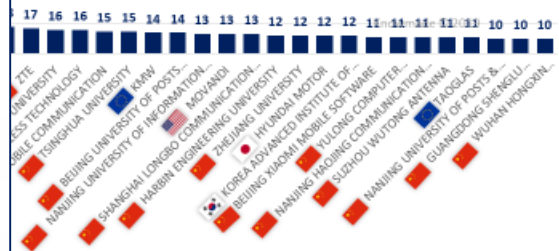
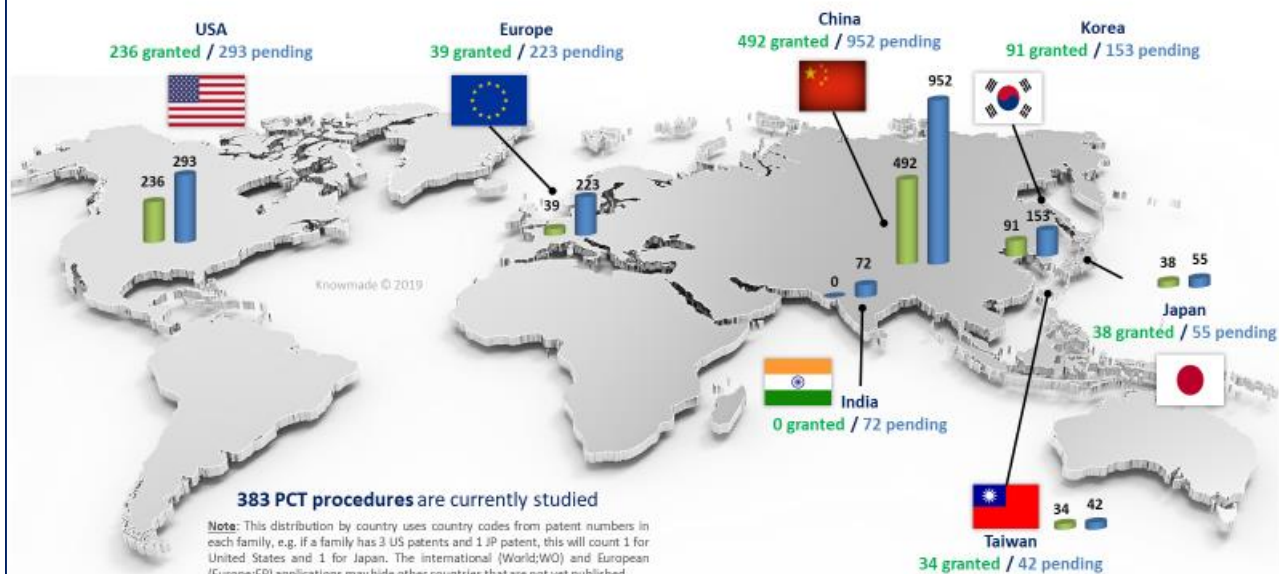


More than 620 IP players are involved in the antenna for 5G related patent landscape



## IP LANDSCAPE OVERVIEW

Geographic map of patent applications



and the concept of "5G" were not define and antenna (around 60GHz) for cellphones and publications has known a huge increase with a

entry -- and is then extended to other countries.

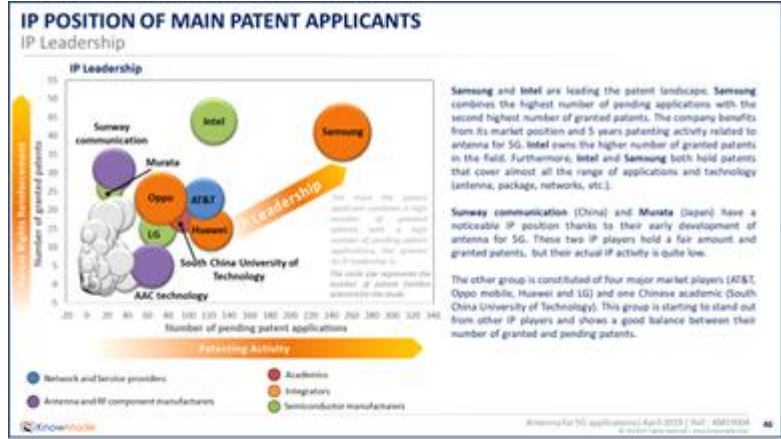
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IP activity. Especially, we notice a high number of Chinese academic published and highly competitive. The high number of academics could of European or US academics seem to deny this hypothesis. Thus, the (e.g. Samsung, ZTE, Huawei and Oppo mobile). Apple and Xiaomi have

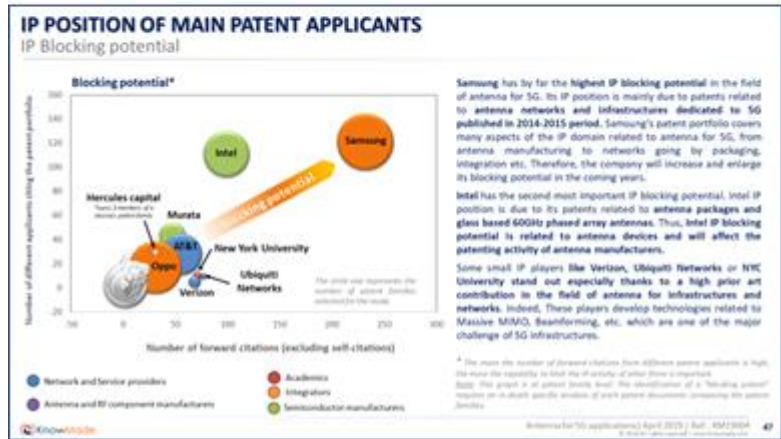
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# Comparison of IP players

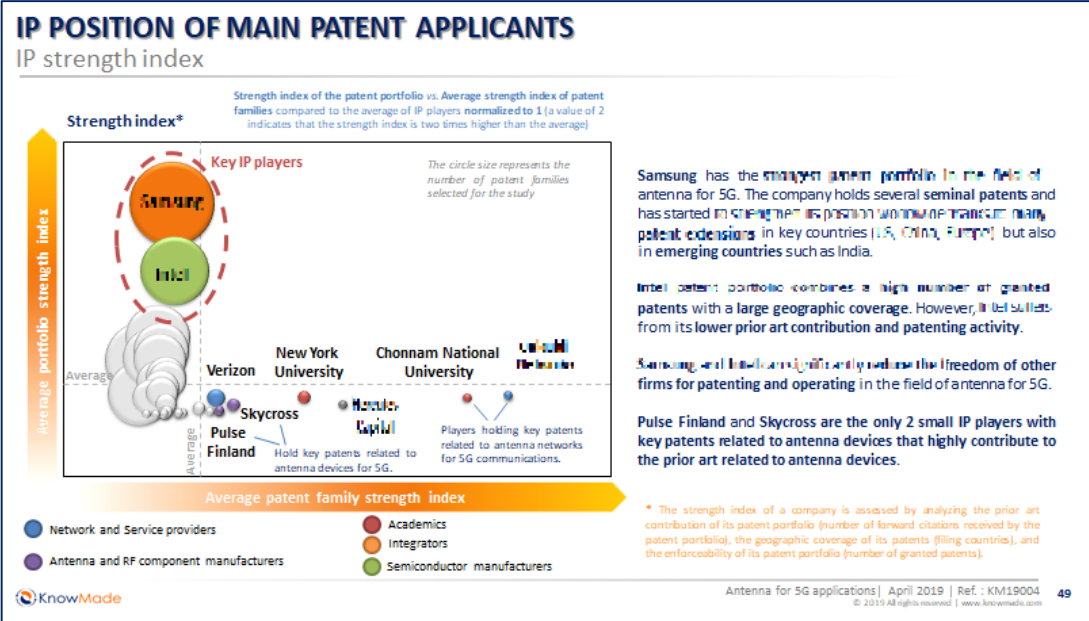
Portfolios analysis and ranking: who has the strongest IP position and why?



IP leadership



Blocking potential



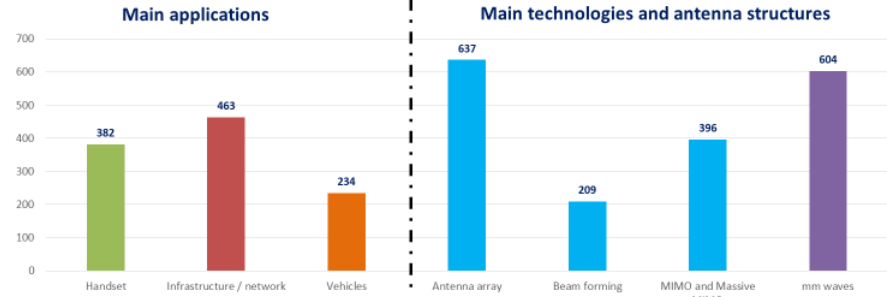
# Understanding the competitive landscape by application or technology

## Corpus segmentation by application, Antenna operation and Antenna technologies

SAMPLE

### PATENT SEGMENTATION

Patents categorized by applications, technologies and antenna structures



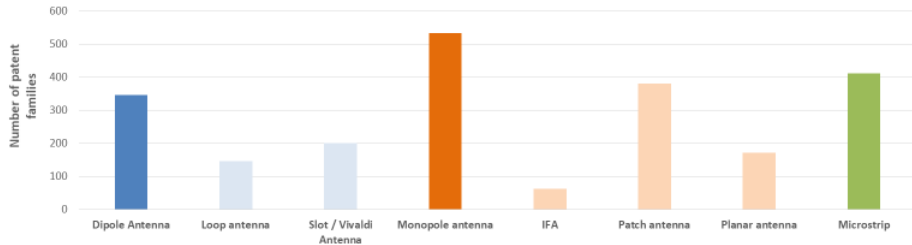
In this report we have segmented the corpus into the main applications, structures, frequency bands and antenna type. The segmentation has been performed manually.

- For the main applications, patents mentioning one or more applications in their description have been selected.
- For the antenna structure, only patents claiming the use of an antenna array and/or devices supporting either MIMO or Beamforming have been selected.
- Finally, all patents describing an antenna device that is or could be used in the mm-wave range have been selected.

### ANTENNA TYPE

Patent segmentation

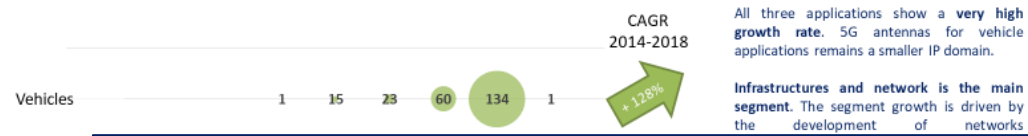
Antenna types mentioned in the patents



- Monopole antenna is the most mentioned antenna types in patent related to antenna for 5G. Especially, PIFA and patch antenna are often used for their small form factor and easy manufacturing.
- Dipole antenna and related sub segments (Loop, slot or Vivaldi antenna) are mainly mentioned in patents related to infrastructures and networks.

### APPLICATIONS OF ANTENNA FOR 5G

Time evolution of patent family publications per main application



All three applications show a very high growth rate. 5G antennas for vehicle applications remains a smaller IP domain.

Infrastructures and network is the main segment. The segment growth is driven by the development of networks

### APPLICATIONS OF ANTENNA FOR 5G

Main patent assignees per application



2010  
Current blocking IP players (Enforceable patents)  
Current active IP players (High number of patent filings)

### APPLICATIONS OF ANTENNA FOR 5G

IP strength index

Strength index of the patent portfolio vs. Average strength index of patent families compared to the average of IP players normalized to 1 (a value of 2 indicates that the strength index is two times higher than the average)

The circle size represents the number of patent families for the application

Samsung is the strongest IP players. The company combines a strong prior art contribution and a high number of enforceable patents in all key countries (China, US, Europe). Samsung's IP strength mainly comes from its portfolio related to

### APPLICATIONS OF ANTENNA FOR 5G

Key patents per application

Category	Handsets	Infrastructures / Networks	Vehicles
Seminal patents	US20150121019 - Miniaturized inverted-L-shaped ground type ultra wide band millimeter wave multi-input multi-output (MIMO) antenna structure (SAMSUNG ELECTRONICS)	US20150121019 - Apparatus and methods for transmitting wireless signals (SAMSUNG ELECTRONICS)	US20150121019 - Antenna and method for vehicle (SAMSUNG ELECTRONICS)
	US20150121019 - Dual frequency on-f antenna and mobile terminal (SAMSUNG ELECTRONICS)	US20150121019 - Car feedback for multi wireless communication systems with antenna array (SAMSUNG ELECTRONICS)	US20150121019 - Vehicle-mounted double antenna communication method (SAMSUNG ELECTRONICS)
	US20150121019 - A multi-antenna system for mobile handsets with a polarized metal back case (SAMSUNG ELECTRONICS)	US20150121019 - Method and apparatus for ensuring channel state information in antenna array (SAMSUNG ELECTRONICS)	US20150121019 - Antenna apparatus and vehicle having the same (SAMSUNG ELECTRONICS)
Blocking patents	US20150121019 - Mobile terminal and antenna structure thereof (SAMSUNG ELECTRONICS)	US20150121019 - Method for multi-input multi-output communication in large scale antenna system (SAMSUNG ELECTRONICS)	US20150121019 - Antenna and method for vehicle (SAMSUNG ELECTRONICS)
	US20150121019 - Samsung metal ring antenna structure (SAMSUNG ELECTRONICS)	US20150121019 - Multi-stage beamforming of multiple-antenna communication system (SAMSUNG ELECTRONICS)	US20150121019 - Broadband antenna in the truck and for vehicle (SAMSUNG ELECTRONICS)
	US20150121019 - Antenna apparatus for mobile terminal (SAMSUNG ELECTRONICS)	US20150121019 - Array antenna having a plurality of directional beams (SAMSUNG ELECTRONICS)	US20150121019 - Antenna and vehicle having the antenna same (SAMSUNG ELECTRONICS)
Promising patents	US20150121019 - Antenna device of mobile terminal and mobile terminal (SAMSUNG ELECTRONICS)	US20150121019 - 2D active antenna array operation for wireless communication system (SAMSUNG ELECTRONICS)	US20150121019 - Method and apparatus for 2D active antenna array operation in vehicular communication system (SAMSUNG ELECTRONICS)
	US20150121019 - Electronic device with millimeter wave antenna (SAMSUNG ELECTRONICS)	US20150121019 - Method for multi-input multi-output communication in large scale antenna system (SAMSUNG ELECTRONICS)	US20150121019 - Communication device and antenna with integrated light emitting diode (LED) (SAMSUNG ELECTRONICS)
	US20150121019 - Antenna structures and methods thereof that have disparate operating frequency ranges (SAMSUNG ELECTRONICS)	US20150121019 - Multi-stage beamforming of multiple-antenna communication system (SAMSUNG ELECTRONICS)	US20150121019 - Broadband antenna in the truck and for vehicle (SAMSUNG ELECTRONICS)



# Understanding and comparing the key players IP strategies

## Key player portfolio analysis

SAMPLE

### IP PROFILES OF KEY PLAYERS

Oppo mobile – IP overview



P strategy



IP player with a strong IP activity

Oppo Mobile is an **emerging IP player**. Indeed, the company has a large number of patent families but most of them are very young and its IP portfolio is composed of **pending applications**. Furthermore, Oppo Mobile players to adopt a **domestic IP strategy**. Indeed, Oppo's patent portfolio is mostly composed of **Chinese patents**.

Contrary to other main IP players, Oppo's IP activity focuses on the sub 6GHz range (4-6GHz) and using **digital beamforming** (DBF) and **IMR** compatible with **MIMO** operations. Thus, Oppo on **well known and matured solutions**. Oppo's IP activity is specific to 5G (mmWave, sub 6GHz) and is **increasing rapidly** and **diversifying**.



### IP PROFILES OF KEY PLAYERS

Oppo mobile – Recent patenting activity



Oppo's recent patenting activity is related to **antenna design for mobile terminal**. Knowmade has also identified one interesting patent related to **antenna design for mobile terminal** but the activity remains marginal.

**US20190147111A1**  
Antenna device for mobile terminal and mobile terminal

And

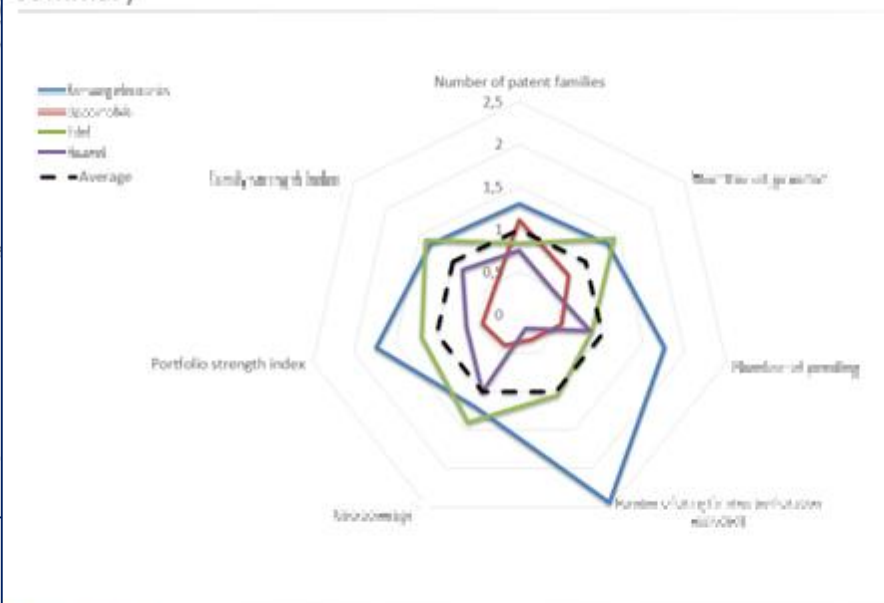
**US20190147111A1**  
Antenna device for mobile terminal and mobile terminal

**US20190147111A1**  
Antenna device for mobile terminal and mobile terminal



### IP PROFILES OF KEY PLAYERS

Summary



**Huawei** is the IP leader and the main blocking IP player thanks to its strong prior art contribution in the field (high number of citations). However, its patent families are **stronger than Oppo's**. Indeed, **Apple** has the **highest number of granted patents** and a higher family strength index showing its portfolio quality.

**Huawei** and **Oppo** are two new IP challengers with two different IP strategies. On one hand, **Oppo** has already **numerous patent families** but the company has not started to extend its portfolio **abroad** and thus suffers from a low family strength index. On the other hand, **Huawei** has a lower number of patent families but the company has started to **strengthen its position with patent extensions in key market areas**.



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# ORDER FORM

## Antenna for 5G and 5G-related applications

Patent Landscape Analysis – April 2019

Ref.:KM19004

### SHIP TO

Name (Mr/Ms/Dr/Pr):

Job Title:

Company:

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State:

Postcode/Zip:

Country:

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IBAN: FR76 1460 7003 6360 6214 5695 139  
BIC/SWIFT: CCBPFRPPMAR

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BIC or SWIFT code: CCBPFRPPMAR

IBAN: : FR76 1460 7003 6360 6214 5695 139

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.

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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.

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## 5. FORCE MAJEURE

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- Posting any Product to any other online service (including bulletin boards or the Internet);

- Licensing, leasing, selling, offering for sale or assigning the Product.

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## 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.

# KNOWMADE

## Patent and Technology Intelligence

# WHAT WE DO

Knowmade helps customers to understand the **competitive landscape**, follow **technology trends**, and find out **opportunities** and **threats** in terms of **technology** and **patents**.

- Interpreting the **competitive landscape** and **technology developments** throughout **patents** and **scientific information**.
- Turning **patents** and **scientific information** into **business intelligence tools** that give you the capability to
  - Understand your **competitive environment**
  - Be ahead of **technology trends**
  - Identify patent & technology **opportunities**
  - Assess patent & technology **risks**
  - Define your **IP** and **R&D strategy**
  - Monetize your **technologies** and know-how
  - Defend your **business**

➤ Strong **technology expertise** with an in-depth **knowledge of patents**.

➤ Highly **specialized** analysts in the following sectors:

## Electronics, Telecommunications and Photonics

Compound semiconductors, Power electronics, Batteries, Memories, RF electronics, Wireless communications, Solid-state lighting & display, Photonics, MEMS Sensors & Actuators, Semiconductor manufacturing, Packaging & Assembly.

## Life Sciences, Healthcare and Agri-Food

Medical devices, Medical imaging, Microfluidics, Biotechnology, Pharmaceuticals, Food-processing

Patents  
Technologies  
Prior art  
Scientific findings  
Opportunities  
Partners  
Competitors  
Newcomers  
M&A targets



Patent landscape analysis  
Scientific review  
IP portfolio assessment  
Patent valuation  
Freedom-to-operate analysis  
Litigation & licensing support  
Patents linked to products  
Technology scouting  
Technology trends  
Competitive IP landscape  
Market trends  
Reverse engineering

Make strategic decisions  
Sustain competitive advantages  
Speed R&D and enhance innovation process  
Align R&D and IP with key business objectives  
Strengthen IP portfolio and acquire technologies  
Anticipate risks and defend core businesses  
Explore new opportunities and monetize IP



# WHAT WE PROPOSE



**Dedicated analyses**

Tailor-made analyses to meet your business needs and budgetary constraints



Patent Landscape Analysis  
 Patent-to-Product Mapping  
 Patent Portfolio Analysis  
 Patent Monitoring Service

**Off the shelf reports and analyses**



**Workshops and trainings**

Tailor made to respond your requests  
 Direct interaction between your team and our experts at your site





# WHAT IS OUR ADDED VALUE

## Patent Search

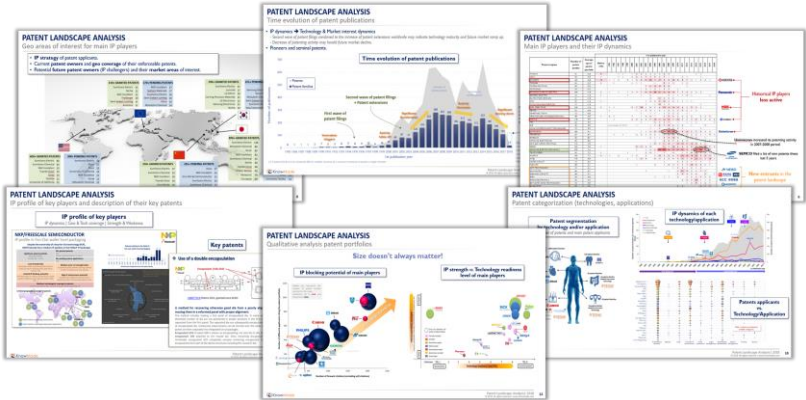
- ✓ **Strong technical expertise of our analysts with PhD degree**
  - Comprehensive search queries and keywords
  - Manual selection of relevant and related patents
  - Manual segmentation by technology & application

## Analytics

- ✓ **State of the art statistical tools**
- ✓ **Innovative methodologies to deliver relevant IP analysis**
- ✓ **Business oriented data representation and graphics**

## Results Analysis

- ✓ **Technical expertise**
  - Highly specialized analysts in your field
  - Benefit from knowledge capitalization
- ✓ **In-depth IP analysis combined with market data and reverse engineering \***
- ✓ **Customer support**



\* Our partners



# CUSTOM STUDY & CONSULTING

## Tailor-made analysis to meet your needs and budgetary constraints

### Prior art search

Evaluate the patentability of your invention in the course of a patent filing.

Invalidate competitor's patents in the course of patent litigation or in anticipation of one.

Make third-party observations concerning the patentability of competitor's inventions.

### Patent landscape analysis

Understand the competitive environment and the technology trends from a patent perspective.

Identify key players, their IP strategy and their key patents.

Know IP collaborations, licensing agreements and litigation history.

### Freedom-to-operate analysis

Assess the risks to infringe third-party patents.

Ensure that your products/processes can be safely manufactured, sold and used in specific countries without infringing patents held by others.

### Litigation and licensing support

Evidence of infringement/non-infringement for offensive/defensive support.

Defend your position in licensing negotiation or patent litigation.



### Patent assessment

Identify most valuable patents prior to patent acquisition/sales, licensing agreement, capital fundraising process, M&A or IP due diligence.

Estimate the financial value of your patent portfolio.

### IP due diligence

Assess the patent portfolio of a company and reveal the SWOT matrix prior to patent acquisition/sale, licensing agreement or M&A.

### Scientific literature analysis

Pinpoint key research findings and new emerging research fields, key laboratories and scientific experts, industrial/academic research collaborations, and identify prospective R&D partners.

### Technology scouting

Identify, qualify and get access to external innovation.

### IP & Technology watch service

Follow IP/technology trends, keep a watch on your competitors and identify new entrants, anticipate the changes, early detect business opportunities and mitigate the risks.

# OFF THE SHELF REPORTS

## « Pre-packaged » analysis

Knowmade team of experts work all year long to collect patent and scientific information, identify and analyze the trends, the challenges, the emerging technologies, the competitive environments, and turn it into results to give you a complete picture of your industry landscape.

Every year, Knowmade publishes a comprehensive collection of reports in various technology fields. These fact-based analyses can provide you with the reliable information you need to advance your business and your competitive position.

The collage consists of the following reports:

- PATENT LANDSCAPE ANALYSIS: Geo areas of interest for main IP players** (Page 1): Includes a world map and lists of granted and pending patents for various countries like the USA, Europe, and Japan.
- PATENT LANDSCAPE ANALYSIS: Time evolution of patent publications** (Page 2): A bar chart showing the number of patent publications from 1985 to 2018, highlighting waves of innovation and activity.
- PATENT LANDSCAPE ANALYSIS: Main IP players and their IP dynamics** (Page 3): A table and chart showing the activity of major patenting companies like Intel, Samsung, and Qualcomm.
- PATENT LANDSCAPE ANALYSIS: IP profile of key players and description of their key patents** (Page 4): Focuses on NXP/Freescale Semiconductor, detailing its IP profile and key patents like double encapsulation.
- PATENT LANDSCAPE ANALYSIS: Patent segmentation by technology and/or application** (Page 5): A chart showing the IP dynamics of various technologies and applications.
- PATENT LANDSCAPE ANALYSIS: Qualitative analysis patent portfolios** (Page 6): A bubble chart comparing the IP blocking potential and technology readiness of main players like Intel, Samsung, and Qualcomm.
- PATENT LANDSCAPE ANALYSIS: Patent categorization (technologies, applications)** (Page 7): A chart comparing the number of patents and main patent applicants across different categories.

# PATENT MONITORS

Take advantage of periodic updates on IP activities



## CONTENTS

### Monthly IP database (Excel file)

- New patent applications
- Patents newly granted
- Patents expired or abandoned
- Transfer of IP rights (re-assignment, licensing)
- Patent litigation & opposition

### Quarterly report (PDF slide deck)

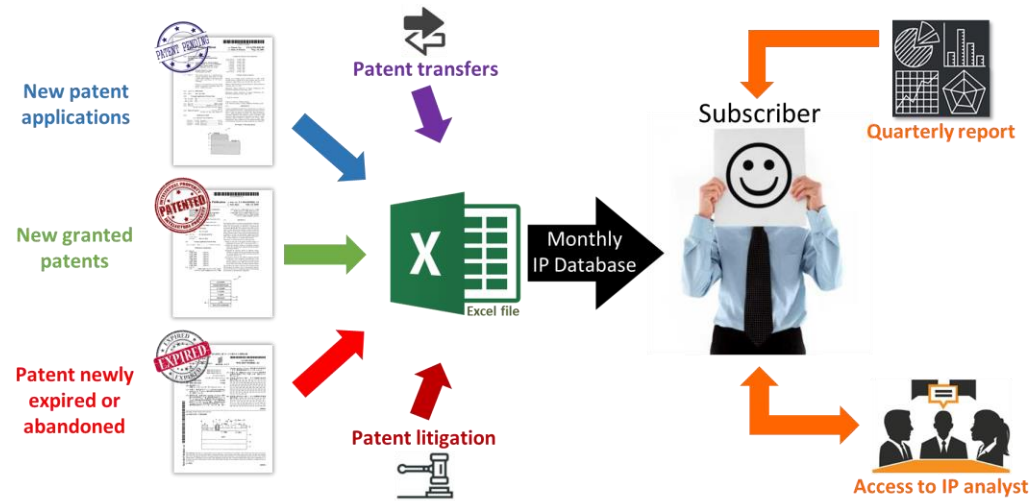
On a quarterly basis, this report will provide the IP trends over the three last months, with a close look to key IP players and key patented technologies.

### Access to IP analysts (100h a year)

On-demand Q&A and discussion session with our analysts on specific patented technologies or company IP portfolios

## ANNUAL SUBSCRIPTION

30 000 € per unit



## PATENT MONITORS 2019

- GaN Power & RF
- GaN Opto & Photonics
- Li-ion Battery
- Post Li-ion Battery
- Solid-State Battery
- RF Acoustic Wave Filter
- RF Power Amplifier
- RF Front-End Module
- Microfluidics

*If you are interested in more than one monitor or by an other topic, please contact us.  
contact@knowmade.fr | www.knowmade.com*

## WHY YOU SHOULD SUBSCRIBE

- ✓ Track your **competitors**, partners or clients
- ✓ Identify **newcomers** to your technology field
- ✓ Early detect **opportunities** and risks for your business strategy
- ✓ Be ahead of **technology trends**
- ✓ Identify emerging research areas and **cutting-edge technology** developments
- ✓ Mitigate patent **infringement risks**
- ✓ Take advantage of **free technologies**



KnowMade SARL  
2405 route des Dolines  
06902 Sophia Antipolis, France

[www.knowmade.com](http://www.knowmade.com)  
[contact@knowmade.fr](mailto:contact@knowmade.fr)