Hewlett Packard Enterprise

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Innovation, Science and Economic Development Canada
Senior Director, Spectrum Planning and Engineering
Engineering, Planning and Standards Branch
235 Queen Street, (6th Floor, East Tower)
Ottawa ON K1A 0H5

VIA ELECTRONIC FILING
e-mail: ic.spectrumengineering-genieduspectre.ic@canada.ca

Chuck Lukaszewski
Vice President
Chief Wireless Technologist

chuckl@hpe.com
+1.408.227.4500

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COMMENTS OF HEWLETT PACKARD ENTERPRISE

Hewlett Packard Enterprise ("HPE") submits these comments in response to the consultation from Innovation, Science and Economic Development Canada ("ISED") on license-exempt use of the 6 GHz band. HPE strongly supports ISED's moving to open that band to the rapidly expanding ecosystem of 6 GHz-capable devices now coming to market to achieve its stated objectives of "universal access," "ensuring all Canadian consumers as well as business and public instituions have access to the latest wireless telecommunications services at affordable prices," and "enhancing the productivity of the Canadian economy."

HPE is one of the world's largest providers of managed wireless local area network ("WLAN" or "RLAN") infrastructure and is a global leader in the Wi-Fi equipment marketplace. HPE's Aruba business unit ships millions of indoor and outdoor Wi-Fi access points ("APs") every year, representing approximately 15% of the global market for such devices. We have been a significant provider of WLAN equipment to Canadian enterprises and service providers for nearly two decades. As a Canadian employer since 1961, Hewlett Packard Enterprise has over 700 employees across the provinces and is invested in the digital transformation of the country's economy and society. Montreal is home to one of Aruba's four global Wi-Fi Research and Development centers, with more than 80 employees working on the next wave of wireless networking and access security software. Our R&D team in Canada produces the software for Aruba's highest volume Wi-Fi 6 access points (APs) and are doing much of the engineering for our next generation 6 GHz-capable APs.

We are particularly encouraged by ISED's clear emphasis on outdoor use cases and the many cogent questions regarding an automatic frequency coordination (AFC) regulatory framework. HPE is the second largest provider of outdoor RLAN equipment in the world (by revenue) and as such we look forward to delivering AFC capable products to the Canadian market.[1] HPE provides mission-critical outdoor equipment to a broad set of industries, including petrochemical, hospitals, universities, airports, the Canadian armed forces, and other government agencies at the national, provincial, and local levels. This marketplace

[1] Wireless LAN Infrastructure (WLAN) Quarterly Market Report and Forecast, 650 Group, 3Q2020

position gives HPE a deep understanding of license-exempt technology growth and use, how ISED rules impact real-world engineering decisions, and how spectrum policy can advance or restrict innovation.

In this proceeding, HPE has partnered with a broad group of equipment manufacturers, software makers, and internet service companies that work together to make the 6 GHz band available for license-exempt use ("the RLAN Group"). HPE supports the comprehensive comments filed by this group (the "Joint Filers"). In addition, HPE fully supports comments of the Wi-Fi Alliance (WFA), the Wireless Broadband Alliance (WBA), and the Dynamic Spectrum Alliance (DSA) filed in response to ISED's Consultation. We submit these individual comments to highlight issues where HPE has specialized insight and equities. The primary focus of our separate comments is (1) the overall AFC regulatory framework; (2) immediate extension of license-exempt RLAN use into the 6875-6930 MHz sub-band; (3) vital extensions to the AFC framework proposed by ISED such as permitting mobile AFC and antenna directivity; and (4) explaining the paradigm shift for how 6 GHz AFC databases will come to market compared with previous efforts and the implications for policymaking.

Q1: ISED is seeking comments on the timelines for the availability of:

a. low-power equipment ecosystems, both Wi-Fi 6E and 5G NR-U

The RLAN industry is moving rapidly to deliver Wi-Fi 6E certified products in 2021, now that five countries have formally opened the band for license-exempt use. [2] Chipmakers announced and began sampling 6 GHz radios products as early as last January. [3] At least two low power indoor (LPI) consumer-oriented 6 GHz capable routers were introduced at the 2021 Consumer Electronics Show last week. [4] And the Wi-Fi Alliance has begun certifying Wi-Fi 6E products, with a total of 12 certified modules and routers listed on its web page as of the ISED filing deadline. [5] All of these announced and shipping products support LPI operation.

The enterprise sector historically follows the consumer sector by six to nine months for new Wi-Fi technology generations. In keeping with that timeframe, HPE expects most major enterprise OEMs to announce and ship one or more Wi-Fi 6E products before the end of 2021 – and possibly as early as the summer. By moving expeditiously, ISED can ensure that enterprise RLAN products are available in Canada this year.

b. standard-power equipment ecosystems, both Wi-Fi 6E and 5G NR-U, under the control of an AFC

In parallel with Wi-Fi 6E – which is an interoperability certification – WFA is also working hard to produce the technical specifications that will enable AFC devices and AFC system operators to function. WFA also publicly stated in the U.S. 6 GHz multi-stakeholder process

[2] United States (April 23, 2020), United Kingdom (July 24, 2020), South Korea (October 16, 2020), Chile (October 22, 2020) and United Arab Emirates (December 28, 2020)
[3] *See* for example: Broadcom; Intel, Qualcomm
[4] *See* https://www.theverge.com/2021/1/11/22203382/netgear-nighthawk-raxe500-wifi-6e-5g-moden-wireless-router-price-release-date , and https://www.linksys.com/us/wifi-6e/
[5] https://www.wi-fi.org/product-finder-results?sort_by=default&sort_order=desc&certifications=1275&keywords=6%20ghz

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that it will deliver candidate certification procedures for AFC devices and systems for evaluation by national regulators later this year.[6] ISED should be able to rapidly progress as a result, and therefore should move immediately to permit both fixed and mobile license-exempt outdoor operations under AFC control. We will address the mobile AFC case below under Question 4.

Fixed and mobile AFC devices – including bundled AFC database services – will be primarily delivered by enterprise vendors like HPE. While outdoor RLANs comprise no more than about one-half of one percent (0.5%) of total consumer and enterprise annual access point shipments by unit volume, virtually all of these APs are sold to enterprises. As a percentage of the enterprise market, the outdoor segment is approximately 4% of the units shipped and over 6% by revenue – comprising over U.S.$400 million. [7] All of which is to say that this is a substantial market segment and ISED should expect prompt product announcements in this area. Given HPE's role in this market, we fully intend to make outdoor Wi-Fi 6E products available in every country that permits such operation.

c. AFC

HPE has been deeply involved in both the development of AFC technical standards as well as the creation of prototypes. We partnered with Federated Wireless to build and demonstrate a working AFC system to the U.S. Federal Communications Commission (FCC) on October 1, 2019. [8] Federated subsequently announced the availability of its AFC for equipment manufacturers to begin product development. [9] The final rules adopted by the FCC should result in a thriving ecosystem of AFC implementations, some from equipment OEMs and some from third parties like Federated that are already certified to provide spectrum database services for TV whitespace and the U.S. Citizen's Broadband Radio Service (CBRS).

HPE advises ISED that its planning assumptions should forecast availability of both AFC devices and AFC system operators by the first half of 2022. As a result, Canada is right to include outdoor standard power RLAN operations in its proposed initial rules. Indeed, by broadening the market for AFC devices Canada is uniquely positioned to help accelerate both the introduction of affordable AFC solutions, and to take a global leadership position by driving adoption of outdoor RLAN operations by other countries.

Q2 ISED is seeking comments on its proposals to allow licence-exempt RLAN use in the 5925-7125 MHz band.

HPE broadly endorses the ISED proposal laid out in the Consultation. The separate jointly filed comments of the RLAN Group as well as those of the WFA, WBA and DSA reflect our viewpoint. As already noted we commend ISED on the exploration of outdoor scenarios,

[6] *See* "Wi-Fi in 6 GHz", presentation to U.S. Multistakeholder Group, https://groups.wirelessinnovation.org/wg/6MSG/document/8227
[7] Wireless LAN Infrastructure (WLAN) Quarterly Market Report and Forecast, 650 Group, 3Q2020
[8] https://ecfsapi.fcc.gov/file/100302586574/2019-10-01%20OET%20AFC%20Demo%20Ex%20Parte.pdf
[9] https://federatedwireless.com/federated-wireless-extends-spectrum-controller-to-the-6-ghz-band-to-accelerate-wi-fi-6-and-5g-service-delivery/

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which taken together with the existing U.S. rules could result in the single largest combined market for outdoor 6 GHz RLAN devices in the world.
As ISED has so thoughtfully recognized in the Consultation, the amount of spectrum currently authorized for license-exempt use is insufficient to meet current, much less future, demand for Wi-Fi and other license-exempt uses. The Joint Filers provide extensive analysis and documentation of the current and projected future situation. [10] To those examples, HPE can add the following market development. Since 2014 – when gigabit-capable Wi-Fi 5 (802.11ac) access points that default to using 80 MHz or even 160 MHz channels became widely available – the vast majority of enterprise and service provider customers intentionally de-feature those products to use narrower 40 MHz or even 20 MHz bandwidths due to the limited amount of spectrum available in the 5 GHz band.

The reason for this behavior is that a shared license-exempt band requires multiple radio channels in order to distribute load and reduce co-channel interference (CCI). It is well known that 2.4 GHz with only 3 channels is heavily congested around the world. This is depicted on the left of Figure 1. This congestion is actually independent of channel size – having just three 160 MHz channels such as Europe is permitting in the lower 6 GHz band will result in the same problem. Both practical experience and academic research over the last 20 years demonstrates that uncoordinated RLANs require no fewer than about seven to nine non-overlapping radio channels to absorb current demand levels, as shown in the middle diagram of Figure 1. For large venue environments with extreme loading levels such as stadia, arenas, university lecture halls, and airports research and years of experience have proven that having 20 or more independent channels enables RLANs to operate successfully and carry unprecedented levels of traffic. Every major Wi-Fi equipment manufacturer has published detailed design guidelines for such environments calling for 20 MHz channels to be used for large venues. [11]

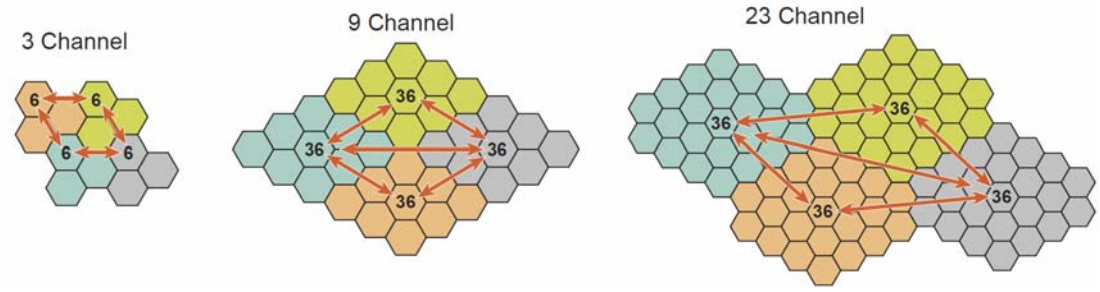

Figure 1. Inter-Cell Distance Increases With Available Channel Count

The mechanism behind this phenomenon is that having fewer channels increases the probability of collisions between co-channel radio cells, even at low load levels. An obvious basic reason for this shown in Figure 1 is that RLANs with small inter-cell distances can hear many more RLANs. But a more subtle effect is the resulting rise in the noise floor from

[10] *See* RLAN Group comments to SMSE-014-20: Consultation on the Technical and Policy Framework for Licence-Exempt Use in the 6 GHz Band, at 15
[11] *See* "Very High Density 802.11ac Networks", Chuck Lukaszewski, Aruba Networks, 2015, https://higherlogicdownload.s3.amazonaws.com/HPE/MigratedAssets/Aruba_Very_High_Density_802.11ac_Networks_VRD.zip

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"hidden" RLAN cells. This reduces the available signal-to-noise level, which in turn reduces the data rate, thereby making each transmission take longer and further increasing the collision probability. By contrast, having more channels both reduces the absolute number of audible co-channel cells, and helps keep the noise floor near the thermal limit, which maximizes data rates and clears channels of data more quickly. This attribute of self-coordinating RLANs enables them to absorb extremely high demand surges.

The reason that most Wi-Fi system owners disable wide channels is that there are not enough 80 MHz channels in most countries. As a case in point, in Canada there are only two usable 80 MHz channels without DFS, and two more with DFS. This is not nearly enough to make a working system, but there are nine 40 MHz channels available and twenty-two 20 MHz channels. Wi-Fi system owners in Canada are better off to use one of those narrower widths, which will deliver much better system performance. However, this means sacrificing higher data rates – limiting peak performance to under 600 Mbps for a typical device in optimal RF conditions for 40 MHz.

As evidence of this behavior, Cisco recently published an anonymized analysis of over 30,000 gigabit-capable configurations which showed that 89% were using 40 MHz or even 20 MHz channel widths, and only 11% were using 80 MHz. [12] As part of this Consultation response, HPE is publishing for the first time statistics on our own customer base. In Figure 2 you can see that over a sample of 500,000 enterprise APs in North America, only 9% are running gigabit-capable 80 MHz channels, while 51% are using half-width channels, and fully 40% of HPE customers studied are using 20 MHz channels. This data set excludes public venues but does include significant higher education, K-12 and healthcare deployments.

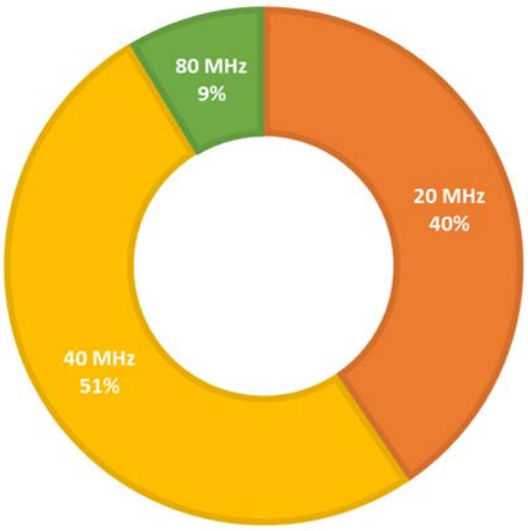

Figure 2. Deployed Channel Widths of 500,000 HPE Customer APs in North America

[12] Brian Hart el. al., *Recommended Direction for EHT*, Cisco, (Sept. 9, 2018), https://mentor.ieee.org/802.11/dcn/18/11-18-1549-00-0eht-candidate-technology-review.pptx

Returning to the question asked in the Consultation, the reason that it is so vital that ISED proceed with opening the full 1,200 MHz for LPI and VLP devices is that this will permit seven 160 MHz channels and fourteen 80 MHz channels. HPE anticipates that its customers will default to multi-gigabit capable 160 MHz channels because seven channels is enough for most RLAN operations, with some backing down to 80 MHz in high CCI environments. And as we argue in Question #4, ISED should seize the moment to permit standard power AFC operation up to 6930 MHz, which would immediately deliver another gigabit-capable 80 MHz channel for these deployments.

Q3 ISED is seeking comments on the proposed footnote Cxx and the changes to the CTFA as shown in table 2. "ADD Cxx: Licence-exempt RLAN applications in the 5925-7125 MHz band must operate in accordance with the established spectrum policy and technical framework; and must not cause harmful interference to, or claim protection from, licensed systems operating in the band."

HPE concurs with this proposal, and endorses the separate comments of the RLAN Group, WFA, WBA and DSA.

Q4 ISED is seeking comments on the proposed rules for standard-power RLANs:

a. indoor and outdoor operation would be permitted
b. RLAN access points would only be permitted to operate under the control of an AFC system in the 5925-6875 MHz frequency range
c. maximum permitted e.i.r.p. would be 36 dBm
d. maximum permitted power spectral density would be limited to 23 dBm/MHz
e. use of a vertical elevation mask, with a maximum e.i.r.p. of 125 mW at elevation angles above 30 degrees over the horizon, would be required

HPE broadly concurs with this proposal, and endorses the separate comments of the RLAN Group Joint Filers as well as those of the WFA, WBA and DSA. We wish to advocate for three particular incremental items, one at variance from the ISED proposal and two that go beyond the currently approved FCC rules.

ISED SHOULD PERMIT STANDARD POWER RLANS TO OPERATE UP TO 6930 MHZ

HPE noted with great interest the Consultation's observation that electronic newsgathering (ENG) is authorized starting at 6930 MHz, leaving a 55 MHz gap above the ISED proposed limit of 6875 MHz for standard power RLANs. We understand and respect the rationale offered by ISED to maintain future flexibility for this gap. However, HPE believes that a compelling case can be made to reconsider this posture, and that ISED should do so now.

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Given Canada's unique posture with regard to ENG operations, there are four reasons why ISED should permit standard power RLANs to operate up to 6930 MHz immediately:

1) Substantial opportunity costs of leaving 6875 – 6930 MHz fallow

There are three distinct opportunity costs that will be incurred by standard power equipment under the current ISED proposal. First, as a threshold matter it will render 6 GHz unusable for super-wide 320 MHz channels that will come with Wi-Fi 7 which is scheduled for IEEE 802.11 working group approval in 2024. [13] An obvious application for such channels is mesh backhaul outdoors, using high-gain and narrow beamwidth antennas. This could be applied in rural areas by combining gigabit or multi-gigabit class satellite or other capacity injection nodes with ultra-wide bandwidth mesh equipment to create a backbone layer to feed individual residential users or to light up gigabit-class hot zones throughout small towns. Similar applications exist in mining and petrochemical sites across Canada, to say nothing of localized high-capacity bubbles for precision agriculture.

The second and more immediate opportunity cost is the loss of a 160 MHz, 80 MHz and 40 MHz channel. Figure 3 shows the final 802.11 channel plan for the upper part of the band from 6425 to 6930 MHz. The red channels would be precluded from use under all circumstances under the present ISED proposal. Given that there are only five 160 MHz channels for AFC under ISED's proposal, due to the minimum channel counts required for RLANs explained in Question #2, this practically prevents the use of 160 MHz channels for access layer applications with repeating channel plans, assuming such channel widths were available at that location according to the AFC.

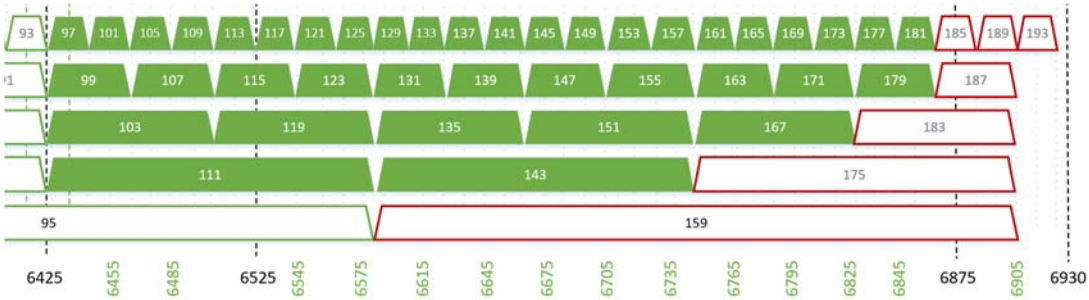

Figure 3. Upper 6 GHz Channel Plan for 802.11 Showing Opportunity Cost of ISED Proposal

This leads directly to the third and most difficult opportunity cost – local variations in spectrum availability rendering 6 GHz unusable for standard power operation, where these additional channels could make the difference between a viable deployment and no deployment at all. This is because in most cities the existing FS deployments preclude AFC operation on at least some channels, and in areas of dense FS utilization there may be few if any channels at all. For example, here is one sample AFC calculation using an HPE prototype for a hypothetical outdoor RLAN in San Francisco shown in Figure 4.

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[13] https://www.ieee802.org/11/Reports/802.11_Timelines.htm

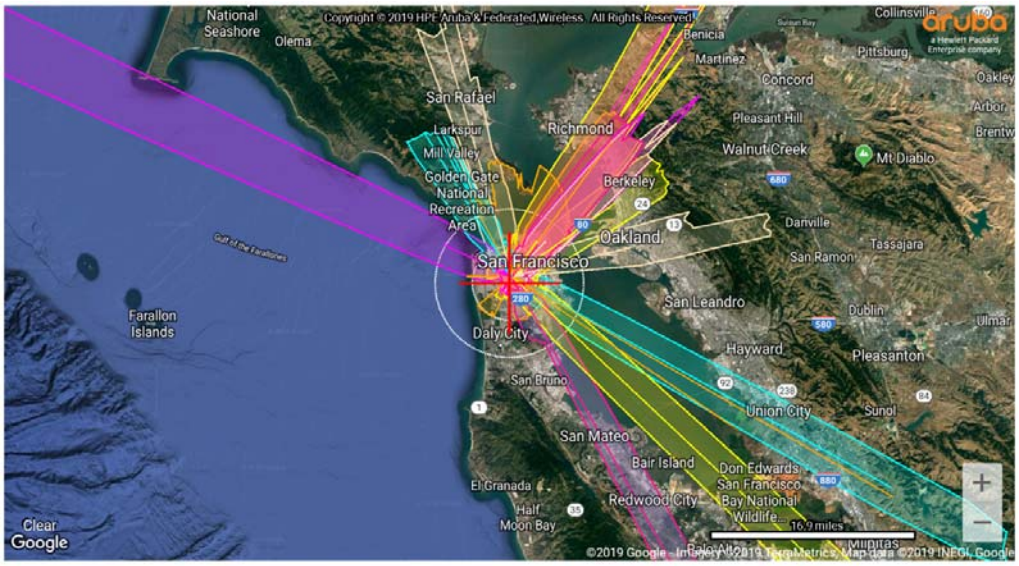

Figure 4. Incumbent Protection Contours Applied to a 6 GHz RLAN in San Francisco

Each of the colored shapes is the calculated protection contour in front of an FS receiver that is applicable to the RLAN. The resulting spectrum availability at this location is shown in Figure 5. Only four 80 MHz and one 160 MHz channels are possible at this location. This scenario is typical of major cities in North America, and availability can be even more constrained in some locations in these cities.

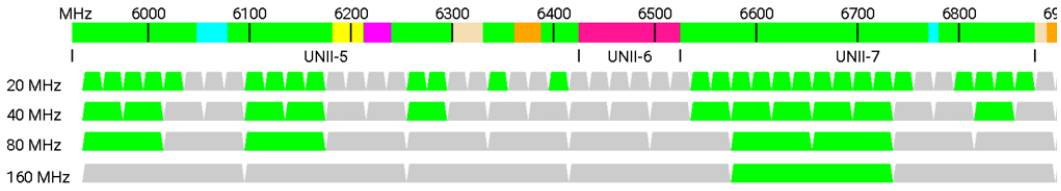

Figure 5. AFC Calculated Spectrum Availability for 6 GHz RLAN in San Francisco

The additional channels that would be available for standard power operation by permitting RLAN use of the 55 MHz below 6930 MHz could be the difference between having enough channels (of any bandwidth) to operate a network at a given location.

2) ENG market developments make licensed 4G / 5G a realistic outcome

The ENG community is actively studying the feasibility of migrating from licensed bands with proprietary high-cost equipment to using off-the-shelf cellular backhaul solutions. The speeds available via mid-band 3 GHz or millimeter-wave spectrum on a 5G network, coupled with network slicing capabilities make this possibility one that must be considered by broadcasters. Therefore, the "flexibility" that ISED seeks may well prove unnecessary.

3) ISED can reclaim this spectrum any time because it is AFC controlled

HPE strongly agrees with ISED that standard power devices must be AFC controlled whether operating indoors or outdoors. Therefore, ISED has complete control over the future use of the 6875 – 6930 MHz sub-band. ISED can at any time revoke some or all of this spectrum, which in turn must be enforced by the AFC system operators. The fact is that ISED can permit AFC operations in this 55 MHz without sacrificing any decisional flexibility.

4) North American spectrum leadership

Finally, by virtue of its unique incumbent structure, Canada has an opportunity to create the most expansive standard power regime in the Americas (if not the world). The issues discussed above with the Wi-Fi channel plan stopping at 6875 MHz are an acute problem in the U.S., especially when compounded by the 100 MHz notch from 6425 – 6525 MHz. This notch has a similar effect on the other side of the U-NII-7 sub-band, deleting one each of a 40 MHz, 80 MHz and 160 MHz channel. As a result, AFC spectrum availability in the U.S. is far from assured, which will create a substantial headwind for 6 GHz adoption by industries that badly need additional outdoor license-exempt bandwidth. By contrast, Canada's ability to deploy a full 1,000 MHz for AFC will unleash applications and use cases that are impossible in most other countries. While ISED rightly desires to harmonize with the U.S. rules, this is a unique opportunity to demonstrate Canadian leadership and innovation. ISED should seize the opportunity.

ISED SHOULD PERMIT AFC SYSTEMS TO USE RLAN ANTENNA PATTERNS BOTH INDOORS AND OUTDOORS

We appreciate and strongly support ISED's recognition that standard-power RLANs will in some cases be deployed indoors. However, HPE wishes to highlight for ISED an important problem with the U.S. AFC rules that it should not repeat. As HPE argued in the current Further Notice of Proposed Rulemaking (FNPRM),[14] "the final rules adopted in the R&O governing LPI operation unexpectedly preclude important indoor enterprise use cases. Specifically, the integrated antenna requirement—for which HPE advocated and continues to support—rules out the use of external directional antennas indoors. But the R&O creates a catch-22 by then prohibiting the use of antenna directivity for AFC devices and foreclosing the obvious alternative, leaving us with no solution for customers with these requirements."

The FCC decided to disallow the use of RLAN antenna patterns by the AFC, and instead requires every RLAN to be treated as an isotropic radiator of a particular EIRP. This has potentially catastrophic spectrum availability consequences for enterprise users with legitimate requirements to employ directional antennas indoors, particularly in metropolitan areas with extensive incumbent Fixed Service operations.

[14] *See* Comments of Hewlett Packard Enterprise, filed in FCC Docket 18-295, Licence exempt Use of the 6 GHz Band, filed June 29, 2020, https://ecfsapi.fcc.gov/file/10629009254053/HPE%206%20GHz%20FNPRM%20Comments%20(FINAL).pdf

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There are countless scenarios where standard-power APs may be necessary indoors and outdoors with connectorized antennas for particular applications, including but not limited to:

- Indoor warehouses and distribution centers where directional antennas are necessary to provide service in long aisles, loading docks, or freezers, where non-temperature-hardened APs typically reside outside the freezer and are connected via coaxial pigtails through a wall or ceiling penetration.
- Civilian and military aircraft hangars and gates, where antenna directivity is essential to providing reliable service above, around, and underneath aircraft that otherwise block signal propagation.
- Sectorized antennas used in lecture halls to provide coverage from walls on either side of the room, where mounting overhead is not feasible and where there is a need to create signal rejection between adjacent auditoriums.
- Indoor sporting arenas and indoor performance halls.
- High-ceiling convention centers, which routinely employ highly directional antennas with 30°x30° beams to provide dense, high-quality signal on the show floor 20-40 meters below.
- Elevator shafts to provide service to client devices inside elevator cars.
- Subway lines, mine shafts, and underground tunnels connecting buildings in campus environments like hospitals, which all make use of directional antennas to reduce AP counts and associated cabling costs.

There are many more examples that could be cited, but in each of these cases, a wireless engineer uses a connectorized, non-omnidirectional antenna with varying beamwidth indoors and aims the boresight to maximize coverage in an intended user position. Of course, directional antennas are also extensively used outdoors, but these examples are much more well known and do not require enumeration. In both cases the result of the FCC rules is the same: to significantly limit 6 GHz spectrum availability by treating the RLAN as having equal interference potential in all directions where a pattern-aware AFC would otherwise indicate usable channels.

Antenna directivity is one topic in the FNPRM, and we are hopeful that the FCC will rectify this problem when it ultimately issues the next 6 GHz Report & Order. From a Canadian perspective, ISED should permit AFCs to incorporate RLAN antenna patterns in their calculations for fixed standard-power devices. It should also permit antenna directivity to be used to calculate spectrum availability for mobile standard-power devices under AFC control.

ISED SHOULD PERMIT MOBILE STANDARD-POWER AFC OPERATIONS

Mobile standard-power APs in vehicles such as buses, trains, subways, intermodal terminal cranes, and other mobile industrial equipment are major use cases for license-exempt technologies today and are likely to increase in the future. Mobile RLAN deployments are also a crucial tool for military and commercial operations that change locations periodically and are deployed for mobile command centers, mining operations, and energy, precision agriculture, and research applications. This is one of the two major topics of the open FNPRM in the U.S. (the other being VLP devices). HPE has argued strongly in support of the FCC permitting mobile AFC operation, and we are confident that the next Report & Order will add these devices to the existing 6 GHz framework. Because mobile AFC devices involve no

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additional complexity for AFC systems, ISED should therefore include mobility in its AFC framework from the beginning.

Mobile standard-power APs can operate without risking harmful interference to licensed services by requiring devices to re-authorize operation through the AFC when in motion. For a mobile standard-power AP installed on a vehicle, for example, the re-check interval would decrease proportionally to the increase in the vehicle's speed. Alternatively, the AFC device could increase the size of its location uncertainty region as the vehicle's speed increases in lieu of decreasing the re-check interval. Provided that the manufacturer can demonstrate compliance with re-check and other reasonable requirements at appropriate speeds, ISED should certify the mobile AP.

Another common enterprise scenario involves mobile RLAN devices within a large privately or publicly owned facility that occupies several square kilometers but is nevertheless private property with controlled access. Examples include military bases, railyards, container terminals, oil fields, refineries, manufacturing plants, airfields, mines, quarries, power plants, and other industrial facilities. In these cases, a simple geofence that fully encloses the property is all that is required. This would allow an AFC to provide available channels for the entire facility, and RLAN devices in motion within the facility would never need to approach a re-check boundary (but would necessarily need frequently to check their position inside the geofence).

Q5 ISED is seeking comments on allowing access to the additional 100 MHz of spectrum in the 6425- 6525 MHz sub-band for standard-power operation.

As argued above, HPE strongly concurs with this proposal. We endorse the separate comments of the RLAN Group Joint Filers, as well as the WFA, WBA and DSA.

Q6 ISED is seeking comments on the equipment availability of standard-power RLANs in the 6425- 6525 MHz band and the impact on the development of AFC systems for Canada due to a potential lack of international harmonization for that sub-band.

In keeping with our answers to questions 1(b) and 1(c) – and as a major supplier of outdoor RLAN equipment – HPE strongly supports ISED moving forward with a large contiguous band of at least 1 GHz (from 5925 through 6930 MHz). Indeed, in some respects this makes the Canadian market more attractive than the U.S. to end users that wish to operate outdoor standard power RLANs due to the ability to operate either five or six 160 MHz channels and either two or three 320 MHz channels. The AFC system operators can easily account for country-by-country variations including coordination zones along international borders. ISED should proceed with its proposal.

From an AFC perspective, the 100 MHz notch from 6425 – 6525 MHz that is required under the U.S. rules reduces the utility and feasibility of some outdoor 6 GHz operations. This is true in two respects. First, we pointed out in Question #4 that it effectively strands up to 60 MHz from 6525 – 6585 MHz for HPE customers wishing to run wider channel widths. While it is true that one could deploy a 40 MHz channel, or three 20 MHz channels to use this range (assuming the AFC showed them available), as a general rule enterprise managed

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RLANs depend on consistency. The second issue is spectrum availability itself. There is no guarantee what channels and channel widths may be available at any particular location in a country permitting AFC. Densely populated metro areas may be some of the most challenging markets for outdoor 6 GHz RLANs. Therefore, the U.S. notch has the collateral effect of removing channels from the next highest sub-band, and makes it less likely that adequate outdoor spectrum will be available in some locations. Due to its different makeup of incumbents, Canada is in a unique position to maximize spectrum availability for the many deserving outdoor applications discussed in the Consultation, as well as generally provide for large usable channel sizes.

Q7 ISED is seeking comments on the proposed rules for low-power indoor-only RLANs:

a. operation would be permitted indoor only across the 5925-7125 MHz band
b. the use of a contention-based protocol (e.g. listen-before-talk) would be required

HPE broadly concurs with these two proposals, and endorses the separate comments of the RLAN Group Joint Filers, plus the WFA, WBA and DSA. This includes the addition of Client-to-Client communication for LPI devices that can detect an enabling signal, and Subordinate Devices that are permitted to employ higher EIRP so long as they comply with the same constraints imposed on LPI access points.

c. maximum permitted e.i.r.p. would be 30 dBm
d. maximum permitted power spectral density would be limited to 5 dBm/MHz

ISED is no doubt aware of the open FNPRM proceeding in the U.S. contemplating increasing the maximum allowed PSD to 8 dBm/MHz. This would also permit upcoming Wi-Fi 7 ultra-wide 320 MHz channels to operate at this PSD without artificially restricting that channel width. We are optimistic that the FCC will ultimately adopt this change.

HPE endorses the separate comments of the RLAN Group, WFA, WBA and DSA requesting that ISED adopt the 8 dBm/MHz PSD value. Given that indoor mesh operation is expected to be a key use case for tri-band Wi-Fi 6E access points, and mesh backhaul channels generally benefit from using the widest possible channelization so as not to congest access layer links, there is a clear rationale to increase the EIRP limit in Canada.

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Q8 ISED is seeking comments on the proposed rules to allow very low-power RLAN devices:

a. operation would be permitted indoors and outdoors across the frequency range 5925-7125 MHz band
b. the use of a contention-based protocol (e.g. listen-before-talk) would be required
c. maximum permitted e.i.r.p. would be 14 dBm
d. maximum permitted power spectral density would be limited to -8 dBm/MHz

HPE broadly concurs with these these proposals (with the exception of the PSD limit), and endorses the separate comments of the RLAN Group Joint Filers, plus the WFA, WBA and DSA.

On question (d) we agree with the Wi-Fi Alliance that -8 dBm/MHz is inadequate to maintain VLP link budgets, especially for narrow channel 20 MHz devices. 1 dBm/MHz is the minimum necessary PSD – at least in a 20 MHz channel – for VLP operation. [15]

Q9 ISED is seeking comments on potential business models for AFC administrators to operate their AFC systems in Canada.

AFC rules and the business models they enable should be animated by a single principle: an AFC implementation must correctly determine whether a device operating at a given location, on a given range of frequencies, and at a given power level would exceed the chosen interference protection criterion for any FS receiver. If so, the AFC must notify the device that those frequencies are not available, given its operational parameters. There are many ways that this fundamental capability can be implemented and enhanced to allow more efficient operations, reduce device costs, and support important use cases such as portable devices and higher power P2P and P2MP connectivity, etc. But in each of these permutations, the core AFC functionality remains unchanged: protecting licensees from harmful interference.

Speaking as a major AP manufacturer currently developing 6 GHz products, we believe that most if not all outdoor products will be bundled with an AFC solution. Whether that solution is developed and operated by the AP manufacturer itself, or whether the manufacturer opts to private label a third-party provider is a question that many companies like HPE are currently working through in the U.S. context. How the AFC function is paid for, or indeed whether there is any separate cost at all to the end user, is a question for the future as the market unfolds. But what is clear today is that AFC portability is not a requirement and indeed would impose unnecessary costs, delays and complexity that would be at odds with ISED's stated objectives. With bundled solutions, AFC portability requirements would also lead to irrational outcomes such as all competitors in a given product category having to support each other's products. Our response to Question #11 offers more thoughts on that aspect of the business model.

ISED should not regulate business decisions such as whether to centralize the AFC under a single entity's management or to open all AFC implementations to any 6 GHz client device.

[15] *See* Wi-Fi Alliance comments to SMSE-014-20: Consultation on the Technical and Policy Framework for Licence-Exempt Use in the 6 GHz Band, at 7

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No need for such regulations has been identified. Maintaining flexibility would allow the market to identify the most advantageous business arrangements and technical implementations. For example, it is unclear today whether the "best" approach will be for manufacturers to provide AFC functionality for their own devices, or whether large numbers of RLAN devices will use third-party AFCs. Although the use of third-party AFC operators may have advantages – and HPE has done prototyping work with one well-known third-party database operator – future trends such as whether AFC operation will prove to be sufficiently profitable as a standalone service cannot be predicted. The marketplace may reveal that certain options are superior for different types of devices, highlighting the importance of regulatory flexibility.

Promising and innovative new ideas can be stymied by the unforeseen consequences of excessive regulation. ISED should remain vigilant and ensure that this does not happen in the 6 GHz band. ISED should avoid mandating a specific, one-size-fits-all approach to AFC design and operation and adopt a flexible set of rules that will allow different AFC implementations to accommodate a wide range of use cases and deployment scenarios including consumer, service provider, enterprise, Internet of Things, and rural access. This will in turnaccommodate different business models and cost constraints as well as their distinct spectrum needs and operational requirements.

Q10 ISED is seeking comments on its proposal to permit the approval of multiple, third party AFC systems, taking into account the potential for the development of a sustainable market for AFC systems in Canada.

As stated above, HPE strongly supports regulatory flexibility to enable a rich ecosystem to develop that supports all of the different use cases demanded by the market. To that end, multiple third-party AFC systems are a key element of that flexibility. But so is the ability for individual manufacturers to construct and certify their own AFC systems. In other words, ISED should in no way prescribe a particular AFC market structure to device makers. Instead, ISED should simply require that each and every AFC device must be certified with at least one certified AFC solution. That solution may come from the device manufacturer or a third-party, depending on the needs of different customer segments and what price those segments are willing to pay for a 6 GHz standard power solution.

ISED must also recognize that the 6 GHz Wi-Fi market will be *fundamentally different* than either the TV white spaces or the CBRS band in the U.S.. Each of those bands requires complex system integration of components from many parties to construct a solution, so the spectrum database is just one of many elements in a network. For example, TVWS radios are often installed at great height, requiring leasing tower space or possibly constructing towers along with associated services. CBRS systems for backhaul applications have similar requirements. Many CBRS devices require a complex cellular core network to be deployed and managed, and specialized user terminals to be acquired. The key point is that in both TVWS and CBRS adding a spectrum database supplier is consistent with the overall model of integrating disparate components.

By contrast, the Wi-Fi market due to its extremely large economies of scale is based on easy-to-deploy integrated solutions where most if not all of the underlying system complexity has been carefully abstracted away from the end user. A simple example is that AP

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manufacturers like HPE used to sell antennas separately from radios, particularly for outdoor applications. This led to much greater system cost – which depressed adoption – and also required experienced professional installers for weatherproofing, grounding and antenna alignment. But since 2014, HPE has shifted to "all in one" units with integrated antennas in a handful of popular configurations. Other manufacturers have pursued a similar simplification strategy. Not only are these cheaper to buy and cheaper to install, but also they eliminate the risk of an installer accidentally or intentionally exceeding regulatory limits. As a result over the last several years, the outdoor Wi-Fi market has grown dramatically in both units and revenue, largely driven by simplification of the user experience.

While HPE appreciates that ISED asked this question – and we support a robust market of third-party AFC providers – the question itself is market constraining because it implicitly excludes non-third-party solutions. While other database-managed bands have operated this way, 6 GHz will almost certainly be different. So long as each AFC device must declare at least one certified AFC solution (from the same provider or not) the regulatory requirement will have been met.

Q11 ISED is seeking comments on potential exit strategies if the AFC administrator decides to cease operation in Canada.

In our answer to the last question, HPE invited ISED to think differently about the makeup of AFC providers as compared with TVWS or CBRS, and to instead approach 6 GHz as a completely new paradigm. Consistent with that approach, HPE would advise ISED that Question #11 also demands a new paradigm for several reasons and that this question is not particularly relevant to 6 GHz.

The historical basis of this question is that TVWS and U.S. CBRS are relatively small markets in terms of absolute units, with a clear delineation between equipment makers and database operators. Given the novelty of spectrum databases, the regulatory approach wisely mandated portability to provide risk protection to early adopters. And given the database synchronization requirements specific to protected incumbents in these bands, the existence of standardized query protocols simplified the goal of portability of database providers. One other vital observation about TVWS and CBRS is that given the comparatively small number of equipment makers on the one hand, and database operators on the other, that the departure of any one vendor had a disproportionate impact on the market.

By contrast, the 6 GHz AFC market will look extraordinarily different. First, the absolute number of radios sold and the number of manufacturers will dwarf those earlier database bands, ensuring substantial consumer choice. Second, the drive towards integrated end-to-end solutions described in Question #10 means that the AFC system cannot be easily decoupled from the AFC device itself. More on that below. And third, the Wi-Fi market has long been characterized by rapid product category innovation that is coupled with routine product discontinuances. Not every seemingly great device idea with a Wi-Fi radio ends up succeeding, and within successful categories not every device maker that starts out lives to its 4th or 5th birthday. In other words, the success of the Wi-Fi industry at innovating to meet ever increasing use cases and customer needs is intrinsically combined with a finite amount of unsuccessful products, companies, or both. And this could be just as true of AFC system operators as it is of AFC device manufacturers.

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Coming to the specific question posed by ISED, there are four reasons that there is no need for an "exit strategy" in the scenario outlined:

1) The AFC device manufacturer will ensure a smooth transition. Standard commercial incentives – including maintenance contracts and warranty commitments – mean that ISED can rely on market mechanisms to solve this class of problem. Because of the integrated, simplified nature of Wi-Fi products, the end user of the device will likely not be capable of switching AFC system providers. In the scenario outlined by ISED, the device manufacturer will proactively contract with another provider and execute whatever software and operational changes are necessary to swing its customers over as transparently as possible. While rare, this exact scenario has occurred with internet backbone providers, web hosting services, Domain Name System (DNS) hosting providers, certificate authorities and other critical enabling elements of modern Wi-Fi networks and been managed without any visible impact or downtime for the end user.

2) The AFC device manufacturer holds all of the relevant information. Since AFC devices will be bundled with the AFC service, ISED's question does not consider the situation from the right end. The business relationship is between the device maker and the end user, meaning that it has all of the customer's account information, software license keys, device identifying information, and possibly even precision geolocation information of the devices. The rapid adoption of cloud-managed Wi-Fi networks in both the consumer and enterprise markets means that device makers increasingly provide centralized system monitoring, device configuration, and stroage of system state information. Since third-party AFC system providers are intermediated by the device makers, any possible failure of a provider will not be directly visible to an end user.

3) The AFC system provider holds no important information. Because the AFC manages interference on a single-entry basis, there is no need for aggregate interfence management. This is the key reason why the FCC agreed with industry that there is no need for AFC-AFC synchronization. The resulting system is "stateless" similar to an internet DNS server, with no relationship between any of the queries even for the same device. In a stateless system there is nothing to transfer between AFC operators, particularly given than they do not have a direct relationship with the end user of the device.

4) The failure of a device maker will result in the shutdown of 6 GHz operation. As articulated earlier, there will be occasional market failures of AFC-based devices or manufacturer or both. This is a sign of a healthy, innovative ecosystem. Much as in the 2.4 GHz and 5 GHz bands, the early adopters that install such devices will operate them for as long as they can and then move on to something else. In this scenario, since the AFC device has been bundled with an AFC service the failiure of the manufacturer to keep up the service is effectively a built-in "dead man switch" that will automatically stop 6 GHz operation when it goes offline.

The bottom line is there is no need to set out any regulatory requirements for the contingency of an AFC system operator failure.

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Q12 ISED is seeking comments on adopting an AFC system model that is harmonized to the maximum extent possible with the AFC system model being implemented in the U.S. and other international markets.

HPE strongly supports maximum regulatory alignment and harmonization, particularly between physically adjacent countries where cross-border AFC calculations will be necessary.

The RLAN Group was gratified that the final AFC rules adopted by the FCC were identical in all substantive respects to longstanding industry positions argued in the record. On March 19 of 2020 towards the end of the first phase of the proceeding, the RLAN Group filed a concise summary of our proposed AFC framework along with the underlying rationale for each key point. Given its relevance to the AFC issues raised by ISED, HPE has attached that document as Annex A to these comments. [16]

HPE believes that ISED should adopt each and every one of the following core aspects of the AFC regime adopted by the U.S.:

- The AFC should protect fixed-service ("FS") receivers from RLAN signals that would exceed -6 dB I/N on a single-entry basis.
- No aggregate interference protections are required;
- Multiple entities will be permitted to operate independent AFC implementation, without burdensome AFC-to-AFC synchronization or registration requirements
- The hybrid path loss model specified by the FCC
- AFC implementations should base their interference-protection calculations for the protection of FS links on data held by the regulator
- AFC implementations should provide interference-protection assessments in three dimensions—i.e., taking both FS receiver and RLAN transmitter height into account;
- The AFC should perform interference-protection assessments using accurate terrain, clutter, and FS antenna patterns whenever that information is available or, when it is not available, using conservative models;
- ISED's rules should be technology neutral with respect to the geolocation techniques that an AFC-controlled access point may employ, so long as a device is capable of determining its uncertainty in meters at a 95% confidence level.
- Both AFC system operators and AFC-controlled devices, should be subject to robust security requirements to ensure that AFC functionality is not modified or circumvented.
- 24 hour AFC recheck interval, and grace period for an AFC device unable to reach its AFC system until midnight of the following day.
- Limitation on the identifying information that must be exchanged between an AFC device and AFC system to a regulatory device certification identifier and a device serial number or other identifier, along with the required geolocation information.
- Permitting the AFC to return a range of spectrum availabilities at different allowable EIRP levels
- No requirement for an AFC device to report its operating state to the AFC system, including channel selections or changes

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[16] https://ecfsapi.fcc.gov/file/1031999525288/AFC%20Ex%20Parte%20(Mar%2019%202020).pdf

Q13 ISED is seeking comments on the implementation considerations for the operation of an AFC system, specifically:

a. information required from licensed users

HPE believes that existing data already collected by ISED is adequate to facilitate AFC protection contour calculations.

b. interference protection criteria for computation of exclusion zones

The AFC should protect fixed-service ("FS") receivers from RLAN signals that would exceed 6 dB I/N on a single-entry basis.

c. information required from standard-power APs

Information exchanged between an AFC device and AFC system should be strictly limited in scope.

- HPE supports the exchange only two identifiers – similar to U.S. rules – a regulatory device certification identifier and a device serial number or other identifier.
- The AP must also submit the required geolocation information including the 95th percentile uncertainty estimate expressed in meters.

HPE opposes any requirement for an AFC device to report its operating state to the AFC system, including channel selections or changes. As a threshold matter, since there is no requirement to manage aggregate interference the AFC system operators have no reason to know – much less retain – the decisions made based on AFC calculations. Recording the frequencies used by each RLAN device, which would require both a transmitter identifier and a database of registered devices, adds additional difficulties. Radio resource management subsystems in APs routinely change channels in response to changing RF conditions. Recording the current state of every one of millions of RLAN devices (and possibly its channel history for some period of time) creates a significant and costly burden with no utility. In addition, maintaining such a log would likely prevent certain AFC architectures, eliminating important use cases and product categories.

d. frequency of AFC update of licensee information

HPE supports a requirement for AFC system operators to update their licensee dataset from ISED no less frequently than every 24 hours.

e. security and privacy requirements

HPE believes that the AFC system and AFC-controlled devices should be subject to robust security requirements to ensure that AFC functionality is not modified or circumvented, similar to prohibitions on end-user modifications of DFS functionality.

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Q14 ISED is seeking comments on any additional considerations, limits or general concerns that should be taken into account in setting detailed standards and procedures for AFC operation.

HPE appreciates the detailed and thoughtful approach ISED has taken to considering AFC operation. Our answers to the foregoing questions fully express our views. As a manufacturer intending to ship AFC-capable equipment to Canada should ISED decide to permit such operations, we are at your disposal for follow up questions or discussion regarding any aspect of AFC operation.

Q15 ISED is seeking comments on its proposal to require AFC systems to protect the following types of licensed stations from standard-power APs:

a. fixed microwave stations
b. fixed point-to-point television auxiliary stations
c. radio astronomy stations

HPE endorses the separate comments of the RLAN Group, WFA, WBA and DSA. We believe that an AFC system in Canada adopted in conformance with the preceding discussion will be more than sufficient to protect two-way FS, one-way STL, FSS and radio astronomy incumbents in Canada.

Q16 ISED is seeking comments on the sample agreement related to the designation and operation of an AFC system in Canada.

HPE appreciates the thoughtful and proactive approach ISED has taken in providing a working draft of an AFCSA document. More specifically, we concur with items #8 and #9 regarding the rejection of any requirement to make public RLAN locations or personally identifiable information (PII). However, these need to be reconciled with provisions #14 and #15 which should not lead to inadvertent disclosure of RLAN location or PII. At this time, due to the speculative nature of the ISED Consultation HPE has not conducted a legal review of the proposed agreement. As a result, HPE may have further comments.

Q17 ISED is seeking comments on the proposed approach to incremental implementation of an AFC system in Canada.

HPE opposes incremental implementation of an AFC system, and endorses the separate comments of the RLAN Group Joint Filers.

Q18 ISED is seeking comments on the objective to maximize the potential for synergies, where possible, in defining the technical and administrative requirements for the respective databases addressing different bands under different technical regimes.

Our responses to Questions #9 - #11 articulate in detail the fundamental differences that we believe exist between the TVWS band in Canada and the 6 GHz market opportunity. It should be abundantly clear from our comments that while we owe a great debt to previous

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efforts like TVWS and U.S. CBRS, that the AFC market is qualitatively and quantitatively different in many critical ways, large and small. In particular, the occasional cessation of availability of AFC devices in 6 GHz is a sign of market strength and innovators pushing the boundaries of consumer acceptance, rather than showing a need to substitute regulatory solutions for product continuity. HPE's advice to ISED is to provide a simply, clear regulatory framework that defines the policy outcomes it desires, and leave the rest to the proven ability of the market to define.

Conclusion

HPE thanks ISED for issuing this Consultation, and commends its careful and innovative approach to opening the 6 GHz band to license-exempt operations. We are already working hard to prepare to build and ship products that will make the 6 GHz band a success. The framework proposed in the Consultation – augmented by specific proposals made by HPE herein – will allow for more efficient use of the band while protecting licensees from harmful interference. And the AFC authorization framework for mobile standard-power devices refines ISED's experience with database-authorized spectrum sharing in other bands. To deliver even more innovation and utility to the country, HPE urges the Commission to (1) permit standard-power operations up to at least 6930 MHz; (2) permit low-power indoor and very-low-power license-exempt operations across the entire 6 GHz band; (2) adopt simple rules that allow flexibility in AFC design while maintaining harmonization with the robust FCC regulatory framework; (3) allow mobile and portable standard-power APs to operate under AFC control; and (4) permit use of RLAN antenna directionality.

Respectfully Submitted,

Chuck Lukaszewski
Vice President & Chief Wireless Technologist

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ANNEX A

RLAN GROUP JOINT COMMENTS TO U.S. FEDERAL COMMUNICATIONS COMMISSION SETTING FORTH MINIMUM REGULATORY STANDARDS FOR AUTOMATIC FREQUENCY COORDINATION (AFC) SYSTEMS AND DEVICES

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March 19, 2020

BY ELECTRONIC FILING

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Re: *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295

Dear Ms. Dortch,

As the Commission considers recent filings relating to low-power indoor and very-low-power unlicensed operations in the 6 GHz band, we write to highlight the deep and stable record already developed on Automated Frequency Coordination ("AFC") for standard-power[1] indoor/outdoor devices operating in U-NII-5, U-NII-7, and the lowest 100 MHz of U-NII-8. The record reflects strikingly broad agreement that AFC control will be an effective means of preventing harmful interference for this class of devices.[2] Indeed, the discussion in the record has centered on the question of which devices must be subject to control by an AFC, not whether the AFC approach is suitable for protecting licensees from harmful interference.

As we have explained,[3] an AFC implementation need not be complex in order to be effective. However, unnecessarily burdensome AFC requirements could greatly increase the cost

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[1] As used herein, "standard power" refers to devices with radiated power of at least 30 but not greater than 36 dBm EIRP.

[2] *See, e.g.*, Comments of National Public Safety Telecommunications Council at 10, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019); Comments of CTIA at 2, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019); Comments of Fixed Wireless Communications Coalition at 22, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019) ("FWCC Comments"); Comments of AT&T Services, Inc. at 4, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019); Comments of Tucson Electric Power Company and UNS Electric, Inc. at 14, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019) ("Tucson Electric Comments"); Comments of Wi-Fi Alliance at 10, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019) ("Wi-Fi Alliance Comments"); Comments of RLAN Group at 39-49, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019) ("RLAN Group Comments"); Comments of the Ultra Wide Band Alliance at 4, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019).

[3] *See* RLAN Group Comments at 49-68.

of AFC implementations, delaying the availability of AFC-controlled devices, limiting innovation, and driving up costs for consumers.

Given these factors, the record strongly supports a decision by the FCC to quickly adopt a set of foundational rules for AFC-controlled operations and certifying AFC implementations.

I. THE COMMISSION SHOULD EXPEDITIOUSLY ADOPT A MINIMUM SET OF AFC REQUIREMENTS.

Our companies strongly support the Commission's long history of light-touch, technology-neutral and innovation-friendly decision-making, especially with respect to unlicensed operations. We hope the Commission continues in this tradition by adopting a targeted, concise set of rules and findings related to AFC to support industry stakeholders' efforts to develop AFC standards and, ultimately, production-ready AFC systems.

Stakeholders are working today to develop these standards. However, clear FCC guidance is required on several important topics in order for this work to advance. Fortunately, the depth and degree of agreement in this docket surrounding AFC afford the Commission the opportunity to speed the availability of AFC-controlled devices to American consumers by adopting rules regarding a limited but fundamentally important set of core aspects of AFC operation.

As part of its decision to open all 1,200 MHz of the band for unlicensed operation, the Commission should adopt rules for at least the following four items:

1. The AFC should protect fixed-service ("FS") receivers from RLAN signals that would exceed -6 dB I/N on a single-entry basis.

2. Multiple entities will be permitted to operate independent AFC implementation, without burdensome AFC-to-AFC synchronization or registration requirements, which are unnecessary to prevent harmful interference but would dramatically increase AFC complexity and compromise user privacy.

3. Consistent with WinnForum's proposal,[4] AFC implementations should be authorized to employ the following path-loss model: (1) for RLAN-to-FS receiver distances up to one kilometer, the WINNER II Combined Urban (C2) model and WINNER II Combined Suburban (C1) models for urban and suburban areas respectively, and the Irregular Terrain Model (ITM) combined with ITU-R P.452 clutter model for rural areas; (2) for RLAN-FS Receiver distances greater than one kilometer, the ITM combined with ITU-R P.2108 clutter model for suburban and urban environments, and (3) ITU-R P.452 clutter for rural environments.

[4] Wireless Innovation Forum, *Propagation Models and Interference Protection Criteria for Sharing between the Fixed Service and Unlicensed Devices in the 6 GHz Band* WINNF-TR-1002, 28 (V1.0.0, 2019).

4. AFC implementations should base their interference-protection calculations for the protection of FS links on ULS data.

To help facilitate and expedite work by industry stakeholders after the release of an Order, the Commission should also make the following five findings:

1. That neither adjacent channel nor aggregate interference protections are required;
2. AFC implementations should provide interference-protection assessments in three dimensions—i.e., taking both FS receiver and RLAN transmitter height into account;
3. The AFC should perform interference-protection assessments using accurate terrain, clutter, and FS antenna patterns whenever that information is available or, when it is not available, using conservative models;
4. The Commission's rules should be technology neutral with respect to the geolocation techniques that an AFC-controlled access point may employ, so long as a device's associated location uncertainty (in all three dimensions) is taken into account in interference-protection assessments;
5. The AFC, and AFC-controlled devices, should be subject to robust security requirements to ensure that AFC functionality is not modified or circumvented.

The Commission has a strong foundation of substantial—and in some cases unanimous agreement—on virtually every item on these two lists, which are also supported by extensive FCC precedent.[5] This light-touch, proactive approach will speed AFC devices to market and incentivize early investment by making clear that the core "rules of the road" have been settled.

II. THE AFC SHOULD USE CONSERVATIVE TECHNICAL PARAMETERS.

Below, we review the state of the record on each of the key technical operating parameters that AFC implementations should incorporate:

Frequencies of Operation

[5] *See, e.g.*, 47 C.F.R. §§ 15.712 (adopting predefined propagation models/exclusion areas for interference protection assessments; adopting interference-protection zones on a single-entry basis; adopting interference protection rules that account for actual height and antenna pattern of protected licensee; allowing multiple database administrators); 15.711(b) (requiring only "a geo-location capability" and permitting variable geolocation accuracy so long as accuracy can be determined with 95% confidence); 96.63 (permitting certification of multiple Spectrum Access System administrators); 96.39 (establishing technology-neutral geo-location rules and permitting professional installation to serve as a geo-location technique).

Standard-power, indoor/outdoor operations under control of an AFC should be permitted in U-NII-5, U-NII-7, and the bottom 100 MHz of U-NII-8.[6]

Interference Protection Threshold

The AFC should implement an interference protection criterion of -6 dB I/N on a single entry basis.[7] The record makes clear that there is no need for aggregate interference protections, which would greatly complicate the design of AFC systems.[8]

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[6] *See, e.g.*, Comments of Qualcomm Incorporated at 11, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019); Comments of Broadcom Inc. at 45, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019) ("Broadcom Comments"); Comments of The Wireless Internet Service Providers Association at 26, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019) ("WISPA Comments"); FWCC Comments at 22 (arguing that AFC is necessary for U-NII-5 and U-NII-7, without taking a position on U-NII-8); Reply Comments of The Utilities Technology Council, the Edison Electric Institute, The American Public Power Association, The National Rural Electric Cooperative Association, The American Petroleum Institute, and The American Water Works Association at 14, ET Docket No. 18-295, GN Docket No. 17-183 (filed Mar. 18, 2019).

[7] *See*, *e.g.*, FWCC Comments at 22; Comments of the Association of American Railroads at 11, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019); Tucson Electric Comments at 11-12; Wi-Fi Alliance Comments at 15; Broadcom Comments at 22; Letter from Rob Alderfer, Vice President of Technology Policy, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 3 (filed Mar. 13, 2020); Letter from David Don, Comcast Corporation, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at attachment 1 (filed Mar. 5, 2020); Letter from Edison Electric Institute, National Rural Electric Cooperative Association, American Gas Association, Utilities Technology Council, American Public Power Association, Nuclear Energy Institute, and American Water Works Association to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 2 (filed Feb. 7, 2020).

[8] *See, e.g.*, RLAN Group Comments at 41; Reply Comments of Wi-Fi Alliance at 29, ET Docket No. 18-295, GN Docket No. 17-183 (filed Mar. 18, 2019); Letter from Mitchell Lazarus and Donald Evans, Counsel to the Fixed Wireless Communications Coalition, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 9 (filed Oct. 31, 2019); Letter from Paul Margie, Counsel to Broadcom Inc. and Hewlett Packard Enterprise, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 1 (filed Aug. 22, 2019); RKF Engineering, *Frequency Sharing for Radio Local Area Networks in the 6 GHz Band* 12 (2018), *as attached to* Letter from Paul Margie, Counsel to RLAN Group, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183 (filed Jan. 25, 2018).

This interference protection should be calculated only for RLAN devices seeking to operate co-channel with an FS link. There is no need for special adjacent-channel protections.[9]

Propagation Models

The record demonstrates that the FCC should authorize AFC implementations that employ the following propagation models for use in conducting interference-protection assessment, which vary depending on whether the AFC-controlled access point is located in either a rural or urban/suburban area, with a view towards permitting other models if they can be demonstrated to be effective:[10]

Table 1: Urban & Suburban Propagation Models

Distance	Propagation Model	Clutter	Building entry
0 m ≤ d < 1000 m	WINNER II Combined Urban (C2) ; *or* WINNER II Combined Suburban (C1)	*n/a*	Recommendation ITU-R P.2109-1
$d \geq$ 1000 m	ITM plus digital elevation model (1as resolution)	Recommendation ITU-R P.2108-0 (p=50%)	Recommendation ITU-R P.2109-1

Table 2: Rural Propagation Model

Distance	Propagation Model	Clutter	Building entry
$d \geq$ 0 m	ITM plus digital elevation model (1as resolution)	Recommendation ITU-R P.452-16	Recommendation ITU-R P.2109-1

These propagation models should be applied taking real-world RLAN transmitter and FS receiver heights into account. This will ensure that interference-protection assessments are as accurate as possible, increasing the robustness of the AFC's interference protection as well as optimizing the spectrum available for RLAN operations. Similarly, the AFC should be permitted to use real-world terrain, clutter, and FS antenna patterns whenever that information is available.

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[9] *See* Reply Comments of RLAN Group at 26-30, ET Docket No. 18-295, GN Docket No. 17-183 (filed Mar. 18, 2019); Letter from RLAN Group to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 12, 2020).

[10] *See* RLAN Group Comments at 43, Declaration of Dr. Vinko Erceg. *See also, e.g.*, Wi-Fi Alliance Comments at 25; Comments of Comsearch at Appendix A, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019); Letter from Rob Alderfer, Vice President of Technology Policy, CableLabs, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 3 (filed Mar. 13, 2020); Letter from 5G Automotive Association to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at Attachment 2 (filed Jan. 24, 2020).

When it is not, AFC implementations should be permitted to employ conservative industry-standard models to provide these parameters.

FS Receiver Information

The AFC should draw all necessary data from the FCC's Universal Licensing System ("ULS"). Because some FS incumbents have raised doubts about the accuracy of ULS registration data, the Commission should open an amnesty window during which FS licensees should be permitted to update their registration data without filing fees and without risking penalties for having failed to maintain accurate ULS registrations in the past.[11] To maximize the time available for licenses to make any necessary corrections, the Commission should open a window for ULS data corrections as soon as possible.

Beyond the need for certain licensees to correct their ULS registration data, the record makes clear that ULS is well suited to provide AFC implementation with the information necessary to protect FS links.[12]

Access Point Geolocation

The Commission should permit AFC-controlled access points to employ any geolocation method to determine their position with a confidence of 95%—i.e., AFC access points must have 95% confidence—that they are within the zone defined by their reported location with a margin of accuracy, expressed as a distance, associated with that location measurement. There are multiple means available today such as built-in geolocation using technologies like GPS, professional installation, and street address lookup. Each may have important advantages, depending on the deployment context. For example, GPS often does not perform well indoors, potentially making professional installation or other approaches a necessity in these environments. In the future, other methods may also become available. The Commission should not foreclose these possibilities today through unnecessarily restrictive rules. Instead, it should leave open the possibility of future innovation and allow the market to determine the most appropriate geolocation approach for a given purpose.

The AFC will determine spectrum availability for a given access point based on its reported location and location uncertainty. A device may report its location with greater or lesser uncertainty—but with the required level of confidence—due to limitations in its location

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[11] The FCC's authority to waive these filing fees is unambiguous. *See* 47 U.S.C. § 159a(d).

[12] *See, e.g.*, Letter from Alex Roytblat, Senior Director of Regulatory Affairs, Wi-Fi Alliance, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at slide 13 (filed Apr. 18, 2019); Tucson Electric Comments at 19-20; Reply Comments of CenturyLink at 4, ET Docket No. 18-295, GN Docket No. 17-183 (filed Mar. 18, 2019); Comments of Dynamic Spectrum Alliance at 10, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019).

technology, anticipated movement of the device between spectrum availability requests, or where it may determine that operation with a reduced number of available channels is an acceptable consequence of reporting its location with greater uncertainty.[13]

AFC Control of Transportable Devices

The Commission should permit AFC-controlled devices to be transportable, as well as fixed. The Commission has already decided in other proceedings that access points subject to database control need not be fixed, so long as transportable devices are able to report their velocity (or the resulting location uncertainty) to allow available frequencies to be reduced accordingly.[14] This flexibility will enable a number of important use cases, such as AFC-controlled access points on school buses, connectivity for first responders and other public safety users, and military applications.

III. THE COMMISSION'S RULES SHOULD EMPHASIZE SECURITY AND ROBUST INTERFERENCE PROTECTION, BUT AVOID MANDATING UNNECESSARY COMPLEXITY.

The Commission's goal in designing its AFC rules should be enabling the greatest degree of flexibility possible for device manufacturers and AFC operators, while ensuring that incumbents are protected from harmful interference.

To this end, the Commission should design AFC operator rules that allow the Commission to:

1) Verify an AFC operator's technical qualifications to operate the AFC,
2) Ensure that an AFC implementation is secure, and
3) Confirm that the AFC implementation does not authorize any RLAN access point to operate at locations and power levels that would allow it to exceed -6 dB I/N with respect to any FS receiver.

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[13] *See, e.g.*, Letter from Jennifer McCarthy, Vice President, Legal Advocacy, Federated Wireless, Inc., to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183, at 2 (filed Dec. 4, 2019); FWCC Comments at 29; Reply Comments of Dynamic Spectrum Alliance at 6, ET Docket No. 18-295, GN Docket No. 17-183 (filed Mar. 18, 2019) ("DSA Reply Comments"); Qualcomm Comments at 17.

[14] *Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37, et al.*, Report and Order, 30 FCC Rcd. 9551, ¶¶ 77-78 (2015).

AFC Testing and Certification

The testing necessary to ensure that the AFC system properly protects incumbents from harmful interference can be conducted at a software level to ensure that AFC implementations provide the correct outputs in response to test inputs. This will allow AFC testing to be extremely thorough while also minimizing the burden on the Commission and avoiding unnecessary delay. AFC-controlled access points would, of course, be separately tested to ensure that they provide accurate inputs to the AFC with which they are designed to operate and respond correctly to AFC outputs. To this end, the Wi-Fi Alliance has an active program to develop standardized certification tests that will be made available to stakeholders and the Commission by the end of 2020.

The Commission Should Not Require AFC Centralization or Synchronization

Beyond the testing requirements described above, the FCC should be careful not to add unnecessary additional layers of regulation. Most critically, there is no need for a single, centralized AFC system, or a need for separate AFC systems to synchronize data with one another. Because the necessary incumbent data can be obtained directly from the FCC, there is no need for this data to be shared dynamically between AFC implementations. In addition, the fact that interference protection is on a single-entry basis only means that no complex radio state data needs to be stored or synchronized between AFCs. A requirement to do so, in addition to being unnecessary, would significantly increase the complexity of AFC implementations and likely foreclose many valuable types of AFC implementations.

The Commission Should Not Require AFC Device Registration or Usage Tracking

The record makes clear that access points should not be required to register with the AFC.[15] Likewise, the AFC should not be required to track the frequencies used by AFC-controlled access points. Such requirements would have little value[16] and they would have very

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[15] *See, e.g.*, Comments of Microsoft Corporation at 21, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019); Comments of Open Technology Institute at New America, American Library Association, Consumer Federation of America, Consortium of School Networking, Public Knowledge, and Access Humboldt at 4, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019) ("Public Interest Organizations Comments"); Broadcom Comments at 41; Reply Comments of Hewlett Packard Enterprise at 28, ET Docket No. 18-295, GN Docket No. 17-183 (filed Mar. 18, 2019).

[16] RLAN Group Comments at 33-34. Note that although some incumbents have supported an AFC device registration requirement, these same incumbents have vocally claimed that after-the-fact remediation is not an acceptable strategy for addressing harmful interference concerns. *See, e.g.,* FWCC Comments at 35 (arguing that the ability for an RS operator to decode an RLAN device identifier "would see little or no use" because "RLAN interference will have to be vanishingly rare" while continuing to argue for burdensome, and unnecessary,

significant costs. First, a registration requirement would likely bring with it a requirement for this data to be either synchronized between AFC implementations or aggregated in a central database. Such synchronization would greatly increase the minimum complexity of an AFC implementation and limit the forms in which an AFC could be deployed.

This registration data would also, presumably, be made accessible to a certain class of users. But if nothing else, properly securing this sensitive consumer data—which would be especially sensitive in the case of registration data for transportable access points—would present a major additional burden on AFC operators. The collection and aggregation of such data would also raise concerns among an increasingly privacy-conscious consumer base.[17]

Market Forces Should be Allowed to Drive Development of Different AFC Operator Implementations

Rather than unnecessary regulatory mandates, the Commission's rules should allow the market to drive the development of AFC architectures and permit multiple entities to operate independent AFC systems. We envisage different specialized AFC implementations to support use cases including enterprise, service provider, consumer, and embedded devices, either individually or in combination (for example, an AFC operator may seek to develop a common system to support both enterprise and service-provider devices).

For the same reason, there should be no blanket requirement for all AFC implementations to interoperate with all devices. A device manufacturer should be allowed to operate an AFC system that serves only the devices it produces, and those systems should be able to operate autonomously. Finally, to ensure that there are robust market-based incentives to develop and maintain AFC implementations and to promote innovation, the Commission should permit AFC operators to charge fees for their services, as it has in other bands for operators of analogous systems.[18]

No Ad Hoc Exclusion Zones for Any Operators Seeking Special Treatment

The AFC should only be required to use data listed in ULS to protect FS licensees as well as a separate set of radio astronomy and fixed-satellite downlink sites (with appropriate

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device registration requirements); Comments of Utilities Technology Council at 11, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019) (arguing both that interference "cannot simply be remedied after the fact" while also requesting device registration requirements).

[17] *See, e.g.*, Comments of NCTA—The Internet & Television Association at 14, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019); Comments of the City of Los Angeles at 14, ET Docket No. 18-295, GN Docket No. 17-183 (filed Feb. 15, 2019); Public Interest Organizations Comments at 28; Broadcom Comments at 43; DSA Reply Comments at 11.

[18] *See, e.g.*, 47 C.F.R. §§ 15.714, 96.65.

interference protection criteria) to protect licensees from harmful interference. Beyond this, the Commission should not permit parties to request the creation of special exclusion zones that duplicate or go beyond the protections described above. No party in this proceeding has demonstrated that these kinds of special protections are necessary. Allowing any particular FS incumbent to enjoy any type of exclusion zone will open the door to a never-ending flood of petitions for similar consideration by others, and will defeat the consumer benefits the Commission hopes to achieve in this docket.

Nor should the Commission permit unlicensed ultrawideband ("UWB") operators to request the creation of special exclusion zones. As we have shown, unlicensed UWB and RLAN devices will be able to share spectrum. We have demonstrated that the probability of RLAN operations causing harmful interference to unlicensed UWB is far lower than UWB proponents have claimed.[19] And even in situations where harmful interference could be possible, property owners and venue operators will have the flexibility to choose which unlicensed technologies to deploy, and how to deploy them. This is no different from the decisions that venue managers make today about which RLAN systems to install, which channels to use, etc. It is critical to emphasize that, as an unlicensed technology, UWB is entitled to no expectation of protection from harmful interference, and the Commission should not set the problematic precedent of granting one class of unlicensed operations priority over another. Unlicensed RLANs and unlicensed UWB should be required to share spectrum on a coequal basis, as other unlicensed technologies do in other bands.

All AFC-Controlled Devices Should Comply with Commission Security Requirements

All AFC devices should be secured against tampering, including unauthorized modification of software. To this end, AFC controlled devices should be subject to the same, updated security requirements that apply to U-NII-1 and U-NII-3 devices, as specified in Section 15.407.

IV. CONCLUSION

The Commission has built a robust record supporting detailed decisions regarding virtually every significant aspect of AFC operations. We therefore encourage the Commission to expeditiously adopt rules that provide prospective AFC operators with the information they need to build production-ready AFC systems, and to begin the process of testing and certifying the first AFC implementations as soon as possible.

[19] *See* Letter from Christopher Szymanski, Broadcom Inc., to Marlene H. Dortch, Secretary, FCC, ET Docket No. 18-295, GN Docket No. 17-183 (filed Jan. 15, 2020).

Respectfully submitted,

Apple Inc.
Broadcom Inc.
Cisco Systems, Inc.
Facebook, Inc.
Google LLC
Hewlett Packard Enterprise
Intel Corporation
Microsoft Corporation
Qualcomm Incorporated
Ruckus Networks, a business segment of CommScope