
# Spectrum Strategies for 5G

If North America wants to lead the World in the 5G Era, this is a critical time to plan and allocate harmonized 5G spectrum in low, mid and high bands.

By Berge Ayvazian and Haig Sarkissian
Wireless 20/20

December 26, 2017

Wireless 20|20

## TABLE OF CONTENTS

## EXECUTIVE SUMMARY

In this report, Wireless 20/20 examines the state of the US sub-6GHz spectrum availability as it applies to 5G Mobile deployments. By asking "What spectrum bands will US operators use for Mobile 5G?", we examine not only the current spectrum holdings of the top 4 US mobile operators, but also, the potential availability of suitable spectrum for mobile 5G deployment in the USA.

5G Americas recently published a white paper entitled ***Spectrum Landscape for Mobile Services*** that highlights the importance of spectrum harmonization across licensed and unlicensed low-, mid- and high-band to support smooth 5G network deployments and delivery of 5G services. Each spectrum band has specific characteristics that make it suitable for certain deployment scenarios. While the low band of spectrum has very good propagation characterisitcs that make it feasible for large area coverage, it has limited capacity due to lack of available spectrum and component design considerations. The mid-band of spectrum provides a type of coverage more feasible for urban deployment, with increased capacity. The high-band of spectrum is more limited in coverage, but could provide very high capacity due to the amount of unused spectrum available at these frequencies. Given the diversity of future applications no single band can meet every 5G requirement.

Just before yearend 2017, 3GPP ratified the 5G New Radio (5GNR) Non-Standalone (NSA) specification during a RAN plenary meeting held in Lisbon, Portugal. The 5G NR specifications for Non StandAlone (NSA) operation are included in the 3GPP's Release 15 where the control of the 5G radio service will be "anchored" in the LTE Evolved Packet Core while 5G NR carriers are used to boost data-rates and reduce latency. This initial standard covers both fixed and mobile applications and completes the common part of 5G NR in both NSA and SA modes, laying a solid foundation for a global unified 5G system with worldwide market scale. As promised earlier in 2017, the accelerated timeline and release of the NSA 5G NR specification by yearend 2017 will enable the next phase of equipment availability and movement to interoperability testing and will provide the basis for initial 5GNR NSA products to be made available in 2018 and enable the initial commercial deployment of 5G enhanced mobile broadband networks based on the 5GNR NSA technology in early 2019.

The global 5G standard for a new OFDM-based air interface is designed to support the wide variation of 5G device-types, services, deployments and spectrum bands. The 5GNR NSA specification also laid out key 5G spectrum bands including:

- **617 MHz to 698 MHz (Band 71)**
- **AWS (Band 66)**
- **2.5 GHz**
- **3.3 GHz to 4.3 GHz**
- **4.4 GHz to 4.99 GHz**
- **24.25 GHz to 29.5 GHz**
- **37 GHz to 40 GHz**

This makes 2018 an even more critical year to plan and allocate harmonized 5G spectrum in low, mid and high bands. Wireless 20/20 believes that a balanced portfolio of 5G licensed and unlicensed spectrum will be required to support 5G network deployments worldwide over the next decade. As indicated in **Exhibit 1**, each spectrum band has specific characteristics that make it suitable for certain deployment scenarios. While the low range of spectrum has very good propagation characteristics that make it feasible for large area coverage, it has limited capacity due to lack of available spectrum and component design considerations. The mid-range of spectrum provides a type of coverage more feasible for urban deployment, with increased capacity. The high-band of spectrum is more limited in coverage, but could provide very high capacity due to the amount of unused spectrum available at these frequencies. Given the diversity of future applications no single band can meet every 5G requirement.

***Wireless 20/20 believes that a balanced portfolio of 5G licensed and unlicensed high, medium and low band spectrum will be required to support 5G network deployments worldwide over the next decade.***

***Exhibit 1***

*5G Spectrum Strategies for Low-, Mid- and High-Band Ranges*


| *Spectrum Bands* | *Licensed* | *Shared* | *Unlicensed* |
|---|---|---|---|
| ***Low-band*** ***Below 1 GHz*** *Limited capacity with large area coverage and indoor penetration* | *600 MHz US* *700 MHz EU* | | |
| ***Mid-band*** ***1 – 6 GHz*** *Good for urban deployment with increased capacity* | *AWS (Band 66)* *2.5 GHz* *3.3 - 4.3 GHz* *4.4 - 4.99 GHz* | *3.5 GHz CBRS US* *3.7-4.2 GHz US* *5.9-7.1 GHz US.* | *5-5.9 GHz* |
| ***High-band*** ***Above 20 GHz*** *Limited coverage with potential for very high capacity* | *4.25 - 29.5 GHz* *27.5-28.35 GHz* *37-38.6 GHz* *38.6-40 GHz* | *37-37.6 GHz* *57-71 GHz* | *64-71 GHz* |

*Source: Wireless 20/20, December 2017*

## WHAT SPECTRUM BANDS WILL US MOBILE OPERATORS USE FOR 5G?

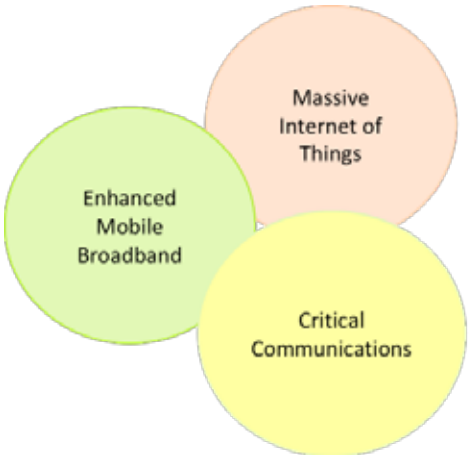
This report provides an overview of the dependencies between the 5G applications spectrum requirements and spectrum ranges in the Mobile Service that may be attractive for deployment of 5G services. Although much of the dialogue on 5G spectrum in the US has focused on millimeter (mmWave) spectrum, it is not clear that mmWave spectrum is suitable for mobile network deployment in the near to mid-term future. In 2016, 3GPP published TR22.891 which contains more than 70 different use cases for potential 5G requirements, categorized in to three different groups; Enhanced Mobile Broadband Critical Communications and Massive Internet of Things.

- **Enhanced Mobile Broadband** includes a number of different use case families related to higher data rates, higher density, deployment and coverage, higher user mobility, devices with highly variable user data rates, fixed mobile convergence, and small-cell deployments.
- **Critical Communications** is driven by the need for low latency, ultra-reliability, and availability to enable, for example, industrial control applications and tactile Internet. These requirements can be met with an improved radio interface, optimized architecture, and dedicated core and radio resources.
- **Massive Internet of Things** focuses on use cases with massive number of devices (e.g., sensors and wearables). This group of use cases is particularly relevant to the new vertical services, such as smart home and city, smart utilities, e-Health, and smart wearables.

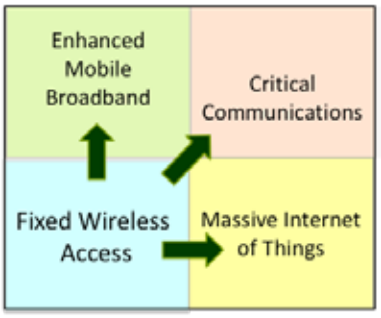
***Exhibit 2***

*New Paradigm for 5G Use Cases*

3GPP Original 3GPP Paradigm for 5G Use Cases




Wireless 20/20 Paradigm for 5G Use Cases




*Source: 3GPP SA1 and Wireless 20/20, December 2017*

Wireless 20/20 has added a new paradigm for 5G Use Cases, including Fixed Wireless Access as the initial effort by US operators to testing 5G technologies as a more cost-effective approach to expand the coverage and capacity of their fixed broadband networks. We believe 5G FWA using mmWave spectrum will be the first application for commericial service beginning in 2018, and will serve as a test-bed for the other three use cases that will require low and mid-range spectrum for deployments in 20so and beyond.

This is exactly why Verizon is concentrating on the **Fixed Wireless Access** use case in order to develop an ecosystem of vendors to advance mmWave technology and showcase the building blocks that will ultimately be necessary for the commercial deployment of mobile 5G. The array of technologies that need to be developed, miniaturized and optimized include antenna technology, RF front end circuits, including mmWave power amplifiers and filters, as well as the associated PHY and MAC digital circuitry capable of utilizing mmWave for the over-the-air interface. All this has to ultimately be developed in low power semiconductor technology for integration in hand held, battery operated smartphones.

***Wireless 20/20 believes the 5G Fixed Wireless Access use case is an ideal application to enable the industry to develop, and test many of the piece-parts that will ultimately be integrated in smartphones.***

Wireless 20/20 believes the 5G Fixed Wireless Access use case is an ideal application to enable the industry to develop, and test many of the piece-parts that will ultimately be integrated in smartphones. Most industry analysis and observers will agree that it is unlikely to see wwWave 5G technology be integrated into smartphones in the next two years. Low-band wireless signals travel further and penetrate obstacles like buildings better than the mid-band and high-band spectrum. But if the Mobile 5G promise is to be met by the 2020 timeframe, sub 6-GHz spectrum will be necessary.

We consider a spectrum to be suitable for 5G deployment if it consists of a minimum of 100 MHz of bandwidth, because, in order to deliver speeds close to 1Gbps, 100 MHz will be needed if an efficient modulation scheme is used that produced 10bits/Hz, assuming TDD technology. According to Joan Marsh, AT&T's VP of Regulatory Affairs, ideally 200 MHz blocks are needed for favorable 5G deployments and maximize the number of blocks available for auction. If FDD technology is used, this would enable 2x100 MHz of spectrum in order to deliver 1Gbps downlink speeds. There is always an opportunity to use asymmetrical downlink vs. uplink spectrum bandwidth, for example by allocating 100 MHz for uplink and 40 MHz for downlink. There is also the option of combining two separate spectrum bands, where one is used for DL and the other is used for UL (Example, AWS use case of 1700/2100 MHz for UL/DL).

By this definition, currently neither AT&T, Verizon nor T-Mobile controls sufficient sub-6GHz spectrum that is suitable for mobile 5G deployment. Only Sprint has the 100 MHz of bandwidth in the 2.5GHz spectrum band that could support 5G deployment with user downlink speeds that could deliver 1Gbps service. T-Mobile participated in the 600 MHz auction and was able to secure 31 MHz of this low-band spectrum in many markets nationwide. The total available

bandwidth available in the 600 MHz LTE Band 71 band is 70 MHz, and T-Mobile obtained an average of 31 MHz, clearly not enough by itself for mobile 5G deployment.

US Mobile operators have several options when it comes to assigning sub-6GHz spectrum for mobile 5G. These include:

A. Re-farm spectrum from 2G and 3G and use channel aggregation to allocate 100MHz of spectrum for 5G.

B. Lobby the FCC to open 3.5 GHz spectrum for 5G.

C. Lobby the FCC for finding 4GHz or 6GHz spectrum that could be used for 5G,

D. Work with existing 2.5 GHz spectrum holders in order to open up the additional 2.6GHz spectrum that is not held by Sprint.

E. Partner with current holders of virgin sub 6Ghz spectrum in the USA (i.e. DISH Networks) and combine their AWS spectrum with existing AWS spectrum to aggregate the necessary 100 MHz for Mobile 5G.

For Sprint, the most logical approach would be option D, where Sprint would potentially consider working with other 2.5GHz owners and essentially control a contiguous 200Mhz of spectrum from 2496 – 2590 MHz in the USA. Sprint and other educational licensees are already asking the FCC to extend the geographic coverage of 2.5 GHz EBS spectrum to county boundaries and issue additional licenses in existing white spaces.

For Verizon, the most logical approach would be option E, where it could partner with DISH and combine DISH's AWS spectrum with its own and thereby control a large chunk of 1700 / 2100 spectrum for 5G. For AT&T, it could enter a bidding war with Verizon over DISH's spectrum, and consider lobbying the FCC to open new 5G spectrum (which could be 3.5GHz, 4GHz or 6GHz).

For T-Mobile, it could increase its effort to lobby the FCC to assign the 3.5 GHz spectrum band for 5G. If successful, this will give T-Mobile a shot at acquiring new, and relatively unencumbered spectrum suitable for 5G. Otherwise it could join AT&T in lobbying for new 5G spectrum in the 4 GHz or 6 GHz bands.

Because of the unclear path for sub-6 GHz spectrum suitable for mobile 5G deployment, the US is lagging other leaders in the field of mobile 5G. Focusing solely on mmWave as the path to mobile 5G has many challenges. China and the EU have recognized the benefits of allocating sub-6 GHz 5G spectrum and are focusing on the 3.5 GHz spectrum band. Canada has the opportunity to designate the 3.5 GHz spectrum for 5G since most of that spectrum is unused in metro markets.

If the FCC is unable to pave the way to make sufficient low band spectrum available for 5G, then perhaps US mobile operators could consider joining forces by sharing 5G spectrum in order to build mobile 5G networks. The question of whether a country needs four separate nationwide 5G mobile networks is more valid today in light of the limited availability of low- and mid-band spectrum. It should not take long for operators to realize that it is more economical to build shared 5G mobile networks than four separate 5G networks each needing separate spectrum.

***If the FCC is unable to pave the way to make sufficient low band spectrum available for 5G, then perhaps US mobile operators could consider joining forces by sharing 5G spectrum in order to build mobile 5G networks.***

## HARMONIZING SPECTRUM BANDS FOR 5G

Despite calls for harmonized 5G spectrum, the US and EU seem to be on different paths at least in the near term. Several spectrum bands were identified by the ITU WRC-15 for future 5G services, including three bands above 6GHz in the 24 GHz, 31 GHz and 40 GHz bands. As indicated in the following exhibit, Europe is currently focusing on sub-6GHz spectrum for initial 5G trials and deployments, including C-Band (3.4 - 3.8GHz), to be allocated for 5G across multiple markets. The EU Council adopted a decision which calls for the coordinated use of the 700 MHz band to drive the roll-out of 5G wireless technology and boost mobile broadband connectivity in all EU member states. As a result of this decision, European mobile operators will obtain exclusive access to the 700 MHz band (694-790 MHz) by June 2020, a timeframe that coincides with the expected deployment of 5G networks in Europe.

In the US, the FCC has been pushing for operators and their vendors to get a head start with 5G by unilaterally identifying new mmWave spectrum bands above 6GHz. The FCC's Spectrum Frontiers1 Notice of Proposed Rulemaking/Final Notice of Proposed Rulemaking (NPRM/FNPRM) was intended to establish a spectrum environment

conducive to 5G investment. These new rules would open up nearly 11 GHz of high-frequency spectrum for mobile and fixed wireless broadband – 3.85 GHz of licensed spectrum and 7 GHz of unlicensed spectrum. The rules create a new Upper Microwave Flexible Use service in the 28 GHz (27.5-28.35 GHz), 37 GHz (37-38.6 GHz) and 39 GHz (38.6-40 GHz) bands, and a new unlicensed band at 64-71 GHz. The FCC will continue to seek comment on bands above 95 GHz. The FCC plans to license spectrum in the 28GHz, 37GHz and 39GHz bands on an exclusive-use, flexible-rights licensed basis, and has identified the 64-71GHz band for unlicensed experimental sharing or other non-exclusive access arrangements. The FCC has already allocated temporary spectrum licenses to mobile operators for field trials, and is planning to move forward with early auctions of licensed mmWave spectrum.

***Wireless 20/20 believes policymakers throughout the world should initiate additional activities to consider lower frequency bands in addition to proceeding with the mmWave bands in the 24-86 GHz band.***

5G Americas has promoted the 'tuning range' concept to achieve regional and global harmonization and encouraged the engagement of national regulators with one another to identify solutions to co-existence issues to allow regional and global harmonization to take place. Wireless 20/20 believes that policymakers throughout the world should initiate additional activities to consider lower frequency bands in addition to proceeding with the mmWave bands in the 24-86 GHz band.

***Exhibit 3***

*Status of States and Territories Considering FirstNet Draft Plans (August 2017)*

| *Europe* | *EU Council* | *FCC* | *USA* |
|---|---|---|---|
| | | *600 MHz band* | *Auction completed* |
| ***By June 2020 for EU 5G*** | *700 MHz band* | | *39 months for repacking* |
| ***C-Band for 5G pre-2020*** | *(694-790 MHz)* | | *Already licensed for LTE* |
| *WRC-15 EU 5G* | *3.4 – 3.8 GHz* | | *CBRS shared* |
| | *24.5 – 27.5 GHz* | *27.5 – 28.35 GHz* | |
| *WRC-15 EU 5G* | | | *28 GHz 5G* |
| | *31.8 – 33.4 GHz* | *37.0 -38.6 GHz* | |
| | | *38.6 – 40 GHz* | *37 GHz 5G* |
| *WRC-15 EU 5G* | | | *39 GHz 5G* |
| | *40.5 – 43.5 GHz* | *64 – 71 GHz* | |

*Source: Wireless 20/20, December 2017*

## US OPERATORS TESTING 5G FWA IN mmWAVE BANDS

***Operators with spectrum in the 28 GHz and 39 GHz bands are among the first to test 5G FWA services in the US. Both AT&T and Verizon have been aggressively pursuing acquisitions of mmWave spectrum.***

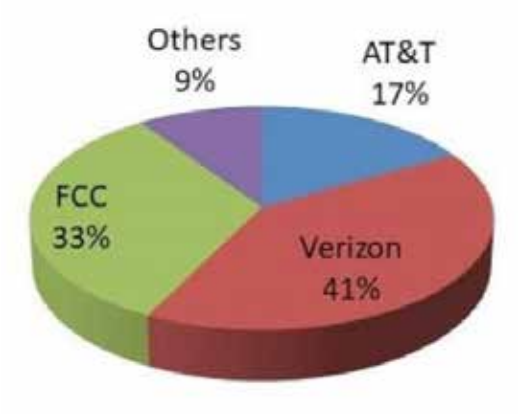
Operators with spectrum in the 28GHz and 39 GHz bands are among the first to test 5G FWA services in the US. Both AT&T and Verizon have been aggressively pursuing acquisitions of mmWave spectrum. In early 2017, Verizon completed the $1.8 billion acquisition of XO Communications with 26,000 route miles of inner-city fiber networks in 85 cities including Seattle, Miami, NYC and Los Angeles. In this transaction, Verizon also obtained an option to buy the 102 licenses XO holds in 28 GHz and 39 GHz bands that cover 63% of US Pops by year-end 2018. Verizon is now using 100+ MHz of 28 GHz and 39 GHz spectrum leased from XO to conduct pre-commercial 5G FWA trials. Verizon also acquired Straight Path after a short bidding war with AT&T, in a $184 per share all-stock transaction reflecting an enterprise value of approximately $3.1 billion. Straight Path was spun off from IDT Corp. in 2013, and held 133 licenses in the 28 GHz band and 735 licenses in the 39 GHz band, including New York City, Los Angeles, San Francisco, Atlanta and Washington, DC. Through the acquisition of XO and Straight Path, Verizon would control 235 of 766 total active LMDS licenses today.

In February 2017, AT&T announced plans to acquire mobile backhaul provider FiberTower out of bankruptcy, which holds interests in a total of 738 mmWave licenses in the 24GHz and 39GHz bands that cover over 30 US cities and towns. FiberTower licenses were originally intended for microwave backhaul links and are not in LMDS bands. Most FiberTower licenses cover 120 MHz contiguous blocks as well as some odd 40 MHz blocks. As such, these licenses are not as valuable as the wider Verizon licenses, and 5G services using the FiberTower spectrum would be limited to a single 100 MHz channel. Neither the financial terms nor a timeline for the transaction were disclosed and 650 of FiberTower's millimeter wave licenses were later terminated for failure to meet the FCC's construction requirements.

AT&T has asked the FCC for permission to use all licenses once controlled by FiberTower, subject to a pending remand from the U.S. Court of Appeals for the District of Columbia circuit. The Competitive Carriers Association has urged the FCC to take back these 650 terminated licenses and auction the 24 GHz and 39 GHz spectrum. Assuming these acquisitions are completed, AT&T and Verizon will control approximately 58% of the licensed mmWave spectrum, limiting the remaining mmWave licensees to 9 percent, based on new charts from Allnet Insights & Analytics. The FCC plans to conduct auctions of the remaining 33% of licensed mmWave spectrum in late 2018 or early 2019.

***Exhibit 4***

*Total Millimeter Wave Spectrum with FiberTower's Terminated Licenses*




*Source: Allnet Insights & Analytics, July 2017*

Verizon and AT&T have also been first movers in conducting field trials of 5G technologies to support fixed wireless services in the US. Both operators have wireline operations that have been deploying fiber, but are now testing 5G FWA as a more cost-effective approach to expand the coverage and capacity of their fixed broadband networks. Verizon plans to use 5G FWA to reduce the capital cost of extending the reach of FiOS services via fixed wireless to more US households in select metros. Verizon has successfully trialed 5G residential applications in 11 markets in 2017 and recently announced it will launch wireless residential broadband services in three to five U.S. markets in 2018. Verizon's first commercial launch is planned to be in the second half of 2018 in Sacramento, CA. This commercial launch plan is based on positive customer experience during the trials and on Verizon's confidence in new technology powered by millimeter-wave spectrum. The 5G commercial launch will not have a material impact on Verizon's consolidated capital expenditures in 2018. The company expects its full-year 2018 capital spending program to be consistent with the past several years. The targeted commercial launches will provide a strong framework for accelerating 5G's future deployment on the global standards. Details of that launch, and the announcement of additional markets, will be provided at a later date. Verizon has built a strong ecosystem partners to help drive forward with 5G industry standards for both fixed and mobile applications.

AT&T has been working with Ericsson, Samsung, Nokia, and Intel to expanding its 5G fixed wireless trials to business and residential customers in Waco, Texas; Kalamazoo, Michigan; and South Bend, Indiana by the end of 2017. Trial participants in the new markets may include universities, hospitals, churches, restaurants, and other small businesses. AT&T's initial fixed wireless 5G trial in Austin provided new insights into millimeter wave (mmWave) performance and propagation. The carrier also learned more about how things like foliage, building materials, device placement, surrounding environment and weather impact the signal and system in a real-world environment. AT&T will continue to test fixed and mobile wireless solutions operating in mmWave spectrum in the field and testbeds. Participants will be able to stream premium live TV via DIRECTV NOW and experience faster broadband services, all over a 5G internet connection. AT&T recently announced its 5G Evolution plans for 2017 and beyond, and is collaborating with more than a dozen global technology companies around 5G standards. AT&T has been testing 5G FWA to understand propagation challenges of very-high-frequency mmWave spectrum and ability to provide large bandwidths. In addition to Austin, Indianapolis is the second metro to benefit from AT&T's 5G Evolution.

AT&T Labs is also conducting "field trials" with several utility companies under its "Project AirGig to deliver low-cost, multi-gigabit wireless internet speeds using power lines. The technology uses a network of mmWave antennas installed on existing aerial power line infrastructure to deliver high-speed internet service. AT&T recently announced the start of Project AirGig field trials in the US and abroad. AirGig has the capability to work across urban, suburban and rural environments, but the most promising areas are in the suburban and rural environment where it can be harder to get fiber in place. AT&T has secured or applied for 300 patents related to the AirGig technology, which has a "synergistic" relationship to 5G since, AirGig's close relationship to the electrical grid could help extend 5G capabilities to more places. AT&T is aggressively deploying equipment, investing in the right mix of spectrum and technology, and laying the foundation for its evolution to 5G while 5G standards are being finalized. Learnings from these new fixed wireless 5G trials will help speed up standards based deployment as early as late 2018.

Verizon estimates the overall market opportunity for 5G residential fixed wireless broadband services to be approximately 30 million households nationwide. A new report from The Carmel Group analyst firm forecasts the U.S. fixed wireless market could grow from more than 4 million subscribers today to 8 million by 2021. The Carmel Group also forecasts fixed wireless revenues would rise from $2.7 billion in 2017 to $5.2 billion by 2021.

Although T-Mobile has only 36 mmWave spectrum licenses, the Un-carrier has conducted successful 5G testing using 28 GHz and 39 GHz LMDS spectrum obtained in the MetroPCS acquisition. But T-Mobile does not plan to use 5G for fixed wireless access and is targeting nationwide 5G coverage by 2020. The Un-carrier Road to 5G is disruptive and T-Mobile sees 5G as completely transforming the mobile Internet and delivering amazing breakthroughs such as live streaming of videos and concerts, 8K video, 4K 360 video, Virtual Reality and Augmented Reality. T-Mobile recently announced plans to begin rolling out a '5G Ready' network in 2019, using part of its 600 MHz 31 MHz of nationwide spectrum licenses acquired for $8 billion in the recent FCC auction. Based on recent discussions, we believe this means that new 600 MHz equipment from Ericsson will be used to support both LTE and 5G in that band. The FCC cannot release all of this low-band 600 MHz spectrum until the remaining broadcast spectrum is repacked, a process that could take 39 months. This makes 600 MHz as a likely coverage band for 5G mobile services to be rolled out after 2020. T-Mobile has confirmed plans to leverage much of its new 600 MHz spectrum in deploying 5G service nationwide by 2020. T-Mobile believes more low- and mid-band spectrum will drive 5G network coverage for the US marketplace.

***Unlike Verizon and AT&T, T-Mobile and Sprint do not plan to use 5G to provide fixed wireless broadband targeting businesses and residential households. As such they are focusing on low-and mid-range spectrum for 5G deployments.***

Unlike Verizon and AT&T, T-Mobile and Sprint do not plan to use 5G to provide fixed wireless broadband targeting businesses and residential households. As such they are focusing on low-band and mid-band spectrum for 5G deployments. Sprint has only 41 mmWave spectrum licenses, and like T-Mobile Sprint does not plan to use 5G to provide fixed wireless broadband targeting businesses and residential households. The cornerstone of Sprint's future 5G network will be a massively dense network that uses high-bandwidth spectrum to deliver vast amounts of data at tremendously high speeds. Sprint is building a strong foundation for 5G by densifying its network with smart antennas to meet future 5G demand for higher data rates. Sprint has worked with both Ericsson and Nokia to demonstrate 5G capabilities with Samsung virtual reality (VR) headsets showing 360 degree views. But rather than acquiring mmWave spectrum, Sprint emphasizes the use of its more than 150 MHz of 2.5 GHz spectrum along with Massive MIMO (32/32 or 64/64) as the anchor band for its 5G activities.

## 5G LOW- AND MID-BAND SPECTRUM REQUIREMENTS

It is clear that low- and mid-band spectrum bands are emerging as critical ingredients for 5G mobile networks to be deployed nationwide. Wireless 20/20 recognizes that mmWave bands offer a huge amount of spectrum, which could deliver orders of magnitude improvements in network speed, capacity and latency. The tradeoff is that mmWave spectrum generally requires line-of-sight, can be affected by weather, and offers relatively limited coverage. Providing nationwide mobile 5G service in these high spectrum bands will also require the deployment of large numbers of small cells—and the formula has yet to be developed to do this at scale. There is also still considerable work to be done to develop the beam-forming antennas and other technology required to deliver 5G mobile services using mmWave bands. As a result, mmWave band networks will be built in denser urban areas and other fixed wireless targeted deployments, where it makes the best economic sense and where the most subscribers can be reached. If the industry is limited to mmWave spectrum, the map will look like 'islands' of 5G in a sea of LTE and LTE Advanced.

The FCC recognizes the importance of low- and mid-range spectrum in the 5G race, and recently proposed policies to increase the usability of additional 3.5 GHz band spectrum for 5G. T-Mobile and the CTIA have been leading an effort to make the 3.5 GHz CBRS band more '5G friendly' by lengthening the terms of the licenses and expanding the geographic service areas. Also in August, the FCC opened an inquiry into new opportunities in the 3.7-4.2 GHz band, to be used for the "next generation of wireless services". This effort is also backed by Google and several wireless ISPs, who would want to use this spectrum allocated for fixed wireless services.

Wireless 20/20 agrees with 5G Americas that countries and regions that want to be leaders in the new 5G wireless era will need to provide more licensed 5G mobile spectrum. The time is now for the planning and allocation of harmonized spectrum in sub-6 GHz low-and mid-bands to help carriers successfully deploy 5G enhanced mobile broadband and massive IoT services nationwide.

This White Paper was authored by Berge Ayvazian and Haig Sarkissian, Senior Analysts and Principal Consultants of Wireless 20/20.

Wireless 20/20 helps mobile operators and their vendors develop their Wireless Network strategies, service offerings, marketing plans, technology roadmaps and business cases. Wireless 20/20 also leverages its WiROI® Business Case Analysis Tools to assist clients in issuing RFPs and evaluating responses.



WP-12262017