What Is 5G?

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5G is the latest in the evolution of mobile wireless technologies. 5G goes beyond 4G LTE, and is expected to bring not just faster downloads, but a much more flexible and responsive network that can adapt to enable different uses. The benefits of next-generation wireless capabilities will reverberate throughout the economy, so it makes sense to adjust policy to spur its deployment and use.

Why Now?

New generations of mobile come in waves, requiring changes throughout the network—yes, people will need new phones to take full advantage of 5G. These improvements stem from improvements in the underlying electronics that are propelled by “Moore’s law.” The first generation of mobile telecommunications was focused purely on basic voice service. The next generation, 2G, was still focused on voice, but it made the switch to digital standards. 3G then introduced data services, expanding the functionality beyond voice to include multimedia, texting, and limited Internet access. It was not until 4G that a full specification based on Internet Protocol (IP) allowed for functional mobile broadband, in turn serving as a platform for dizzying innovation in mobile applications. These waves of technological changes have come in roughly decade-long cycles—1G mobile voice in the 1980s, 2G in the 1990s, 3G basic data in the 2000s, and 4G LTE data in the 2010s.

At the center of any generation of mobile is what is known as the radio interface. The radio interface allows the end-user device—your smartphone—to connect with the rest of the network over the air. Throughout the country, mobile operators have deployed hundreds of thousands of what are called base stations—usually white rectangular boxes a couple feet tall located on cell towers or on top of buildings. These base stations use electro-magnetic spectrum—radio waves—to send signals of encoded information to your smartphone. “Wireless” networks are mostly wired, only going wireless for the last few hundred or thousand feet. The radio interface is simply the language in that phones, tablets, or other devices use to communicate with the base station to reach the rest of the Internet.

For 4G, this radio interface technology is called Long Term Evolution, or LTE. For 5G, the standard is called New Radio, or NR—an apt if not so creative name.

Applications and Impact

The NR standard is unique in its adaptability. It is flexible enough to be applied to a variety of different application demands and a range of different spectrum bands, and it can change particular communications along a number of technical parameters for a specific purpose. 5G is been designed to achieve three broad types of use cases: (1) enhanced mobile broadband, (2) massive deployments of Internet of Things (IoT) sensors, and (3) ultra-reliable, secure connections for critical applications.

Enhanced mobile broadband is focused on a better Internet experience for users, bringing much fast-er downloads and a more responsive network. This is the use case people are most familiar with.

The IoT use case envisions 5G connecting a massive number of sensors that can monitor various factors in the built and natural environments and send alerts or control systems directly. For example, sensors could be placed along a water pipe or gas line to monitor for the beginnings of a leak, alerting a city to the need for repairs. Or consider an IoT device measuring humidity in a greenhouse. It only needs to send a tiny bit of information every few hours. The 5G NR specification allows the base station to check in only when needed and can use simple encoding that doesn’t take much processing power for the sensor to communicate. This allows for cheap sensors with long battery life—measured in years, not days. The last use-case, that of ultra-reliable critical connections, are for communications that absolutely must get through, and get through quickly. For example, for public safety, industrial robotics control, or for connected vehicles coordinating with each other.

Prospects for Continued Progress

When 5G services are fully deployed, the NR standard will be joined by other technological components. One prominent example is new equipment that uses extremely high-frequency spectrum. To visualize it, just think of spectrum as waves of energy—the same electro-magnetic energy that makes up visible light and x-rays. Engineers are able to make devices that vibrate these waves in careful ways to encode information.

You may hear about millimeter-wave spectrum, or mmWave. This spectrum is so-named because its wavelength—the size of the wave of energy—gets down the size of millimeters or smaller. Such a small wavelength allows for much smaller antennas, so lots of individual antennas can fit in a single device or on a single base station. With a large number of small antennas, engineers can essentially split up one data communication into several smaller streams and send it over multiple different antennas. These narrow beams can also be “steered” to direct the radio waves only toward the device they’re intended to reach. With these technological breakthroughs, mmWave spectrum will allow tremendous bandwidth to be apportioned to individual users, enabling gigabit speeds over wireless.

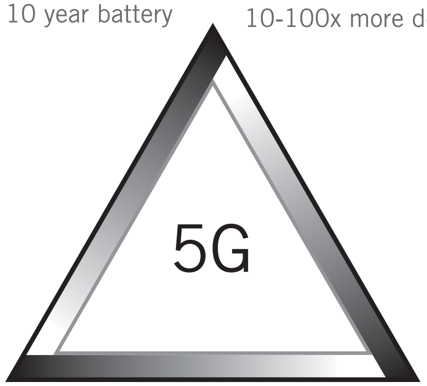
The downside to mmWave spectrum is that it comes with a higher cost to deploy. This high-frequency spectrum does not propagate as far as other spectrum, and with its tiny wavelength it is easily blocked by buildings, foliage, and urban clutter. This short propagation is why operators are looking to a new architecture known as small cells.

5G Use Cases

Massive IoT

Large Number of Connections
with Low Power, Low Cost

10 year battery | 10-100x more devices



Enhanced Broadband

Throughput Capacity

100 Mbps reliably | >10 Gbps peak

Critical Communications

Low-Latency, High-Reliability

<1 ms radio latency | 10^{-9} error rate

Policy Implications

Successful 5G deployment and use of 5G will produce tremendous economic benefits, and it is in the national interest to spur quick and broad adoption. The two main policy levers to accelerate 5G rollout are spectrum and infrastructure deployment. The FCC is making good progress in allocating more spectrum for 5G, but a lot of spectrum remains locked up with legacy technology that is not always the most efficient use.

Getting the most out of 5G technologies will require potentially hundreds of thousands of new small cells to be installed, which brings its own challenges. Policymakers are rightfully in the process of evaluating ways to streamline the permitting process and access to rights-of-way at a local level to help spur the needed infrastructure deployment for 5G.

Recommended Reading

Doug Brake, "5G and Next Generation Wireless: Implications for Policy and Competition" (Information Technology and Innovation Foundation, June 30, 2016), https://itif.org/publications/2016/06/30/5g-and-next-generation-wireless-implications-policy-and-competition.

Joshua New and Daniel Castro, "Why Countries Need National Strategies for the Internet of Things" (ITIF Center for Data Innovation, December 16, 2015), http://www2.datainnovation.org/2015-nationaliot-strategies.pdf.

Doug Brake, "Standing in the Way of Next-Gen Wireless: What Gives, Mayor Liccardo?" (Information Technology and Innovation Foundation, November 6, 2017), https://itif.org/publications/2017/11/06/standing-way-next-gen-wireless-what-gives-mayor-liccardo.

"Wireless Opportunities: Improving Federal Radio Systems and Freeing Spectrum for New Uses" (Information Technology and Innovation Foundation, May 17, 2017), https://itif.org/events/2017/05/17/wireless-opportunities-improving-federal-radio-systems-and-freeing-spectrum-new.