



Small Cells

Good Things Come in **Small Packages**

We Got a Wave in the Air

Radio waves are part of the electromagnetic spectrum that includes ultraviolet light and cell phone signals. Think of the way light looks through a prism, with each color in the prism representing a radio wave with each band having certain qualities.¹

Cell phones, radios, and TVs all use parts of this spectrum. Some work better for some uses, but in general, wireless signals follow a **rule of thirds when it comes to the size of the antenna: height, power, and propagation.**

The higher the transmitter, the further the signal goes and the better its quality. **The more power a signal has, the further it can go and still carry the information without breaking up.**

Propagation describes the way radio waves travel when they are transmitted from one point to another. All radio waves are affected by the medium in which they travel and the way they propagate in the Earth's atmosphere.²



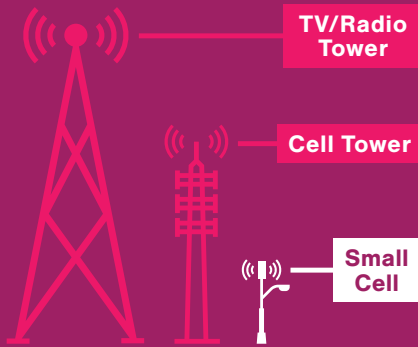
Height



Power



Propagation



Big and Bigger

Masts used by TV stations can be really, really tall — some of the tallest structures in the U.S. That's because radio waves work best by line-of-sight, and TV and radio stations need lots of power to push their signal over long distances.³

While not as tall as a TV station's, **stand-alone cell phone antennas range between 100 and 400 feet.** They don't need as much heavy equipment or the high power levels required by TV and radio stations, but they do need to receive as well as transmit. That means **they have to be close enough to someone's cell phone to pick up that signal and then send it on its way.** Cell phone antennas also need to be close enough to each other so that they can "hand off" a signal as a user goes from one cell to another.⁴

Let's Get Small

In a 5G world, there will be less dependence on old-style antennas and tall masts. 5G uses a different part of the spectrum, with different characteristics, and needs different antennas. Radio waves are often described by wavelength, the distance from one peak of the wave's electric field to the next. **5G transmissions are carried by millimeter waves that vary in length from 1 to 10 millimeters,** compared to the waves that serve today's smartphones, which measure tens of centimeters in length, or a TV station's signal that can be as long as five and a half meters.⁵

Millimeter waves are handy for 5G because they can be used over and over again since the signal doesn't travel very far and uses very little power. **Vast amounts of data can be sent over millimeter waves because they can be strung together in contiguous blocks.** These characteristics of millimeter waves and 5G technology mean that the transmitter-receiver, or base station, is tiny when compared to a conventional cell phone base station or the behemoth broadcast facilities.⁶

Their small size allows them to be placed unobtrusively on utility poles or hidden in buildings. The capabilities that make small cells attractive also require them to be placed closer together than a conventional cell phone antenna at about 275 yards apart. That means that **thousands of these tiny base stations need to be installed to form a dense network,** with each tiny base station acting as a member of a relay team.⁷

Combined with other 5G technologies, the results are:

- ✔ **Very little lag time**
- ✔ **Blazing speeds**
- ✔ **Ability to communicate with thousands of devices at once**
- ✔ **Advanced tactile capabilities making virtual and enhanced reality easier**

Small cells are a critical technology component of 5G, proving the old saying about good things coming in small packages also applies to telecommunications.

1. <https://pharmaxchange.info/2011/08/introduction-to-the-electromagnetic-spectrum-and-spectroscopy/>

2. <http://www.antenna-theory.com/intro/main.php>; https://www.ntia.doc.gov/files/ntia/publications/key_characteristics_sub-committee_final_report_nov_17_2017.pdf

3. https://en.wikipedia.org/wiki/List_of_tallest_structures

4. <https://www.steelintheair.com/cell-phone-tower/>

5. <https://spectrum.ieee.org/video/telecom/wireless/5g-bytes-millimeter-waves-explained>; <https://www.livescience.com/50399-radio-waves.html>; <http://www.csgnetwork.com/freqwavelengthcalc.html>; https://en.wikipedia.org/wiki/UHF_television_broadcasting

6. https://www.ntia.doc.gov/files/ntia/publications/key_characteristics_sub-committee_final_report_nov_17_2017.pdf; <https://www.smallcellforum.org/what-is-a-small-cell/>

7. <https://spectrum.ieee.org/video/telecom/wireless/5g-bytes-small-cells-explained>