Voice over WLAN Design Guide R7.2 for OmniAccess® Stellar Access Points AP1101, AP1201, AP1221/AP1222 AP1201H, AP1231/AP1232 and AP1251 AP1311, AP1321/AP1322 and AP1361/62/61D

8158s and 8168s WLAN Handsets

Rainbow UCaaS client for iOS mobile and Android mobile

OTC for iOS mobile, Android mobile and Windows mobile

OXE Release R12.2 and more
OXE with OTMS Release R2.6 and more
OXO Connect Release R4.0 and more

edition 01

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Omnivista 2500 R45R3
8158s and 8168s software version 2.2.13
OTC application version 2.60
Rainbow UCaaS client version 1.84

Disclaimer

This documentation is provided for reference purposes only and does not fully describe the capabilities of each Product and related features. Therefore, ALE International declines any liability for inaccuracies contained herein. For an exhaustive view on features list and product limits for the current product release please see the required Feature List/Product Limits document available through the ALE eBusiness Portal web site.

In the interest of continued product development, ALE International reserves the right to make improvements or other changes to this document and the products it describes at any time without prior notice.

1. Introduction & Objectives

It is the intent of this guide to aid Sales Engineers in designing and selling telecommunications solutions incorporatiang Voice over Wireless LAN (VoWLAN) solution with next generation 8158s & 8168s WLAN handsets, with ALE Collaborative apps running with iOS devices, Android devices or Windows devices and with Stellar wifi 6 access points AP13XX supported since OmniAccess® Stellar AWOS 4.0 releases all modes.

This document has been created specifically in the context of an architectural and technical Pre-Sales Design Guide approach. It is clearly understood that a client's choice of solution components and design options will take into account many factors that will not be explored here (such as financial considerations, deployment constraints, and business process limitations).

VoWLAN product offering with next generation ALE 8158s and 8168s is a multi-stage solution aimed at meeting customer demand for converged voice and data wireless environments based on 802.11 technologies. 8158s and 8168s WLAN handsets is the result of leveraging existing OmniPCX Enterprise features with OEM products available in the ALE portfolio from Ascom and others.

Rainbow and OTC (OpenTouch Conversation) applications are offering unified communications service that delivers collaboration services available to users such as contact management, presence, chat, video calls, screen and file sharing, and Voice for the same data wireless environment. The last versions of Rainbow UcaaS application provide far telephony integration with ALE PBXs (Private Branch eXchange), these applications are integrating with ALE OXO Connect and OmniPCX Enterprise, as well as non-ALE PBXs for the Rainbow solution. The Rainbow UCaaS application takes hybrid cloud and open platform approaches in the cloud.

Technically speaking, the VoWLAN solution can be built on several WLAN topology schemes but must always adhere to the Voice over WLAN operational design restrictions *(For more information on design restrictions, see: section Voice over WLAN Design Rules of this document and the latest ALE OmniPCX Enterprise Standard Offer document)*.

1.1 Product Releases

Below is the list of products composing communication products (Medium/Large/Small Enterprises) that are covered in this document, with release number allowing readers to refer to corresponding presales presentations or technical documentations to get additional information on VoWLAN features:

- **OXO (OmniPCX Office) Connect release 4.0 and more**
- **OXE (OmniPCX Enterprise) release 12.2/12.3/12.4 and more**
- **OTMS (OpenTouch Multimedia Services) release 2.6 and more**

1.2 Validated Software versions for 8158s/8168s, Rainbow UCaaS, OTC application & OTMS solution

Warning the following versions are subject to change:

- **WLAN Stellar:** 4.0.2 all mode
- **8158s/8168s software version:** 2.2.13
- **WinPDM /IMS3 (Integrated Messaging and wireless Services):** 3.13.4/4.6.2
- **Rainbow UCaaS client:** 1.84
- **OTC mobile client:** 2.60

- For more details, check the latest validated software versions and related release notes available on ALE Business Portal.

Please refer to the relevant presales presentation on the eBusiness Portal for detail on the communication platforms (OmniPCX Enterprise, OXO Connect, Rainbow, OpenTouch)

2. WLAN Components

2.1 OmniAccess® Stellar Access Points (Distributed Controller)

OmniAccess® Stellar Access Points are a family of high performance and distributed WLAN controllers which deliver speeds of latest IEEE (Institute of Electrical and Electronics Engineers) 802.11 standards.
AP11XX series are IEEE 802.11ac wave 1.
AP12XX series are IEEE 802.11ac wave 2.
AP13XX series are IEEE 802.11ax.
(For more details refer to the related datasheets)

2.1.1 OmniAccess® Stellar 802.11ac wave 1 Access Points.

OAW-AP1101

Minimum software version 3.0.2.38 is equivalent to AP207

Dual-Radio (Indoor)

802.11a/b/g/n/ac wave1 (Dual Band concurrent)

5GHz: 802.11ac very high throughput (VHT) support: VHT 20/40/80
2.4GHz: 802.11n high-throughput (HT) support: HT 20/40

1× 10/100/1000Mb/s full/half-duplex Ethernet (RJ-45)
PoE-PD: 48 V DC (nominal) 802.3af or 802.3at PoE (Power over Ethernet)

Built-in antenna 2×2:
- 2, 3.4 dBi at 2.4 GHz
- 3.96 dBi at 5 GHz

AP1101 access point group is an autonomous system that consists of a group of **distributed OmniAccess® AP1101s controllers**.

AP1101 in Express mode
One AP-Group supports up to 32 OmniAccess® Stellar Access Points with AP1101s and AP1201Hs (version 3.0)
When mixed with minimum of 4 Stellar AP12XX or minimum of 4 AP13XX, one AP1101 AP-Group supports up to 64 OmniAccess® Access Points, 512 clients and 16 WLANs (SSID)
When mixed with minimum of 8 Stellar AP12XX or minimum of 8 AP13XX, one AP1101 AP-Group supports up to 255 OmniAccess® Access Points, 512 clients and 16 WLANs (SSID)

AP1101 in Enterprise mode
One AP1101 AP-Group supports up to 4000 OmniAccess® Access Points (any model any mix version 3.0.7 min)

OAW-AP1101

2.1.2 OmniAccess® Stellar 802.11ac wave 2 Access Points.

OAW-AP1201 **Minimum software version 3.0.2.38 is the 2x2:2SS equivalent to AP305** **Dual-Radio (Indoor)** **802.11a/b/g/n/ac wave2 (Dual Band concurrent)** Data rate up to 3 MU-MIMO (Multi-User Multi Input Multi Output) capable devices simultaneously 5GHz: 802.11ac very high throughput (VHT) support: VHT 20/40/80 2.4GHz: 802.11n high-throughput (HT) support: HT 20/40 1× 10/100/1000Mb/s full/half-duplex Ethernet (RJ-45) PoE-PD: 48 V DC (nominal) 802.3af or 802.3at PoE Built-in antenna 2×2 @2.4GHz, 2x2 @5GHz: - 5.5 dBi at 2.4 GHz - 5.5 dBi at 5 GHz Application monitoring & control /DPI **Integrated BLE 5.0 radio/Zigbee/Thread HW** **Medical EMC EN 60601-1-1 & 60601-1-2** AP1201 access point group is an autonomous system that consists of a group of **distributed OmniAccess® AP1201s controllers.** **AP12XX in Express mode** One AP12XX AP-Group (any model any mix) supports up to 64 OmniAccess® Access points with minimum of 4 AP12XX (except AP1201H) or minimum of 4 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 3.0.7 min) One AP12XX AP-Group (any model any mix) supports up to 255 OmniAccess® Access points with minimum of 8 AP12XX (except AP1201H) or minimum of 8 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 3.0.7 min)	 **OAW-AP1201**

AP12XX in Enterprise mode One AP12XX AP-Group supports up to 4000 OmniAccess® Access Points (any model any mix version 3.0.7 min), 1024 concurrent clients and 16 WLANs (SSID)	

OAW-AP1221 /AP1222 **Minimum software version 3.0.2.38 is equivalent to AP325/324** **Dual-Radio (Indoor)** **802.11a/b/g/n/ac wave2 (Dual Band concurrent)** Data rate up to 3 MU-MIMO capable devices simultaneously 5GHz: 802.11ac very high throughput (VHT) support: VHT 20/40/80 2.4GHz: 802.11n high-throughput (HT) support: HT 20/40 1× 10/100/1000Mb/s full/half-duplex Ethernet (RJ-45) PoE-PD: 48 V DC (nominal) 802.3af or 802.3at PoE **OAW-AP1221** Built-in antenna 2×2 @2.4GHz, 4x4 @5GHz: - 3.61 dBi at 2.4 GHz - 4.45 dBi at 5 GHz **OAW-AP1222** 4 RP-SMA connectors for external dual band antennas. Optional BLE radio through USB port Application monitoring & control /DPI AP1221/AP1222 access point group is an autonomous system that consists of a group of **distributed OmniAccess® AP1221/AP1222s controllers.** **AP12XX in Express mode**	 **OAW-AP1221**  **OAW-AP1222**

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One AP12XX AP-Group (any model any mix) supports up to 64 OmniAccess® Access points with minimum of 4 AP12XX (except AP1201H) or minimum of 4 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 3.0.7 min) One AP12XX AP-Group (any model any mix) supports up to 255 OmniAccess® Access points with minimum of 4 AP12XX (except AP1201H) or minimum of 4 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 3.0.7 min) **AP12XX in Enterprise mode** One AP12XX AP-Group supports up to 4000 OmniAccess® Access Points (any model any mix 3.0.7 min), 1024 concurrent clients and 16 WLANs (SSID)	

OAW-AP1231 /AP1232 **Minimum software version 3.0.2.38 is equivalent to AP345/AP344** **Three-Radio (Indoor)** **802.11a/b/g/n/ac wave2 (Dual Band concurrent)** Data rate up to 6 MU-MIMO capable devices simultaneously Dual 5GHz: 802.11ac very high throughput (VHT) support: VHT 20/40/80 2.4GHz: 802.11n high-throughput (HT) support: HT 20/40 1× 10/100/1000Mb/s full/half-duplex Ethernet (RJ-45) 1× 10/100/1000/2500Mb/s full/half-duplex Ethernet (RJ-45) PoE-PD: 48 V DC (nominal) 802.3at PoE **OAW-AP1231** Built-in antenna 4×4 @2.4GHz, dual 4x4 @5GHz: - 3.9 dBi at 2.4 GHz - 5.9 dBi at 5 GHz **OAW-AP1232** 8 RP-SMA connectors for external dual band antennas. Integrated BLE radio Application monitoring & control /DPI	 **OAW-AP1231**  **OAW-AP1232**

AP1231/AP1232 access point group is an autonomous system that consists of a group of **distributed OmniAccess® AP1231/AP1232s controllers.** **AP12XX in Express mode** One AP12XX AP-Group (any model any mix) supports up to 64 OmniAccess® Access points with minimum of 4 AP12XX (except AP1201H) or minimum of 4 AP13XX, 768 concurrent clients and 16 WLANs (SSID) (version 3.0.7 min) One AP12XX AP-Group (any model any mix) supports up to 255 OmniAccess® Access points with minimum of 8 AP12XX (except AP1201H) or minimum of 8 AP13XX, 768 concurrent clients and 16 WLANs (SSID) (version 3.0.7 min) **AP12XX in Enterprise mode** One AP12XX AP-Group supports up to 4000 OmniAccess® Access Points (any model any mix 3.0.7 min), 1024 concurrent clients and 16 WLANs (SSID)	

OAW-AP1251 **Minimum software version 3.0.2.38 is equivalent to AP365** **Dual-Radio (Outdoor)** **802.11a/b/g/n/ac wave2 (Dual Band concurrent)** Data rate up to 3 MU-MIMO capable devices simultaneously 5GHz: 802.11ac very high throughput (VHT) support: VHT 20/40/80 2.4GHz: 802.11n high-throughput (HT) support: HT 20/40 2× 10/100/1000Mb/s full/half-duplex Ethernet (RJ-45) PoE-PD: 48 V DC (nominal) 802.3af or 802.3at PoE **OAW-AP1251** Built-in antenna 2×2 @2.4GHz, 2x2 @5GHz: - 8.46 dBi at 2.4 GHz - 6.62 dBi at 5 GHz	 **OAW-AP1251**

Application monitoring & control /DPI AP1251 access point group is an autonomous system that consists of a group of **distributed OmniAccess® AP1251s controllers.** **AP12XX in Express mode** One AP12XX AP-Group (any model any mix) supports up to 64 OmniAccess® Access points with minimum of 4 AP12XX (except AP1201H) or minimum of 4 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 3.0.7 min) One AP12XX AP-Group (any model any mix) supports up to 255 OmniAccess® Access points with minimum of 8 AP12XX (except AP1201H) or minimum of 8 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 3.0.7 min) **AP12XX in Enterprise mode** One AP12XX AP-Group supports up to 4000 OmniAccess® Access Points (any model any mix 3.0.7 min), 1024 concurrent clients and 16 WLANs (SSID)	

OAW-AP1201H **Minimum software version 3.0.4.17 is the equivalent to AP303H** **Dual-Radio (Indoor Hospitality)** **802.11a/b/g/n/ac wave2 (Dual Band concurrent)** Data rate up to 3 MU-MIMO capable devices simultaneously 5GHz: 802.11ac very high throughput (VHT) support: VHT 20/40/80 2.4GHz: 802.11n high-throughput (HT) support: HT 20/40 **Uplink 1× 10/100/1000Mb/s full/half-duplex Ethernet (RJ-45) PoE.** **Downlink 3× 10/100/1000Mb/s full/half-duplex Ethernet (RJ-45) 1x PoE** **Passive Pass through one pair, back and bottom** **1x USB 2.0 type A 5 V 500mA** PoE-PD: 48 V DC (nominal) 802.3af or 802.3at PoE	 **OAW-AP1201H** **OAW-AP-MNT-DSK kit**

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Built-in antenna 2×2 @2.4GHz, 2x2 @5GHz: - 4.1 dBi at 2.4 GHz - 7.1 dBi at 5 GHz Application monitoring & control /DPI AP1201H access point group is an autonomous system that consists of a group of **distributed OmniAccess® AP1201Hs controllers.** **AP12XX in Express mode** One AP12XX AP-Group supports up to 32 OmniAccess® Access points, 512 concurrent clients and 16 WLANs (SSID) One AP12XX AP-Group supports up to 64 OmniAccess® Access points with minimum of 4 AP1201H, 512 concurrent clients and 16 WLANs (SSID) **AP12XX in Enterprise mode** One AP12XX AP-Group supports up to 4000 OmniAccess® Access Points (any model any mix version 3.0.7 min), 1024 concurrent clients and 16 WLANs (SSID)	

2.1.3 OmniAccess® Stellar 802.11ax (wifi 6) Access Points.

OAW-AP1311 **Minimum software version 4.0.2 is the 2x2:2SS equivalent to AP505** **Dual-Radio (Indoor)** **802.11a/b/g/n/ac/ax (wifi-6) (Dual Band concurrent)** Data rate up to 8 MU-MIMO capable devices simultaneously High efficiency Wifi-6: OFDMA (Orthogonal Frequency Division Multiplex Access), BSS coloring, Extra Range 5GHz: 802.11ac/11ax very high throughput (VHT) support: VHT 20/40/80 2.4GHz: 802.11n high-throughput (HT) support: HT 20/40 1x1 full band scanning radio Bluetooth Low Energy (BLE) 5.1/ Zigbee radio	 **OAW-AP1311**

2× 10/100/1000Mb/s full/half-duplex Ethernet (RJ-45) PoE-PD: 48 V DC (nominal) 802.3af or 802.3at PoE **1x USB 2.0 type A 5 V 500mA** **Modbus IIoT** **OAW-AP1311** Built-in antenna 2×2 @2.4GHz, 2x2 @5GHz: - 3.5 dBi at 2.4 GHz - 3.7 dBi at 5 GHz Application monitoring & control /DPI AP1311 access point group is an autonomous system that consists of a group of **distributed OmniAccess® AP1311 controllers.** **AP13XX in Express mode** One AP13XX AP-Group (any model any mix) supports up to 64 OmniAccess® Access points with minimum of 4 AP12XX (except AP1201H) or minimum of 4 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 4.0.2 min) One AP13XX AP-Group (any model any mix) supports up to 255 OmniAccess® Access points with minimum of 8 AP12XX (except AP1201H) or minimum of 8 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 4.0.2 min) **AP13XX in Enterprise mode** One AP13XX AP-Group supports up to 4000 OmniAccess® Access Points (any model any mix 4.0.1), 1024 concurrent clients and 16 WLANs (SSID)	

OAW-AP1321 /AP1322 **Minimum software version 4.0.1 is equivalent to AP515/514** **Dual-Radio (Indoor)** **802.11a/b/g/n/ac/ax (wifi-6) (Dual Band concurrent)** Data rate up to 8 MU-MIMO capable devices simultaneously	 **OAW-AP1321**

High efficiency Wifi-6: OFDMA, BSS coloring, Extra Range

5GHz: 802.11ac/11ax very high throughput (VHT) support: VHT 20/40/80

2.4GHz: 802.11n high-throughput (HT) support: HT 20/40

1x1 full band scanning radio

Bluetooth Low Energy (BLE) 5.1/ Zigbee radio

Uplink 1× 10/100/1000/2500Mb/s full/half-duplex Ethernet (RJ-45)

Downlink 1× 10/100/1000Mb/s full/half-duplex

Ethernet (RJ-45)

PoE-PD: 48 V DC (nominal) 802.3at PoE

1x USB 2.0 type A 5 V 500mA

OAW-AP1321

Built-in antenna 2×2 @2.4GHz, 4x4 @5GHz:

- 3.5 dBi at 2.4 GHz
- 3.7 dBi at 5 GHz

OAW-AP1322

4 RP-SMA connectors for external dual band antennas.

Application monitoring & control /DPI

AP1321/AP1322 access point group is an autonomous system that consists of a group of **distributed OmniAccess® AP1321/AP1322s controllers.**

AP13XX in Express mode

One AP13XX AP-Group (any model any mix) supports up to 64 OmniAccess® Access points with minimum of 4 AP12XX (except AP1201H) or minimum of 4 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 4.0.1 min)

One AP13XX AP-Group (any model any mix) supports up to 255 OmniAccess® Access points with minimum of 8 AP12XX (except AP1201H) or minimum of 8 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 4.0.1 min)

OAW-AP1322

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AP13XX in Enterprise mode One AP13XX AP-Group supports up to 4000 OmniAccess® Access Points (any model any mix 4.0.1), 1024 concurrent clients and 16 WLANs (SSID)	

OAW-AP1361 **OAW-AP1362 /61D *** **Minimum software version 4.0.1 is equivalent to AP575/AP574 with SFP and AP577 (13 dBi built-in antenna)** **Dual-Radio (Outdoor)** **802.11a/b/g/n/ac/ax (wifi-6) (Dual Band concurrent)** Data rate up to 8 MU-MIMO capable devices simultaneously High efficiency Wifi-6: OFDMA, BSS coloring, Extra Range 5GHz: 802.11ac/11ax very high throughput (VHT) support: VHT 20/40/80 2.4GHz: 802.11n high-throughput (HT) support: HT 20/40 1x1 full band scanning radio Bluetooth Low Energy (BLE) 5.1/ Zigbee radio Uplink 1× 10/100/1000/2500Mb/s full/half-duplex Ethernet (RJ-45) PoE 802.3at/bt Uplink 1x SFP Downlink 1× 10/100/1000Mb/s full/half-duplex Ethernet (RJ-45) PoE PSE output 802.11at PoE-PD: 48 V DC (nominal) 802.3at PoE **1x USB 2.0 type A 5 V 1000mA** **OAW-AP1361** Built-in antenna 2×2 @2.4GHz, 4x4 @5GHz: - 4.85 dBi at 2.4 GHz - 6.48 dBi at 5 GHz **OAW-AP1362** 6 N-type connectors for external dual band antennas. **OAW-AP1361D** Built-in antenna 2×2 @2.4GHz, 4x4 @5GHz: - 7.5 dBi at 2.4 GHz - 7.4 dBi at 5 GHz	 **OAW-AP1361** **OAW-AP1361D**  **OAW-AP1362**

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Application monitoring & control /DPI AP1361/AP1362/AP1361D access point group is an autonomous system that consists of a group of **distributed OmniAccess® AP1361/AP1362/AP1361Ds controllers.** **AP13XX in Express mode** One AP13XX AP-Group (any model any mix) supports up to 64 OmniAccess® Access points with minimum of 4 AP12XX (except AP1201H) or minimum of 4 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 4.0.1 min) One AP13XX AP-Group (any model any mix) supports up to 255 OmniAccess® Access points with minimum of 8 AP12XX (except AP1201H) or minimum of 8 AP13XX, 512 concurrent clients and 16 WLANs (SSID) (version 4.0.1 min) **AP13XX in Enterprise mode** One AP13XX AP-Group supports up to 4000 OmniAccess® Access Points (any model any mix 4.0.1), 1024 concurrent clients and 16 WLANs (SSID)	

*** Support of VoWLAN with AP1362/61D is only for links configurations like Bridging /Multi-meshing topologies that are carrying voice.**

2.2 Antennas for OmniAccess® Stellar Access Points

(For more details refer to the related antenna datasheets)

2.2.1 General Remarks concerning Antennas

Any type of antenna (802.11a or b/g/n) can be connected to an Access Point operating in MU-MIMO, provided the fact that the quantity of antennas matches the MIMO value:

- 2 antennas of the same type for 2x2 MU-MIMO AP
- 4 antennas of the same type for 4x4 MU-MIMO AP

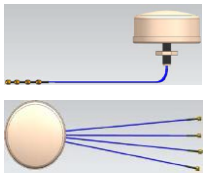
  or 8 antennas of the same type for dual 4x4 MU-MIMO AP

Note: Connector type RP-SMA or N-Type should be considered

When a MU-MIMO AP (all OmniAccess® Stellar Access Points are MU-MIMO except AP1101) operates in pure 802.11a or 802.11b/g/n:

- all the antennas must be connected (e.g. four antennas on AP1222, AP1322 and eight antennas on AP1232)

2.2.2 INDOOR ONLY Antennas (RP-SMA)

Model	Picture	Band	Gain	Polarization	Beamwidth
ANT-O-6 **Indoor MIMO (4 or 8 Antennas needed for MIMO)** Omnidirectional Direct-mount on AP		2.4-2.5 GHz 4.9-5.9 GHz	4.0 dBi 6.0 dBi	**Vertical Linear** 1x RP-SMA/m	E-Plane 45° H-Plane 360° E-Plane 25° H-Plane 360°
ANT-O-M4-5 **Indoor 4x4 MIMO (for mesh link applications or client access)** Omnidirectio!nal Ceiling-mount kit 4 cables		2.4-2.5 GHz 4.9-5.9 GHz	3.3 dBi 5.5 dBi	**Linear Vertical & Horizontal** **4x RP-SMA/j+86/500 mm**	E-Plane 90° H-Plane 360° E-Plane 35° H-Plane 360°

2.2.3 OUTDOOR ONLY Antennas

Electrical protections like surge and lightning protections have to be considered for any external antennas installations, as well as compliance with local regulatory if exist for outdoor electrical installation has to be assured.

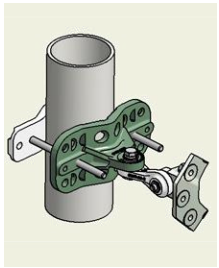
The external antennas below have been validated with Stellar OmniAccess access points. The RP-SMA type is the dedicated mounting with indoor OmniAccess Stellar access points and this limitation has to be considered when designing the installation of following external antennas.

Model	Picture	Band	Gain	Polarization	Beamwidth
ANT-S-M4-30 **Outdoor 4x4 MIMO (for mesh/bridge link applications only)** Sector antenna IP-67 4 RP-SMA cables		4.9-5.9 GHz	13 dBi	Dual slant +-45° & Vertical & Horizontal 4x 300mm cables	E-Plane 37° H-Plane 37°

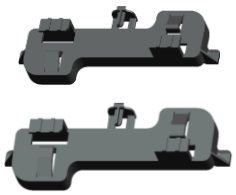
ANT-S-M4-60 **Outdoor 4x4 MIMO (for mesh/bridge link applications only)** Sector antenna IP-67 4 RP-SMA cables **equivalent to ap-ant-48**		2.4-2.5 GHz 4.9-5.9 GHz	6 dBi 6 dBi	Dual slant +-45° & Vertical & Horizontal 4x 300mm cables	E-Plane 60° H-Plane 60° E-Plane 60° H-Plane 60°
ANT-S-M4-120 **Outdoor 4x4 MIMO (for mesh/bridge link applications)** Sector antenna IP-67 4 RP-SMA cables		2.4-2.5 GHz 4.9-5.9 GHz	5 dBi 5 dBi	Dual slant +-45° & Vertical & Horizontal 4x 300mm cables	E-Plane 70° H-Plane 120° E-Plane 70° H-Plane 120°

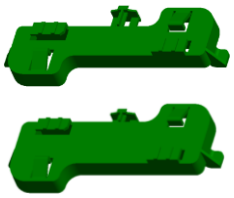
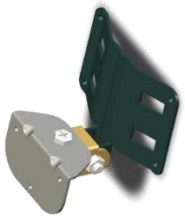
ANT-O-M2-5 **Outdoor 2x2 MIMO (for mesh/bridge link applications only)** Omnidirectional UL94 /IP-67 2” Pole-mount kit 2 N-type cables **equivalent to ant-2x2-5005**		2.4-2.5 GHz 4.9-5.9 GHz	5 dBi 8 dBi	Vertical & Horizontal 2x 300mm cables	E-Plane 35° H-Plane 360° E-Plane 25° H-Plane 360°
ANT-O-M4-9 **Outdoor 4x4 MIMO (for mesh/bridge link applications only)** Omnidirectional UL94 /IP-65 2” Pole-mount kit 4 N-type cables **equivalent to ant-2x2-5010**		2.4-2.5 GHz 4.9-5.9 GHz	7.5 dBi 9 dBi	Vertical & Horizontal 4x 300mm cables	E-Plane 22° H-Plane 360° E-Plane 11° H-Plane 360°

2.2.4 Antennas mounting kits

Model	Picture	Characteristics
MNT-22 **Pole or Wall-mount kit for Pigtail RG 316 mounting** Az/El ajustable Included with ANT-S-M4-60 & ANT-S1-M4-120		
MNT-23 **Pole or Wall-mount kit for Pigtail RG 316 mounting** Az/El ajustable Included with ANT-S-M4-30		
2" Pole **Pole-mount kit for ANT-O-M2-5 and ANT-O-M4-9** Az/El ajustable Included with ANT-O-M2-5 and ANT-O-M4-9		

2.2.5 AP mounting kits

Model	Picture	Characteristics
OAW-AP-MNT-B **Ceiling-mount kit (for T-shaped standard rail mounting)** Included in box		

OAW-AP-MNT-C **Ceiling-mount kit (for other-form rail mounting)**		
OAW-AP-MNT-W **Wall/Ceiling-mount kit**		With screws
AP-MNT-OUT **External-mount kit for AP1251**		With expansion bolts and hose clamps
AP-MNT-OUT-H **External-mount kit for AP1361/62/61D**		With expansion bolts and hose clamps

2.2.6 AP external power adapters

The OmniAccess® Stellar Access Points can be supported via a localized external power supply. This AC/DC transformer is the same type of device used to recharge batteries in PDAs, mobile phones, and some laptop computers. While an available option, the use of localized power is discouraged due to the likely location of Access Point placement and this proximity to AC outlets, fire-code safety concerns, and power autonomy costs.

Model	Picture	Characteristics
ADP-30HRBD **AC power adapter for AP1101, AP1201, AP1201H, AP1221 and AP1222** **AP1311, AP1321 and AP1322**		AC100-240V input, 48V DC output, 30W Compatible 802.3af/at

ADP-60GRBC **AC power adapter for AP1101, AP1201, AP1201H, AP1221, AP1222, AP1231 and AP1232** **AP1311, AP1321 and AP1322**		AC100-240V input, 48V DC output, 60W Compatible 802.3af/at
ADP-50GRBE **AC power adapter for AP1101, AP1201, AP1201H, AP1221, AP1222, AP1231 and AP1232** **AP1311, AP1321 and AP1322** **In replacement of ADP-30HRBD and ADP-60GRBC**		AC100-240V input, 48V DC output, 50W Compatible 802.3af/at

2.3 RF Director Management

The initial goal of RF (Radio Frequency) Spectrum Management is to configure and calibrate radio settings for the wireless network. After the radio network is operational, the goal of RF Spectrum Management changes to that of tuning and adjusting radio parameters in order to maintain a high degree of performance. With ALE, RF Spectrum Management is largely automatic, requiring little configuration or intervention from the administrator.

OmniAccess Stellar versions 4.0 and more provide a set of functionalities to simplify WLAN operations and provide the relevant support for dense 802.11ac/ax environments, this for all AP12XX and AP13XX.

The key components of ALE RF Director solution are:

- **Calibration:** Used continuously throughout the life of a wireless network; Calibration functions allow network administrators to optimize power and sensitivity settings of the network on an antenna by antenna basis.

- **Optimization:**
  - DRM (Dynamic Radio Manager) version 4.0.2 provides per radio a channel list setting that defines a perimeter for automatic channel assignment.
  - Auto Radio Resource Allocation: allows individual access points to monitor for RF changes and, in conjunction with Calibration information, make appropriate channel assignment changes.
  - DRM version 4.0.2 provides power range setting per radio that enables DFS/TPC (Dynamic Frequency Selection/Transmission Power Control) to ensure access points stay clear with local regulations in term of power transmission.

- Self-Healing: In the event that an AP fails, surrounding APs can automatically increase their transmit power level to fill in any gaps.

- Dynamic Load Balancing: ensures optimum performance by automatically spreading client association in an equitable manner to avoid the premature saturation of a single AP, on a client count & channel utilization basis.
- Band steering: steer the dual band clients on client a count & channel utilization basis

- Air time fairness: ensures higher download speed to latest 802.11ac/ax devices when slower devices are connected to the same AP (giving equal amounts of air time to each client regardless of minimum datarates)

- DRM version 4.0.2 get Stellar wireless network ready with latest 802.11ac/ax devices by enabling by default MU-MIMO and 802.11ax (AP13XX Access Points). Both functions can be deactivated to interoperate with older devices.

- **RF Monitoring:**
  - Coverage Hole Detection: Continuous monitoring of client data access and error rates provides for the identification of coverage holes or areas of diminished service.
  - Interference Detection: notifies network administrators when localized interference becomes sufficient to cause performance degradation.
  - ACC: minimizes interference from 3G/4G/LTE networks, distributed antenna systems or small cell/femtocell equipments.

- **Channel width setting:**
  - 40/80Mhz modes disabling or DFS sub-bands disabling (5Ghz band) in case of presence of radar systems/weather stations or for specific operations.

- **Wireless Intrusion Protection:**
  - Can identify and defeat a wide assortment of DoS attacks (Deny of Service) aimed at Wifi networks.
  - DRM version 4.0.2 supports full scan of all channels for prevention on all Stellar wifi 6 AP13XX by activating scan on dedicated 1x1 radio.

2.4 Fast roaming Management

OmniAccess Stellar® versions 3.0.7 and more add the following Enterprise roaming features to the **PMK (Pairwise Master Key) /OKC (Opportunistic Key Caching) caching** and **802.11r Fast Basic Service Set Transition (FT):**

A set of functionalities give fast roaming as result for latest 802.11ac/ax clients roaming from AP to AP within OmniAccess Stellar® AP-Group:

- **Assisted roaming for 802.11r,11k or 11v capable clients:**
  jointly with 802.11k and 802.11v standard based protocols, assists the roaming based on **RSSI** (Received Signal Strengh Indicator) **roaming threshold** for a proper clients mobility within the AP-Group.
- **Client Network Context Sharing (CNCS):**
  updates a Client Context database upon clients associations between adjacent APs within the AP-Group

- **L3 (Layer 3 /IP layer) roaming handling:**
  allows automatically tunneling of client traffic from the "Home AP VLAN" for WLAN campus deployments with SSIDs assigned to different user VLANs (Virtual LAN)
- **Sticky client avoidance:**
  based on clients RSSI monitoring, enables the client disconnection when RSSI becomes weak and goes under **RSSI association threshold**

The 802.11k standard is supported to help 802.11k clients to speed up their search for adjacent APs available as roaming candidates by creating an optimized list of channels. This list is built and sent by associated Stellar® Access Point. When 802.11k client decide to roam, this handy neighbor list allows the client to probe the correct "new AP" and provide a fast AP transition at less than 150ms for voice applications.

The 802.11v – BSS Transition Management offers a full network assisted roaming enhancement for 802.11v client devices where the AP will try to assist in the roaming decision making by providing a recommendation in the form of request to the client, at any time on decision of Stellar roaming. The request will contain a suggestion of the best available AP that client could potentially roam to.

OmniAccess Stellar roaming relies on **Clients Network Context Sharing (CNCS**) between adjacent APs enabling the roaming decision based on updated Client Network Context between a "new AP" and the "Home AP". All APs learn about their neighboring APs through "over-the-air" (or "on-LAN" exchanges depending AP-Group setting) allowing to announce each other their respective current LAN management on wired network side.
On each client association/dis-association the "new AP" updates its Client Network Context database and sends a *Add/Del Client Network Context* to all adjacent APs. On receiving APs, the *Add/Del Client Network Context messages* are discarded when the AP is not in the concerned WLAN service or is not managed by the same OV.

Client Network Context	AP Context	Fast roaming
WLAN service, MAC, IP address, Current assignment (VLAN ID, Access Role Profile, Redirect URL)	MAC, IP address & IP OV	802.11r Fast Transition /OKC /PMK caching

Figure 1: Client Network Context

Campus WLAN deployments generally require the provisioning of different APs supporting the same SSID but assigned with different VLANs for users. A wireless user that roams across APs that are assigned to different user VLANs is initiating **L3 roaming**. Stellar allows automatically the tunneling of client traffic from the Home AP and establishes L2 (Layer 2 /MAC layer) GRE tunnel to the "Home AP" via the "new AP" at early stage of roaming. The traffic is transparently tunneled to the Home AP, allowing user to roam without a change of IP address and keeping all policies including QoS (Quality of Service) and security ACLs (Advanced Control List) maintained when the user roams.

OmniAccess Stellar L3 roaming is supported in Enterprise mode only, with the use of advanced AOS OS6860/60E switches for L2 GRE tunneling handling. The decision to build/delete GRE tunnels upon CNCS database is applicable for all clients, 8158s, OY8128 SE or any 802.11ac data devices.

8158s and 8168s WLAN handsets support **PMK /OKC caching**, **802.11r Fast Transition and 802.11k standard in their version 2.2.9.**
802.11r is supported for data devices with 802.1x authentication methods.

3. Server Elements (DHCP, TFTP, Management, RADIUS, IMS3)

3.1 DHCP Server

Customers have two IP address allocation schemes to choose for 8158s and 8168s WLAN handsets, static mode and dynamic mode. Static mode operation is very simple and requires no expanded explanation. Terminals are simply programmed manually with IP addresses, subnet mask, default gateway, and TFTP (Trivial File Transfert Protocol) server information for NOE mode (New Office Environment). Optionally, 8158s and 8168s WLAN handsets can be configured in a dynamic mode via standard DHCP (Dynamic Host Configuration Protocol) server options.

Dynamic mode is recommended due to ease of use and speed of reconfiguration. An external or an internal DHCP server (OmniPCX Enterprise) can be used for all 8158s and 8168s VoWLAN solutions. ALE does not currently offer the DHCP Server hardware platform and recommends the customers or business partners source this equipment from their usual PC Server supplier.

Dynamic mode is the default mode for OmniAccess® Stellar Access Points IP address allocations. It is recommended to configure OmniAccess® Stellar Access Points in a dynamic mode via standard DHCP server options specially to facilitate any AP Group deployment.

The automatic provision of APs configuration can be done from standard TFTP server options to specific Capwap option if Omnivista 2500 server is used.

Dynamic mode is also the recommended mode for any DHCP deployment of 8158s and 8168s WLAN handsets with an IMS3 server. IMS3 deployment is configured via standard DHCP server options and specifically 43 option to facilitate any deployment of 8158s and 8168s WLAN handsets.

ALE has validated the following DHCP Server software platforms for use with 8158s and 8168s VoWLAN solutions.

Validated DHCP Server software platforms	
Windows 2003 (Server)	ALE VitalQIP
OXE embedded for 8158s and 8168s WLAN handsets	

3.2 TFTP Server

A TFTP Server is mandatory for all 8158s and 8168s VoWLAN solutions in NOE mode. The TFTP Server is responsible for supplying Binary to the 8158s and 8168s WLAN handsets. TFTP Server can be also responsible for supplying the Configuration of the OmniAccess® Stellar AP1101 if necessary.

TFTP Server functions can be hosted from the OmniPCX Enterprise Communication Server or external.

There are no unique TFTP Server requirements beyond standard TFTP protocol specifications to support 8158s and 8168s WLAN handsets in NOE mode. It is possible to combine TFTP Server and DHCP Server functions on a single external platform.

ALE has validated the following TFTP Server platforms for use with 8158s solutions.

Validated TFTP Server software platforms	
3Com TFTP Server (3CDaemon)	OXE embedded for 8158s and 8168s WLAN handsets

3.3 Omnivista 2500 Server

A Omnivista 2500 management server is mandatory for the deployment of Stellar solutions in Enterprise mode.

Omnivista 2500 is responsible for registering Stellar Access Points, for supplying Binaries to the APs and managing full wireless/wired mobility with a unique network profiling to the devices networking on the supervised site. Omnivista 2500 is also responsible for advanced management of Stellar wireless protection (WIPS), for advanced management of guest/BYOD network accesses and for advanced networking strategies.

Omnivista 2500 server includes an internal RADIUS (Remote Authentication Dial-In User Service) server within its embedded Unified Policy Authentication Manager (UPAM) that is associated with any authentication method which requires the use of a Network Authentication Server (NAS) in an 802.1x architecture.

Use of DHCP server is still required and declaration of the Omnivista 2500 management server to Stellar APs is done via the standard option 138 of the DHCP server.

ALE has validated the following 2500 Management Server platforms for use with 8158s and 8168s WLAN solutions.

Validated Omnivista 2500 Server software platforms	
2500 NMS Enterprise version 4.5R02 and later	

3.4 RADIUS Server

A RADIUS server is always associated with any authentication method for devices that require the use of a Network Authentication Server (NAS) in a 802.1x architecture.

In Express mode application of a strong authentication method like WPA2 or WPA3 Enterprise for 8158s and 8168s WLAN handsets requires the use of external RADIUS server. In this case 8158s and 8168s WLAN handsets support both 802.1X EAP-TLS (Enhanced Authentication Protocol – Transport Layer Security) and PEAP (Protected Extensible Authentication Protocol) methods and Stellar access points have the role of RADIUS client for all the vowlan handsets.

8158s and 8168s WLAN handsets do not support WPA3 encryption in version 2.2.9.

The use of the Omnivista 2500 internal RADIUS server in Enterprise mode is the preferred mode as it allows apply a single NAS server for both voice and data wireless/wired devices and apply coherent 802.1x network access policies for an entire Enterprise network supervised by the Omnivista 2500 server. Enterprise mode gives always the possibility for 8158s and 8168s WLAN handsets to authenticate through their external RADIUS server if maintained for the Voice over WLAN.

ALE has validated the following Radius servers platforms for use with 8158s and 8168s WLAN solutions.

Validated Radius servers on 8158s and 8168s WLAN	
Microsoft Network Policy Server (NPS)	Microsoft IAS
Steel-Belted	FreeRadius
Clearpass	2500 NMS Enterprise version 4.5R02 and later

3.5 IMS3 Server

The use of IMS3 server for automatic provisioning of 8158s and 0T8128 WLAN handsets with a pre-defined SSID is recommended for large Voice over WLAN deployments. With the 6.1.2 version, a pre-defined "**AWS-INIT**" SSID is embedded in handset and broadcast by OmniAccess® Stellar Access Points on both 2.4Ghz & 5Ghz bands. A DHCP deployment with IMS3 server provides the easiest method to centralize the management and configure all 8158s and 8168s.

There is always the possibility to use a combination of IMS3 and WinPDM cradle for handsets administration.

ALE has validated the following IMS3 server platform for use with 8158s and 8168s WLAN solutions.

Validated IMS3 server on 8158s and 8168s	
Ascom IMS3/Elise3 administration tool version 4.6.2	

4. OmniTouch WLAN Handsets

4.1 General Description

ALE makes now two models available for next generation of WLAN handsets, one for office (8158s) and one for industrial use (8168s). The performance of these handsets is very similar but their designs and options are focused for use in specific environments. Both models are handling SIP (Session Initiation Protocol) and legacy NOE protocols.

All of these terminals are products of an OEM partnership between ALE and Ascom.

Main differencies between 8158s and 8168s WLAN handsets:

8158s has a black&white screen

8168s has a color screen and in addition embed the following features:

- Hands-free
- Push-To-Talk
- Ekahau RTLS (Real Time Location System)

Figure 2: 8158s WLAN handset & 8168s WLAN handset

4.2 8168s handset Look and Feel

Figure 3: 8168s look and feel

This picture describes the main functionalities and keys available on 8168s WLAN handset

4.3 8158s and 8168s handsets Physical Features

Mechanical characteristics	8158s	8168s
Dimensions (hxwxd)	137x52x21 mm - 5,39x2,04x0,82 in.	
Weight	135g - 4,8oz excl. clip	
Display type	B&W graphical	Color graphical
Display size (pixels)	240x320	
Display Backlight	Yes	
Keypad Backlight	Yes	
Hands-free	Yes	
Vibrator	Yes	
Headset connector	3,5mm jack	

This table presents the physical features of the next generation WLAN handsets (8158s & 8168s).

4.4 8158s and 8168s handsets Technical characteristics

Technical characteristics	8158s	8168s
Navigation keys	4	
OK key	Yes	
Soft keys	3	
Volume keys +-	Yes	
Loudspeaker key	Yes	
Mute key	Yes	
Dial by name key	Yes	
Keypad lock key	Yes	
Alarm Button/ Profile key	Alarm /Profile key configurable	
Push to Talk key	Yes	
Color (front panel/ bezel/keys)	Black/Black/Black	
IP class	IP44	
Belt clip (standard)	Yes	
Belt clip (swivel)	Accessory	
Security chain hole	Yes	
Operating Temp.	-5 +45°C, +23 +113°F	
Operating humidity	10 to 95% non condensing	
Talk time	Up to 10 hours	
Standby time	Up to 100 hours	
Charging time	Less than 4 hours	

This table presents Technical characteristics of next generation WLAN handsets (8158s & 8168s WLAN).

4.5 Push-To Talk on 8168s handset

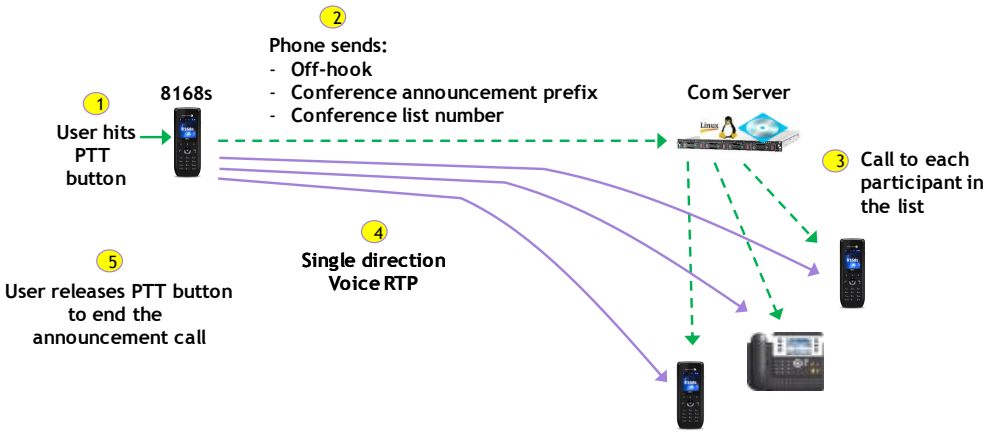


Figure 4: Push-To-Talk operation

PTT (Push-To-Talk) on 8158s and 8168s WLAN is based on OXE Mastered conference announcement, using single direction voice RTP (Real Time Protocol).

- Automatic off-hook and speak to participants in conference list
- Participants are MUTEd automatically and cannot be UN-MUTEd, the announcement is forced to
- loudspeaker.
- predefined Announcement lists (up to 12) can be created on each 8168s.

There is a parameter in 8168s WinPDM (configuration tool), indicating the list number in use for Push To Talk. On 8168s local menu, there is also a field corresponding to “PTT list number”.

Participants to PTT can be wireless or wired phone sets.

A 8168s WLAN cannot be the initiator of the OXE Mastered conference.

Warning: Push-To-Talk is Not supported on OXE in OTMS configuration (OpenTouch Multimedia System)

4.6 8158s and 8168s handsets Features

Feature	8158s	8168s
Radio support	802.11n/11ac	
Wireless security	802.11i, 802.11w WPA/WPA2/WPA3 Personal & Enterprise *	
Authentication	Open WPA/WPA2/WPA3 802.1x & EAP : PEAP-MSCHAPv2, EAP-TLS, EAP-FAST	
Certificates	Factory and up to 8 root & clients	
QoS	802.11e, WMM	
Power Save	U-APSD, WMM-PS	
Call admission control	TSPEC-based CAC	
Fast roaming	PMK caching & OKC (Opportunistic Key Caching) 802.11r Fast Transition, 802.11k	
Bluetooth	No	BTLE Bluetooth for headset

This table presents QoS and Security and QoS features of OmniTouch WLAN handsets 8158s & 8168).
* WPA3 personal & Enterprise are not supported in current 81x8s software version 2.2.13. **Refer to 81x8s release note to have the minimum software version to support WPA3.**

Feature	8158s	8168s
Audio codec	ITU-T G711 (A,µ), G729AB	ITU-T G711 (A,µ), G729AB Opus Narrowband Opus Wideband
Telephony protocol	ALE telephony: dual stack protocols (NOE or SIP) *	
IP address assignment	Static, DHCP	
DSCP	Pbx settings or local settings	
SUOTA	SW update over the air TFTP (NOE only) WLAN (SIP or NOE)	
Location support	No	IR,LF, Poll location BLE RTLS Ekahau
Serviceability	Diagnostic, Syslog, sftp, site survey tool	
Configuration tool	PDM (Portable device manager) IMS3 gateway for mass deployment (optional)	
System registration	Up to 4 systems Auto selection and manual selection	
WLAN infrastructure	ALE OmniAccess® Stellar, ALE OmniAccess® WLAN, HPE/Aruba Networks, Cisco, Extreme Networks, Ruckus Wireless	
Languages (Handset MMI)	Arabic, Chinese (simplified), Czech, Danish, Dutch, English, Finnish, French, German, Greek, Hungarian, Italian, Norwegian, Polish, Portuguese (Brazilian), Russian, Slovak, Spanish, Swedish, and Turkish	
Additional languages	1 downloadable additional language	
System languages	System dependant	
Screensaver	Yes, customizable	
User profiles	5 pre-defined among 10 user configurable	

	User-defined custom sounds

This table presents additional features of OmniTouch WLAN handsets 8158s & 8168).
***** 81x8s SIP is not supported in current OXE and OXO software releases. 81x8s TLS telephony protocols encryptions are not supported in current software releases. **Refer to 81x8s and OXE/OXO release notes to have the minimum software versions to support telephony protocols features.**

4.7 Integrated Messaging and Wireless Services (IMS3) Tool for 8158s and 8168s handsets

The IMS3 (Integrated Messaging and Wireless Services) is a web-based tool used for 8158s devices management, messaging, and alarms control. The module is based on ELISE3 hardware and the Linux operating system, designed as an all in one central device management.

The device management is supported via the LAN of the installation.
IMS3 is able to manage the wlan radio settings of 8158s in both NOE and SIP modes.

This Ascom product is directly "bought and resold" by ALE.

4.8 WinPDM Administration Tool for 8158s and 8168s handsets

The WinPDM (Windows Portable Device Manager) Administration Tool is a software utility installed on a PC, the Configuration Cradle is connected to this PC via an USB cable.

8158s and 8168s WLAN configuration through a Configuration Cradle is always supported

Note: The configuration cradle does not intend to replace the Desktop Charger, as it just provides a light power feeding to keep the battery operational during the 8158s and 8168s WLAN configuration.

4.9 Integrated Messaging and Wireless Services (IMS3) Specifications

- Web-based application on ELISE3 hardware and Linux operating system
- 1x 10baseT or 100baseT Ethernet LAN port
- USB Host port 2.0 for device management via USB
- Serial R232 ports used for external Ascom protocols
- AUX inputs/outputs and error relay for alarm systems

4.10 WinPDM Specifications

- Install on a PC running Windows XP SP2 or Windows 7 (Vista is not supported)
- SUN Java Runtime Environment version 6.x or higher
- Acrobat Reader 4.0 or higher

- USB port 1.1 or higher
- Administrator rights to the computer

4.11 Needed parameters on 8158s and 8168s handsets

SIP and NOE Parameters cannot be set from inside the IMS3 or WinPDM. Assigning a phone number to the device is done by registering the handset to the PBX in the normal fashion. When 8158s and 8168s WLAN are configured in static mode TFTP parameters must be configured via IMS3 or WinPDM.

WLAN and other Network parameters :
a few can be set using the Handsets Admin menu from the keypad, **advance parameters must be set using the IMS3 or WinPDM**. Some User settings cannot be performed from the keypad so **the IMS3 or WinPDM must be used.** Using **IMS3 Templating** or WinPDM Templates for all tasks will reduce the risk for errors and will make the deployment faster. Storing all handsets parameter files in the **IMS3 databases will create a status record of handsets belonging to an installation**

4.12 Integrated Messaging and Wireless Services (IMS3) Technical Overview

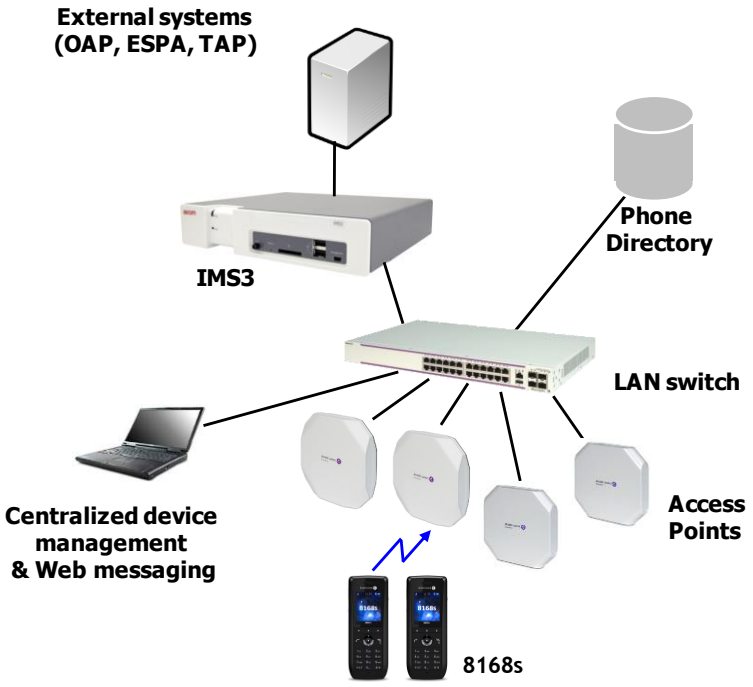


Figure 5: IMS Diagram

IMS3 (integrated Messaging and Wireless Services) is an embedded Linux server connected to the LAN of the installation and provides a centralized management for all 8158s and 8168s WLAN phones and configuring each phones, management of templates for several common settings or all devices.

IMS3 is able to manage the wlan radio settings of 8158s and 8168s WLAN in both NOE and SIP modes.

This web-based server can download the phonebook from a phone or a phone contact, then download specific language file to a phone (add a language) if needed.
A Backup of all individual settings phone, including contacts can be done and Software Upgrade can be scheduled for a specific date or time.

IMS3 server can control several phones at the same time.

Management of 8158s and 8168s handsets with IMS3 is recommended for 8158s and 8168s devices handling (upgrades), installations migrations (PDM to IMS3 migrations, mixed 8158s and 8168s installations with 81x8 handsets and scalability handling with Integrated wireless services (200 handsets and more with multiple IMS3).
IMS3 stays mandatory for Ascom Messaging Services & Alarm system handling.

Please refer to Configuration Manual IMS3 for further configuration guidelines with Ascom IMS3 version 4.6.2.

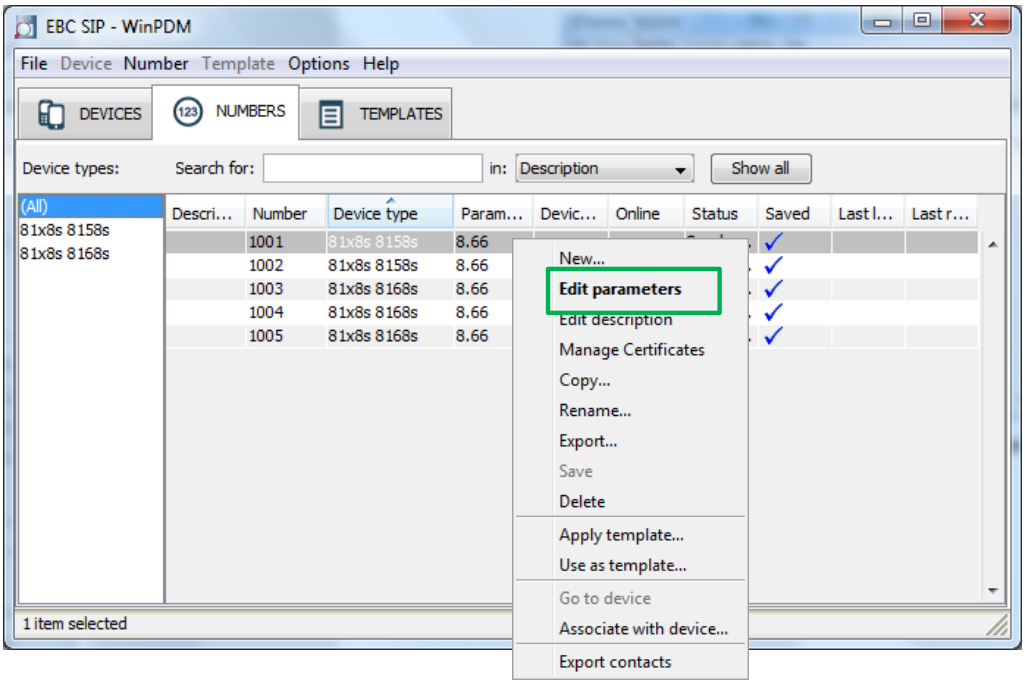


Figure 6: IMS3 Phones overview window

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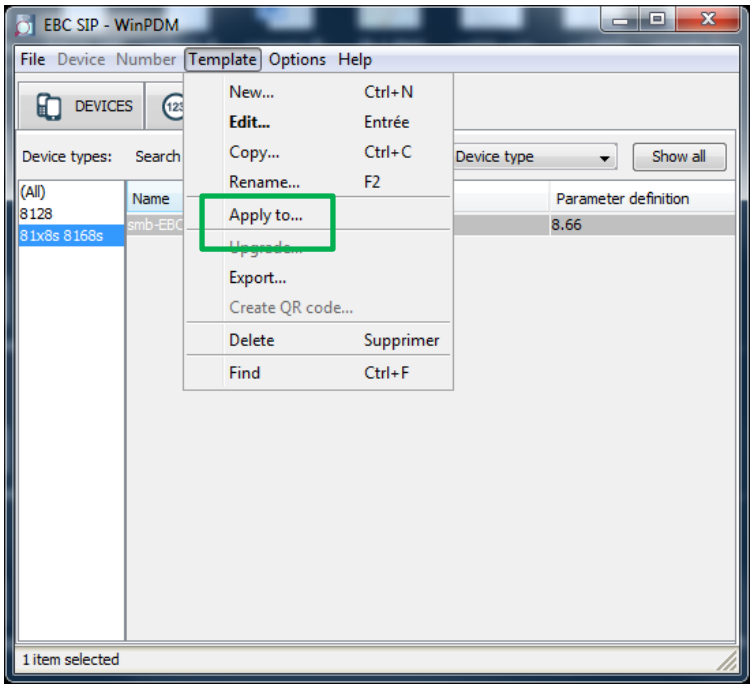

Figure 7: Template assignment with IMS3

4.13 WinPDM Technical Overview

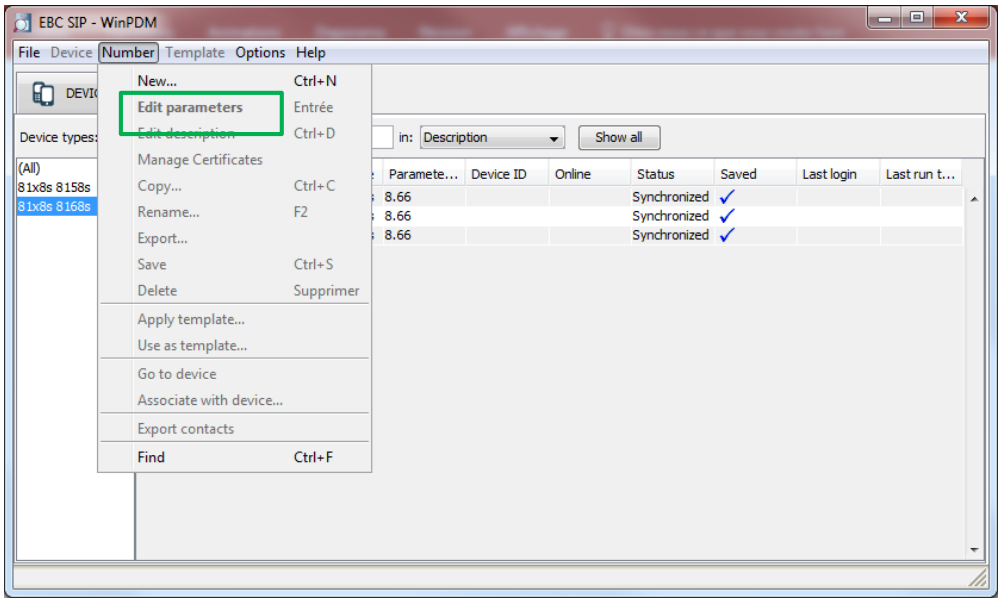

Figure 8: Handset administration tool window

Alcatel·Lucent Enterprise

A Java based software containing both a server and a client. Application will be installed in one folder and the databases in a second folder. The application can be updated with new versions without losing the database. Handset data can be imported or exported to other PCs running WinPDM. The database is separated in Sites, a collection of handsets records. Several Installations corresponding to different customer sites can be supported on a single application.

4.14 Home Screen Customization for Hospitality

In order to answer customer needs in hospitality, it is now possible to configure the 8158s or 8168s WLAN screensaver with up to four lines. Following is an example:

Figure 9: Home screen customization

4.15 Home Screen Prerequisites

Here are the prerequisites in order to set up home screen:

- Up to 4 lines
- For each line, max 32 characters input
- WinPDM .13.4
- Import of 8158s and 8168s software pkg to WinPDM is required to allow the 4 lines text message feature.

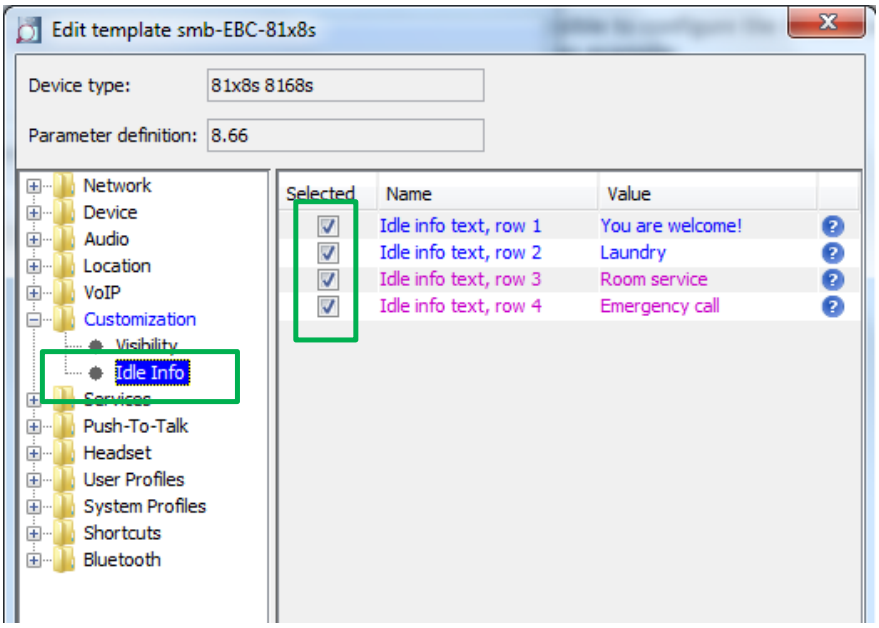

Figure 10: Four line creation with IMS3 or WinPDM

This template shows a configuration example of the fourline display message. Question mark "?" provides additional information/help.

The 4-line display message can be specific to a user and can be created one by one.

The same 4-line display message can also be sent to multiple users. Different templates can be created for different purposes. For instance a first template can be assigned to one or several users, while some other templates can be dedicated to one or some other users.

5. Rainbow UCaaS client

5.1 General Description

The Rainbow application is a cloud-based Unified Communication Service (UCaaS) that makes additional collaboration services available to users regardless of existing communication systems.

The Rainbow solution adopts different approaches in the cloud for communications, the hybrid mode integrates Alcatel-Lucent Enterprise OXO Connect and OmniPCX Enterprise PBXs, as well as non-ALE PBXs in premise networks with addition of WebRTC gateway, and the Full Cloud mode that relies on Softswitch and WebRTC gateway integrated into the Rainbow Cloud. To illustrate Audio/Video features on UCaaS Rainbow client, guidelines focus on the hybrid cloud mode where appliance WebRTC gateway is integrated with Alcatel-Lucent PBXs.

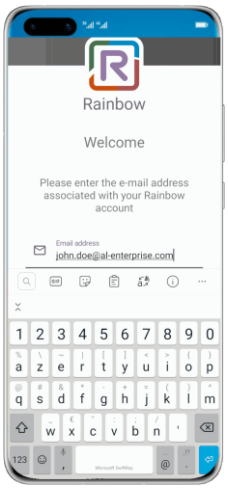

Figure 11: Rainbow UCaaS client on Android mobile

5.2 Look and Feel

Rainbow is a solution that provides features like contacts management, chat, screen and file sharing, meetings organization but also Audio/Video calls in HD quality, a telephony presence and reception of business calls from a smartphone.
Rainbow UcaaS client is easy to deploy since it only takes a single click to download and install it from Internet.

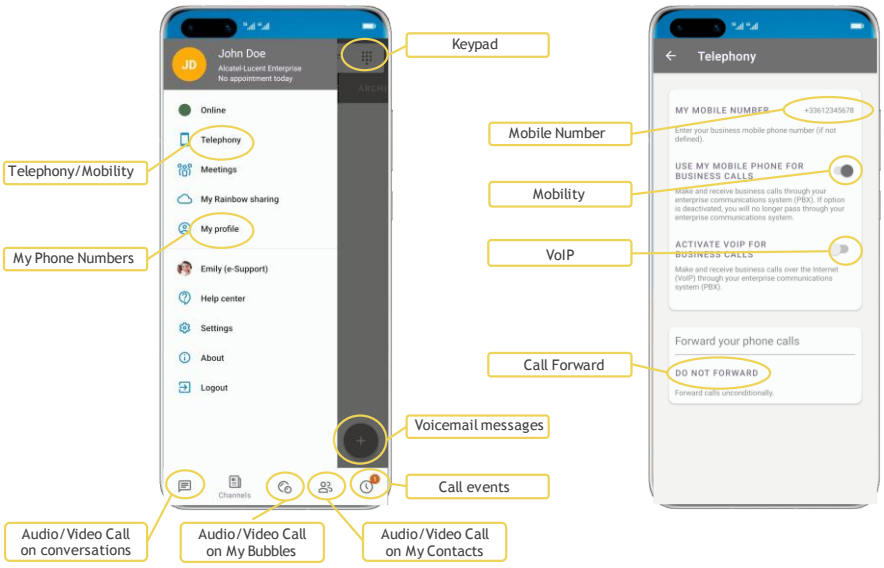

Figure 12: Audio/Video features on Rainbow UCaaS client

Alcatel·Lucent Enterprise

The picture describes key Audio/Video functionalities available on Rainbow UCaaS client

5.3 Certified devices

Audio/Video performances and features with Rainbow UcaaS Client are strongly dependent on the platform on which the client is installed. ALE provides certifications and lists of supported mobile devices with a focus on:

- QoS management for Audio/Video flow for Rainbow Client
- Support of roaming and security protocols over the WLAN
- Support of codecs for Rainbow client
- Compatibility with a business use or a rugged/industrial use

To find out which Rainbow features are supported on a consumer smartphone, please refer to **Device White List - Tested And Certified Devices** document in Reference Documents chapter $30, the document provides a list of devices tested with consumer smartphones for ALE applications. Refer also to chapter $27.9 on ALE applications for recommandation on required WLAN protocols.

To know Audio/Video functions supported on a specific smartphone (Hardened Smartphone) please also refer to **DSPP (Third-party Partner Products) program** to have the IWR (InterWorking Report) status for a specific manufacturer developing the application with ALE. Details on the DSPP program can be found under BPWS.

Feature	
Radio support	802.11n/ac/ax 5G/LTE
Wireless security	802.11i, 802.11w WPA/WPA2/WPA3 Personal & Enterprise
Authentication	Open/WPA/WPA2/WPA3 802.1x & EAP : PEAP-MSCHAPv2, EAP-TLS, EAP-FAST
QoS	802.11e, WMM
Power Save	Power save polling, WMM-PS
Fast roaming	PMK caching & OKC (Opportunistic Key Caching) 802.11r Fast Transition, 802.11k, 802.11v
Bluetooth	Bluetooth for headset Headset HD

Audio codec	Opus NB, WB
Video codec	VP8
Audio/Video protocol	WebRTC

Figure 13: Audio/Video features

Audio/Video features are system dependant. Please refer to manufacturers product information to be informed about supported features.
Rainbow application gives preference to WLAN 802.11ac/ax radio to support all requirements for a business use with Audio/Video.
Rainbow application supports all Audio/Video streaming in WebRTC regardless of business call made with the other phones.
Notification & Alarm functionality is supported with Rainbow Alert service.

Technical & physical characteristics	
Technical characteristics	**System dependant**
IP address assignment	Static, DHCP
SUOTA	SW update over the air (WLAN or 5G/LTE)
Location support	Bluetooth Low Energy GPS
Talk/Standby/Charging time	
Languages/ System languages	
Hands-free	
Programmable buttons	
Physical characteristics	**Platform dependant**
IP class	
Dimensions/weight	
SIM slots	
Display type	
Cameras	
Vibrator/Sensors	
Headset connector	
Operating/Storage temp. Humidity	
Belt clip/House	Accessories

Figure 14: Technical & physical features

Phone physical features like Headset, Hands-free kit, Vibrator, Loudspeaker, SIM slots for the support of 5G/LTE radio, or accessories, are those of the platform supporting the Rainbow application. Refer to the manufacturer's technical documentation to find out which features are suitable for a specific use.

5.3.1 DSPP certifications status

DSPP program provides certifications for some handset's manufacturers, please refer to the related manufacturer's IWR to find out voice features supported on the handset. List of handsets supported is as follows:

Spectralink Versity (SIP client) under DSPP program with IWR
Spectralink 84xx (SIP client) under DSPP program with IWR
Ascom MyCo III (SIP client) under DSPP program with IWR

A DSPP program is active to provide certifications for ruggedized smartphones (industrial smartphones) supporting the Rainbow application, with IWR delivery.

Consult regularly the Business Partner Web Site (**https://businessportal.al-enterprise.com**) in order to be informed about latest inputs concerning the DSPP certifications for such devices and manufacturers.

6. PBX services

6.1 PBX features

8158s and 8168s sets in NOE mode use integrated NOE features (dial by name, notification for messaging, multi-line, multiple calls, normal/casual conference, enquiry call, transfer, call parking, automatic call back, different forwards, voice mail access, send/read text message, etc…) and as a result can be globally considered as an IP Touch set, but limited by its ergonomics (a part of boss/assistant features, no MLA, no key programming, no interphony, etc…).

Warning: 8158s and 8168s WLAN handsets supported with OmniAccess® Stellar WLAN Access Points in SIP mode use integrated PBX SIP Extension features. For more details see Feature List and Product Limits.

6.2 Loudspeaker Announcement

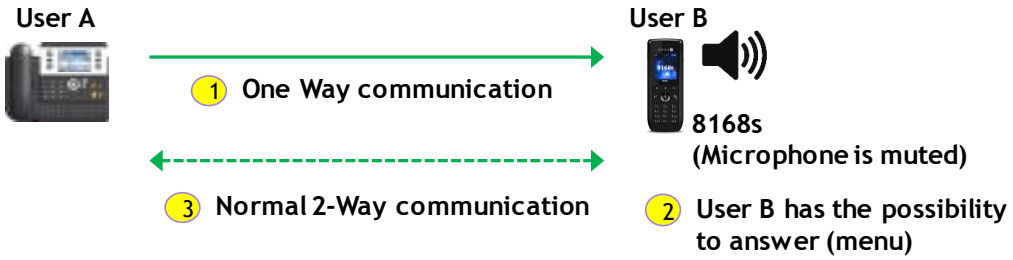

Figure 15: Loudspeaker Announcement

The OXE Loudspeaker Announcement feature is available on 8168s, but not on 8158s. because 8158s has no loudspeaker. A one-way communication takes place directly on 8168s loudspeaker. The 8168s user can answer the call (via the menu) if he wishes to do it.

6.3 Voice over WLAN offer: handset packs and options

OmniTouch 8158s WLAN handset This pack includes the 8158s handset, the battery and the belt clip, without the desktop charger. (Ref 3BN78421AA) Note: The desktop charger must be ordered separately	 Battery 8158s Belt Clip
OmniTouch 8168s WLAN handset This pack includes the 8168s, the battery and the belt clip, without the desktop charger. (Ref 3BN78422AA) Note: The desktop charger must be ordered separately	 Battery 8168s Belt Clip
Standard Battery for 8158s, 8168sWLAN handsets (Ref: 3BN78427AA)	 Battery

Belt Clip for 8158s, 8168s WLAN handsets (Ref: 3BN78423AA)	 **Belt Clip**
Swivel Clip for 8158s, 8168sWLAN handsets (Ref: 3BN78425AA)	  **Swivel Clip**
Leather Carrying Case for 8158s, 8168sWLAN handsets (Ref: 3BN78424AA)	 **Leather Carrying Case**
Desktop Charger for 8158s, 8168sWLAN handsets Europe (Ref 3BN78403AA) UK,US, AUS (Ref 3BN78403AB) For other countries but without Power supply/Mains plug (Ref 3BN78403AC)	 **Desktop Charger (with power supply)**

Rack Charger 6 slots to fit 8158s, 8168s WLAN handsets (Ref 3BN78406AA) A power cord (with an IEC13 Female connector) must be ordered separately : (e.g. Ref 3BA03215AA generic power cord) (e.g. Ref 3EH35004AA Power cord Europe for France)	 **Rack Charger**
Corded Monaural Headset for Mobile Jack Plug 3.5mm - Plantronics HW510N-(Ref3GV28047AD)	

Batteries Rack Charger 6 slots to fit batteries for 8158s, 8168sWLAN handsets (Ref 3BN78425AA) A power cord (with an IEC13 Female connector) must be ordered separately : (e.g. Ref 3BA03215AA generic power cord) (e.g. Ref 3EH35004AA Power cord Europe for France)	 **Batteries Rack Charger**

Configuration cradle for 8158s, 8168sWLAN handsets (Ref: 3BN78414AA) This device is similar to a desktop charger but has an USB port instead of a DC power connector. The configuration cradle only maintains power feeding during 8158s and 8168s WLAN handsets configuration but does not intend to replace a desktop charger for battery loading. WinPDM software runs on a PC connected to a configuration cradle and allows an easy configuration of 8158s & 8168s WLAN sets. Note: At least one cradle tool is required for 8158s & 8168s WLAN sets configuration.	 **Configuration Cradle**
IMS3 (Integrated Messaging and Wireless Services for 8158s, 8168s WLAN sets (Ref 3BN78415AA) Ascom IMS3 server is embedded Linux server which provides a centralized web-based tool used for 8158s & 8168s WLAN sets management, messaging and alarms control. It permits the overview and the configuring of all phones, the templates management for phones, Software Upgrades and phonebook management. IMS3 server runs as a standalone IP server and is connected to the LAN to allows easy configuration and maintenance of 8158s & 8168s WLAN sets on the installations	 **IMS3**

WinPDM software is available from ALE Business Portal

7. OmniAccess® Stellar Access Points architectures

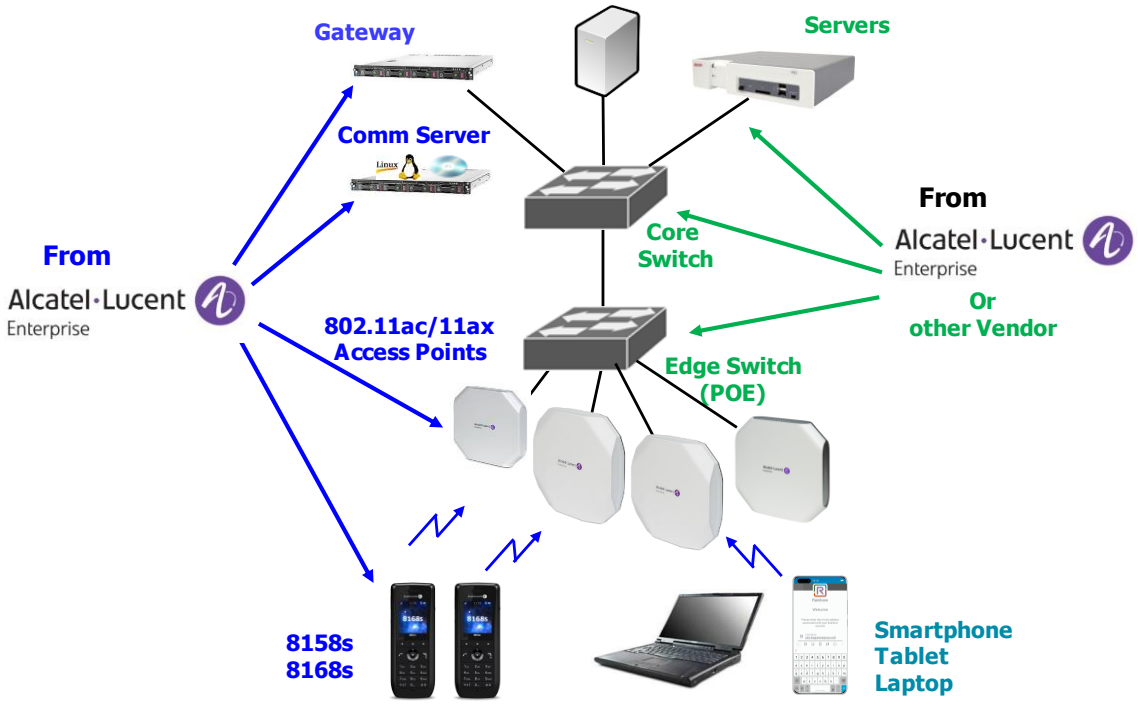

Figure 16: OmniAccess® Stellar architecture

ALE OmniAccess® Stellar WLAN infrastructure provides a support for the ALE VoWLAN solution.

In this case the Com Server, WLAN switch(es) & Access Points, and also the 8158s/8168s WLAN handsets are all provided by ALE. The edge switch and the core switch can be either provided by ALU or coming from other vendors. The edge switch must be POE compatible (AP power feeding).

8. OmniAccess® Stellar Access Points Mode of Operation

Being as no two customer network environments are exactly the same, it is critical for technology such as VoWLAN to possess a great degree of flexibility. ALE 8158s and 8168s WLAN solution is not exempt from this requirement. The following section highlights some 8158s and 8168s WLAN architectural adaptabilities.

8.1 Wifi-Express Mode

OmniAccess® Stellar Access Points in Wifi-Express Mode are configured to automatically connect each other using the Stellar protocol optimized for lightweight a centralized access points management and a distributed traffic transport.

In Wifi-Express Mode, a Primary Access Point Manager (PVM) is elected for the management of all the AP-Group. Configuration of the AP-Group is done directly on the Primary Manager GMIP (Group Multicast IP Protocol) through a Web-based configuration tool and applies for all Access Points within the AP-Group ID created.

It is possible to mix AP11XX wave 1, AP12XX wave 2 and AP13XX models within a same AP-Group since OmniAccess® Stellar version 4.0. One AP13XX AP-Group (any model any mix) supports up to 255 OmniAccess® Access points, 1024 concurrent clients and 16 WLANs (SSID) with the condition have minimum of 4x AP13XX (any model any mix) in the group.
One AP1101 only AP-Group supports up to 64 OmniAccess® Access points, 256 concurrent clients and 16 WLANs (SSID) in version 4.0.
Wifi-Express operational mode allows for a low-cost redundancy proposal for small configurations. Stellar Access Points can perform near-immediate transfer of management responsibilities to a Secondary Access Point Manager and in so doing maintain operation during periods of partial network outage and/or Primary Access Point Manager maintenance.

8.2 Wifi-Enterprise Mode

The Wifi-Enterprise mode is supported since OmniAccess® Stellar version 3.0, Stellar Access Points in Wifi-Enterprise Mode are configured to automatically connect at their first boot to their Omnivista® ov2500 server using Stellar secured protocol optimized for a centralized management of all OmniAccess® Stellar access Points.
The configuration of the AP-Group is done directly by the ov2500 management server through a Web-based configuration tool and applies for all Access Points, any model/any mix, within AP-Group created during registration of Stellar Access Points in the server.
Like in Wifi-Express mode, the Stellar control plan and traffic transport stay distributed on each AP.

The conversion of a Wifi-Express managed AP into Wifi-Enterprise mode, or reversely, is always possible through a factory reset. The consultation of the operation mode is done directly on the IP of the Access Point through a Web-based consultation page.

Wifi-Enterprise operational mode allows scalable configurations for large sites and can manage up to 4000 Access points, any model/any mix, with OmniAccess® Stellar version 4.0. The maintenance is done by the OmniVista® 2500 server whatever the operations/events on each access points and Stellar Access Points WLAN service stays in operation when ov2500 server is off or in maintenance.

9. OmniSwitch®/networking Mode of Operation

The following section highlights some networking architectural adaptabilities for ALE 8158s and 8168s WLAN solution and OmniSwitch access switches family are represented as fully interoperables with the solution.

The scenarios apply for both Stellar Wifi-Express and Wifi-Enterprise modes.

9.1 Overlay Mode Operation

In this scenario, Access Points are directly connected to an existing LAN infrastructure 10/100/1000 Ethernet data switch (from ALE or third-party supplier) or 100/1000/2500 Ethernet data switch if required for Stellar Wifi 6 access points. The switches have the ability to provide Power over Ethernet (IEEE 802.3af/at) to Access Point (AP) on all Ethernet ports (Power Class 3 for all ports simultaneously) or High Power over Ethernet (802.3bt/bz) if required for specific Wifi 6 access points (AP1361/1362/1361D)

This type of operational mode is desirable and advantageous in the following situations:

1. In small buildings or locations where cables lengths are less than 100m (in order to leverage integrated IEEE 802.3af/at/bt capabilities or HPoE 802.3bt/bz capabilities).
2. Where there is no existing data network or existing data network is already operating at maximum capability.
3. For small WLAN environments requiring only a small number of Access Points.
4. To meet requirements for completely independent voice and data networks/backbones.

The Wifi-express mode fits particularly with this type of overlay mode of operation
as it allows independent wifi management and does not need centralized Wifi /IT management.

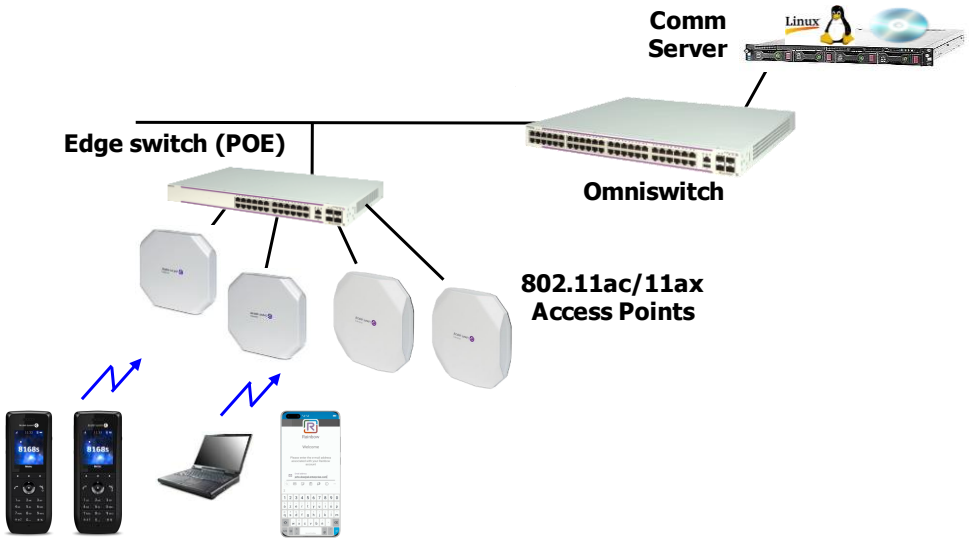

Figure 17: Overlay mode

9.2 Remote Stacking /Virtual chassis Mode Operation

In this scenario, Access Points are directly connected to Edge switches stacking remotely managed and seen as a single switch to manage.

At core switches level, the **Virtual Chassis technology** provides a single logical switch with high-avaibility and resiliency, this from 2 switches up to 8 with OmniSwitch 6900 family. 2-tier design is deployed generally for core network, providing modular networking and scalability to larger networks with a native core switching up to 100 Gigabit.

Virtual Chassis technology includes advanced routing features like L3 VPN/routing and IP tunneling to help the roaming with OmniAccess Stellar, version 4.0 for inter-VLAN topologies, for any models.

OmniSwitch 6860/E/6900 provide user configured QOS treatment for SIP/RTP/SRTP traffic flows and snoop the voice quality metrics of media streams to help diagnostics on voice quality.

Core	Maximum router interfaces per switch (per VLAN)	L2 GRE tunnel interfaces per switch	SIP snooping	AOS version
OS6860/E	4096 (16)	750	Yes	AOS 8.5R2 min
OS6900	4096 (16)	1024	No	AOS 8.5R2 min

Figure 18: OmniSwitch 6860/E/6900 IP specifications

This type of operation mode can be highly desirable and advantageous in the following situations:

1. When existing data network elements are present and capable to supporting WLAN Access Points and traffic.

2. In large and/or multi-floor buildings where cables lengths are commonly in excess of 100m from the data switching centers and wiring closets to Access Points, thus causing problems for Inline Power over Ethernet (IEEE 802.3af/at or 802.bt/bz)
   In cases such as this, localized power options can be proposed to meet or eliminate the distance limitation and power problems.
3. When system failover/redundancy of the WLAN Access Points elements is highly desired.
4. For the support of roaming running in large and/or multi-floor buildings and with inter-VLAN topologies.

The Wifi-Enterprise mode fits particularly with this type of networking mode of operation since it is compatible with a centralized Wifi /IT management for an existing data network already supporting data traffic.

9.3 Network connectivity

Network connectivity and power options must be provided by an Ethernet switch or other source. It is important to ensure that the desired Ethernet switch is capable of supporting the QoS requirements of the VoIP traffic that it will be forced to carry. The uplink paths between ALE switches in stacking receive the high priority to ensure a sufficient level of voice quality.

Figure 19: OmniSwitch family with POE (IEEE 802.3af, 802.3at or 802.3bt/bz):
OS6450-P24/P48, OS6350-P24/P48 and MultiGigabit OS6560-P24Z8/P24Z24

The Ethernet switch must be capable of supplying sufficient and standard format power (full 15W limit of IEEE 802.3af,30W limit of IEEE 802.3at and 90W limit of IEEE 802.3bt/bz) In the event that this cannot be achieved, several power injectors options are available:

- Inline Power Injectors can be used to provide IEEE 802.3af/at power to individual Access Points. These low-cost, single port (one in, one out) injectors can be used in situations where only one or a few devices require power. These devices require a local AC outlet connection to produce IEEE 802.3af/at or 802.3bt power and then inject this power along with the Ethernet traffic that pass transparently through it.

Ref OAW-PD-3501G/AC : 1 Port 802.3af PoE Midspan 10/100/1000 15.4W

Ref OAW-PD-9001GR/AT/AC : 1 Port 802.3at PoE Midspan 10/100/1000 30W

Ref OAW-PD-9501GR/AC : 1 Port 802.3at PoE Midspan 10/100/1000 60W (no support of 2.5GE)

Ref OAW-PD-9001GO-ET/AC : 1 Port 802.3at PoE 10/100/1000 30W Outdoor with surge protection. Cut blunt cable required.

Ref OAW-PD-9001-25GR/AC : 1 Port 802.3at PoE Midspan 10/100/1000/2500 30W

Ref OAW-PD-9601GO/AC : 1 Port 802.3at PoE 10/100/1000 90W Outdoor with surge protection. Cut blunt cable required.

Ref PD-MOUNT- : Pole/wall mount kit for Outdoor PoE.

Ref PC-OD-AC-P-INT : 5m Outdoor AC cable for PD-9001GO-ET/AC and PD-9601GO/AC

Figure 20: Inline Power Injector

OS6860-P48

OS6860E-U28D

OmniSwitch 6900 family

Figure 21: OmniSwitch family OS6860/E/6900 Core topologies

10. Quality of Service (QoS)

The first responsibility of the LAN infrastructure is to control the QoS, QoS management responsibilities are shared between the Stellar WLAN AP, the 8158s and 8168s WLAN WLAN handsets and the LAN switch infrastructure components.

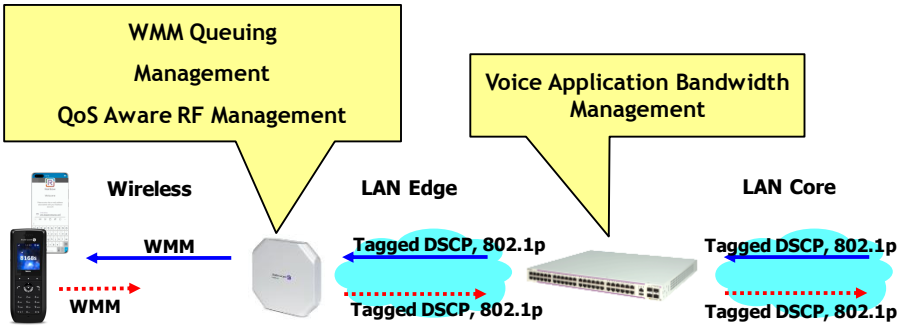

Figure 22: End-to-End QoS

An end-to-end QoS ensures a prioritization or Voice over Data from Wireless to LAN and vice versa. Ensure that network switches and routers do not change the DSCP (Differentiated Services Code Point), 802.1p value set for 8158s and 8168s WLAN sets or coming from LAN.

WMM	DSCP (downlink DSCP)	802.1p (downlink 802.1p)
Background	8 (2,8)	1 (1,2)
Best effort	0 (0,24)	0 (0,3)
Video	40 (26,32,40)	4 (4,5)
Voice	46 (48,56)	6 (6,7)

Both Wifi-Express and Wifi-Enterprise modes of OmniAccess® Stellar Access Points apply the above default WMM/802.1p-DSCP mapping for all critical QoS applications, can edit and adapt the mapping as necessary for the needs of a customized QoS on LAN.

- For packets from the wireless, the DSCP value, if existing, is kept without overwritten. 802.1p value is determined based on WMM/802.1p-DSCP mapping
- For wired packets to the wireless, WMM is determined based on the WMM/802.1p-DSCP mapping. If conflict between DSCP and 802.1p exists, the one with higher priority of mapped WMM will take effect

11. Application Visibility & enforcement (Packet Inspection)

Another responsibility of the LAN is to control the Voice Application.
OmniAccess® Stellar AP12XX and AP13XX Access Points integrate a Stateful Packet Inspection technology (DPI), monitored by the **Application Visibility & enforcement** feature available on Omnivista® 2500 server in Wifi-Enterprise mode. **Application Visibility & enforcement /DPI** jointly provide IT a detailed visibility into the applications with the consumed bandwidth. That gives 2500 server the possibility to immediately enforce policies to control the bandwidth permitted for the Voice LAN, this at Access Point level or user level.

- Omnivista 2500 signature kits designed for UA/UDP applications (8158s/8168s in NOE mode) and for SIP applications (8158s/8168s in SIP mode).
- Application Visibility of UA/UDP & SIP applications on Omnivista 2500 with calls in use and bandwidth consumption statistics

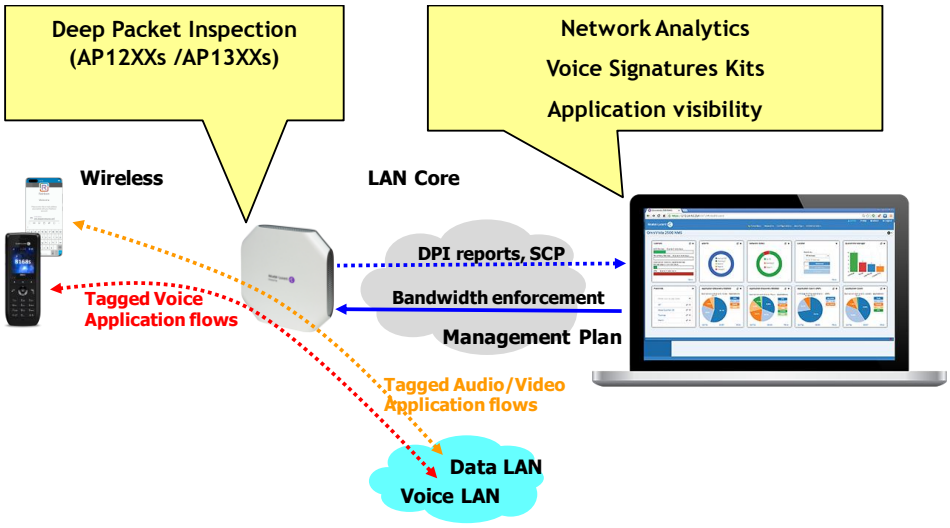

Figure 23: Voice Application control

The voice application bandwidth control in Wifi-Express mode is managed directly by Stellar DPI, through the PVM, and is declined per user. There no Voice analytics and Voice application visibility in Wifi-Express mode.

The Voice Application Bandwidth on LAN must always be translated, assuming ideal conditions for the transport of Voice Application in the LAN, into a maximum limit of simultaneous voice conversations that can be reached per Access Point. The Bandwidth can be also declined per user or per location.

12. Security

Security is always a sensitive topic to discuss, and opinions on how best to provide for it vary greatly from one engineer to the next. With this in mind, ALE is constantly developing the list of security options available within the 8158s and 8168s VoWLAN solution offer to satisfy as many different opinions as possible.

As part of the Voice over WLAN solution offer, ALE makes the following security recommendations:

12.1SSID Broadcast

When designing and managing a Wireless LAN, engineers must make calculated compromises between performance and ease of use. One such decision is that of whether or not to broadcast the SSID (Service Set Identifier) of a wireless network. Broadcasting the SSID allows clients to "scan" for available network and then attempt to join them. This eliminates the need for users to explicitly know the name of the network that must be defined in their 802.11 client configuration, since it can be learned from the over-the-air broadcasts (excluding 8158s and 8168s WLAN handsets that must be configured manually by design). Obviously, not broadcasting the SSID provides the opposite: users must know the SSID.

In the above mentioned way, it is commonly thought that we can offer a limited realm of security simply by not broadcasting the SSID of the Wi-Fi environment dedicated to VoWLAN activity. In truth, this practice is often far more troublesome to network administrators than it is to network attackers. The advantages of SSID broadcast usually far exceed the threat of visibility it offers.

Since all 8158s and 8128 SE WLAN terminals must be manually configured with an SSID, the decision to enable or disable SSID broadcast is of little consequence to ALE 8158s and 8168s WLAN handsets. There is no impact to ease of use or functionality presented by the state of SSID broadcast. ALE recommends that customers maintain their current or desired security policies governing this topic.

12.2 Authentication

12.2.1 802.1X Authentication on 8158s and 8168s WLAN sets

8158s and 8168s WLAN handsets support the following 802.1X authentication methods:

- PEAP-MSCHAPv2, EAP-FAST and EAP-TLS

PEAP- MSCHAPv2 ((Protected Extensible Authentication Protocol - Microsoft Challenge Handshake Authentication Protocol) uses TLS to create an encrypted Tunnel

- A certificate is required on server side (Radius Server)
- No certificate need on client side (8158s and 8168s)
- Only the Radius server is authenticated, but not the 8158s or 8168s

EAP-TLS (EAP-Transport Layer Security)

- is based on certificates (client and server sides)
- the both 8158s and 8168s WLAN handsets and Radius server are authenticated

There are 2 modes of operation with EAP-TLS on 8158s and 8168s WLAN handsets:

- An ALE "Default certificate" that is embedded in 8158s and 8168s

  WLAN handsets
- A "certificate provided by the customer PKI" (Public Key Infrastructure).

  In this case the customer certificate overrides the default ALE certificate that remains present but inactive in the 8158s and 8168s WLAN handsets.

In order to minimize the re-authentication delay the following methods are used:

- OKC (Opportunistic Key Caching) that is available on ALE WLAN infra (8158s and 8168s) with WPA2 only.
- 802.11r Fast Transition that is used by 8158s and 8168s with WPA2 or WPA3 if enabled on Stellar access points.

12.2.2 Radius Servers

Validated Radius servers on 8158s and 8168s WLAN sets:

- Microsoft Network Policy Server (NPS)
- Microsoft IAS
- FreeRadius
- OmniVista 2500 Enterprise

12.3 Encryption

- At present, for the WLAN R 7.2 offer, ALE provides encryption options based on WPA-PSK (Wifi Protected Access – Preshared Key), WPA2-PSK and WPA3-SAE (Wifi Protected Access 3 – Simultaneous Authentication of Equals based on preshared Key) and preferably WPA2 and WPA3 Enterprise mode based on EAP-PEAP or EAP-TLS 802.1X authentication. WPA3-SAE encryption is mandatory for Wifi 6 installations.
- 802.11w Management Frames Protection is enabled when WPA3-SAE encryption is enabled and 8158s and 8168s handsets support 802.11w encryption by default. Devices that do not support 802.11w can coexist with WPA3 encryption when enabled and supported by Stellar access points.

12.4 MAC Address Filtering

MAC (Medium Access Control) address filtering facilities are provided for within ALE OmniAccess product platforms. ALE strongly encourages the use of Local MAC address filter rules to help ensure that only authorized wireless clients are permitted to join the VoWLAN network.
For more information on MAC address filtering, please refer to the ALE VoWLAN Engineering Reference.

12.5 Rogue Activity Detection

Rogue Access Points and Rogue Ad-Hoc Wi-Fi activity can seriously degrade VoWLAN voice quality by wreaking havoc with carefully designed and implemented Radio Frequency coverage patterns. For this reason, ALE strongly recommends the use of the OmniAccess WIDS/WIPS (Wireless Intrusion Detection & Protection) option to identify and eliminate these potential threats. The nominal cost of this technology option provides an immense amount of investment protection, and the value of Rogue Activity Detection cannot be stressed enough.

There is two ways to achieve Rogue activity detection on OmniAccess® Stellar WLAN Access Points. Either by using the active channels of Access Points and therefore dedicating some APs to a Rogue prevention scan, making then channels unavailable for data traffic. Either by using the **1x1 full scan radio** dedicated to activity detection, radio implemented separately on the OmniAccess® Stellar Wifi 6 access points, this on 2.4Ghz and 5Ghz bands.

ALE strongly recommends to enable the 1x1 full scan radio mode of Wifi 6 access points for Rogue activity detection while exploiting all active channels on the other radios for the same APs.

12.6 Isolation Practices

Network segmentation is seen as a critical core component of any network security design. Separating traffic by type and application scope allows for more sophisticated security methodologies to be later implemented. VPN, Packet Inspection/Filtering, Access Control Lists, and other security technologies generally rely on network segmentation in order to be most effective.

For the above reasons, ALE strongly suggests a Voice and non-Voice domain separation on VoWLAN equipment. Sharing the VoWLAN environment with non-voice related elements is a compromise in security that does not need to be made. For example at OmniAccess® Stellar WLAN Access Point level ALE recommends to implement first a single **Voice VLAN** dedicated to Voice and a **Data VLAN** dedicated to Wireless Data.

12.7 Non-voice applications Control & Visibility (Packet Inspection)

It is assumed that the VoWLAN environment will be hosted on a customer network which also supports data networking environments. To assure privacy and system security, security controls should be implemented at network routing points to restrict the ability of non-voice related elements from gaining access to VoWLAN and OmniPCX Enterprise components. These security controls can be delivered in the form of router or route-switch based Access Control Lists or via dedicated Packet Filtering and Packet Inspection platforms.

Application Visibility & control /DPI for Stellar AP12XX /AP13XX wireless Access Points in Wifi-Enterprise mode allows jointly strong access control policies, network protection and detailed visibility into the non-Voice applications usages.

12.8 Auxiliary Security Measures

In addition to the standard security mechanisms discussed above, some customers may desire to implement specialized security measures that apply specifically to their environment. Use of MAC address controls within the external TFTP server or DHCP server, as well as other application security methods can be very advantageous. ALE offers none of these server-based features, but encourages customers to explore the security capabilities present in third-party support hardware.

13. Location systems

13.1 Ekahau RTLS

Ekahau RTLS (Real-Time Location System) provides a geo-localization of 8168s WLAN handset within a building or an outdoor RF covered area, and is made of a server (Ekahau Positioning Engine) and an Ekahau client that is embedded on 8168s WLAN handset. Ekahau RTLS is not supported on 8158s set.

The Ekahau RTLS solution provides an accurate localization of 8168s WLAN handsets, that is based on information exchanged between the RTLS agent on 8168s and the Ekahau server (via the APs and the WLAN controller):

- RSSI information are extracted from AP Beacons and Probe Responses
- Client triangulation is performed by the Ekahau Positioning Engine
- Position is based on a stored site survey

Ekahau RTLS solution is **managed via AAPP (ALE Application Partner Program)** and Ekahau Location Protocol is supported on OmniAccess Stellar WLAN infrastructures.

Note: there is no AAPP IWR (Interworking Report) as OXE is not at all involved in RTLS operation.

Ekahau RTLS includes the following features:

- Ekahau Tracker: End-user application for real-time tracking and analyzing the location of people
- Ekahau Finder: End-user application for real-time grouping, locating and viewing the location of people
- Ekahau Engine (dedicated Windows server): Systems and device management through a web-based interface

The EPE (Ekahau Positioning Engine) runs on Windows Server 2000, Windows Server 2003 or underVMWare. Hardware recommendations depend on the number of Tag clients to be serviced.

Ekahau Location Survey

For more details see: http://www.ekahau.com/products/real-time-location-system/overview.html

Deployment recommendations:

- Ekahau RTLS feature is supported on 8168s WLAN set (not on 8158s)
- Ekahau RTLS and 2500 server cannot be installed on the same physical server
- Required Design rules for the Ekahau RTLS solution in order to get decent accuracy
- One AP at -65dBm (or better) and 2 APs at -75dBm or better.

13.2 OmniAccess® Stellar Asset Tracking

OmniAccess® Stellar Asset Tracking solution is the ALE integrated geo-location solution based on BLE technology and available since version 4.0 for access points. It provides the geo-location of 8158s and 8168s sets (or any smartphone) within building areas, when BLE is enabled on devices.
The solution is made of BLE beacons for calibration (autocalibration beacons), Stellar BLE gateways (AP1201BG or any AP12XX/AP13XX with built-in BLE or BLE dongle) and OV Cirrus as asset manager with location engine integration.

The location information is built from:

- BLE RSSI informations provided by 81x8s sets (or any smartphone) to Stellar BLE gateways
- BLE RSSI informations provided at the same time by autocalibration beacons, that provide locations references (BLE RSSI informations from fixed beacons).

Stellar Asset Tracking includes the following features:

- BLE calibration (OV asset tracking manager): End-user application for autocalibration beacons placement and operation
- Asset provisioning (OV asset tracking manager): Devices management through web-based interface.
- Asset search (OV asset tracking manager): Web End-user application for devices real-time locating and viewing locations (handsets or any smartphone)
- Statistics/Analytics (OV asset tracking manager): End-user application for location monitoring and statistics.

The solution is available in both Wifi-Express and Wifi-Enterprise modes. The Stellar AT positioning engine does not require Omnivista 2500 server and is available only through the web interface via the OV Cirrus solution for Stellar.

Deployment recommendations:

- Add autocalibration BLE beacons in some cases of areas (openspace or conference rooms, if necessary to assist AP1201BG or AP12XX/AP13XX access points)
- 8 meters maximum between autocalibration beacons
- BLE gateways must be surrounded by minimum of 6 autocalibration beacons for proper accuracy (triangulation configuration)
- Configuration of BLE gateway as autocalibration beacons is not possible

For more details on the solution see: https://www.al-enterprise.com/en/products/asset-tracking

14. Design Process for VoWLAN

14.1 Pre-Sales Data Collection

In order to prepare an ALE VoWLAN solution, several pieces of documentation must be sourced from the customer. The accuracy of a final system proposal is directly related, in most cases, to the amount and quality of information collected prior to initiating design formulation.

14.1.1 Physical Diagram (to include existing wireless technologies)

A clear understanding of the customer's physical network topology is essential in order to properly determine the possible future locations and integration points of VoWLAN support elements. This physical diagram should be as complete as possible and include information related to all existing customer infrastructure (Data Wi-Fi, LAN, MAN, closet switching platforms (to include power feeding abilities), core routing platforms, copper and fiber patching facilities (termination types).) Again, an accurate 8158s and 8168s VoWLAN solution cannot be developed without this information.

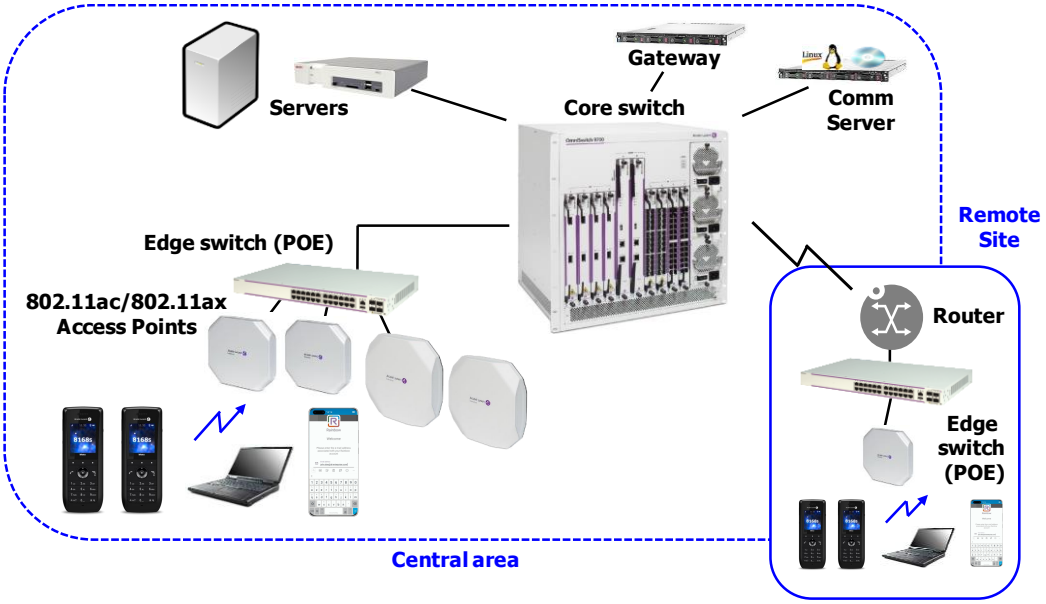

Figure 24: Physical Diagram

The physical diagram is responsible for helping the design engineer in gauging a number of placement and connectivity options from the number of locations where OmniAccess Stellar Access Points, wifi 5 or wifi 6, Appliance platforms can be housed, to the type of physical connectors needed on the fiber patch cords to connect them to the network. To meet this requirement, the physical diagram must contain as much detail as possible.

This diagram should also detail cable-plant distances and the ability of existing data network switches to support IEEE 802.3af/at, or HPoE 802.3bt/bz, power in sufficient quantity for the proposed solution.

Of a much more complex nature is the presence and status of existing wireless technology. The Physical diagram should detail, in as much detail as possible, the presence of existing or proposed Bluetooth, Wi-Fi, microwave technology, high-gain or industrial radio transmitters, DECT/PWT (Digital Enhanced Cordless Telephone /Personal Wireless Telephone) technologies and other interference or radio spectrum competitors.

14.1.2 Logical Diagram

Logical Diagrams are also critical for complete and accurate solution construction. The logical diagram must include information related to the existing customer VLAN strategy, QoS policies, Security measures, redundancy and fault tolerance schemes, as well as future provisioning and traffic shaping. Information gathered from the logical diagrams will determine IP addressing schemes, security measures, and VLAN mapping as well as influence certain physical design options (ideal TFTP & DHCP Server location, etc.)

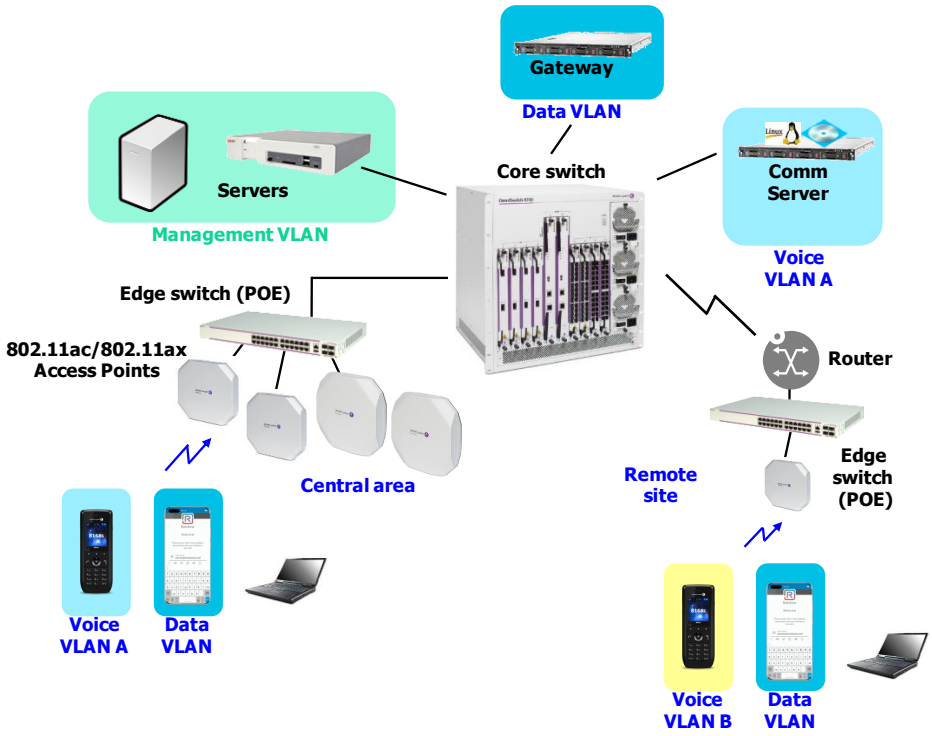

Figure 25: IP Logical Diagram

This diagram shows the different domains at layer 2 currently used in the customer network: VLANs, Broadcast domains, IP subnets and IP addressing Plan.

14.1.3 Floor Level Maps/Diagrams

To complete detailed planning, a floor level diagram is required. This floor level diagram can be used in the design process in two different ways, Prediction Planning and the Site Survey. This diagram does not necessarily need to include detail on how desks are situated within office and where toilets and potted plants are located within restroom, but walls, dividers, elevators, pillars, windows, doors, and other obstacles should be clearly marked and to scale.

Figure 26: Floor Map (with scale & legend)

15. Customer Specific Application & Design Considerations

15.1 Voice Network Topologies

When studying VoWLAN topologies it is needed to use some terminology in order to well define the various basic configurations

15.1.1 Campus definition

Network topology where all components: Com Servers, IPMG (IP Media Gateway), Switch/Routers, etc. are scattered over a large geographic area and are interconnected through High Speed links (such as Fiber Optic cabling), resulting in no delay or bandwidth concerns.

15.1.2 Multi-Node definition

Several OmniPCX Enterprise Nodes belonging to the same Homogenous ABC network.

15.1.3 Multi-Site definition

Topology comprised of a Single OmniPCX Enterprise Node with one or several remote site(s). For instance it can be a headquarter and one or more branch offices.

15.2 Single OXE Node in a Multi-Site Environment (Campus / Remote Site)

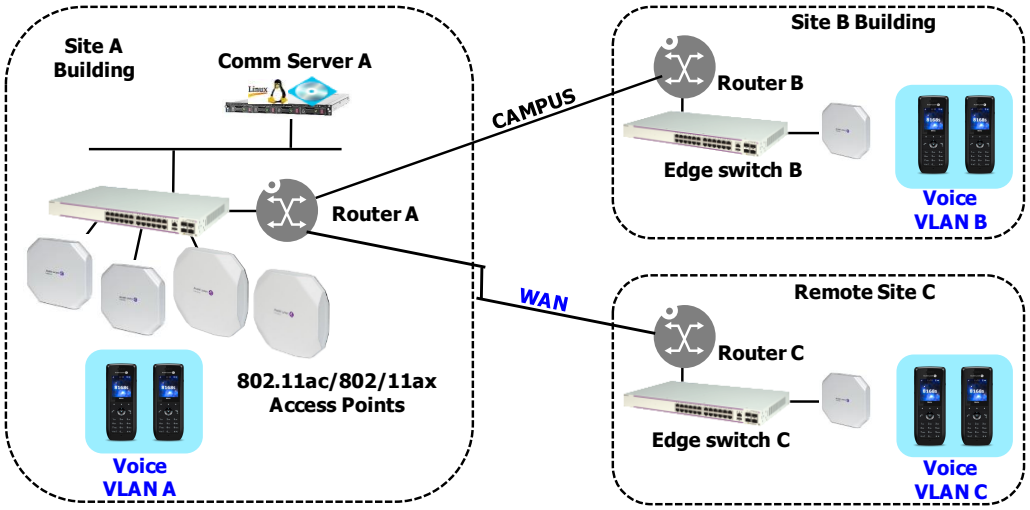

Figure 27: Single-OXE Node and Multi-Site

This topology based on a single OXE node allows a VoWLAN implementation on remote sites.
For Roaming and Handover restrictions in campus or remote site see the chapter dedicated to Roaming & Handover.

15.3 Multi-Site OXE with Rainbow PBX integration (Campus / Remote Site)

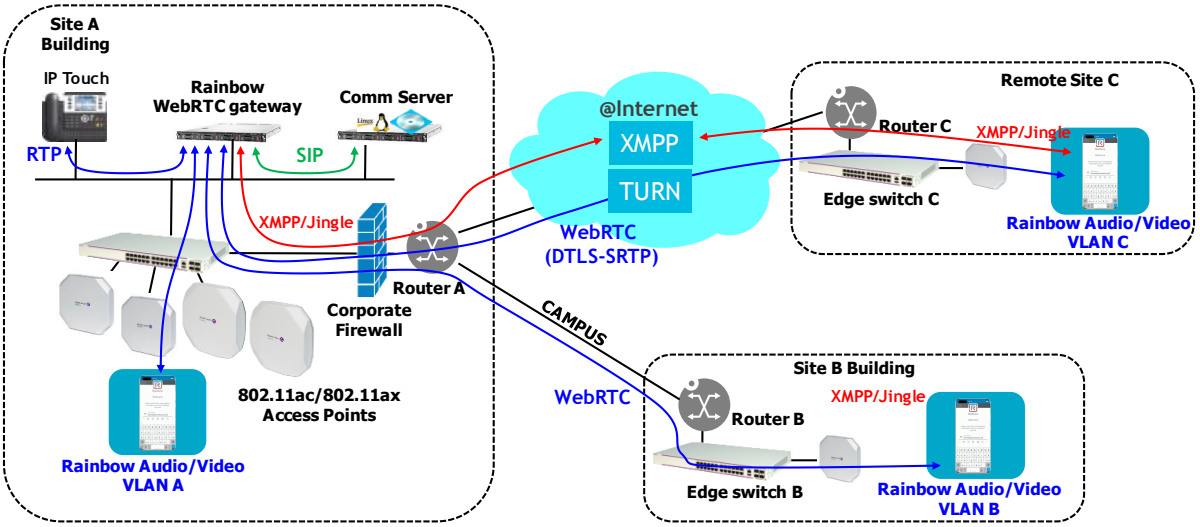

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Figure 28: Multi-site OXE with Rainbow PBX integration

This topology based on single OXE allows smartphones using their Rainbow as VoIP client and make or receive business calls through the corporate OXE.

Rainbow WebRTC gateway manages the encryption of WebRTC (DTLS-SRTP) on Rainbow Cloud side to OXE (S)RTP on IP phones, and determine best media paths on Rainbow side thanks to OTMS mechanisms. The flows between Rainbow clients and Rainbow WebRTC gateway are relayed thru TURN relays in the Cloud when they can't reach each other on their local network. Flows are direct when Rainbow clients and WebRTC gateway can reach each other on local network (corporate or campus networks)

For roaming and Handover restrictions see the chapter dedicated to Roaming & Handover

15.4 Multi OXE Node in a Multi-Site Environment (WAN)

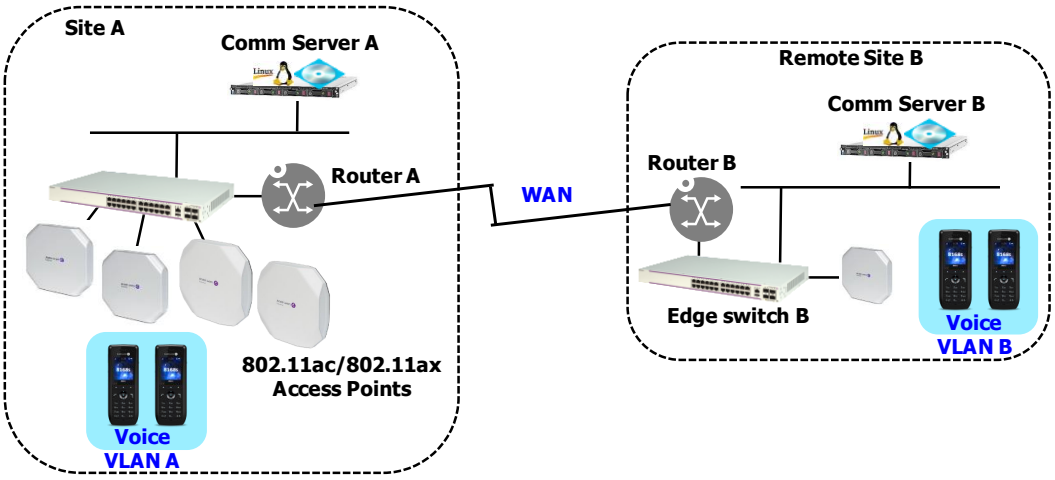

Figure 29: Multi-OXE Node and Multi-Site

Same configuration as previously, but now in an OXE Multi-node OmniPCX topology.
For Roaming and Handover restrictions see the chapter dedicated to Roaming & Handover.

15.5 Multi-WLAN Layer 2 Configuration

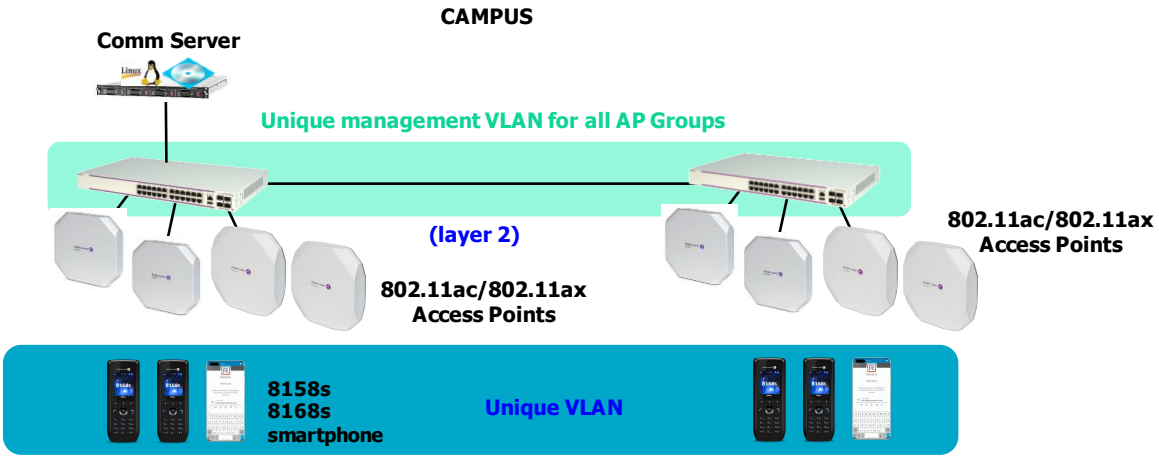

Figure 30: Layer 2 configuration (WLAN Stellar)

Layer 2 configuration means that all WLAN Stellar AP-Groups are in a unique VLAN/IP subnet and 8158s, 8168s WLAN sets or smartphones with Rainbow client are all in the same Voice VLAN/IP subnet. This topology allows quick handover.

15.6 Multi-WLAN Layer 3 Configuration

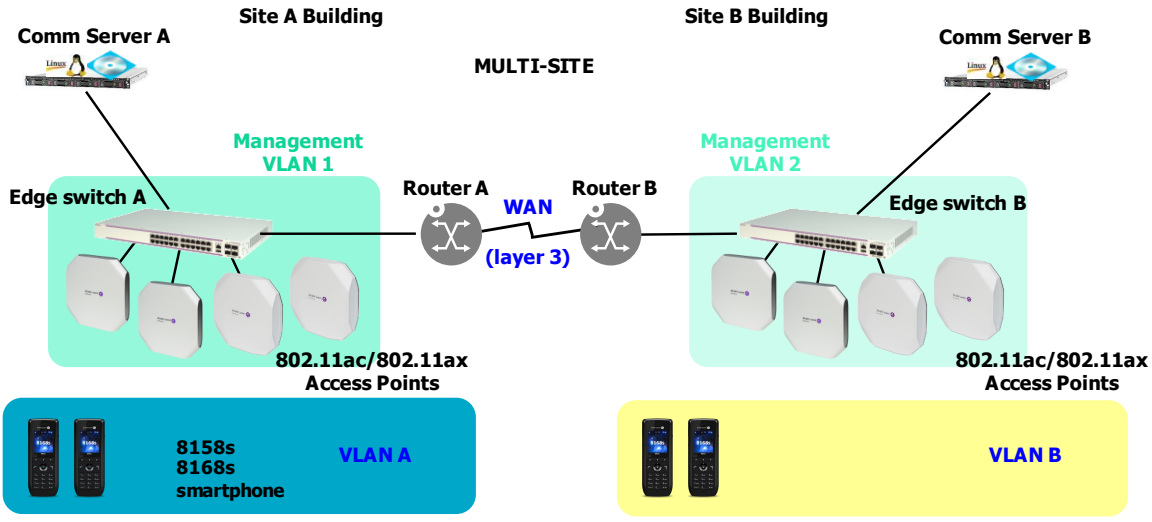

Figure 31: Layer 3 configuration (WLAN Stellar)

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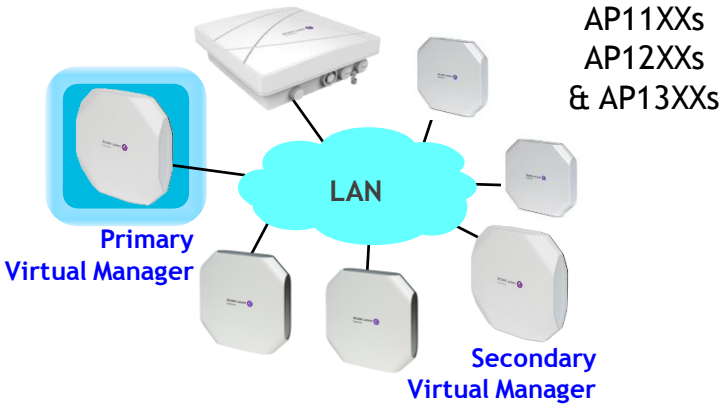
Layer 3 configuration means that each WLAN is in a different VLAN/IP subnet and 8158s, 8168s WLAN handsets or smartphones with Rainbow client can be spread over several Voice VLANs/IP subnets; This topology matches much better customer Multi-Site needs (WAN routed network) as reduces the quantity of voice users per subnet.

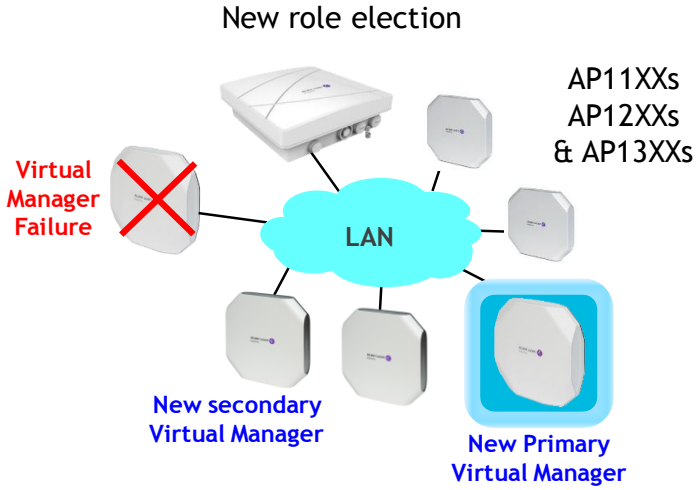
16. VoWLAN on OmniAccess® Stellar Access Points

16.1 OmniAccess® Stellar in Wifi-Express mode

OmniAccess® Stellar Wifi-Express Mode depicted here is a distributed WLAN controller solution based on a Virtual Manager (VM) and does not require any License. This mode permits Access Points automatically connect each other using Stellar protocol with the Configuration of Access Points group through a Web-based configuration tool without the handling of any OmniVista 2500.



16.1.1 Managers role election



- Each AP in AP-Group is eligible to become Primary Virtual Manager

- In case of Primary Virtual Manager failure a new Primary Virtual Manager election takes place
- Wireless devices can be associated to any AP or to the AP acting as Primary Virtual Manager

- Primary Virtual Manager Election process:
  - In case several AP started at the same time: AP with highest MAC is PVM
  - Once PVM is designated, its emits an SSID dedicated to the configuration of AP-Group

- Normal Operation
  - The Primary Virtual Manager centralizes the AP Group management
  - The Group is identified by a "Group ID" and all AP with same "ID" are put in the group
  - All other APs are member and are called Members
  - Any next AP which want to connect to AP-Group and exceeds limit of Members is rejected

- Primary Virtual Manager Election after a Virtual Manager AP failure
  - Another AP has the possibility to rescue the role of centralized management and is called Secondary Virtual Manager (SVM)
  - The AP eligible to become Secondary Virtual Manager in case of PVM failure is the AP with second highest MAC

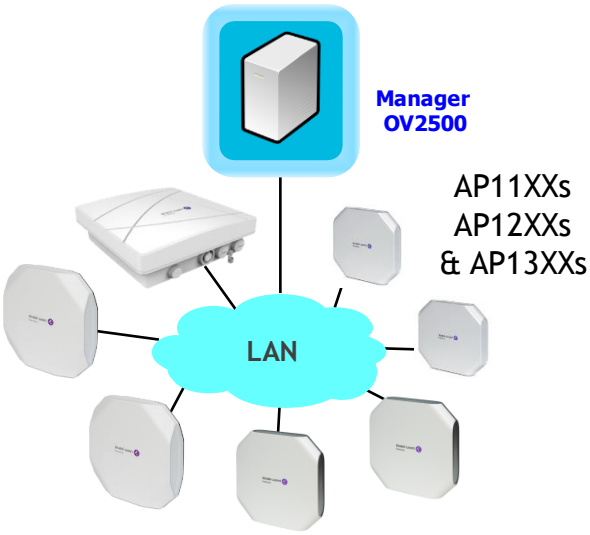
- Operation for mixed AP13XXs, AP12XXs and AP11XXs
  - There is always the possibility to mix AP13XXs, AP12XXs and AP11XXs (any model any mix) within the AP-Group.
  - All rules detailed before for the virtual manager election apply on highest AP models

16.1.2 Wifi-Express OmniAccess AP scope for 8158s and 8168s WLAN solution

Up to 32 Stellar Access Points per AP-Group, with AP1101 and AP1201H models only & 256 users, 16 SSIDs
Up to 64 Stellar Access Points per AP-Group, with minimum of 4 AP12XXs (except AP1201H) or minimum of 4 AP13XXs & 256 users per radio, 16 SSIDs
Up to 255 Stellar Access Points per AP-Group, with minimum of 8 AP12XXs (except AP1201H) or minimum of 8 AP13XXs & 256 users per radio for AP12XXs, 512 users per radio for AP13XXs, 16 SSIDs

16.2 OmniAccess® Stellar in Wifi-Enterprise mode

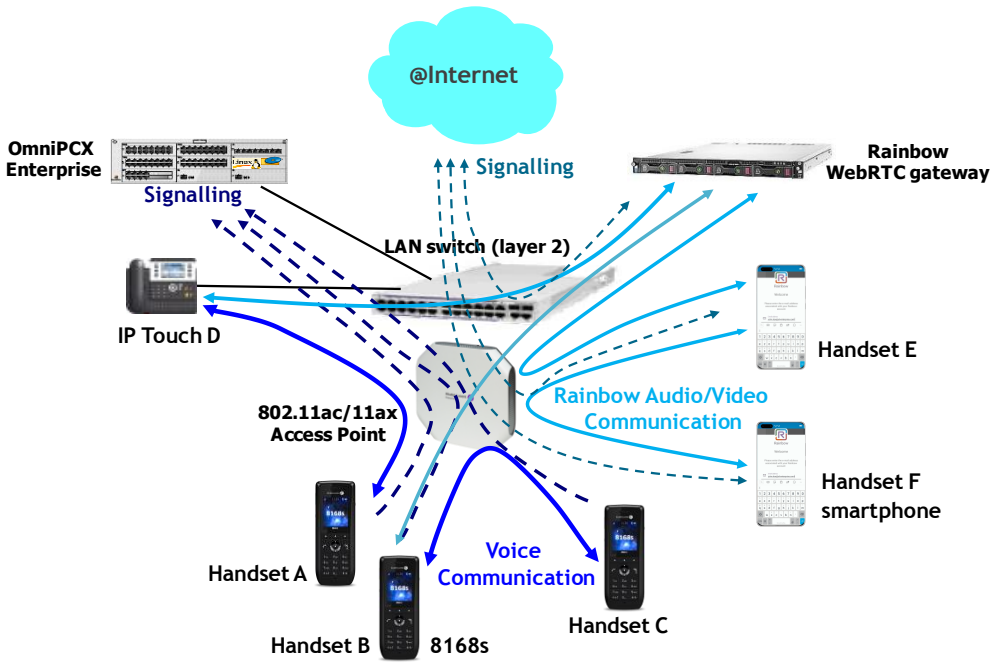
OmniAccess® Stellar Wifi-Enterprise Mode depicted here is a distributed WLAN controller solution based on a centralized and licensed management mode with the handling of Omnivista® 2500 server. Wifi-Enterprise mode permits Access Points automatically connect at their first boot to their 2500 server using Stellar secured protocol optimized for a centralized management for all OmniAccess® Stellar access Points.
The configuration AP-Group is done directly on 2500 management server through a Web-based configuration tool.



16.2.1 Wifi-Enterprise OmniAccess AP scope for Voice over WLAN solution

Up to 4000 Stellar Access Points (any model any mix) per Omnivista® 2500 server, 256 users per radio for AP12XXs, 512 users per radio for AP13XXs and 16 SSIDs

16.3 Voice Communication on a Single Stellar Access Point



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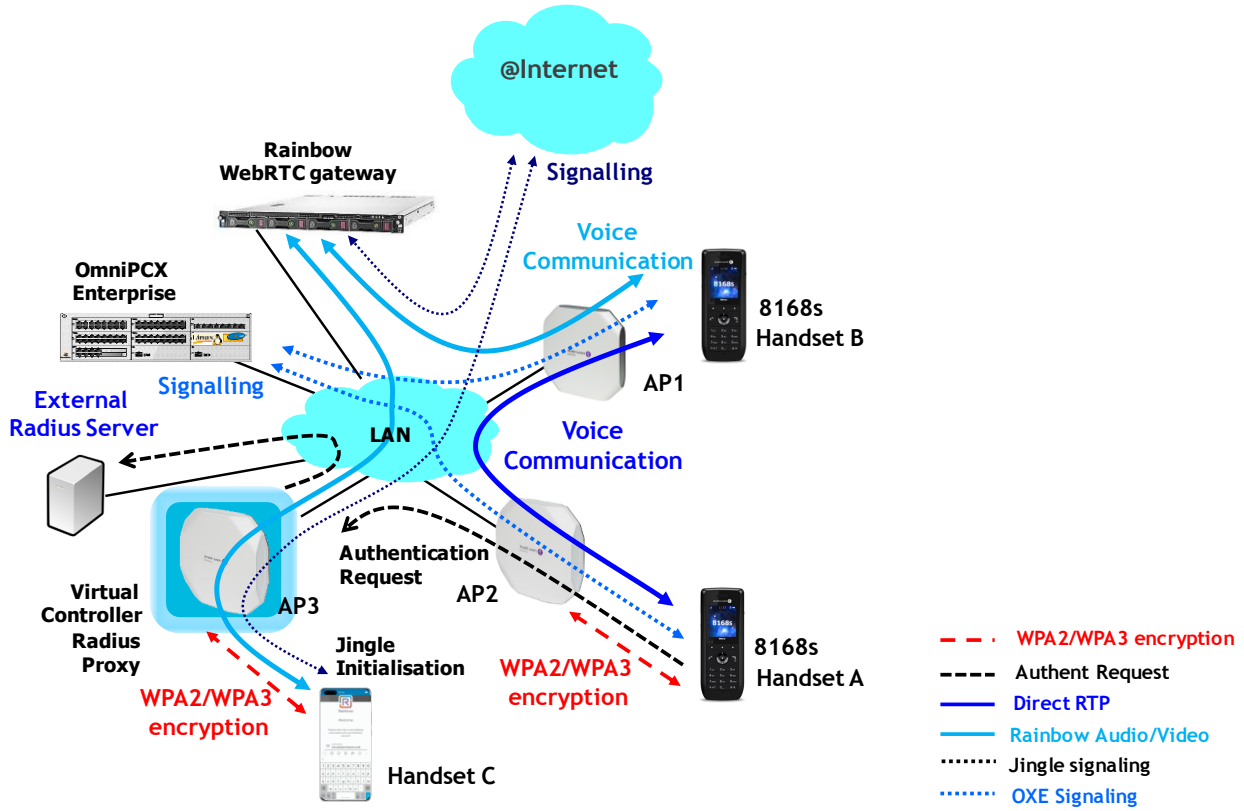
8158s and 8168s WLAN handsets, and smartphones with Rainbow client are supported on single Access Point

- Direct RTP between handset A and IP Touch D, and between handsets B and C
- Direct WebRTC between smartphone E and F
- WebRTC – RTP between smartphone E and IP Touch D via Rainbow WebRTC gateway
- The single Access Point acts as a standalone AP-Group controller

16.4 Voice Communication through different Stellar APs



In this Wifi-Express scenario the voice communication (Direct RTP or WebRTC) does need to go through the Access Point where wireless device is associated to.

Encryption when configured (e.g. WPA2 or WPA3 Enterprise encryption) takes place from the wireless device and ends at the AP the wireless device is associated to. WPA3 Enterprise will be supported in further versions of 8158s and 8168s handsets.

802.1x authentication is managed by external Radius server and Rainbow initialization itself is managed by XMPP Cloud services. The Primary Virtual Manager acts as a Radius Proxy.

16.5 Voice Communication Bandwidth per Stellar AP

Feature	Max Voice, Audio/Video communication bandwidth per AP (per user) *	Max call per AP ** (voice users equivalent)	AP model
Enterprise handsets	14Mbps (400Kbps)	Up to 35 Voice streams (18)	All Stellar AP13XX in 11ax
8158s, 8168s	13Mbps (400Kbps)	Up to 32 Voice streams (16)	All Stellar AP12XX in 11ac
	12Mbps (400Kbps)	Up to 30 Voice streams (15)	Stellar ap1101 in 11ac
low case (AP1101)	*5Mbps (400Kbps)*	*Up to 12 Voice streams (6)*	*Stellar ap1101 in 11n*
Rainbow UCaaS	4.2Mbps (120Kbps)	Up to 35 Audio streams (35)	All Stellar AP13XX in 11ax
client Audio only *	4Mbps (120Kbps)	Up to 32 Audio streams (32)	All Stellar ap12XX in 11ac
	4Mbps (120Kbps)	Up to 30 Audio streams (30)	Stellar ap1101 in 11ac
low case (AP1101)	*2.5Mbps (120Kbps)*	*Up to 12 Voice streams (12)*	*Stellar ap1101 in 11n*
Rainbow UCaaS	Up to 105Mbps (3Mbps)	Up to 35 Audio/Video streams	All Stellar AP13XX in 11ax
client Audio/Video	Up to 96Mbps (3Mbps)	Up to 32 Audio/Video streams	All Stellar ap12XX in 11ac
HD ***	Up to 90Mbps (3Mbps)	Up to 30 Audio/Video streams	Stellar ap1101 in 11ac
low case (AP1101)	*Up to 36Mbps (3Mbps)*	*Up to 12 Audio/Video streams*	*Stellar ap1101 in 11n*
OTC mobile	24.5Mbps (700Kbps)	Up to 35 Voice streams	All Stellar AP13XX in 11ax
	22.5Mbps (700Kbps)	Up to 32 Voice streams	All Stellar ap12XX in 11ac
	21Mbps (700Kbps)	Up to 30 Voice streams	Stellar ap1101 in 11ac
low case (AP1101)	*8.5Mbps (700Kbps)*	*Up to 12 Voice streams*	*Stellar ap1101 in 11n*

Some Figures for Maximum Voice communication Bandwidth consumption per Stellar AP:

- Estimation of Max Voice, Audio/Video communications Bandwidth on LAN per Access Point
- Related Max Voice, Audio/Video communications Bandwidth on LAN per user
- Measured maximum of simultaneous Voice, Audio/Video communications per Access Point

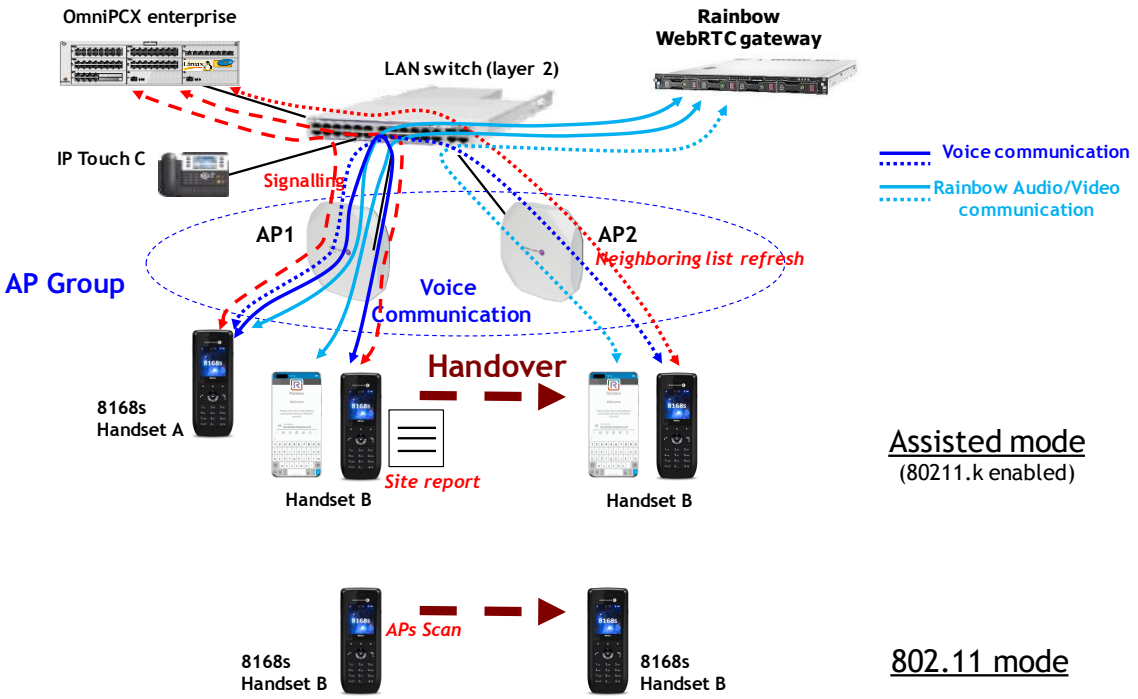
* Audio-codec considered here for Bandwidth table is G.711 /Opus Narrowband.

** R-value (estimated MOS for Audio) higher than 80

*** Audio/Video codec considered here is VP8 Audio/Video HD

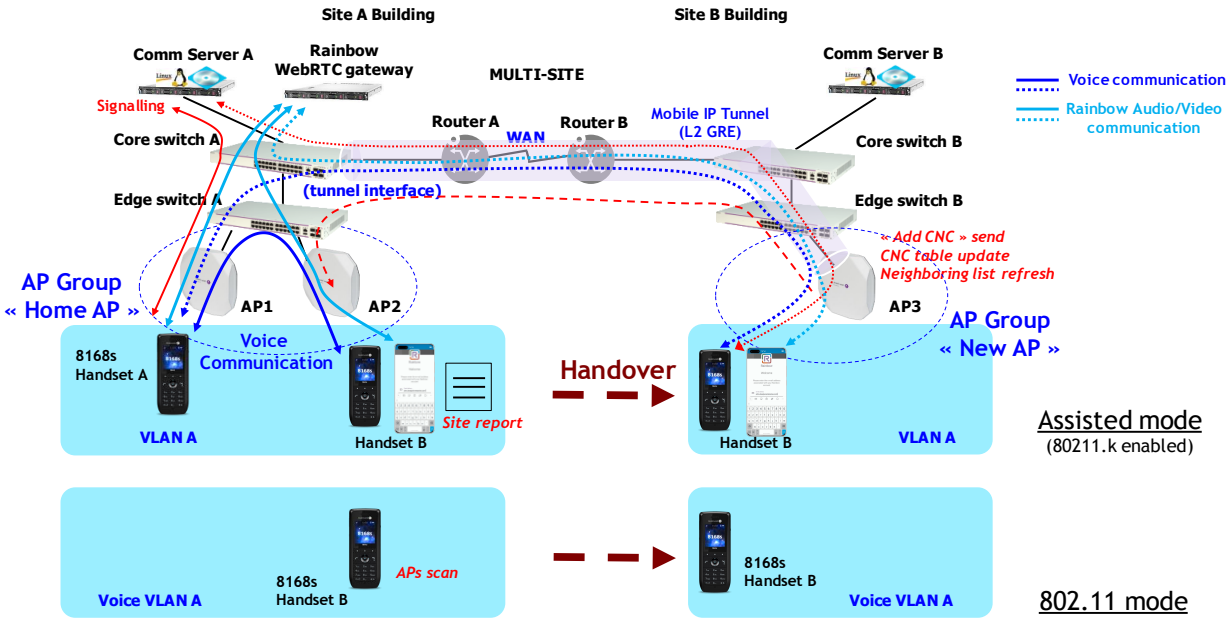
Note the limit of consumed Bandwidth is for Stellar ap132x 802.11ax with up to 35 simultaneous voice calls per Access Point. 802.11ac/11ax operation is recommended for VoWLAN to avoid interferences existing in the 2.4 GHz radio band (Bluetooth, microwave oven, intruder detection systems, etc.), nevertheless 802.11n can also be used.

16.6 Layer 2 Handover on Stellar AP



- AP1 & AP 2 are in the same AP group (Layer 2)
- 8168s or WLAN handset or smartphone with Rainbow client B performs a handover between AP1 and AP2 within the same AP group
- If 802.11k enabled on Voice SSID, 8168s or smartphone starts for a Layer 2 handover as long as it can see another AP in report list with RSSI that equals to RSSI threshold value.
- If 802.11k disabled on a separated Voice SSID, 8168s WLAN handset starts for a Layer 2 handover (within the same AP group) as long as it can see another AP with a RSSI that is 6 dB better than the current one.

16.7 Layer 3 Handover on Stellar AP



AP1 and AP2 are Virtual Controllers for “Home AP” AP group, AP3 is Virtual Controller for “New AP” AP group. The communication between “Home AP” group and “New AP” group is performed in layer3

- A mobile IP Tunnel (L2 GRE) is created between the two AP groups by the “New associated AP3”, to the Home AP2. At creation of the tunnel AP3 sends “Add CNC” message to its adjacent APs and is updating its Client Network Context table and refreshing its neighboring list.
- 8168s or smartphone with Rainbow client B performs the handover from AP2, belonging to “Home AP” group 1 to AP3 belonging to “New AP” group. Like in L2 handover 8168s or smartphone starts for a handover as long as it can see another AP in report list with RSSI that equals to RSSI threshold value.
- If 802.11k disabled only 8168s can perform handover in 802.11 mode.
- Up to 6 simultaneous voice communications have been validated through the Mobile IP Tunnel.

Recommendations to perform a Layer 3 handover between two Stellar AP groups:

- Same Voice SSID on both AP groups
- « L3 roaming » enabled on Voice SSID on both AP groups
- Network configuration must be the same on both Stellar AP groups (DTIM, Radio, 802.11k, Security mode, network policy, etc.)

Re-authentication is necessary during a L3 handover. It is recommended using a single Radius server to shorten the re-authentication delay and enable the 802.11r on both Stellar AP groups.

AP model	L2 GRE tunnel interfaces per AP	Client Network Context Per AP	AWOS version
ap1101	16	255	AWOS 4.0.2
ap122x	16	255	AWOS 4.0.2
ap123x	16	255	AWOS 4.0.2
ap1311	16	255	AWOS 4.0.2
ap132x	16	255	AWOS 4.0.2

Figure 32: OmniAccess Stellar IP specifications

The Handover layer 3 is applicable to Multi-Site (WAN) environments with OmniAccess Stellar AP13xx series, AP12xx series and with version 4.0.2.

16.8 Voice communication over Bridging/Multi-point Meshing

Aim of Bridging / Multi-meshing introduced in GA version 3.0.4 is to extend voice over LAN & over WLAN in areas where the ethernet cabling is not possible and allow VoIP and data users extension in such areas. The bridging mode offers a Point-to-point wireless Mesh link while daisy-chain meshing mode offers Point to multi-point wireless LAN meshing with broadcast of WLAN services at each node on the Mesh for the connected devices.

OmniAccess Stellar® version 4.0.2 supports both bridging and meshing modes on AP12xx series and AP13xx series. The values and rules highlighted in this chapter may subject of changes.

16.8.1 Wireless bridging mode

All 802.11n and 802.11ac/ax radios can operate as mesh in OmniAccess Stellar® bridging wireless mode. There is no broadcasting of WLAN services to the clients in this mode, each AP is managed as Bridge AP and connect its radios to the LAN. The bridge AP belongs to LAN AP-Group to which it is associated with and is reported as bridge AP on both Wifi-Express and Wifi-Enterprise WebUI interfaces. The LAN is recreated on ethernet ports of each Stellar bridge APs with a link aggregation.
Voice and data VLANs can be propagated through Stellar® bridging wireless link.
5Ghz is the preferred band to exploit 802.11n/ac technologies (MIMO, MU-MIMO and TxBF) and 802.11ax technologies (extended MU-MIMO, OFDMA and Extra Range).

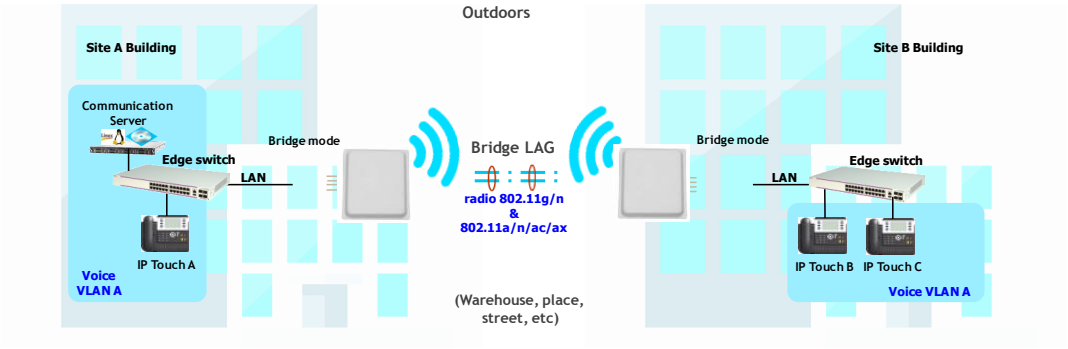


Figure 33: Wireless bridging mode

- Bridging mode is intended to connect two distant independently managed sites over wireless and then intended to outdoor infrastructures only
- Use only directional antennas for outdoor bridging
- Cross-polarization (usually dual slant + -45 °, vertical & horizontal) is recommended for the performance of bridge APs in MU-MIMO. It is important to keep the same polarization for the two antennas of the link
- Mesh link can be configured with both 802.11g/n and 802.11an/ac/ax radios simultaneously. 802.11g/n alone must not be considered.
- Keep same series to configure a bridge ie. use 802.11ax access points to benefit to 802.11ax technologie.
- 5Ghz is preferred band for voice and data bridge. The 40Mhz mode is recommended in 802.11an/ac/ax.
- It is not recommended to configure multiple bridge Aps for a same LAN, if there is two bridge AP in the setup, the AP downlink will connect to the bridge AP with best RSSI.

16.8.1.1 Supported APs

Indoor and outdoor AP1222/AP1232/AP1251, AP1322/AP1361/AP1362/AP1361D are supported for bridging mode

16.8.1.2 Supported antennas

The recommended antennas are directional antennas, please refer to antennas datasheets for detailed characteristics.

Antenna	Type
ANT-S-M4-30	4 external outdoor
AP1251 wall mounting equivalent to ap365	integrated outdoor
ANT-S-M4-60 equivalent to ap-ant-48	4 external outdoor
AP1361 wall mounting equivalent to ap575	Integrated outdoor
ANT-O-M2-5 equivalent to ant-2x2-5005	2 external outdoor
ANT-O-M4-9 equivalent to ant-2x2-5010	2 external outdoor

AP1361D wall mounting	equivalent to ap577	Integrated outdoor

16.8.2 Wireless Point to Multipoint mode

OmniAccess Stellar® multi-point meshing mode can be deployed both in indoor or outdoor infrastructures. Both 802.11n and 802.11an/ac/ax radios can operate as mesh link. Stellar® APs connected to the LAN/WAN are root Aps, if 2 root APs are configured in same AP-Group the AP downlink will connect to the root AP with the best RSSI.

All Stellar® access points support Auto-Mesh feature with release 4.0.2, where the administrator has just to enable root ap in Stellar APs connected to the LAN/WAN. Any neighbor AP booting with no connection to the LAN will try to connect as Mesh access point first.

Any Mesh AP connector can broadcast 5 client WLAN services maximum.

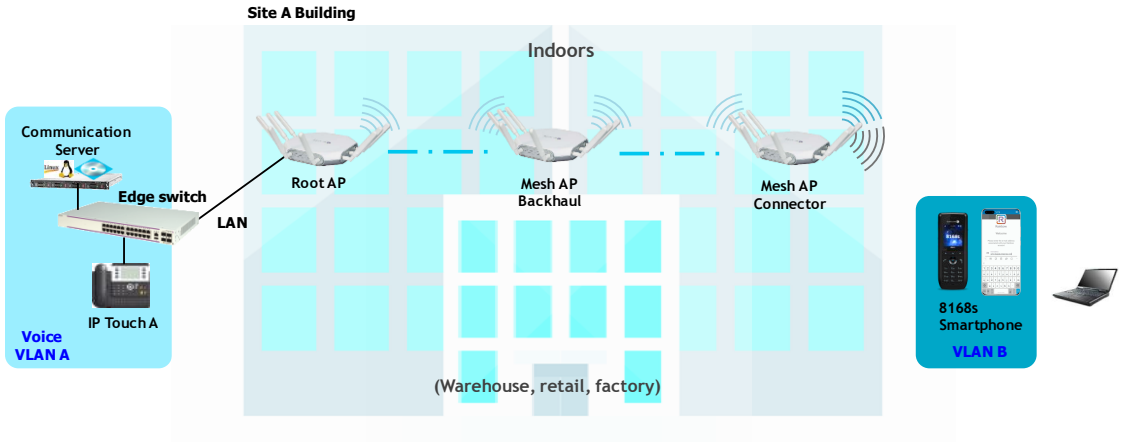


Figure 34: Wireless Point to Point Indoor Meshing

- The maximum distance for Indoor meshing in 802.11a/g/n/ac/ax is 70m (a typical 802.11ac/ax indoor cell radius is 40m). The RF indoor prerequisites are identical to indoor coverages:
  - **SNR 25 dB or better**
  - **RSSI at least -67 dBm**

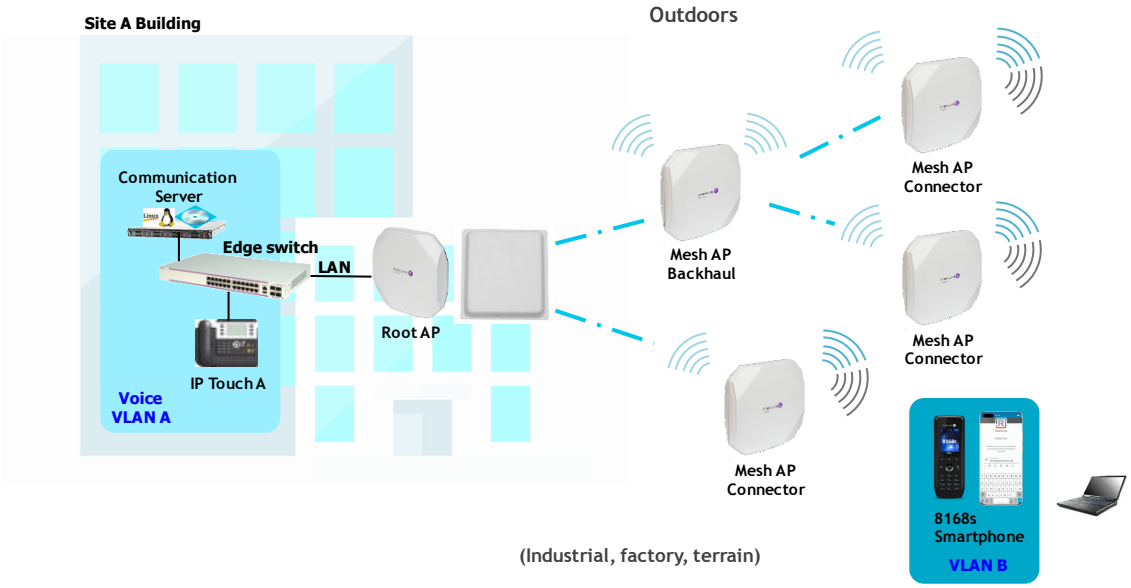


Figure 35: Wireless Point to Multipoint Outdoor Meshing

- 5Ghz is the recommended band for voice and data extension in Point to Multipoint mode

Due the sharing of AP bandwidths in multi-meshing topologies it is not recommended to have more than 4 root directions in multi-meshing and 4 node Aps per mesh link.
5Ghz is the preferred band to exploit 802.11ac technologies (MIMO, MU-MIMO and TxBF) and 802.11ax technologies (extended MU-MIMO, OFDMA, BSS coloring and Extra Range) in multi-meshing topologies.

16.8.2.1 Supported APs

Indoor and outdoor AP1101/AP1201/AP1221/AP1222/AP1231/AP1232/AP1251, AP1311/AP1321/AP1322/AP1361/AP1362 are supported for Point to Multipoint meshing.

16.8.2.2 Supported antennas

The recommended indoor antennas are standard dipoles. Mix of antennas or mix of polarization are not recommended for MU-MIMO purpose in 802.11a/g/n/ac/ax.

Indoors	Mounting type	Role	Geometry
ANT-O-6	**External indoor with AP1222/AP1232/AP1322**	**Root/mesh**	**omnidirectional**
ANT-O-6	External indoor with AP1222/AP1232/AP1322	Root/mesh	omnidirectional
ANT-O-M4-5	External indoor with AP1232/AP1322	Root/mesh	omnidirectional
Outdoors	**Mounting type**	**Role**	**Geometry**
AP1251 **Equivalent to ap365**	Integrated outdoor Horizontal mounting	Root/mesh	omnidirectional
ANT-S-M4-120 **Equivalent ap-ant-45**	External outdoor with AP1222, mixed with AP1251	Root	120°
AP1361 **Equivalent to ap575**	Integrated outdoor Horizontal mounting	Root/mesh	omnidirectional
ANT-O-M2-5 **Equivalent ap-2x2-5005**	External outdoor with AP1362, mixed with AP1361	Root/mesh	omnidirectional

Figure 36: Point to Multipoint type of mountings

16.8.3 Point to Multipoint Meshing limitations

Any Point to Multipoint Meshing feature comes with several restrictions that requires attention from the beginning of meshing deployments:

- There is no combinatory possible between Bridging topologies and Meshing topologies, only one mode can be defined for a Mesh area extension.
- The Global call transit capacity of a Mesh root AP has to be shared between all Mesh Points
  - 4 voice mesh hops max - the bandwidth will be divided by 3 when reaching a mesh point and the first root point has 4 mesh links to manage.
  - 4 voice mesh directions max - In such topology with identical bandwidth for the 4 directions, the available bandwidth at a given mesh point will be equivalent to the mesh root AP bandwidth divided by 4.
- Max transit capacity of about 15 8158s /8168s per root AP, each mesh point can handle up to 8 8158s /8168s calls in 802.11g/a/n/ac/ax

Due 802.11r/PMK/OKC caching and keys exchange handling through Meshing configurations, the VoIP is carried in **best effort mode** for 8158s/8168s handsets.

16.8.4 Bridging/Point to Multipoint Meshing management

Bridging and Point to Multipoint Meshing are supported in both Stellar® Wifi-Enterprise & Wifi-Express management. Bridge APs or Meshing APs can be configured only one by one. A bridge AP cannot join AP-Group but bridge A bridge link or multi-link link are reported in both AP-group management and can be displayed in topology application in Wifi-Enterprise mode.

- Maximum of 16 APs in a MESH to one Root AP in management
- Maximum of 5 APs in any Point to Multipoint connection in management
- Maximum of 4 hops in management

16.8.5 Outdoor topologies considerations

16.8.5.1 Antennas placement and installations

The antenna location and its possible obstructions must be considered from the beginning of antenna installation, the antennas must be placed as high as possible and comply with local regulations in terms of radio emission and electrical protections. The possible obstructions (trees, buildings, etc.) must be identified.

The antennas must then be aligned so that their radiated power lobes are directed at each other (Line of Sight running). The larger WLAN distances (1/5 mile or more) can only be considered with high-gain directional antennas and with the use of low VHT/HE modes.

Consider the mounting possibilities and constraints of the site to make the correct choice of antenna. Consider in particular the type of mounting pole/mast, pole/reverb, wall or facades of buildings (including here the possibility of mixing an indoor AP with an outdoor antenna) and accessible heights.

Stellar AP Antennas	Recommended installations	Type of mounting	Lighting protections Grounding
AP1251	Specific indoor: harsh environments indoors (warehouse, factory, retail, industrial) Specific outdoor: industrial, terrain, events	On ceiling for specific indoors or on pole or wall. No more than 10m height for indoors (tilt adjustable with kit **AP-MNT-OUT**)	DC grounded Surge protection with **OAW-PD9001GO6ET/AC** power injector
ANT-S-M4-60	Specific outdoor: industrial, terrain Outdoor: heavily-built urban, sub-urban	On Pole or wall (tilt adjustable with kit **MNT-22**)	DC grounded Surge protection when mixed Stellar indoor RPSMA and AP **OAW-PD9001GO6ET/AC** power injector
ANT-S-M4-120	Specific outdoor: industrial, terrain Outdoor: heavily-built urban, sub-urban	On Pole or wall (tilt adjustable with kit **MNT-22**)	DC grounded Surge protection when mixed Stellar indoor RPSMA and **AP OAW-PD9001GO6ET/AC** power injector
ANT-S-M4-30	Specific outdoor: industrial, terrain	On Pole or wall (tilt adjustable with kit **MNT-23**)	DC grounded Surge protection when mixed Stellar indoor RPSMA and AP **OAW-**

	Outdoor: heavily-built urban, sub-urban		**PD9001GO6ET/AC** power injector
AP1361	Specific indoor: harsh environments indoors (warehouse, factory, retail, industrial) Outdoor: heavily-built urban, sub-urban, meshing with LAN distances with high density	On ceiling for specific indoors or on pole or wall. No more than 10m height for indoors (tilt adjustable with kit AP-MNT-OUT-H)	DC grounded Surge protection with **OAW-PD9001GO6ET/AC** power injector or **PD-9601GO/AC**
ANT-O-M2-5	Outdoor: heavily-built urban, sub-urban, meshing with LAN distances with high density	On Pole or wall (tilt adjustable with kit AP-MNT-OUT-H)	DC grounded Surge protection when mixed with Stellar outdoor N-type AP1362 and **OAW-PD9001GO6ET/AC** power injector or **PD-9601GO/AC**
ANT-O-M4-9	Outdoor: heavily-built urban, sub-urban, bridging with LAN distances with high density	On Pole or wall (tilt adjustable with kit AP-MNT-OUT-H)	DC grounded Surge protection when mixed with Stellar outdoor N-type AP1362 and **OAW-PD9001GO6ET/AC** power injector or **PD-9601GO/AC**
AP1361D	Outdoor: heavily-built urban, sub-urban, bridging with LAN distances with high density	On pole or wall. (tilt adjustable with kit AP-MNT-OUT-H)	DC grounded Surge protection with **OAW-PD9001GO6ET/AC** power injector or **PD-9601GO/AC**

!

16.8.5.2 Distance considerations in 802.11n/ac/ax

Bandwidths in Bridging/Meshing decline significantly with the distance between two Bridge/Mesh APs. Bridge/Mesh link installation in 802.11n/ac/ax is often a compromise between distance and link performances.
In table below the 40Mhz mode is considered the best mode for performances on voice and data mesh link in 802.11n/ac/ax but at the detriment to the mesh link distance.

Stellar AP Antennas	Recommanded distance 802.11ac/ax	AP mode	Performances per link*
ANT-S-M4-30	**320m**	mode VHT40 (MSC9) low band DFS	System operating margin: 3dB MU-MIMO on LoS: 80% Max LAN speed: 250Mbps Concurrent clients: 256
ANT-O-M4-9	**240m**	mode HE40 (MSC9) low band DFS with outdoor AP1362	System operating margin: 3dB MU-MIMO on LoS: 80% Max LAN speed: 250Mbps Concurrent clients: 512
ANT-O-M4-5	**195m**	mode HE40 (MSC9) low band DFS with outdoor AP1362	System operating margin: 3dB MU-MIMO on LoS: 80% Max LAN speed: 250Mbps Concurrent clients: 512
AP1361D Wall mounting	**160m**	mode HE40 (MSC9) low band DFS	System operating margin: 3dB MU-MIMO on LoS: 80% Max LAN speed: 250Mbps Concurrent clients: 512
AP1251 Wall mounting	**150m**	mode VHT40 (MSC9) low band DFS	System operating margin: 3dB MU-MIMO on LoS: 80% Max LAN speed: 150Mbps Concurrent clients: 256
AP1361 Wall mounting	**100m**	mode HE40 (MSC9) low band DFS	System operating margin: 3dB MU-MIMO on LoS: 80% Max LAN speed: 250Mbps

			Concurrent clients: 512
ANT-S-M4-60	**60m**	mode VHT40 (MCS9) low band DFSwith indoor AP1222	System operating margin: 3dB MU-MIMO on LoS: 80% Max LAN speed: 250Mbps Concurrent clients: 256
AP1361 horizontal mounting	**60m**	mode HE40 (MSC9) low band DFS	System operating margin: 3dB MU-MIMO on LoS: 80% Max LAN speed: 250Mbps Concurrent clients: 512
AP1251 horizontal mounting	**65m**	mode VHT40 (MSC9) low band DFS	System operating margin: 3dB MU-MIMO on LoS: 80% Max LAN speed: 150Mbps Concurrent clients: 256
ANT-S1-M4-120	**50m**	mode VHT40 (MSC9) low band DFS with indoor AP1222	System operating margin: 3dB MU-MIMO on LoS: 80% Max LAN speed: 250Mbps Concurrent clients: 256

Figure 37: Performances in LoS running configuration

* Notes

Values in the table are given as an indication and are based on:

- on RF calculator for distance between two APs (SOM). for more details on such calculation: https://proxim.force.com/s/article/Link-Calculator
- Capabilities of each AP are given here with all radios running (3 radios for AP123X) and must be divided by the number of mesh links on each node (for example a multi-meshing link with 4 directions gives an /4 root AP capability)

Larger distances (from 1/5 mile) can only be envisaged for pure voice extensions only with use of lower throughput modes and low datarates.

16.8.5.3 Electrical considerations

Voltages and currents caused by lightning, power cross and electrostatic charges occurring on outdoor antennas may present significant safety hazard in external installations, possibly leading electrocution and fire. These hazards can be reduced by proper bonding, grounding and surge protection.

It is strongly advised to comply outdoor installations requirements (requirements that are mandatory in certain regions). As reference **Grounding and Bonding requirements for communications equipments** standard on grounding can help on best practices in outdoor APs and installations. Refer to following ANSI / TIA-607-B standard, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises (https://www.tiaonline.org)

16.9 Voice communication over Remote Access Point

16.9.1 Overview

A Remote AP is AP installed on Remote site and managed differently by the headquarter. Remote AP launches automatically a VPN tunnel up to a VPN VA server at headquarter. This tunnel is created during RAP provisioning in OmniAccess® Stellar Wifi-Enterprise mode via Omnivista® 2500 server, any further configuration can be done via Omnivista® 2500 server.

16.9.1.1 Different modes for Stellar RAP

- Tunnel mode: all traffic between Remote AP and VPN VA goes through a VPN tunnel
- Local breakout: Traffic between 2 users at remote location remains local and does not go through VPN tunnel. Forwarding of packets in the VPN tunnel and/or local bridging is based on routes defined in Omnivista® 2500 server.

16.9.1.2 Stellar RAP versus Stellar AP

- It is not recommanded to use RAP in headquarter due to VPN tunnel constraints, RAP are an extension of corporate network outside the headquarter.
- The capacity in term of bandwidth and quantity of users on a RAP is much lower than on AP, for example the expected encrypted performance with AP1201H configured as RAP is about 100Mbps while the same Stellar AP1201H in headquarter has about 433Mbps of bandwidth.
- In case 2 RAPs are geographically collocated, 8168s handover between 2 RAPs is not supported.

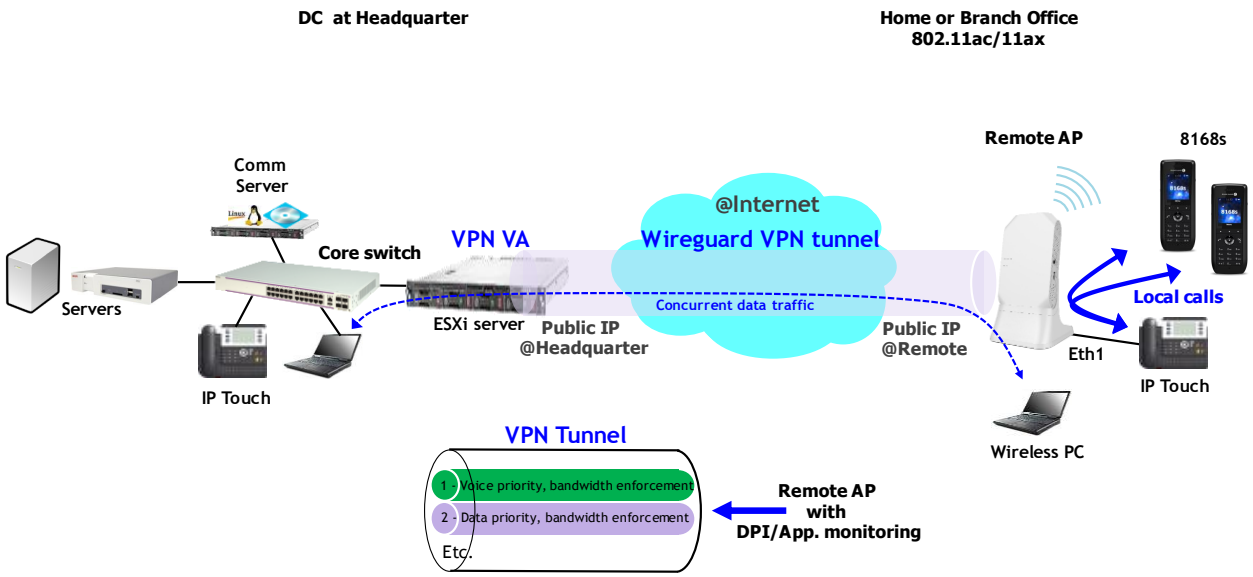


Figure38: Stellar RAP for Home office

Recommendations for VoWLAN for remote office:

- Stellar remote AP must be configured in tunnel mode, all voice traffic backs to headquarter.
- Up to 30 users or devices are shared between wired and wireless, refer to voice communication bandwidth per AP table.
- Up to 12Mbps encrypted throughput for voice, refer to voice communication bandwidth per AP table.
- Bandwidth enforcement must apply to limit concurrent data traffic versus voice traffic according to the available bandwidth on WAN

Recommandations for VoWLAN for home office

- Up to 8 users or devices are shared between wired and wireless, refer to voice communication bandwidth per AP table.
- Up to 3Mbps encrypted throughput for voice, refer to voice communication bandwidth per AP table.
- Bandwidth enforcement must apply to limit concurrent data traffic versus voice traffic according to the available bandwidth on the Internet.

As shown in figure, a priority and bandwidth can be assigned for each class of traffic to carry on RAP and can be based on ARP/policies defined in Omnivista 2500 server, when RAP is managed in Wifi-Enterprise mode.

Alcatel·Lucent Enterprise

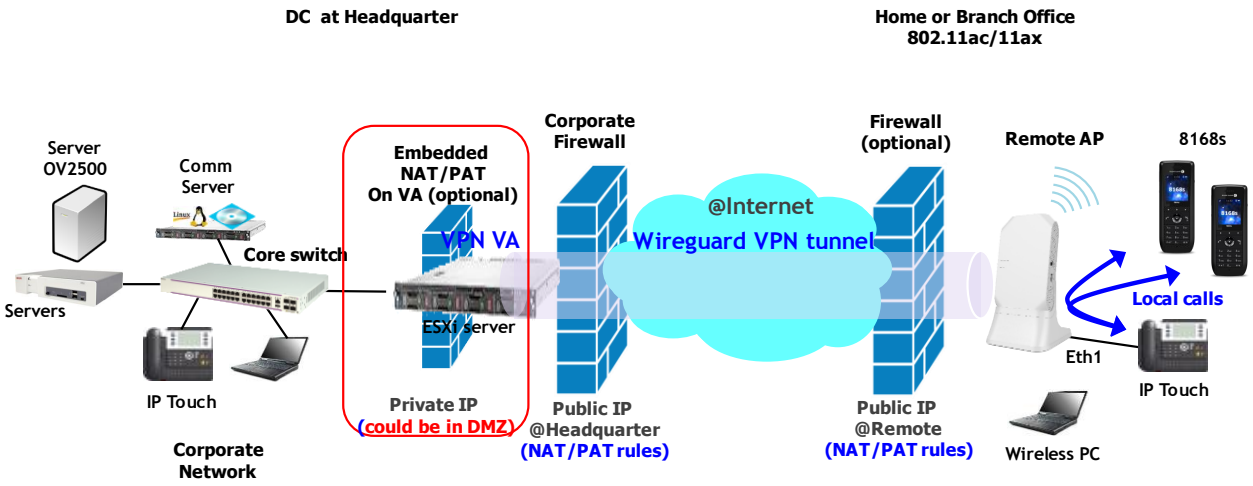


Figure 39: Implementation at Headquarter

The above picture shows how to implement a Stellar RAP access point at the headquarter. The purpose of such topology is first to handle all Wireguard VPN tunnels created between remote APs and VPN VA, the VA installed at headquarter provides here secure link over Internet using Wireguard open source solution which the more recent VPN technology on the market.

At security point of view, VPN VA is installed on data center at headquarter and all VPN traffic goes through the corporate firewall. A NAT traversal function is performed by the firewall for Wireguard and optional NAT/PAT rules can be added on VA itself if not managed by corporate firewall.

This implementation is also fully adapted when the customer requires that any Wireguard VPN tunnel ends in a DMZ (Delimitarized Zone) at headquarter. In this case the VPN VA ensures the VPN terminations in DMZ are in charge of Stellar RAP only.

Only one AP licence required per RAP when managed in Wifi-Enterprise mode with Omnivista 2500 server. No additional licence is required for the security for Stellar Remote access points, VPN VA installation at headquarter does not require license.

17. VoWLAN 8158s and 8168s Validation Tests on OmniAccess® Stellar AP

17.1 81x8s on AP1101

ALE VoWLAN 8158s and 8168s solution has been validated on AP1101 and as a result is supported.

17.2 81x8s on AP1201

ALE VoWLAN 8158s and 8168s solution has been validated on AP1201 and as a result is supported.

17.3 81x8s on AP1221

ALE VoWLAN 8158s and 8168s solution has been validated on AP1221 and as a result is supported.

17.4 81x8s on AP1222

ALE VoWLAN 8158s and 8168s solution has been validated on AP1222 and as a result is supported.

17.5 81x8s on AP1231

ALE VoWLAN 8158s and 8168s solution has been validated on AP1231 and as a result is supported.

17.6 81x8s on AP1232

ALE VoWLAN 8158s and 8168s solution has been validated on AP1232 and as a result is supported.

17.7 81x8s on AP1251

ALE VoWLAN 8158s and 8168s solution has been validated on AP1251 and as a result is supported.

17.8 81x8s on AP1201H

ALE VoWLAN 8158s and 8168s solution has been validated on AP1201H and as a result is supported.

17.9 81x8s on AP1311

ALE VoWLAN 8158s and 8168s solution has been validated on AP1311 and as a result is supported.
Refer to 81x8s interoperability reports to have the minimum AWOS software version.

17.10 81x8s on AP1321

ALE VoWLAN 8158s and 8168s solution has been validated on AP1321 and as a result is supported.

17.11 81x8s on AP1322

ALE VoWLAN 8158s and 8168s solution has been validated on AP1322 and as a result is supported.

17.12 81x8s on AP1361/62/61D

ALE VoWLAN 8158s and 8168s solution has been validated on AP1361/62/61D and as a result is supported.
Support of VoWLAN with AP1362/61D is only for Bridging /Multi-meshing configurations that are carrying voice on their mesh links.

18. 802.11n

18.1 802.11n specifications

802.11n is supported on both 2.4 GHz and 5 GHz Radio Bands.

Some particularities with 802.11n:

- HT20 configuration (20 MHz channel)
- HT40 configuration (40 MHz channel aggregation)
  HT40 is currently used in the 5 GHz radio band (802.11an) as many channels are available.
  HT20 is mainly used in the 2.4 GHz radio band (802.11bgn). HT40 configuration in the 2.4GHz radio band remains possible for a hot spot (using few APs) but is not adapted to a large deployment due to the 3-channels limitation in 2.4 GHz (interferences between channels)

- 64-QAM modulation (Quadratic Amplitude Modulation)
- Up to 4 streams
- Beam forming (explicit and implicit)
- Backwards compatibility with 11a/b/g

802.11n improves RF coverage of 30% when using 802.11n clients only and can run in 2.4 GHz and 5 GHz in 2 modes (40 MHz channel and 20 MHz channel. 802.11n is backward compatible with 802.11a/b/g.

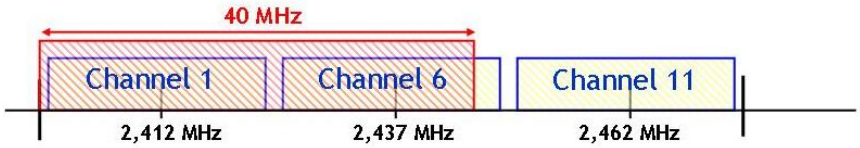


Figure 40: Channel aggregation in 2.4GHz

802.11n can operate either in 20 MHz or 40 MHz. The picture above shows channel aggregation made of 2 channels is possible in 2.4 GHz (802.11 b/g /n) but makes the AP implementation difficult to avoid interferences between APs. As a reminder channels 1, 6 and 11 must not interfere. If channels 1 and 6 are aggregated in the same AP, the only remaining channel is 11, and it becomes difficult to ensure at the same time a correct coverage and avoid interferences between APs using the same channel number (i.e. channels 1 & 1, 6 &6 and channels 11 & 11).

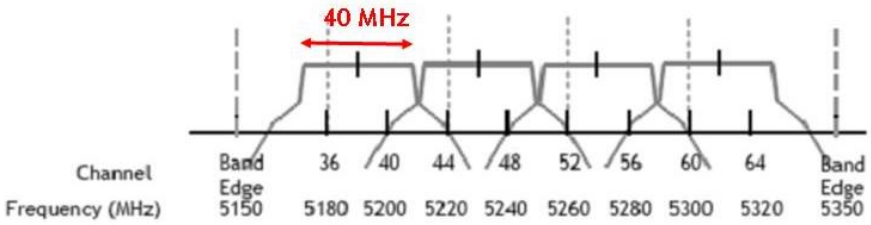


Figure 41: Channel aggregation in 5 GHz

5 GHz radio (802.11a/n) offers many more channels making possible a 802.11n operation in 40 MHz (aggregation of 2 channels on the same AP). In this example above 20 MHz channels 36 and 40 have been aggregated in order to create a 40 MHz channel.

18.2 8158s and 8168s operation in 802.11n

In order to match WLAN network characteristics 8158s and 8168s WLAN handsets can be configured either:

- On 5GHz (802.11 a/n)
- On 2.4GHz (802.11 b/g/n)

The main benefit of configuring 8158s/8168s WLAN handsets in 802.11n is that they can work in an environment where n is implemented in the infrastructure and there is no need to configure a separate legacy network just for the handsets. The 8158s/8168s WLAN handset understands 802.11n PHY and MAC mechanisms/extensions.

The only "n" related setting that can be set right now is the 802.11 protocol to use.
If 8158s/8168s WLAN handsets are configured in a/n or b/g/n, they will work in **a 20MHz "n" network (HT20)** and legacy network.
The handsets can coexist with 40 MHz channels (channel bonding HT40).

8158s and 8168s WLAN handsets when configured in 802.11n operate in **1x1 MIMO mode**

Due to AP deployment constraints in b/g/n operation (limit of 3 channels in 802.11 b/g/n) and also the potential risk of interference in 2.4 GHz band (Bluetooth, Intrusion radar, microwave oven, etc.),
the recommended 802.11n mode for 8158s and 8168s WLAN is 802.11a/n

19. 802.11ac/ax

19.1 802.11ac specifications

Some particularities with 802.11ac:

- 802.11ac is only supported on the 5 GHz Radio Band
- Even wider channels (80 MHz and 160MHz for wave 2) HT80 and HT160
- Better modulation (256-QAM for wave 2)
- Additional streams (up to 8 for wave 2)
- Multi-User-MIMO streams
- Explicit Beam forming
- Backwards compatibility with 11a/b/g/n

(Refer to http://www.802-11.ac.net for in-depth information)

802.11ac strenghtens the RF coverage with beamforming and improves speed for simultaneous clients with use of wider bandwidth channels (up to 160Mhz) on the 5GHz. 802.11ac is backward compatible with 802.11a/b/g/n.

OmniAccess® Stellar AP1101 is 802.11ac wave 1 and OmniAccess® Stellar AP12XX are 802.11ac wave 2 and are compatibles with 8158s/8168s WLAN handsets under 802.11ac operations.

19.2 802.11ax specifications

802.11ax brings the high efficiency WLAN on both 2.4GHz and 5 GHz Radio Bands. Some particularities with 802.11ax:

- Even wider high-efficient channels (80 MHz and 160MHz) HE80 and HE160
- Better modulation (1024-QAM)
- OFDMA access (Orthogonal Frequency Division Multiplex Access)
- BSS coloring
- Additional Multi-User-MIMO streams, downlink and uplink (up to 8)
- Extended symbols durations and extended GIs
- TWT (Target Wake Time) for specific devices
- Backwards compatibility with 11a/b/g/n/ac

(Refer to http://www.802-11.ax.net for in-depth information)

802.11ax improves the efficiency of WLAN with a better access to radio resources and a better channel utilization in high-density contexts, for a numerous variety of clients, on both 2.4GHz and 5GHz bands. 802.11ax is backward compatible with 802.11a/b/g/n/ac.

OmniAccess® Stellar AP1311 and OmniAccess® Stellar AP13XX are 802.11ax and are compatibles with 8158s/8168s WLAN handsets under 802.11ax operations.

19.3 8158s & 8168s WLAN operation in 802.11ac/ax

In order to match WLAN network characteristics 8158s and 8168s WLAN handsets can be configured :

- On 5GHz (802.11ac)

This above picture shows how different modes of operation are multiplexed on access points:

- 802.11n (HT20) –matching 8158s/8168s operation-mode
- 802.11an (HT40)
- 802.11ac (VHT40, VHT80 wave 1 and wave 2)
- 802.11ax (VHT40, VHT80)

8158s/8168s WLAN handsets are 802.11ac in 1x1 MIMO mode (HT20 operation). Due to the backward compatbility of 802.11ax with 802.11ac, 8158s/8168s WLAN handsets are natively compatible with 802.11ac operations and compatible with 802.11ax operations.

20. MU-MIMO in 802.11

802.11n technology has introduced the MIMO (Multiple-Input-Multiple-Output) technology that takes advantage of multipath effects. 802.11ac/ax technologies enhance the MIMO with the ability to multiplex several users on each spatial stream and then provide a Multi-User MIMO.

Multi-User MIMO is defined as MxN: e.g. 2x2, 3x3 and up to 4x4

M = number of transmit antennas

N = number of antennas at the receiver.

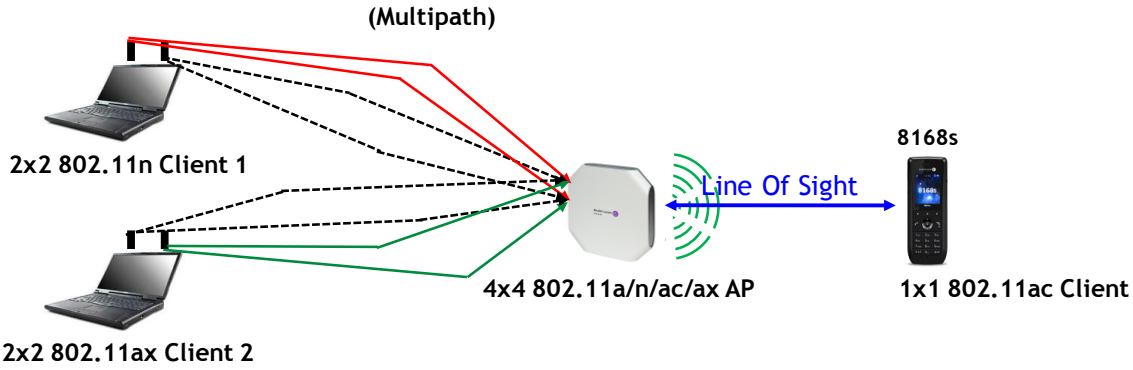


Figure 42: MU-MIMO principle with 2 spatial streams

This picture shows different clients that are associated to a backward compatible 802.11n/ac AP using a 4x4 MU-MIMO mode and taking advantage of multipath reflections and users multiplexing on each path, while the 8158s and 8168s WLAN, configured in 802.11n or 11ac, use line of sight to reach the AP and uses diversity provided by this 802.11a/n/ac/ax AP.

21. Converged Wireless Environments (Voice & Data Combinations)

One of the most significant reasons that businesses look to use wireless LAN technology to support voice is the desire to have a single infrastructure for both voice and data services. While this may at first sound like a very simple thing to implement, it often is far more complex to design than most customers originally anticipate. Alone, a VoWLAN environment has some challenges that must be overcome. Combined with a need to coexist with data client service, VoWLAN environments can face a tremendous amount of competition that requires special planning to minimize.

One of the major complexity factors faced during the design stage is the varied nature of the standards that can be used to support a data WLAN, and the affects each method has on voice quality and performance.

21.1 Mixing Voice and Data on both wireless band

21.1.1 Voice on 2.4GHz wireless band

This implementation is possible but not recommended as 2.4GHz radio band is prone to interferences from Bluetooth, microwave oven and intrusion radar.

21.1.2 Data on 2.4GHz wireless band

This implementation stays possible on installations with data devices using 802.11 b/g/n radio. It is also strongly advisable with the use of PCs still working with radio 802.11b.

This is an ideal situation for voice subscribers to take benefit greatly from the density and coverage capabilities of the 10-13 non-overlapping channels (depending on local market restrictions) the 802.11a radio makes available.

There is no direct radio competition to Data Wireless solutions that require use of the 2.4 GHz IEEE 802.11g realm. Data wireless elements stay free to utilize the full theoretical 54 Mbps of the IEEE 802.11g network. Congestion and competition are eliminated when mixing Voice and Data on different wireless band.

21.1.3 VoWLAN Use Case with 802.11n

When dual-radio access points deployed, the scenario mixing WiFi customer needs in 802.11a/n and 802.11b/g/n stay possible.

There is some specific requirements to have such scenario:

- 802.11b/g being currently used by legacy PCs (still about 30% of the total quantity of wireless PCs)
- Voice should be preferably in 802.11a
- 802.11n here cannot be based on 802.11b/g (i.e. 802.11 b/g/n mode) in a deployment made of many adjacent APs, because only two channels remain available (the aggregated channel for 802.11n and the third available channel), resulting in interference occurrence between adjacent APs.
- The only possible choice for Voice is 802.11n based on 802.11a (i.e. 802.11a/n mode).

Due to customer requirements, Voice and some most recent Data clients can share the same 802.11a radio band. Voice & Data sharing on the same radio has a direct impact on the allowed density of voice/data users per AP.

21.1.4 Deployment recommendations with 802.11n

Some considerations for a Voice site survey when mixing Voice and Data on both wireless bands. To validate Voice coverage planning specifically for all Voice and Data clients on the 5GHz wireless band, please refer to Environment Verification & Validation paragraph that highlights practices to have to conduct proper Voice site survey on this band.

- 802.11n cannot be based on 802.11b/g (i.e. 802.11 b/g/n mode) in a deployment made of many adjacent APs, because only two channels remain available (the aggregated channel for 802.11n and the third available channel), resulting in interference occurrence between adjacent APs.
- A Voice site survey must be performed in 802.11n with a minimum RSSI level of **-60 dBm**.
- A Voice site survey must be performed in 802.11a with a minimum RSSI level of **-65 dBm**.
- Floor maps for involved buildings must be provided and also the areas to be covered in WiFi
- Quantity of voice/data users per zone/area or room are also required.
- Access Points must be visible (not hidden behind false ceiling)
- Staircases must be covered with access points
- Even if all users are expected to arrive in one shot, it is preferable starting the 8158s and 8168s WLAN deployment in a first step with just a few targeted users to check the good operation with final tuning, and in a second step extend to all VoWLAN users, smartphones or PCs.

The gigabit support stays mandatory for AP Ethernet connection due to bandwidth involved by MU-MIMO operation and channel aggregation:

- Channel planning approach related to 40MHz channel bandwidth instead of 20MHz
- Gigabit Ethernet ports, Gigabit Ethernet cabling, Gigabit controller throughput
- Power sources for 40MHz support : PoE+ followed by 802.3at
- Driver maturity for Wireless 802.11n clients must be considered

21.2 Voice and Data on the 5GHz wireless band

Because IEEE 802.11a utilizes the 5 GHz wireless spectrum that fits VoWLAN needs, it offers no direct radio competition to Data Wireless solutions that require use of the 2.4 GHz IEEE 802.11g realm. This is an ideal situation that offers the greatest benefit for both voice and data subscribers. As a result of the lack of frequency competition, Data wireless elements are free to utilize the full theoretical 54 Mbps of the IEEE 802.11g network.

Utilization of the 5 GHz wireless spectrum is also great advantage to Voice subscribers to take benefit greatly from the density and coverage capabilities of the 10-13 non-overlapping channels (depending on local market restrictions) it makes available.

Customers seeking this type of solution can unify the infrastructure elements by using ALE OmniAccess Stellar product suite for both Wi-Fi formats. ALE OmniAccess Stellar Access Point can be effectively leveraged to construct networks for both 2.4 GHz (802.11b/g/n) and 5 GHz (802.11a/n/ac/ax) networks simultaneously.

Another advantage is the fact that there is no environmental interference from Bluetooth and microwave oven in 802.11a.

In some specific cases 802.11a radio may be prone to RADAR interferences at 5 GHz (DFS, 802.11h) or sometimes not allowed by local regulations.

- Voice over WLAN with **8158s and 8168s WLAN handsets** must be configured in 802.11ac
- **802.11n Data Wireless PCs** if still exist must be configured in 802.11a/n
- Due current adoption of **802.11ac radio** (up to 70% of wireless PCs today) and more recently **802.11ax Data Wireless PCs**, 802.11a Access Points must be configured in a backward compatible 802.11a/n/ac/ax mode
- Due current adoption of **802.11ac dual band smartphones**, and more recently **802.11ax smartphones**, 802.11a Access Points must be configured in a backward compatible 802.11a/n/ac/ax mode

All 802.11a Access Points handling Voice over WLAN must use exclusively the four Non-DFS channels (Dynamic Frequency Selection) **36, 40 ,44 and 48** to avoid Radar interference in indoors.

Possibility to extend channel plan by using DFS channels **starting from channel 56 and upper** and using the DFS/TPC function to control the power transmission of DFS channels in indoors.

Check with local regulations to see which DFS channels are authorized to be deployed in indoors. This extension will also minimize interference risks between areas working in 802.11a and the new VoWLAN network also operating in 802.11a, the Data wireless or smartphones can use 802.11a channels that are out of the four first channels.
Most of DFS channels are prone to interfere with Radars, radar interference may happen but is unlikely to occur (airport proximit, military area etc.). Check in a second step if area of deployment with DFS is prone to radar interferences, in case of radar interference the DFS channel plan should be limited to non-interfered channels.

Due requirements of Voice and Data on the 5GHz wireless band, Voice and Data clients can share different corporate Vlans on a same SSID.

22. Roaming and Handover on Stellar AP

22.1 Roaming definition

Refers to the ability to be reached (ie: making and receiving calls) in a different Site or Network.
Inside a site or a network, provides a wireless device the capability to associate to an AP after a power-on or a reset of this device.

22.2 Handover definition

Refers to the ability to move from one AP coverage area to another AP without service disruption or loss in connectivity.

22.3 Handover and Roaming restrictions

This table is a summary of roaming and handover capabilities according to the different VoWLAN topologies.

Roaming and handover capabilities are linked directly to the Stellar WLAN Access Points configurations:

- Single Stellar AP-Group
- Different Stellar RF domains in layer 2 or 3 with OXE topologies
- Any mix/any model of Stellar WLAN Access Points

VoWLAN Topologies	Roaming	Handover
OXE Single-Node (Campus) Stellar Access Points in layer 2	OK	OK (within a same AP Group)
OXE Single-Node (Campus) Stellar Access Points in layer 3	OK	OK
OXE Single-Node (WAN) Stellar Access Points in layer 3	OK	OK
OXE Multi-Node (WAN) Stellar Access points in layer 3	OK	OK
OXE Multi-Node (WAN) with Rainbow PBX integration Stellar Access points in layer 3	OK	OK
Remote Site (WAN) Stellar Access Points in layer 3	OK*	Not Applicable because no handover between Headquarter and Remote Site

***** 8158s, 8168s, or smartphones with Voice application: WLAN Roaming between headquarter and a Remote Site is possible only if:

- There is enough bandwidth on WAN to ensure additional bandwidth involved by 8158s, 8168s or smartphone with Voice application, WLAN roamers
- The SSID is the same on Headquarter and Remote Site.
- In Personal Mode (WEP, WPA, WPA2 or WPA3) the Pre-shared keys are identical on Headquarter & Remote Site

Refer to OXE Remote Site IP configuration guidelines VoWLAN can only be handled in **Best Effort mode** for 8158s and 8168s WLAN handsets in certain configurations. VoWLAN is always handled in **Best Effort mode** for Voice apps running on smartphones.

- 802.11k must be enabled on Data and Voice SSIDs handling Voice applications running on smartphones.
- Layer 3 roaming must be enabled on Stellar Access Point when Stellar Access Point is in layer 3

On any new association, Stellar WLAN Access Point defines the type of roaming upon Client Network Context as follow:

Client Network Context exists?	Client Ntw Context WLAN service and Access Role profile exists?	Client Ntw Context VLAN Id = AP Access Role VLAN Id?	Type of Roaming
No	Client Context creation	Client Context creation	Undefined
Yes	Yes	Yes	Layer 2 roaming
Yes	Yes	No	Layer 3 roaming

Figure 43: Client roaming management on new AP

22.4Roaming on specific WLAN infrastructures

8158s and 8168s handsets support the **Check IP connectivity after roaming** mode for WLAN infrastructures with no handover capabilities, in their version 2.2.13. This setting enables to make the handset ping default gateway after roaming in order to detect that IP address of the gateway has changed.

If so (a new subnet), the DHCP client will ask for new lease and new IP address. Handset will however not keep any calls when changing IP address.
This mode does not support the seamless layer 3 handover.

23. G711, G729A and Opus codec

Used in Multi-Site configuration (One Com Server)
- G711 in Intra-domain and G729A in Inter-Domain (WAN)
- G711 in Intra-domain with Opus codec, and G729A in Inter-Domain (WAN)

Used in Multi-Node Configuration
- G711 in Intra-domain and G729A in Extra-Domain (WAN)

For more details about 8158s and 8168s WLAN restrictions see Feature List and Product Limit for OmniPCX Enterprise

23.1 G711 considerations

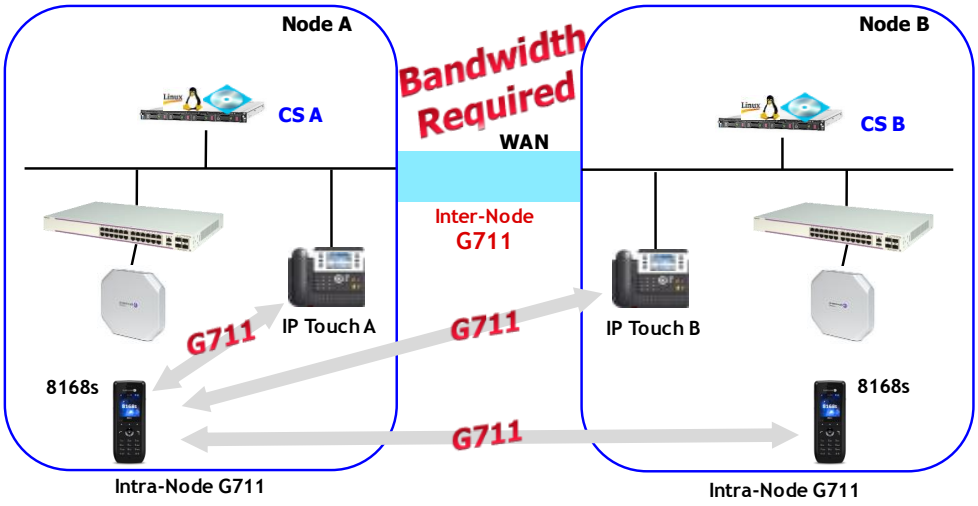


Figure 44: G711

This topology fully based on G711 does not contain any compression.
This configuration is supported but requires a minimum of bandwidth on WAN (no Voice compression).
In this example G711 is permanently used whatever the call destination is (intra-node or extra-node).

23.2 G729 considerations

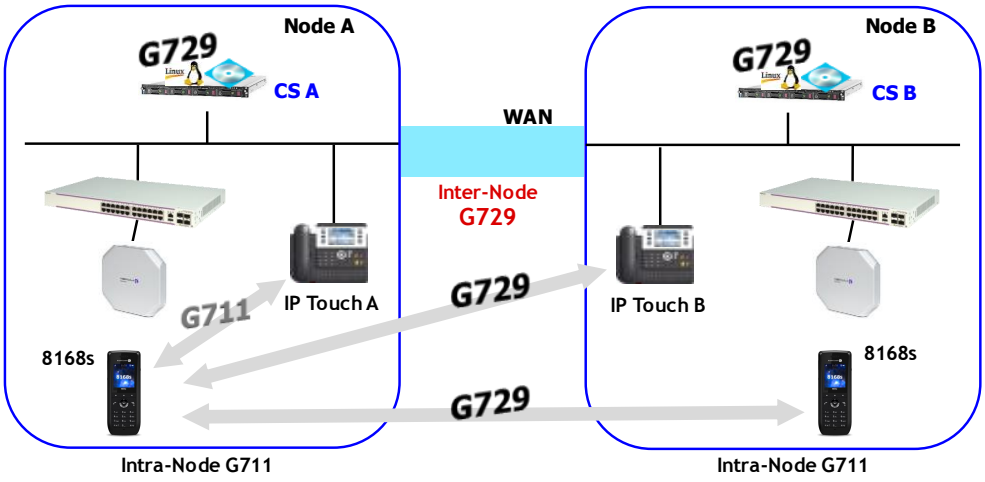


Figure 45: G729

Alcatel·Lucent Enterprise

This topology based on G729 allows compression on WAN for 8158s and 8168s WLAN handsets.
(8158s and 8168s WLAN handsets do not support G723). Generic rules:

- The OXE Network must be homogeneous in G729
- G729 must be set on all OXE nodes
- When compression is required (i.e. on WAN), G729 must be used by all 8158s, 8168s WLAN & IP Touch sets.

23.3 Opus codec considerations

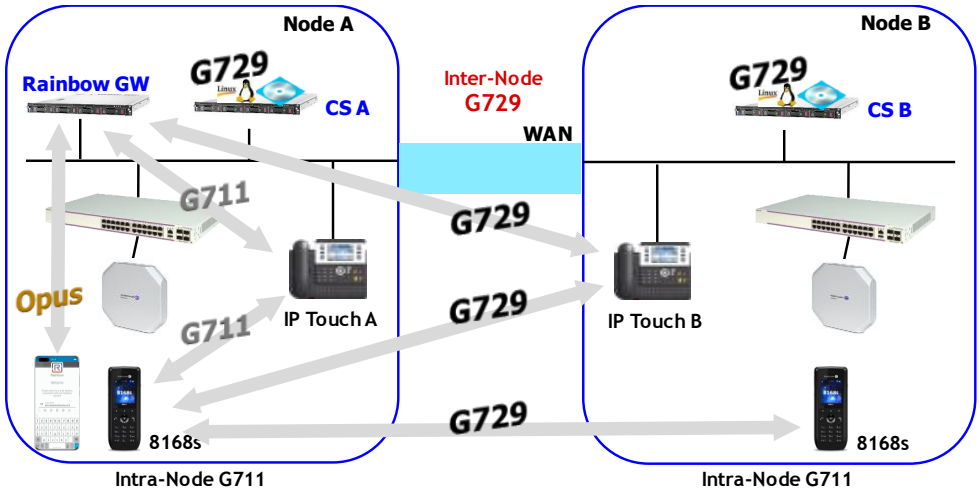


Figure 46: Opus codec

This topology based on G729 allows compression on WAN for 8158s, 8168s WLAN handsets and smartphones with Voice applications.
(8158s and 8168s WLAN handsets do not support G723). Generic rules:

- The OXE Network must be homogeneous in G729
- G729 must be set on all OXE nodes
- When compression is required (i.e. on WAN), G729 must be used by all 8158s, 8168s WLAN, smartphones & IP Touch sets.
- When dedicated audio codec used by some handsets (i.e Opus codec for a Rainbow client) the audio gateway converts the audio in G711 that does not contain any compression for OXE nodes.

24. Voice over WLAN Design Rules (ALE WLAN infra)

ALE 8158s and 8168s WLAN handsets support the following radios:

- On 2.4GHz (802.11b/g/n)
- On 5GHz (802.11a/n or 802.11ac)

24.1 Security on 8158s and 8168s WLAN solution

24.1.1 Encryption

WPA-PSK with TKIP (Temporal Key Integrity Protocol) Personal and Enterprise modes
WPA2-PSK with AES (Advanced Encryption Standard) Personal and Enterprise modes
WPA3 Personal and Enterprise modes, with SAE (Simultaneous Authentication of Equals), 192-bit cryptography in Enterprise mode.
PMF (Protected Management Frame) 802.11w

24.1.2 Authentication

802.1X authentication
- PEAP-MSCHAPv2
- EAP-TLS

24.2 Wireless Services Licensing with IMS3

Utilisation of IMS3 (Integrated Messaging and Wireless Services) Web-based tool for 8158s and 8168s handsets is subject to the following references and licenses (IMS3 version 4.6.2 minimum is required).
- **3BN78415AA** IMS3 central management unit
- **3BN78415AB** IMS3 central management license
- **3BN78415AC** IMS3 central management license for 100 devices
- **3BN78415AD** IMS3 central management license for 500 devices
- **3BN78415AE** IMS3 central management license for 1000 devices
- **3BN78415AF** IMS3 central management license for 2500 devices
- **3BN78418AA** IMS3 license upgrade for 100 to 500 devices
- **3BN78419AA** IMS3 license upgrade for 500 to 1000 devices
- **3BN78420AA** IMS3 license upgrade for 1000 to 2500 devices

24.3 WLAN Licensing

24.3.1 License Overview in Wifi-Express Mode

There is no licenses for OmniAccess® Stellar WLAN Access Points in Wifi-Express Mode.

24.3.2 License Overview in Wifi-Enterprise Mode

The Omnivista 2500 Server software platform serves as License Server in Wifi-Enterprise mode (NMS Enterprise version 4.5 R03 minimum is required).

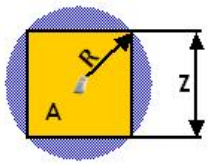
- **OV4-START-NEW** starter pack version 4 include 10 ALE devices, 10 APs, 10 GAs and 10 BYOD licenses for small WLAN infrastructures
- **OV-AP-NM-XX-N** required for Stellar Access Points and includes RF management, WIPS and spectrum floorplan/heatmap (For instance a configuration made of 16 Stellar APs requires **OV-AP-NM-20-N** license)
- **OV-AP-XX-K12** required for Stellar Access Points and includes 1YR 24x7 remote support

25. Predictive Environment Solution Options (Responding to RFx)

When answering an RFP (Request For Proposal) or RFQ (Request For Quotes), normally, there is little possibility of scheduling a Site Survey for various reasons: Building under construction or not yet built, short delay to answer the RFP, fair competition clause, etc. In these cases we can make a compromise between absolute accuracy of design and ease of offer presentation by trying to evaluate the user environment and theorize the required quantity of Access Points. It is essential to never forget to clearly indicate on the RFP, or unsolicited bid, that a compulsory Site Survey is required to verify the correct quantity of AP and their related locations.

25.1 Predictive Data Coverage charts for 802.11b/g/n and 802.11a/n/ac/ax

The following predictive method can be used to produce a budgetary design. Many environment variables like wave propagation, type of building, wall structure, interferences, etc. may, unexpectedly-affect the size quality, and complexity of the RF (Radio Frequency) coverage plan.



Buiding type		Average User Throughput			
		1 Mbps	5 Mbps	12 Mbps	18 Mbps
Typical Office	A (m^2) R (m) Z (m)	650 18 25	550 16,5 23,5	450 15 21	350 13,5 19
	dBm	**-85dBm**	**-75dBm**	**-70dBm**	**-65dBm**
Drywall Office	A (m^2) R (m) Z (m)	450 15 21	350 13,5 19	300 12,5 18	250 11,5 16,5
	dBm	**-85dBm**	**-75dBm**	**-70dBm**	**-65dBm**
Brickwall Office Space	A (m^2) R (m) Z (m)	350 13,5 19	300 12,5 18	250 11,5 16,5	N/A N/A N/A
	dBm	**-85dBm**	**-75dBm**	**-70dBm**	**-65dBm**

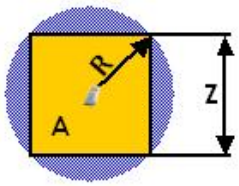
Figure 47: User Throughput (type of Wall) for 802.11b/g/n

In the above chart:

R="The coverage radius provided by an AP and is used to define a perimeter or radial-footprint."

Z="The coverage square contained within the perimeter(R)."

A="The area of (Z^2) covered in square meters."



Buiding type		Average User Throughput				
		802.11bgn: 12 Mbps	802.11an: 15 Mbps	802.11an: 18Mbps	802.11ac: 30 Mbps	802.11ax: 30 Mbps or more (high density WLAN)
Typical Office	A (m^2) R (m) Z (m)	450 15 21	450 15 21	324 13 18	290 12 17	290 12 17
	dBm	**-70dBm**	**-65dBm**	**-65dBm**	**-65dBm**	**-65dBm**
Drywall Office	A (m^2) R (m) Z (m)	324 13 18	324 13 18	290 12 17	225 10 15	225 10 15
	dBm	**-70dBm**	**-65dBm**	**-70dBm**	**-65dBm**	**-65dBm**
Brickwall Office Space	A (m^2) R (m) Z (m)	290 12 17	290 12 17	N/A N/A N/A	N/A N/A N/A	N/A N/A N/A
	dBm	**-70dBm**	**-65dBm**	**-65dBm**	**-65dBm**	**-65dBm**
Hospital	A (m^2) R (m) Z (m)	324 13 18	324 13 18	290 12 17	225 10 15	225 10 15
	dBm	**-70dBm**	**-65dBm**	**-65dBm**	**-65dBm**	**-65dBm**
Warehouse /Manufacturing with no obstacles, metallic separations	A (m^2) R (m) Z (m)	450 15 21	450 15 21	324 13 18	290 12 17	290 12 17
	dBm	**-70dBm**	**-65dBm**	**-65dBm**	**-65dBm**	**-65dBm**

Figure 48: User Throughput for 802.11b/g/n and 802.11a/n/ac/ax

These charts provide indications about building coverage for 802.11b/g/n and 802.11a for data, but on the other hand it is important to keep in mind the RSSI levels required for Voice over WLAN

For more details see the chapter: **Required RSSI levels for a Voice Site Survey (VoWLAN)** Erreur ! Source du renvoi introuvable.

25.2 Predictive Data Coverage example for 802.11ac/ax

For the following example (Drywall construction office building), use of the above defined calculation table results in an estimated bandwidth average of roughly 30 Mbps for data 802.11ac/ax Wi-Fi traffic. We apply the same calculation strategy to VoWLAN simply by focusing on the performance of 802.11ac/ax at an estimated signal strength of -65dBm.

Calculating Access Point Quantity

- **Drywall building with a theoretical bandwidth of 30 Mbps for 802.11ac/ax (-65dBm)**
- **Determine Radius & Z factors: R=~10m Z=~15m Z^2=~225m^2 (approximated with margin of error)**
- **Divide the building floor in rectangles and calculate the number of AP by dividing the area of each rectangle by Z^2:**

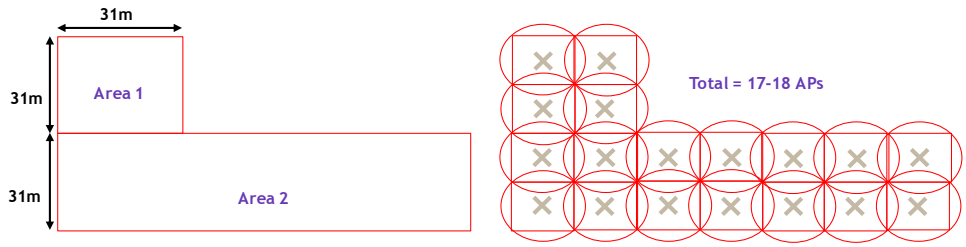


Figure 49: Predictive Method: AP Calculation

Example Results:
Area 1 => Quantity of AP = (31 x 31)/225 = 4.2=> 5 AP (rounded up to next highest whole number)
Area 2 => Quantity of AP = (31 x 96)/225 = 13.2=> 14 AP

Note 1: This calculation remains an approximation.

Note 2: The area covered by an Access Point in 802.11ac/ax is smaller than in 802.11b/g/n

Note 4: This calculation considers cover the needs requested by Voice applications and therefore does not cover needs in high density deployments, with high number of users, bandwidth requirements that requires a larger quantity of APs. High density data calculation is out of scope of this VoWLAN guide.

Only a Voice over WLAN site survey can determine the exact quantity of APs to be installed in order to ensure the both, a seamless RF coverage and a correct handover.

25.3 Predictive Tool Coverage Planning

In the interest of easing predictive planning for large sites, or sites not yet fully constructed, several predictive coverage planning tools are available. These tools focus almost exclusively on the service requirements of 802.11 data clients with typical power and sensitivity specifications. It is for this reason that the use of predictive planning tools is recommended by ALE. Even in the case of ALE predictive planning tool, the unique operational characteristics of 8158s and 8168s WLAN handsets, or smartphones Voice apps cannot be taken into full consideration, resulting in often flawed and under-engineered proposals. When the use of such tools is absolutely mandatory, it is recommended that a coverage plan of 160% or better be used in order to ensure proper plan overlap at the desired -65 dBm level. It is assumed that future versions of predictive coverage planning tools will be more accurate, and capable of calculating plans based on VoWLAN characteristics.

26. Environment Verification & Validation

After collecting information on the customer data networking environment from both a logical and physical perspective, and evaluating the customer voice communications needs; it becomes important to verify and validate the collected information. These operations are not meant to be insulting to a customer or business partner, nor are these practices meant to be "revenue generation" tactics. The processes outlined below are incredibly important steps required to ensure customer satisfaction and to provide for baseline references for support contracts and service level agreements.

26.1 Pre Install VoWLAN Radio Coverage Audit (Site Survey)

It is recognized that in many situations, a customer may be unwilling or unable to perform a wireless audit before the establishment of budgetary costs (RFP/RFQ.) Regardless of whether or not predictive tools were used to define a "budgetary" topology design, a Radio Coverage Audit (also known as a Site Survey) is mandatory for all 8158s , 8168s or smartphones Voice apps solutions prior to installation. Voice quality and coverage continuity cannot be guaranteed without this compulsory environmental evaluation.

In ideal situations, this audit would be performed as the first step towards building a VoWLAN solution. The results of the audit could be used to strategically identify ideal locations for Access Points to maximize coverage and minimize radio spectrum conflict. By working backwards from the Access Points, we could easily see where best to place and how best to size Wireless Switches and/or Wireless Appliances.

VoWLAN Radio Coverage Audits are very specific in that they focus on the requirements of 802.11b/g/n or 802.11a based wireless clients. Being small, handheld, battery operated devices; ALE wireless handsets possess unique radio sensitivities. Where a typical Wi-Fi enabled PC could find the ability to maintain a useful connection with a signal as weak as -80dBm, 8158s and 8168s WLAN terminals lose reliable communications capabilities beyond -75 dBm in all 802.11 radios while a level of -65dBm is required to ensure a correct handover. It is for this reason that typical Data Wi-Fi surveys, as well surveys for other digital wireless technologies, cannot be used for VoWLAN solutions.

Again: A VoWLAN Radio Coverage Audit is mandatory for all solutions prior to installation.

ALE OmniAccess Stellar family can be used to support data as well as voice. For solutions that propose both voice and data coverage, it is important to distinguish between the needs of the voice and data elements. If voice and data are to share between Access Points, bandwidth consumption and client saturation need to be incorporated into the overall audit results.

The specificity of VoWLAN audits requires a certain level of solution specific training and knowledge. For the benefit of ALE customers and Business Partners, ALE Professional Services organization can provide VoWLAN and WLAN Radio Coverage Audits at a competitive price. For more details on this service, please contact ALE Professional Services.

26.2 Post Install Survey

Wireless networks are often changing to meet new application demands, business processes, or in response to external influences (neighboring networks and other spectrum disturbing sources.) For this reason, ALE recommends regular radio coverage surveys in order to continuously revalidate system operation. This is not a mandatory process, but a recommended one as proactive network modification is often less costly and disruptive than reactionary engineering to sudden holes or degradations in the RF coverage plan.

The regularity by which a customer should consider RF coverage re-evaluation depends greatly on network size, radio spectrum competition, sensitivity to degraded voice quality, rate of user population growth, and other factors. As a general rule, ALE recommends re-evaluation whenever new technology demand is generated or roughly every 18 months. Some customers may be able to happily use VoWLAN technology in a static environment for many years without a renewed survey, others may find that continuous evolution of network demands require a validation every six months. It is recommended to set proper customer expectations before they decide to implement VoWLAN technology.

26.3 ALE Professional Services Offer

Specific service offer is available from ALU Professional Services to provide a **Voice Site Survey** with on-site deployment of Access Points (accurate positions resulting from the Site survey) and also WLAN switch configuration.
Send your request to: Professional.Services@al-enterprise.com

27. Requirements for Voice and Data on the 5GHz wireless band

27.1 Introduction

This part highlights general best practices and specific guidance for 8158s, 8168s WLAN handsets, ALE UCaaS Rainbow client, OTC mobile collaborative applications, other smartphone Voice apps, and running with Android devices running Android OS 8 or later, iOS devices running iOS 9 or later and Mac computers running macOS 10.13 or later.

ALE strongly recommends a 5GHz only wireless network for such platforms and this part focuses completely on a 5GHz network layout as a best practice for all devices detailed above.

Although many of the enterprise features like 802.11r and 802.11k were introduced for some devices (like iOS and macOS devices, android devices) it is recommended updating such devices supporting 802.11r and 802.11k features to their latest versions.

For example Apple continually adds support for industry-standard technologies that enhance the connectivity for Wi-Fi clients; however these enhancements are only supported on specific iOS devices or Mac computers. Apple maintains a serie of knowledges base articles that list which device is supporting the various technologies as described in the **Apple Roaming on iOS** document.

27.2 WLAN guidelines for handsets, Android devices or iOS devices

A Site survey first is mandatory to avoid coverage holes and ensure correct handover when moving from an access point to another access point.

This survey must include use cases and account for various devices types that is planned on using, different use cases may have different survey methodologies for instance a critical network that requires voice, video, data and Location Based Services can differ significantly from a general network use with data or voice.

As reminder a smartphone user is expected to move during its call through different areas, staircases, halls and even rest room. However a 100% coverage stays not possible (e.g elevator, white room, etc)

The **use of 802.11a/n/ac/ax 5GHz radio band** is the recommended radio band for high density coverages with smartphone users, 802.11a/n/ac/ax backwards the compatibility to the 802.11n for devices and 5GHz channels are free of common devices operating on the 2.4 GHz band such as Bluetooth, microwave ovens or specific radio links. **802.11b rates have to be deselected**

8158s, 8168s handsets and smartphones may need to use the 802.11h Dynamic Frequency Selection (DFS): the DFS process changes channel when a radar is detected (weather radar, air traffic control, sea traffic, military use, etc.) and ALE recommend to carefully monitor the DFS channels if radar activity has been detected during the survey.

With the adoption of 802.11a/n/ac, the channel bonding capability allows multiple 20Hhz channels and 5GHz offers today a choice of 20MHz, 40MHz and 80MHz (and 80 + 80MHz mode with 802.11ac - wave 2) channel width modes. With the usage of 5 GHz band shared with data, ALE recommends the **40MHz channel width** in environments where throughput performance is required for smartphones in this band By enabling the DFS channels, the number of 40MHz channels available increases to 10 (EU).

802.11ax brings the high efficiency on the 5GHz band, especially for Voice-Data-Video type applications in a context of high cell overlap and higher number of connected clients. Increase the airtime allocated to all clients, Voice and Data, whatever their bandwidth needs, enable an improved access to the radio resources,

optimize the use of channels and the APs resources are recommendations for dense wireless network on the 5GHz band. ALE recommends to enable **airtime fairness** and the **802.11ax** to support handsets and smartphones devices with 802.11ax.
With a majority of MU-MIMO capable wifi clients today on the 5GHz band, ALE recommends to enable the **MU-MIMO** with 802.11a/n/ac/ax.

Enabling low data rates can be a path taken to maximize range and maintain a reliable connection to an AP from a farther distance. At the other hand lower data rates typically require more air time, can reduce the cell capacity and may impact app performance for the smartphone especially for time-sensitive Voice-Video-Data type of applications. Consider configuring higher data rates and disabling low data rates with the objective to deploy high-performance WLAN and improve the roaming. ALE recommends a **minimum data rate of 12Mbps** and **enabling 12Mbps and 24Mbps** as the 2 mandatory data rates best practice for smartphones devices or laptops.

Stellar DRM is enabled by default on the access points and has been designed to manage the RF environment in a dynamic way with practically no IT intervention. DRM calculates and assigns the best channels and power combinations, and keeps a track of high utilization on all channels and will mitigate a load-balancing and roaming for smartphones devices as necessary. **Band-steering to the 2.4GHz can be deactivated** for some devices that require a better performance with the 802.11a/n/ac/ax 5GHz.
To estimate if the current 5GHz AP coverage is sufficient for 8158s/8168s handsets or apps running on smartphones, Stellar provides Access Point's view of the client signal.

27.2.1 Required RSSI (Received Signal Strength Indicator) levels

The wireless cell planning is done using an AP placement tool which estimates the placement of AP based on the building/campus characteristics. The approach of a cell planning for Laptops/smarphones/Tablets and handsets is to have sufficient overlap between adjacent cells in order to ensure that sufficient radio signal strength is present during the device roaming between the cells. Without any specific roaming algorithm, Laptops/smartphones/Tablets and handsets devices are generally sticky under a low RSSI.

To take relevant actions and maintain reliable communications during users mobility,

- **a -70 dBm RSSI (or better)** is required to decide on followings
- for a sticky client (no optimisation on roaming): client deauthentication and reasssociation to another adjacent AP
- for a client with roaming capabilities: roaming assistance to provide best candidate AP and optimise client handover (generally a -62dBm RSSI (or better) is required to ensure a correct roaming)

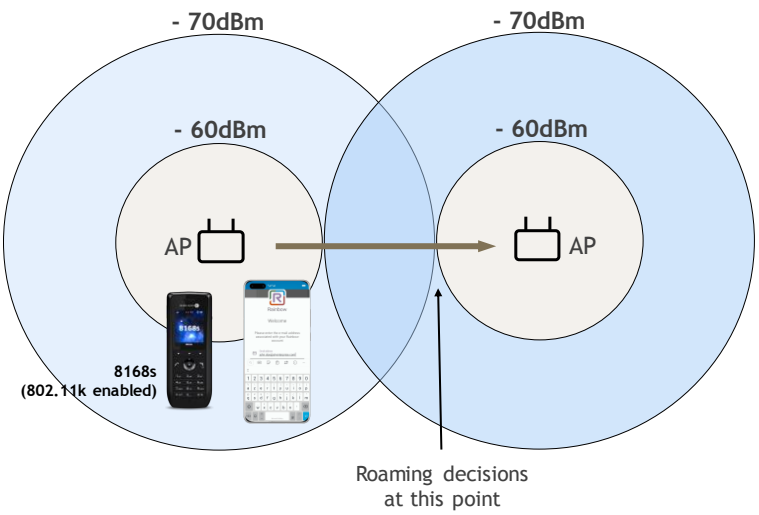


Figure 50: Cell overlap between adjacent cells

To make up for fading effects in an indoor office environment it is recommended that the radio signal strength at the cell coverage boundary does not drop below -70 dBm. The APs should be placed to overlap their boundaries by approximately 8 dB. This means that when the device reaches a point where the RSSI is -70 dBm, the smartphone is also inside the adjacent cell and the RSSI from that AP is around -62 dBm.

27.2.2 Required RSSI levels for WLAN Handsets on separate SSID

The following wireless cell planning applies for separate and dedicated SSID for Voice where 8158s and 8168s WLAN handsets, or other handsets, support the handover with their legacy roaming algorithms. Recent roaming protocols like the 802.11k are disabled on separate voice SSIDs.

The basic approach to cell planning is to have sufficient overlap between adjacent cells in order to ensure that sufficient radio signal strength is present during a handover between the cells, see the figure below

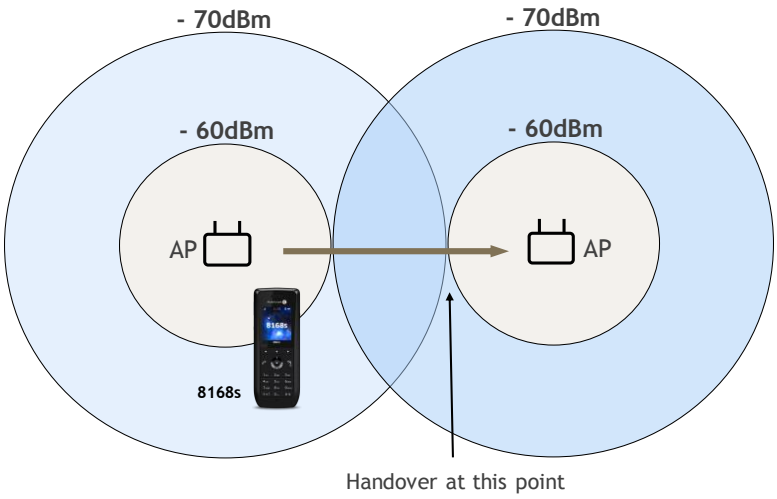


Figure 51: Cell overlap between adjacent cells with a legacy roaming

It is recommended that a site survey is done using built-in tools embedded in handsets. 8158s and 8168s WLAN tool provides a true measurement of the RF environment based upon the radio of the handset. Other wireless analyzer can be used to provide additional assistance during a site survey.

The distance between the APs is often a trade-off between the amount of APs and coverage. To make up for fading effects in an indoor office environment it is recommended that the radio signal strength at the cell coverage boundary does not drop below -70 dBm. The APs should be placed to overlap their boundaries by approximately 6–10 dB.
This means that when the handset reaches a point where the RSSI is -70 dBm, the handset is also inside the adjacent cell and the RSSI from that AP is between -60 to -64 dBm. The recommendations above ensure a fading margin of approximately 20dB which should be appropriate for "normal" environments.

Note: The illustration above is valid when AP transmission power are configured to 100mW (20dBm). Since the 8158s and 8168s WLAN handsets transmission power is pre-configured to approximately 100 mW, this ensures a symmetric wireless link. Note that the illustration also is valid for other transmission power settings, but the same power setting must be set in both the handset and AP.

27.2.3 Required RSSI levels for a Voice Site Survey (VoWLAN)

Following are the Required RSSI levels for a Voice Site Survey with 8158s/8168s handsets, laptops/ smartphones configured in 802.11a/n/ac/ax.

-70 dBm (or better) to maintain a voice communication

-60 dBm to -64 dBm (or better) to ensure a correct handover

27.2.4 Required SNR (Signal Noise Ratio) and ground levels

Following are the Recommended SNR (Signal Noise Ratio) and Noise levels for a Site Survey with 8158s/8168s handsets, laptops/ smartphones configured in 802.11a/n/ac/ax.

a 25 dB SNR (or better)
Noise level < -92 dBm
RSSI > -67 dBm

27.2.5 EIRP (Equivalent Isotropically Radiated Power) considerations for smartphones

Smartphones set generally lower EIRP (Effective Isotropic Radiated Power) than APs in 5 GHz band, a reason for that is to save power and maintain an acceptable autonomy for the smartphone battery.

A reduced EIRP has an impact on the RF range, the picture below shows an asymmetrical transmission between an iPhone and a Stellar access point. In this example, with only 11dBm in 5 GHz the RF range provided by the iPhone is much shorter than the Access Point RF range (EIRP here is 8 times lower).

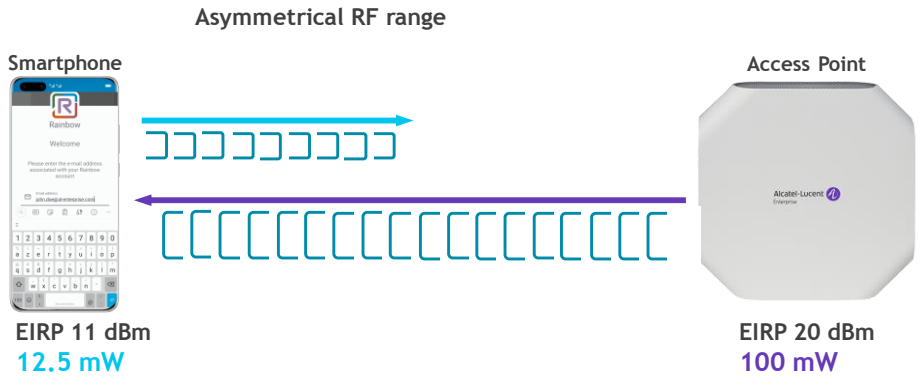


Figure 52: Impact of EIRP on RF Range

Reducing Access Point EIRP in order to match smartphone EIRP is not a solution, as it would increase by a large factor the quantity of Access Points to cover the same area and with the following severe cost impacts:

- Additional Access Points
- Additional Ethernet cabling
- Additional LAN switch ports
- Higher risk of interference between APs
- Higher risk of coverage holes

As result VoWLAN on smartphone is supported on a **Best Effort scheme** in comparison with 8158s, 8168s professional WLAN handsets.

- Smartphone must be close to Access Point for a VoWLAN operation.
- A seamless handover is smartphone dependant.

27.3 Quality of Service (QoS)

It is crucial to implement the correct end-to-end quality of service (QoS) to achieve optimal results for handsets or apps running on smartphones devices associated to Stellar WLAN.

The WiFi multimedia (WMM - IEEE 802.11e standard) certification ensures interoperability between vendors by defining the correct QoS marking and prioritization according to four Access Categories (AC) – Background, Best effort, Video and Voice.

Designative (informative)	IP DSCP (PHB value)	802.1p	802.11e/WMM
Reserved	56-63	7 (unused)	---
Reserved	48-55	6 (unused)	---
Voice	46 (EF)	6	Voice
Signaling	40 (CS5)	5	Video
Interactive video	34,36,38 (AF4x)	4	Video
Streaming video	26,28,30	4	Video
Voice control (signaling)	24 (CS3)	4	Video
Background (transactional/interactive)	18,20,22 (AF2x)	3	Best Effort
Background (Bulk Data)	10,12,14 (AF1x)	2	Background
Best Effort	0 (BE)	0	Best Effort
Scavenger	8 (CS1)	1	Background

Figure 53: Default QoS marking for main categories of traffic

The table above indicates for information the IETF (Internet Engineering Task Force) marking translation recommendations (RFC 4594 last IETF guidelines on DSCP marking) per type of traffic.

For instance on 8158s/8168s handsets a DSCP value of 46 is recommended for the Voice traffic and a value of 26 is recommended for the Voice signaling.

On iPhone, iMac or Android Laptop/smartphone a DSCP value of 46 is recommended for pure Voice apps. To remain the data traffic in a **Best Effort mode** for smartphones with non-WMM traffics, or with several traffics without marking (ie collaborative Video-Voice-Data applications) it is recommended to put the DSCP value 18.

A VoIP audit with the following criteria can be the reference to measure the effective application of QoS markings on handsets and smartphones (the following values are given as an indication and vary according to codecs algorithms & packet framings on each data streams).

For a good Voice quality (close to the MOS score of 4) the network performance has to stay:

- **Network round trip delay must be less than 250 ms**
- **802.11 retransmissions should be kept under 15%**
- **Jitter must be less than 100 ms**
- **Packet loss must be less than 2%**

27.3.1 Battery life considerations

Battery life is a key differentiator when comparing a professional WLAN handset, a smartphone or a laptop.

On a smartphone, in order to maintain an acceptable autonomy for battery, a legacy power saving polling applies with reduction of EIRP as consequence to lower power consumption.
8158s /8168s support by default the automatic power save delivery WMM Unscheduled-APSD (U-APSD - IEEE 802.11e standard) that provides the transmission of multiple frames together by Stellar AP to the handset during a service period.

APSD is a more efficient power management method than legacy 802.11 Power Save polling, some figures below concern 8158s /8168s professional WLAN handset autonomy in WiFi mode:

- **Talk time: up to 10 hours**
- **Standby time: up to 100 hours**

27.4 Application Visibility & Monitoring

The **Application Visibility & Monitoring (AVM)** on Omnivista® 2500 classifies applications using the integrated **Stateful Packet Inspection technology (DPI)** of OmniAccess® Stellar AP12XX and AP13XX Access Points when running in WiFi-Enterprise mode. AVM provides application-level visibility, applications monitoring and control based on defined policies and can detect over 2000 individual

protocol and service signatures including ALE IP Voice-Video-Data-based collaborative applications like Rainbow UCaaS client, OTC mobile client or ALE WLAN handsets in NOE or SIP mode.

ALE IP collaborative applications are supported from OV42R1, AWOS 3.0.3 or later with **AppSig.upgrade_kit version 2** signature files.

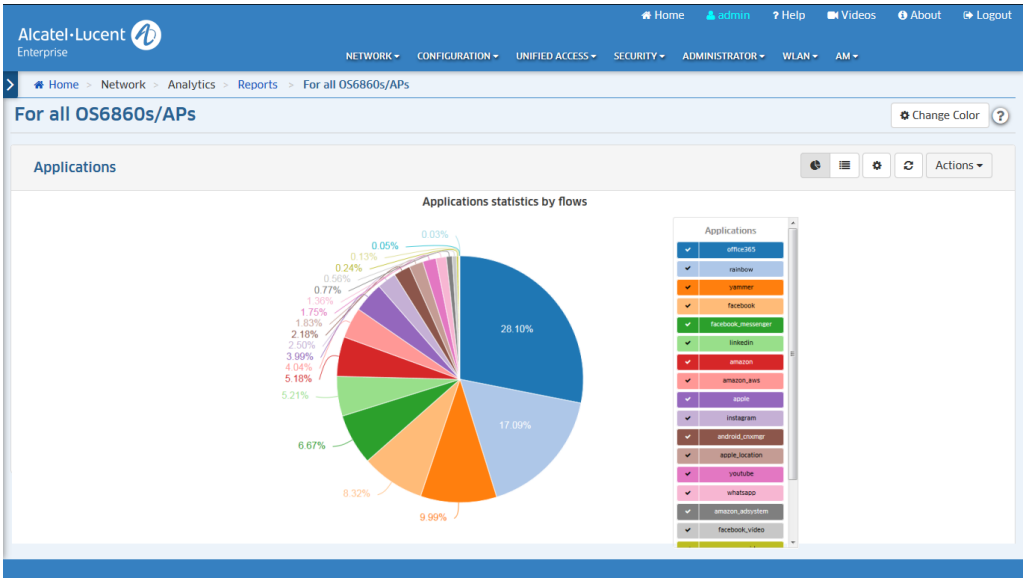


Figure 54: Top N applications visibility with Rainbow UCaaS client recognition

With Application Visibility & Control enabled on Stellar and Rainbow UCaaS profiling set, OmniVista 2500 server has a complete visibility and traffic control for all Rainbow traffic on a WLAN. The picture above shows the Top N applications at a time, with smartphones or laptops devices associated to the WLAN, initiating Rainbow Chat-Voice or Video calls on the network.
With Application Visibility & Control enabled on Stellar and NOE/SIP profiling set, OmniVista 2500 server has a complete visibility and traffic control for all voice traffic on a WLAN.

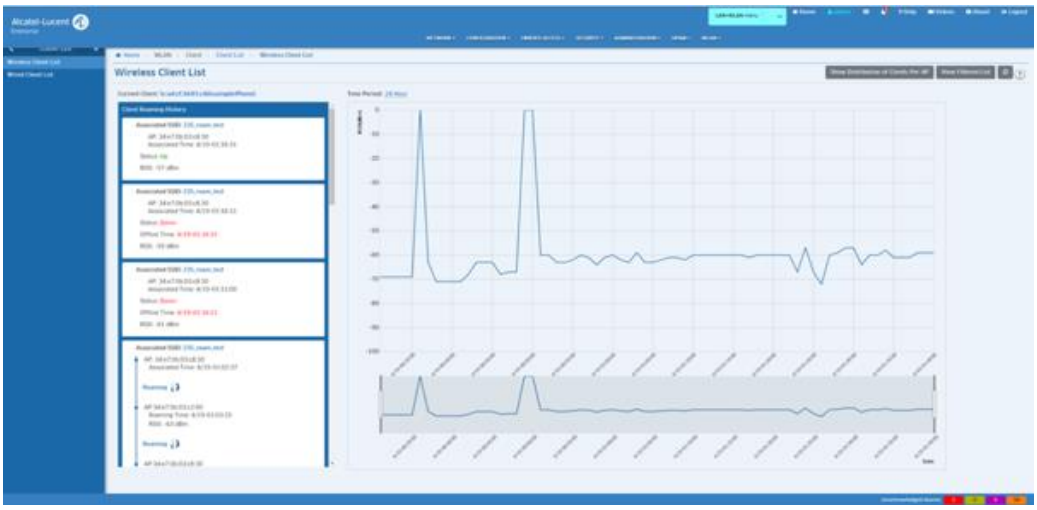


Figure 55: Voice-Data-Video roaming historic in Wifi Enterprise mode

OmniVista 2500 server can also display up to 30 days of historic in roaming and RSSI for all Voice-Data-Video applications and then track the behavior of devices in term of roaming and connectivity.

A special attention is needed on how Business users with smartphones perform multi-media or rich media on the Enterprise WLAN. Contrarily to a strong differentiated service like Voice, the behavior for a IP Voice-Video-Data-based collaborative application along Business days is unpredictable:

- Participation of users to conference calls with unpredictable duration, or long-duration calls, at any time
- Users in Webinar mode requiring continuous, uninterrupted media stream for a long-duration, at any time

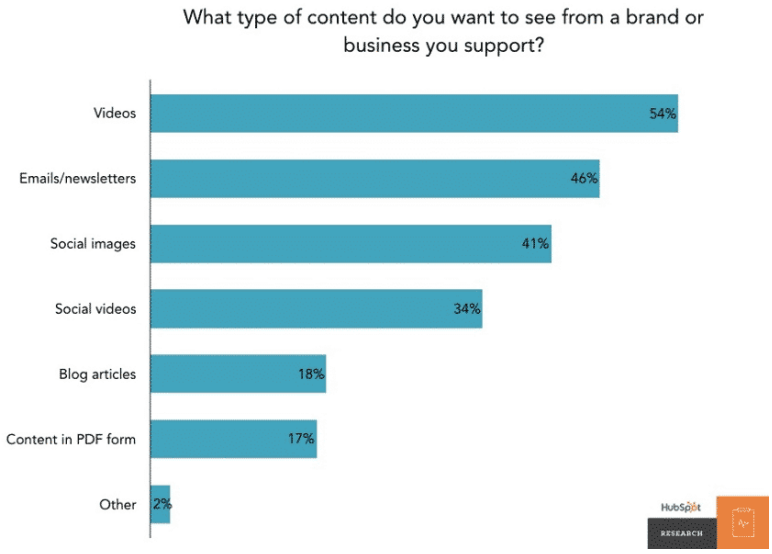


Figure 56: File sharing VS Video traffic per user in network

(source HubSpot Research 2018)

Alcatel·Lucent Enterprise

Another point is IP Voice-Video-Data-based collaborative applications compete today more and more with similar heavy-bandwidth applications (like videos). Picture above shows the increasing demand per user for video traffic then depicts a continuous consumption of 1 Mbps traffic within the business hours per user.

Some figures for a Bandwidth consumption handling per Stellar AP:

Radio	ALE application	Estimated bandwidth per AP (per user)	AP model
802.11a/n/ac/ax	Rainbow UCaaS client	15 Mbps (1 Mbps)	All Stellar
802.11a/n/ac/ax	OTC mobile	10 Mbps (700 Kbps)	All Stellar
802.11a/n/ac/ax	8158s/8168s handsets *	6 Mbps (400 Kbps)	All Stellar

- As reference for an estimated bandwidth per AP

- It is advised to provide a detailed visibility into the applications with the real consumed bandwidths.
- As a best practice QoS policy for application monitoring can be defined based on the thresholds of table above to have an estimated bandwidth control per IP collaborative application. It is advised to set logging trace to alert IT if consumed bandwidths exceed threshold values, this at access point level.
- IP Collaborative apps are not the most bandwidth consuming applications but the use of 1 Gigabit access switches is mandatory with IP Collaborative apps.
- By comparison exchanges of large files have more impact in term of bandwidth consumption considering also files sharing is unpredictable and sporadic during the business day. If it is planned to deploy collaborative IP apps with high file sharing traffic in some areas, consider the ALE multi-gigabit access switches option from the beginning.

27.5 Stellar Wi-Fi optimisations

Roaming is an integral part of an Enterprise wireless network. Handsets and smartphones are bound to roam from one Access Point to another and have to remain connected to the WLAN all the time as the user moves. OmniAccess Stellar Access Points optimizations implies enabling of **IEEE standards based 802.11r, 802.11k and 802.11v optimizations** on both wireless Stellar infrastructure as well on client devices.

Roaming enhancement *	Devices implementation With all Stellar AWOS 4.0.2 Wifi-Express & Enterprise mode	OS implementation
802.11k – Neighbor reporting 802.11r – Fast Transition (FT)	iPhone 4s and more (including Pro series) Samsung Galaxy S8 and more Huawei Pro series Google Pixel 3 and more Xiaomi series 8158s/8168s WLAN handsets	iOS 8 and above is recommended Android 10 and above Android 10 and above Android 9 and above MiUI 12 Ascom 2.2
Adaptative 802.11r	iPhone 6s and more Samsung Galaxy S8 and more Huawei Pro series Google Pixel 3 and more Xiaomi 8158s/8168s WLAN handsets	iOS 10 and above Android 10 and above Android 10 and above Android 9 and above MiUI 12 Ascom 2.2
802.11v – BSS Transition management	iPhone 5s and more Samsung Galaxy S10 and more Huawei Pro series Xiaomi	iOS 7 and above Android 10 and above Android 10 and above MiUI 12

***** List given as indication only and not exhaustive. Please refer to manufacturers product information to be informed about latest inputs about 802.11k/11v/11r support.

Figure 57: Support for roaming enhancements standards on Stellar

ALE recommends **enabling 802.11k and 802.11v** to implement Enterprise environment configured for efficient roaming then **enabling the 802.11r** to increase the efficiency of keys exchanges during roaming. Some devices do not require 802.11k and 802.11v but associate transparently to WLANs where protocols are enabled.

Enabling 802.11k and 802.11v have no impact on non-supporting devices but devices which do not support 802.11r may not be able to associate to a 802.11r WLAN, then ALE recommends set **specific WLAN** for devices supporting 802.11r, 802.11k and 802.11v.
802.11k capable clients monitor and maintain their current WLAN connection until the RSSI crosses the **-70dBm threshold**. Certain clients like Mac clients monitor and maintain their current WLAN connection until the RSSI crosses the -75dBm threshold. Once crossed the client initiates a scan to to a suitable AP that can roamed to.

27.5.1 802.11r supported modes

802.11r -Fast Transition (FT) is supported from Stellar AWOS 3.0.7 and allows the client-AP handshake and key exchange with new AP to be done before the client roams to the new AP. 802.11r allows to reduce the number of packets exchanged between the APs and 802.11r client whose credentials are already cached.

A FT authentication request is sent to new AP and client receives FT authentication response from the new AP, then client completes its roam from home AP to new AP by sending a re-association request to the new AP. This **over-the-air FT mode** is the preferred mode for high density Enterprise environment and is the default mode on Stellar OmniAccess access Points.

Fast Transition (FT) roaming 802.11r is supported with WPA/WPA2/WPA3 and WPA2/WPA3 Enterprise with 802.1x. The domain of the 802.11r is delimited to the Stellar AP-Group

Pairwise Master Key (PMK) caching and Opportunistic Key caching (OKC) are basic modes running for a best-effort roaming with client supporting PMK and OKC when 802.11r is disabled on WLAN.

Adaptative 802.11r is key enhancement specifically designed for iOS devices running iOS 10 and above and is supported on OmniAccess Stellar Access Points. All other iOS devices (including Mac clients) will be able to associate using standard WPA2/WPA3 or WPA2/WPA3 Enterprise. Once 802.11r is enabled on Stellar Access Points the AP provides the information in beacons to the clients.
When association requests iniate by clients the Stellar AP confirms the 802.11r handling by mentioning the 802.11r domain and BSS FT parameters. This mechanism is the same per user when client is running iOS 10 or more and supports adaptative 802.11r, the AP answers by enabling the 802.11r for this user.

802.11r -Fast Transition (FT) is supported by 8158s and 8168s WLAN handsets and enable the reuse of PMKSA (Pairwise Master Key Security Association) when roaming between Stellar APs.

27.5.2 802.11k & 802.11v supported modes

Stellar OmniAccess Access Points support both the 802.11k – Radio measurement & neighbor reporting and 802.11v BSS Transition management.

802.11k standard allows clients to request reports containing information about known neighbor APs that are candidates for roaming. The AP responds with a list of neighbor APs on the same WLAN and with their Wi-Fi channel numbers. Having this handy neighbor list allows the client to probe the correct new AP when it envisage its roaming. This feature is especially useful for clients with high-mobility and constrained battery resources such handsets and smartphones.

If 802.11k was introduced early by some manufacturers like Apple, it is recommended to check support of 802.11k on equipment and **update to minimum OS** as last design changes can be implemented in last releases. Some equipment do not support 802.11k like some Mac computers.

On Stellar infrastructure, the 802.11k algorithm uses DRM to define neighbors to the AP to which client is associated, the AP returns a list of neighbor APs to the client. With AP list the client does not need to scan all channels to find which AP it can roam to and then mechanism reduces the channel utilization and thereby potentially saves air-time. Additionaly battery life of devices benefits of mechanism since devices do not have to scan or probe each channel regularly.

802.11k standard is supported by 8158s and 8168s WLAN handsets and limits the list of channels to scan by the handsets for roaming. Handsets can backward to a full scan mode for the channels if setup backwards.

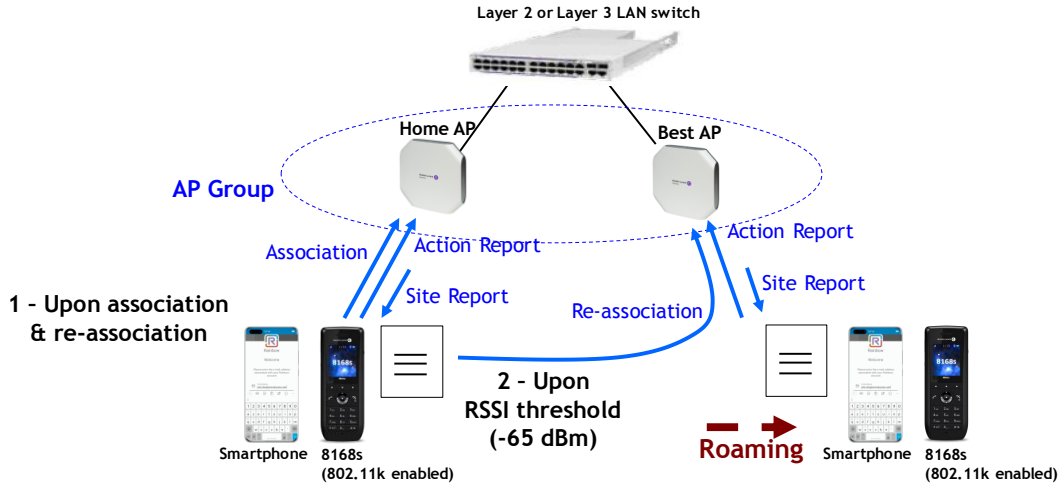


Figure 58: 802.11k Neighbor Report flow

In 802.11k process, equipment authenticate with new AP and de-authenticate from the Home AP upon RSSI value defined in Stellar AP Group RF profiling with **RSSI roaming threshold** parameter. Equivalent default de-authentication mechanism exists for any sticky client in a Stellar AP-Group and is based on default **RSSI association threshold** in case clients did not de-authenticate with higher RSSI values and it is initiated by the AP-Group. RSSI association threshold value can be also modified.

802.11v - BSS Transition Management is a part of Stellar DRM features which acts as a platform for the clients within AP-Group. 802.11v offers a full network assisted roaming enhancement for any client devices where the AP will try to assist in the roaming decision making by providing a recommendation in the form of request to the client, at any time on decision of Stellar DRM. The request will contain a suggestion of the best available AP that client could potentially roam to. The client has always the freedom to choose whether to accept or reject the AP 802.11v request.
802.11v feature is **recommended and useful for clients with high-mobility**, such as smartphones or handsets.

Stellar 802.11v BSS Transition Management Function supports the following:

- **BSS transition Management Query** transmitted by client if client support it
- **BSS transition Management Request** transmitted by AP to the client and sent at any time by DRM based on default **RSSI roaming threshold** for the AP-Group and Stellar load-balancing status (clients count per channel & channel utilization). **RSSI roaming threshold** value can be modified. iOS device supporting 802.11v respond to the BSS Transition Management Request and use the list of proposed APs to make their roaming. This list could be different from a neighbor 802.11k list supported only upon associations or re-associations.
- **BSS transition Management Response** transmitted by the client to the AP including the accept/reject reason of a BSS TM request.

802.11v is a good recommendation to roam to the right AP and can be sollicited at any time outside an association/re-association block frame. Some equipment like Mac computers do not support 802.11v.

8158s and 8168s handsets reject the APs 802.11v request in their current version.

Enabling 802.11r, 802.11k and 802.11v together on the WLAN is the best way to quicken the roaming process.

27.6 802.1X/EAP authentication

EAP TLS is the recommended authentication method working jointly with 802.11r FT.
If installations with EAP-FAST exist a separate SSID needs to be created for EAP TLS authentication method.
EAP-FAST method is not supported by 8158s and 8168s handsets,

27.7 SSID (Service Set Identifier)

It is advised have separate SSID to support 802.11r/802.11k/802.11v clients.
It is advised have separate SSID for clients that not support 802.11r/802.11k/802.11v.
8158s and 8168s WLAN handsets work on all above SSIDs and then can share a separate SSID broadcasted for voice with other handsets.

27.8 Monitoring

Stellar tracing
The **Power save mode (PS) /Radio Measurement & Neighbor reporting (RRM) /BSS Transition Management (BTM)** modes set for a device can be monitored via CLI since AWOS 3.0 or Syslog logging in both Wifi-Express and Wifi-Enterprise modes.

Stellar roaming and RSSI tracing
OmniAccess Stellar access points allow to easily trace the clients roaming behavior and their connectivity, by giving the time of roaming and the RSSI historical information, AP per AP. This tracing is supported in both Wifi-Express and Wifi-Enterprise modes, specialy for Voice-Data-Video applications with high mobility and RSSI historical information.

With more hardware resources the OmniVista 2500 server with Wifi-Enterprise mode can also display up to 30 days of roaming and RSSI history for all Voice-Data-Video applications.

Clients tracing
Apple - Airport utility requires IOS 9 or later

27.9 ALE applications

27.9.1 Certified devices

OTC mobile version 2.60	supported OS	System
iOS mobile	iOS 13 and more	OTMS
Android mobile	Android 10 and more	OTMS
Rainbow UCaaS client version 1.84	**supported OS**	**System**
iOS mobile	iOS 13 and more	Rainbow
Android mobile	Android 10 and more	Rainbow

To know the support of ALE collaborative applications on a specific smartphone please refer to the Device White List – OTC Smartphone app document in the reference Documents chapter to have the detailed devices support and compatible OS. Table gives the indication of minimum OS required to support last OTC and Rainbow releases.
Please refer to https://www.openrainbow.com for further informations

OTC version 2.60.x Rainbow UCaaS client version 1.84	supported OS	System
Windows Desktop	Windows 8,10 Enterprise x64	OTMS /Rainbow
Mac Desktop	OSX	OTMS /Rainbow

For laptops, to know the wifi capabilities for ALE collaborative applications refer to the network driver and manufacturer product informations to know features supported by the driver. Table gives the indication of minimum OS required to support last OTC and Rainbow releases.

27.9.2 Certified Wifi 6 devices

In addition for Stellar Wifi 6 installations, it is useful to check wifi 6 compatibility of device with Wifi 6 standard to benefit from the latest developments brought by 802.11ax, in particular the gain in bandwidth for more demanding voice-data-video applications like Rainbow. The certified devices for ALE applications can coexist with Wifi 6 Stellar access points due the backward compatibility of wifi 6 with wifi 5. All these devices will keep their current performance, or even slightly improved performance with Wifi 6 access points.

The Wifi Alliance has now its Wifi 6 certification program, a program based on a list of mandatory features for wifi 6 products. The list is regularly updated on the Wifi Alliance website, and is accessible via the Product Finder page: https://www.wifi.org/product-finder

27.9.3 Authentication & encryption

WPA-PSK-TKIP, **WPA2-PSK-AES** are all supported on iOS and Android certified smartphones for ALE collaborative applications. Last **WPA3-SAE** methods are the most recent encryptions and **WPA3 Enterprise** is the most optimal for Enterprise with 802.11r Fast Transition and offers the lower roam times and the strongest security. **WPA3-SAE** become mandatory with Wifi 6 access points and ALE advises to look at the support of **WPA3-SAE** methods with Wifi 6 devices.

OmniAccess Wifi 6 Stellar offers the PMF encryption to clients when **WPA3-SAE** is enabled as encryption method for the WLAN.

27.9.4 Quality of Service

		WMM	Legacy power saving	WMM U-APSD	WMM-AC (WLAN CAC)	DSCP
iOS mobile	iPhone 6s and later	Yes	Yes	No	No	Yes
Android mobile	Samsung Galaxy Huawei Google Pixel Xiaomi	Yes	Yes	No	No	Yes
Windows laptop	Enterprise x64	Yes	Yes	No	No	Yes
Mac laptop	OSX	Yes	Yes	No	No	Yes

The table states, by device, on the support of Quality of Service required by ALE collaborative applications and is given as indication. Refer to the manufacturer product informations to have the detail of QoS features supported by the device.

27.9.5 Roaming performances

This table lists by device observations that could be made on the roaming, and is updated according to validated returns, deployments made on the Stellar solution or related notes according to devices and infrastructure concerned.

Some platforms are currently under tests at the date of document writing then only roaming observations are not considering all smartphones or Wifi 6 Stellar access points.

		Rainbow UCaaS client	OTC client
iOS mobile	iPhone 5s, 6s and later	L2/L3 Handover (2)	L2/L3 Handover (1)
Android mobile	Samsung Galaxy S8 and later Google Pixel 3 and later Huawei Pro series Xiaomi Series		L2/L3 Handover (1)
Windows laptop	Enterprise x64	L2/L3 Handover (3)	
Mac laptop	OSX	L2/L3 Handover (3)	

Notes:

(1) OK. Tests with smartphones devices in white list. Sometimes blank due to voice packet loss but communication is maintained.

(2) OK. Tests with iPhone 8 and 11 with psk 802.11r. Average roaming break is #87ms. User communication is maintained. All Stellar AP12XX, AP1101 and Wifi 6 AP1321

(3) OK. Tests with laptop and updated driver. Sometimes blank due to voice packet loss but communication is maintained. Specific measure on Handover performance (seamless roaming) is not appreciable when current video streaming occurs during the roaming

27.9.6 ALE Collaborative Products Support

Following are ALE Technical Support rules concerning ALE collaborative applications

- ALE Technical Support can troubleshoot voice quality when customers use corporate ALE WLAN infrastructure
- ALE Technical Support cannot troubleshoot voice quality when customers use mobile data networks or non-corporate WLAN infrastructure
- ALE Technical Support does not certify, endorse or provide support for non-ALE WLAN infrastructure

27.10 Non-ALE collaborative applications

The collaborative applications listed below are for information only and are not supported by ALE technical support.

		Legacy Power Saving	WMM	WMM U-APSD	WMM-AC (WLAN CAC)	DSCP
Skype for Business	iOS mobile Android mobile Windows laptop Mac laptop	Yes	Yes	No	No	Yes
Facetime	iOS mobile Android mobile Windows laptop Mac laptop	Yes	Yes	No	No	Yes

The essential Quality of Service features required for collaborative applications are known supported by applications like Skype for Business or Facetime. Other applications like Google Hangout, Lync 2013, Teamspeak etc. can have the same level of Quality of Service with up to date devices. Please refer to manufacturer products informations to have more details.
ALE does not provide Quality of Service performances for such applications.

27.11Best practices summary

Table below depicts the comparative per operation and summarize best practices for a 5GHz network and coverage design.

BEST EFFORT operation Smartphones/5GHz laptops	OPTIMIZED operation 8158s and 8168s WLAN handsets
5GHz only network and coverage design for smartphones anf laptops	5GHz radio band network and coverage design recommended for Voice, 2.4GHz radio in case of 5GHz deployment cannot be realized
Low channel utilization (no more than 40%), high channel utilization may be the indication of new sources of interferences or AP outages	Voice is compatible with high channel utilization (up to 80%)
Monitoring APs channels changes with 802.11h DFS	Monitoring APs channels changes with 802.11h DFS

Connecting the WLAN with Best Effort QoS value (DSCP 18 AF2X)	Connecting the WLAN with Voice QoS value (DSCP 46 EF)
Configuring 802.11r mode WLAN for fast transition 802.1x with WPA2 or WPA3 802.11r compatible clients	Configuring 802.11r mode WLAN for fast transition 802.1x with WPA2 or WPA3 802.11r mode
Configuring 802.11k on WLAN to provide devices with neighboring list. Refer to manufacturer products informations to be informed of 802.11k support	Configuring 802.11k on WLAN to provide handsets with neighboring list. 802.11 roaming mode possible with separate SSID
Configuring 802.11v BSS transition management on WLAN to balance devices load across access points. Refer to manufacturer products informations to be informed of 802.11v support	Handsets ignore 802.11v in their current version
Configuring 802.11k/802.11v with higher RSSI roaming threshold than the default one (12 Dbm) in case of good 5GHz coverages for smartphones/laptops 31 dBm threshold value can be set as a reference	Configuring 802.11k with higher RSSI roaming threshold than the default one (12 Dbm) in case of good 5GHz coverages for handsets 31 dBm threshold value can be set as a reference
Consider the 40Mhz channel bonding with DFS channels available. Consider 80Mhz channel bonding only in case of heavy bandwidth is needed	40Mhz and 80Mhz channel bonding with DFS channels available can be considered. The lower 20Mhz is possible if required
Minimum data rate of 12Mbps and 24Mbps. If 5GHz coverage is marginal set 6Mbps at the lowest rate and make sure 12Mbps and 24Mbps are enabled as well	Minimum data rate of 12Mbps and 24Mbps, or lower minimum data rates if required on both 5Ghz and 2.4Ghz radio bands
Leaving all 802.11n and 802.11ac MCS rates enabled	Leaving all 802.11n and 802.11ac MCS rates enabled
Observe a minimum of 3 APs with average RSSI measurement of -67 dBm or better (no less than -72 dBm) This measurement is all the more to observe that smartphone EIRP is lower than AP EIRP in the 5GHz band	Observe a minimum of 3 APs with average RSSI measurement of -70 dBm or better (no less than -80 dBm in coverage boundaries)
Note short lasting battery in Wi-Fi for smartphones/laptops	Long lasting battery design with WLAN U-APSD for handsets
Seamless roaming (or Handover) depend on smartphone platform/laptop driver roaming capabilities, on some applications, or in case of 5GHz network marginal coverage	Seamless roaming (or Handover) design with handsets guaranties no Voice service disruption, with average 85ms break or less with most recent 802.11k/11r when moving across the access points

Excluding channels 149, 153 from ACS in case of heavy peer-to-peer activity on UNII-3 band	Excluding channels 149, 153 from ACS in case of heavy peer-to-peer activity on UNII-3 band
Upgrading all devices to most recent version of iOS mobile, Android mobile, Windows laptops and macOS	Upgrading handsets to most recent version of OS
Recommends have a RF monitoring with a Voice audit as reference: - minimum Signal to Noise of 25 dBi - no more than 15% for 802.11 retransmission - Packet loss remain under 1% - Jitter should be kept to less than 100ms	Recommends have a RF monitoring with a Voice audit as reference: - minimum Signal to Noise of 25 dBi - no more than 10% for 802.11 retransmission - Packet loss remain under 1% - Jitter should be kept to less than 100ms

28. Design Examples

28.1 Configuration for up to 8 AP (Demo & small area coverage)

This configuration example depicts a model well adapted to a Demo context in Wifi-Express Mode for up to 8 AP.

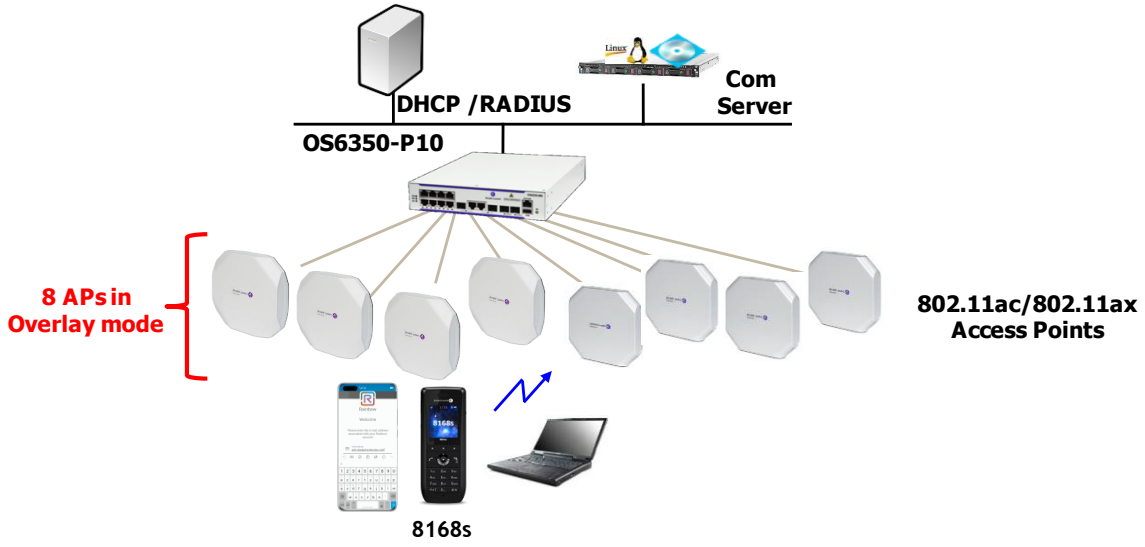


Figure 59: Configuration for 8 AP

This entry topology takes advantage of the OAW-6350 that proposes 8 POE+ ports to connect and feed up to 8 Access Points (POE+)

28.2 Configuration for up to 16 AP (with redundancy)

This example depicts a model for up to 16 AP in Wifi-Express Mode.

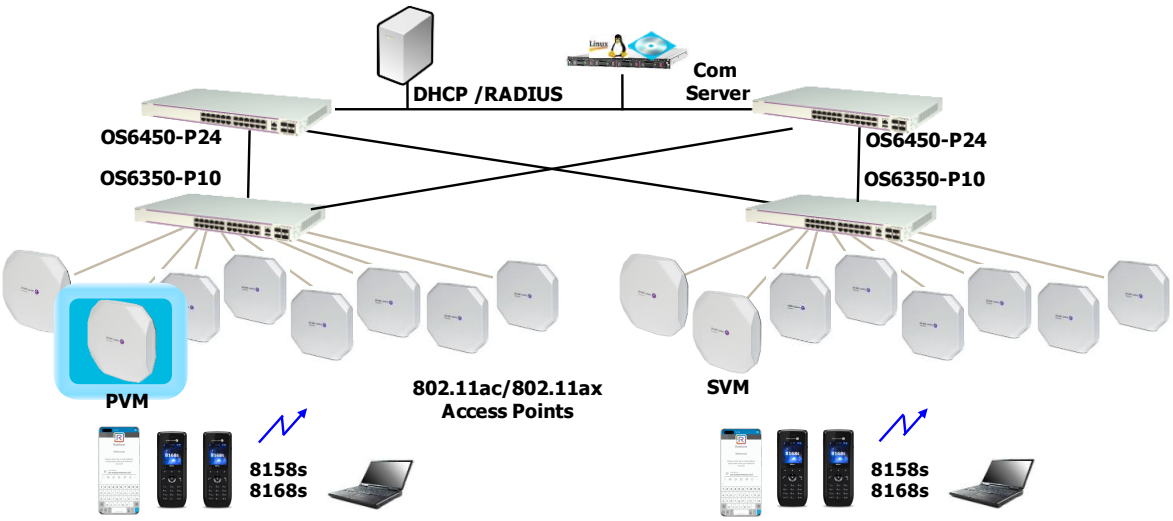


Figure 60: Configuration for up to 16 AP (with redundancy)

In this scenario, the backup process takes place between the 2 WLAN Access Points of the same model. In order to ensure a full backup, the total quantity of AP must not exceed the maximum number of AP supported by the AP-Group. Depending on the global Bandwidth a Gigabit port can be used on both OS6450.

28.3 WLAN in different RF domains

This example depicts a model for up to 3 groups of Access Points in Wifi-Express Mode, forming 3 distincts RF domains.

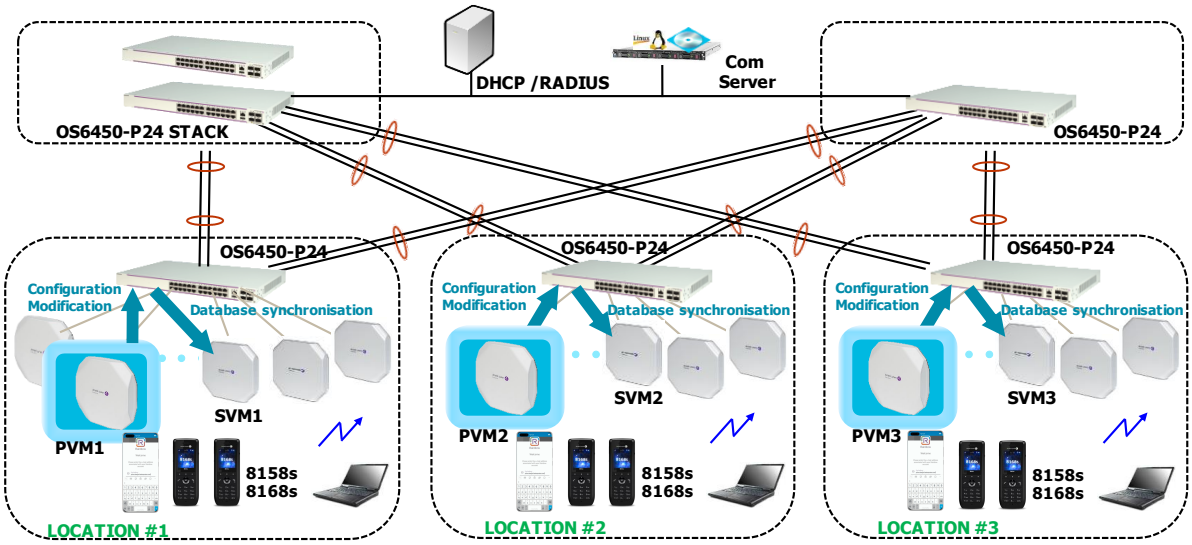


Figure 61: WLAN in different RF domains

28.3.1 PVM – SVM Redundancy scenario

Each Stellar Access Point is located in different AP-Group and managed in Wifi-Express Mode. They are configured to automatically connect each other using the Stellar protocol optimized for lightweight a centralized access points management.
Configuration of each AP-Group is done directly on the Primary Manager through the GMIP of the group created (differents AP-Group ID) and through Web-based configuration tool and applies for all Access Points within the AP-Group. On any configuration modification, a Database synchronization is done on Secondary Virtual Manager.

28.4 WLAN RF domains in Wifi-Enterprise

This example depicts a model for up to 3 groups of Access Points in Wifi-Enterprise Mode, forming 3 distincts RF domains with varied scales.

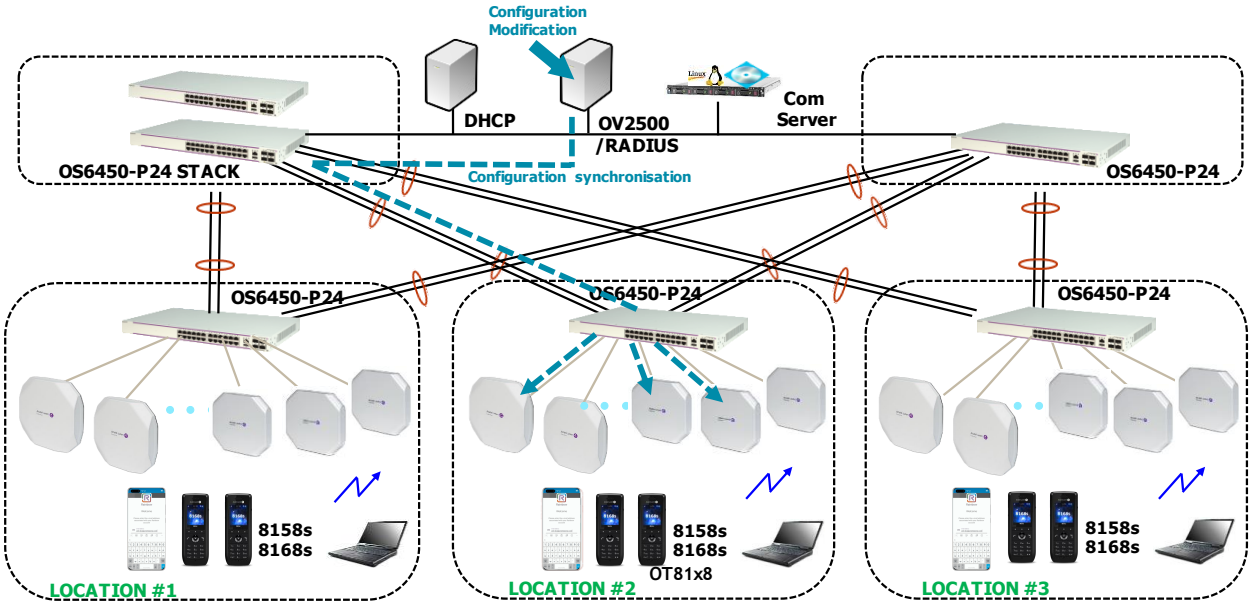


Figure 62: WLAN in Wifi-Enterprise mode

28.4.1 Wifi-Enterprise management scenario

Each access point is located in a different group and managed in Wifi-Enterprise mode. The Access Points are configured to automatically register on the Omnivista 2500 Server Software Platform.
The configuration of each AP group is done directly on the Omnivista 2500 platform through Web-based configuration tool of 2500 Server and applies to all access points within the AP group.
For all configuration, security, accounting and fault tasks, Access Points and Omnivista Server communicate using Message Queue Telemetry Transport (MQTT) protocol. The MQTT session is performed on Stellar management plan and remains active as long as Omnivista Server is reachable.

There is no specific manager role for access points in Wifi-Enterprise groups.

29. Quotes & Orders

Quotation process for the Voice over WLAN solution is not fully automated within ACTIS as many of ALE other voice technologies. For this reason, engineers are strongly encouraged to complete the framework of the target VoWLAN design prior to beginning the ACTIS process. All hardware components must be manually selected from the “Onsite WLAN Mobililty equipment” menus.

Design engineers should pay special attention during the quotation process to insure that necessary items are not accidentally omitted. For instance, an 8158s or 8168s WLAN user is complete with a terminal, battery, charging stand, charging stand power plug, and some form of clothing attachment.

Each of these items must be selected separately within ACTIS (or in bundle package combination.) Infrastructure items are no less attention demanding. Design engineers should pay special attention to power cords, uplinks options, and mounting hardware.

To process quotation of IMS3 (integrated Messaging and Wireless Services) for 8158s or 8168s WLAN place order with the following items:

- a Server (3BN78415AA)
- a license to use the server (3BN78415AB)
- a license to deploy 100/500/1000/2500 handsets (3BN78415A C/D/E/F)

The order is realized via an eSR indicating the desired references.

OmniAccess® Stellar Access Points are not supported by ACTIS tool.

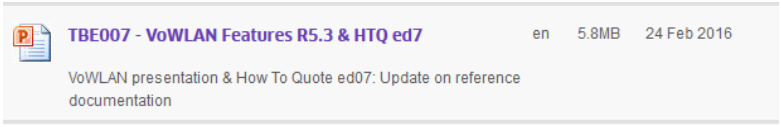
OmniAccess® Stellar WLAN Access Points bring an optimized cost with a minimum options to quote and can reduce the impact of possible expenses that could be possible by unforeseen future needs. Despite insure that necessary items are not accidentally omitted during the quotation process. For instance, External power supply or PoE inline block.

For more detailed information on the QUOTING process for VoWLAN solutions, refer to **VoWLAN section of the PreSales Presentations.**

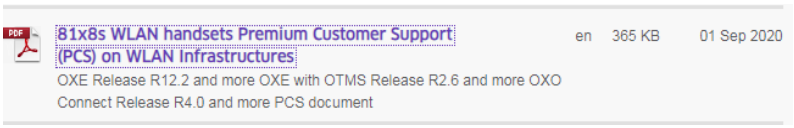
30. Reference Documents

30.1 VoWLAN section of PreSales Presentations

Business Portal:



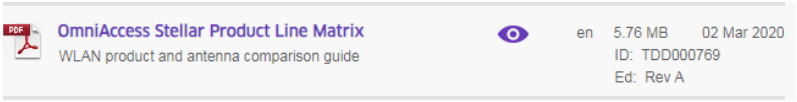
https://businessportal.al-enterprise.com/node/220902



https://businessportal.al-enterprise.com/81x8s-wlan-handsets-premium-customer-support-pcs-wlan-infrastructures

30.2 VoWLAN R7.2 documents

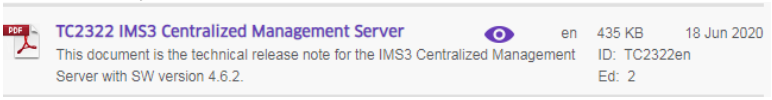
Technical Documentation Library:



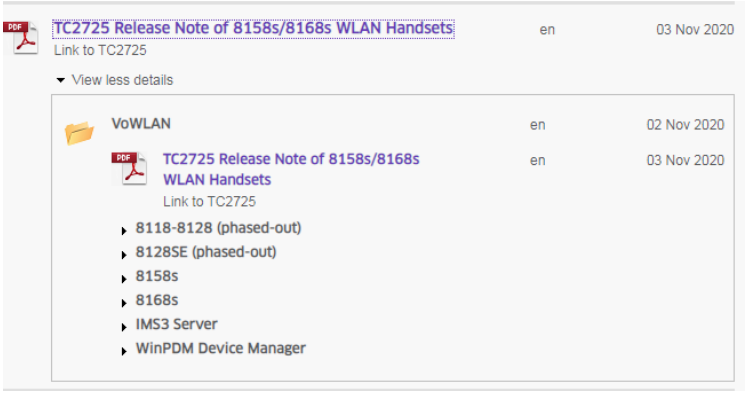
https://businessportal.al-enterprise.com/TDD000769

30.3 8158s, 8168s WLAN & Stellar Technical communications

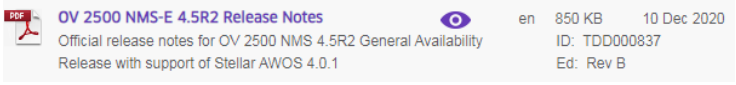
Technical Documentation Library:



https://businessportal.al-enterprise.com/TC2322en



https://businessportal.al-enterprise.com/tc2725-release-note-8158s8168s-wlan-handsets



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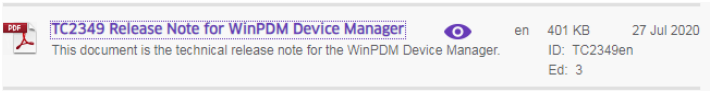

https://businessportal.al-enterprise.com/TC2349en

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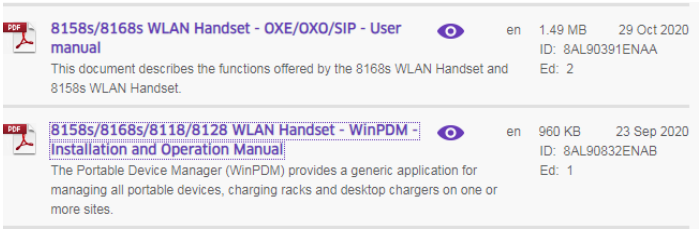
30.4 8158s, 8168s WLAN & Stellar Manuals & Application Notes

Technical Documentation Library:



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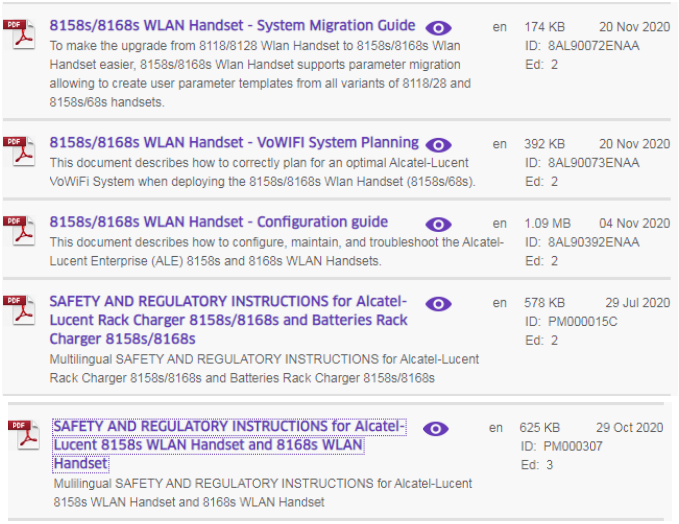
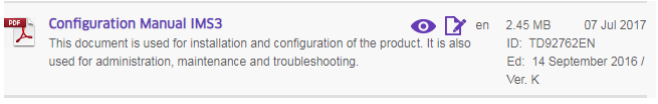
https://businessportal.al-enterprise.com/8AL90832ENAB

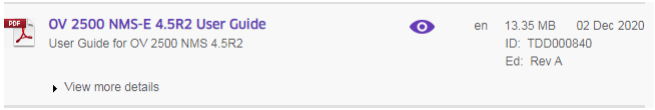


https://businessportal.al-enterprise.com/8AL90072ENAA
https://businessportal.al-enterprise.com/8AL90073ENAA
https://businessportal.al-enterprise.com/8AL90392ENAA
https://businessportal.al-enterprise.com/PM000015C
https://businessportal.al-enterprise.com/PM000307

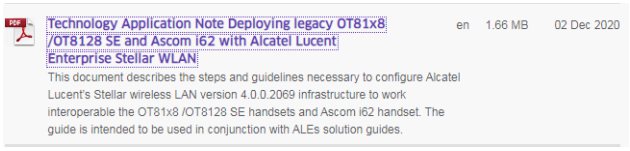


https://businessportal.al-enterprise.com/TD92762EN

https://businessportal.al-enterprise.com/TDD000842



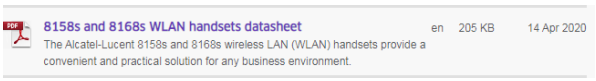
https://businessportal.al-enterprise.com/TDD000840



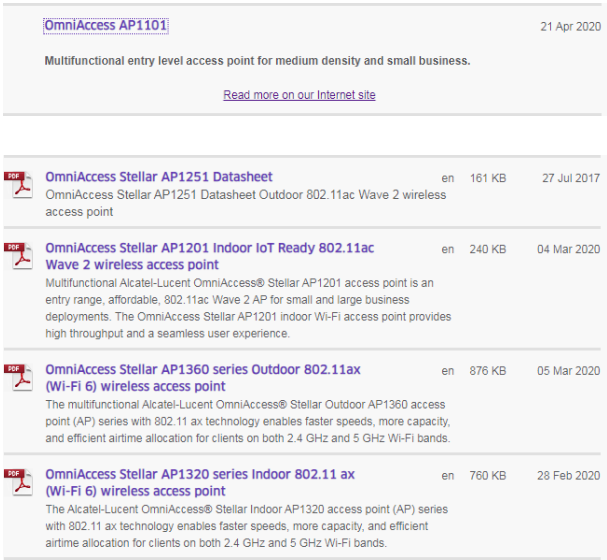
https://businessportal.al-enterprise.com/technology-application-note-deploying-legacy-ot81x8-ot8128-se-and-ascom-i62-alcatel-lucent

30.5 8158s, 8168s WLAN & Stellar Datasheets

Technical Documentation Library:



https://businessportal.al-enterprise.com/8158s-and-8168s-wlan-handsets-datasheet



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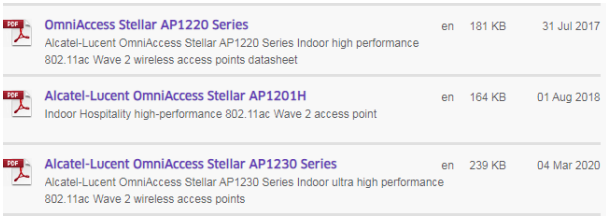
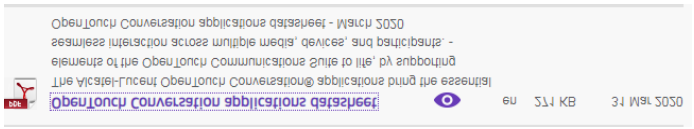


https://businessportal.al-enterprise.com/products/omniaccess-wlan/omniaccess-wlan-access-points/omniaccess-ap1101
https://businessportal.al-enterprise.com/omniaccess-stellar-ap1251-datasheet
https://businessportal.al-enterprise.com/ap1201
https://businessportal.al-enterprise.com/omniaccess-stellar-ap1360-series-outdoor-80211ax-wi-fi-6-wireless-access-point
https://businessportal.al-enterprise.com/omniaccess-stellar-ap1320-series-indoor-80211-ax-wi-fi-6-wireless-access-point
https://businessportal.al-enterprise.com/omniaccess-stellar-ap1220-series
https://businessportal.al-enterprise.com/ap1201h
https://businessportal.al-enterprise.com/alcatel-lucent-omniaccess-stellar-ap1230-series

30.6 ALE applications Technical Documentation

Technical Documentation Library:



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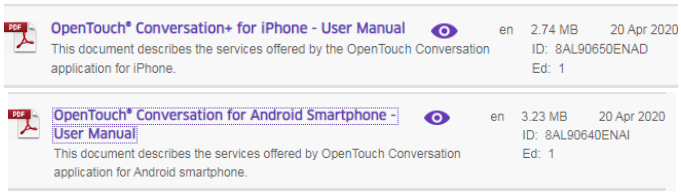

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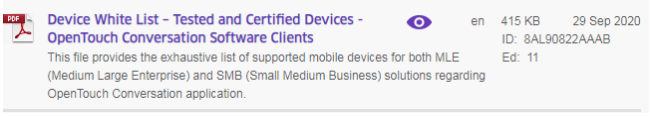
https://businessportal.al-enterprise.com/8AL90640ENAI



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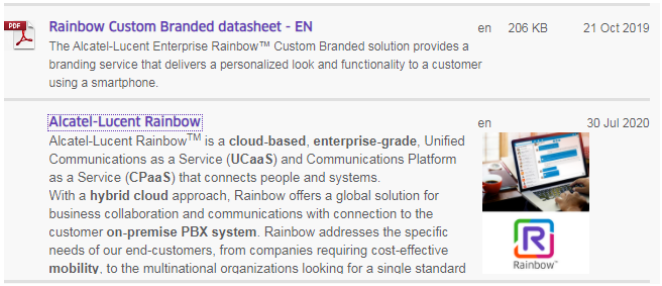

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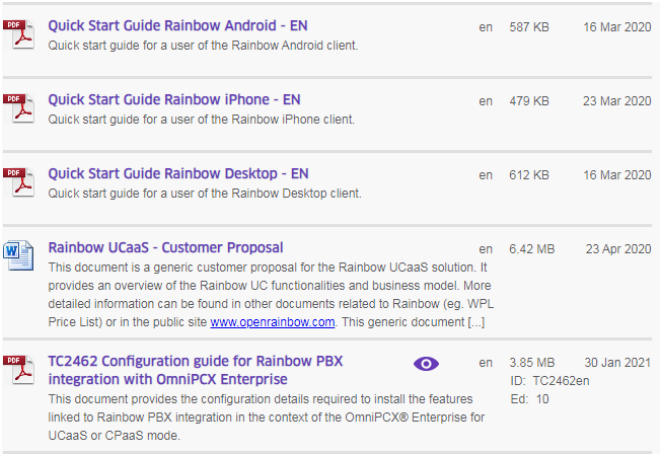
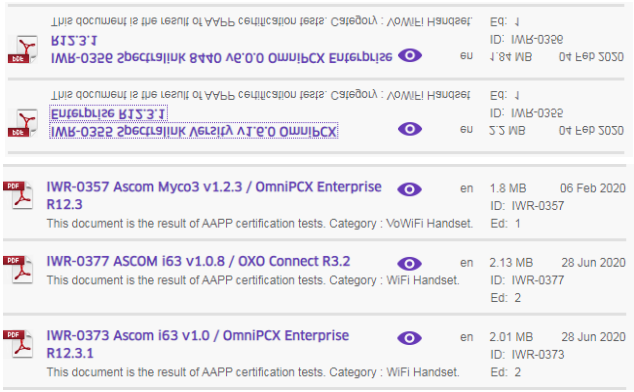
https://businessportal.al-enterprise.com/alcatel-lucent-rainbow-0



https://businessportal.al-enterprise.com/node/519836
https://businessportal.al-enterprise.com/node/520871
https://businessportal.al-enterprise.com/node/519811
https://businessportal.al-enterprise.com/rainbow-ucaas-customer-proposal
https://businessportal.al-enterprise.com/TC2462en

30.7 InterWorking Reports (DSPP Program)



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https://businessportal.al-enterprise.com/IWR-0355
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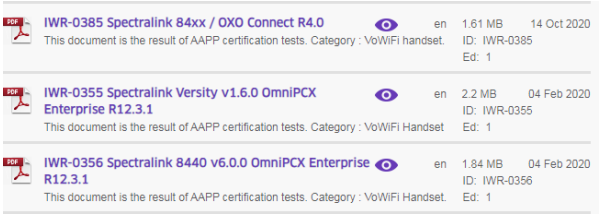
https://businessportal.al-enterprise.com/IWR-0373



https://businessportal.al-enterprise.com/IWR-0385
https://businessportal.al-enterprise.com/IWR-0355
https://businessportal.al-enterprise.com/IWR-0356

31. Annex

31.1 Site Survey Tool

The Site Survey Tool is a portable engineering tool for measuring and monitoring the air interface of Wireless Local Area Networks (IEEE 802.11). This Tool helps to determine:

- The quantity of needed Access points
- The correct placement for these Access Points

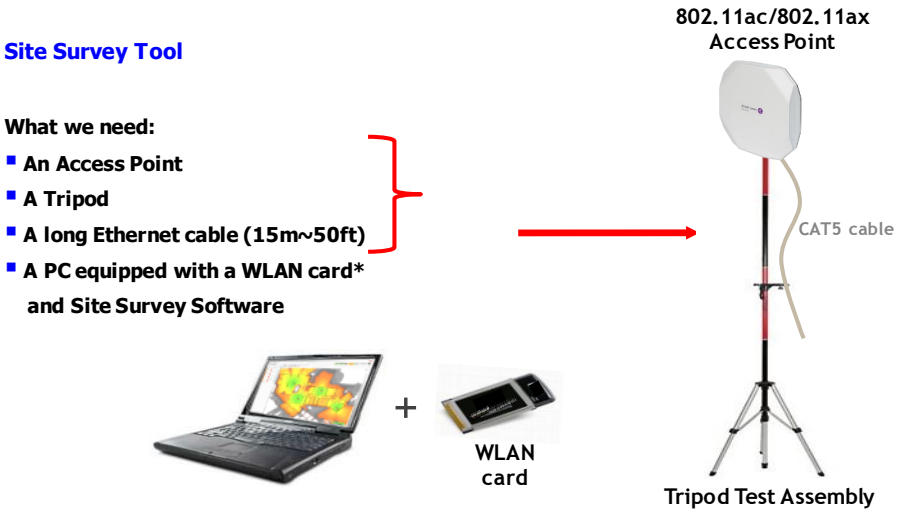


Figure 63: Site Survey components

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The Site Survey tool is mainly used by ALE Professional Services and Business Partners. A site Survey is required every time it is needed to perform a quotation for VoWLAN implementation. A VoIP audit is also necessary. OmniAccess Stellar APs can feed 2.4GHz or 5GHz channels being configured in manual mode. The WLAN adapter must be compliant with the Survey Soft.

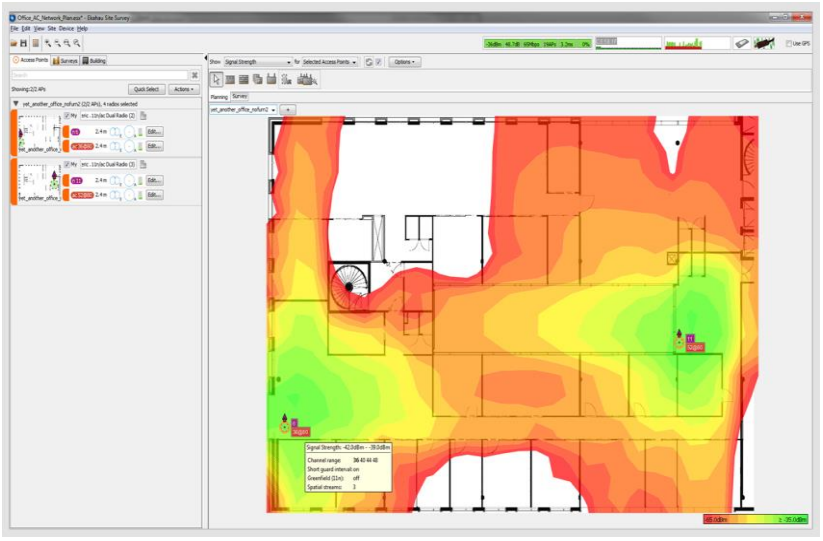

Figure 64: Survey Result

The above picture shows a site survey result done in 802.11a. Just compare the color to the scale. The target is to obtain a signal strength of **-60 dBm** or better required for example for 8158s and 8168s WLAN handsets operation.

31.2Site Survey Tool Example

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Ekahau PRO Site Survey 10.3 includes Alcatel-Lucent OAW-AP12XX, OAW-AP1321, OAW-136X series and external indoor antennas

Alcatel-Lucent OAW-AP1221, OAW-AP1231, OAW-AP1251, OAW-AP1222, OAW-AP1232
Alcatel-Lucent OAW-AP1321, OAW-AP1361/62/61D
ANT-O-6, ANT-O-M4-5 and ANT-S-M4-60

If needed during Site survey Ekahau RF spectrum analyzer tool can be integrated with the RF survey.
For further details refer to: https://www.ekahau.com/products/ekahau-connect/pro/#buynow

Ekahau PRO Site Survey 10.3 is now included in Ekahau Connect tools suite, now available on iOS and Android mobile and that provide surveys directly from a smartphone.

Note: This Site Survey software is not orderable from ALE but can be furnished as service during ALE survey.

31.3 Embedded Site Survey on 8158s/8168s

31.3.1 Show RSSI mode

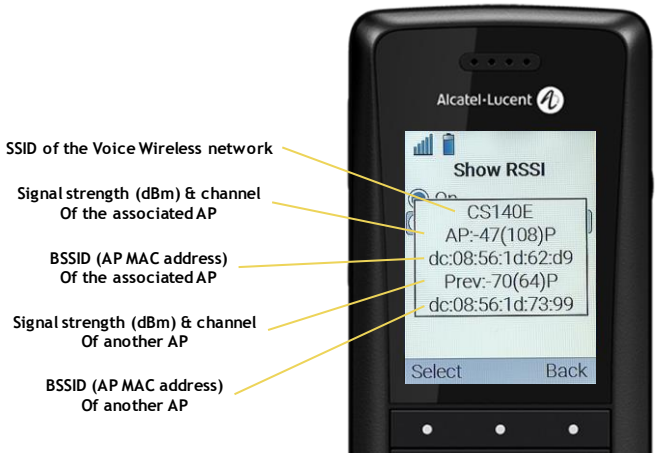

Figure 65: Show RSSI on 8168s

An embedded Site Survey is present on 8158s and 8168s WLAN. This mode is accessible through 8158s and 8168s WLAN parameters menu. The 8158s and 8168s WLAN "Show RSSI" provides the signal strength (in dBm), the channel and the BSSID (Basic Service Set Identifier) MAC address of the associated AP and also the signal strength (in dBm), the channel and the BSSID (Basic Service Set Identifier) MAC address of another AP. It can be used at any time to evaluate coverage by testing signal strength, to gain information about an AP, and to scan an area to look for all APs regardless of SSID.

Note: This 8158s /8168s WLAN embedded site survey is not intended to replace the VoWLAN Site Survey tool, but provides additional diagnostics for handover capability.

31.3.2 Scan all Channels

Figure 66: Scan all Channels

This mode displays the different SSIDs discovered by the 8158s & 8168s WLAN and provides channel numbers and Signal Strength

END OF DOCUMENT

Voice over WLAN Deployment Guide
OmniAccess® Stellar Access Points
Healthcare Use Case

Stellar AWOS version 4.0.2 and more

OmniVista 2500 version 4.5R3 and more

Alcatel·Lucent Enterprise

Table of Contents

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History

Edition 01: VoWLAN R7.2 OXE R12.2/12.3/12.4, OTMS R2.6, OXO Connect R4.0
OmniAccess® Stellar AWOS GA 4.0.2 Access Points, all modes
Omnivista 2500 R45R3
8158s and 8168s software version 2.2.13
Rainbow UCaaS client version 1.84
OTC application version 2.60

Disclaimer

This documentation is provided for reference purposes only and does not fully describe the capabilities of each Product and related features. Therefore, ALE International declines any liability for inaccuracies contained herein. For an exhaustive view on features list and product limits for the current product release please see the required Feature List/Product Limits document available through the ALE eBusiness Portal web site.

In the interest of continued product development, ALE International reserves the right to make improvements or other changes to this document and the products it describes at any time without prior notice.

1. Introduction

Voice wireless deployment today is conducting any high-density WLAN deployment and is a mandatory prerequisite for any new wireless Voice and Data deployments on the 5GHz wireless band with 802.11ac or more recent 802.11ax standards.

The importance of voice in Enterprise communications no longer needs to be demonstrated, the voice is the adapted support for critical missions, interventions and make a connected and available staff at any time.

ALE OmniAccess® Stellar solution for healthcare is a turn-key solution and provides the following benefits:

- Set of Unified & Hybrid communication services with OmniPCX OXE/OXE with OTMS, OXO communication servers and messaging systems
- High-available WLAN with OmniAccess® Stellar Access Points
- High-efficient WLAN with Wifi 6 Stellar Access Points
- WLAN/LAN mobility integration with OmniAccess® Stellar unified wireless infrastructure
- Offering the last generation of wireless IP phones with the last wireless standards and handling of audio HD (ALE 81x8s handsets)
- Ensuring staff security with functions like alarm or Man-down features (ALE 8168s handsets)-
- Handling New Audio/Video usages with combination of mobile devices and Rainbow UCaaS collaborative application
- Driving cost savings combining Voice with geo-location systems like Real-time location systems (RTLS) or OmniAccess® Stellar Asset Tracking solution for devices location and asset tracking.

All benefits with Voice today depend on successful deployment of a wireless network layout on the 5GHz band for WLAN infrastructure and clients with 802.11ac or last 802.11ax standards. The purpose of this document is to educate presales, network and system engineers in charge of voice wireless deployments in Healthcare.

1.1 Voice and Audio/Video over WLAN deployment steps

This guide provides a 5-steps Voice and Audio/Video deployment guideline over a OmniAccess® Stellar Wireless LAN infrastructure.

Prepare – identify Voice and Audio/Video usages: understand the challenges and the requirements.
Plan – requirement of wireless infrastructure, Voice devices, environments, performance, security and management.
Design – Choices in architecture.
Implement – Deploy and manage Voice users as per design. The guide provides a template of configuration for Voice over WLAN with Omnivista 2500 server.
Operate – provide the Voice service to users, monitor the Voice devices, maintain and extend the service.

1.2 Healthcare environment Context

Healthcare is the particularly vertical market that is most likely to be concerned by a VoWLAN (Voice/Voip over Wireless LAN) deployment answering to the collaborative requirement of a mobile staff in their critical health missions. This guide is illustrated with a typical Use Case of a Large Health etablishment with several care and service centers (300-1000 voice users range site) where challenges are similar with most of Healthcare environments:

- Ensure the staff efficiency
- Quality of care
- Patient satisfaction
- Assistance in medical diagnostics

The current challenges that Hospitals face today for both Voice & Data are following:

- Increasing of Number of connections per user/number of equipment per users
- New usages with wireless collaborative/voice devices (smartphones, tablets)
- Time and resources saving
- Computerization and automation of health data
- New usages in health care: teleconsultation or telemedecine
- New medical devices

Hospitals must comply with local regulations for the security and hosting of Health data:

- HIPAA (Health Insurance Portability and Accountability Act) in USA
- GDPR (General Data Protection Regulation) and ISO27001 in Europe
- HDS (Hébergeur de Données de Santé) in France

For the WLAN deployment we retain the compliance of the wifi installation with the EMC standard (ElectroMagnetic Compatibility) for compatibility with medical equipment.

2. Preparation

2.1 Voice user usages

In preparation step we take in account the realistic expectations with users. A Voice usage for the mobile staff, like doctors or nurses, with quick notification services, is not the same than for any administrative /office user or any external guest user using Audio/Video. The following questions must be asked for a suitable voice usage.

- What are the voice coverage requirements on site?
- Which roaming parameters can be accommodated for the users?

Take in account the kind of clients that will handle Voice or Audio/Video:

- Dedicated handsets, smartphones or laptops?
- Depend on wireless clients in place, what are the radio frequencies to be used for Voice?
- How much bandwidth is required for handsets or collaborative applications handling Voice?

Mind on specific outcomes deliveries for voice if required:

- Which services, alarms or notifications, must be supported with voice?
- Which mobility with voice across all sites? Off-site/teleworking for mobile staff for example will require L2 or L3 tunnel concentrator to serve the branch extensions.
- If high autonomy is expected on-site for users with handsets, a battery recharge station will answer to possible low-battery conditions.

2.2 Challenges in Voice

VoWLAN implementation and its usage in many verticals markets shows number of challenges: Voice is a mission-critical system and WLAN must remain highly available with high level of security. For business continuity reasons no operational process can be interrupted.

Note the RF behavior that cannot always be reliably predicted, the nature of radio frequency (RF) in the environment is important. The Voice WLAN must not give off signal that interfere with systems that are in place.

2.3 Importance of a Site Survey

It is essential to convey a Site Survey, it is part of the preparation activity for deploying a Voice WLAN infrastructure. It is the way to anticipate any RF coverage issue. Some electrical equipment can share unlicensed RF bands being used by the 802.11 VoWLAN devices (ex: ISM band).

3 complementary tools are generally used in a site survey and answer each a specific need:

- The RF spectrum analysis enables to see non-WLAN items in detail in the RF environment then provide an easy identification and isolation of the interference sources in WLAN.

- The site planner provides simulation and help in access points placement by selecting requirements in term of coverage (signal) and in term of access points (simulation of antennas, antenna tilt, power, height, obstacles etc.). The planner proposes an automated location of access points and channels then provides a simulated heatmap.

- The site survey provides the in situ real measurement of some expected WLAN parameters and identify areas where wanted prerequisites could not be reached. A passive site survey method applies generally.

2.3.1 Understand the RF environment

Know the RF environment variables is an essential step during preparation:

Standard RF environment variables	Specific RF environment variables in Healthcare
2.4GHz/5GHz cordless phones	Cabinets and metal equipment
Elevators	Electric motors
Air-conditioning ducts	Fire walls /Fire doors (seen also in Hostels)
Radio equipment: DECT /non-WLAN access points	Refregirators
WLAN environment	Plasma lighting
Microwave ovens	Areas with medical devices
Walls fabricated from wire mesh and stucco	Magnetic Resonance Imaging (MRI)
Transformers	

Figure 1: **RF variables**

2.3.2 Access points requirements

An Initial survey is required for any new Installation to determine the number of required Access Points and their optimal placement. Keep Voice traffic in mind for any actual voice and data deployment on the 5GHz band with 802.11ac/ax.
A 5GHz design implementation is conducting today 802.11 WLAN surveys.

2.3.2.1 AP placement for administrative/office areas

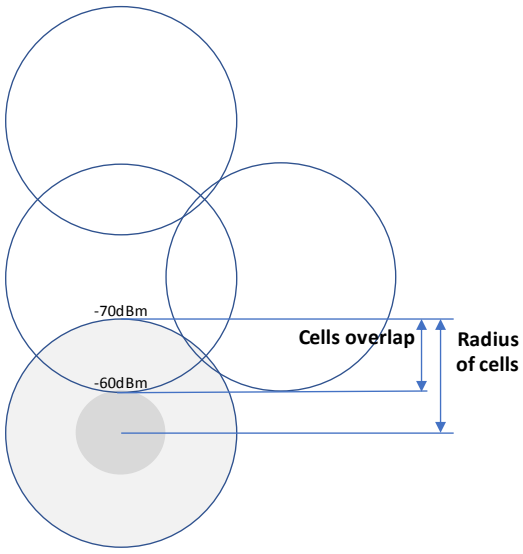


Figure 2: **Typical AP deployment pattern for offices**

The deployment of **1 access point per 225 square meters** in administrative/office buildings is the standard rule in 802.11ac/ax design to support Voice and then provide at the same time a high data performance with a proper coverage for Voice. The 802.11ax increases the number of AP per square meter to meet high-density requirements if necessary.
The standard mounting for access points in indoors is the ceiling mounting with a height of about 2,4m-3,5m.

Consider the possible management spaces in buildings (between floors) or areas with containment shielding and extensive steel support structures (for example air-conditioning ducts)

2.3.2.2 AP placement for areas with geo-location

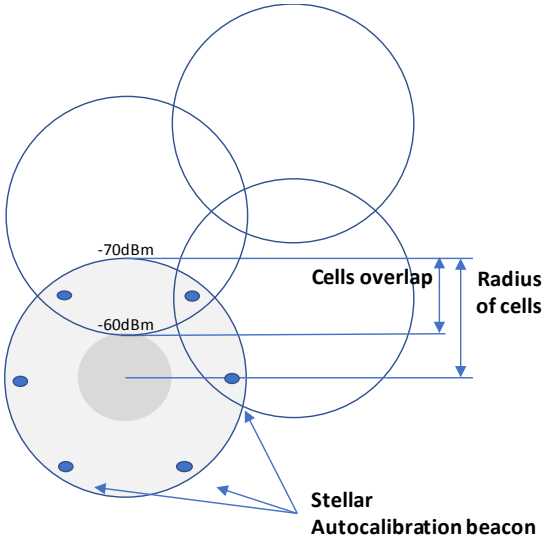


Figure 3: **Typical AP deployment pattern for areas with geo-location**

The deployment of geo-location for voice and data mobile equipment in hospital is required in areas where a tracking and an inventory of equipment is necessary at the same time as voice and data wifi coverage. The AP deployment must take into account placement constraints for a geo-location service. Stellar Asset Tracking or RTLS geo-location solutions are built on a hexagonal placement of APs to ensure the correct triangulation of RSSI measurements received from equipment and thus ensure correct accuracy on locations.

OmniAccess Stellar Asset Tracking solution produces the location information from BLE RSSI information provided by equipment equipped with BLE chipset. All Stellar Access Points equipped with BLE are gateways for Stellar geo-location and it is necessary to surround Stellar Access Points with a minimum of 6 calibration beacons to provide the correct location references to the gateway.

Figure illustrates the typical AP deployment pattern for Voice and Data coverage with geo-location service. The pattern is compatible with both RTLS and Stellar Asset Tracking solutions. Deployment of APs with Stellar BLE autocalibration beacons is close to a hexagonal deployment (pattern in "zigzag") and maintains the same density of AP per square meter as for offices, ie 225 square meters. A distance of 10 meter maximum between Stellar beacons is thus defined to provide the best possible location accuracy with the Stellar solution. It is also possible that the geo-location solution provider (like RTLS Ekahau / Stanley) suggests their own AP deployment recommendations.

2.3.2.3 AP placement for Open space/Auditorium

Different cases of indoor placement must be considered during 802.11ac/11ax survey.

The first placement is typical open space/auditorium coverage with an unique AP at the center of the area where AP placement could manage a requested clients concentration and supports all the traffic for all the room.
The ceiling height can be variable in case of auditorium.

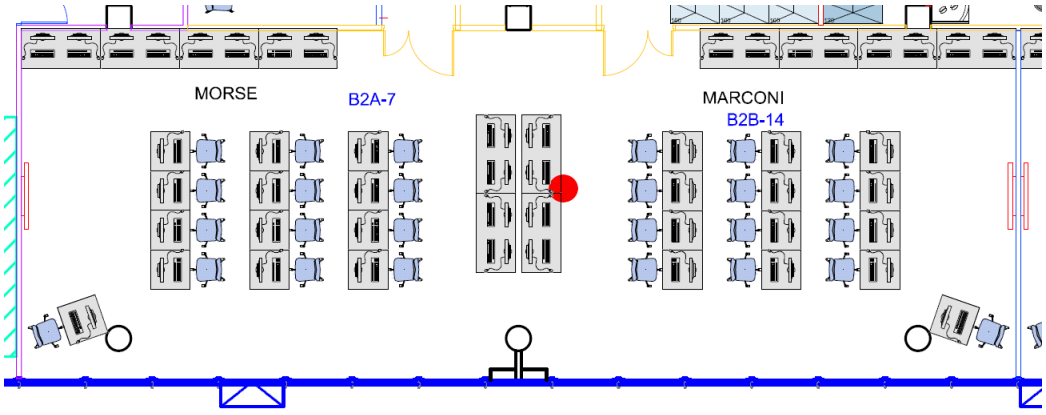


Figure 4: **Typical AP deployment pattern in Open space/Auditorium**

2.3.2.4 High-density considerations

The approach here is to identify areas with a concentration of wireless clients, all Voice and Data applications combined, and areas with high bandwidth requirement.

As a reference for a standard usage in offices, the average of clients per AP on the 5GHz band with 802.11ac/11ax is about 25-30 clients, all type of applications. Any high concentration of wireless clients should be considered from this value.

Always as a reference for a standard usage in offices, the average available bandwidth per user and per AP on the 5GHz band with 802.11ac/11ax is around 10Mbps, for all types of applications. Any high bandwidth requirement should be also considered from this value.

Let consider an extreme usage for the auditorium above. With a capacity up to 50 users and intensive throughput on the 5GHz band required by collaborative applications such as Rainbow UCaaS clients with use of Audio/Video HD, the placement of an unique AP at the center of auditorium becomes critical to answer to the concentration of wireless clients and the need for bandwidth. Indeed in this case 50 users request up to 450 Mbps wireless bandwidth in this space, it is necessary to consider placement of multiple APs for this area.

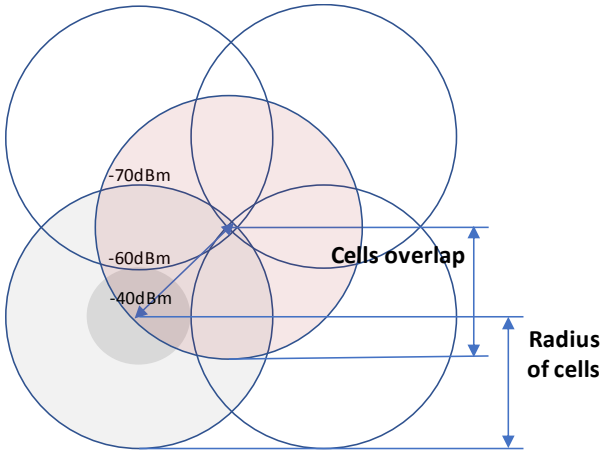


Figure 5: Typical AP deployment pattern in high-density

The figure illustrates the typical AP deployment pattern for voice and data coverage in high-density, by adding supplementary access points on existing installation on the 5GHz band. The existing installation will not require rearrangement and the existing APs are advantageously replaced by 802.11ax Access Points which meet the bandwidth and high-density requirements in this area.
The placement doubles the number of APs by 225 square meters and doubles the bandwidth available to wireless users, all Voice and Data applications combined.

2.3.2.5 AP placement for areas with obstacles

This example shows placement with fireproof door which is a typical RF obstacle between 2 neighboring access points then that cannot communicate with their radio.
In this case a static neighboring discovery must be managed.

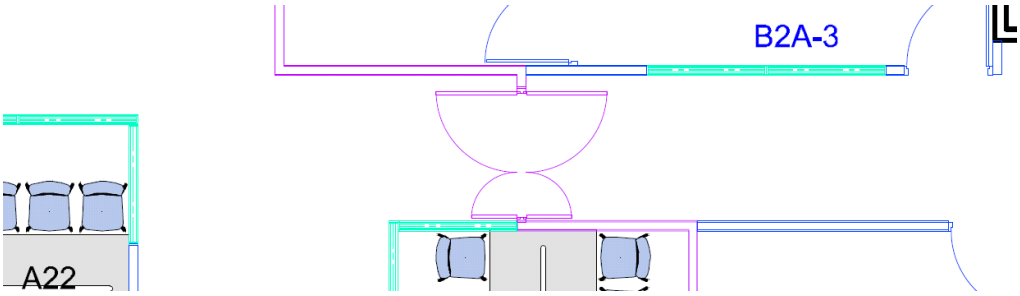


Figure 6: Deployment pattern with fireproof door

2.3.3 Initial Site Survey

The initial Survey highlighted in this guide is a basic Survey specifically conducted for 2 buildings in order to identify areas which cannot be covered for Voice and is essentially conducted on the 5GHz wireless band in 802.11ac.

- To define the access points placement and their mounting type
- To realize a survey document for critical Voice coverage on the 5GHz band

Only passive site analysis has been conducted during this initial site survey, detection of interferences in areas with known RF interferences emissions was not screened during the survey. It remains necessary to conduct RF spectrum analysis if important sources of interferences are known.

Survey Tool used during the survey:

- Mobile Pod with Stellar 802.11ac access point (AP1221)
- PC with Airmagnet Surveyor 9.2 for 802.11ac and with Floor Ground plans

Methodology in measures:

Walking along the halls, offices or rooms away with Stellar mobile Pod, to measure parameters for halls and offices nearby. Measure on both 2.4GHz and 5GHz bands (2.4GHz still required band for some equipment today) on following the main parameters: Signal power, Signal Noise Ratio (SNR) and estimated datarates parameters for 802.11ac/11ax design.

Figure 7: **Survey conducted with Stellar Mobile Pod**

The recommended SNR and noise levels during a Voice site survey in 802.11ac/11ax are:

- 25dBi SNR (or better)
- -67dBm (or better) RSSI
- -92 dBm (or less) noise level

5GHz Transmission power

5GHz Datarates

2.4GHz Signal Noise Ratio

Figure 8: **Data measured with Airmagnet – 1st floor – Rooms – Building 1**

As result this initial site Survey for Voice provides the following placement for the building 1.

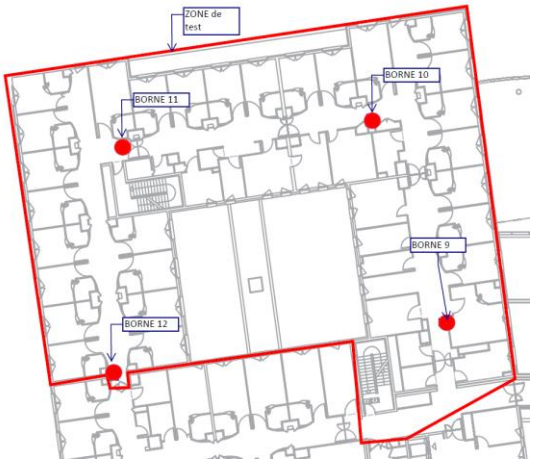
Building 1:

3 story building - survey places 16 access points, in a ceiling-mounting

Level -1 – survey area = 5 access points

RDC – survey area = 8 access points

1st floor – survey area = 4 access points



APs placement

Figure 9: **Proposal for AP placement – 1st floor – Rooms – Building 1**

Note for a deployment with **voice and data coverage** for users with collaborative Audio/Video applications on site, the datarates measurements taken on the 5GHz band (figure 8.2) will be essential to determine whether the coverage provided for voice only will also be sufficient for voice and data coverage.

2.3.4 Electromagnetic compatibility and compliance

Medical environments are particularly evaluated for electromagnetic compliance. In Survey highlighted here, at wireless side, radios are tested for compliance based on applicable national regulation (French regulation here).
ALE Stellar & networking solutions are certified per international regulatory standards applicable for 802.11ac/11ax radios.

A hospital meets with Medical electromagnetic compatibility Standards

- Electromagnetic Compatibility (EMC) and International Electronical Commission (IEC) 601-1-2 standards (Japan meet the CISPR 11 emission requirements or meet the CISPR 22)

and meets with safety requirements for medical devices

- Effects of RF emissions on human health.
- Transmission power of WLAN devices is low relative to expected immunity levels of equipment in healthcare environments. 802.11bgn and 802.11ac are not used by patient monitoring systems.
- Recommendations with medical equipment (hearing aids or pacemaker devices), WLAN 802.11ac/11ax radios have very little risk of creating EMI but minimum distance of 1 meter between WLAN devices and medical equipment is recommended.

Guidelines and programs are recommended to establish specifications for required immunity of all electronic devices used particularly in healthcare, identify and train responsible people.

2.4 High Avaibility considerations

Voice is a service that requires the High Avaibility of the wireless infrastructure but High Avaibility is also required for areas where medical Data equipment are combined with Voice and Data equipement and have to stay continuously under RF coverage and connected.

The point is to identify areas that require multiple access points with High Availability, enabling removal of Access Point in some areas while other Access Points are still in function. This is the case where either there is failure of any element in the network (Access Point, Switch, Power Supply, even Management failure) but also in typical usage of infection control by replacing a non-sterile Access Point without disrupting the wireless service.

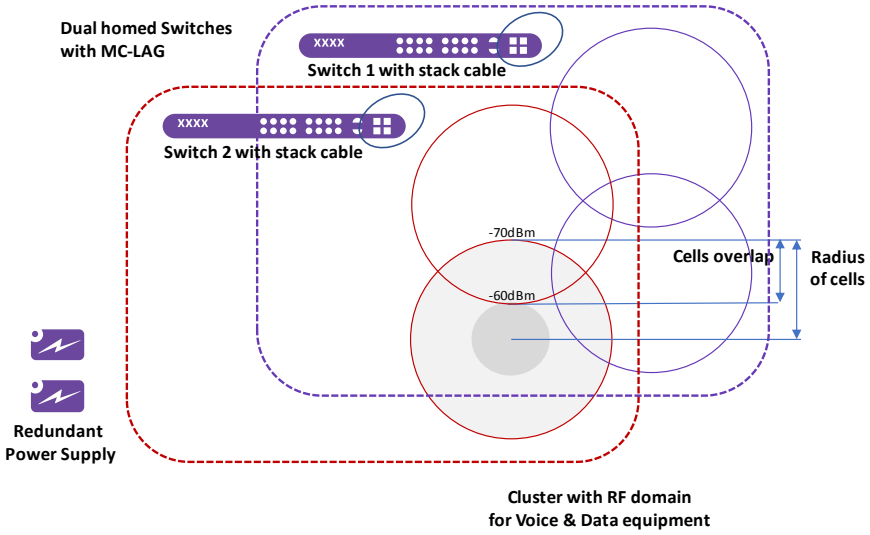


Figure 10: **High Avaibility for areas with critical equipment**

The figure illustrates a cluster of Stellar wireless controllers connected to two satellite rooms for the switching. It is useful to divide multiple access points as much as possible into two interleaved grids, each grid is connected to a different LAN access switch to ensure the continuity of RF coverage with neighboring APs in the area for all Voice and Data equipment, in case failure occurs in the network.

The WLAN High Availability is ensured by the redundancy of Stellar wireless controllers in a AP Group, within the cluster adjacent APs share the same RF context and adapt automatically in case of AP failure. Two separate redundant switches provide the power and LAN continuity to the neighboring APs for a continuous coverage of the area.

Voice equipment can roam on their new AP and critical medical wireless equipment remains continuously under RF coverage. A Stellar RF domain is defined for the area for client control in particular, criteria for equipment de-authentication, roaming or advanced scanning if required, in addition to channels and transmission power selections for the area.

2.5 Network process & prioritization considerations

Voice applications are the most sensitive to packet loss and delay and it is necessary to guaranty the highest quality of service (QoS) priority with appropriate marking.

QoS context for Audio/Video applications combined with a smartphone is slighty different; the need in bandwidth is higher and cell coverages on the 5GHz wireless band are lower; traffic on network is done in Best Effort scheme and QoS priority on network is close to a video streaming marking for these applications.

The network enforces QoS using tagging based on 802.11e and Wifi-Multimedia WMM based for both applications.

2.6 Security considerations

Understand any security vulnerability that can exist in deployment is important point to care during preparation.

2.6.1 Security in mobile environment

Eliminate any authentication, encryption method or outdated measure that affect if incorporated in the new WLAN infrastructure. Robust encryption, authentication and standard-based security measures are essential.

Use the last security standards, WPA2 or better WPA3 (Wifi protected Access) Enterprise for encryption, EAP (Extensible Authentication Protocol) and 802.1x protocols, for an effective Enterprise-Class protection against spoofing attacks. WPA3 methods become the necessary encryptions for high-density design on the 5GHz wireless band with 802.11ax (Wifi 6 access points).

Monitoring DoS (Denial-of-Service) attacks for Voice on the network, using network snooping technologies, is a good practice. Enable SIP snooping on handsets for the key staff for example permits report such attacks or SIP failures to the IT staff.

Protect against wireless attacks and wireless containment with Rogue access points Detection and Protection mechanisms is a requirement for wireless network that convey mission-critical traffic.

2.6.2 Voice type of Access

Identify the different categories of Voice users like; operational staff, key staff, administrative/office staff, patients and Guest users. Multiple WLAN accesses can be envisaged to control access for each through dedicated SSIDs (Suscriber Service IDentifier), for example SSID for key Staff with Voice handsets and Audio/Video combined with smartphone.

Each VLAN is isolated, a Voice VLAN provides an unique access privilege to the internal communication network while a Data VLAN provides access to larger corporate resources. Handsets and Audio/Video users can share the both Voice and Data VLANs on a same SSID.

Identify the business requirements for the other class of users like Guests that access their company Intranet but also are making Voice through the internet (using Cloud collaborative applications with Audio/Video through Internet or using corporate VPN)

2.6.2.1 Implementation of professional Voice over WLAN

The specificity of Voice illustrated in the example of this guide is to provide professional communication for the workforce everywhere it operates on the sites, with a dedicated service for Voice with handsets. The Survey for this example is detailed in chapter 2 and the followings are considered for Voice:

- A fleet of up to 400 professional handsets: 8158s handsets and i62 messenger handsets with OXE business communication system (OXE R11.2 communication server with OT8158s in version 2.2.13, i62 handsets in version 6.0.8)
- A Desktop Softphone solution with combination of laptops for staff in offices (with OXE licence 3BA09851JA - license 328 et 331)
- A defined QoS for site on the Voice VLAN
- A WPA2 Enterprise security method for all the devices

3. Plan

Deploy with well-considered and long-term plan helps achieving a return of investment for the customer and enables the support of all devices identified during the Preparation Step, Voice handsets and Audio/Video users with Cloud collaborative applications in combination with smartphones, PC etc.
Make a plan based on requirements for Voice and Audio/Video solutions is a necessity.

3.1 Define the service for equipment

Consider the amount of bandwidth the Voice and Audio/Video applications need. Define the requirements in roaming, for Voice security, to manage and monitor. Access to the Voice WLAN configuration and ability to manage it and then consider the support of Voice over WLAN with all parameters to monitor for the IT staff.

3.2 Hardware/software version and configuration management

Define strong policies for HW/SW changes and configuration management, for example configuration management for HW handsets is done with a central management server for handsets (like IMS3 server for 81x8s handsets).

3.3 Voice capacity planning

Latency-sensitive applications such as pure Voice applications must be prioritized and the support of fast handoff between cells must be done for full Voice service.

OmniVista 2500 is advantageously used for WLAN planning for large-scale deployments, integrating a Heatmap tool. The OmniVista 2500 tool is used to continuously optimize physical and performance characteristics of the wireless infrastructure.
This is critical there is no interference with vital equipment in installation and map with a 802.11 spectrum already in use is a plus.

3.3.1 RF management

The WLAN spectrum is shared with other technologies: smartphones, Bluetooth, microwave ovens and potential devices for interferences and must coexist with 3G/4G/LTE networks or other radio systems like radars, satellites or medical equipment.
2 spectrum bands are available: 2.4GHz – 802.11b/g/n and 5GHz – 802.11a/n/ac/ax

Deploy the 5GHz band for more robust system operation and performance in Voice with 802.11a/n/ac/ax protocols. The 2.4GHz band can still exist for some devices.
For a bandwidth reliability with Voice use the 802.11a/n/ac/ax.

Advantages to use the 5GHz band 802.11ac/ax:

- High data-throughput via channel aggregation (20/40/80Mhz)
- Higher aggregate WLAN capacity to support more users per cell, more data-intensive applications with Voice and Audio/Video applications included
- Reduced interference from non-802.11 wireless devices
- Improved performance in RF-reflective indoor environments (802.11ac/ax technologies: MU-MIMO and TxBF)
- Improved performance in dense indoor environments (802.11ax technology: OFDMA, BSS coloring, enhanced MU-MIMO with fast modulation)
- Larger number of non-overlapping channels (typically 21) resulting in less co-channeling interferences

For any new greenfield Voice and Audio/Video over WLAN deployments, IT must consider 802.11ac/ax-based access points deployment as best investment in performances and extended equipment life-cycle. 802.11ax wireless migrations can be performed gradually within the Stellar scalable solution.

3.3.2 Capacity planning

The capacity planning is critical. Co-channeling Interferences (CCI) limit the available bandwidth and define the AP channel utilization and how many clients each access point should support.

A standard Voice and data plan is about 20-30 users per 802.11ac or 802.11ax cell and provides at minimum an average connection speed of 60Mbps per access point and meet the service agreement:

- Make simultaneous voice calls by each access points with QoS
- Guaranty a data rate of more than 6 Mbps for any device and application

	802.11n	802.11ac	802.11ax
Advertised data rate	144Mbps	173Mbps	208Mbps
Effective throughput	50Mbps	61Mbps	75Mbps

Figure 11: **Effective throughputs**

In the figure data rates are rates carried over de medium and user throughput is estimated from advertised data rates from the access point. Values are done as reference for 2x2 MU-MIMO access point.

3.3.2.1 Handoff and roaming

Voice clients are highly mobile and require fast roaming to avoid disruption of voice service when Voice users are roaming between cells.
Smartphones in combination with Audio/Video applications and Enterprise handsets are the most demanding devices in roaming, with a preferred seamless handoff time for the Enterprise handsets.

	Opportunistic caching (OKC) with 802.1x/EAP authentication	802.11r - Fast transition (FT) 802.11k - Neighbor reporting	802.11v - BSS transition management	Comment
Enterprise handsets 8158s, 8168s				
802.11 mode	Enable	Disable	Disable	100ms (or less) seamless handoff time
802.11k mode	Disable	Enable	Disable	60ms (or less) seamless handoff time
Devices for employees				
Android devices iOS devices	Disable	Enable	Enable	Enable features based on device capability to improve roaming experience. Android for S9 and above, iOS 10 and above have the last updated implementation of 802.11r/802.11k/802.11v
MacOS laptops Windows laptops	Disable	Enable	Enable	802.11r/802.11k/802.11v can help improve roaming experience on macOS or Windows laptops. OKC is supported when 802.11r not

				supported on some Windows laptops. Check the support of OKC/802.11r/802.11k/802.11v on devices for employees
Devices for Guests				
Any device	Disable	Disable	Disable	Disable all the OKC/802.11r/802.11k/802.11v features by default

Figure 12: Fast roaming considerations on the 5GHz wireless band

	Association RSSI threshold	**Roaming RSSI threshold**	**Comment**
Enterprise handsets 8158s, 8168s			
802.11 mode	Default	Default	Defaults values are: Association RSSI threshold 12 dB Roaming RSSI threshold 18dB
802.11k mode	9dB (2.4GHz) 6dB (5GHz)	30dB (2.4GHz) 30dB (5GHz)	
Devices for employees			
Android devices iOS devices	Default	30dB (2.4GHz) 30dB (5GHz)	
MacOS laptops Windows laptops	9dB (2.4GHz) 6dB (5GHz)	30dB (2.4GHz) 30dB (5GHz)	Sticky connectivity is the recommended behavior for non-roaming devices like laptops.
Devices for Guests			
Any device	9dB (2.4GHz) 6dB (5GHz)	Default	Sticky connectivity is the recommended behavior for Guests

Figure 13: Roaming optimisation on 5GHz wireless band

Plan dedicated SSIDs for devices that have similar type of RF capabilities, roaming, QoS and security capabilities.

In case of roaming layer 3 must be envisaged (voice infrastructures with WAN) plan the areas where handsets are visiting between sites and then where roaming layer 3 applies for Stellar Access Points. Only OmniSwitches OS6860/E/N/6900 are supporting Stellar roaming layer 3.

Check also wireless infrastructures or areas with no handover capabilities.

As roaming is depending on protocols involved for the roaming and devices roaming capabilities, all characteristics have to be reported in a site book and roaming capability for the site communicated to users if necessary.

3.3.3 Reliability and Redundancy

WLAN must be highly reliable in installations and IT have to create a robust network architecture

- A single access point failure could create an outage for multiple users.
- A Voice client or Audio/Video client can dynamically switch from one access point to another

Access points that interleave to different LAN access switches can preserve a complete RF coverage as possible.

3.3.4 Management with OmniVista 2500

WLAN involves a large number of access points for Voice and Audio/Video, and combine the management of wired and wireless networking is something that must be addressed at the planning stage. Poorly planned and managed WLAN can result to inconsistent delivery.

Stellar distributed-based architecture enables to install, upgrade, manage the environment and adapt scale while providing the required Healthcare services.
Centralized management with OmniVista 2500 system enables IT managers to design, control and monitor the entire wireless & wired network to simplify operations and reduce total cost of ownership.

4. Design

4.1 Access Points coverage

At design process step, resurveying, re-planning and testing the Access Points placements and capacity defined at plan step for Voice (from site survey and capacity planning) might be required in some cases. Cells overlap between floors must be checked if necessary. The advantage to plan with 802.11ac/ax from the beginning is that placement and spacing of 802.11a MU-MIMO access points remains the same for any migration.

4.2 Antennas & RF selection

Consider the followings for antennas and RF design for Voice and Audio/Video on the 5GHz wireless band.

For antennas:

- Indoor environments often only need enclosure and integrated antennas
- Place antennas beyond the reach of users or any other passerby
- Consider antennas gain when setting maximum transmission power for AP

The channel selection depends on frequencies permitted for a particular region. Stellar Access Points automatically manage authorized channels for a country, with always the possibility to define specific channel plan in areas where interferences are detected during the initial site survey.

- Stellar adjacent cells are using as possible non-overlapping channels, then minimize the channel utilization and stay compatible with data operation at the same time.

Take the immediate benefits of 802.11ac wave 2 or last 802.11ax from the beginning with channels aggregation (20Mhz, 40Mhz or 80Mhz) and RF optimizations for indoor environments.

Feature	Recommended settings	Description
ACS	Enable	The AP performs dynamic monitoring and selects the best channel to reduce the workload and the complexity of network maintenance and optimization
APC	Enable	It is recommended that the APC function be enabled to allow the AP to dynamically adjust the transmission power to avoid coverage saturation
Transmission power	13dBm max for 5GHz (Open Space) 16dBm max for 5GHz (Office with wall) 7dBm max for 2.4GHz	The AP performs transmission power adjustement in the range of 6-40dBm max depending on regulation. It is recommended to limit RF emissions on the 2.4GHz band.
Bandwidth setting	HT20 for 2.4GHz HT40 for 5GHz	It is recommended that the 5GHz band be configured to HT40 to improve the isolation between channels and reduce the interference between APs
Band steering	Enable	Band steering connects clients to 5GHz first and improves the user experience. It is recommended that this feature be enabled.
Force to 5GHz	Enable	This feature force clients to connect to the 5GHz radio and improves the user experience. Enabling this feature is recommended.
Background Scanning	Enable	Background scanning is required to support ACS/APC. Recommended configurations are as follows: Scanning Interval: 900s Scanning Duration: 50ms

Load balance	Enable	Load balancing can effectively balance the services between APs and improve network capacity
Voice/video awareness	Enable	Where applicable
Airtime Fairness	Enable	Airtime fairness allows all clients to have the same transmission timeslot and achieve higher wireless performance
MU-MIMO	Enable	MU-MIMO is recommended by default with a majority of MU-MIMO compatible devices. Disabling only if not compatible devices still exist
High Efficiency	Enable	802.11ax is recommended by default with a majority of MU-MIMO compatible devices

Figure 14: RF considerations on 5GHz wireless band

The table describes parameters to consider when setting a RF domain for a particular area. It is recommended at the same time to manage band steering to the 5GHz band and set RF optimizations for clients.

4.3 Data rates selection

802.11ac wireless throughputs are reaching 1733Mbps (4x4 MU-MIMO mode) on the 5GHz band and therefore require 1 Gbps Ethernet connection to the wired infrastructure, or more with the use of 802.11ac 3-radio access points. 802.11ax wireless throughputs are reaching the 2400Mbps (4x4 MU-MIMO mode) on the 5GHz band. Some 802.11ax deployments may require an upgrade of edges switches or aggregation switches to Multi-Gigabit switches.

From an user's perspective, 802.11ac/ax data rates ensure a minimum 6 Mbps effective, or more, for any voice and Audio/ Video application and minimum data rates of 6 Mbps, or more, can be set for voice and data over the 5 GHz wireless band, on an SSID basis.

4.4 Security

Design with robust encryption, authentication and standard-based security measures is essential. Use of last security standards: WPA2 or better WPA3 (Wifi protected Access) or WPA2/WPA3 Enterprise with Extensible Authentication Protocol (EAP) and with 802.1x protocols.
MAC and IP address spoofing are common in WLAN and EAP/802.1x authentication with unique encryption key per user is the most effective against spoofing attacks.
Handling of DoS attacks on network using snooping technology; like SIP snooping for SIP handsets or DHCP snooping for IT, protect against wireless attacks and wireless containment for Rogue access points, as said in Plan chapter, are best practices.

4.5 Quality of Service

4.5.1 Unified management for Voice and Audio/Video

OmniVista 2500 unified system management tool adds the capability of a Web user interface and CLI command for configuration, performance monitoring, security, fault management and accounting options for Voice and Audio/Video users over WLAN:

- Wireless Intrusion detection & Protection system (WIDS/WIPS) protects against wireless threats such Rogue access points and denial-service attacks.
- A WIDS/WIPS deployment mode is based on policy in OmniVista 2500
- Jointly with Stellar access points DPI (Deep Packet Inspection) function, OmniVista 2500 APV (Application level-control & Visibility) enables Voice and Audio/Video applications visibility for NOE, SIP or Rainbow applications, and with enforcements on Voice/Audio/Video traffics based on QoS policies.
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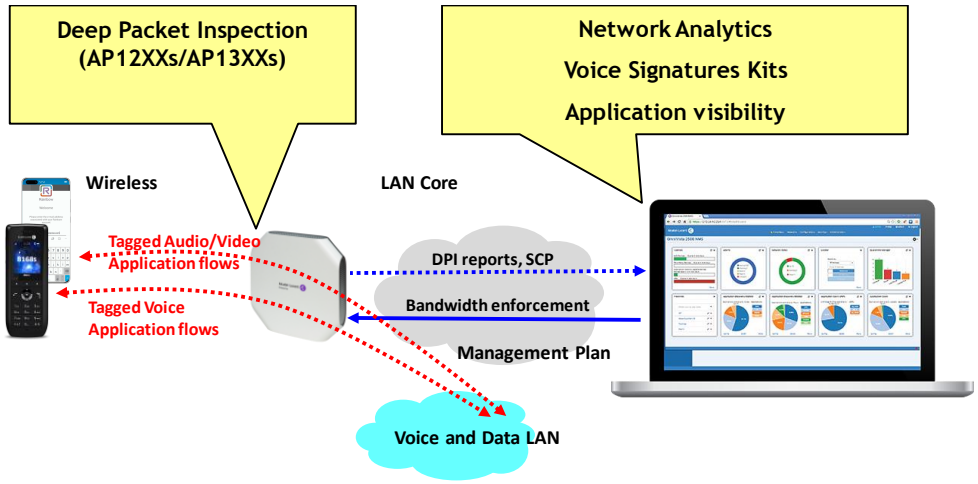

Figure 15: **Enterprise Voice enforcement with Stellar DPI /OV2500 App Visibility**

Feature	Max Voice, Audio/Video communication bandwidth per AP (per user) *	Max call per AP **	AP model
Enterprise handsets 8158s, 8168s	13Mbps (400Kbps) 12Mbps (400Kbps)	Up to 35 Voice streams Up to 32 Voice streams Up to 30 Voice streams	All Stellar AP13XX in 11ax All Stellar AP12XX in 11ac Stellar ap1101 in 11ac
Rainbow UCaaS client Audio only * **	4.2Mbps (120Kbps) 4Mbps (120Kbps) 4Mbps (120Kbps)	Up to 35 Audio streams Up to 32 Audio streams Up to 30 Audio streams	All Stellar AP13XX in 11ax All Stellar ap12XX in 11ac Stellar ap1101 in 11ac
Rainbow UCaaS client Audio/Video HD ** **	Up to 105Mbps (3Mbps) Up to 96Mbps (3Mbps) Up to 90Mbps (3Mbps)	Up to 35 Audio/Video streams Up to 32 Audio/Video streams Up to 30 Audio/Video streams	All Stellar AP13XX in 11ax All Stellar ap12XX in 11ac Stellar ap1101 in 11ac
OTC mobile	24.5Mbps (700Kbps) 22.5Mbps (700Kbps) 21Mbps (700Kbps)	Up to 35 Voice streams Up to 32 Voice streams Up to 30 Voice streams	All Stellar AP13XX in 11ax All Stellar ap12XX in 11ac Stellar ap1101 in 11ac

Based on G711 payload *
R-value ≥ 80 (estimated MOS for Audio) **
Opus NB (Narrow band) for Audio ***
VP8 for Audio/Video HD ****

Figure 16: **Bandwidth values for analytics per ALE application**

- OmniVista 2500 adds graphical view of Stellar managed access points via integrated Floor planning tool, Heatmap, to maintain the WLAN in its environment.

Consider common policies to guide the QoS traffic prioritization, well driven policies help drive application, network design, deployment and operations and then a migration strategy can be considered.

- Define a policy to support Voice operations (VoIP real-time operations)
- Define a policy to Support Conferencing real-time operations (Collaborative apps operations)

At Enterprise handsets management side, IMS3 server centralizes management of ALE Enterprise handsets over the air and provide toolsets allowing the easiest deployment of Voice clients with handsets, including handsets & QoS policies management.

4.5.2 Delivering voice quality

ALE high-avaibility mobile campus with Stellar WLAN improves the Voice quality by prioritizing traffic with 802.11e/WMM and DSCP/802.1p.

For 802.11ac/ax Voice deployment cases it is imperative to enable the WLAN with Wifi Multimedia WMM and with AES cryptography, this additionally to stringent signal strength and coverage to deliver quality Voice over WLAN (VoWLAN)

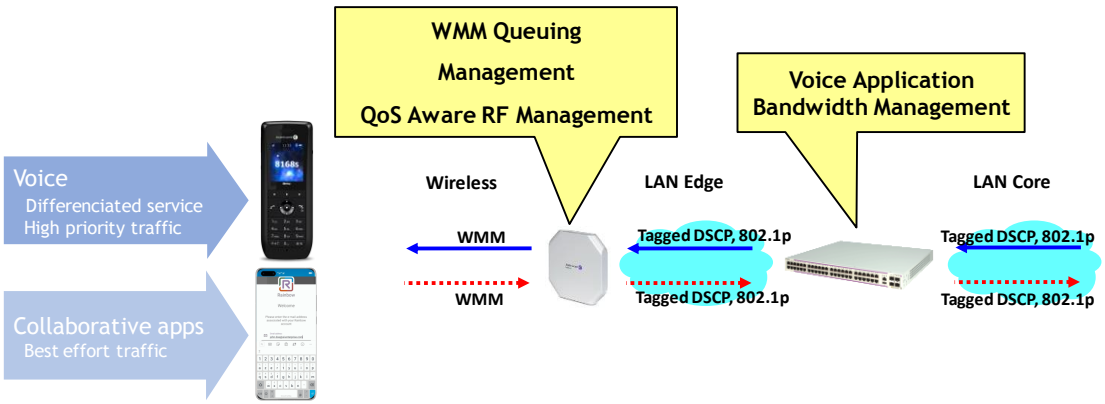

Figure 17: **Voice/Audio/Video client Packet Prioritization & Process**

ALE Voice Enterprise handsets mark packets using WMM. The QoS approach meets requirements for voice over mobile campus network and achieves end to end QoS through the network.

	IP DSCP	802.1p	802.11e/ WMM	Comment
Enterprise handsets 8158s, 8168s	46 (EF) Voice 26 (AF3x) Signaling	6 4	Voice Video	QoS marking is directly from Enterprise handsets
Android devices	18 (AF2x)	3	Best Effort	Smartphone with Audio/Video
iOS devices	18 (AF2x)	3	Best Effort	Smartphone with Audio/Video
MacOS laptops **Windows laptops**	18 (AF2x) 0 (BE)	3 0	Best Effort	Laptop with Audio/Video Data laptop

Figure 18: **QoS marking for Voice/Audio/Video applications per device**

	Power saving	Preco DTIM	Talk time	Standby time
Enterprise handsets 8158s, 8168s	APSD power management	5	Up to 15 hours	Up to 100 hours
Android devices	Legacy 802.11 polling	1	Up to 10 hours	10h-40h (depend on vibrator, GPS, LTE, etc. use)
iOS devices	Legacy 802.11 polling	1	Up to 10 hours	10h-40h (depend on vibrator, GPS, LTE, etc. use)
MacOS laptops Windows laptops	Legacy 802.11 polling	1	--	--

Figure 19: **Power saving per device**

4.6 WLAN outages recovery

To ensure business continuity in many verticals, a wireless deployment must be designed with the possibility of natural disasters or other occurrences that cause failure (Power Outage).

- Maintain the Voice communications systems during a disaster by continuing to operate via an auxiliary power.
- An auxiliary power to both wired and wireless networks is a key consideration in design
- Maintain Voice or Audio/Video during Power Outages by design; including the operation of IT servers on auxiliary power.

The wireless should be able to resume service using the Power over Ethernet (PoE). Current 802.11ac and 802.11ax access points can operate using PoE that provide 30 watts or DC power.
The use of inline power injector can be an option if edge switches cannot provide power for 802.11ac/11ax access points.

4.7 Architecture

The picture below depicts here a typical WLAN installation for Voice and Data including one 3 4-floor building and one smaller building.

For example:

Building 1
Number of APs: 16
Usage: office, medical staff, doctors, nurses

Building 2
Number of APs: 10
Usage: medical staff, doctors, nurses

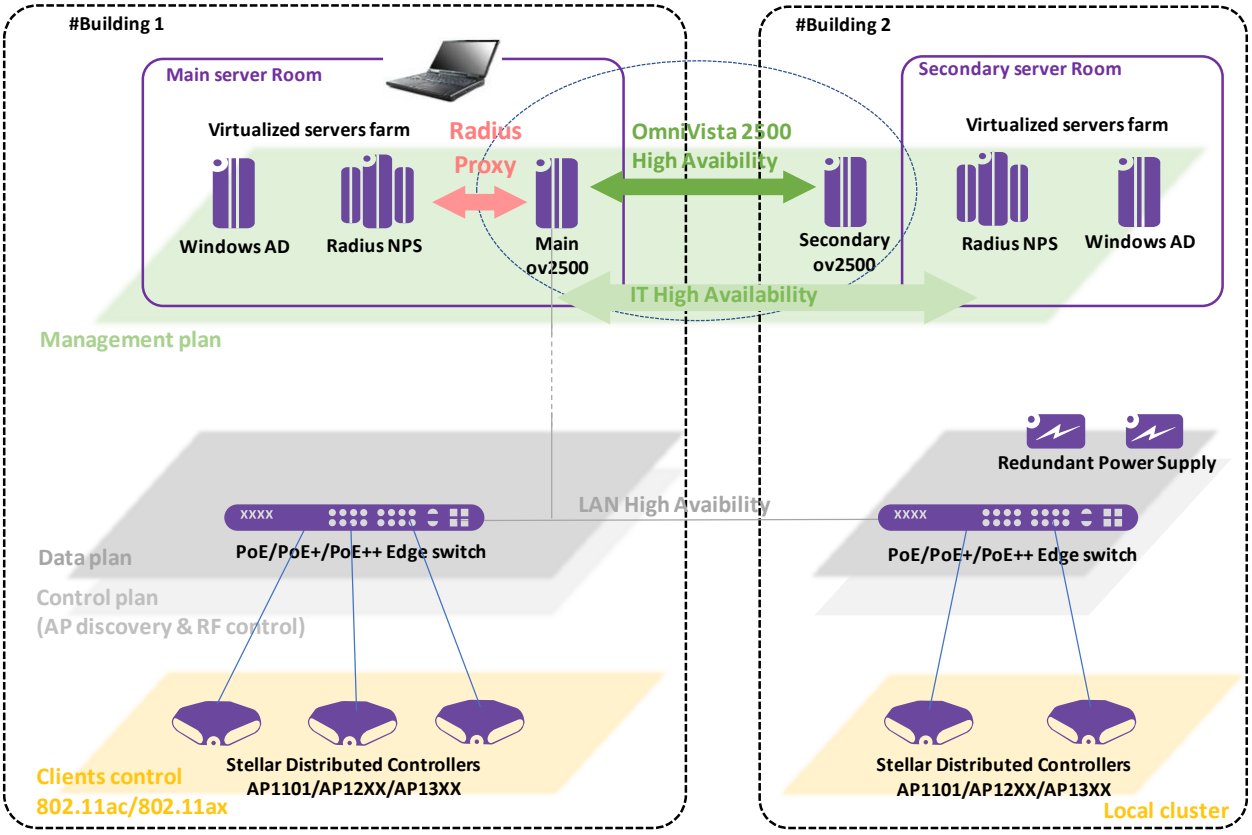

Figure 20: **Stellar WLAN Network architecture for Healthcare**

4.7.1 Benefits with ALE OmniAccess Stellar WLAN Network

The ALE OmniAccess Stellar WLAN architecture for Healthcare is based on the centralization of the management on-site, in a High Avaibility mode, with control from redundant OmniVista 2500 to deliver Enterprise-class reliable and scalable wired and wireless network.

The Stellar distributed architecture is composed exclusively of interconnected Access Points to deliver a unified, Enterprise-class wireless solution, with the required resource management, capability, connectivity and services (heatmap, RF planning, Application visibility) for mobility with Voice and Data, using the last 802.11ac wave 2 and 802.11ax standards.

Stellar clusters rely on a high-available Core network, generally built in a 2-tier design, that scales to larger single-site or multi-site networks. APs in a same cluster first discover each other at radio level and then exchange their RF database at LAN level for their auto-channel and auto-power process, by listening their RF neighboring environment in a regular basis.

A Stellar AP cluster operates as a local, distributed wireless controller and meets coverage needs in certain areas, for example aeras where medical equipment are in combination at the same time with voice and data equipement.

The key points of a local cluster of Stellar wireless controllers are:

- No single point of failure for the cluster, adjacent APs adapt their channel and power to the most appropriate settings in case of AP failure
- No controller VM (Virtual Machine)
- RF domain with dedicated profile settings
- Any controller in cluster can run without active 2500 management

The solution integrates the main Positioning Engines of the market (Ekahau, Stanley) that use WLAN infrastructures to calculate location of mobile devices or can use, with advantage, the integrated geo-location service of Stellar Asset Tracking solution for Voice and Data mobile clients.
This Stellar architecture supports the main external Notification/Messaging and Alarm systems for the security of mobile staff, with OXE operating with IQ Messenger Notification/Messaging system, or standalone IMS3 system (Ascom) for handsets 81x8s.

The benefits of this Stellar architecture for Voice and Data deployment are the following:

- Omnivista 2500 is the platform to simplify the on-site management, monitoring, diagnostic/resolution of problens for Voice and Data clients.
- A single Omnivista 2500 provides management with visibility on all sites
- Within a single mobile environment, Voice clients can roam freely anywhere with no interruption to applications. It is essential to enabling a campus-wide access in the different buildings to assist the medical staff in making treatment decisions.
- Easy integration of WLAN Voice and Data users
- Unified WLAN/LAN network policy and best practice map wireless security policies to the wired network.
- Voice usage can be visualized through Voice analytics policy for all the site.
- Authentication framework between clients, access points and existing Authorization, authentication, Accounting (AAA) Radius NPS server based on EAP/802.1x
- Support of last 802.11ac wave 2 and 802.11ax standards for last recent Voice and Data clients
- High-available wireless network among all sites, for different RF domains
- High-efficient wireless network with Stellar 802.11ax Access Points
- Geo-location of key staff devices, reducing time in searching key assets and improving the inventory management
- Notification/Messaging and Alarm services for key staff devices

This is the recommended architecture by ALE for Healthcare, easy to deploy, delivering a high level of reliability, security, management and a scalable wireless network to a larger single -or multi-site- network.

For any detail on specific architecture point on Stellar mobility please refer to **Mobility Campus Solution Guide 2.0**

4.8 Portfolio for Voice/Audio/Video

Management servers, Notification/Messenging, Alarm or IT servers are not depicted.

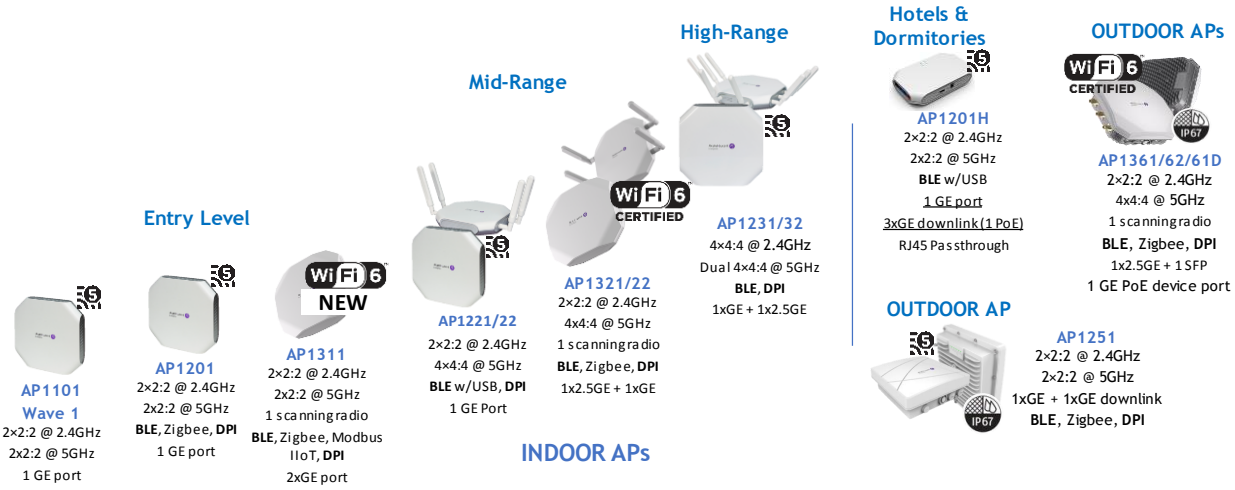

Figure 21: **Stellar lineup for Voice/Audio/Video**

All 802.11ac Stellar access points support Voice/Audio/Video from release 3.0.5.1046 in all modes. All 802.11ax Stellar access points support Voice/Audio/Video from release 4.0.2.1057 in all modes. The full QoE analytics and reporting for Voice/Audio/Video is supported on all Stellar access points with DPI function (AP1101 and AP1201H excepted).

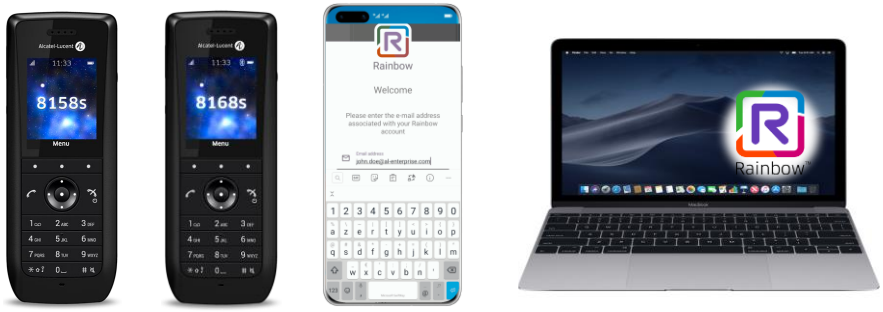

Figure 22: **Enterprise 8158s, 8168s handsets, Android mobile & iOS mobile**

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Figure 23: **Handsets tools & accessories**

5. Implementation

5.1 Planning of Deployment

All components and resources must be ready before configuration execution through the OmniVista 2500. Below a Step-by-Step list to suggest order to execute for a proper implementation:

- Inventory of equipment
  - Ensure the adequate cable categories for a proper cabling
  - Order equipment, ordering fiber Gigabit/Multi-Gigabit interface if necessary

- Cabling
  - Run cabling in the ceiling and respect grid pattern as possible for Wireless redundancy. Install cabling before access points.
  - Identify the areas (conference rooms, auditoriums) where high-density is added to the standard Voice/Audio/Video coverage (ie one 802.11ac wave 2 access point per 225 square meters). As example high-traffic areas such emergency rooms and intensive care in hospitals can require additional access points.
  - Validate access points plan locations using Site external tools or the integrated Floor plan map of OmniVista 2500 .
  - Run the cabling for the deployment between switches

- Access point mounting
  - Identify 802.11ac or 802.11ax access points models for high-density areas.
  - Install dipole antennas where external antennas are identified to be installed in some areas

- Network configuration
  - Configure switches and VLANs to support the management
  - Configure switches and VLANs to support Voice and Data in the network, configure access to the Internet for collaborative applications or SaaS management (OV Cirrus)
  - Install all servers for Voice/Audio/Video; that is including OmniVista 2500 for the Management, IMS3 server for handsets, Notification/Messaging, Alarm servers, location servers and IT servers.

- Configure the Radius to accept EAP sessions
- Configure Domain Name System (DNS) for all Voice/Audio/Video devices
- Configure DHCP scopes and DHCP options for the management
- Configure the IMS3 server for Voice handsets deployment
- Connect access points dedicated to the Voice/Audio/Video installation
- Configure the Management WLAN ssid for Enterprise handsets
- Install, template and configure Voice handsets via IMS3

Note the quotation process for Voice/Audio/Video over Stellar WLAN is not fully automated within ACTIS. To process order or quotation for handsets, Stellar access points, servers, accessories or licenses, realize the order via an eSR indicating the desired references:
- The items
- License to deploy handsets or Stellar access points

Performing the acceptance testing with Site Survey tool and with defined signals quality, throughputs and roaming scheme for Voice/Audio/Video. Objective of well-conducted survey is to anticipate any RF coverage issue:
- Identify access points locations need to be tested with a good coverage
- Test the coverage of the access points with known attenuations (walls) or obstacles (room doors).

Perform RF spectrum survey in case of difficult RF environment:
- Areas with extensive concrete and metal
- Areas with medical equipment or radio equipment

Note Site Survey softwares are not orderable from ALE

Start installations in one location, for example a building with floors that are not critical for care and run a pilot mode with few users. Provide a quantitative measurement of WLAN and Voice/Audio/Video clients against specific criterias (roaming, latency, quality in Audio etc.). Validate the use case under the worst-case scenario conditions.

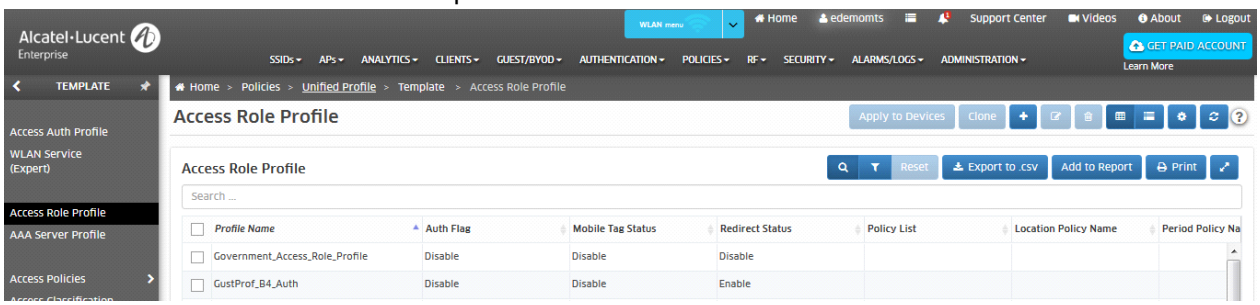
5.2 OmniVista 2500 configuration

Menus highlighted here depict as a template the most basic configuration for Voice and Audio/Video over WLAN done via OmniVista 2500 release 4.5R3 menus and configuration done specifically on Enterprise handsets. For any advanced configuration (analytics, advanced policies, LBS/Asset Tracking or RTLS management for mobile devices) please refer to relevant guides.

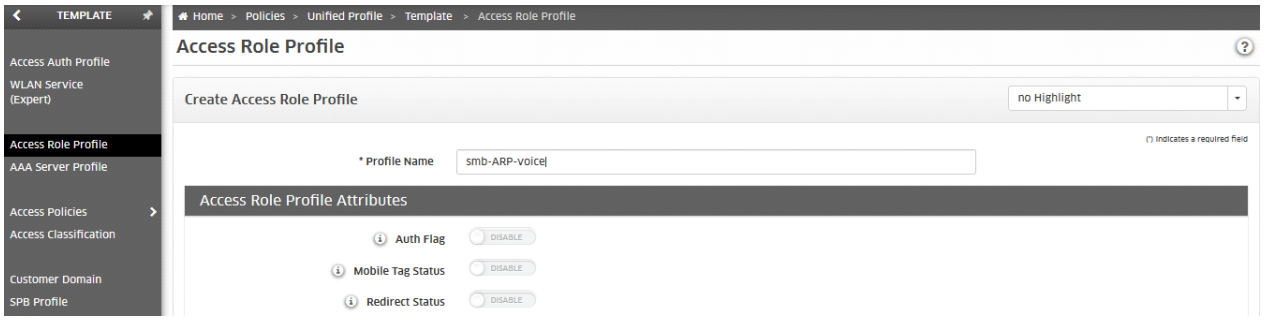
For general settings (RF domain settings, SSID, policies) it is recommended to apply the followings settings on the OmniVista 2500 server, access of RF, SSID and policies settings is done through the new 'WLAN menu' and sub-menus from the main page of the OmniVista 2500 server since its version 4.3R3.

5.2.1 ARP Profile

Go to Policies > Unified Profile > Template > Access Role Profile and **click** + to create



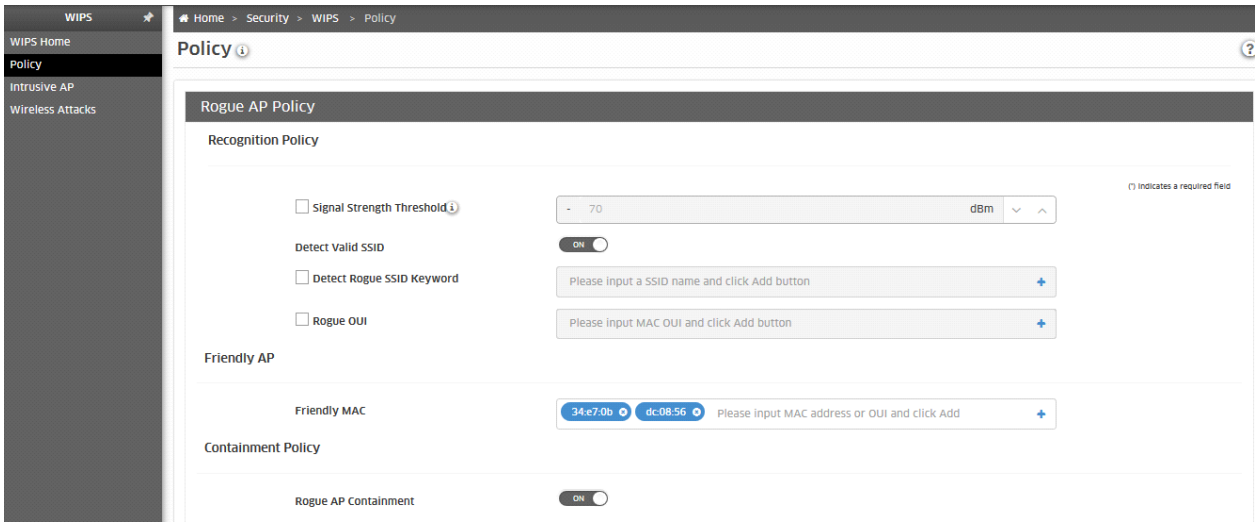
Enter **smb-ARP-voice** name and click **create**

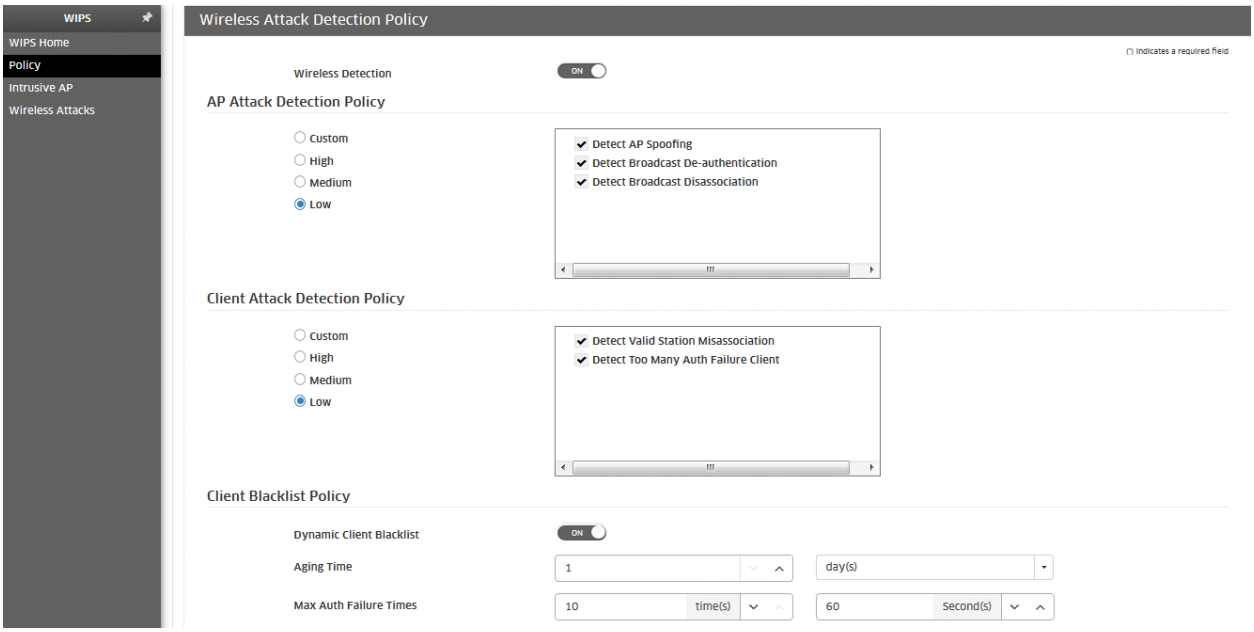


5.2.2 Security settings

Rogue AP containment, wireless attack detection, dynamic client blacklisting and security options are done through the following 'WIPS Policy' menu.

Go to SECURITY > WIPS > Policy and **select** the policies you want to apply for the wireless security.



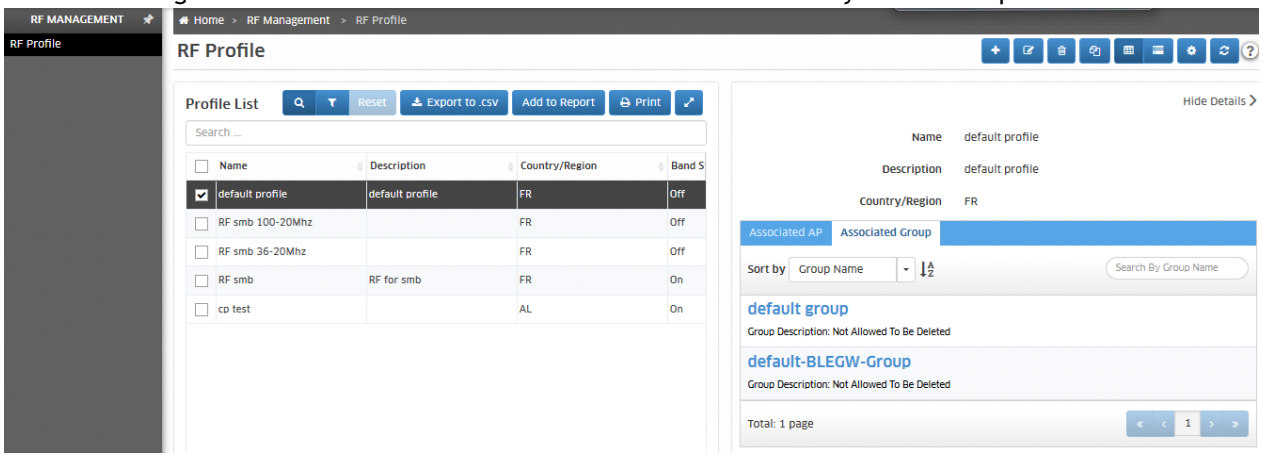


Intrusive APs and their actual classification can be listed through the 'Intrusive AP' menu.

5.2.3 RF settings

Dynamic Radio Management (DRM) settings are done through the following 'RF Profile' menu and the RF domain is assigned to the AP-Group managing the Voice/Audio/Video over WLAN for a specific area.

Go to RF Management > RF Profile > RF Profile and **click Edit** to modify default RF profile



Select **FR-France** country/region in this example. The 802.11d Regulatory Domain is defined from the country specified at the creation of the AP-Group.
Enable band steering on the 5GHz on Stellar access points.

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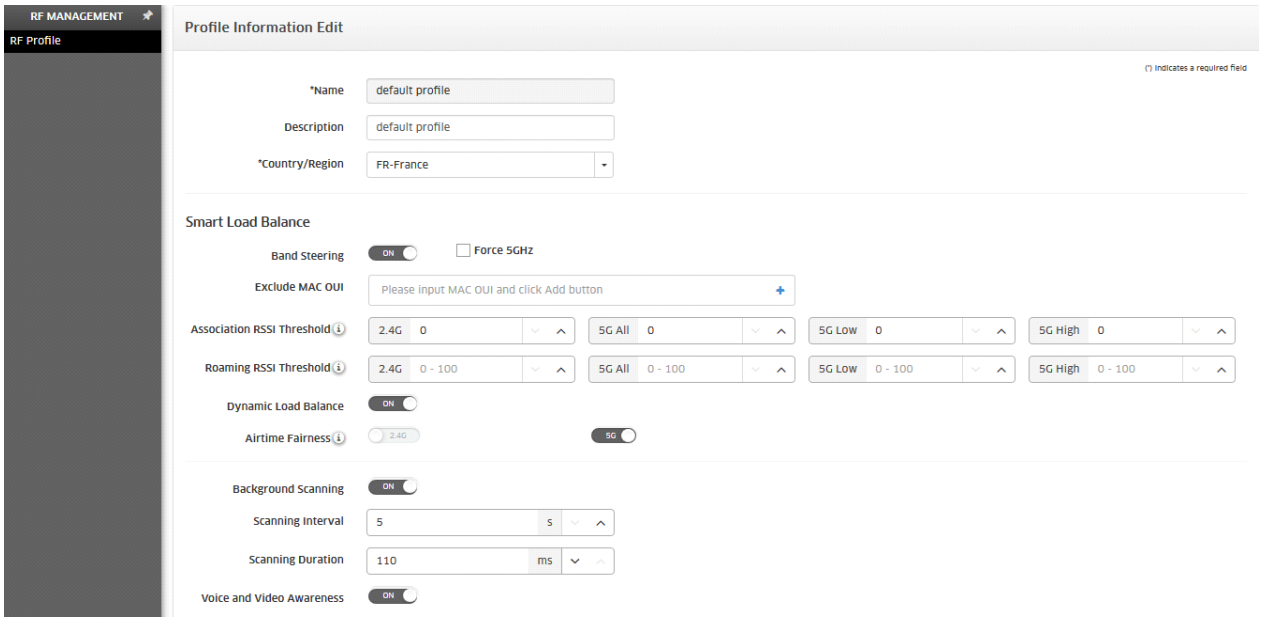
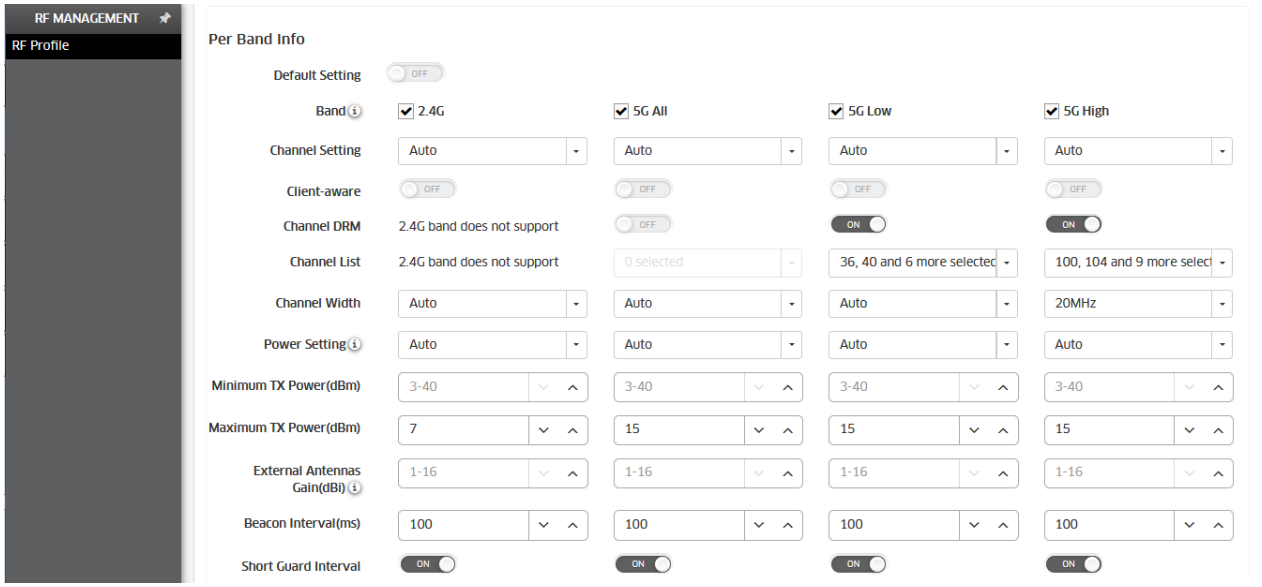
Set 110ms for scanning and set the RF optimizations for Voice/Audio/Video.
Voice/Video Awareness, Load Balancing and AirTime Fairness are the prerequisites to guaranty the best experience during the Voice/Audio/Video calls.

Enable ACS/APS to select automatically best channels and powers; set maximum transmission power adapted for the area for both 2.4GHz and 5GHz band. It is recommended to limit RF emissions on the 2.4GHz band. Configure HT 20MHz for 2.4GHz and HT 40MHz for 5GHz to have sufficient isolation between channels.

MU-MIMO and 802.11ax for Wifi 6 access points are enabled by default.





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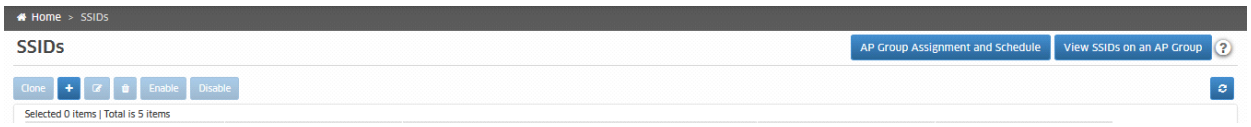
5.2.4 SSID settings

The SSID setting is done through the new following 'SSIDs' menu, this SSID is assigned to the AP-Group managing the Voice over WLAN. The **ARP-voice** access role profile created before will be assigned to the SSID.
The L3 roaming is available only for advanced configurations and is deselected here in this configuration. Voice prerequisites are underlined in the following menus.

Go to SSIDs > SSID and **click** + to create

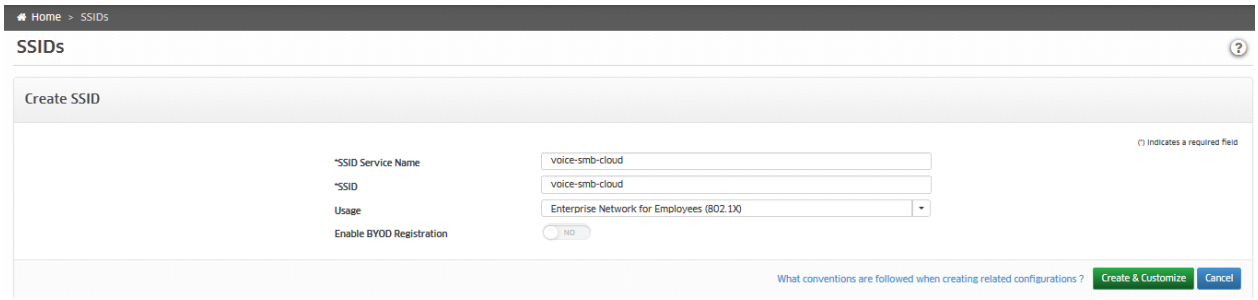


The configuration details settings for a WPA2 Enterprise security that enable handsets to access the network as trusted devices and with strong security level. In this mode, Stellar access points are the network access point for the 802.1x authentication and must

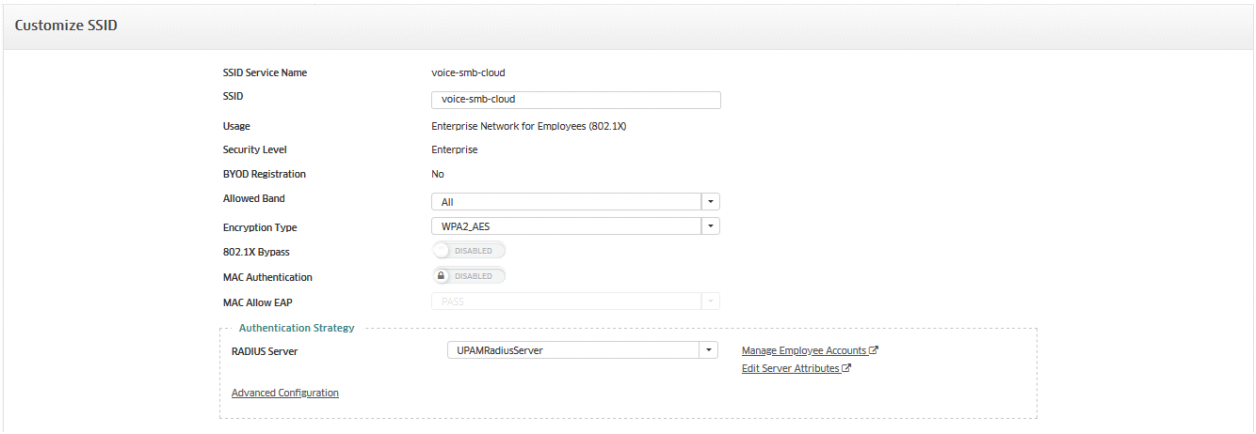
- Enable the 802.1x authentication
- Select integrated UPAM Radius server of Omnivista 2500 Enterprise as the AAA authenticator server

The local database of UPAM Radius server will be used to manage users accounts.

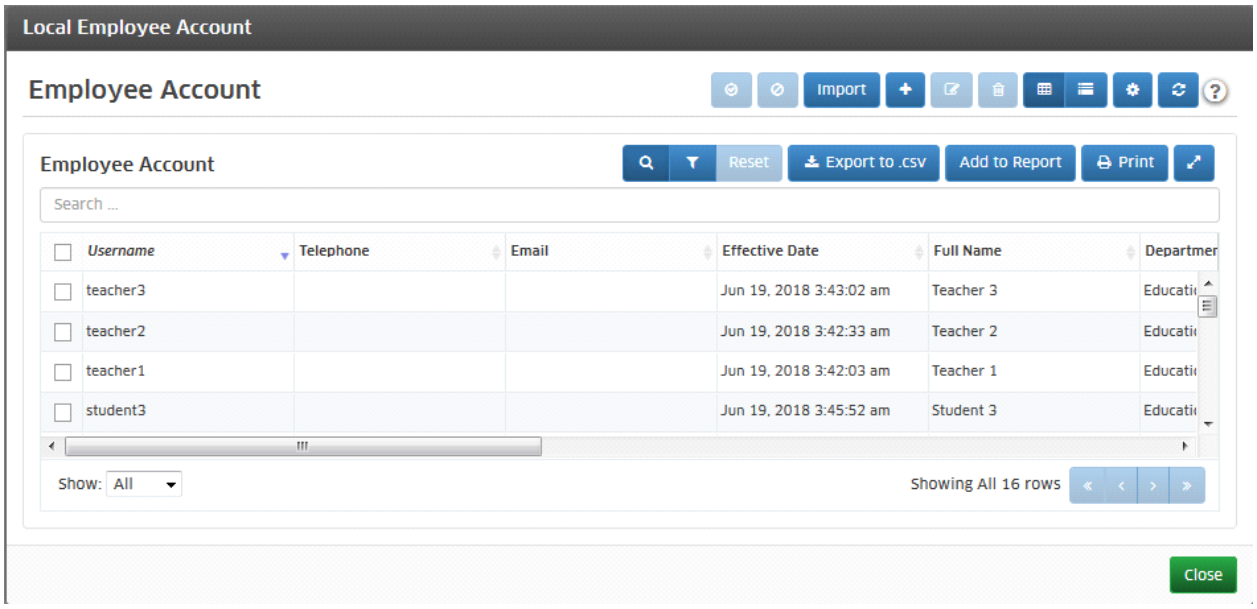
Enter **voice-enterprise** name, select **Enterprise Network for Employees (802.1x)** usage and click **create**



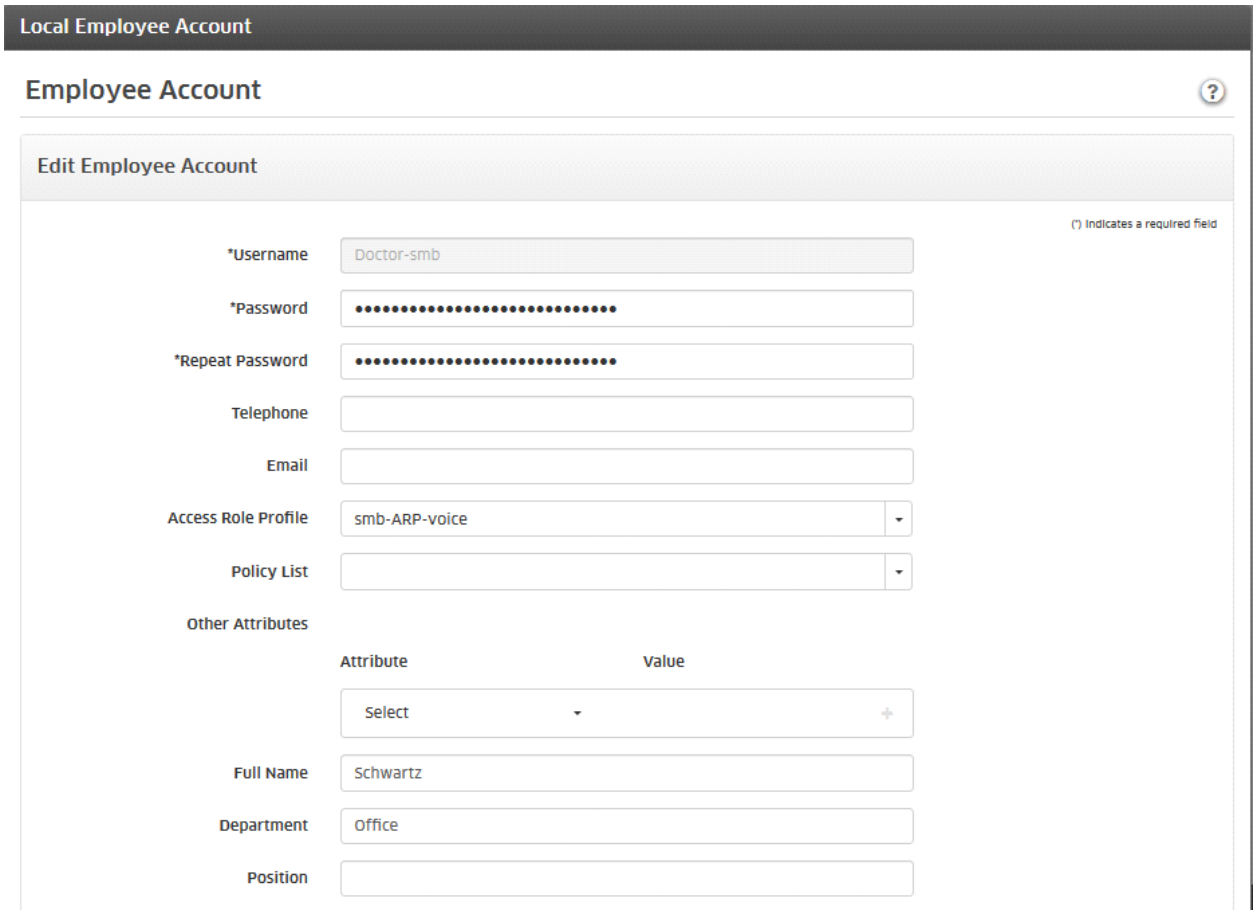
Select **WPA2-AES** encryption and Click Manage Employee Accounts under the *Authentication strategy panel*. AAA server profile is **UPAMRadiusServer** by default.



The default authentication strategy uses the local database, create new account for the handset in the local database. **Click +** to create.

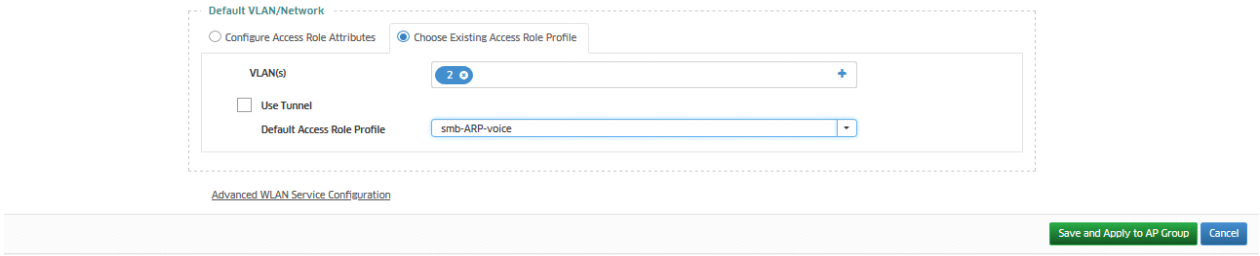


Identify explicitly the user of the handset with its *Username and Password*, the password is 1234567890 Assign ARP created previously for the voice then click **create**



When back to SSID customization page, select **Choose Existing Access Role Profile** under *Default VLAN/Network* panel and select **smb-ARP-voice** access role profile previously created.

Click **Save and Apply to AP Group** and **apply** to related voice AP-Group



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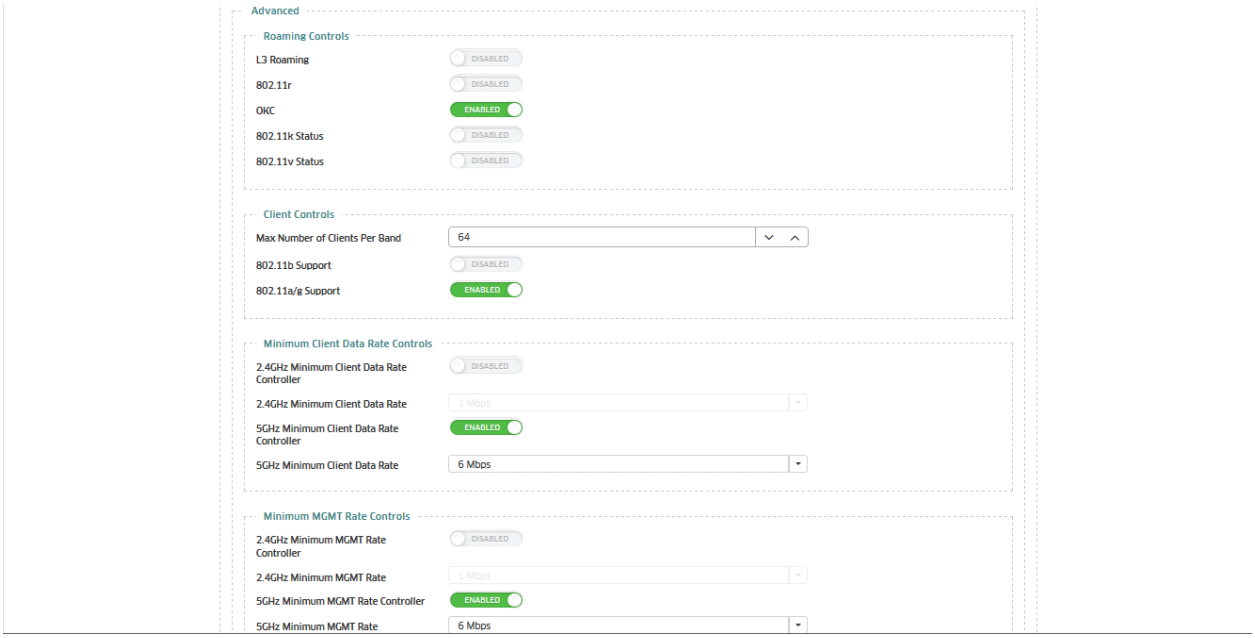
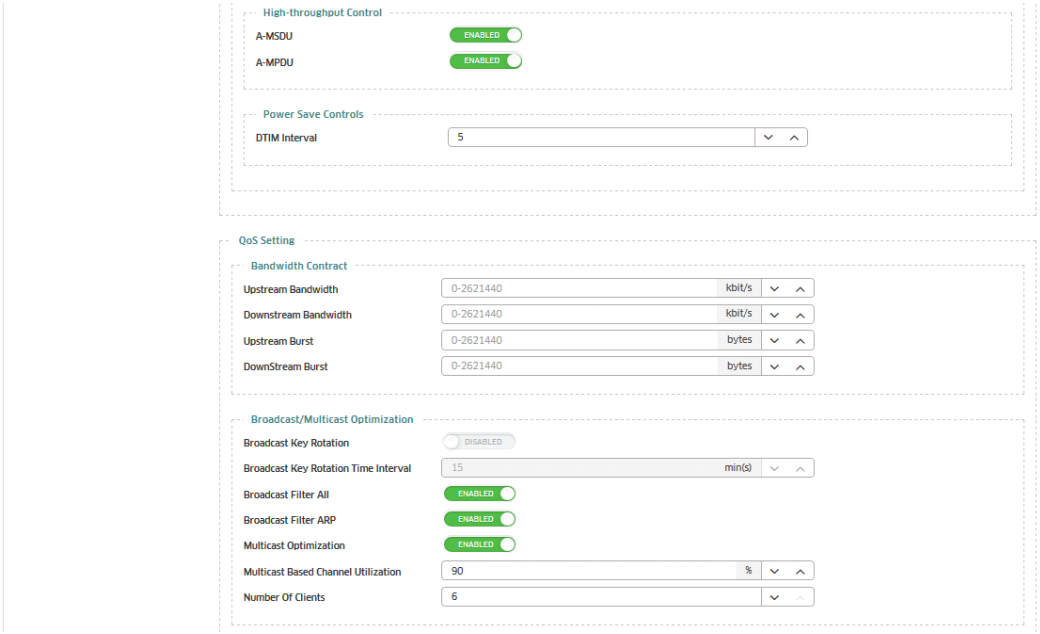
5.2.5 Advanced SSID parameters

Go back to SSIDs > SSID, select SSID for voice and **click edit**

Select **Advanced WLAN service configuration** at bottom of the page to manage followings:

- For a proper roaming of devices, it is required to select the 802.11r, 11k, 11v and OKC method deselected.
- 802.11b must be deselected if devices require to connect in 802.11n mode.
- Beacon interval is fixed to 100ms.
- DTIM interval is set to 5.
- It is recommended to enable broadcast filters.
- The WMM /DSCP-802.1p mapping need to be edited to enforce 3 WMM/0x18 (AF2x) DSCP marking for Audio/Video devices. Enterprise handsets provide their own WMM tagging.
- Minimum data rates of 6Mbps are set for all the devices.



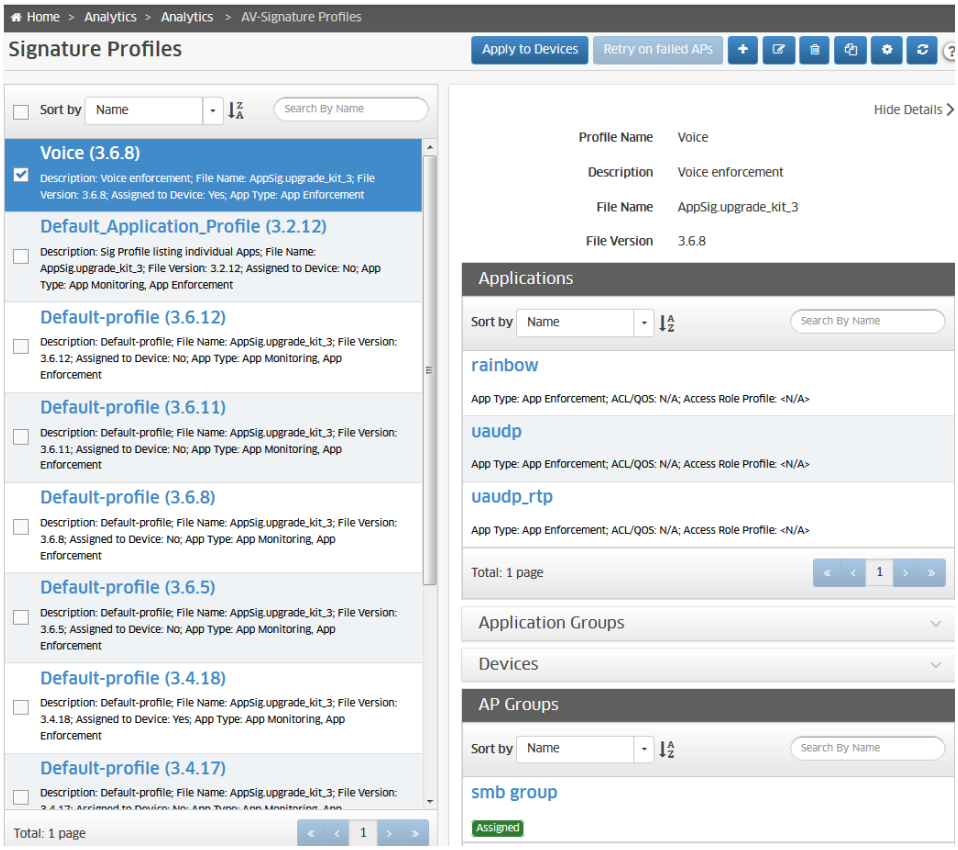


5.2.6 Analytics & QoS policies

Setting of Analytics and QoS for Voice/Audio/Video are done first through management of Signature to enable Voice/Audio/Video Application Visibility and DPI (Deep Packet Inspection) function on Stellar access points and secondly through management of client packet process itself with enforcement on traffics based on QoS policies.

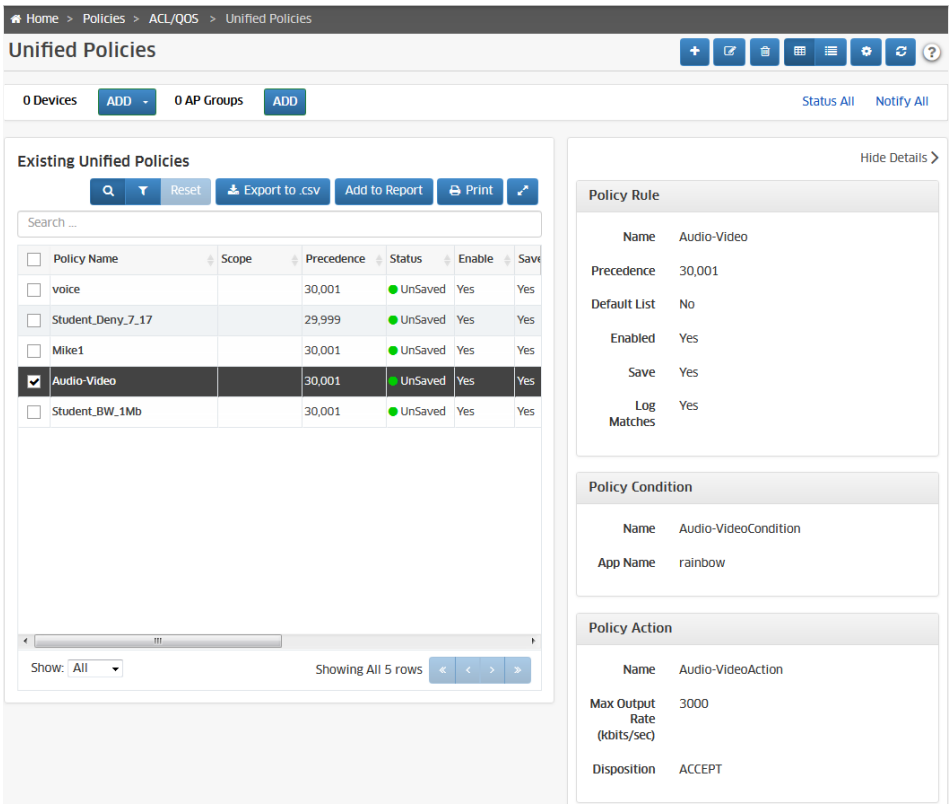
5.2.6.1 Signature profile

Go to Analytics > AV-Signature Profiles and **click +** to create profile
Create Signature profile by choosing, step-by-step, last Application Kit, Rainbow & uaUDP applications (handsets in NOE mode) and apply profile to AP Group.

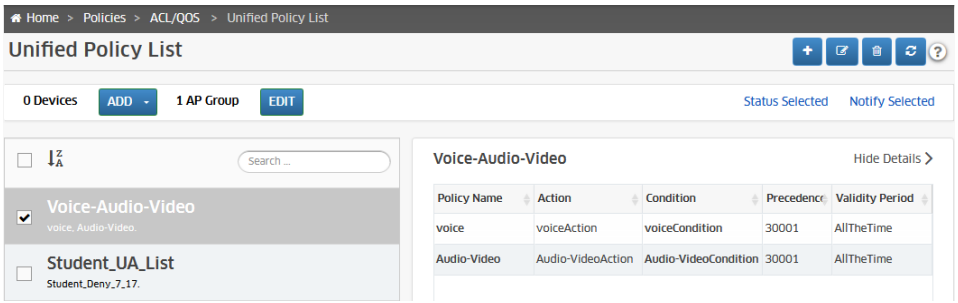


5.2.6.2 QoS policies

Go to Policies > ACL/QOS > Unified Policies and **click +** to create Voice policy and Audio-Video policy by choosing respectively L7 Rainbow and uaUDP applications with max rate QoS action of 400Kbps and 3Mbps on each.



Go to Policies > ACL/QOS > Unified Policies List and **click +** to create Voice-Audio-Video policy list by adding policies previously created before. Apply policy list to AP Group.



5.2.7 Settings on Enterprise handsets

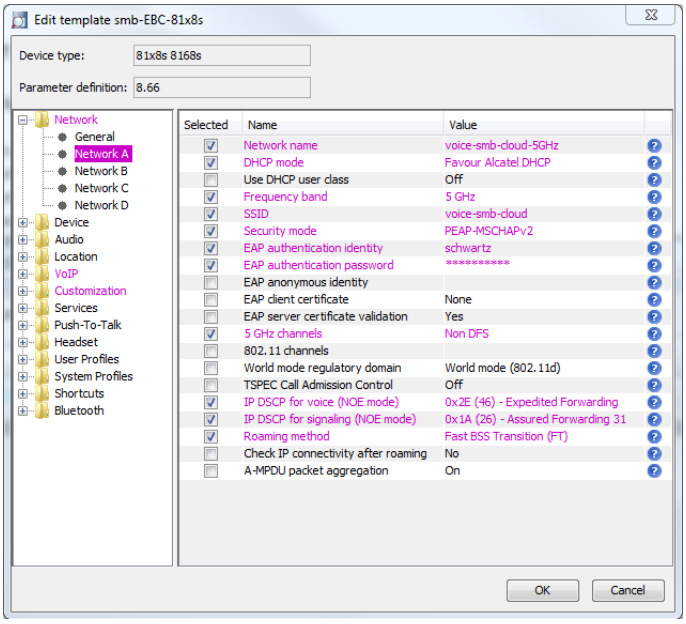
Below both modes 802.11n/802.11ac modes are detailed for 8158s and 8168s handsets.

The roaming mode is 802.11 roam and the World Mode Regulatory Domain is recommended.
TSPEC Call Admission Control must be deactivated on handsets.
The handset is transmitting its own tagged (0x1A/0x38) DSCP and handset power autonomy is enabled.

To help the roaming performance, it is advised to set directly a channel plan (1,6,11 for mode 802.11n on the 2.4GHz band or non DFS channels for mode 802.11ac). A maximum of 8 channels can be allowed.

5.2.7.1 Recommended Settings for Radio 11a

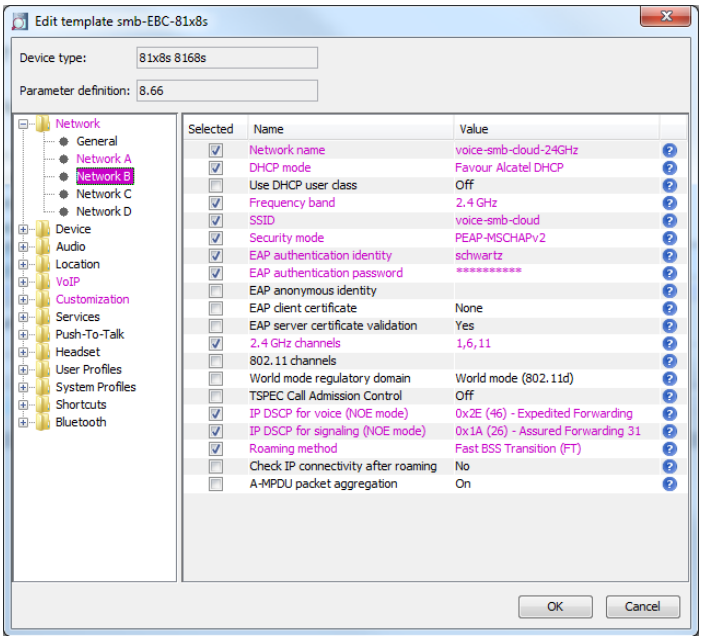
WPA2 Enterprise



5.2.7.2 Recommended Settings for Radio 11n

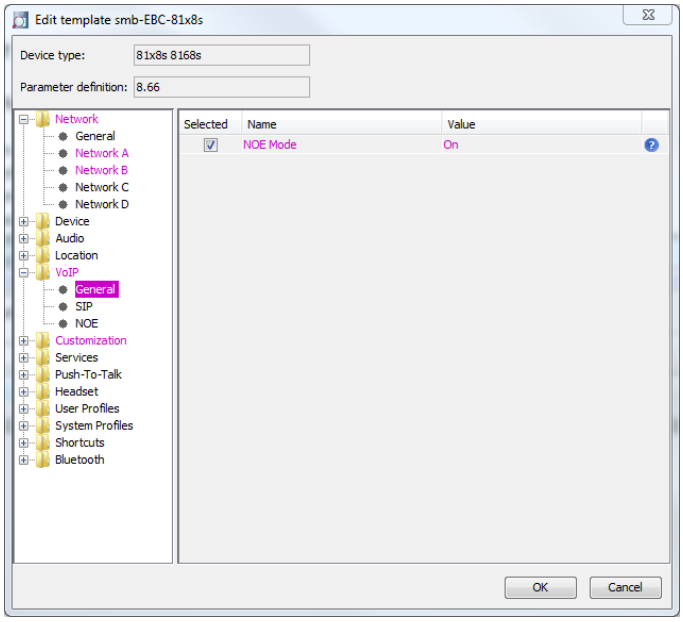
In case 802.11ac deployments are not possible, the 802.11n protocol is a possibility and must be selected.

WPA2 Enterprise

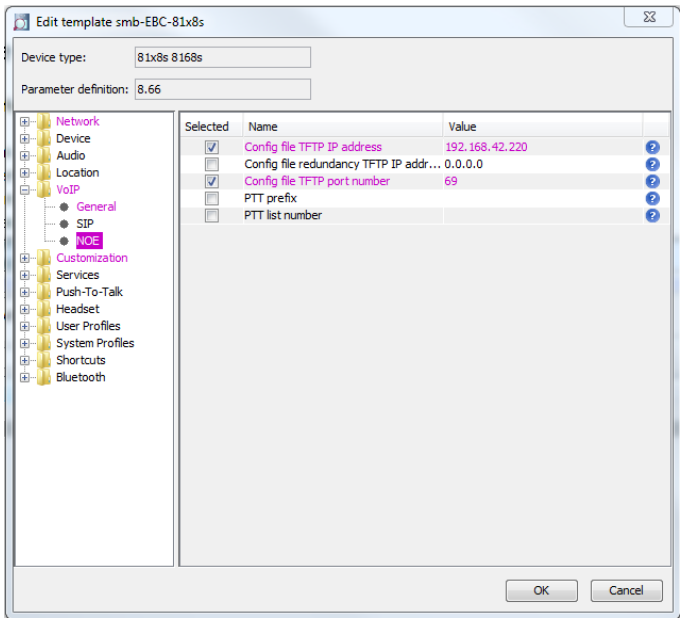


5.2.7.3 Recommended Settings for NOE VoIP

The VoIP setting is 20ms packetization by default and configuration of the IP address of NOE communication server. G.711 or G.723 payloads can be defined at NOE server communication side.

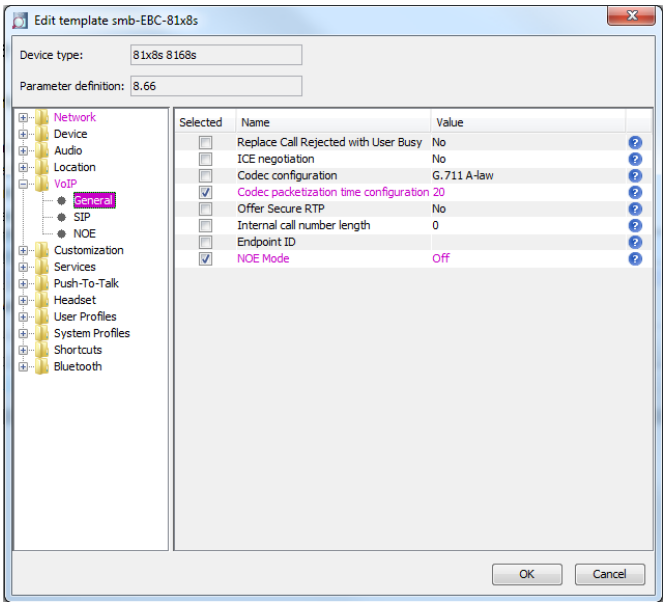


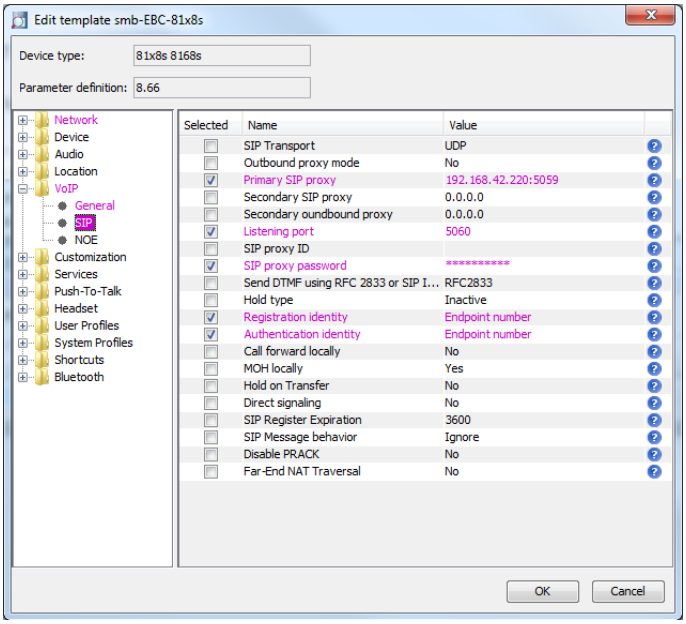
Alcatel·Lucent Enterprise



5.2.7.4 Recommended Settings for SIP VoIP

The VoIP setting is defining the SIP VoIP protocol, a 20ms packetization and the IP address of SIP proxy of the SIP communication server.
G.711 is the only possible payload for 81x8s voice communications with SIP protocol.





In this example, OXO system is the SIP communication server and provides SIP proxy password for the endpoint number.

5.2.7.5 Settings for location

Ekahau RTLS Controller is managed in handsets through the location menu. BLE chipset is enabled on devices with Stellar Asset Tracking solution and is managed through the ... menu.

5.2.8 Further configurations

Further configurations are for devices location, first on OV Cirrus, as Stellar Asset Tracking manager with integrated engine for geo-location for all devices, handsets, smartphones or PC:

- Heatmap setup in OV Cirrus
- BLE calibration
- Asset provisioning through OV Cirrus Web-based interface

In addition, Enterprise handsets implement Ekahau Location Protocol (ELP) for their asset tracking. 8158s and 8168s scan actively APs to collect RSSI informations from Stellar WLAN and forward location informations to external Ekahau RTLS location engine.

Stellar LBS/Asset Tracking, external Ekahau RTLS engine configurations are not depicted in this guide, please refer to relevant Stellar or Ekahau guides.

For notification/Messenging and Alarm, Management server configurations refer to relevant guides:

- Alarm management for Enterprise handsets
- Rainbow Alert service of Rainbow UCaaS

6. Operation

6.1 Ongoing maintenance & optimizing

Monitoring, updating & Maintaining are best practices during ongoing maintenance & Fine-tuning of a Site with Voice and Audio/Video.

6.1.1 Monitoring the performances

Monitoring Voice, Audio/Video site requires metrics, following parameters are suggested to be monitored:

6.1.1.1 Coverage for Voice/Audio/Video

Know the coverage by identifying poor Signal-to-Noise locations or possible AP outages.
Know Access Points utilization in 802.11ac/11ax, measuring their interferences.
Monitor with RF scanning on the 5GHz band.
Know client concentration and concurrent Voice users per Access Points.

OmniVista 2500 provides enhanced and visible Voice/Audio/Video monitoring with **WLAN analytics** through different menus,
as example:

At Site level view

- Successful connects/Time to connect
- Roaming history
- Coverage QoE

At Client level view

- Wireless Client List /number of devices per user
- Wireless Client distribution accross frequency bands /across APs
- Wireless Client session list
- Wireless Client throughput consumption

Etc.

6.1.1.2 VoIP audit

As title of reference for any VoIP audit, network performances for any communication during an audit must stay:

- 802.11 retransmissions should be kept under 15%
- Packet loss must be less than 2%
- Jitter must be less than 100ms
- Network round trip delay must be less than 250ms

The Mean Opinion Score (MOS) measures how voice quality is perceived by people during conversations. Score 4 is expected as a minimum for a complete satisfaction in Enterprise communications.

MOS	Quality	Impairment	R-value equivalent
5	Excellent	Imperceptible	90-100
4	Good	Perceptible but not annoying	80-90
3	Fair	Slightly annoying	70-80
2	Poor	Annoying	50-70
1	Bad	Very annoying	< 50

Figure 24: Mean Opinion Score (MOS)

6.1.1.3 System performances

Use the proper tools for the installation, during ongoing maintenance or infrastructure optimization Logging on OmniVista 2500, location engines or Notification/Messenging/Alarm/Management servers OmniVista 2500 logging for APs maintenance (AP reboots etc.)

Doublecheck with Network resources (Access Points, Switches or Server), OmniVista 2500 provides visible Network monitoring with **Network analytics** through different menus, as example:

- AP Uptime, Downtime
- Link Uptime, Downtime
- AP CPU utilization, memory utilization
- AP Channel assignment, channel utilization

6.1.2 Managing & Updating the infrastructure

There is a significant benefit to use Omnivista 2500-based architecture with PALM 4.0 for the management of HW/SW Life Cycle for all Networking devices on site: Stellar Access Points, Switches, OmniVista 2500 etc.

Updating HW Networking infrastructure, servers, handsets, UCaaS client with the latest software is a best practice. Have latest update for Stellar Access Points, Handsets, IMS3 servers, tierce servers, switches or clients to address compatibility, issues or more new services (management for handsets, location and Messaging servers), to find latest released softwares with release notes, please refer to ALE Business Partner Website https://businessportal.al-enterprise.com through **Technical support - Product selection**.

6.1.2.1 Tracking devices with location systems

Tracking the mobile fleet, handsets or smartphones, is a part of the ongoing maintenance and can be easily handled with use of integrated **Stellar Asset geo-location solution (LBS/AT)** or other external geo-location like Ekahau RTLS (Real-Time Locating System).

6.1.3 Surveying

If RF site survey tools can define Access Points placement for any greenfield Voice and Audio/Video over WLAN installation they can also help to re-surveying coverage or monitoring coverage for voice, Audio/Video at any time if necessary.

By experience ALE preconizes two Site Survey kits, **Ekahau site survey PRO** and **Airmagnet Survey PRO**, that are two separated autonomous Site Survey solutions for premise networks.

	Ekahau Site Survey Pro 10.3	Airmagnet Survey PRO 10.1
	Ekahau PRO Site Survey now included in Ekahau Connect tools suite	**Survey data through Link-Live Cloud Service**
Spectrum analyzer	**Ekahau Spectrum analyzer** Integration with Ekahau Site survey PRO	**Airmagnet Spectrum XT** Integration with Airmagnet Site Survey PRO
Radio	2.4GHz-5GHz WLAN in depth spectrum analysis both radios 2.4GHz-5GHz	2.4GHz-5GHz WLAN plot noise and co-channel interference Identify areas where spectrum interferers were dectected (spectrum XT)
Accessories	802.11ac and 802.11ax USB Ekahau adapter	802.11ac and 802.11ax USB adapter

Auto-planning tool	**Ekahau Auto-Planner** Integration with Ekahau Site Survey PRO	**Airmagnet Planner** Integration with Airmagnet Survey PRO
Type of coverage	Plan for indoor, factories etc. 3D WLAN planning Outdoor with combination of GPS	Plan for indoor, factories etc. Outdoor with combination of GPS support and Google Earth map
Edit	Antenna, height, tilt, power, attenuation etc.	Antenna, height, tilt, power, obstacles etc.
Technology	802.11a/b/g/n/ac/ax support	802.11a/b/g/n/ac/ax support

Passive site survey	**Ekahau Site Survey PRO 10.3 kit**	**Airmagnet Survey PRO 10.1 kit**
Reporting		WLAN coverage support
Type of coverage	Indoor/Outdoor	Indoor/Outdoor

Figure 25: Site Survey Kits

Ekahau PRO 10.3 passive site survey for example supports all Alcatel-Lucent Wifi 5/Wifi 6 Stellar Access points, current external indoor antennas (**ANT-O-6, ANT-O-M4-5 and ANT-S-M4-60**) and external outdoor (**ANT-S-M4-30, ANT-S-M4-60, ANT-S-M4-120, ANT-O-M2-5, ANT-O-M4-9**) or and can be delivered as a service by Professional Services to secure any voice and data deployments.

6.2 Support & Troubleshooting

For administrator support with relevant training, infrastructure support, access to the resources (software, hardware, support /troubleshooting guidelines), please refer to latest troubleshooting guidelines.

6.2.1 81x8s troubleshooting tools

It is possible to local troubleshooting on a specific 81x8s handset through two tools:

- Connect a specific handset via Syslog through its IP address to recover Handset VoIP system informations or WLAN & VoIP statistics
- Run local Fast Survey on 81x8s, this embedded Fast Site Survey present on 81x8s can be used at any time to evaluate coverage by testing signal strength, gain information about an AP, and scan an area to look for all APs regardless of SSID. It is accessible via the local Parameters menu (code is 40022 to access Fast survey or other troubleshooting). Refer to **Embedded Site Survey 81x8s 31.3 – VoWLAN Design Guide R7.2.**

6.2.2 Smartphones troubleshooting

Enterprise dedicated WLAN troubleshooting tools are rare on smartphones, the most advanced is **Apple – Airport utility** (requires iOS9 or later) to see WLAN network and monitor Access Points for problems.

6.2.3 Stellar troubleshooting tools & analyse

Jointly with **OmniVista 2500 WLAN analytics** and logging for troubleshooting, Stellar CLI enables also global configuration archive for any specific AP and specific debug tools at CLI level.

It is possible to conduct **RF scan** and **Wireless packets capture** on a specific Stellar Access point, both tools are integrated in Stellar Access Point. A **WLAN analyzer /802.11** protocol analyzer is required to analyse 802.11 protocols, observe and diagnose behavior of installed networks (for example WireShark with 802.11 decoder).

6.2.4 Training and certifications

There is variety of courses available for IT organization and experts under **ALE Knowledge hub** with ACSE modules on technology including a certification part, plus other documentation, video or partner material on different technologies like OmniVista 2500, OmniAccess Stellar WLAN or OmniSwitch LAN.

Please refer also to **Data Networking eDemos** to have specific demonstration and details on specific subjects like, for example:

- OmniAccess Stellar enterprise: https://edemo.al-mydemo.com/?page_id=3030
- OmniVista 2500 Enterprise: https://edemo.al-mydemo.com/?page_id=1731
- Application Visibility and Enforcement: https://edemo.al-mydemo.com/?page_id=995
- Network Analytics: https://edemo.al-mydemo.com/?page_id=1186

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