OMNIACCESS STELLAR BRIDGING/MULTI-POINT MESHING GUIDELINES

Alcatel-Lucent Enterprise OmniAccess® Stellar WLAN AWOS 4.0.4
Alcatel-Lucent Enterprise OmniVista® Cirrus 4.6.2

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AP1322, AP1301 release 4.0.4
OmniVista® Cirrus version 4.6.2

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1. Introduction & Objectives

OmniAccess Stellar is an advanced wireless meshing solution for the enterprise with WLAN mesh technology that supports the latest Wi-Fi standards for mesh links and remote WLAN clients, and comes with an easy configuration that allows extensive, secure, scalable and high-speed coverage for areas that are difficult to connect to the wired LAN.

Stellar Wi-Fi 6 access points offer versatility for the Bridging/Multi-meshing solution. They are designed for demanding environments such as urban, terrains etc. and more specific deployments such as factories, warehouses. They offer many options at remote sites such as additional downlink ports and local PoE for remote equipment. Stellar mesh with Wi-Fi 6 access points enables the provision of mobility at a controlled cost for indoor and outdoor coverages, outdoor Wi-Fi 6 access points can support different installations configurations with different antennas and accessories.

A Stellar mesh cluster can be managed in both Wi-Fi Enterprise and Wi-Fi Express modes. Now with Wi-Fi Enterprise Mode with Omnivista, it is simply a matter of identifying Stellar access points to be included in a meshing configuration to form mesh group from group of APs already managed via Omnivista. The Enterprise mode with Omnivista allows you to manage the group of APs for meshing, manage the RF for the group, manage the transport of various VLANs to the remote sites, manage SSIDs broadcasted and QoS to the remote clients, as well as the management of the different remote ports available on APs.

This guide is intended to help Network engineers, Presales and Sales engineers in the design of Stellar solutions incorporating Bridging/Meshing topologies and in implementing and maintaining meshing network in their enterprise environment using Omnivista 2500.

2. Architecting Bridging/Multi-Point Meshing

OmniAccess Stellar is a Multi-Point mesh architecture in high-availability mode.

The Stellar mesh access points form a cluster of routers but with no cabling between the different access points and form Point-to-Point mesh links that do not need to be routed to a LAN port. Each mesh access point passes data from one access point to another, transferring it according to the Wi-Fi mesh link defined in each access point. The mesh infrastructure thus defined is fixed.

OmniAccess Stellar Access points can have 2 roles in a cluster, a **mesh role** that defines the access point as a mesh node in the cluster and a **root role** that defines the access point as a gateway to the LAN.

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All data traffic of a Stellar mesh infrastructure is forwarded from/to the gateway (access point with root role) connected on the LAN. Stellar mesh supports the duplication of the root role, if two access points are configured root in the same AP group, the mesh access points will connect to the root access point that has the best RSSI for the mesh link.
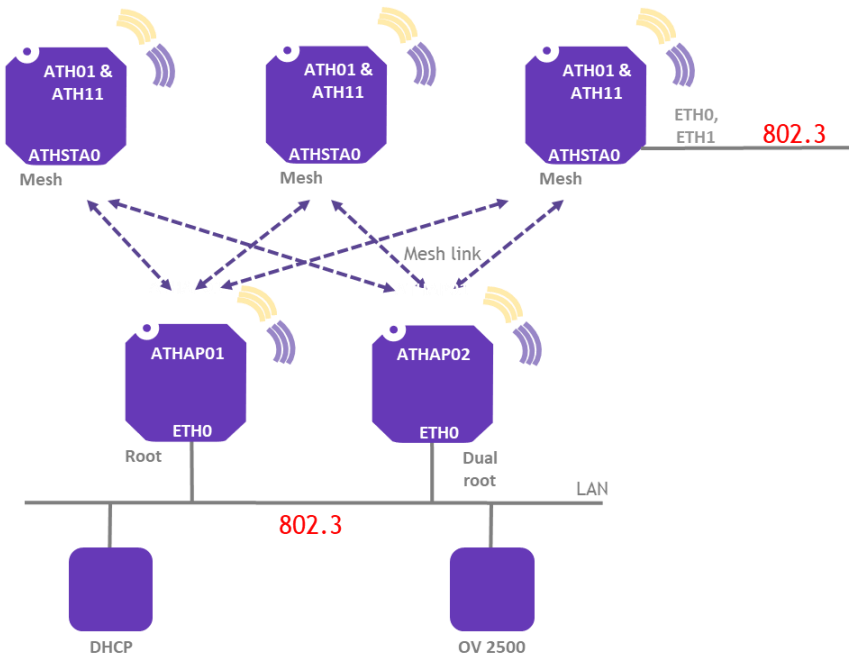

Figure 1: Stellar Bridging/Multi-Point Meshing

This architecture allows two configurations:

- **The distribution of corporate VLANs over a mesh link**. The Bridge configuration is the typical use case of a Point-to-Point mesh configuration and certainly the most used configuration in Enterprise that enables to extend the corporate LAN to some remote sites or buildings. The Bridge delivers only one mesh link and only one mesh access point (Bridge configuration) is attached to the remote site. There is no broadcast of SSID to deliver WLAN services to remote Wi-Fi clients and all corporate LAN is bridged at the remote site.

- **The configuration of a Multi-Point wireless** for areas where cabling is not possible. Typical Multi-Point installations are outdoor industrial sites, events sites, terrains etc. but also indoor configurations like WLAN mesh installations in factories, storage buildings, warehouses or even at home.

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The bandwidth of a mesh link is shared between mesh backhaul and wireless client traffic. On dual and tri-radio 2.4GHz/5GHz Stellar Wi-Fi 6 access points the mesh backhaul can be configured on the 5GHz band or the 2.4GHz band and the WLAN services can be delivered on both 2.4GHz/5GHz radios.

In the case of Multi-Point meshing, each mesh access points communicates with the root gateway and with WLAN clients using the same channel and radio and therefore the wireless throughput is divided by 2 at each mesh node for the data traffic that must be retransmitted to reach the wired LAN.

The distances between Stellar access points of a mesh cluster play a crucial role in the performance of the mesh link, especially for the bandwidth available for such type of link which is shared. There is always a trade-off between distance and link performance, and this point of architecture is developed more specifically further for outdoor configurations where the impact of distance is important (see use cases outdoors)

2.1 Auto-Mesh

To help with configurations from scratch, Stellar access points also support an Auto-Mesh feature where the administrator only needs to activate a Stellar access point connected to the LAN/WAN in root mode. Any AP from scratch booting without a connection to the LAN and in the neighbourhood of this root AP will attempt to connect as a Mesh Access Point using the default mesh link.

2.2 Advanced Wireless Distribution System

OmniAccess Stellar access points operate in advanced Wireless Distribution System (WDS) mode. Each access point in the mesh cluster operates as a station in WDS mode, this allows for transparent Ethernet bridging across APs, a common broadcast domain for all devices connected across wireless connections and the transport of different corporate VLANs.

When WDS is used, the access points switch to **4-MAC addresses** format available in 802.11 instead of the 3 addresses used in a normal client-access point traffic. The LAN device sends a packet to the bridge device and the 802.3 frame is relayed through the client WDS AP.
The WDS AP redirects the frame to the bridged device using the second 802.11 MAC source. The equipment responds using 802.3 MAC source as destination. The WDS AP relays the frame to the destination using the second 802.11 MAC destination. The connection between the two devices is established at 802.3 level.

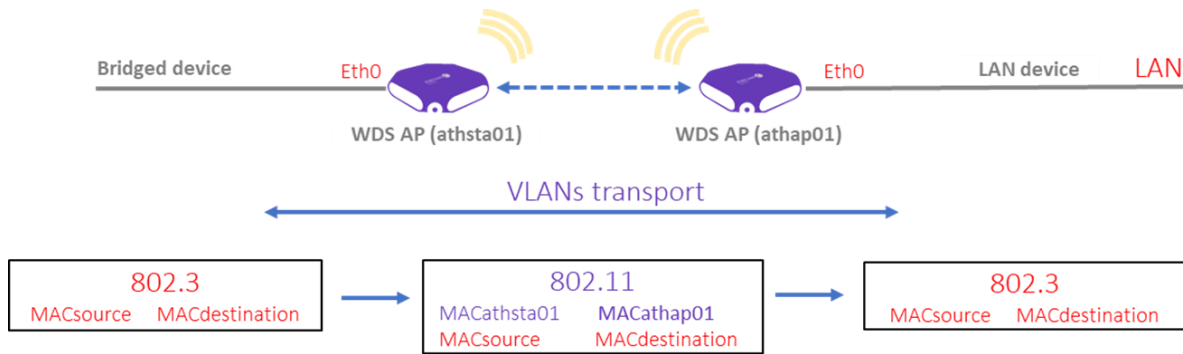The WDS mode is supported for Bridge and Multi-Point mesh configurations.

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Figure 2: Advanced Wireless Distribution System

The management of complementary ethernet ports of mesh access points is supported in Enterprise mode, it is possible to transport different corporate VLANs, tagged or untagged, and to forward them to different defined ports on the AP that will serve as downlink ports for the wired remote client traffic.
Downlink port functionality managed on Omnivista 2500 will be supported with advantage on Stellar access points that have an additional Gigabit Ethernet port such as AP1361/1362/1361D outdoor access points.

ENET1 port of AP1361/1362/1361D additionally handles the POE PSE output to provide 802.3af/at POE output for remote connected equipment at mesh access point.

3. Use cases

3.1 Outdoor bridging

The wireless bridge is the most requested use case in Enterprise, it connects two distant buildings and extends the whole enterprise LAN where it is not possible by cabling. This is typically the case when crossing a public access like a street or avenue. It is a Point-to-Point configuration and typically an external installation.

There is no broadcasting of WLAN services to remote Wi-Fi clients in Bridge mode. Each access point is managed in Bridge mode and connects its radio to the ethernet port ENET0 of the AP. The Bridge extends the LAN and distributes the corporate VLANs on the different ports of the bridge access point, by default on Ethernet port ENET0 but also on the PSE ethernet port ENET1 to power some PoE equipment, typically like an IP camera, this without having to use an additional PoE injector.

In Wi-Fi Enterprise mode, Access Role Profiles (ARP) are generally already assigned for each VLAN, which allows you to define a role for each VLAN with the appropriate ACLs and QoS enforcements or define a role on a particular port on the bridge access point.

The radio topology is typically Line of Sight (LoS) and requires a careful installation of antennas and access points. The bridge is usually installed on the roof of a building to meet the installation and height requirements for this type of configuration.
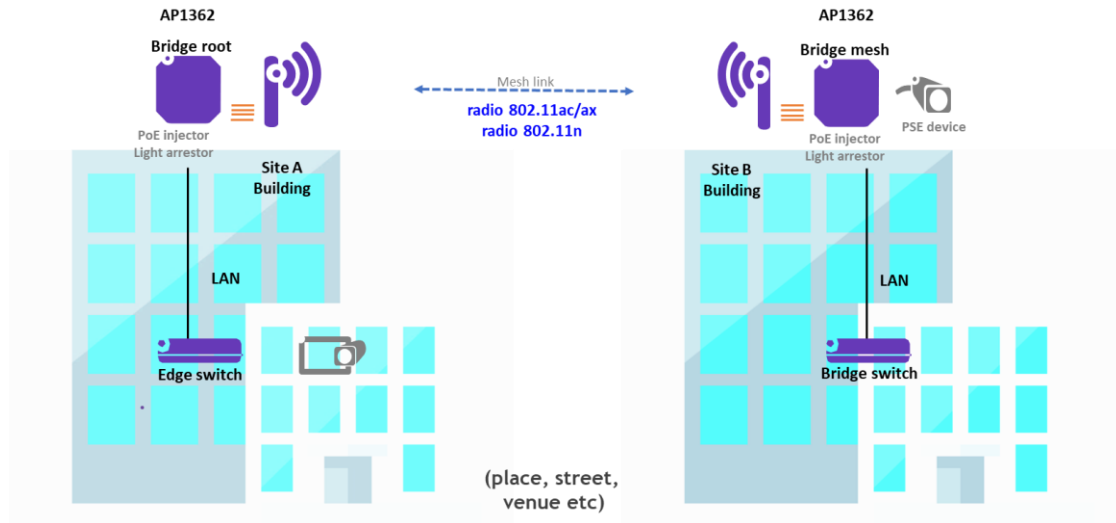

Figure 3: Outdoor Bridging

3.1.1   Prerequisites

- 1 access point as bridge
- The Bridge root can be dual
- It is not recommended to configure multiple Bridge APs within a same Bridge, if there is two Bridge AP in the setup, the AP downlink will connect to the bridge AP with best RSSI.
- 5GHz band is the preferred band to exploit 802.11ac technologies (MIMO, MU-MIMO, TxBF) and 802.11ax technologies (extended MU-MIMO, OFDMA, Extra Range and long Guard Interval features for outdoor infrastructures).
- Bridging mode is intended to connect two distant managed sites over wireless and then intended to outdoor infrastructures only
- Use only directional antennas or highly directional antennas for outdoor bridging
- MU-MIMO antennas (usually with dual slant + -45 °, vertical & horizontal polarization) are recommended for the performance of bridge APs. It is important to keep the same type of antennas and polarization for the two antennas of the link
- Keep same APs series to configure a bridge ie. use 802.11ax access points to benefit to 802.11ax technology.
- Due data traffic over the Bridge, share the 5GHz band with wide bandwidth modes, 40MHz mode and more are recommended in 802.11ac/ax.
- Transport of 0-4095 tagged VLANs

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3.1.2 Supported access points

Outdoor IP67 rated AP1361/AP1362/AP1361D (Wi-Fi 6). Note indoor AP1322 (Wi-Fi 6) with external patch antenna are also supported for bridging mode indoors.
Outdoor IP67 rated AP1251 and indoor AP1222 (Wi-Fi 5).

3.2 Multi-Point outdoor Meshing

Multi-Point meshing is the use case in Enterprise where we want to carry out extensions of the network in places where the cabling remains difficult of access in certain parts of the company. This type of deployment can be done outdoors (industrial, event venues, campgrounds etc.) but also indoors (factories, warehouses, storage etc) with the necessary prerequisites for outdoor installations.
Stellar allows Multi-Point mesh configurations from a root access point that can be redundant as in the case of the Bridge. In Multi-Point mode the root AP and each mesh access point can broadcast WLAN services to remote Wi-Fi clients. Each AP mesh connects its Wi-Fi clients and additionally its different ports to connect remote equipment (depending on the model).
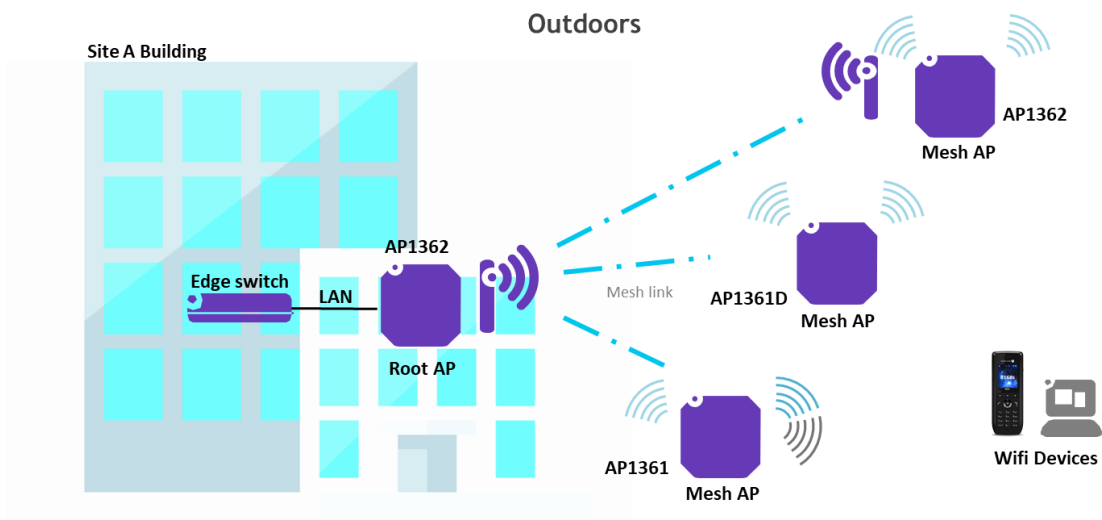
Figure 4: Multi-Point outdoor meshing

3.2.1   Prerequisites

- Maximum of 16 mesh access points for mesh configuration
- The Mesh root can be dual
- There is no combinatory possible between Bridging topologies and Meshing topologies
- 5GHz band is the preferred band to exploit 802.11ac technologies (MIMO, MU-MIMO and TxBF) and 802.11ax technologies (extended MU-MIMO, OFDMA, Extra Range and long Guard Interval for outdoor infrastructures).
- Use only omnidirectional or semi-directional MIMO antennas for mesh root access point

- nLoS configurations are possible, in case of semi-directional antenna use for root access point, consider a loss of at least 3dB at the limit of beamwidth for the placement of mesh APs.
- MU-MIMO antennas (usually with dual slant + -45 °, vertical & horizontal polarization) are recommended for the performance of mesh APs. It is important to keep the same type of antennas and polarization for each antennas pair in links
- Keep same APs series to configure a mesh ie. use 802.11ax access points to benefit to 802.11ax technology.
- Due data traffic over the mesh link, share the 5GHz band with wide bandwidth modes, 40MHz mode and more, are recommended in 802.11ac/ax.
- Transport of 0-4095 tagged VLANs

3.2.2   Rules at mesh access point

Any Point to Multi-Point meshing deployment comes with some rules on each mesh AP that requires attention from the beginning of the deployment:

- Any Mesh AP connector can broadcast 5 client WLAN services maximum.
- Any AP adjacent to the root, with factory setup and without a LAN connection, will attempt to connect first as a mesh access point and carry over the client SSIDs of the root access point.
- The Global call transit capacity of a Mesh root AP has to be shared between all mesh access points and clients traffics. The bandwidth will be then divided by 2 on a mesh access point for each SSID traffic.
- There is no roaming between mesh APs, there is no handling of PMK/OKC or keys exchanges handling through mesh access points.
- VoIP and real-time applications are carried in best effort mode only.

3.2.3   Supported access points

Outdoor IP67 rated AP1361/AP1362/AP1361D (Wi-Fi 6).
Outdoor IP67 rated AP1251 (Wi-Fi 5).
AP1361 and AP1251 access points can be mounted on a pole to achieve the same coverage as indoor coverage for their Wi-Fi clients, the configuration with root could be nLoS in this case.

3.3 Outdoor considerations

An outdoor Bridge or Mesh installation needs to be planned and there are several points to consider for this type of installation.

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3.3.1   Antennas placement and installation

The placement of the antennas and possible radio obstructions must be considered at the beginning of the installation. In the case of a bridge the antennas must be placed as high as possible and comply with local regulations in terms of radio emissions.

The possible obstructions have to be identified (trees or other buildings) and in general the height of the installation must take into account the height of the obstructions to which a minimum distance is added to have a sufficient clearance of Fresnel zone for the link. Usually at least 60% minimum of clearance is considered for the Fresnel zone. Rooftop installations are recommended whenever possible.

The antennas should be aligned in such a way that the main radiation lobes are facing each other, as typical Line of Sight (LoS) configuration.

Consider all mounting possibilities and site constraints to make the correct choice of mounting kit for the antennas. Specially consider mast/pole, pole/reverb, wall and building facade mounts as necessary with accessible heights.

3.3.2   Regulations

From a regulatory point of view, an installation must comply with the local authorities (civil aviation and local administrative authority). The channels used for links also must comply with local legislation.

3.3.3   Protection

Voltages and currents caused by lightning or currents and electrostatic charges which can occur on outdoor antennas present a safety hazard to outdoor installations, and a possible risk of electric shock or fire. These risks are reduced by surge protection and a proper grounding of the installation. Some best practices for electrical installations outdoors can be retrieved in TIA drafts listed in TIA-6076B as example.

3.3.4   Accessories

OmniAccess Stellar AP outdoor mounting kits are supplied separately and can be found in ALE network catalog. The mast kit is supplied with AP1251 and AP1361/1362/1361D access points.

POE injectors for outdoor access points must be IP67 rated and must provide enough power to supply 802.3af/at to the access point but also to the PD equipment if powered by the AP. These devices need a local power outlet to provide 802.3af/at but also 802.bt for the newer Wi-Fi 6 access points. They also inject Ethernet traffic for the AP and usually have power protection to protect the network.

Lightning arrestors can also be added between the antenna and the access point.

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Nomenclatures in ALE catalog are as follows to help with some kit/accessory references for outdoors:

- **AP-MNT-OUT-H**   Outdoor mount kit for Stellar AP1361/1362/1361D
- **PD-9001GO-ET/AC /PD-9601GO/AC**   Outdoor PoE injectors for Stellar AP1361/1362/1361D
- **PD-OUT/MBK/ET /PD-OUT/MBK/S**   Pole/Wall mount kit for outdoor PoE injectors
- **PWR-CORD-XX**   Power cords for outdoor PoE injectors (country specific)
- **AP-OUT-SFP-KIT**   SFP outdoor kit for Stellar AP1361/1362/1361D

Note **2" Pole mount kit** is included with ANT-O-M2-5/ANT-O-M4-9 antennas.

Stellar installation	Type	Mounting / Protection	Recommended Configurations
AP1251 (Wi-Fi 5) Equivalent to AP365	2x2 Integrated MU-MIMO	Pole/Wall mounting Tilt adjustable with kit AP-MNT-OUT DC grounded PD-9001/AC injector	Industrial, Terrain, Events
AP1361 (Wi-Fi 6) Equivalent to AP575	4x4 Integrated MU-MIMO	Pole/Wall mounting Tilt adjustable with kit AP-MNT-OUT-H DC grounded PD-9001/AC injector	Industrial, Terrain, Events Heavily-built urban, sub-urban With distance and speed
ANT-O-M2-5 With AP1362 (Wi-Fi 6) Equivalent to ANT-2x2-5005	**2 external outdoor MU-MIMO 2x**	Pole mounting with pole-mount kit DC grounded PD-9001/AC injector	Industrial, Terrain, Events Heavily-built urban, sub-urban With distance and speed
ANT-O-M4-9 With AP1362 (Wi-Fi 6) Equivalent to ANT-2x2-5010	**2 external outdoor MU-MIMO 2x**	Pole mounting with pole-mount kit DC grounded PD-9001/AC injector	Industrial, Terrain, Events Heavily-built urban, sub-urban With distance and speed
AP1361D (Wi-Fi 6) Equivalent to AP577	4x4 Integrated MU-MIMO	Pole/Wall mounting Tilt adjustable with kit AP-MNT-OUT-H DC grounded PD-9001/AC injector	Industrial, Terrain, Events With distance and speed

Figure 5: Outdoor considerations

3.4 Distances in 802.11ac/ax

The throughput of a mesh link declines significantly with the distance between the access points of the link. The installation of an 802.11ac/ax mesh link is often a compromise between distance and link performance.

In the table below performances are indicated for Stellar Line of Sight (LoS) configurations on the 5GHz band. They are typically the performances for a bridge link with the 40MHz mode considered as the minimum channel width to have as shared bandwidth on the link. The values in the table are given as an indication for the different Stellar outdoor topologies and are based on:

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- A RF calculation for the optimal distance between 2 APs. The calculation is based on the **RF link budget** for each Stellar AP and antenna type. The calculation takes in account the RF Free Path Loss (RFPL) and a margin of 10dB for the System Margin (SOM) for the receiver. This value is usually adopted by default to consider possible radio fluctuations due to external conditions encountered on a bridge link, for example like wind, rain etc.
- The capacity of each AP on the 5GHz band in 40MHz mode with a speed estimation (speed values are from Ekahau PRO planner)

The 80MHz channel width can also be considered with interest over shorter distances.

Stellar installation	802.11ac/ax distance *	AP mode	Link performance **
ANT-O-M4-9 with AP1362 (Wi-Fi 6)	355m	HE40 MCS6 DFS channel 100+ (EU)	220Mbps LAN speed (Ekahau planner)
ANT-O-M2-5 with AP1362 (Wi-Fi 6)	270m	HE40 MCS6 DFS channel 100+ (EU)	220Mbps LAN speed (Ekahau planner)
AP1361D (Wi-Fi 6)	320m	HE40 MCS6 DFS channel 100+ (EU)	220Mbps LAN speed (Ekahau planner)
AP1361 (Wi-Fi 6)	270m	HE40 MCS6 DFS channel 100+ (EU)	220Mbps LAN speed (Ekahau planner)
AP1251 (Wi-Fi 5)	270m	VHT40 MCS6 DFS channel 100+ (EU)	100Mbps LAN speed (Ekahau planner)

* Calculation based on RF link budget for the technology. A calculator is available on https://www.proxim.com site under Knowledge Center

* Outdoor bridge configuration is considered with 10 dB of System margin (SOM) minimum

** Estimated performance for data at -70dBm and 20dB SNR from receiver. For shorter distances consider wider bandwidths, 40MHz and more

Figure 6: Performances in LoS configurations

3.4.1 Long distances considerations

Longer distances (1/5 mile and more) can also be considered but only with high gain, MIMO compatible directional antennas, and with also with lower HE/HT data rate negotiation. Long distances may be suitable for applications where the data rate is not the priority, pure voice applications may be a use case.

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The use of external high gain antennas from the market of the grid/parabolic type can be considered if they are compatible with:

- Wi-Fi frequency bands including the 5GHz
- MIMO compatible with polarization diversity (a 2x2 MIMO antenna configuration is minimum for polarization diversity)
- Impedance of 50 ohms
- Limited cable loss (< 1.5dB)
- N-type connector
- DC grounding

Always refer to the manufacturer's datasheets for this type of antenna before performing a link budget for long distances, as previously done in the table for Stellar installations.

3.5 Multi-Point indoor meshing

3.5.1 Multi-Point indoor meshing Enterprise

Indoor meshing is generally used for wifi deployments and coverage extensions for some hard-to-reach parts of buildings. This is the case for factories and certain industrial areas.
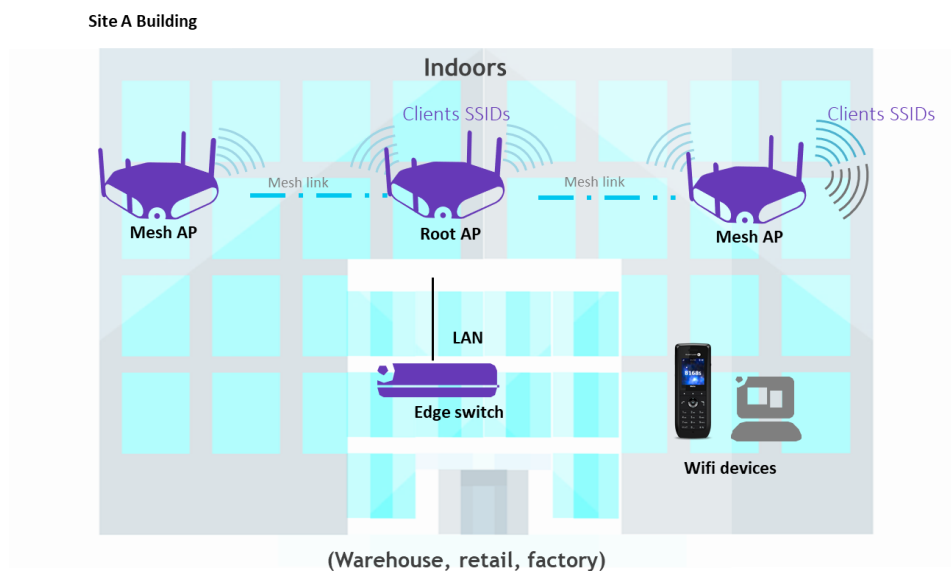

Figure 7: Wireless Multi-Point indoor meshing

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The RF requirements for indoor meshing are similar to indoor coverage for offices:
- **SNR of 20dB, or better for voice**
- **RSSI of at least -67dBm**

It is recommended to use omni-directional and external antennas with sufficient antenna gain to guarantee the quality of the mesh links, e.g. the use of the external omni-directional **ANT-O-6** antenna mounted directly on the Stellar AP1322 (or AP1222) is a good practice.
The AP1361 or AP1251 are IP67 rated and are also used and mounted on the ceiling in case of harsh environment (humidity, dust, etc.).
Patch antennas are not recommended for indoor mesh, they are more recommended for specific indoor coverage.

3.5.2 Multi-Point indoor meshing at Home

It is also possible to have a mesh configuration at home with Enterprise level connectivity in rooms where Wi-Fi coverage is desired. This type of deployment is accelerating with homeworking today. With the shorter distances in home, Stellar multi-point mesh can provide higher throughput links and set up optimal Wi-Fi performance with the latest entry-level Wi-Fi 6 access points, such as **AP1301**. The Stellar Wi-Fi 6 mesh provides fast Internet access to equipment with the latest Wi-Fi and security standards.

In addition to the router, the Stellar Root mesh communicates with several mesh APs placed in different rooms of the house, office, living room or other, with the lightest possible installation. The group of APs uses the DHCP server of router and is managed in Wi-Fi Express mode. The management is done by the Express mode GUI, access point by access point, from a simple smartphone or tablet.
With a single SSID broadcast and a password, roaming from room to room is possible for different types of equipment on both bands:
- Laptop connecting on the 2.4GHz band
- Smartphones connecting on 5GHz and supporting the latest Wi-Fi 6 standard (802.11ax)
- Connection to Google Chromecast on 5GHz which allows to realize the broadcast of multimedia content
- And potentially the connection for other Wi-Fi equipment (gaming consoles etc.)
- Benefit of high data rates on 5GHz band with wide channels (80MHz) for latest smartphones (Dual band Wi-Fi 6), connected TV or consoles.

Prerequisites at home:
- Root AP must be placed close to existing router box and will be connected on router itself. Wi-Fi service of router can be disabled.
- Use of standard DHCP server of router
- Once configured the placement of the mesh APs is done where the Wi-Fi coverage is required. The recommended distance limit for the mesh link is no more than 2 rooms (5 meters). It is important to consider how to connect equipment such as consoles, TVs and other devices for the placement.

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- Level-entry AP1301 provides the latest Wi-Fi 6 technology on both radio bands and gives the benefit of a high-performance LAN connection at a distance of 3-5 meters with high data rates.
- Wall mounting kit is sold under **OAW-AP-MNT-W** reference as well as 48V block on the market. A power outlet near the installation is sufficient. Both accessories allow a clean and definitive installation.
- In case Stellar mesh is used for video streaming, or to connect game consoles, the use of specific SSID with QoS specific to these media is recommended. The QoS is directly managed by SSID in Stellar Express mode.

Figure 8: Wireless Multi-Point meshing at Home

3.5.3   Rules at mesh access point

Rules at each access point are the same as for outdoor Multi-Point meshing:

- Maximum of 16 APs in a mesh configuration to one Root AP
- Any Mesh AP connector can broadcast 5 client WLAN services maximum
- Any AP adjacent to the root, with factory setup and without a LAN connection, will attempt to connect first as a mesh access point and carry over the client SSIDs of the root access point.
- Global call transit capacity of a Mesh root AP has to be shared between all mesh access points and clients traffics. The bandwidth will be then divided by 2 on a mesh access point for each SSID traffic.
- There is no roaming between mesh APs, there is no handling of PMK/OKC or keys exchanges handling through mesh access points.
- VoIP and real-time applications are carried in best effort mode only.

3.5.4   Supported access points

Indoor AP1301/AP1311/AP1321/AP1322/AP1331/AP1351/AP1361 (Wi-Fi 6) are supported for Multi-Point meshing in indoor.
Indoor AP1201/AP1221/AP1222/AP1231/AP1232/AP1251 (Wi-Fi 5) are also supported.

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4. Survey

4.1 Ekahau PRO survey tool

A survey is essential for planning an outdoor mesh installation and becomes <u>mandatory</u> in the case of bridge installation. It allows a simulation of the mesh links and provides an estimate of the performance that can be expected with Stellar meshing, especially concerning throughputs.

Ekahau PRO Site Survey version 10.4 now includes Wi-Fi 6 Alcatel-Lucent Stellar **AP1301, AP1301H, AP1311, AP1321, AP1322, AP1331, AP1351, AP1360 series** with external outdoor and indoor antennas.
- Antennas **ANT-O-6**, **ANT-O-M2-5**, **ANT-O-M4-9** and **ANT-S-M4-60**

The Ekahau planner tool is perfectly suited for outdoor mesh link calculation. The site survey software can be provided by ALE as a service for a coverage survey and helps the quotation of the installation.

4.2 Link survey

If distances calculation given earlier for a bridge allow to know the distances for a given WLAN technology (e.g. an installation with 802.11ax access point) it is possible to obtain specifically requested results in terms of throughput and AP placement, and thus evaluate the feasibility of an installation needed for the customer.

The **Ekahau PRO planner tool** allows:

- To simulate the radio propagation of each access point in the mesh group according to: the associated antenna parameters, the configuration of the access point, including the transmitted power and EIRP (power radiation), the placement to be expected for the access point and the radio settings that have been defined for it (number of MU-MIMO spatial streams, guard interval value, etc.)
- To provide an estimate of the link in terms of throughput, but also in terms of the quality of the link, this estimate is usually based on the received power and the SNR level at the remote AP.

The figure below shows, for example, the **placement of a directional AP1361D** made with the Ekahau Planner tool, for the <u>recommended 802.11ax distance</u> for this outdoor AP with integrated antennas. This placement can be fully adapted to the floor plans and site information provided by the partner.
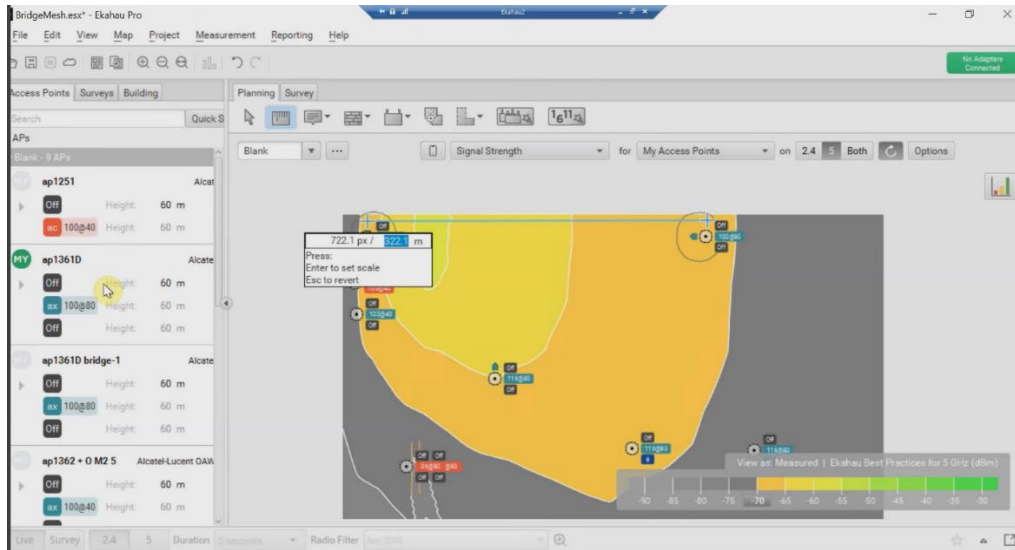
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Figure 9: AP placement with Ekahau PRO

The following figure shows some performance measurements obtained for the AP1361D placement seen previously; the configuration here is 802.11ax enabled on the **5GHz band using the channel 106** (the shared bandwidth is 80MHz for this channel) and using 4x4 MU-MIMO spatial stream with a MCS5 QAM64 modulation negotiated for a wireless HE of more than 1Gbps wireless for the link. This clearly shows the performance achieved for this type of link in 802.11ax.
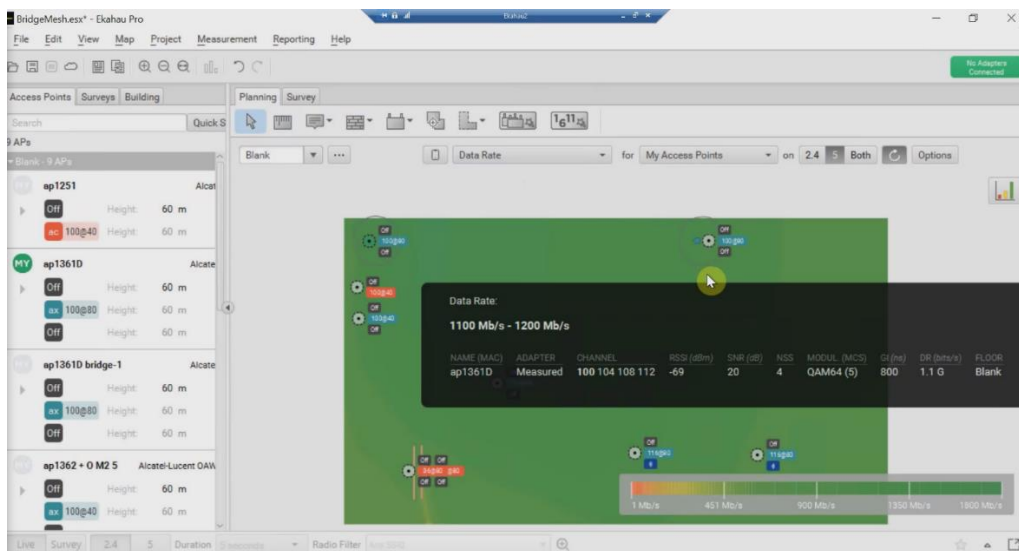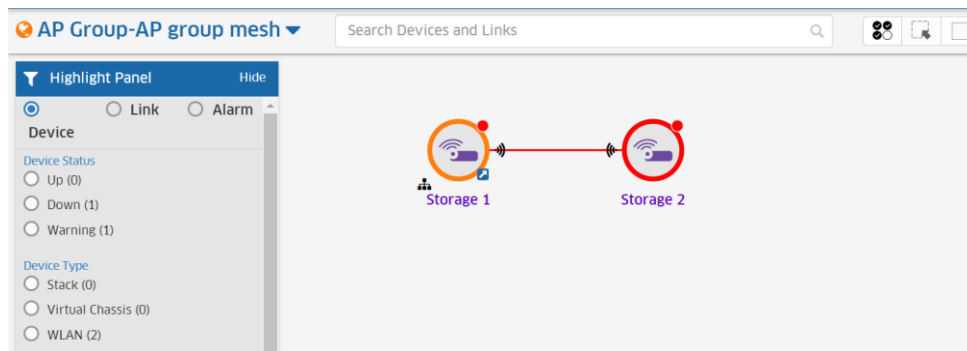

Figure 10: Link measurement with AP1361D

This type of survey can be carried out for any type of link, for external bridge links or for Multi-point mesh links.

5. Configuration & Operation

5.1 Management in Enterprise mode

In this part we cover the procedure for managing an indoor mesh with Omnivista 2500, consisting of 2 Stellar APs. The topology will be as follows:

5.1.1 Topology

Stellar access points form by default a standard AP group with the management of one or more AP group(s), RF profile(s) and access profiles, which is the management process done usually with Omnivista 2500 for Stellar access points. The creation of a mesh group consists of specializing certain APs in the installation to operate in **root** or **mesh** mode.

Identify the APs that will be part of the mesh group
**OV2500 -> NETWORK -> AP REGISTRATION -> Access Points**

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If IP configuration for APs is done by DHCP it is recommended to define IP reservations for all the APs of the future mesh group, and ideally to manage a static IP configuration in the case of a bridge.

It is recommended to create a dedicated mesh (or bridge) AP group and assign it to the identified APs.
**OV2500 -> NETWORK -> AP REGISTRATION -> AP Group -> + (Create icon)**
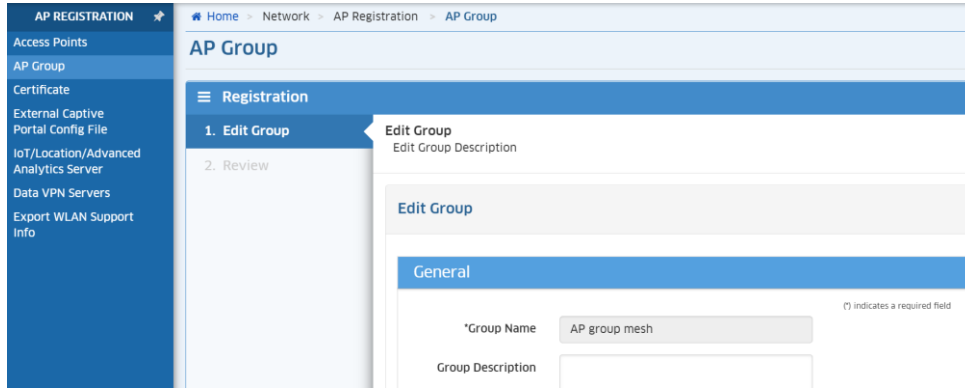
- Enter AP Group Name and configure the profile as described below

Time	**- Local time** with UTC time zone
SSH login	**- Enabled** for Support account and for root account
AP WEB	**- Enabled** for Administrator account

Wireless mesh/bridge working frequency, regulatory, channeling, transmission powers for indoor and more (notably for 802.11ax activation and long GIs as necessary) must be the same for all APs of the Mesh group (or Bridge).
It is recommended to create a dedicated RF profile for the mesh (or bridge).
OV2500 -> WLAN -> RF Management -> RF Profile -> + (Create icon)
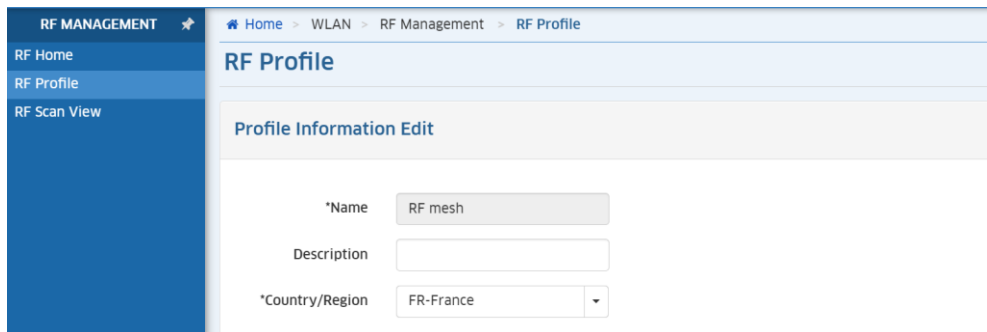
- Enter RF Profile Name and configure the profile as described below ie. FR-France in the example

Country/region	**- FR-France**
Band steering	**- Enabled** Force 5GHz
Load balance	**- Enabled**

Airtime Fairness	**- Enabled** on 2.4GHz and 5GHz

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Background Scanning   **- Disabled** select Wi-Fi 6 non-working channel
Band   **- Select** 2.4GHz and 5GHz all
Channel DRM   **- Enabled** for 5G All
Channel List   **- Set list [100,104,108,112]** for 5GHz All
Channel width   **- 80MHz** for 5G All
Power setting   **- Set DFS/TPC** to 15dBm for 5G All indoor
MU-MIMO   **- Enabled**
High Efficiency   **- Enabled**

- Apply this RF Profile to the Mesh AP Group

Manage the SSIDs to broadcast for clients in a Multi-point mesh configuration. Create each SSID to broadcast to clients in the mesh configuration and assign them to the Mesh AP Group.
OV2500 -> WLAN -> SSIDs -> + (Create icon)

- Enter SSID Service Name and configure the profile as described below.
SSID   **- SSID storage**
Security Level   **- Personal**
Allowed Band   **- All**
Encryption Type   **- WPA3 SAE AES**
Password   **- ************
Default VLAN/Network **- Se**t Untagged VLAN and VLAN 94 (example here)

Save and Apply to the AP Group mesh.
- In Advanced WLAN Service Configuration configure as described below.
- HT Control   **- Enabled** for A-MSDU /A-MPDU (by default)

In the case of multiple VLANs identify ARP profile(s) that will handle the VLANs to be distributed over the wireless mesh link. Assign the management VLANs to the mesh access points that can authenticate 802.1x clients (not the use case here)

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5.1.2 Mesh roles

In this section all identified access points for the meshing are moved to their respective mesh roles. From the list of access points, select each access point for meshing (or bridge) and edit the Mesh Configuration menu.

OV2500 -> NETWORK -> AP REGISTRATION -> Access Points -> (Select AP and Edit details /Edit Mesh Configuration)
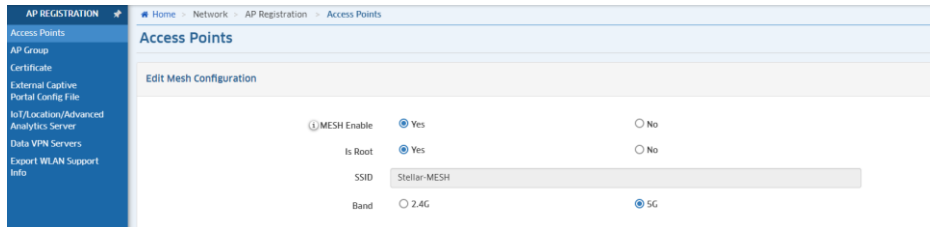
- Select Storage1 AP as Root and configure the Mesh configuration as described below.

MESH Enable	**- Yes**
Is Root	**- Yes**
SSID	**- Stellar-MESH**
Band	**- 5GHz**
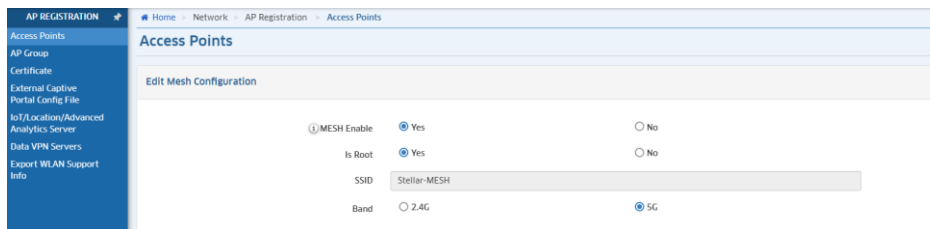
- Select Storage2 AP as Mesh and configure the Mesh configuration as described below.

MESH Enable	**- Yes**
Is Root	**- No**
SSID	**- Stellar-MESH**
Band	**- 5GHz**

At this point in the management all mesh APs are configured and can be disconnected from the former LAN. They can be placed in their respective locations in the buildings: typically with a ceiling mounting in indoor (or roof mounting in the case of the bridge) and powered up. A boot with the initialization of the mesh configuration takes several minutes.

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Once each root and mesh AP are managed and running, you can doublecheck mesh configuration is running on APs with mesh icons highlighted on Stellar topology.
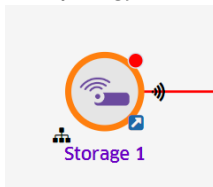
5.1.3   Downlink ports

In the case of a bridge, management of the additional Ethernet ports ENET0/1 of the APs as downlink ports for wired traffic from remote sites is done by managing a uNP authentication profile for the bridge. A uNP authentication profile allows you to assign a predefined uNP port configuration and to individually specify on each port an UNP port status and define the authentication process parameters for the ports.

OV2500 -> UNIFIED ACCESS -> UNIFIED PROFILE -> Template -> Access Auth Profile -> + (Create icon) to create uNP configuration for Bridge APs downlink ports.

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- Enter a Profile Name and configure the profile as described below.

Default Settings   - AP Mode **- Disabled**
No Auth/Failure/Alternate – Trust tag **- Enabled**
          - Bypass VLAN **- [VLAN list to bypass]**

- Save and Apply this uNP authentication Profile to the Mesh AP Group (with Apply to Devices button)
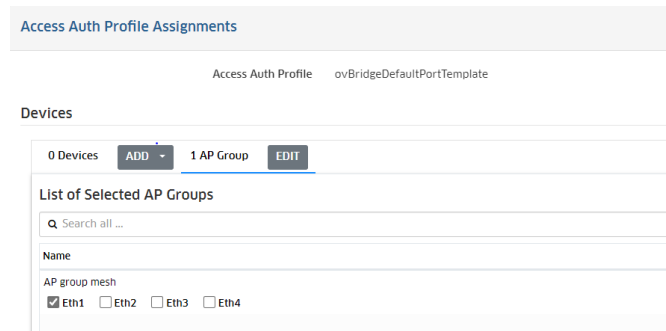
- Select ports on which you want to assign this uNP authentication Profile and apply

5.2 Management with APUI

For AP groups managed in Express mode, the management of each mesh AP is done directly via their APUI interface which is accessible by clicking on @IP of each access point listed in the former cluster.
WEB GUI (Main Page) -> AP

Stellar APUI is also accessible in Enterprise mode from the menu **OV2500 -> NETWORK -> AP REGISTRATION -> Access Points**. Select the AP to be managed from the access point list and click on the **Action -> AP web** menu. AP web access has been previously activated in dedicated mesh AP group. APUI login is the administrator login for the group.
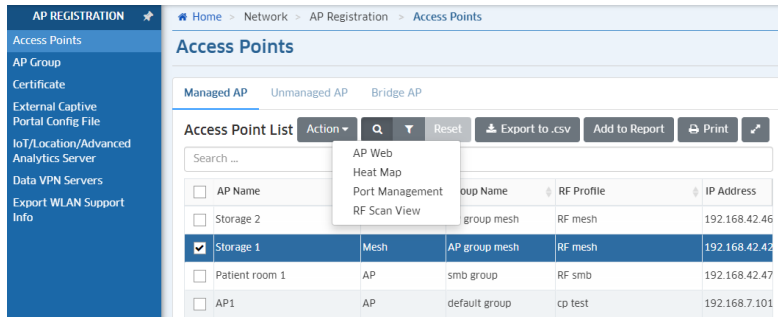
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Edit Mesh Configuration menu with APUI

Connect to APUI of AP identified as Root(s)/Mesh(s) and Access to
APUI -> NETWORK -> AP INTERFACE -> Backhaul0 -> (Click Edit Interface)
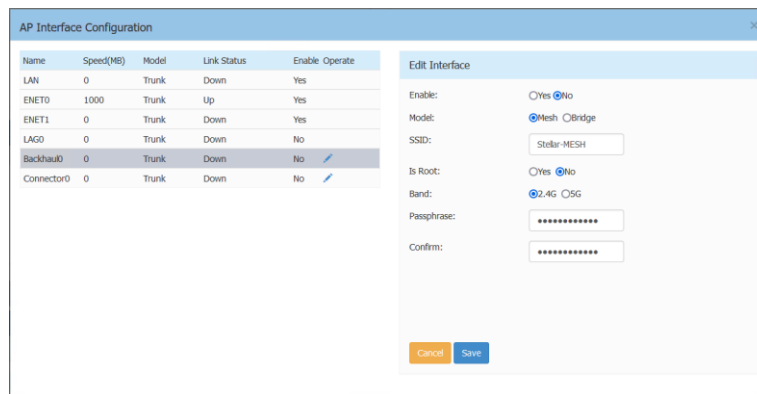
- Enable and Set AP mesh role you want for this AP (Mesh/Bridge/Is Root) and Mesh SSID settings
(Band/passphrase) and Save

Edit Ports Configuration menu with APUI

Connect to APUI of AP identified as Root(s)/Mesh(s) and Access to
APUI -> NETWORK -> AP INTERFACE -> Enet0/1/2/3 -> (Click Edit Interface)
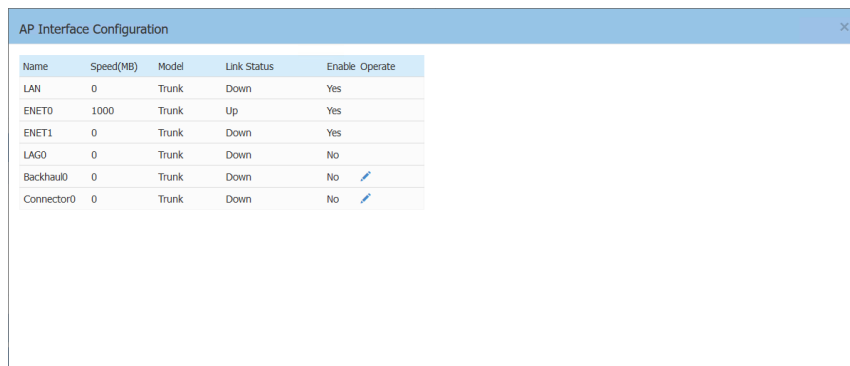
- Enable the Interface you want for this AP and set VLANs you want to trust and bypass and Save

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5.3 Monitoring Mesh

During Mesh operation all wireless metrics for each Mesh AP (or Bridge ones) are accessible from SSH console of APs. In Enterprise mode Stellar SSH console access must be activated in AP group dedicated to Mesh.

OV2500 -> Network -> AP Registration -> AP Group -> (Select mesh AP Group and click the Edit button)
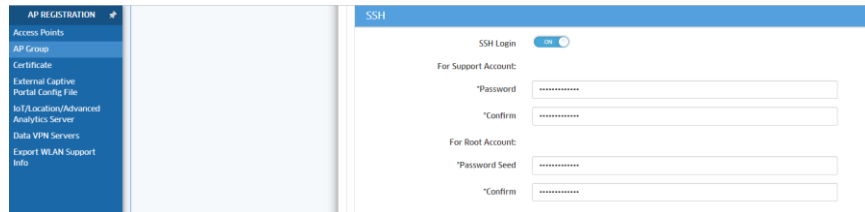
- Configure the AP Group as described below.

<u>SSH</u>   - SSH Login   **- Enabled**
                - For Root Account   **- password** for root account

5.3.1 RF configuration

Monitoring the RF configuration received by each AP in a Mesh group is done by retrieving rfprofile.conf file:

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```
root@Storage 1:~$ cd /tmp/config
root@Storage 1:~$ more rfprofile.conf

{
        "RFService":[
                {
                        "bandSteering":"enable",
                        "bandSteeringForce5g":"enable",
                        "LoadBalance":"enable",
                        "backgroundScanning":"enable",
                        "bgsmode":"workChannel",
                        "ScanningEnhance":"disable",
                        "countryCode":"FR",
                        "ScanningInterval":20,
                        "ScanningDuration":110,
                        "neighborCount":64,
                        "VoiceVedioAwareness":"enable",
                        "airtimeFairnessAt2G": "enable",
                        "airtimeFairnessAt5G": "enable",
                        "perBandInfo": {
                                "2.4G":{
                                        "band":"enable",
                                        "radioOff:"disable",
                                        "channelSetting":"AUTO",
                                        "channelWidth":20,
                                        "autoChannelWidth":"enable",
                                        "powerSetting":"21",
                                        "shortGuardInterval":"disable",
                                        "shortGuardIntervalPeriod":1,
                                        "signalStrengthThreshold":0,
                                        "roamingSignalStrengthThreshold":0,
                                        "powerValMax":"0",
                                        "powerValMin":"0",
                                        "radioMode":"normal",
                                        "scanDuration":"normal",
                                        "Gain":"4",
                                        "clientAwareness":"enable",
                                        "MuMIMO":"enable",
                                        "highEfficiency":"enable",
                                        "beaconInterval":100
                                }
```

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```
            "5G_all":{
                    "band":"enable",
                    "radioOff:"disable",
                    "channelSetting":"AUTO",
                    "channelWidth":80,
                    "autoChannelWidth":"disable",
                    "globalChannelWidth":20,
                    "autoGlobalChannelWidth":"enable",
                    "powerSetting":"21",
                    "shortGuardInterval":"disable",
                    "shortGuardIntervalPeriod":1,
                    "signalStrengthThreshold":0,
                    "roamingSignalStrengthThreshold":0,
                    "channelLists":[
                        100,
                        104,
                        108,
                        112
                    ],
                    "powerValMax":"0",
                    "powerValMin":"0",
                    "radioMode":"normal",
                    "scanDuration":"normal",
                    "Gain":"4",
                    "chainmask":15,
                    "clientAwareness":"enable",
                    "MuMIMO":"enable",
                    "highEfficiency":"enable",
                    "beaconInterval":100
                }
            }
        }
    }
```

Knowing channels used for mesh links, their current utilization and the possible radio detections on specific channels enables to refine channels settings as best as possible for the better mesh experience. Note Stellar DRM is handled at Root level only for remote clients on mesh SSIDs.

Monitoring channels for a mesh link is done with iwlist athXX channel command:

```
root@Storage 1:~$ iwlist athap1 channel
athap1 109 channels in total; available frequencies:
Channel 36 : 5.18 GHz
Channel 40 : 5.2 GHz
Channel 44 : 5.22 GHz
Channel 48 : 5.24 GHz
Channel 52 : 5.26 GHz
Channel 56 : 5.28 GHz
Channel 60 : 5.3 GHz
Channel 64 : 5.32 GHz
Channel 100 : 5.5 GHz
Channel 104 : 5.52 GHz
Channel 108 : 5.54 GHz
Channel 112 : 5.56 GHz
Channel 116 : 5.58 GHz
Channel 120 : 5.6 GHz
Channel 124 : 5.62 GHz
Channel 128 : 5.64 GHz
Channel 132 : 5.66 GHz
Channel 136 : 5.68 GHz
Channel 140 : 5.7 GHz
Current Frequency:5.52 GHz (Channel 104)
```

Stellar access points handle radio detections on UNII-2 DFS sub-band, all detections are directly displayed on AP console.

```
root@Storage 1:~$ [ 305.332833] _GOLSOH_Radar found on channel 52 (5260MHz)
```

5.3.2   Monitoring links

The link quality metric is an evaluation of the robustness of a mesh link and is based on signal strenght and SNR levels, it can decrease dramatically if prerequisites are not observed for the link (distance or no observations in configuration: frequencies, wrong installation, nLoS configurations in outdoors etc.). The Bit Rate negociated between two nodes is an estimation of the speed of the link.

Monitoring a link in a Mesh group is done with iwconfig athXX (BSSID or ESSID) command:

```
root@Storage 1:~$ iwconfig athap1
athap1   IEEE 802.11ac ESSID:"Stellar-MESH"
         Mode:Master Frequency:5.52 GHz Access Point: DC:08:56:13:3A:49
         Bit Rate:780 Mb/s Tx-Power=17 dBm
         RTS thr:off Fragment thr:off
         Power Management:off
         Link Quality=50/94 Signal level=-76 dBm Noise level=-95 dBm
         Rx invalid nwid:67037 Rx invalid crypt:0  Rx invalid frag:0
         Tx excessive retries:0  Invalid misc:0  Missed beacon:0
```

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5.3.3 Monitoring mesh SSIDs

List all the interfaces of a Mesh group in order to retrieve interfaces used for SSIDs broadcasted on 2.4GHz and 5GHz bands for Mesh clients is done via wlanconfig command. In our scenario, these are the **ath01** and **ath11** interfaces that handle SSID "SSID_storage" on both bands.

```
root@Storage 1:~$ iwconfig
…
ath01    IEEE 802.11ng ESSID:"SSID storage"
         Mode:Master Frequency:2.437 GHz Access Point: DC:08:56:35:28:81
         Bit Rate:173 Mb/s Tx-Power=3 dBm
         RTS thr:off Fragment thr:off
         Power Management:off
         Link Quality=53/94 Signal level=-75 dBm Noise level=-95 dBm
         Rx invalid nwid:47691 Rx invalid crypt:0  Rx invalid frag:0
         Tx excessive retries:0  Invalid misc:0  Missed beacon:0


eth1     no wireless extensions


eth0-94  no wireless extensions


ath11    IEEE 802.11ac ESSID:"SSID storage"
         Mode:Master Frequency:5.52 GHz Access Point: DC:08:56:35:28:81
         Bit Rate:780 Mb/s Tx-Power=17 dBm
         RTS thr:off Fragment thr:off
         Power Management:off
         Link Quality=94/94 Signal level=-23 dBm Noise level=-95 dBm
         Rx invalid nwid:56940 Rx invalid crypt:0  Rx invalid frag:0
         Tx excessive retries:0  Invalid misc:0  Missed beacon:0
…
…
```

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Monitoring the clients served on final mesh nodes is done with wlanconfig athXX list command. Metrics here are the usual measures on clients associated with a specific BSSID interface, with clients data rates, RSSI, operating band and clients capabilities

```
root@Storage 1:~$ wlanconfig ath01 list
ADDR            AID CHAN TXRATE RXRATE RSSI MINRSSI MAXRSSI IDLE TXSEQ RXSEQ CAPS XCAPS
d4:6e:0e:18:60:38 1  6   72M   72M   63  62     67    0   0   65535 EPSs cORI
ACAPS ERP STATE MAXRATE(DOT11) HTCAPS   VHTCAPS ASSOCTIME IEs    MODE            PSMODE
0  f 0  P       0     gR   00:03:20 RSN WME  IEEE80211_MODE_11NG_HT20 0
RXNSS TXNSS
1   1
Minimum Tx Power : 5
Maximum Tx Power : 18
HT Capability : Yes
VHT Capability : No
MU capable : No
SNR : 63
Operating band : 2.4 GHz
Current Operating class : 0
Supported Rates : 2 4 11 12 18 22 24 36 48 72 96 108
```

6. Related documents

LAN/WLAN Datasheets & Networks Guides:

Stellar AP1360 datasheet
https://myportal.al-enterprise.com/a4F5I000000YNnKUAW

User guide for OmniVista 2500 NMS
https://myportal.al-enterprise.com/a4F5I000000HIIRUA4

AWOS 4.0.4 Stellar User Guide
https://myportal.al-enterprise.com/a4F5I000000HIS7UAO

Product Line matrix & Installation Guides:

Stellar Product Line matrix /Stellar antennas matrix
https://myportal.al-enterprise.com/a4F5I000000Y6ezUAC

Stellar AP1361 Installation Guide
https://myportal.al-enterprise.com/a4F5I000000Y6glUAC

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