ListenTech-Note

Wireless Access Point Optimization for Listen Everywhere

Overview:

This tech note provides information on optimizing the Listen Everywhere (LE) server performance through networking best practices, identifying potential signal depreciation, and enterprise-grade networking equipment suggestions. As our Network Configuration tech note reviews the network settings for optimal performance of the LE server, the wireless access point (WAP) selection and physical placement is just as crucial to ensure that users have a strong and stable connection to the wireless network.

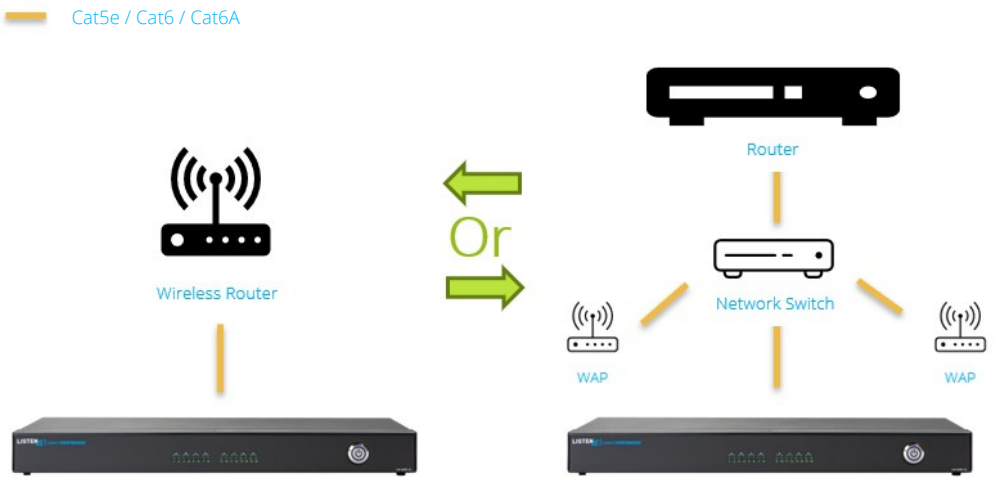
The details outlined are simply suggestions. Deviations from the suggestions and listed equipment can provide varying results. Users are also not limited to the examples or suggested equipment. If the application requires more complex setups or more robust equipment, please consult a networking professional for further guidance.

Network Topologies:

The LE server has been designed to be integrated into an existing network or used in a stand-alone network. The following sections review the topology and considerations for each network type.

Integration into an Existing or Isolated Network:

When integrating into a network with a dedicated DHCP server (typically a router), the LE server will function as a DHCP client. Ensure that the network has the capability to deliver IP addresses based on the number of planned clients.

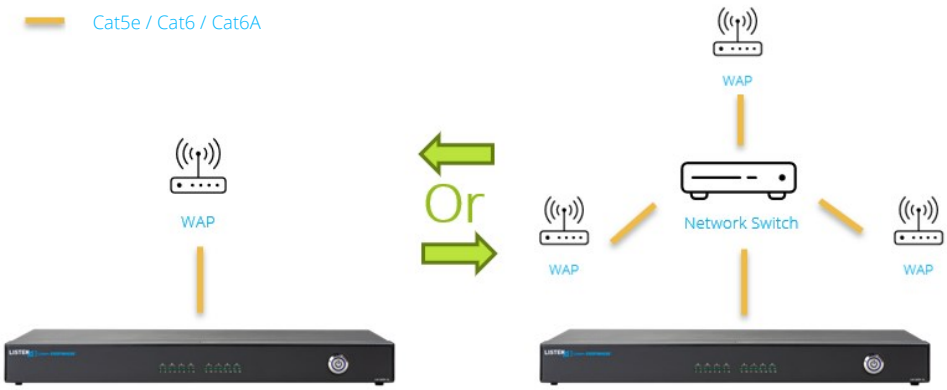


Integration into an existing network has many benefits:

- No need to design a new network.
- Ability to handle large client load.
- Ability to utilize internet connectivity. This is essential for some venues to:
    - Receive updates from the Cloud Services page.
    - Utilize certain cloud-based features to be available. Please refer to our Network Configuration tech note for more information.
    - Utilize dynamic link QR codes.

Stand-alone Network:

When a stand-alone network is desired, the LE server can function as the DHCP server. This option can be toggled within the server admin page. No internet connectivity is available when in this mode.



The network settings when in DHCP mode are:

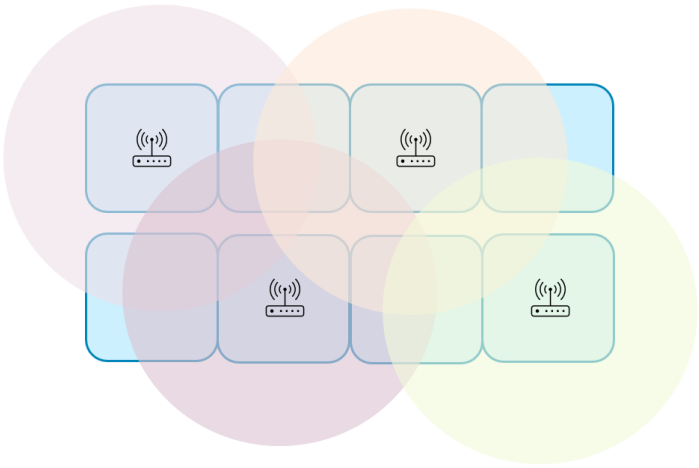
- Gateway: 172.30.0.1
- Netmask: 255.255.0.0
- Lease Time: 2 Hours

This type of network would be ideal for demo purposes, portable applications, or small applications. However, it is recommended to use a dedicated enterprise router for applications that must support numerous clients. It is also important to note that without internet connectivity, some cloud-based functions will not be available. Please refer to our Network Configuration tech note for more information.

Access Point Placement Best Practices:

Following the provided best practices for both indoor access points and outdoor access points may decrease the occurrence of connection dropouts, packet loss, and latency.

Indoor Wireless Access Points:

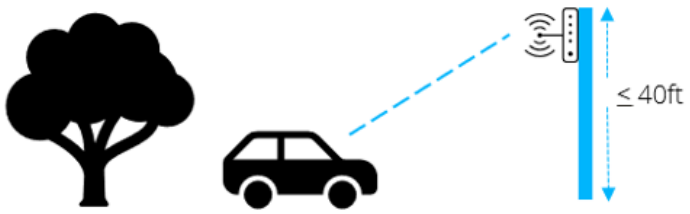


- Spread out your access points: This will ensure the best coverage in each area. Reference to the access point's radiation map may be required to determine optimal placement. When using multiple access points, it is recommended that they are set to different channels where the coverage area overlaps.
- Include at least one access point in assembly areas: Simply put, include accessible and strong wireless connections where your venue would need it the most.
- Avoid placing next to electronic devices: Devices that emit electromagnetic signals, such as microwaves, can block or attenuate wireless signals.
- Consider building materials: Building structures such as concrete or brick may greatly attenuate the Wi-Fi signal. See the Signal Attenuation section for more information.
- Place the access point(s) on or below the ceiling: Placing an access point above a ceiling can introduce it to a harmful environment (i.e. heat and dust). Obstructions within the ceiling/plenum (HVAC ducts, pipes, various metal) can also negatively impact your wireless signal. Placing below the ceiling better avoids these negative impacts and provides the best performance for users.
- Mount APs based on the manufacturer's instructions: Be sure to read the instructions if there are special mounting requirements. Typically, mounting below the ceiling is recommended.

Outdoor Wireless Access Points:

- Clients should be within line-of-sight of the access point: This will greatly increase wireless communication between the access point and the mobile device in use.

- Mount at a height 40ft or less: APs should be placed high enough to achieve line-of-sight, but not too high where a proper connection cannot be established. This helps avoid multipath reception caused by reflective surfaces, such as cement.
- Secure physical mounting: Access points and masts may sway in the wind if not properly mounted.
- Avoid physical obstructions: This includes walls, trees, etc. Physical obstructions may cause signal attenuation.

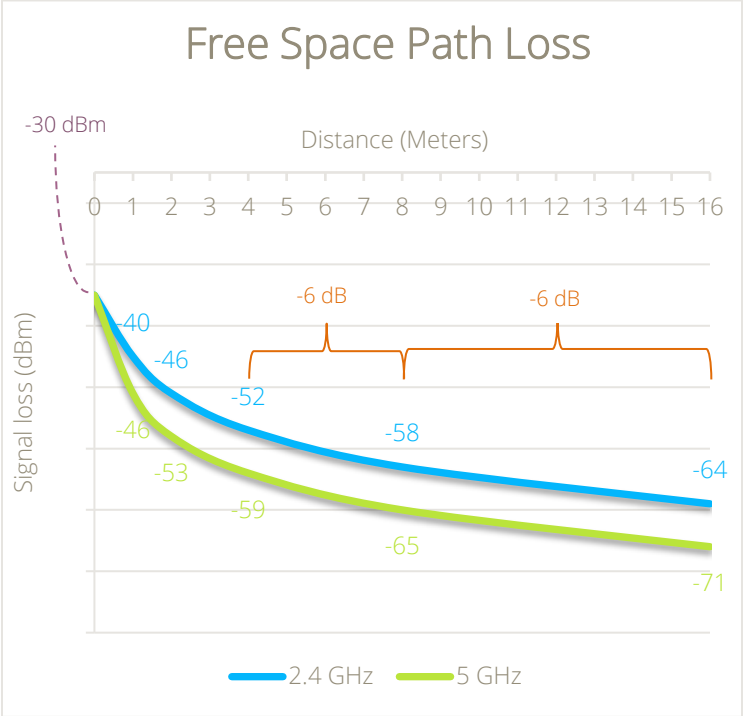


- Point the antenna to the correct direction: Not all outdoor APs have omnidirectional, or 360-degree, coverage. If you have an AP with a directional antenna, be sure to adjust the antenna accordingly.
- Make sure other networking equipment is outdoor rated: If your other equipment is not outdoor rated, be sure to use weather-protected enclosures and/or weatherized seals.
- Avoid poor weather conditions: Harsh weather conditions, such as rainstorms, can negatively impact Wi-Fi signals.

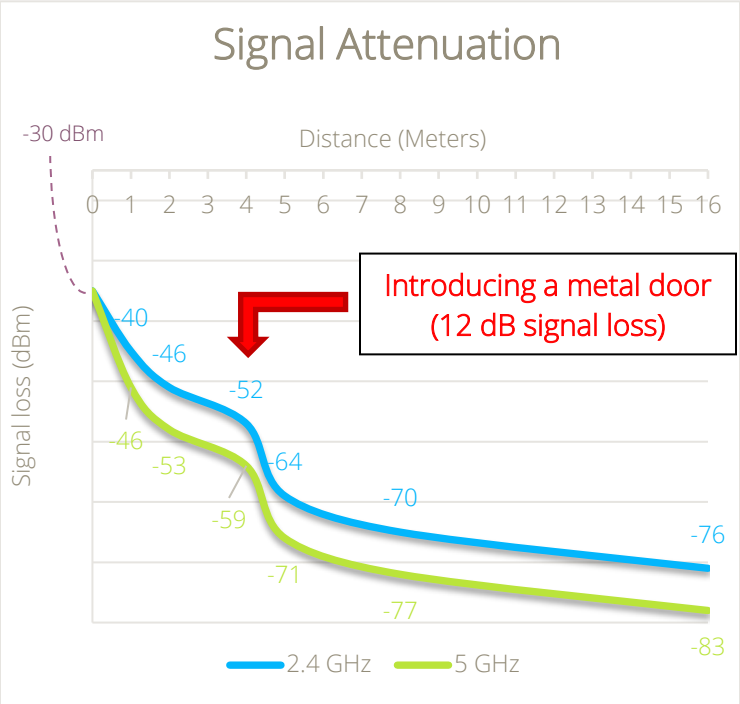
Free Space Path Loss:

Free space path loss (or FSPL) refers to the amount of transmission signal that degrades from a transmitter as it travels through air. As it pertains to networking, the transmission signal is the Wi-Fi signal, and the transmitter is the access point. The chart to the right depicts a typical FSPL from an access point to a mobile device. It follows an inverse square law where -6dB is added every time the distance from the source is doubled.

Source: https://www.semfionetworks.com/blog/free-space-path-loss-diagrams



Signal Attenuation:
Signal attenuation refers to a reduction in strength of a wireless transmission. As it pertains to networking, the wireless transmission refers to the Wi-Fi signal and the signal attenuation would be caused by an object, such as a wall or door. The signal attenuation would be used in conjunction with the FSPL to determine the resulting signal strength of a wireless access point at a given distance. The chart to the right represents the FSPL with the addition of an object (metal door) at 4m.



The chart below contains examples of some estimated signal attenuation of certain objects:

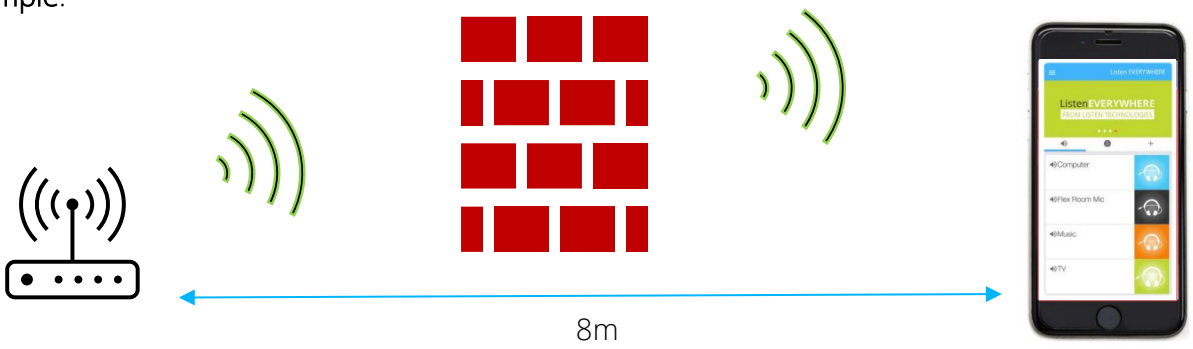
Obstruction	Attenuation
Besser Block	4 dB
Brick	3 dB
Brick Wall	2-8 dB
Concrete Wall	10-15 dB
Cubicles	3-5 dB
Door (Metal)	12 dB
Door (Solid wood)	4 dB
Door (Hollow wood)	3 dB
Dry Wall	4 dB
Glass Window	2 dB
Gyprock Plaster (Metal frame)	7 dB
Gyprock Plaster (Wooden frame)	5 dB
Human Body	3 dB
Limestone	5 dB
Marble	5 dB
Office Window	3 dB
Wooden wall	8 dB

Sources:
ftp://files.dlink.com.au/FAQs&White%20Papers/Signal%20Attenuation.pdf
https://blog.ibwave.com/a-closer-look-at-attenuation-across-materials-the-2-4ghz-5ghz-bands/
https://www.dataloggerinc.com/resource-article/basics-signal-attenuation/

Signal Strength Calculation:

After considering WAP placement, FSPL, and signal attenuation, one could obtain a pretty accurate assessment of the access point signal loss and signal strength. Using a smartphone app to scan for signal strength is also a good method, especially scanning in the location(s) where users will assemble. Ideally, a network designer should conduct an on-site survey to determine an accurate heatmap of the coverage area. Determining signal strength is important when considering *which* access point is needed for an application and *where* to place it. Signal strength is calculated by summing the total FSPL and total signal attenuation.

Example:



After calculating the signal strength, one can determine a fairly accurate measurement of the signal quality with the chart below. It is strongly advised that there should be no less than -70dBm while using the Listen Everywhere system. This ensures that the UDP packets are delivered more quickly and more reliably.

Signal Strength	Signal Status	Description
-30 to -50 dBm	Excellent	Max achievable signal strength. The client can only be a few feet from the AP to achieve this. Not typical or desirable in the real world.
-50 to -67 dBm	Very Good	Minimum signal strength for applications that require very reliable, timely delivery of data packets.
-67 to -70 dBm	Okay	Minimum signal strength for reliable packet delivery.
-70 to -80 dBm	Not Good	Minimum signal strength for basic connectivity. Packet delivery may be unreliable.
-90+ dBm	Unusable	Approaching or drowning in the noise floor. Any functionality is highly unlikely.

Sources:
https://www.metageek.com/training/resources/wifi-signal-strength-basics.html
https://techmusa.com/wireless-dbm-table/

Network Equipment:

In summation, the previous sections should provide guidance to installing an access point and a better understanding of the performance expected from an access point. The Listen Technologies technical support team has complied the tables below to assist with enterprise-grade network equipment selection. Performance will vary between applications, so it is best to consult the device manufacturer or a networking professional to assist with setup and maintenance. The listed models are only examples; there are more models offered by the manufacturer.

Indoor Wireless Access Points

Note: Wireless access points listed utilize 802.11ac (Wi-Fi 5) Wave 2 technology. 802.11ax (Wi-Fi 6) access points are also suggested and available but excluded from the list due to the higher price point.

Make	Model	# of Users	Speed (2.4GHz)	Speed (5GHz)
Aruba	300 Series	256	300 Mbps	1300 Mbps
	310 Series	256	300 Mbps	1733 Mbps
	320 Series	256	600 Mbps	1733 Mbps
	330 Series	256	600 Mbps	1733 Mbps
	340 Series	256	800 Mbps	2166 Mbps
Cisco	Aironet 1830	-	-	867 Mbps
	Aironet 1840	-	-	1733 Mbps
EnGenius	ECW120	-	400 Mbps	867 Mbps
Linksys	LAPAC2600C	-	800 Mbps	1733 Mbps
Luxul	AC3100	128	-	3167 Mbps
Ruckus	ZoneFlex R320	256	300 Mbps	867 Mbps
	ZoneFlex R510	512	300 Mbps	867 Mbps
	Zoneflex R610	512	450 Mbps	1300 Mbps
	Zoneflex R650	512	574 Mbps	2400 Mbps
Ubiquiti	UAP-nanoHD	200+	300 Mbps	1733 Mbps
	AP-AC-HD	500+	800 Mbps	1733 Mbps
Zyxel	NWA1123-ACHD	-	Combined 1.75 Gbps	

- (dash) = Not advertised by the manufacturer

Outdoor Wireless Access Points

Note: Wireless access points listed utilize 802.11ac (Wi-Fi 5) Wave 2 technology. 802.11ax (Wi-Fi 6) access points are also suggested and available but excluded from the list due to the higher price point.

Make	Model	# of Users	Speed (2.4GHz)	Speed (5GHz)
Cambium	CnPilot E505	100	300 Mbps	867 Mbps
	CnPilot E510	256	400 Mbps	867 Mbps
	CnPilot E700	512	400 Mbps	1733 Mbps
DrayTek	VigorAP 918R Series	256	400 Mbps	867 Mbps
	VigorAP 920R Series	256	400 Mbps	867 Mbps
EnGenius	ECW160	-	400 Mbps	867 Mbps
	ENH1350EXT	-	400 Mbps	867 Mbps
Ubiquiti	UWB-XG-US	1,500	-	1733 Mbps

- (dash) = Not advertised by the manufacturer

Routers / Firewalls / Gateways

Make	Model / Series
Cisco	Meraki MX[2]
Fortinet	Fortigate[1]
Grandstream	GS-GWN7000[3]
pfSense	Enterprise Firewalls[1]
Ubiquiti	EdgeRouter[2]
	Unifi Security Gateway[3]

[1] Top-rated firewalls of 2020 according to IT Central Station
[2] Top-rated firewalls of 2020 according to Digital Trends
[3] Top-rated routers of 2020 according to BestReviews.Guide

Should you have any further questions or concerns, please contact Listen Technologies' Technical Services team at 1-800-330-0891 or support@listentech.com for assistance.