Prepared Remarks of FCC Chairman Tom Wheeler
'The Future of Wireless: A Vision for U.S. Leadership in a 5G World'
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A few months ago, I found myself in a situation I never would have imagined when I became FCC Chairman. I was in Dallas, Texas; I was at the helm of an excavator; and I was using a piece of heavy machinery to dig up dirt. For those of you trying to picture this scene, yes, I was wearing a suit. I was also wearing a pair of virtual reality goggles, and I hadn't left the FCC.

While I may have been in DC physically, I am telling you that I was "AT" the site. I sat in the mock-up of an excavator, and, I had complete control sensitivity, equivalent to being there. I could be transported to a site in Texas 1,400 miles away without physically moving an inch.

Granted, remotely digging dirt in Dallas probably isn't high on the list of transformational advancements that will define the 21st century. But what if you replace the heavy machinery with a scalpel so a world-class surgeon can move from hospital to hospital without leaving her own surgery suite? Or how about students sitting in a classroom taking a virtual tour inside the human body?

Now, you've heard of such amazing things before, but making these kinds of activities possible without fat cables leading to the VR headset could not be accomplished because of three limiting factors:

1. Speed of the wireless connections: We all know the difference in the performance of a direct fiber connection compared to a wireless connection. The next generation of wireless must be like mobile fiber – and that means speeds 10 to 100 times faster than today.

2. Responsiveness: Ten thousandths of a second is an eternity in computer-to-computer connections. The surgeon's scalpel needs to be immediately responsive, not a blink later. The technical folks call this latency. It currently averages about 10 milliseconds or about one hundredth of a second. That may sound pretty fast but it's forever in computing. Latency needs to be less than one millisecond – or less than one thousandth of a second – to provide for real-time interactions.

3. Spectrum capacity: High-speed wireless broadband requires digital information racing down broad spectrum pathways. To accomplish speed and latency requires large swaths of spectrum – multiples of what is available today.

To seize the opportunities before us, we need the next generation of wireless connectivity – a fifth generation, or 5G. And if the United States is going to continue to be a world leader in wireless, we need to speed the deployment of 5G, here, on our shores.

The virtual reality example is but one sample of the effects of high-speed, low-latency connectivity and why American leadership in 5G must be a national priority. The driving force

of the 21st century will be powerful processing centralized in the cloud and wirelessly connected to thin clients.

Autonomous vehicles will be controlled in the cloud. Smart-city energy grids, transportation networks, and water systems will be controlled in the cloud. Immersive education and entertainment will come from the cloud. Such futures, however, won't come to pass unless the pathway to the cloud is low-latency, ultra-fast, and secure.

If we've learned anything in the generational march through wireless connectivity, it is that we have always underestimated the innovation that would result from new generations of wireless networks.

First-generation wireless – 1G – was voice. In the early 1980s, McKinsey told AT&T there would be 900,000 cell phone subscribers by the turn of the century. Turns out there were 109 million. So they were ONLY off by a factor of roughly 100.

Second-generation – 2G – allowed both talk and text. But no one understood the power of text. From shifting the way an entire group – teenagers – communicate, to a developing-world tool for banking the unbanked, innovators seized on the new capability in unimagined ways.

Third-generation – 3G – married wireless and digital networks to open the door to connecting with another new technological development called the Internet, yet still at a stripped-down level.

Today's technology – 4G – completed the digital migration, enabling higher speeds for sophisticated applications including video. Again, greater capability led to unanticipated innovation: without 4G, there could be no WAZE … or Uber … or Snapchat … or Instagram.

Now, I've listed some examples of what 5G makes possible, but if anyone tells you they know the details of what 5G will deliver, walk the other way.

Yes, 5G will connect the Internet of Everything. If something can be connected, it will be connected in a 5G world. But with predictions of hundreds of billions of microchip-enable products from pill bottles to plant waterers, you can be sure of only one thing: the biggest IoT has yet to be imagined.

Yes, 5G will connect the unconnected and compete with the uncompetitive. Millions of Americans can't access high-speed connectivity because it's too costly to run fiber to the home. Verizon CEO Lowell McAdam has been speaking lately about using 5G connectivity to expand high-speed broadband service to rural areas. Fiber-fast wireless connectivity will deliver that long-sought goal of competitive high-speed Internet access for consumers.

But, let's stop the imagining. Here's the key – the interconnected world we live in today is the result of decisions we made a decade ago. The interconnected world of the future will be the result of decisions we must make today. That is why 5G is a national priority, and why, this Thursday, I am circulating to my colleagues proposed new rules that will identify and open up

vast amounts of spectrum for 5G applications. We call it the Spectrum Frontiers proceeding, and we will vote on it July 14th.

Our 5G proposal is the final piece in the spectrum trifecta of low-band, mid-band, and high-band airwaves that will open up unprecedented amounts of spectrum, speed the rollout of next-generation wireless networks, and re-define network connectivity for years to come. I'm confident these actions will lead to a cornucopia of unanticipated innovative uses, and generate tens of billions of dollars in economic activity.

Let's revisit that spectrum strategy for a moment. Rule number one is that the technology should drive the policy rather than the policy drive the technology. And technology for 5G is not one thing, it is many things. The marriage of Moore's Law and wireless connectivity involves smart antenna systems, new more-efficient transmission formats, low-energy systems, network virtualization, and much more. And on the spectrum side, these technologies require new access to spectrum in multiple bands – the wireless future will not be a one-size-fits-all future.

So, our spectrum trifecta begins with low-band spectrum that is optimal for wide-area coverage applications. At this very moment, we are in the midst of the world's first incentive auction to make greenfield low-band spectrum available. The broadcasters have stepped up to bring their spectrum to market; shortly, the wireless industry will have the opportunity to fulfill their repeated requests for more spectrum with beachfront allocations.

Mid-band spectrum often seems the Jan Brady of the spectrum world - - the overlooked middle child. But its characteristics enable an order of magnitude increase in spectrum efficiency. The Commission's recent AWS-3 and new Citizens Broadband Radio service in the 3.5 GHz band were landmarks in using new sharing tools to open up new mid-band spectrum, and we need to continue looking for other mid-band opportunities.

And high-band spectrum will be the focus of our decision next month. These bands offer huge swaths of spectrum for super-fast data rates with low latency, and are now becoming unlocked because of technological advances in computing and antennas.

If the Commission approves my proposal next month, the United States will be the first country in the world to open up high-band spectrum for 5G networks and applications. And that's damn important because it means U.S. companies will be first out of the gate.

We will be repeating the proven formula that made the United States the world leader in 4G. It's a simple formula: Lead the world in spectrum availability, encourage and protect innovation-driving competition, and stay out of the way of technological development.

Unlike some countries, we do not believe we should spend the next couple of years studying what 5G should be, how it should operate, and how to allocate spectrum, based on those assumptions. Like the examples I gave earlier, the future has a way of inventing itself. Turning innovators loose is far preferable to expecting committees and regulators to define the future. We won't wait for the standards to be first developed in the sometimes arduous standards-setting process or in a government-led activity. Instead, we will make ample spectrum available and

then rely on a private sector-led process for producing technical standards best suited for those frequencies and use cases.

Leadership in networks leads to leadership in uses, which quickly moves across borders.

A result of this national leadership is the creation of a home-field advantage, similar to what we experienced with 4G.

The main value of 5G will not be found in workshare or intellectual property. The main value of 5G by far will be in consumption rather than production. It will be in material gains and improvements in quality of life and economic opportunity.

I would also emphasize that the development of 5G is not anything like an international zero-sum game. Rather, it is a contest in which everyone can win. Our success and that of others, redounds to the benefit – literally – of everyone in the world.

We are already seeing industry gearing up to seize this opportunity. I have seen 5G hardware and firmware; the technology is here. It is also important, however, to recognize that 5G technology will be in constant evolution. It would be a mistake to think 5G can be frozen in a snapshot; it is more like a video with many new scenes, all building on each other. The systems and standards of 5G will be continually improving and evolving.

On the network side, Verizon and AT&T tell us they will begin deploying 5G trials in 2017. These efforts will, of course, help inform the standards process by putting stakes in the ground. And the first commercial deployments at scale are expected in 2020.

This timeline requires that we act to pave the way today. With the new rules I am proposing in our Spectrum Frontiers order, we take our most significant step yet down the path to our 5G future.

The big game-changer is that 5G will use much higher-frequency bands than previously thought viable for mobile broadband and other applications. Such millimeter wave signals have physical properties that are both a limitation and a strength: they tend to travel best in narrow and straight lines, and do not go through physical obstacles very well. This means that very narrow signals in an urban environment tend to bounce around buildings and other obstacles making it difficult to connect to a moving point. But it also means that the spectrum can be reused over and over again.

Brilliant engineers have developed new antennas that can aim and amplify signals, coupled with sophisticated processing, allowing a moving device to pick up all of the signals bouncing around and create one coherent connection. To make this work, 5G buildout is going to be very infrastructure intensive, requiring a massive deployment of small cells. But it also opens up unprecedented opportunities for frequency reuse and denser, more localized, networks.

The ability to use this high-frequency spectrum opens much bigger chunks of spectrum. Current blocks of licensed low-band spectrum are usually 5 to 10 MHz in width. With 5G, however, we

are looking at blocks of at least 200 MHz in width. This will allow networks to carry much more traffic per user – gigabits of throughput instead of megabits. This is an order of magnitude growth in the channel capacity available to a provider, supporting, for example, simultaneously high-speed connections to mobile end users as well as "backhaul on demand" via immediate, dynamic provisioning of fixed wireless transport to the nearest fiber interconnection point, allowing faster and more flexible deployment of small cells.

The key point here is that by opening up these higher-frequency bands, we are making available more licensed spectrum for mobile than in the cumulative history of mobile spectrum allocation. And we're not done. As a part of our July 14 action, we also plan to ask for comments on opening up other high-frequency bands.

And, what we'll be considering on July 14 is not just licensed spectrum. Unlicensed will continue to play a critical role in future 5G networks. Our plan proposes making a massive 14 gigahertz unlicensed band. Consider that – 14,000 megahertz of unlicensed spectrum, with the same flexible-use rules that has allowed unlicensed to become a breeding ground for innovation.

Opening up spectrum and offering flexibility to operators and innovators is the most important thing we can do to enable the 5G revolution, but it's not the only thing.

We also need to work our way through spectrum sharing issues. Sharing is essential for the future of spectrum utilization. Many of the high-frequency bands we will make available for 5G currently have some satellite users, and some federal users, or at least the possibility of future satellite and federal users.

This means sharing will be required between satellite and terrestrial wireless; an issue that is especially relevant in the 28 GHz band. It is also a consideration in the additional bands we will identify for future exploration. We will strike a balance that offers flexibility for satellite users to expand, while providing terrestrial licensees with predictability about the areas in which satellite will locate.

However, we must reject any notion that the 5G future will be the sole province of urban areas. The 5G revolution will touch all corners of this country.

Three months ago, I indicated as directly as I am capable that it would be advantageous for the satellite and mobile industries to come together to propose realistic ideas for their coexistence in the upper bands -- and to do so quickly. Satellite and terrestrial stakeholders have suggested a range of sharing options, and the draft Spectrum Frontiers Order seeks to provide a balanced solution that addresses the needs of both parties.

I am confident we will adopt rules that will enable satellite, terrestrial, and federal operations to co-exist and thrive.

To make sure we have this connectivity with high-band spectrum will require a lot more small cells, which means a lot more antenna siting decisions by local governments. That's why it's important that the Commission has streamlined our environmental and historic preservation

rules, and tightened our 'shot clock' for siting application reviews. America's local governments will play an important role in determining how we fulfill this national priority.

In addition, all these small cell sites will need to be connected, so we'll need a lot more backhaul. That's a challenge we're going to address through our proceeding on Business Data Services, the kind of dedicated access that wireless providers need to connect cell towers and antennae to their networks. These backhaul connections can be as much as 30 percent of the cost of operating a wireless network. And with the additional sites required to support use of the millimeter wave spectrum, that percentage is likely to increase, to as much as 50 percent.

In many areas, however, competition in the supply of backhaul remains limited, and that can translate into higher prices for wireless networks and then higher prices for consumers. Lack of competition doesn't just hurt the deployment of wireless networks today, it threatens as well to delay the buildout of 5G networks with its demand for many, many more backhaul connections to many, many more antennae. Before the end of this year the Commission will take up a reform proposal – supported by the nation's leading wireless carriers, save one – that will encourage innovation and investment in Business Data Services while ensuring that lack of competition in some places cannot be used to hold 5G hostage.

As we build the next-generation network, a lesson learned from our previous experience is that it must be secure. New platforms, systems, software and technologies will mean new vulnerabilities. Cybersecurity issues must be addressed during the design phase for the entire 5G ecosystem, including devices. This will place a premium on collaboration among all stakeholders. We continue to prefer an approach that emphasizes that industry develop cybersecurity standards just as we have done in wired networks.

In the spirit of the election season, I thought I'd close these remarks by referencing a campaign speech from the 60s. For a change, I don't mean the 1860s.

On July 15, 1960, John F. Kennedy strode to podium at the Los Angeles Coliseum to accept the Democratic nomination for President, and famously challenged the American people to be pioneers of a New Frontier. He spoke of harnessing the power of the technological revolution and exploring uncharted areas of science and space. JFK's vision charted a path that took us to the moon and laid the foundation for the Internet.

This July 14, the FCC will have the opportunity to take an historic step to open up yet another frontier that promises to propel our nation – and the world – forward. Once again, we are looking to the sky to unlock new discoveries and unleash American ingenuity. We are the pioneers of a new spectrum frontier. Working together, we can write the next chapter in the mobile revolution that has already transformed our lives and society. Working together, we can unleash new waves of innovation and discovery that we are yet to imagine.