

Geolocation General Description

Persistent Inquiry Accepted (PIA) AFC Device

1. Introduction

In US, 6GHz (5925 – 7125MHz) is separated into 4 bands, U-NII 5 ~ U-NII8. There are thousands of deployed incumbents in these bands. FCC opens 6 GHz band for unlicensed operation and defines two regulatory classes for the devices using unlicensed bands, in order to coexist with these incumbent services. The two classes are “Lower Power Indoor (LPI)” and “Standard Power (SP)”. Since Standard Power Access Point has higher EIRP, its operation must be controlled by an AFC (Automated Frequency Coordination) System.

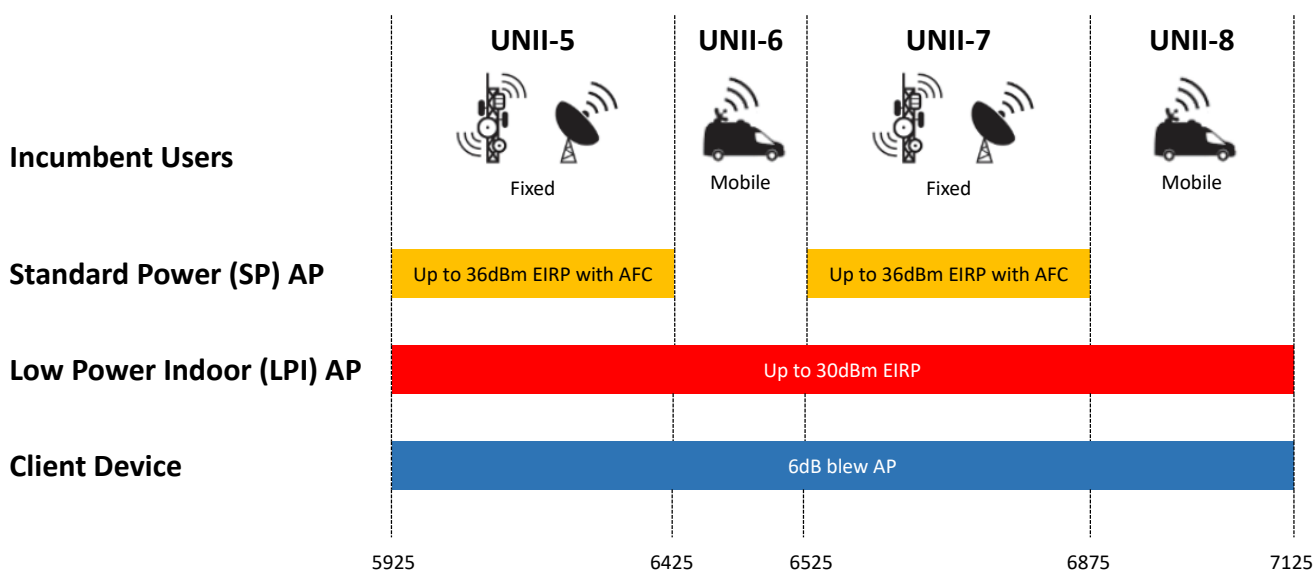


Figure 1. Incumbent Users and Power Specification per Frequency [1] [2]

AFC System calculates a protection area around every 6GHz incumbent service based on licensee data in FCC’s Universal Licensing System (ULS). AFC device requests available spectrum from AFC System, then controls its EIRP in U-NII 5 and U-NII 7 properly.

PIA, AFC Device – Geolocation General Description

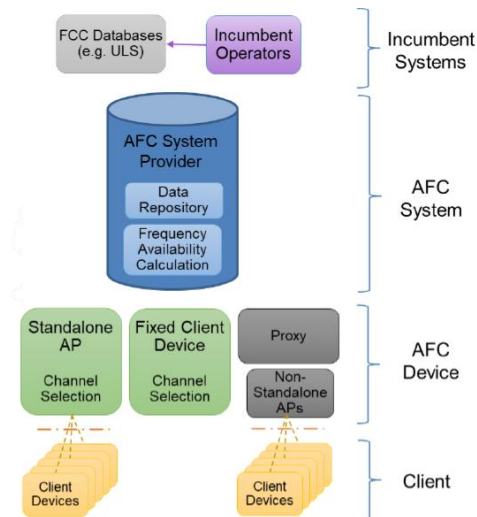


Figure 2. Architecture of AFC System [3]

Asus Wi-Fi AP supports 6GHz frequency as a “Lower-power Indoor (LPI) Access Point” or a “Standard Power (SP) Access Point”. Its design follows FCC’s regulation described in Figure 3, for indoor usage only. So it has no weatherproofing feature, undetachable antenna, and wired power. This document describes how Asus Wi-Fi AP is compliant with the regulation when operates as a Standard Power Access Point.

Low Power Indoor (LPI) Access Point

- Fixed indoor only
- Up to 30dBm EIRP
- Available in U-NII 5~8 bands
- No antenna connectors
- No weatherproofing
- Wired power

Standard Power (SP) Access Point

- Fixed indoor / outdoor
- Up to 36dBm EIRP
- Available in U-NII 5 and 7 bands
- Controlled by AFC System
- Automated geolocation



Subordinate Indoor Client

- Under LPI AP control
- No direct Internet connection
- Up to 30dBm EIRP

Mobile Client

- Indoor / outdoor
- 6dBm EIRP

Fixed Outdoor Client

- Attached to structure
- Up to 36dBm EIRP

Figure 3. 6GHz Device Classes of Operation [4]

2. General Description

2.1 General Overview of Method

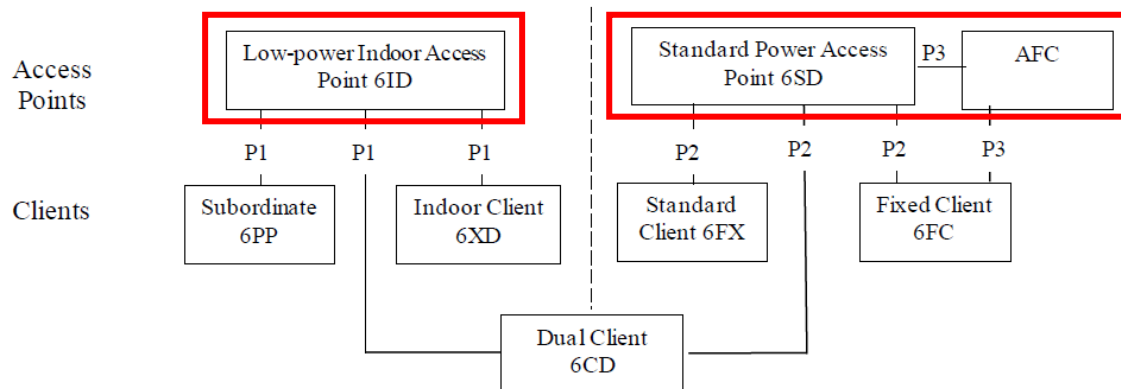
As shown in Figure 4, FCC defines Standard Power Access Point is **6SD** and Low Power Indoor Access Point is **6ID**. The interface between 6SD and AFC System is **P3**. When 6SD device requests available spectrum from AFC System via P3, the message includes:

- Device descriptor
- Location
- Frequency range
- Channels
- Desired power

AFC System returns following information:

- Frequency
- Channel
- Expire time

With this information, Wi-Fi AP can operate 6GHz Wi-Fi signal with standard power.



P1 Client and subordinate devices under control of low-power indoor access point.

P2 Client devices under control of standard access point.

P3 Standard Power Access Point and Fixed Client devices managed by the AFC.

Figure 4. Device Classes [5]

Asus Wi-Fi AP can be a Low Power Indoor AP (6ID) or a Standard Power AP (6SD). As a 6SD, it uses two Cloud Services and embedded barometer to determine its geolocation. It calculates which 6GHz resources are preferred to use. Then it sends request to AFC System via P3 interface to get available frequency, channels and expire time. With these, Asus Wi-Fi AP can provide 6GHz Wi-Fi service with standard power. Without getting availability from AFC System, Asus Wi-Fi AP can only work as a 6ID. The process is showed in Figure 5.

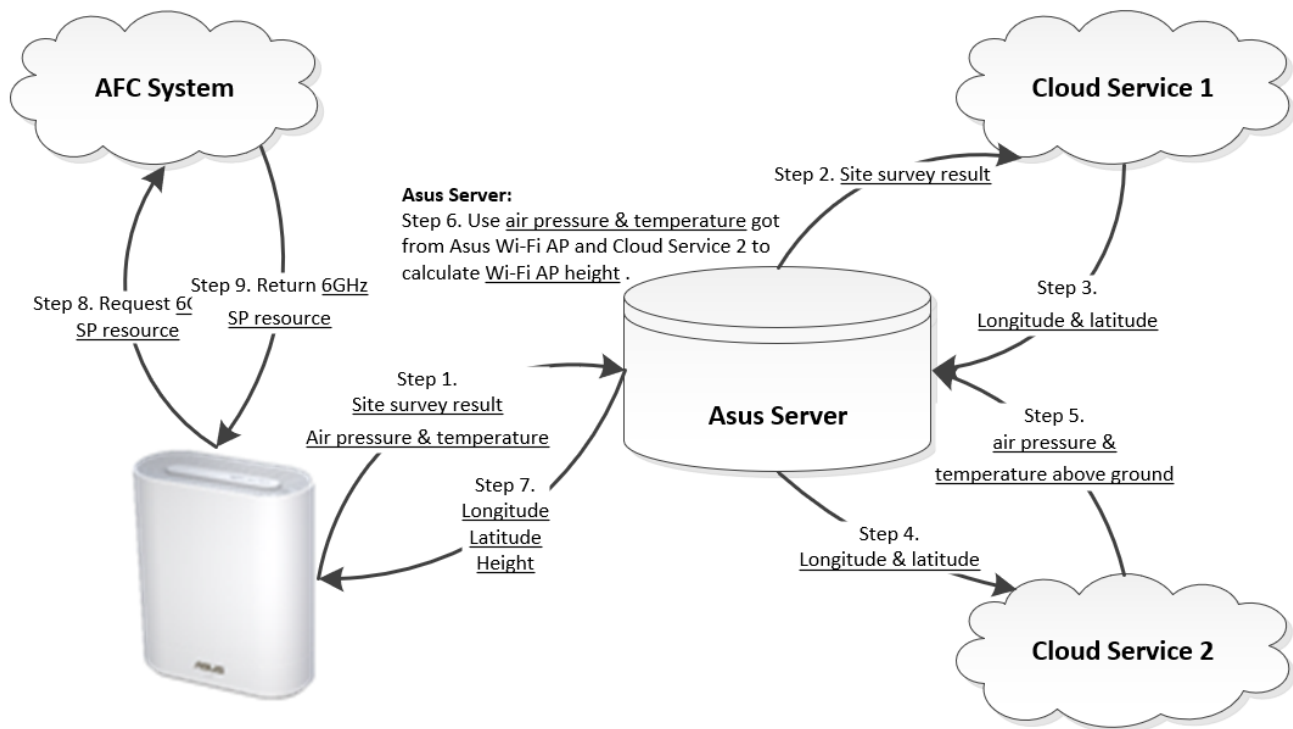


Figure 5. Positioning Process

Since this positioning process depends on ambient Wi-Fi AP's status, this PIA is only applicable for Asus Wi-Fi AP located in urban and suburban areas.

2.2 Attestation Confirming Location Uncertainty with 95% Confidence Level

The Location object of message sent from Asus Wi-Fi AP to AFC System includes location uncertainty. Per Section 10 of "FCC KDB 987594 D01 U-NII 6GHz General Requirements v02r02" [6], uncertainty of the requested coverage area with a 95% confidence level is necessary. Asus designed test plans to show that the Cloud Service used for positioning has 99.32% confidence level with 17.66 meters horizontal uncertainty. And the vertical uncertainty is 9.99 meters.

2.3 Statement of Daily and After Power Cycle Operation

Per Section 10 of "FCC KDB 987594 D01 U-NII 6GHz General Requirements v02r02" [6], Asus Wi-Fi AP needs re-authorization with the AFC to re-obtain operating parameters after a new power cycle. Asus Wi-Fi AP is a Low Power Indoor AP (6ID) after a power cycle. After having process described in clause 2.1, it can be a Standard Power AP (6SD) with available 6GHz channels got from AFC System. This process is also operated every 24 hours, in order to make sure Asus Wi-Fi AP is compliant with FCC regulations.

Reference

- [1] E. Danel, "An Introduction to Wi-Fi 6E Spectrum in the 6 GHz band," 20 Oct. 2020. [Online]. Available: <https://www.litepoint.com/blog/an-introduction-to-wi-fi-6e-spectrum/>.
- [2] M. Gibson, "Unlicensed @ 6 GHz," 22 Sep. 2020.
- [3] Wi-Fi Alliance, "AFC System Reference Model v1.0," 22 Jun. 2021.
- [4] D. Wright, "Dynamic Spectrum Access," 12 Jan. 2022. [Online]. Available: <https://blogs.arubanetworks.com/corporate/dynamic-spectrum-access-part-two/>.
- [5] FCC, "987594 U-NII 6 GHz devices 5.925-7.125 GHz DR02-45002," 17 Mar. 2023.
- [6] FCC, "987594 D01 U-NII 6GHz General Requirements v02r02," 22 Aug 2023.