



AFC System to AFC Device Interface Specification Version 1.0

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1 Introduction

This document is the technical specification for Wi-Fi Alliance AFC System to AFC Device Interface, which defines a messaging protocol and transport for the interface between an AFC System and an AFC Device. This specification defines the architecture, protocols, and functionality for entities that support AFC System to AFC Device Interface. AFC Devices that might support this interface include, for example, Standard Power Access Points, proxies of Standard Power Access Points, and Fixed Client Devices.

1.1 References

Knowledge of the documents listed in this section is required for understanding this specification. If a reference includes a date or a version identifier, only that specific version of the document is required. If the listing includes neither a date nor a version identifier, then the latest version of the document is required. In the event of a conflict between this specification and the following referenced documents, the contents of this specification take precedence.

- [1] IETF RFC-2616, "Hypertext Transfer Protocol -- HTTP/1.1", June 1999.
- [2] NGA.STND.0036_1.0.0_WGS84 (Version 1.0.0 - July 8, 2014): Department of Defense (DoD) World Geodetic System (WGS) 1984.
- [3] IETF RFC-8259, "The JavaScript Object Notation (JSON) Data Interchange Format", December 2017.
- [4] FCC 20-51, "Report and Order and Further Notice of Proposed Rulemaking," ET Docket 18-295 Unlicensed Use of the 6 GHz Band, April 24, 2020.
- [5] IEEE P802.11ax/D8.0, "IEEE Draft Standard for Information Technology -- Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks" -- Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment Enhancements for High Efficiency WLAN, Nov 2020.
- [6] IETF RFC-5246, "The Transport Layer Security (TLS) Protocol Version 1.2", August 2008.
- [7] IETF RFC-8446, "The Transport Layer Security (TLS) Protocol Version 1.3", August 2018.
- [8] IETF RFC-3647, "Internet X.509 Public Key Infrastructure Certificate Policy and Certification Practices Framework", November 2003.

1.2 Definitions and acronyms

1.2.1 Shall/should/may/might word usage

The words shall, should, and may are used intentionally throughout this document to identify the requirements for the AFC Interface Technical program. The words can and might shall not be used to define requirements.

The word *shall* indicates a mandatory requirement. All mandatory requirements must be implemented to assure interoperability with other AFC Interface Technical products.

The word *should* denotes a recommended approach or action.

The word *may* indicates a permitted approach or action with no implied preference.

The words *might* and *can* indicate a possibility or suggestion.

1.2.2 Conventions

The word *ignored* shall be used to describe bits, bytes, fields or parameters whose values are not verified by the recipient.

The word *reserved* shall be used to describe objects (bits, bytes, or fields or their assigned values) whose usage and interpretation will be defined in the future by this specification or by other specifications/bulletins. A reserved object shall be set to zero unless otherwise stated. The recipient of a reserved object shall ignore its value unless that object becomes defined at a later date. The sender of an object defined by this specification shall not use a reserved code value.

1.2.3 Abbreviations and acronyms

Table 1 defines the abbreviations and acronyms used throughout this document. Some are commonly used in publications and standards defining the operation of wireless local area networks, while others have been generated by Wi-Fi Alliance.

Table 1. Abbreviations and Acronyms

Acronyms	Definition
AFC	Automated Frequency Coordination
AGL	Above Ground Level
AP	Access Point
EIRP	Equivalent Isotropically Radiated Power (in units of dBm)
HTTP	Hypertext Transfer Protocol
HTTPS	HTTP plus TLS
JSON	JavaScript Object Notation
NRA	National Regulatory Authority
PSD	Power Spectral Density
TLS	Transport Layer Security
URL	Uniform Resource Locator

1.2.4 Regulatory Definitions

The terms defined by National Regulatory Authorities are described in this section.

The terms defined by the FCC [4] described in Table 2 are used in this document.

Table 2. FCC Definitions

Term	Definition
Access Point (AP)	A U-NII transceiver that operates either as a bridge in a peer-to-peer connection or as a connector between the wired and wireless segments of the network. NOTE: For the purpose of this document, the terms "Access Point" or "AP" refer to those operating in the AFC-required bands (i.e., 5.925-6.425 GHz and 6.525-6.875 GHz bands). AFC-required bands are subject to the adopted rules.
Automated Frequency Coordination (AFC) System	A system that automatically determines and provides lists of which frequencies are available for use by access points operating in the 5.925-6.425 GHz and 6.525-6.875 GHz bands.
Client Device	A U-NII device whose transmissions are generally under the control of an access point and that is not capable of initiating a network.
Fixed Client Device	A client device intended as customer premise equipment that is permanently attached to a structure, operates only on channels provided by an AFC, has a geolocation capability, and complies with antenna pointing angle requirements.

1.2.5 AFC System to AFC Device Interface Definitions

The definitions in Table 3 are applicable to this specification.

Table 3. Definitions

Term	Definition
AFC Device	Generic name of entities accessing an AFC System. NOTE: As defined in this section, such entity includes Standalone AP and Proxy representing one or more Non-Standalone APs, and Fixed Client Devices.
AFC URL	The Uniform Resource Locator address used by AFC Devices to communicate with an AFC System
Available Spectrum	A radio frequency range in which a Standalone AP, Non-Standalone AP, or Fixed Client Device can operate at its location without causing harmful interference to incumbent radio systems.
Channel Center Frequency Index	Based on Annex E of [5], the channel number from either the channel set column or the channel center frequency index column in Table E-4, which can be used to calculate the channel's center frequency.
Non-Standalone AP	A Standard Power Access Point which does not communicate with the AFC System directly and operates based on the information of Available Spectrum provided by the AFC System via the Proxy.
Proxy	An entity engaging in communications with the AFC System on behalf of one or more Non-Standalone APs.
Regulatory Database	A database server that is managed by an NRA and that maintains the information necessary for the calculation of Available Spectrum.
Standalone AP	A Standard Power Access Point which communicates with the AFC System directly and operates based on the information of Available Spectrum provided by the AFC System.
Global Operating Class	Operating class as used in Table E-4 of Annex E of [5]

2 Architecture

This document defines the signaling protocols for the interface shown in blue in the reference architecture in Figure 1. This architecture diagram shows three examples of AFC Devices: a Proxy, a Standalone AP, and a Fixed Client Device. Note that a Proxy engages in communications with the AFC System on behalf of one or more Non-Standalone APs.

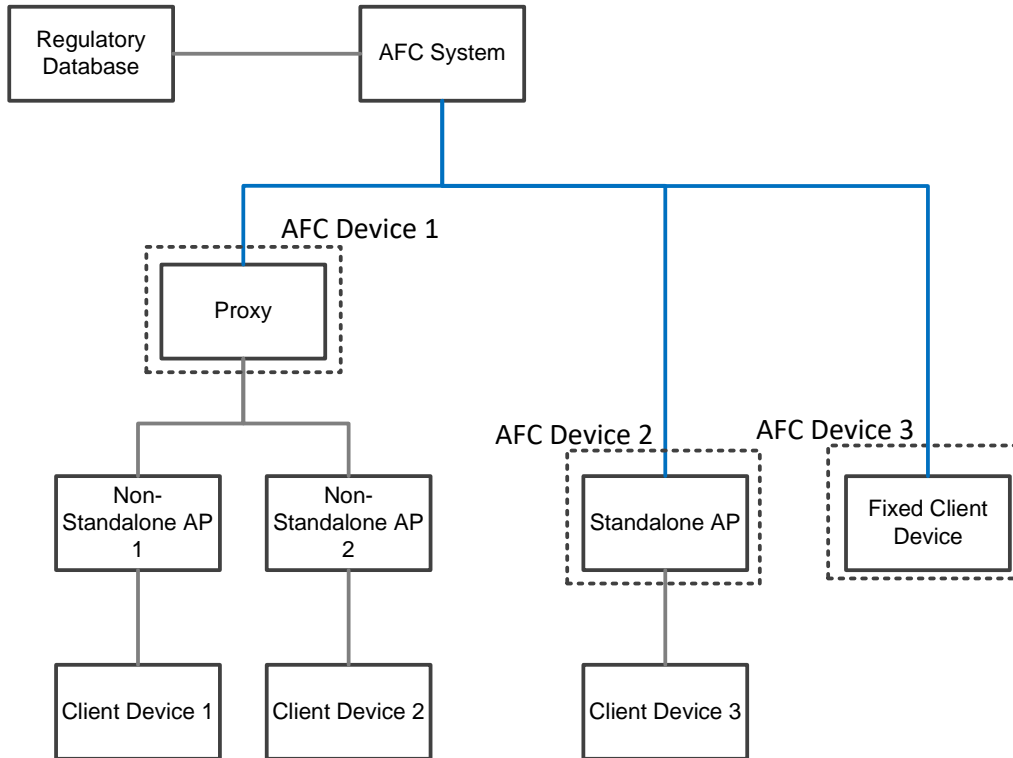


Figure 1. Reference Architecture of AFC System

3 Message encoding and transport

3.1 General

All the messages specified in this document are JSON objects and shall be transported by using HTTPS (HTTP plus TLS) as specified in this section.

3.2 JavaScript Object Notation (JSON)

All the messages shall be generated by using JSON [3].

NOTE - Unicode characters are used and have a default encoding of UTF-8.

A message shall contain one JSON object, which is either a Request message, Response message or a Standalone Vendor Extension as defined in this clause. When an AFC Device sends a message to the AFC System, one or more requests may be aggregated together in the array of Requests contained in the Request message. In response to this request, the AFC System shall include the same number of responses aggregated in the array of Responses in the Response message sent to the requesting AFC Device.

A field value of JSON object may be one of the JSON data types: string, number, boolean, object, or an array of one of those types. If a field is an object, a name for the object is given and a separate table describes fields in the object. An AFC System and AFC Device shall ignore any unknown field within the JSON object. When an optional field is not used, it shall be omitted. See also section 4 for more details.

3.3 AFC URL

All the messages specified in this document shall be transported between an AFC Device and an AFC System located at an AFC URL. An AFC URL has the following format:

Format: \$BASE_URL/\$METHOD

- \$BASE_URL consists of at least the AFC System host name and may include one or more additional paths.
- \$METHOD corresponds to a pair of a request and a response message defined in section 4. AFC method names are listed in Table 4 Vendor(s) may define additional path(s) following \$METHOD if \$METHOD is equal to vendorExtensions.

Table 4. AFC Methods

\$METHOD	Request message	Response message
availableSpectrumInquiry	Available Spectrum Inquiry Request message	Available Spectrum Inquiry Response message
vendorExtensions	Standalone Vendor Extension message optionally defined by vendor(s). Vendor specific version if it exists, may be indicated in this message.	

An Available Spectrum Inquiry Request message is sent by an AFC Device to an AFC System for retrieval of Available Spectrum information, and an Available Spectrum Inquiry Response message is sent by an AFC System responding to the Available Spectrum Inquiry Request message sent by the AFC Device.

Support for vendor extensions is optional, and the format is defined by the vendor. Such definitions are outside the scope of this document.

3.4 HTTPS

3.4.1 HTTP

HTTP version number shall be 1.1 as specified in [1], or a later version.

The HTTP POST method shall be used for all requests from the AFC Device to the AFC System.

HTTP request message shall include at least the following headers:

- host: <AFC System host name included in \$BASE_URL>
- contentType: application/json

HTTP response message shall include at least the following headers:

- Date: <AFC System time, upon which all AFC System to AFC Device interface timers are based>

AFC shall respond with HTTP status code 404 (NOT FOUND) if it finds that invalid method is specified in the URL.

AFC shall respond with HTTP status code 400 (BAD REQUEST) if any of the following are true:

- HTTP request header does not include required header fields specified in this section;
- HTTP Payload contains neither an AvailableSpectrumInquiryRequestMessage nor a StandaloneVendorExtension object.

3.4.2 TLS

TLS shall be performed for AFC authentication by the AFC Device, prior to any communication. TLS-v1.2 as specified in [6] or newer versions of TLS (e.g., as specified in [7]) shall be used to perform authentication. Older versions of TLS shall not be used.

During the TLS message exchange, the AFC Device shall authenticate an AFC System according to the procedures defined in [8]. An AFC Device that is unable to successfully authenticate an AFC System shall abort the TLS connection establishment procedure.

Subsequent to successful authentication, the AFC Device and AFC System shall negotiate a ciphersuite to use for encrypting all communications between the two entities. The AFC Device and the AFC System shall both support at least the following ciphersuites:

- TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
- TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

Stronger ciphersuites may be negotiated and used if both sides support them.

An AFC Device which is unable to successfully setup such an encrypted connection with an AFC System shall abort the TLS connection establishment procedure.

4 Message payload and Parameter Definitions

4.1 General

4.1.1 Parameter Presence

Presence of a parameter field is defined by using the following indicators:

- Required (R): The field shall always be included within the object it belongs to.
- Conditionally-Required (CR): The field shall be included within the object it belongs to if the specified condition is met.
- Conditionally-Optional (CO): The field may be included within the object it belongs to if and only if the specified condition is met.
- Optional (O): The field may be included within the object it belongs to, anytime.

4.1.2 JSON Data Types

This document uses three primitive JSON types (respectively, string, number and boolean) and two structured types (JSON object and array) as defined in RFC-8259 [3].

4.2 Message Payloads for Available Spectrum Inquiry

4.2.1 Available Spectrum Inquiry Request message

The HTTP Payload of Available Spectrum Inquiry Request message is represented by AvailableSpectrumInquiryRequestMessage object defined in Table 5.

Table 5. AvailableSpectrumInquiryRequestMessage object

Fields	Presence	Descriptions
NAME: version DATA TYPE: string	R	The version number of the AvailableSpectrumInquiryRequest. The string shall be parsed as two non-negative integers separated by a decimal point, for example, n.m. The integer value to the left of the decimal point (n) is the major version number, and the integer value to the right of the decimal point (m) is the minor version number.
NAME: availableSpectrumInquiryRequests DATA TYPE: array of object: AvailableSpectrumInquiryRequest	R	This field represents Available Spectrum Inquiry Request for one or more APs or Fixed Client Devices. (4.2.1.1)
NAME: vendorExtensions DATA TYPE: array of object: VendorExtension	O	This field contains optional vendor extensions. (4.2.2.5)

4.2.1.1 AvailableSpectrumInquiryRequest object

The AFC System can determine Available Spectrum based on PSD across a range of frequencies, or based on EIRP for a list of Channels, or both. The AvailableSpectrumInquiryRequest object shown in Table 6 includes at least one of inquiredFrequencyRange or inquiredChannels objects.

If inquiredFrequencyRange is specified, the request is for a spectrum availability response provided by the AFC System on the basis of frequency. If inquiredChannels is specified, the request is for a spectrum availability response provided on the basis of channels. If both inquiredFrequencyRange and inquiredChannels are specified, the request is for a spectrum availability response provided by the AFC System both on the basis of frequency, and on the basis of channels.

Table 6. AvailableSpectrumInquiryRequest object

Fields	Presence	Descriptions
NAME: requestId DATA TYPE: string	R	Unique ID to identify an instance of an Available Spectrum Inquiry request. The value shall be unique within the request message. See example in Appendix A
NAME: deviceDescriptor DATA TYPE: object: DeviceDescriptor	R	This field contains the information of an AP or Fixed Client Device. (4.2.1.2)
NAME: location DATA TYPE: object: Location	R	This field describes the geographic area within which the AP or Fixed Client Device is located, including location uncertainty. (4.2.1.3)
NAME: inquiredFrequencyRange DATA TYPE: array of object: FrequencyRange	CR	This field contains one or more frequency ranges for which the AP or Fixed Client Device is requesting spectrum availability. One or both of inquiredFrequencyRange and inquiredChannels shall be present. If inquiredFrequencyRange is present, it indicates that the AFC System is to provide spectrum availability on the basis of frequency. (4.2.1.9)
NAME: inquiredChannels DATA TYPE: array of object: Channels	CR	This field contains one or more lists of channels for which the AP or Fixed Client Device is requesting spectrum availability. One or both of inquiredFrequencyRange and inquiredChannels shall be present. If inquiredChannels is present, it indicates that the AFC System is to provide spectrum availability on the basis of channels. (4.2.1.10)
NAME: minDesiredPower DATA TYPE: number	O	This field contains the minimum desired EIRP in units of dBm. This field is optionally present in a query by inquiredChannels; otherwise it is absent. If a query by inquiredChannels is performed and this field is absent, the AFC is to provide a response for all inquiredChannels.
NAME: vendorExtensions DATA TYPE: array of object: VendorExtension	O	This field contains optional vendor extensions. (4.2.2.5)

4.2.1.2 DeviceDescriptor object

The DeviceDescriptor object fields are defined in Table 7.

Table 7. DeviceDescriptor object

Fields	Presence	Descriptions
NAME: serialNumber DATA TYPE: string	R	This field contains the device serial number of an AP or Fixed Client Device. See example in Appendix A
NAME: certificationId DATA TYPE: string	R	This field contains the certification ID of an AP or Fixed Client Device. For the US, this is the FCC ID of the AP or Fixed Client Device.
NAME: ruleSetIds DATA TYPE: array of string	R	This field contains the identifiers of the regulatory rules supported by an AP or Fixed Client Device. Acceptable values are: <ul style="list-style-type: none"> 47_CFR_PART_15_SUBPART_E Allowed field values depend on the rules of each National Regulatory Authority.

4.2.1.3 Location object

The Location object fields are defined in Table 8.

Table 8. Location object

Fields	Presence	Descriptions
NAME: ellipse DATA TYPE: object: Ellipse	CR	Description of the geographic area within which the AP or Fixed Client Device may operate, including location uncertainty, described as an ellipse defined by the geographic coordinate of its center and the lengths of its major and minor semi-axes (4.2.1.4). This field shall not be included if either linearPolygon field or radialPolygon field is included in this object. If neither linearPolygon field nor radialPolygon field is included in this object, this field shall be included.
NAME: linearPolygon DATA TYPE: object: LinearPolygon	CR	Description of the geographic area within which the AP or Fixed Client Device is located, including location uncertainty, described as a polygon defined by an array of the geographic coordinates of its vertices (4.2.1.5). This field shall not be included if either ellipse field or radialPolygon field is included in this object. If neither ellipse field nor radialPolygon field is included in this object, this field shall be included.
NAME: radialPolygon DATA TYPE: object: RadialPolygon	CR	Description of the geographic area within which the AP or Fixed Client Device is located, including location uncertainty, described as a polygon defined by its center and an array of vectors (4.2.1.6). This field shall not be included if either ellipse field or linearPolygon field is included in this object. If neither ellipse field nor linearPolygon field is included in this object, this field shall be included.
NAME: height DATA TYPE: number	R	This field represents the height of the AP or Fixed Client Device antenna in meters Above Ground Level (AGL), as measured relative to local ground level.
NAME: verticalUncertainty DATA TYPE: number	R	This field indicates the vertical distance above and below the value of the height field within which the AP or Fixed Client Device is located. This value is a positive integer in meters.
NAME: indoorDeployment DATA TYPE: number	O	This field indicates whether the deployment of the AP or Fixed Client Device is located indoors, outdoor, or is unknown <ul style="list-style-type: none"> • 0: unknown. • 1: indoor. • 2: outdoor.

4.2.1.4 Ellipse object

The Ellipse object fields are defined in Table 9.

Table 9. Ellipse object

Fields	Presence	Descriptions
NAME: center DATA TYPE: object: Point	R	This field represents the geographic coordinates of the center point of an ellipse within which the AP or Fixed Client Device is located.
NAME: majorAxis DATA TYPE: number	R	This field represents the length of the major semi axis of an ellipse within which the AP or Fixed Client Device is located. The value is a positive integer in meters.
NAME: minorAxis DATA TYPE: number	R	This field represents the length of the minor semi axis of an ellipse within which the AP or Fixed Client Device is located. The value is a positive integer in meters.
NAME: orientation DATA TYPE: number	R	This field represents the orientation of the majorAxis field in decimal degrees, measured clockwise from True North. The allowed range is from 0 to 180.

4.2.1.5 LinearPolygon object

The LinearPolygon object fields are described in Table 10.

Table 10. LinearPolygon object

Fields	Presence	Descriptions
NAME: outerBoundary DATA TYPE: array of object: Point	R	This field represents the vertices of a polygon within which the AP or Fixed Client Device is located. At least three and no more than 15 unique vertices may be used to define the polygon. Connecting lines between successive vertices may not cross any other connecting lines between successive vertices. The distance between successive vertices should not exceed 130 km.

4.2.1.6 RadialPolygon object

The RadialPolygon object fields are described in Table 11.

Table 11. RadialPolygon object

Fields	Presence	Descriptions
NAME: center DATA TYPE: object: Point	R	This field represents the geographic coordinates of the center point of a polygon within which the AP or Fixed Client Device is located.
NAME: outerBoundary DATA TYPE: array of object: Vector	R	This field represents the vertices of a polygon within which the AP or Fixed Client Device is located. At least three and no more than 15 unique vertices may be used to define the polygon. Connecting lines between successive vertices may not cross any other connecting lines between successive vertices. The distance between successive vertices should not exceed 130 km.

4.2.1.7 Point object

The Point object fields are described in Table 12.

Table 12. Point object

Fields	Presence	Descriptions
NAME: longitude DATA TYPE: number	R	This field represents longitude of the AP or Fixed Client Device location in decimal degrees. The AFC System shall assume values in this field to have 6 decimal places of precision and shall treat the Point object as a mathematical point with no dimensional attributes. The precision to which this value is specified shall not be interpreted as an indication of location uncertainty. The allowed range is from -180 to +180. Positive values represent longitudes east of the prime meridian; negative values west of the prime meridian. The value shall be relative to the WGS 84 datum [2].
NAME: latitude DATA TYPE: number	R	This field represents latitude of the AP or Fixed Client Device location in decimal degrees. The AFC System shall assume values in this field to have 6 decimal places of precision and shall treat the

		<p>Point object as a mathematical point with no dimensional attributes. The precision to which this value is specified shall not be interpreted as an indication of location uncertainty.</p> <p>The allowed range is from -90 to +90. Positive values represent latitudes north of the equator; negative values south of the equator. The value shall be relative to the WGS 84 datum [2].</p>
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4.2.1.8 Vector object

The Vector object fields are described in Table 13.

Table 13. Vector object

Fields	Presence	Descriptions
NAME: length DATA TYPE: number	R	This field represents a distance in meters from a specified Point object.
NAME: angle DATA TYPE: number	R	This field represents the direction of a vector in decimal degrees, measured clockwise from True North. The allowed range is from 0 to 360.

4.2.1.9 FrequencyRange object

The FrequencyRange object fields are described in Table 14.

Table 14. FrequencyRange object

Fields	Presence	Descriptions
NAME: lowFrequency DATA TYPE: number	R	This field represents the lowest frequency of the frequency range in MHz. The value shall be an integer.
NAME: highFrequency DATA TYPE: number	R	This field represents the highest frequency of the frequency range in MHz. The value shall be an integer.

4.2.1.10 Channels object

The Channels object fields are described in Table 15.

Table 15. Channels object

Fields	Presence	Descriptions
NAME: globalOperatingClass DATA TYPE: number	R	This field is the global operating class used to define the channel center frequency indices (see Annex E of [5]) and operating bandwidth.
NAME: channelCfi DATA TYPE: array of number	O	This field is the list of channel center frequency indices for which spectrum availability is being queried. If no value is provided, the request is for spectrum availability for all center frequency indices for the given globalOperatingClass for channels that are entirely contained within the bands being coordinated by AFC System.

4.2.2 Available Spectrum Inquiry Response message

The HTTP Payload of Available Spectrum Inquiry Response message is represented by AvailableSpectrumInquiryResponseMessage object defined in Table 16.

Table 16. AvailableSpectrumInquiryResponseMessage object

Fields	Presence	Descriptions
NAME: version DATA TYPE: string	R	The version number of the AvailableSpectrumInquiryRequest. The string shall be parsed as two non-negative integers separated by a decimal point, for example, n.m. The integer value to the left of the decimal point (n) is the major version number, and the integer value to the right of the decimal point (m) is the minor version number.
NAME: availableSpectrumInquiryResponses DATA TYPE: array of object: AvailableSpectrumInquiryResponse	R	This field contains Available Spectrum Inquiry Responses for one or more APs or Fixed Client Devices.
NAME: vendorExtensions DATA TYPE: array of object: VendorExtension	O	This field contains optional vendor extensions. (4.2.2.5)

4.2.2.1 AvailableSpectrumInquiryResponse object

The AvailableSpectrumInquiryResponse object fields are described in Table 17.

Table 17. AvailableSpectrumInquiryResponse object

Fields	Presence	Descriptions
NAME: requestId DATA TYPE: string	R	Unique ID to identify an instance of an Available Spectrum Inquiry request. The value shall be same as provided in the corresponding AvailableSpectrumInquiryRequest object.
NAME: availableFrequencyInfo DATA TYPE: array of object: AvailableFrequencyInfo	CR	This field contains the maximum EIRP levels for each of the requested frequency ranges. This field shall be included if and only if availability was requested on a frequency basis and the Response Code definitions indicates SUCCESS. (4.2.2.2)
NAME: availableChannelInfo DATA TYPE: array of object: AvailableChannelInfo	CR	This field contains zero or more available channels and their corresponding maximum EIRP levels. (4.2.2.3) This field shall be included if and only if availability was requested on a channel basis and the Response Code definitions indicated SUCCESS. NOTE - If the array size is zero, it indicates that none of the requested channels are available for the AP or Fixed Client Device at or above the requested minimum power.
NAME: availabilityExpireTime DATA TYPE: string	CR	This field contains the time when the spectrum availability specified in the response expires. This field shall be included if and only if the Response Code definitions indicates SUCCESS. The string value shall be represented with UTC and conformant with the following format: FORMAT: YYYY-MM-DDThh:mm:ssZ
NAME: response DATA TYPE: object: Response	R	This field contains information on the outcome of the Available Spectrum Inquiry. (4.2.2.4)
NAME: vendorExtensions DATA TYPE: array of object: VendorExtension	O	This field contains optional vendor extensions. (4.2.2.5)

NOTE - If both inquiredFrequencyRange and inquiredChannels are present in the request, both availableFrequencyInfo and availableChannelInfo are present in an AvailableSpectrumInquiryResponse object that indicates SUCCESS. The object provides spectrum availability determined on the basis of frequency, and separately, on the basis of channels.

4.2.2.2 AvailableFrequencyInfo object

The AvailableFrequencyInfo object fields are described in Table 18.

Table 18. AvailableFrequencyInfo object

Fields	Presence	Descriptions
NAME: frequencyRange DATA TYPE: object: FrequencyRange	R	This field contains a frequency range of the available spectrum. (4.2.1.9)
NAME: maxPsd DATA TYPE: number	R	This field contains the maximum permissible EIRP available in any one MHz bin within the frequency range specified by the frequencyRange object. The limit is expressed as a power spectral density with units of dBm per MHz. See example in Appendix A

4.2.2.3 AvailableChannelInfo object

Table 19. AvailableChannelInfo object

Fields	Presence	Descriptions
NAME: globalOperatingClass DATA TYPE: number	R	This field is the global operating class used to define the channel center frequency indices (see Annex E of [5]) and operating bandwidth.
NAME: channelCfi DATA TYPE: array of number	R	This field is the list of channel center frequency indices which are available for use at an EIRP greater than or equal to minDesiredPower, in units of dBm as specified in the request.
NAME: maxEirp DATA TYPE: array of number	R	This field is the maximum permissible EIRP in units of dBm available for each of the channels specified in the channelCfi list, in the same order. In addition, in any portion of the channel, the conducted PSD plus the maximum antenna gain cannot exceed the maxEirp divided by the channel width defined by the globalOperatingClass.

4.2.2.4 Response object

Table 20. Response object

Fields	Presence	Descriptions
NAME: responseCode DATA TYPE: number	R	This field contains the type of the response. The value shall be integer and allowed values are shown in Table 23.
NAME: shortDescription DATA TYPE: string	O	This field contains a short description related to the result indicated by the responseCode field. The value may be a human-readable string. (Table 23)
NAME: supplementalInfo DATA TYPE: object: SupplementalInfo	O	This field contains supplemental information that can help resolve failures. (Table 24)

4.2.2.5 VendorExtension object

Table 21. VendorExtension object

Fields	Presence	Descriptions
NAME: extensionId DATA TYPE: string	R	This field identifies the vendor and field type of a vendor extension. The format and content of the extensionId field is defined by the vendor.
NAME: parameters DATA TYPE: any	R	This field (4.3) contains the payload as specified by the vendor extension identified by the extensionId field. It may be defined using any JSON primitive or structured data type as described in section 4.1.2.

4.3 Message Payload for Standalone Vendor Extensions

Vendor extension messaging may be supported in standalone mode, apart from a spectrum inquiry request or response. The high-level format is generic and supports communications in AFC-System-to-AFC-Device and AFC-Device-to-AFC-System directions, as defined by the vendor. Vendor extension messaging is optional, but if used, certain fields may be required by the vendor.

4.3.1 Standalone Vendor Extension

The Standalone Vendor Extension message is a free-formatted message generated by using at least StandaloneVendorExtension object as defined in Table 22.

Table 22. StandaloneVendorExtension object

Fields	Presence	Descriptions
NAME: vendorExtensions DATA TYPE: array of object: VendorExtension	R	This field contains vendor extensions. (4.2.2.5)

4.4 Standard Response Code definitions

Table 23 defines the Response Code values. Response Codes -1 and 0 are mandatory and shall be supported by all AFC Systems and AFC Devices. Response Codes provided in ranges 100-199 and 300-399 are optional.

NOTE - Additional vendor-specific Response Codes may be supported, but their definition is outside the scope of this document.

Response Codes are defined as follows:

- -1: General Failure
- 0: SUCCESS
- 100 – 199: General errors related to the protocol
- 300 – 399: Error events specific to message exchanges for the Available Spectrum Inquiry

Supplemental vendor specific extension Response Codes are outside the scope of this document and are expected to be handled inside of the Vendor Specific Extension construct (4.3.1 Standalone Vendor Extension).

Table 23. Response Code definitions

Response Code value	Presence	Description	
-1	R	Name:	GENERAL FAILURE
		Interpretation	Non-specified failure
		Other Information:	

Response Code value	Presence	Description	
0	R	Name:	SUCCESS
		Interpretation:	The request is approved by the AFC System.
		Other Information:	None
100	O	Name:	VERSION_NOT_SUPPORTED
		Interpretation:	Incompatible interface version number. The AFC System and/or the AFC Device do not support the indicated interface version.
		Other Information:	The communication can be attempted again using a different version number. In the case of an AFC Device attempting to communicate with an AFC System, communications with the same version, but a different AFC System, could be attempted.
101	O	Name:	DEVICE_DISALLOWED
		Interpretation:	This specific device as identified by the combination of its FCC ID and unique manufacturer's serial number is not allowed to operate under AFC System control due to regulatory action or other action.
		Other Information:	None
102	O	Name:	MISSING_PARAM
		Interpretation:	One or more fields required to be included in the request are missing.
		Other Information:	The supplementalInfo field shall carry a list of missing parameter names.
103	O	Name:	INVALID_VALUE
		Interpretation:	One or more fields have an invalid value.
		Other Information:	The supplementalInfo field shall carry a list of the names of the fields set to invalid value.
106	O	Name:	UNEXPECTED_PARAM
		Interpretation:	Unknown parameter found, or conditional parameter found, but condition is not met.
		Other Information:	The supplementalInfo field shall carry a list of unexpected parameter names.
300	O	Name:	UNSUPPORTED_SPECTRUM
		Interpretation:	The frequency range indicated in the Available Spectrum Inquiry Request message is at least partially outside of the frequency band under the management of the AFC System (e.g., 5.925-6.425 GHz and 6.525-6.875 GHz bands in the US).
		Other Information:	None

Table 24 defines the SupplementalInfo object, which may be attached to some responseCode values.

Table 24. SupplementalInfo object definitions

Fields	Presence	Descriptions
NAME: missingParams DATA TYPE: array of string	CR	This field contains a list of names of missing parameter(s). This field shall be included if and only if the response code indicates MISSING_PARAM.
NAME: invalidParams DATA TYPE: array of string	CR	This field contains a list of names of parameters with invalid values. This field shall be included if and only if the response code indicates INVALID_VALUE.
NAME: unexpectedParams DATA TYPE: array of string	CR	This field contains a list of names of unexpected parameters. This field shall be included if and only if the response code indicates UNEXPECTED_PARAM.

Appendix A (Informative) Message Examples

A.1 Example of HTTP Payload of Available Spectrum Inquiry Request message and corresponding Available Spectrum Inquiry Response message

The following JSON object is an example of an Available Spectrum Request message for an AP. The AP inquires regarding spectrum availability on both a frequency and channel basis.

In this example request scenario, the AP queries spectrum availability on a frequency basis throughout U-NII 5. It also requests channel availability for all 80 MHz channels in U-NII 5 & 7, and for 160 MHz channels in U-NII 5 only.

```
{
  "version" : "1.0",
  "availableSpectrumInquiryRequests":
  [
    {
      "requestId": "11235813",
      "deviceDescriptor":
      {
        "serialNumber": "ABCDEFGH",
        "certificationId": "EFGHIJK",
        "rulesetId": "47_CFR_PART_15_SUBPART_E"
      },
      "location":
      {
        "ellipse":
        {
          "center":
          {
            "longitude": 37.425056,
            "latitude": -122.984157
          },
          "majorAxis": 100,
          "minorAxis": 50,
          "orientation": 70
        },
        "height": 3.0,
        "verticalUncertainty": 2,
        "indoorDeployment": 2
      },
      "inquiredFrequencyRange":
      [
        {
          "lowFrequency": 5925,
          "highFrequency": 6425
        }
      ],
      "inquiredChannels":
      [
        {
          "globalOperatingClass": 133
        },
        {
          "globalOperatingClass" : 134,
          "channelCfi": [15, 47, 79]
        }
      ],
      "minDesiredPower": 24
    }
  ]
}
```

```
]
}
```

The following JSON object is an example of an Available Spectrum Response message that responds to the Available Spectrum Request message above.

The query results below are based on a scenario in which the AP has three FS channels in U-NII 5 & 7 to contend with: 6020 - 6050 MHz with 116 dB of total path loss; 6360 - 6390 MHz with 91 dB of total path loss; and 6680-6690 MHz with 129 dB of total path loss.

NOTE - Total path loss includes all factors, including BEL, propagation loss, FS antenna discrimination, etc.

```
{
  "version": "1.0",
  "availableSpectrumInquiryResponses":
  [
    {
      "requestId": "11235813",
      "availableFrequencyInfo" :
      [
        {
          "frequencyRange" :
          {
            "lowFrequency" : 5925,
            "highFrequency" : 6020
          },
          "maxPSD" : 23.0
        },
        {
          "frequencyRange" :
          {
            "lowFrequency" : 6020,
            "highFrequency" : 6050
          },
          "maxPSD" : 1.0
        },
        {
          "frequencyRange" :
          {
            "lowFrequency" : 6050,
            "highFrequency" : 6360
          },
          "maxPSD" : 23.0
        },
        {
          "frequencyRange" :
          {
            "lowFrequency" : 6360,
            "highFrequency" : 6390
          },
          "maxPSD" : -24.0
        },
        {
          "frequencyRange" :
          {
            "lowFrequency" : 6390,
            "highFrequency" : 6425
          },
          "maxPSD" : 23.0
        }
      ]
    }
  ]
}
```

```
],
"availableChannelInfo" :
[
  {
    "globalOperatingClass" : 133,
    "channelCfi" : [7, 39, 55, 71, 135, 151, 167],
    "maxEirp" : [27.8, 36, 36, 36, 36, 33.0, 36]
  },
  {
    "globalOperatingClass" : 134,
    "channelCfi" : [47],
    "maxEirp" : [36]
  }
],
"availabilityExpireTime" : "2020-11-03T13:34:05Z",
"response" :
{
  "responseCode" : 0,
  "shortDescription" : "Success."
}
}
]
```