

5G NR Femtocell User Manual



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1. Network topology

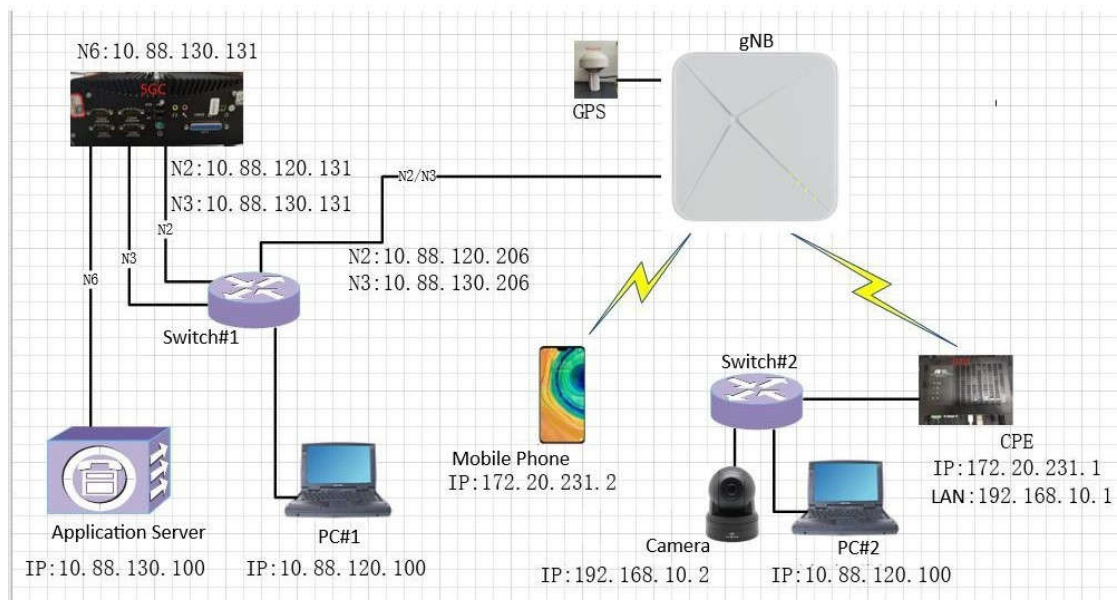


Figure 1. Networking diagram

2. Hardware connection

2.1 Physical map of 5G femto cell



Figure 2. Front view of the femto cell

2.2 Interface Description

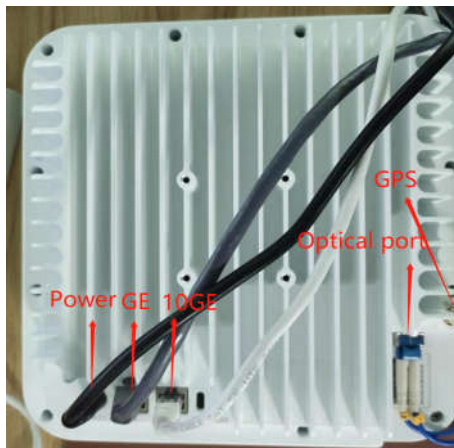


Figure 3. Femto cell interface diagram

2.3 Hardware environment

There are a total of 3 network interfaces. From left to right, they correspond to GE, 10GE, and 10G optical port. The corresponding network port names are fm1-mac3, fm1-mac9, and fm1-mac10.

2.4 Connection method

- 1) GE port: management IP: 192.168.5.100, account/ password: root /waiting
- 2) 10 GE/10G Optical Port: N2/N3 interface

The specific configuration should be modified according to the actual situation

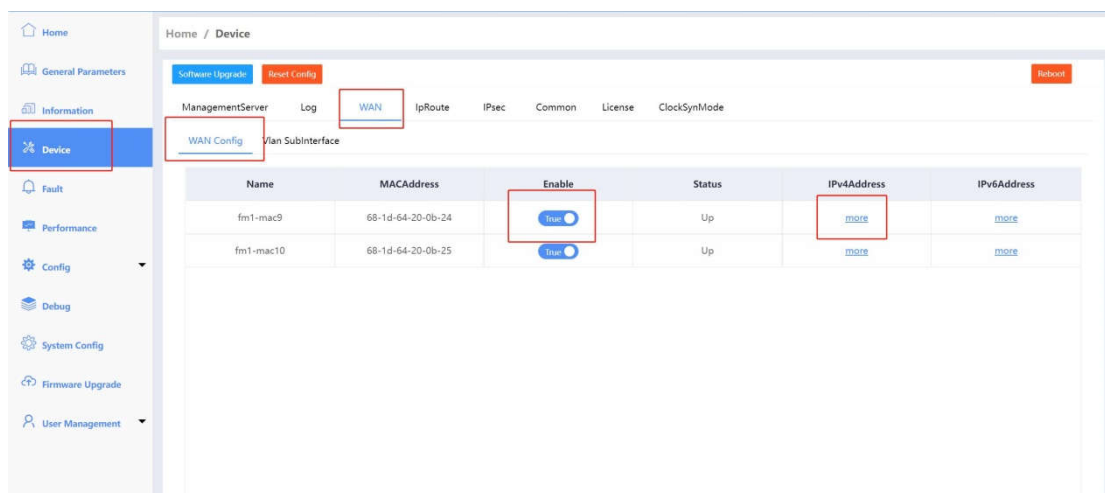


Figure 4. Service port configuration

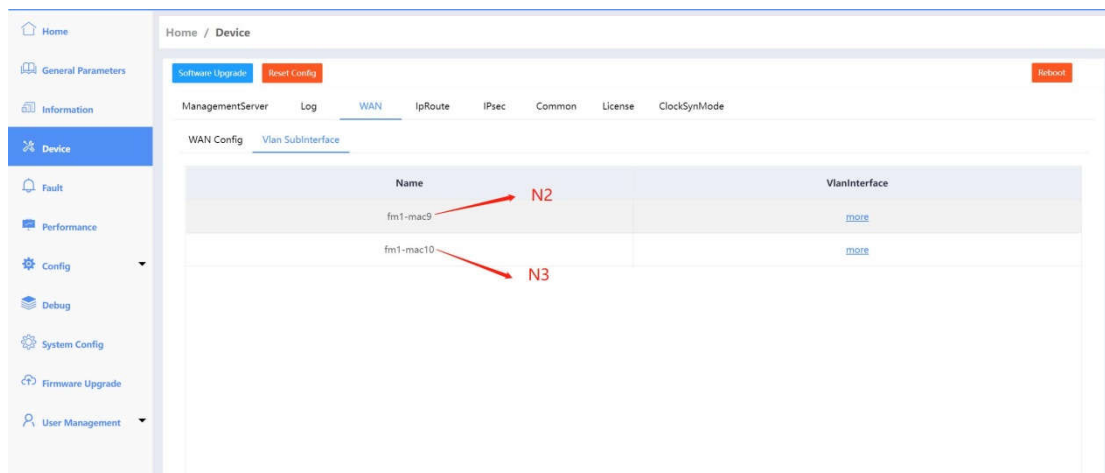


Figure 5. Configure N2/N3 VLAN

- 3) Routing configuration

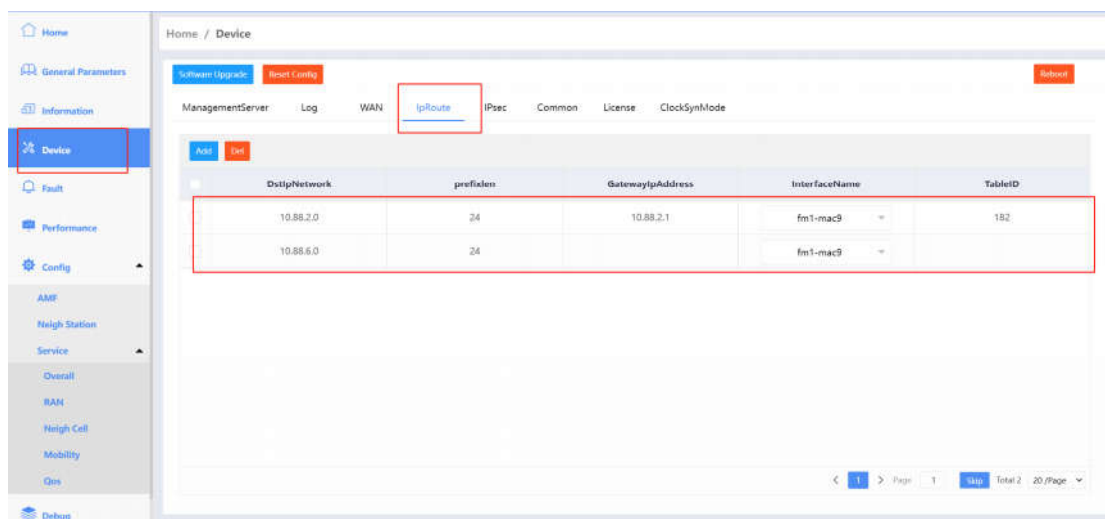


Figure 6. Configure routing

Notice: The destination network segment is the ip of 5GC AMF, the network prefix length is the number of mask digits, the gateway address is the corresponding gateway, the port name is the service port name, and the routing table ID is filled in according to the actual situation (the valid range is between 1 and 252).

2.5 Start-mode

Power-on self-start

2.6 SSH Login Method

1) Network port 1 default allocation IP

- a) fm1-mac3 : 192.168.5.100 (management IP)
- b) fm1-mac9 : 10.88.120.212/10.88.130.212 (the femto cell is connected to the core network N2 /N3 IP)

2) PC connection switch set IP

For example: 192.168.5.150 or 10.88.120.150 or 10.88.130.150, the femto cell can log in through SSH connection

3) Login to the femto cell

Username: root , Password: waiting

2.7 WEB Login Method

After the femto cell process is running, use IE or Google browser , use the management network port IP (the computer has this network segment IP locally and can connect to the femto cell), and add ":8400" after the IP to enter the web page, for example: 192.168.5.100:8400

Login account: root

Login password: waiting

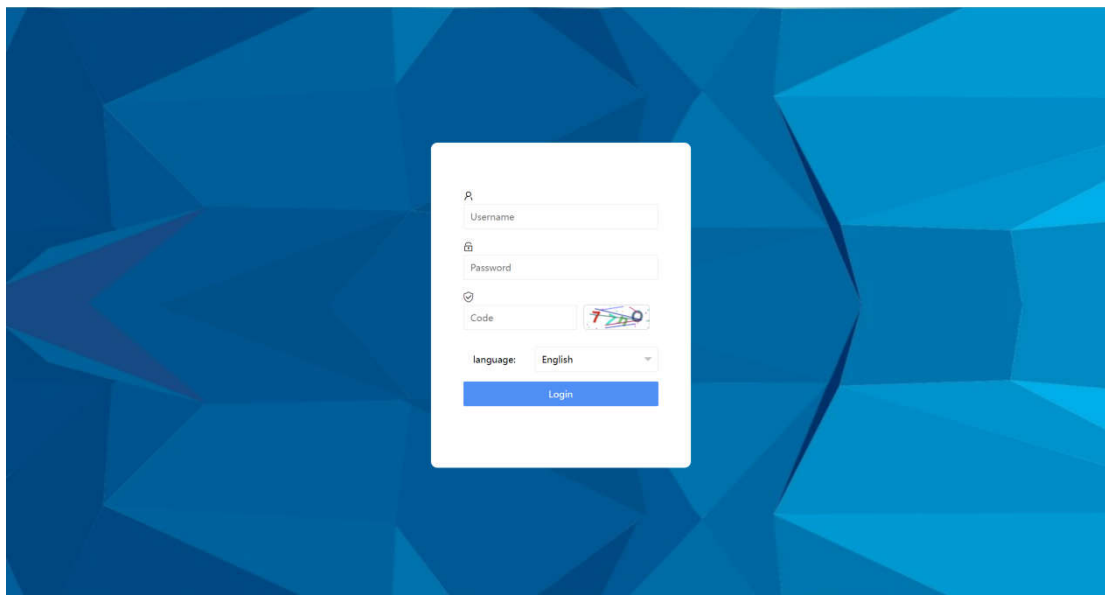


Figure 7. WEB login page

3. Quick-Start

Common configuration parameters, you can modify the parameter configuration of the femto cell through the WEB: such as WAN IP, AMF IP, PLMN, PCI , TAC frequency, number of layers, number of antennas, etc.

3.1 Modify WAN IP

The configuration of WAN IP depends on which physical connection port you

use. If you only use 10GE, then only need to enable MAC9 and configure the IP. If you use MAC10, you only need to enable MAC10 and configure IP.

Note that when a physical interface is not applicable, you need to turn off enable and ensure that all IP addresses under the network card are deleted. The following figure shows the screenshot of both 10GE and 10G optical interfaces.

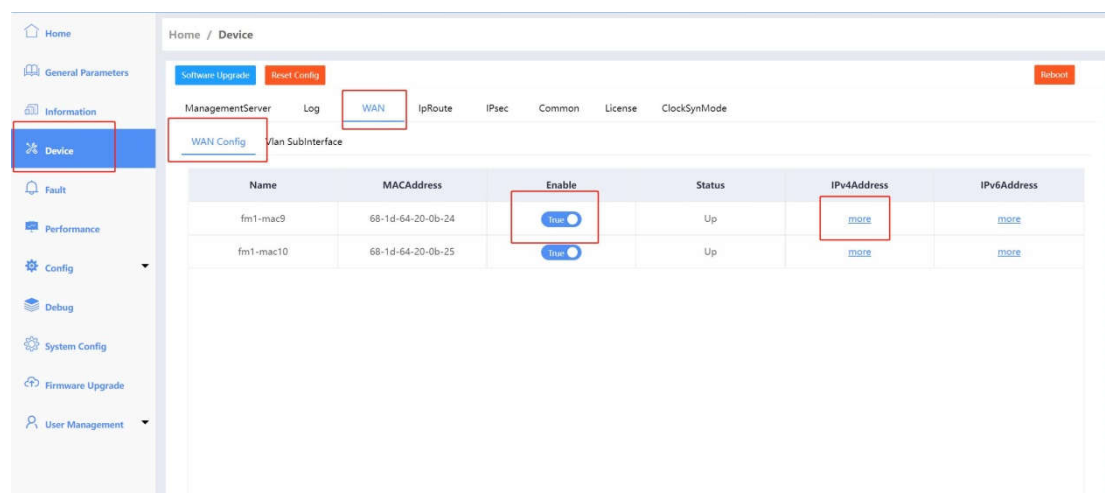


Figure 8. WAN IP

VLAN Configuration

When the VLAN function is required, configure the VLAN ID and VLAN IP according to the following configuration method (the following figure shows that only MAC10 is used and VLAN is enabled. Before configuration, should get the physical connection and confirm that the status of the network card is Up)

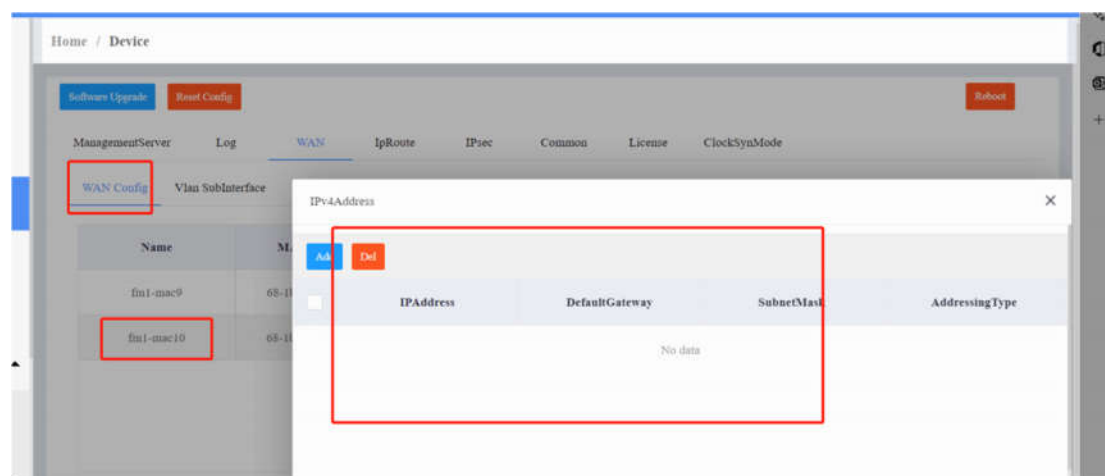


Figure 9. WAN IP when VLAN enable

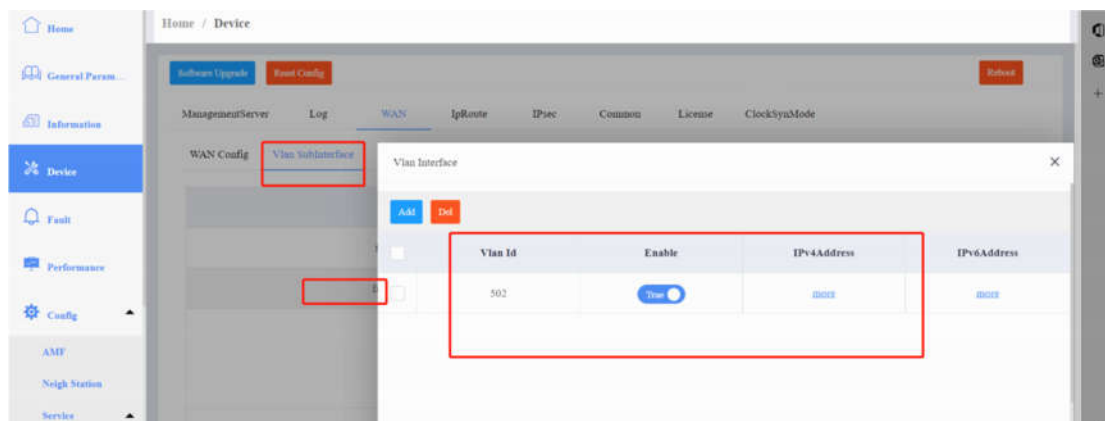


Figure 10. VLAN ID modify

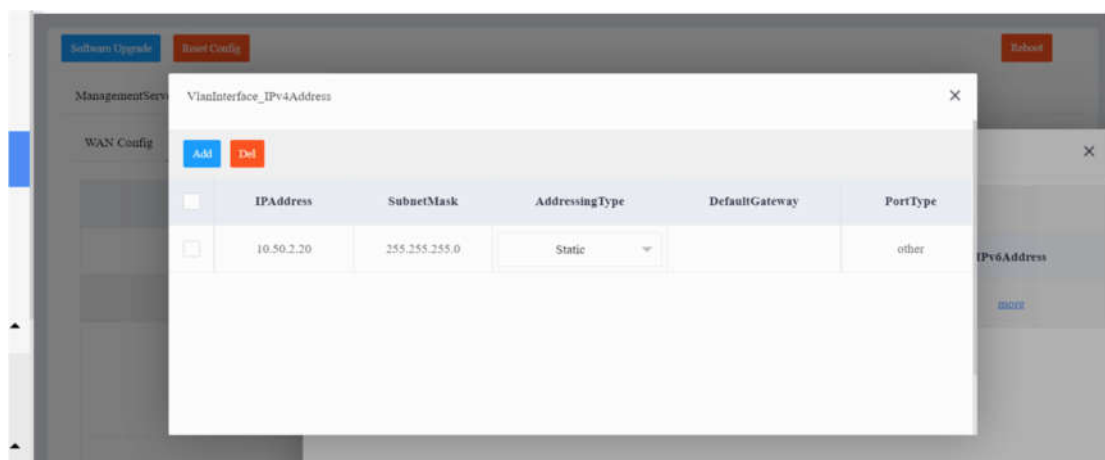


Figure11. VLAN IP modify

3.2 Route Modify

When the WAN IP is not the same segment with the AMF IP, The local route must be added to make the route between the gNB and the 5GC is reachable.

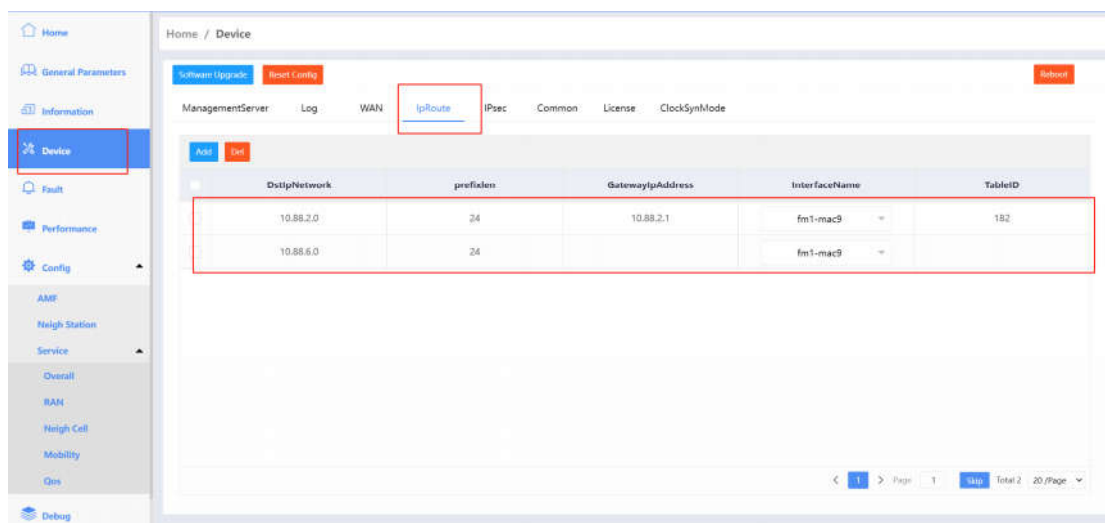


Figure 12. Configure route

Note: The destination network segment is the IP of 5GC AMF, the network prefix length is the number of mask digits, the gateway address is the corresponding gateway, the port name is the service port name, and the routing table ID is filled in according to the actual situation (the valid range is between 1 and 252).

3.3 Modify AMF IP and N3 IP

Home / General Parameters

FAPService

ParameterName	ParameterValue
PhyCellID	54
CellIDWithinGnb	1
ULayers	0
DiLayers	0
PdschMcstTable	qam256
PuschMcstTable	qam64
NRARFCNUL	513000
NRARFCNDL	513000
AbsoluteFrequencySSB	504990
TA	1000

GNB

ParameterName	ParameterValue
GnbId	236
GnbIdLength	22

AMF

IPAddress	PrimaryPLMNID	AdminState
10.88.2.150	46011f	On

Figure 13. AMF IP

Home / Config / AMF

AmfIP1	LocalUpIPAddress	LocalUpIPv6Address	LocalPort	AmfPort	PLMNID	AmfName	AdminState
10.88.2.150	10.88.3.25		60110	38412	46011f		On

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Figure 14. N3 IP of the gNB

3.4 Modify PLMN

After logging in to the web interface, there are four PLMNs that need to be modified, as shown in the following figure:

1. AMF PLMN

The screenshot shows the 'General Parameters' page in the web interface. The 'FAPService' table lists parameters for Cell 1, and the 'AMF' table shows the IP address, Primary PLMN ID, and Admin State.

ParameterName	ParameterValue
PhyCellID	54
CellIdWithinGnb	1
Uilayers	0
Dilayers	0
PdschMcsTable	qam256
PuschMcsTable	qam64
NRARFCNDL	513000
NRARFCNUL	513000
AbsoluteFrequencySSB	504990
TA	more

ParameterName	ParameterValue
GnbId	236
GnbIdLength	22

IPAddress	PrimaryPLMNID	AdminState
10.88.2.150	46011f	☒

Figure 15. AMF PLMN

2. Broadcast PLMN

The screenshot shows the 'General Parameters' page in the web interface. The 'FAPService' table lists parameters for Cell 1, and the 'Broadcast PLMN' table shows the IP address, Primary PLMN ID, and Admin State.

ParameterName	ParameterValue
PhyCellID	54
CellIdWithinGnb	1
Uilayers	0
Dilayers	0
PdschMcsTable	qam256
PuschMcsTable	qam64
NRARFCNDL	513000
NRARFCNUL	513000
AbsoluteFrequencySSB	504990
TA	more

ParameterName	ParameterValue
GnbId	236
GnbIdLength	22

IPAddress	PrimaryPLMNID	AdminState
10.88.2.150	46011f	☒

Figure 16. Broadcast PLMN-TA

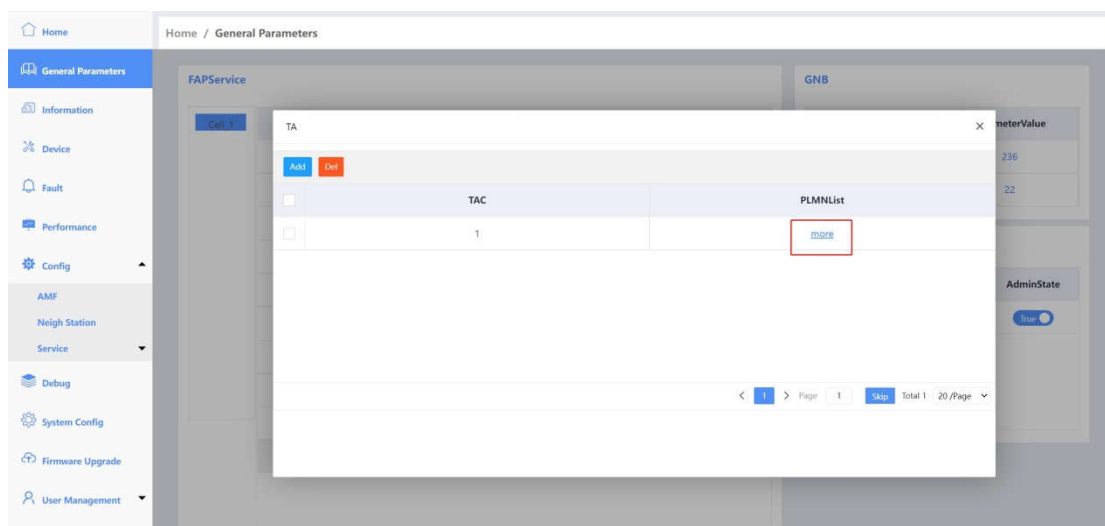


Figure 17. Broadcast PLMN - Cell PLMNID list

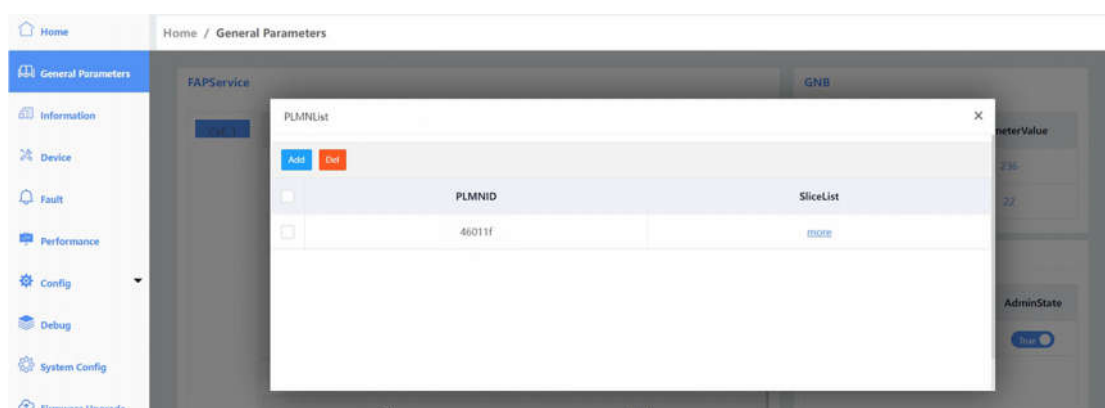


Figure 18. Broadcast PLMN - Cell PLMNID

3. QoS PLMN

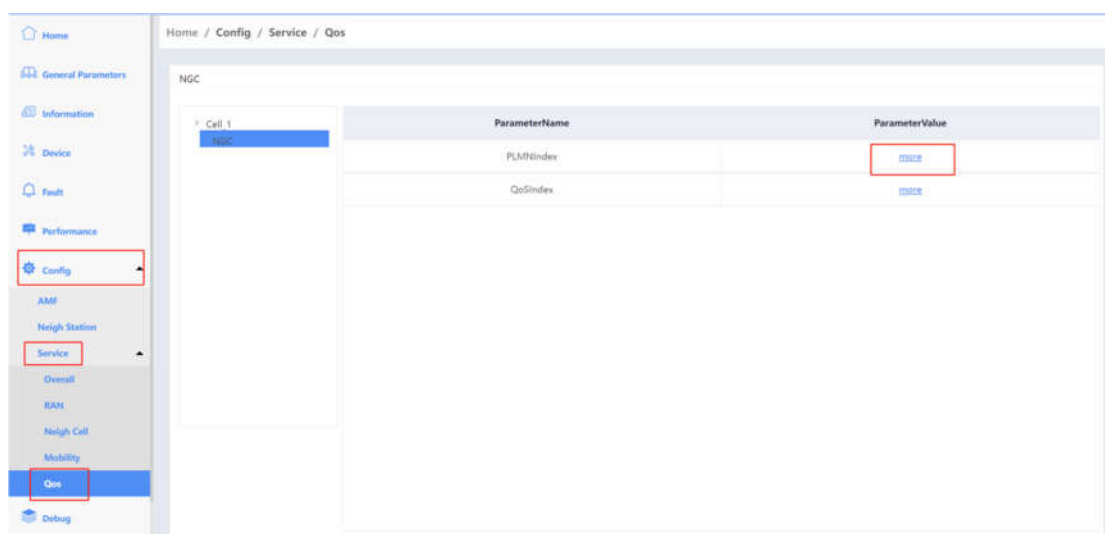


Figure 19. QoS PLMN

1) 5qi 9 PLMN

Note: Some type of 5GC defaults to QoS 9. When connecting to other core networks, the QoS needs to be confirmed and modified accordingly.

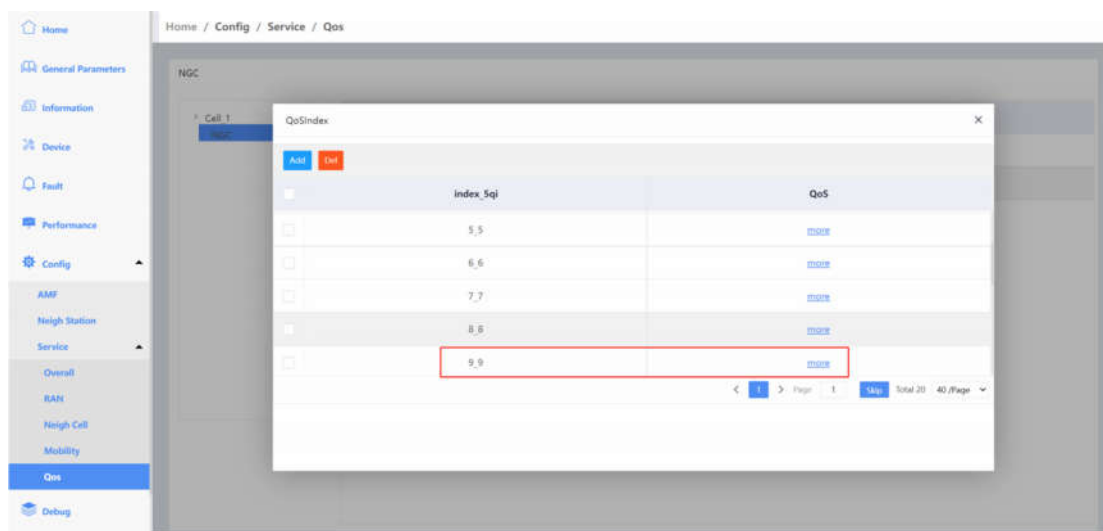


Figure 20. PLMN-5qi 9

3.5 Modify Frequency, Bandwidth and SSB and RB number

The distribution of downlink NRARFCN and uplink NRARFCN corresponds to the downlink and uplink center frequency points, and the absolute value of SSB frequency and frequency band indication, 4 parameters need to be modified.

SSB Value Calculation :

Reference Website - https://www.sqimway.com/nr_refA.php

Fill in the channel synchronization and run.

Arfcn GSCN is equal to AbsoluteFrequencySSB.

Normally the first Coreset(0) check that shows ok will be selected. Take the following as an example. (3550-3650M)

AbsoluteFrequencySSB = 637344

NRARFCNDL/NRARFCNUL = 640000.

Channel synchronization

Frequency band	n78	SCS ss/PBCH	30 kHz
SCS Common	30 kHz	Bandwidth	100 MHz
NR Arfcn scan	640000	Control ResourceSet Zero	10 (48 RBs, offset 12)

Run

Full range for band TDD n78	Min	Max	Step
Frequency [MHz]	3300	3800	
NR-ARFCN	620000	653332	2
GSCN	7711	8051	1
Restricted range for a bandwidth of 100 MHz	Min	Max	
Frequency [MHz]	3350.01	3750	
NR-ARFCN	623334	650000	
NR-ARFCN selected	Frequency [MHz]	Point A Arfcn	Point A [MHz]
640000	3600	636724	3550.86
GSCN scan	Min	Max	
GSCN	7885	7947	

GSCN synchronization							SS/PBCH & SIB1		NR-ARFCN		Initial DL BWP	
GSCN	Frequency (MHz)	ΔMHz GSCN NR-ARFCN	Arfcn GSCN	N	M [1,3,5]	CRB _i	k _{SSB} (#SC)	Offset to Point A (#RB)	CRB _i	k _i	CRB _{start}	Coreset(0) check
7885	3555.84	44.16	637056	386		13	20	6	137	6	-9	Invalid
7886	3557.28	42.72	637152	387		17	20	14	137	6	-5	Invalid
7887	3558.72	41.28	637248	388		21	20	22	137	6	-1	Invalid
7888	3560.16	39.84	637344	389		25	20	30	137	6	3	ok
7889	3561.6	38.4	637440	390		29	20	38	137	6	7	ok
7890	3563.04	36.96	637536	391		33	20	46	137	6	11	ok
7891	3564.48	35.52	637632	392		37	20	54	137	6	15	ok
7892	3565.92	34.08	637728	393		41	20	62	137	6	19	ok
7893	3567.36	32.64	637824	394		45	20	70	137	6	23	ok
7894	3568.8	31.2	637920	395		49	20	78	137	6	27	ok
7895	3570.24	29.76	638016	396		53	20	86	137	6	31	ok
7896	3571.68	28.32	638112	397		57	20	94	137	6	35	ok
7897	3573.12	26.88	638208	398		61	20	102	137	6	39	ok

Figure 21. Calculate SSB

Common NRARFCN & SSB

Bandwidth	NRARFCN	SSB	Centre Frequency
100M	663334	660672	3950.01M
	656666	654608	3849.9M
	650000	647520	3750M
	643334	640608	3650.01M
	636666	633984	3549.99M
	633440	630720	3501.6M
	630000	627264	3450M
	513000	512910	2565M

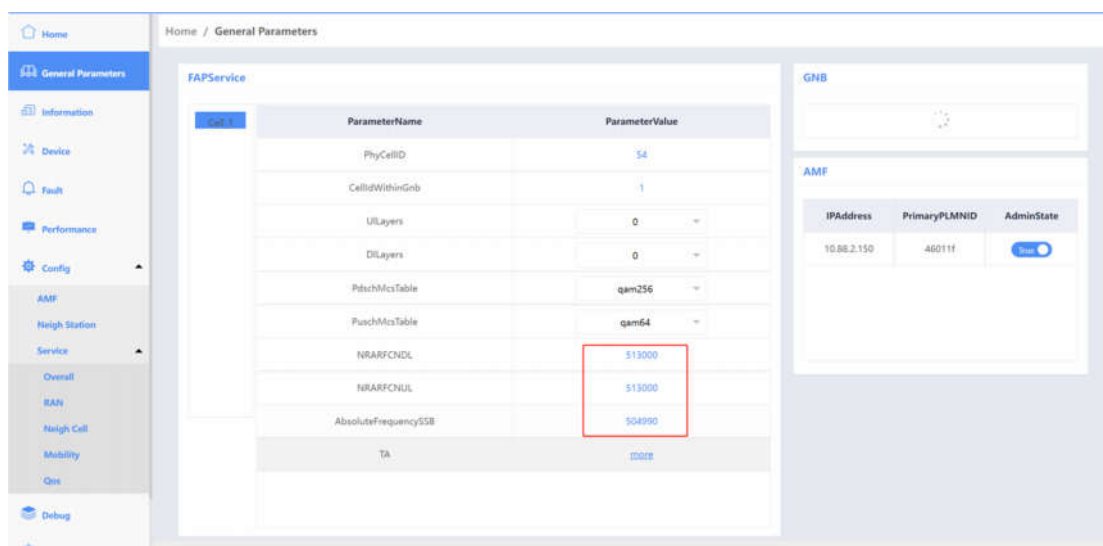


Figure 22. Center frequency ARFCN and SSB ARFCN

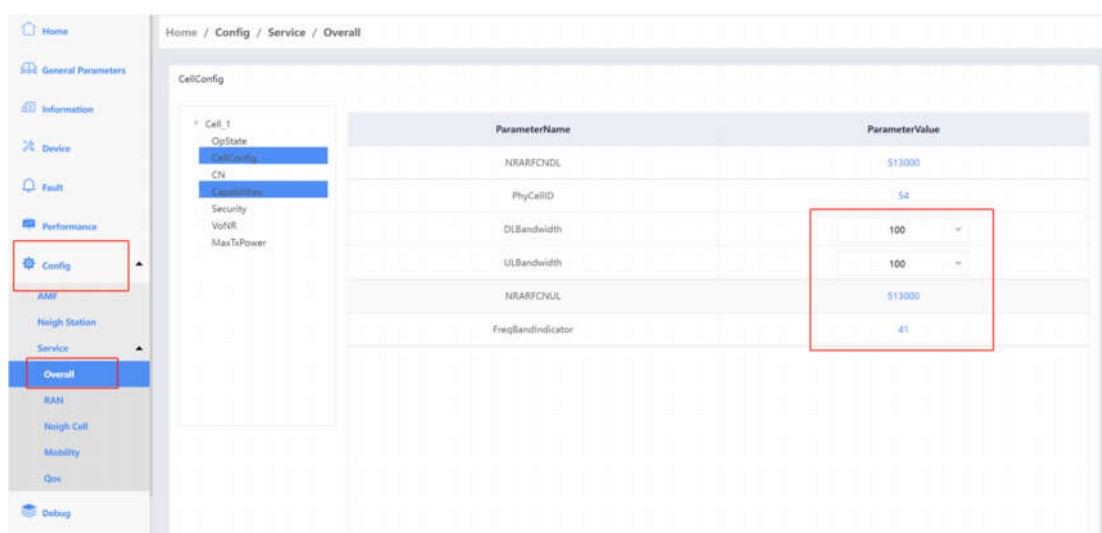


Figure 23. Bandwidth and frequency bands

Note: When bandwidth is 100MHz, SRS config should be enable:

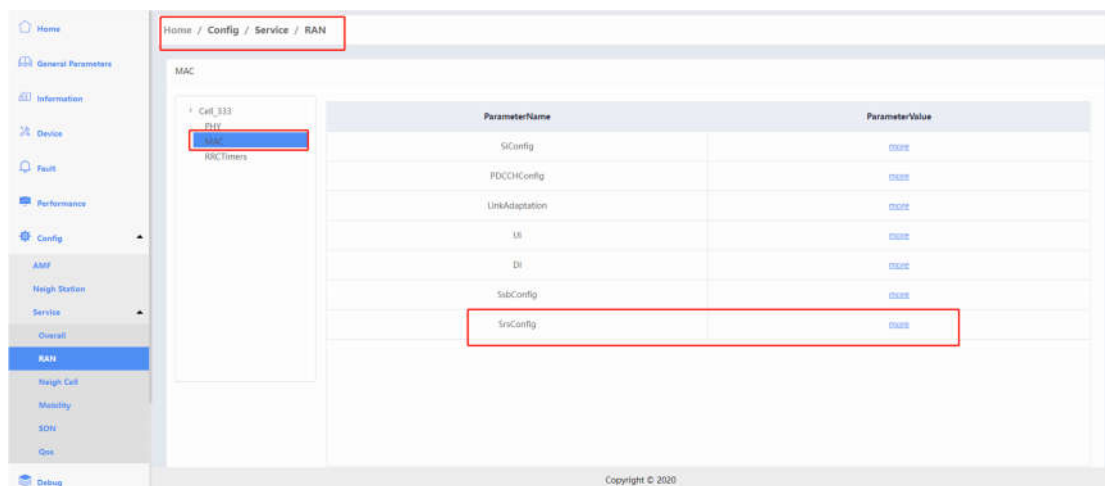


Figure 24. Srsconfig

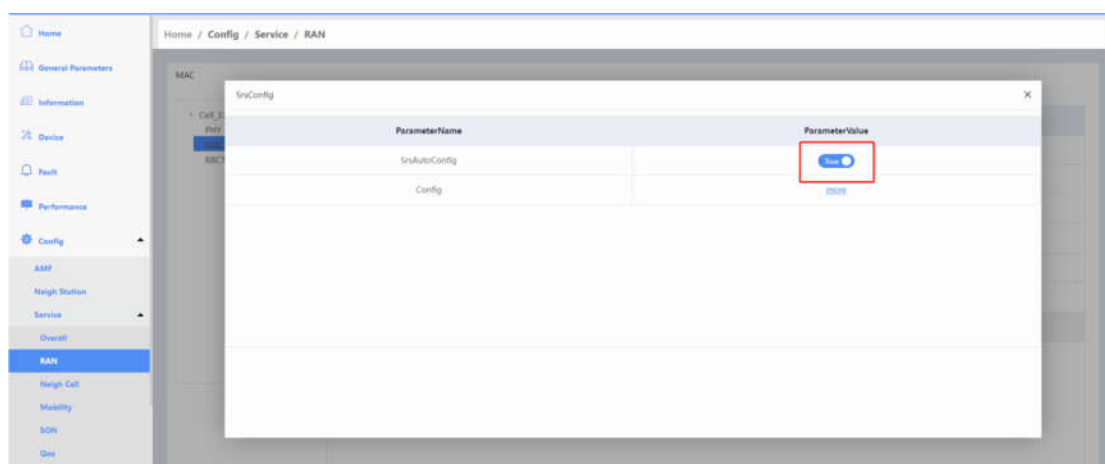


Figure 25. Srs Enable

RB number:

Path:

Home/Config/Service/RAN/MAC/PDCCHConfig/ControlResourceSetToAddModList

Bandwidth/Mhz	100	90	80	60	40
RB number	273	245	217	162	106

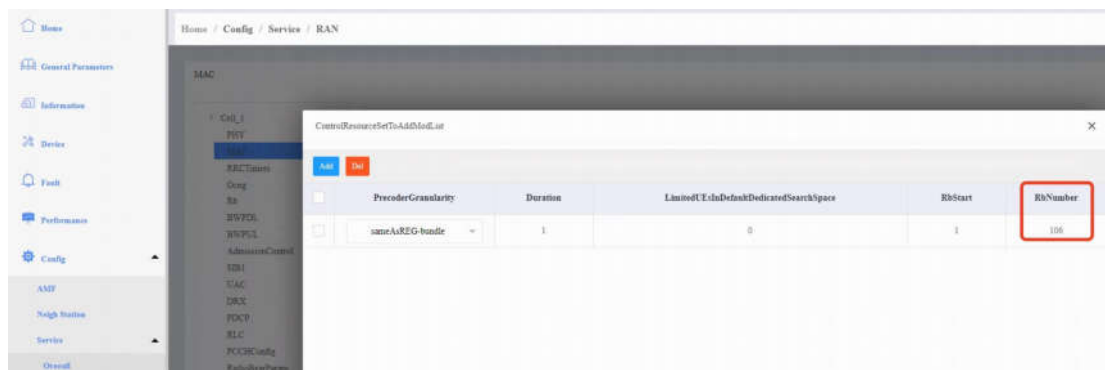


Figure 26. RB Number Configuration

3.6 Modify Frame Format

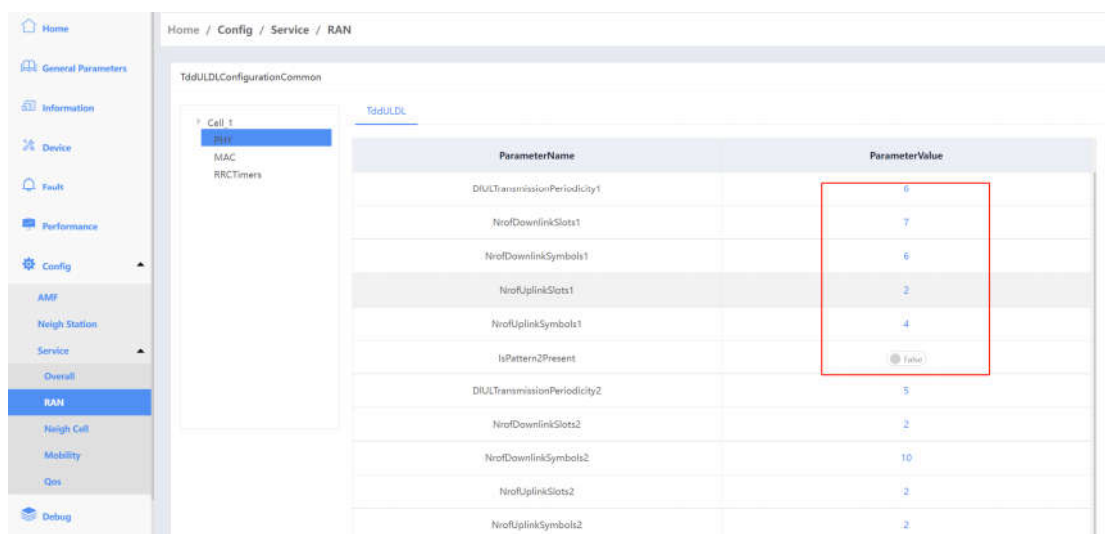


Figure 27. View the current frame format

To modify to DSUUU frame format, you need to configure like this:

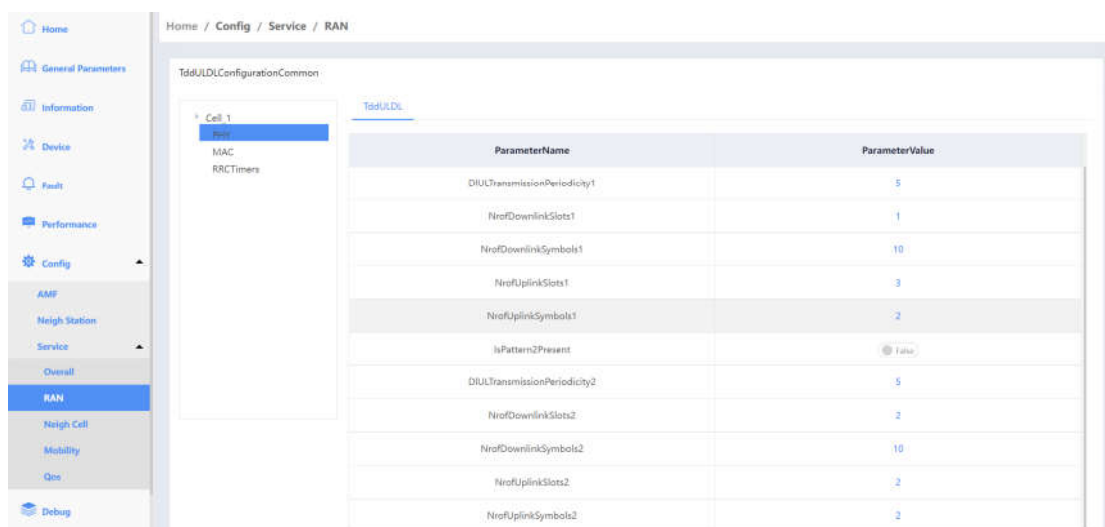


Figure 28. DSUUU frame format configuration

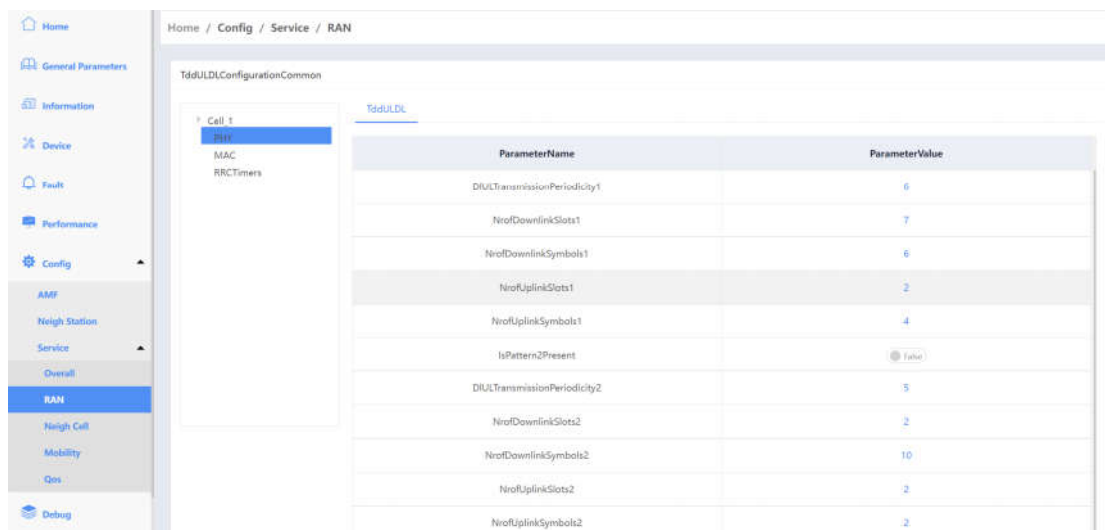


Figure 29. DDDDDDSUU frame format configuration

Note: If you need to run the DSUUU's uplink peak rate, you need to change the value of the periodic BSR timer to sf5 (RAN-MAC- ul - Periodic BSR Timer)

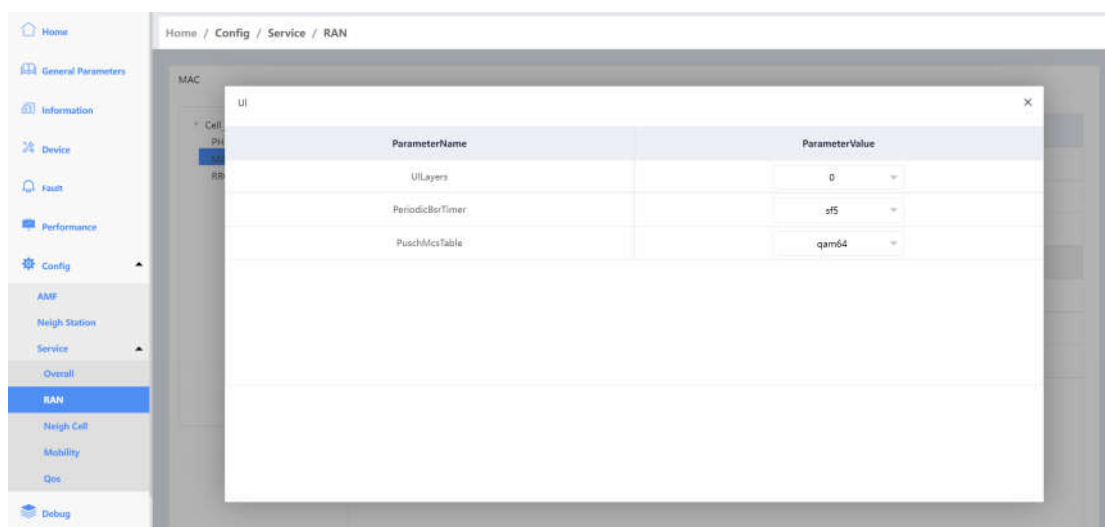


Figure 30. Modifying the BSR timer

3.7 Clock Sync Mode

For the femto cell, the clock sync mode should be set to GPS_mode / GNSS_mode to reduce the impact of clock out of sync.

Need reboot (not restart) after changing the sync mode.

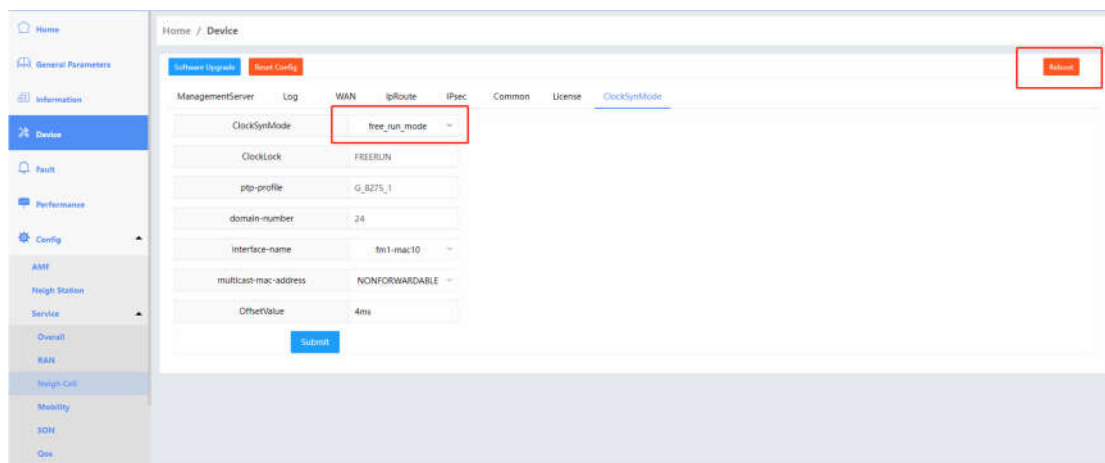


Figure 31. Clock Sync Mode

3.8 Neighbor Station and Neighbor Cell Configuration

Add Neighbor Station

Step1: Configure Local ServerIP (N2)

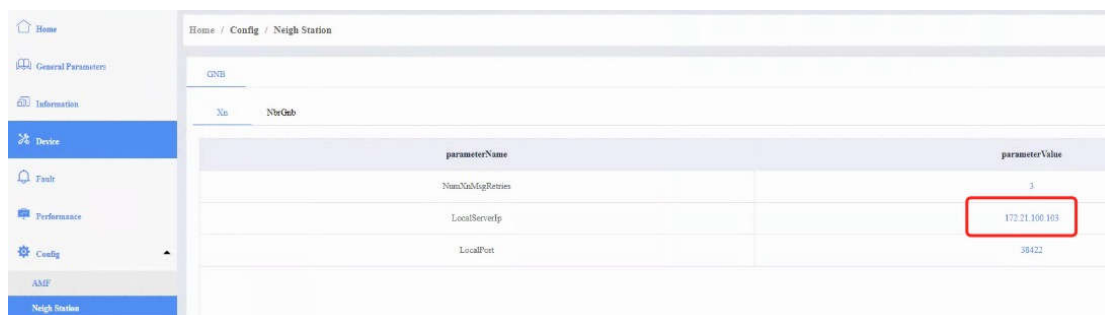


Figure 32. Local Server IP

Step2: Configure Neighbor Station's parameters

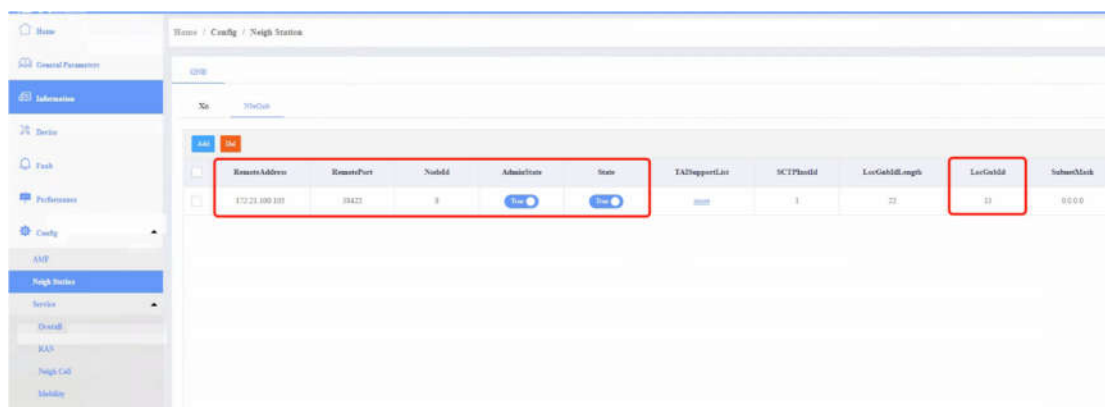


Figure 33. Neigh Station

Add Neighbor cell (NR cell and LTE cell)

Neigh NE Cell

Configure the neighbor cell parameters

(PLMNID, CID, subFrequency, PhyCellID, TAC)

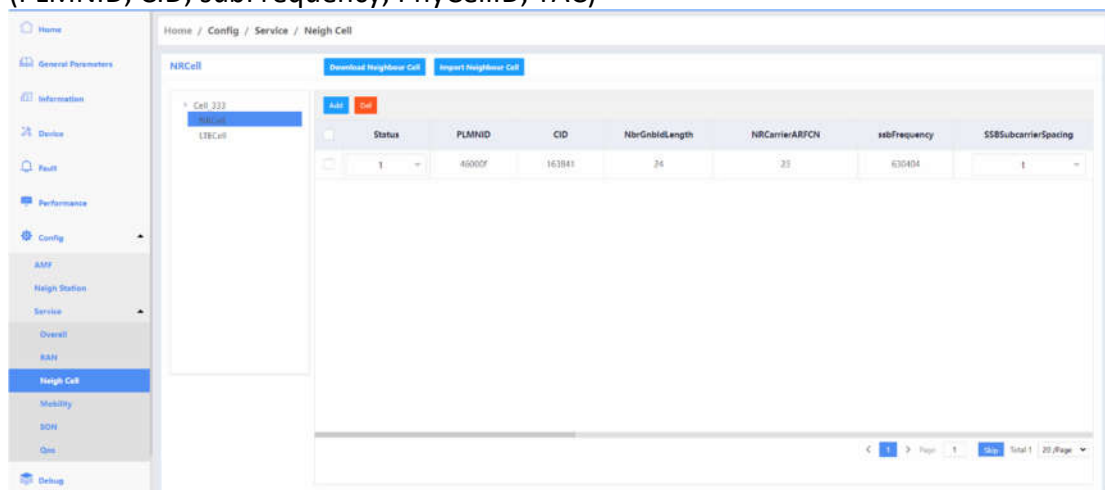


Figure 34. Neigh NR Cell

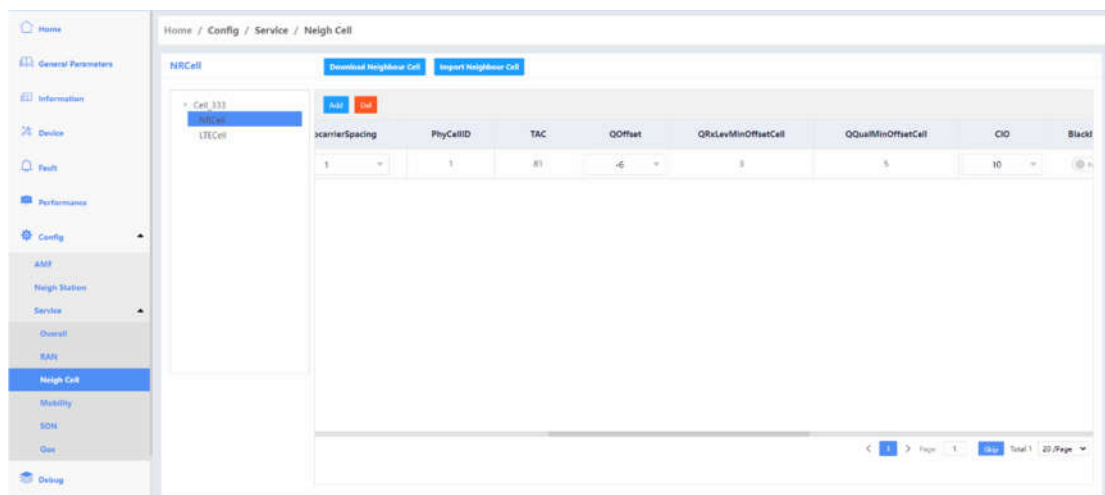


Figure 35. Neigh NR Cell

Neigh LTE Cell

Same as the NR Cell

3.9 Mobility Parameter

a) **Intra-Frequency Handover**
Change A3OffsetRSRP value to -18

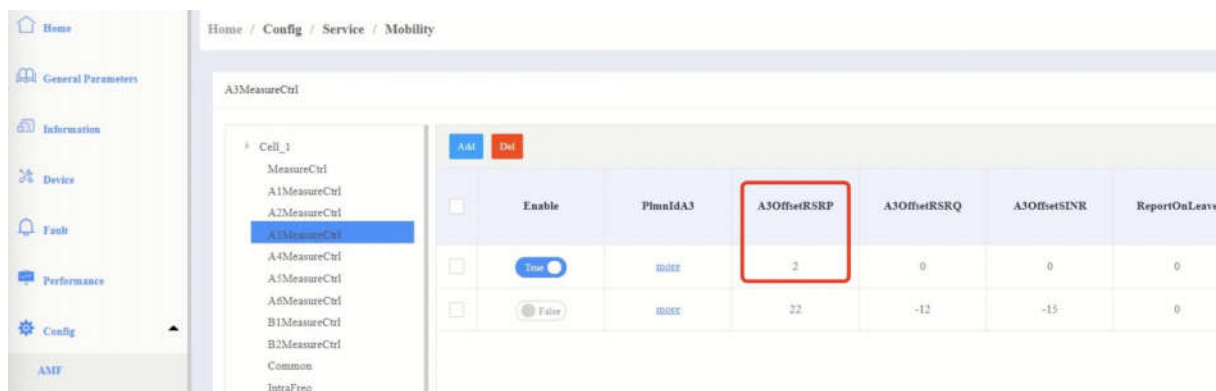


Figure 36. A3offsetRSRP

When the RSRP difference of the two cells is bigger than 18, handover will happen.

Note: this value can be adjusted.

b) **Inter-Frequency Handover**
Step 1: Change NR_SmeasureConfig to 0.

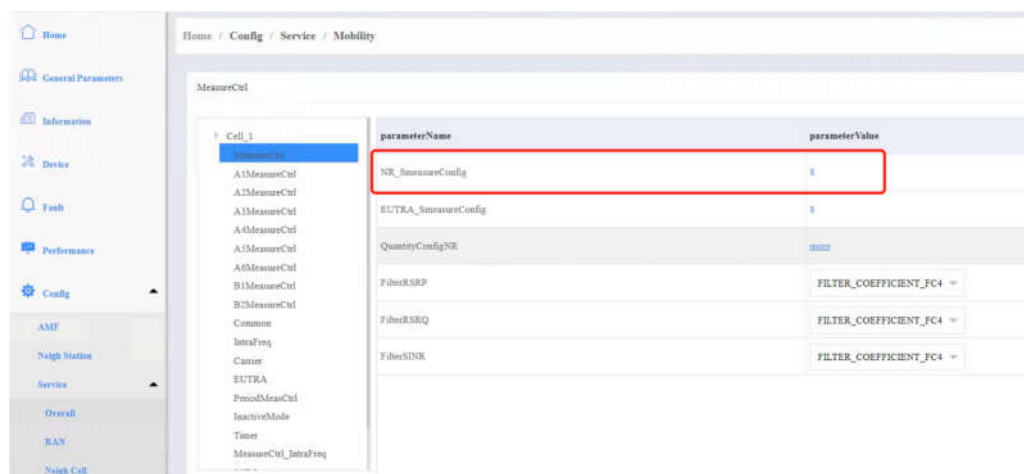


Figure 37. SmeasureConfig

Step 2: Disable the A1MeasureCtrl

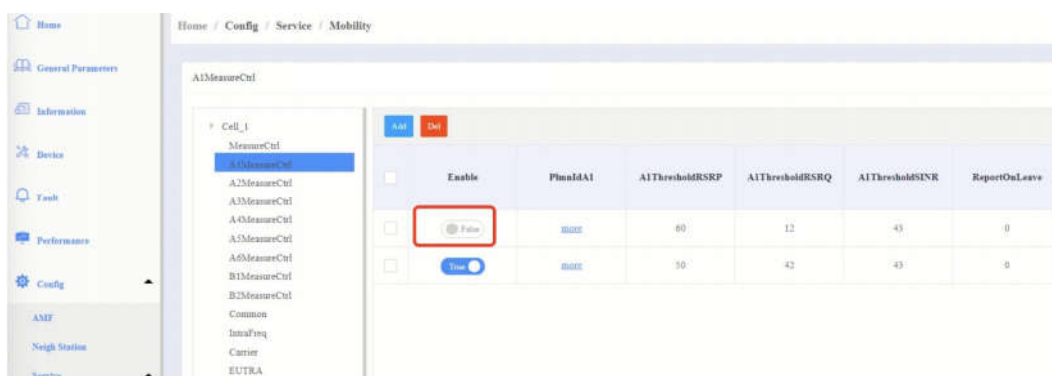


Figure 38

Step 3: Disable the A3MeasureCtrl

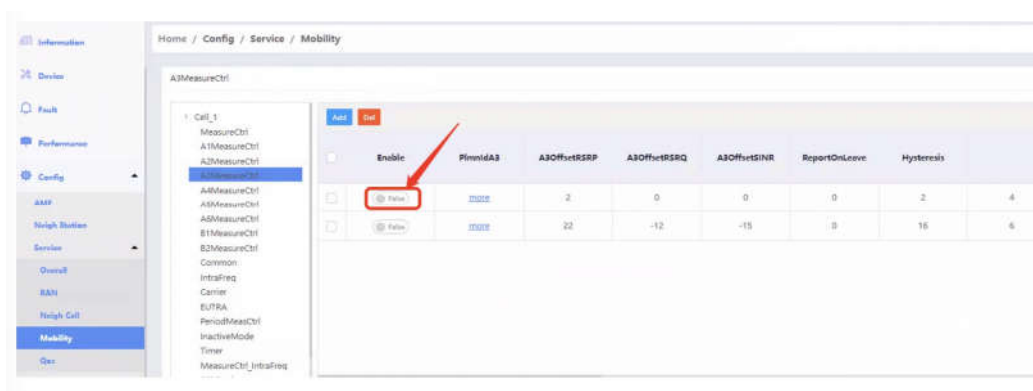


Figure 39

Step 4: Disable the PeriodMeasCtrl

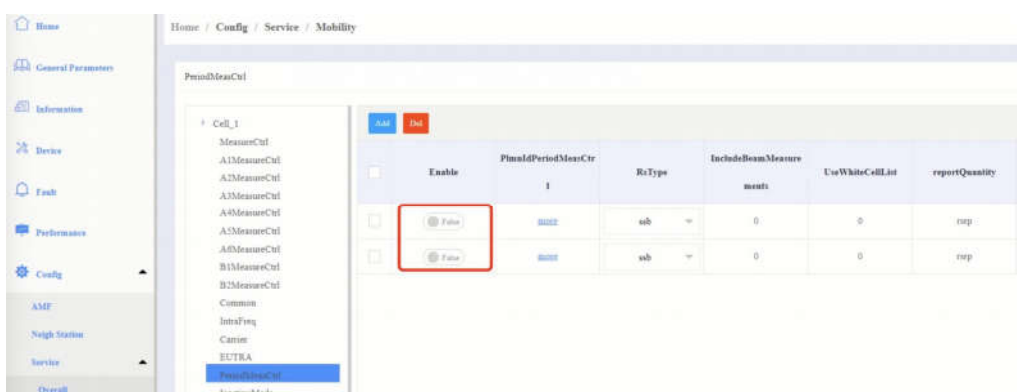


Figure 40

Step 5: Enable the A2MeasureCtrl

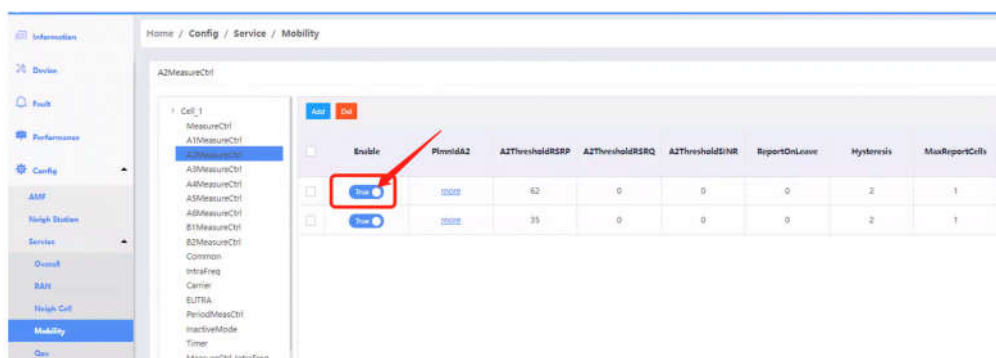


Figure 41

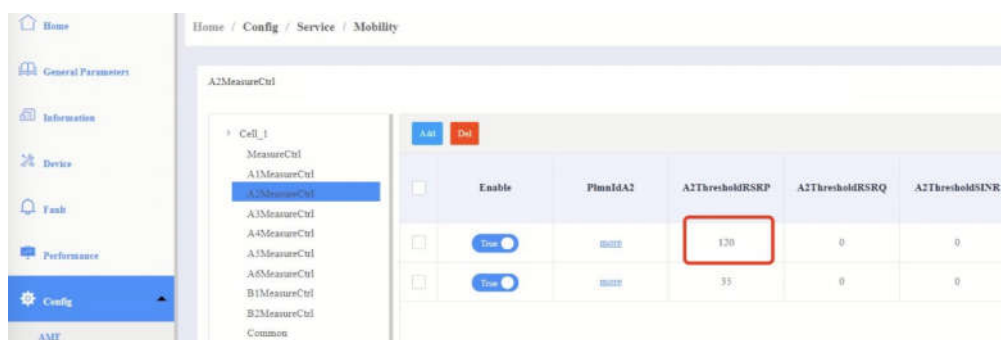
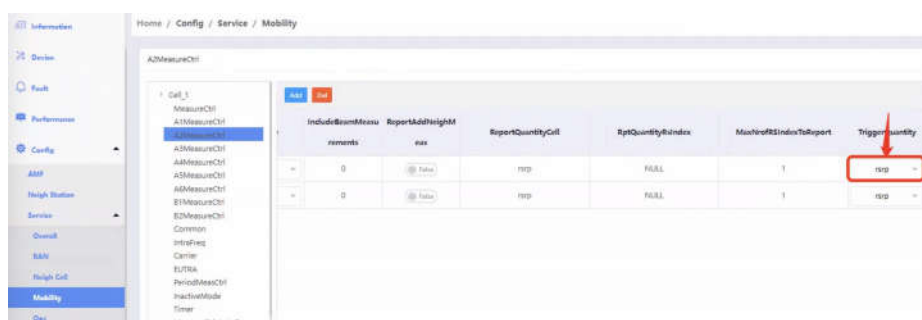
Step 6: Configure A2

Figure 42

ThresholdRSRP: $120 - 156 = -36$

When RSRP smaller than -36, it will trigger the measurement report.

Note: A2ThresholdRSRP can be adjusted according to the situation.

Step 7: Set the trigger quantity to RSRP**Step 8: Enable the A5MeasureCtrl**

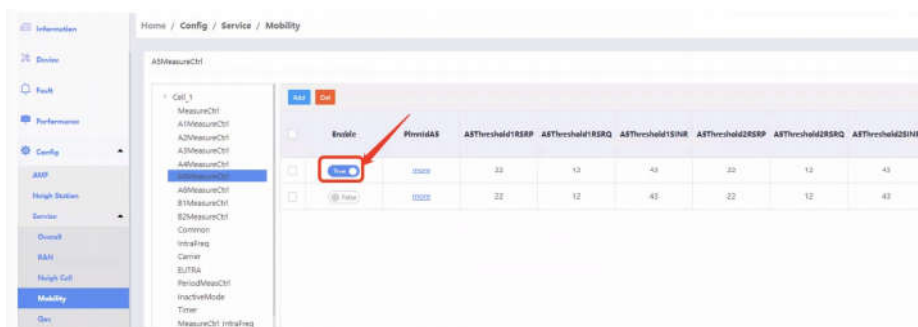


Figure 43

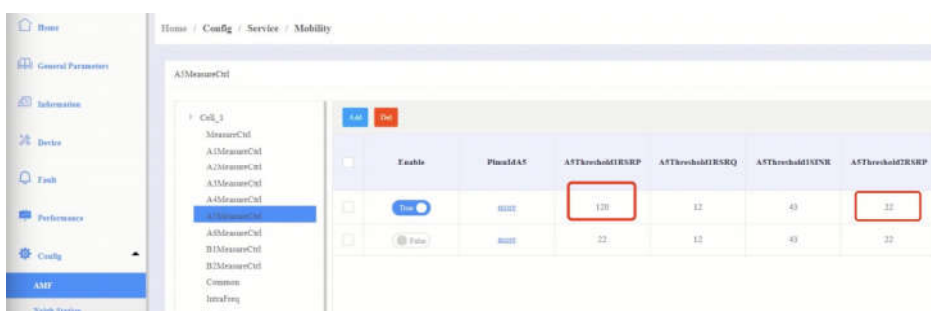
Step 9: Configure A5 TresholdRSRP

Figure 44

Threshold1RSRP: $120 - 156 = -36$

Threshold2RSRP: $22 - 156 = -134$

When the RSRP of service cell is smaller than -36 and the RSRP of target cell is bigger than -134, then handover will happen.

Note: Threshold1RSRP & Threshold2RSRP can be adjusted according to the real use. The values suggested here will be easier to make the inter freq handover happen, and thus test this feature.

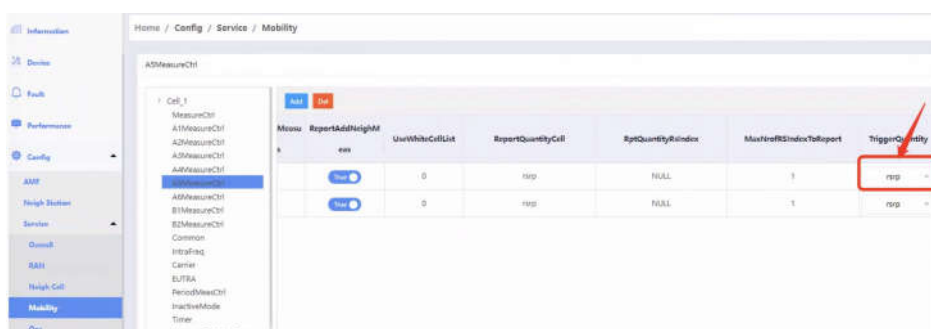
Step 10: Make sure the trigger quantity is RSRP

Figure 45

Step 11: Configure the SSB Freq of Neighbor Cell

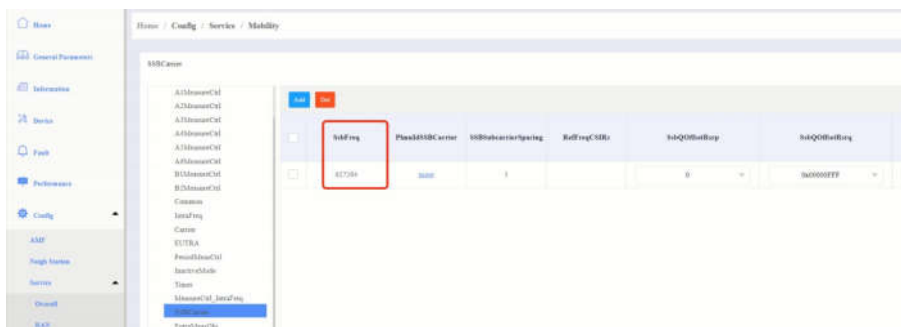


Figure 46

Step 12: Repeat the above confirmation on the handover target cell.

4. Status information

4.1 Operating status

After logging in to the femto cell network management, click the home page to view the cell running status.

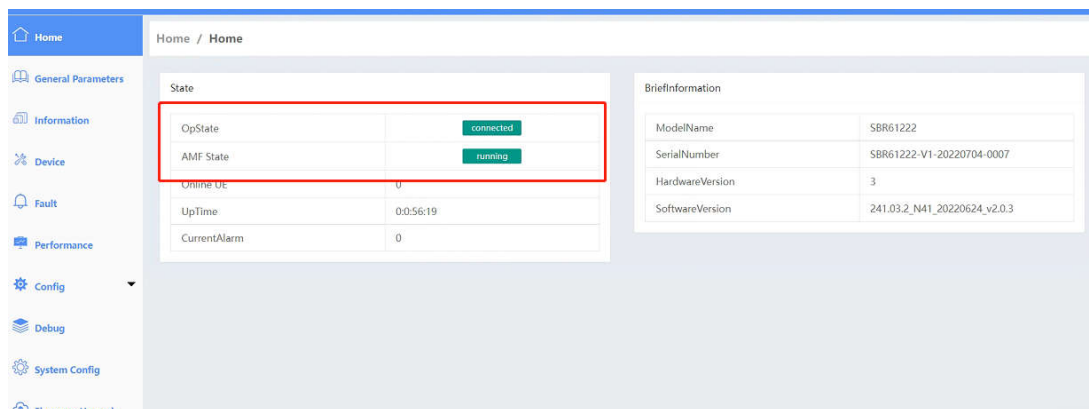


Figure 47. Running state

4.2 Alarm

Click the "Fault" > "Current Alarm" menu, and the current active alarm of the femto cell is displayed on the operation interface.

Click the "Alarm" > "Historical Alarm" menu, and the operation interface displays the historical alarm information of the femto cell.

Click the "Fault" menu, select "Alarm Type", fill in the start time and end time of "Time Query", click the "Query" button, select historical alarms according to

conditions.

Home / Fault

Warn Type: Select Please Time: Begin End Search Reset

CurrentAlarm HistoryAlarm

	AlarmSeverity	AlarmName	AlarmDesc	AlarmRaiseTime
☐	Critical	SCTP CONNECTION TO AMF FAIL	NGAP to AMF 10.88.2.150 is down Cause: Unknown	2022-10-01T04:25:35+00:00
☐	Critical	F1 TO DU SETUP FAIL	F1AP to DU 192.0.2.10 is down	2021-08-26T14:21:46+00:00
☐	Critical	F1 TO CU SETUP FAIL	F1AP to CU 1 is down	2021-08-26T14:21:46+00:00

< 1 > Page: 1 Skip Total 3 / 20 / Page

Figure 48. Alarm

4.3 Debug

Click the submenu "Debug", as shown in the figure below.

Home / Debug

Download Capture Speed Ping Rcmdump HealthyCheck

File Type: LogFile

FileName	FileSize	FileType
Log_20221001_0446+0000_RCF468_SNR172456789.tar.gz	1073.49kb	gz

Figure 49. Debug information

1. File types: log files, configuration files and performance files;
2. Packet capture type: local packet capture and forwarding packet capture;

Local packet capture:

- a) Click the button "Start packet capture" to automatically start packet capture locally; you can check whether the data plane and fapi

b) The button "Start capturing packets" changes to "Stop capturing packets", click this button, the system will automatically download the log to view the data package download status.

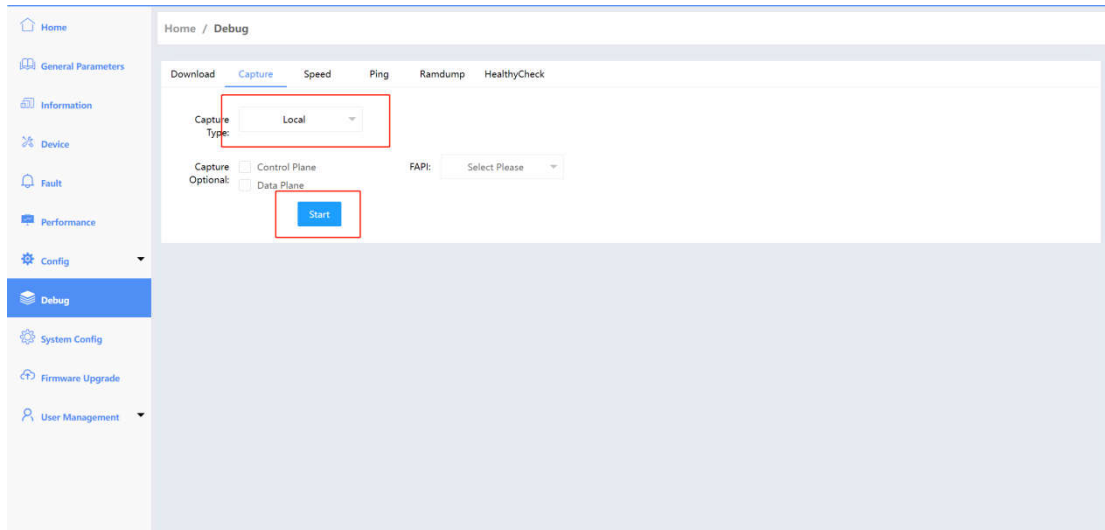


Figure 50. Local capture

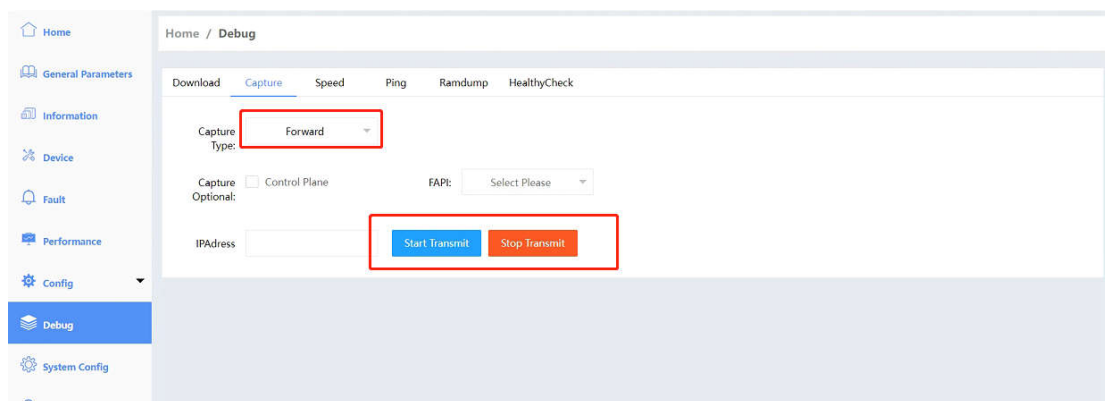


Figure 51. Forward capture

Forward capture: Change the capturing type to "forwarding and capturing", IP The address fills in the ip of the local computer and uses tcpdump or wireshark Just grab the package.

3. Packet capture options: signaling plane, FAPI, data plane.

Signaling plane: Also known as the control plane, it can capture network access signaling such as sctp / ngap / F1AP , log File is small ; FAPI: BBU internal phy and mac Interactive messages, you can view information such as MAC scheduling, log The file is relatively large ; the data plane: also known as the user plane, in the fapi Based on the original data packet, log File is the largest.

4.4 Protocol stack version upgrade

Click the submenu "Device", click the "Software Upgrade" button, and select the corresponding upgrade package to upgrade.

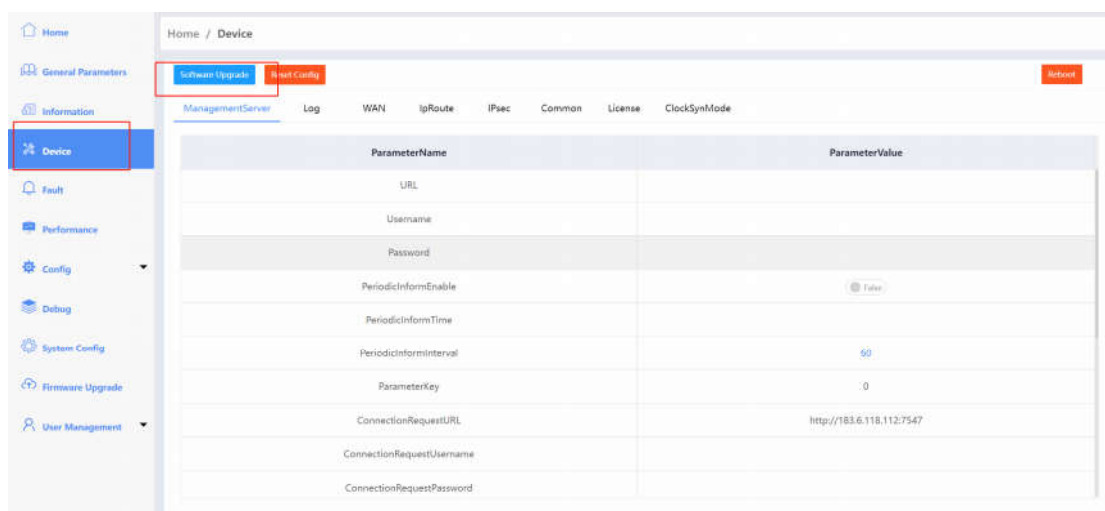


Figure 52. Version upgrade

4.5 Reboot the device

Click the submenu "Restart" to restart the femto cell process.

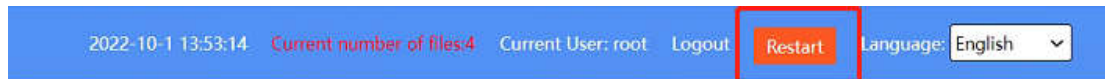


Figure 53. Restart the protocol stack

WARNING! This is NOT a CONSUMER device. It is designed for installation by FCC LICENSEES and QUALIFIED INSTALLERS. You MUST have an FCC LICENSE or express consent of an FCC License to operate this device. Unauthorized use may result in significant forfeiture penalties, including penalties in excess of \$100,000 for each continuing violation.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Caution: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

RF Exposure Information

This device meets the government's requirements for exposure to radio waves.

This device is designed and manufactured not to exceed the emission limits for exposure to radio frequency (RF) energy set by the Federal Communications Commission of the U.S. Government.

This device complies with FCC radiation exposure limits set forth for an uncontrolled environment. In order to avoid the possibility of exceeding the FCC radio frequency exposure limits, human proximity to the antenna shall not be less than 20 cm during normal operation.