

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC

In the Matter of	:
	:
Unlicensed Use of the 6 GHz Band	: ET Docket No. 18–295, GN
	: Docket No. 17–183; FCC
	:18–147

Comments of Teradek, LLC and Amimon, Inc. to the Proposed Rule :
on Unlicensed Use of the 6 GHz Band :
Set Forth in 47 CFR Part 15. :

To : The Federal Communications Commission

SUMMARY

In its Notice of Proposed Rule Making (NPRM) the Commission proposes to expand unlicensed use of the 5.925–7.125 GHz band (6 GHz band) while protecting the incumbent licensed services that operate in this spectrum. In the 5.925– 6.425 GHz and 6.525–6.875 GHz sub-bands the proposed rules will allow unlicensed access points to operate only on frequencies determined by an automated frequency control (AFC) system. In the remainder of the 6 GHz band, the 6.425–6.525 GHz and 6.875– 7.125 GHz sub-bands, no AFC system will be required, and the unlicensed access points will be permitted to operate at lower transmitted power. The proposed rules will also permit unlicensed client devices to operate under the control of an access point throughout the 6 GHz band.

Teradek LLC and others provide wireless video products to mission critical applications e.g. cinema, episodic TV and live broadcast production, based on the technology provided by Amimon Inc. Amimon’s technology is currently the only solution capable of sub-millisecond latency for end-to-end video transmission. Sub one millisecond delay is essential in most live and on site video production, for essential functions such as remote camera control or focus, live switching between multiple cameras, or Steadicam or gimbal photography.

Our transmitters are usually mounted on or integrated into video cameras and are often mobile, but their mobility is typically limited by the production stage area or event arena. Sometimes our devices are mounted on moving vehicles, e.g. for car scenes. It is worth mentioning that almost all cinema and television productions use one or more of our products for wireless video transmission. Our key customers include every national broadcaster globally, all the major film studios like Warner, 20th Century Fox, Disney, as well as new media companies like Netflix, Hulu, Amazon, and Apple, as well as several governmental agencies for surveillance applications.

In many ways, our products are very similar to the use of wireless microphones. We are used for similar applications, by the same customers, at the same location, but we do not enjoy the same protections of a designation frequency as wireless microphones do.

In many cases more than ten of our devices may be used on a single set or stage. As such we are heavily constrained by the available bandwidth of the 5GHz unlicensed spectrum, and impacted by the many sources of interference in the unlicensed 5GHz band, so we welcome the FCC's proposal to expand the use of the 6GHz band.

However, we have some concerns. Due to the nature of on-set video production, there is often no Internet access available at the time of the production, which usually will not exceed one full day of continuous usage. The typical operator of a camera, which in this case is also the operator of our transmitter device, may not be technically proficient enough or cannot devote extra time in setting the system up or registering it with a database like AFC. Due to the mobility that is often required with such cameras, devices are often powered from the camera batteries and can therefore not be required to connect to mains power while indoors.

Our modules are also ubiquitous in the drone market, where they provide long range, extremely low delay air to ground video for aerial videography and surveillance.

In the consumer's home, or in the corporate boardroom, WHDI (Wireless Home Digital Interface, www.WHDI.org) has become a standard for transmitting sub one millisecond delay HD video in the home between video source equipment like laptops, DVD players and set top boxes, and television sets. WHDI adopters include Hitachi, LG, Sony, Samsung, Sharp, Mitsubishi, Toshiba and more. Amimon is the exclusive provider of WHDI chipsets for these products.

All our products currently operate in the 5GHz unlicensed bands, but are WHDI based, not 802.11 based. The requirement to use 802.11 or any other specific protocol would prohibit our WHDI devices from using the 6 GHz bands.

The 6GHz band portion of the electromagnetic spectrum is currently underutilized and the proposal is generally well received. However, certain proposals are unduly limiting to any devices not based on the 802.11 standard itself, e.g. our wireless video transmitters, or any COFDM video transmitter used by broadcasters and government agencies globally. As such reference to the 802.11 standard should be expanded to include wireless video transmitters or struck from the final rule. We shall provide comments hereunder limited to the specific sections on which we are suitably qualified to provide meaningful input.

Further specific comments on the proposal follows:

Ad Section 3:

The proposed framework for U-NII-5 and U-NII-7 prohibits unlicensed devices from operating co-channel with any fixed link within that link's defined exclusion zone. Thus, for example, if a

fixed service receiver is receiving a specific channel, then unlicensed devices operating in the defined exclusion zone of this receiver must use a different channel. The Commission seeks comment on this proposal.

Similar to the licensing of new fixed links, which require frequency coordination to protect existing links, the Commission proposes to implement a frequency coordination process for unlicensed devices in these bands to ensure that these new unlicensed devices do not cause harmful interference to fixed service incumbents. Prior to operating in these bands, a standard-power access point would determine or receive a list of permissible operating frequencies and restrict operation to those frequencies. Similarly, client devices would have to obtain a list of permissible operating frequencies from a standard-power access point and restrict operation to those frequencies. The Commission seeks comment on this proposal. Are there any alternative methods to ensure protection of incumbent services? What are the costs and benefits of any proposed alternative?

Our Response:

The list that the client device would have to obtain does not have to be a full list of all the permissible frequencies. A partial list is enough. This can simplify the client code. It should only make sure that the used frequency is allowed. The benefits of this alternative are obvious— much simpler client code and therefore a less costly option for the device manufacturer.

Ad Section 5:

Determining Permissible Frequencies of Operation. To determine whether an individual unlicensed device can transmit at a particular location on a given frequency, the Commission proposes that standard-power access points be required to obtain a list of permissible frequencies from an AFC system prior to transmitting or a list of prohibited frequencies in which it cannot transmit. The Commission envisions the AFC system to be a simple database that is easy to implement. The Commission seeks comment on this proposal. What capabilities should be incorporated into the AFC system? Should it be a centralized model where all data and computations are in a central location or the cloud? In this case, the standard-power access point will establish a connection with the AFC system, provide its location and technical details, and the AFC system will communicate the list of permissible frequencies (or a list of prohibited frequencies) back to the standard-power access point. Or should the AFC system's architecture be a de-centralized model where the standard-power access point maintains a local database and performs the necessary computations to determine which frequencies are permissible? Under such a model, how would the local database within the standard-power access point be kept up to date? What are the trade-offs, including the costs and benefits, between a centralized versus a decentralized model in terms of efficiency, device complexity, and ability to protect fixed service stations?

Our Response:

We propose that AFC will support both options of centralized and de-centralized architecture, and that the standard-power access point will be able to choose between them. This will ease the AP design challenges.

For the case of centralized location, the accuracy of the location should be defined by the standard. We propose that the access point will declare its location accuracy in its query, such that the AFC will be able to add the appropriate margins to its list. This will allow coverage of an arena and local mobility (walking with the camera).

For the case of centralized location, and mobile (but with low mobility) access point, the access point will also be able to define a certain area in which it intends to operate and ask from the centralized location for a list of permissible operating frequencies that will be valid for the full area of operation. This is similar in effect to the location accuracy mentioned above, except that location accuracy defines a round area, while this suggestion defined an arbitrary shape of area.

Centralized and cloud based AFC mechanisms should be easier to update for ad-hoc events and ordering frequencies for news gathering / broadcasting events.

We propose that AFC listing should be done more than 24 hours prior to the actual use of the frequency.

There is a difference between AFC access for getting "freedom to operate" approval than from "purchasing a fixed timely channel allocation".

In case the AP is allowed to use either one (cloud based or centralized), then the purchasing of a fixed channel should cause both AFC databases to be updated.

We also propose that there should be different price for frequency advance allocation timing.

Ad Section 6:

Should the AFC system determine frequency availability using the maximum permissible power for a standard-power access point, or should it determine frequency availability at power levels less than the maximum, and calculate a list of available frequencies and the maximum power permitted on each one? If the AFC system calculates the maximum power for each frequency, how would it control the power levels of standard-power access points to ensure that they operate at permissible levels? How should frequency availability information be reported to standard-power access points? Should the AFC system report availability for discrete frequency bands, e.g., 10 or 20 megahertz channels, or should it simply report the range or ranges of available frequencies? Alternatively, should the AFC simply list the range or ranges of unavailable frequencies?

Our Response:

We propose that the AFC would determine frequency availability at power levels less than the maximum and calculate a list of available frequencies and the maximum power permitted on each one. To ensure that the access point operates at the permissible level, we propose to

employ a certification process either in a certification lab, or self-certification. This will ease the certification process.

Ad Section 8:

The Commission seeks comment on whether device registration in the AFC database is necessary. What are the advantages and disadvantages of each approach? Would a registration requirement increase cost or complicate design and operations of devices and the AFC? Would a registration requirement be beneficial for determining the source if a fixed service station were to experience harmful interference? If device registration is required, what information should be provided? Should the information be limited to a device identifier, location, and some basic technical information? Or should device ownership data and contact information also be required? The Commission also seeks comment on how registration information should be entered into the AFC system. Should it be entered manually by a person, such as a professional installer or the equipment user, or should we require automated entry of some or all of the information? The Commission additionally seeks comment on whether there are methods that can be used when a device registers and/or operates to verify its location and operating parameters. For example, could a two step verification process be used such that registrants must certify as to the accuracy of the information entered into the AFC system?

Our Response:

We propose that any device should be registered in the AFC and that it should happen automatically. This will enhance ease of use for the end-user. The next part of the inquiry is how much information should be given. We submit that a two step verification or manual user registration is too much. Just sharing the device ID, central location and working range should be more than adequate.

Ad Section 9:

The Commission recognizes that, because licensed use of these bands is not static, the AFC system must be designed to ensure that unlicensed operations protect new and modified licensed operations. The Commission proposes to adopt a requirement that devices periodically verify whether frequency availability has changed. Is a periodic re-check interval the most appropriate method to determine changes in frequency availability information and, if so, what should the maximum permissible interval for verifying frequency availability be? Would an alternative method be more appropriate, such as requiring the AFC system to have the capability to direct devices to change frequencies? Should the Commission adopt a general performance rule instead of specifying a particular re-verification mechanism? The Commission also seeks comment on what should happen when a device and the AFC system are temporarily unable to communicate during the frequency re-verification/update process. Should the Commission, for example, allow the device to temporarily continue operating for a period before requiring it to cease operations?

Our Response:

We propose that:

- a. the rate of AFC access for the updated free frequency list refresh will vary between different geographic regions, and that the central AFC system will include information regarding the required rate of refreshing the list for each region. Once the AFC access capabilities are implemented, the user should have no extra burden applying a timer and re-validating the list accordingly)
- b. In any case, the rate of refreshing the list will not be higher than once every 24 hours.
- c. The AFC system should not have the ability to direct devices to change frequencies. This would place an unnecessary burden on both the AFC system and the devices.

Ad Section 11:

The Commission proposes to designate multiple entities to operate AFC systems. The Commission seeks comment on this proposal. Should the Commission require that devices have the capability to communicate with all AFC systems or should they only be required to have the capability to communicate with a subset of the designated AFC systems? For example, should a manufacturer be allowed to operate an AFC system that serves only devices that it produces? Should the Commission allow the functions of an AFC system, such as a data repository, registration, and query services, to be divided among multiple entities, or should the Commission require all functions of a single AFC system to be performed by a single entity? Can each AFC system operate autonomously or is there a need for them to communicate any information with each other? If so, what information would need to be exchanged? Given the potential complexity of multiple AFC system operators needing to coordinate, should the Commission instead designate only a single AFC system operator?

Our Response:

We propose that if there will be multiple AFC systems, then access points should be required to have the capability to communicate with at least one of them.

We also propose that a manufacturer be allowed to operate an AFC system that serves only devices that it produces, provided that the AFC system would be certified by an external independent lab with a standard certification procedure. The advantage of this approach is ease of design, and the creator will own the AFC.

Ad Section 21:

To counteract the effects of fading, FWCC states that licensees design their fixed microwave systems with fade margins of 25–40 dB. The Commission seeks comment on FWCC’s characterization of the fade margin. What are the typical design criteria for fixed service station fade margins? The Commission also seeks comment on whether and specifically how fading might affect the levels of the potentially interfering signal being transmitted from unlicensed devices. Given that atmospheric conditions affect multipath fading, should the interference protection criteria be relaxed or other allowances made in areas where fades are not as prominent? How might this be accomplished? Should the Commission consider the time of day

fading occurs in conjunction with the relative busy hours for unlicensed traffic when determining the interference protection criteria? To what degree? Given that the loss of synchronization can occur even without the presence of any interference, can such events be attributed to atmospheric multipath fading? Given the diurnal and seasonal nature of atmospheric multipath fading, are there mitigation strategies that can take advantage of this phenomenon to ensure the potential for causing harmful interference is minimized?

Our Response:

Response included with Section 22 below.

Ad Section 22:

Several different propagation models can be used to determine the appropriate exclusion zones. The Commission believes that in the first kilometer, an effective propagation model should include clutter loss in addition to both line-of-sight and nonline- of-sight conditions. Beyond the first kilometer, the propagation model should include a combination of a terrain-based path loss model and a clutter loss model appropriate for the environment. The Commission seeks comment on this approach, as well as the appropriate propagation models for this application. Can some of the propagation models for different conditions be combined into a single model? Is using curve fitting to combine propagation models of different ranges of applicability into a single model an appropriate approach for this application? What are the costs and benefits of each propagation model? What other factors should be considered when choosing an appropriate propagation model?

Our Response to Sections 21 and 22:

We propose that the AFC model should attempt to bring the probability of harmful interference to be below a certain threshold, by considering together the probability density function of the fading of the fixed microwave system (the incumbent licensee) and the probability density function of the path loss of the interference coming from the unlicensed user.

For example: suppose that a C/I of 20dB is considered harmful, and the desired probability threshold is $P_T = 10^{-6}$, we believe that the following situation should be allowed:

- (1) $C < C_T$ with probability of P_1 (due to random fading)
- (2) $I > I_T$ with probability of P_2 (due to random path loss of the interference signal)
- (3) $C_T/I_T > 20\text{dB}$
- (4) $P_1 \cdot P_2 < P_T$

(The other option, which we believe is too conservative, is to choose the thresholds C_T and I_T such that $P_1 < P_T$ and $P_2 < P_T$)

Ad Section 23:

If expressed in terms of latitude, longitude, and height, what is the required accuracy of the location of each standard-power access point to ensure fixed service protection? Rather than requiring a certain location accuracy for a standard-power access point, would it be more appropriate to assign an area of uncertainty around the computed location, based on the

underlying technology and propagation environment, and then build the necessary processing into the AFC system to adjust its separation distance between the standard-power access point and fixed service receiver based on the area of uncertainty? If so, who will determine such an assignment and how, particularly with respect to indoor deployment? How will the location accuracy information be shared with the AFC? Will it be part of the registration process? What are the costs and benefits of any proposed alternative?

Our Response:

We propose that the access point will declare its location accuracy in its query, such that the AFC will be able to add the appropriate margins to the list of allowed frequencies. This will increase practical uses, for example, it will allow coverage of an arena and local mobility (walking with the camera).

We propose that low mobility access point (not air borne), will define a certain area in which it intends to operate and request the centralized location for a list of permissible operating frequencies that will be valid for the full area of operation. This is similar in effect to the location accuracy mentioned above, except that location accuracy defines a round-shaped area, while this suggestion defines an arbitrary shape.

Low-mobility is required for ad-hoc events such as news gathering or broadcasting events.

Ad Section 24:

The typical installation height above ground of a standard-power access points should probably range from 5 meters to 30 meters. The Commission seeks comment on whether this estimate of typical standard-power access point heights is appropriate. The Commission seeks comment on whether to limit the maximum installation height of outdoor standard-power access points. If so, should that limit be set to 30 meters? Because frequency availability will depend on the height of standard-power access points, will the AFC system inherently address this matter by limiting the availability of permissible frequencies?

Our Response:

We propose that the typical installation height is lowered to between 2 meters and 30 meters. We aim to lower the minimum height from 5 to 2 meters, as we'd like to allow mobile systems, which won't be able to use 5 meter poles.

Lower installation (maximum 2 meters height) may be needed for ad-hoc events such as news gathering or broadcasting events.

Ad Section 25:

The Commission seeks comment on requiring that every standard-power access point be professionally installed. If the Commission requires professional installation, what mechanisms should be in place to ensure that a nonprofessional or unlicensed person cannot perform an installation? Should the Commission rely on an industry-led process to develop professional installer accreditation standards as the Commission has done in similar situations? Should AFC

system(s) be required to take steps to ensure that only standard-power access points that have been professionally installed can receive a list of frequencies upon which to operate? If the Commission adopts a professional installation requirement, should it exempt certain access points that are less likely to cause interference such as, for example, those installed indoors or that are below a specified height? Are there other measurement/ geolocation tools, existing or on the horizon, that can complement GPS? If so, can they be used in lieu of professional installation? Should the Commission require that geolocation capability be built into the standard-power access points? Are there other means of obtaining location information, such as street address and floor number? If so, how will this impact the contour calculations? What are the costs and benefits of any proposed alternative?

Our Response:

We propose to allow temporary installations at a height of 2-3 meters (6-9 feet), meant to be used for less than 30 days, without requiring professional installation.

Ad Section 26:

The Commission proposes to require client devices that operate in the U–NII–5 and U–NII–7 bands to be under the control of a standard-power access point. Notwithstanding this proposal, the Commission seeks comment on whether client devices should be allowed to transmit probe requests, consistent with 802.11 standard, as means for joining a network, prior to receiving a frequency assignment. If so, is there any way to allow such use without causing harmful interference to the incumbent users? The Commission seeks comment on what assumptions to make about the area in which a client device can operate.

Our Response:

We propose to allow probe requests, and to specify certain limitations to such probe requests. However, we propose not to limit the probe request procedure to 802.11, since our products will not be 802.11 compliant. We wish to point out that other wireless technologies are used, such as our WHDI technology used by sub-millisecond wireless video transmission devices in the 5Ghz band.

Ad Section 27:

The Commission seeks comment on the typical or maximum operating radius for communications between a client device and a standard-power access point. How should the distance be incorporated into any frequency coordination computation to ensure incumbents are protected? The Commission’s proposed rules define a client device as “a U–NII device whose transmissions are generally under the control of an access point and that is not capable of initiating a network.” The Commission seeks comment on this definition.

Our Response:

We propose not to limit the distance between the access point and the client. Instead, we propose that the access point will report to the AFC the maximal distance between the access point and its clients, as well as the transmission power of the clients, and the AFC will take it into account for allowing frequencies. This will ensure a professional installation.

We also propose to define a client as “a U–NII device whose transmissions are conditioned upon receiving an indication from an access point, that the frequency is allowed.”

Ad Section 39:

The Commission does not propose to make changes to existing provisions in Part 15 for unlicensed wideband and ultra-wideband systems as the Commission expects such systems will continue to coexist with all other systems, both licensed and unlicensed, within the 6 GHz band. The Commission seeks comment from interested parties regarding the potential effect of our proposals on their existing unlicensed devices and use models. To the extent that parties believe new devices could adversely affect existing operations, they should suggest specific rules and mitigation strategies that would minimize such risk.

Our Response:

We propose that Part-15 is used for the basis of regulatory approval of U-NII-5,6,7,8, allowing various types of modulation (not limited only to the 802.11), with no limit in the used channel bandwidth. This enhances technology neutrality.

Ad Section 44:

The Commission seeks comment on these proposed power limits. The Commission also seeks comment on whether higher power operations could be permitted in rural and underserved areas under certain conditions. If so, should such operations be limited to only the U–NII–5 and U–NII–7 bands and only under the control of an AFC system? Commenters advocating for higher power should also address how much more power they believe is necessary to serve these areas and provide comment on how to define rural and underserved areas in this context. Additionally, commenters should address whether such operations should be limited to point-to-point operations (possibly with a minimum antenna gain) or if point-to-multipoint operations should be permitted.

Our Response:

We propose that point-to-multipoint operation is range limited according to the AFC reported distance of the AP. This will restrict the maximum operational distance between the access point and its clients. This should be reserved for professional use only.

Ad Section 48:

Prohibition on use in Moving Vehicles and Drones. The Commission proposes that unlicensed access points (both standard-power access point and low-power access point) be prohibited from operating in moving vehicles such as cars, trains, or aircraft. The Commission is especially concerned about the interference consequences of allowing operation onboard aircraft because the longer line-of-sight distances from devices at typical aircraft altitude could result in interference over a wide area. The Commission seeks comment on this proposal and whether there are alternative, feasible proposals to use the band for moving vehicles. The Commission also propose that unlicensed devices, whether a standard-power access point, low-power access point, or client device, operating under these rules not be permitted for use with unmanned aircraft systems. The Commission seeks comment on this proposal.

Our Response:

We propose that the access point will define its center geographical position and request a radius of operation. Within this operational radius, mobility is allowed (not for an aircraft). Since motion picture cameras are sometimes in motion, restricting this will unduly restrict film creation.

Ad Section 50:

The Commission seeks comment on whether to require standard-power access points in these bands to transmit digital identifying information. If so, should such a requirement be applied in all instances (standard-power access points and low-power access points and their associated client devices)? If, as proposed, low-power access point operation would be restricted to indoors and such devices would not have any identifying information in the AFC database, would there be any practical benefit to requiring low-power access points to transmit digitally identifying information? Would a specific format for such information need to be specified and would there be a need for specialized equipment to detect and decode the identifying information? If so, could this function be easily incorporated into new equipment or retrofitted to existing equipment? How much would adding this capability into equipment cost?

Our Response:

In order to allow technology neutrality, we propose that the system's "call-sign" (identity) will be transmitted periodically, and openly, according to its protocols.

Ad Section 53:

The Commission seeks comment on requiring manufacturers to provide consumers with information on any specific operational requirements applicable to devices operating in the U–NII–5 through U–NII–8 bands to prevent harmful interference. How should this information be conveyed, e.g., by device labeling or in the user’s manual, and what information should be provided? Depending on the types of operational requirements that the Commission adopts, examples of information that could be provided include that certain devices may be operated

only indoors, may not be operated on board aircraft, require professional installation, or must update their location information with an AFC system when installed at a new location.

Our Response:

We propose that the user must be informed by the manufacturer of the limitations and regulatory constraints of using the U-NII-5,6,7,8 bands. This information can be conveyed by labeling on the product, product inserts or by its User Guide.

Respectfully submitted,

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