

Test Report
For
Trial of 5G Base Station and User Equipment
operating at 3.5 GHz band



HTCL
September, 2019

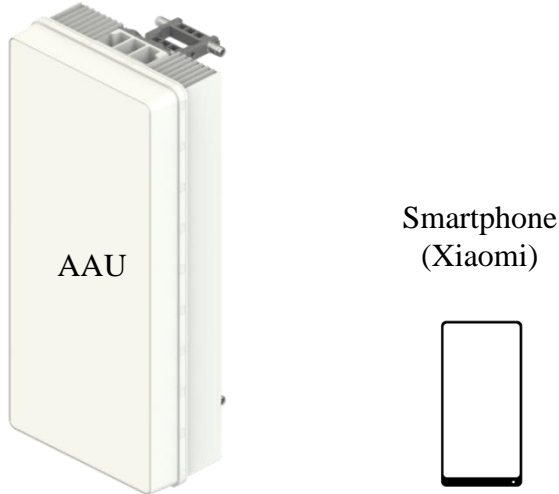
1. Introduction

On 21 March 2017, the Communications Authority (“CA”) promulgated its work plan for making available additional radio spectrum for public mobile services to meet the increasing aspirations of service users towards 2020 and beyond. The work plan has identified a number of frequency bands, including the 3.4 – 3.6 GHz band (“3.5 GHz band”), the 24.25 – 27.5 GHz band and the 27.5 – 28.35 GHz band (“26/28 GHz bands”), that can be made available for reallocation to mobile services to prepare for the launch of 5th generation mobile (“5G”) services.

Temporary permit was issued by the CA to Hutchison Telephone Company Limited (“HTCL”) in 1Q-2019 for conducting 5G NR network trial tests in the 3.5 GHz in 2019.

2. Test scope

2.1) Test equipment and device



Equipment	Item	Specifications
Active Antenna Unit (AAU)	Frequency Band	3.5 GHz
	Max Bandwidth	100 MHz
	TxRx Configuration	64T64R
	Polarization	+45° / -45°
	Sweep Range	H:15° ~ 90°, V: -8° ~ 25°
Smartphone (Xiaomi)	Frequency Band	NR: 3.5 GHz, LTE: 1.8 GHz
	TxRx Configuration	1T4R

2.2) Test locations

Location	Scenario	Bands	Antenna Configuration
Hutchison Telecom Tower (“HTT”)	Indoor	3.5 GHz band	bearing = 60° ~ 120° down-tilt = 0°
Causeway Bay	Outdoor	3.5 GHz band	height = 20 meter bearing = 250° down-tilt = 10°



5G AAU on 3.5 GHz band at trial location in Causeway Bay

2.3) Test configuration

Frequency			DL : UL	Modulation	Max EIRP	
Band	Range	SCS			AAU	Phone
3.5 GHz	100 MHz	30 KHz	4 : 1	256QAM (DL)	25 dBm (Indoor)	20 dBm (Indoor)
	3.45-3.55 GHz			64QAM (UL)	45 dBm (Outdoor)	26 dBm (Outdoor)

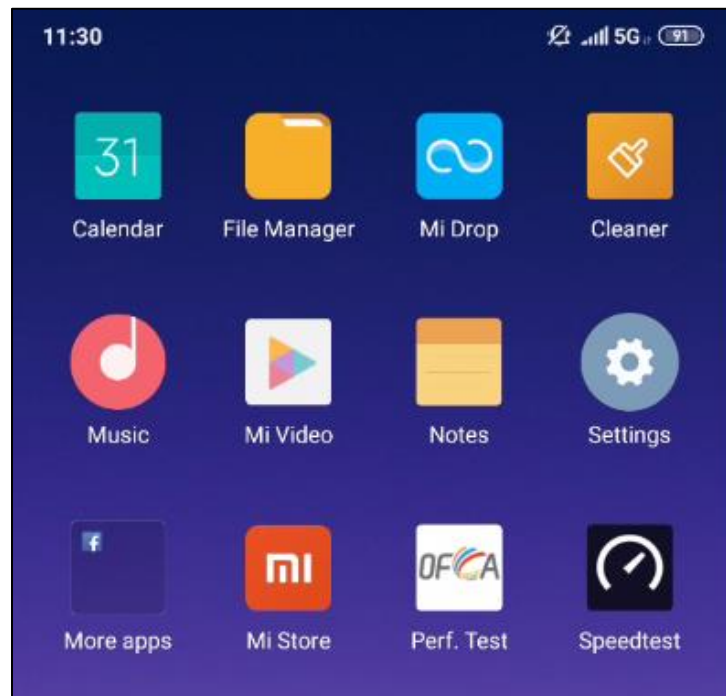
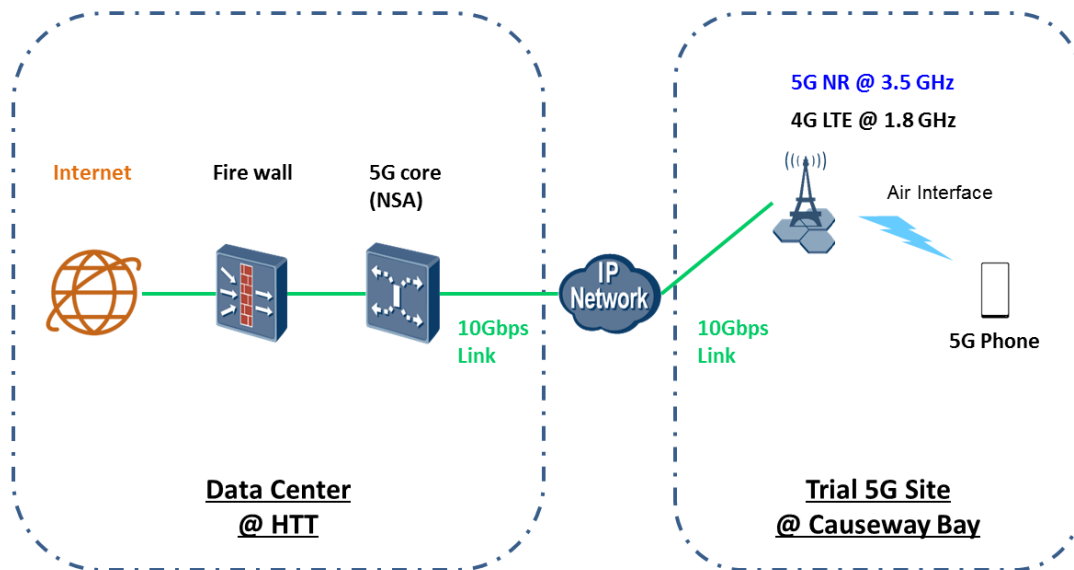
SCS refers to Sub-Carrier Spacing.

The theoretical air interface max speed under such configuration is around 1.7 Gbps and 82 Mbps for downlink and uplink, respectively.

2.4) Test setup diagram

An end-to-end 5G network architecture was built using non-standalone (NSA) option 3x based on 3GPP standard release 15. The co-located LTE 1.8 GHz band (2x 10 MHz bandwidth) was used as the anchoring carrier of 5G NR.

A 5G smartphone from Xiaomi was used for testing the speed and latency of the 5G network using OFCA's speed test app (<http://speedtest.ofca.gov.hk/>)



3. Test Results

3.1) Test at the indoor locations

Due to the limited test period and resources available, only initial configuration of test equipment and devices were arranged at the indoor location, before moving forward to the outdoor location for more comprehensive trial tests.

3.2) Test at the outdoor locations

A) Outdoor test locations and radio environment



Test Location	5G NR RSRP	5G NR SINR
1	-87 dBm	22 dB
2	-98 dBm	17 dB

B) Speed Test

5pcs of tests are conducted at each location using OFCA's speed test app.

The measured max speed in average is 1.1 Gbps and 77 Mbps for downlink and uplink, respectively, which is around 65% and 95% of the theoretical max speed.

Test Location	Test No.	Downlink (Mbps)	Uplink (Mbps)
1	1	1,106	67.1
	2	1,134	76
	3	1,111	72.6
	4	1,106	69.4
	5	1,074	73.1
	Average	1,106	71.6
2	1	714	80.1
	2	664	82.3
	3	659	75.8
	4	706	73.9
	5	694	73.9
	Average	687	77.2

The relatively better performance measured on uplink is because it is easier for uplink to achieve its max data stream layer (1 layer) than that for downlink (4 layers) under the measurement environment.

The main reasons for the differences between the theoretical max speeds and measured max speeds are considered as below:

- imperfect radio conditions, e.g. SINR, Tx/Rx layers, modulations etc;
- constraints on the test device, e.g. system processing capability;
- inadequate time and resources to perform end-to-end optimization, e.g. on transmission backhaul, application protocol, interface and equipment;

C) Latency Test

5pcs of tests are conducted at location 1 using OFCA's speed test app.

Test Location	Test No.	5G NR (ms)	4G LTE (ms)
1	1	14	39
	2	13	35
	3	13	33
	4	13	34
	5	13	33
	Average	13.2	34

The measured latency in average is 13 ms on 5G NR, which is much faster than the 34 ms on 4G LTE.

Nevertheless, there are many factors which may affect the end to end round trip time latency results, such as network architecture, network loading, equipment processing capability and transmission delay etc. We would further explore these issues in the following 5G trial test and deployment.

4. Conclusions and Way Forward

In all, this trial test have successfully demonstrated the capability and performance of a 5G smartphone under an end-to-end 5G network operating at 3.5 GHz band. This 5G network is configured using the NSA option 3x, as specified in 3GPP standardization release 15.

In the outdoor environment, the measured max speed in average is 1.1 Gbps and 77 Mbps for downlink and uplink, respectively, which is around 65% and 95% of the theoretical max speed. The measured latency in average is 13 ms on 5G NR, which is much faster than that on 4G LTE.

We would further explore the capability and performance of the other types of 5G smartphone in the following 5G trial test and deployment.