

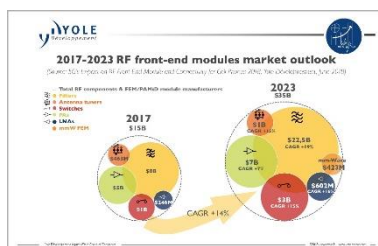


## FOR IMMEDIATE RELEASE:

### 2018, a new year for RF FE module market

Extracted from: 5G's Impact on RF Front-End Module and Connectivity for Cell Phones Technology & Market report, Yole Développement, July 2018 - RF Front-End Module Comparison report, System Plus Consulting, April 2018 - RF Acoustic Wave Filters Patent Landscape Analysis and RF Front-End Modules For Cellphones Patent Landscape from Knowmade, January 2018.

**LYON, France – July 16, 2018:** Telecom revolution taking place at the early 21st century has led to impressive innovations, especially at the devices level. “We are today at the first step of 5G implementation,” asserts **Paul Leclaire, Patent & Technology Analyst at Knowmade**. “5G comes with strong technology challenges that reshuffle the cards and change the competitive landscape.” The RF FE<sup>1</sup> modules market will be so highly impacted by new 5G standard. According to [Yole Développement \(Yole\)](#), it is expected to reach US\$35.2 billion in 2023.



Yole Group of Companies including Knowmade, [System Plus Consulting](#) and Yole combine their expertise to propose today a comprehensive analysis of the RF front-end module industry. They mix their knowledge of the RF FE ecosystem, their

understanding of the IP landscape and their analysis of the today's RF technologies to detail the industry evolution and highlight the technology trends. Yole Group of Companies affirms today its market positioning on the RF FE sector with four dedicated reports:

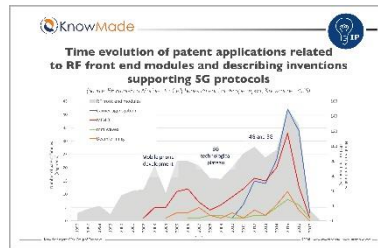
- [5G's Impact on RF Front-End Module & Connectivity for Cell Phones Market & Technology](#)
- [RF Front-End Module Comparison](#)
- [RF Front-End Modules for Cellphones Patent Landscape](#)
- [RF Acoustic Wave Filters Patent Landscape Analysis](#)

With technology & market, IP, reverse engineering & costing reports in addition to dedicated strategy consulting services, the Yole Group aims to propose a clear understanding of the RF FE industry with relevant answers to the questionings of the industrial leaders.

How is 5G enabling new business opportunities? Who has the most to win/lose with 5G implementation? What will the impact on the RF FE market? Analysts of the Yole Group of Companies invite you to discover a complete vision of the boiling RF FE world.

<sup>1</sup> FE : Front-end

RF FE modules market, along with the WiFi connectivity sector, is showing an impressive 14% CAGR<sup>2</sup> between 2017 and 2023. The related IP landscape is dominated by the market leaders. The rapid deployment of Chinese companies with significant R&D activities pushes other players to actively expand and protect their inventions and market. Therefore, IP strategy is critical for insuring the companies a leading market position in the coming years. Knowmade's team



proposes today two dedicated patent landscape analyses focused on RF FR industry: RF Front-End Modules for Cellphones report and RF acoustic wave filters report. Both patent landscapes are detailed on [Knowmade corporate website](#).

“Under a positive evolution, LTE<sup>3</sup> evolution clearly is the first growth wave”, explains **Cédric Malaquin, Technology & Market Analyst at Yole**. “However most of the market opportunities in the mid-term will come from 5G NSA<sup>4</sup> radio, which became prevalent in late December 2017<sup>5</sup>. Therefore, the need for dual connectivity implies evolution on RF<sup>6</sup> frontend architecture and additional components.”

“Not all components will exhibit equal market growth,” adds **Claire Troadec, Director, Power and Wireless, at Yole**. “Filters, which represent the RF front-end industry’s biggest market segment, will almost triple from 2017 - 2023.” Yole’s analysts explain, this growth will come mainly from the significant penetration rate of high-quality BAW<sup>7</sup> filters, which will be required for the ultra-high frequency range defined by 5G NR<sup>8</sup>. Another example is co-existence filters for diversity antenna-sharing with Wi-Fi, since rejection band will be critical.

LNA<sup>9</sup> market is expected to grow at a 16% CAGR with the implementation of the diversity module, along with integration in power amplifier modules for handsets. The switch market will enjoy the same growth due to the addition of a new RF path with 4x4 MIMO implementation, which will lead to more diversity switch needs. The antenna tuner market is also expected to record significant growth with 4X4 MIMO technology’s penetration. It is worth noting that 4x4 MIMO will be mandatory for 5G. PA<sup>10</sup> will be the sole market to remain almost flat over this period. High-end LTE PA market growth, especially in high and ultrahigh band, will compensate for the 2G/3G market’s shrinkage (currently, this market is handled by MMMB<sup>11</sup> PA)...

<sup>2</sup> CAGR : Compound Annual Growth Rate

<sup>3</sup> LTE: Long-Term Evolution

<sup>4</sup> NSA : Non-Stand-Alone

<sup>5</sup> As defined in 3GPP during release 15

<sup>6</sup> RF : Radio Frequency

<sup>7</sup> BAW : Bulk Acoustic Wave

<sup>8</sup> NR : Noise Reduction

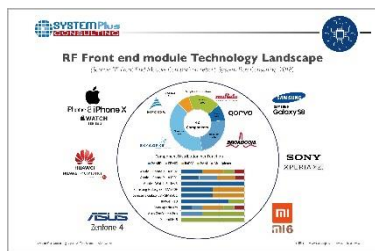
<sup>9</sup> LNA : Low Noise Amplifier

<sup>10</sup> PA : Power Amplifier

<sup>11</sup> MMMB : Multi-Mode Multi Band

A detailed description of RF FE modules report from Yole is available on [i-micronews.com](http://i-micronews.com), [RF electronics report](#).

“2018 is a new year for RF Front-End Module suppliers, and a turning point for some smartphone-making OEMs<sup>12</sup>”, announces **Dr. Stéphane Elisabeth, Project Manager at System Plus Consulting**. “In 2017, we saw an important choice in adopting PAMiDs<sup>13</sup> that distinguished high-end and mid-range smartphones.” Today, the distinction between these categories is becoming wider as companies work towards 5G wireless communication protocols. High-end OEMs are seeking new ways to integrate more capabilities into one device, which creates space on printed circuit boards for 5G components in the future.



At the same time, isolation techniques for all FE communication devices are getting better, in a market with high-quality competitors... System Plus Consulting's analysts conducted the relevant comparative technology

study, RF Front-End Module Comparison, focused on 10 flagship smartphones, 40 FE modules as well as other RF components. Aim of this study is provide valuable insights and technical data on the technical choices made by the leading smartphones manufacturers and compare integration technologies. Content of this comparative analysis is available on [System Plus Consulting website](#).

Yole, Knowmade and System Plus Consulting, all part of Yole Group of companies will attend [European Microwave Week](#) (September 23-28 - Madrid, Spain). Yole Group will also present its vision of the RF FE module industry during the RF Electronics session at SEMICON Europa (November 13-16 – Munich, Germany). Agenda will be available soon on [i-micronews.com](http://i-micronews.com).

Ask for a meeting with our experts right now! Contact: [Léonor Martin](#), Marketing & Communication Assistant, Yole Group of Companies



In addition, the Wireless Technologies for 5GS webcast powered by Yole Group of Companies is still available. Make sure to watch it and get a deep understanding of RF electronics innovations. [More on i-micronews.com](http://i-micronews.com).

Stay tuned on the RF Electronics world!

<sup>12</sup> OEM : Original Equipment Manufacturers

<sup>13</sup> PAMiD : Power Amplifier Module integrated Duplexer

## ABOUT THE RF ELECTRONICS REPORTS:

### 5G'S IMPACT ON RF FRONT-END MODULE AND CONNECTIVITY FOR CELL PHONES

*How is 5G enabling new business opportunities despite flat mobile growth? – Produced by Yole Développement (Yole).*

#### Companies cited in the report:

AIROHA, Akoustis, Alcatel, Alcatel-Lucent, Analog Devices Inc. (Hittite), Amazon, Amkor, Apple, ASE Group, ASUS, AT&T, BLU, Broadcom Ltd. (Avago Technologies, Javelin Semiconductor), Brocade, Cavendish Kinetics, Cisco, China Mobile, China Telecom, China Unicom, Coolpad, DelfMEMS, Ericsson, Fujitsu, GLOBALFOUNDRIES, Gartner, Gionee, Google, Facebook, HTC, Huawei (HiSilicon), Infineon, Intel, IPDIA, JCET/STATS ChipPAC, KDDI, KT, Kyocera, Lava, Lenovo, LG, LG U+, MACOM, Marvell, Maxim Integrated, Mediatek, Microsoft, Mitsubishi Electric, Motorola, Murata Manufacturing Company, Nokia, NEC, NTT Docomo... [Full list](#)

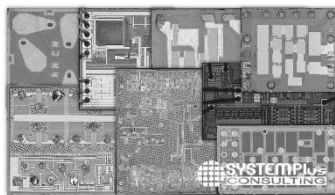


#### Authors:

- As a Technology & Market Analyst, specialized in RF devices & technologies within the Power & Wireless division at Yole Développement (Yole), **Cédric Malaquin** is involved in the development of technology & market reports as well as the production of custom consulting projects. Prior his mission at Yole, Cédric first served Soitec as a process integration engineer during 9 years, then as an electrical characterization engineer during 6 years. He deeply contributed to FDSOI and RFSOI products characterization. He has also authored or co-authored three patents and five international publications in the semiconductor field. Cédric graduated from Polytech Lille in France with an engineering degree in microelectronics and material sciences
- **Claire Troadec** is Director, Power and Wireless, at Yole Développement (Yole) where she has been a member of the MEMS manufacturing team since 2013. Claire graduated from INSA Rennes in France with an engineering degree in microelectronics and material sciences. She then joined NXP Semiconductors, and worked for 7 years as a CMOS process integration engineer at the IMEC R&D facility. During this time, she oversaw the isolation and performance boost of CMOS technology node devices from 90 nm down to 45 nm. She has authored or co-authored seven US patents and nine international publications in the semiconductor field. Claire also managed her own distribution company before joining Yole Développement.

### RF FRONT-END MODULE COMPARISON

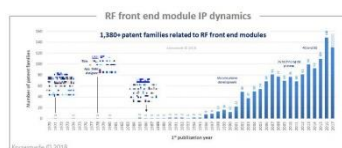
*Extensive overview of 40 RF Front-End modules and components found in 10 flagship products... – Produced by System Plus Consulting.*



**Products analyzed in the report:** the Apple Watch Series 3, Apple iPhone 8 Plus, Apple iPhone X, US and European versions, Samsung Galaxy S8+, US and European versions, Huawei P10, Asus Zenfone 5 Pro, Sony XZs and Xiaomi Mi6...

#### Authors:

- **Dr. Stéphane Elisabeth** has joined System Plus Consulting's team in 2016. He has a deep knowledge of Materials characterizations and Electronics systems. He holds an Engineering Degree in Electronics and Numerical Technology, and a PhD in Materials for Microelectronics.
- **Nicolas Radufe** is in charge of physical analysis at System Plus Consulting. He has a deep knowledge in chemical and physical analyses. He previously worked in microelectronics R&D for CEA/LETI in Grenoble and for STMicroelectronics in Crolles, France.



### RF FRONT-END MODULES FOR CELLPHONES PATENT LANDSCAPE

*Which players show an active patenting activity to stay in and win the 5G race? - - Produced by Knowmade.*

**Companies cited in the report:** Qualcomm, Broadcom, Skyworks, TDK, Murata, Nokia, Intel, Qorvo, ST Ericsson, LG Innotek, Samsung Electronics, Mediatek, Sony, RFAxis, Huawei,

Renesas, Samsung Electro Mechanics, Motorola, ZTE, NXP, LG Electronics, Foxconn, Nec, Hitachi, Sony Ericsson Mobile Communications, Panasonic, Infineon Technologies, Texas Instruments, Analog Devices, Toshiba, Maxlinear, Apple, Taiyo Yuden ... [Full list](#)

### **RF ACOUSTIC WAVE FILTERS PATENT LANDSCAPE ANALYSIS**

*SAW and BAW filters are key components of today's mobile communication modules thanks to their small size, low cost and high performance. But who has the best IP position for the upcoming 5G protocol? – Produced by Knowmade.*

**Companies cited in the report:** Murata Manufacturing, Taiyo Yuden, Skyworks, Kyocera, Broadcom, Hitachi, Qualcomm/NXP, TDK, Toyo Communication Equipment, Samsung, LG, Seiko Epson, Qorvo, Nihon Dempa Kogyo, NEC, Epson, Sanyo, Siemens, Mitsubishi, Japan Radio, NGK, CTS, Intellectual Ventures, Philips, Thomson, UBE Industries, Intel, Wisol, Alps Electric, Zenith Radio, NGK Spark Plug, Sony, STMicroelectronics, CEA, Clarion, Institute of Acoustics – Chinese Academy of Sciences, Texas Instruments, Beijing Zhongxun Sifang Science Technology, Chinese Electronics Technology Research Institute, Motorola, Tianjin University, Jiangsu Changjiang Electronics Technology, MEMS Solution, NTT, Northrop Grumman, Canon, Ericsson, Clarisay, Resonant... [Full list](#)

#### **Authors of both Knowmade's reports:**

- **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.
- **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



#### **ABOUT KNOWMADE**

Knowmade is a Technology Intelligence and IP Strategy consulting company specialized in analysis of patents and scientific information. The company supports R&D organizations, industrial companies and investors in their business development by helping them to understand their IP environment and follow technology trends. KnowMade is involved in Compound Semiconductors, Power Electronics, RF & Microwave Technologies, LED/OLED Lighting & Display, Photonics, Memories, MEMS & Sensors, Manufacturing & Advanced packaging, Batteries & Energy management, Biotechnology, Pharmaceuticals, Medical Devices, Medical Imaging, 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. In parallel the company proposes litigation/licensing support, technology scouting and IP/technology watch service. Knowmade's analysts combine their technical and patent expertise by using powerful analytics tools and proprietary methodologies to deliver relevant patent analyses and scientific reviews.

More info on <http://www.knowmade.com> and follow Knowmade on [Linkedin](#).



#### **ABOUT SYSTEM PLUS CONSULTING**

System Plus Consulting specializes in the cost analysis of electronics, from semiconductor devices to electronic systems. Created more than 20 years ago, System Plus Consulting has developed a complete range of services, costing tools and reports to deliver in-depth production cost studies and estimate the objective selling price of a product. System Plus Consulting engineers are experts in Integrated Circuits – Power Devices & Modules – MEMS & Sensors – Photonics – LED – Imaging – Display – Packaging – Electronic Boards & Systems. Through hundreds of analyses performed each year, System Plus Consulting offers deep added-value, reports to help its customers understand their production processes and determine production costs. Based on System Plus Consulting's results, manufacturers are able to compare their production costs to those of competitors. System Plus Consulting is a sister company of Yole Développement (Yole). More info. on [www.systemplus.fr](http://www.systemplus.fr)

#### **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 80 collaborators worldwide

covering MEMS & Sensors - Imaging - Medical Technologies - Compound Semiconductors - RF Electronics - Solid State Lighting - Displays - Photonics - Power Electronics - Batteries & Energy Management - Advanced Packaging - Semiconductor Manufacturing - Software & Computing - Memory and more...

The “More than Moore” market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO and KnowMade, support industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business. . For more information, visit [www.yole.fr](http://www.yole.fr) and follow Yole on [LinkedIn](#) and [Twitter](#).

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Yole Développement, System Plus Consulting, Knowmade, PISEO and Blumorpho are part of Yole Group of Companies.

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