



Objectives

Upon completing this chapter, you will be able to

- Understand the role of Voice over Wireless LANs (VoWLAN).
- Define VoWLAN applications.
- Determine ROI of a VoWLAN solution.

VoWLAN Applications and Benefits

This chapter describes various applications of Voice over Wireless LAN (VoWLAN) systems. Real-world examples and case studies provide you with a solid understanding of how VoWLAN can benefit a company. Details are also given about tangible benefits and expected return on investment (ROI).

The Role of VoWLAN Solutions

VoWLAN systems are an extension to wired Voice over Internet Protocol systems and an alternative to traditional analog and digital voice communications. VoWLANS offer significant benefits of providing mobility and wirelessly converging voice with data applications. With VoWLANS, hospitals, enterprises, retail stores, warehouses, and home owners can reduce telephony costs and enable mobile applications.

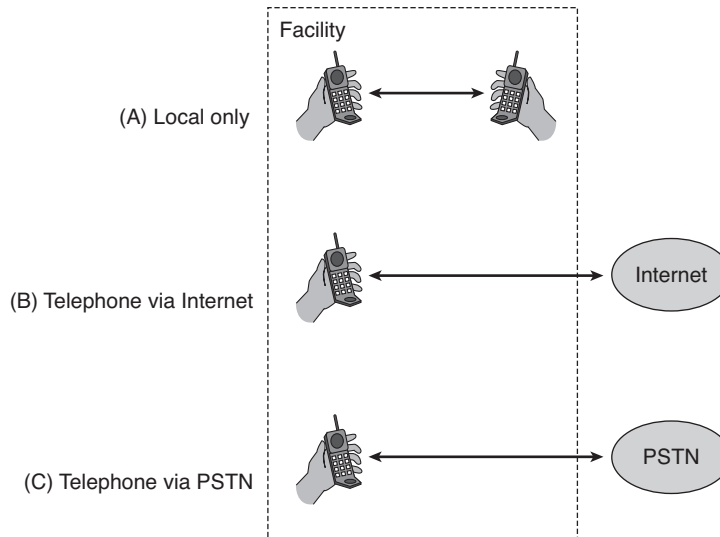
Examples of the systems that VoWLANS can replace include the following:

- Wired telephones
- Cellular telephones
- Two-way radios

With VoWLANS, people can use VoWLAN phones to communicate by voice wirelessly with others inside and outside a facility. The experience is very similar to using a traditional wired telephone, except the user is free to move about the building. Furthermore, a VoWLAN phone can operate from many of the growing Wi-Fi hotspots, enabling a person to make use of the same mobile phone while within or away from the office or home. Some cellular phones incorporate VoWLAN capability, which enables users to make calls over traditional cellular networks when no wireless local-area network (wireless LAN) is available.

Figure 1-1 shows the basic usage models of a VoWLAN system. The optimum approach depends on user requirements and existing telephone hardware.

The local-only configuration (part A of Figure 1-1), which is similar to two-way radios, consists of a wireless LAN that merely enables a user to talk to other users directly connected to the network. This supports a mix of wireless and wired VoIP telephones. For example, a clerk looking for a part in a warehouse may use a VoWLAN handset to communicate with a manager sitting at a desk and using a wired VoIP phone.

Figure 1-1 VoWLAN Usage Models: (A) Local Only, (B) Telephone via Internet, and (C) Telephone via PSTN

More advanced VoWLAN systems (Parts B and C of Figure 1-1), however, allow users to place actual telephone calls from their VoWLAN handsets. The telephone traffic can travel over the Internet or the Public Switched Telephone Network (PSTN). With these two models, the use of the system is virtually the same as a traditional telephone. For example, a sales agent in her home office in Ohio may dial a phone number on her VoWLAN phone to call a customer in California.

The primary benefit of VoWLAN solutions is cost savings. For instance, according to recent studies, federal, state, and local agencies could achieve savings of \$4.5 billion annually by making telephone calls over the Internet. In addition, VoWLAN systems are easier to deploy and allow flexible communications. VoWLAN plays a critical role in realizing these savings by mobilizing the workforce.

History of VoWLANs

The two primary technologies of VoWLANs are wireless LANs and VoIP. Both have been evolving over the past decade and are now stable enough to support wireless voice communications.

VoIP

The earliest indication of VoIP systems was in the mid-1990s, when Vocaltec, Inc. released Internet Phone Software. This software ran on PCs and translated voice signals into digital packets that could be sent over the Internet. Both the sending and receiving callers must use

the same software. Sound quality was not as good as traditional telephones, but long distance calls could be made for free.

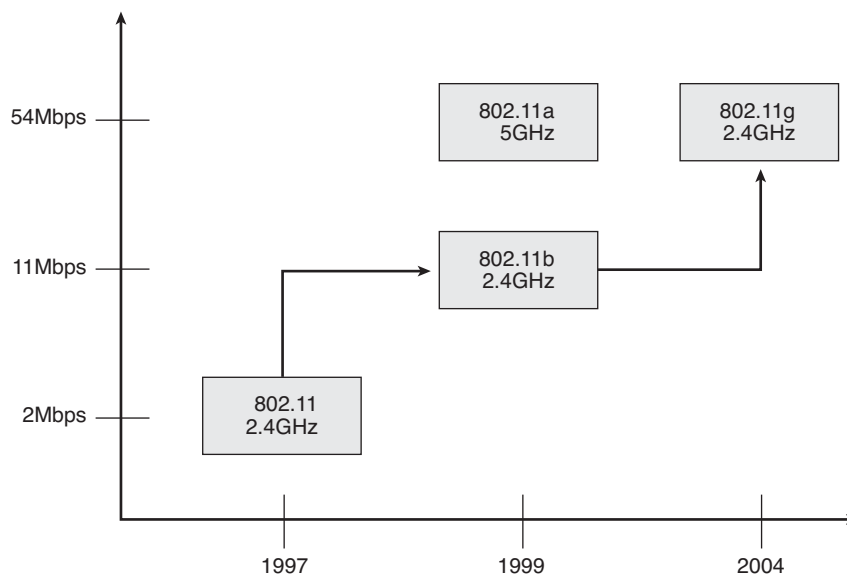
Throughout the late 1990s, entrepreneurs began establishing gateways and switches to allow people to make free phone calls over the Internet using standard telephones. The users had to utilize a PC to set up the call, but then they were free to talk from standard wired telephones connected to a PC. With these systems, the VoIP market began evolving. Many companies, including Cisco, began selling VoIP equipment about the year 2000 to enterprises to converge voice and data and provide mobility.

Wireless LANs

In the early 1990s, the first wireless LAN products, NCR WaveLAN and Motorola Altair, appeared on the market. At this time, there were no applicable standards and prices were relatively high, at around \$1,500 per wireless adapter. As a result, only companies having applications with significant benefits from wireless connectivity, such as inventory management and price marking, could afford to deploy wireless LAN solutions.

Figure 1-2 summarizes the evolution of the 802.11 standard. In 1997, the Institute of Electrical and Electronics Engineers (IEEE) ratified the first version of the 802.11 wireless LAN standard. 802.11 at this point provided up to 1Mbps and 2Mbps data rate operation in the 2.4GHz frequency band using direct sequence and frequency hopping, which are both spread spectrum technologies. The capacity of these first 802.11 solutions was not good enough to effectively support voice applications.

Figure 1-2 *Evolution of the 802.11 Standard*



To enhance the performance of wireless LANs, the IEEE ratified the 802.11a and 802.11b standards in 1999. 802.11a provides up to 54Mbps data rates in the 5GHz band using orthogonal frequency division multiplexing (OFDM). 802.11b extends the maximum data rates of the initial 2.4GHz direct sequence 802.11 standard to 11Mbps. Later, in 2004, IEEE released 802.11g, which further extends data rates in the 2.4GHz band to 54Mbps using OFDM. The higher data rate 802.11 standards, 802.11a, 802.11b, and 802.11g, offer adequate capacity for supporting VoWLAN applications. 802.11a, however, provides the highest capacity, mainly because the Radio Frequency (RF) channels in the 5GHz band do not overlap with each other as they do in the 2.4GHz band. 802.11n, which will offer 100Mbps or more performance, is nearing ratification.

Other recent improvements to the 802.11 standard include security (802.11i), which includes much stronger encryption and authentication mechanisms than the initial standard. The use of Temporal Key Internet Protocol (TKIP) and Advanced Encryption Standard (AES), along with 802.1i protocols, makes wireless LANs very secure. Also, the ratification of the 802.11e standard in 2006 offers quality of service important for VoWLAN applications.

Within the past couple of years, the prices for wireless LAN adapters have decreased to well under \$100 each. This dramatic drop in prices has fueled the proliferation of wireless LANs for a variety of applications in all markets. The Wi-Fi Alliance has also been actively promoting wireless LANs through the Wi-Fi brand and mandating interoperability testing.

Because of the proliferation of wireless LANs, VoWLAN solutions are also proliferating. Companies offering VoIP equipment, such as Cisco, have been marketing VoWLAN phones that interface with their digital telephony systems. Even service providers, such as Vonage, now offer Wi-Fi phones that interface with their Internet Protocol (IP) telephony service.

Healthcare

Hospitals were one of the first users of VoWLAN solutions, such as Vocera, mainly because of the significant need for effective communication among high-valued medical staff. The ability for doctors and nurses to respond quickly with verbal instructions is crucial for saving the lives of patients. For example, Children's Hospital in Madera, California, uses a VoWLAN system to support push-to-talk features on its VoWLAN phones to broadcast Code Blue alerts that summon emergency teams. Patients receive a higher level of care, which leads to faster recovery. VoWLAN systems allow hospital staff to not waste time looking for a phone to use.

An issue with deploying VoWLANs in hospitals, though, is the difficulty in providing adequate wireless LAN coverage. Hospitals include x-ray rooms surrounded by lead, irregular metal objects, and unpredictable traffic flows of people. These factors lead to significant signal impairments. In addition, RF interference from other wireless systems

operating in the 2.4GHz band, such as frequency-hopping spread spectrum devices, can cause degradation in performance. As a result, installers must conduct thorough RF site surveys when identifying optimum placement of wireless access points.

Hospital in Northeast U.S. Benefits from VoWLAN Solution

Doctors and nurses at this hospital, as in others, are always on the move, taking care of patients. To do this effectively, the doctors and nurses must be capable of contacting each other immediately as emergencies arise, which is fairly often. For example, a nurse may find that a particular patient develops complications a few hours after surgery and needs immediate attention from a doctor. Before VoWLAN systems, the nurse would try calling the doctor on a cell phone. Cell coverage in the hospital was not very good, and the call would go immediately to the physician's voice mail. If the nurse could not make immediate contact with the doctor over the cell phone, which was about 75 percent of the time, the nurse would then call the doctor's pager. Pager coverage was very good throughout the hospital. The physician would receive the page and then find a wired phone to call the nurse. This task added significant delays because a phone could not always be found quickly, and the nurse would have to wait around a phone for the doctor to call (taking the nurse away from the patients needing assistance).

The hospital deployed a wireless LAN that supports the use of VoWLAN phones, enabling doctors and nurses to stay in immediate contact with each other. Now when a nurse needs a doctor's attention to help an ailing patient, the nurse can simply call the doctor directly using the VoWLAN phone. All calls go through because the wireless LAN was installed in a manner that provides signal coverage in all parts of the hospital. This solution significantly reduces communications delays, and patients receive immediate attention and care.

The hospital installed 120 wireless LAN access points to provide signal coverage for the VoWLAN phones. To determine optimum access point installation locations, the hospital conducted an RF site survey. Ensuring high enough signal strength and cell overlap throughout the hospital is very important to maintain effective operation of the phones and roaming.

Enterprises

Enterprises are taking advantage of VoWLAN applications to provide mobility to workers and reduce costs through a common network infrastructure for voice and data. In many cases, enterprises implementing VoWLAN are doing so as an extension to wired VoIP systems. A company, for example, can equip the majority of the employees with a wired VoIP desk phone, and VoWLAN handsets are given to the employees needing mobility. Certainly the benefit of going wireless is that users can carry their phone with them throughout the facility, which enables them to respond faster to customer needs and

functions within the company. The use of VoWLAN phones also eliminates the costs associated with rewiring telephone lines when employees change offices.

Enterprise executives making the decision to spend money on the necessary hardware and services need solid numbers before committing funds. An issue with deploying VoIP, and especially VoWLAN, in enterprises, however, is accurately predicting ROI. Assessing the returns a company will achieve by enabling faster response to customer needs, for example, is difficult. A company must be capable of achieving significant productivity benefits before moving forward with a VoWLAN deployment.

Executive Management Team at Corporate Headquarters Benefits from VoWLAN Solution

A particular enterprise, as with most other companies, has an executive management team located in a centralized location of the company's headquarters facility. All of these executives are infrequently in their offices—they manage by walking around and keeping tabs on their various departments. For example, the IT manager is generally visiting with technicians distributed in various parts of the facility, making sure that projects, such as PC hardware upgrades, are going smoothly. The problem is that when issues arise, the technicians have no way of contacting the IT manager immediately. The technicians use a phone in the office where they are working to call the manager's office, and 90 percent of the time must leave a voice message. In most cases, hours would pass before the manager would receive the message.

The solution to this problem was for this company to make use of an existing wireless LAN and deploy VoWLAN phones to the managers. This solution enables just about anyone to reach an appropriate manager within seconds, without experiencing the delays of voice mail.

Universities

A university environment is highly mobile, with teaching staff and students moving among different classrooms, libraries, and offices. The use of VoWLANs at a university offers tremendous benefits by enabling university staff to stay in touch from anywhere on campus. This capability makes teachers more accessible to students, and the learning environment is much safer. A teacher, for example, can report safety issues as they occur, rather than having to wait until a class ends.

A challenge of deploying a VoWLAN system at a university is that coverage must include a wide variety of buildings and outdoor areas. An extensive RF site survey is very important to take into account the varying facility construction and obstacles blocking radio waves. Even after installing the system, reevaluating coverage from time to time is generally necessary to determine whether student traffic and campus functions offer major signal attenuation.

Retail

To satisfy the needs of customers and staff, retail store managers must be accessible from anywhere within the store. Voice communications with these managers is crucial in providing customer satisfaction. For example, a customer may need to replace a part found broken when putting together a newly purchased bicycle, or someone may need to know the status of a shipment of a particular brand of dog food. Whenever the need arises, immediate communication with the store manager is necessary, and customers cannot be kept waiting, or they will shop somewhere else. In this type of environment, VoWLAN really shines. In many cases, the retail store already has an existing wireless LAN, and the store managers and staff can benefit from low-cost telephony.

Retail stores use existing wireless LANs to support bar code applications, such as price marking and inventory management. These applications make the deployment of VoWLAN systems in retail stores more of a plug-and-play situation. The existing wireless applications, however, generally have very low capacity requirements, and the access points already in place may not be capable of supporting the much higher bandwidth demands of voice communications. For example, a store may only have a wireless LAN based on the initial 802.11 standard, such as direct sequence spread spectrum supporting up to 2Mbps data rates. This particular store would need to upgrade its access point hardware to at least 802.11b, which introduces costs for hardware and services in addition to purchasing the wireless handsets.

Retail Chain Goes with VoWLAN Solution

An electronics retailer with 230 stores throughout the United States sells PCs, software, and games. This company makes lots of calls between stores. A customer may want an item, for example, that a particular store does not have in stock. The store clerk would then begin calling other stores to check on the item's availability. This situation happens a lot throughout the day and results in extremely high telephone bills. Another issue is that the store clerk generally learns that the item is not in stock when he or she is with the customer where the item is supposed to be within the store. The time needed to walk back to the register area or office to place the calls to other stores adds enough delay that some customers decide to forego checking on the item at other stores. This delay results in losing potential sales.

To resolve these problems, the retail company decided to make use of the wireless LANs already existing in the stores and supporting bar code applications to support the VoWLAN phones. Now the store clerk can place calls immediately to other stores when performing inventory checks. This solution keeps the customer's attention and results in greater sales. The telephone bills are also much less due to being able to route the phone calls over the company's WAN infrastructure, which interconnects all the stores.

Warehouses

Warehouses involve a host of functions where VoWLAN systems can provide significant benefits. Clerks end up being scattered throughout the warehouse facility, which can be quite expansive, and communication with other clerks and managers is essential to perform various functions. In most cases, having the clerks and managers meet face-to-face to communicate is not practical. In fact, being able to even find each other is often not possible, due to the numerous rows of bins and products. For example, an order may come in for the shipment of a particular item to a customer. Rather than waiting for a clerk to return to the main office, having the shipping department call a clerk directly and have him pick the item is much faster and more productive.

As with retail environments, many warehouses already have existing wireless LANs. However, because these wireless networks primarily support relatively low-performance bar code solutions for implementing inventory management functions, the wireless LAN may not have enough capacity to support a large number of VoWLAN phones. A company must analyze the wireless LAN and ensure that adequate data rates, signal strength, and roaming exist to support wireless voice applications.

Warehouse Deploys VoWLAN Phones to Speed Up Operations

A relatively large warehouse was experiencing delays when processing orders. For example, when assembling an order for shipping, warehouse clerks would pick items from shelves based on lists prepared earlier in the day. Orders would often change, though, which would require the clerks to not pick certain items or pick others that were not on the list. To communicate this information, the warehouse manager would page the applicable clerk through an overhead loudspeaker system. The clerk would then walk all the way back to the manager's office to learn of the changes to a particular order. This process would incorporate delays, which significantly decreased the warehouse's productivity and order placement time.

The solution was to install a wireless LAN for supporting VoWLAN phones. As changes to orders take place now, the warehouse manager can call the clerk directly on the VoWLAN phone and explain the change to the order. This call avoids the need for the clerk to walk back to the manager's office, which speeds up the picking operation. In addition, the installation of the wireless LAN also makes setting up a wireless bar code system for performing inventory management functions possible. This solution will also save the company a tremendous amount of time and money when performing inventories.

Manufacturing

In manufacturing facilities, line supervisors monitor production lines, and managers must be able to contact each other and other employees immediately to check the status of various operations and solve problems that regularly arise. A division manager in charge of

a particular business unit, for example, is certainly anxious to ensure that the plant is getting products ready to ship in time to make revenue numbers. If a part of the orders for that period is at risk of not being completed in time, fixes can be considered and put in place to keep manufacturing on schedule.

A VoWLAN system makes communications in manufacturing extremely beneficial because managers are constantly on the move. In many cases, a manufacturing plant will have an existing wireless LAN in place, making the deployment of a VoWLAN extremely feasible. Even if the installation of wireless access points is necessary, the VoWLAN solution is still worthwhile because of the monetary benefits associated with immediate communications. In this situation, the value of the company to shareholders depends on effective communication among stakeholders in the manufacturing process. A VoWLAN solution allows managers to communicate immediately and solve problems to keep production in line with sales.

Toy Manufacturer Benefits from a VoWLAN System

The managers at a toy manufacturer were having trouble communicating with each other. For example, the manufacturing line for a particular toy would begin having mechanical troubles, which would require the manufacturing line supervisor to shut down production until someone could perform necessary repairs. This plant is large, and a single centralized maintenance group takes care of many production lines. The line supervisor would use his office phone to call the maintenance chief, who would then need to track down the right mechanic to fix the problem. The issue was that “phone tag” would result, causing significant delays. Often an hour or more would elapse before this coordination would be done and a mechanic would be notified that he needed to work on the problem. Meanwhile, the company would be losing \$500,000 each hour the production line was shut down. Something had to be done to speed up communications needed to coordinate maintenance when problems arise on one of the production lines.

To solve the problem, this company installed a wireless LAN throughout the manufacturing plant to support the use of VoWLAN phones. All managers, supervisors, and maintenance staff were equipped with VoWLAN phones. A production line supervisor can now call the maintenance chief directly via VoWLAN phones. The maintenance chief may be out of his office assisting one of the mechanics and still be able to receive the call immediately. The maintenance chief can use the VoWLAN phone to coordinate the right mechanic to fix the problem. Because everyone carries the VoWLAN phone with them at all times, telephone tag is no longer an issue, and communication is immediate. This time savings significantly reduces downtime of the production lines, which in turn improves the company’s profits.

Small Offices and Homes

Many small offices and homes are installing wireless LANs to support mobile access to common Internet applications. Service providers, such as Vonage, are strongly advertising the capability of using the Internet for making phone calls to augment or replace standard

PSTN telephones. Home and small-office owners are taking advantage of Internet telephony to save money on long-distance phone calls.

The use of VoWLAN is further extending the benefits of VoIP by providing mobility and even replacing the need for a cellular phone. A consumer is likely to select a VoWLAN solution as compared to wired VoIP service to enable mobility similar to what cordless phones offer. Someone can take the phone around the house and talk while doing house chores.

A single access point can easily support most home and small-office voice applications. Range is sufficient for the entire home, and a single 802.11b or 802.11g access point can support the limited number of phones (generally only one) that will be in use simultaneously. RF interference from microwave ovens and neighboring wireless LANs set to the same channel can cause significant impacts on performance, however. Consumers may have to reconfigure the RF channel of their access point to have effective wireless voice service.

Unfamiliarity with wireless technologies may preclude some consumers from purchasing VoWLAN equipment. In addition, the inability of Internet telephony to operate during power outages and limited operation of 911 services may keep some consumers from moving forward with a wired or wireless VoIP solution. Despite these issues, though, VoWLANs in homes and small offices is expected to proliferate over the next few years.

Home Owner Finds Value in Internet Telephony

Madison Leigh of Fairborn, Ohio, found that her monthly long-distance phone bill was running more than \$100 per month because she was making regular phone calls to her father, living in a rest home in Chicago. Madison was paying only 10 cents per minute, but the phone calls were running into the hours, discussing issues that her father was having living in the rest home. Madison saw an advertisement on television for Vonage Internet-based calling, so she investigated the service and found that it would save her approximately \$70 per month. After hearing about Wi-Fi, she found that she could have wireless voice over Internet connectivity, which she thought was a good idea because she could talk on the phone from anywhere in the house, similar to what her cordless phone had been providing.

Jack's Foreign Auto Parts and Repair

Jack's Foreign Auto Parts and Repair, based in the eastern United States, is a small business specializing in the repair of foreign automobiles and the sale of hard-to-find automobile parts to car enthusiasts worldwide. Jack employs eight mechanics and one administrative person, who takes care of invoicing and paying the bills. Jack supervises

the mechanics and provides necessary guidance on the shop floor. He is on the phone most of the day, making international calls, trying to locate rare parts worldwide for fixing the cars. His phone bill had been running nearly \$1,000 per month! When purchasing a new fax machine at a local office supply store, he saw a Wi-Fi phone and router advertising the ability to slash long-distance phone call costs, especially overseas. After thinking about it a bit and doing some research on the Internet, Jack purchased the solution and installed it at his company. He now pays roughly \$50 per month in phone bills.

Security Systems

The ability for people to quickly report wrongdoings and suspicious activities is vitally important for providing security in all companies and organizations. A person equipped with a wireless phone, for example, can get critical information to the appropriate organization for it to respond to an emergency situation. For example, a security person in an airport can report the findings on an unattended piece of luggage, which would trigger a reaction from the airport security team. VoWLAN systems can certainly support these types of functions to bolster security through faster response to situations.

Companies can also deploy wireless security cameras that send video over wireless LANs. This approach is much more feasible than running wires to each camera. The ease of installation allows a greater number of cameras to be put in place, which increases the viewing of the different parts of a facility or campus.

A major issue with using wireless LANs for supporting wireless voice and video is that they are vulnerable to denial of service (DoS) attacks. A person wanting to disrupt the security system can block the flow of voice and video signals by jamming the network. For example, someone can transmit either an overriding RF signal or specialized protocols (such as multiple CTS frames having long NAV values) that block phones and cameras from accessing the network. Also, wireless video cameras are vulnerable to sniffing. For example, someone could passively monitor the video stream using a tool such as driftnet. Companies must consider these threats and plan accordingly.

Airport Improves Security with VoWLAN

Security personnel at a large airport in the southern United States continually walk throughout the airport looking for potential security issues and responding to passengers needing medical assistance. In the past, the security people would use two-way radios to communicate with a central security office, which would dispatch appropriate support staff in response to situations. The radios, however, were not reliable because of range issues. In some parts of the airport, the security agents would be too far away from

the office to work effectively. In some cases, the range was so great that communications were not possible. In addition, the two-way radios were limiting, because only someone else having a two-way radio was able to communicate with the roving security personnel. Having someone use a phone to contact the mobile person was not possible.

Because of the need for improved security, the airport decided to take advantage of VoWLAN technology. A wireless LAN had to be put in place, but the airport had wanted to do so anyway to offer a public wireless LAN to passengers and other airport applications. It was much more cost-effective to build a common wireless LAN infrastructure for multiple applications. The public wireless LAN users could be kept separate from the airport applications, such as the VoWLAN solution for the security personnel, through the use of different VLANs.

Now, security personnel can immediately report incidents that need attention and receive a quicker response than before.

Metro Rail Monitor Tracks with VoWLAN

A city in the midwestern United States has a passenger rail system that moves people around various parts of the city. Before implementing a wireless, video-based monitoring system, the operator of the train had to keep an eye on track conditions and report findings to maintenance staff via an unreliable two-way radio, which often fell out of range from the maintenance office, or through a cell phone. Both ways, however, took a great deal of time. The operator was finding that performing other important tasks was difficult, such as driving the train and being alert to the safety of passengers.

The city equipped the train with Wi-Fi cameras on the front of each train and mounted access points periodically along the tracks. A maintenance person can now view the entire track as the train moves—saving the time of the operator and a maintenance person riding on the train. Problems with the track can now be found and repaired much faster, saving time of staff, and making the transport system safer for passengers.

Determining ROI

Before moving forward with the installation of a VoWLAN system, companies should complete an ROI study that provides the basis for decisions on funding. A worthy ROI must indicate enough benefits before a company will put forth the money to fund the hardware and services necessary to install and support the system. In most cases, a company desires to recoup money spent within one to three years. If the benefits are not well defined or they are not sufficient, deploying the system may not be worth the expense. Not only should the ROI study indicate a positive result, but it should also be clear enough to be understood by a wide variety of decision makers.

This section describes each of the steps necessary for the ROI study and illustrates the main points through a hypothetical case study, which highlights a fictitious company, Acme Furniture. This case study defines a project that a large manufacturing and retail company undertakes to realize the benefits of VoWLAN systems in corporate offices, manufacturing plants, distribution centers, and retail stores. The case study continues throughout the remaining chapters to demonstrate the process of defining requirements, designing the solution, installing and configuring the hardware, and performing operational support.

Initial Analysis

The first step of performing an ROI study is to do some initial analysis. At least enough details must be known to define benefits and determine the costs for necessary hardware, software, and services to install and support the system. In the initial stages of the project, especially during the ROI study phase, not all details may be known; however, the details will come into full view as the project progresses with funding.

The following are tasks that a company should complete as part of the initial planning phase:

- Identify significant communications delays. Spotting problems that the company is having before justifying a VoWLAN solution is very important. If people within a company have no need to communicate with anyone while away from their desks, probably no need exists for a VoWLAN system. They can just use the existing wired telephone system. People who are often mobile and need to communicate with other employees or people outside the facility, however, will likely benefit from a VoWLAN system. Analyze these types of situations, and look for delays that employees have when responding to important events. For example, a doctor requiring even five minutes to look for an available phone is likely taking too long to respond to a page for a patient needing prompt attention.
- Identify primary goals and expected benefits. As with any project, clearly spell out what you expect to gain by deploying a VoWLAN solution. State productivity enhancement goals, such as decreasing customer response time to one minute, and costs that a company would like to eliminate by replacing existing communications mechanisms and using a converged infrastructure for data and voice.
- Define preliminary application requirements. Determine just enough requirements to assess the existing network infrastructure and adequately determine costs of the solution. In the ROI study phase, at least identify who will benefit by having VoWLAN handsets and how many you will need. Also, predict the number and frequency of calls that each person will complete on a regular basis. This information helps when determining whether upgrades are necessary for the network to support the calls. Be certain to include present and future requirements.

- Assess existing networks. Determine whether the existing wired network infrastructure has the capacity to support predicted VoWLAN traffic. If not, factor in the upgrades as a cost for deploying the VoWLAN system. Certainly, the cost of the solution depends on the presence of an existing wireless LAN. When a wireless LAN is already in place, be sure to test its ability to support voice. More access points may be necessary to achieve the coverage that is necessary for voice traffic, which introduces costs.
- Consider changes that may take place in the future. To achieve expected ROI, the VoWLAN system must continue to operate and provide benefits for several years. Company moves, growth, and mergers may introduce costs (or benefits) when moving and expanding the system. If these types of changes are known, take them into account during the life of the system.

Case Study: Acme Furniture Gets Started with a VoWLAN Solution

Acme Furniture is a fictitious company that manufactures, distributes, and sells top-quality furniture to the home market within the continental United States. The company has 750 employees, with the corporate headquarters and a single manufacturing plant in Columbus, Ohio. The company also has 80 retail stores and 10 distribution centers located throughout the United States.

Acme Furniture has been growing significantly over the past couple years as the relatively large population of baby boomers has been upgrading their furniture after their children leave home. Bob, the company president, has been happy with the company financials, but he strongly feels that improving communications is necessary based on the increasing number of issues cropping up in the warehouse and retail stores.

Line supervisors in the factory have been complaining for months about the delays in getting status on special furniture orders. The corporate executives and construction teams often play telephone tag for a day or longer before getting in touch with each other. Also, retail store managers often need to contact distribution centers to check on whether they have particular furniture in stock, which results in delays and occasionally lost sales because the customer is not willing to wait. Bob felt that mobile phone technology might be a viable solution to these problems.

In addition, long-distance phone calls between the corporate offices, stores, and distribution centers amount to approximately \$3,000 per month. Bob has been eyeing this number on the financial report for several years, wondering how he can eliminate or reduce it considerably. His IT manager, Debbie, felt that the deployment of a VoWLAN system could be a feasible way of achieving the reduction in long-distance charges.

With these issues in mind, Bob contracted a consultant, Eric, to help determine whether Acme Furniture should move forward with the deployment of a VoWLAN solution. Eric's job was to define initial requirements and determine costs and savings of the resulting VoWLAN system. This information would provide Bob with the basis to approve the project.

Eric documented the communications problems and long-distance telephone costs and then took a closer look at the situation. He found that the company can significantly decrease the communications delays to a few minutes instead of hours and nearly eliminate the costs for intercompany long-distance telephone calls. Eric recommended that Acme Furniture make use of VoWLAN technology to meet these goals.

Eric's recommendation was to initially equip the following employees with VoWLAN handsets:

- Five of the clerks in each distribution center
- The store manager in each store
- Ten line supervisors in the manufacturing plant
- Seven IT personnel
- Ten corporate office executives

The total count of VoWLAN handsets is 127. Acme furniture will grow its workforce by approximately 25 percent over the next few years, and the company will revisit the benefits of adding more wireless telephones after the first year.

The retail stores, manufacturing plant, and distribution centers already have wireless LANs in place. Radio frequency signal testing was done, and they have sufficient signal strength to support voice traffic. The corporate office, a two-story building with approximately 50,000 square feet, does not have any wireless connectivity.

Costs

As part of the ROI analysis, a company must define operational and capital costs. This analysis gives a full depiction of what the company will need to pay out to realize the system and resulting benefits.

Operational Costs

For operational costs, figure all services necessary to deploy and support the solution. The following defines each of the operational cost elements for deploying a VoWLAN system:

- **Planning**—Encompasses the definition of complete requirements that address security concerns, performance needs, and project planning.
- **Network assessment**—Includes surveying existing wireless LANs and determining the capacity of the local- and wide-area networks (WANs) for supporting voice traffic requirements.
- **Installation**—Includes setting up and configuring all components, such as VoWLAN handsets, voice gateways, software that interfaces with the existing PBX, and wireless LAN access points.

- **Testing**—Ensures that the installed system operates efficiently and meets all requirements.
- **Training**—Provides necessary skills to IT staff that will be supporting the system.
- **Operational support**—Needed on a recurring basis for IT personnel to add new users, troubleshoot problems, and respond to user problems.

Some companies will perform only the planning and operational support and outsource the other elements. As a result, the costs for these operational elements generally result from bids by prospective contractors.

Capital Costs

Capital costs include hardware and software that make the system work. The following identifies the capital cost elements for deploying a VoWLAN system:

- **VoWLAN handsets**—The wireless telephone hardware needed for each user.
- **Voice gateway**—The platform that manages wireless VoIP traffic and interfaces with an existing PBX.
- **Wireless access points**—The hardware that interfaces the VoWLAN handsets to the network.

In addition, upgrading the existing routers with applicable quality of service may be necessary.

Case Study: Acme Furniture Defines Costs for a VoWLAN Solution

With the initial analysis complete, Bob, the president of Acme Furniture, directs Eric, the hired consultant, to determine the approximate costs of deploying a VoWLAN solution. The deployment costs are one part of the financial analysis that Bob needs to make a decision. After determining costs, Eric will attempt to quantify the benefits. In Table 1-1, Eric identifies the operational costs for deploying a VoWLAN solution at Acme Furniture.

Table 1-1 *Operational Costs for a VoWLAN System at Acme Furniture*

Element	Cost
Planning	\$25,000
Network assessment	\$20,000
Installation	\$50,000
Testing	\$15,000
Training	\$15,000
Support	\$20,000 (per year)
Total	\$145,000

The installation costs include setting up the system, as well as the costs to install 12 access points in the corporate headquarters.

In Table 1-2, Eric identifies the capital costs for deploying a VoWLAN solution at Acme Furniture.

Table 1-2 *Capital Costs for a VoWLAN System at Acme Furniture*

Element	Cost
VoWLAN handsets (127)	\$63,500
Call Manager	\$50,000
Access points	\$6,000
Total	\$119,500

As a result, the total first year cost of deploying a VoWLAN solution to meet Acme Furniture's requirements is \$264,500, which includes \$119,500 in capital costs and \$145,000 in operational costs. The company will also incur an annual cost of \$20,000 for ongoing operational support.

Eric met with the IT manager, Debbie, and found that an Ethernet network resides in the corporate offices, with plenty of capacity to support voice traffic. Also, based on the call volumes as indicated by existing telephone bills, the WAN interconnecting the corporate offices, manufacturing plant, stores, and distribution centers does not need any additional capacity to support initial requirements, but it will likely need an upgrade as the company expands the system.

Savings

The calculation of savings resulting from a VoWLAN solution includes the combination of quantitative and qualitative benefits. The following sections take a look at each of these types of benefits to see how they can help justify VoWLAN costs.

Quantitative Benefits

The quantitative benefits comprise the actual dollar savings resulting from the deployment of a VoWLAN solution. This money is generally cash that a company avoids paying for particular services, but it can also include sales of hardware that the VoWLAN system is replacing. The following are the types of quantitative benefits that you can realize with a VoWLAN solution:

- **Reduced long-distance telephone charges**—The routing of intercompany VoIP telephone calls is virtually free; therefore, a VoWLAN system can eliminate the long-distance charges associated with each VoWLAN user.

- **Fewer wired telephone lines**—A company can eliminate the need for a wired telephone line for each VoWLAN user, which saves any associated fees. Because VoWLAN users are wireless, there is no need to rewire telephone lines when changes are made to the workforce.
- **Increased productivity**—This benefit is somewhat difficult to define in some cases, but it allows employees to complete work faster and better serve customers. This results in higher revenues for the company, which is certainly a benefit.

Qualitative Benefits

Qualitative benefits enhance the operation of the company, but they do not result in definable dollar savings. These types of benefits often lean management toward funding the project when quantitative benefits are marginal or not well defined. The following are the types of qualitative benefits that you should consider when performing an ROI study for a VoWLAN solution:

- **Improved safety**—This benefit is certainly very important to any company. In some cases, the regular use of VoWLAN phones can provide vital and immediate communications in times of emergency situations.
- **Better image to customers**—With the use of VoWLAN phones, customers will see company employees getting things done faster and more efficiently, which makes the customer more inclined to do business with the company.
- **Increased employee morale**—Employees equipped with VoWLAN handsets have less frustration because of the elimination of telephone tag and searching for a phone when they need one.

Case Study: Acme Furniture Defines Benefits for a VoWLAN Solution

Previously, Eric, the consultant performing an ROI study for Acme Furniture, defined the total costs of a VoWLAN solution. Eric next determined the benefits that the company will gain by spending this money. In doing so, he met with the IT manager, Debbie, and the division heads of the manufacturing plant, distribution centers, and stores, who are Brian, Denise, and Sierra, respectively.

Debbie located past telephone bills and work orders and totaled up what the costs have been for equipping potential VoWLAN users with wired telephones. The average cost of adding or changing a phone line is approximately \$100, but there are only a few of the planned VoWLAN users where this applies over the past few years. As a result, Eric does not bother including this benefit in the study. If all employees were to have VoWLAN handsets, though, the savings per year would be \$50,000 total per year, which would have been significant. Debbie does reiterate that the monthly long-distance telephone bill is approximately \$3,000 per month, and the deployment of a VoWLAN solution will eliminate these costs.

Brian discussed lots of issues that line supervisors are having when getting status from construction teams making the furniture at the plant, but pinpointing lost revenue that could equate to quantitative benefits was not possible. However, a VoWLAN solution in this situation would result in excellent qualitative benefits. It is common for companies to not fully define productivity benefits.

In the distribution centers, Denise explains that the use of mobile telephones will improve productivity and will surely speed up the processing of orders, but no studies have been done to assess the actual impacts on revenue. As with the case with the manufacturing plant, Eric will include this as a qualitative benefit.

Sierra provides details on the sales lost due to not getting timely product availability information to customers. A study that surveyed customers as they exited the stores was conducted on this subject during the previous year, and it found that Acme Furniture was losing roughly \$250,000 per year due to this problem. These people would leave the store before finding out that the particular furniture item that they wanted was in stock at a distribution center.

Eric tabulated the quantitative benefits of deploying a VoWLAN solution at Acme Furniture in Table 1-3.

Table 1-3 *Quantitative Benefits of a VoWLAN Solution at Acme Furniture*

Element	Savings
Long-distance telephone service	\$36,000 per year
Increased sales at stores	\$250,000 per year
Total	\$286,000 per year

The total savings of \$286,000 per year is amazing, and it is actual cash savings. Eric defines the following additional benefits:

- Better customer service due to line supervisors having more direct communications with construction teams in the manufacturing plant.
- Increased (undefined) productivity in the distribution centers because of direct communications among warehouse clerks and administrative offices.
- Improved safety because employees carrying VoWLAN phones can contact the appropriate services immediately if an emergency situation occurs.

For Acme Furniture the biggest payoff is clearly the ability to increase sales at the stores through faster inventory checks. That benefit alone is enough to invest in the project.

Payback Period

With the costs and savings of a VoWLAN deployment in mind, you should calculate the payback period to determine whether the project is worth investing in. The payback period is the amount of time that the system needs to operate to realize enough savings

to pay off the initial expenses. Most companies move forward with a payback period of less than three years. The quantitative benefits, however, must exceed the support costs on a yearly basis.

For example, a company may find that a VoWLAN system will save \$75,000 through lower long-distance telephone charges. If the initial cost for hardware and services amounts to \$80,000 and an annual support cost of \$15,000 is necessary, the payback period is just over one year. This should prompt most companies to implement the system.

Case Study: Acme Furniture Determines a Favorable Payback Period

Eric, the consultant working with Acme Furniture, utilizes the costs and benefits of deploying a VoWLAN system for the company to determine the payback period and yearly net benefits. This is something that the company president, Bob, had requested Eric find out before deciding whether it is worth installing the system. Based on a total quantitative benefit of \$286,000 per year and a first-year cost of \$264,500, which includes hardware, services, and first year's support costs, Eric is happy to announce that the payback period is just under one year. After this payback period occurs, the company will receive a yearly combination of cost savings and additional revenue of \$266,000, which takes into account the \$20,000 per year support cost.

Bob is very happy with these numbers and readily agrees to fund the project. He hands over Eric's rough financial analysis to the company's accountant, Madison, who will figure in capital depreciation, finance costs, and other details. The benefit of more than a quarter million dollars per year, though, is certainly big enough to cover any alterations that Madison might make to the analysis.

Chapter Summary

The deployment of a VoWLAN solution can provide substantial benefits to companies. In most cases, the primary benefits are increases in productivity due to improved communications and lower long-distance telephone charges. A doctor in a hospital who carries a VoIP phone is reachable immediately and can respond to patient needs quickly. Also, a company can make use of VoWLANs and route calls over the Internet or a private WAN, which makes these calls much less expensive than using the traditional PSTN. In addition, a VoWLAN solution is a lower-cost method for implementing mobile phone technology inside larger facilities as compared to cellular systems. A company should, however, complete a financial study to adequately define benefits and the costs of deploying and supporting the VoWLAN system.

Chapter Review Questions

- 1 What types of user devices can VoWLAN systems replace?
- 2 VoWLANs are an extension to a wired VoIP system. True or false?
- 3 Which wireless LAN technologies can adequately support voice traffic?
- 4 What are two quantitative benefits of VoWLAN solutions?
- 5 Improved safety is not a benefit of VoWLAN solutions. True or false?
- 6 What are examples of operational costs of a VoWLAN solution?
- 7 The initial financial study must include all technical details of the requirements, design, installation, and support. True or false?
- 8 What are the primary elements that comprise the capital costs of a VoWLAN system?
- 9 What is the purpose of conducting initial analysis for a VoWLAN system?