

# **Licensed-Assisted Access (LAA)**

## **Test Report**

**Version 2.1**

**Date: 26 January 2018**

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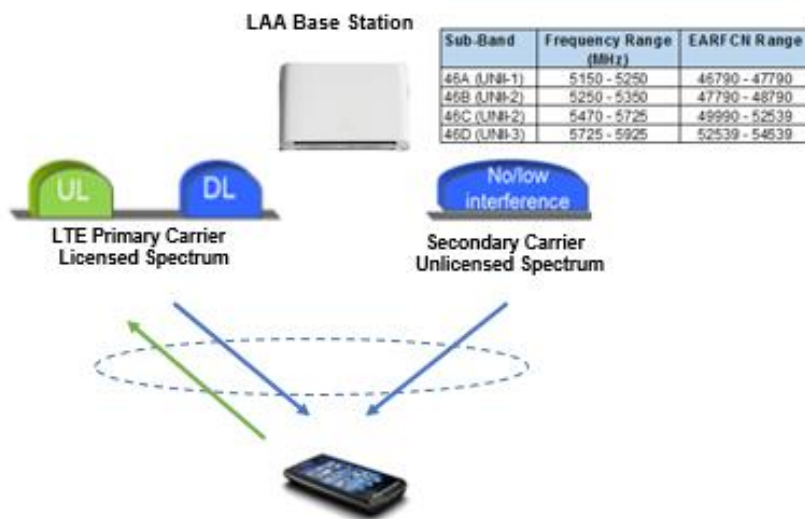
## 1. Overview

### 1.1 Introduction

Licensed Assisted Access (LAA) is part of the LTE Advance Pro functionality, it was introduced in Release 13 of 3GPP (a Global standardization organization for cellular network technology). LAA offers better downlink performance through carrier aggregation of the unlicensed frequency band of 5 GHz with the licensed LTE frequency band. The topology of LAA is illustrated in Figure 1 below. LAA helps mobile operators to utilize portions of the unlicensed frequency band to deliver a better end-user quality of experience and significant increase in the downlink data rate.

As Wi-Fi is the dominant applications on unlicensed frequency band of 5 GHz, the key operation principle is that LAA is in coexistence but fairly sharing use of unlicensed frequency band of 5 GHz with Wi-Fi. This is accomplished by dynamically selecting clear channels in 5 GHz to avoid interference with Wi-Fi users. If there is no clear channel available, LAA will share a channel fairly with others. This is accomplished by the feature called Listen Before Talk (LBT). The LBT will be used by most of technologies in unlicensed spectrum to ensure fair spectrum sharing globally.

Figure 1 – Topology of LAA



Source Reference: Qualcomm

## 1.2 Scope and purpose

The purpose of the test is to study and verify if there is any impact on Wi-Fi Network in coexistence with Licensed-Assisted Access (LAA). It covers the following major areas:

- Measure and compare any performance difference in Wi-Fi client on coexistence of LAA and Coexistence of multiple Wi-Fi routers
- Performance impact on network connection of Wi-Fi network in coexistence of LAA
- Performance impact on streaming applications of Wi-Fi network in coexistence of LAA
- Performance impact on Wi-Fi network in different load conditions of coexistence of LAA
- Impact of LAA with adjacent channel to Wi-Fi network
- Channel Selection / Re-selection of LAA

The test cases are derived with reference to similar tests done in overseas, with special emphasis on actual use cases. Wherever possible, reference is also made to similar coexistence test cases proposed by the Wi-Fi Alliance. However, due to limitation of test tools, some of the test cases of the Wi-Fi Alliance were not included.

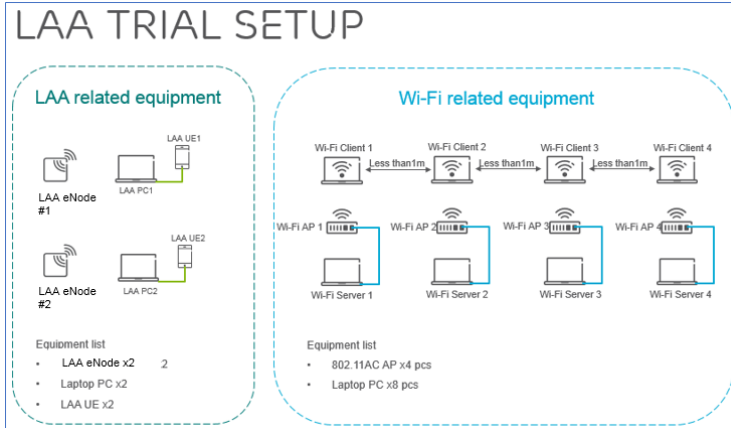
## 1.3 Disclaimer and Limitation

- Copyright – SmarTone owns the copyright for this coexistence test report and all reserves all rights therein. The use, duplication or distribution of the result on this report requires the endorsement and pre-approval from SmarTone. The unauthorized use and distribution of this test report is an infringement the copyright of SmarTone.
- The measurement and testing was focus on studying any performance different with Wi-Fi on co-existence of LAA sharing use of unlicensed band spectrum as compare to co-existence of Wi-Fi system sharing use of spectrum. The performance measurement of LAA is not the scope of this study.
- The radio condition of the test lab environment is having level of interference by the third parties 5GHz band devices, best effort has been paid to achieving more accurate and consistent measurement results, but it is subjected to existence and extents of interference from third parties' devices.
- The specific measurement tools like sniffer is not available on this test, the alternative measurement methods to capture the packet loss, jitter and frame re-transmission rate through TCP ping, Wireshark trace with data transfer in TCP & UDP was adopted.
- Test tools to measure the packet loss, jitter and frame re-transmission rate on streaming services and VoIP is not available, user experience test to observe the picture quality and voice quality was deployed on the measurement.

## 2. Test Tools, Methodology and Approach

### 2.1 Test Setup

Figure 2 – Test Setup diagram:



### 2.2 Test Equipment

#### 2.2.1 List of Equipment:

1. 2 x LAA eNode
2. 4 x Wi-Fi (802.11ac AP)
3. 10 x Notebook Client
4. 2 x LAA UE

#### 2.2.2 Testing Tools

Tools	Applications
Iperf	As load generator for data stream on UDP and TCP
Wireshark	Data and Log collection for Packet loss and retransmission measurement
Ping (command)	TCP Ping to www.ofca.gov.hk with 1,440-byte ping size in 100 times for latency and Jitter measurement
Windows Perfmon	Data throughput Logging and monitoring
VLC	Video streaming test tools (480p, 96fps)
Acrylic Wi-Fi Home	Wi-Fi Scanner freeware to scan wireless network and view WLAN channel, signal before test
QXDM	Mobile test tools to monitor the data throughput on licensed band and unlicensed band of LAA mobile.

(Remarks: Packet loss and retransmission rate was captured by Wireshark with transfer mode in TCP as transfer mode in UDP always returned with zero packet loss and retransmission rate on Wireshark).

## 3. LAA and Wi-Fi Coexistence Tests

### 3.1 Base Line performance measurement on Wi-Fi – KPI measurement for Wi-Fi

**Description:**

This is the baseline performance measurement for Wi-Fi at vacant channel condition

**Reference:**

Coexistence Test Plan (Ver 1.1) of Wi-Fi Alliance, Section 4.5 Procedure A

**Test Equipment:**

- 1x Wi-Fi Station
- 1x Wi-Fi Client (Notebook Client)
- 1x Laptop (Server)

**Test Configuration:**

LAA Configuration	Test Setup	
LAA SCell is Turn Off	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
	Wi-Fi Network	1x Wi-Fi Station, 1x Wi-Fi Client (Good Coverage, ~ -40 to -50 dBm)
	Channel Map	Wi-Fi: Ch 40 (20MHz, 802.11ac mode) and Wi-Fi: Ch 157 (20MHz, 802.11ac mode)

**Test Result:**

This measurement result is used as reference case for test cases. No Pass/Fail for this case.

Wi-Fi Client	Result with Wi-Fi in Ch40	Result with Wi-Fi in Ch157
Download Throughput	113.7 Mbps	106 Mbps
Packet Lost	0%	0%
Retransmission	0%	0%
Latency	9 ms	14 ms
Jitter	3.6 ms	3.6 ms

## 3.2 Base Line performance measurement on LAA – KPI measurement for LAA

### Description:

This is the baseline performance measurement for LAA on vacant channel condition

### Reference:

No Reference

### Test Equipment:

- 1 x LAA eNode
- 1 x LAA UE

### Test Configuration:

LAA Configuration	Test Setup	
LAA SCell un Licensed Band is Turn On	Traffic Type	Full Buffer UDP
	Wi-Fi Network	No Wi-Fi
	Unlicensed Band of LAA Band 46: UNII-1: Band 46: UNII-3	Mapping to Wi-Fi Channel Ch 40 (20MHz BW, 5190 – 5210 MHz) Ch 157 (20MHz BW, 5775 – 5795 MHz) (Good Coverage, ~ -40~-50 dBm)

Remarks: 2600MHz carrier with 10MHz bandwidth was deployed on PCell Licensed band.

### Test Result:

This is the reference case of the test. No Pass/Fail for this case.

Download Throughput	PCell Licensed-Band	SCell Unlicensed Band	Total
LAA with Band 46, UNII-1 (Ch40)	70.6 Mbps	113 Mbps	183.6 Mbps
LAA with Band 46, UNII-3 (Ch157)	71 Mbps	113 Mbps	184 Mbps

The download throughput of LAA in 183 Mbps is captured, this is achieved by carrier aggregation of LTE frequency band with 10 MHz Bandwidth and unlicensed 5GHz frequency band with 20MHz Bandwidth. The download performance of LAA is similar the same with unlicensed band in UNII-1 and UMII-3.

## 3.3 Coexistence Test with 2x/4x Wi-Fi/LAA – KPI measurement for Wi-Fi/LAA

### Description:

The test is to verify any impact with Wi-Fi on coexistence of the Wi-Fi and LAA

### Reference:

Coexistence Test Plan (Ver 1.1) of Wi-Fi Alliance, Section 4.5 Procedure B and Procedure C

### Test Equipment:

- 4x Wi-Fi Stations
- 4x Wi-Fi Clients (Notebook Client)
- 4x Laptops (Server)
- 2 x LAA eNode
- 2 x LAA UE



## Test Configuration:

Item	LAA Configuration	Test Setup in Wi-Fi	
1	LAA BTS is Turn Off (Baseline for co-existence of 2 Wi-Fi in UNII-3)	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
		Wi-Fi Network	2x Wi-Fi Station, 2x Wi-Fi Client (Good Coverage, ~ -40 to -50 dBm)
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
2	1x LAA BTS is On with data transfer and replace 1 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz) (Co-existence of LAA in UNII-3)	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
		Wi-Fi Network	1x Wi-Fi Station, 1x Wi-Fi Client (Good Coverage, ~ -40 to -50 dBm)
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
3	LAA BTS is Turn Off (Baseline for Co-existence of 2 Wi-Fi in UNII-1)	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
		Wi-Fi Network	2x Wi-Fi Station, 2x Wi-Fi Client (Good Coverage, ~ -40 to -50 dBm)
		Channel Map	Wi-Fi: Ch 40 (20MHz, 802.11ac mode)
4	1x LAA BTS is On with data transfer and replace 1 Wi-Fi LAA SCell Unlicensed band set to UNII-1, Ch40 (20MHz BW, 5190 – 5210 MHz) (Co-existence of LAA in UNII-1)	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
		Wi-Fi Network	1x Wi-Fi Station, 1x Wi-Fi Client (Good Coverage, ~ -40 to -50 dBm)
		Channel Map	Wi-Fi: Ch 40 (20MHz, 802.11ac mode)
5	LAA BTS is Turn Off (Baseline for Co-existence 2 Wi-Fi in UNII-3)	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
		Wi-Fi Network	2x Wi-Fi Station, 2x Wi-Fi Client (Weak Coverage, ~ -82dBm)
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
6	1x LAA BTS is On with data transfer and replace 1 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz) (Co-existence of LAA in UNII-3)	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
		Wi-Fi Network	1x Wi-Fi Station, 1x Wi-Fi Client (Weak Coverage, ~ -82dBm)
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
7	LAA BTS is Turn Off (Baseline for co-existence of Multiple Wi-Fi in UNII-3)	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
		Wi-Fi Network	4x Wi-Fi Station, 4x Wi-Fi Client (Good Coverage, ~ -40 to -50 dBm)
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
8	1x LAA BTS is On with data transfer and replace 1 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz) (Co-existence of LAA with Multiple Wi-Fi in UNII-3)	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
		Wi-Fi Network	3x Wi-Fi Station, 3x Wi-Fi Client (Good Coverage, ~ -40 to -50 dBm)
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
9	2x LAA BTS is On in data transfer and replace 2 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz) (Co-existence of 2 LAA with 2 Wi-Fi in UNII-3)	Traffic Type	Full Buffer UDP/TCP from Server to Client
		Wi-Fi Network	2x Wi-Fi Station, 2x Wi-Fi Client (Good Coverage, ~ -40 to -50 dBm)
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
10	LAA BTS is Turn Off (Baseline for co-existence of Multiple Wi-Fi in UNII-3)	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
		Wi-Fi Network	4x Wi-Fi Station, 4x Wi-Fi Client (Weak Coverage, ~ -82 dBm)
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
11	2 x LAA BTS is On with data transfer and replace 1 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz) (Co-existence of LAA with Multiple Wi-Fi in UNII-3)	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
		Wi-Fi Network	3x Wi-Fi Station, 3x Wi-Fi Client (Weak Coverage, ~ -82 dBm)
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
12	2x LAA BTS is On in data transfer and replace 2 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz) (Co-existence of 2 LAA with 2 Wi-Fi in UNII-3)	Traffic Type	Full Buffer UDP/TCP from Server to Client
		Wi-Fi Network	2x Wi-Fi Station, 2x Wi-Fi Client (Weak Coverage, ~ -82 dBm)
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)

Remarks: LAA unlicensed band in UNII-3 with factory default setting in 1W EIRP was used to carry out the measures for coexistence test items of Wi-Fi and LAA

## **Test Result :**

Performance parameters of data throughput, packet loss, latency, retransmission, jitter and network connection time of a Wi-Fi Client under co-existence of Wi-Fi with LAA scenarios and co-existence of Wi-Fi APs scenarios are measured on all test items.

The test result illustrated that the measured performance parameters of Wi-Fi client under co-existence of Wi-Fi and LAA scenarios are having similar the same with co-existence of Wi-Fi APs scenarios. This is valid for the test scenarios for unlicensed band of LAA operated in UNII-3 with 1W EIRP downlink power. Hence, it is demonstrated that the co-existence of Wi-Fi and LAA will not impose any negative impact on usage experience of Wi-Fi user.

## 3.4 Wi-Fi Client Network Connection Test with existence of LAA

### Description:

The test is to verify any accessibility of Wi-Fi network with the existence of the LAA.

### Reference:

Coexistence Test Plan (Ver 1.1) of Wi-Fi Alliance, Section 4.2

### Test Equipment:

- 2x Wi-Fi Stations
- 11x Wi-Fi Client (Notebook Client/Handset)
- 2x Laptops (Server)
- 1 x LAA eNode
- 1 x LAA UE

### Test Configuration:

Item	LAA Configuration	Test Setup in Wi-Fi	
		Traffic Type	Wi-Fi Network
1	LAA BTS is Turn Off- (Base Line for accessibility on Co-existence of Wi-Fi)	Full Buffer UDP from Wi-Fi AP to Client	2x Wi-Fi Station, 11x Wi-Fi Client
		Wi-Fi Network	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
		Channel Map	
2	LAA BTS is On with data transfer and replace 1 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz) (Co-existence of LAA in UNII-3)	Full Buffer UDP from LAA to UE	1x Wi-Fi Station, 10x Wi-Fi Client
		Wi-Fi Network	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
		Channel Map	

### Test result :

No negative impact on accessibility and setup delay with Wi-Fi connections is observed on existence of LAA with Wi-Fi.

## 3.5 Streaming Service Test over Wi-Fi network with existence of LAA

### Description:

The test is to verify any impact on steaming service over Wi-Fi with the existence of LAA.

### Reference:

Coexistence Test Plan (Ver 1.1) of Wi-Fi Alliance, Section 4.4

### Test Equipment:

- 2x Wi-Fi Stations
- 2x Wi-Fi Clients (Notebook Client)
- 2x Laptops (Server)
- 1 x LAA eNode
- 1 x LAA UE

### Test Configuration:

Item	LAA Configuration	Test Setup in Wi-Fi	
1	LAA BTS is Turn Off- (Base Line for streaming service on Co-existence of Wi-Fi)	Traffic Type	Streaming on one Wi-Fi Client and Full Buffer UDP download from other Wi-Fi AP to Wi-Fi Client
		Wi-Fi Network	2x Wi-Fi Station, 2x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
2	LAA BTS is On with data transfer and replace 1 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz, Co-existence of LAA)	Traffic Type	Streaming on one Wi-Fi Client and Full Buffer UDP download from LAA to UE
		Wi-Fi Network	1x Wi-Fi Station, 1x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)

### Test Result :

No negative impact on picture quality of video and Wi-Fi user experience (No delay frame, picture stood and broken sound) is observed when a Wi-Fi neighbor is replaced by LAA.

## 3.6 VoIP Test over Wi-Fi network with existence of LAA

### Description:

The test is to verify any impact on VoIP service over Wi-Fi with the existence of LAA.

### Reference:

Coexistence Test Plan (Ver 1.1) of Wi-Fi Alliance, Section 4.4

### Test Equipment:

- 2x Wi-Fi Stations
- 2x Wi-Fi Clients (Notebook Client/Handset)
- 2x Laptops (Server)
- 1 x LAA eNode
- 1 x LAA UE

### Test Configuration:

Item	LAA Configuration	Test Setup in Wi-Fi	
1	LAA BTS is Turn Off- (Base Line for VoIP service on Co-existence of Wi-Fi)	Traffic Type	VoIP on one Wi-Fi Client and Full Buffer UDP download on Wi-Fi AP and Wi-Fi Client
		Wi-Fi Network	2x Wi-Fi Station, 2x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
2	LAA BTS is On with data transfer and replace 1 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz) (Co-existence of LAA)	Traffic Type	VoIP on one Wi-Fi Client and Full Buffer UDP from LAA to UE
		Wi-Fi Network	1x Wi-Fi Station, 1 x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)

### Test Result :

No negative impact on speech quality (No muting, No one way audio and No Clipping sound) is observed when a Wi-Fi neighbor is replaced by LAA.

## 3.7 Coexistence Test on Wi-Fi network with existence of LAA with different load

### Description:

The test is to verify the coexistence of Wi-Fi network with the existence of the LAA of different load.

### Reference:

Coexistence Test Plan (Ver 1.1) of Wi-Fi Alliance, Section 4.5 Procedure C

### Test Equipment:

- 2x Wi-Fi Stations
- 2x Wi-Fi Clients (Notebook Client)
- 2x Laptops (Server)
- 1 x LAA eNode
- 1 x LAA UE

### Test Configuration:

Item	LAA Configuration	Test Setup in Wi-Fi	
1	LAA BTS is Turn Off- (Base Line for load test on Co-existence of Wi-Fi)	Traffic Type	Wi-Fi: Full Buffer UDP from Wi-Fi AP to Client
		Wi-Fi Network	2x Wi-Fi Station, 2x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
2	LAA BTS is On with data transfer and replace 1 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz) (Co-existence of LAA)	Traffic Type	Wi-Fi: Full Buffer UDP from Wi-Fi AP to Client LAA: 25% Load UDP
		Wi-Fi Network	1x Wi-Fi Station, 1x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
3	LAA BTS is On with data transfer and replace 1 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz) (Co-existence of LAA)	Traffic Type	Wi-Fi: Full Buffer UDP from Wi-Fi AP to Client LAA: 50% Load UDP
		Wi-Fi Network	1x Wi-Fi Station, 1x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
4	LAA BTS is On with data transfer and replace 1 Wi-Fi LAA SCell Unlicensed band set to UNII-3, Ch157 (20MHz BW, 5775 – 5795 MHz) (Co-existence of LAA)	Traffic Type	Wi-Fi: Full Buffer UDP from Wi-Fi AP to Client LAA: Full Buffer UDP
		Wi-Fi Network	1x Wi-Fi Station, 1x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)

### Test Result :

The Wi-Fi Client is having similar the performance as baseline, no negative impact on usage experience of Wi-Fi user with coexistence of LAA under different load condition is observed.

## 3.8 Adjacent Channel Test on Wi-Fi network with existence of LAA

### Description:

The test is to verify impact of Wi-Fi network on adjacent channel with LAA.

### Reference:

Coexistence Test Plan (Ver 1.1) of Wi-Fi Alliance, Section 4.3 Procedure F

### Test Equipment:

- 3x Wi-Fi Stations
- 3x Wi-Fi Clients (Notebook Client)
- 3x Laptops (Server)
- 1 x LAA eNode
- 1 x LAA UE

Item	LAA Configuration	Test Setup in Wi-Fi	
		Traffic Type	
1	LAA BTS is Turn Off- (Base Line for adjacent of 2 Wi-Fi)	Traffic Type	Full Buffer UDP from Wi-Fi AP to Client
		Wi-Fi Network	2x Wi-Fi Station, 2x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode) Wi-Fi: Ch 161 (20MHz, 802.11ac mode)
2	LAA BTS is On with data transfer and replace the Ch161 Wi-Fi with LAA SCell Unlicensed band set to UNII-3, Ch 161 (20MHz BW, 5795 – 5815 MHz) (Adjacent Channel of LAA to Wi-Fi)	Traffic Type	Full Buffer UDP from Wi-Fi AP to Client
		Wi-Fi Network	1x Wi-Fi Station, 1x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode)
3	LAA SCell is Turn Off (Base Line for adjacent of 3 Wi-Fi)	Traffic Type	Full Buffer UDP from Server to Client
		Wi-Fi Network	3x Wi-Fi Station, 3x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode) Wi-Fi: Ch 161 (20MHz, 802.11ac mode) Wi-Fi: Ch 165 (20MHz, 802.11ac mode)
4	LAA BTS is On with data transfer and replace the Ch161 Wi-Fi with LAA SCell Unlicensed band set to UNII-3, Ch 161 (20MHz BW, 5795 – 5815 MHz) (Adjacent Channel of LAA to 2 Wi-Fi)	Traffic Type	Full Buffer UDP from Server to Client
		Wi-Fi Network	2x Wi-Fi Station, 2x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode) Wi-Fi: Ch 165 (20MHz, 802.11ac mode)

### Test Result :

The performance parameters (such as throughput, network access time, latency etc.) of Wi-Fi client under co-existence of Wi-Fi and LAA scenarios are similar the same with base line case. Hence, no negative impact on usage experience of Wi-Fi user with coexistence of LAA under adjacent condition.

## 3.9 Channel Selection / Re-selection Test of LAA with the existence of Wi-Fi

### Description:

The test is to verify the available of channel re-selection feature on LAA with existence of Wi-Fi.

### Reference:

Coexistence Test Plan (Ver 1.1) of Wi-Fi Alliance, Section 4.1 Procedure B

### Test Equipment:

- 2x Wi-Fi Stations
- 2x Wi-Fi Clients (Notebook Client)
- 2x Laptops (Server)
- 1 x LAA eNode
- 1 x LAA UE

### Test Configuration:

Item	LAA Configuration	Test Setup in Wi-Fi	
1	LAA BTS On with LAA SCell Unlicensed band set to UNII-3, Ch157 (20 MHz BW, 5775 – 5795 MHz)	Traffic Type	Full Buffer UDP/TCP from Wi-Fi AP to Client
		Wi-Fi Network	2x Wi-Fi Station, 2x Wi-Fi Client
		Channel Map	Wi-Fi: Ch 157 (20MHz, 802.11ac mode) Wi-Fi: Ch 161 (20MHz, 802.11ac mode)

### Test Result :

Test result demonstrates that LAA takes less than 1 second to perform the channel reselection to vacant channel, this mitigation function of LAA is effective and working fine.



## 4. Overall Summary

It is concluded that all tests were passed as detailed in the table below.

Test Case	Description	WFA Reference	Pass / Fail
3.1	Base Line performance measurement on Wi-Fi – KPI measurement for Wi-Fi	Section 4.5	Pass
3.2	Coexistence Test with 2x/4x Wi-Fi/LAA – KPI measurement for Wi-Fi/LAA	Section 4.3	Pass
3.3	Wi-Fi Client Network Connection Test with existence of LAA	Section 4.2	Pass
3.4	Streaming Service Test over Wi-Fi network with existence of LAA	Section 4.4	Pass
3.5	VoIP Test over Wi-Fi network with existence of LAA	Section 4.4	Pass
3.6	Coexistence Test on Wi-Fi network with existence of LAA of different load	Section 4.5	Pass
3.7	Adjacent Channel Test on Wi-Fi network with existence of LAA	Section 4.3	Pass
3.8	Channel Selection / Re-selection Test of LAA with the existence of Wi-Fi	Section 4.1	Pass

Based on the result, it was demonstrated that existing Wi-Fi networks were not negatively affected by the coexistence of an LAA device more than an additional Wi-Fi device. Many of the test cases were done by forcing both the Wi-Fi device and the LAA device to use the same radio channel, and this is considered the worst-case scenario. In most of the actual situation when channel selection procedure is effective, the Wi-Fi device and LAA device will select and use different radio channels, and the interaction between the two can be avoided.

With better interference mitigation and resource sharing algorithm, LAA proves to improve the user throughput, overall network capacity and spectral efficiency of the unlicensed band. The overall test result on coexistence of LAA and Wi-Fi network is positive for Wi-Fi in terms of end user applications perspective, and positive in terms of overall system perspective.