Healthcare WLAN Design Guidelines

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WIRELESS DESIGN

In hospitals, connecting medical devices to a wireless network improves workflows, ensures access to real-time patient data, and provides an excellent solution for accessing electronic healthcare records from portable computers. Patients and their guests also use the hospital's guest wireless network, which also needs to be reliable and provide good wireless internet access.

Staff utilize Wi-Fi phones and badges to communicate. These portable voice sets need to seamlessly roam through a hospital and broadcast messages to multiple people when the user is walking through the facility - without the call being disconnected.

Clinical staff use the wireless network to triangulate assets and monitor temperature of refrigerators containing medicine that may need to be disposed of, if it reaches a certain temperature - during a power outage, for example.

Security and maintenance staff expect their voice handsets to work in all areas of a hospital campus – steam tunnels, rooftops, laundry, parking lots and boiler rooms.

All of these requirements come together to create a WLAN environment that has to be designed with the proper coverage and capacity in order to operate effectively.

Site Assessments

Hospital Wi-Fi must begin with a thorough site assessment. The rules one would typically follow to design an office building or manufacturing facility are different when designing for healthcare. A site survey is required for most hospital WLAN designs. Through the process of collecting the site survey RF data, very important wall attenuation variables will be detected as well as signal propagation patterns of the wireless network, all of which enable a proper WLAN design.

Buildings are never designed with Wi-Fi in mind. Some Labor & Delivery departments may have odd shaped floor plans, X-Ray and MRI rooms have shielding in the walls, steam tunnels with metal pipes between buildings, and other areas that have been remodeled over and over again.

Hospitals require a lot of homework to be done before the design begins. The first step is to go on-site and walk through the entire building with a set of floor plans to ensure accuracy. In-scope and out-of-scope coverage areas need to be determined – such as some portions of a first floor begin a retail space at the street level. In order to design a WLAN, a few things need to be uncovered, such as what the walls are made of and how much RF attenuation is present, and what areas are off-limits to AP installation.

Many environments prohibit the installation of APs in stairwells, elevators & shafts, etc. There are additional areas to avoid placing APs in for other reasons - bathrooms and other "wet" areas, such as decontamination rooms, custodial closets, and dishwashing areas in kitchens. Other locations may be too difficult to get data cabling to, or the AP installation point may be too far from the data closet, etc.

The first step in designing a WLAN is gathering the requirements – such as voice, data, RTLS and capacity. During the requirements gathering phase, one discovers how to design the WLAN to meet the customer's needs. Capacity requirements are not the same for all areas throughout a hospital, therefore coverage and capacity can be designed using different areas within ESS. Waiting rooms, break rooms, conference rooms and cafeterias may require more access points to handle the WLAN client capacity than what would be required for Wi-Fi coverage.

The predictive WLAN model starts with capacity in mind. By using capacity and airtime tools within ESS, one can determine the capacity requirements (number of access points on non-overlapping channels) of different areas of the hospital. Not all areas of the hospital require the same amount of capacity, and one may find that an RTLS requirement provides more capacity than is required in many areas. Hospitals mainly use access points with omnidirectional antennas, however directional antennas may need to be used for specific coverage and channel re-use requirements.

When using ESS to design a wireless network, one needs to know the RF attenuation in decibels (dB) of the walls, ceilings, etc. A signal source and signal strength meter can be used to measure the RF attenuation in free space (about 20-25 feet apart) and then with a wall between the source and meter. One can do the math to figure out how much attenuation is in the wall and that information can be used when modeling and designing your WLAN. This process is taught in an ECSE class.

Hospital Wi-Fi networks are always evolving – just like the wired local area network. The initial phase is the requirements gathering and RF design, the building and commissioning of the WLAN (which may include LAN cabling upgrades as well) and then the validation of the new WLAN. It does not stop there, however. Many Enterprise environments "refresh" wired network hardware every few years and WLANs are no different. If the existing WLAN is not meeting the customer's requirements, simply swapping out the access points may not fix the issue. For example, an 802.11b/g WLAN design will be different than a wireless network based on the 5 GHz frequency band. A complete re-design would be required to meet today's needs.

Before refreshing the WLAN, use ESS to do a validation survey. The survey will give a visual representation of what the existing RF looks like. The WLAN Engineer can use this survey to identify coverage gaps and other issues that can be used to properly redesign the WLAN. Many times, a validation survey will unearth configuration issues, offline access points, misconfigured printers and other equipment that is using the Wi-Fi spectrum.

The interior of the facility must have Wi-Fi coverage that meets the voice, capacity, and data requirements for a 5 GHz WLAN if those are what is needed. Voice coverage typically requires two 5 GHz "overlapping" signals' worth of coverage at a signal level of -67 dBm and may use either 20 MHz or 40 MHz channel widths. These overlapping signals are not supposed to be on the same channel; this overlapping signal is commonly referred to as "AP overlap", "backup" or "secondary coverage". When designing for voice, a signal to noise ratio (SNR) is also a design goal - Voice over Wi-Fi typically requires a signal to noise ratio of 25 dB. It is best to know what devices will be used, and design to those requirements since not all voice handsets are the same. For example, the Cisco 8821 series phone's WLAN requirements may differ from the Vocera application running on a smartphone, which may differ from another device that is not listed here.

When designing WLANs, special care must be taken to not design the access point locations so the APs will be broadcasting on the same channel within the same proximity of each other. If two access points are on the same channel and can detect each other's signal at -85 dB or greater, co-channel interference is created. If the access points are within "ear shot" of each other, one will defer – meaning it will not transmit. When this occurs, the bandwidth is shared between the two access points and does not increase the capacity

of the WLAN. When two access points are on the same channel and can hear each other at -85 dB or greater, it is called "sharing a collision/contention domain." The quantity of devices sharing a collision/contention domain affects the performance of the WLAN. This is why it is important the AP power and channel deployment match the WLAN design.

Our data requirements usually require APs to be as close to the clients in denser areas as possible – which is the reason for placing APs in conference rooms, waiting areas and break rooms, and other areas where more clients/users may congregate. Nursing stations, for instance, are areas where shift changes happen and many VoWiFi sets are with staff or stored on the chargers. Most staff carry smartphones and those devices are likely to be associated to the Wi-Fi as well – especially in break rooms and cafeterias.

When designing, remember that multi-floor buildings are three dimensional, so it would be wise to design it with accurate propagation characteristics between floors which can be modeled in ESS. Keep an eye on the different views in ESS – such as Signal Strength (both Primary and Secondary), Signal to Noise Ratio (SNR) and Channel Overlap. You may find that the hospital environment has a denser deployment of APs than other types of facilities, which will likely reduce your design to 40 MHz or 20 MHz channels, depending on how much spectrum you are using.

During the construction phase, you will be approached many times with requests to relocate APs for a myriad of reasons. Spaces are being remodeled, someone doesn't want an AP in their office, or the space is no longer being used. Be ready to defend the design and modify it if needed. Open the ESS project and make the changes if you have to in order to verify that it will still meet all of your requirements. Moving two APs closer to each other in one room could negatively affect your voice calls.

Validation and Testing

When your new WLAN is built you'll need to do a validation survey. A validation survey ensures that your WLAN is meeting your requirements and is built the way it was designed. After deploying a new WLAN, the validation results may show something less than optimal. In this case, you can "tune" your WLAN and re-survey. When tuning a WLAN, you may end up turning off the automatic channel planning and deploy the static power and channel plan from your design. If you used 20 of the 5 GHz channels in your design, be sure to use them in your deployment. If you designed your higher density WLAN with 20 MHz channels, be sure to use 20 MHz channels in the real world. Changing the AP or controller's settings to use 40 MHz (or higher) channels may increase co-channel contention (CCI/CCC) and retry packets, lower signal to noise ratio as well as and the average data rate on the client.

When tuning the WLAN, use your validation survey data to help you decide how to change the power and channels that you wish to modify in the real world. Look at the signal strength and channel overlap.

The tuning process can take some time, but it will prove to be well worth the effort. During the re-surveying (validation surveys) in tuning process, look at the APs and make sure they are installed properly. If the WLAN was designed with APs that were meant to be horizontal/parallel to the floor, check to see if they are mounted that way.

Periodic validation surveys will assist in keeping your WLAN healthy. You may start to see patterns with problem areas that are reported by the user community. The views mentioned above will show a visual representation of what the WLAN looks like in the problem areas. The signal strength grey-out slider within ESS can be helpful if signal strength is the suspected culprit. Not all WLAN client devices are created equal, and do not “see” the WLAN just like the WLAN client used in your Validation Survey.

In conclusion, I will wrap it up with the following ‘checklist’:

- Design your WLAN with perimeter APs if you need RTLS, but keep the RF inside the building as much as possible. Try to keep your APs away from windows unless you want the signal to go outside the building. APs in front of windows may affect location-based services.

- Follow the access point manufacturer’s recommended height and mounting orientation when designing and installing them.

- Go on-site and see the facility, measure the walls for RF attenuation, and do a validation survey of the existing infrastructure.

- Document the off-limits areas for APs - it will cut down on modifications to the design during construction.

- Learn how to design WLANs and how to properly use ESS. Take the ECSE class. Read the CWNA and CWDP books.

- Gather all of the requirements – capacity, data, voice, RTLS, and the applications that will be used.

- Observe the users – foot traffic patterns for voice users, where people gather, walk between buildings, etc.

- Find out what the WLAN does today, and what it is going to be used for tomorrow – is the existing WLAN meeting the current and future needs?

- Design for 5 GHz WLANs. Define your requirements and design for them. Such as secondary coverage @ -67 dBm for voice, or -72 dBm x 3 APs for RTLS.

- Do a post deployment validation survey. After the system is built, do a survey to ensure everything is working properly and verify that it is built how it was designed.

- Be prepared to defend your design. If rooms require AP’s in them, insist on placing them in those areas.

- Use the area tool to define capacity planning for your WLAN design.

- Design the access point placement according to the manufacturer’s recommendations.

- Do not skip the on-site visit/survey of the facility.

- Do not simply design for one requirement. Take all of them into account when designing hospitals and medical office buildings.

- Do not design “Hall-Fi” where APs are lined up in a hallway because they are easier to install. Hall-Fi creates Co-Channel Interference (CCI), which reduces WLAN capacity.

- Measure the floor to floor propagation. It could be 20+ dB, or it could be less than 5 dB if the building was built in 1920.

- Do not be afraid to be creative with your design. Use directional antennas if needed.

- Do not skip the validation design after it is built. You may have to tweak your design when you see the results.

- Do not use an AutoPlanner to design your WLAN. It may get you started with access points on the floor, but don’t leave it that way. Move them around as if you were designing it yourself.

About Ekahau

Ekahau is the global leader in solutions for enterprise wireless network design, optimization and troubleshooting. More than 15,000 customers, including 30% of Fortune 500 companies, run their networks with Ekahau's Wi-Fi planning and measurement solutions.

Our software and hardware solutions design and manage superior wireless networks by minimizing network deployment time and ensuring sufficient wireless coverage across all industries, project sizes, building infrastructures and levels of complexity.

We are recognized for delivering the easiest-to-use, most reliable solutions for Wi-Fi planning, site surveys, troubleshooting and optimization. Whether a corporate office, hotel, hospital or university – if the Wi-Fi works well, it has likely been built using Ekahau's Wi-Fi Design solutions.

Learn more about Ekahau's solutions to design, optimize and troubleshoot Wi-Fi networks at **www.ekahau.com** or contact us at **1-866-435-2428.**

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