Insight

The Road to 5G: A Primer

JUAN LONDOÑO | NOVEMBER 30, 2021

Executive Summary

- 5G refers to the fifth generation of cellular broadband network technologies and will include higher speeds for downloads and lower latency—both of which will be needed to power the technologies of the future, such as telehealth and autonomous cars.
- There are clear economic benefits to the United States' leadership in the implementation of 5G; there are also significant security advantages—ensuring that U.S. 5G technology remains competitive will reduce allies' reliance on Chinese government-supported firms, such as Huawei or ZTE, thus reducing those systems' vulnerability to decryption.
- The widespread adoption of 5G has faced multiple hurdles, but lessons from the deployment of 4G networks and America's leadership in that process can shed light on strategies to facilitate deployment.

Introduction

The importance of a robust internet infrastructure has never been clearer. This is true not only for the increasing demands and uses of our current technologies, but for a wide array of emerging technologies, including the Internet of Things and autonomous vehicles. Widespread deployment of 5G mobile networks will be needed to provide the high-speed, low-latency connectivity these emerging technologies require. Policymakers on both sides have emphasized the importance of "winning the race to 5G," but what, exactly, does that mean and why is it important?

After the introduction of 4G-capable phones in 2010, it took around 18 months for users to gain access to network speeds that were significantly superior to those of previous technology. Today, more than two years after 5G's launch, network speeds using 5G technology have not yet presented a significant speed upgrade over 4G. Estimates of when high-speed 5G will see widespread adoption – usually defined as two-thirds of the population — vary from late 2021 to late 2023.

This piece examines the foundational questions regarding 5G, why it's important for the United States to lead in 5G implementation, and how policies can help or hinder 5G development and deployment.

What Is 5G and Why Do We Need It?

5G refers to the fifth generation of cellular broadband network technologies. Over the last few years, companies have deployed this technology in the United States and around the world. As with prior generations, improvements in this technology significantly benefit both current consumers and emerging technologies.

The advantages of 5G include higher download speeds and greater bandwidth in comparison to the fourth-generation network technologies still used by most of the world. For consumers, the faster download speeds make it easier to share videos or use data-intensive applications with less of a lag. The greater bandwidth allows consumers' growing number of connected devices to have a reliable connection. At the same time, the lower latency supports real-time applications for which even millisecond delays could cause failure. Widespread adoption of 5G will be key in the growth of new technologies, such as autonomous vehicles, which require a strong internet infrastructure.

It is important to understand that not all 5G is created equal. The speed and reach of 5G service can vary depending on the spectrum band over which the technology is operating. Radio spectrum is commonly divided into three categories: the low-band, the mid-band, and the high-band. These divisions stem from the differences in the speed and reach each spectrum band supports, with the low-band the slowest but furthest-reaching, and the high-band the fastest but with the most limited range. The mid-band is often considered the "sweet spot" of 5G spectrum because it has the greatest balance between range and speed, which makes operating rights in that range a valuable resource for carriers. Currently, AT&T, Verizon, and T-Mobile say that current 5G nationwide service – around 200 million users – is still mostly reliant on low-band spectrum, which is significantly slower than mid- or high-band spectrum.

5G will also provide another tool in bridging the digital divide in both rural and urban areas

by providing an alternative to wired broadband. In rural areas, 5G is able to provide high-speed internet access to a wider range of the population, meaning it could serve areas that are generally more difficult or costly to reach with traditional broadband. In urban areas, it can help in two key ways. First, the greater bandwidth will support more devices, providing better service to households. Additionally, the faster speeds and lower latency, as discussed above, will make the apps used for services, such as virtual learning and telehealth, more accessible on a mobile connection.

Why Should We Care About "Winning the Race to 5G"?

In the implementation of 4G, the United States faced relatively few challenges to its position as the global leader of this groundbreaking technology. This has not been the case with 5G, as Chinese companies – especially government-backed Huawei and ZTE – have risen as competitors.

At the forefront of these concerns is the implications a delay would have on national security. The alternative to U.S. leadership in this sector could result in our allies relying on Chinese companies controlled by the ruling communist party. If the United States falls behind on its internet infrastructure, innovators may look to deploy and develop their technologies first in other regions. If these networks in-turn rely on equipment from these dubious vendors, the Chinese Communist Party could force and exploit backdoors in this technology to gather information on individuals, companies, or even governments. Because of these concerns, the United States has decided to "rip and replace" – the practice of removing and replacing any Huawei or ZTE 5G equipment currently in government systems. Some of our allies, including the United Kingdom, have made similar commitments.

Even apart from these concerns about national security, delays in the implementation of 5G could also significantly harm the U.S. economy. A recent report by CTIA claims that the adoption of 5G will bring 4.5 million jobs and over $1.5 trillion in economic growth over the next decade. The report also estimates that the construction process of the 5G network has led networks to invest around $275 billion for the development and deployment of these technologies.

Widespread access to 5G will also provide another piece in bridging the digital divide in both rural and urban areas by offering an alternative to wired broadband. In rural areas, 5G is able to provide a faster service in comparison to current wireless technology, meaning it could provide a reliable high-speed connection in areas that are generally more difficult or costly to reach with traditional broadband. In urban areas, it can help in two key ways.

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As the COVID-19 pandemic has underscored, many businesses now rely on connectivity that 5G networks can provide to reach consumers. The pandemic forced businesses to accelerate their adoption of online options and to navigate the different public health measures and the concerns of those who no longer felt comfortable shopping in-person. And while physical sales still constitute a majority of retail transactions, consumers are increasingly pressuring retailers to adopt a mixed approach, providing both online and in-person options. For a seamless transition, infrastructure that can sustain an always-online economy must be constructed.

Finally, an effective 5G deployment by the United States and its allies will be important in the continuing leadership for telecommunications improvements. It will also take significant research and development resources and build on the success of previous innovations and deployments of each new generation of technology. The global leadership of U.S. companies in 4G provided a positive framework for the development and deployment of 5G technologies. But now as 5G is deployed, companies and innovators are already looking to develop the technologies that will lead to the next telecommunications generation, 6G. Delays in implementation and unclear opportunities for profit for networks could slow down investment by mobile carriers in these future technologies.

Challenges and Opportunities in the Development of 5G

The deployment of 5G networks hasn't come without challenges, and despite work by the Federal Communications Commission (FCC) to facilitate deployment, there is still significant work to be done. Fortunately, the deployment process of 4G technologies offers some lessons for industry insiders and policymakers regarding the potential challenges and benefits in the process of adopting 5G.

One key lesson from the deployment process of 4G was how it powered devices in a way that could not have been predicted at its start: At the time of its deployment, cellphones were far away from doing much beyond voice calling, texting, and sending and receiving low-quality video. At the end of 4G's lifecycle, many network-connected or "smart" devices that could not have been imagined before the deployment of this technology. These are welcome advances, but they also pose a challenge regarding which technologies, protocols, or devices should be prioritized on the superior spectrum bands.

As no one can clearly predict the future of 5G, investments related to 5G-ready technologies

run the risk of becoming irrelevant or obsolete. The risky nature of these investments is a reason for which the development of these technologies needs to be led by the private sector. As history has taught, it is usually private actors that have both the capacities and the incentives to either make the right investments, or to quickly pivot away from profit-draining mistakes. The discussion around broadband access can provide a great example of this, as government-led municipal broadband has often led to high cost, low-quality service, while also deterring private investment.

The biggest challenge U.S. companies currently face is their lack of access to 5G-ready spectrum, the most basic piece of the infrastructure puzzle. They often must wait for government to clear spectrum bands and auction off licenses to access the spectrum. Notably, much of the critical mid-band spectrum needed for these networks is currently in use by incumbents, often with different government agencies such as the Department of Defense, the Federal Aviation Administration, and the Department of Transportation either controlling the spectrum or raising concerns about reallocation. As available bandwidth becomes scarcer, these friction points are natural and will need to be addressed.

Conclusion

5G's capabilities will prove indispensable in propelling the U.S. economy and protecting the country's national security interests. The service's faster download speeds and higher bandwidth will provide consumers with superior internet access and power many emerging technologies, such as telehealth and autonomous cars.

Additionally, it is critical for the United States to lead in the deployment of 5G in order to maintain an edge over competitors, such as China, whose telecommunications services may leave our allies' computer systems vulnerable.

Nevertheless, progress on the rollout of 5G has been beset by persistent delays as networks had to develop a monetization and investment strategy, while at the same time have had difficulty gaining access to additional spectrum bands. Policymakers must balance the need to address these concerns appropriately, and maintain steady progress toward 5G deployment.