# The Importance of a Healthy mmW 5G Ecosystem


Anokiwave

mmW Solutions. Enabling a new world

www.anokiwave.com

innovation@anokiwave.com


# Executive Summary

mmW 5G is finally becoming a commercial reality. According to the Jan 2021 GSMA report:

- Commercial 5G services have launched with 107 operators in 47 markets.
- Around 135 million connections registered by mobile operators worldwide by Q3 2020
- This adoption is expected to increase to over 1.7 billion by 2024 according to a report by Counterpoint Research.

As the market demand for mmW 5G grows, there is a greater need for market readiness and choices for equipment and devices especially using the lower profile active antenna technology. However, mmW 5G active antenna design continues to be a challenge for most OEMs, system integrators, and radio manufacturers who have largely operated in sub-6 GHz technologies, posing a steep learning curve for utilizing mmW active antennas.

Anokiwave silicon core IC technologies have been used to enable mmW 5G radio systems since 2016 and are the underpinnings of large portion of deployed 5G networks today. Since then, each year Anokiwave has released new generations of silicon ICs in all mmW 5G bands, all of which are in volume production and used by industry's leading players in fielded radios. Anokiwave's ICs enable industry's best performing, smallest form factor, lowest cost, and lowest DC power mmW 5G radios.

To further accelerate this mmW 5G market growth, Anokiwave is now introducing scalable mmW active antenna solutions and partnerships with multiple baseband companies. Anokiwave continues to lay a path for the industry to adopt mmW active antennas at a commercial scale and make mmW 5G a reality for all.

# Table of Contents


Executive Summary ..... 2

The Importance of a Healthy mmW 5G Ecosystem ..... 4

mmW Phased Array Antenna Experience ..... 6

Creating A Healthy mmW Ecosystem Structure ..... 8

Conclusion ..... 9

*5G will be a game changing technology with significant economic impact. According to recent data from IHS Markit, the 5G value chain will deliver $3.8 trillion in economic output by 2035. As 5G develops, companies are expected to look beyond connectivity and collaborate across the value chain leading to new business models and innovation over multiple sectors ranging from transport, media, education, health, energy, as well as traditional connectivity, with lightning-fast speed and improved network reliability.*

# The Importance of a Healthy mmW 5G Ecosystem

by Ke Lu, Anokiwave, Inc.

Fifth Generation (5G) cellular wireless systems promise higher wireless performance levels than ever before, using wide bandwidths at millimeter-wave (mmW) frequencies. Those systems are spreading rapidly to meet the ever-rising needs of growing wireless users and now things, in the form of billions and possibly trillions of Internet of Things (IoT) sensors, that will require connectivity to the Internet. Current 4G wireless systems simply ran out of bandwidth for the growing numbers of wireless users and devices. Worldwide wireless users are hoping that a 5G New Radio (NR) telecommunications ecosystem that extends into the mmW frequency range can provide the bandwidth for near zero-latency communications and instantaneous access to wireless voice, data, and video communications almost anywhere.

Users of available 5G NR systems are starting to see the improvements compared to earlier cellular wireless generations. 5G service providers such as AT&T, Verizon, and T-Mobile are leveraging bandwidths at mmW frequencies and are demonstrating impressive Internet access rates. 5G NR systems are offering download speeds of about 8Gb/s for digital files, or about 100 times faster than what is possible with 4G LTE networks. Such faster wireless network speeds allow the download of a large video file, such as a full movie, in mere seconds on a 5G NR network versus minutes on a 4G network.

*mmW 5G systems will provide bandwidth and speed to meet the demands of wireless users and billions and possibly trillions of Internet of Things (IoT) sensors, that will require connectivity to the Internet.*

Development of 5G NR networks extending into the mmW frequency range has been in progress for years, since the shortcomings of 4G LTE became apparent for growing numbers of wireless users. Major service providers such as Verizon have been erecting the infrastructure for their 5G NR Ultra-Wideband (UWB) networks at a steady and rapid pace to provide 5G service in 32 cities within the U. S. by the end of 2019 and in 60 U. S. cities by the end of 2020. 5G NR networks are being built in two configurations, as non-stand-alone (NSA) and stand-alone (SA) networks. In NSA 5G networks, 5G infrastructure will be built on top of existing cellular network equipment, and some of that earlier equipment and spectrum will be reused for dynamic spectrum sharing (DSS). In SA 5G networks, the 5G infrastructure equipment will operate on its own, without relying on any previously installed infrastructure equipment.

Of course, wireless cellular communications infrastructure capable of operation at 24 GHz and higher requires dependable electronic components and technology operating at frequencies that have previously been used only within niche markets, such as for military electronic systems. But interest in the use of mmW frequency bands has been growing with 5G networks, as signified by growth in the annual sales of mmW electronic components exceeding 100% since 2018.

For the 5G ecosystem to support the massive numbers of expected users and interconnected IoT devices, it will rely heavily on the commercialization of mmW frequency bands, such as bands n257 (26.50 to 29.50 GHz), n258 (24.25 to 27.50 GHz), n260 (37.0 to 40.0 GHz), and n261 (a subset of band n257, from 27.50 to 28.35 GHz). These 3GPP frequency bands are sometimes referred to as “capacity layers” for 5G NR

*With mmW 5G rapidly expanding, the number of use cases for mmW electronically steerable antennas is growing at an exponential rate. Antennas that are scalable in size and performance are critical, and at the heart of these systems is mmW silicon technology.*


5G brings innovation over multiple sectors with lightning-fast speed and improved network reliability.

networks since they add so much bandwidth and capacity to 5G networks compared to earlier cellular wireless generations.

The wide usage of UWB and other mmW systems demands the wireless industry to further enhance its ability to innovate on multiple fronts: it must build a healthy ecosystem to encourage innovation, drive down the cost to increase market penetration, and expand use cases to create value and improve user experience.

To achieve these goals, the industry must adopt the thinking "Handset Technology for Infrastructure™" meaning innovative fast turn platforms in high volume with high quality and low cost are a key to commercialization of mmW networks.

## Building the Ecosystem - Step 1: mmW Phased Array Antenna Experience

The use of mmW frequencies in 5G NR networks opens generous swaths of bandwidth for low-latency voice, data, and video communications. Advanced antenna systems (AAS) are essential components for the successful implementation of indoor and outdoor 5G NR networks at mmW frequencies. mmW antennas at 24 GHz and higher frequencies must use different approaches than antennas for lower frequencies. At mmW frequencies where signal energy is limited, electromagnetic (EM) transceivers typically work with multiple antennas, as in multiple-input, multiple-output (MIMO) setups, or with phased-array antennas capable of forming directional beams to send and receive signals. Phased-array antennas use beamforming and beam-tracking techniques to adjust the amplitudes and phases of multiple antenna elements in an array and to direct EM energy within a narrow beam to and from a user.

Because phased-array antennas focus electronically rather than mechanically like many other types of tuned antennas, they make effective transmission and reception of mmW signals where signal power is limited, as in 5G NR networks. The design of such antennas is not trivial and requires knowledge of many electronic elements, including high-frequency transmission lines and printed-circuit-board (PCB) materials, as well as a systems understanding of the antenna. Fortunately,

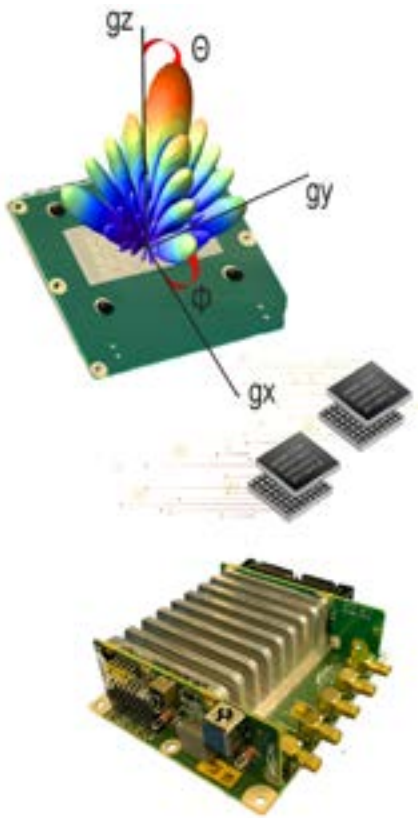
*Successful mmW 5G systems employ the concept of "Handset Technology for Infrastructure™" with innovative fast turn platforms in high volume with high quality and low cost.*

companies like Anokiwave have been developing high-performance, commercial integrated-circuits (ICs) for 5G NR phased-array antennas as well as mmW ICs for aerospace/defense, and SATCOM markets for some time. Si-based system-on-chip (SoC) active devices such as beamformers from Anokiwave provide the electronic control of antenna element amplitude and phase needed for focusing phased-array antennas, both for traditional applications such as in military radar systems and for emerging applications such as 5G systems.

The design knowledge and experience integrated into Anokiwave's different antenna and beamformer SoCs help speed and ease the development of the mmW portions of 5G wireless networks, especially for engineering partners more familiar with the lower-frequency, baseband parts of those networks.

To further ease the adoption of systems in the 5G mmW frequency bands the ICs are available as parts of Antenna Innovator Kits. The kits include reference designs as examples on how to use the ICs in a practical 5G phased-array antenna. As an example, the AWA-0213-PAK Phased Array Innovator's Kit (PAK) includes an assembled antenna array based on the company's Gen-3 beamforming ICs and up/down converter ICs. The PAK contains a dual-polarized array with integrated local oscillator (LO). It is capable of two-transmit/two-receive (2T2R), half-duplex MIMO operation with high EIRP over wide 3GPP bandwidths. This kit is intended to help 5G equipment manufacturers evaluate the array level performance of Anokiwave ICs, develop new mmW 5G NR radio front ends, and introduce their arrays into the market quickly.

Anokiwave's engineering expertise is available to 5G system developers needing to know more, at both circuit and antenna levels. Anokiwave offers an array of products and services to partner with customers at each step of the array design. At the System Engineering level, system requirements are defined as well as architectures and trade-offs understood. Array and board level designs give developers a complete solution with board stack-up, routing, layout, and digital control signaling. The 5G beamforming and up/down converter ICs cover every mmW band in 5G, and are production ready to be shipped and deployed in commercial volumes. They offer the highest dB linear power per channel, best in class receive sensitivity, low




*Anokiwave's AWA-0213-PAK is a complete scalable dual polarization Phased Array Antenna Front End providing high linear EIRP at wide 3GPP bandwidths.*

DC power, and patented ZeroCal® to eliminate array calibration.

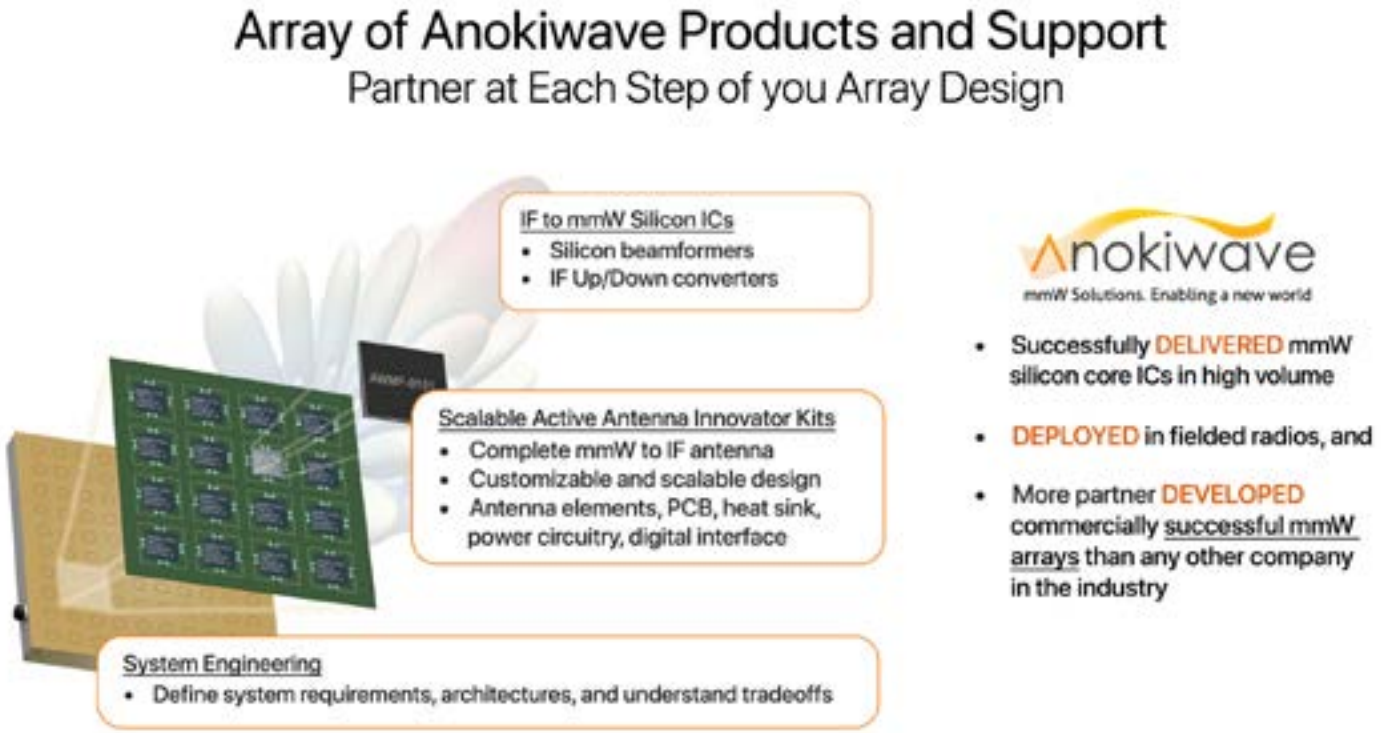
## Building the Ecosystem - Step 2: Creating A Healthy mmW Ecosystem Structure

The expansion of 5G as an UWB “next generation” wireless solution will depend on a reliable mmW ecosystem as made possible with phased-array antenna SoCs. In fact, an open 5G NR ecosystem that can be supported by any number of suppliers will ease the operation of baseband and mmW components within 5G system applications. The 5G NR wireless radio components market is currently dominated by large companies bundling baseband and mmW front-end electronics. While such large companies can be dependable sources of much-needed radio solutions for 5G NR systems, a lack of specialty companies within a 5G NR ecosystem may limit innovation as 5G NR extends to the masses at mmW frequencies. Fortunately, innovative companies such as Anokiwave can address this challenge by continuously showing the path forward by offering products that enable their partners to establish reliable yet differentiated mmW antenna array capabilities.


*As 5G NR extends to the masses at mmW frequencies, a healthy 5G ecosystem is supported by many suppliers with innovative solutions.*

By working with multiple baseband partners, Anokiwave can support end-to-end mmW solutions for 5G NR wireless systems. A healthy 5G NR ecosystem will consist of a layered structure with multiple companies per layer, including system-level companies to integrate different sections, such as the mmW antenna array, high-frequency transceiver, and baseband modem, into a final product.

As time has shown with lower frequencies, shared resources and practical competition can help drive innovation for component solutions. Working with a baseband modem supplier, for example, helps to develop and produce a baseband SoC modem for 5G NR that meets 3GPP specifications while working with a mmW phased-array SoC supplier can lead to the development of phased-array SoCs for 24- 28- or 39-GHz 5G system use. Integrated solutions such as SoCs from Anokiwave can provide practical UWB solutions for 5G NR wireless networks operating through mmW frequencies.




Anokiwave offers partners and customers a rich set of tools that enable quick entry into the mmW 5G ecosystem

## Conclusion

As the mmW services expand beyond infrastructure into small cell radio units and CPE, an ecosystem is required that combines the hardware and software necessary for complete solutions. The flexibility to optimize the array for different use cases is important as the needs vary from application to application. Collaboration between companies supplying essential parts of this ecosystem will enable the compatibility of hardware and software that allows this flexibility and enables the mass adoption of mmW 5G.

*Anokiwave powers the 5G link with the industry's most complete portfolio of Silicon mmW ICs shipping in volume for use in deployed radios - enabling intelligent, scalable 5G antenna arrays.*

www.anokiwave.com