

## Applications and Considerations for Wireless LAN Use in Healthcare

### Healthcare Trends

Healthcare is a natural environment for wireless LAN solutions. With a large mobile population of doctors, nurses, physician's assistants and other caregivers, wireless LANs bring the ability to access the latest patient charts, medical records and clinical decision support data at all times, anywhere in the healthcare organization. And as caregivers travel among different facilities, wireless allows for easy connectivity at each site.

Early adopters in healthcare recognized these benefits and deployed the first wireless LAN solutions in the late 1990's. This trend was given further momentum with the release of a 1999 report on Adverse Drug Effects (ADEs) which recognized that upwards of 100,000 deaths per year were related to preventable medical errors. Following in 2000, a Presidential mandate was issued requiring healthcare providers reduce data errors by 50% in 5 years. Numerous states passed subsequent legislation to address this growing concern. Coupled with the release of an industry standard - IEEE 802.11b - healthcare organizations began deploying wireless LAN solutions in larger and larger numbers. The proven ability of wireless to allow for immediate availability of treatment records at the point of care along with clinical decision support through instant access of medical reference databases has saved many healthcare facilities millions of dollars.

### Advancing Patient Care and Reducing Costs with Wireless LANs

Since these early days, the number of applications that wireless is used for in healthcare has grown significantly. Healthcare institutions use wireless for:

- Patient charting - Input clinical data at the point of care eliminating transcription errors while allowing other healthcare providers instant access to the most updated patient treatment history.
- Prescription automation - Immediate look up of adverse drug interactions, patient-specific dose checking coupled with accurate information from the latest medical reference guides.
- Treatment verification - 100% verification of patient identity using barcodes for medication disbursement and other procedures providing the additional benefit of streamlined insurance billing.

- Patient registration - Simplification of patient registration through self-administered check-in.
- On demand communication - Instant access to the closest and most appropriate caregiver without noisy overhead paging, using voice over Wi-Fi phones and other innovative communications devices.
- Respiratory care - Bedside management of post-operative patient therapy with immediate updates of patient treatment records and on-floor scheduling.
- Materials management - Barcode scanning of new inventory for rapid disbursement of supplies to departments minimizing overstocking or out of stock situations.
- Inventory tracking - Low cost RFID tags provide real-time visibility of critical mobile equipment and drugs to ensure proper controls and prevent theft.

Wireless, combined with the appropriate Clinical Information Systems, proper training, staff support and mobile computing devices, has the ability to transform healthcare. Wireless technology is helping to ease the strain on critically understaffed organizations helping to drive productivity gains in many areas. With the breadth of applications and resulting increase in client density, it is more important than ever to choose a wireless LAN system that will deliver the performance and quality of service in this type of environment.

## Considerations for Wireless LAN Solutions in Healthcare Applications

There are several environmental and application characteristics that are unique to healthcare organizations that must be considered when choosing a wireless LAN infrastructure.

### *High UserDensity Environments*

Healthcare organizations typically have very high user or client density in a several areas, such as the emergency and admitting rooms. When as few as three to five clients simultaneously contend for service on the same access point, throughput performance can severely degrade due to the back off<sup>1</sup> that is introduced by the multiple collisions. Current conventional wisdom to support high client density is to introduce even more access points, reduce their transmit power and space them more closely. However, doing so actually is counterproductive as the 802.11b/g standard only supports 3 non-overlapping channels. With tighter spacing, more co-channel interference is created resulting in increased collisions. This creates a vicious cycle of increased collisions among clients, which further reduces overall throughput performance.

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<sup>1</sup> Back off is the process in 802.11 that helps manage client congestion. The 802.11 standard uses the Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA) protocol. If clients try to access the network simultaneously, their signals will collide and neither will get through to the access point. Both clients will then exponentially increase the amount of time they wait before retransmitting the signal. With more clients, the number of collisions goes up and hence lengthy back off times can result, degrading throughput performance.

## *Simultaneous Voice and Data Applications*

Historically, wireless LANs have been primarily used for data applications. But, increasingly enterprises of all types are looking to support voice over wireless (VoWi-Fi) applications as well. This couldn't be truer than in healthcare where there is an ever increasing need to communicate with other healthcare personnel; nurses contacting physicians, physicians contacting pharmacists or other specialists, unit staff contacting support staff such as transportation, housekeeping or dietary. And, unlike most other enterprises, it can be critical to reach the right person immediately in a life-threatening situation demanding the highest reliability in the communication system. All of this has traditionally been accomplished through calls or pages. However, significant inefficiencies result as nurses and other staff wait for calls or pages to be returned, causing delays and interruption of patient care.

As IT administrators gain confidence and experience with Wi-Fi deployments for data, they are now looking at voice over Wi-Fi as an increasingly desirable technology for clinicians. However, voice applications drive a more stringent set of requirements on the wireless LAN infrastructure. Voice applications are:

- Reliant on comprehensive RF coverage
- Actively mobile while in use as compared to data applications
- Highly sensitive to latency, jitter and delay
- Dependent on seamless handoff between access points

### *Comprehensive RF Coverage*

*Wi-Fi deployments that are focused on data applications are often limited in coverage, typically in areas like conference rooms and other public concentration points. It is not practical to limit voice applications to specific areas. Like the cellular network, the need for voice connectivity dictates that it be available anywhere, which often requires more access points to be deployed in the network to ensure adequate coverage.*

### *Actively Mobile*

*Voice is a truly mobile application. While it is generally not practical to simultaneously walk and use a laptop or tablet to check email or access a network application, it is commonplace to walk and talk at the same time. Therefore, voice over Wi-Fi devices will introduce nearly constant roaming across access points.*

### *Sensitivity to Latency and Delay*

*Voice applications, unlike data, are highly sensitive to latency, jitter and delay and require a high quality of service in the network to work properly. Delay is caused by a variety of factors in the end-to-end system, including the codec, propagation through the network, queuing in routers and switches, the jitter buffer and congestion. Allowing for the other portions of the network, the wireless LAN can contribute approximately 15 ms of delay to the entire system. Congestion due to variation in the traffic causes jitter (delay variation). Congestion also causes collisions, which increases packet loss and degrades voice quality.*

*A converged voice and data network will have many clients, increasing collisions. Collisions are a primary cause of delay as they cause back off. Another source of collisions is called 'hidden node.' Hidden node occurs when there are multiple clients within a single cell that are able to communicate with an access point, but cannot 'hear' each other. In addition, multiple access points will create additional co-channel interference, further increasing back off.*

### *Require Seamless Handoff*

*As mentioned above, roaming across access points will be commonplace with a voice over Wi-Fi device. Roaming among access points causes delay as the client re-associates and re-authenticates as it moves from one access point to another. Decreasing the spacing of access points to simultaneously address the issue of high client density worsens this problem.*

### *Complex Building Topologies*

Many healthcare institutions are in well-established facilities and have building topologies that are long, narrow configurations - T, U or H-shaped. Older buildings such as these often use concrete or metal building materials which are not conducive to wireless LAN propagation. The combination of these two factors are particularly challenging for wireless LAN deployments. Access points typically radiate in a 360 degree pattern around the device. With long narrow corridors, typical access point deployments are highly inefficient. Often, complex site surveys are required to plan around the unique environment challenges that both large and small healthcare institutions present.

### *HIPPA Compliance*

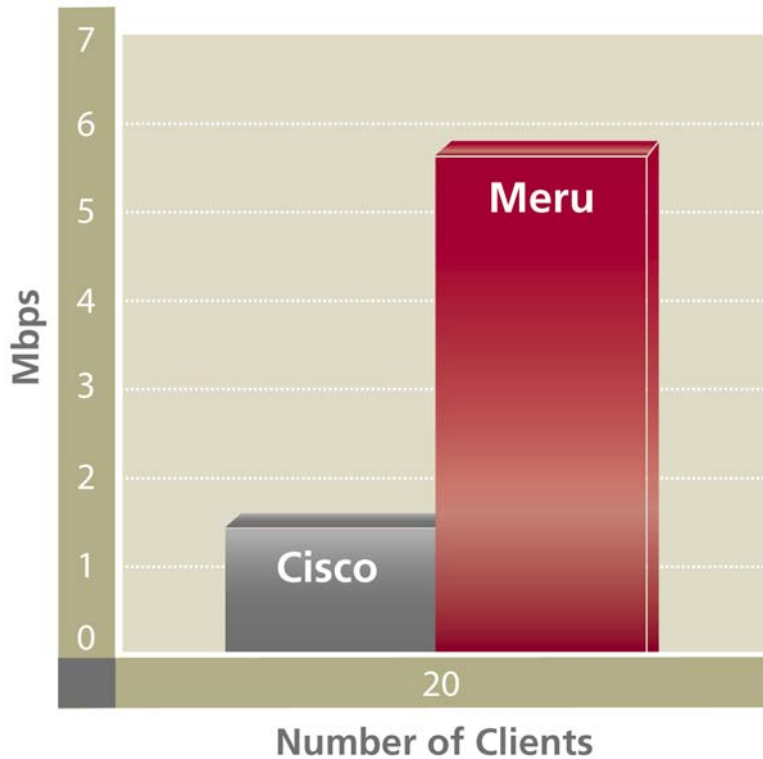
The Health Insurance Portability and Privacy Act legislates that healthcare institutions protect patient data that is stored, transmitted or accessed across networks. As a transport and access mechanism, wireless LANs must be certified as HIPPA compliant. Security technology for a wireless LAN must include authentication, encryption, provide an audit trail and event reporting.

## Benefits of Meru WLAN Solution for Healthcare

Meru addresses all of the unique considerations a healthcare institution presents.

### *Designed for High Density*

Meru Wireless LANs employ Air Traffic Control™ technology which deterministically schedules client transmissions. This significantly mitigates client collisions, allowing high densities of clients to have excellent throughput performance. For larger areas where multiple access points are used, Meru Cellular WLAN architecture uses coordinated APs to manage co-channel interference and collisions from clients in other cells. The combination of Air Traffic Control technology and coordination of APs results in unparalleled performance for even the largest networks in the world.



### *The First True Converged Wireless LAN Network for Voice and Data*

The Meru Wireless LAN Solution is a purpose-built converged voice and data network. Addressing head on voice application sensitivity to delay, jitter and latency, Meru reduces or eliminates the wireless LAN impact on these factors. By building on the system's ability to control channel activity with its Air Traffic Control technology Meru dynamically recognizes when a VoIP call is initiated and reserves bandwidth over the air for the call resulting in unparalleled call quality and connection reliability.

It is important to note that while IEEE is introducing 802.11e to solve some of the quality of service issues, this standard does not address several important areas. Meru uses 802.11e and builds upon it to provide a much more robust system. 802.11e only delivers downstream Quality of Service performance. This means that client communications upstream to the Access Point are not managed and contention is likely in a dense environment. Meru's patented call flow intelligence determines which streams are voice applications and automatically manages quality of service in both directions.

Additionally, 802.11e does not provide Quality of Service on a per application basis. This means that if a laptop is simultaneously running a soft phone for a voice over Wi-Fi call as well as checking email, the device receives the high priority assigned to it, not just the voice over Wi-Fi application. This situation worsens contention. Meru's Quality of Service capability is on a per-application basis, not per-device, so each application receives the correct QoS settings.

Furthermore, 802.11e does not address the critical issue of handoff between APs or indirect sources of interference from hidden nodes or co-channel interference. Handoff can take up to several seconds, which will destroy the quality of the voice call. Contention from hidden nodes causes additional delay and transmission errors, which will impact voice quality. Co-channel interference - the impact of multiple access points being heard by each other - will also add noise to the environment, causing quality issues. Meru's Cellular WLAN Architecture coordinates APs and creates a Virtual Cell, which eliminates handoffs and manages intercell contention. Multiple APs appear as a single AP to the voice client so no handoff or re-authentication is needed as the client roams. Client access to the medium is deterministically scheduled so that voice clients reach the network in a consistent, regular basis. These methods allow Meru to deliver a five-fold increase in density of voice calls over any other WLAN solution.

### *E(z)RF Greatly Simplifies Deployment*

A hospital's high density of clients, unique building topology and construction create a challenging environment for wireless LAN deployment. The multi-floor configuration and need for highly directional antennas to efficiently cover the long narrow corridors create an environment where co-channel interference is impossible to avoid. Other wireless LAN solutions require complex channel planning to try and mitigate co-channel interference, which can add significantly to installation time and cost. Meru greatly simplifies this process with Virtual Cell technology which eliminates co- and cross-channel interference. With the worry of co-channel interference removed, Meru access points are simply placed in the best positions to ensure complete coverage. Complex 3-dimensional site plans to ensure that access points on the floor above or below are on different channels are a thing of the past and the network is up and operating cleaner and smoother in less time.

### *A HIPPA Compliant Solution*

Meru has a multi-layered approach to security which clearly conforms to today's HIPPA regulations. WPA Certified™ ensures that all client traffic is encrypted. For those clients that cannot support WPA, VPN support is embedded in the system. And as for voice clients, VPN clients are not interrupted while roaming due to Meru's zero hand off capability between access points. WPA and VPN also provide the requisite authentication of the user accessing the network. Meru seamlessly integrates with RADIUS servers to verify the identity of each client. With RADIUS or VPN authentication, each access is logged creating a complete audit trail.

Beyond these minimum requirements, Meru adds proactive security measures such as rogue access point detection and prevention. This ensures that your network is not breached through an employee attaching an unsecured access point to the corporate Ethernet network. And, Meru enables location-based access to the network so that multiple user communities can be supported. As an example, vendors might be allowed access to the Wi-Fi network, but only in 1<sup>st</sup> floor meeting rooms. Any attempt to access the network from any other floor of the hospital would be blocked by setting up a policy that only permitted access from that portion of the Wi-Fi network.

## Summary

Healthcare has been improved greatly with wireless LAN technology. The freedom of anytime, anywhere access to network applications enables caregivers to focus on improving patient care, instead of wasting time due to inaccessibility of patient treatment histories, drug interactions, test results other vital information. The next wave of improvement in workflow and efficiency will be the seamless integration of voice communication. Voice will allow the richest resource - other staff members - to be reached easily and without delay. Simultaneously supporting voice and data brings new challenges to the wireless LAN network. Meru uniquely solves these challenges allowing healthcare institutions to confidently deploy Wi-Fi as a primary network, increasing patient satisfaction with care while removing inefficiencies and cost from healthcare operations.