

Coverage, capacity, quality of service, and security considerations for delivering excellent voice quality on enterprise wi-fi networks.

Introduction

Wi-Fi telephony, also known as Voice over wireless LAN (VoWLAN), delivers the all the capabilities and functionality of the enterprise telephone system in a mobile handset. The Wi-Fi phone is a WLAN client device, sharing the same wireless network as laptops and PDAs. The handset is functionally equivalent to a wired desk phone, giving end-users all the features they are used to having in a wired office phone. The benefits of VoWLAN can result in substantial cost savings over other wireless technologies by leveraging the Wi-Fi infrastructure and by eliminating recurring charges associated with the use of public cellular networks. For end users, VoWLAN enables employee mobility, resulting in increased responsiveness and productivity.

Delivering enterprise-grade VoWLAN means that wireless networks must be designed to provide the highest audio quality throughout the facility. Because voice and data applications have different attributes and performance requirements, thorough WLAN deployment planning is a must. A Wi-Fi handset requires a continuous reliable connection as a user moves throughout the coverage area. In addition, voice applications inherently have a low tolerance for network errors and delays. Whereas data applications are designed to accept frequent packet delays and retransmissions, voice quality can deteriorate with just a few hundred milliseconds of delay or a small percentage of lost packets. Whereas data applications are typically bursty in terms of bandwidth utilization, voice conversations use a consistent but relatively small amount of network bandwidth.

Using a Wi-Fi network for voice is not complex, but there are some aspects that must be considered to help ensure the best end- user experience. A critical objective in deploying enterprise-grade Wi-Fi telephony is to maintain similar voice quality, reliability, and functionality that are expected from a wired telephone. Spectralink pioneered the use of VoWLAN in a wide variety of applications and environments, making the Spectralink 80-Series Handsets the market leader in this category. Based on our experience with enterprise-grade deployments, this white paper provides a high-level discussion of the unique deployment considerations of VoWLAN, along with solutions and recommendations.

Coverage

One of the most critical considerations in the deployment of VoWLAN is to make sure there is sufficient wireless coverage to provide seamless connectivity to mobile handset users. Enterprise Wi-Fi networks are often initially designed for data applications and may not provide adequate coverage for voice users. Such networks may be designed to only cover areas where data devices are used and may not include coverage in other areas such as stairwells, break rooms, or building entrances—all places where telephone conversations are likely to occur. The overall quality of coverage is also more important for voice applications. Coverage that may be suitable for data applications may not be seamless enough to support the requirements for voice. In areas of poor wireless coverage, the performance of data applications may be acceptable due to retransmission of packets, but this same situation will not be acceptable for real-time voice applications.

Another factor to consider when determining the coverage area is device usage. Wireless handsets are used differently than wireless data devices. Telephone users tend to walk as they talk, while data users are usually stationary or periodically nomadic. Wi-Fi telephones are typically held very close to the user's body, introducing additional radio signal attenuation, while data devices are usually set on a surface or held out so the user's body has little affect. This factor may result in reduced range for a Wi-Fi phone compared to a data device. Therefore the Wi-Fi network layout should account for some reduction of radio signal propagation.

To provide seamless connectivity for VoWLAN applications, APs must be positioned with sufficient overlapping coverage to ensure there are no gaps, or dead spots, between them. As wireless voice users move throughout the workplace, the device will seek out other APs to roam to in order to maintain the most reliable network connection.

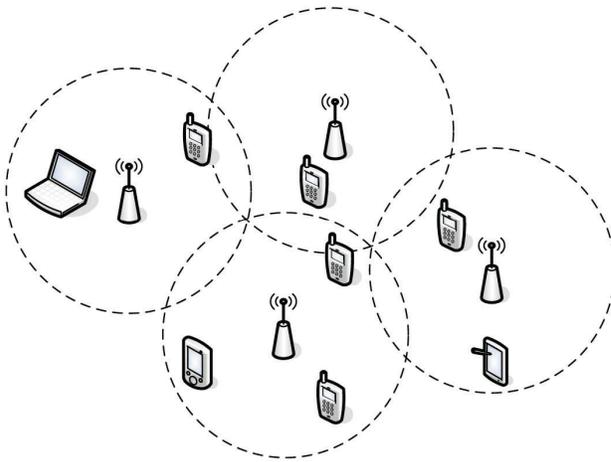


Figure 1: Overlapping AP coverage provides seamless connectivity for VoWLAN users.

A properly designed Wi-Fi network will provide for a seamless handoff between APs to deliver excellent voice quality throughout the facility. The WLAN layout must factor in the transmission settings that are configured within the APs. The transmission of voice requires relatively low data rates and a small amount of bandwidth compared to other applications. Wi-Fi networks include automatic rate switching capabilities so that as the radio signal degrades while the user moves away from the AP, the radio can adapt and use a less complex, slower transmission method to send the data. The result is increased range but at reduced transmission rates, which lowers the total bandwidth available to all devices associated with an AP. It is important to take rate switching into account when laying out a Wi-Fi network, and either accept less bandwidth (and capacity) to increase coverage, or increase the number of APs required to maintain acceptable coverage at higher data rates.

The maximum signal strength of the APs can also be modified to allow denser deployment while minimizing co-channel interference from nearby APs. It is important to take this network design consideration into account in order to maintain as much consistency as possible for wireless devices. A WLAN site survey is useful for determining the received signal level for wireless devices throughout the coverage area, and device vendors usually recommend specific minimum signal levels to maintain excellent voice quality. Although it is possible that Wi-Fi handsets may operate at signal strengths below the recommended values, real world deployments involve many radio signal propagation challenges such as physical obstructions, interference, and multipath propagation that impact both signal strength and quality. Planning AP coverage to the recommended signal levels will provide an adequate buffer for these propagation challenges and provide a reliable and consistent level of performance.

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In general, Wi-Fi networks should be deployed using industry best practices for channel selection, power levels, and overlapping coverage. A wireless site survey is highly recommended for any Wi-Fi network deployment; however, it is especially critical for VoWLAN and is essential for large, complex facilities. A site survey can help ensure that the wireless network is optimally designed and configured to support voice by confirming coverage, cell overlap, channel allocation and reuse, packet transmission quality, and other wireless LAN infrastructure deployment decisions.

Key takeaway

Plan for comprehensive Wi-Fi coverage to provide seamless connectivity, since VoWLAN users are mobile throughout the facility. Utilize site surveys, analysis services and planning tools to deploy the APs in optimal locations using proper channel selection and power settings.

Capacity

Network capacity requirements factor into the number of APs required, although in most cases the coverage area is the primary factor. Data traffic is often bursty and sporadic. This is usually acceptable because data applications can tolerate some network congestion resulting in reduced throughput and slower response times. Voice applications however, cannot tolerate unpredictable delays because the bandwidth requirements are constant while the user is in a call. Voice traffic can be predicted using probabilistic usage models, allowing a network to be designed with high confidence in meeting anticipated voice capacity requirements.

Several factors determine the AP bandwidth utilization during a Wi-Fi telephone call. The first is the VoIP protocol used and its characteristics. The type of codec utilized combined with the packet rate will determine the size of the voice packets along with any additional overhead information required for the protocol. Actual voice 'data' will generally account for little more than half of a typical packet, with 802.11 and IP protocol overhead filling the rest. The 802.11 protocols include timing gaps for collision avoidance, which means network utilization is more accurately quantified as a percentage overall bandwidth rather than actual data throughput. The percentage of bandwidth used increases for lower data rates, but it is not a linear function due to the bandwidth consumed by the timing gaps and overhead. Therefore, as the handset users move away from AP coverage and the packet rate decreases, the result is increased bandwidth consumption per call.

The maximum number of simultaneous calls an AP can support is determined by dividing the maximum recommended bandwidth usage by the percentage of bandwidth used for each individual call. Approximately 20 to 40 percent of the AP bandwidth must be reserved for channel negotiation, association requests, occasional retries, and the possibility of transmission rate reductions caused by interference or other factors. In addition, lower overall bandwidth is available as the number of devices associated with an AP increases. The following table provides the typical number of simultaneous calls supported per AP at given transmission rates.

AP Transmission Rate	Typical Number Simultaneous Calls per AP
54 Mbps	12 – 20 calls
11 Mbps	8 – 12 calls
2 Mbps	5 – 7 calls

Figure 2: Typical Number of Calls Supported per AP

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The number of simultaneous calls supported by an AP can be a fraction of the number of actual users expected in the coverage area. In most enterprise applications, the number and duration of telephone calls can be statistically predicted using traffic analysis to meet anticipated caller density. Areas where heavier VoWLAN usage is expected, such as cafeterias and auditoriums, can be covered with higher call capacity and can handle more users through additional AP installations.

Key takeaway

Wi-Fi networks offer sufficient call capacity for most enterprise usage models, so investments in WLAN can be leveraged for both voice and data applications. Wi-Fi deployment planning should consider the number of VoWLAN users, frequency of voice calls, and areas of higher density usage. Additional coverage may be required in areas where users congregate or for high call-traffic applications.

Quality of Service

CQoS is required for any network that supports multiple applications that have different requirements for packet latency and jitter. When data and voice are competing for bandwidth, it is necessary to have mechanisms to prioritize voice packets over data, preserve battery life for handhelds, and allocate appropriate AP bandwidth for the device's supported applications. The original 802.11 standards did not provide such QoS mechanisms, so proprietary solutions including Spectralink Voice Priority (SVP) were developed to allow time-sensitive voice applications to coexist with delay-tolerant data applications on a Wi-Fi network without compromising audio quality. Completion of the IEEE 802.11e standard in 2008 led to the creation of the Wi-Fi Multimedia (WMM) family of QoS specifications by the Wi-Fi Alliance, providing an enterprise-grade, standards-based solution for VoWLAN.

Excellent voice quality for Spectralink 80-Series Handsets is delivered on a shared Wi-Fi network using SVP. Adopted by the majority of enterprise-class WLAN vendors, SVP is well-proven to provide high-quality audio over the WLAN. SVP is compatible with 802.11 standards, but uses proprietary methods for packet prioritization, battery management and call admission control. SVP provides prioritization of voice packets at the AP and gives voice packets favorable network access. SVP also improves network capacity and handset battery life through the synchronized delivery of packets using the SVP Server. Controlling the timing of packet transmissions allows devices to use their radio resources more efficiently and make AP handoff decisions without the risk of missing packets.

In addition to SVP, the Spectralink 80-Series Handsets offer the use Wi-Fi Standard QoS. Used together, WMM, WMM Power Save, and the forthcoming WMM Admission Control QoS mechanisms provide an enterprise-grade, standards-based alternative to SVP. The handset is compatible with AP implementations of these three features and all three are required for enterprise-grade QoS without an SVP Server. WMM provides a prioritization mechanism with four levels assigned to different types of wireless applications: voice, video, best-effort, and background traffic. Using the second component, WMM Power Save, the APs buffers downlink traffic until the application requests packet delivery, allowing handheld devices to conserve battery life and make AP handoff decisions without the risk of missing packets. The third component, WMM Admission Control, allows the AP to manage bandwidth based on traffic requirements submitted by the device. APs reject requests if insufficient resources are available, leaving the client device to find a neighboring AP with enough bandwidth. The WMM Admission Control specification is complete and the Wi-Fi Alliance expects to launch their certification program in early 2010.

The Spectralink 80-Series Handsets support a third QoS method, using Cisco Client Extensions Version 4 (CCXv4). CCX certification requires client devices operating on a Cisco

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WLAN to use industry-standards and Cisco-specific features, thereby allowing IT managers more uniform deployments as client devices follow the same operating methods. The handset is certified for CCXv4, which is specifically designed for voice applications. Selecting CCXv4 for QoS delivers enterprise-grade QoS without an SVP Server.

Key takeaway

Spectralink offers three enterprise-grade QoS mechanisms to help ensure good voice quality, extended battery life, and management of AP bandwidth resources. The Spectralink 80-Series Handsets offer customers the flexibility to choose the best QoS method for their unique environment.

Security

A primary concern often raised with any wireless technology is security. Security provisions are critical for any enterprise Wi-Fi network. WLANs do not provide any physical barrier from malicious attackers since radio waves that penetrate walls can be monitored and accessed from outside the building. The extent of security measures used is typically proportional to the value of the information on the network. The security risk for VoWLAN is not limited to the typical wired telephony concerns of eavesdropping on calls or unauthorized usage, but is equivalent to the security risk of accessing the data and systems that reside on the network. Determining the proper level of security should be based on identified risks, corporate policy and an understanding of the pros and cons of the available security methods.

Wired Equivalent Privacy (WEP) encryption was defined in the original 802.11 standard. WEP uses a single encryption key for all devices and all packets. Although security flaws have been identified, WEP still provides strong encryption that requires an experienced and dedicated hacker to break. In some cases WEP security may be acceptable for Wi-Fi telephony, but it is never recommended for wireless data applications with sensitive information transmitted over the Wi-Fi network.

Recognizing the need for stronger security standards beyond WEP, the IEEE developed the 802.11i standard, which includes stronger encryption, key management, and authentication mechanisms. Wi-Fi Protected Access (WPA) is based on draft 3.0 of the 802.11i specification and WPA2 is the Wi-Fi Alliance's certification program based on the ratified 802.11i standard. The major enhancement of WPA2 over WPA is the inclusion of the Advanced Encryption Standard (AES), which is widely accepted as one of the most secure encryption algorithms available.

WPA2 has two different authentication modes, Personal and Enterprise, both of which are supported on the Spectralink 80-Series Handsets. Authentication mechanisms verify the identity of the device and then allow access to the network. Personal mode uses a password-based authentication method called Pre-Shared Key (PSK). Personal mode is good for time-sensitive applications such as voice, because the key exchange sequence is limited and does not affect roaming between Wi-Fi access points (APs). Enterprise mode, on the other hand, requires the device to mutually validate credentials with an 802.1X authentication server (using RADIUS) on the LAN every time the device roams to a different AP. As the device roams, authentication delays during handoff negatively affect time-sensitive, highly-mobile applications such as voice. Fortunately, the WLAN community is adopting fast AP handoff mechanisms that mitigate authentication delays without compromising security. The Spectralink 80-Series Handsets support WPA2 Enterprise mode with the use of fast AP handoff.

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In order to maintain the appropriate security levels for different wireless applications, VLANs can be used to segregate traffic into different security classes. Separating voice devices, call servers and access gateways onto a unique VLAN allows different levels of security to be implemented without compromising the overall network security.

Key takeaway

Various enterprise-grade Wi-Fi security mechanisms are available, depending on risk tolerance and deployment preferences. WEP provides basic security that is adequate for voice applications, but not for data. WPA2 Personal uses PSK, which provides greater security than WEP with minimal authentication delays. WPA2 Enterprise provides the highest level of security but must be used with a fast AP handoff method to ensure voice quality. Segregating voice and data traffic provides flexibility in choosing the most appropriate security mode for each application.

Conclusion

Wi-Fi telephony offers mobility, accessibility and improved productivity to enterprise voice users. To provide the highest-quality end-user experience, certain network design criteria must be met. As a result, deploying voice applications on a Wi-Fi network requires proper planning upfront. Site survey services and tools are highly recommended to identify any potential network issues before deployment, with ongoing network performance monitoring to maintain consistent quality and performance.

VoWLAN requires specific considerations for coverage, capacity, QoS, and security. Fortunately, proprietary and industry-standard solutions are available to help ensure enterprise-grade voice quality and system performance in just about any wireless environment. By applying the guidelines described in this document, IT professionals can confidently design and deploy a Wi-Fi telephony solution.

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About Spectralink

Spectralink, a global leader in wireless solutions, solves the everyday problems of mobile workers through technology, innovation and integration that enable them to do their jobs better. By constantly listening to how customers move through their workdays, Spectralink is able to develop reliable, enterprise-grade voice and data solutions and deliver them through a powerful, durable device.

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