Vehicular Mimo Mesh Networking XK-M367 FHSS Hopping

The broadband FHSS MIMO mesh networking is a mobile broadband multimedia communication system designed with the new concept of "wireless grid network". The system with powerful functions and excellent performance; All nodes can realize real-time interaction of multi-channel voice, data, image and other multimedia information by adopting distributed network architecture without central AD hoc network under the condition of non-line-of-sight and fast movement. Supports any network topology, such as point-to-point, point-to-multipoint, chain-like relay, mesh network and hybrid dynamic topology.

The network adopts the same frequency networking and multi-hop relay. Each node device can move quickly and randomly, and the network topology can be changed and updated quickly without affecting the network transmission.The whole network is convenient to deploy, flexible to use, simple to operate and easy to maintain. It can provide users with reliable, timely, efficient and secure full IP clear voice, broadband data, high-definition video and visual command and scheduling and other multimedia integrated services under complex application scenarios such as fast movement and non-line-of-sight shielding.

The broadband self-organizing network can be widely used in the military, public security, armed police, fire protection, civil air defense, electric power, petroleum, mining, transportation, water conservancy, forestry, radio and television, medical, water and air communications and other sectors, providing users with reliable, timely, Rich integrated services such as safe and efficient voice, data, video and visual command and dispatch can meet users' wireless broadband communication needs in normal or emergency situations to the greatest extent, and truly achieve "anytime, anywhere on demand".

Performance:

- Mesh network (self-forming, self-healing, self-adapting), high-speed throughput
- Non-visual urban construction jungle multi-path transmission terrain, effective connection
- High-speed movement of ground, water and air, effective connection
- Multiple antenna settings, omnidirectional, high gain orientation or mixing
- GPS and Multicast Support

Advantages:

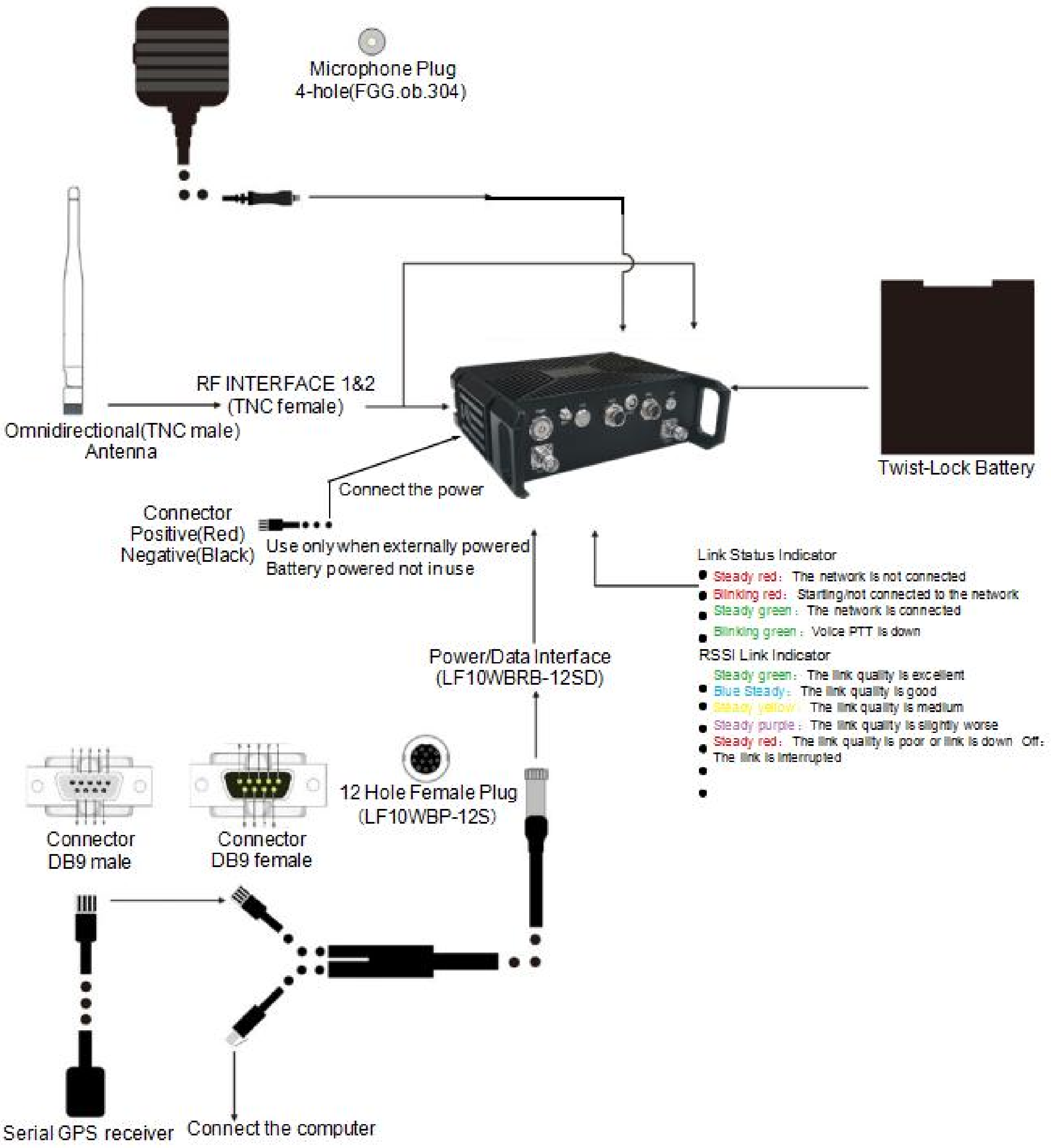
- Increased 4.5 times coverage in densely populated areas
- The same communication range and transmission volume, reducing transmission power by 10 times
- Increase the distance by 2 times in the visible limit environment
- Increase 2-4 times transmission rate

Significant applications in Non Line of Sight /Multipath Fading environments, video/data/voice

critical ommunications:

- Robot / Unmanned Vehicle, Reconnaissance / Surveillance / Anti-Terrorism / Monitoring
- Air-to-air & air-to-ground & ground-to-ground, public safety / special operations
- Urban network, emergency support / normal patrol / traffic management
- Inside and outside the building, fire fighting / rescue and disaster relief / forest / civil air defense / earthquake
- TV broadcast wireless audio / video / live broadcast
- Marine communication / high speed transmission on the opposite side of the ship
- Low deck wireless network / ship landing

Backpack&Vehicular Radio (Battery & External power supply) Quick Start Guide



Vehicular Radio

Figure 2-4 Vehicular Radio Enclosure

1 Auxiliary Connection Port [LF10WBRB-12SD]

2 Radio switch

3 WiFi Antenna [SMA Female]

4 Power Switch

5 Power supply port(13.8-24V,13.8/10A)

6 Push-to-Talk (PTT) Connector HGG.0B.304

7 RS232, Ethernet, and Serial Port Connector [LF10WBRB-12PD]

9 RF Channels 1-2 Connectors [TNC Female]

8 Link Status Indicator

- Steady red: The network is not connected
- Blinking red: Starting/not connected to the network
- Steady green: The network is connected
- Blinking green: Voice PTT is down

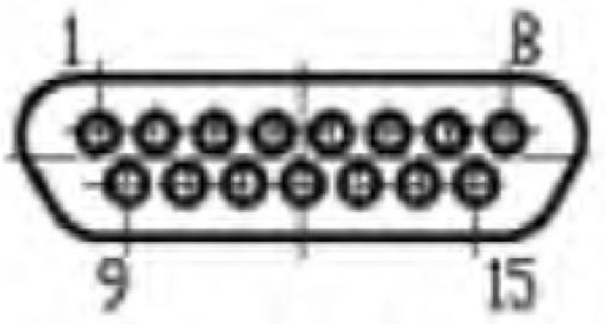
RSSI Link Indicator

- Steady green: The link quality is excellent
- Blue Steady: The link quality is good
- Steady yellow: The link quality is medium
- Steady purple: The link quality is slightly worse
- Steady red: The link quality is poor or link is down
- Off: The link is interrupted

Technical parameters	
Waveform	Mobile Network MIMO Mesh Radio Fhss Hopping
MIMO Technology	Spatial multiplexing,Space-time coding;Diversity,TX /RX beam forming
Receive Sensitivity	-103dBm@5MHz BW
Channel Bandwidth	2.5/5/10/20MHz ,40MHz optional
Data Rate	1-100Mbps(20MHz BW)/180Mbps(40MHz BW) Adaptive,QoS
Modulation Mode	TD-COFDM,BPSK/QPSK/16QAM/64QAM/256QAM adaptive
RF Output Power	MIMO 20watts×2 (Airborne/Backpack/Vehicle Rack-mounted/Outdoor)
Single Hop Communication Distance	100-300 KM (visible), 1-30 KM (urban area)
Mode	Point-to-point/Point-to-multi point/Multi point-to-multi point,Automatic relay, Star/Line/Network/Hybrid
Single Hop Delay	Average 10mS(20MHz BW)
Encryption	DES, AES128/256,Chip /TF card encryption customized
Anti-interference Mode	Manual spectrum scanning channel selection, Intelligent frequency channel Selection/Autonomous frequency hopping/Roaming mode optional/MESH Radio Manet FHSS Hopping
Local/Remote Management	Operating frequency, channel bandwidth, network ID, transmit power and other parameter settings, spectrum scanning, real-time display and statistical records of network topology, link field strength signal-to-noise ratio, upload and download traffic, GPS/Beidou electronic map, temperature/voltage/interference Monitoring, software upgrade
Others	The startup time is less than 30 seconds, and the network access/update/switchover time is less than 1 second.There is no limit on the user capacity of a single system and the number of hops in Mesh networks. The total

	bandwidth loss of multiple hops is less than 30%.Automatic carrier tracking, support over 800 km/h mobile communication
Bands	
BAND	Frequency range (MHz)
UHF	350-700
L Band	1000-1500
MIIT	336-344/512-582/566-626/606-678/1420-1520/1430-1444
S Band	1800-2500
Lower C Band	4400-5000
Upper C Band	5100-6000
Environmental	
Operation Temperature	-40ºC ~+80ºC
Protection Level	IP66,IP67/IP68 Customized
Mechanical	
Size/Weight	18.3x15.4x6.3cm/1.56kg(20watts×2 Vehicle FHSS Mesh Radio)
Installation/Color	4 Mounting Holes/Black,Lron Gray,Army Green Optional
Power	
Supply Voltage	18-24VDC(20Watts×2 Airborne/Vehicle Rack-mounted/Outdoor)
Power consumption	Operation 6-7A/Standby 0.5-0.7A@18V(20Watts×2 Airborne/Vehicular/Outdoor Radio)
Power Selection	Power Supply by Twist-Lock Battery or Main Cable
Interface	
Basic interface	RF 2xTNC,1-2xRJ45 Ethernet 10/100BaseT,WiFi AP, 1xRS232-485-422-USB-Bluetooth/1.2-230.4Kbps,DC Input
Push to talk/Auxiliary interface	MIC, SP, PTT, GND/1xRS485,1xUSB2.0 OTG
Network Extension Optional	Public Network Routing/4G LTE, WB-NB integration, Fiber, Satellite
Video Extension Optional	Low Delay HDMI/SDI/CVBS, 4K/2K/1080P/720P/D1
Link Status Indicator	Steady red - The network is not connected Blinking red - Starting/not connected to the network Steady green - The network is connected Blinking green - Voice PTT is down
RSSI Link Indicator	Steady green - The link quality is excellent Blue Steady - The link quality is good Steady yellow - The link quality is medium Steady purple - The link quality is slightly worse Steady red - The link quality is poor or link is down
Management Interface/Control Interface	Web-based network management/GUI, API secondary development interface/SNMP
OEM	
Size/Weight	10.1x5.4x1.9cm/123.5g
RF	SMP

Definition of on-board MESH connection port pins



Power supply/Ethernet/serial port connection pins

J30J-9ZKNP5-J	definition
1	RS232_RXD
2	RS232_TXD
3	RS232_GND
4	5V output
5	100-Base T ETHO M1P
6	100-Base T ETHO M1N
7	100-Base T ETHO M2P
8	100-Base T ETHO M2N
9	Sbus
10	Sbus_VCC
11	Sbus_GND
12	GND IN
13	GND IN
14	VCC IN
15	VCC IN

一、 Overview of network functions

1.1 Voice Transmission

Wireless broadband ad hoc networks support 4 nodes to simultaneously perform voice broadcasting, achieving intra group voice conference mode. Voice communication between node devices, automatically multicast to all other nodes connected to it in the network, can be achieved by inserting earphones for instant communication, or optional with PTT button voice control. At the same time, the device can also be associated with a computer using wireless broadband self-organizing network terminal system software for voice input through the computer. After the voice input of any node is sent to the computer microphone, it will automatically multicast and send to all other nodes connected to it in the network.

1.2 Data Transmission

1.2.1 IP data transmission

IP data communication can be achieved between any MESH node in a wireless broadband ad hoc network, which can serve as a data channel, enabling real-time IP data exchange between various mobile data interrupts (computers, mobile phones, PADs, etc.) connected to devices.

1.2.2 File Transfer

After each MESH node in the wireless broadband self-organizing network is connected to a computer or other data terminal, file transfer operations can be performed.

1.3 Video Transmission

Wireless broadband ad hoc networks support both unicast and multicast video modes.

1.4 Video transcoding

Wireless broadband ad hoc networks support video transcoding, which can be used to transcode videos to designated decoders. Can output to terminal devices such as display screens, monitors, video matrices, etc.

1.5 WIFI

Wireless broadband self-organizing network, including individual equipment and onboard equipment with built-in Wi Fi communication modules. The computer console can be connected to MESH nodes through Wi Fi.

1.6 Real time monitoring

1.6.1 Real time monitoring of equipment working status

Wireless broadband self-organizing network individual equipment and on-board equipment come with status indicator lights, which can reflect the system's working status in real time. The corresponding relationship between specific indicator lights and working status is shown in Table 6-1.

Definition of indicator lights	Corresponding light color	Equipment corresponding status
Link status indicator light	Red light always on	Not connected to the network
	Red light flashing	Power on/not connected to the network
	Green light always on	Connected to the network
	Green light flashing	Voice PTT pressed
RSSI link indicator light	Green light always on	Excellent link quality
	Blue light always on	Good link quality
	Yellow light always on	Link quality is average
	Purple light always on	Slightly poor link quality
	Red light always on	Poor link quality
	Light goes out	Link interruption

Table 6-3

1.6.2 Real time monitoring of node network status

As shown in Figure 6-1, the wireless broadband ad hoc network terminal system software can hover the mouse over the nodes on the topology page to view the status of the corresponding nodes, and can also view the signal-to-noise ratio/modulation method/distance between nodes/estimated rate between each node.

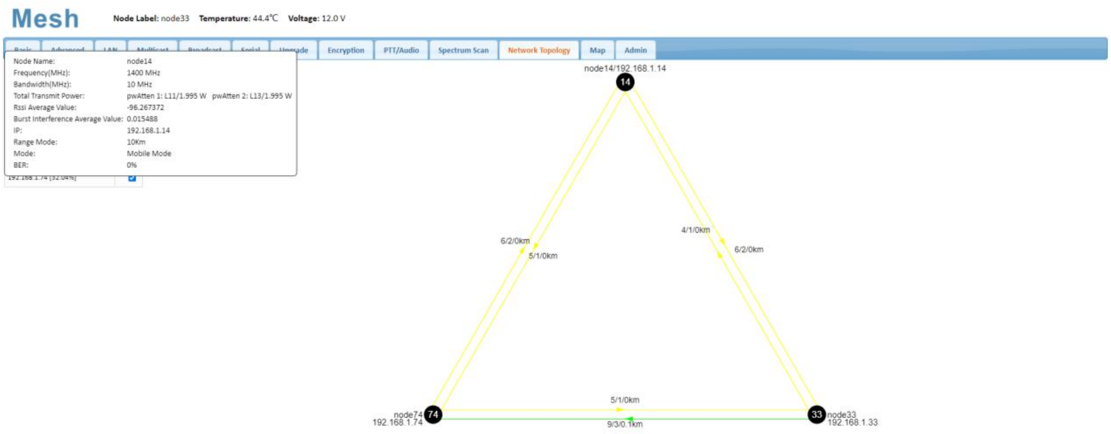


Figure 6-1

1.6.3 Real time monitoring configuration of remote parameters

The wireless broadband self-organizing network terminal system software can remotely and uniformly configure the parameters of the entire network, and the parameters marked with * in the settings can be uniformly configured. As shown in Figure 6-2.

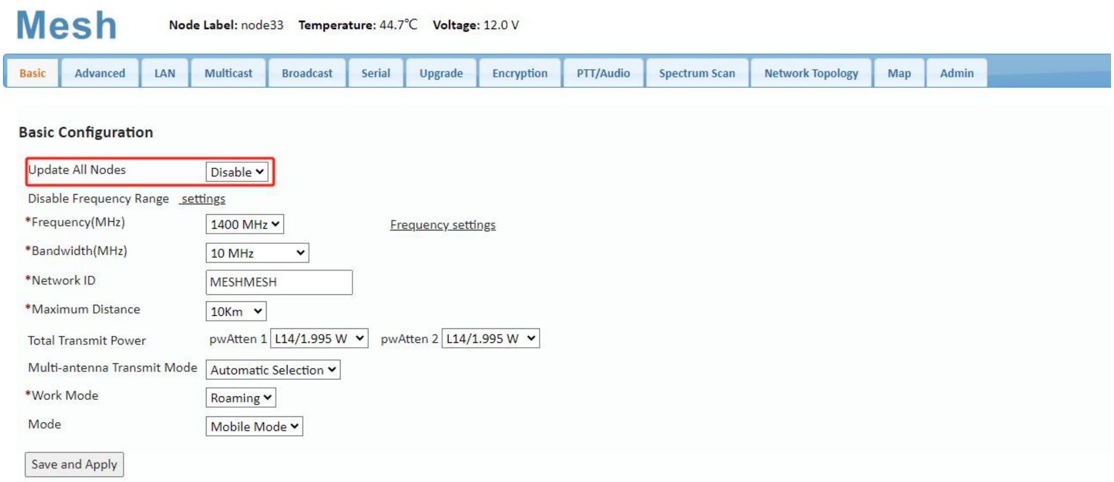


Figure 6-2

1.6.4 Real time monitoring system topology changes

Wireless broadband ad hoc networks can monitor real-time changes in MESH ad hoc network topology. As shown in Figure 6-3, the real-time self-organizing network topology diagram will be displayed on the MESH terminal system software interface.

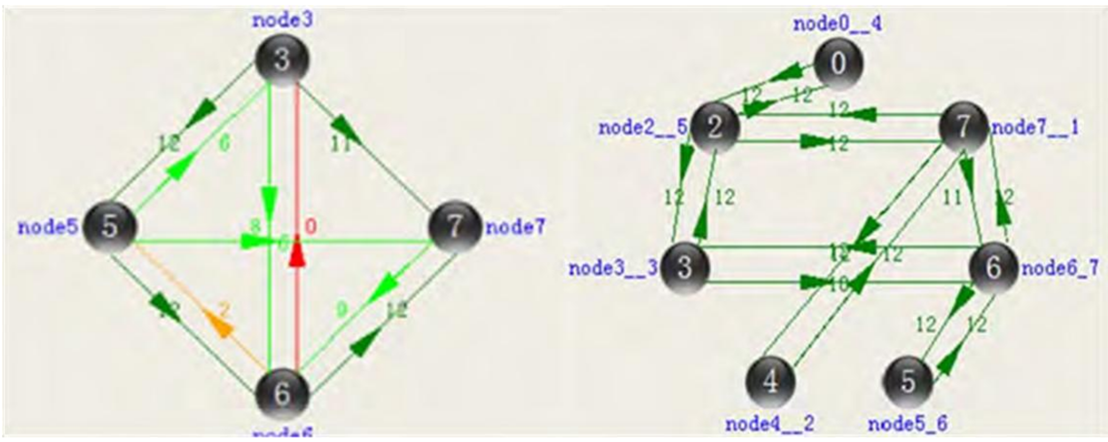


Figure 6-3

Meanwhile, on the GIS map interface of the MESH terminal system software, the connection relationships between all nodes can also be displayed, as shown in Figures 6-4.

Figure 6-4

1.6.5 Real time monitoring of wireless link quality

As shown in Figures 6-5, wireless broadband ad hoc networks can display link quality through color monitoring of the network topology diagram connection lines in the MESH ad hoc network terminal system software.

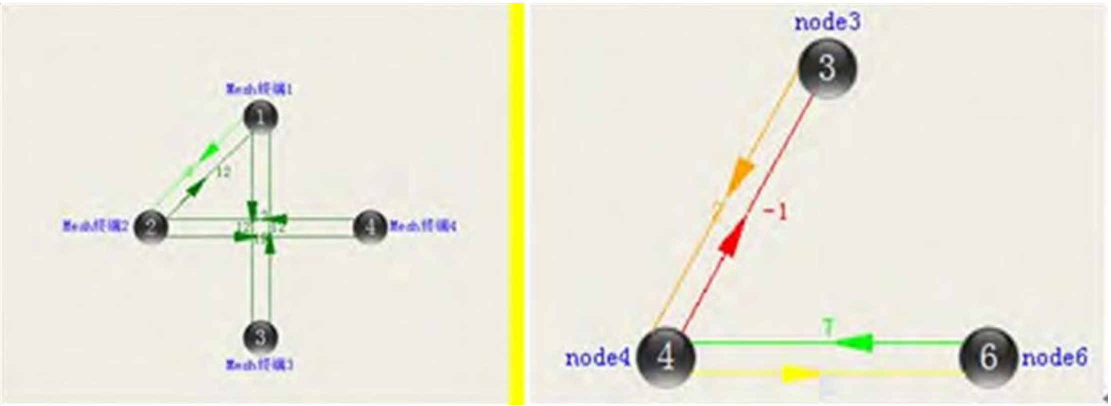


Figure 6-5

The link quality relationship corresponding to the color of the connection lines in the topology diagram is described in Table 6-2.

Link quality	colour
excellent	Dark green
good	Light green
commonly	yellow
Slightly inferior	orange
difference	red
break link	nothing

Table 6-2

1.6.6 Real time monitoring and positioning of GPS information

All devices in wireless broadband ad hoc networks (including individual equipment, outdoor fixed station equipment, portable control equipment, vehicle equipment, etc.) can be equipped with GPS positioning modules and GPS antennas. As shown in Figures 6-6, the MESH terminal system software displays real-time geographic location information of all terminals.

Figure 6-6

1.7 GIS Maps

The road map is shown in Figures 6-7, and the map interface can display real-time geographic locations and specific positioning information such as longitude and latitude of all MESH node devices.

Figure 6-7

As shown in Figures 6-8, while displaying the geographical location information of the MESH terminal, the link quality between each node is also differentiated by the color of the connecting lines.

Figure 6-8

The satellite image display is shown in Figures 6-9

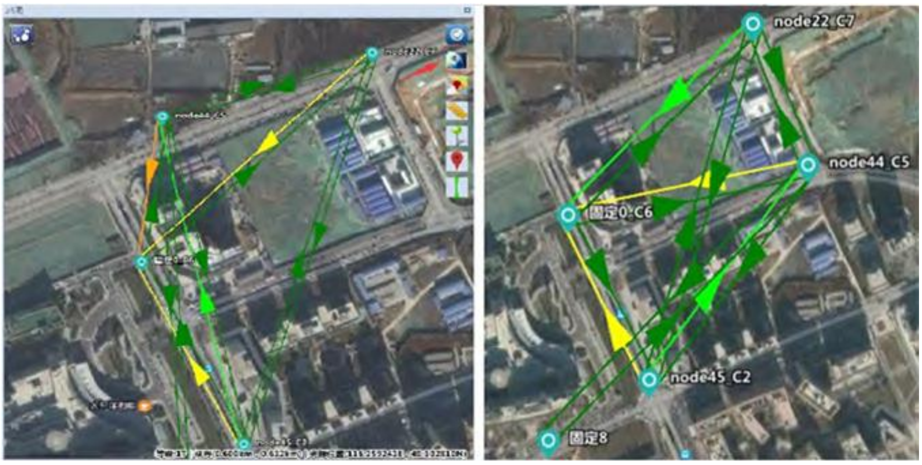


Figure 6-9

二、 WEB interface

2.1 Login to web interface

Connect the laptop to the radio station using the provided Ethernet cable, ensuring that the radio station is properly connected to the antenna, the power supply is red positive and black negative, and the power supply is compatible before the radio station can be turned on. After the radio station is turned on, the user can type "ping<IP address>" to confirm whether the radio station is fully started. Please ensure that your laptop is on the same subnet as the radio station.

Attention:

a. Please use a matching antenna. When using, keep the antenna vertical and place it at least 10 meters away from the radio stations to avoid power saturation between them;

b. The power supply should strictly ensure a voltage of 12-24V. For some customized equipment, the voltage range is 18-36V. Please refer to the label for specific voltage ranges. The current is reserved according to the corresponding equipment model. If using battery power, ensure that the battery is fully charged.

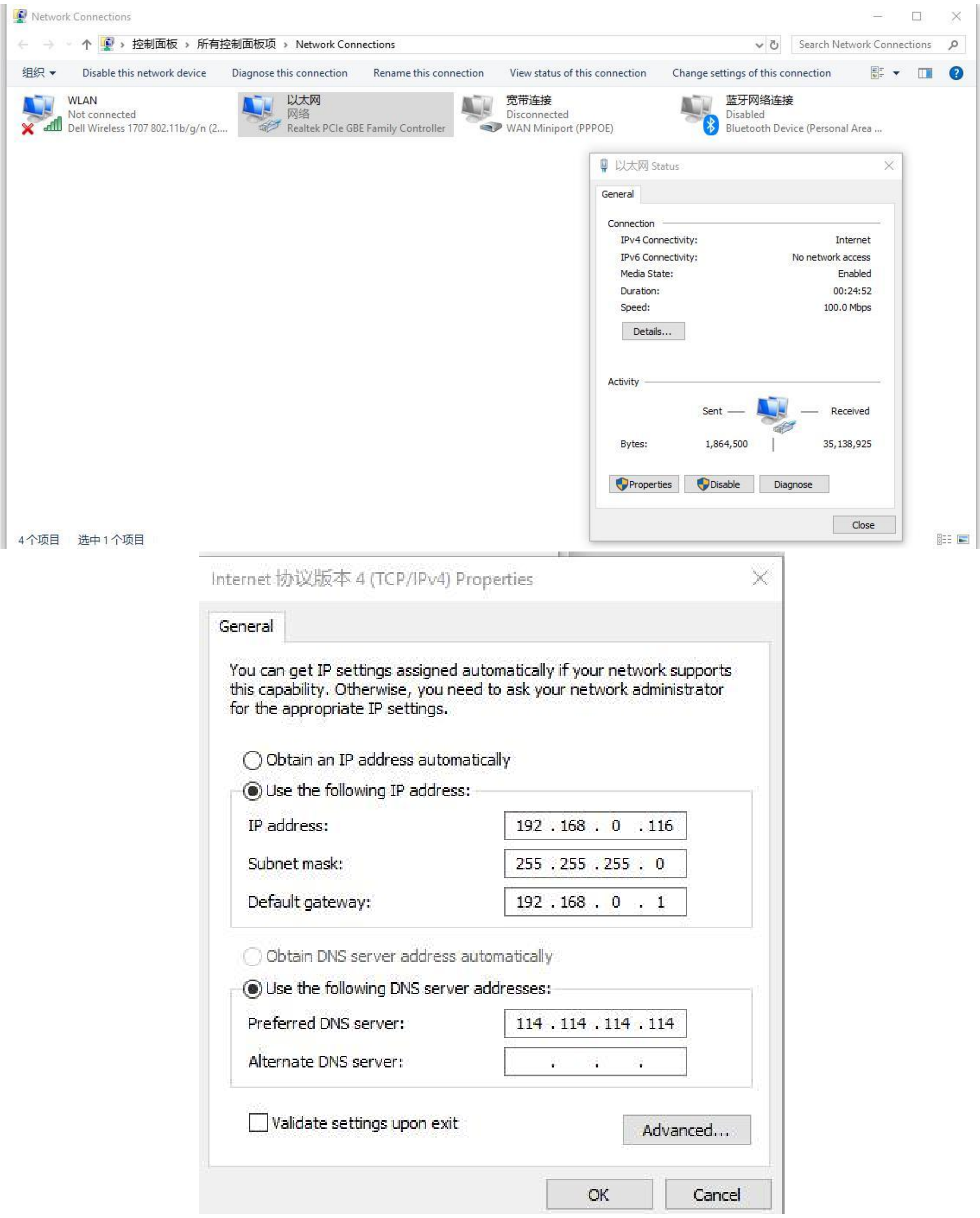


Figure 7-1 Address Configuration

The computer IP address configuration method is as follows:

- Open the Network and Sharing menu and click on "Change adapter settings"
- Select Local Connection, right-click, and select Properties
- Select IPv4 and click on "Properties"
- Set the IP address to 192.168.1.XX and then set the subnet mask to 255.255.255.0. Click OK. The computer IPv4 settings should be on the same network segment as the radio station.

For example, the radio station should be 192.168.1.36, and the computer should be 192.168.1.XX

In the browser (it is recommended to use 360 browser), enter the radio IP address 192.168.1.xx to log in.

2.2 Basic parameters

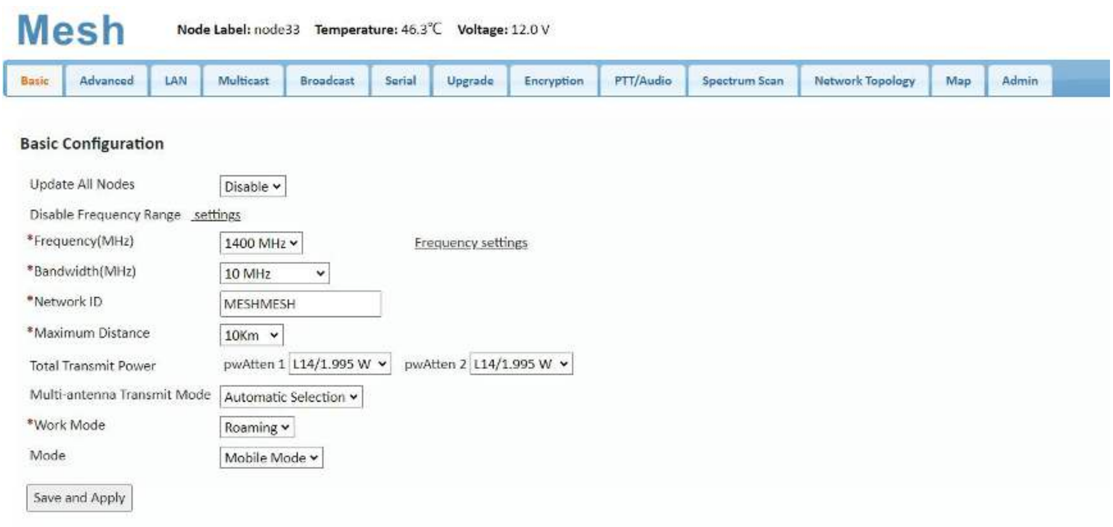


Figure 4-3 Basic Settings Page

This page is used for basic settings. Below is a brief explanation of each parameter. The parameter with * in the web page must be consistent, otherwise network access cannot be achieved.

Modify network wide consistency parameters: configured separately, only local radio stations can be modified;

When setting up a unified network, select "Network wide setting". This function can only be used when the link quality of the entire network is good, to avoid situations where some nodes have not successfully modified their configuration and have not been connected to the network.

Disabled frequency range: Unneeded frequency points can be added, and disabled frequency points cannot be selected after addition.

Center frequency: used to modify the current frequency used; The frequency list can be customized to add frequencies within the working range of the radio station.

Channel bandwidth: defines the RF bandwidth of the signal, which can be appropriately reduced based on the maximum rate required for actual transmission, thereby increasing the transmission distance.

Network ID: used to identify the ID of the local area network composed of radio stations. Only when the network ID is consistent can networking be carried out;

Maximum distance: Adjust the maximum distance based on the actual distance used, and the maximum distance should be slightly greater than the actual distance. When the maximum distance setting is too large, it may cause air collisions and performance degradation. The larger the maximum distance setting, the greater the delay to protect the air port transmission time.

Total transmission power: Set the transmission power of radio antenna 1 and antenna 2 separately. Generally, the maximum power is set by default. If tested at close range indoors, the power can be appropriately reduced, and the power of antenna 1 and antenna 2 should be kept consistent.

Multi antenna transmission mode:

1. Automatic selection: (default automatic selection) Diversity and MIMO are automatically selected by the node according to the situation, with the principle of which mode has the highest available transmission rate.

2. Diversity: Fixed diversity work, which can effectively ensure stable data transmission during diversity, with a maximum rate slightly lower than during MIMO.

3. MIMO: Force MIMO, unless the signal-to-noise ratio is too low and the underlying layer believes that MIMO cannot be transmitted correctly. MIMO needs to work, and there are many influencing factors, mainly the propagation environment. The more independent (low correlation) the signals received on the two receiving antennas, the higher the probability of working in MIMO mode; On the contrary, if the signal correlation between the two receiving antennas is stronger, the probability of operating in MIMO mode is lower or even unable to support MIMO transmission.

Working mode: (Here, it is recommended to use full network configuration for one click full network modification)

Single frequency mode: This mode is used by default, with a fixed single frequency point. After enabling this mode, all network devices use a unified frequency list for sequential frequency hopping communication.

Frequency hopping mode: It is necessary to ensure that all nodes are enabled in this mode, and the frequency values, arrangement order, and number of frequency points in the frequency list must be consistent. It is best to select a relatively clean frequency before configuration and add it to the frequency list in order. After enabling this mode, all network devices use a unified frequency list for sequential frequency hopping communication.

Enhanced intelligent frequency selection: It is necessary to ensure that all nodes are enabled in this mode, and the frequency values, arrangement order, and number of frequency points in the frequency list must be consistent. After enabling this mode, when transmitting data between MM/SM devices, a relatively clean frequency will be selected to transmit data to the other party based on the environmental noise of the destination node. Each node may use different frequencies to send and receive data.

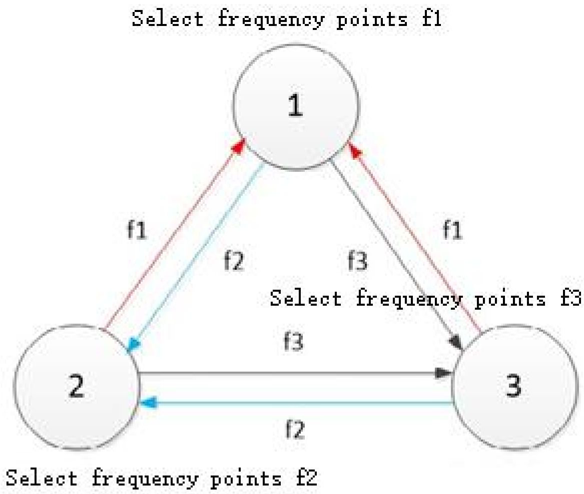
Roaming mode: Assuming two subnets with different frequencies are fixed, a mobile Mesh vehicle station continuously shuttles between the two subnets. This mobile Mesh car station needs to be configured in roaming mode and use mobile station mode. You can refer to the roaming mode operation instructions below for further understanding.

Mode:

Mobile station: In single frequency point/enhanced intelligent frequency selection/adaptive frequency hopping mode, all nodes are set to a mobile station by default; In roaming mode, radio

stations that move back and forth between two subnets are set to mobile station mode.
Fixed Station: In roaming mode, all radio stations within two fixed subnets are set as fixed stations.
The use of roaming mode can be found in the example below.
Save and Apply: Apply and save the latest configuration parameters.
Powerful anti-interference capabilities of MM/SM broadband ad hoc networks: intelligent frequency selection, enhanced intelligent frequency selection, autonomous frequency hopping, adaptive frequency hopping, dynamic adaptive anti-interference
A. Enhance intelligent frequency selection
When working at fixed frequency points in current wireless self-organizing networks, in order to avoid interference, it is necessary to manually intervene and select a relatively good frequency point based on the spectrum scanning results of all nodes in the network for operation. On the one hand, this manual intervention method has low efficiency and high requirements for users. On the other hand, due to geographical differences, it is often impossible to select a frequency point with low interference throughout the entire network for networking and transmission.
The adaptive enhanced intelligent frequency selection technology currently used in the system is based on the frequency point list configured during system operation. Real time perception and spectrum monitoring of the entire network wireless environment are carried out for these frequency points during operation. Each node intelligently adjusts its own working frequency points based on external electronic environment, interference conditions, and other factors. Each node dynamically selects its own working frequency points based on the optimal reception performance of this frequency point. Each node independently selects and does not depend on each other, thereby achieving intelligent dynamic cross frequency networking, avoiding interference, improving overall network transmission performance, and achieving optimal network performance. At the same time, without human intervention, the complexity of network configuration and use is greatly reduced, enhancing network usability.
For example, as shown in the figure below, nodes 1, 2, and 3 choose frequency points f1, f2, and f3 as their working frequency points based on their real-time perception and spectrum monitoring of their wireless environment (f1, f2, and f3 can be the same or different, each node is independently selected and independent of each other). When nodes 2 and 3 send data to node 1, frequency point f1 is used; 1. When two nodes send data to node 2, frequency point f2 is used; 1. When two nodes send data to node 3, frequency point f3 is used. When there are more nodes present, so on. In short, due to the intelligent and dynamic adjustment of their own working frequency points by each node, which are independently selected and independent of each other, the frequency points used by each edge (a certain direction between two nodes is called an edge, such as node 1 → 2 and node 2

→ 1 being one edge respectively) in the network are different from each other, thus achieving the optimal solution for the entire network. At the same time, this function is completely automatically completed by the system, and real-time adjustments are made based on the external wireless environment and spectrum detection situation, without the need for manual intervention, making it simple and easy to use.



In actual field applications, the interference situation of each node is consistent, and there is almost no situation where the same frequency point is the optimal receiving frequency point. Therefore, compared to the interference avoidance technology of other radio stations, when the entire network operates at a unified frequency point and switches to another frequency point after interference, it is obvious that enhancing intelligent frequency selection technology is far superior to interference avoidance technology in many aspects such as robustness, ease of use, anti-interference ability, and transmission performance, and can achieve the optimal solution of the entire network, achieving the optimal transmission performance of the entire network.

B. Enhanced intelligent frequency selection

The ordinary intelligent frequency selection technology detects and perceives in real-time during the working process, and selects frequency points based on a pre configured frequency point list. Therefore, the selection of frequency point lists is particularly important. Due to the fact that the frequency list is manually selected and configured, if the frequency list is not selected properly, it will affect the overall system performance and performance.

Enhanced intelligent frequency selection technology can effectively solve the above problems. Enhanced intelligent frequency selection technology no longer relies on existing frequency point lists, but within the frequency band supported by the hardware equipment (this frequency band is determined by the specific hardware implementation), with smaller frequency steps (such as 1MHz), while networking, real-time perception and spectrum monitoring of the entire wireless environment are carried out on the entire frequency band to select the optimal working frequency point.

Based on the dynamic perception results and considering factors such as external electronic environment and interference, each node intelligently and dynamically adjusts its own working frequency point throughout the entire frequency band, taking into account the optimal reception performance of that frequency point. Each node dynamically and independently selects its own working frequency point, and is independent of each other, thus achieving intelligent dynamic cross frequency networking throughout the entire frequency band, avoiding interference, improving overall network transmission performance, achieving optimal network performance, further reducing network configuration and usage complexity, and enhancing network usability.

In terms of networking logic and functional performance, enhanced intelligent frequency selection technology is basically the same as intelligent frequency selection technology. Its biggest improvement lies in more accurate detection, scanning, and analysis of the entire frequency band, stronger adaptability to the environment, and better performance. At the same time, the transmission mechanism of control information and data information has been further optimized, improving anti-interference ability and enhancing the robustness of systems in complex environments.

C. Frequency hopping

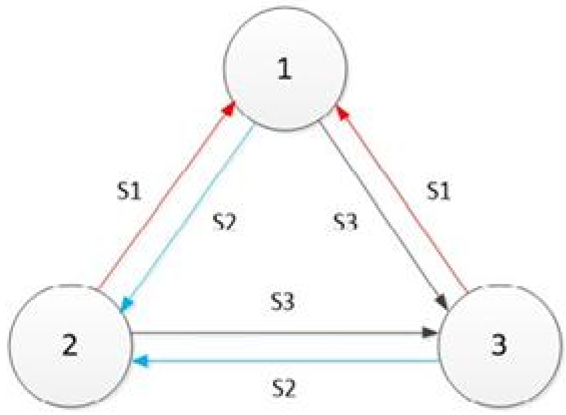
High speed frequency hopping is also a conventional anti-interference method. Compared with other measures, it can greatly reduce the risk of being captured, tracked, and detected, effectively combating various interference methods such as tracking interference.

The current system supports a hopping rate of no less than 1000 hops per second, with a maximum of 256 hopping points. The relevant hopping patterns have been fully randomized. At the same time, by increasing the complexity of the hopping patterns, prolonging the repetition period, and flexibly using the corresponding hopping network patterns, the difficulty of the enemy deciphering the hopping patterns can be greatly increased, effectively reducing system risks.

D. Adaptive frequency hopping

Conventional frequency hopping, when subjected to large-scale interference in the working frequency band, results in a higher probability of system interruption, an increase in error rate, and a significant decrease or even interruption in business transmission capacity. The introduction of adaptive frequency hopping technology can effectively improve this situation, further enhance the system's anti-interference ability, and greatly improve the data service transmission ability under large-scale interference conditions.

Adaptive frequency hopping technology introduces dynamic real-time spectrum monitoring of the entire network while operating at high speeds. It relies on the existing frequency hopping point list, or within the frequency band supported by the hardware equipment (this frequency band is determined by the specific hardware implementation), with smaller frequency steps (such as 1MHz), to achieve real-time perception and spectrum monitoring of the entire wireless environment of the network. (Note: Frequency point list or set frequency band range, choose one of the two modes)
Based on real-time spectrum monitoring results, each node intelligently and dynamically selects several optimal frequency points to form a frequency hopping frequency set according to the external electromagnetic environment and interference situation, achieving intelligent, dynamic, and heterogeneous frequency set frequency hopping networking, effectively avoiding interference while high-speed frequency hopping.
For example, as shown in the figure below, nodes 1, 2, and 3 select subsets S1, S2, and S3 from all available frequency sets based on their real-time perception and spectrum monitoring of their wireless environment as the frequency hopping frequency sets (S1, S2, and S3 sets, whose elements can be the same or different, each node independently selects itself and is independent of each other). When nodes 2 and 3 send data to node 1, frequency set S1 is used for frequency hopping transmission; 1. When two nodes send data to node 2, frequency set S2 is used for frequency hopping transmission; 1
When two nodes send data to node 3, frequency set S3 is used for frequency hopping transmission. When there are more nodes present, so on. In short, due to the intelligent dynamic adjustment of each node
The entire self frequency hopping frequency set is independently selected and independent of each other. Therefore, in the network, the frequency hopping frequency set used by each edge (a certain direction between two nodes is called an edge, such as node 1 → 2 and node 2 → 1 being one edge respectively) is different from each other, thus achieving the optimal frequency set for the entire network. At the same time, this function is completely automatically completed by the system, and real-time adjustments are made based on the external wireless environment, spectrum detection situation, and interference situation, without the need for manual intervention, making it simple and easy to use. Strong anti-interference ability and strong system robustness.



E. Dynamic adaptive anti-interference

In order to enhance the survival ability of the system in complex electromagnetic environments and ensure the transmission of data services as much as possible, the system also has the ability to dynamically adapt to interference while adopting all the aforementioned frequency hopping, enhanced intelligent frequency selection and other technologies.

During the data transmission process between any two nodes, the receiving end will collect real-time information such as signal-to-noise ratio, error rate, etc. Based on this information, the optimal modulation and coding format and related retransmission strategies will be selected, and the corresponding results will be fed back to the sending end in real time. The sending end will adjust the sending strategy (dynamically adjust transmission redundancy) according to the feedback information, thereby achieving dynamic adaptive anti-interference.

Through dynamic adaptive anti-interference, the system can ensure maximum transmission efficiency and achieve the optimal transmission capacity in the corresponding environment when not disturbed; When subjected to interference, it can effectively counteract the impact of interference, sacrificing efficiency while striving to ensure the reliable and stable transmission of data services.

At present, the system supports four different anti-interference capabilities, corresponding to four different maximum redundant insertion, detection, and processing capabilities:

Anti-interference level 1: able to ensure normal communication and data transmission when resources (time or frequency band) are disturbed within 15%;

Anti-interference level 2: able to ensure normal communication and data transmission when resources (time or frequency band) are disturbed within 30%;

Anti-interference level 3: able to ensure normal communication and data transmission when resources (time or frequency band) are disturbed within 50%;

Anti interference level 4: can ensure normal communication and data transmission when resources (time or frequency band) are disturbed within 70%;

Operation instructions for roaming network working mode

A. Network deployment

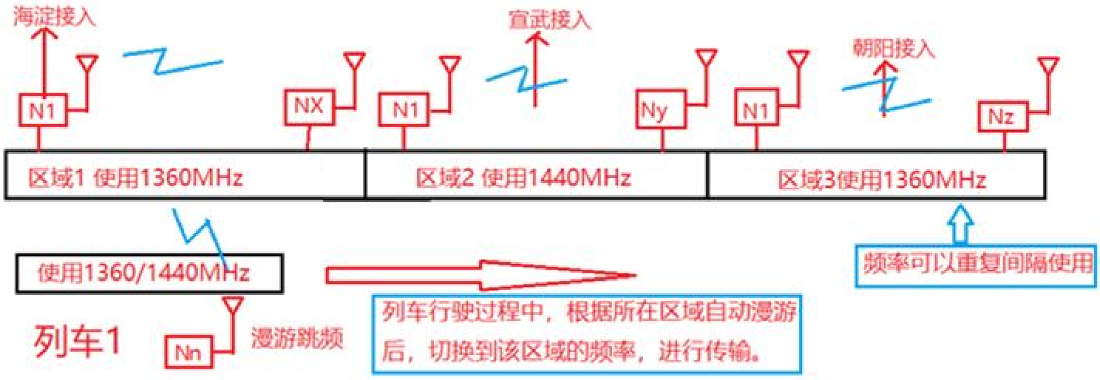


Figure 7-4

As shown in Figure 7-4, in the subway network, a track is divided into several areas, and adjacent areas are distinguished by two frequencies (at the intersection of multiple subway lines, multiple frequencies are distinguished).

Taking train 1 running on the track as an example, zone 1 is set to use 1360MHz, and zone 2 is set to use 1440MHz (to avoid mutual interference between subnets, frequencies should be staggered as much as possible, and it is recommended to stagger by 20MHz or more. At the intersection of multiple subway lines, it is more necessary to plan reasonably.)

In regions 1, 2, and 3, the fixed stations fixed on the track are set to operate in single frequency point mode, and the mode parameters are set to fixed station mode. All equipment on the train is set to roaming mode and the mode parameters are set to mobile station mode.

This can achieve roaming switching when the train passes through different areas at high speed, ensuring stable transmission.

B. Parameter settings

Here, it is necessary to set the working mode and parameter mode of each radio station, and add the frequency that needs to be roaming to the frequency list

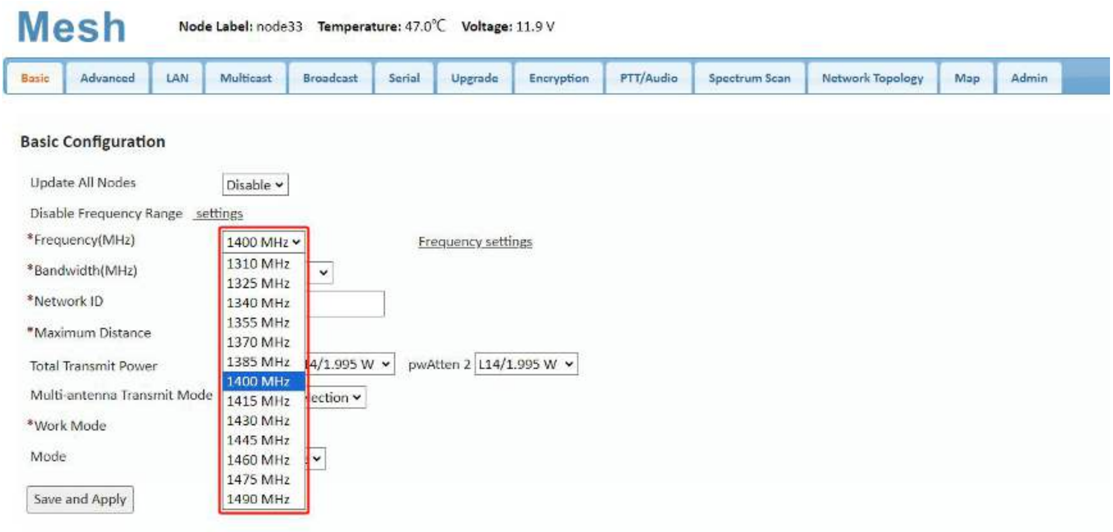


Figure 7-5 Frequency List

Add the list required for roaming to the frequency list as shown in Figure 4-5.

Radio settings:

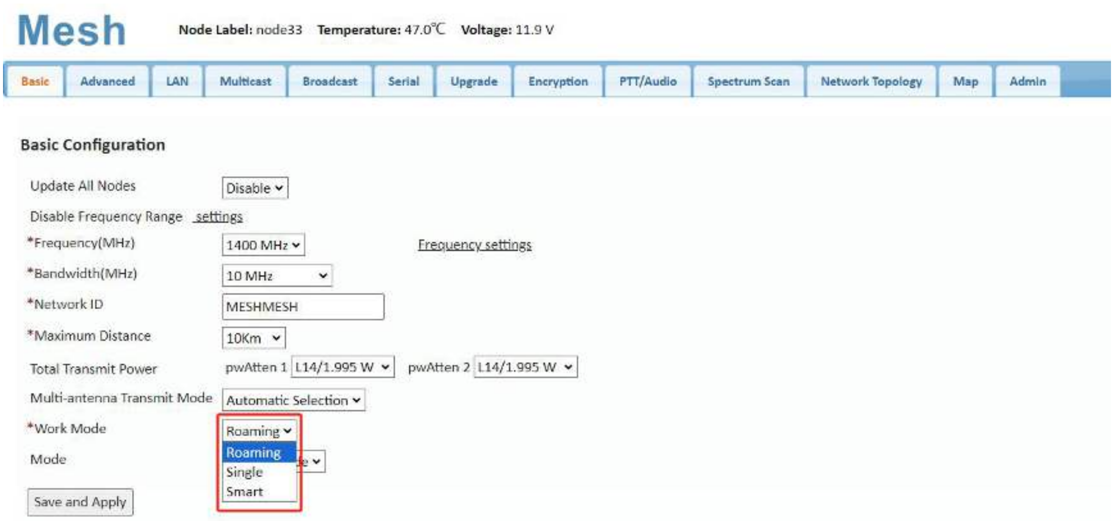


Figure 7-6 Working mode settings

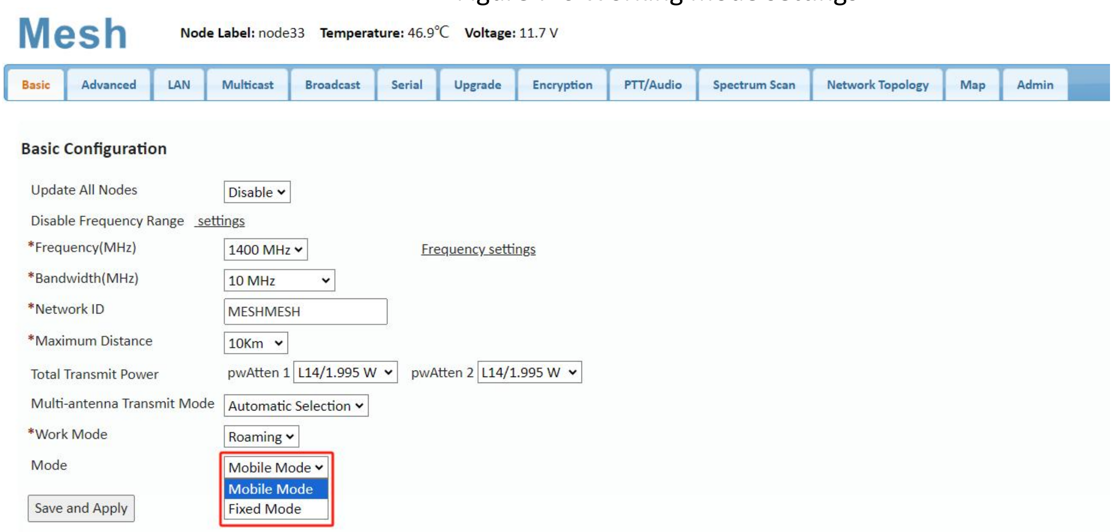


Figure 7-7 Mode parameter settings

As shown in Figures 7-6 and 7-7, the track fixed point radio station is set to single frequency point mode and fixed station mode, respectively; The radio station on the train is set to roaming mode and mobile station mode.

C. Implementation effect

After following the above operation settings, when the train is running on the track, the radio station on the train can make its own judgment and automatically connect to Zone 1, Zone 2, or Zone 3, achieving automatic roaming switching between different regional subnets.

2.3 Advanced Settings

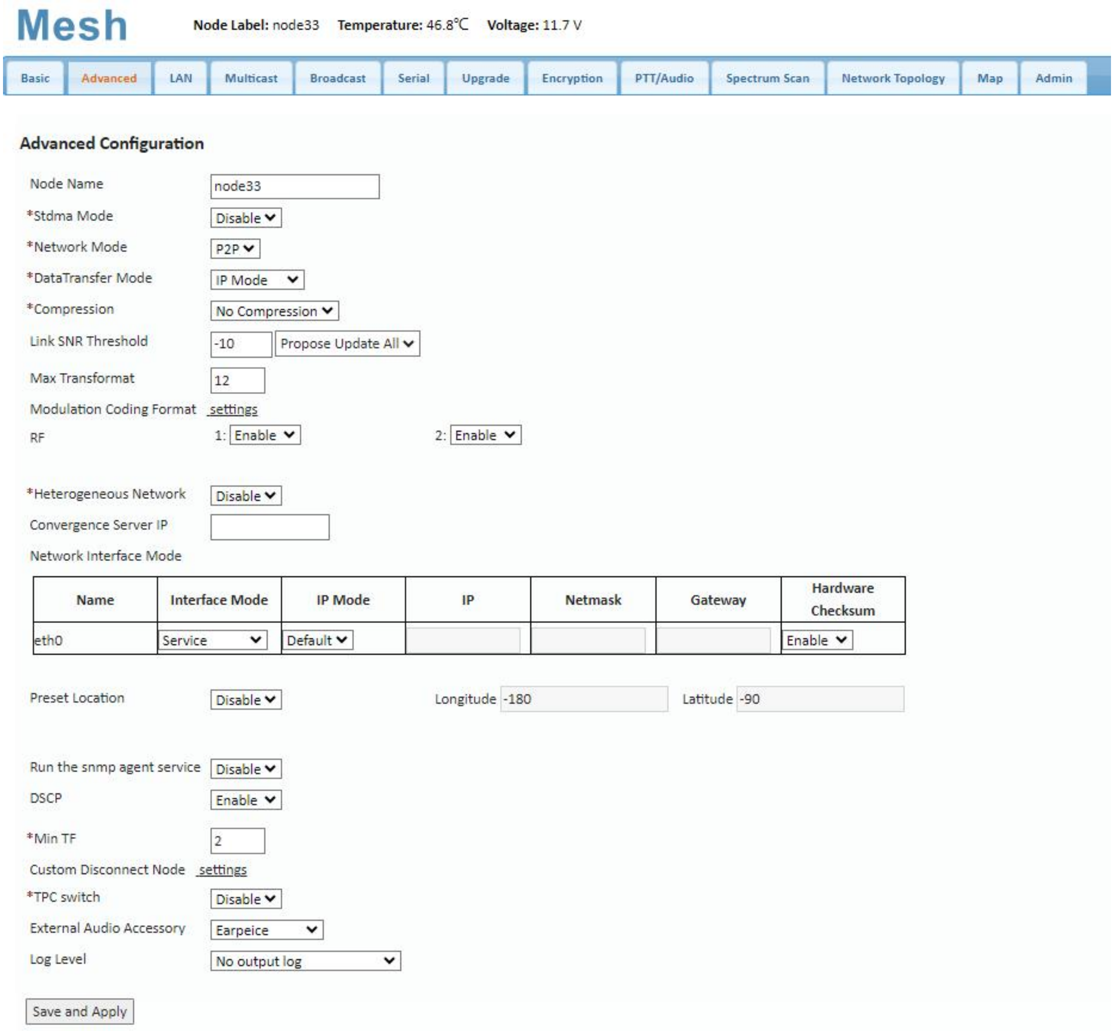


Figure 7-8 Advanced Settings Page

This page is used for advanced settings. Below is a brief explanation of each parameter.

Node Name: Name the radio station for easy identification in map mode.

Space multiplexing mode (this function is optional): In space multiplexing mode, the bandwidth of the radio station does not decrease after reaching three hops in a chain network. Networking mode: By default, peer-to-peer mode is used, which means all nodes have the same functional role.

Data transmission mode: IP mode is used by default, non operator users should use IP mode; The MAC mode is a transparent transmission mode customized for the operator's network, and switching to the MAC mode requires confirmation from technical personnel.

Data compression: defaults to non compression mode. The compression mode can improve the transmission capacity when transferring the original file (uncompressed) data, and cannot perform secondary compression on compressed packets, videos, etc.

Link signal-to-noise ratio filtering threshold: By modifying the link signal-to-noise ratio filtering threshold, the lowest signal-to-noise ratio displayed on the link in the topology can be modified. When it is below the filtering threshold, the route will be filtered, and when data transmission is carried out, it will be transmitted through other better links.

Maximum transmission format for sending signals: Set the maximum transmission format for the radio station and limit the upper limit of the transmission format.

Modulation encoding mode: The modulation encoding mode of the channel of the destination node can be specified. The modulation encoding format range is 2-12, corresponding to the lowest to highest format, as shown in the table below. Default adaptive mode, carefully modify, incorrect configuration will cause the link to be unable to transmit. In practical applications, radio stations will choose the best format for transmission based on link conditions. The minimum transmission format of a radio station is 2, which means that when the radio station is actually used, the transmission format is adaptive between 2 and the maximum format.

Encoding format	modulation mode	Encoding efficiency
2	QPSK	1/3
3	QPSK	2/3
4	16QAM	1/3
5	16QAM	2/3
6	64QAM	1/3
7	64QAM	2/3
8	256QAM	1/3
9	256QAM	2/3
10	1024QAM	1/3
11	1024QAM	1/3
12	1024QAM	3/4

RF transceiver: The RF port can be opened or closed according to actual usage.

Heterogeneous networking: disabled by default. When two or more nodes in the mesh network are connected to the public or private network, this function needs to be turned on to avoid looping.

Aggregation server IP: This feature is currently not open for use.

Network interface mode: default business interface mode, IP acquisition adopts default configuration mode. (Ethernet hardware verification cannot be turned off!)

Location preset: The latitude and longitude of the radio station can be preset.

Running the snmp agent service: disabled by default, this service is currently not supported

DSCP: Increase the priority of ping packets

Minimum transmission format: Minimum format 0, default to maintaining minimum format 2.

Custom disconnection node: Not set by default (modify carefully!) can force this radio station to disconnect directly from the specified node. At the specified node end, the node ID of this radio station must also be entered to disconnect directly in both directions. In a special scenario, nodes A, B, and C form a triangular network. At this time, the three nodes are interconnected in pairs, but the AC direct link is unstable, with varying signal-to-noise ratios. On the other hand, the A-B and B-C links are stable, and the AC direct connection can be forcibly disconnected. The link from A to C is relayed through B to improve link stability.

Power control switch: default off. The automatic power adjustment function can be turned on when there are only two nodes, and the radio will automatically adjust the optimal power based on the status between the nodes. When the number of nodes is greater than 2, it does not take effect.

External voice accessories: This service is currently not supported

Log level: Disabled by default. Opening it will seriously affect transmission performance and is only available for troubleshooting by manufacturer personnel.

Language: Supports switching between Chinese and English.

Save and Apply: Apply and save the latest configuration parameters.

2.4 LAN

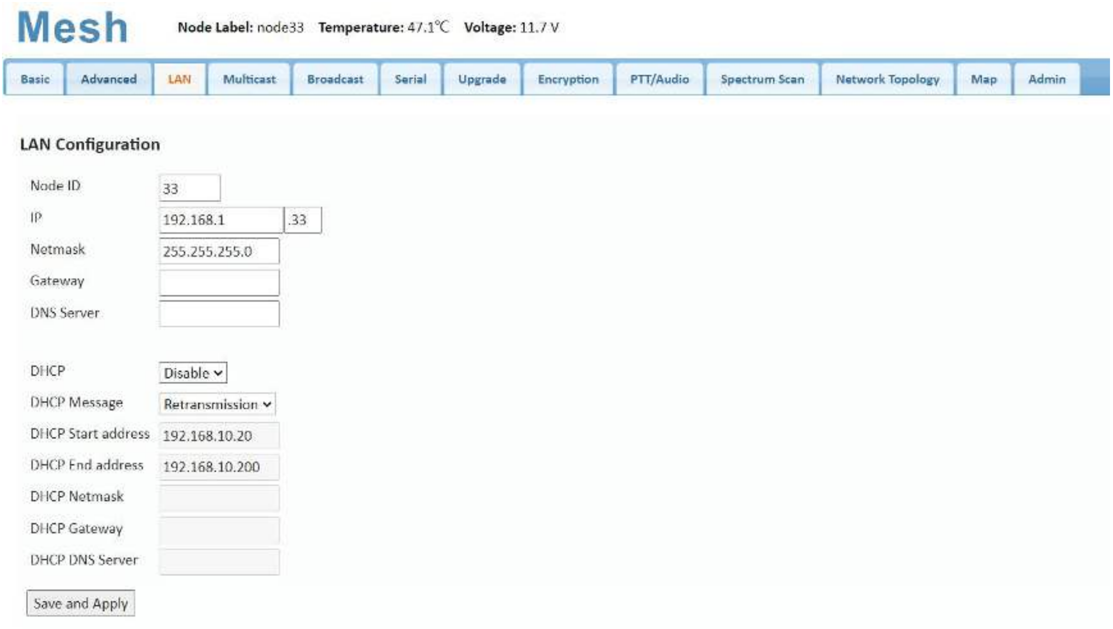


Figure 7-9 LAN

This page is used for LAN settings. Below is a brief explanation of each parameter.

Node ID: Set the ID of the node.

IP address: used to configure the network segment (network number) of the radio station, and the IP (host number) is consistent with the node ID.

Subnet Mask: The default is 255.255.255.0. Be cautious when making modifications. The radio station will automatically restart after modification, and the computer's IP and mask need to be adjusted to the same subnet, otherwise the radio station cannot be logged in; If modifications are needed, please contact technical personnel.

Default gateway: does not need to be configured for the same network segment.

DNS server: No configuration required.

DHCP Server: When the DHCP server is enabled, the radio station will randomly select an IP address from the address pool generated from the DHCP start address to the DHCP end address to assign an IP to the terminal (the terminal will enable dynamic allocation function). This feature is disabled by default.

DHCP messages: In forwarding mode, DHCP messages within the local area network can be forwarded by default.

DHCP subnet mask: configured according to the DHCP server, it can be left unconfigured within the local area network.

DHCP gateway: DHCP server or exit gateway can be specified.

DHCP DNS server: A DNS server can be specified to allocate DNS.

Save and Apply: Apply and save the latest configuration parameters.

2.5 Multicast Settings

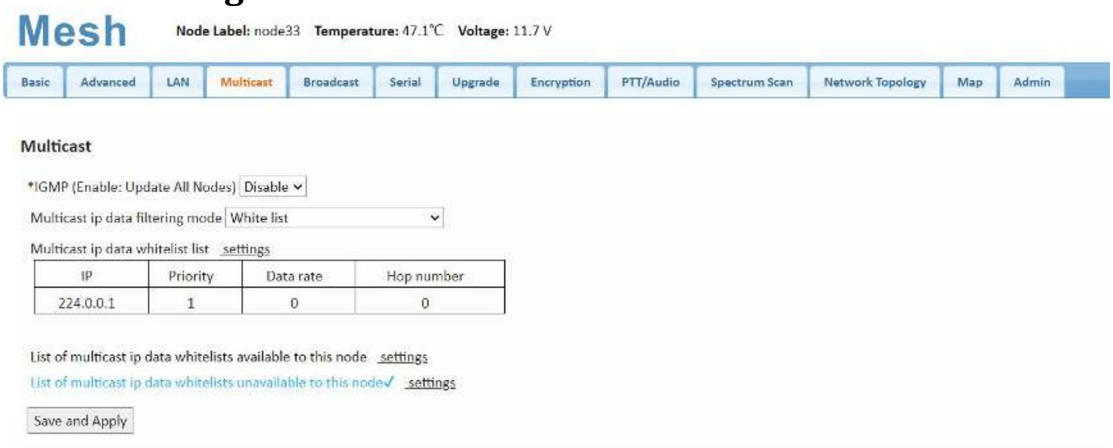


Figure 7-10 Multicast Settings

This page is used for multicast settings. Below is a brief explanation of each parameter.

IGMP (consistent across the entire network when enabled): When enabled, IGMP is used to automatically filter multicast data. The default mode is off.

Multicast IP data filtering mode: After turning off IGMP, multicast data can be filtered using whitelist/blacklist. It is recommended to use whitelist mode. (This is a restriction when the sender sends data.)

Whitelist mode: After activation, the corresponding multicast group IP needs to be added to the whitelist before this node can multicast and send to that multicast group IP;

Blacklist mode: After adding the corresponding multicast group IP to the blacklist, this node cannot send multicast data to the multicast group;

Can enter the multicast IP data whitelist of this node: By adding a multicast IP whitelist, allow some multicast data to enter this node. All multicast IP data is received by default here. The blacklist mode prohibits some multicast IP data from entering this node. (This is a restriction when the receiving end receives data.)

Save and Apply: Apply and save the latest configuration parameters.

2.6 Broadcasting Settings

Figure 7-11 Broadcasting Settings

Broadcast IP Data (UDP) Whitelist: Add the required port number to the whitelist and set priority.

Save and Apply: Apply and save the latest configuration parameters.

2.7 Serial Port Settings

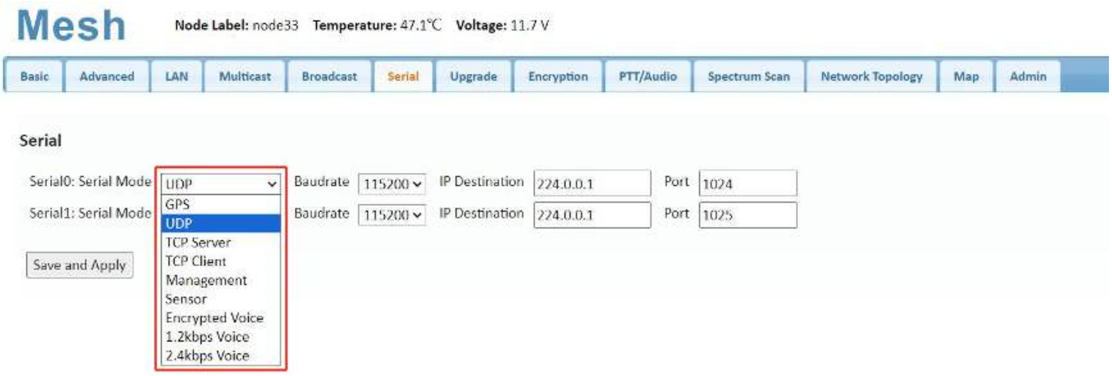


Figure 7-12 Serial Port Settings

Serial port 0/Serial port 1:

Working mode:

GPS mode: When connecting the GPS module, select GPS mode and set the baud rate that matches the GPS module;

UDP mode: Set a matching baud rate. The peer IP can be set to a multicast IP (to be added to the whitelist in multicast settings), or a unicast address can be specified, and the port number needs to match the settings.

TCP Server: As a TCP Server mode, it is necessary to configure the baud rate and port number to match the TCP client of the opposite end.

TCP Client: When using TCP Client mode, it is necessary to configure the baud rate, peer IP, and port number to match the peer TCP Server.

Management mode: The radio station can be managed through a serial port, and the baud rate needs to be configured.

Save and Apply: Apply and save the latest configuration parameters.

2.8 Version Information

Figure 7-13 Upgrade

This page allows you to view the serial number, device type, and factory version number of the device.

2.9 Security

Figure 7-14 Safety

Encryption mode: No encryption by default, DES/AES128/AES256 encryption can be set, with unlimited length and support for Chinese. Be cautious in configuration and keep records. If encryption is enabled, all radio stations within the node must use the same encryption mode and password.

2.10 PTT/Audio

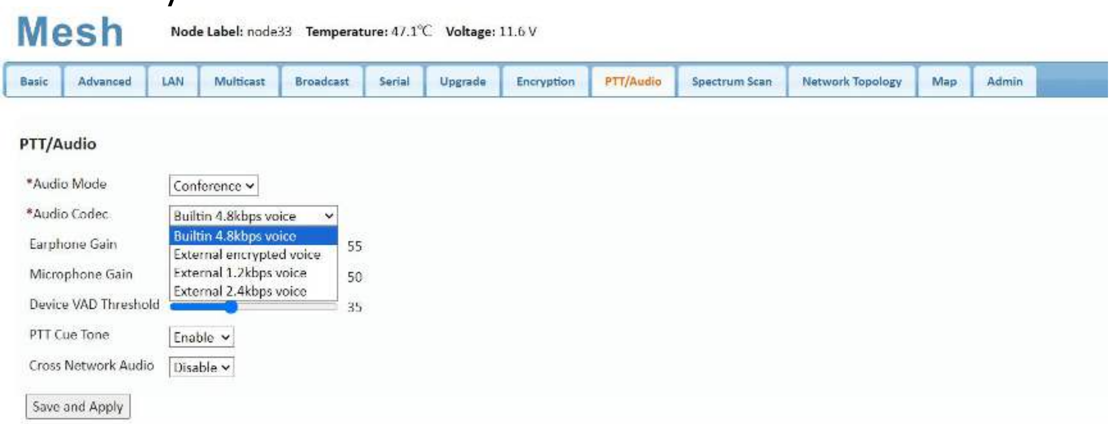


Figure 7-15 PTT/Audio

Earphone gain: The default configuration is 65, which can be configured according to the situation.

Microphone gain: The default configuration is 50, which can be configured according to the situation.

Device VAD threshold: The default configuration is 35, please modify it carefully here.

PTT prompt sound: When playing mode, there will be a prompt sound when the PTT is triggered by the hand.

2.11 Spectral Scanning

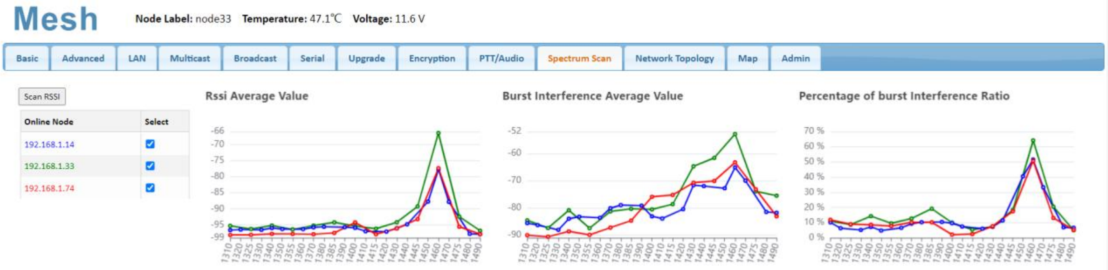


Figure 7-16 RSSI values

As shown in Figure 7-16: When scanning RSSI values, corresponding nodes can be selected for scanning; Above the RSSI image, the color corresponding to the IP address corresponds to the curve of the same color in the image below.

The frequency point with the smallest interference is selected, which includes the average RSSI value, burst value, burst interference ratio, and three parameters that are relatively small at the same time. (The peak represents high interference, while the trough represents low interference. Based on comparing the RSSI values of multiple radio stations with their troughs, select the frequency point with the lowest relative interference.)

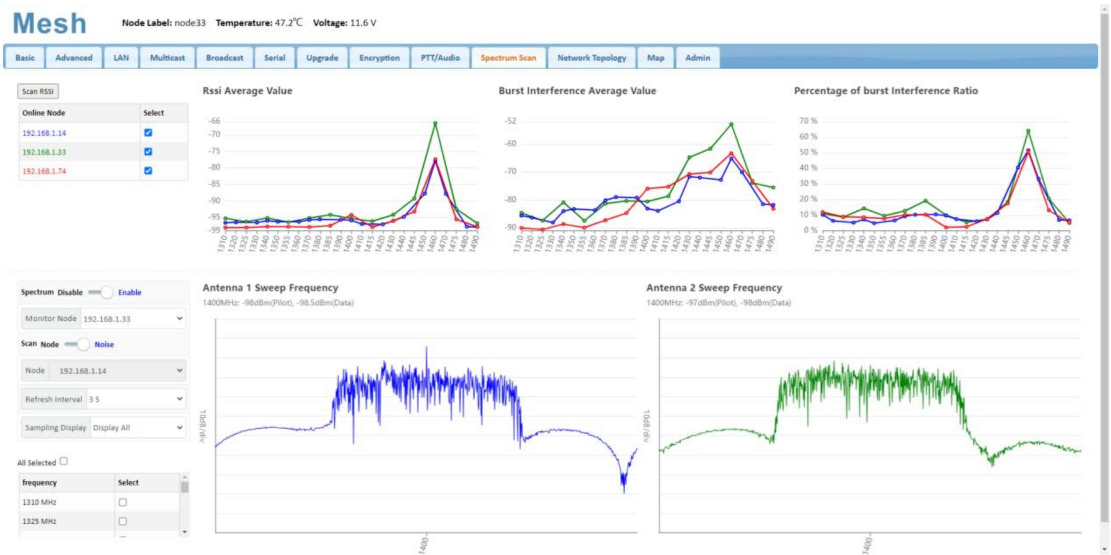


Figure 7-16 Spectral Scanning

In the drop-down menu of monitoring points, you can select any node within the local area network to scan, click "Spectrum Scan Open", and the above figure will appear.

Antenna 1 lead: It is the field strength received by antenna 1, and the first sampling begins in the receiving state. At this time, there may be no signal, which is not accurate enough.

Antenna 1 data: refers to the received field strength of antenna 1, and a second sampling is conducted in the middle section of the signal, which is relatively accurate. Therefore, the value of "data" is used as a reference standard.

Antenna 2 is the same.

Scanning noise: When scanning noise, multiple frequency points can be selected to observe the background noise of the node, as shown in the figure below. At 1370MHz, the background noise of node 192.168.1.42 is -77.5dBm for antenna 1 and -77.5dBm for antenna 2.

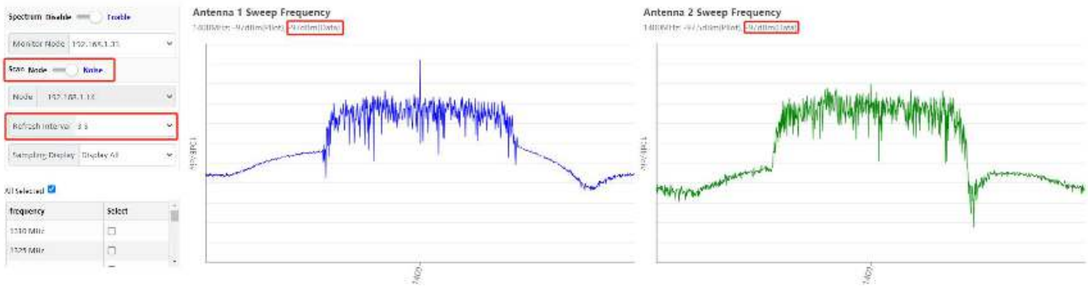


Figure 7-18 Background noise of scanning nodes

Scanning nodes: When clicking on "Scan Noise", it will automatically switch to "Scan Nodes" mode to observe the signal strength of the corresponding node received.

As shown in the diagram below, the monitoring point "192.168.1.42" received a receiving field strength of "192.168.1.83" in the "scanning node" state. The receiving field strengths of antenna 1 and antenna 2 are both -14dBm.

Note: In general, the received field strengths collected by antenna 1 and antenna 2 are the same or close.

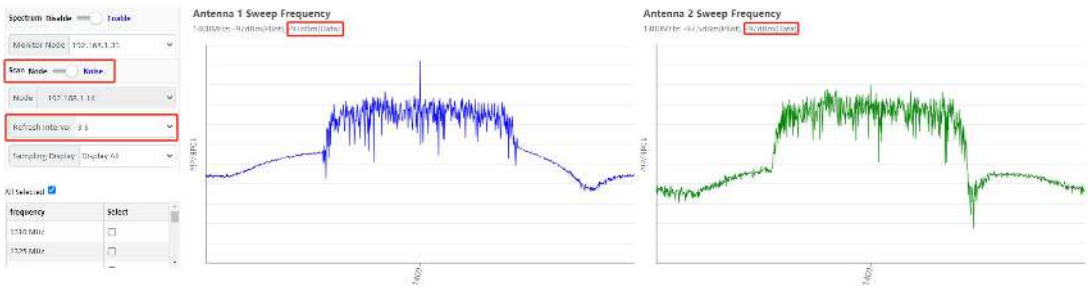


Figure 7-19 Viewing the receiving field strength of nodes

2.12 Network topology

Figure 7-20

Network Topology

On the topology page, select an online node, and the percentage after the node is the percentage of the current node occupying the entire network resources. All online nodes are selected by default here, and some nodes can be selected for display according to the situation.

The values on the connecting line between nodes are: signal-to-noise ratio/modulation coding format/straight-line distance between nodes. View the signal-to-noise ratio, modulation encoding format, and straight-line distance between nodes. The signal-to-noise ratio range is -10dB to 30dB, and the modulation encoding format range is 1-12. The straight-line distance between nodes is visually displayed.

The relationship between link quality and link color is shown in the table below:

Link quality	colour
excellent	Dark green
good	Light green
commonly	yellow
Slightly inferior	orange
difference	red
break link	nothing

Right click on the node and a floating window will appear, where you can choose to view the status of the current node or neighboring nodes; Click "192.168.1.xx" on the web page of this node; in the node information: ERX is the network port receiving; PRX is the air port receiving; PTX is an air launch

192.168.1.33 State of this node Close

Wireless		Data Transmission	
Capture Count	42	Data Tx Overflow	0
Crc Count	0	Data Fw Overflow	0
BER	0%	Data Rx Lost	0
Maximum Frequency Offset	92.3872	Retransmit	0
Average Frequency Offset	20.631	Audio Tx Overflow	0
Minimum Frequency Offset	-40.2331	Audio Rx Lost	0
Maximum Slot Offset	216	ERX Packets(pkt/s)	0
Average Slot Offset	169	ERX Bytes(Mbps)	0
Minimum Slot Offset	136	PTX Bytes(Mbps)	0
Subband1 Diversity Capture Count	42	PRX Bytes(Mbps)	0
Subband1 Diversity Crc Count	0		
Subband1 Diversity BER	0%		
Subband1 Diversity Maximum SNR	9.52026		
Subband1 Diversity Average SNR	7.96922		
Subband1 Diversity Minimum SNR	6.78785		
Subband1 Layer1 Capture Count	0		
Subband1 Layer1 Crc Count	0		
Subband1 Layer1 BER	0%		
Subband1 Layer1 Maximum SNR	5.82772		
Subband1 Layer1 Average SNR	3.1982		
Subband1 Layer1 Minimum SNR	1.0115		
Subband1 Layer2 Capture Count	0		
Subband1 Layer2 Crc Count	0		
Subband1 Layer2 BER	0%		
Subband1 Layer2 Maximum SNR	6.9291		
Subband1 Layer2 Average SNR	5.09017		
Subband1 Layer2 Minimum SNR	3.51875		

Figure 7-21 Node Information

As shown in Figure 7-21, right-click on a node in the topology to view its information, including bit error rate, signal-to-noise ratio of antenna 1/antenna 2, and the actual amount of data transmitted in real-time.

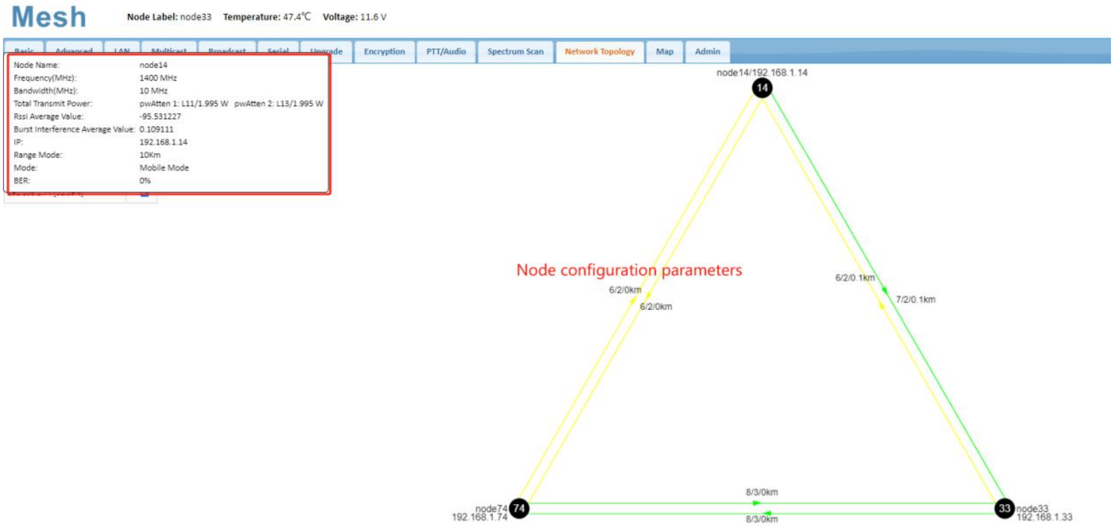


Figure 7-22 Basic Configuration Parameters of Nodes

As shown in Figure 7-22, the mouse hovers over the node and displays the basic parameters of the node, such as center frequency, channel bandwidth, transmission power, RSSI average, etc., making it easy to observe the status of the radio station in real time.

2.13 Map

The serial port 0 of the radio is set to GPS mode, and the baud rate is changed to the baud rate of the GPS used. Place the GPS module outdoors and connect it to the serial port of the radio station to view the real-time positioning of each node on the map.

Figure 7-23 Setting GPS module bit rate for serial port 0

A. Offline map mode: defaults to offline map mode, and when the computer is unable to access the internet, it can display real-time location information for each node.

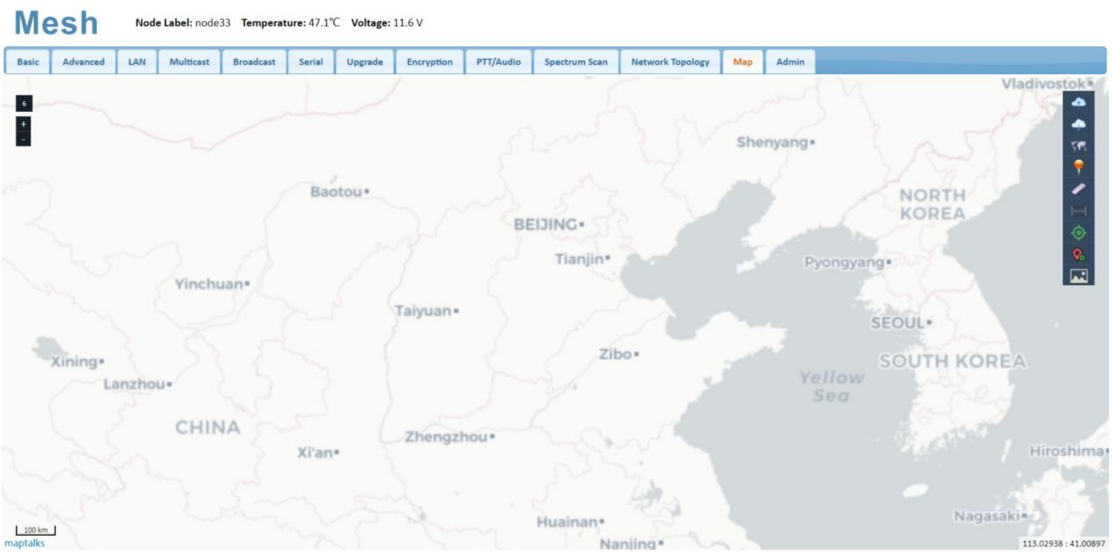


Figure 7-24 Offline Diagram

As shown in Figure 7-25, click on zoom in and out to choose to zoom in or out of the map; Click "Import" to import the map image. After connecting the GPS device to the device, the location of each node can be viewed in real-time on the map.

Road map display: It is possible to simultaneously view the real-time geographic location of nodes and the topology structure between nodes.

Map ranging: Turn on the map ranging function, left click the mouse to select the starting and ending points. After selection, right-click the mouse to display the distance. Click "Map Ranging" again to turn off this function.

Location tracking: specifies that a node is always located in the center of the map interface.

B. Online map mode: When the computer is connected to the internet, click on this option as shown below to switch to online map mode and load the online map.

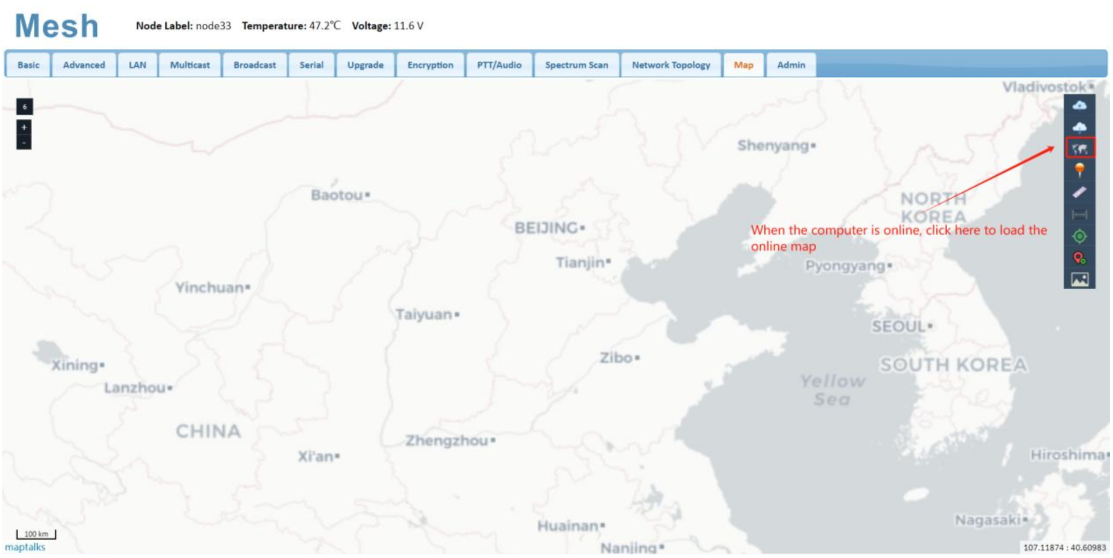


Figure 7-25 Online Map

2.14 Management Interface

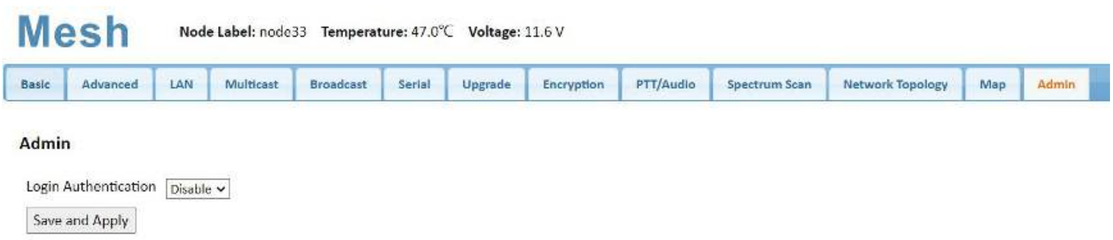


Figure 4-26 Management Login