quick Mesh project (qMp.cat) workshop

guifi.net community

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Contents

1 Introduction

The basic material to deploy qMp networks.

The devices used have Power over Ethernet (PoE) of 24 V, it means that the electrical power and data of the device goes through an ethernet cable. The blue cable in figure 1 is what is deployed into an outdoor place (typically rooftop or a balcony) where the qMp devices will be installed and takes the PoE interface in PoE injector. The other interface in the PoE injector is LAN [1] and can be placed to a PC or a switch/router if it is wanted to connect more PC's. Finally, the PoE injector requires standard electrical power. **Warning**: a PoE connection to a device that is not prepared to work with PoE 24 V, for example an ethernet interface of a computer, can produce malfunction of its ethernet interface.

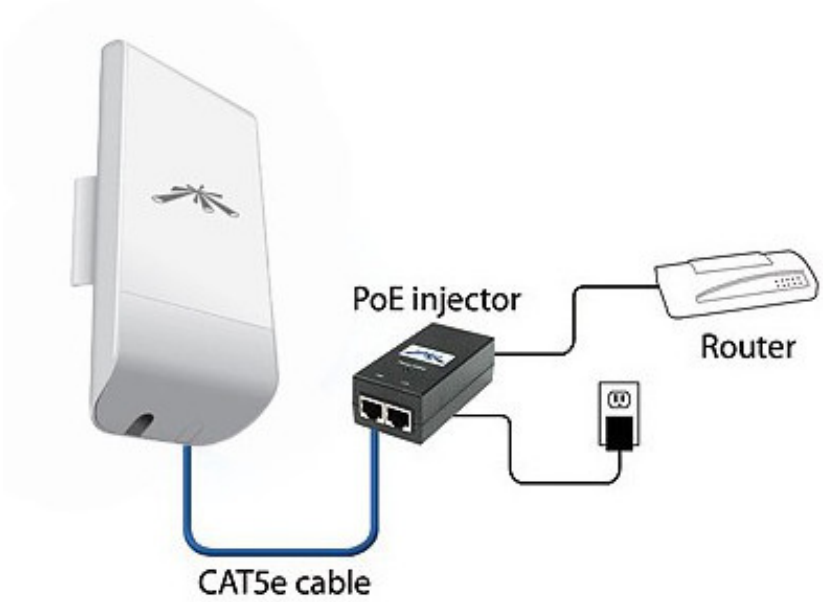

Figure 1: PoE network diagram

2 Installer basics: Items

- Outdoor cable and RJ45 connectors (sold separately). The cable should be for outdoor to resist the weather.
  - UTP cable: cable without protection. But sometimes it is enough.

[1] To have a reference, LAN cable can make a length up to 100 m if only is carrying data

  - FTP cable (recommended): cable with basic protection. ESD prevention [2]. The difference is that the cable has ground.

- Crimp tool: to join RJ45 connector to cable.
- Cable tester (recommended): a unexpensive one can help to work quickly and reliably in the installation of cable.
- Cable cutter: To take a segment of cable for a installation. Note: UTP cable is easier to cut than FTP.
- Cable tie: To lock the cable & device to a antenna pole and other cables.

3 Installer basics: 5 GHz devices

The devices selected are working in the 5 GHz band because 2.4 GHz is widely used in cities and have more interferences. They are from Ubiquiti manufacturer and compatible with qMp firmware.

Unexpensive around 70 euro.

NanoStation Loco M5 (NSLM5) Short distances (less than 1 km). The connection with the other candidate node has an acceptable connection and there is no need to increase the power signal of wifi. It uses the same firmware as NanostationM5.

Nanostation M5 (NSM5) [3] If is needed a better connection to specific node. Recommended for Internet sharing.

NanoBeam M5 (NBM5) different models [4] When there is a long distance connection (more than 1 km).

XW series Are new versions of devices NSLM5, NSM5, etc. but with new processors. The first introduced was NBM5 as a replacement to NanoBridge M5 (now deprecated). This devices requires qMp 4 and is not stable yet. The rest of devices specified are AirMax (XM) and use qMp 3.1 (stable release).

Expensive between 100 and 300 euro.

[2] `http://en.wikipedia.org/wiki/Electrostatic_discharge`
[3] `http://dl.ubnt.com/datasheets/nanostationm/nsm_ds_web.pdf`
[4] `http://ubnt.com/downloads/datasheets/nanobeam/NanoBeamM_DS.pdf`

Rocket M5 [5] Base station to put different kind of devices.

Rocket M5 + Sector Antenna (S) 90 or 120 deg [6] when the need is to cover a zone region with constant coverage of 90 or 120 deg from the device. There are High Gain (HG) and Mid Gain (MG) versions.

Rocket M5 + Dish (D) [7] Longest distances (50 km link [8]).

Summary of some relevant information at Table 1:

Table 1: Devices specifications

Devices	Gain (dBi)	Beamwidth (deg) Hpol/Vpol/Elevation	Proc.	RAM (MB)	Flash (MB)
NSLM5	13	45/45/45	24KC	32 S	8
NSM5	16	43/41/15	24KC	32 S	8
NBM5	16, 19, 22, 25	see on datasheet	74KC	64 D	8
XW series	-	-	74KC	-	-
RM5 S90 MG, HG	17, 20	see on datasheet	24KC	64 S	8
RM5 S120 MG, HG	16, 19	see on datasheet	24KC	64 S	8
RM5 D	30, 34	see on datasheet	24KC	64 S	8

Proc Processor Specs.

24KC Atheros MIPS 24KC, 400MHz

74KC Atheros MIPS 74KC, 560MHz

RAM Type of RAM:

S SDRAM

D DDR2

4 qMp basics: Testing operations

Figure 2 shows the first screen obtained when there is a log in a qMp node. To come back to this screen, go to the menu clicking at:

[5] http://ubnt.com/downloads/rocketM5_DS.pdf

[6] http://dl.ubnt.com/AirMax5GSectors.pdf

[7] http://ubnt.com/downloads/datasheets/rocketdish/rd_ds_web.pdf

[8] http://blog.altermundi.net/article/completamos-el-enlace-de-50km/

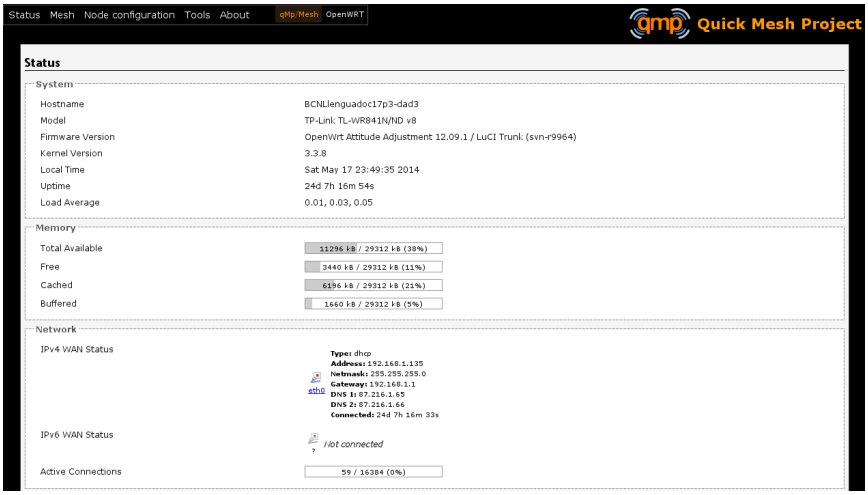

Figure 2: First screen

`qMp/Mesh / Status`

alternatively:
`http://admin.qmp/cgi-bin/luci/qmp/status`

When there is a scroll down action, appears Associated Stations. Figure 3 has the wifi links with other qMp nodes and what signal associated (dBm). The guifi.net good practices says that the backbone should be better than -75dBm [9]. In that figure there are different kind of links with different qualities. Good quality means high parameters of: dBm, RX Rate, TX Rate [bandwidth (Mbps)] and MCS codification (the number).

These qualities refer to connection to different nodes, only is shown the MAC address. But the MAC is enough to identify a node, because the last four characters are appended in every hostname of the network. Later, it will be known how to go to different nodes in the network.

Another measure of quality is shown on Figure 4. This is the quality in terms of the routing protocol of the network (bmx6). A 0-100 rating in terms of reception and transmission (rx/tx).
To arrive there, go to the menu clicking at:

`qMp/Mesh / Mesh / Links`

alternatively:
`http://admin.qmp/cgi-bin/luci/qmp/mesh/links`

[9] Catalan: `http://guifi.net/ca/BonesPractiquesUER`

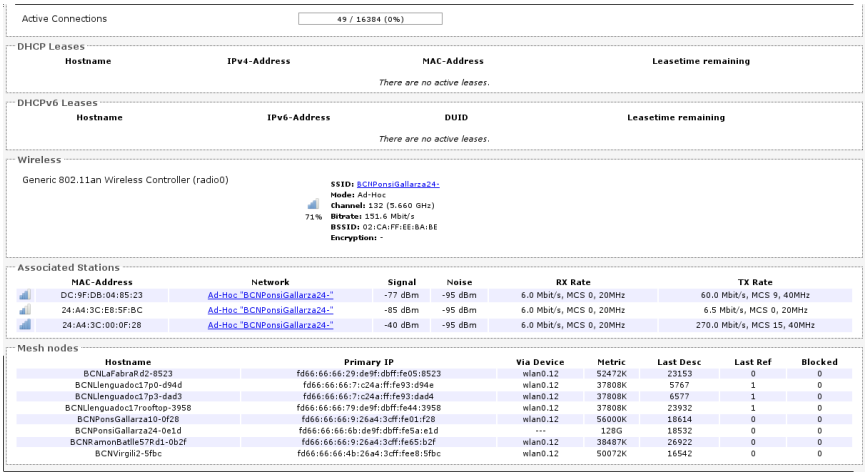

Figure 3: Associated stations

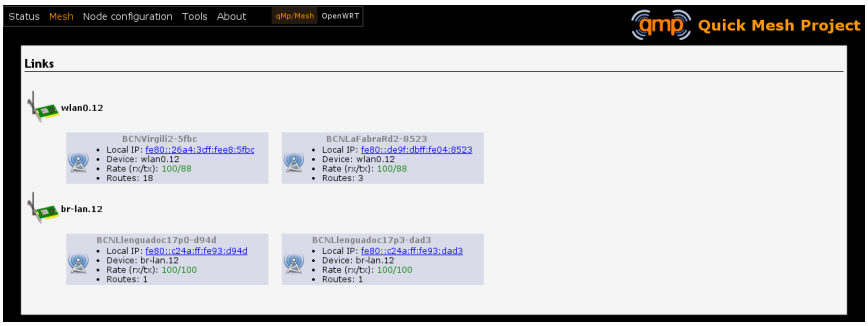

Figure 4: Links of the node

Also, can be made a bandwidth test between nodes. Figure 5 perform a TCP connection benchmark and give the Mbps between the node and other possible destinations. Wait until a single test ends to know all the bandwidth in the link or route.
To arrive there, go to the menu clicking at:

`qMp/Mesh / Tools`

alternatively:
`http://admin.qmp/cgi-bin/luci/qmp/tools`

Figure 6. After the general scan, when there is a node candidate to do a stable connection, there is the need to analyse the quality of this link in

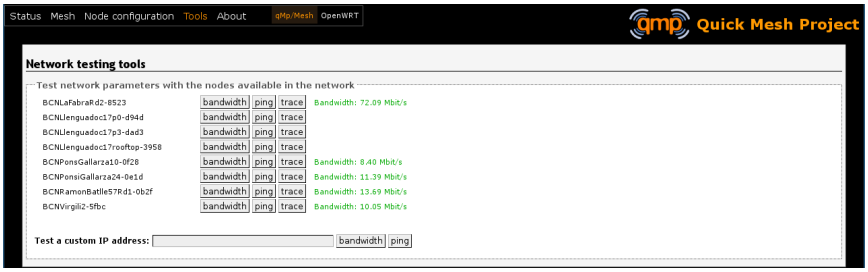

Figure 5: Bandwidth Test

real-time. This helps to select an optimised place to lock the device in the installation.
To arrive there, go to the menu clicking at:

`OpenWRT / Status / Realtime Graphs / Wireless`

alternatively:
`http://admin.qmp/cgi-bin/luci/admin/status/realtime/wireless`

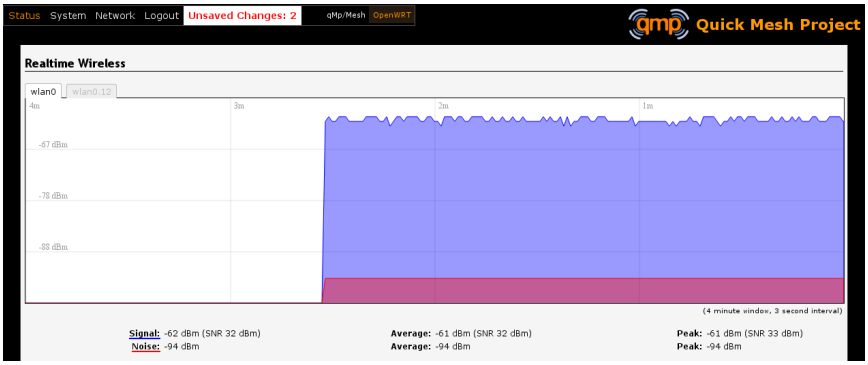

Figure 6: Strength of the best wifi signal in real-time

The situation could be that cannot be a connection to the node to the network. Perhaps it is in another channel. Figure 7 shows a wifi scan. qMp always use BSSID: `02:CA:FF:EE:BA:BE`, in Mode `Ad-Hoc`. These are two solid references to find other qMp networks. In the figure there are two qMp networks in channels: 140 and 132.
To arrive there, go to the menu clicking at:

`OpenWRT / Network / Wifi / "Scan"`

alternatively:
`http://admin.qmp/cgi-bin/luci/admin/network/wireless` and click Scan.

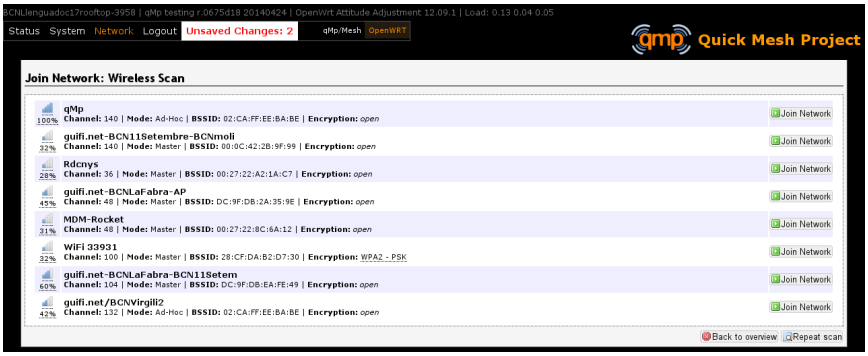

Figure 7: Wifi scan: find qMp network

If there is a design of a new qMp network it is important to select a channel that is not used. Figure 8 shows how another AP (Access Point) is also using channel 140.

Figure 8: Wifi scan interference

Figure `wifi-channel-power` shows where to change wifi parameters as channel and power signal of wifi. By default, qMp uses 17, but it can be increased.

Use the power signal of wifi with care, in the interested network is a communication and/or coverage signal, but for the other networks it is another noise in the environment that make its communications more difficult.
To arrive there, go to the menu clicking at:

`OpenWRT / Node configuration / Wireless Settings`

alternatively:
`http://admin.qmp/cgi-bin/luci/qmp/configuration/wifi/`

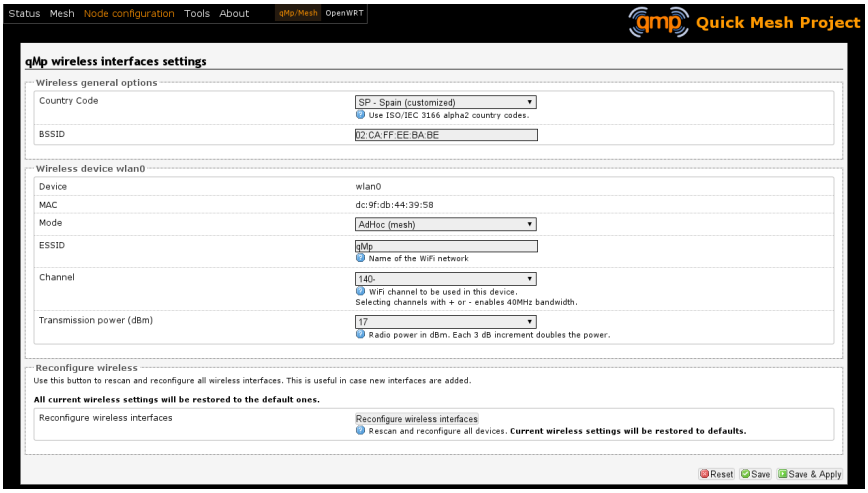

Figure 9: Wifi: Channel & power signal

Figure 10, marked as red, shows that there is a WAN Node, the node makes announcement of this network as `Internet`. If can be arrived there, it means there is an internet connection, try it with a browser. Also could be interesting to perform additional internet bandwidth tests [10] , [11] , [12] , [13].

But perhaps the WAN node cannot be accessed, or there is not a WAN node in the network. Can be checked if there is a tunnel to Internet.

In the same view, can be browsed for a Border Node. Figure 10 shows it (marked as blue), the node makes announcement of the network `10.0.0.0/8`, it means, access to the rest of guifi.net
To arrive there, go to the menu clicking at:

`qMp/Mesh / Mesh / Tunnels`

alternatively:
`http://admin.qmp/cgi-bin/luci/qmp/Mesh/Tunnels`

[10] `http://www.catnix.net/en/speedtest`
[11] `http://speedtest.net`
[12] `http://testdevelocidad.es`
[13] `http://testvelocidad.eu/`

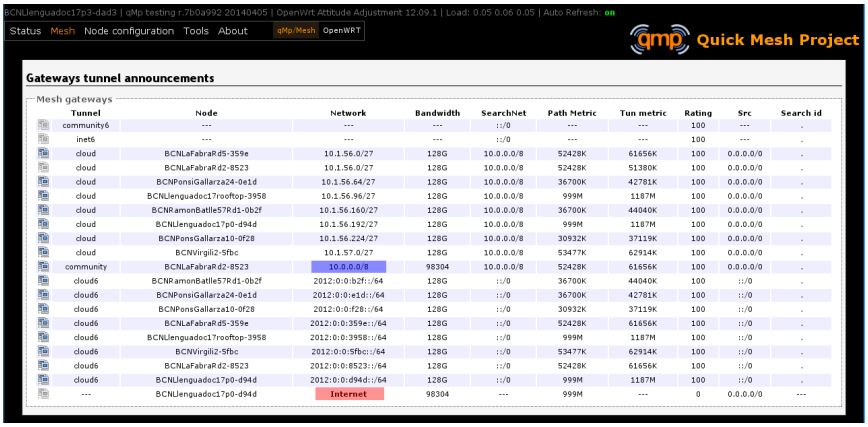

Figure 10: Tunnels

5 qMp basics: Basic install and maintaining

Figure 11, this is the final setup when the node is prepared to be in testing phase, that is, its operation should be ok but it was recently connected.

In guifi.net web page, after adding the device, it is received a unique IPv4 address inside guifi.net, and is needed a `255.255.255.244` netmask. Use the same node name as in the web or the network organization page.
To arrive there, go to the menu clicking at:

`qMp/Mesh / Node configuration / qMp easy setup`

alternatively:
`http://admin.qmp/cgi-bin/luci/qmp/configuration/easy_setup/`

Figure 12: When the node is working fine is important to make a backup of the configuration. It is not recommended to upgrade the node using this menu for the qMp firmware.
To arrive there, go to the menu clicking at:

`OpenWRT / System / "Backup/Flash Firmware"`

alternatively:
`http://admin.qmp/cgi-bin/luci/admin/system/flashops`

For upgrade the node at the moment it is only possible via Command Line Interface (CLI). Do a login with ssh session:

`ssh root@admin.qmp`

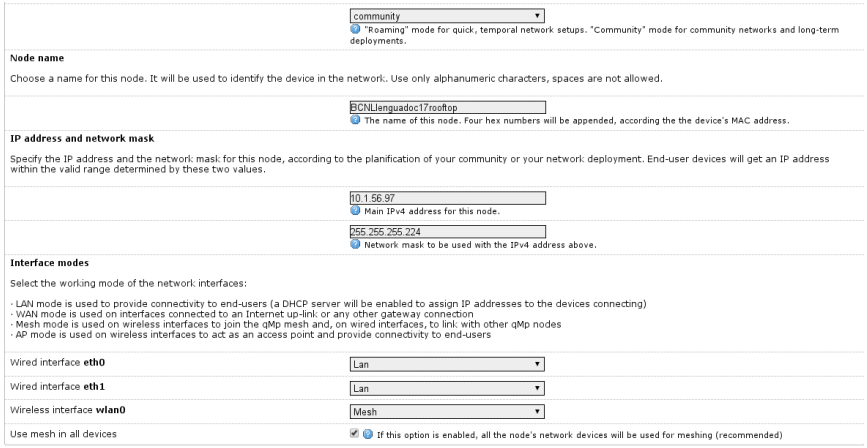

Figure 11: Quick setup

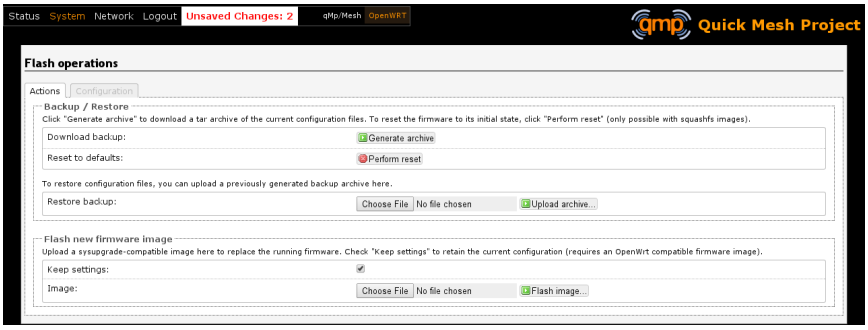

Figure 12: Backup

password: 13f
From this point, there are three methods:

1. Automatic upgrade (with internet connection in the node).

   ```
   qmpcontrol upgrade
   ```

2. Upgrade with a link (with internet connection in the node).

   ```
   qmpcontrol upgrade "http://...qmp.bin"
   ```

   It means the URL where is located the qMp firmware, remember that can be found all the firmwares supported here: `http://fw.qmp.cat`

3. Upgrade with a local file (without internet connection in the node).

   (a) Put the file inside qMp node, open a new CLI and put

   ```
   scp qmp.bin root@admin.qmp:/tmp
   ```

   It will ask for the password

   (b) With the existing ssh session opened before, or a new one, login with ssh and:

   ```
   qmpcontrol upgrade "/tmp/qmp.bin"
   ```

Confirm to continue with the upgrade process and wait until it is finished.

Note: qMp only save common settings after the upgrade, concretely:

```
# cat /etc/config/qmp | grep preserve
```

For other file changes, perform a backup before the upgrade.

6 qMp basics: Visualise the network

Figure 13 shows a screen that presents all the qMp nodes conforming the network. By clicking the blue spherical icon to the left of each node it is possible to obtain additional information about them. In particular, the network address announced by one node can be found under the `Gateways announced` label, and the IP of the node in the first address of that network. In the example shown in the figure, the network address is `10.1.56.96` and the IP of the qMp node is `10.1.56.97`.
To arrive there, go to the menu clicking at:

```
qMp/Mesh / Mesh / Nodes
```

alternatively:
`http://admin.qmp/cgi-bin/luci/qmp/mesh/nodes`

Figure 14 is the graph that shows the nodes, the edges with the bmx6's quality rate show how each are connected.
To arrive there, go to the menu clicking at:

```
qMp/Mesh / Mesh / Graph
```

alternatively:
`http://admin.qmp/cgi-bin/luci/qmp/mesh/graph`

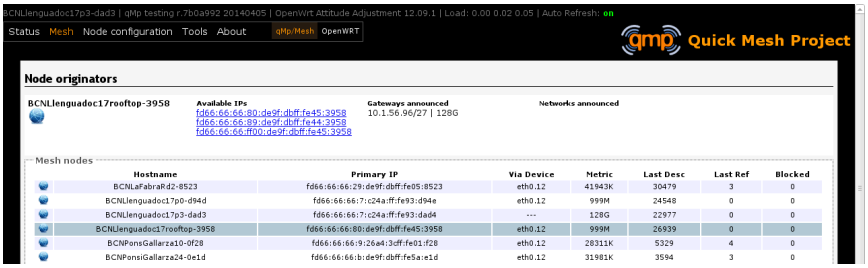

Figure 13: IP address of nodes

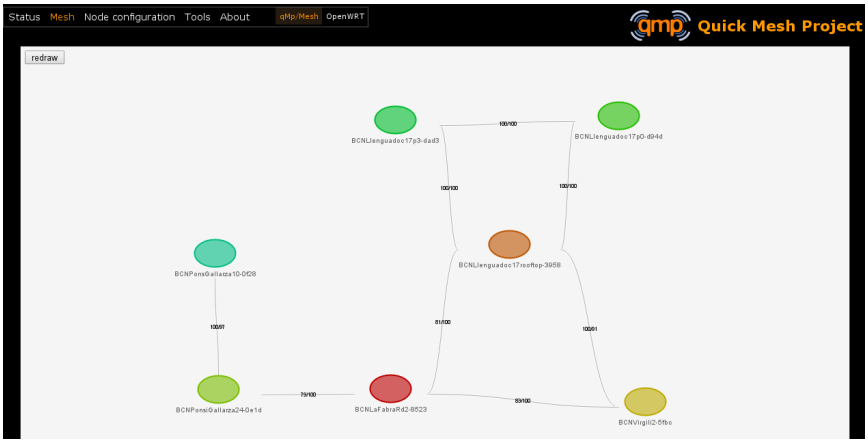

Figure 14: Graph of the network

7 Proposed qMp network node design: WAN node design

To build a WAN node, figure 15 shows how the qMp node should be connected to the network (through wifi via bmx6 routing) and to the Internet (through ethernet to ISP [14] router via DCHP client).

It is recommended to use the device Nanostation M5 because it has two ethernet interfaces (eth0, eth1). With one can be made a DHCP server to connect to the qMp node with a laptop. And for the other ethernet, a DHCP client to the ISP router.

If is a Nanostation Loco M5, it only has one ethernet (eth0 [15]). This interface will be used for the connection to the internet access through the

[14] Internet Service Provider
[15] eth1 is ignored

ISP router (DHCP client). It means that there is no way to automatically connect to the qMp node with the laptop (no DHCP server). To access that node, use another qMp node that is in the same network (using the wifi interface).

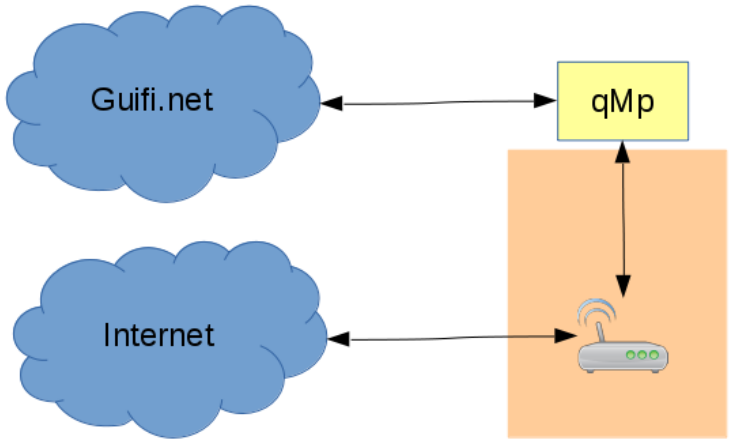

Figure 15: Network diagram generic WAN node

To set the ethernet that will do the DHCP client to the ISP router there are 2 options.

Option 1: in the quick setup, last part says what to do with interfaces (figure 16). The interfaces have 3 selections: `Mesh`, `Lan` (DHCP server) and `WAN` (DHCP client).

Figure 16: Option 1: Set DHCP client to interface with quick setup

Option 2: Figure 17 shows the screen that set the DHCP client interface, and there is no need to do a quick setup with the node.
To arrive there, go to the menu clicking at:

`OpenWRT / Node configuration / Network Settings`

alternatively:
`http://admin.qmp/cgi-bin/luci/qmp/configuration/network/`

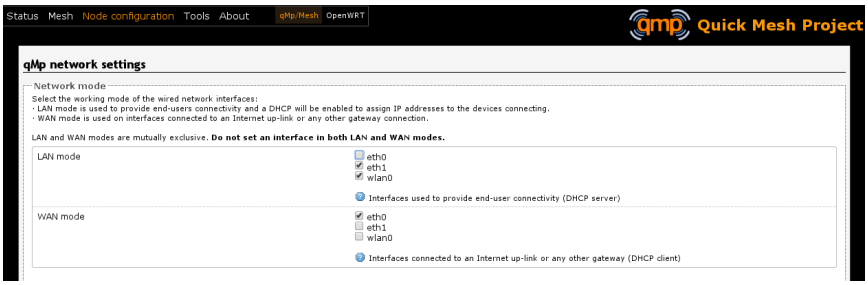

Figure 17: Option 2: Set DHCP client to interface with network settings

To test that is working the DHCP client to the ISP router, check the IPv4 WAN Status, section Network. Figure 18 shows a successful WAN connection. Figure 19 shows that there is no WAN connection: there is no DHCP client or is not correctly connected.

Figure 18: WAN status online

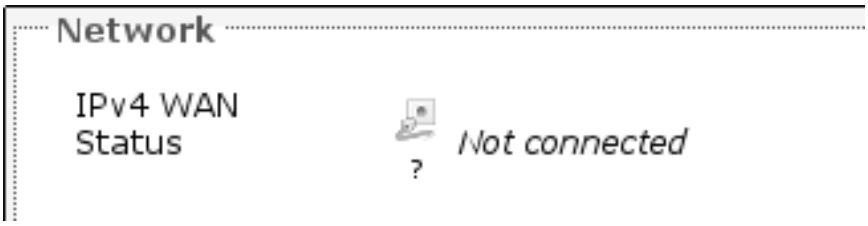

Figure 19: WAN status offline

To arrive there, go to the menu clicking at:

`qMp/Mesh / Mesh / Status`

alternatively:
`http://admin.qmp/cgi-bin/luci/qmp/status`

8 Proposed qMp network node design: General node design

Figure 20 shows the elements of a simple node installation: A qMp node connected to its network and a 2.4 GHz wifi router as an AP that it is necessary to give wifi coverage inside the place.

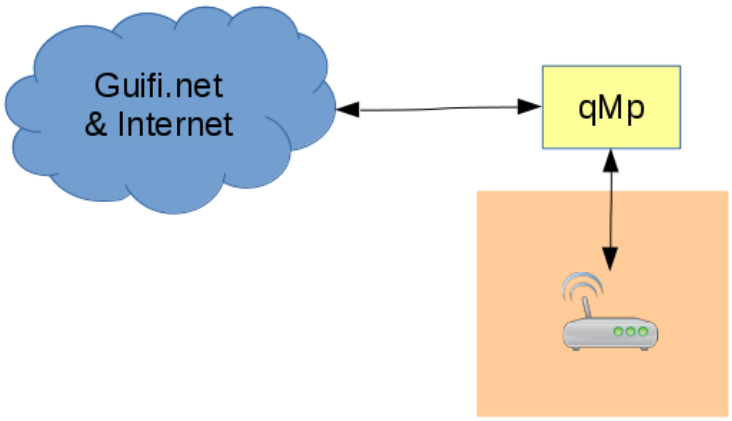

Figure 20: Network diagram generic node

9 Flash qMp node

Steps to flash a device with qMp firmware. It is assumed a Ubuntu/Debian GNU/Linux computer and a 5 GHz device previously recommended:

1. Download the **Factory image** [16] for a supported device that has the factory operating system [17]. **Sysupgrade image** is for OpenWRT or qMp nodes that want to upgrade. **Guifi image** has better integration with guifi.net web.

2. Rename the downloaded file to `qmp.bin`.

[16] `http://fw.qmp.cat/`
[17] `http://qmp.cat/Supported_devices`

3. Download the tftp packets with the system's repository. In CLI: `$ sudo apt-get install tftp-hpa`.

4. Disconnect the internet connection.

5. Open a CLI and put:

   ```
   $ ping 192.168.1.20
   ```

   It will help to know when the device is in the reset mode.

6. Connect the equipments as shown in Figure 21.

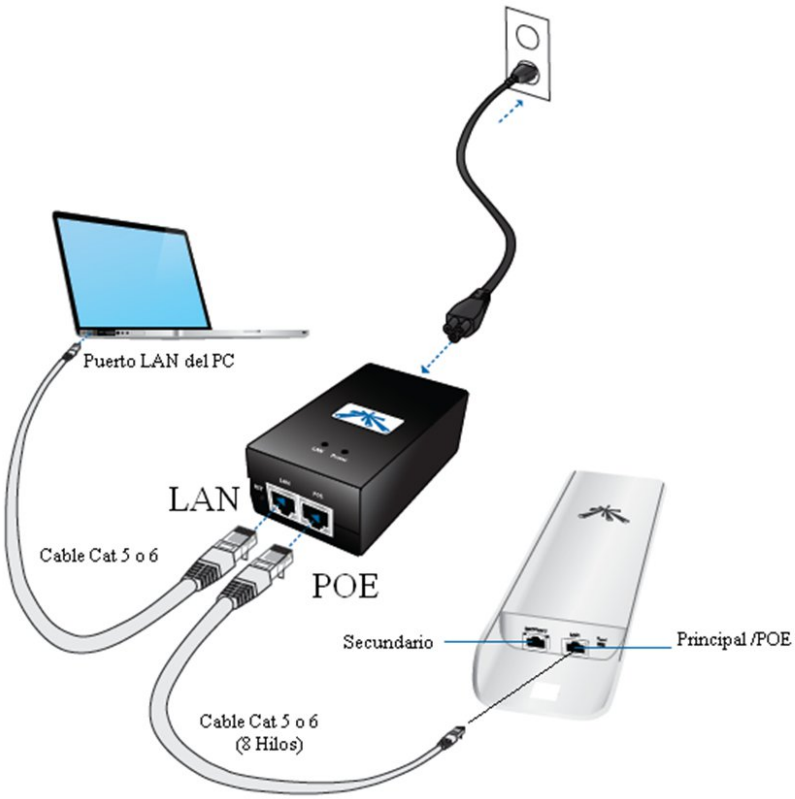

Figure 21: Network Diagram to Flash Device

7. Configure the network following one of these options:

(a) **GUI option**: configure in the preferred network manager a ethernet network with static IP in the computer to connect to the device:
IP: 192.168.1.10
Subnet: 192.168.1.100
Gateway: 192.168.1.1

(b) **CLI option**:

```
$ sudo ip a a 192.168.1.25/24 dev eth0
```

8. Put mode TFTP server in the device following one of these options:

(a) **Reset in the device option**: Disconnect the interface of the device. Remove the device's lid. With one hand take an object with round toe, press and hold reset button (Figure 22) while with the other hand insert the ethernet cable to the interface in device.

Figure 22: Reset device

(b) **Reset in the PoE injector option**: Check if the device has reset in PoE (Figure 23). Disconnect the PoE interface in PoE injector. With one hand take an object with round toe, press and hold reset button while with the other hand insert the ethernet cable to the PoE interface in PoE injector.

Figure 23: Reset power injector

9. Observe if the device start the reset mode needed for continue:

   - **Device led option**: Wait until the led 1 and 3 change to 2 and 4 cyclically. With this video resource it will give an idea of time and led colors involved in the process [18].
   - **PC screen option**: the ping starts responding. The output of the `ping 192.168.1.20` should be something like:

     ```
     64 bytes from X: icmp_req=X ttl=X time=X ms
     ```

10. If is in reset mode stop pressing the reset button and put the device in a stable place.

11. In a new CLI window, go where is the downloaded firmware `qmp.bin`:

    ```
    cd /path/to/the/qmpbin_directory
    ```

    And there, execute:

    ```
    $ tftp 192.168.1.20
    $ mode octet
    $ trace
    $ put qmp.bin
    ```

    [Transmission process]

[18] `https://www.youtube.com/watch?v=xIflE_-V-B4#t=50s`

```
$ quit
```

12. After about 5 minutes, the 4th led of the ramp (the most right led, Figure 24) is on, and not blinking. This is the moment to go the next step.

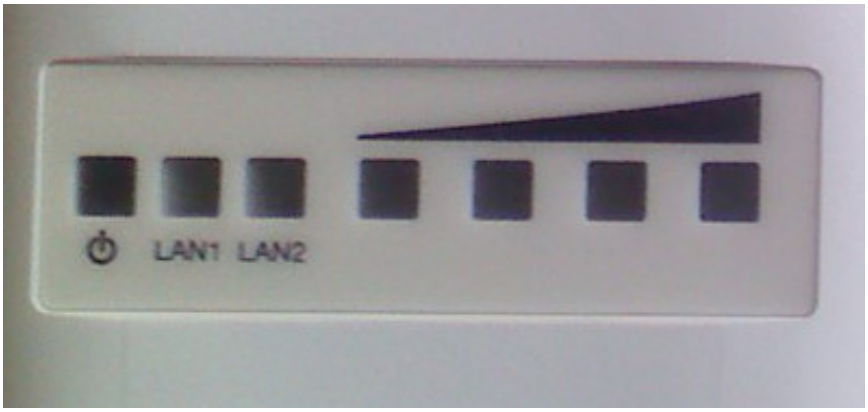

Figure 24: Led system in the device

13. Reconfigure the network to do a DHCP client in ethernet port (Automatic IP) and try to connect again the PC to the device.

14. Check that the device responds to ping:

    ```
    $ ping 172.30.22.1
    ```

    This is the fixed IP address in roaming mode (by default in qMp). More general approach is to get the gateway address:

    ```
    $ ip r | grep default | cut -f3 -d' '
    ```

    Open a web browser and check if this web can be accessed (**Warning** it will only work if the PC is connected to the device via DHCP):

    ```
    http://admin.qmp
    ```

    alternatives:

    ```
    http://172.30.22.1
    http://<gateway_ip>
    ```

15. Login access is user: root
    password: 13f

Other references [19] , [20] , [21]

10 Making a panorama with Hugin

With the Hugin it is very easy to do panorama photos, and is free open source software [22]. The panorama photos are very useful to see which nodes are near.

1. How to do the photos? Take the same physical point and start doing photos from right to left, with 20% of overlap between them.

2. Follow the steps in Hugin's program (Figure: 25)

   (a) `1.Load images`, select all images in the directory it is wanted to do a panorama.

   (b) `2.Align`.

   - this takes a process to search for common points (control points) in the different photos to give sensation of continuity in the photo.
   - if there is not enough control points, search control points manually or do the photos again.

   (c) `3.Create panorama`: save a .pto and .tiff files in the directory with all images.

3. Conversion of .tiff to .jpeg
   If it is wanted to share the panorama.

   ```
   sudo apt-get install imagemagick
   convert pan.tiff pan.jpeg
   ```

   An example is showed in figure 26

[19] `http://wiki.ubnt.com/Firmware_Recovery`
[20] `http://www.qmp.cat/#Use-the-firmware`
[21] tftp info: `http://wiki.openwrt.org/doc/howto/generic.flashing.tftp`
[22] `http://hugin.sourceforge.net/`

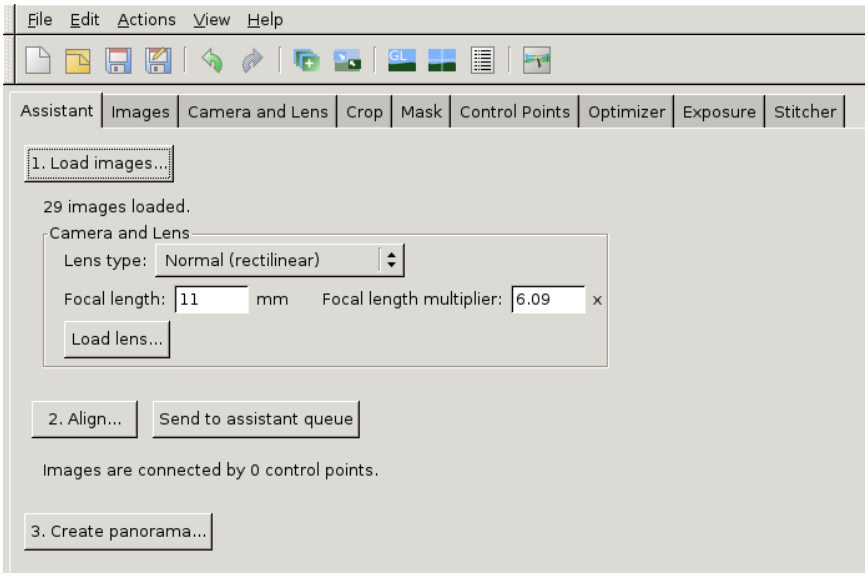

Figure 25: Hugin

Figure 26: Example of panorama using hugin

11 About monitoring

Perform a monitoring of the network is important as a measure of quality assurance. Are presented 3 alternatives.

11.1 From the guifi.net web

can be obtained the graphs. It helps to know if the device is up, its ping and the network traffic. Figure 27 shows how it looks like.

It is required a qMp version with guifi package: `qMp-Guifi` should appear in the bin package name.

The server part uses a package developed by guifi.net community called `snpservices`. For install it can be followed this guide [23], basically, a Debian

[23] There is no English translation: `http://ca.wiki.guifi.net/wiki/Servidor_de_gr%`

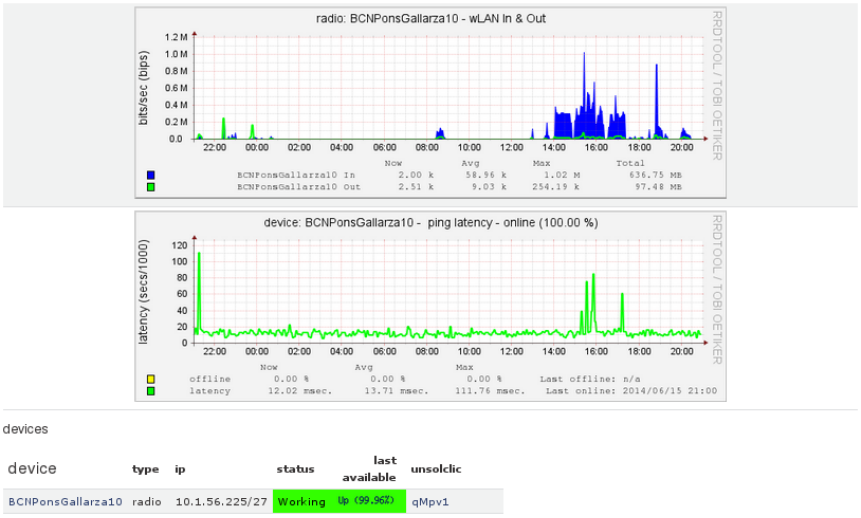

Figure 27: Graph server in guifi.net

repository is obtained, it is installed the package and is set the id of the graph server (other parameters remain default). To obtain the id of the graph server create a service of type graph server in the guifi.net web. For example, the id of the graph server of Barcelona can be obtained from the URL: `http://guifi.net/en/node/55045`, and it is `55045`.

qMp uses the package `mini_snmpd` [24] configured to the guifi.net website. After creating the node and the device in the web, it generates the `unsolclic` file. Figure 28 shows how simple is: put there the URL of the device and apply.

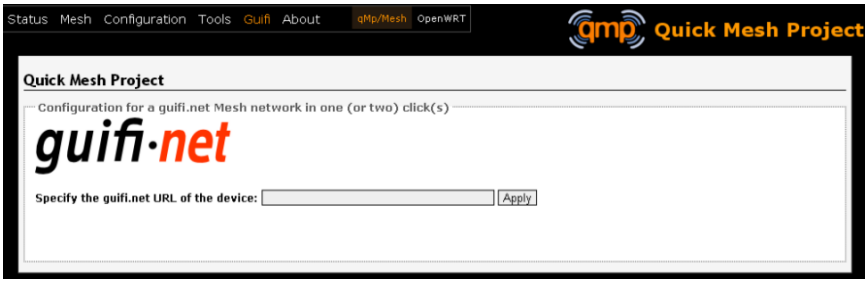

Figure 28: guifi.net menu in qMp firmware

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[24] `http://wiki.openwrt.org/doc/howto/snmp.server`

11.2 munin:

For a GNU/Linux Debian 7 Wheezy server (apache 2.2)

```
sudo apt-get install munin
```

by default it does monitoring of the server itself (localhost).

For make the graphs available for every user [25], in order to follow the Community Network model of open all network data, change the following lines in `/etc/munin/apache.conf`:

```
Order allow,deny
Allow from localhost 127.0.0.0/8 ::1
Options None
```

like so:

```
Order allow,deny
Allow from all
Options FollowSymLinks SymLinksIfOwnerMatch
```

Apply the changes in the HTTP server:

```
# service apache2 restart
```

Add qMp nodes for monitor them editing the file `/etc/munin/munin.conf`:

```
[qMp-node1] address 10.x.x.x
use_node_name yes
[qMp-node2] address 10.x.x.x
use_node_name yes
```

Apply the changes in the monitor (it will start appearing after few minutes):

```
# service munin-node restart
```

The graphics are very similar to those of guifi.net web, but provide more information. Except that there is an error with network traffic monitoring and is not provided.

11.3 qmpsu:

At the moment, there is not a generic package of qmpsu for qMp networks, only for Sants neighborhood (Barcelona). Figure 29 shows how it looks like.

[25] Solution for apache 2.2 and 2.4: `http://stackoverflow.com/questions/9127802`

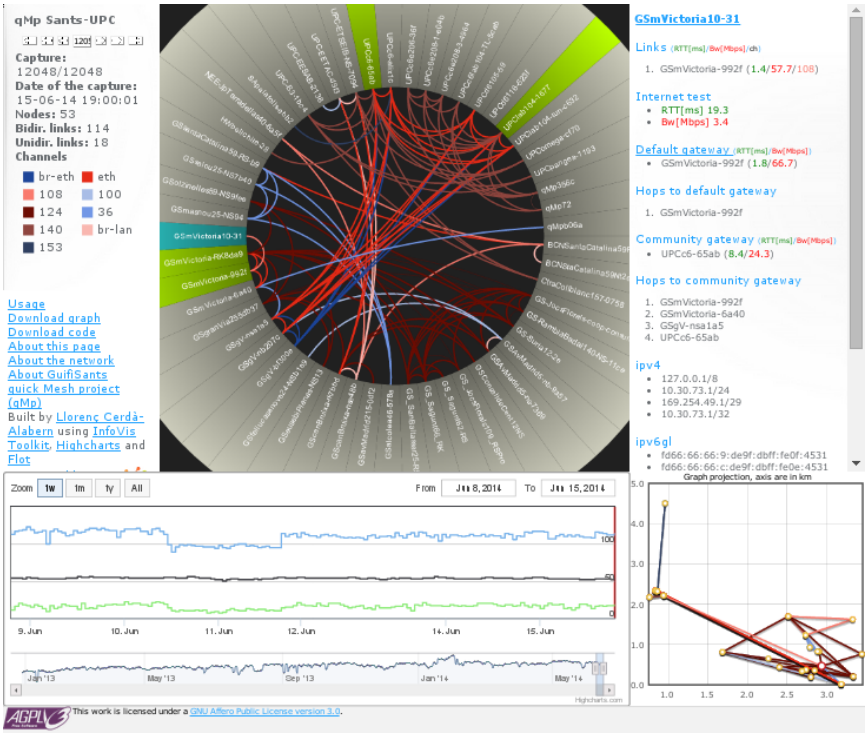

Figure 29: qmpsu view