

the expansion of mobile and fixed services into the millimeter wave (mmW) bands as proposed in the *NPRM*, and concurs with many of the comments in this proceeding that support providing existing fixed mmW licensees the flexibility to deploy both fixed and mobile operations at 28 GHz, 37 GHz, and 39 GHz.² Sprint also suggests that the Commission adopt rules that will adequately protect existing fixed mmW operations, as well as future expansion of fixed services in these bands, from harmful interference.

Sprint is uniquely positioned to speak to the issue of protecting fixed point-to-point microwave operations in the bands proposed by the *NPRM*. To support the growing data demands of our customers, and in an effort to avoid the high cost of traditional wireline circuits, Sprint has deployed a significant wireless backhaul network. Sprint holds approximately 19,000 fixed microwave licenses, and is one of the largest users of licensed fixed microwave systems in the United States. In the 28 GHz band, Sprint operates an LMDS license,³ and currently operates over two hundred 28 GHz microwave paths as a lessee. As 5G services emerge, Sprint anticipates its need for backhaul solutions, including fixed microwave backhaul, will increase.

II. THE COMMISSION MUST PERMIT INCUMBENT FIXED POINT-TO-POINT MICROWAVE OPERATIONS TO CONTINUE AND ALLOW FOR FUTURE GROWTH IN FIXED MICROWAVE OPERATIONS

The 28 GHz and 39 GHz bands support hundreds of operational fixed point-to-point microwave links. The demand from wireless consumers for high-speed data is well documented

² See comments of Samsung Electronics America, Inc. and Samsung Research America at 17, PCIA – The Wireless Infrastructure Association at 9, 4G Americas at 13, Facebook, Inc. at 3, Huawei Technologies, Inc. (USA), Huawei Technologies Co., Ltd. at 12, FiberTower Spectrum Holdings at 6, Skyriver Communications, Inc. at 3, Cisco Systems, Inc. at 5, Information Technology Industry Council at 4, Consumer Technology Association at 10, Telecommunications Industry Association at 6, Nokia at 14, XO Communications, LLC at 6, ESOC, Hughes and Alta at 15, and SES Americom at 5.

³ FCC License WPLM314.

and that demand will only increase as 5G systems are tested, deployed and operationalized. Current capacity requirements demand robust backhaul solutions, and wireless backhaul is an important alternative for delivering significant capacity with good reliability, particularly given the high cost of traditional wireline backhaul circuits.⁴ Microwave point-to-point frequencies in the traditional 6 GHz, 11 GHz, 18 GHz, and 23 GHz bands have become scarce in sections of the country, prompting some, including Sprint, to seek wireless backhaul solutions in other bands.

Sprint recognizes that emergent 4G and 5G-like technologies and services are being deployed and will continue to be deployed in the near-term future, with 5G services themselves being deployed on a wide scale basis following completion of standardization activities in the next couple of years. Providers of these services will require additional spectrum for service links and backhaul solutions, and Sprint supports the Commission's proposal to authorize new mobile and fixed licenses in the mmW bands. In addition, Sprint supports permitting current 28 GHz and 39 GHz licensees to provide both fixed and mobile operations to other entities through secondary markets provided the Commission likewise protects open and equitable access in such secondary markets as conditions of review in possible future corporate acquisitions of these licenses and/or licensees.

III. THE COMMISSION SHOULD ADOPT RULES THAT PROMOTE COLLABORATION AMONG USERS TO PREVENT HARMFUL INTERFERENCE, PARTICULARLY TO FIXED OPERATIONS.

Sprint agrees with the visions provided by 4G Americas, CTIA and others in this proceeding that 5G will encompass a broad variety of devices and uses, including Internet of Things sensors, telemedicine equipment, vehicular broadband access and safety systems, agriculture machinery, new gaming and virtual reality devices, and higher speeds for existing

⁴ See Comments of Sprint Corporation, WC Docket No. 05-25 (Jan. 27, 2016).

mobile devices.⁵ As discussed earlier, the network to support 5G systems will need to have greatly expanded connection to fixed network infrastructure, including the Internet and network servers, and it is essential that the Commission adopt rules that will enable and protect the expanded deployment of fixed microwave links in the mmW bands.

With the wide variety of transmitters, devices and use cases that are likely to be deployed in the mmW bands, it is essential that the Commission adopt interference protection rules that are flexible enough to permit highly differing uses in the band while at the same time minimizing the potential for harmful interference between users in adjacent bands or at the edges of geographic areas.⁶

Sprint supports CTIA's recommendations that the Commission "empower the marketplace to work collaboratively to resolve any interference issues that arise...and only involve itself in interference disputes where absolutely necessary."⁷ The potential for adjacent channel interference in the mmW bands is most likely to occur when two fixed microwave paths on adjacent frequency blocks are deployed in the same polarization with the antennas pointed directly at each other. Using the Commission proposed power levels and out-of-band emissions ("OOBE") limits, Sprint's analysis indicates that OOBE interference or brute force receiver overload blocking interference can occur under such conditions in the 28 GHz, 37 GHz, and

⁵ See *5G Technology Evolution Recommendations*, White Paper attached to Comments of 4G Americas, pages 2-8, and *The Next Generation of Wireless: 5G Leadership in the U.S.*, Thomas K. Sawanobori, SVP and Chief Technology Officer, CTIA, February 9, 2016, pages 5-7, available at http://www.ctia.org/docs/default-source/default-document-library/5g_white-paper-web.pdf.

⁶ A mmW licensee has an inherent ability to address the interference potential between the different users on its network. The Commission can generally rely on the licensees and the relevant standards bodies to adopt approaches that best meet industry's needs. The Commission, however, should adopt more specific limits to avoid harmful interference when different uses occur on adjacent frequency blocks in the same geographic area or at the edges of geographic boundaries between two licensees on the same channel.

⁷ CTIA comments at 29.

39 GHz bands at distances of up to three kilometers. To avoid such interference, Sprint recommends that the Commission require an operator proposing to initiate new fixed operations to coordinate those operations with the adjacent block operator when a new fixed transmitter would be located within 3 km and within +/- 10 degrees of the receive azimuth of an existing fixed receiver, or a new fixed transmitter would be within 1 km of an existing fixed receiver, but outside the +/- 10 degree receive antenna main lobe.

The operator initiating new service would be required to contact the incumbent licensee and negotiate technical parameters to avoid interference. Sprint recognizes that the Commission's Universal Licensing System ("ULS") currently contains latitudes, longitudes, and frequencies of licensed point-to-point paths, and those operating under lease, at 28 GHz and 39 GHz. Current ULS data may be sufficient to act as a database to prevent interference and existing licensees should be granted a fixed time period to confirm geographical coordinates, frequencies, and identify any missing path receive points and revise the ULS data as necessary.

We expect that in many cases the two operators will either agree that no harmful interference will occur or adopt interference mitigation approaches so that both licensees operations will not experience harmful interference. As such, we do not envision the need for a dynamic sharing system or Spectrum Access System to protect point-to-point systems. A database solution in which new operators can easily identify incumbents they need to coordinate with is preferable to these other systems.

Sprint also agrees that the Commission should adopt signal limits that would apply at the geographic border of the licensing area, as discussed in paragraphs 289-292 of the *NPRM*. Sprint, however, has concerns with the proposed 47 dBuV/m field strength limit at the border and suggests that the Commission adopt instead a power limit measured in a specified bandwidth. A field strength approach, particularly one that uses the 47 dBu/V level applied in

some other bands, may not be the best metric as it is inconsistent with the protection level provided in the other bands because it ignores the frequency component and measurement bandwidth that are important factors in determining the potential for interference.

The formula to convert field strength to power is:

$$P(\text{dBm}) = E(\text{dBuV/m}) + G(\text{dBi}) - 20 \text{ Log } F (\text{MHz}) - 77.2$$

Examining the PCS band, which applies a 47 dBuVm limit at a BTA boundary and the international border, for 1930 MHz we arrive at ~ -95 dBm permitted border power for the channel bandwidth. The same rule applies to the Broadband Radio Service/Educational Broadband Service (“BRS/EBS”) spectrum in the 2.5 GHz band in 5.5 megahertz wide channels.

However, if a 47 dBuV/m field strength border limit were to be used at 28 GHz, 37 GHz, and 39 GHz, the border power values become quite different due to the extremely high frequency component. Additional uncertainty also exists because no measurement bandwidth is specified.

Sprint’s findings are shown on the chart below.

Field str.	47 dBuV/m	Field str.	47 dBuV/m	Field str.	47 dBuV/m	Field str.	47 dBuV/m
Frequency	1930 MHz	Frequency	2600 MHz	Frequency	29000 MHz	Frequency	39000 MHz
Gain	0 dBi	Gain	0 dBi	Gain	0 dBi	Gain	0 dBi
P(dBm)	-95.9111 dBm	P(dBm)	-98.4995 dBm	P(dBm)	-119.44796 dBm	P(dBm)	-122.021 dBm

The current field strength protection at a border in the PCS and BRS/EBS bands were established by ensuring that just enough power was permitted for the operator to provide service at its border while reasonably protecting the service area beyond that border. It is not clear that would be the case for the 28 GHz, 37 GHz, and 39 GHz bands, in part because the channel bandwidths and the block sizes are unknown at this time. Sprint suggests, therefore, that a consistent measurement bandwidth be applied to the border protection limit. When establishing power limits at a border, the Commission should consider establishing an absolute power limit in dBm using a one megahertz bandwidth, as was proposed in the 3.55-3.65 GHz Second Further

Notice of Proposed Rulemaking in GN Docket No. 12-354.⁸ Consideration should also be given for the thermal noise floor of a receiver at wide bandwidths, as receivers using 100 megahertz wide channels would be 20 dB less sensitive than receivers using one megahertz wide channels. Sprint recommends that an absolute value such as dBm/MHz should be considered in the protection rule.

IV. STRICT 5G OUT OF BAND EMISSIONS LIMITS SHOULD NOT BE DETERMINED TODAY AS TECHNOLOGY IS EMERGING.

Sprint agrees with other commenters⁹ that the proposed measurement for unwanted OOBE should not be defined in terms of EIRP, as presented in proposed rule section §30.203, because emergent 5G mobile equipment bandwidths are unknown and new protection criteria will need to be created.¹⁰ The current protection criteria outlined in FCC Rule Section 101.103(a) should continue to act as a guideline to operators coordinating with each other to avoid interference. Sprint will continue to work with CTIA and other operators to develop a consensus limit for OOBE.¹¹

Sprint has particular concerns with the proposal to measure OOBE “in the 1 megahertz bands immediately outside and adjacent to the licensee’s frequency block using a resolution

⁸ See *Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, GN Docket No. 12-354, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959 (2015) at paras 191-197.

⁹ Ericsson Comments at 13; and Straight Path Communications Inc. Comments at 43.

¹⁰ Historically the FCC has adopted OOBE limits that relate only to transmitter power and not to EIRP. See, for example, FCC Rule Section 24.238 (a) for Broadband PCS (“The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB”) and FCC Rule Section 22.917(a) for the Cellular Radiotelephone Service (“The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB”).

¹¹ CTIA Comments at 30.

bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter.” Over two decades ago, the Commission began adopting similar rules because, in part, using a wide measurement bandwidth could inappropriately include some of the power of the fundamental signal itself.¹² Furthermore, as shown in the figure below, using a 1% measured bandwidth for occupied bandwidths of one megahertz and smaller resulted in a significant OOB relaxation that was needed for practical filter design. Over the years and as digital technology advanced, occupied bandwidth has continued to increase in an effort to deliver greater speeds and higher capacity, while the rule has been used unchanged in many other frequency bands. This approach has become increasingly difficult for the manufacturers of equipment, particularly as it is extremely challenging to design wideband and high frequency filters that roll off quickly to meet the OOB mask in the first one megahertz next to the fundamental signal. Indeed, this proposed rule may be too challenging for mmW device manufacturers to meet.

Sprint sees no compelling need to apply such tight OOB limits in a band that has to date had only limited use. The anticipated new mobile and fixed uses of these bands can be designed to accommodate a more reasonable OOB approach. Furthermore, the proposed rule would unnecessarily impose an OOB requirement in the first one megahertz that actually penalizes the use of broader bandwidths.

¹² See, e.g., 47 C.F.R. § 24.238.

Impact of Proposed Requirement To Use A 1% Measurement Bandwidth For OOB In The One Megahertz Bands Immediately Outside And Adjacent To The Licensee's Frequency Block			
Channel Bandwidth (megahertz)	1% Measurement Bandwidth (kilohertz)	Normal OOB Power Limit (dBm/MHz)	Proposed OOB Power Limit in first megahertz (dBm/MHz)
1	10	-13	7
5	50	-13	0
10	100	-13	-3
15	150	-13	-5
20	200	-13	-6
40	400	-13	-9
50	500	-13	-10
60	600	-13	-11
70	700	-13	-11
80	800	-13	-12
90	900	-13	-13
100	1000	-13	-13
200	2000	-13	-16
500	5000	-13	-20

As shown above, while applying the OOB limit using a 1% measurement bandwidth in the first megahertz adjacent to the fundamental signal provided a 20 dBm relaxation when signals are only one megahertz wide, using this approach will result in a huge penalty for the proposed wideband operations in the mmW bands. Sprint recommends instead that an absolute value independent of the occupied bandwidth be adopted instead: $43 + 10 \text{ Log } (P_{watts})$ measured using a 100 kilohertz bandwidth, which would result in a 10 dB relaxation as has been historically applied for one megahertz wide channels.

V. CONCLUSION

Sprint supports the opportunities for 5G mobile services in the mmW bands proposed in the *NPRM*. As a nationwide commercial carrier offering data-intensive mobile services to a rapidly growing number of customers, Sprint cannot ignore the opportunities for future services presented in the *NPRM*. The Commission should acknowledge the immediate need to protect fixed point-to-point and point-to-multipoint operations in the bands proposed by the *NPRM*. Sprint recommends using current technical methods for avoiding interference through active

collaboration between users. Coordination zones established by a reliable, updated database would effectively identify potential interference cases. Sprint also proposes that the Commission follows a flexible approach for interference protection and consider the technical performance of 5G equipment as further development of 5G products and standards are completed.

Respectfully submitted,

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