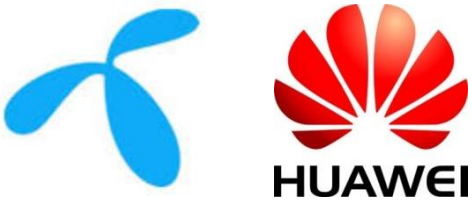
Huawei Microwave Radio System
26/28GHz NG-PTMP Test Report for Telenor



Huawei Technologies Co., Ltd.

Contents

1 OVERVIEW

1.1 Introduction

Purpose of this document is to provide a description of the activities performed for innovation case of the microwave radio product – NG-PTMP (26&28GHz).

1.2 The Innovation Case Description with Telenor

1. NG-PTMP product is an innovation of Huawei in the microwave industry. We need a more professional customer like Telenor to explore the direction of innovation and define new products. We hope to explore together through this kind of joint testing.
2. Our scope of cooperation includes: defining and exploring commercial scenarios and cases together, and defining product specifications (bandwidth, auto-aligning, anti-interference, product form, etc.) with Telenor.
3. Based on the discussion and exploration of the above two parts, defining the core chipset specification is an extremely important step for the release of commercial products in the future. This is the key scenario and factor that determines the future commercial PTMP products.

Therefore, we recommend to complete it in a few steps. In the first step, we will carry out the communication and testing of the prototype together, and the customer has a preliminary concept and understanding of product performance. After this innovative test is completed, Telenor will have a full understanding of product performance. Based on this test process and results, we can open some discussion and exploration. We sincerely hope that Telenor will join in this joint innovation test.

1.3 Devices information

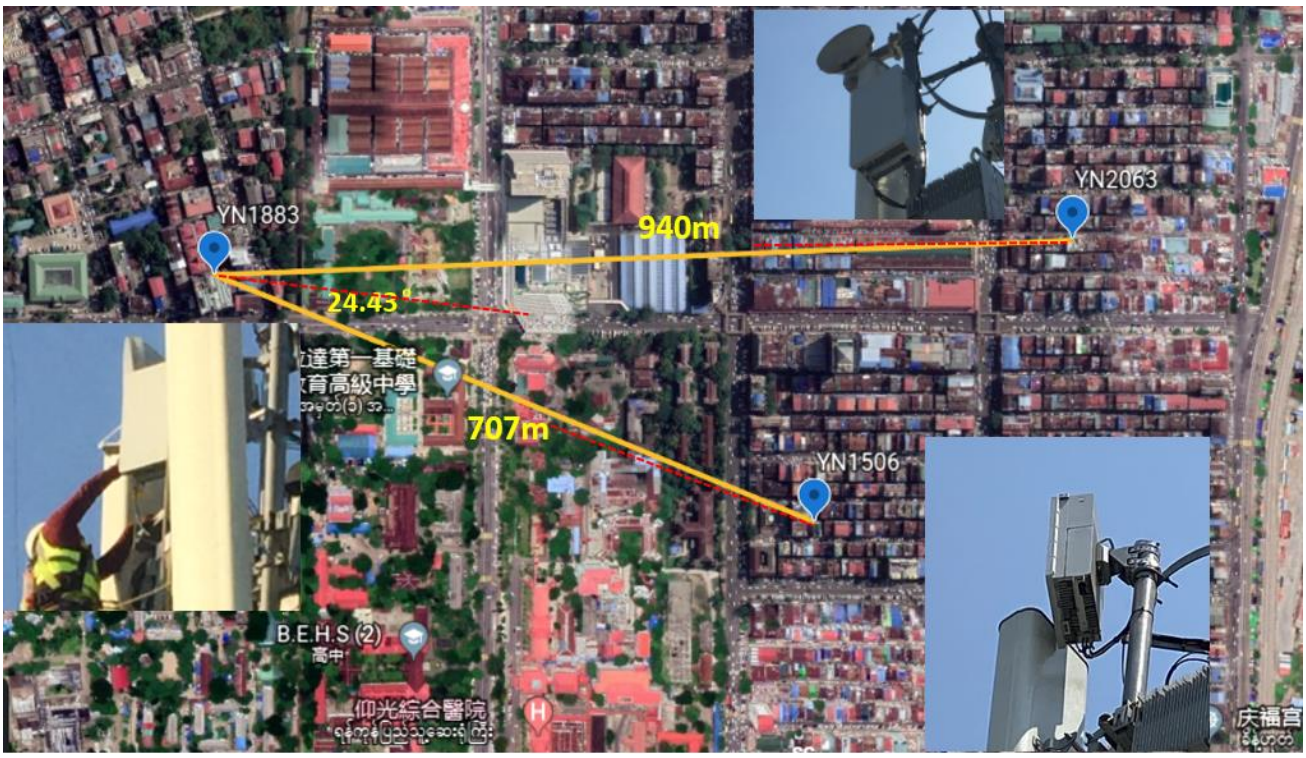
Product	Version	Quantity	Remark
BBU5900	/	3	NG-PTMP prototype
HAAU5213	/	3	

1.4 Test Meters Information

Type of Meter	Manufacture	Model and Serial number	Quantity
Embedded in GUI	-	-	1

1.5 Link Information

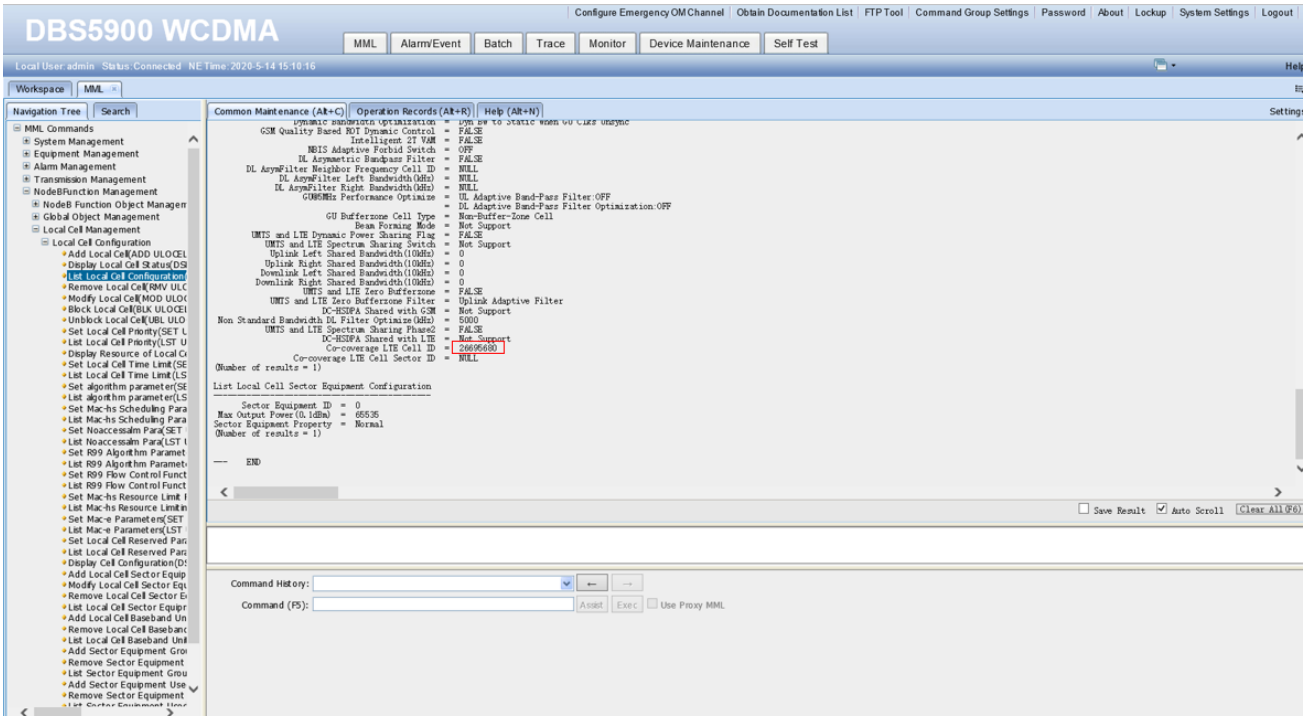
1.5.1 Field Map



1.5.2 Site Information

Parameters	Hub	Leaf 1	Leaf 2
Name	YN1883	YN2063	YN1506
Longitude	96.15374	96.15395	96.15113
Latitude	16.78223	16.77368	16.77634
Path Distance	/	940m	707m
Streams	/	2	2
Air capacity	/	3.95Gbps	3.95Gbps

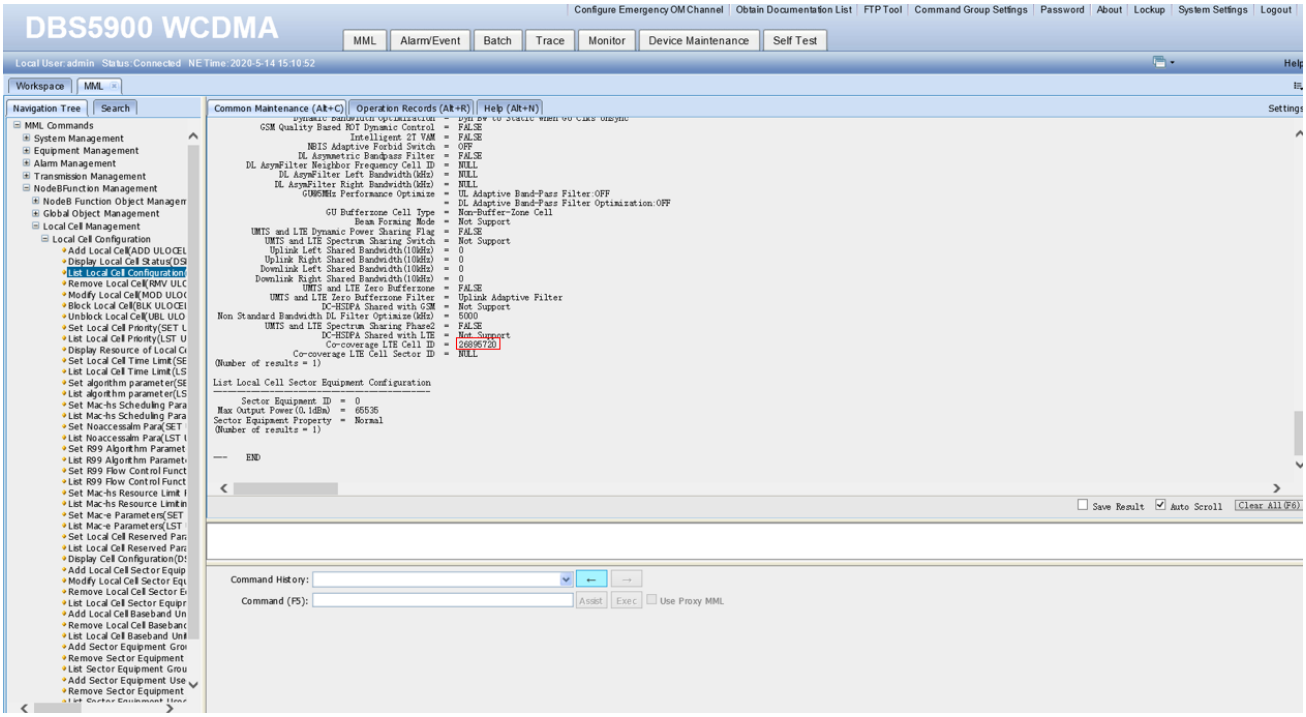
Frequency configuration: each site have two cells, first Cell 26.695680GHz; second Cell 26.895720GHz
Bandwidth: first Cell 200MHz, second Cell 200MHz, total 400MHz.
NG-PTMP is a TDD product, the frequency configuration of the three sites is same.
First cell:

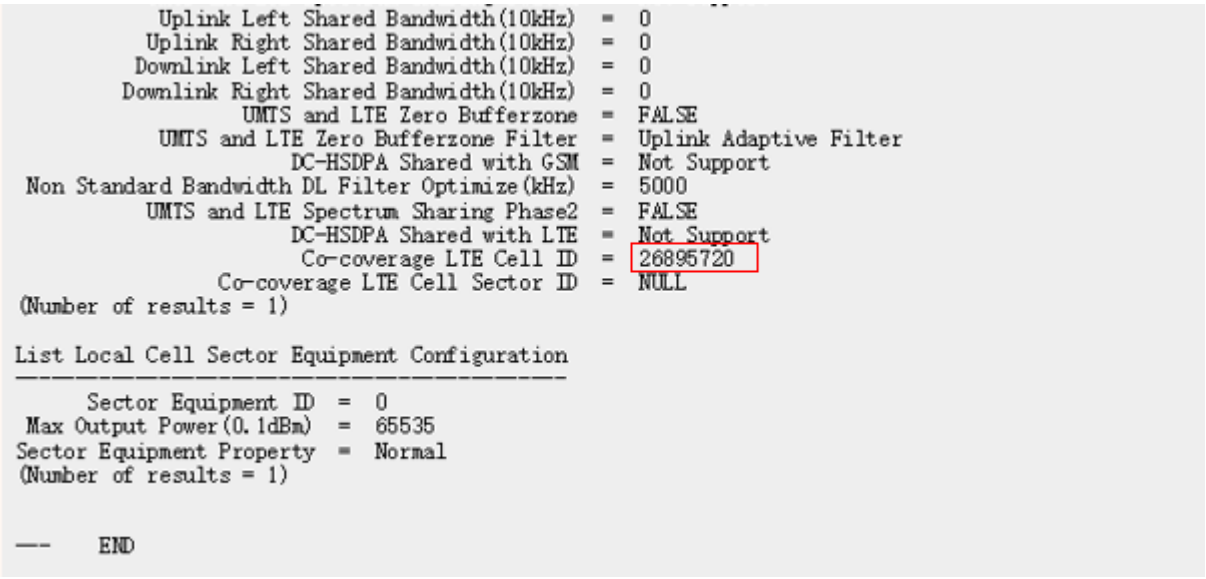



```
                                Beam Forming Mode  =  Not Support
        UMTS and LTE Dynamic Power Sharing Flag  =  FALSE
           UMTS and LTE Spectrum Sharing Switch  =  Not Support
             Uplink Left Shared Bandwidth(10kHz)  =  0
            Uplink Right Shared Bandwidth(10kHz)  =  0
          Downlink Left Shared Bandwidth(10kHz)  =  0
         Downlink Right Shared Bandwidth(10kHz)  =  0
                    UMTS and LTE Zero Bufferzone  =  FALSE
          UMTS and LTE Zero Bufferzone Filter  =  Uplink Adaptive Filter
                      DC-HSDPA Shared with GSM  =  Not Support
 Non Standard Bandwidth DL Filter Optimize(kHz)  =  5000
           UMTS and LTE Spectrum Sharing Phase2  =  FALSE
                     DC-HSDPA Shared with LTE  =  Not Support
                      Co-coverage LTE Cell ID  =  26695680
                Co-coverage LTE Cell Sector ID  =  NULL
(Number of results = 1)

List Local Cell Sector Equipment Configuration
--------------------------------------
      Sector Equipment ID  =  0
 Max Output Power(0.1dBm)  =  65535
Sector Equipment Property  =  Normal
(Number of results = 1)
```

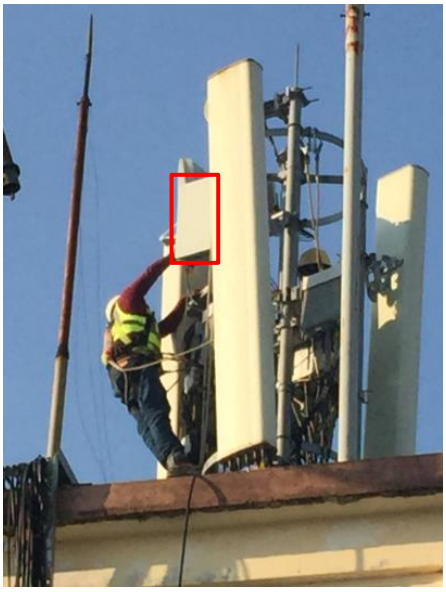
Second cell:





1.5.3 Site Photo

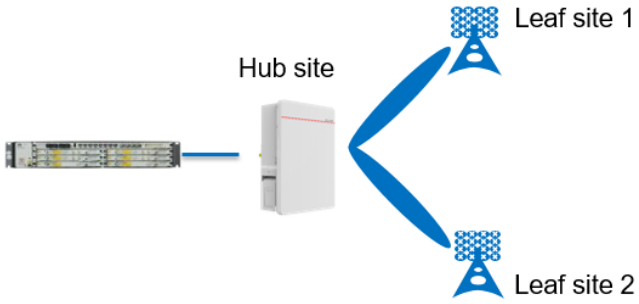
Hub site_YN1883:



Leaf site_YN2063:

Leaf site_YN1506:

1.6 Test Topology



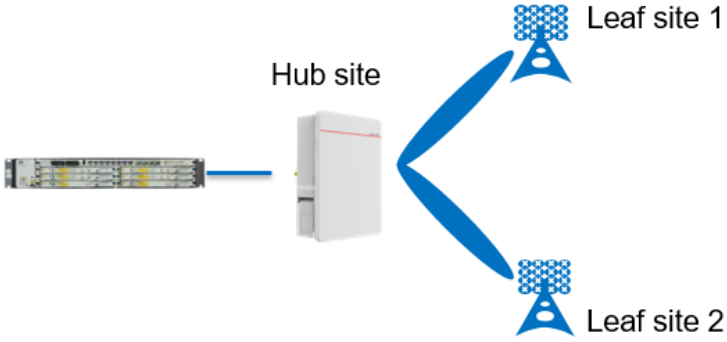
1.7 Test Summary

On April 3, the 26 / 28GHz NG-PTMP innovative test was finished. The test cases included automatic antenna adjustment, anti-shake, UI performance statistics, and throughput test. All test cases were successfully completed. The sector throughput in the PT2P scenario can reach 7.9 Gbps.

No.	Title Number	Test Items	Date	Result	Signature
1	2.1	Antenna Automatic Alignment Test	2020.4.3	PASS	
2	2.2	Anti-shaking Test	2020.4.3	PASS	
3	2.3	Performance Collection on UI for Throughput	2020.4.3	PASS	
4	2.4	PT2P Throughput test	2020.4.3	PASS	

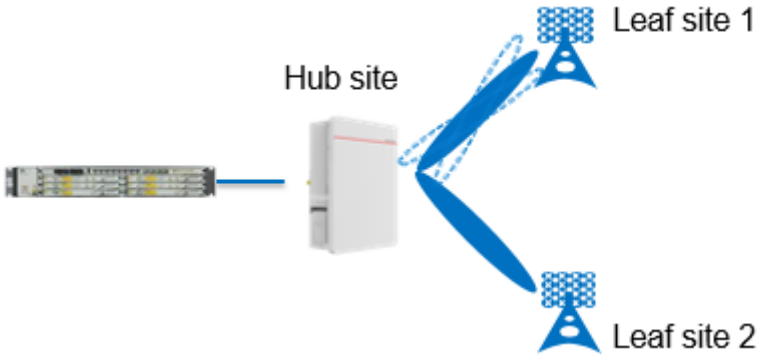
2 FIELD TEST CASE RESULT

2.1 Antenna Automatic Alignment Test

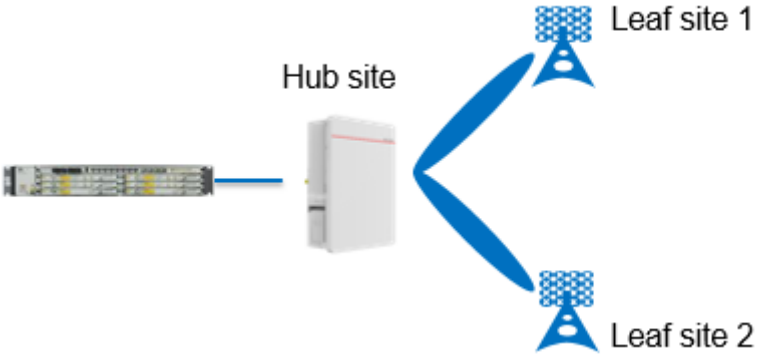
Test Purpose	The objective is to verify the function that antenna can be aligned automatically.
Test Topology	
Test Steps	(1) Finished hardware installation as shown in the diagram above (2) Power on the equipment. (3) Finished software and link configuration. (4) Wait the link up, record the link up time
Expected Results	The microwave link will be up. The alignment of link will be performed automatically after powered up.
Pass/Fail	PASS
Remarks	Beam-forming antenna. After the hub and spoke are configured, the optimal beam is automatically selected.

UE1 CC 0	DOWNLINK	UE2 CC 0	DOWNLINK
THP(Mbps)	1975	THP(Mbps)	1976
SINR(dB)	29.38	SINR(dB)	29.45
RSRP(dBm)	-68.76	RSRP(dBm)	-68.77
MCS	26	MCS	26
UE_BEAM_ID	52	UE_BEAM_ID	7
BS_BEAM_ID	77	BS_BEAM_ID	70
UE1 CC 1	DOWNLINK	UE2 CC 1	DOWNLINK
THP(Mbps)	1975	THP(Mbps)	1978
SINR(dB)	29.36	SINR(dB)	29.44
RSRP(dBm)	-68.78	RSRP(dBm)	-68.77
MCS	26	MCS	26
UE_BEAM_ID	52	UE_BEAM_ID	7
BS_BEAM_ID	77	BS_BEAM_ID	70

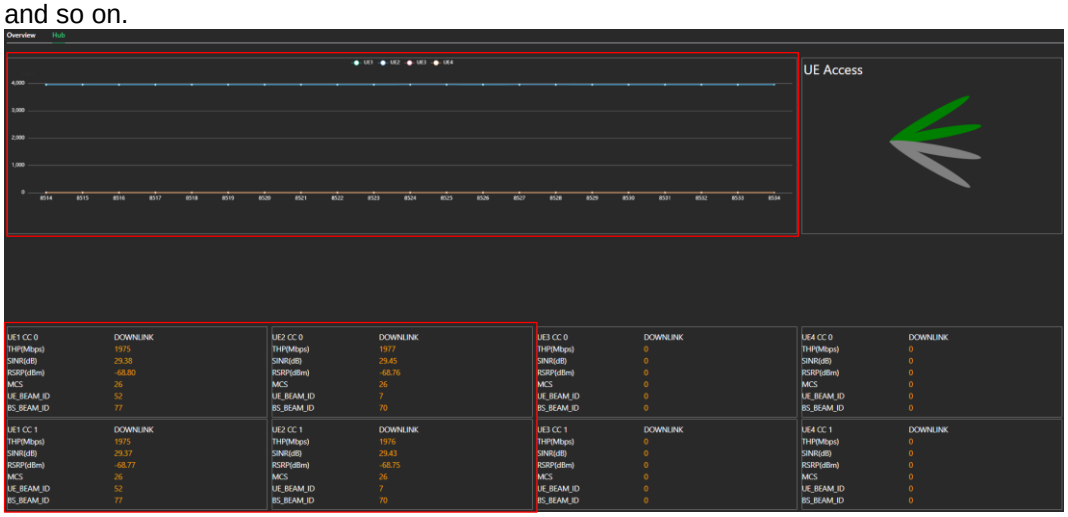
2.2 Anti-shaking test

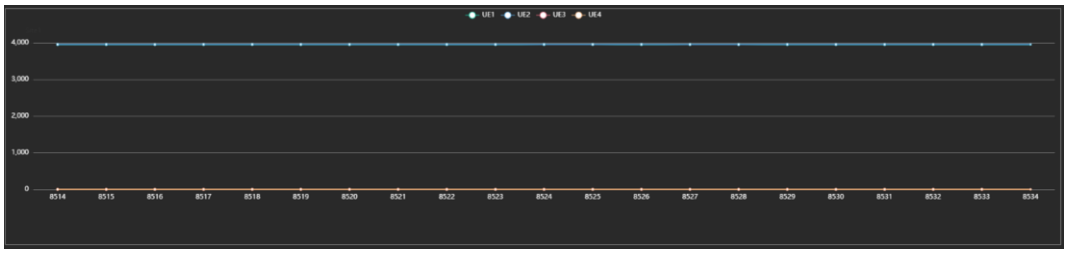
Test Purpose	The object of this case is to verify the anti-shaking mechanism
Test Topology	
Test Steps	(1) Finished hardware installation as shown in the diagram above (2) Power on the equipment, Finish software and link configuration. (3) Activate the link and measure the link performance (4) Rotate the AAU in leaf site 1 and observe the link performance
Expected Results	During the rotation, the performance of the link will not be affected.
Pass/Fail	PASS
Remarks	During the rotation, the capacity is not affected.

2.3 Performance Collection on UI for Throughput

Test Purpose	The object of this case is to verify performance collection for throughput on UI
Test Topology	
Test Steps	(1) Create the test environment as shown in the diagram above. (2) Power on the equipment (3) Configure radio link parameters and confirm the link works normally. (4) Open the performance collection UI for NG-PTMP (5) Check the throughput performance on UI for NG-PTMP
Expected Results	The throughput will be collected on performance UI

Pass/Fail	PASS
Remarks	Performance statistics include the throughput, SINR, RSRP, MCS, BS Beam, UE beam and so on.





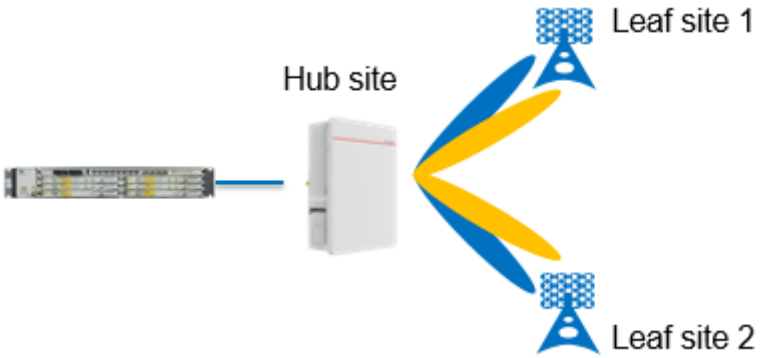
UE1 CC 0	DOWNLINK
THP(Mbps)	1975
SINR(dB)	29.38
RSRP(dBm)	-68.80
MCS	26
UE_BEAM_ID	52
BS_BEAM_ID	77

UE2 CC 0	DOWNLINK
THP(Mbps)	1977
SINR(dB)	29.45
RSRP(dBm)	-68.76
MCS	26
UE_BEAM_ID	7
BS_BEAM_ID	70

UE1 CC 1	DOWNLINK
THP(Mbps)	1975
SINR(dB)	29.37
RSRP(dBm)	-68.77
MCS	26
UE_BEAM_ID	52
BS_BEAM_ID	77

UE2 CC 1	DOWNLINK
THP(Mbps)	1976
SINR(dB)	29.43
RSRP(dBm)	-68.75
MCS	26
UE_BEAM_ID	7
BS_BEAM_ID	70

2.4 PT2P Throughput Test for Single Sector

Test Purpose	The objective is to test throughput of one sector for NG-PTMP
Test Topology	
Test Steps	(1) Create the test environment as shown in the diagram above. (2) Configure radio link parameters and confirm the link works normally. (3) Test the throughput and record the test results.
Expected Results	The throughput can reach 7Gbps@400MHz for One sector.
Pass/Fail	PASS
Remarks	The sector capacity 7.9Gbps, UE1 capacity 3.95Gbps, UE2 capacity 3.95Gbps. 

Recommendation for future technology…

Microwave bottle neck, big challenge for 5G…

Wireless evolution: 5G gear up

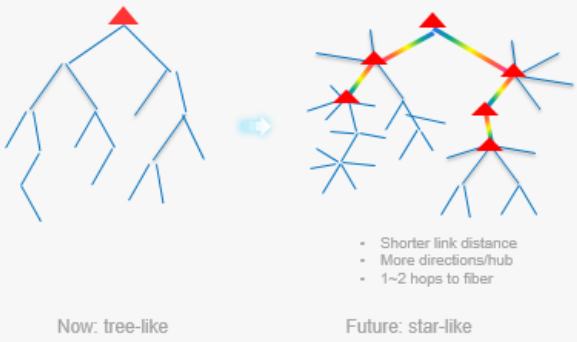
Wireless Site Capacity Forecast

Scenario	Distance	4G	5G Initial	5G Mature
Urban	<2Km	350Mbps	2Gbps	10Gbps
Suburb	2-7Km	250Mbps	1Gbps	4Gbps
Rural	> 7Km	100Mbps	500Mbps	2Gbps

** From Huawei Research Institute working with European Tier operators' capacity prediction*

10x traffic growth in future years.

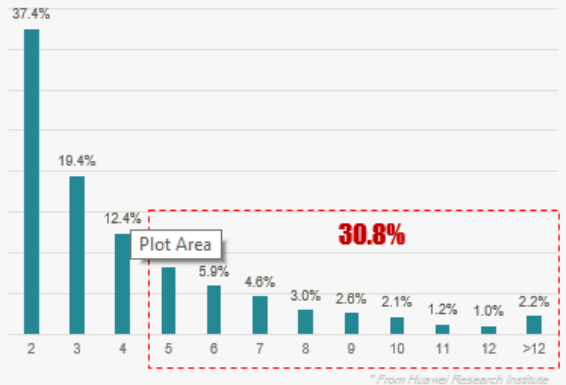
Network topology: tree-like to star-like



Fiber extending to edge, more star-like hub sites appears

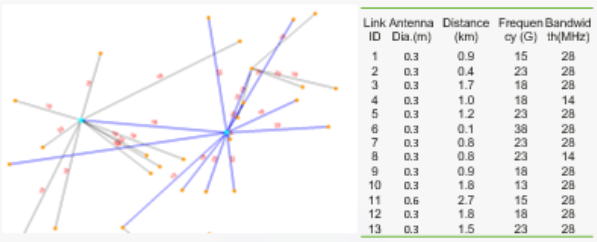
Hub site challenges

Hub site distribution by direction number



Averagely, 30.8% of hub sites have >=5 directions. This number will be higher in 5G era.

Analysis of a real case



Link ID	Antenna Dia.(m)	Distance (km)	Frequency (G)	Bandwidth(MHz)
1	0.3	0.9	15	28
2	0.3	0.4	23	28
3	0.3	1.7	18	28
4	0.3	1.0	18	14
5	0.3	1.2	23	28
6	0.3	0.1	38	28
7	0.3	0.8	23	28
8	0.3	0.8	23	14
9	0.3	0.9	18	28
10	0.3	1.8	13	28
11	0.6	2.7	15	28
12	0.3	1.8	18	28
13	0.3	1.5	23	28

A real hub site with 13 directions

1. Challenge 1: frequency bands
   13 Frequency bands, 336 MHz in total
2. Challenge 2: on-tower space/load
   13 antennas, 13 ODUs, ~130 KG on-tower