Signaling Protocols and Procedures for 6 GHz Band; AFC System - Standard Power Device Interface Technical Specification

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1 Introduction

This document is the technical specification of signaling protocols and procedures for the interface between the AFC System and Standard Power Access Point (SPAP)/Fixed Client Device (FCD) (collectively referred to as "Standard Power Device" or "SPD") and, where present, between the AFC System and Proxy on behalf of one or more SPDs.

As a prerequisite or foundation, any readers are encouraged to use this technical specification together with "AFC System to AFC Device Interface Technical Specification" produced by Wi-Fi Alliance (hereinafter called "the WFA SDI document") [n.1]. As per WINNF-RC-3006 [n.2], support for the WFA SDI document is non-exclusive and the Wireless Innovation Forum (WInnForum) may endorse additional interfaces for application areas where the WFA SDI document is not an ideal match.

2 Scope

The scope of this technical specification is to specify the signaling protocols and procedures for compliance with the R0, R1 and R2 requirements specified in WINNF-TS-1014 [n.3] when using the WFA SDI document [n.1]. The interface between the Proxy and SPD is outside the scope of this document.

The key words "required", "shall", "shall not", "should", "should not", "recommended", "may", and "optional" in this document are to be interpreted as described in RFC-2119 [n.4]. In addition, the key word "conditional" shall be interpreted to mean that the definition is an absolute requirement of this specification only if the stated condition is met.

3 References

3.1 Normative References

The following referenced documents are necessary for the application of the present document.

[n.1] AFC System to AFC Device Interface Specification v1.3, Wi-Fi Alliance, available at: https://www.wi-fi.org/file/afc-system-to-afc-device-interface-specification

[n.2] WINNF-RC-3006, "Endorsement of Wi-Fi Alliance AFC System to AFC Device Interface Specification", Wireless Innovation Forum

[n.3] WINNF-TS-1014, "Functional Requirements for the 6 GHz Band under Control of the AFC System", Wireless Innovation Forum

[n.4] RFC-2119, "Key words for use in RFCs to Indicate Requirement Levels", March 1997.

[n.5] 3GPP TS 38.101-1, "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone", available at:

https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3283

[n.6] 3GPP TS 38.104, "NR; Base Station (BS) radio transmission and reception", available at: https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3202

3.2 Informative References

The following referenced documents are not necessary for the application of the present document, but they assist the reader with regard to a particular subject area.

Not applicable for this version of this technical specification

4 Definitions and Abbreviations

4.1 Definitions

For the purposes of the present document, the definitions given in [n.3] and the following apply.

Certified FCC ID List: A list of the certified FCC IDs for equipment classes "6SD" (i.e., SPAP) and "6FC" (i.e., FCD).

Channel-Based Query: Query for availability of Channel(s) identified in a manner specific to an air interface.

Disallowed Device List: A list of the disallowed FCC IDs and the disallowed combination of the FCC ID and the device serial number.

Frequency-Based Query: Query for availability of frequency range(s) without specifying a Channel size across which the Standard Power Device will operate.

4.2 Abbreviations

For the purposes of the present document, the abbreviations given in [n.3] and the following apply.

ARFCN	Absolute Radio Frequency Channel Number
CFI	Channel Center Frequency Index
FCD	Fixed Client Device
NR	New Radio
SPAP	Standard Power Access Point
SPD	Standard Power Device

5 Architecture of AFC System – Standard Power Device Interface

5.1 Baseline Architecture

This section provides the interfaces related to the protocols that are defined in this technical specification. The figure below is a subset of the architecture described in [n.1], where SPD may be SPAP or FCD.

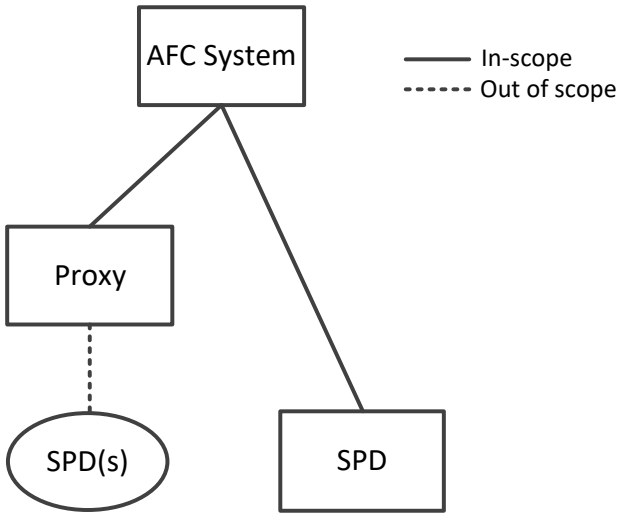

Figure 1: Protocol Interface

6 Compliance with WInnForum 6 GHz Requirements

6.1 General

This section specifies the protocol-specific requirements for compliance with WINNF-TS-1014 [n.3] when using the protocol specified by the WFA SDI document [n.1].

6.2 Device Registration (Mandatory)

6.2.1 *General*

This section provides the protocol-specific requirements for compliance with the device registration requirements specified in WINNF-TS-1014 [n.3] when using the WFA SDI-based protocol. In addition, this section provides clarification for handling of non-zero response code (i.e., the *responseCode* field) in certain situations.

6.2.2 *Protocol-Specific Requirements for Standard Power Devices*

All the registration parameters required by WINNF-TS-1014 [n.3] shall be provided by the SPD or the Proxy on behalf of the SPD to the AFC System by following the format of the *AvailableSpectrumInquiryRequest* object specified in the WFA SDI document [n.1].

6.2.3 *Protocol-Specific Requirements for AFC System*

According to the format of the *AvailableSpectrumInquiryRequest* object specified in the WFA SDI document [n.1], the AFC System shall assess if all the required registration parameters are provided with valid values.

If the field of at least one mandatory parameter is missing, the AFC System shall return the *responseCode* 102 (MISSING_PARAM). The AFC System may additionally include the

supplementalInfo field (data type: object: *SupplementalInfo*) containing the *missingParams* field (data type: array of string) to indicate a list of names of missing parameters.

If the value of at least one parameter does not follow the format or the allowed range of the values according to the definitions specified in the WFA SDI document [n.1], the AFC System shall return the *responseCode* 103 (INVALID_VALUE). The AFC System may additionally include the *supplementalInfo* field containing the *invalidParams* field (data type: array of string) to indicate a list of names of parameters with invalid values.

The AFC System shall return the *responseCode* 106 (UNEXPECTED_PARAM) if the *location* field (data type: object: *Location*) includes two or more fields indicating horizontal area of location uncertainty (i.e., the *ellipse* field, the *linearPolygon* field and the *radialPolygon* field). The AFC System may additionally include the *supplementalInfo* field containing the *unexpectedParams* field (data type: array of string) to indicate a list of names of unexpected parameters.

The AFC System shall return the *responseCode* -1 (GENERAL_ERROR) if one of the following conditions is met.

- The *certificationId* field (data type: array of object: *CertificationId*) does not include the *CertificationId* object representing the FCC ID;
- The *rulesetIds* field (data type: array of string) does not include the string "US_47_CFR_PART_15_SUBPART_E".

The AFC System shall maintain the Certified FCC ID List obtained as per R1-AGR-01-a [n.3]. The AFC System shall return the *responseCode* 103 (INVALID_VALUE) if the value of the *nra* field (data type: string) in the *CertificationId* object is "FCC" but the value of the *id* field in the *CertificationId* object is not included in the Certified FCC ID List.

The AFC System shall maintain the Disallowed Device List as per R1-AGR-05 [n.3]. If the AFC System finds that either the FCC ID or the combination of the FCC ID and the serial number (i.e., the *serialNumber* field) is included in the Disallowed Device List, the AFC System shall return the *responseCode* 101 (DEVICE_DISALLOWED).

6.3 Frequency Availability Query Methods (Mandatory)

6.3.1 *General*

This section provides the protocol-specific requirements for compliance with the frequency availability query requirements specified in WINNF-TS-1014 [n.3] when using the WFA SDI-based protocol [n.1].

6.3.2 *Support of Frequency Availability Query Methods*

WINNF-TS-1014 [n.3] specifies the requirements for the following two methods of frequency availability query:

- Frequency-Based Query (R2-DGR-02-a and R2-AGR-03-a)
- Channel-Based Query (R2-DGR-02-b and R2-AGR-03-b)

For the Frequency-Based Query, this specification leverages the *inquiredFrequencyRange* field (data type: array of object: *FrequencyRange*) in the *AvailableSpectrumInquiryRequest* object and the *availableFrequencyInfo* field (data type: array of object: *AvailableFrequencyInfo*) in the *AvailableSpectrumInquiryResponse* object.

For the Channel-Based Query, this specification leverages the *inquiredChannels* field (data type: array of object: *Channels*) in the *AvailableSpectrumInquiryRequest* object and the *availableChannelInfo* field (data type: array of object: *AvailableChannelInfo*) in the *AvailableSpectrumInquiryResponse* object. Specifically, this specification defines the references to the allowed values of the *globalOperatingClass* field in the *Channels* object for support of air-interface specific channelization, where the allowed values of the *globalOperatingClass* field are defined to be associated with a single Channel bandwidth and a set of the corresponding Channel Center Frequency Indices (CFIs).

NOTE: The WFA SDI document allows vendors to define and use their proprietary references to the allowed values of the *globalOperatingClass* field.

According to R2-AGR-02 [n.3], the AFC System and the SPD can employ either or both of the above methods. If the AFC System finds none of the query methods which the AFC System does support is used by the SPD in the *AvailableSpectrumInquiryRequest* object, the AFC System shall return the *responseCode* 301 (UNSUPPORTED_BASIS) in the *AvailableSpectrumInquiryResponse* object. The AFC System may additionally include the *shortDescription* field (data type: string) to indicate that the failure has been caused by the use of the method unsupported by the AFC System.

NOTE: This failure is caused only when either of the *inquiredFrequencyRange* field and the *inquiredChannels* field is included in the *AvailableSpectrumInquiryRequest* object and the AFC System does not support the query method corresponding to the included field.

6.3.3 *Protocol-Specific Requirements for Frequency-Based Query*

In the *AvailableSpectrumInquiryRequest* object corresponding to the SPD employing the Frequency-Based Query, the *inquiredFrequencyRange* field shall be included. As per R2-DGR-02-a-i [n.3], each of the *FrequencyRange* objects in the *inquiredFrequencyRange* field shall include a frequency range up to one and one-half times the SPD's intended operating Channel bandwidth away from the center frequency of the SPD's intended operating Channel to the extent that such frequencies are within the U-NII-5 and U-NII-7 bands. If the *minDesiredPower* field (data type: number) is included in the *AvailableSpectrumInquiryRequest* object intending only the Frequency-Based Query, the AFC System shall return the *responseCode* 106 (UNEXPECTED_PARAM). If the *inquiredFrequencyRange* field includes the frequency range at least partially outside of the U-NII-5 and U-NII-7 bands, the AFC System shall return the *responseCode* 300 (UNSUPPORTED_SPECTRUM).

The AFC System shall determine the maximum allowed Power Spectral Density (PSD) in dBm/MHz for each 1 MHz interval across the queried frequency range(s) in accordance with all

the protection requirements specified in WINNF-TS-1014 [n.3]. When generating the *AvailableFrequencyInfo* object, the *frequencyRange* field in the *AvailableFrequencyInfo* object shall represent the frequency range across which the determined maximum allowed PSD in dBm/MHz (i.e., the *maxPsd* field in the *AvailableFrequencyInfo* object) for each 1 MHz interval is exactly the same. The value of the *maxPsd* field in the *AvailableFrequencyInfo* object shall not exceed 23 dBm/MHz.

NOTE: 23 dBm is the maximum PSD limit in dBm/MHz of Standard Power Devices specified in CFR 15.407(a)(4).

6.3.4 *Protocol-Specific Requirements for Channel-Based Query*

In the *AvailableSpectrumInquiryRequest* object corresponding to the SPD employing the Channel-Based Query, the *inquiredChannels* field shall be included. In each element (i.e., the *Channels* object) of the *inquiredChannels* field, the SPD shall specify its queried Channel(s) by using the *globalOperatingClass* field and optionally the *channelCfi* field (data type: array of number) to the extent that such Channels are within the U-NII-5 and U-NII-7 bands. The AFC System shall determine the maximum allowed e.i.r.p in dBm (i.e., the *maxEirp* field in the *AvailableChannelInfo* object) for each queried Channel in accordance with all the protection requirements specified in WINNF-TS-1014 [n.3]. If the *channelCfi* field is included in the *Channels* object, the AFC System shall determine the maximum allowed e.i.r.p in dBm as per WINNF-TS-1014 [n.3] for only the Channels corresponding to the *globalOperatingClass* field and the *channelCfi* field. Otherwise, the AFC System shall determine the maximum allowed e.i.r.p in dBm for the Channels corresponding to the *globalOperatingClass* field and all the CFIs defined for the value of the *globalOperatingClass* field to the extent that such Channels are within the U-NII-5 and U-NII-7 bands. If any queried Channel identified by the pair of the *globalOperatingClass* field and the CFI in the *channelCfi* field is at least partially outside of the U-NII-5 and U-NII-7 bands, the AFC System shall return the *responseCode* 300 (UNSUPPORTED_SPECTRUM).

When generating the *AvailableChannelInfo* object, the size of the *channelCfi* field and the *maxEirp* field within the *AvailableChannelInfo* object shall be the same, and the order of the elements of the *maxEirp* field shall be exactly matched to the order of the elements of the *channelCfi* field. If the *minDesiredPower* field was included in the *AvailableSpectrumInquiryRequest* object, the AFC System shall exclude the pairs of the Channel CFI and the maximum allowed e.i.r.p less than the value of the *minDesiredPower* field from the *channelCfi* field and the *maxEirp* field, respectively. Otherwise, the AFC System shall exclude the pairs of the Channel CFI and the maximum allowed e.i.r.p less than its minimum e.i.r.p limit for frequency availability determination from the *channelCfi* field and the *maxEirp* field, respectively.

NOTE: Default value of the minimum e.i.r.p limit for frequency availability determination is 21 dBm according to R0-AGR-01 (CFR 15.407(k)(2)) [n.3]. The AFC System is allowed to set the minimum e.i.r.p limit to the value less than 21 dBm.

In this version of this specification, the following air interface-specific channelization are supported for references to the allowed values of the *globalOperatingClass* field:

- IEEE 802.11 channelization (see the WFA SDI document [n.1])
- 3GPP 6 GHz channelization [n.5][n.6] (i.e., NRU1 feature. See section 6.4.)

Support of any air interface-specific channelization listed above is optional for AFC Systems and SPDs but at least one air-interface specific channelization (one from the above list or reference for other air interface specific channelization defined outside the WInnForum) shall be supported for the Channel-Based Query. If the AFC System supporting the Channel-Based Query does not support the value of the *globalOperatingClass* field specified by the SPD in the *AvailableSpectrumInquiryRequest* object, the AFC System shall return the *responseCode* 103 (INVALID_VALUE).

6.3.5 *Protocol-Specific Requirements Common to All Query Methods*

When generating the *AvailableSpectrumInquiryResponse* object, the AFC System shall set the *availabilityExpireTime* field (data type: string) if and only if the *responseCode* is 0 (SUCCESS). The SPD shall not continue to operate on the obtained available frequencies or Channels exceeding the expiry time indicated by the *availabilityExpireTime* field, except the SPD fails to successfully obtain a new list of available frequencies or Channels at the next timing of the access to the AFC System (see R0-DGR-04 [n.3]).

In the following situations, the SPD shall consider it failed to successfully obtain a new list of available frequencies or Channels and shall follow R0-DGR-04 [n.3].

- The SPD could not reach to the AFC System.
- The SPD has received HTTP response with non-200 HTTP status code.

6.4 3GPP Specific Features (Optional)

6.4.1 *NRU1 Feature*

6.4.1.1 General

This feature enables the SPD and the AFC System to employ 3GPP 6 GHz channelization [n.5] [n.6] for the Channel-Based Query.

6.4.1.2 Feature Dependencies and Interworking

The support of this feature requires the SPD and the AFC System to support the Channel-Based Query (see section 6.3.4).

6.4.1.3 Description

In this specification, the Channel CFI values (the *channelCfi* field) for 3GPP 6 GHz Channels are equivalent to the NR Absolute Radio Frequency Channel Numbers (NR-ARFCNs) of the band n48 specified in 3GPP TS 38.101-1 [n.5] and TS 38.104 [n.6]. Annex A of this specification

provides the reference table for the mapping among the allowed global operating classes, a single Channel bandwidth and a set of the corresponding Channel CFIs.

For the purpose of determining the maximum allowed e.i.r.p of a queried 3GPP 6 GHz Channel, the AFC System shall derive the center, the lower and the upper frequencies of the queried 3GPP 6 GHz Channel by using the following formulas:

$$F_{c,\,GOC}(n) = 3000 + 15 \cdot \frac{CFI_{GOC}(n) - 600000}{1000}$$

$$F_{lower,\,GOC}(n) = F_{c,\,GOC}(n) - BW_{GOC}/2$$

$$F_{upper,\,GOC}(n) = F_{c,\,GOC}(n) + BW_{GOC}/2$$

where:

- $CFI_{GOC}(n)$: The n-th Channel CFI corresponding to the queried global operating class (the *globalOperatingClass* field)
- $F_{c,\,GOC}(n)$: The center frequency (in MHz) of the 3GPP 6 GHz Channel corresponding to $CFI_{GOC}(n)$
- $F_{lower,\,GOC}(n)$: The lower frequency (in MHz) of the 3GPP 6 GHz Channel corresponding to $CFI_{GOC}(n)$
- $F_{upper,\,GOC}(n)$: The upper frequency (in MHz) of the 3GPP 6 GHz Channel corresponding to $CFI_{GOC}(n)$
- BW_{GOC}: The Channel bandwidth (in MHz) corresponding to the queried global operating class (the *globalOperatingClass* field)

Annex A (Normative) Extensions to Global Operating Classes and CFI for 3GPP 6 GHz Channelization

This annex provides the extensions to global operating class and CFI for 3GPP 6 GHz channelization. Table 1 shows the mapping among the 3GPP 6 GHz global operating classes, Channel bandwidth and Channel CFIs.

NOTE: The CFIs values which results in the Channel at least partially outside of U-NII-5 and U-NII-7 bands are marked with asterisk (*).

Table 1: Mapping among the global operating classes, channel bandwidth and CFIs for 3GPP 6 GHz channelization

Global Operating Class	Channel Bandwidth (MHz)	Channel CFIs
300	20	797000, 798332, 799668, 801000, 802332, 803668, 805000, 806332, 807668, 809000, 810332, 811668, 813000, 814332, 815668, 817000, 818332, 819668, 821000, 822332, 823668, 825000, 826332, 827668(*), 829000(*), 830332(*), 831668(*), 833000(*), 834332(*), 835668, 837000, 838332, 839668, 841000, 842332, 843668, 845000, 846332, 847668, 849000, 850332, 851668, 853000, 854332, 855668, 857000, 858332(*), 859668(*), 861000(*), 862332(*), 863668(*), 865000(*), 866332(*), 867668(*), 869000(*), 870332(*), 871668(*), 873000(*), 874332(*)
301	40	797668, 800332, 803000, 805668, 808332, 811000, 813668, 816332, 819000, 821668, 824332, 827000, 829668(*), 832332(*), 835000(*), 837668, 840332, 843000, 845668, 848332, 851000, 853668, 856332, 859000(*), 861668(*), 864332(*), 867000(*), 869668(*), 872332(*)
302	60	798332, 799668, 803668, 805000, 809000, 810332, 814332, 815668, 819668, 821000, 825000, 826332, 830332(*), 831668(*), 835668(*), 837000, 841000, 842332, 846332, 847668, 851668, 853000, 857000(*), 858332(*), 862332(*), 863668(*), 867668(*), 869000(*), 873000(*)
303	80	799000, 804332, 809668, 815000, 820332, 825668, 831000(*), 836332(*), 841668, 847000, 852332, 857668(*), 863000(*), 868332(*)

Global Operating Class	Channel Bandwidth (MHz)	Channel CFIs
304	100	799668, 803668, 810332, 814332, 821000, 825000, 831668(*), 835668(*), 842332, 846332, 853000, 857000(*), 863668(*), 867668(*), 869000(*), 870332(*), 871668(*)
305-306	Reserved	

Annex B (Informative): Revision History

Document History		
V1.0.0	1 September 2022	Initial Release
V1.1.0)	12 January 2023	Implemented: ▪ WINNF-22-I-00116-CR NR-U 100 MHz ▪ WINNF-22-I-00124-r1 Architecture Section for TS-3007