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A. Marushchak

WHAT IS 5G?

Vinnytsia National Technical University

Abstract

It's the next generation of mobile internet connection and offers much faster data download and upload speeds. Through greater use of the radio spectrum it will allow far more devices to access the mobile internet at the same time. Whatever we do now with our smartphones we'll be able to do faster and better. Think of smart glasses featuring augmented reality, mobile virtual reality, much higher quality video, the internet of things making cities smarter. These things will be done faster with 5G technology.

Keywords: 5G, AT&T, Verizon, Signal, network, Internet, cellular, capacity, virtual reality.

Introduction

5G is an investment for the next decade, and in previous mobile transitions, we've seen most of the big changes happening years after the first announcement. Take 4G, for instance. The first 4G phones in the US appeared in 2010, but the 4G applications that changed our world didn't appear until later. Snapchat came in 2012, and Uber became widespread in 2013. Video calls over LTE networks also became big in the US around 2013. With the 5G transition, there's another twist. There are three main kinds of 5G—low-band, mid-band, and high-band—and while the US put its bet on low and high, it turns out that mid-band is probably the best way to do it. T-Mobile has mid-band—that's the "ultra capacity" stuff—but AT&T and Verizon had to wait for the C-band auction, which just ended, to get theirs. So following that plan, while we're getting fits and starts of 5G right now, you should expect the big 5G applications to crop up in 2022 [1].

Results of the research

5G gives carriers more options in terms of airwaves than 4G did. Most notably, it opens up "high-band," short-range airwaves that didn't work with 4G technology. But 5G can run on any frequency, leading to three very different kinds of 5G experiences—low, middle, and high.

The key thing to understand here is that 5G isn't much faster than 4G on the same old radio channels. Instead, the 5G spec lets phones use much wider channels across a broader range of frequencies. The carriers and the FCC have to make those wider channels available, though, and that's where they've largely fallen short. With 4G, you can combine up to seven, 20MHz channels to use a total of 140MHz of spectrum. Most of the time, though, phones are using 60MHz or less [1].

With new phones in low- and mid-band 5G, you can combine two 100MHz channels for 200MHz usage—and stack several more 20MHz 4G channels on top of that. In high-band 5G, you can use up to eight 100MHz channels. But if you don't have the airwaves available, you don't get the speeds.

Carriers can also flexibly share channels between 4G and 5G using dynamic spectrum sharing (DSS). DSS makes the walls between 4G and 5G channels movable, so carriers can split channels between 4G and 5G based on demand. That's what Verizon has been using for its "nationwide" 5G. It doesn't free up any new airwaves for 5G—it just reuses odds and ends of 4G—so we haven't seen DSS 5G offer better performance than 4G.

Low-band 5G operates in frequencies below 2GHz. These are the oldest cellular and TV frequencies. They go great distances, but there aren't very wide channels available, and many of those channels are being used for 4G. So low-band 5G is slow. It acts and feels like 4G, for now. Low-band 5G channels are from 5MHz in width (for AT&T) up to 15MHz (for T-Mobile), so you can see they aren't roomier than 4G. Complicating things, AT&T and T-Mobile low-band phones sometimes show 5G icons when they aren't even using 5G, making it hard to tell any difference [2].

Mid-band 5G is in the 2–10GHz range. That covers most current cellular and Wi-Fi frequencies, as well as frequencies slightly above those. These networks have decent range from their towers, often about half a mile, so in most other countries, these are the workhorse networks carrying most 5G traffic. Most other countries

have offered around 100MHz to each of their carriers for mid-band 5G. Here in the US, T-Mobile's "ultra capacity" 5G network runs on channels of up to 80MHz of mid-band. AT&T and Verizon both just bought some C-Band spectrum between 3.7 and 4GHz, which they'll likely start rolling out in late 2022 [2].

High-band 5G, or millimeter-wave, is the really new stuff. So far, this is mostly airwaves in the 20-100GHz range. These airwaves haven't been used for consumer applications before. They're very short range; our tests have shown about 800-foot distances from towers. But there's vast amounts of unused spectrum up there, which means very fast speeds using up to 800MHz at a time. We've seen speeds over 3Gbps on Verizon's high-band network, which it calls "ultra wideband." Unfortunately, we found in our Fastest Mobile Networks 2020 tests that Verizon's network had as little as 4–5% coverage on our citywide drives. AT&T and T-Mobile also have some high-band, but they haven't talked much about it for months. Figure one shows a comparison of the speeds of different network technologies [2].

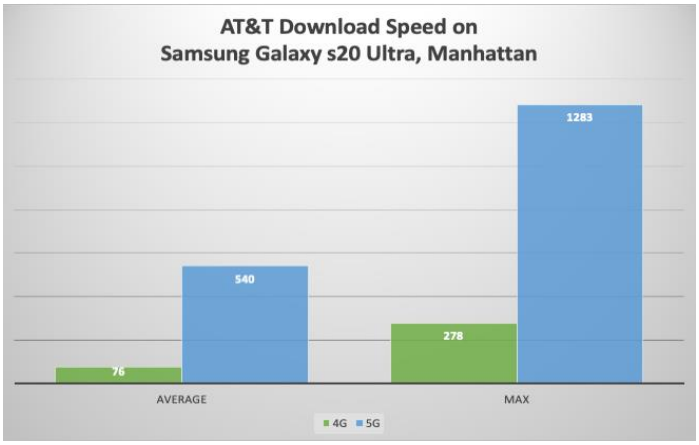

Figure. 1. Comparison of 4G and 5G technology speeds

One aspect of 5G is that it will connect many more devices. Right now, 4G modules are expensive, power-consuming, and demand complicated service plans, so much of the Internet of Things has stuck with Wi-Fi and other home technologies for consumers, or 2G for businesses. 5G will accept small, inexpensive, low-power devices, so it'll connect a lot of smaller objects and different kinds of ambient sensors to the internet.

The biggest change 5G may bring is in virtual and augmented reality. As phones transform into devices meant to be used with VR headsets, the very low latency and consistent speeds of 5G will give you an internet-augmented world, if and when you want it. The small cell aspects of 5G may also help with in-building coverage, as it encourages every home router to become a cell site [2].

Conclusion

The world is going mobile and we're consuming more data every year, particularly as the popularity of video and music streaming increases. Existing spectrum bands are becoming congested, leading to breakdowns in service, particularly when lots of people in the same area are trying to access online mobile services at the same time. 5G is much better at handling thousands of devices simultaneously, from mobiles to equipment sensors, video cameras to smart street lights.

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Marushchak Artem Volodymyrovych - second-year student of group 3PI-19b, FITKI, Vinnytsia National Technical University, Vinnytsia, e-mail: maryskhak@gmail.com.

Supervisor: ***Varchuk Liana Viktorivna*** - *Teacher at the Department of Foreign Languages, Vinnytsia National Technical University, Vinnytsia.*