WHITEPAPER

Enabling the Growing 5G mmWave Ecosystem Using Silicon mmWave ICs

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PUBLISHED BY:

FierceWireless

The advent of 5G mobile networks will change our relationship with data and the way we work and live. No longer an edge technology, as 5G begins to roll out, many organizations are closely scrutinizing the ways the technology can be utilized for their unique needs — present and future.

5G networks will provide dedicated high-speed bandwidth, which is low-latency, power-efficient, ultra-reliable, and entirely wireless. 5G networks will incorporate support for time-sensitive networking[1], a technology that enables existing Ethernet and 5G networks not only to coexist but also to converge and function as a cohesive network, exchanging data seamlessly over the disparate components that make up their combined infrastructure.

Over the next five years, 5G will become so cost-effective that both new and existing facilities will be able to forgo wired infrastructure entirely and rely solely on 5G for the traffic that currently flows through copper wire, fiber optics, cellular repeaters, and Wi-Fi routers and hubs. mmWave antennas that are scalable in size and performance are critical to the successful roll-out of 5G services, and at the heart of these antennas is mmWave silicon technology.[2]

The Growth of 5G and mmWave Technology

Despite the advances in 4G LTE, cellular networks are struggling to keep up with the rapidly increasing demand for bandwidth[3] The solution provided by 5G networks creates more bandwidth by using frequencies in the millimeter-wave range — a vast swath of unused radio space between 24 and 100 GHz.

Frequencies in this mmWave spectrum will be used extensively by 5G networks. This spectrum will be utilized because the amount of bandwidth available in the mmWave ranges far surpasses 4G and previous wireless networking technologies. The global mmWave technology industry held market value over $220.5 million in 2018, a figure which jumped to nearly $300 million in 2019[4]

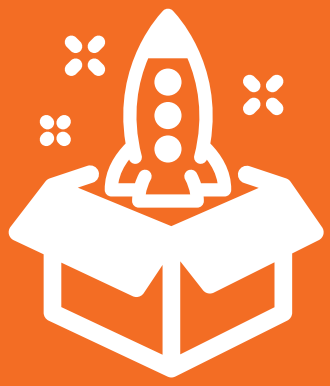
The 5G network is expected to have the fastest rollout of any cellular technology in history. This rollout is expected to go to the mass market in 2020. Some analysts project that market value will reach $3.25 billion within the next five years, representing a compound annual growth rate of 40.4 percent.

Consumer interest is piqued, and device manufacturers like HTC, LG, Motorola, and Samsung have already released 5G-capable phones for early adopter consumers eager to harness the power of mmWave technology[5] Use cases for frequencies in this newly available range has increased by a factor of five, as consumer and enterprise solutions are continually developed to take advantage of mmWave capabilities. Some industry analysts predict that 5G will be available to 40 percent of the global population by the end of 2024 — a faster rollout than even that of LTE[6]

Providers Spending Billions on mmWave Spectrum

Verizon, AT&T, T-Mobile, and other large telecommunications providers are already showing a clear and sustained commitment to 5G and mmWave technology. Since 2017, carriers have either spent or committed to spend nearly $14 billion on mmWave frequencies through acquisitions or via spectrum made available by FCC auctions. Verizon's purchase of XO Communications for $1.8B, that included a large amount of mmWave spectrum assets, in 2017[7] and Straight Path for $3.1B in 2018[8] started these large investments on mmWave spectrum. AT&T followed suit with the acquisition of FiberTower for $207M in 2018[9]. Each of these companies owned valuable spectrum in the 28 GHz and 39 GHz bands.

Auction 101 in 2018 for additional spectrum in the 28 GHz band resulted in $702M in winning bids, with Verizon winning the majority of spectrum in this auction[10]. Auction 102, for spectrum in the 24 GHz band, followed in 2019 raising $2B in bids with AT&T and T-Mobile winning the majority of these licenses[11]. Auction 103,



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the FCC's latest auction of mmWave spectrum resulted in $7.6B in proceeds with winners yet to be announced[12] These considerable expenditures show the clear continuation of earlier commitments to the technology by telecommunications providers: Operators across North America had already invested heavily in the years leading up to the launch of 5G by spending over $100 billion on spectrum acquisition in the last five years.

Backhaul and the Limitations of Fiber Technology

Globally, the demand for backhaul is being driven by a significant increase in the number and use of connected devices. Both AT&T and Verizon have already turned to Integrated Access and Backhaul (IAB) technology to address this potential bottleneck[13] IAB provides a reliable alternative to traditional backhaul over fiber by using the same mmWave infrastructure and spectral resources for access and backhaul data traffic.

IAB allows for the communication of many different small cells to relay traffic over mmWave with the same beam technology made possible by antenna arrays. These arrays are small enough to be deployable in traffic or street lights, alongside existing communication equipment, or anywhere an electrical connection is present. IAB enables providers to install 5G antennas in locations where routing fiber cables would be prohibitively expensive, such as across train tracks or powered rails.

The Importance of Silicon IC Technology for 5G

The underlying architecture of 5G network infrastructure is considerably different from earlier generations of cellular and wireless networks, in large part because of the nature of mmWave frequencies. mmWave frequencies don't reach as far or penetrate quite as much as earlier technologies. To account for this drop-off in signal range, novel techniques are needed for mmWave 5G antennas that will achieve higher signal strength at mmWave frequencies.

5G network infrastructure is composed of many more smaller cell sites or base stations to compensate for this. Within these cells, many small antennas are arranged and used in arrays to create

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highly focused, directional, and steerable three-dimensional antenna beams in a process known as “beamforming.” A critical piece of the hardware responsible for transmitting these beams is IC technology. As 5G relies on beamforming, it — and the devices capable of it — will rely on the right silicon IC components.

Unlocking the Full Potential of 5G With Integrated Chipsets

Sourcing integrated chipsets capable of handling the demands of the various new devices that will be designed for the 5G environment will become critical to the successful production and deployment of those devices. Chipsets that are robust, affordable, and capable of meeting the exacting requirements of mmWave operation will be in high demand.

As new parts of the spectrum become available, new use cases will arise to take advantage of the high-speed, low-latency, and ultra-reliable connections made possible by 5G and mmWave technology. These new use cases will require intelligent, adaptable antenna array solutions built on integrated silicon solutions.

Anokiwave: Pioneering mmWave Solutions

Anokiwave, a fabless semiconductor company dedicated to providing industry-leading IC solutions for next-gen mmWave applications, is meeting the challenges presented by the high demands of 5G technology. Their innovative, unique ICs support multiple steerable three-dimensional beams and the antenna arrays required to produce them, both in terms of size and thermal capacity. This beamforming technology is necessary for the highly directional transmission and reception made possible by 5G and mmWave infrastructure.

The advanced digital capability of Anokiwave’s silicon ICs supports the new developments that power 5G and mmWave innovation. The 5G ecosystem requires software-controlled, continually shaped and optimized antenna arrays, distributed IAB-capable base stations, and, in the case of installation infrastructure, devices housing hundreds of small, integrated antennas. Handsets and other mobile devices housing dozens of similar antennas are also required.

Conclusion

Existing 5G and mmWave communication capabilities are enabling operators to launch 5G networks with unprecedented reach and potential. Not only are the major providers already working toward seamless nationwide coverage, but the consumer’s electronics manufacturers are also bringing new devices to market to capitalize on the potential of 5G. For that reason, the infrastructure necessary for robust mmWave utilization will see increasing deployment.

5G promises unprecedented speed, reliability, and security of data traffic, but only if devices using the right integrated chipset solutions are utilized. Components that are prohibitively expensive, unable to cope with thermal demands, or unavailable in different configurations

could slow the growth of the 5G network and its widespread adoption.

Integrated chipsets will be the most critical components of the new hardware being designed and manufactured with the demands of 5G and mmWave technology in mind. From base stations connected to fiber backbones down to consumer handsets and mobile computing devices, the ability of the provider to reach end-users and of the end-user to utilize 5G technologies relies on silicon ICs capable of handling the rigors of this demanding new landscape. ■

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