

5G POLICY PRIMER: THE U.S. COMPETITION-BASED INDUSTRY MODEL IS WINNING THE GLOBAL “RACE” TO 5G

The United States is leading the push to 5G with investment and smart spectrum policy, building on robust infrastructure that was fostered by a light-touch regulatory environment. The federal government can help lead by removing barriers and promoting infrastructure deployment.

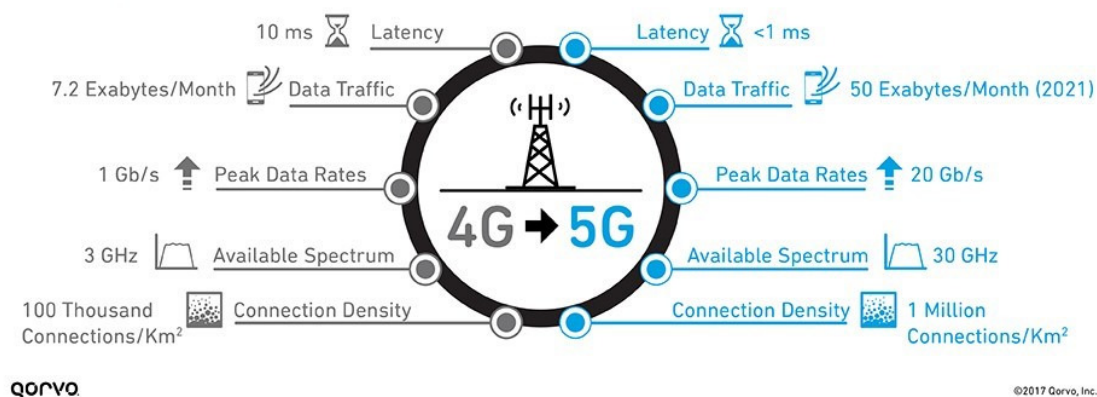
A popular talking point is that the U.S. is at risk of “losing” the race to 5G deployment. Such breathless reports give inadequate attention to the great strides U.S. operators and the government are making to advance 5G. Some policymakers suggest the U.S. can “win” by nationalizing our communications infrastructure or adopting a top-down approach to growing private, heterogeneous networks. But this approach would slow—not advance—national objectives and remove the biggest advantages we have in the race: robust competition and light-touch regulations, both of which spur world-leading innovation and investment.

WHAT IS 5G?

5G is the fifth generation of wireless technology. It will be the most robust wireless communication technology deployed to date and will enable faster and more powerful networks, and a dramatic change in how we live, work, and play. Smart cities, autonomous cars, industrial IoT, connected health care, and distance education will rely on the 5G network’s **ultrafast speeds, massive device connectivity, ultra-reliability, ultra-low latency, and better capacity and coverage.**

5G is not brand new. It is not a flash cut technology. 5G will build on the existing, robust LTE and LTE-Advanced technology and infrastructure that has made the United States a global leader in technology and connectivity. 5G represents an evolution of technology, not an overhaul.

Comparing 4G and 5G



U.S. INDUSTRY IS DEPLOYING 5G RAPIDLY

The four national wireless carriers are in what some in the press have dubbed an “early 5G arms race,”¹ making the introduction of 5G service in the United States imminent. Each has already conducted trials and begun deployments in initial cities. All four carriers will be “providing 5G services between late 2018 and mid-2019,” and nearly half of the mobile subscriptions in North America will be 5G by 2023.²



AT&T is rapidly deploying advanced LTE technologies that will serve as the runway to 5G throughout the country. AT&T offers “5G Evolution in more than 140 markets, covering nearly 100 million people with theoretical peak speeds of at least 400 Mbps,”³ and AT&T plans to serve over 400 markets by the end of 2018.⁴ In addition, AT&T is starting to upgrade cell towers with LTE-Licensed Assisted Access (“LTE-LAA”), which achieves theoretical peak speeds of up to 1 Gbps.⁵ AT&T has deployed LTE-LAA in 15 markets and expects to reach at least 24 later this year.⁶

AT&T “expect[s] to be the first U.S. company to introduce mobile 5G service in a dozen markets by late 2018.”⁷ AT&T’s “millimeter wave mobile 5G trials are . . . going well” and AT&T is “on track to launch service in parts of 12 markets by the end of this year.”⁸

To support massive 5G data use, AT&T is virtualizing its network. AT&T is expanding deployment of software-defined networking,⁹ as well as related elements like white box (replacing traditional proprietary routers inside cell towers with new hardware built around open standards that can be quickly upgraded via software)¹⁰ and Network AI (deploying open source software in AT&T’s centralized network cloud and in AT&T’s edge cloud).¹¹ Having already virtualized 55 percent of its network, AT&T plans to reach 75 percent virtualization by 2020.¹²

AT&T continues to invest in spectrum for its 5G build out. “[F]uture wireless growth will increasingly depend on [AT&T’s] ability to offer innovative video and data services on a wireless network that has sufficient spectrum and capacity to support these innovations,” and AT&T “continue[s] to invest significant capital in . . . obtaining additional spectrum that meets [its] long-term needs.”¹³



Sprint is building a foundation for 5G. Sprint is “building a strong foundation in LTE” that will “pave[] the way for an innovative 5G network to take the customer experience to a whole new level.”¹⁴ It is “upgrading thousands of cell sites and lighting up tens of thousands of small cells” in order “to give [its] customers an even stronger 4G LTE Advanced network and launch mobile 5G.”¹⁵ “Sprint’s deployment of Massive MIMO radios, a key technology for 5G, is underway.”¹⁶

Sprint “expect[s] to provide commercial [5G] services and devices by the first half” of 2019.¹⁷ It notes that “[w]ith 204 MHz of spectrum and more than 160 MHz of 2.5 GHz spectrum in top 100 markets, Sprint is uniquely positioned with enough capacity to deliver a nationwide 5G mobile network using licensed spectrum.”¹⁸ Sprint also has indicated interest in supplementing its spectrum portfolio in Auctions 101 and 102, saying “the upcoming [auc]tion [i]s an excellent opportunity to potentially supplement [Sprint’s] existing 2.5-gig spectrum portfolio for our 5G deployments.”¹⁹ Additionally, Sprint and LG are partnering to build a 5G phone, which they claim will be the first mobile 5G smartphone in the U.S.²⁰



T-Mobile has been upgrading its LTE network and deploying 5G-ready infrastructure. T-Mobile’s 600 MHz spectrum is “live in 992 cities and towns and 33 states” according to CEO John Legere, and “the 600 megahertz gear [it is] deploying will be upgradable to 5G with a software update.”²¹ T-Mobile is adding 25,000 small cells to activate LTE-LAA technology, which adds extra capacity and speed, while paving the way for 5G.²² T-Mobile has announced a \$3.5 billion partnership with Nokia to speed deployment.²³

T-Mobile has taken a “multi-spectrum” strategy to 5G preparedness.²⁴ T-Mobile has assembled a portfolio of low-, mid-, and high-band spectrum for 5G. In 2017, “T-Mobile made its largest network investment ever, tripling its low-band spectrum holdings by



purchasing 45% of the spectrum sold in the US government's 600 MHz auction – 31 MHz nationwide.”²⁵ “These holdings cover 100% of the U.S.”²⁶ T-Mobile also has “an impressive volume of mid-band spectrum to deploy 5G,”²⁷ as well as “a nice big, hefty chunk” of millimeter wave spectrum.²⁸

T-Mobile's “plan [is] to bring 5G to 30 cities in 2018 starting with New York, L.A., Dallas, Las Vegas, with nationwide coverage coming in 2020...and [T-Mobile will] be ready for the first 5G smartphones in 2019.”²⁹

Verizon has made 5G “the linchpin of its entire corporate strategy”³⁰ and is laying the groundwork for 5G. Verizon “made the strategic investment in millimeter wave spectrum that enable[s] ultra-wideband 5G services,”³¹ and it is upgrading its LTE network through densification and the integration of LTE-LAA, carrier aggregation, 4x4 MIMO, and 256 QAM technologies.³² Verizon is deploying fiber in 50 markets outside its ILEC footprint “to take full advantage of the many use cases that will come to bear in 5G.”³³ One analyst calls Verizon a “fiber giant” that is well positioned to leverage its fiber holdings for 5G.³⁴

Verizon announced the commercial launch of 5G wireless residential broadband service, to take place in the second half of 2018, beginning with Houston, Los Angeles, Sacramento, and Indianapolis.³⁵ The chief executive of Verizon's wireless business, Ronan Dunne, notes that fixed wireless is just “the first opportunity” for 5G, and that “quickly [Verizon] will move to the overall 5G mobility play” in 2019.³⁶ Indeed, Verizon and Nokia recently announced a mobile 5G milestone: “handing off a signal seamlessly to a vehicle traveling between two radio sectors.”³⁷ Additionally, Motorola will provide device support for Verizon's mobile 5G launch in 2019,³⁸ and Verizon reportedly is actively considering a partnership with Apple or Google as a 5G TV provider.³⁹

SMART SPECTRUM POLICY IN THE U.S. IS ADVANCING 5G

THE FCC HAS BEEN DOING ITS PART TO MAKE SPECTRUM AVAILABLE

“You need to make more spectrum available to win the race, and right now we've made more spectrum available than any other country in the world, in fact, four gigahertz more than second-place China.” FCC Commissioner Brendan Carr

FCC Chairman Pai has championed forward-thinking spectrum policy and light-touch network regulation. The FCC is making additional low-, mid-, and high-band millimeter wave spectrum available for 5G services. The United States is leading the world in high-band millimeter wave

spectrum allocations to support 5G, thanks to the FCC's expeditious work on spectrum.

Low Band: Clearing broadcasters and deploying wireless services in the 600 MHz band following the incentive auction, which made 70 MHz of licensed spectrum available for commercial wireless use.

Mid Band: Proposing rule changes and licensing frameworks to unleash additional spectrum for 5G services in the 2.5 GHz band, the 3.5 GHz band, and the 3.7-4.2 GHz band.

High Band: Moving aggressively to make nearly 5 GHz of spectrum available for flexible wireless use in the 24 GHz, 28 GHz, 37 GHz, 39 GHz, and 47 GHz bands, beginning with a 28 GHz auction in November 2018.

CONGRESS IS PUTTING MORE SPECTRUM INTO THE PIPELINE

Congress has been pushing to support new network technology and infrastructure. The enactment of the **RAY BAUM'S Act**, including parts of the **MOBILE NOW Act**, in the 2018 omnibus appropriations bill paves the way for future auctions. The law directs the FCC to focus on commercializing mid-band and millimeter wave spectrum and includes provisions to expedite communications facility siting.

Congress is also considering several bipartisan bills related to 5G spectrum and network build-out:

- The **AIRWAVES Act**, which would add to a 5G spectrum pipeline by requiring the FCC and the NTIA to make additional 5G spectrum available across many mid and high bands at specific dates;
- The **SPECTRUM NOW Act**, which would facilitate and expedite spectrum sharing between federal and commercial users by giving NTIA more flexibility to administer the Spectrum Relocation Fund.

SMART INFRASTRUCTURE POLICY IS SPEEDING DEPLOYMENT

Following decades of effort to rationalize wireless facilities siting, the federal government has been promoting streamlined rules and predictable timetables for decisions about facilities placement. This enables updates and modifications of existing facilities and will speed the placement of newer, smaller cells that will promote 5G.

The FCC and the Executive Branch have been eliminating barriers to wireless infrastructure deployment. The FCC has developed time lines and “shot clocks” to govern local review of siting requests and it has barred state and local moratoria on telecommunications deployment. The FCC has also excluded small wireless facilities from burdensome NEPA and NHPA reviews and. A January 2018 *Presidential Executive Order on Streamlining and Expediting Requests to Locate Broadband Facilities in Rural America* directed federal property managing agencies to “accelerate the deployment and adoption of affordable, reliable, modern high-speed broadband connectivity in rural America.”

Congress has been doing its part. Parts of the recent **RAY BAUM'S Act** address siting on federal lands. Section 6409 of the Middle Class Tax Relief and Job Creation Act of 2012 likewise addressed timelines and discretion for local and state review of siting applications. Congress is considering additional steps.

- The **STREAMLINE Small Cell Deployment Act**, which would streamline siting processes for small cell deployment, including by defining “small cells” and providing more uniformity for how state, local, and tribal authorities treat siting requests.

Some states have taken progressive steps to encourage infrastructure investment in their communities. Many states have adopted sensible infrastructure regulation to speed deployment. According to the National Conference of State Legislatures, twenty states “have enacted small cell legislation that streamlines regulations to facilitate the deployment of 5G small cells.”⁴⁰ This is another indicator of success in preparation for next generation networks.

DEBUNKING COMMON MYTHS ABOUT CHINA AND THE RACE TO 5G

MYTH: CHINA IS WINNING THE RACE TO 5G BECAUSE IT HAS THE MOST CELL SITES PER SQUARE MILE AND PER PERSON.

Reality: The raw number of cell sites in a country is not all that informative. There is much more that goes into the 5G equation, including the technology built into the network, whether the network will be standalone or will rely on existing infrastructure, how much 5G spectrum is available, and the geographic realities of the areas being covered. A simple tally of cell sites does not capture the nuance required to measure 5G progress. In the United States, thousands of cell sites that have been deployed for decades host multiple carriers and services for wide coverage. At the same time, private entities are investing in new sites and network densification. And a continued focus from

the FCC to eliminate barriers to wireless infrastructure deployment and encourage 5G investment—such as its recent action to make small cell deployment less burdensome—will hasten the investment in 5G.

MYTH: CHINA BETTER SUPPORTS INDUSTRY ACCESS TO SPECTRUM FOR 5G.

Reality: *First*, China lags behind the United States in 5G spectrum—not the other way around: “[R]ight now we've made more spectrum available than any other country in the world, in fact, four gigahertz more than second-place China.”⁴¹ *Second*, China pursues a wholly different spectrum policy than the United States. China makes spectrum available mostly to a small number of state-owned enterprises. In the United States, there are four major private carriers and hundreds of smaller carriers, who compete for customers and spectrum. The U.S. approach recognizes that competition will yield the best results—spectrum will end up with the operator that values it the most and will accordingly put it to its highest and best use. The United States’ commitment to competition and light regulation flows from Congressional direction in the earliest days of wireless. As part of the Omnibus Budget Reconciliation Act of 1993, Congress directed the FCC to regulate the wireless industry with a light touch. The FCC and Congress have repeatedly recognized that this regulatory philosophy enabled a vibrant wireless sector to flourish. Thus far, the United States’ bet has been a good one, enabling the United States to become the clear global leader in 4G.

MYTH: CHINA WILL REAP MOST OF THE REWARDS OF INNOVATION IF IT “BEATS” THE WORLD TO 5G DEPLOYMENT.

Reality: The argument that China will seize “sustained leadership and the potential to capture a greater share of the benefits associated with 5G”⁴² if 5G is commercially available in that country before it is in the United States is flawed. The argument only looks at speed to market and fails to look at the market itself. A deeper look at the Chinese versus American markets shows the fallacy in the argument. The U.S. market is characterized by robust competition; the Chinese market, which is controlled by the government, is highly concentrated. The U.S. market has risen to the top globally because of the federal government’s commitment to light-touch regulation; the Chinese market is defined by rigid regulation. To say that the two markets are apples and oranges would not do the distinction justice. Even though China’s approach *might* give that country some speed-to-market advantages, ultimately, the Chinese regime is one that will stifle innovation and experimentation. The United States, on the other hand—by facilitating competition and lightly regulating emerging technologies—will foster innovation and experimentation. The global leader in 5G technology will not simply be the first country to offer commercial 5G, but instead will be the country that fosters investment and innovation in networks and the businesses and social uses that the networks enable.

NOTES

- ¹ See Mike Dano, *Verizon, AT&T Show Surprise Increase In Network Spending in Q1*, FierceWireless (May 7, 2018), <https://www.fiercewireless.com/5g/verizon-at-t-show-surprise-increase-network-spending-q1>.
- ² Ericsson Mobility Report, at 6, 11 (June 2018), <https://www.ericsson.com/assets/local/mobility-report/documents/2018/ericsson-mobility-report-june-2018.pdf>.
- ³ AT&T Inc., Q2 2018 Earnings Call (July 24, 2018).
- ⁴ AT&T Newsroom, *AT&T Bringing 5G to More U.S. Cities in 2018* (July 20, 2018), http://about.att.com/story/5g_to_launch_in_more_us_cities_in_2018.html.
- ⁵ See *id.*
- ⁶ AT&T Newsroom, *AT&T Builds on 5G Foundation in More Than 100 New Markets* (Apr. 20, 2018), http://about.att.com/story/att_builds_on_5g_foundation_in_more_than_100_new_markets.html; AT&T Newsroom, *AT&T Bringing 5G to More U.S. Cities in 2018* (July 20, 2018), http://about.att.com/story/5g_to_launch_in_more_us_cities_in_2018.html.
- ⁷ 2017 SEC Form 10-K for AT&T at 2. See also Monica Allevan, *AT&T Plans to Launch Mobile 5G In A Dozen Cities by Late 2018*, FierceWireless (Jan. 4, 2018), <https://www.fiercewireless.com/wireless/at-t-plans-to-launch-mobile-5g-dozen-cities-by-late-2018>; AT&T, *AT&T To Launch Mobile 5G In 2018* (Jan. 4, 2018), http://about.att.com/story/att_to_launch_mobile_5g_in_2018.html.
- ⁸ AT&T Inc., Q2 2018 Earnings Call (July 24, 2018).
- ⁹ AT&T Innovation Blog, *Setting the Record Straight on 5G Evolution* (Apr. 19, 2018), http://about.att.com/innovationblog/5g_evolution_record.
- ¹⁰ AT&T Newsroom, *AT&T Is Deploying White Box Hardware in Cell Towers To Power Mobile 5G Era* (March 25, 2018), http://about.att.com/story/att_deploying_white_box_hardware_in_cell_towers.html.
- ¹¹ AT&T Innovation Blog, *Network AI: AT&T's Framework for Its Open Source Efforts That Will Drive Our Software-Defined Network in 2018 and Beyond* (March 27, 2018), http://about.att.com/innovationblog/att_framework.
- ¹² AT&T Newsroom, *AT&T Drives Path to Nationwide Mobile 5G with Multi-Gigabit Speeds* (Feb. 20, 2018), http://about.att.com/story/multigigabit_mobile_5g.html.
- ¹³ 2017 SEC Form 10-K for AT&T at 2.
- ¹⁴ *Id.*
- ¹⁵ Sprint Corporation, Press Release, *Sprint's Next-Gen Network Build Gains Momentum*, Aug. 1, 2018, <http://investors.sprint.com/news-and-events/press-releases/press-release-details/2018/Sprints-Next-Gen-Network-Build-Gains-Momentum/default.aspx>.
- ¹⁶ Sprint Corporation, Q1 FY 2018 Earnings Call (Aug. 1, 2018).
- ¹⁷ Sprint Corporation, Q1 FY 2018 Earnings Call (Aug. 1, 2018).
- ¹⁸ Sprint Press Release, *Sprint Unveils Six 5G-Ready Cities; Significant Milestone Toward Launching First 5G Mobile Network in the U.S.* (Feb. 27, 2018), <http://newsroom.sprint.com/sprint-unveils-5g-ready-massive-mimo-markets.htm>. See also 3Q2017 SEC Form 10-Q for Sprint at 42 (arguing that Sprint's "substantial spectrum holdings are sufficient to allow us to continue to provide consistent network reliability, capacity, and speed, as well as to provide current and future customers a highly competitive wireless experience").
- ¹⁹ Sprint Corporation, Q1 FY 2018 Earnings Call (Aug. 1, 2018).
- ²⁰ Mike Dano, *Sprint, LG Promise First Mobile 5G Phone, Coming Next Year*, Fierce Wireless (Aug. 14, 2018), <https://www.fiercewireless.com/5g/sprint-lg-promise-first-mobile-5g-phone-coming-next-year>.
- ²¹ T-Mobile US Inc., Q2 2018 Earnings Call (Aug. 1, 2018), <https://www.youtube.com/watch?v=WQrBSv3pBWw>; see also, e.g., T-Mobile, Q4 and Full-Year 2017 Investor FactBook (February 2018), at 7, <http://investor.t-mobile.com/Cache/1001231994.PDF?O=PDF&T=&Y=&D=&FID=1001231994&iid=4091145> at 7 ("Our 600 MHz spectrum holdings will be used to deploy America's first nationwide 5G network expected by 2020"); T-Mobile, Video Vlog, Exhibit 99.3, <http://investor.t-mobile.com/Cache/1001228566.PDF?O=PDF&T=&Y=&D=&FID=1001228566&iid=4091145> at 2 ("When the time comes, we will literally turn on 5G with the flip of a switch! And as I've said many times before, we expect to be the first wireless provider with a nationwide 5G network.").
- ²² T-Mobile Press Release, *T-Mobile Building Out 5G in 30 Cities This Year ... And That's Just The Start* (Feb. 2, 2018), <https://www.t-mobile.com/news/mwc-2018-5>.

²³ T-Mobile Newsroom, *T-Mobile and Nokia Ink \$3.5 Billion, Multi-year 5G Network Agreement* (July 30, 2018), <https://www.t-mobile.com/news/nokia-5g-agreement>.

²⁴ See, e.g., *id.* (“T-Mobile is in a unique position with 5G, with its unpopulated spectrum holdings and multi-spectrum strategy. While other wireless companies must kick customers off their congested LTE networks to build out 5G, the Un-carrier is building 5G on wide-open airwaves. . . . A multi-spectrum strategy is critical to delivering a breakthrough consumer experience—an experience that includes national coverage and reliability from low band spectrum, reliable capacity and consistent mobile broadband speed with mid band spectrum and multi-gigabit hotspots in urban areas and on campuses with millimeter wave”).

²⁵ T-Mobile Newsroom, *T-Mobile 600 MHz Extended Range LTE Now Live in 900+ Cities & Towns, Coming to Puerto Rico* (June 6, 2018), <https://www.t-mobile.com/news/extended-range-lte-puerto-ric>.

²⁶ *Id.*

²⁷ T-Mobile Newsroom, *Setting the 5G Record Straight: Announcing Plans for Nationwide 5G from T-Mobile* (May 1, 2017), <https://www.t-mobile.com/news/nationwide-5g-blog>.

²⁸ See Telco Transformation, *T-Mobile Walks a Fine Line on 5G Spectrum* (Feb. 9, 2018), http://www.telcotransformation.com/author.asp?section_id=696&doc_id=740479 (T-Mobile has what its CTO calls “a nice big, hefty chunk” of mmW spectrum).

²⁹ T-Mobile US Inc., Q2 2018 Earnings Call (Aug. 1, 2018), <https://www.youtube.com/watch?v=WQrBSv3pBWw>; see also See Wireless Week, *T-Mobile Goes “All In” on 5G, Sets 2020 Target for Nationwide Mobile Network* (May 2, 2017), <https://www.wirelessweek.com/news/2017/05/t-mobile-goes-all-5g-sets-2020-target-nationwide-mobile-network>.

³⁰ Mike Dano, *For Better or Worse, Verizon Bets the Farm on 5G*, Fierce Wireless (July 24, 2018), <https://www.fiercewireless.com/5g/editor-s-corner-for-better-or-worse-verizon-bets-farm-5g>.

³¹ Verizon Communications Inc., Q2 2018 Earnings Call (July 24, 2018).

³² Sean Kinney, *Verizon tallies more than 1,100 markets with LTE-Advanced*, RCR Wireless (July 16, 2018), <https://www.rcrwireless.com/20180716/network-infrastructure/lte/verizon-lte-advanced-tag17?elqTrackId=5FCE649CB371738188DCEB5ECBDACD81&elq=65a7ace43f454e92a3ed2884d0740305&elqaid=7233&elqat=1&elqCampaignId=6185> (interview with Verizon Chief Network Engineers Officer and Head of Wireless Networks Nicola Palmer); Sean Kinney, *Verizon’s Vestberg on balancing network capex with buying spectrum*, RCR Wireless (May 21, 2018), <https://www.rcrwireless.com/20180521/carriers/verizon-network-capex-spectrum-tag17> (comments of Verizon EVP, CTO and President of Global Networks Hans Vestberg).

³³ Verizon Communications Inc., Q2 2018 Earnings Call (July 24, 2018).

³⁴ Kendra Chamberlain, *Verizon Is a “Fiber Giant” for 5G, Report Says*, Fierce Wireless (Aug. 8, 2018), <https://www.fiercewireless.com/tech/verizon-a-fiber-giant-for-5g>.

³⁵ Verizon Communications Inc., Q2 2018 Earnings Call (July 24, 2018); Monica Allevan, *Verizon, Nokia Complete 5G NR Mobility Call*, Fierce Wireless (August 17, 2018), <https://www.fiercewireless.com/wireless/verizon-nokia-complete-5g-nr-mobility-call>.

³⁶ Mike Dano, *Verizon Wireless Chief on 5G Use Cases: Retail, Manufacturing, Gaming, and More*, Fierce Wireless (Aug. 8, 2018), <https://www.fiercewireless.com/5g/verizon-s-wireless-chief-5g-use-cases-retail-manufacturing-gaming-and-more>.

³⁷ Monica Allevan, *Verizon, Nokia Complete 5G NR Mobility Call*, Fierce Wireless (August 17, 2018), <https://www.fiercewireless.com/wireless/verizon-nokia-complete-5g-nr-mobility-call>.

³⁸ Sean Kinney, *Verizon launching mobile 5G in 2019*, RCR Wireless (August 3, 2018), <https://www.rcrwireless.com/20180803/5g/verizon-launching-mobile-5g-in-2019>.

³⁹ Scott Moritz, *Verizon Is Seeking Google or Apple as 5G TV Provider*, Bloomberg (July 23, 2018), <https://www.bloomberg.com/news/articles/2018-07-23/verizon-is-said-to-seek-google-or-apple-as-5g-tv-provider>.

⁴⁰ *Mobile 5G and Small Cell Legislation*, National Conference of State Legislatures (May 7, 2018), available at <http://www.ncsl.org/research/telecommunications-and-information-technology/mobile-5g-and-small-cell-legislation.aspx>. Identifying Arizona, Colorado, Delaware, Florida, Hawaii, Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, North Carolina, New Mexico, Ohio, Oklahoma, Rhode Island, Tennessee, Texas, Utah, and Virginia.

⁴¹ Julia Manchester, *FCC commissioner: US in 'great shape' in 5G network race with China, other countries*, The Hill (August 13, 2018), <http://thehill.com/hilltv/rising/401526-fcc-commissioner-us-is-in-great-shape-in-5g-race-with-china-other-countries>.

⁴² *5G: The chance to lead for a decade*, Deloitte, at 2 (August 2018).