Recommendations for Addressing Blank, Uncollected, Erroneous, or Conflicting Database Elements for Incumbent Systems in the U.S. U-NII 5 & 7 Bands for the Purpose of Automated Frequency Coordination Systems

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1 Introduction

According to the U.S. Federal Communications Commission (FCC):

"[b]*ecause ULS is the official Commission compendium of license records, licensees are obligated under the terms of their licenses to keep their information filed with the Commission current and complete. Thus, licensees have the responsibility, as well as significant incentive, to maintain the continued accuracy of data in the Universal Licensing System to ensure that they are protected from harmful interference not only from new unlicensed devices, but also from new fixed microwave links that may access the band. To the extent licensees determine that their actual operations differ from the Commission's licensing records, they should modify those records to ensure they are properly protected from harmful interference from any other spectrum users*"[1]

A previously-published document, Technical Report WINNF-TR-1008 [1], is a summary of 6 GHz fixed service incumbent data in the Unlicensed National Information Infrastructure (U-NII) 5 and 7 bands as available in the FCC's Universal Licensing System (ULS), how to access the data, and some of the problems that can arise with the data. This document is a companion to WINNF-TR-1008 and provides recommendations to licensees and the FCC on blank, uncollected, erroneous, or conflicting incumbent data. The discussion in this document is within the context of the U.S. 6 GHz U-NII rules governing Automated Frequency Coordination (AFC) Systems and unlicensed devices [3], and the text of the FCC Report and Order in which the rules were adopted [4].

The WInnForum 6 GHz Committee is developing requirements for the 6 GHz AFC System that will address how to handle blank, uncollected, erroneous or conflicting data in the Technical Specification "Operational and Functional Requirements for the U.S. 6 GHz Band" (WINNF-TS-1014 [2]).

This document provides recommendations to incumbents and the FCC on specific actions to be taken.

1.1 Call for action to the FCC

The Wireless Telecommunications Bureau has been directed to issue a Public Notice (PN) reminding the incumbents of the importance of maintaining accurate information in the ULS (data-

[1] *Report and Order and Further Notice of Proposed Rulemaking*, FCC 20-51, para. 31

accuracy PN).[2] The WInnForum recommends that the Wireless Telecommunications Bureau issue this Public Notice as soon as possible.

Examples of blank data in the ULS can be found in the following ULS fields:

- Antenna Make
- Antenna Model
- Antenna Gain
- Antenna Height
- Emission Designator
- Passive Billboard Receive Dimensions
- Passive Billboard Transmit Dimensions
- Passive back-to-back receive antenna gain
- Passive back-to-back transmit antenna gain
- No passive receive antenna data
- No passive transmit antenna data

Examples of conflicting data in the ULS can be found in the following ULS fields:

- Antenna Make, Model and Gain
- Antenna Heights that are 0, negative or very large
- Emission Designators that reflect a 0 MHz bandwidth or too large for the band.
- Diversity antenna height and gain
- Path length is unreasonably large
- Receive parabolic antenna model is provided with billboard dimensions
- Transmit parabolic antenna model is provided with billboard dimensions

The WInnForum recommends that the Wireless Telecommunications Bureau modify the ULS to collect additional data:

- Receive-Only Loss
- Receiver Noise Figure
- Diversity Receive Antenna Make and Model

The WInnForum recommends that the Wireless Telecommunications Bureau establish a process for notification of an inaccuracy, error, or data conflict in the ULS.

1.2 Call for action to the Incumbents

Based on the above considerations, all incumbents should promptly review all of their link data and correct any errors. Note that under the FCC's Order, AFC Systems are required to operate

[2] *Report and Order and Further Notice of Proposed Rulemaking*, FCC 20-51, para. 31

using whatever information is in ULS, including blank data.[3] Therefore, it is in the best interest of the incumbents to ensure that their ULS data are accurate and complete.

1.3 Terms Used in this Document

The following acronyms and keywords are used in this document.

1.3.1 Acronyms

AFC	Automated Frequency Coordination
AGL	Above Ground Level
AMSL	Above Mean Sea Level
FCC	Federal Communications Commission
ULS	Universal Licensing System
U-NII	Unlicensed National Information Infrastructure

1.3.2 Keywords

The following terms are used with respect to ULS data:

- Blank data: Fields that exist in the ULS database but are not populated for some of the incumbent systems.
- Uncollected data: Information that is important for the interference calculations (e.g., antenna patterns), but the necessary field is not available in the ULS at all.
- Erroneous data: Data that are clearly wrong (for example, an antenna gain of 449 dBi).
- Conflicting data: Data that are not self-consistent (for example, a maximum antenna gain that is not consistent with the listed antenna model).

2 Blank data

Blank data are fields that exist in the ULS database but are not populated for some of the incumbent systems. The most common blank data needed for AFC System are discussed below.

Requirements addressing the issues identified in this section will be addressed by the WInnForum in WINNF-TS-1014 [2].

[3] *Ibid*

2.1 Antenna Model and Gain

2.1.1 Discussion

The FCC ULS data provides fields for recording the antenna make, model and gain for each microwave transmitter and receiver on each path. To properly protect the microwave receivers, an AFC System needs to use this data to determine the radiation pattern envelope for the receiving antenna, and therefore predict interference levels from unlicensed devices.

As mentioned in section 3.4.1 of WINNF-TR-1008 [1], the FCC's ULS data does not contain the make, model, and gain for all receive antennas on licensed paths. In most cases, these licenses pre-date the implementation of ULS and have been renewed without this data ever since.

2.1.2 Recommendation

In the absence of antenna make, model, and gain for a receive antenna the following are recommended (in priority order):

1. The FCC is encouraged to release the data accuracy PN as soon as possible. Note: examples of licenses where the antenna make, model or gain is not listed on the receiver antenna are found in the Appendix on sheet *2.1.2 Blank Rx Make Model Gain*.

2. Licensees are encouraged to modify their licenses to fill in blank data.

2.2 Antenna Height

2.2.1 Discussion

The FCC ULS data provides a field for the receiver antenna height AGL. To properly protect a microwave receiver, an AFC System needs to use the receiver antenna height AGL to determine the propagation losses, especially when there is blockage due to terrain or clutter.

As mentioned in the section 3.4.1 of WINNF-TR-1008 [1], the FCC's ULS data does not contain the receiver antenna height AGL for all receive antennas on licensed paths. In most cases, these licenses pre-date the implementation of ULS and have been renewed without this data ever since.

2.2.2 Recommendation

In the absence of receiver antenna height AGL the following are recommended (in priority order):

1. The FCC is encouraged to release the data accuracy PN as soon as possible. Note: examples of licenses where the receiver antenna height AGL is not listed are found in the Appendix on sheet *2.2.2 Blank Rx Height*.

2. Licensees are encouraged to modify their licenses to fill in blank receiver antenna height AGL data.

2.3 Emission Designator

2.3.1 Discussion

The FCC ULS data provides a field for the emission designator. To properly protect a microwave receiver, an AFC System needs to use the emission designator from the transmit site to determine receiver's bandwidth, which is used to determine whether unlicensed devices are operating on frequencies that are co-channel or adjacent channel to the incumbent.

The FCC's ULS data does not contain the emission designator for all transmitters on licensed paths. In most cases, these licenses pre-date the implementation of ULS and have been renewed without this data ever since.

2.3.2 Recommendation

In the absence of an emission designators, the following are recommended (in priority order):

1. The FCC is encouraged to release the data accuracy PN as soon as possible. Note: examples of licenses where the emission designator is not listed on the transmit path are found in the Appendix on sheet *2.3.2 Blank Emission Designator*.

2. Licensees are encouraged to modify their licenses to fill in blank data.

2.4 Passive Repeater

2.4.1 Discussion

The FCC ULS provides the ability to specify intermediate passive repeater locations to reflect and direct microwave signals where there is no line-of-sight directly between a transmit and receiving antenna. There are two types of passive repeaters: billboard and back-to-back parabolic antennas. The ULS allows for the entry of the billboard antenna dimensions in height and width, as well as the make, model, and gain for a parabolic antenna. When passives are employed, each passive location will have either a billboard or a back-to-back antenna. This assessment of the ULS data in this section focuses blank data in the passive repeater information.

The first set of blank data is where the antenna model looks like a billboard, but no dimensions are provided on either the transmit or the receive location of the segment, depending on which end of the segment is indicated to be the passive.

The second set of data is where a parabolic antenna make and model is provided, but there is no specified gain.

The third set of data is where there is no passive antenna data. There are no make, model, gain, or billboard dimensions. In this instance, we know there is a passive at this site, but do not know whether it is a billboard or back-to-back parabolic antenna.

Paths employing passive repeaters that are not included in ULS cannot be protected by AFC Systems.

2.4.2 Recommendation

In the instance where there are blank passive repeater billboard or back-to-back antenna data, the following are recommended (in priority order):

1. The FCC is encouraged to release the data accuracy PN as soon as possible. Note: examples of licenses where the passive repeater data is blank are found in the Appendix on sheet *5.6.2 Blank and Conflicting Passives*, with the "issue" column containing the following text:
    a. Blank receive billboard dimensions
    b. Blank transmit billboard dimensions
    c. Blank back-to-back receive antenna gain
    d. Blank back-to-back transmit antenna gain
    e. No passive receive antenna data
    f. No passive transmit antenna data
2. Licensees are encouraged to modify their licenses to fill in the blank passive data.

3 Uncollected Data

Uncollected data refers to information that are important for the interference calculations (e.g., antenna patterns), but the necessary field is not available in the ULS at all.

3.1 Receive-Only Losses

3.1.1 Discussion

In reference to section 3.4.1 of WINNF-TR-1008 [1], receive-only losses are not collected by the ULS. Receive-only losses record the amount of loss between a receive antenna and the radio receiver as a result of the signals passing through transmission lines, circulators, and connectors. Without consideration of receiver losses, incumbent receivers might be over-protected.

3.1.2 Recommendation

The FCC is encouraged to modify ULS to collect the receiver losses for the receivers for each path.

3.2 Receiver Noise Level

3.2.1 Discussion

In reference to section 3.5.3 of WINNF-TR-1008, the noise level of a receiver on a per-MHz basis is determined by the combination ground and atmospheric temperatures, and the noise figure, which is a measure of the amount of noise introduced by the receiver itself. While temperature is typically assumed to be 290K, the noise figure varies and is not collected by the FCC ULS. In order to calculate the noise level, the following relation is used:

N (dBm/MHz) = -114 dBm/MHz + NF (dB)

Where:

- N is the receiver noise power spectral density.
- -114 dBm/MHz is a conversion factor of k_BT, with k_B being Boltzmann's constant, and T being the standard temperature[4].
- NF is the receiver noise figure.

The noise figure is currently not provided for 6 GHz links in the ULS. One solution is to determine the receiver noise figure from the applied radio make and model. This solution, just as with the antenna patterns, would require extensive databases and research.

3.2.2 Recommendation

The FCC is encouraged to modify ULS to collect the noise figure for the receivers for each path.

3.3 Antenna Patterns

3.3.1 Discussion

In reference to section 3.4.1 of WINNF-TR-1008 [1], antenna patterns are not collected by the ULS. While there are reference antenna standards such as Recommendation ITU-R F.699 [n.5] that can be used to estimate off-axis radiation suppression, manufacturer-provided antenna pattern data is more accurate and will promote a higher degree of sharing with unlicensed devices.

[4] k_B = 1.38064852 x 10^{-23} m^2 kg s^{-2} K^{-1} = -228.6 dB(W Hz^{-1} K^{-1}) = -138.6 dB(mW MHz^{-1} K^{-1}). T = 290K. Adding $10\log_{10}$(290 K) gives -114 dB(mW MHz^{-1}) (commonly written as -114 dBm/MHz).

As opposed to other data collected in ULS, entering antenna pattern data requires a lot more data to be provided and stored in ULS. This could unnecessarily burden the applicant and could complicate the licensing system.

3.3.2 Resolution

There is no recommendation to the FCC regarding uncollected antenna pattern data since the antenna make and model can be used to obtain it.

3.4 Diversity Receive Antenna Make and Models

3.4.1 Discussion

In reference to section 3.4.1 of WINNF-TR-1008 [1], diversity receive antenna make and models are not collected by the ULS. The only way to know that there is a diversity receive antenna in use on a link is through the reporting of the diversity receive antenna gain, beamwidth and height. Without recording the diversity receive antenna make and model, incumbent receivers might not be properly protected.

3.4.2 Recommendation

The FCC is encouraged to modify ULS to collect the diversity receive antenna make and model for the receivers for each path.

4 Data Elements that Could be Erroneous

4.1.1 Discussion

During the treatment by the AFC System of the ULS data, situations could occur where, while not infringing on any FCC regulation, the data could lead to inconsistent, inapplicable, or erroneous results.

One example would be of an antenna height of several kilometers. While not formally outlawed by FCC regulations, such a height could lead to errors (specifically, the interference models mandated by the FCC cannot handle such heights without significant errors). However, as the height is not in theory impossible or prohibited, the AFC System cannot be the sole arbiter and decide to drop the data. The data is then treated as if it were correct if the processing does not impair the AFC System operations.

The AFC System could be forced to process data that will lead to incoherent results. Requirements addressing these issues will be addressed by the WInnForum in WINNF-TS-1014 [2].

4.1.2 Recommendation

In the instance where there are data elements that could be erroneous, the following are recommended (in priority order):

1. The FCC is encouraged to release the data accuracy PN as soon as possible.
2. Licensees are encouraged to review their licenses to ensure the accuracy of their data.

5 Conflicting Data

If conflicting data present in the ULS database cannot be resolved using recommendations defined in subsequent subsections, the treatment by the AFC System of such conflict is out of the scope of this document and is not expected to be specified.

5.1 Antenna Model and Gain

5.1.1 Discussion

There are several ways in which the ULS antenna model could conflict with the gain for a receiver antenna:

1. Antenna gain does not fall within manufacturer's specification, or reasonable tolerances, of the known antenna model.
2. Antenna model is unknown to the AFC System.
3. Antenna gain does not meet the FCC's minimum gain requirements or is unreasonably large for antennas in the band.

5.1.2 Recommendation

In the instance where antenna make, model, and gain for a receive antenna are conflicting, the following are recommended (in priority order):

3. The FCC is encouraged to release the data accuracy PN as soon as possible. Note: examples of licenses identifying antenna make, model, and gain conflicts with respect to the receive antenna are found in the Appendix for each of the conflicting methods:
    a. Sheet *5.1.2 Ant Model Gain Tolerance*
    b. Sheet *5.1.2 Ant Model Unknow*n
    c. Sheet *5.1.2 Ant Gain Out of Bounds*
4. Licensees are encouraged to modify their licenses to revise the data to be non-conflicting.

5.2 Emission Designators

5.2.1 Discussion

There are several ways in which the ULS emission designator could be incorrect:

1. Emission bandwidth is 0 MHz. An emission bandwidth of 0 MHz is not physically possible.

2. Emission bandwidth is larger than the largest authorized bandwidth of 60 MHz. While there is the possibility that a waiver of the FCC rules could be requested to exceed 60 MHz, the licenses where this occurs in the FCC database do not appear to include waivers.

5.2.2 Recommendation

In the instance where the ULS emission designator is incorrect, the following are recommended (in priority order):

5. The FCC is encouraged to release the data accuracy PN as soon as possible. Note: examples of licenses where there are emission designators on paths with 0 MHz or very large bandwidths are found in the Appendix on sheet *5.2.2 Err Emission Designators*.

6. Licensees are encouraged to modify their licenses to correct the emission designator data.

5.3 Antenna Height

5.3.1 Discussion

There are several ways in which the ULS antenna height AGL could be incorrect:

1. Antenna height AGL is zero or negative.

2. Antenna height AGL is unreasonably large and is likely instead erroneously provided as Location Ground Elevation AMSL.

5.3.2 Recommendation

In the instance where antenna height AGL is zero, negative, or unreasonably large, the following are recommended (in priority order):

1. The FCC is encouraged to release the data accuracy PN as soon as possible. Note: examples of licenses where the antenna height AGL of the receive antenna is zero, negative, or unreasonably large are found in the Appendix on sheet *5.3.2 Conflicting Antenna Ht.*

2. Licensees are encouraged to modify their licenses to correct the antenna height AGL values.

5.4 Diversity Antenna Height, Gain, and Beamwidth

5.4.1 Discussion

The FCC ULS provides three fields for recording diversity antennas: Diversity Height AGL, Diversity Gain and Diversity Beamwidth. The presence of data in these fields indicates that there is a diversity receive antenna on the path that requires protection from unlicensed devices.

There are several ways in which this data could be conflicting or incorrect:

1. Diversity height AGL is zero or negative

2. Diversity height AGL is unreasonably large, and is likely instead erroneously provided as Location Ground Elevation AMSL.

3. Diversity antenna gain does not meet the FCC's minimum gain requirements or is unreasonably large for antennas in the band.

4. Data is present in one or two of the fields but is absent from the third. An AFC System would need at least the height and gain to make a fair assessment of interference. Beamwidth is less critical but can be used to corroborate the gain.

5.4.2 Recommendation

In the instance where one of the two fields -- diversity antenna height or diversity gain -- are blank but the other exists, or two of the three fields (diversity antenna height, gain, or beamwidth) are conflicting, the following are recommended (in priority order):

1. The FCC is encouraged to release the data accuracy PN as soon as possible. Note: examples of licenses where one of the two fields (diversity antenna height, diversity antenna gain) is blank but the other exists, or the three diversity fields of antenna height, gain, and beamwidth are conflicting are found in the Appendix on the following sheets:

    a. Sheet *5.4.2 Conflicting Div Ht Gain.*

    b. Sheet *5.4.2 Blank Div Height or Gain*.

2. Licensees are encouraged to modify their licenses to correct the diversity antenna height, gain, and beamwidth values.

5.5 Path Length

5.5.1 Discussion

The FCC ULS provides the latitude and longitude for the transmit and receive locations of a path. This location data can be used to calculate the great circle path length. An assessment of typical path lengths indicates that most paths in the U-NII 5 and U-NII 7 bands are less than 150 km. All paths with length greater than 150 km were reviewed and 7 paths were deemed to have errors in the transmit location or receive location coordinates. Receive location errors will protect the wrong incumbent receiver and transmit location errors will affect the computed pointing direction for the receive antenna.

5.5.2 Recommendation

In the instance where path length is unreasonably large, the following are recommended (in priority order):

1. The FCC is encouraged to release the data accuracy PN as soon as possible. Note: examples of licenses where the path length is unreasonably large are found in the Appendix on sheet *5.5.2 Erroneous Path Length*.

2. Licensees are encouraged to modify their licenses to correct the antenna height AGL values.

5.6 Passive Repeater

5.6.1 Discussion

The FCC ULS provides the ability to specify intermediate passive repeater locations to reflect and direct microwave signals where there is no line-of-sight directly between a transmit and receiving antenna. There are two types of passive repeaters: billboard and back-to-back parabolic antennas. The ULS allows for the entry of the billboard antenna dimensions in height and width, as well as the make, model, and gain for a parabolic antenna. When passives are employed, each passive location will have either a billboard or a back-to-back antenna. This assessment of the ULS data focuses on conflicting data in the passive repeater information.

This set of data is conflicting in that an apparently parabolic antenna is specified, but there is no gain and there is a billboard reflector height and width specified.

Paths employing passive repeaters that are not included in ULS cannot be protected by AFC Systems.

5.6.2 Recommendation

In the instance where there are conflicting passive repeater billboard or back-to-back antenna data, the following are recommended (in priority order):

1. The FCC is encouraged to release the data accuracy PN as soon as possible. Note: examples of licenses where the passive repeater data is conflicting are found in the Appendix on sheet *5.6.2 Blank and Conflicting Passive*, with the "issue" column containing the following text:

    a. Conflicting. Receive parabolic antenna with billboard dimensions

    b. Conflicting. Transmit parabolic antenna with billboard dimensions

2. Licensees are encouraged to modify their licenses to correct the conflicting passive values.

6 Notification of an inaccuracy, error, or data conflict in the ULS

6.1.1 Discussion

Correcting data inaccuracy in the ULS is the responsibility of the licensees. In the event an AFC System or its administrator detects an inaccuracy, error, or conflict in the ULS, it is beneficial to inform the licensee and the FCC. However, this notification by an AFC System administrator is not seen as mandatory.

6.1.2 Recommendation

In the event an AFC System or its administrator detects an inaccuracy, error, or conflict in the ULS, it is strongly recommended that the AFC System administrator notify the licensee and the FCC.

WInnForum recommends that the FCC establish a process to allow this to occur.

7 References

[1] Wireless Innovation Forum Technical Report 1008 (WINNF-TR-1008-V1.0.0), *Incumbent Fixed Service Data in the U.S. U-NII 5 & 7 Bands*, (January 2021), available at https://www.wirelessinnovation.org/assets/work_products/Reports/winnf-tr-1008-v1.0.0%206%20ghz%20incumbent%20data%20technical%20report.pdf

[2] Wireless Innovation Forum Technical Specification 1014 (WINNF-TS-1014-V0.0.0-r5.1 (IR1), *Operational and Functional Requirements for the U.S. 6 GHz Band*, (April 2021)

[3] 47 CFR 15, Subpart E, available at https://ecfr.federalregister.gov/current/title-47/chapter-I/subchapter-A/part-15/subpart-E?toc=1

[4] Federal Communications Commission, *In the Matter of Unlicensed Use of the 6 GHz Band and Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz, Report and Order and Further Notice of Proposed Rulemaking*, FCC 20-51 (April 24, 2020), available at https://docs.fcc.gov/public/attachments/FCC-20-51A1.pdf

[5] Recommendation ITU-R F.699-8 (01/2018) Reference radiation patterns for fixed wireless system antennas for use in coordination studies and interference assessment in the frequency range from 100 MHz to 86 GHz, available at https://www.itu.int/rec/R-REC-F.699/en

Appendix A: FCC ULS Licenses Containing Blank, Erroneous, or Conflicting Data

The recommendations provided in this document include references to this appendix. This spreadsheet provides a listing of example FCC ULS licenses that contain blank, erroneous, or conflicting data for licenses with a license status of Active only. This list is meant to be illustrative for the benefit of the FCC but is not complete. The FCC ULS is a regulatory database that tracks license statuses to ensure regulatory transparency and adherence to rules. As such, the ULS also includes other license statuses such as Canceled, Expired, Terminated, and Termination Pending. However, these statuses are not considered in this appendix as it is understood that the AFC Systems do not need to protect systems that are no longer active.