Morse Micro
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How to configure 802.11s Mesh
APPNOTE-32

Table of Contents

1 Scope

This application note provides a guide on configuring and verifying using the 802.11s Mesh feature on Morse Micro OpenWRT products.

This document outlines the configuration of an 802.11s Mesh network designed to provide backhaul connectivity for 802.11bgn Wi-Fi and LAN connections through 802.11ah HaLow links. The described scenario serves as a representative reference configuration. Please note that the latency and throughput of the network will depend on the 802.11ah link performance and the number of hops in the mesh.

The prerequisites for this application note are:

- 2 x Morse Micro HaLowLink1 devices, with the latest software installed (this guide was written based on v.2.7.3).[1]
- *1+ x additional Morse Micro HaLowLink1 devices are required to test meshing behaviour such as self-healing and dynamic route finding.*
- 1 x laptop with ping, and traceroute installed.
- 1 x internet connection accessible via 2.4GHz Wi-Fi with access credentials known.
- Familiarity with accessing and configuring Morse Micro HaLowLink1 devices, as per the User Guide.

By following this application note you will learn:

- How to configure HaLowLink1 devices to setup an 802.11s mesh;
- How to validate the mesh is operating; and
- How to validate that the mesh is self-healing.

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[1] *Any 802.11ah HaLow Wi-Fi compliant devices that implement 802.11s can be used (such as Morse Micro EKH01 or EKH03), but this guide assumes HaLowLink1 devices for simplicity)*

2 Theory of Operation

802.11s Mesh is a Wi-Fi feature that allows multiple wireless devices to "interconnect to create a wireless LAN mesh network". [link] This can be used to extend the area covered by a network by creating wireless links that manage the multiple paths between nodes and is capable of automatically recovering connectivity and dynamically adjusting routes in response to environmental changes..

This application note uses multiple HaLowLink1 devices to create an 802.11s mesh network over the 802.11ah HaLow radios. This application note chooses to target a network that:

- uses an 802.11bgn 2.4 GHz radio as a client connecting to a Wi-Fi hotspot running on mobile phone for uplink to the internet
- provides a laptop access to the internet via 802.11bgn 2.4 GHz Access Points that are backhauled by the 802.11s mesh network via the 802.11ah HaLow radios.

Note: an 802.11s mesh network can extend any network over wireless; can use Ethernet or other wireless for internet access; and can use Ethernet or other wireless as the means for accessing the mesh. This application note chooses the above topology to remove options in order to simplify the guide.

The target network architecture from the choices above is shown below:
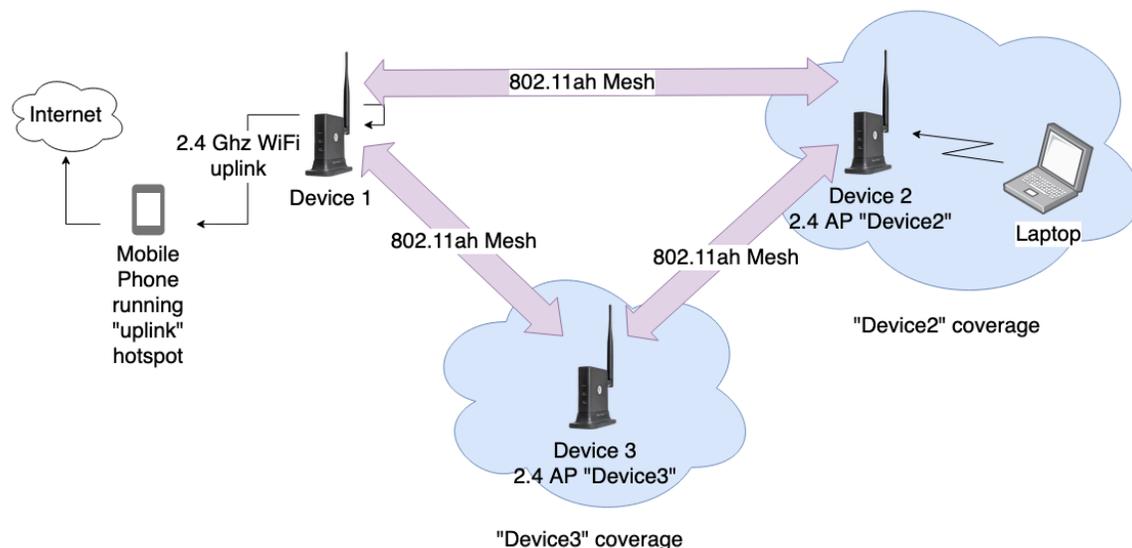
This network will demonstrate that from a laptop connected to Device 2 via 2.4GHz Wi-Fi can communicate to the internet via the 802.11ah Mesh network.

The physical devices will be moved (or mesh thresholds changed) so the network topology changes to rely on a network path through Device 3, as shown in the diagram below:
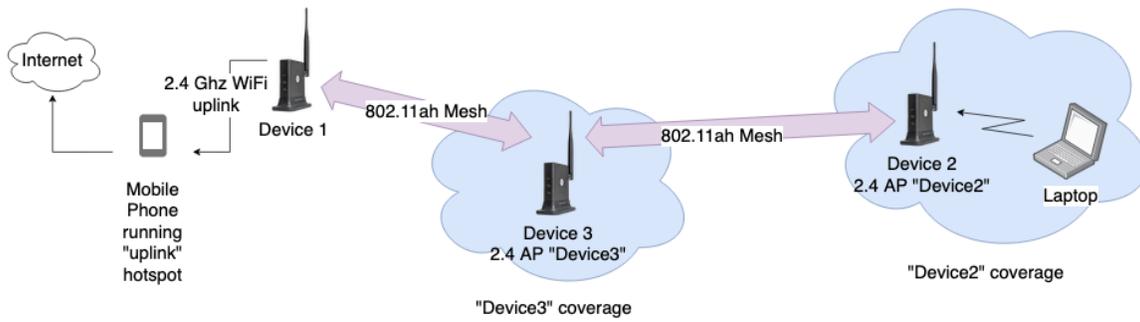
This topology will demonstrate the mesh self-heals, and will validate that the laptop connected to the 802.11bgn 2.4 GHz can still communicate to the internet via the mesh network.

3 How to Configure

This guide covers two different ways to configure 802.11s mesh in HaLowLink1 devices:

1. An approach that uses the UI Wizard and push button DPP (Device Provisioning Protocol). This is the easiest method.
2. An approach that uses manual configuration via the UI. This is more involved, but is more tailorable.

Both approaches configure the following:

- A single device (Device 1) is configured as the Mesh Gate - i.e. the device that provides integration to another distribution system. This device uses its 2.4GHz radio for uplink to an existing Wi-Fi network that has an internet connection.
- A number of devices (e.g. Device 2, Device 3) that are configured as mesh nodes. These devices use their 802.11ah HaLow radio to participate in the mesh, and use their 802.11bgn 2.4GHz radio to provide an Access Point.

Both approaches are documented below.

Note: This guide does not cover setting regulatory domain, or channels for these devices. It is assumed you have set this correctly and are otherwise using the devices with factory defaults.

Refer to the HaLowLink1 User Guide for detailed instructions regarding proper configuration of regulatory domain and wireless channels.

3.1 Recommended Approach - Configuring HaLowLink1 via Wizard and Push Button

3.1.1 Overview

The HaLowLink1 device supports configuring an 802.11s Mesh and adding Extender devices to the mesh via a UI Wizard and DPP push buttons. This is the easiest way to configure an 802.11s mesh network.

Pre-requisites:

- 2 x HaLowLink devices, loaded with the latest software (2.7.3+)
    - *Additional HaLowLink1 devices are required if you would like to test a multi-hop mesh and/or mesh self-healing.*
- 1 x laptop
- 1 x mobile phone with Wi-Fi hotspot capability and an internet connection

The high-level network architecture is shown in the diagram below:
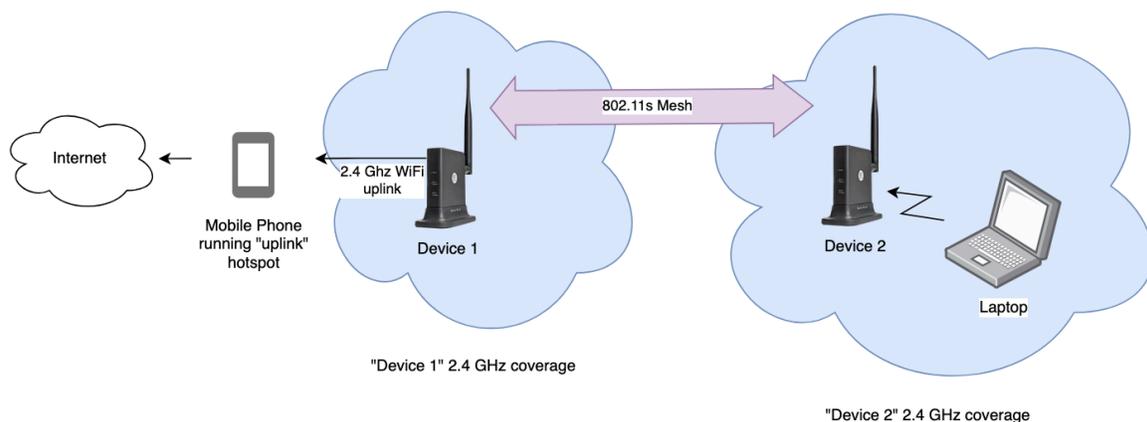
- Device 1 will provide the uplink to the internet by connecting as a client to the mobile phone's "uplink" hotspot. Device 1 will operate as a Mesh Gate in the 802.11s mesh.
- Device 2 will connect to the 802.11s mesh, will operate as a node in the 802.11s mesh, and will also operate an 802.11bgn Access Point.
- The laptop will connect as a client to the 802.11bgn Access Point from Device 2, and will be able to reach the internet by having traffic travel over the mesh to Device 1, and then via the mobile phone to the internet.

3.1.2 Step-by-step guide for Wizard and Push Button approach

The following is a step by step guide to configure and validate a mesh network. The two devices used as examples are HaLowLink1s with the following:

- Device 1 - SSID: halowlink1-af0f
- Device 2 - SSID: halowlink1-ae6b

To provide an uplink for this guide, determine the SSID and password of your 2.4GHz uplink (this guide uses a phone hotspot configured with SSID: `uplink` and Password: `uplink-password`).

Step 1: Configuring Device 1 as a Mesh Gate

1. Connect your laptop to Device 1 via its 802.11bgn 2.4 GHz (e.g. Wi-Fi SSID halowlink1-af0f, password printed on device label)
2. Access the web UI at http://192.168.12.1, login using the "Device Password" (printed on device label) and select the "Wizard" from the menu (direct link)
3. Choose HaLow Mode: 802.11s Mesh and Network Mode: "...use 2.4 GHz for an uplink"

4. Click "Save and apply"
   a. The device is now running an Access Point and Mesh Point on its 802.11ah radio and is still running an Access Point on its 802.11bgn radio. The device's Wi-Fi SSID (halowlink1-af0f) is used as the Access Point SSID, and the Mesh ID.
5. Go to Home (http://192.168.12.1/cgi-bin/luci/admin/home)
6. Find the Uplink(2.4GHz) card, which should say "Disconnected"

7. Click the word "Disconnected" and provide the uplink network details (`uplink / uplink-password`)
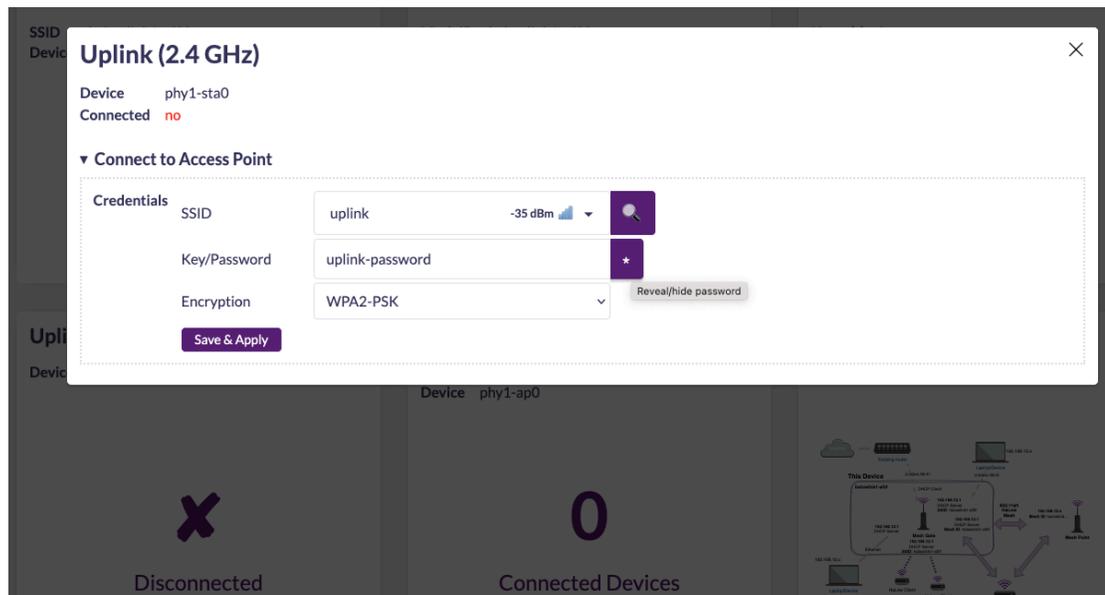
Step 2: Validating Internet Connectivity on Device 1

Device 1 should now provide uplink to the internet via the configured 2.4 GHz uplink network. Steps to validate are:

1. Connect to Device 1's 2.4 GHz Access Point (halowlink1-af0f) with your laptop.
2. Check you can reach the internet (i.e. load www.morsemicro.com in your browser).
   Note: Please ensure that your laptop is not connected to the internet via another network during this test.

Step 3: Configuring Device 2 as a Mesh Extender

For more information, see the "HaLow extender" section in the HaLowLink1 User guide.

1. Put Device 2 into Extender mode by holding down the physical push button until the status light flashes aqua (i.e. 10+ seconds).
2. Wait for Device 2 to reboot into Extender mode (i.e. Status LED is solid Aqua)
3. Pair Device 2 with Device 1 by doing the following:
   a. First press and release button on Device 1 to put it into pairing mode (Wi-Fi HaLow Status LED slowly blinks)
   b. Press and release button on Device 2 to pair it with Device 1 (Wi-Fi HaLow Status LEDs should slowly blink in both devices).
   c. Wait 30+ seconds, and both devices' HaLow status light should stop slow flash, and show solid/blinking traffic.

Step 4: Validating Mesh Connectivity on Device 2

Device 2 should now provide uplink to the internet via Device 1. Steps to validate are:

1. Connect to Device 2's 2.4 GHz Access Point (halowlink1-ae6b) with your laptop
2. Check you can reach the internet (i.e. load www.morsemicro.com in your browser)

You now have a functioning 802.11s mesh network.

Configure and Validate Additional Devices (e.g. Device 3)

Additional devices (e.g. Device 3) are configured and validated using the same steps as for Device 2.

Repeat the "Device 2" process for Device 3 to add another Extender to the mesh. Test the self-healing behaviour of the mesh by moving Device 2 out of range of Device 1, and/or by adjusting the "RSSI threshold for joining" mesh setting (see Troubleshooting section for more information).

Note: If testing on your desk, we recommend a cabled test setup with the appropriate attenuation and RF splitter/hubs for the thresholds you set.

3.1.3 Detailed explanation for Wizard and Push Button configuration

The following annotates the prior diagram with more details from the example configured, including the 802.11 mesh terminology (as per Certified Wireless Network Professional 802.11s Mesh guide):
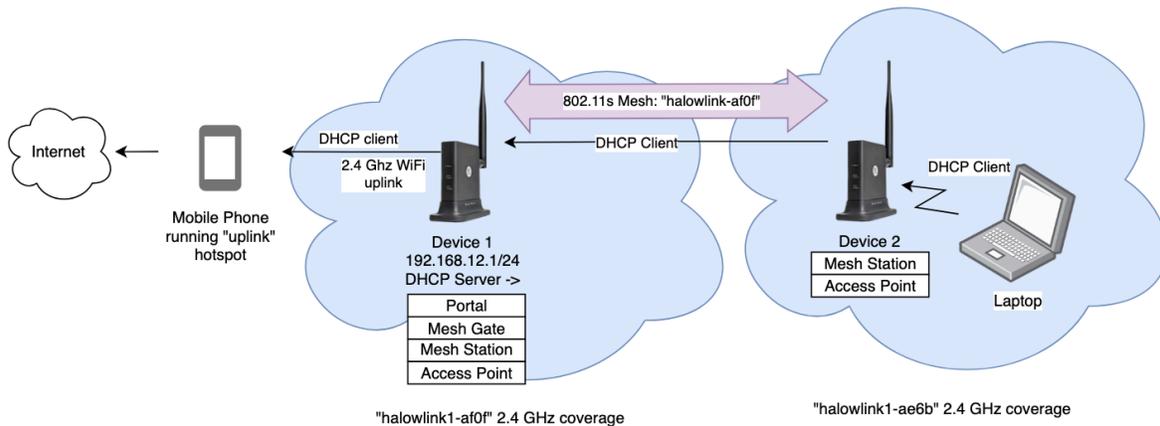
The points to note are:

- Both Device 1 and Device 2 participate in the 802.11s Mesh as Mesh Stations. The Mesh ID and settings come from the Device 1 configuration, and are distributed to Device 2 via DPP (push button).
- Device 1 is configured to have a static address 192.168.12.1 and to operate a DHCP server on the lan network (i.e. the mesh; its 802.11bgn 2.4 GHz Access Point; and LAN and USB LAN ports). This is identical to the out-of-the-box configuration for a HaLowLink1.
- Device 2 is configured to obtain its address via DHCP. It also has all physical ports (LAN, USB LAN, and WAN), and its 802.11bgn 2.4 GHz Access Point into its lan network.
  - I.e. connecting to any physical port or the Access Point in Device 2 will provide access to the internet via the mesh->Device1->phone hotspot->phone internet connection.

This is a detailed diagram of the two devices, and the resulting configuration from an OpenWRT perspective:

Device 1

wan firewall zone

wan Interface
Dynamic IP
DHCP Client

phy1-**sta0**
radio1 802.11**bgn** Access Point
SSID: "halowlink1-af0f"

lan firewall zone

lan Interface
Static IP: 192.168.12.1/24
DHCP Server

wlan1
radio0 802.11**ah** Mesh Point
MeshID: "halowlink1-af0f"

wlan0
radio0 802.11**ah** Access Point
SSID: "halowlink1-af0f"

phy1-**ap0**
radio1 802.11**bgn** Access Point
SSID: "halowlink1-af0f"

usblan ethernet port

lan ethernet port

forwarding

wan ethernet port

connects to

DHCP server on lan interface gives DHCP lease to

forms mesh link with

Device 2

lan firewall zone

lan Interface
Dynamic IP (e.g. 192.168.12.102/24)
DHCP Client

wlan1
radio0 802.11**ah** Mesh Point
MeshID: "halowlink1-af0f"

phy1-**ap0**
radio1 802.11**bgn** Access Point
SSID: "halowlink1-**ae6b**"

wan ethernet port

usblan ethernet port

lan ethernet port

wan firewall zone

wan Interface
Dynamic IP
DHCP Client

No devices

connects to

Internet

Mobile Phone
running "uplink"
hotspot

wan port removed from all interfaces

DHCP server on lan interface gives DHCP lease to

Laptop
(e.g. 192.168.12.192/24)

This SSID is from Device 2, not Device 1.

wan port has moved into lan interface to provide extra physical ports

Legend

	Firewall Zones		Network Interfaces	Device usage indication		Device type indication			
HalowLink1	lan	wan	lan	used device	unused in this config	2.4 GHz Radio	Halow Radio	Ethernet	Note

3.2 Advanced Approach - Configuring via UI without Wizard

3.2.1 Overview

The HaLowLink1 supports 802.11s and can be configured without relying on the wizard and push button pairing. This process is more complex. There are many inter-related settings which must be correct - setting incorrect configuration parameters may result in temporary loss of device connectivity or administrative access..

NOTE: We expect this process to be followed by users familiar with configuring 802.11s mesh networks and/or users that are experimenting with 802.11s. It is expected that occasional connectivity issues may occur as part of the learning process. A common cause is being unable to determine the IP address of a device because it changes from using a static IP address to a DHCP provided IP address. See Troubleshooting for more guidance.

Common objections to the Wizard and Push Button configuration are:

1. It does not have the SSIDs I want in all of the devices.
2. It does not have an 802.11ah HaLow Access Point as well as an 802.11bgn 2.4 GHz Access Point in all of the devices.
3. I do not know how to incorporate this with other 802.11ah HaLow products that support 802.11s meshing.

We will address points 1 and 2 in this section. Point 3 is out of scope for this document, but will be similar to the configuration performed in this guide.

Note: This section will perform the full configuration from scratch via the UI - but the approach is similar to adjust the configuration from the previous Wizard and Push Button section to address the objections.
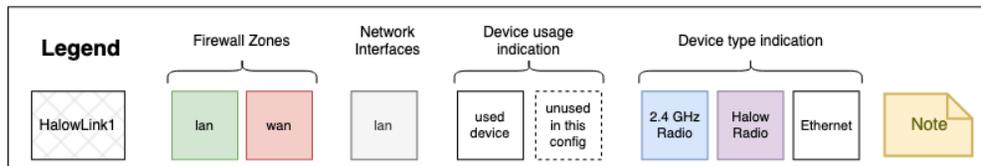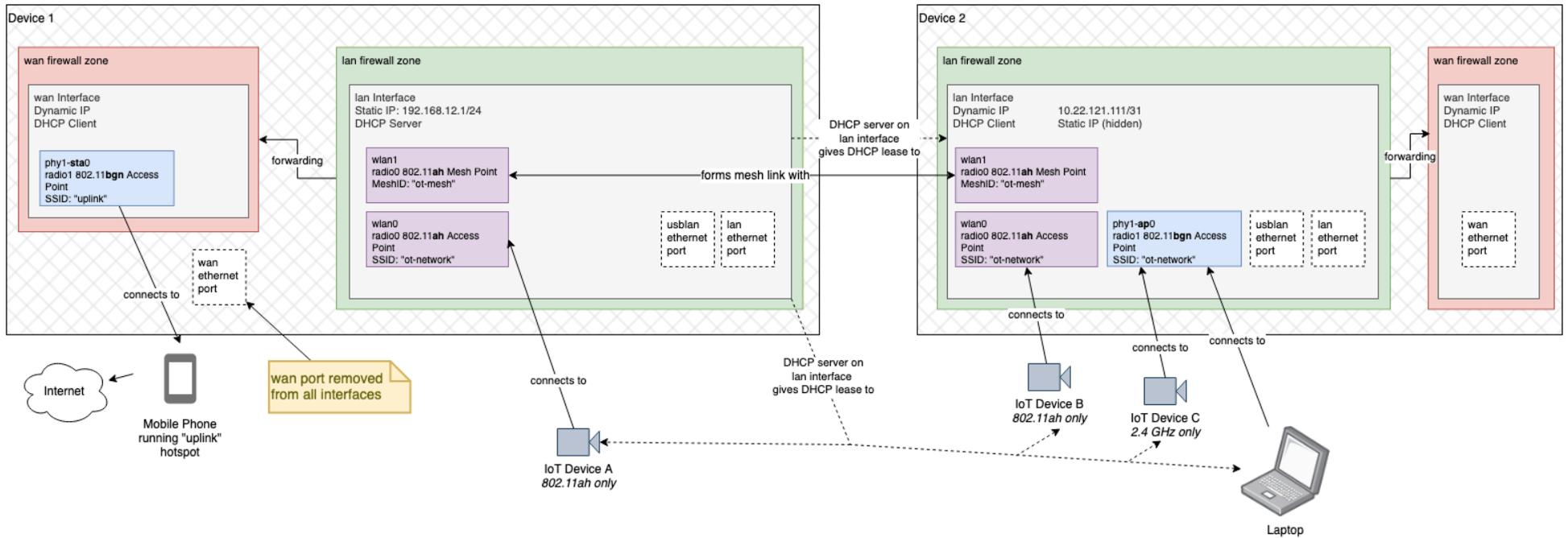
3.2.2 Requirements for the example via UI

The Wizards and Push Button example ignored some of the requirements from the original plan for ease of use. This example will use requirements from an expected IoT deployment where:

- REQ1 - There are existing 2.4 GHz only Wi-Fi IoT devices that are configured as clients with SSID: "ot-network" and Password: "ot-network-password".
- REQ2 - These 2.4 GHz only devices are geographically dispersed, and we want to use an 802.11ah HaLow mesh to provide coverage to them, so our 2.4 GHz Access Points must use this SSID.
- REQ3 - There are also 802.11ah Wi-Fi IoT devices configured as clients with the same 'ot-network' configuration, and we also want the mesh to provide coverage to them.
- REQ4 - At the uplink we *do not* want the uplinking mesh device to also run any 802.11bgn 2.4GHz Access Points, as these will add unnecessary interference, but we do want to run an 802.11ah Access Point at the uplink mesh device.

The conceptual architecture for this example is below. Note it includes "IoT Devices" which we will not cover in this guide:
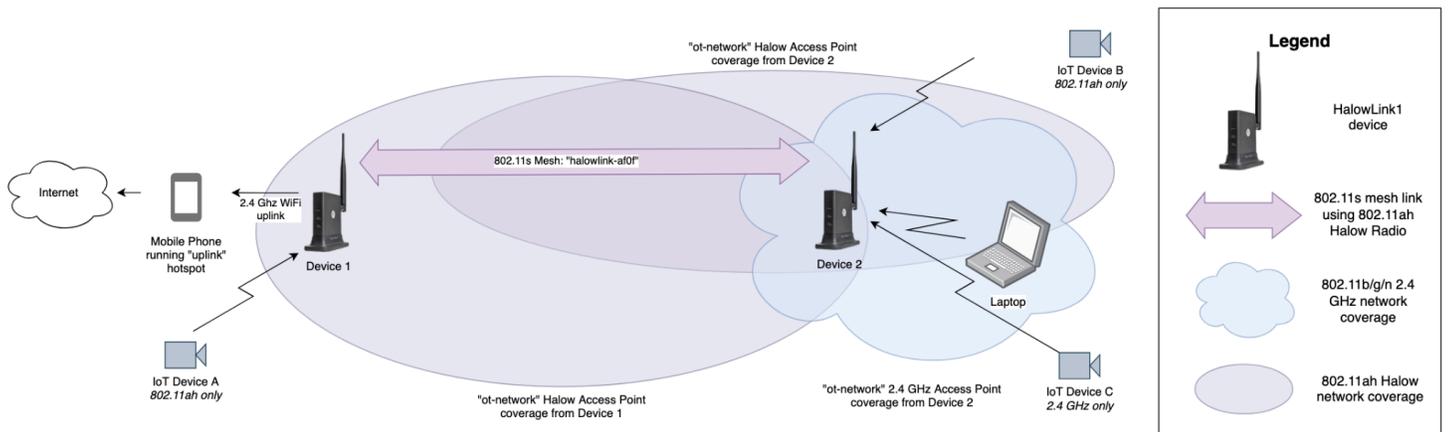
And this is a detailed diagram of the network, including the two HaLowlink devices we will configure :

Device 1

wan firewall zone

wan Interface
Dynamic IP
DHCP Client

phy1-**sta0**
radio1 802.11**bgn** Access Point
SSID: "uplink"

forwarding

lan firewall zone

lan Interface
Static IP: 192.168.12.1/24
DHCP Server

wlan1
radio0 802.11**ah** Mesh Point
MeshID: "ot-mesh"

wlan0
radio0 802.11**ah** Access Point
SSID: "ot-network"

usblan ethernet port

lan ethernet port

DHCP server on lan interface gives DHCP lease to

forms mesh link with

Device 2

lan firewall zone

lan Interface
Dynamic IP   10.22.121.111/31
DHCP Client   Static IP (hidden)

wlan1
radio0 802.11**ah** Mesh Point
MeshID: "ot-mesh"

wlan0
radio0 802.11**ah** Access Point
SSID: "ot-network"

phy1-**ap0**
radio1 802.11**bgn** Access Point
SSID: "ot-network"

usblan ethernet port

lan ethernet port

forwarding

wan firewall zone

wan Interface
Dynamic IP
DHCP Client

wan ethernet port

wan ethernet port

connects to

Internet

Mobile Phone running "uplink" hotspot

wan port removed from all interfaces

connects to

IoT Device A
802.11ah only

DHCP server on lan interface gives DHCP lease to

connects to

IoT Device B
802.11ah only

connects to

IoT Device C
2.4 GHz only

connects to

Laptop

Legend

	Firewall Zones	Network Interfaces	Device usage indication	Device type indication	
HalowLink1	lan / wan	lan	used device / unused in this config	2.4 GHz Radio / Halow Radio / Ethernet	Note

### 3.2.3 Step-by-step guide for configuring entirely via UI

The following is a step by step guide to configure and validate a mesh network. The two devices used as examples are HaLowLink1s running v2.7.3 with the following:

- Device 1 - SSID: halowlink1-af0f
- Device 2 - SSID: halowlink1-ae6b

To provide an uplink for this guide, determine the SSID and password of your 2.4GHz uplink (this guide uses a phone hotspot configured with SSID: `uplink` and PW: `uplink-password`).

Configure <u>Device 1</u> to have 2.4 GHz uplink to internet

1. Connect your laptop to Device 1 via its 802.11bgn 2.4 GHz
   (e.g. Wi-Fi SSID halowlink1-af0f)
2. Access the web UI at http://192.168.12.1, login using the "Device Password"
3. Select Quick Config page (*you may have to toggle "Advanced Config"*)
   (http://192.168.12.1/cgi-bin/luci/admin/config)
4. Add a new wireless device to the 802.11b/g/n radio
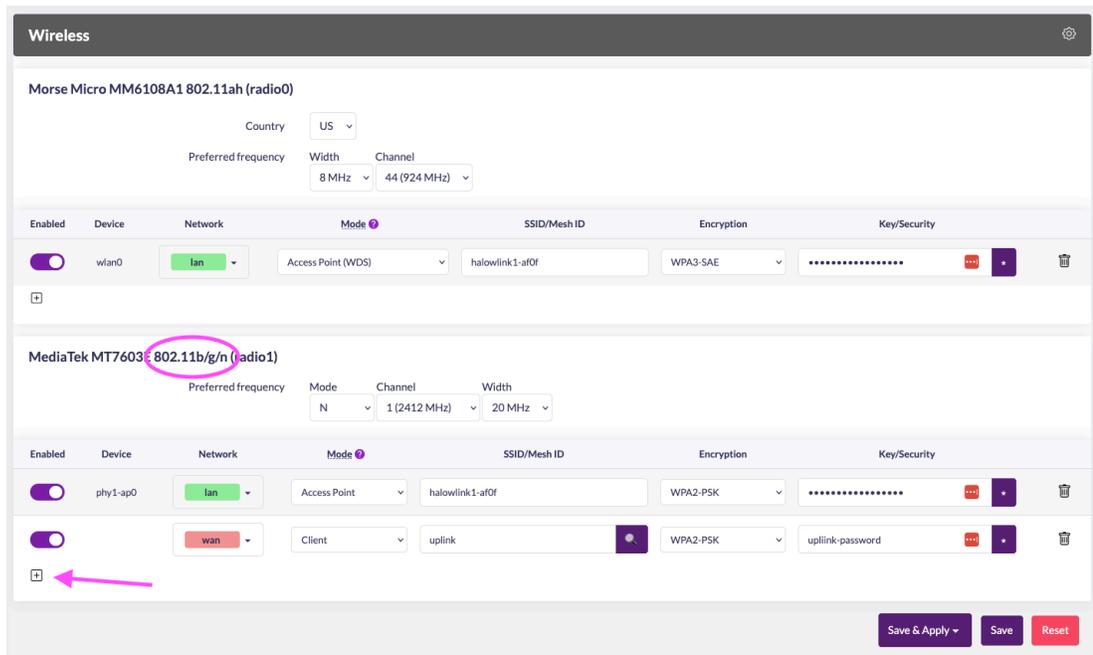
5. Input the following details:
   a. Ensure 'enabled' is selected
   b. Network: wan
   c. Mode: client
   d. ESSID: `uplink`

      e.   Encryption: *Match the security protocol exactly to that configured on the uplink hotspot (commonly WPA2-PSK).*

      f.   Key/Security: `uplink-password`

6. Remove the wan Ethernet device from the wan network by deselecting 'wan' in the Ethernet dropdown.
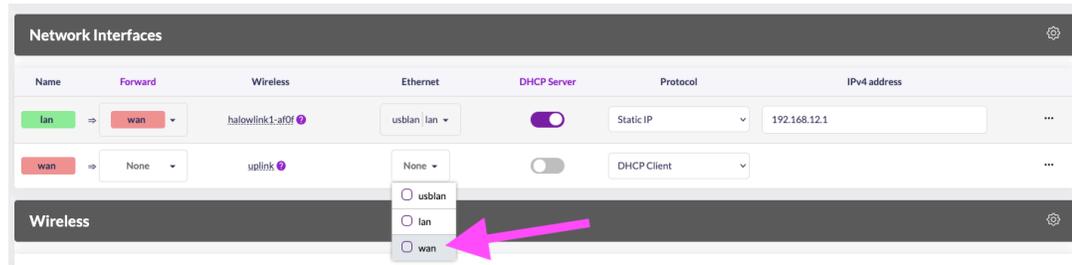
7. Click Save & Apply

## Validate **Device 1** has an internet 2.4 GHz uplink

1. Ensure your hotspot is enabled.
2. Connect to Device 1's 2.4 GHz Access Point (i.e. halowlink1-af0f) with your laptop.
3. Check you can reach the internet (i.e. load www.morsemicro.com in your browser).

Troubleshooting

● If you cannot see your device's 802.11bgn 2.4 GHz Access Point, it may be that your hotspot is unavailable or the device has incorrect parameters.
    ○ The HaLowLink1 only brings up its 802.11bgn 2.4 GHz Access Point *after* its 802.11bgn 2.4 GHz client successfully connects to the 'uplink' SSID.

## Configure **Device 1** to have 802.11ah Access Point with "ot-network" SSID

4. Select Quick Config page (http://192.168.12.1/cgi-bin/luci/admin/config)
5. Change the settings for the existing Access Point for the 802.11ah radio
      a.   ESSID: `ot-network`
      b.   Key/Security: `ot-network-password`
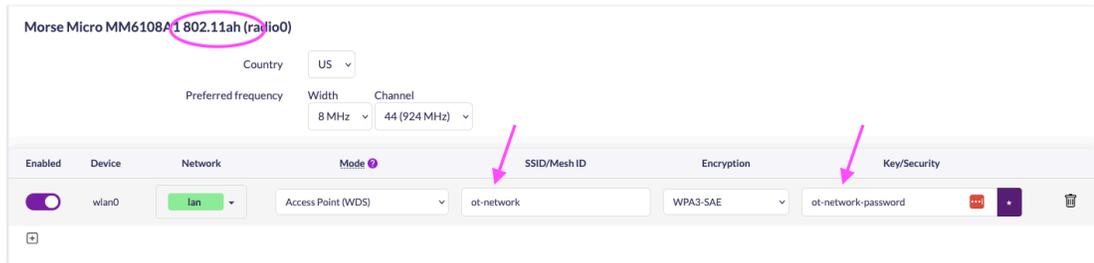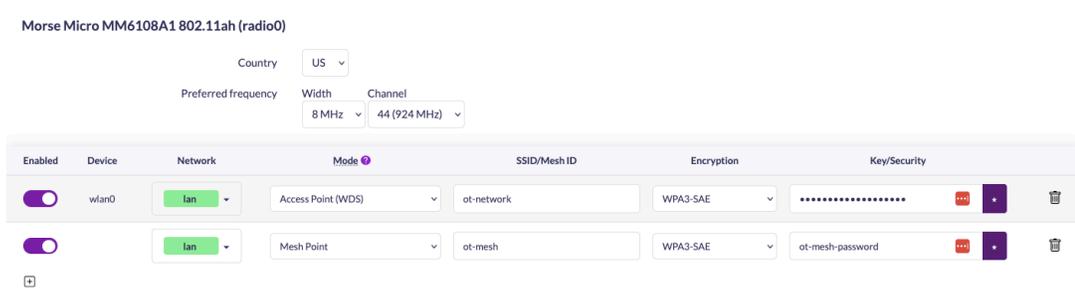
6. Click "Save & Apply" (note you might lose connection and need to reconnect)

Configure **Device 1** to have 802.11ah Mesh Point with "ot-mesh" SSID

7. Select Quick Config page
   (http://192.168.12.1/cgi-bin/luci/admin/config)
8. Add a new wireless device to the 802.11ah radio
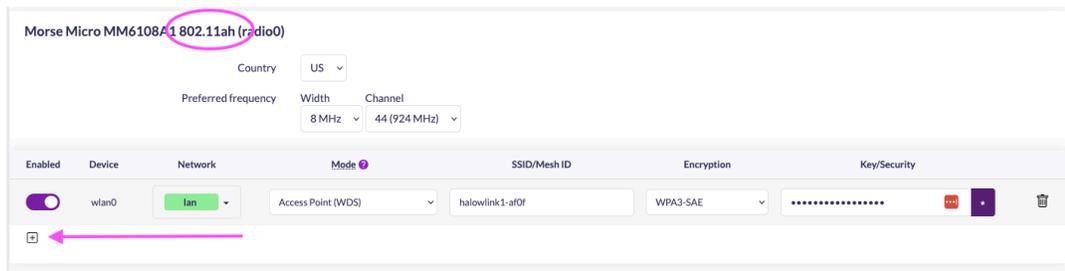
9. Input the following details:
   a. Enabled: true
   b. Network: lan
   c. Mode: Mesh Point *(Note: this is called 802.11s mesh in Network > Wireless config page)*
   d. MeshId: `ot-mesh`
   e. Encryption: WPA3-SAE
   f. Key/Security: `ot-mesh-password`

10. Click "Save & Apply" (note you might lose connection and need to reconnect)

Validate **Device 1** 802.11ah configurations

We cannot validate the 802.11ah mesh is working yet, but we can validate by inspecting the expected configuration on the Network > Wireless page (http://192.168.12.1/cgi-bin/luci/admin/network/wireless).

Note that we have not met REQ4 yet, and are keeping the 802.11bgn 2.4 GHz Access Point configured now to maintain access to Device 1.

Configure **Device 2** to have 'ot-network' for Access Point on both 802.11bgn and 802.11ah radio

11. Connect your laptop to Device 2 via its 802.11bgn 2.4 GHz (e.g. Wi-Fi SSID halowlink1-ae6b)
12. Access the web UI at http://192.168.12.1, login using the "Device Password".
13. Select Quick Config page (*you may have to toggle "Advanced Config"*) (http://192.168.12.1/cgi-bin/luci/admin/config)
14. Change the settings for the existing Access Points for both the 802.11ah and 802.11bgn radios
    a. ESSID: `ot-network`
    b. Key/Security: `ot-network-password`
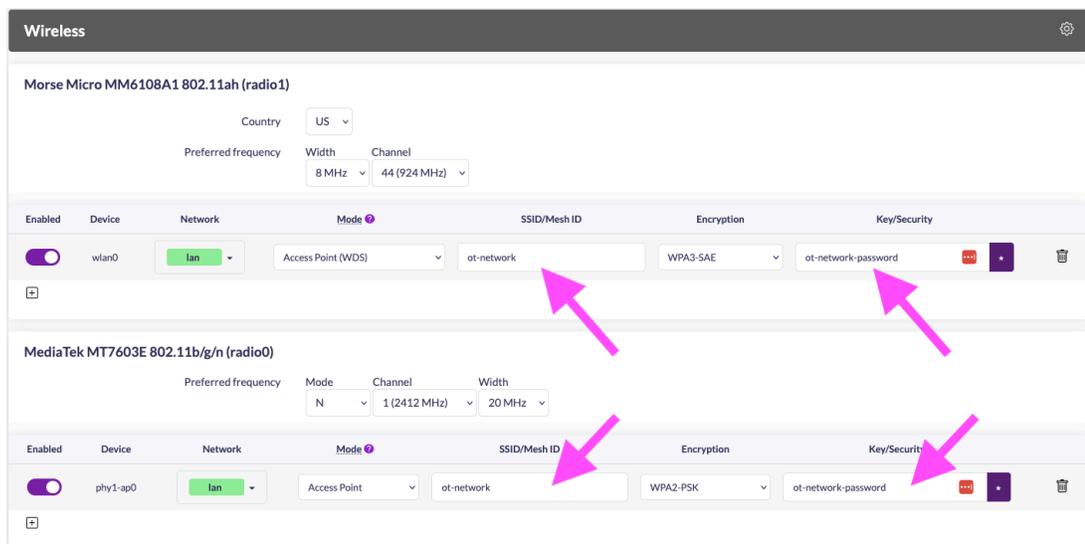
15. Click "Save & Apply". You will lose connection to Device 2, as its SSID will change from the device default to "ot-network".

Reconnect to Device 2 using "`ot-network` / `ot-network-password`".

Configure **Device 2** to have 802.11ah Mesh Point with "ot-mesh" SSID

1. Select Quick Config page
   (http://192.168.12.1/cgi-bin/luci/admin/config)
2. Change the lan network to have:
   a. DHCP Server: Disabled
   b. Protocol: DHCP Client

3. Add a new wireless device to the 802.11ah radio
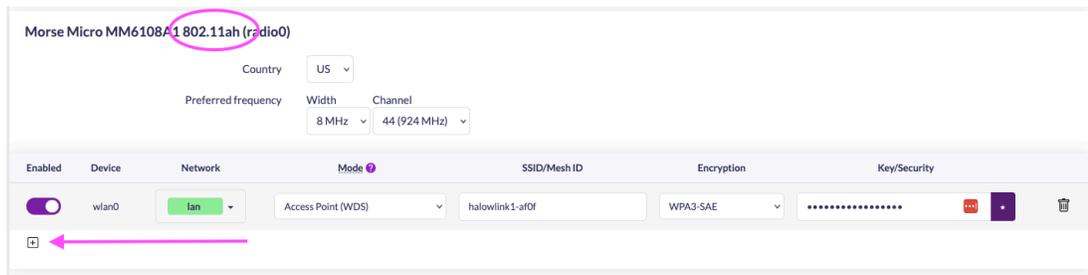
4. Input the following details:
   a. Enabled: true
   b. Network: lan
   c. Mode: Mesh Point *(Note: this is called 802.11s mesh in Network > Wireless config page)*
   d. MeshId: `ot-mesh`
   e. Encryption: WPA3-SAE
   f. Key/Security: `ot-mesh-password`
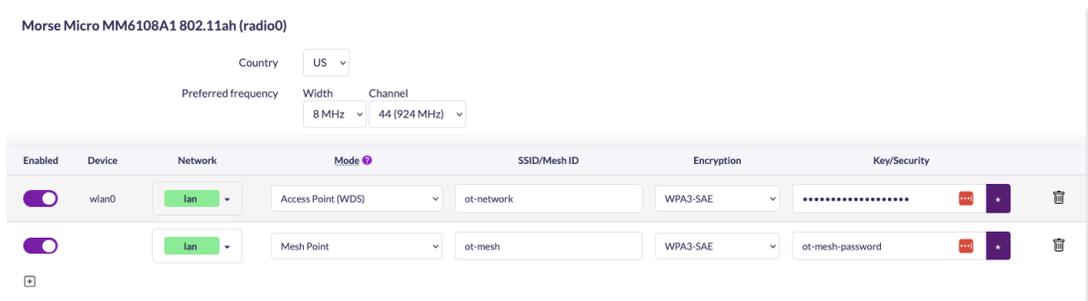
5. Click "Save & Apply" (note you might lose connection and need to reconnect).

6. You will be warned about a connectivity change. Choose "Apply and keep settings".

Connectivity change

The network access to this device could be interrupted by changing settings of the "lan" interface.

If the IP address used to access LuCI changes, a manual reconnect to the new IP is required within 90 seconds to confirm the settings, otherwise modifications will be reverted.

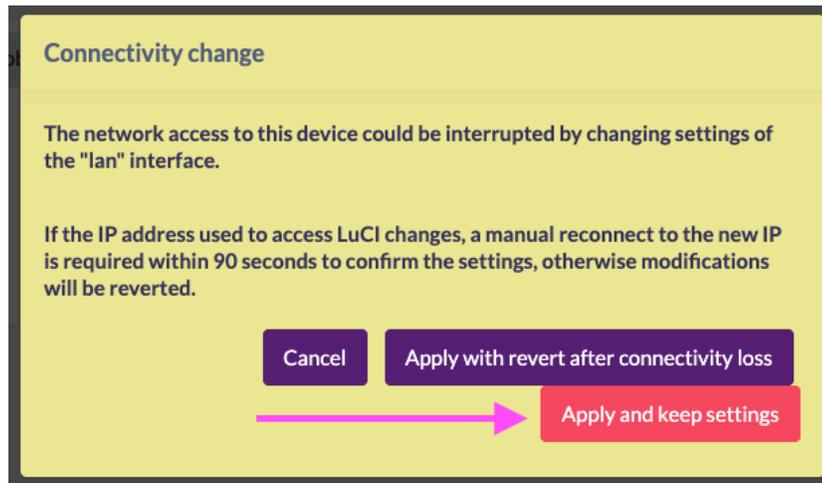Cancel   Apply with revert after connectivity loss   **Apply and keep settings**

Note: We will likely lose connectivity for longer than 90 seconds, as Device 2 will get a new IP from Device 1's DHCP server, but it will take time for us to determine it and get back into the UI.

Validate Device 2 configurations and the mesh network

We have now configured the mesh with two devices, where your laptop has connectivity to the internet.

Before we validate, you must check:
- The "uplink" hotspot is up and has an active internet connection
- Device 1 is powered on (and has all three status lights on - Status & Wi-Fi 2.4 GHz green; Wi-Fi HaLow purple)
- Device 2 is powered on (and has all three status lights on - Status & Wi-Fi 2.4 GHz green; Wi-Fi HaLow purple)
- Your laptop is connected to the "ot-network" SSID (i.e. the one provided by Device 2)

Check connectivity to Device 1

Go to http://192.168.12.1 and login with Device 1's credentials.
- Your laptop is connecting to Device 1 through the following path:

```
laptop -> "ot-network" 2.4 AP -> Device 2 -> "ot-mesh" link -> Device 1
```

If you cannot connect to Device 1, please refer to the troubleshooting section

Check connectivity to the Internet

Go to www.morsemicro.com in your browser.

- Your laptop is connecting to the internet through the same path as to Device 1

Examine traceroute from laptop to see hop via Device 1

Running `traceroute 8.8.8.8` (i.e. a Google DNS server) you can see that the first hop is via the 192.168.12.1 link.

```
↳ ~ traceroute -v 8.8.8.8
Using interface: en0
traceroute to 8.8.8.8 (8.8.8.8), 64 hops max, 40 byte packets
 1  halowlink1-af0f (192.168.12.1) 48 bytes to 192.168.12.176  8.516 ms  7.352 ms  7.271 ms
 2  192.168.87.82 (192.168.87.82) 48 bytes to 192.168.12.176  14.745 ms  18.659 ms  15.695 ms
 3  10.4.92.245 (10.4.92.245) 48 bytes to 192.168.12.176  236.008 ms  139.683 ms  442.146 ms
 4  10.4.93.2 (10.4.93.2) 76 bytes to 192.168.12.176  53.332 ms  37.596 ms  38.707 ms
 5  *^C
```

Inspect DHCP leases in Device 1 to determine Device 2's address

Login to Device 1's UI, and go to Home (http://192.168.12.1/cgi-bin/luci/admin/home).

Click on "DHCP Leases", and look for the MAC address of Device 2. For example, here is the table for the two devices used throughout this guide:

Local Network   ✕

IPv4 192.168.12.1/24
IPv6 fd1e:fbd2:dee::1/60

MAC Address	Hostname	IPv4	Expiry	IPv6	IPv6 Expiry
!7:77:4A	mma-2400.lan	192.168.12.176	720 min(s)	Laptop	
94:83:C4:61:AE:6C	halowlink1-ae6b.lan	192.168.12.102	354 min(s)	Device 2	

Use the IP address found here to get to the UI of Device 2.

Configure and validate Device 3

To configure another device, follow the same steps as for Device 2. Any device configured this way will join the mesh network and behave just like Device 2.

4 Troubleshooting

I'm connected to my device, but I don't know its IP address. How do I find it?

There are a few techniques:

Method A: Using DHCP Server Leases
1. Log into the device that is running the DHCP server and go to the Home page (http://192.168.12.1/cgi-bin/luci/admin/home).
2. Click on "DHCP Leases", and look for the MAC address of the device you want to find.

Method B: Accessing via Debug IP (10.22.121.111)
1. HalowLink1 devices bind a static IP address 10.22.121.111/31 for retaining debug access.
2. Add a static IP address to your laptop's network connection: 10.22.121.110/31 (i.e. with netmask 255.255.255.254)
3. Connect to the debug IP address 10.22.121.111, ensuring your laptop is only connected to one device.

I am unable to separate the HaLowLink1 devices sufficiently to test mesh self-healing. What can I do?

This is expected, as HaLow's strength is the extended range! You can see the performance of the mesh in two ways:

1. Move Device 1 and 2 far enough apart that they cannot communicate, so you know they are communicating via Device 3.
2. Move Device 1 and 2 far enough apart so their throughput is low, and see that introducing Device 3 improves the throughput.
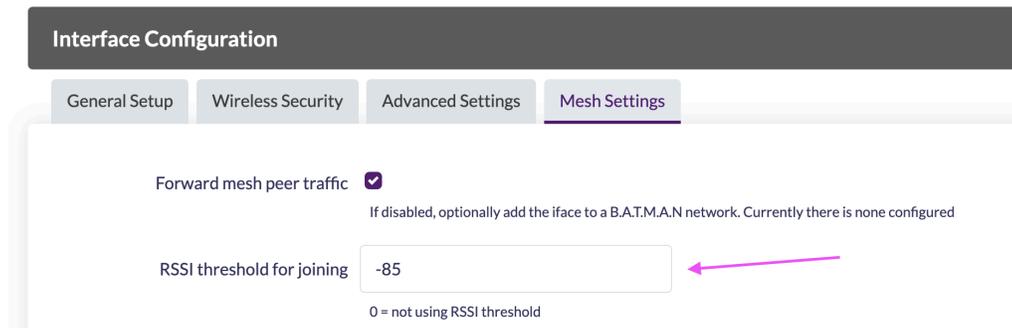
To achieve "move the devices further apart", there are a few options:

- Physically separating the devices - though this is very impractical for a demo;
- Separating the devices in RF isolation chambers with controllable attenuation;
- Configuring the "RSSI threshold for joining" mesh advanced option - which will prevent stations for joining a mesh if they are below the threshold; and
- Configuring the "mesh_max_peer_links" mesh setting - which will restrict the number of peers a node has.

Providing physical or RF separation is out of the scope of this document.

To adjust the Mesh RSSI threshold for joining:

- Go to Network > Wireless settings
  (http://192.168.12.1/cgi-bin/luci/admin/network/wireless)
- Click "Edit" on the "ot-mesh" device
- Update the RSSI threshold for joining under "Mesh Settings"

Interface Configuration

| General Setup | Wireless Security | Advanced Settings | **Mesh Settings** |

Forward mesh peer traffic ☑

If disabled, optionally add the iface to a B.A.T.M.A.N network. Currently there is none configured

RSSI threshold for joining   -85

0 = not using RSSI threshold

This threshold determines the minimum RSSI a node must see to establish a peer connection in the mesh. A value of 0 means "peer with any device". A value of -75 means "peer only with devices that have RSSI greater than -75".

To adjust the `mesh_max_peer_links` setting:

- Log into the device via ssh (e.g. `ssh root@192.168.12.1`)
- Use an editor to update the file `/etc/config/mesh11sd`.
- Update the `mesh_max_peer_links` to the value you desire.
- Save the file and restart the wireless (e.g. `wifi down && wifi up`)

This setting will limit the number of peer links a node establishes. For example, set this to 2 for a number of devices and they will form a chain.

5 Frequently Asked Questions (FAQ)

Why does this application note use 2.4GHz for the uplink to the internet?

Multiple methods exist to configure the network topology under examination. This application note utilizes a smartphone-provided hotspot as it is universally accessible and simplifies network testing. We believe this choice is the simplest for any user to test - even in an office environment - as it does not require plugging Ethernet cables into existing infrastructure.

Can I use the WAN or LAN Ethernet for uplink to the internet?

Yes you can.

- To use the WAN port - you would connect the WAN port to your uplink gateway (on its 'lan' side). You should also ensure the uplink 2.4 GHz client is not connected.
- To use the LAN port - this is more complex, as the 'lan' side of your uplink gateway is probably running a DHCP server already (to hand out DHCP leases in your network). You should:
    - Change Device 1's lan interface to be a DHCP client.
    - Plug the LAN port into the lan side of your uplink gateway.
    - Use the DHCP lease table from your uplink gateway to determine the IP addresses given to Device 1 and Device 2.

Can I connect to the mesh via the LAN port on the HaLowLink (Device 2 / Device 3) instead of via the 2.4 GHz Wi-Fi network?

Yes, if your device has an available Ethernet port this is possible. For example EKH01 platforms do not have an additional 2.4 GHz radio, so using the Ethernet port is required. When you connect via a LAN port on Device 2 or 3 your laptop will receive an IP address from the DHCP server on the network (i.e. likely from Device 1).

What will the throughput and latency be like?

As with all wireless links, the throughput and latency will depend on the quality of the radio link (i.e. noise, distance etc). For 802.11s mesh links another factor is the number of hops needed to route frames. For the 802.11ah throughput performance, please refer to the expected data rate [link] and your device capability.

6 Revision History

Release Number	Release Date	Release Notes
1.0	2025-04-02	Initial release

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Morse Micro is a leading Wi-Fi HaLow fabless semiconductor company based in Sydney, with global offices. As the world's premier Wi-Fi HaLow company, we pioneer next-gen IoT wireless connectivity solutions. Morse Micro is now sampling its Wi-Fi CERTIFIED HaLow MM6108 production silicon: the fastest, smallest, lowest power and longest-range Wi-Fi HaLow chip available in the market.

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