SKYWORKS®

Top 10 Small Cell Infrastructure Questions

Understanding the Trends and Challenges for Today's Small Cells and How Power-Efficient Power Amplifiers Can Help Overcome Them

It shouldn't come as a surprise that demand for small cell networks is on the rise. After all, small cells offer a cost-effective solution for filling data capacity gaps and getting networks ready for 5G without the need to build more expensive macro sites. There is a catch, however. These benefits come with increased design challenges; namely, how to address heat issues, Power-over-Ethernet (PoE) requirements and the need for wider instantaneous bandwidths, in addition to any associated impact on carrier operating cost and reliability.

Overcoming these design challenges, among others, will be critical to reaping the true benefits of small cells for infrastructure applications. And that's where the power amplifier (PA) comes in — a notoriously power-hungry, small cell component that has the potential to help the industry overcome many of these emerging challenges. This Q&A seeks to shed light on some of the key trends and challenges in the small cell market, while also focusing on the PA's role in overcoming these challenges.

1. What are small cells, and why do we need them?

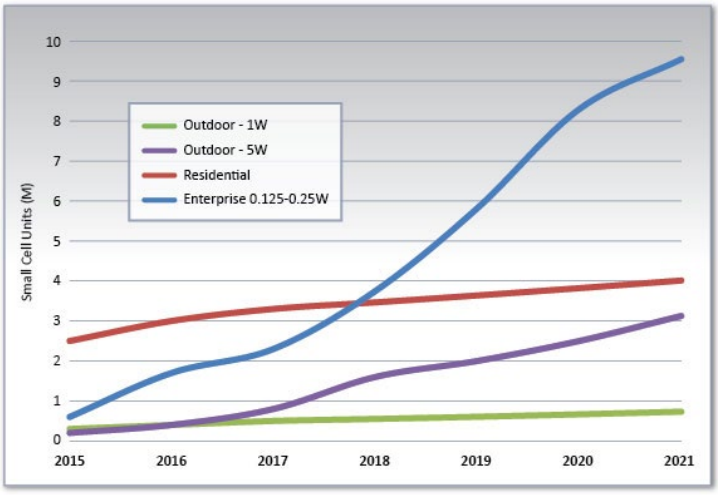
Small cells are relatively low-cost and easy-to-deploy low-power radio access nodes with a typical range of 10 to several hundred meters. They can be used in the home, an office, and commercial, retail or outdoor public space to improve data capacity and connectivity for end users.

We need small cells because, as a society, we are consuming more and more content (i.e. upcoming 8K video and virtual/augmented reality) on an ever-increasing number of devices. Cellular and wireless networks already feel the strain from all that data, and the problem will only worsen in coming years as the Internet of Things (IoT) proliferates. IDC analysts predict that by 2020 there will be an estimated 28 billion connected IoT devices. Small cells offer a viable solution, especially for indoor applications where most of the heavy data usage occurs.

2. What are some of the key uses of small cells?

The majority of the capacity usage occurs in enterprise indoor applications, so this is one of the key areas where small cells are needed to cost effectively fulfill the data capacity demand.

Another potential use for small cells is to be the enabler of the Citizens Band Radio Service (CBRS), which was recently established by the FCC for shared wireless broadband use of the 3.5 to 3.7 GHz band. When deployed using small cells, the 3.5 GHz CBRS technology provides mobile operators a way to supplement the coverage and capacity of their licensed services and increase throughput data rates to customers. It also allows enterprises and venue owners to augment the user experience, while enabling new use cases.



[1] Source: Skyworks and Mobile Experts

Figure 1. Enterprise is driving small cell growth

3. What's driving the growth in the small cell market?

According to a recent MarketsandMarkets research report, increasing demand for higher-bandwidth spectrum, rising mobile data traffic on existing networks and telecom-based technological growth are all factors boosting demand for small cell networks.

Another factor driving growth of small cells is the expansion of both public and private enterprise applications (Figure 1). What makes the small cell so appealing is that it offers a simple, quick, and low-cost way to boost coverage, capacity, and service, while leveraging existing broadband connections. That benefit is all the more compelling in enterprise applications, supporting the bring-your-own-device (BYOD) trend.

4. How are small cells evolving?

Today, small cells are typically single band and MIMO capable. Next-generation small cells, however, will be multimode, multiband, and higher order modulation MIMO-capable (Figure 2). They will be smaller, lighter, and will consume less power than their predecessors, while also being more flexible and manageable. In addition, next-generation small cells are being designed from the ground up to be part of the heterogeneous network, or HetNet, a patchwork network that combines many diverse wireless data technologies operating over a wide range of licensed and unlicensed spectrum.

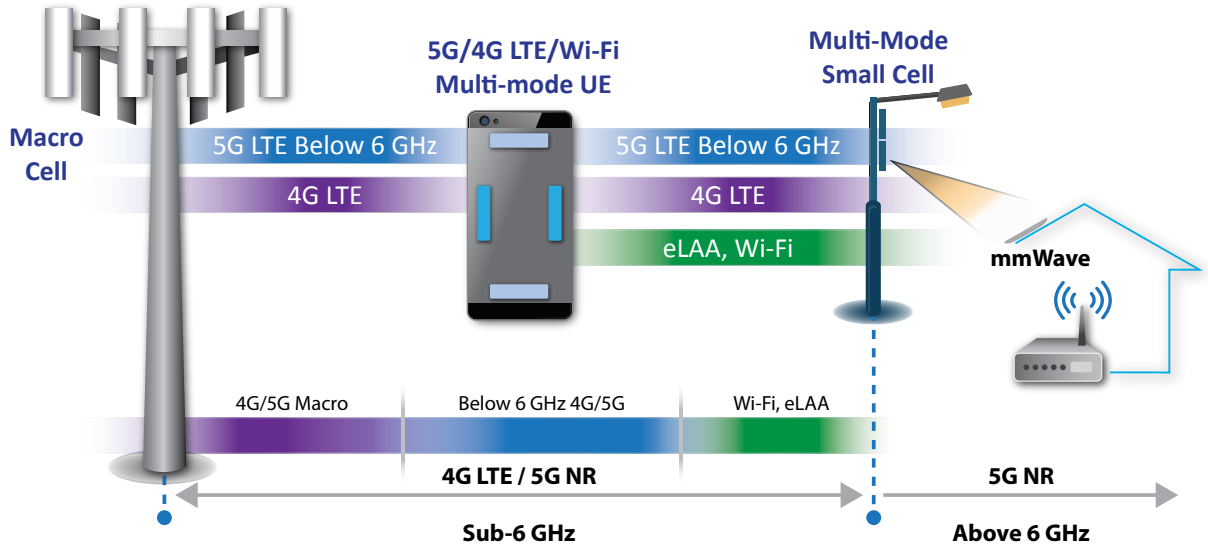


Figure 2. Next-generation small cells will consume less power, making the need for power-efficient PAs like Skyworks' SKY662xx-11 high-efficiency 4W PA family all the more critical.

5. What are some of the key trends in small cell infrastructure?

One key trend for small cells is Power-over-Ethernet (PoE), or the process of using Ethernet cabling as a backhaul and adding DC power for powering the small cell. This approach lowers the installation cost for operators as well as the total cost of the solution.

For example, while today's smartphones are theoretically able to download data at high speeds, a simple test typically reveals they are not reaching these peak speeds because of their distance from the base station. Small cells bring the base station closer to the user and, by doing so, increase throughput. Carriers want to deploy next-generation small cells in the metrocell indoors to give users the best experience they demand. And, they want to deploy them using PoE, which offers an easier, faster, cheaper way to power small cells than routing another power line.

Another trend is the stringent data rate and power consumption requirements for indoor and outdoor network systems. These requirements will become even more critical with the proliferation of IoT devices and new applications, which are creating an explosion of data and taxing existing network infrastructure and phone data capacity. One option for filling the capacity gap is to employ a combination of indoor small cells (1 Gbps peak downstream) and massive MIMO for outdoor venues (1 Gbps peak downstream) to ensure high spectral efficiency and improved coverage for cell edge users.

6. What are some of the challenges for the small cell infrastructure market?

One key challenge is heat. Small cells often run hot, and this heat degrades the operation of its parts. The heat adversely affects small cell reliability and results in increased operating cost.

Another challenge is how to power small cells. For indoor deployments such as on a wall or ceiling, as well as outdoors at the street level, PoE offers the most practical solution. However, when using PoE, there is a limit to the amount of power the small cell box can consume. That limit impacts many things, not the least of which is how many bands it can accommodate. If the small cell consumes a lot of power, only one band can be supported. If it consumes less power, three or four bands and different carriers could be supported all at the same time (via carrier aggregation) and enable higher data capacity.

Providing a single small cell that can support multiple bands (e.g., 3G, LTE, and Wi-Fi) is an additional challenge. This is being driven by the need for operators to maximize capacity while delivering high-quality voice and data connections at dense locations (e.g., a shopping mall).

7. How can PAs help address the challenges facing small cells?

In a small cell, everything comes down to heat. PAs are used to enhance signal strength and improve the network connection, thereby enhancing data transmission. They are also one of the largest contributors to power consumption and, in turn, impact how much heat is generated by the small box. If the PA consumes a lot of power, a fan, along with more metal, are required to dissipate the heat. This increases cost. It also means that very few bands can be supported in the same box. Power-efficient, or "green" PAs transmit high-power RF while consuming less power. By removing the heat, they make it possible to have multiple bands in one box and drive down operating costs — critical factors that make PAs a key enabler of small cell deployment.

Virtually any small cell would benefit from the removal of heat, whether powered by PoE or not. For example, if the small cell is using a linear PA with a lower efficiency, most of the power it is consuming is dissipated through heat and not used to produce RF power. If the small cell is powered by high efficiency PAs, the benefit comes from being able to use a smaller heatsink and removal of fans, as well as being able to accommodate multiple bands in one box.

8. Are all small cell PAs created equal?

Absolutely not. PAs are designed with different features and characteristics to enable their use in a range of applications. That is why selecting the correct PA is such a critical task. If designers do not take the time to pick the right one for their application, they may end up negatively impacting the small cells overall cost and/or performance. To avoid this problem, here are some key parameters and features to look for when selecting a PA for a small cell:

- **High-Efficiency:** Selecting a power-efficient PA will ensure it is suitable for PoE applications. It will also result in higher overall system efficiency. For comparison purposes, traditional linear PAs offer roughly 8 to 10 percent power-added efficiency (PAE), while a power-efficient PA would average 35 to 40 percent PAE.
- **Low Operating Cost:** Selecting a PA that can lower operating cost is always advantageous. One area where cost can be eliminated is in the heatsink. Power-efficient PAs require less heatsink metal and eliminate the need for fans, both of which reduce costs. Other cost savings can

SKYWORKS®

come from selecting a PA suitable for PoE applications. Using PoE eliminates the need to drill in or add more cabling to power the small cell, significantly lowering operating cost.

- **Better Reliability:** Reliability issues can dramatically impact the PA's performance and, in turn, the small cell. High heat can lead to reliability issues and degrade parts over time. Consequently, selecting a power-efficient PA that does not produce as much heat is highly advisable.
- **High-gain:** High-gain PAs improve overall system efficiency by being able to connect directly to the transceiver without having to add a pre-driver PA, which alone could consume 50 to 80 mA of power. By eliminating that block, the high-gain PA reduces power from the driver, increasing system efficiency and driving down cost.
- **Band Coverage:** There are many prevalent bands, so selecting a PA that covers the majority is a safe bet—for example, something that addresses the 700 MHz to 6 GHz range. Here again, power efficiency is critical, as it enables multiple bands and carriers to be supported in one small cell.
- **Pin-to-Pin Compatibility:** Selecting a PA from a family of PAs that are all pin-to-pin compatible and have a footprint universal to all the bands the family supports (e.g. from 700 MHz to 6 GHz) can be very attractive. It allows the designer to just copy the footprint when they are designing the PC board. Even the external bill of materials is identical because all of the key circuitry is included inside the PA multi-chip-module (MCM).

9. Will PAs play a role in 5G as well?

Yes. In fact, analysts from Mobile Experts research firm predict that over the next two years, thousands of base stations will be upgraded with massive MIMO radios. Additionally, pre-5G deployment has already begun. And, it is driving a large number of radios given that different pre-5G systems use active antenna systems (AAS) for beamforming and massive MIMO. With 5G on the horizon, infrastructure companies will increasingly require network-scalable, power-efficient, and high-performance RF solutions to meet carrier bandwidth demands. Power-efficient PAs will play a critical role in helping these companies meet those needs.

10. What do you see as the future of small cells?

Today, small-cell networks offer a way to augment existing 4G networks. In the future, they will serve as an enabler of 5G. For 5G to work, a great deal more physical infrastructure than previous technology generations (e.g., 3G, 4G, and 4.5G) will be required as macro base stations will need to be supplemented in a process known as network densification. Small cells will fill this need by providing carriers a way to densify their networks and fill in coverage gaps, especially in urban areas.

For more information about how to use power-efficient PAs to overcome the challenges of small cell infrastructure applications, please visit www.skyworksinc.com/smallcells.

Author and Contact Information

Aroonchat Chatchaikarn, Ph. D.
(Aroonchat.Chatchaikarn@skyworksinc.com)

Sr. Marketing Manager, Communication Infrastructure
Skyworks Solutions, Inc.

For more information about our solutions, please visit us at www.skyworksinc.com