5G will totally redefine how the radio frequency (RF) front-end interacts in-between the network and the modem. Indeed, new radio frequency bands, sub-6 GHz, and mm-wave (as defined in 3GPP release 15) pose big challenges for the industry. However, with these challenges comes opportunity to disrupt the market’s leadership.

On the sub-6 GHz side, the current front-end leaders (Broadcom, Qorvo, Skyworks, and Murata) have already begun adapting to these changes. Broadcom prepared for the arrival of 5G ultra-high band by integrating mid and high bands together. And with its FBAR BAW filter technology, Broadcom also owns the main critical building block for the high and ultra-high frequency bands. Skyworks is positioned on the 5G ultra-high band market with its newly announced Sky5TM platform. Moreover, the company has already earned some design wins in the high-end segment with its SkyOneR LiTE platform, in addition to the low-end segment with its leading position among Chinese OEMs (Huawei, Oppo, Vivo, Xiaomi).

Qorvo has a similar approach, with a broad product portfolio covering the high-end and low-end segments with its RF FusionTM and RF FlexTM platforms, respectively. Another Qorvo strength is its internal test and packaging capability, which enable quick reaction time and continuous improvement. Notably, Qorvo was the first player to unveil a front-end module for ultra-high band coverage.

Murata mostly covers the low band, but is very well positioned for the growing, diversity module market. Qualcomm is the new entrant that brings with it an end-to-end solution from modem to antenna. Also, strategic investment in TDK Epcos’ filtering technology has become profitable. The first revenue was generated in the RF front-end segment during 2017. We can expect further revenue to come in the near future. A first mobile phone (i.e. Sony’s XZ2) already adopted Qualcomm’s complete solution.

Along with sub-6 GHz, the mm-wave front-end module will completely disrupt the front-end industry, representing a completely different technology mindset that could create a new path to high data-rate access. While Qualcomm is one of the new entrants clearly positioned for mm-wave technology, all of the top platform providers (i.e. Intel, Samsung, HiSilicon, and Mediatek) are exploring this new business opportunity.

The sub-6 GHz radio band will always be required for radio coverage and link integrity, but complexity could drop in the sub-6 GHz regime with mm-wave technology’s arrival, especially in dense urban areas when the mm-wave network is deployed. The mud fight has already begun.

5G - WHO HAS THE MOST TO WIN (AND LOSE)?

From the lte race to the 5G mud fight
5G offers a bigger market opportunity to the RF front-end industry...

The mobile handset RF front-end market, along with the WiFi connectivity sector, is expected to reach $35.2B in 2023 at a CAGR of 14%. LTE evolution clearly is the first growth wave (as we stated in our 2017 report), but most of the market opportunities in the mid-term will come from 5G non-stand-alone (NSA) radio, which became prevalent in late December 2017 (as defined in 3GPP during release 15). The need for dual connectivity (i.e. the 5G new radio (NR) band attachment to the LTE) implies evolution on RF front-end architecture and additional components.

Not all components will exhibit equal market growth. Filters, which represent the RF front-end industry’s biggest market segment, will almost triple from 2017 - 2023. This growth will come mainly from the significant penetration rate of high-quality BAW filters, which will be required for the ultra-high frequency range defined by 5G NR. Another example is co-existence filters for diversity antenna-sharing with Wi-Fi, since rejection band will be critical.

The LNA 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.

Power amplifier (PA) will be the sole market to remain almost flat over this period. High-end LTE PA market growth, especially in high and ultra-high band, will compensate for the 2G/3G market’s shrinkage (currently, this market is handled by multi-mode multi band (MMMB) PA).

...but complexity for the RF front-end should be expected too.

LTE evolution has led to complex architecture in today’s mobile phones, mostly due to carrier aggregation. Meanwhile, RF’s board area and available antenna space have been reduced, leading to a densification trend with more handset OEMs adopting power amplifier modules and implementing new technics, i.e. antenna-sharing between LTE and WiFi. In the low-frequency band, the inclusion of the 600 MHz band (for which T-Mobile recently acquired licenses) will pose new challenges for low-band antenna design and antenna tuners.

5G will add even more complexity, with new radio bands released in ultra-high frequencies (N77, N78, N79). This first field is being addressed by Skyworks and Qorvo via a new product release, as explained in this flyer’s first section. Band re-farming (early bands are N41, N71, N28, N66, with more to come) with dual connectivity will also contribute to increasing constraint for the front-end. More densification in front-end modules will be required to enable new band integration, which is the approach followed by Broadcom with its innovative mid/high band module.

Another new 5G requirement will be 4x4 MIMO implementation, which will turn from a “nice to have” luxury on LTE high-end mobile phones to a “must-have” for every 5G handset. This will add a significant amount of RF streams in the handset, and combined with carrier aggregation requirements will lead to more complex specifications for antenna tuners and multiplexers.

Last but not least is the implementation of the mm-wave module into the handset - a topic that poses many challenges, ranging from antenna array integration (taking into account radiating efficiency and hand-blockage effects) to power amplifier efficiency, since antenna gain cannot be too high given the low number of antenna array elements allowable in the handset format. While still at the R&D level, great progress...
has been made on these mm-wave front-end silicon-based platforms, demonstrating record power efficiency and noise level improvement. Bulk CMOS is preferred by Qualcomm, with TSMC’s 28nm platform. Other possible platforms include SiGe and RFSOI, for example with GLOBALFOUNDRIES’ capability.

With this new mm-wave connectivity for cell phones, we are entering an exciting new era of technology competition and breakthrough performance. This will seriously impact RF front-end’s bill of materials, and could be useful for reducing overall connectivity cost. Who then will be the first OEM to implement this technology when it’s ready? Could it be Chinese OEMs like Huawei and Vivo, with their strong market dynamics and appetite for differentiation/competition with market leaders like Apple and Samsung? Or will it be the current leaders, who are always first to innovate?

For this latest chapter, let’s not forget that Samsung has always been very keen to utilize innovative connectivity solutions: for example, they were the first to implement 4x4 MIMO solutions (on the S7 in 2016).

Get ready to place your bets!

COMPANIES CITED IN THE REPORT (non exhaustive list)

Related reports
• Advanced RF Sip for Cellphone 2017
• Broadcom AFEEM-8072
• RF Front End Modules for Cellphones - Patent Landscape Analysis
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LINKED REPORT
RF Front-End Module Comparison 2018 - Structural, Process and Cost Report by SystemPlus Consulting
Extensive overview of 40 RF Front-End modules and components found in 10 flagship products, including the Apple Watch Series 3, iPhone 8 and X, Samsung Galaxy S8, Huawei P10, Asus Zenfone4 Pro, Sony XZs and Xiaomi Mi6.

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