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ADTRAN

Configuration Guide

Mesh Networking in vWLAN

This configuration guide provides an in-depth look at mesh networking in ADTRAN Bluesocket virtual wireless local area network (vWLAN) products. Included in this guide are an overview of mesh networking, mesh networking configuration considerations for vWLAN, and the configuration steps necessary for mesh networking operation in vWLAN.

This guide consists of the following sections:

Introduction to Mesh Networking in vWLAN

Mesh networking in vWLAN allows Bluesocket Access Points (BSAPs) to connect and communicate with each other or with other BSAP networks without the restriction of wired connections. Mesh networking can extend reach for traditional local area networks (LANs) where wired LAN infrastructure is not available, and it can be used to provide a wireless bridge between two or more buildings or locations.

Mesh networking infrastructure is configured in a hierarchical structure, where master devices (mesh portals) act as a parent device to other non-master child devices (mesh points). Mesh portals are BSAPs that forward traffic between a mesh network and a wired LAN, and mesh points are BSAPs that have a wireless backhaul link upstream toward the wired network (and the mesh portal). Each mesh network consists of one mesh portal and multiple mesh points. *Figure 1* demonstrates the relationship of mesh points and the mesh portal within the vWLAN mesh network.

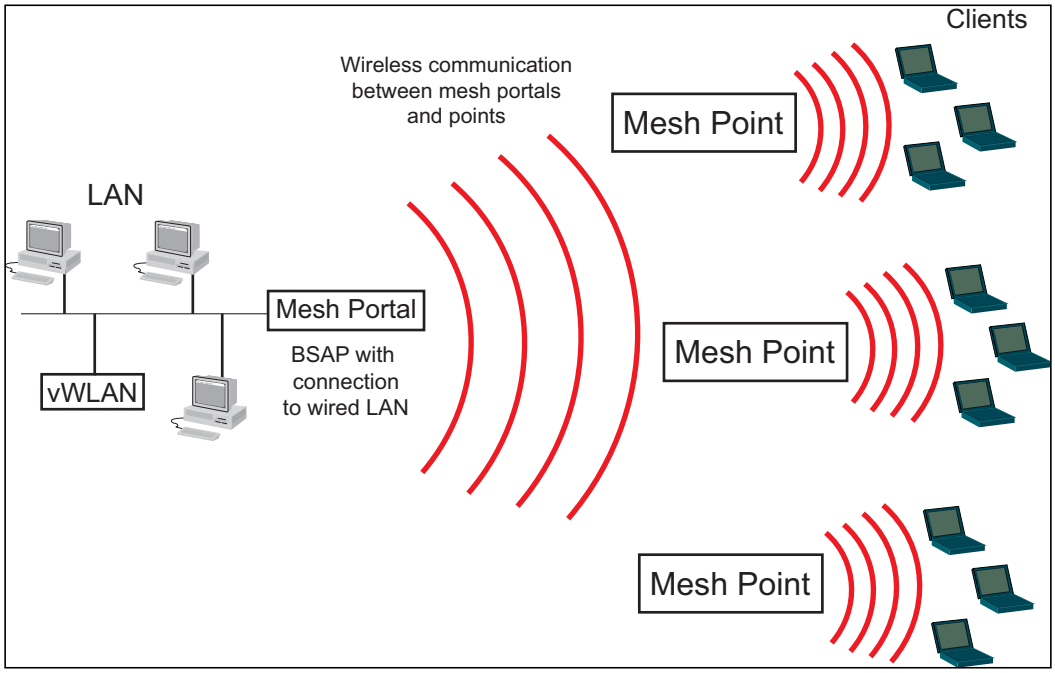


Figure 1. Mesh Points and Mesh Portals in vWLAN Mesh Networking

Typical Mesh Networking Configurations

Mesh networking can be used in a variety of ways to connect multiple sites wirelessly, often producing a cost savings over T1 or fiber connections. Mesh networks are created using multiple-hop connections, point-to-point connections, and point-to-multipoint connections. These network configurations are discussed in the following sections.

Multi-hop Mesh Networks

Multi-hop mesh networks (see *Figure 2 on page 3*) are formed when one mesh portal connects to multiple mesh points in a single line and the portal uses a routing technique to pass information along a wireless path until it reaches its destination. This type of network is used when distance becomes an issue in typical point-to-point or point-to-multipoint configurations. Multi-hop networks can be configured for no more than three hops deep.

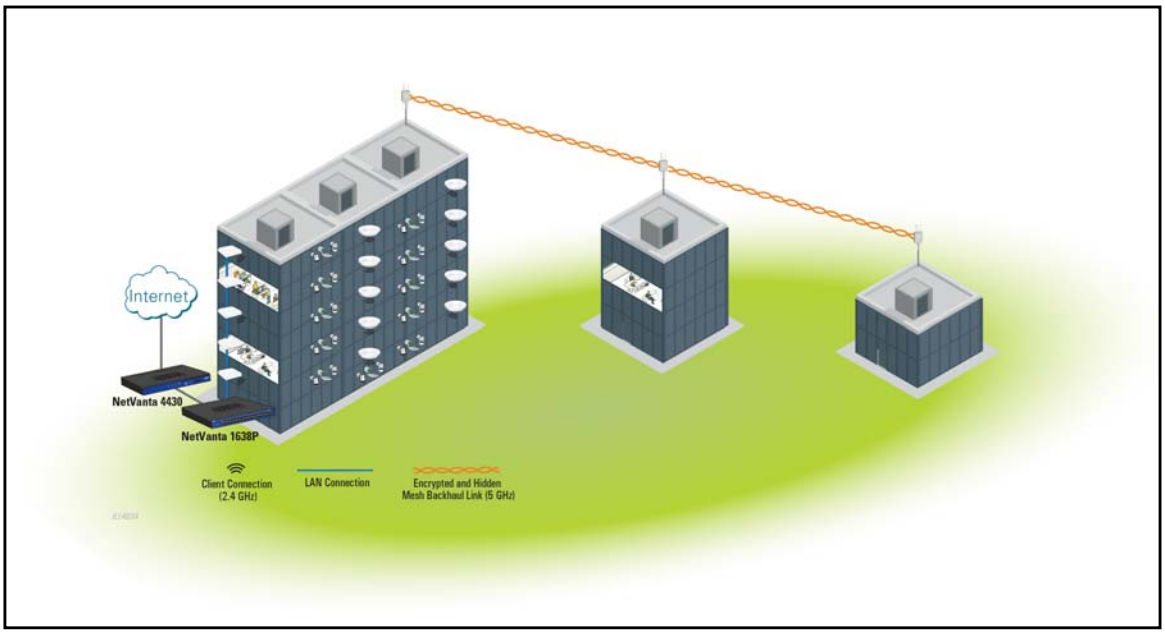


Figure 2. Multi-hop Mesh Network Topology

NOTE

Data throughput is reduced approximately 50 percent with each hop in a multi-hop network design.

Multi-hop mesh networks can be used to provide access where traditional cabling configurations are impractical. For example, a business wants to add wireless access to a pavilion outside of their main company infrastructure. A mesh portal could be mounted on the main building with access to the internal network. The mesh point could be mounted on the pavilion to provide wired or wireless connectivity.

Point-to-Point Mesh Networks

A point-to-point mesh network is formed when only two BSAPs are used to create a bridge link between two wired networks. Point-to-point connections typically use directional antennas, and can provide long-range outdoor links.

Point-to-point mesh networks can be used to connect two campus buildings (Building 1 and Building 2) where only one of them (Building 1) has access to the Internet (See *Figure 3 on page 4*). Instead of installing fiber connections through the parking lot or using microwave connections to extend Internet access to Building 2, achieve point-to-point bridging utilizing ADTRAN's secure, reliable, and affordable mesh networking solution.

With point-to-point bridging you can deploy an outdoor AP on top of Building 1 as a mesh portal (MPP 1) cabled to the network with Internet access, and then deploy a second AP on Building 2 as a mesh point (MP2). The mesh portal in Building 1 might be referred to as the parent and the mesh point in Building 2 might be referred to as the child. MP2 can form a secure over-the-air uplink on the 5 GHz radio to MPP1. By connecting MP2 to an Ethernet switch in Building 2, traffic from Building 2 can be backhauled to Building 1 and ultimately out to the Internet, all while maintaining VLAN tagging across the uplink.

> **NOTE** *Careful planning is required when implementing a point-to-point mesh network. If the point-to-point connection is used for redundancy, it can create unintended consequences (such as if someone enables the BPDU filter). It is imperative that the Fresnel zone and RF line-of-sight calculations are performed prior to installing mesh networks.*

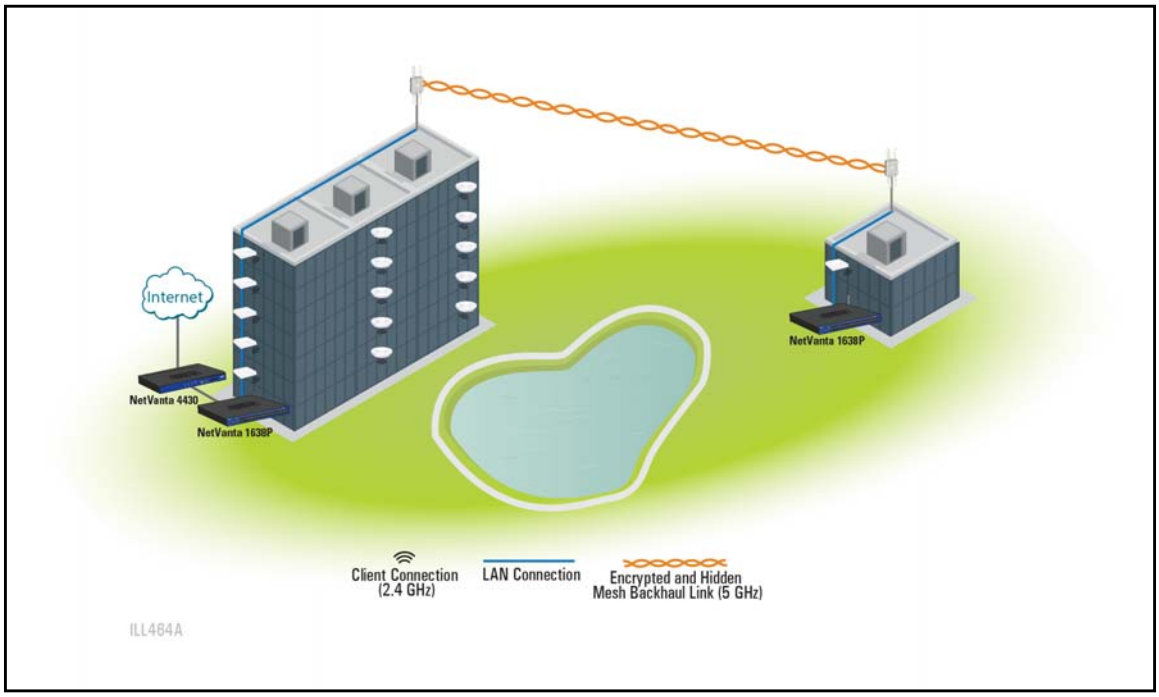


Figure 3. Point-to-Point Mesh Network Topology

Point-to-Multipoint Mesh Networks

Point-to-multipoint mesh networks use one mesh portal to communicate with up to five mesh points. In this type of network, there is always one mesh portal acting as a master, while all other connected mesh points are treated as nodes. A typical point-to-multipoint network has a central mesh portal that connects to other mesh points, forming a hub-and-spoke configuration. *Figure 4 on page 5* illustrates a point-to-multipoint mesh network.

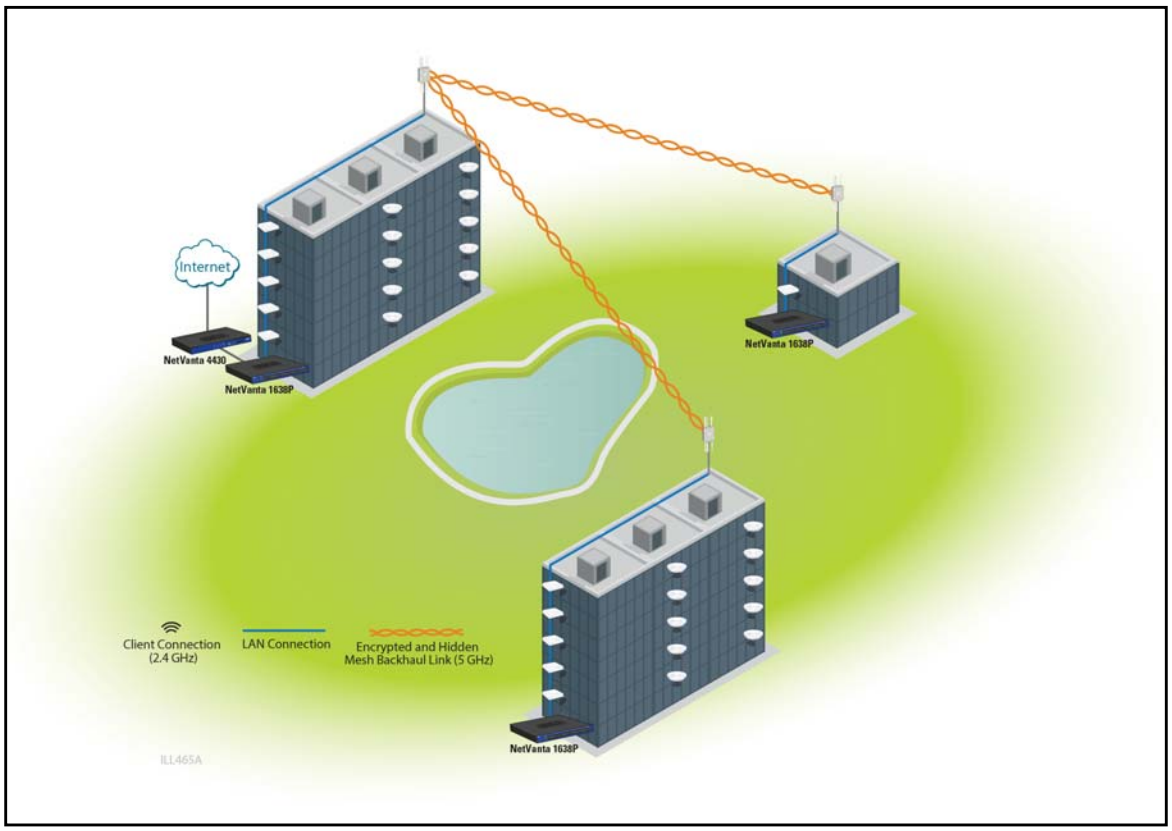


Figure 4. Point-to-Multipoint Mesh Network Topology

Point-to-multipoint configurations allow you to extend point-to-point bridging by adding a third building without Internet access (Building 3) to the scenario described in the previous section. You can deploy an additional outdoor AP as a mesh point (MP3) on the top of Building 3. This configuration creates one parent mesh portal and multiple mesh point children.

NOTE

Even though this wireless link allows access to buildings without cabling, it is still a wireless link that is shared by all users. Careful attention to bandwidth considerations and wireless design should be done to ensure success of the installation.

Mesh Network Deployment Considerations

To configure a well-functioning mesh network, you must consider several items: link budgeting, how to install outdoor antennas, and other mesh-specific deployment considerations such as familiarity with the Fresnel zone, radio frequency (RF) line of sight issues, free-space path loss, and proper antenna configurations. These considerations are discussed briefly in the following sections.

RF Line of Sight

The RF line of sight is the area along the radio link path through which the bulk of the radio signal power travels between two antennas. This area is known as the first Fresnel zone of the radio link. For a radio link

not to be affected by obstacles along its path, no object, including the ground, must intrude within 60 percent of the first Fresnel zone. A clear line of sight ensures reliable wireless links between the antennas. *Figure 5* illustrates the concept of a good RF line of sight.

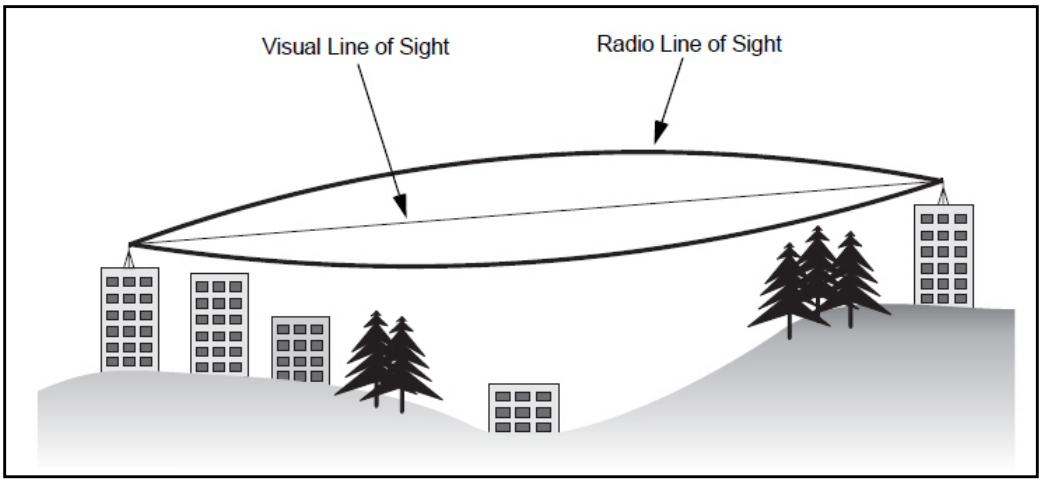


Figure 5. RF Line of Sight

If there are obstacles in the radio path, there may still be a radio link, but the quality and strength of the signal will be affected. Calculating the maximum clearance from objects on a path is important as it directly affects the decision on antenna placement and height. It is especially critical for long-distance links, where the radio signal could be easily lost.

When planning the radio path for mesh networking links, consider these factors:

- Avoid any partial line of sight between the antennas.
- Be cautious of trees or other foliage that may be near the path, or may grow and obstruct the path.
- Be sure there is enough clearance from buildings and that no building construction will eventually block the path.
- Check the topology of the land between the antennas using topographical maps, aerial photos, or satellite image data.
- Avoid a path that may incur temporary blockage due to the movement of cars, trains, or aircraft.

Antenna Height

Antenna height is an important consideration in the deployment of mesh networks, along with antenna strengths and RF line of sight. Usually, a reliable wireless link is best achieved by mounting the antennas at each end high enough for a clear radio line of sight between them. The minimum height required depends on the distance of the link, obstacles that may be in the path, topology of the terrain, and the curvature of the earth (for links over three miles). For long-distance links, a mast or pole may be needed to attain the minimum required height. Use the information in *Table 1 on page 7* to estimate the required minimum clearance for the ground or path obstruction.

Table 1. Antenna Height and Minimum Clearance

Total Link Distance	Max Clearance for 60% of First Fresnel Zone at 5.8 GHz	Approximate Clearance for Earth Curvature	Total Clearance Required at Midpoint of Link
0.24 mile (402 m)	4.5 ft (1.4 m)	0	4.5 ft (1.4 m)
0.5 mile (805 m)	6.4 ft (1.95 m)	0	6.4 ft (1.95 m)
1 mile (1.6 km)	9 ft (2.7 m)	0	9 ft (2.7 m)
2 miles (3.2 km)	12.7 ft (3.9 m)	0	12.7 ft (3.9 m)
3 miles (4.8 km)	15.6 ft (4.8 m)	1.8 ft (0.5 m)	17.4 ft (5.3 m)
4 miles (6.4 km)	18 ft (5.5 m)	3.2 ft (1.0 m)	21.2 ft (6.5 m)
5 miles (8 km)	20 ft (6.1 m)	5 ft (1.5 m)	25 ft (7.6 m)
7 miles (11.3 km)	24 ft (7.3 m)	9.8 ft (3.0 m)	33.8 ft (10.3 m)
9 miles (14.5 km)	27 ft (8.2 m)	16 ft (4.9 m)	43 ft (13.1 m)
12 miles (19.3 km)	31 ft (9.5 m)	29 ft (8.8 m)	60 ft (18.3 m)
15 miles (24.1 km)	35 ft (10.7 m)	45 ft (13.7 m)	80 ft (24.4 m)
17 miles (27.4 km)	37 ft (11.3 m)	58 ft (17.7 m)	95 ft (29 m)

To avoid any obstruction along the path, the height of the object must be added to the minimum clearance required for a clear RF ling of sight. *Figure 6 on page 7* illustrates these principles. In this example, a mesh network is used to connect building A to building B, which is located three miles away. Midway between the two building is a small tree-covered hill. *Table 1 on page 7* shows that for a three mile link, the object clearance required at the midpoint is 17.4 ft. The treetops on the hill are at an elevation of 56 ft, so the antennas at each end of the link need to be at least 73 ft high. Building A is six stories high (66 ft), so a 7.5 ft mast or pole must be constructed on its roof to achieve the required antenna height. Building B is only three stories high (30 ft), but is located at an elevation that is 39 ft higher than building A. To mount an antenna at the required height on building B, a mast or pole of only 4.3 ft is needed.

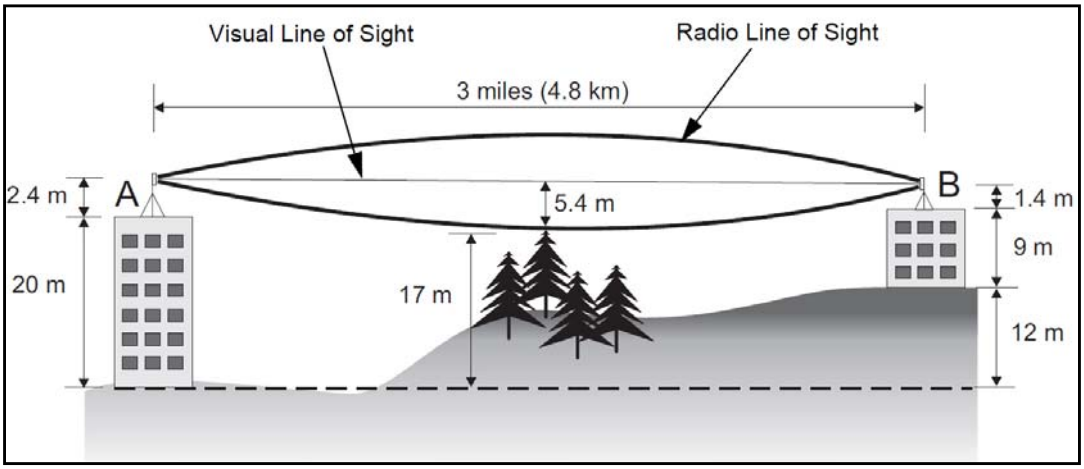


Figure 6. Configuring Antenna Height and RF Line of Sight

Antenna Position and Orientation

Once the required antenna height has been determined, other factors affecting the precise position of the mesh networking antennas must be considered:

- Directional antennas are preferred, when possible, over the default omni-directional antennas for mesh links. This is especially true for point-to-point applications. The performance of a link is generally directly affected by the antenna type.
- Be sure there are no other radio antennas within 6 ft (2 m) of the BSAP.
- Place the BSAP away from power and telephone lines.
- Avoid placing the BSAP too close to any metallic, reflective surfaces, such as roof-installed air conditioning equipment, tinted windows, wire fences, or water pipes.
- The BSAP antennas at both ends of the link must be positioned with the same polarization direction, either horizontal or vertical.

Antennas and Data Rates

When you are planning to deploy a mesh network, be sure to take into account the maximum distance and data rates available for the various antenna options. The fresnel zone should always be calculated and the bandwidth requirements on the other side of the meshed links need to be calculated to make sure they fit well within the bandwidth that is provided by the length (approximately 50% of the data rate of the link).

vWLAN BSAP Mesh Network Functionality

A mesh network is formed in vWLAN when a BSAP is connected to the network as a mesh portal. When the mesh portal becomes active, it receives it's vWLAN configuration on its wired interface, and subsequently uses a mesh service set identifier (SSID) for communication. Once the mesh portal is configured and available, other BSAPs configured as mesh points can establish uplink connections to the mesh portal, establish a connection to vWLAN through the mesh portal, and begin using the mesh SSID. Multiple mesh points can be configured as part of the mesh network, and can be configured through a connection to the mesh portal or to previously configured mesh points.

When configured as a mesh portal, a BSAP requires no special configuration changes since its connection to vWLAN is over the wired interface. When configured as a mesh point, a BSAP attempts to connect to its configured uplink parent BSAP. A mesh point will continue to scan for its uplink parent until it is successful or until new provisioning information is received. While a mesh point is in the process of establishing its connection with vWLAN, its wired port is in the disabled state. This means that any traffic received on the wired port that is not destined for the BSAP's fallback port is discarded. Once the mesh point establishes its connection with vWLAN over the mesh network, it checks the wired port mode derived as part of its configuration. If the wired port mode is enabled, any traffic received on the wired interface is backhauled through the mesh network to the mesh portal. If the wired port mode is disabled, all traffic received on the wired interface continues to be discarded unless directly destined for the BSAP's fallback port. BSAPs used in the mesh network reserve the 5 GHz radio exclusively for mesh connections and control channel operations; wireless clients cannot connect to the mesh-only radio. Client access is only available via the 2.4 GHz radio.

Once the mesh portal and all mesh points have been successfully associated with each other, and have received and acted upon their configuration from vWLAN, the mesh network is considered active. The vWLAN can then control all BSAPs in the mesh network. Once the mesh network is active, wireless clients can connect to configured SSIDs on BSAP radios not configured for mesh networking.

Mesh Network Security and SSIDs

Each mesh portal and mesh point uses a specific SSID for secure, over-the-air, mesh backhaul communications. This SSID is automatically configured as a hidden or non-broadcast SSID and automatically secured with WPA2/AES encryption. There is no need to create mesh SSIDs or configure complex encryption settings.

Mesh Reformation

Once the mesh network is active, extended interruptions to any uplink in the network, changes to a mesh point's configured uplink, or changes to core mesh configuration settings, cause a mesh point to revert to passively listening to beacons on all channels on both radios. Scanning both radios for the new mesh network requires the mesh point to drop its SSIDs and client associations on any radios not configured for mesh networking. The mesh network is reformed once an uplink mesh point or mesh portal is discovered.

Hardware and Software Requirements and Limitations

Mesh networking is available on BSAPs as outlined in the *vWLAN Product Feature Matrix*, available online at https://supportforums.adtran.com. BSAP 1800 Series products do not support the mesh networking feature. Third-party AP mesh implementations are not compatible with vWLAN mesh networking and third-party AP access (Unified User Access) is not supported on APs in the mesh network.

Mesh networking in vWLAN supports a maximum number of three hops and five nodes per mesh portal. After the first hop in the mesh network, traffic throughput is roughly halved. It is recommended to use similar APs when building a mesh network (for example, 193x with 193x BSAPs or 192x with 192x BSAPs).

When a mesh point is operating with LAN extensions, users on the wired port are not authenticated or managed by the vWLAN system.

The BSAP operating channel is determined by the mesh portal based on Dynamic RF channel scanning or a static configuration. The channel can be reconfigured at any time through a static configuration change performed by an administrator.

Spanning tree should be enabled in the mesh network to prevent loops.

vWLAN AP traffic capturing is not permitted on BSAPs in the mesh network.

AP firmware updates can be performed as usual on APs operating in the mesh network. The mesh configuration must be maintained through the reboot after a new version of AP firmware is activated.

During firmware upgrades of mesh APs, don't apply domain tasks until all APs have completed the download and are in the pending state.

Mesh Networking Data Layer Traffic

All traffic from a BSAP using the mesh SSID or mesh radio is switched through the network without changing any of the existing VLAN tags or tunnel endpoints.

A wired client on a mesh point LAN extension has the VLAN tag applied before reaching the BSAP (based on port or network configuration). The traffic is directly switched through the AP to its uplink.

Dynamic radio frequency (RF) scanning on a mesh portal radio is configured for **Set Once and Hold** when the radio is configured for mesh networking. This means that after the initial configuration of the mesh portal channel by the channel scanning process, the mesh portal channel does not automatically change, but rather an RF recommendation is sent to the system administrator. The administrator can update the mesh portal channel by editing the BSAP configuration.

In addition, radio calibration is not performed on a radio in mesh network mode.

Mesh Networking and Dynamic Frequency Selection (DFS)

The DFS feature was introduced in vWLAN firmware release 2.6, with native support on the BSAP 1925, 1935, and 1940 Series. The BSAP 1920 and 1930 Series products will support DFS if they are using hardware revision K. As of firmware release 3.1, DFS is supported on the BSAP 2020 in Europe. Any BSAP unit that supports DFS is shipped with a “DFS Capable” sticker on the box and on the AP.

When using mesh networking with DFS enabled, it is important to note that each part of the mesh network must check the channel for radar before it can support downstream mesh points. For a single hop mesh network, this means that it will take 60 seconds before the mesh point transmits traffic after the mesh portal has connected. For a two hop mesh network, this delay grows to 120 seconds.

If a mesh portal detects radar on its current channel, it must vacate the channel. This will cause any associated mesh points to disconnect. If a mesh point detects radar on its current channel, that portion of the mesh network and any downstream mesh points are disconnected. At this point, the vWLAN system will move the mesh portal to a new channel.

If a mesh uplink (mesh portal or mesh point servicing downstream mesh points) detects radar on its current channel, it stops data services to connected clients within 200 ms. It then moves to a new channel within 10 seconds of the radar detection event. During this 10 second time period, the device can transmit data as many times as necessary for an aggregated time period of 60 ms. Once the device moves to a new channel, it must monitor the new channel for radar signals for the next 60 seconds (if the channel is a DFS channel). If it detects radar on the new channel, the process begins again.

If a mesh device downstream detects radar on its current channel, it communicates the radar detection event to the mesh device upstream to which it is connected. When the upstream portal device receives the radar detection event from the downstream device, it reacts as if it detected the radar and proceeds to change channels.

Only a single channel is configured for a mesh portal. If the mesh portal detects radar interference, it will move channels. The channel block list applies only to the mesh portal and not the mesh point. If the mesh portal and mesh points are using different AP templates, only the mesh portal template block list applies.

Mesh portals change channels in only two cases: the administrator changes the mesh portal channel, or radar is detected. Mesh points change channels in only two cases as well: if the upstream mesh device changes channels or if the upstream devices changes channels because radar is detected.

For more information about DFS and its configuration in vWLAN, refer to the configuration guide *DFS in vWLAN*, available online at https://supportforums.adtran.com.

Configuring BSAPs for Mesh Networking

By default, mesh networking is not configured on a BSAP. In order to form a mesh network, the BSAPs must be configured with the information needed to connect to the mesh network. This information is removed upon a factory default of the BSAP or when an AP template without mesh functionality

configured is applied to the BSAP. The following parameters must be configured on the BSAP for mesh networking to function:

1. **Mesh Mode** must be set to **portal** or **point**. By default, this setting is **Off**.
2. **Mesh Country Code** must be specified. This a two-to-three digit code chosen from the list.
3. **MAC Address of Uplink AP** must be set to the mesh uplink AP Ethernet MAC address. By default, this value is all zeros.
4. **MAC address of the Override MAC** can be specified. This setting is optional. By default, this value is all zeros.

Mesh Networking Configuration Order

Most operations of a mesh networking BSAP are configured in the same manner as other BSAPs in the vWLAN system.

Typically, the mesh networking implementation follows this order:

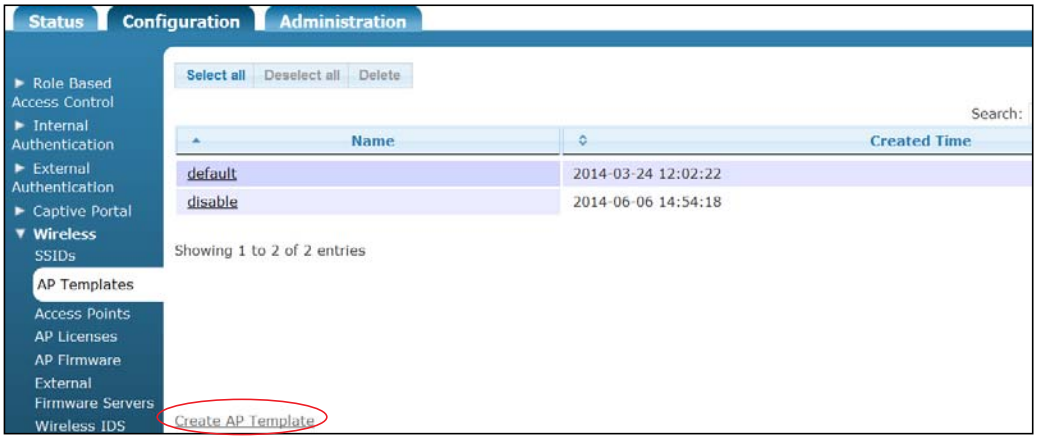
1. Provide power to the BSAP(s).
2. The BSAP(s) discover the vWLAN.
3. The BSAP(s) are licensed, placed into a domain, and upgraded (if needed).
4. A mesh networking AP template is configured on the vWLAN. Refer to *Creating a Mesh Networking AP Template on page 12*.
5. The mesh networking template is applied to the BSAP(s) used for mesh networking, specifying whether the AP is a mesh portal or a mesh point.
6. The Ethernet bridge mode for the mesh point BSAP(s) is configured. Refer to *Configuring the Mesh Settings Per AP on page 13*.
7. The channel for the mesh portal is configured (optional). Refer to *Configuring the Mesh Settings Per AP on page 13*.
8. The uplink for one or more mesh points is configured. Refer to *Configuring the Mesh Settings Per AP on page 13*.
9. The configuration is pushed to the appropriate BSAPs.
10. The BSAPs reboot and the mesh network becomes active.
11. The mesh networking BSAPs are moved into their proper physical locations.
12. Dynamic AP discovery and channel scanning is performed for wireless client connections and typical vWLAN operations.
13. The BSAPs can be visualized on the AP heat map in the vWLAN.

BSAP Mesh Network Configuration Using the GUI

The majority of the mesh configuration necessary for the BSAP can be completed using the vWLAN graphical user interface (GUI). The two basic steps for GUI configuration of mesh networking are to create an AP template for mesh networking, and to configure the specific mesh settings on a per-AP basis. To complete the GUI configuration for mesh networking, refer to the sections below.

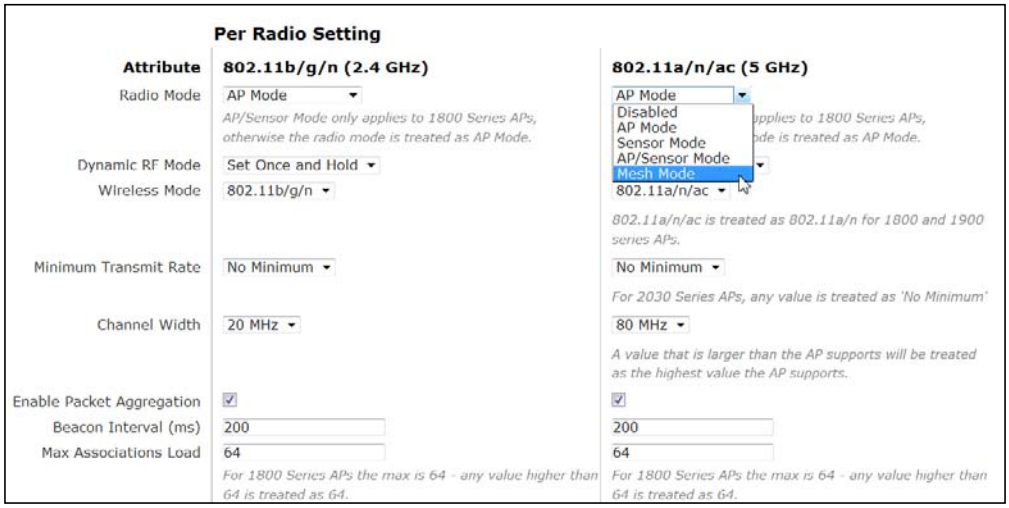
Creating a Mesh Networking AP Template

1. Once the BSAP has been discovered by vWLAN, connect to the vWLAN GUI and navigate to the **Configuration** tab, **Wireless** > **AP Templates**. Select **Create AP Template** from the bottom of the menu. Here you will begin configuring the AP template for mesh networking. In this configuration, specify the radio, radio channel, and additional mesh networking attributes for the mesh portals and mesh points.



> *When an AP is moved into a domain, it is automatically assigned the default template. Setting the 802.11a radio to mesh mode on the default template results in all new APs being provisioned for mesh networking, which may not be the desired behavior.*

2. In the template, specify the name of the AP template, the Secure Shell (SSH) password, login form, domain name system (DNS) servers, and appropriate network settings as you normally would for an AP template. Then, specify the AP is in mesh network mode by selecting **Mesh Mode** from the 802.11a/n/ac **Radio Mode** drop-down menu. Mesh networking is only available on the 802.11a/n/ac radio.

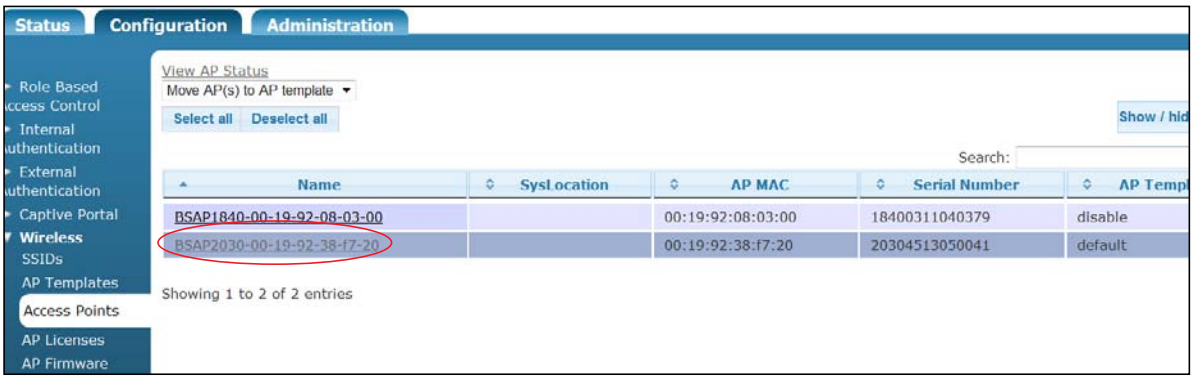


3. Once the 802.11a/n/ac radio is set for **Mesh Mode**, the **Dynamic RF Mode** setting is set to **Set Once and Hold** when the radio is configured for mesh networking. This means that after the initial configuration of the mesh portal channel by the channel scanning process, the mesh portal channel does not automatically change, but rather an RF recommendation is sent to the system administrator. The administrator can update the mesh portal channel by editing the BSAP configuration. In addition, radio calibration is not performed on a radio in mesh network mode. No SSIDs or access groups can be specified for a radio in mesh mode. Otherwise, configure all radio settings as you would for any other AP template. When the configuration parameters are complete, select **Create AP Template** from the bottom of the menu. The newly created template is now displayed in the **Configuration** tab, **Wireless** > **AP Templates** menu and can be applied to APs as they are added to the network.

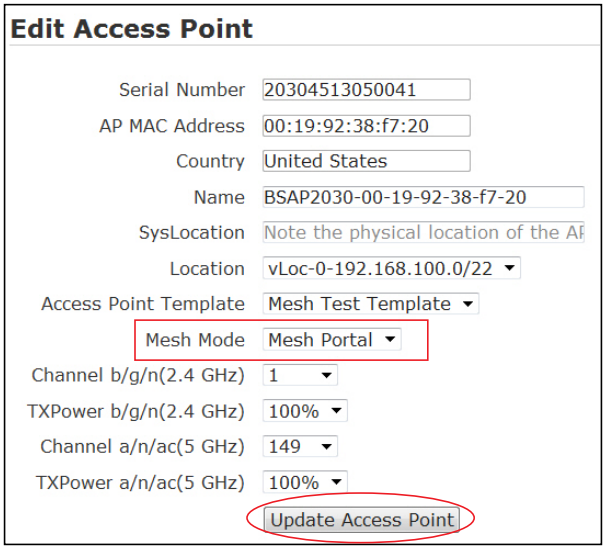
> NOTE *All traffic from a BSAP using the mesh SSID or mesh radio is switched through the network without changing any of the existing VLAN tags or tunnel endpoints.*

Configuring the Mesh Settings Per AP

1. Once an AP template with mesh networking enabled is applied to an AP, you can make further configurations to the specific AP. These configurations include the AP mesh mode, the uplink AP, and the Ethernet bridge setting. To access these configurations, navigate to the **Configuration** tab, **Wireless** > **Access Points**. Select the AP to update from the list.



2. In the **Edit Access Point** menu, ensure that the AP is configured to use an AP template with mesh mode enabled, and select whether the AP is a mesh portal or mesh point from the **Mesh Mode** drop-down menu. A mesh portal always has a connection to the vWLAN over the wired port, and a mesh point always has a wireless connection to the vWLAN. If you are configuring a mesh portal, select **Update Access Point** once the mesh mode is specified.

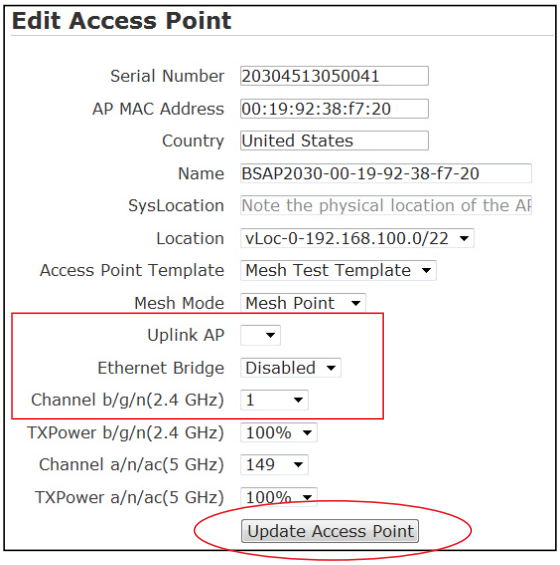


If you are configuring a mesh point, you must also specify the uplink AP (using the **Uplink AP** drop-down menu) and the Ethernet bridge setting (**Enabled** or **Disabled**). The uplink AP is the AP to which this mesh point should connect. Only BSAPs that have a matching mesh network configuration are available for selection as an uplink AP. You cannot save the AP's configuration until an uplink AP has been selected for the mesh point.

The Ethernet bridge setting allows a LAN extension to exist on the mesh point by specifying whether the bridging of the AP's wired interface is enabled or disabled. You cannot configure this setting for non-mesh APs or for mesh portal APs.

> NOTE *Upstream wired traffic an be tagged or untagged before reaching the BSAP (based on port or network configuration).*

Make your selections from the appropriate drop-down menus and select **Update Access Point**.



3. Apply the configuration or reboot the AP for the updated mesh network configuration settings to take effect.

> *When changes are made to mesh portal settings, all attached mesh points change accordingly. When changes are made to mesh point settings, they are applied to a single mesh point. The domain of a mesh point cannot be changed in the vWLAN, rather, it must be changed on the mesh portal to which the points are connected.*

Configuring BSAP Mesh Settings Using the CLI

You can configure certain elements of the vWLAN mesh network using the serial console on the BSAP. Under normal circumstances, however, mesh networking configuring should be completed using the GUI. Use the serial console configuration as an alternative, such as when at a remote site. Available mesh network configurations include the BSAP's mesh mode, country code, and the MAC address of the uplink BSAP.

> *Normally there is no need to access the AP serial console menu. The AP automatically discovers and communicates with the vWLAN. It is recommended to use the serial console menu to configure the AP only in a lab or test environment or where a predefined static IP address for the AP is desired. The only exception is in a situation where changing DHCP or DNS is not possible.*

Accessing the BSAP Serial Console Menu

You can access the AP's command line interface (CLI) using either a VT100 terminal emulation program or an Ethernet SSH client. To access the AP serial console menu using either method, follow these steps:

1. Connect a DB-9 to RJ-45 serial cable (rollover cable) to the AP's **CONSOLE** port, and connect the other end of the serial cable to the PC.

> *The console port is not available on BSAP 1920 Series. Use the fallback IP address (**192.168.190.1**) instead. The console port is also not available on the BSAP 1940 Series. For configuration of these BSAPs, use SSH as described below.*

2. Run a VT100 terminal emulation program with the following settings: 115,200 data rate, 8 data bits, no parity bits, 1 stop bit, and no flow control. Select **<Enter>** to access the AP's CLI.

3. At the prompt, enter the user name **adm1n** and the password **blue1socket**.

> *This is the default user name and password. If the AP has been configured with an AP template that has a different password, use that user name and password.*

OR

1. Configure an SSH client (for example, Putty) by ensuring that port **2335** is enabled.

2. Use the SSH client to connect to the AP using the AP's mesh networking fallback IP address (**192.168.190.1**).
3. Log into the AP's CLI by entering the user name **adm1n** and the password **blue1socket** at the prompt.

> *This is the default user name and password. If the AP has been configured with an AP template that has a different password, use that user name and password.*

If the AP does not have any configuration from the vWLAN, connect to the AP's CLI following these steps:

1. On the computer you are using to connect to the **Ethernet** port on the vWLAN appliance, create a static IP address on the same subnet as the AP. For example, create a static IP address of **192.168.190.2**.
2. Directly connect your computer to the **Ethernet** port. The **Ethernet** port is a standard Gigabit Ethernet port with a default IP address of **192.168.190.1**. Verify that there is IP connectivity by pinging the AP.
3. Configure an SSH client (for example, Putty) by ensuring that port **2335** is enabled.
4. Log into the AP's CLI by entering the user name **adm1n** and the password **blue1socket** at the prompt.

> *This is the default user name and password. If the AP has been configured with an AP template that has a different password, use that user name and password.*

Mesh Networking Configuration Commands

The BSAP CLI provides methods for configuring the mesh mode, country code, and uplink BSAP MAC address for the AP. The mesh radio, clone MAC address, or wired port mode cannot be configured through the AP's serial console. These items must be configured using the vWLAN GUI. Once any changes have been made using the CLI, they must be saved to flash memory and the AP must be rebooted for them to take effect.

> *The CLI configuration will overwrite the static values of the BSAP so it is recommended to configure the BSAP in the GUI before attempting to bring up a statically configured mesh AP.*

To access the mesh network configuration, follow these steps:

1. From the CLI's **Main Menu** select **Mesh Configuration**:

```
(Main Menu)
1) Network Configuration
2) Save/Apply configuration
3) Restore Defaults
4) Show Version Information
```



```
5) Reboot AP
6) Utilities
7) Stand-alone Wireless Configuration
8) Stand-alone Security Configuration
9) Restart Radio
b) Mesh Configuration

Main -> b
```

2. From the **Mesh Configuration** menu, select the option you want to configure. To specify the country code, select **Set Country Code** (option 1) from the menu. At the prompt, enter the correct country code from the list and select **Enter**.

```
(Mesh Configuration)
1) Set Country code

Mesh Cfg -> 1

(Mesh Configuration)
36 Australia
40 Austria
56 Belgium
100 Bulgaria
124 Canada
-MORE-

Enter Country code (United States=840) -> 840
```

3. To specify the BSAP's mesh mode, select **Set Mesh Mode** (option 2) from the **Mesh Configuration** menu and specify whether the AP has mesh disabled (**0**), is a mesh portal (**1**), or a mesh point (**2**).

```
Mesh Cfg ->2

(Mesh Configuration)
0. Disabled
1. Mesh Portal
2. Mesh Point

Enter Mesh Mode (Mesh Point) ->2
```

4. To configure the uplink MAC address for the BSAP, select **Set Mesh Uplink MAC address** (option 3) from the **Mesh Configuration** menu. Enter the Ethernet MAC address in hexadecimal format at the prompt.

```
Mesh Cfg ->3

(Mesh Configuration)
Current Uplink MAC address: 00:19:92:31:14:80
Enter MAC address of uplink AP in hexadecimal format as found on shipping container or the label on
bottom.
A MAC address is a 6 octet address that uniquely identifies any wireless device.
Please enter the MAC address
Usage: <HH:HH:HH:HH:HH:HH> or <HH HH HH HH HH HH> or <HHHHHHHHHHHH> (H is
```


hexadecimal digit)
Uplink MAC address ->**00:19:92:03:12:b0**

5. To view the BSAP's current configuration, select **Mesh Configuration Summary** (option 4) from the **Mesh Configuration** menu.

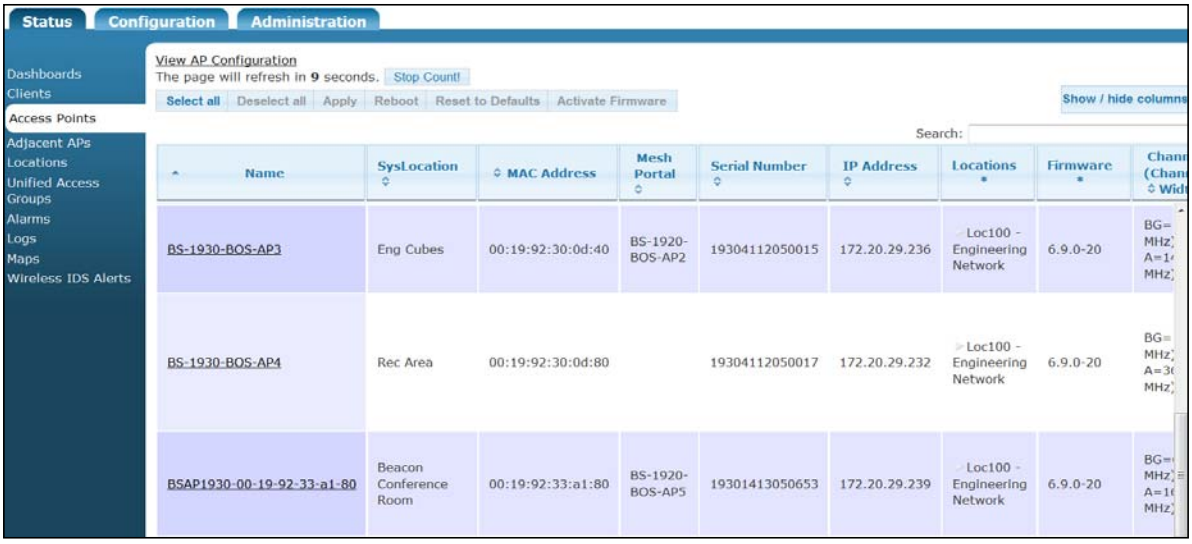
   Mesh Cfg ->**4**

   (Mesh Configuration)
   Mesh Country Code United States
   Mesh Mode: Mesh Point
   Uplink MAC address: 00:19:92:31:14:80
   Wired Port Bridging: Enabled
   Mesh Channel: 36

6. Select **Save/Apply Configuration** from the **Main Menu** and then reboot the AP for any configuration changes to be applied.

Viewing Mesh Network Configurations

Mesh configurations can be viewed using the vWLAN GUI by either viewing the AP's status or a related AP map. To view the AP's configuration, navigate to the **Status** tab and select **Access Points**. Included in the AP information is the associated mesh portal for each AP.



To view the mesh topology on the AP map, navigate to the **Status** tab and select **Maps**. Any previously created maps are listed in this menu. Each AP in the mesh network is represented on a map and has a link connecting it to its uplink address along with an arrow indicating the direction of traffic flow. To create a new AP map, follow the steps outlined in the *vWLAN Administrator's Guide*, available online at http://supportforums.adtran.com.