

Wi-Fi 6E real test comparison against Wi-Fi 6 and Wi-Fi 5



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Introduction

In this paper, Wi-Fi 6E is examined against Wi-Fi 6 and Wi-Fi 5. This test is based on using the Aruba access point AP-635 (Wi-Fi 6E supported) along with Samsung Tablet S8 Ultra that supports Wi-Fi 6E (client test). Three different SSIDs are created for each band/physical layer (6 GHz/ax, 5 GHz/ax, and 5 GHz/ac) and each access point broadcasted one Wi-Fi protocol. This is to make the protocol fully dedicated to each access point. Two test cases are introduced to check both the speed on the different protocols and the channels for 6 GHz.

Wi-Fi 6E Overview

The Wi-Fi Alliance, a group of Wi-Fi platform vendors that works with the FCC and electronics manufacturers to set standards for Wi-Fi technology, announced the Wi-Fi 6E designation in 2020 for any IEEE 802.11ax (Wi-Fi 6) products that support 6 GHz wireless spectrum. Essentially, this means Wi-Fi 6E enables faster speeds and lower latencies than Wi-Fi 6 and earlier iterations.[1]

The new Wi-Fi 6E (E for Extended) has the same capabilities and features that are used on Wi-Fi 6 like OFDMA, BSS Coloring, TWT, and 1024-QAM Modulation. The most important value of Wi-Fi 6E is the new 6 GHz band that enhanced wireless networking limitations and will make Wi-Fi more important on projects that required higher speed, stable connection, and more security, especially IoT, VR, AR...etc.

Nowadays, wired solutions are more costly and difficult to deploy, so the dependency on wireless is increased and wireless enhancement like Wi-Fi 6E will make the integration between technologies smooth.

The opening of the 6 GHz band is the biggest spectrum addition to Wi-Fi since 1989. The jump from 5 GHz to 6 GHz might not sound like much, but it essentially quadruples the number of airwaves (14 additional 80MHz channels, and seven additional 160MHz channels, where available) available for routers and smart devices. That means less signal interference.[1]

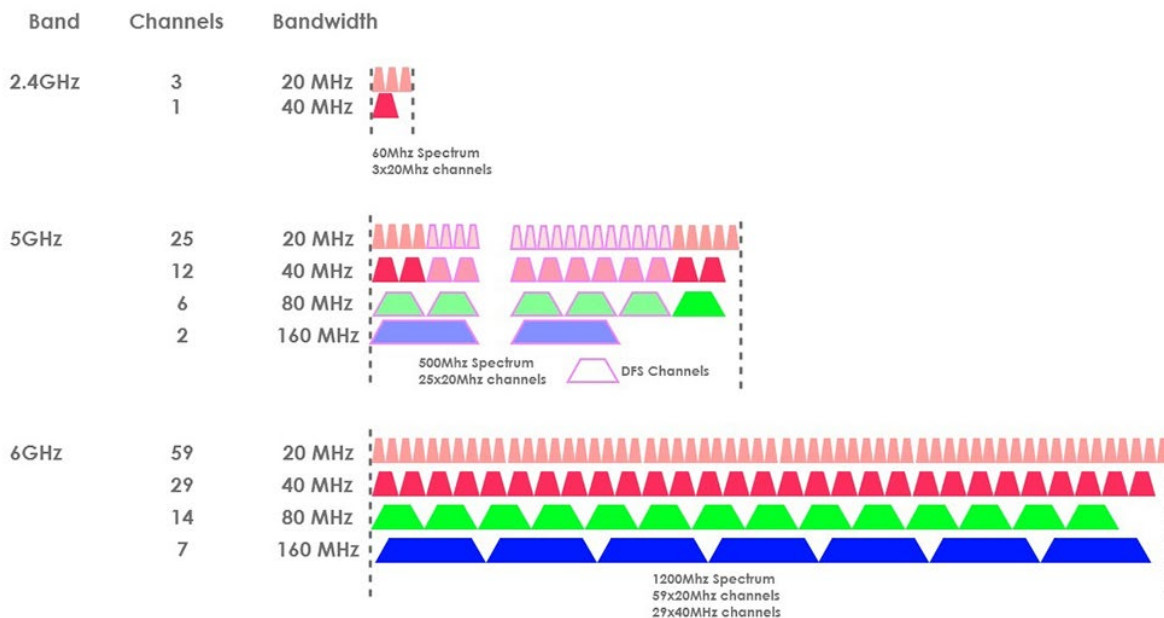


Figure 1 Wi-Fi Bands Overview [2]

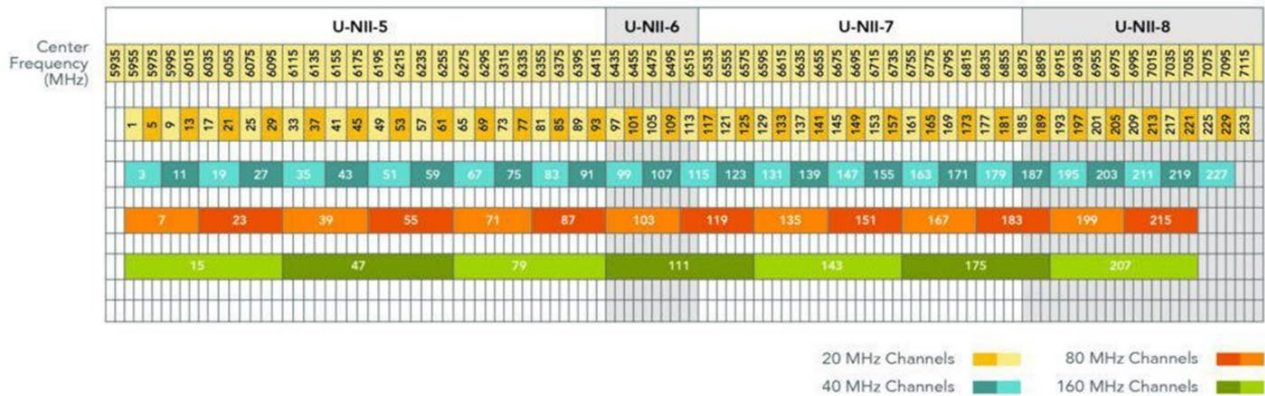


Figure 2 Wi-Fi 6 GHz band Spectrum [3]

The 6 GHz band has wider and clean channels, also the channels are more than double compared to 5 GHz band. Wi-Fi 6E delivered more efficiency, higher bandwidth, and connection stability.

Wi-Fi 6E 6 GHz band have below channels:

- 6 GHz band Supporting up to 59 non-overlapping channels at 20MHz width
- 6 GHz band Supporting up to 29 non-overlapping channels at 40MHz width
- 6 GHz band Supporting up to 14 non-overlapping channels at 80MHz width
- 6 GHz band Supporting up to 7 non-overlapping channels at 160MHz width

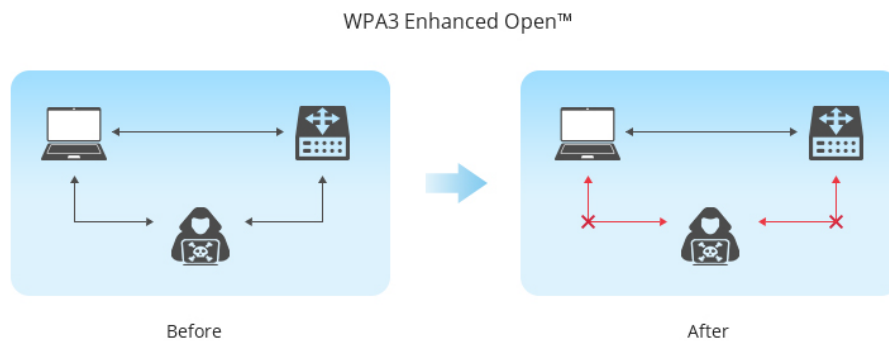


Figure 3 WPA3 Enhanced [4]

Wi-Fi 6E use the high encryption mechanism, WPA3, as a mandatory method for connection, this gives higher security encryption against an attacker or the hacking of data traffic.

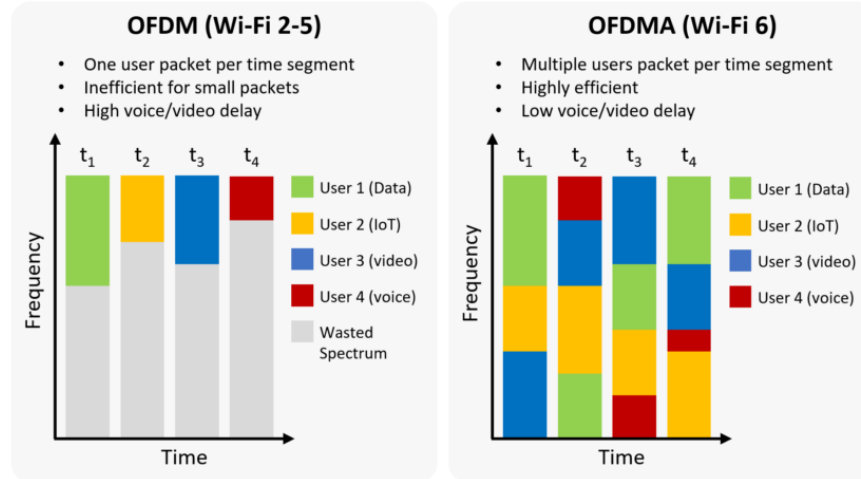


Figure 4 Wi-Fi 6E 6 GHz Wi-Fi Spectrum [5]

The OFDMA technology allows multi-users to send at the same time instead of waiting and keeping in the queue like previous Wi-Fi OFDM.

The OFDMA technology works on a technique that divides each channel to sub-channels so each sub-channel can carry different data from multi-users at the same time without waiting.

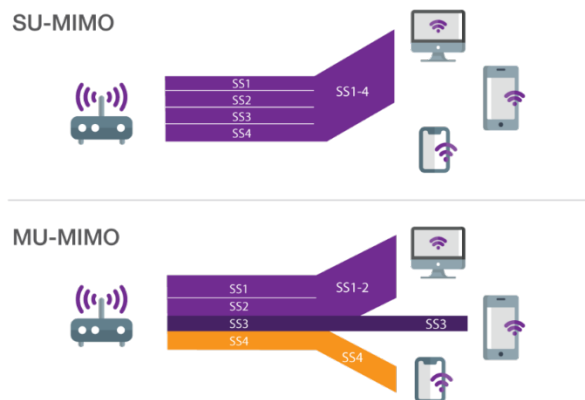


Figure 5 SU-MIMO & MU-MIMO [6]

MU-MIMO technology is one of the Wi-Fi 6 feature that is also supported on Wi-Fi 6E that give the ability to Access Points to send and receive data from multi-user at the same time depending on the Access Points antenna stream and user antenna stream as well (up to 8 streams)

Test Overview

I prepared a lab demo to examine 3 types of Wi-Fi protocols (Wi-Fi 6E, Wi-Fi 6 (ax) and Wi-Fi 5 (ac)). The main goal of this lab demo is to examine the new Wi-Fi 6E real test and find the comparison with the previous generation of Wi-Fi protocols (Wi-Fi 6 (ax) and Wi-Fi 5 (ac)). Also, to explore the new band 6 GHz channel overview on Wi-Fi 6E, do compare it with the previous generation of Wi-Fi protocols (Wi-Fi 6 (ax) and Wi-Fi 5 (ac)) channels.

Lab demo devices:

- **Aruba Virtual Mobility Conductor (VMCR):** to centralize and manages Wireless Controllers, Access Points, and users.
- **Aruba Virtual Mobility Controller (VMC):** all Access points are joined Mobility Controller and download image and configuration, WLAN profile, policies ... etc.
- **Layer 3 distribution Switch**
- **Layer 2 access switch:** POE++ supported, multi-gig ports (Access Points terminated on access switch and used POE++ as a power source)
- **Access Points:** Used 3 different models of Access Points
 - **Aruba AP-635:** Supported Wi-Fi 6E (6 GHz)
 - **Aruba AP-515:** Supported Wi-Fi 6 (ax/5 GHz)
 - **Aruba AP-315:** Supported Wi-Fi 5 (ac/5 GHz)
- **Client device:** Samsung Tablet S8 Ultra for testing purposes.

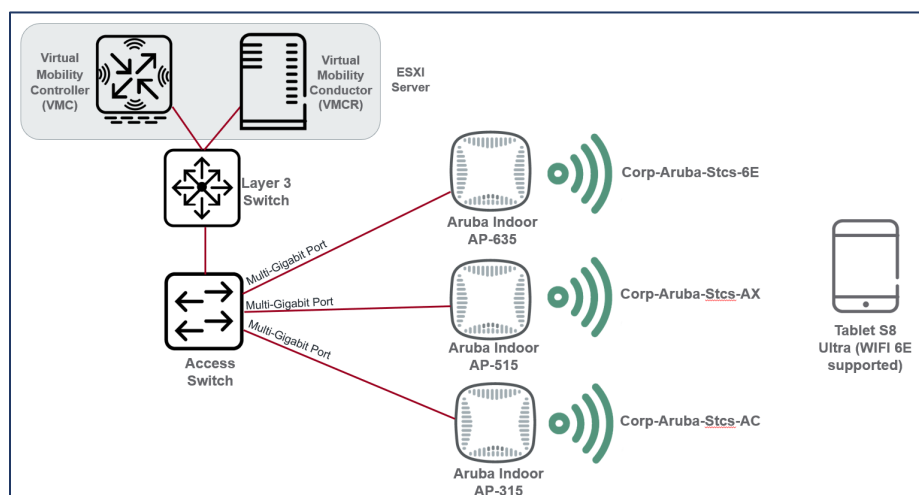


Figure 6 High-level Lab diagram

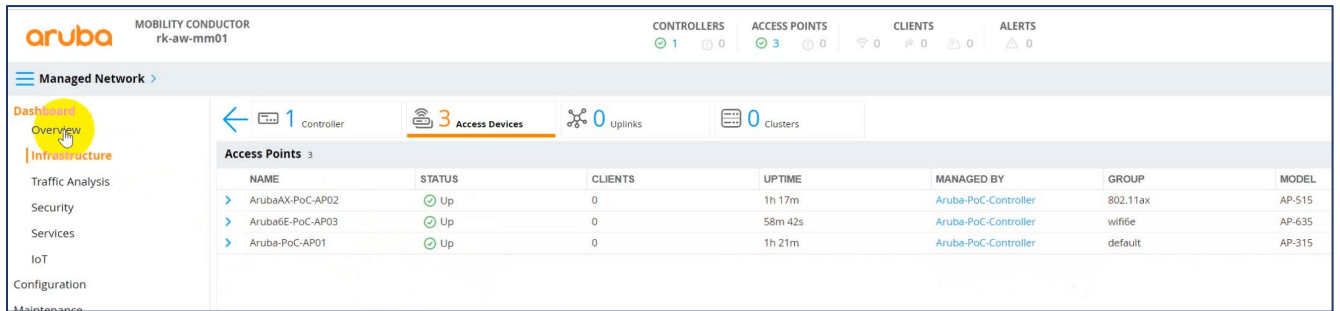


Figure 7 Access Points Registered on Mobility Controller

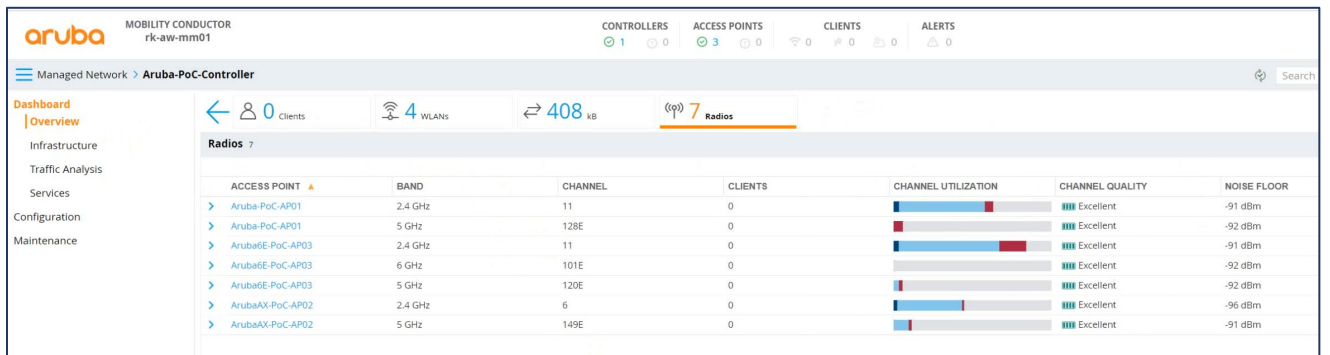


Figure 8 Access Points information

Test Procedures

1. Login to Aruba virtual Mobility Controller (vMC)
2. Create new 3 WLAN with bellow SSIDs names:
 - a. **Corp-Aruba-Stcs-6E** (Enable 6 GHz band only and disable 5 GHz and 2.4 GHz)
 - b. **Corp-Aruba-Stcs-AX** (Enable 5 GHz band (802.11ax) only and disable 2.4 GHz)
 - c. **Corp-Aruba-Stcs-AC** (Enable 5 GHz band (802.11ac) only and disable 2.4 GHz)
3. Customize the “**Corp-Aruba-Stcs-6E**” SSID to broadcast from **Aruba Indoor AP-635**
4. Customize the “**Corp-Aruba-Stcs-AX**” SSID to broadcast from **Aruba Indoor AP-515**
5. Customize the “**Corp-Aruba-Stcs-AC**” SSID to broadcast from **Aruba Indoor AP-315**
6. Turn on the Wi-Fi adapter on **Samsung Tablet S8 Ultra** (Client device)
7. Associate client device (**Samsung Tablet S8 Ultra**) to “**Corp-Aruba-Stcs-6E**” Wi-Fi SSID
 - a. Perform **network speed test** using **Aruba Utility software**.
 - b. Check Samsung Tablet S8 Ultra Wi-Fi card connection speed.
8. Disassociate from previous SSID and re-associate to (**Samsung Tablet S8 Ultra**) to “**Corp-Aruba-Stcs-AX**” Wi-Fi SSID.
 - a. Perform **network speed test** using **Aruba Utility software**.
 - b. Check Samsung Tablet S8 Ultra Wi-Fi card connection speed.
9. Disassociate from previous SSID and re-associate to (**Samsung Tablet S8 Ultra**) to “**Corp-Aruba-Stcs-AC**” Wi-Fi SSID.
 - a. Perform **network speed test** using **Aruba Utility software**.
 - b. Check Samsung Tablet S8 Ultra Wi-Fi card connection speed.
10. Display channels supported on each of Wi-Fi 6E, Wi-Fi 6(ax), Wi-Fi 5(ac) at channel width 20MHz, 40MHz, 80MHz and 160MHz.

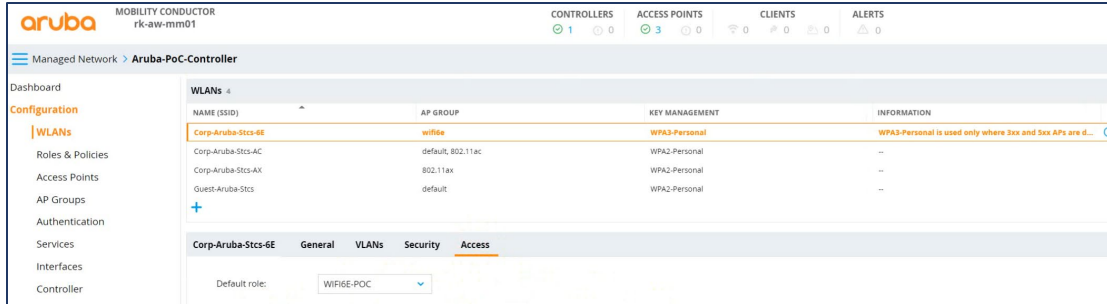


Figure 9 WLANs and SSID Name, Group and Encryption

Wi-Fi 6E Test Cases

Case No.	Description
Test Case 1	Compare wireless network speed test (Wi-Fi 6E vs Wi-Fi 6 vs Wi-Fi 5)
Test Case 2	Wi-Fi 6E new band 6 GHz channel's view

Table 1 Wi-Fi 6E Test Cases

Test Case 1: Compare wireless network speed test (Wi-Fi 6E vs Wi-Fi 6 vs Wi-Fi 5)

1. Associate client device (**Samsung Tablet S8 Ultra**) to “**Corp-Aruba-Stcs-6E**” Wi-Fi SSID
 - a. Check real Samsung Tablet S8 Ultra Wi-Fi card connection speed.

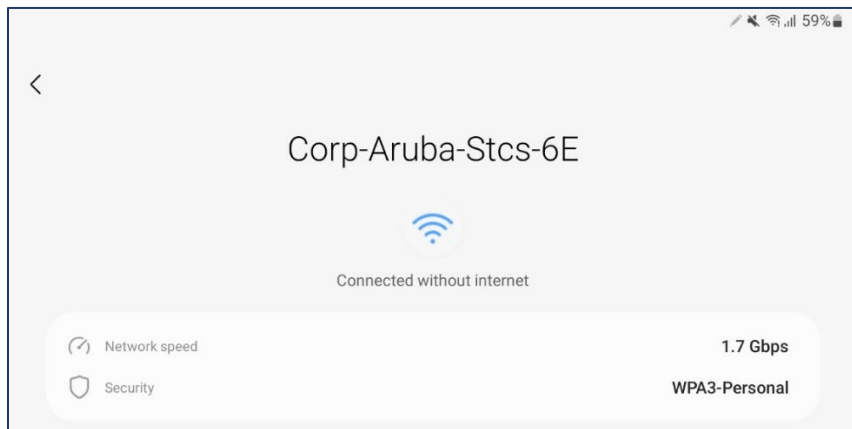


Figure 10 Samsung Tablet S8 Ultra Wi-Fi card connection speed (Associated to Corp-Aruba-Stcs-6E)

- b. Perform **network speed test** using **Aruba Utility** software.

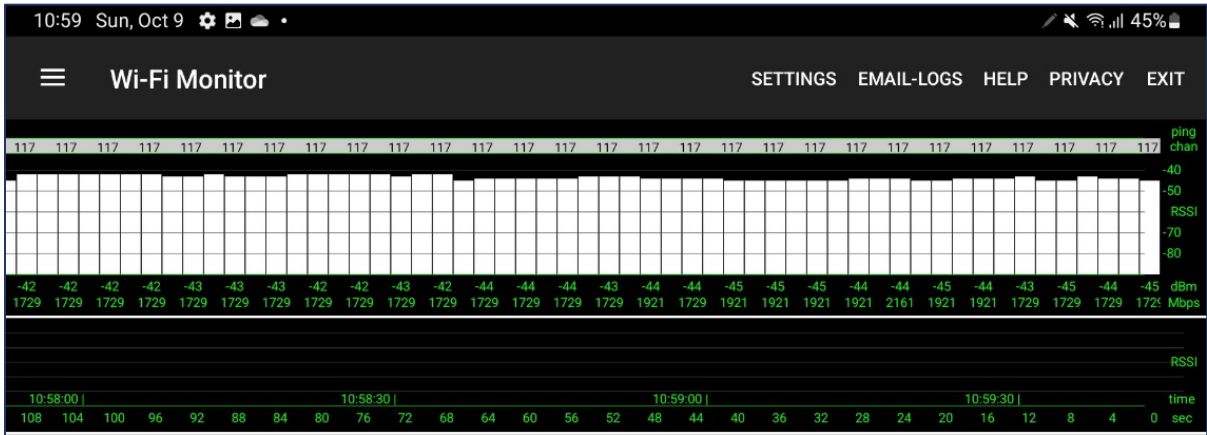


Figure 11 Aruba Utility software shown speed test (Associated to Corp-Aruba-Stcs-6E)

- 2. Associate client device (**Samsung Tablet S8 Ultra**) to “**Corp-Aruba-Stcs-AX**” Wi-Fi SSID
 - a. Check real Samsung Tablet S8 Ultra Wi-Fi card connection speed.

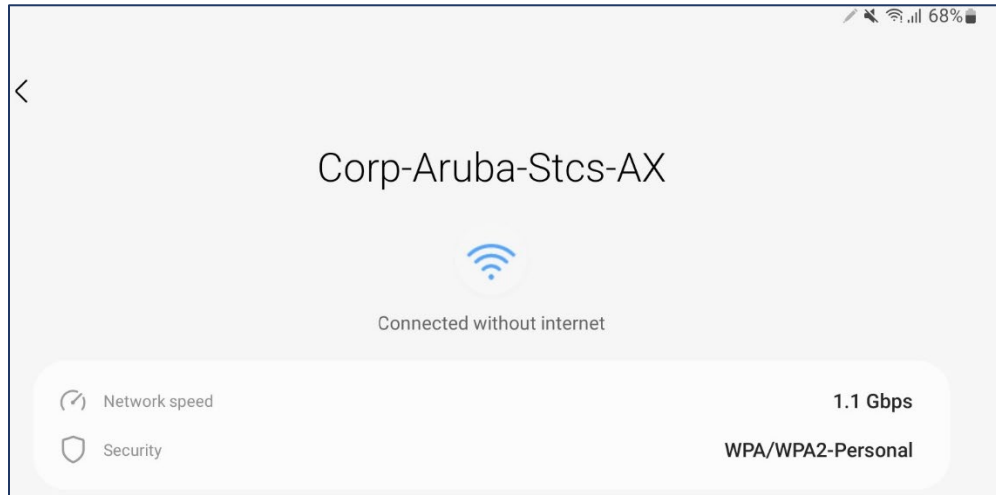


Figure 12 Samsung Tablet S8 Ultra Wi-Fi card connection speed (Associated to Corp-Aruba-Stcs-AX)

- b. Perform **network speed test** using **Aruba Utility** software.

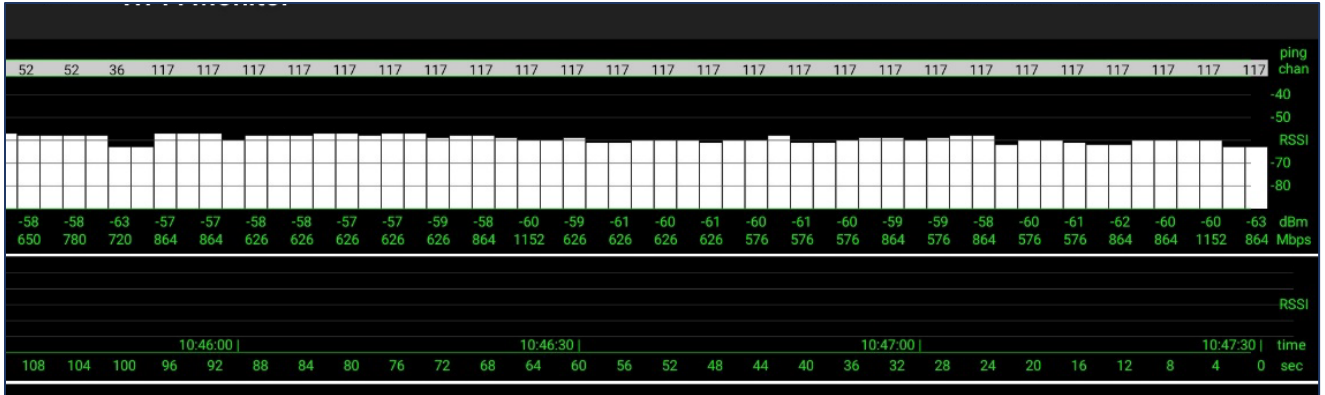


Figure 13 Aruba Utility software shown speed test (Associated to Corp-Aruba-Stcs-AX)

3. Associate client device (**Samsung Tablet S8 Ultra**) to “**Corp-Aruba-Stcs-AC**” Wi-Fi SSID
 - c. Check real Samsung Tablet S8 Ultra Wi-Fi card connection speed.

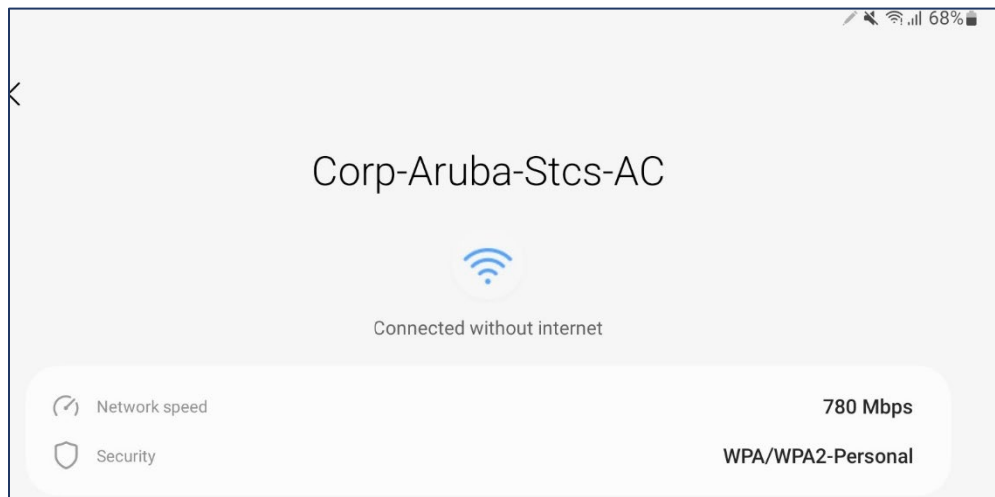


Figure 14 Samsung Tablet S8 Ultra Wi-Fi card connection speed (Associated Corp-Aruba-Stcs-AC)

- d. Perform **network speed test** using **Aruba Utility software**.



Figure 15 Aruba Utility software shown speed test (Associated to Corp-Aruba-Stcs-AC)

Test Case 2: Wi-Fi 6E new band 6 GHz channel's view

Explore supported channels for Aruba6E-PoC-AP03 (Wi-Fi 6E supported) as per Saudi Arabia regulatory domain

```

(Aruba-PoC-Controller) #show ap allowed-channels ap-name Aruba6E-PoC-AP03
Allowed Channels for AP "Aruba6E-PoC-AP03" Country Code "SA" Country "Saudi Arabia"
PHY Type      Allowed Channels
-----
2.4GHz (indoor) 1 2 3 4 5 6 7 8 9 10 11 12 13
5GHz (indoor) 36 40 44 48 52 56 60 64 100 104 108 112 116 120 124 128 132 136 140 144 148 152 156 161 165
6GHz (LP indoor) 1 5 9 13 17 21 25 29 33 37 41 45 49 53 57 61 65 69 73 77 81 85 89 93 97 101 105 109 113 117 121 125 129 133 137 141 145 149 153 157 161 165 169 173 177 181
1 185 189 193 197 201 205 209 213 217 221 225 229 233
2.4GHz (outdoor) 1 2 3 4 5 6 7 8 9 10 11 12 13
5GHz (outdoor) 100 104 108 112 116 120 124 128 132 136 140 144 148 152 156 161 165
2.4GHz 40MHz (indoor) 1-5 2-6 3-7 4-8 5-9 6-10 7-11 8-12 9-13
5GHz 40MHz (indoor) 36-40 44-48 52-56 60-64 100-104 108-112 116-120 124-128 132-136 140-144 148-152 156-161
6GHz 40MHz (LP indoor) 1-5 9-13 17-21 25-29 33-37 41-45 49-53 57-61 65-69 73-77 81-85 89-93 97-101 105-109 113-117 121-125 129-133 137-141 145-149 153-157 161-165 169-173 177-181
1 185-189 193-197 201-205 209-213 217-221 225-229
2.4GHz 40MHz (outdoor) 1-5 2-6 3-7 4-8 5-9 6-10 7-11 8-12 9-13
5GHz 40MHz (outdoor) 100-104 108-112 116-120 124-128 132-136 140-144 148-152 156-161
5GHz 80MHz (indoor) 36-48 52-64 100-112 116-128 149-161
5GHz 80MHz (LP indoor) 1-13 17-29 33-45 49-61 65-77 81-93 97-109 113-125 129-141 145-157 161-173 177-189 193-205 209-221
5GHz 160MHz (indoor) None
5GHz 160MHz (outdoor) None
5GHz 160MHz (LP indoor) 1-29 33-61 65-93 97-125 129-157 161-189 193-221
5GHz DFS 52 56 60 64 100 104 108 112 116 120 124 128 132 136 140
support_zero-wait-dfs No
    
```

Figure 16 Channels supported for Aruba6E-PoC-AP03 (AP Supported Wi-Fi 6E)

Explore supported channels for Aruba6E-PoC-AP02 (Wi-Fi 6 supported) as per Saudi Arabia regulatory domain

```
Allowed Channels for AP "ArubaAX-PoC-AP02" Country Code "SA" Country "Saudi Arabia"
-----
PHY Type           Allowed Channels
-----
2.4GHz (indoor)    1 2 3 4 5 6 7 8 9 10 11 12 13
5GHz (indoor)     36 40 44 48 52 56 60 64 100 104 108 112 116 120 124 128 132 136 140 149 153 157 161 165
2.4GHz (outdoor)  1 2 3 4 5 6 7 8 9 10 11 12 13
5GHz (outdoor)    100 104 108 112 116 120 124 128 132 136 140 149 153 157 161 165
2.4GHz 40MHz (indoor) 1-5 2-6 3-7 4-8 5-9 6-10 7-11 8-12 9-13
5GHz 40MHz (indoor)  36-40 44-48 52-56 60-64 100-104 108-112 116-120 124-128 132-136 149-153 157-161
2.4GHz 40MHz (outdoor) 1-5 2-6 3-7 4-8 5-9 6-10 7-11 8-12 9-13
5GHz 40MHz (outdoor)  100-104 108-112 116-120 124-128 132-136 149-153 157-161
5GHz 80MHz (indoor)  36-48 52-64 100-112 116-128 149-161
5GHz 80MHz (outdoor)  100-112 116-128 149-161
5GHz 160MHz (indoor)  36-64 100-128
5GHz 160MHz (outdoor) 100-128
5GHz (DFS)        52 56 60 64 100 104 108 112 116 120 124 128 132 136 140
support zero-wait-dfs No
(Aruba-PoC-Controller) *#
```

Figure 17 Channels supported for ArubaAX-PoC-AP02 (AP Supported Wi-Fi 6E)

Explore supported channels for Aruba6E-PoC-AP01 (Wi-Fi 5 supported) as per Saudi Arabia regulatory domain

```
Allowed Channels for AP "Aruba-PoC-AP01" Country Code "SA" Country "Saudi Arabia"
-----
PHY Type           Allowed Channels
-----
2.4GHz (indoor)    1 2 3 4 5 6 7 8 9 10 11 12 13
5GHz (indoor)     36 40 44 48 52 56 60 64 100 104 108 112 116 120 124 128 132 136 140
2.4GHz (outdoor)  1 2 3 4 5 6 7 8 9 10 11 12 13
5GHz (outdoor)    100 104 108 112 116 120 124 128 132 136 140
2.4GHz 40MHz (indoor) 1-5 2-6 3-7 4-8 5-9 6-10 7-11 8-12 9-13
5GHz 40MHz (indoor)  36-40 44-48 52-56 60-64 100-104 108-112 116-120 124-128 132-136
2.4GHz 40MHz (outdoor) 1-5 2-6 3-7 4-8 5-9 6-10 7-11 8-12 9-13
5GHz 40MHz (outdoor)  100-104 108-112 116-120 124-128 132-136
5GHz 80MHz (indoor)  36-48 52-64 100-112 116-128
5GHz 80MHz (outdoor)  100-112 116-128
5GHz 160MHz (indoor)  None
5GHz 160MHz (outdoor) None
5GHz (DFS)        52 56 60 64 100 104 108 112 116 120 124 128 132 136 140
support zero-wait-dfs No
(Aruba-PoC-Controller) *#
```

Figure 18 Channels supported for Aruba-PoC-AP01 (AP Supported Wi-Fi 5)

Results

Wi-Fi Technology	Wi-Fi Speed Test (Practically)
Wi-Fi 6E	1.7 Gbps
Wi-Fi 6 (ax)	1.1 Gbps
Wi-Fi 5 (ac)	780 Mbps

Table 2 Test Case 1 Results

Wi-Fi Technology	Wi-Fi 6E Channels
Wi-Fi 6E ⁷	<p>Support 2.4GHz, 5GHz, and new 6 GHz band</p> <p>6 GHz band Supporting up to <u>59 non-overlapping</u> channels at 20 MHz width</p> <p>6 GHz band Supporting up to <u>29 non-overlapping</u> channels at 40 MHz width</p> <p>6 GHz band Supporting up to <u>14 non-overlapping</u> channels at 80 MHz width</p> <p>6 GHz band Supporting up to <u>7 non-overlapping</u> channels at 160 MHz width</p> <p>⁷ Supported frequency bands as per Saudi Arabia regulatory domain</p>
Wi-Fi 6 ⁸ (ax)	<p>Support 2.4GHz, 5GHz (NO 6 GHz band)</p> <p>5 GHz band Supporting up to <u>24 non-overlapping</u> channels at 20 MHz channel width</p> <p>5 GHz band Supporting up to <u>11 non-overlapping</u> channels at 40 MHz channel width</p> <p>5 GHz band Supporting up to <u>5 non-overlapping</u> channels at 80 MHz channel width</p> <p>5 GHz band Supporting up to <u>2 non-overlapping</u> channels at 160 MHz channel width</p> <p>⁸ Supported frequency bands as per Saudi Arabia regulatory domain</p>
Wi-Fi 5 ⁹ (ac)	<p>Support 5GHz (NO 2.4GHz band and NO 6 GHz band)</p> <p>5 GHz band Supporting up to <u>19 non-overlapping</u> channels at 20 MHz channel width</p> <p>5 GHz band Supporting up to <u>9 non-overlapping</u> channels at 40 MHz channel width</p> <p>5 GHz band Supporting up to <u>4 non-overlapping</u> channels at 80 MHz channel width</p> <p>5 GHz band Supporting up to <u>0 non-overlapping</u> channels at 160 MHz channel width</p> <p>⁹ Supported frequency bands as per Saudi Arabia regulatory domain</p>

Table 3 Test Case 2 Results

The Conclusion

- Wi-Fi 6E speed test is significantly better than the previous generation (Wi-Fi 6 and Wi-Fi 5).
- Wi-Fi 6E is more efficient than the previous generation (Wi-Fi 6 and Wi-Fi 5) due to clean channels.
- Wi-Fi 6E 6 GHz band has 59 Channels at 20 MHz which is more than double the channels compared to Wi-Fi 6 and Wi-Fi 5 which leads to more stable connection and less interference, especially in high-density places like stadiums – festivals - outdoor paths walk– malls... etc.
- Wi-Fi 6E 6 GHz band has 7 non-overlapping Channels at 160 MHz compared to Wi-Fi 6 only 2 non-overlapping Channels at 160 MHz that give more bandwidth and stability for sensitive data like voice and video over Wi-Fi.
- Many sectors will be taken advantage of the new Wi-Fi 6E like healthcare which need more bandwidth and free channel, for example, the patient MRI and other testing send through the hospital Wireless network.
- Also, universities that provide lectures remotely to their student worldwide area.
- Nowadays the IoT will be involved strongly and the dependence on Wi-Fi will be more mandatory so with new 6 GHz new band will help to support that need.
- Wi-Fi 6E will support Mobile GSM Networks by offloading 4G/5G data traffic to the Wi-Fi network, which will reduce the cost of GSM mobile towers and easy to deploy and maintain.
- Wi-Fi 6E support only the WPA3 encrypting method, so for clients who looking for higher security like the banking sector, government organization, and sensitive area it is the best choice.



Figure 19 Compare the interference and utilization between 2.4GHz, 5GHz and 6 GHz band



Figure 20 Aruba Access Point (AP-635), new 6 GHz band

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