

# Is Your Wireless LAN Voice & Video Ready?

Key Considerations in Optimizing Wireless LANs for  
Real Time, All the Time, Applications

Featuring research from

**Gartner**

# Introduction



As I meet with customers and prospective customers around the globe, more and more of them relate their growing concern with the deluge of consumer devices that are invading their enterprise networks. Smart phones, tablets, netbooks – this sudden proliferation of devices frustrates IT departments and CIOs alike. And, knowing that this trend will not abate in the months and years to come, only serves to heighten their frustration.

I feel their pain. I have had the privilege of being the CIO of many

global companies during my career and have witnessed many changes in enterprise networks over the years. When faced with an inevitable trend or unavoidable change, my counsel has been to embrace this new era and guide the IT organization to, “Just say yes!”

The key lies in how you adopt and implement change.

The starting point has to be to look at any change from a people first perspective. Assess the situation and the needs of all concerned starting with the customer or user. Consider back-office operations, but remember that the network is for people. After that, the selection of technology becomes paramount. Deploy or create the right technology for the right purpose, ensuring it can accommodate the business applications that customer and users are demanding, while allowing you to plan for future growth.

In the fifth issue of this newsletter series, I am very pleased to present some perspectives on the impact of the consumerisation of IT – or as some call it, the “Bring Your Own Device” (BYOD) era – on enterprise wireless networks. The explosion of mobile devices and communications has placed an unprecedented strain on wireless networks. This newsletter presents some key considerations for selecting wireless LANs, and outlines how imperative it is to support the full breadth of enterprise applications and provide an end-user experience indistinguishable from that of a wired network.

Among the wealth of information you will find in this newsletter is a new research paper discussing top considerations for supporting voice over wireless authored by Tim Zimmerman, research director at Gartner Research.

We have also included a case study on Hawaii Medical Center, a hospital that is embracing this new era of consumerisation. They have taken a people first approach, leveraging video to reduce costs, and running voice and video over their wireless network to maximize employee mobility and productivity.

Finally, we have included an article on how Avaya Wireless LAN 8100 outpaces the industry in delivering superior performance, scalability and support for multimedia, voice and video capabilities.

Avaya’s next generation Split Plane Architecture is an enabler of real-time application support over wireless networks. With Avaya Wireless LAN solutions, your network can scale to meet the mobile traffic explosion and the stringent demands required to support real-time applications such as voice and video. So when you are evaluating your next networking solution, be sure to look at Avaya Data Networking.

Steve Bandrowczak,  
Vice President and General Manager,  
Avaya Data Networking

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# Top Five Reasons to Choose Avaya Wireless LAN 8100

More and more wireless devices are invading business networks. Smart phones, tablets such as the Apple iPad devices, netbooks, RFID tags and other equipment use wireless as their primary, and sometimes only, method of accessing the Internet. Enterprise networks have to be capable of handling the explosive growth of consumer devices while also meeting the stringent requirements that real time applications, such as voice, unified communications and video-on-demand place on the WiFi infrastructure.

Avaya's wireless LAN solution moves beyond industry standards in delivering features and capabilities that elevate the Avaya Wireless LAN 8100 in its support of real-time applications.

Here are five capabilities that make a difference:

## Dynamic Call Admission for today's dynamic networks

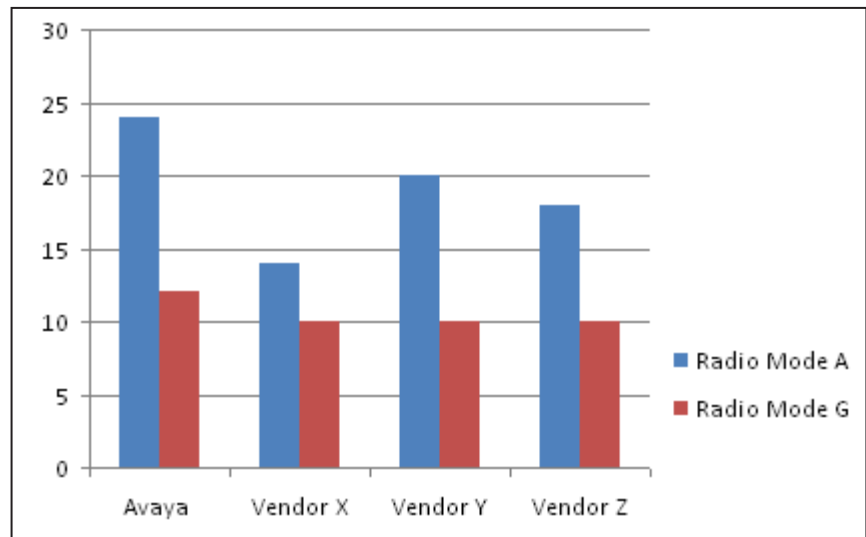
Call Admission Control is used in the call set-up phase for real-time media traffic. Most call admission systems today are preconfigured to allow only a fixed number of calls and assume that each call requires a uniform resource commitment. This assumption leads to more complex engineering, which results in overbuilt networks.

Avaya's Dynamic Call Admission Control solution ensures high performance and low latency for voice sessions while allowing more calls to be admitted per wireless Access Point (AP) (Figure 1). By building on the established IEEE 802.11e and WiFi Alliance WMM standards, Avaya's Call Admission control solution provides superior call quality and greater call distribution flexibility.

The basis of Avaya's Call Admission Control solution partitions RF bandwidth based on the traffic needs of an AP's service area and involves three key functions: Media Measurement, Net-flow Estimation, and Admission Decision.

**FIGURE 1**

Number of Voice Calls Supported per Access Point where packet loss <0.5%



\*Based on Avaya internal testing; Vendor X, Y and Z represent leading wireless LAN vendors.

To make accurate admission decisions, the AP must first have a precise view of network resource consumption. Avaya's solution calculates the resource consumption of the entire network in real time by measuring the PHY rate, RF bandwidth use, co-channel and other interference, received signal strength and the resources required by the incoming call.

Then, when a new call is initiated and a signal request is sent to the AP, Call Admission Control's new-flow estimator combines the resource requirements for the new call with the current estimated resource usage to estimate the total resource impact of the call. This information is forwarded to the admission decision function, which then decides whether or not to admit a new call. The admission decision function can admit the call or, if resources are too limited, can borrow available bandwidth from other access categories to meet the call's resource

needs. This allows networks to maximize the number of possible calls while preserving call integrity and QoS.

The Call Admission Solution can also reserve bandwidth for mobility traffic to ensure a high probability of successful handoff if a call moves to an adjacent AP. This is particularly important for emergency calls (E-911) which must have a high probability of success, independent of the calling load.

## Optimized Architecture for an Optimized Network

Whether for a wired or wireless network, the network's fundamental architecture dictates the network's key attributes such as reliability and flexibility.

The main challenge with the variety of wireless LAN architectures in the market today (distributed, centralized, etc) is that

they are all optimized for one attribute. For example, centralized solutions excel at L3 mobility but compromise efficiency and scaling since all wireless traffic traverses through the controller, thus creating a bottleneck. Distributed solutions excel at efficiency but compromise on L3 mobility.

An architecture that is optimized for both efficiency and mobility is critical in the new wireless era; one that can efficiently route high bandwidth video and low latency voice traffic while providing ubiquitous mobility to users as they roam.

With the Avaya Wireless LAN 8100 Series, customers can have the best of both worlds. The WLAN 8100 Series provides an architecture optimized for both mobility and efficiency (Figure 2), as it allows for efficient

data routing and scaling while preserving the centralized control essential for user mobility.

The key difference with Avaya's Split-Plane architecture lies not only in the decoupling of control and data traffic, but in how traffic is handled. The Wireless Control traffic remains centralized, enabling centralized control and provisioning, and can be virtualized and/or made available in the 'control cloud'. The Data traffic is routed directly from source to destination (eliminating the controller as a choke point) through the optimal LAN switching path. This allows for packet forwarding in the hardware, reducing latency and jitter for voice and video. The decoupling of control and data enables independent scaling of control and forwarding capacity of the wireless network.

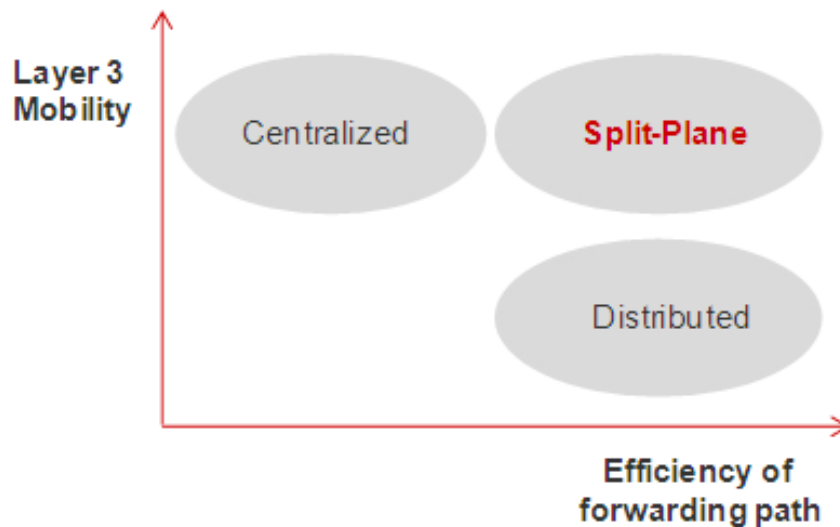
### Real-Time, Accurate Location Tracking for 911 Calls

When emergencies occur, it is critical that 911 dispatchers be able to quickly and accurately locate the source of a call. This task is a difficult one given that so many of these calls come from mobile devices that can change location at a moment's notice.

Very little attention has been given to this problem from a wireless LAN perspective and most E-911 tracking systems are ineffective for wireless LAN handsets.

A number of solutions have tried to address this problem with limited success. With the Wireless LAN 8100 Series, Avaya supports full E-911 VoWLAN integration out of the box. The Wireless LAN 8100 Controller interfaces

**FIGURE 2**  
Mobility and Efficiency characterization of different wireless LAN architectures



Source: Avaya

with the Avaya Communication Server 1000 call server or Aura call server to precisely identify the location of an emergency call. This is made possible by allowing the mobile handset or client application to communicate with the nearest AP to establish an Emergency Response Location (ERL). The ERL is then relayed to emergency dispatchers in the event of an E-911 call. If the call location changes, dispatchers are updated in real-time. ERLs are mapped to APs and cover the entire wireless network area. Because Access Points are rarely moved, mapping devices to Access Points is an efficient and reliable way to establish their location and is resistant to disruption by future technological changes.

### Let the User Roam

In order for wireless networks to compete with their wired counterparts, they need to provide seamless network access and true user mobility. The Avaya Wireless LAN 8100 Series provides a mobility control framework, along with the necessary suite of sophisticated software algorithms that provide cross-network mobility and service continuity.

The Avaya wireless LAN 8100 supports roaming between APs on the same subnet (Layer 2 roaming) and on different subnets (Layer 3 roaming). While support for L2 roaming is well understood and a table-stake requirement, L3 roaming is more complex and some wireless LAN solutions

provide only partial support, if any. L3 roaming is important for wireless LAN deployments in multi-story buildings or multi-tenant networks where the wireless LAN on each floor or per-tenant have a different subnet.

The challenge with L3 roaming is that as a client roams between subnets, they may no longer have an IP address and gateway that are valid within the new IP subnet, resulting in their data session or voice call failing. Roaming hand-off time may also be excessive.

The Avaya Wireless LAN 8100 supports seamless L3 roaming. The client hand-off time from AP to AP is less than 50ms irrespective of whether the APs are on the same or different wireless LAN switches. The user does not need to re-authenticate or re-login as they roam and they maintain the same IP address across subnets.

### Access Control: Identification of UC, Video Traffic

Identity and policy-based network access control (NAC) is a key consideration for wireless LAN networks. The wireless network must be able to correctly identify the type of user traffic (for example, voice, video or data) so that it can be properly prioritized and routed. Industry standards specify four quality of service (QoS) classes (called "access categories") for voice, video, best effort data and background data. Special

access procedures ensure that packets from voice sessions receive highest access priority, which ensures low latency and loss, followed in priority by video and two data classes.

When a user connects to a wireless network, policies should be applied based on network location, connection security and access type, where the user is dynamically assigned to a specific VLAN, setting QoS and assigning ACLs.

Avaya offers a complete network access control solution, in conjunction with the Identity Engines portfolio. The Avaya Wireless LAN 8100 Series centers on user identity **as well as devices** as its means for delivering user services. The Avaya Wireless LAN Controller software maintains a record of all authenticated users and controls their network authorization by enforcing their policies wherever they roam in the wireless LAN network. Enforced policies include attributes such as VLAN/subnet membership, roaming policies, access control lists, multicast and class of service.

### Why Avaya?

Avaya has the breadth and depth of experience to address an enterprise's needs to create a truly wireless business. Whether voice, data, wired, wireless, access control or management, Avaya has a solution for business grade networks.

Source: Avaya

# Hawaii Medical Center



Partnering with Avaya for always-on network performance and advanced technologies to enhance collaboration, productivity, and patient care.

Dean Pang, CIO of Hawaii Medical Center (HMC), expressed the dilemma of many healthcare providers and other organizations when he commented, "We wanted and needed to update current communications technologies (such as video conferencing), but we didn't have a network robust enough to support them. We were struggling along with a mix of disparate IT equipment that was difficult and expensive to maintain. We couldn't achieve any consistency, and we had no clear migration path for the future."

Older network. Disparate equipment. High costs of maintenance. No migration path for the future. It's a story that's echoed many places these days, both in healthcare and other industries. Visionary IT leaders and other administrators want to introduce current technologies but their infrastructure is holding them back.

HMC found the right prescription – a broad Avaya solution that provided a network for the future and communication capabilities that are on today's leading edge of technology.

## Challenges

- Deadline for deploying a new electronic medical records (EMR) system
- Strong demand for high quality video conferencing and other tools that could enhance collaboration and drive greater productivity
- Need to deploy the most advanced communications capabilities to ensure optimum patient care and safety

## Solutions

- Avaya Ethernet Routing Switches (Series 4000 and 8800)
- Avaya Wireless LAN 8100 Series
- Avaya 1000 Series Video Conferencing Systems
- Avaya Flare® Experience with Avaya Desktop Video Devices
- Avaya Aura® Collaboration Server

## Business Value

- High-performance network with always-on reliability for core business processes and the EMR system
- Cost-efficiencies with green power savings and ease of management
- Enhanced collaboration and productivity
- Competitive advantage, to attract/retain the best physicians and their patients

- Communications capabilities to help ensure world-class patient care

The insufficiencies of HMC's data network came into sharp focus when they began to plan for the installation of a Cerner® Millennium electronic medical records (EMR) system. With all members of the clinical team needing mobile access to EMRs anytime, anywhere throughout HMC's facilities, along with various electronic reporting requirements, having a secure, reliable wired and WiFi data network was critical. And as a Federal grant to help deploy the system carried with it a deadline, obstacles had to be overcome quickly.

"It didn't make any sense for us to invest significantly in an old infrastructure," Pang stated. "The need to accommodate a sophisticated EMR system was just the impetus we needed to look at upgrading the entire infrastructure."

After talking to several vendors, HMC chose Avaya to replace their 20-year-old Cisco network with an integrated, robust solution that would enhance HMC's capabilities in a number of critical areas. This solution included Avaya Ethernet Routing Switches (4000 and 8800 Series), Avaya WLAN 8100 Series data networking products, Avaya Desktop Video Devices with the Avaya Flare® Experience, and Avaya 1000 Series Video Conferencing Systems. Completing deployment was an Avaya Aura® Collaboration Server that provided Avaya Aura® core functions on a single server, enabling HMC to take full advantage of data and video collaboration. With this server in place, HMC is positioned for cost-effective future expansion to a full Avaya Aura® unified communications solution, offering telecommunications, mobility and home office options, contact center technologies, and comprehensive multimedia capabilities.

By choosing Avaya as the provider for their wired and wireless network and several critical applications, HMC was able to consolidate and streamline their infrastructure, realizing savings in power and related operating costs. At the same time, they gained a network with the always-on reliability, stability, and high performance that Pang knew HMC needed. He commented, "With Avaya, we now benefit from the convenience and cost-efficiencies of partnering with one vendor for our data and multimedia services, yet at the same time we have an open standards platform that provides excellent interoperability with third-party vendor products."

### **The Data Network and EMR Challenge: "A Huge Accomplishment"**

Thanks to their Avaya solution, HMC has an integrated wired and WiFi network with the bandwidth and performance to support normal business processes and an EMR system that tracks patient information at

every point of care. The WLAN component lets them extend EMR access to mobile computer units that are used throughout HMC's two hospitals, from patients' bedsides to hallway consults across any department. Their network also supports integration with wireless medical devices, such as EKG machines so that test results and monitoring can be uploaded directly to a patient's EMR, saving time and reducing errors related to manual entry. Finally, with Avaya Identity Engines Ignition Server and Guest Manager authentication and access controls, HMC's data network provides the security and protection required for safe, compliant handling of patients' confidential EMRs.

"Today the EMR system touches all aspects of healthcare for patients, from registration to scheduling to nurse documentation and lab results," Pang explained. "The stability, reliability, and ease of management that we have with the Avaya network are essential to our success in all aspects of patient care because so much of it is now handled on the go, electronically instead of on paper."

And Pang credits Avaya's service capabilities in meeting some tough deadlines to coordinate data network installation with their EMR implementation. "Our needs put a lot of pressure on Avaya and they responded with great service," he noted. "When our Cerner® EMR system went live on schedule, it represented a huge accomplishment for HMC and Avaya."

### **Videoconferencing: "Far Superior... Easy to Manage"**

With two campuses 20 miles apart, face-to-face meetings between individuals and groups in the two locations represent a potential drain of travel time and expenses. Their Avaya 1000 Series Video Conferencing Systems let HMC greatly reduce this need for cross-campus travel by providing a high quality, face-to-face video forum that's ideal

for everything from clinical consultations between physicians to taking continuing medical education credits.

Pang commented, "Our organization uses video conferencing extensively for administrative meetings, departmental meetings, staff training, clinical issues, and educational programs. Our conferencing facilities are almost always fully booked because our people strongly prefer video conferencing over audio conferencing."

With this strong preference, it is no surprise that HMC's video use is projected to expand dramatically over the next few years. Thanks to their robust data network, HMC is equipped with the performance and scalability they need to support high quality Avaya video images while accommodating these growth demands.

"Our new Avaya video conferencing systems are far superior to the product we used previously.

I've heard many compliments about the difference between the blurry images we had before and the sharp, brilliant images we have now with Avaya. It's also a huge benefit to be able to share presentations within the video conferences. Overall, our video capabilities have really enhanced the level of collaboration that takes place in meetings and among the teams that use these tools," he added.

Pang also noted that the new video conferencing systems are easier to manage and maintain than video products used previously. In fact, their IT team is currently working with Avaya on extending video conferencing outside of the HMC network. "We are really looking forward to offering our staff the opportunity to video conference with individuals in other facilities. Our doctors, in particular, will welcome the chance to

collaborate with colleagues in other medical organizations," he said.

### **The Avaya Flare® Experience: "Awesome"**

Pang sees HMC's Avaya Flare® Experience as the next logical extension of the network environment, "With the Avaya Desktop Video Device, people have the capability to initiate a video conference spontaneously or to attend a conference without even going to a conference room. It's an awesome product that will definitely expand our already heavy use of video conferencing."

Delivered on the Avaya Desktop Video Device, the Avaya Flare® Experience offers quick and easy access to real-time communications and collaboration tools. Capabilities include desktop video, social media, audio/video/web conferencing, multiple directories, presence, instant messaging, and contextual history. It eliminates the need to use different interfaces or directories to communicate across various types of tools.

The Avaya Desktop Video Device is a fit-for-purpose collaboration tool with high definition video and high quality audio combined with a capacitive touchscreen interface. These features enable users to initiate informal desktop conferences in their format of choice, both within and across campuses. Whether reviewing a particular medical approach, meeting a new board member, or discussing patient care coordination, the opportunities for meaningful collaboration are vast.

"Here at the medical center, there's very high interest in this tool. We see it as a real advancement in being able to collaborate more easily and to increase productivity. Its broad functionality and portability make it an attractive tool to provide for our physicians and administrators," said Pang.

And moving forward, HMC may find video conferencing and Avaya Flare® yields more than just collaborative efficiency. With leading edge capabilities that empower doctors and nurses, and tools that can deliver more interactive, collaborative patient care, this Avaya solution offers HMC a key differentiator in a highly competitive healthcare market.

### **Looking Ahead**

Pang stated, "One of the greatest advantages that we have with our Avaya solution is the ability to utilize our older systems and equipment until we are ready to replace them. For example, we are using an Avaya Collaboration Server, which provides all of the Avaya Aura® core functions on a single server, as a quick method of implementing Avaya video conferencing and the Flare® Experience. Over time, we are planning to move our overall environment to an Avaya Aura® unified communications platform with Avaya one-X® products for our telecommunications and unified communications needs. However, even then we will realize cost savings by being able to retain some of our analog and digital desk phones. It's valuable to have this flexibility to move ahead at our own comfortable pace."

HMC can also consider the value of leveraging the expertise of the Avaya healthcare solutions group. This group offers an array of healthcare-specific solutions, such as Mobile Device Checkout and Avaya Patient Follow-up, providing workplace communications and collaboration, mobility, automated outreach and other technologies to enhance patient care coordination, pre-admissions preparedness, and post-discharge care.

Pang concluded, "We feel extremely comfortable with Avaya because the company's philosophy and products coincide so well with ours. At HMC, we are all about empowering our physicians and all of our staff to provide the best possible care and service to our patients and their families. Avaya's vision for the future will help us to do that, particularly as it relates to real time multimodal collaboration and other healthcare specific applications. We have the assurance that Avaya is here for us now and will always be here for us in the future."

## **Systems and Applications**

### **Data Networking**

- Avaya Ethernet Routing Switch 8800
- Avaya Ethernet Routing Switch 4524GT-PWR
- Avaya Configuration and Orchestration Manager
- Avaya Identity Engines Ignition Server

- Avaya Identity Engines Ignition Guest Manager

- Avaya Wireless LAN 8100 Series

--- WLAN Controller 8180

--- WLAN Management Software 8100

### Unified Communications

- Avaya Desktop Video Devices with the Avaya Flare® Experience
- Avaya 1000 Series Video Conferencing Systems
- Avaya CallPilot™
- Avaya Aura® Collaboration Server (Avaya Aura® 6.0 core functions)
- Avaya Communication Server 1000M
- Avaya Aura® Unified Communications (future)
- Avaya one-X® softclients (future)

### About Hawaii Medical Center

Hawaii Medical Center (HMC) is a full-service, acute and tertiary care hospital system with two campuses on Oahu. HMC West provides comprehensive general hospital care and primarily serves the nearly 160,000 residents of Leeward Oahu and the Waianae Coast. HMC East is designed to service physician specialty referrals and includes the Transplant Center of the Pacific and a skilled nursing facility.

HMC's stated vision is to be one of the most respected and innovated providers of quality healthcare in Hawaii and to be recognized for its commitment and relevance in meeting the changing needs of its people.

### About Avaya

Avaya is a global leader in business communications and collaboration systems, providing unified communications, contact centers, data solutions and related services to organizations of all sizes around the world. For more information please visit [www.avaya.com](http://www.avaya.com).

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Source: Avaya

# Best Practices: 10 Steps to Overcome VoWLAN Challenges



**Tim Zimmerman:**

Tim Zimmerman is a research director in Gartner Research. His research includes networking issues focusing on wired and wireless local-area networking (WLAN) technologies and vendors as well as RFID and ruggedized mobile devices.

Mr. Zimmerman's previous experience in the wired and wireless networking industry has included technical, marketing and management roles with Intermec, SyVox, Hand Held Products, Meru Networks and Norand, totaling more than 20 years.

Although the momentum of wireless is growing, the penetration of wireless LANs (WLANs) in enterprise office environments beyond conference rooms and reception areas is limited. IT organizations are looking to further their all-wireless office strategies to consider supporting applications beyond just data. This research looks at the challenges of this and provides best practices for users who expect toll-quality calls on their smartphones. It also addresses the concerns of enterprises that are looking to completely cut the wires to the desktop.

## Key Findings

- Most voice over wireless LAN (VoWLAN) phones have single antennas that take advantage of only a portion of the robust 802.11n functionality, such as multiple-input and multiple-output (MIMO).
- Wireless coverage for VoWLAN must be different than traditional data-centric implementations. Users expect coverage to be available in hallways, stairwells and elevators, as they move throughout the enterprise.
- Latency is one of the biggest issues associated with VoWLAN, since it is responsible for jitter and dropped calls. Tools for measuring and identifying issues with end-to-end voice streams over wired and wireless mediums are very limited.

## Recommendations

- Ensure that the enterprise WLAN meets the capacity and transaction density requirements for all applications, including voice. Phone calls must not drop or be distorted throughout the targeted areas.
- Document and enforce an enterprise device security policy, such as WPA2, so that VoWLAN devices do not become a network access gateway for hackers.
- Define metrics and measure and proactively manage the latency associated with VoWLAN streams to ensure toll-quality communications. Roaming events must stay under 100ms to ensure high-quality continuous voice.

## ANALYSIS

Although commercial WLAN hotspots are seemingly everywhere, their penetration in enterprise office environments beyond conference rooms and reception areas is limited. IT organizations are looking to further their all-wireless office strategies to consider supporting applications beyond just data. One such application is voice. VoWLAN has its promises and challenges. WLAN deployments at the edge of the network are providing increasingly better performance and pushing wired networking back to the core. As capacity and reliability improve in properly designed WLANs, enterprises are

considering supporting VoWLAN to replace wired phones, the use of cellular phones in buildings and two-way radios.

Designing a network to support VoWLAN requires a more systematic and thorough design approach than was required for wireless infrastructures that only serviced clients looking to check e-mail or access the Internet. This approach should include thorough pre- and post-site surveys to determine compliance with signal requirements, channel layout, data rates and other parameters needed to make the implementation successful.

This research identifies the inherent challenges of voice solutions and lays out a set of best practices to help enterprises maximize their voice experience in offices, hospitals or any environment where wireless has been deployed.

## Challenges That Affect VoWLAN

Some of the inherent characteristics of voice and wireless media that make deploying VoWLAN a challenge include:

- Capacity and transaction density
- Low tolerance for jitter/latency
- The antennas of VoWLAN clients

- Call flow and compression algorithms used in 802.11 handsets
- Handset security and physical standard limitations

### Capacity and Transaction Density

The bandwidth or total capacity of an access point decreases as the distance from the access point (AP) increases. Voice deployment requires predictable bandwidth throughout the premises. This requires that enterprises understand the number of potential active users in a coverage area and allocate the necessary bandwidth to ensure connectivity in a worst-case scenario. Enterprises should plan for the consumption of 6 Mbps per user in a given access point to accommodate data, voice and video traffic. Although voice clients don't require this kind of capacity, the strategic planning assumption enables each user to have a unicast video stream, in addition to an active voice call. This scenario requires that enterprises plan for overlapping coverage, layered access points and frequency steering to meet capacity requirements.

### Low Tolerance for Jitter/Latency

Although enterprises try to ensure that each user has the capacity for his or her call, it is latency that actually kills the quality of any voice call. A delay of 100 ms may not cause a call disruption, but it could affect call quality, causing the conversation to become garbled and of poor quality (jitter). Although these problems can be tolerated in the wide-area market, where mobile phones typically have such problems, in the office, where toll-quality voice is expected (as delivered on desk phones), such a reduction in quality would not be acceptable.

### The Antennas of VoWLAN Clients

While 802.11n access points support 2x3 or 3x3 MIMO to provide better coverage, and frame aggregation to improve performance, it is important to note that Wi-Fi-enabled phones typically have only

one antenna and support specific channel configurations. Specifications for each device are listed on the manufacturer's website. The specifications for several popular smartphones, including the Apple iPad, Cisco Cius and Apple iPhone 4, follow:

- The Apple iPad is a one-spatial stream (single antenna), 802.11n-enabled device that operates in 2.4 GHz and 5 GHz spectrums using 20 MHz channels.
- The Cisco Cius tablet is a one-spatial stream (single antenna), 802.11n-enabled device that operates in the 2.4 GHz spectrum using 20 MHz channels, and the 5 GHz spectrum using 20 MHz or 40 MHz channels.
- The Apple iPhone 4 is a one-spatial stream, 802.11n-enabled device that operates in only the 2.4 GHz spectrum using 20 MHz channels.
- The Cisco 7925 is a single-antenna, 802.11a/b/g-enabled device that operates in the 2.4 GHz spectrum using 20 MHz channels, and at 5 GHz using 20 MHz channels.
- The Cisco 9971 is a single-antenna, 802.11a/b/g-enabled device that operates in the 2.4 GHz spectrum using 20 MHz channels, and at 5 GHz using 20 MHz channels.
- The Snom 8xx uses a USB radio that is a one-spatial stream (single antenna), 802.11n-enabled device that operates in the 2.4 GHz spectrum using 20 MHz channels, and in the 5 GHz spectrum using 20 MHz or 40 MHz channels.

### Call Flow and Compression Algorithms Used in 802.11 Handsets

When a VoWLAN is being used, it is important to understand the communications that are taking place. The general call flow includes call signaling, which coordinates the placing,

offering and answering of the call. How the endpoints communicate with each other is covered by either H.323 – an umbrella specification defined by the International Telecommunication Union – Telecommunication Standardization Sector (ITU-T) that includes a group of protocols for voice and video over networks – and Session Initiation Protocol (SIP), which was developed by the Internet Engineering Task Force (IETF) and defines voice communications using Internet specifications.

In addition to how voice is communicated, it is important to understand how it is compressed. The amount of bandwidth used in a voice call largely depends on compression algorithms. Most of the 802.11 handsets support G.711a, G.711u and G.729a audio compression codecs that require about 64KB of throughput.

### Handset Security and Physical Standard Limitations

Voice handset development has not kept pace with WLAN infrastructure development:

- Many legacy handsets do not support the latest security standards. Falling to the lowest possible security settings to enable voice traffic makes the network vulnerable to attacks.
- Many WLANs restrict the number of devices in active call mode per AP. If more devices try to connect, the call is not allowed. If a device roams into an access point that is at its maximum, the call will be dropped.
- Power conservation on voice handsets is also a problem, reducing expected battery life to only a few hours.

### Best Practices to Optimize a WLAN to Support VoWLAN

To overcome these challenges, follow these best practices to minimize problems with VoWLAN implementations.

## Properly Configure High-Density Voice and Video-Rich Wireless Deployments

For areas with a large number of end users or devices simultaneously accessing the WLAN, it is important to properly design and configure the wireless network for high-density usage. The following radio frequency (RF) design best practices are recommended to help properly deploy a high-density wireless network:

- **Accurately assess end-user bandwidth requirements:** Determine the bandwidth required for each user and the number of users to be supported by each access point.
- **Determine total bandwidth for each access point:** Calculate the total bandwidth required for each access point by multiplying the bandwidth required by the number of users to be supported by each access point.
- **Signal-to-noise ratio:** The signal-to-noise ratio for the environment should be 25 dB to 30 dB for a VoWLAN installation. This means that, typically, the receiver sensitivity should be -67 dBm to -70 dBm throughout the entire coverage area.
- **Verify coverage areas:** When we think of wireless coverage, it is easy to think of cubicles and offices as work areas, but with voice, areas such as hallways, elevators and stairwells also need to be covered appropriately, since users will carry their phones and will expect to remain connected.
- **Verify the packet loss:** There should be no more than 1% packet loss on the network, whether the connection is wired or wireless, to ensure a quality voice experience.

- **Perform a thorough site survey:** A site survey helps define the contours of RF coverage for each area within a building and on campus. By performing a thorough site survey, organizations can discover building regions where multipath distortion is occurring and uncover campus areas where RF interference is high. The site survey also helps organizations more accurately determine the number of access points required to meet business and operational requirements.
- **Accurately define and test access point placement:** Determine the best placement for each access point and the distance between access points based on the site survey results, channel availability and total bandwidth required for each access point. In general, the closer each access point is to its neighboring access point, the more important it is to control the RF environment. The exact distance between access points is determined during the site survey.

Although enterprises are looking to design the WLAN for the best voice performance, regulations may also require that it be designed for location. Enhanced 911 (E-911) regulations and the associated requirements may vary in regard to the required accuracy, but the WLAN infrastructure must also consider the ability to accurately determine the location of Wi-Fi devices.

### Disable Lower Data Rates in 2.4 GHz/5 GHz, and Utilize All the Available 5 GHz Channels

When 802.11a/b/g clients communicate on the WLAN, they can pull down overall WLAN performance. 802.11a and b clients only should be phased out in favor of 802.11g or 802.11g/n devices. Gartner recommends that you consider disabling the modulation coding schemes that reflect the lower 2.4 GHz or 5 GHz data rates on the WLAN (such as 1 Mbps and 2 Mbps, up to 11 Mbps).

Encourage dual-band clients to operate in the 5 GHz frequency by enabling the band steering functionality in the access point. Because 5 GHz has eight times the spectrum of 2.4 GHz, it is usually less congested. Band steering encourages clients to use the 5 GHz bands, helping free 2.4 GHz bands in mixed client environments.

In the U.S. Federal Communications Commission (FCC) regulatory domain, DFS for radar avoidance is required to use the 5 GHz channels in the UNII-2 and UNII-2 Extended bands. Implementers should be careful about turning on DFS in areas where regulations do not require it. DFS in a WLAN with a poor signal-to-noise ratio may see the access points reconfigure dynamically if there is a temporary interference source. Wireless intrusion protection should be used to detect and alert the enterprise when there is an issue other than from the military or a satellite, where regulations require DFS, so that non-DFS situations can be addressed permanently.

### Use Separate SSIDs and VLANs

To optimize the performance and security of the WLAN, it is important to choose configuration settings that are best for the application requirements. Most of these settings will apply to the access points. In order to allow the best granularity for policy enforcement, including quality of service (QoS), we recommend that voice be placed on a separate service set identifier (SSID) than data traffic, if possible. This allows SSIDs to be aggregated or mapped into a voice-specific VLAN. While this will help voice-only devices, tablets or laptops that are used for more than voice will require a choice based on the primary usage scenario for the device. For enterprise deployments, we also recommend that broadcasting the SSID be turned off, since anyone who is supposed to use the SSID will know about it.

## Avoid Limitations on Active Calls per Access Point

The challenge of transaction density is important. Some solutions have a hard-coded limitation to the number of active calls that an access point can support. If a VoWLAN device with an active call roams into a coverage area and the number of active calls has already been maximized, the call may be dropped; or if a person is already in a coverage area where the limit has been reached, the call may not be initiated. It is important to plan for these scenarios upfront – imagine a dropped call when a nurse is talking to a doctor. Implementers need to ensure that the necessary resources are available to address all potential VoWLAN needs if the number of calls is adaptive, or provide overlapping coverage with load balancing or some other mechanism that allows the mobile client to roam to an access point that has not been operating at maximum call capacity.

## Turn Off Dynamic Transmit-Power-Level Control

Transmit power control (TPC) is a technology that has been used for years in the cellular industry to help phones conserve power and reduce fading issues as people move through the coverage cell. This functionality and DFS mechanisms are defined in 802.11h, and ratified as part of the 802.11 standard to ensure a standard method of operation under the European regulatory requirements governing the 5 GHz band. Beyond the regulatory concerns, wireless vendors have extended the marketing of TPC to provide self-healing capabilities by increasing the power in the coverage cell when the WLAN infrastructure detects a coverage hole in the WLAN due to access point failure or changes in the coverage area.

The complication with dynamically increasing or decreasing the transmit power on the access point is that it significantly affects the abilities of the mobile clients attached to the access point. Users may be standing in one spot today and communicating well,

and the next day be in a coverage hole. A properly designed WLAN should not need to dynamically change its access point power.

## Improve QoS With WMM

Wireless Multimedia Extensions (WME), also known as Wi-Fi Multimedia (WMM), is a Wi-Fi Alliance interoperability certification, based on the IEEE 802.11e standard. It provides basic QoS functionality for WLAN networks. WMM prioritizes traffic according to four access categories – voice, video, best effort and background. Without this prioritization feature, priority access to the wireless medium is carried out using a queuing system that does not guarantee any prioritization of voice traffic. Additionally, while voice-only devices should be designed to use WMM, soft clients on devices such as laptops or smartphones may only see voice as another application, and may not take advantage of the additional QoS capabilities.

## Monitor and Proactively Address Latency

Latency is one of the biggest issues that affects voice. Network vendors that control both the wired and wireless components should be able to manage and control latency issues that will allow them to identify and resolve issues, while maintaining toll quality on the VoWLAN voice stream. Without solution-specific functionality, enterprises are left with a limited toolset, such as using Opnet Technologies to measure packet latency. While this solution can identify when a voice stream is experiencing latency above a recommended threshold, it can only provide directionality where the latency is occurring, unless measurements are done at each component.

## Configure Switches to Recognize 802.1p

One of the things that implementers need to remember is that, while a portion of the traffic is wireless in a WLAN solution, it also traverses the wired infrastructure. Switch vendors with wired and wireless products should be able to add value, such as seamless configuration of parameters and

optimization of component hand-offs with end-to-end control of the voice stream. Implementers of multiple vendor solutions need to make sure QoS tags match. Configure Ethernet switches to recognize 802.1p or DSCP tags to maintain QoS when wireless packets traverse the wired medium to reach the central controller.

## Use Network and System Management

The following system management tips apply to all devices, but should specifically be followed for VoWLAN devices, since the communication parameters are not seen by the end user:

- **Choose strong SNMP community strings** – Although many network administrations will use a graphical user interface to configure the parameters of one or many phones via a common profile, SNMP configurations are often still available on many devices. A strong configuration string prevents the device from being hacked and turned into a gateway onto the network.
- **Configure all SNMP ports to read-only, if possible** – This is highly recommended if configuration is being completed through other means.

## Detect and Mitigate Interference and Security Issues With WIPS

Interference from Wi-Fi and non-Wi-Fi sources can dramatically affect WLAN performance and end-user satisfaction. Gartner recommends that organizations regularly scan the RF environment and immediately address RF interference that affects the WLAN. Reducing wireless RF interference helps improve network reliability and performance for all Wi-Fi clients.

Source: Gartner RAS Core Research, G00213414, Tim Zimmerman, Michael J. King, 7 June 2011



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