

# AOT THROUGHPUT TEST SERVICES

202310

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# 1. Services Overview

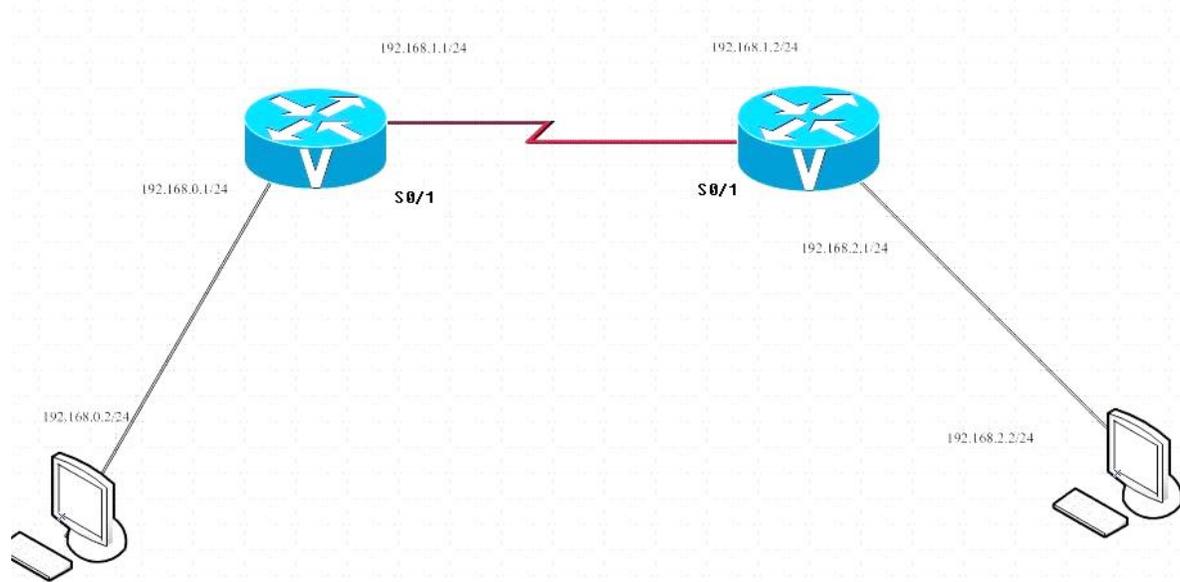
- Antenna design expertise, test and validation service, and production validation testing services to support multiple product evaluations. It includes the following two distinct design stages:
  - Pre-Production Test Support: Testing is focused on providing preliminary validation and testing support for all pre-production products. This may include, but is not limited to, gateways, media bridges, set-top boxes, client stations, and sensors. This testing is intended to aid in understanding and evaluation of the performance of various chipset platforms, device configurations, and in-home deployment scenarios.
  - Production Validation Testing: Testing specific to the validation and testing of a Home Media Networking system. The testing will include a single access point (AP) and multiple single model stations (STA). The AP may be integrated into a STB or a standalone unit that plugs into an STB. Likewise, the STA may be integrated into STB or standalone. In either configuration, testing requires that external test fixtures can pass throughput from the AP to the STA via Ethernet into the AP and Ethernet out of the STA.

## 2. Validation and Test Services

- ❑ Testing and characterization of access point and client devices to determine the relative throughput performance characteristics of each device
- ❑ Testing options focus on different aspects of wireless system performance, to include the following:
  - Initial verification testing
  - Throughput testing
    - Point-to-point (P2P)
    - Point-to-multipoint (P2MP)
  - Interference testing
  - Interoperability testing
  - Competitive benchmark testing

# 2.1 Verification Testing

- Initial test to ensure the ability of the AP and STA to operate with each other
- Verification includes confirming the final deployment configuration and the ability of the units to associate, ping, and pass traffic
- The goal of this test is to validate that the units are capable of going through the main phases of this test plan

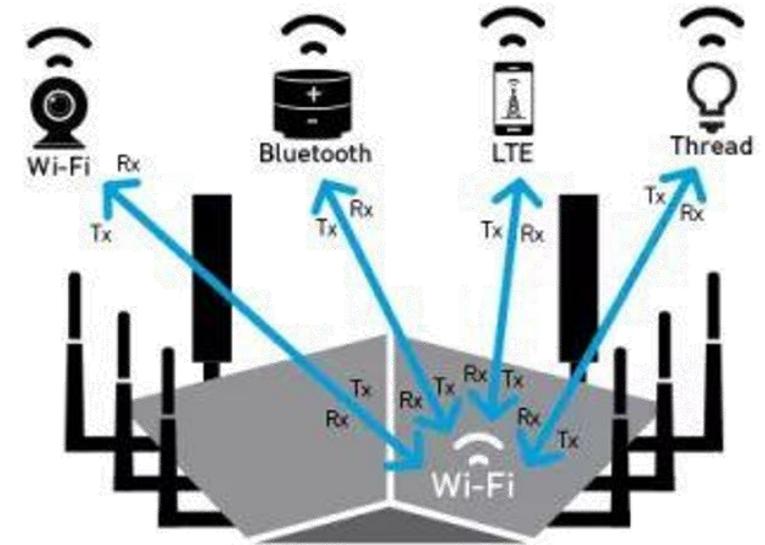


## 2.2 Throughput Testing

- Base level throughput analysis to measure typical over-the-air performance across various test link and environmental conditions.
  - Consists of transmitting a maximum and steady traffic load across the wireless link to measure the maximum throughput that is attainable
  - Performed at commercial office and residential test facilities
- Testing conducted for Point-to-Point and Point-to-Multipoint scenarios
  - **Point-to-Point** - Single client test to measure throughput between AP and client
    - Testing for each device pair conducted at short, medium and long range test links
  - **Point-to-Multipoint** - Multi-client test designed to measure how AP distributes traffic to multiple devices, e.g., three, four and five client test environments
    - Clients equally distributed at short, medium, and long range test locations

## 2.3 Interference Testing

- This will test the systems in a controlled environment with various sources of interference introduced. Examples include same channel, adjacent channel and two channels removed 802.11-traffic interference and non-802.11 interference in the same frequency band using commercially available cordless telephones as the interference source. The effect of the interference on throughput is observed. Then separately the system's ability to move to a free channel and the effect of the channel change on packet loss is measured.



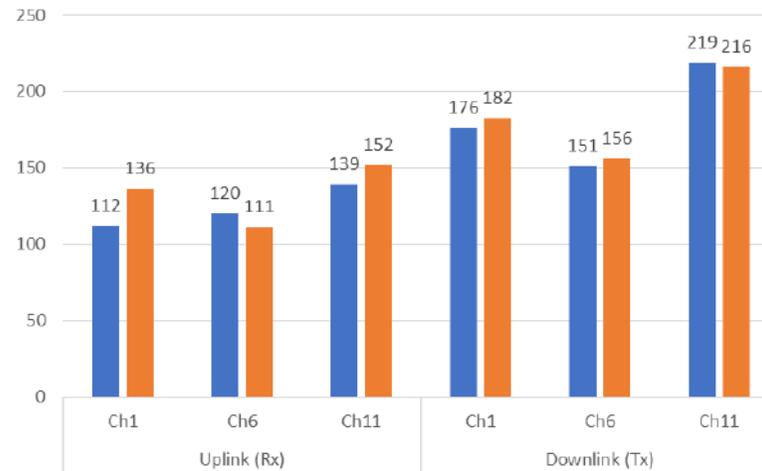
External Device Interference

## 2.4 Interoperability Testing - Multiple Clients

- Interoperability testing to characterizing the performance of access point with client devices found in a typical home or small office
  - Devices include media bridges, laptops, tablets, and smart phones.
  - Testing designed to compare relative throughput performance of client devices in both point-to-point and point-to-multipoint scenarios
- Testing conducted for Point-to-Point and Point-to-Multipoint scenarios:
  - Point-to-Point : Single client test to measure throughput between AP and client
    - Testing for each device pair conducted at short, medium and long range test links
  - Point-to-Multipoint (P2MP) - Multi-client test designed to measure how AP distributes traffic to multiple clients, e.g., three, four and five client tests
    - Clients equally distributed at short, medium and long range test locations
    - Each client device must first be characterized in a single client throughput test.

## 2.5 Competitive Benchmark Testing

- Optional benchmark testing of home networking products against other competitor devices. Testing may include any of the prior testing, including point-to-point and point-to-multipoint throughout testing, rate vs. range testing, and interoperability testing.



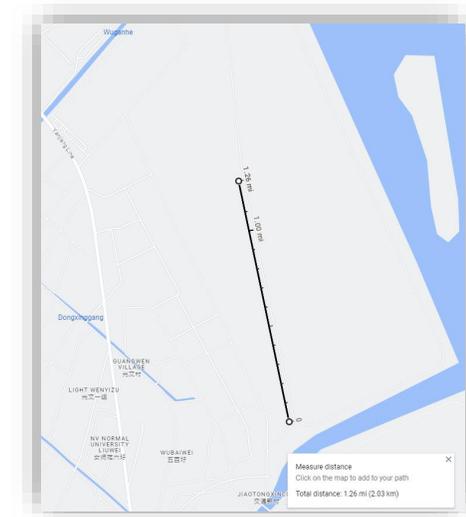
# 3. Throughput Test Scenarios

- Point-to-Point

- Short range
  - » RSSI between -30 and -40 dBm
  - » Focus is on max achievable throughput
  - » Line of site and/or walls
- Mid range
  - » RSSI between -65 and -75 dBm
  - » No line of site, walls
- Long range
  - » RSSI  $\geq$  -85dBm
  - » Focus is on reach
  - » No line of site, walls, office environment

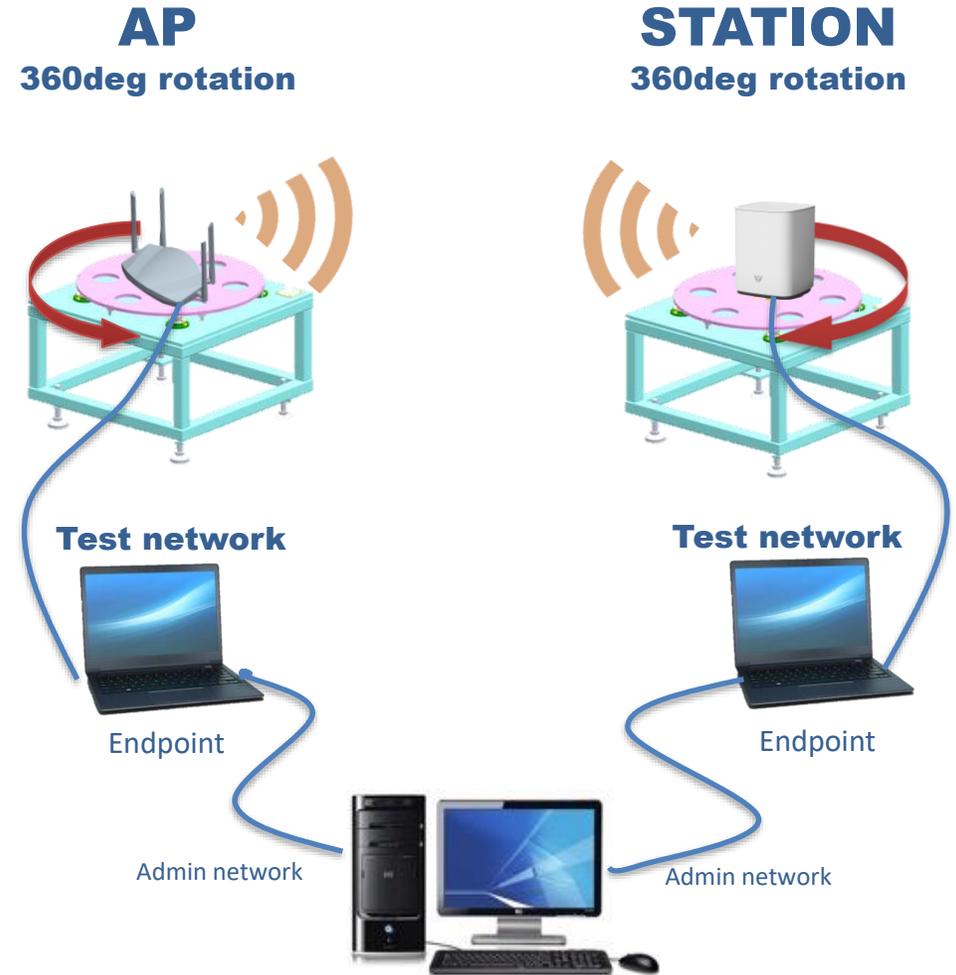
- Point-to-Multipoint

- P3MP
  - RSSI of -30, -65, and -85 dBm
  - Rate capped to (TBD)
  - Line of site and/or walls
- P4MP (optional)
  - RSSI of -30, -65, -80, and -85 dBm
  - Rate capped to (TBD)
  - Line of site and/or walls
- P5MP (optional)
  - RSSI of -30, -45, -65, -70, and -85 dBm
  - Rate capped to (TBD)
  - Line of site and/or walls



# 3.1 OTA T-put Test Process

- AOT method for extensive OTA throughput testing
  - Testing system manages effect of multipath fading on testing reliability
  - Both downlink (Tx) and uplink (Rx) throughput tests at different levels
- Traffic Type: TCP or UDP
- Traffic Measurement Software: IxChariot
- Client & Access Point Locations:
  - Both placed on a step-motion turntable rotating with a step size of 10 degrees
- Testing options focus on different aspects of wireless system performance, to include the following:
  - Initial verification testing
  - Throughput testing
  - Point-to-point (P2P)
  - Point-to-multipoint (P2MP)
  - Interference testing
  - Competitive benchmark testing



## 3.2 Office & Residential Test Environments (Indoor)

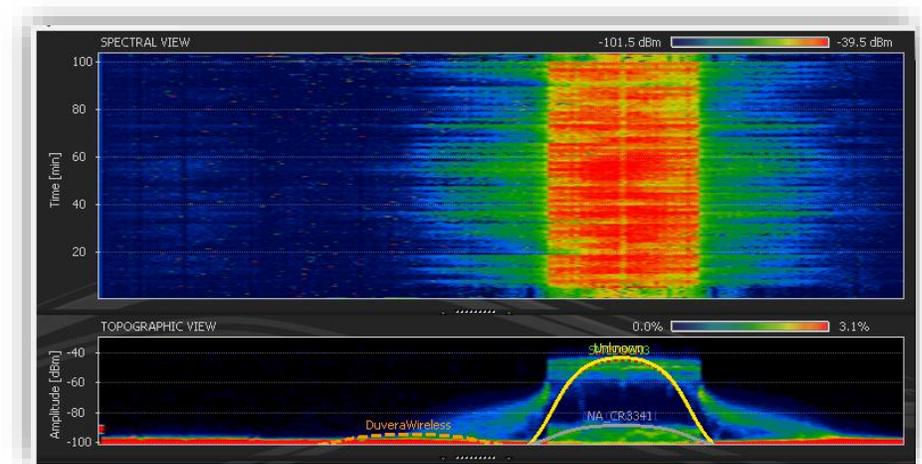
- Superior design is based on reliable performance testing
  - residential and office test environments for over-the-air throughput testing
  - anechoic chambers for antenna pattern testing

Suzhou Chamber



## 3.3 OTA T-put Test Scenarios (Indoor)

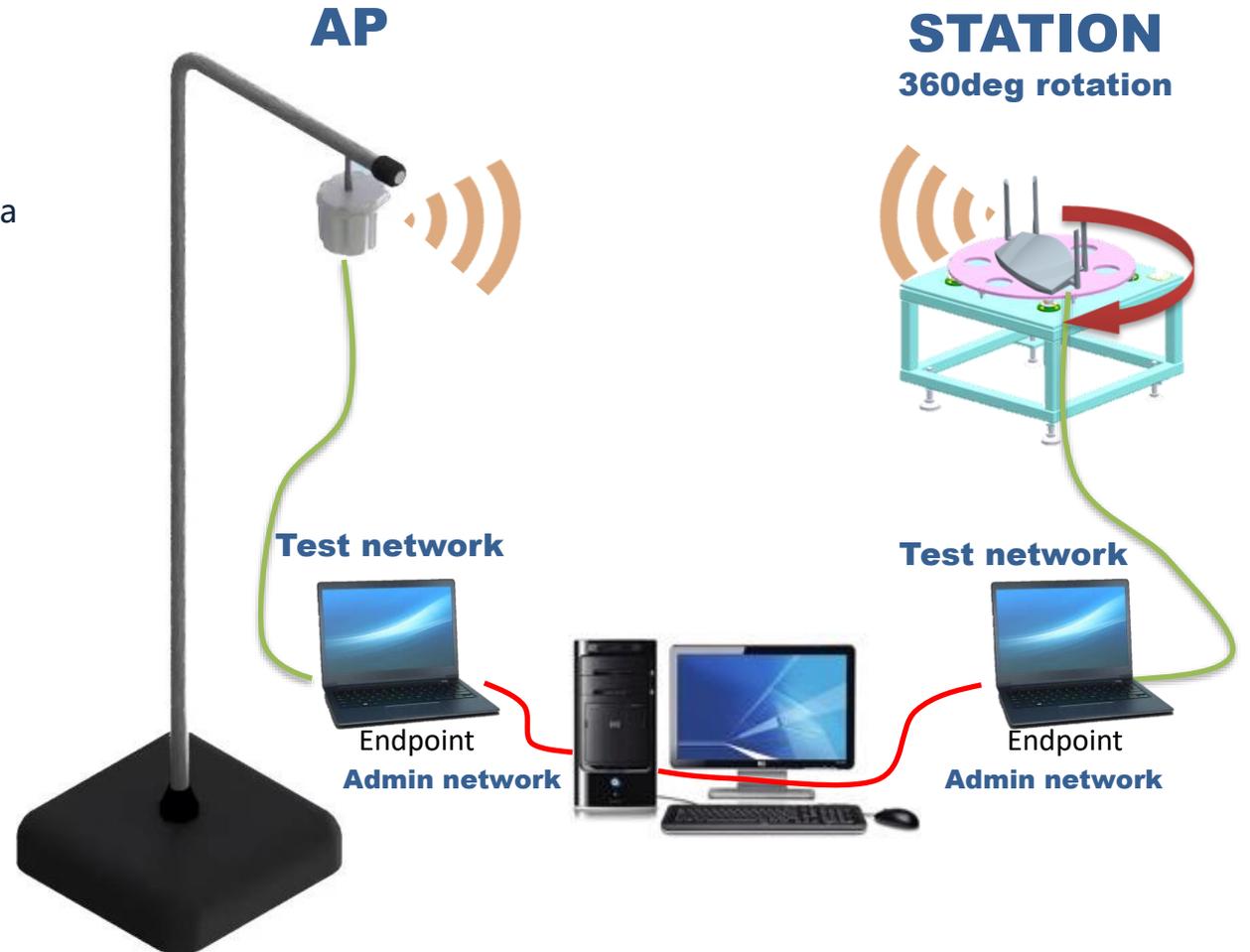
- Test Environment: selected based on measurement requirements
  - Office & Residential Test Environments
- Environment Conditions:
  - Clean measurement environment w/o external interferers
  - Spectrum monitored during all measurements
- Test Links:
  - LoS (short range, long range >100m), NLoS (various)
  - Specific distance and number of walls between an AP and a client
  - Multi-floor measurement setup



Spectrum Monitoring of OTA Testing

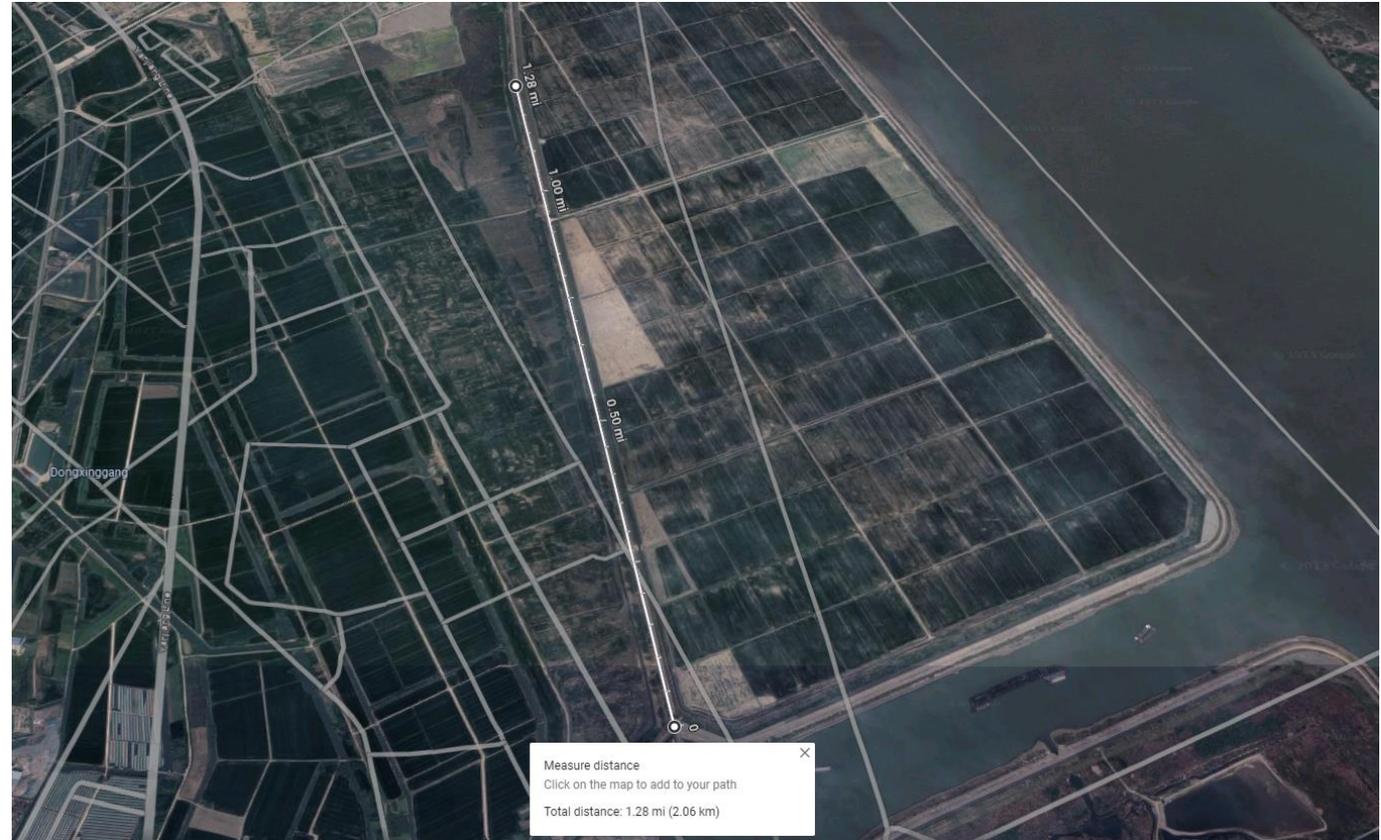
## 3.4 OTA T-put Test Scenarios (Outdoor)

- Environment Conditions:
  - Clean measurement environment w/o external interferers
  - Spectrum monitored during all measurements
- Client & Access Point Locations:
  - The STATION is placed on a step-motion turntable rotating with a step size of 10 degrees

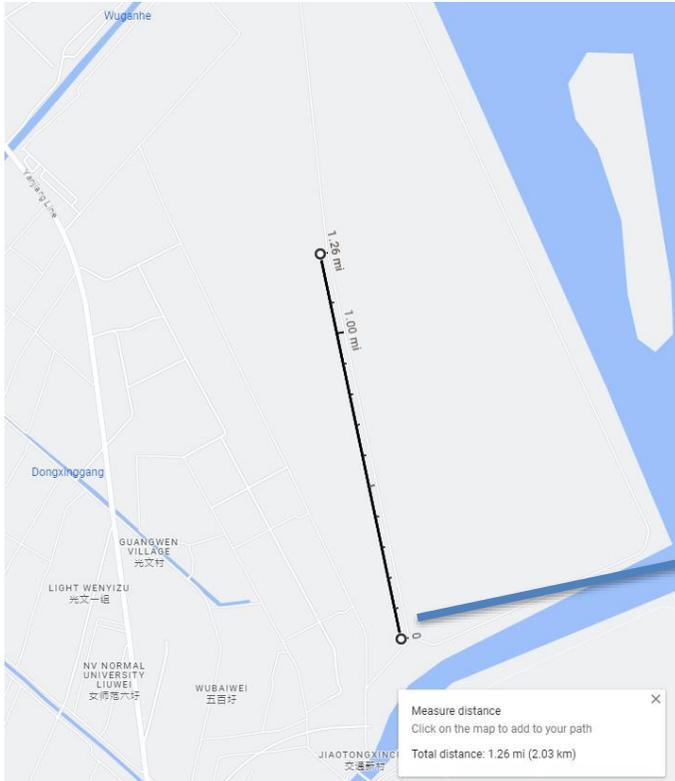


## 3.4 OTA T-put Test Scenarios (Outdoor)

- Test Environment: Suzhou
- Test Links:
  - LoS (short range, long range : up to 2km)



# 3.4 OTA T-put Test Scenarios (Outdoor)



# Appendix



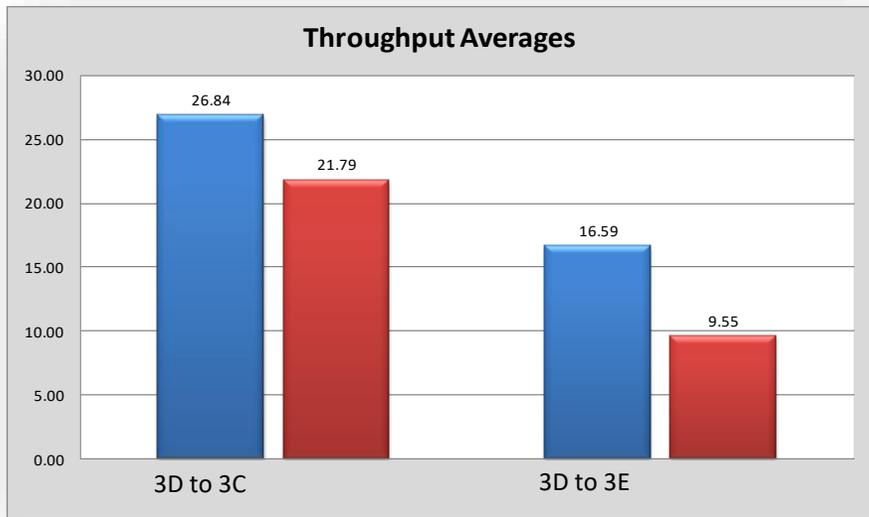
# OTA T-put Test Plan Sample (Indoor)

P2P Test Plan							
Test Type	Traffic Type	AP	STA	Bandwidth	Channel	Link Type	Test
Point-to-Point (P2P)	Downlink Traffic throughput test (360 degree / 36 steps)	AP-xxx	STA	20MHz	2.4GHz Band Channel 1	RSSI -45 dBm	1
						RSSI -70 dBm	2
						RSSI -75 dBm	3
					2.4GHz Band Channel 6	RSSI -45 dBm	4
						RSSI -70 dBm	5
						RSSI -75 dBm	6
					2.4GHz Band Channel 11	RSSI -45 dBm	7
						RSSI -70 dBm	8
						RSSI -75 dBm	9
				80MHz	5GHz Low Channel 36	RSSI -45 dBm	10
						RSSI -75 dBm	11
						RSSI -79 dBm	12
					5GHz Low Channel 64	RSSI -45 dBm	13
						RSSI -75 dBm	14
						RSSI -79 dBm	15
					5GHz High Channel 100	RSSI -45 dBm	16
						RSSI -75 dBm	17
						RSSI -79 dBm	18
	5GHz High Channel 157			RSSI -45 dBm	19		
				RSSI -75 dBm	20		
				RSSI -79 dBm	21		
	20MHz			Uplink Traffic throughput test (360 degree / 36 steps)	2.4GHz Band Channel 1	RSSI -45 dBm	22
						RSSI -70 dBm	23
						RSSI -75 dBm	24
					2.4GHz Band Channel 6	RSSI -45 dBm	25
						RSSI -70 dBm	26
						RSSI -75 dBm	27
					2.4GHz Band Channel 11	RSSI -45 dBm	28
						RSSI -70 dBm	29
						RSSI -75 dBm	30
	80MHz				5GHz Low Channel 36	RSSI -45 dBm	31
						RSSI -75 dBm	32
						RSSI -79 dBm	33
					5GHz Low Channel 64	RSSI -45 dBm	34
						RSSI -75 dBm	35
						RSSI -79 dBm	36
					5GHz High Channel 100	RSSI -45 dBm	37
						RSSI -75 dBm	38
						RSSI -79 dBm	39
	5GHz High Channel 157			RSSI -45 dBm	40		
				RSSI -75 dBm	41		
				RSSI -79 dBm	42		

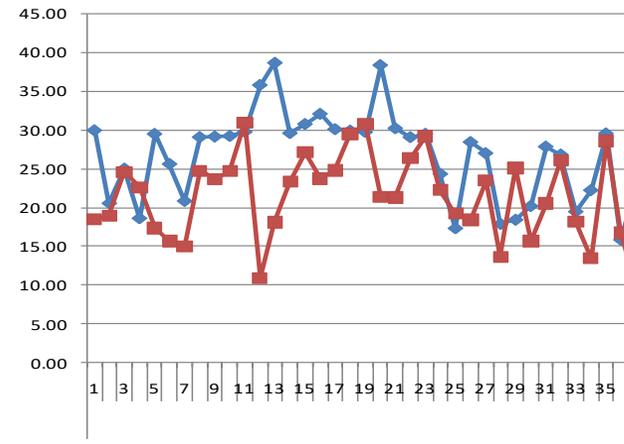
# OTA T-put Test Plan Sample (Outdoor)

5G Result		Client														
Distance(Client<->AP)	channel BW	Orientation	AP TX Power	RSSI	RSSI	TX(Mbps)	RX(Mbps)	RX Link		Test Time	MCS rate		NSS		Bandwidth	
				AP	Client			TX Link Rate (Mbps)	Rate (Mbps)		TX	RX	TX	RX	TX	RX
10m	157 VHT80	0	25							90s						
	157 VHT80	90	25							90s						
	157 VHT80	180	25							90s						
	157 VHT80	270	25							90s						
	Average		25							90s						
50m	157 VHT80	0	25							90s						
	157 VHT80	90	25							90s						
	157 VHT80	180	25							90s						
	157 VHT80	270	25							90s						
	Average		25							90s						
100m	157 VHT80	0	25							90s						
	157 VHT80	90	25							90s						
	157 VHT80	180	25							90s						
	157 VHT80	270	25							90s						
	Average		25							90s						
210m	157 VHT80	0	25							90s						
	157 VHT80	90	25							90s						
	157 VHT80	180	25							90s						
	157 VHT80	270	25							90s						
	Average		25							90s						
445m	157 VHT80	0	25							90s						
	157 VHT80	90	25							90s						
	157 VHT80	180	25							90s						
	157 VHT80	270	25							90s						
	Average		25							90s						
670m	157 VHT80	0	25							90s						
	157 VHT80	90	25							90s						
	157 VHT80	180	25							90s						
	157 VHT80	270	25							90s						
	Average		25							90s						

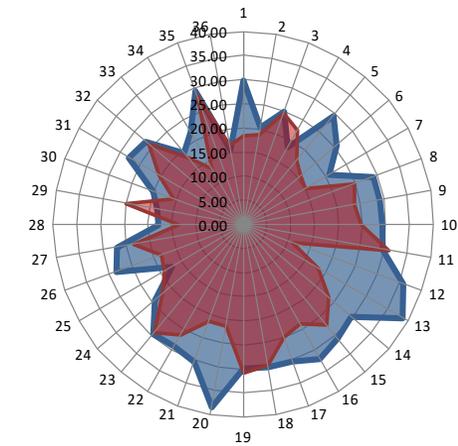
# OTA T-put Test Result Sample



Individual data 36 stop test



Polar Area Graph





# Thank you!