Introduction to Voice over Wireless LAN (VoWLAN)

White Paper

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Introduction

Voice over Wireless LAN (VoWLAN) is a technology involving the use of wireless voice communication over a network or the Internet. To understand how VoWLAN works, it is important to first understand how this technology came to be what it is today. This white paper will take a look at the various stages of technological progression involving VoWLAN and provide an overview of the technology, beginning with the introduction of wireless LAN (Wi-Fi), before proceeding to look at Voice over IP (VoIP) and Voice over Wireless LAN (VoWLAN).

Wireless LAN (WLAN)

Before Wi-Fi (short for “wireless fidelity”) was introduced, most organizations would already have been on wired local area network (LAN). The term ‘Wi-Fi’ is coined by the Wi-Fi Alliance to specify wireless local area networks (WLAN) based on IEEE 802.11 standards. The role of the Wi-Fi Alliance is to oversee the testing of products’ interoperability with IEEE 802.11 specifications and qualify products that pass the tests with a label “Wi-Fi certified” (registered trademark).

The 802.11b standard, often called Wi-Fi, is part of the IEEE 802.11 standards. It uses the Ethernet protocol and CSMA/CA (carrier sense multiple access with collision avoidance) for path sharing. The modulation method for 802.11b is known as complementary code keying (CCK), which allows higher data speeds and low susceptibility to multipath propagation interference. For more information on IEEE 802.11b standard, please refer to specifications defined by the IEEE.

The 802.11g standard is also an IEEE specification for wireless local area networks (WLANs). It provides high-speed wireless transmission over relatively short distances up to 54 megabits per second (Mbps) as compared to 11 Mbps theoretical maximum with earlier 802.11b standard.

Networks employing 802.11g operate at radio frequencies between 2.400 GHz and 2.4835 GHz, the same band as 802.11b. The difference however is 802.11g employs orthogonal frequency division multiplexing (OFDM) instead of CSMA/CA to obtain higher data speed. An FDM modulation technique transmits large amounts of digital data over radio wave and works by splitting radio signal into multiple smaller sub-signals for transmission simultaneously at different frequencies to the receiver. This feature makes 802.11b and 802.11g devices compatible within a single network, and modification of an 802.11b access point to 802.11g usually needs only a firmware upgrade.

Many businesses and establishments today are using WLAN solutions as an extension to their wired LAN. Service providers, airports, hotels, fast-food facilities and others are offering public access to Wi-Fi networks and the Internet through hot spots at various locations where there are network access points (APs). With these access points and hot spots, users of laptops, PDAs and other gadgets can now access the Internet over Wi-Fi almost anywhere.

Voice over IP (VoIP)

The primary purpose of Wi-Fi when it was first introduced was for access to the Internet and for use with certain applications on various electronic gadgets. As the technology progresses, Voice over Internet Protocol (VoIP) was introduced.

VoIP offers voice communication over Wi-Fi networks as an alternative to communication through standard telephone, mobile cellular phones or other communication devices. It allows a phone call to be made over the Internet using Internet Protocol (IP) and provides substantial cost savings through this mode of communication in comparison to traditional telecommunication.

To use VoIP, telephones designed specifically for Voice over IP systems are required for conversion of standard telephone audio into digital form for

transmission over the Internet and likewise for conversion of incoming digital phone signals from the Internet to standard telephone audio. Physically, a VoIP phone resembles a traditional wired or cordless telephone.

Voice over Wireless LAN (VoWLAN)

Voice over Wireless LAN (VoWLAN) is the next wave technology involving the **use of voice communication over the Internet** after VoIP. VoWLAN is a method of sending voice information in digital form over a wireless **broadband** network, similar to VoIP but differing from it in that VoWLAN delivers voice over wireless devices, not wired phones. Based on the same IEEE 802.11 (Wi-Fi) specifications, VoWLAN transports data over wireless local area networks or the Internet and is sometimes called "VoWi-Fi" or "Wi-Fi VoIP".

VoWLAN uses voice-enabled wireless devices such as PDAs or Wi-Fi phones to communicate. A Wi-Fi phone looks and operates like a cellular phone, but sends voice over WLAN access point to a VoIP gateway or IP PBX as discrete data packets instead of analog voice stream. When a call is made, the voice data is transmitted across to the destination within the private network or out onto the Internet or Public Switched Telephone Network (PSTN). Software-based ‘phone’ application or ‘softphone’ may also be used to communicate through devices such as a laptop or desktop computer.

Considerations before Deployment

As can be seen from the description in this paper thus far, there are many benefits and compelling reasons for switching to a VoWLAN system. However, there are several factors that must be considered before deploying any VoWLAN solution. These factors include current limitations and barriers inherent with VoWLAN solutions, such as bandwidth, payload sizing, voice performance, encoding and decoding methods, compression techniques, Quality of Service (QoS), speed and reliability of encryption and authentication methods, proprietary nature of available products, and others.

Proper capacity planning is one of the most important factors to consider when deploying packet voice networks such as VoWLAN. This includes bandwidth calculation, designing, payload sizing, and ensuring good voice quality.

To calculate how much bandwidth a voice call occupies depends on a number of factors. Among the most important are:

- Codec and sample period
- IP/UDP/RTP header
- Transmission medium
- Silence suppression

The codec (coder/decoder) determines the amount of bandwidth the voice data occupies and the rate at which the voice is sampled. The number of codec samples per packet will affect how many packets are sent per second (pps) and the quality of voice transmission.

The IP/UDP/RTP (Internet Protocol User Datagram Protocol Real-time Transport Protocol) header is generally seen as a fixed overhead of 40 octets per second although on point-to-point links, RTP (Real-time Transport Protocol) header compression can reduce this to 2 to 4 octets (RFC 2508).

The transmission medium will add its own headers, checksums and spacers to the packet, while silence suppression can reduce the required bandwidth by as much as 50 percent.

Depending on the category of codec complexity will determine the resources required. There are two categories of codec complexity: medium and high complexity. The difference between medium and high complexity codecs is the amount of CPU utilization necessary to process the codec algorithm. Two

of the more popular voice codecs used by VoIP and VoWLAN solutions are G.711 and G.729.

G.711 is a pulse code modulation (PCM) codec for voice frequencies telephone encoding on a 64 kbps channel. It operates at 8 kHz sample rate with 8 bits per sample or 8000 samples per second. Two different encoding algorithms are used by G.711: *mu-law* and *a-law*. Mu-law is used in North America and Japan and a-law is used in Europe and the rest of the world. There is no significant difference between the two algorithms, but the correct version must be used in order to successfully interoperate with other devices.

G.729 is a codec that use Conjugate-Structure Algebraic-Code-Excited Linear Prediction (CS-ACELP) speech compression algorithm to conserve bandwidth. While G.711 uses 64Kbps, G.729 can use as little as 8Kbps. This can make a big difference on internet connections with low bandwidth or poor quality.

The key issue of deploying VoIP or VoWLAN is in managing voice quality with limited bandwidth. This may be done by determining how many simultaneous voice calls are required over WAN links and the consumption of each voice call. Considerations will need to take into account the compression technique of the different codec used, the voice payload size and the type of link to calculate for optimal configuration. Depending on the configured voice payload size will determine the bandwidth used. When the voice payload size is increased, the bandwidth reduces and the overall delay increases.

For example, if a G.729 call with voice payload size of 20 bytes (20 ms) is required, it will mean:

> (40 bytes of IP/UDP/RTP headers + 20 bytes voice payload) * 8 bits per byte * 50 pps = 24 Kbps.

If a G.729 call with voice payload size of 40 bytes (40 ms) is required, it will mean:

> (40 bytes of IP/UDP/RTP headers + 40 bytes voice payload) * 8 bits per byte * 25 pps = 16 Kbps.

Based on the calculations shown above, it can be seen that while the payload size is doubled, the number of packets per second required for the latter is reduced by half.

Having gone through all the considerations mentioned in this paper, a capacity planning prior to venturing into packet voice network solutions is now possible. Knowing the requirements will help determine the optimal voice payload size required for use in maintaining an acceptable level of voice quality in transmission.

Wi-Fi Phones

To communicate using VoWLAN, Wi-Fi phones or cellular phones with built-in Wi-Fi capabilities will be required. Wi-Fi phones are essentially wireless phones that communicate using signals similar to the way cordless phones work. Signals are received by Wi-Fi enabled devices to establish connection to high speed phone lines wirelessly at locations where there are hot spots with access points (APs).

Hot spots are Wi-Fi access enabled points that are located in public areas, such as fast food chains, restaurants, airports, and many others. There are a variety of ‘hot spots’ which allow access to the Internet via Wi-Fi, and these hot spots can normally reach a range of 300 feet (91.44 meters) with no obstructions or network congestion. Locations with hot spots in the vicinity provide a great way to send and receive voice transmission over the Internet using a Wi-Fi phone with high speed transmission of data without restriction by wires. For business people that need to make calls at high speeds or

access the Internet on the move, this technology provides an effective solution to meet their needs.

Access Points (APs) are locations where Wi-Fi network have been enabled to connect users to other users within a network or the Internet, and can serve as the point of interconnection between the WLAN and the wired network. APs enable the transmission and receiving of wireless data and act as a transceiver. Each access point can serve multiple users within a defined network area. Where users go beyond the range of an access point, the next one is automatically established. The number of access points on a WLAN depends on the number of users and the size of network.

Wi-Fi phones use VoIP technology to translate conversations into data that is sent over the Internet wirelessly, rather than by standard circuit-switched phone system still commonly used today. **The key advantage of a Wi-Fi phone is its ability to transmit data at high speed, faster than traditional cellular phone. The disadvantage is that Wi-Fi coverage is not as broad as the cellular phone.**

There are a variety of factors that determine just how **fast** connection and data transmission will be. These factors include:

- The number of people accessing the Internet through the same hot spot
- The proximity of the nearest access point to the Wi-Fi device
- Software and Wi-Fi card specifications
- Speed of access point cabling
- Obstruction of Wi-Fi signals during transmission (example, metal and concrete)

The security offered by Wi-Fi technology currently is not as good as that offered by standard Internet access. All wireless Internet access devices have certain degree of security risks, hence it is a good idea to restrict wireless

surfing to data extractions and transmission rather than to send and receive confidential information. Using this approach provides maximum benefit of speed and convenience without jeopardizing security risks.

Wi-Fi technology offers one of the fastest and most convenient solutions to wireless access, both indoors and outdoors, using radio waves to connect and transmit data. Data transmission is no longer restricted to just offices and buildings but anywhere with access points. With public access points and hot spots, everyone can now enjoy the benefits of Wi-Fi technology and gain full wireless access to files and connection to corporate networks at just about any place, reaping the benefit of a mobile office without the hassle of wires or connections, thus enabling many more people to enjoy cost-effective connectivity. With the number of hot spots and access points increasing by the day, accessibility to Wi-Fi technology is no longer a concern.

Using Wi-Fi phones to make calls generally helps reduce the cost of call charges and access fees, depending on the alternative Internet telephony service subscribed. No extra charges for long distance calls are usually required using voice over IP solutions because the concept of 'long distance' does not exist with this type of technology. Wi-Fi devices are normally lightweight and convenient, and although there are a limited number of Wi-Fi phones on the market at the moment, this number is rapidly increasing, and consumers can select from a wide range of choices.

There are many benefits to using Wi-Fi phones. The main benefits include:

- Convenient wireless access on the go
- Savings on calls and access fees charged by traditional cellular phone service providers, depending on alternative telephony service subscribed (for example: Skype).

- Increasingly easy access with hot spots and access points being located in many public areas.
- Configurable high speed data processing and access using codec sampling per packet and voice payload sizing.

As the technology in this area continue to advance, the accessibility and choices that come with Wi-Fi technology will be broaden and this is likely to increase in popularity and usability with Wi-Fi phones or cellular phones with converged capabilities of Wi-Fi, depending on the types of service and availability from the various telephony service provider. As of now, Internet telephony service provider such as Skype is gaining popularity with their service which offers free calling between computers and low-cost calling to regular telephones that aren't connected to the Internet. For details and updates of their services, please visit their web site at: http://www.skype.com.

Setting up a Wi-Fi Environment

Setting up a Wi-Fi environment is relatively easy, fast and cost-effective.

IEEE 802.11 network infrastructure with Wi-Fi devices connected wirelessly via Access Point (AP) or wireless router for data transmission

To set up a basic Wi-Fi environment for wireless Internet access, all that is needed is a Wi-Fi enabled device and a wireless Access Point (AP) with connection to the internet. This usually takes the form of a DSL or ADSL modem which users of broadband Internet access should already possess.

The wireless AP or wireless router can be purchased from any networking solution vendors. Signal boosters may also be purchased if required, to improve the reliability and functions of the wireless system. Once installed, the configuration should allow about 100 feet (30.48 meters) of coverage in all directions. Detailed instructions on setting up a Wi-Fi environment are available with the access point purchased. If needed, access point retailers or manufacturers may also be contacted for assistance.

To enable voice communication over Wi-Fi, devices such as PDAs, laptops, desktop computers or Wi-Fi enabled devices will be necessary. The wireless AP will receive the signals from the Wi-Fi device and transmits data over the network that it is connected to, in most cases, the Internet.

When installing a Wi-Fi system, a key point to remember is that walls and other obstructions can affect the signal from the access point. Signal boosters should be able to help with this, but it is still an important point for consideration when purchasing an access point and when deciding on where to place it.

Wi-Fi phones are available at fairly reasonable price and new models are gradually being introduced with better functionality. Together with the necessary equipment for the wireless system, a complete Wi-Fi environment solution should be available at an affordable cost. When purchasing Wi-Fi phones, areas to consider may include phone features, system standards and requirements, protocol support, IEEE standard specifications, support for Sessions Initiation Protocol (SIP), amongst other technical details.

Future of Packet Voice Network Solutions

The IEEE and the Wi-Fi Alliance have been developing standards for improvements to mitigate limitations in VoIP and VoWLAN solutions. Consideration for improvements include intelligent security and better encryption for networks using 802.11i standard in speeding up authentication with roaming, 802.11e standard for defining QoS measures to prioritize voice traffic, 802.11r standard to specify fast-roaming protocol to minimize packet loss when users move from one access point to another within a WLAN, and 802.11k standard for Radio Resource Management protocol to enable pre-discover handset conditions of WLAN networks in selecting the best available paths.

Currently, VoWLAN solution is most frequently used in the retail, manufacturing and health care sectors because of the early adoption of WLANs. As greater enhancements are being fine tuned in VoWLAN, deployment of VoWLAN will gradually see a greater interoperability and seamless mobile connectivity between private WLANs and public wireless and cellular networks.

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