BUILDING 5G SMALL CELLS WITHOUT COMPROMISING PERFORMANCE

Before small cell technology took its place as a central component to realizing the promise of 5G networks, it played an important role in helping to improve the coverage and capacity of 4G. These mini base stations could be installed in discrete locations like on buildings or streetlights and became part of heterogeneous networks—together with traditional macro base stations—to improve service in high-traffic locations such as sporting events and concert venues. In this pursuit, small cells have proven valuable for extending signal penetration and increasing wireless density and these small, lightweight devices will continue to be a key technology for the data-intensive transition to 5G.

Small Cells and the mmWave Spectrum

One of the ways we'll overcome the capacity limitations to accommodate 5G innovations is by operating in the mmWave band. But the physics of this higher frequency spectrum presents a dilemma. In terms of capacity and speed, it fits the bill for the high data rate promise of 5G, but it has range limitations and an inconvenient inability to penetrate walls. These constraints are why it hasn't been seriously considered for cellular networks before now. Enter small cells and their proximity to end users, and we have a path forward for taking advantage of the mmWave.

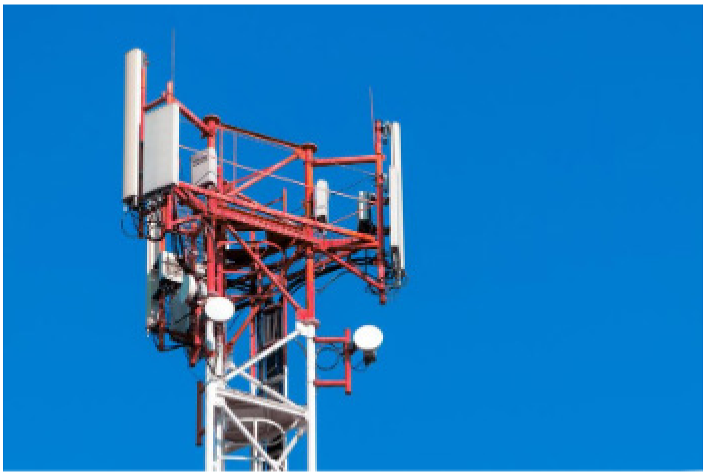
Building high-performance mmWave radios in a form factor to accommodate small cell installation and operation brings its own set of engineering challenges. Weight is important because these small cells are being deployed on existing infrastructure and need to be light enough not to compromise the supporting structure. Thermal plays a role as well, both internal temperature and external. In such a small form factor there's no room for fans to cool off the electrical components or the large fins required for heat sinks. Extreme climates need to be accounted for as well, and the smaller the housings of these units are, the more external temperatures affect the electronics inside.

In a typical base station or macrocell, you're likely to find a 256-element, 28-GHz array. In these larger configurations, cost and footprint are less of a consideration, and they may have a lot of components tucked in there, including an antenna assembly, feed network, beamforming ICs, RF filters, RF switches, RF amplifier, mixer, and transceiver.

So how do you compress the radio design into a 180mm X 200mm small cell without compromising performance? By decreasing the complexity of the design, reducing the number of RF components, and by getting as much functionality as possible into a single tile.

Passive Components in a 28-GHz Small Cell

Size and performance are important considerations for bandpass filters and power dividers, so let's look at how to approach integrating them into a small cell tile. For filtering in space-constrained tiles, the amount of board area available for passive components is important. If you have to move components to a separate card, you'll increase the size of your tile and bring down performance. As the signal moves from the transceiver into the beamforming network ICs, power dividers are required to split the signal. Feed networks should be implemented between the beamforming ICs, further complicating the component. For a deeper look at the considerations for building feed networks and the different methods for structuring power dividers, check out our Microwaves & RF article.



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Calculating Effective Isotropic Radiated Power (EIRP)

Finally, EIRP is an important factor in the performance of a 5G antenna system. We want to make the most out of the power available, which means minimizing loss. In the equation below for EIRP in a beamforming antenna, you can use three factors to optimize EIRP, all of which have an impact on the overall system: element TX power (P_out), the number of elements (N_elem), and individual Element Gain (Elem_gain):

$$\text{EIRP(dBm)} = \text{P\_out(dBm/element)} + \underbrace{10*\text{LOG}_{10}(\text{N\_elem})}_{\text{BF Gain}} + \underbrace{\text{Elem\_gain(dB)} + 10*\log_{10}(\text{N\_elem})}_{\text{Antenna Gain}}$$

Improvements in active component design advance the cause of mmWave small-cells, but not at the expense of careful passive-element selection. Effective implementation can reduce both the size and overall cost of the system, and the right passive components lay the groundwork for a successful small cell through efficiency at every stage of design.

For a more detailed look at how the design of passive components can help address the challenges of small cell development, listen to our webinar on the topic.

Watch Webinar

If you need help, please contact us and we can guide you through the process.

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