This chapter covers the following topics:

- Recommended Facility Documentation
- Limitations Affecting Equipment Installations
- Using Cookie Cutter Designs

CHAPTER 8

Discovering Site-Specific Requirements

Often when a decision is made to install a WLAN, the decision makers do not realize that WLAN installation sites vary widely. Those who decide to move to wireless networks understand their environment and assume that most other WLAN systems and sites are much the same as theirs, and therefore the WLAN installation should be similar (and easy). Even in something as similar as a chain of retail stores, minor variations such as stock and shelving arrangements can cause coverage to vary. In reality, unless the two sites are built from the same architectural plans and populated with users and contents in a similar way, the two seemingly similar sites can be as different as night and day. Before a survey or installation is scheduled, each site needs to be evaluated separately.

This chapter addresses site-specific issues relevant to WLAN survey and installation tasks. This chapter examines topics such as site layouts, facility contents, building and constructions variations, different environmental conditions at the site, and other site-specific requirements. This chapter also discusses the need for accurate floor plans, building and construction specifics, an inventory of building contents, and an awareness of customer issues related to specific installation limitations.

Recommended Facility Documentation

Any engineer surveying and installing a WLAN system needs facility documentation, the collection of which should be part of the initial design stage. Facility documentation enables the engineers defining the WLAN, or trying to survey and install it, to identify areas of concern, areas of coverage, user densities, and even types of antennas to consider, before ever walking onto the site. After the survey has been completed, the facility documentation becomes a critical part of the overall documentation and should be kept current as to any changes and maintained with the rest of the network documentation for future reference. The facility documentation should include (but is not to limited to) the following:

- Site map (or floor plans)
- Building construction details
- Building contents inventory
- User-area and user-density information
- Problem-area (for WLAN) information

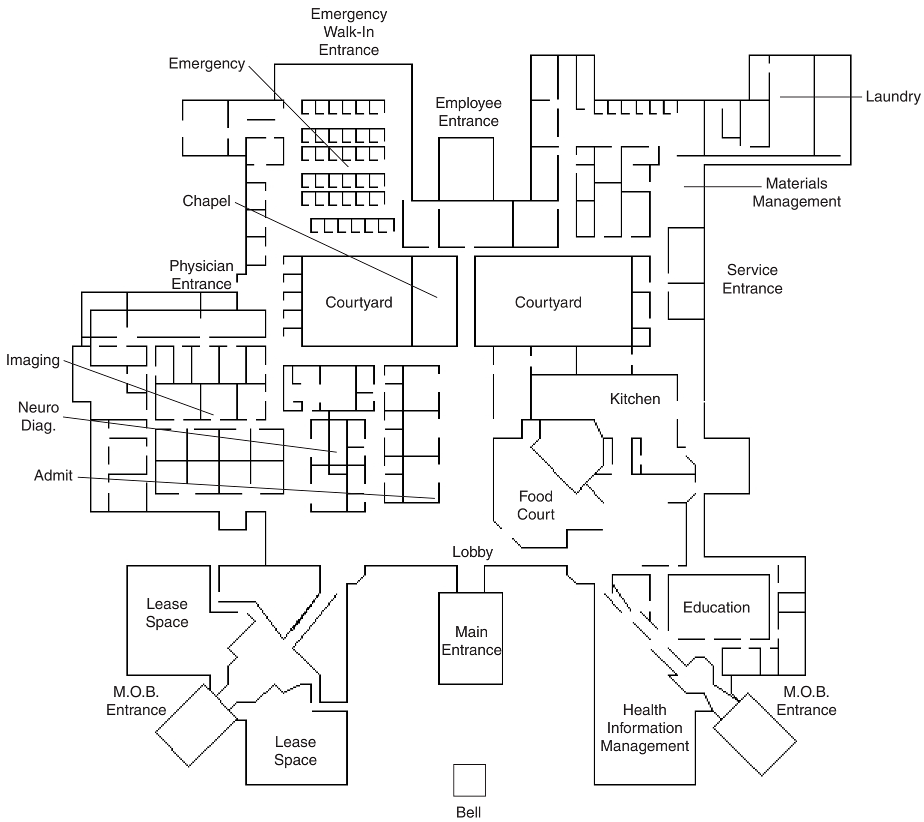
Site Map

Before beginning any site survey, obtain a good site map or floor plan of the site. In some cases, the site map might not really be a floor plan, but more of a site layout, including building layout and contents as well any outdoor areas that will be covered.

This site layout document will become part of the final survey and network documentation. As such, having a soft copy of this document is very helpful so that it can be copied and distributed as necessary to the survey engineers, installation team, and network support staff. Extra copies of the site map should be available to make notes on during the actual survey and installation steps, as well as during any presurvey discussions.

Prior to the survey, you can use the site map document to define desired coverage areas; identify where coverage is not needed; and define user locations and densities, problems areas, network closets, cable runs, and plenum areas. Basically, this document becomes the physical schematic of the wireless network (see Figure 8-1).

Figure 8-1 *Typical Site Map*



Building Construction

Building construction can vary widely from site to site. Materials and construction techniques in San Francisco differ significantly from those used in New York City, London, or Cairo. Differences in building construction, even though sites might look similar, can cause RF to react in completely different ways. Figure 8-2 shows examples of various building materials.

Figure 8-2 *Building Materials*

A multifloor building might use precast, reinforced concrete for flooring. Although this type of construction might create some attenuation problems for RF, the effect on RF penetration is significantly less than it would be with a floor of poured concrete over a steel pan. Although some RF may get through in this latter example, the steel pan provides a very good RF shield between floors (see Figure 8-3).

Walls can be similarly deceiving. In most industrial buildings, it is common to use steel studs with drywall or plasterboard over them. The drywall and plasterboard cause only a slight attenuation of RF signals, and the placement of the steel studs has little effect at all. Other walls might be concrete block, with or without steel reinforcement, which cause only limited attenuation of RF. However, precast concrete, typically using steel reinforcement, is a different story. The amount of steel used for reinforcement inside the concrete will cause the RF attenuation to vary from one building to another.

Although drywall and plaster usually minimally affect RF, the material behind the wall can pose problems. Consider a real example from a health-care facility. The RF energy was having a hard time getting into several offices. Further questioning of maintenance personnel at the facility and reviewing some older building documents revealed that this area had been remodeled recently. Before the area was used as offices, it was the radiology department. The x-ray room had been turned into offices. And, as typical with x-ray rooms, the walls were shielded to prevent x-ray energy from leaking out of the room. The walls were not removed, just covered over; therefore, the RF could not get into the offices.

Figure 8-3 *Steel-Pan Floor Construction*

In some buildings, the walls might be made from a form of reinforced wire mesh, with a plaster-type material spread across it (often called *stucco*). The mesh can work much like an RF screen, causing a severe level of signal loss or RF attenuation.

Steel outside walls, or steel walls separating parts of a building, can detrimentally affect RF coverage (because the wall might not just restrict RF penetration, it might also create a large number of multipath signals). This is common in industrial facilities, where a building has undergone one or more additions. What was once the outside wall might now be a partition between the old and new sections of the building, causing both multipath signals and an RF shield between building sections.

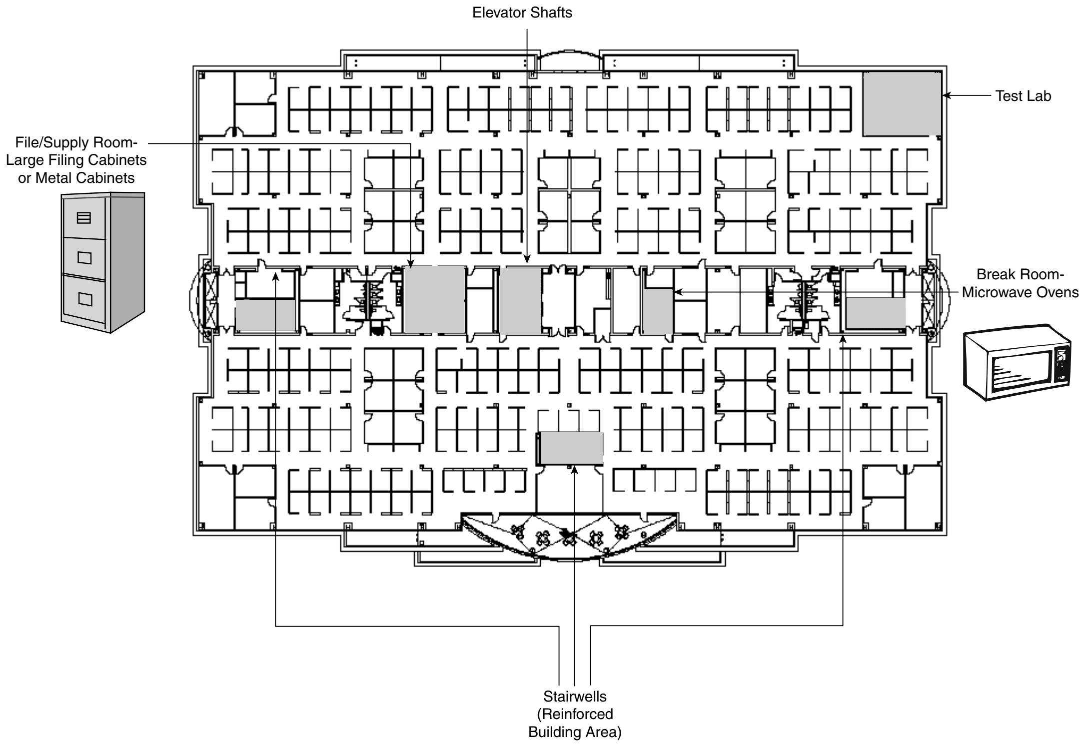
Be sure to research this information before or during the survey and document your findings on the site map.

Building Contents

One often-overlooked area of concern is the building contents. Those with minimal WLAN and RF experience sometimes underestimate the effect that building contents can have on a WLAN.

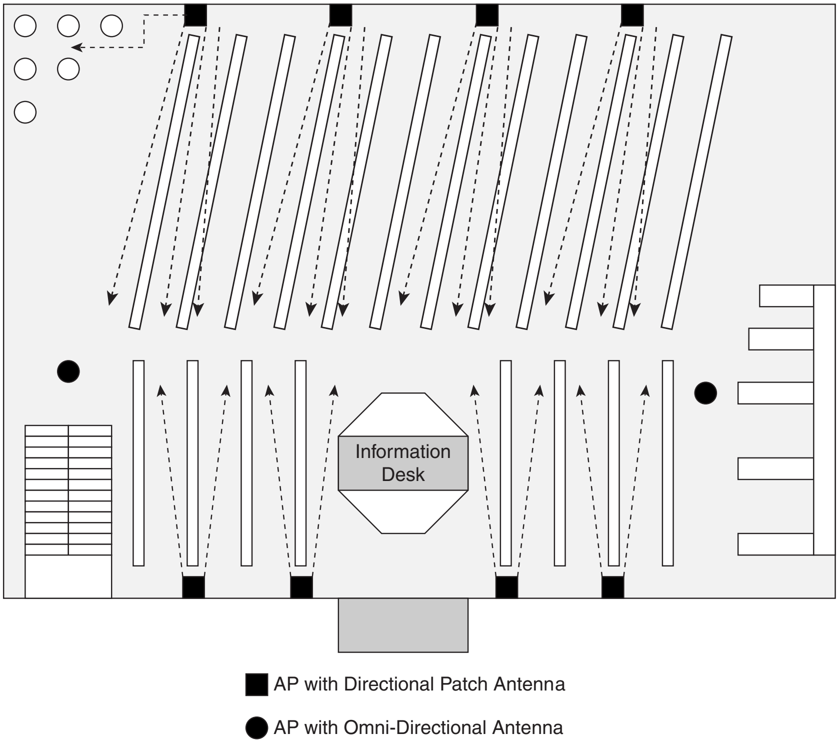
Figure 8-4 shows several examples of problems that can occur in a typical office environment. Areas such as file rooms and storage rooms are often filled with steel cabinets, creating a very large RF shield for RF entering that room, or even passing through it to other areas of the facility. Although most would assume an area filled with cubicles should have minimal effect on RF, it might in fact create a challenge for RF coverage. The number of cubical partitions, the amount of steel in the partitions and desks, and the size and make-up of the bookshelves can affect RF range.

Figure 8-4 *Office Issues*



Another area that is very difficult to cover is a library or documentation area. Shelves full of books are shelves full of paper, and most paper has a high level of attenuation to WLAN frequencies. It is very common for WLANs to use directional antennas, focusing the RF energy down the aisles of the books. (See Figure 8-5.) Because of similar shelving, warehouses and even some retail stores also use directional antennas in this way.

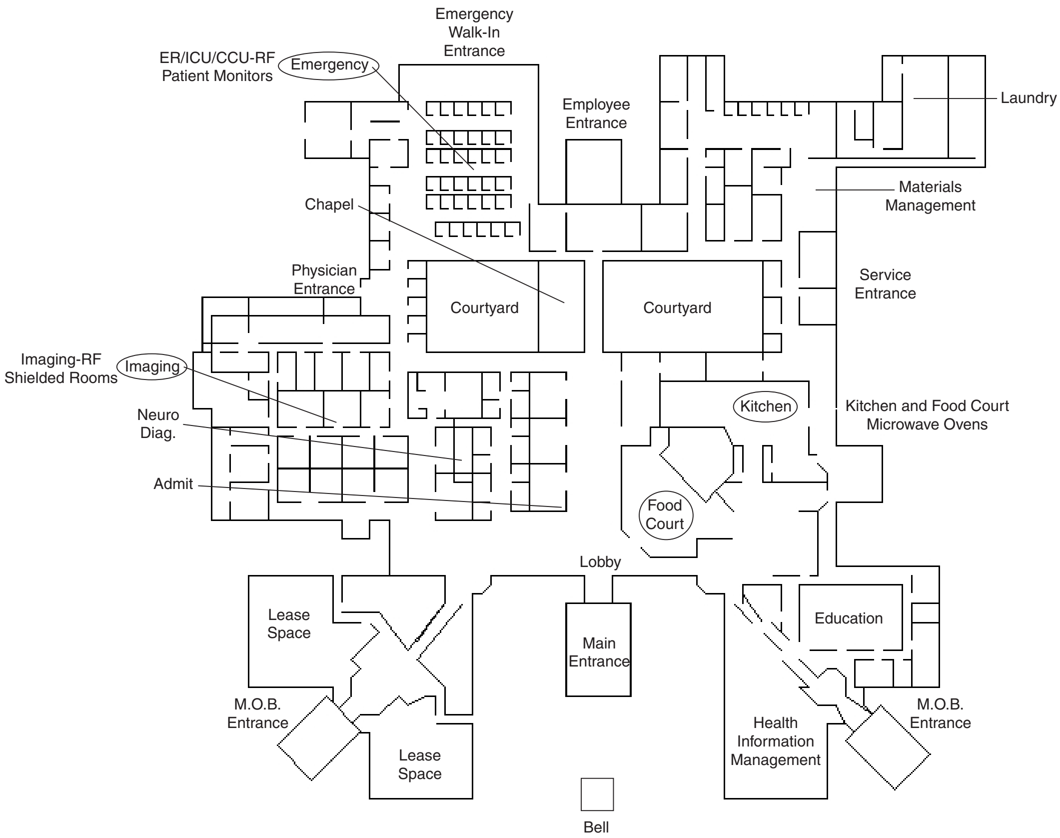
Figure 8-5 *Directional Antennas for Library Coverage*



Kitchens and break-rooms usually contain microwave ovens. Microwaves are also found around many health-care and industrial facilities for purposes other than heating food. Although microwaves pose no problems for 5-GHz WLANs, they can be problematic for 2.4-GHz WLANs. The typical microwave oven uses the same frequencies as a 2.4-GHz WLAN. (This is because 2.4 GHz is the resonant frequency of water, and when 2.4-GHz energy strikes water molecules, it is absorbs the energy and causes the molecules to vibrate, creating friction and heat.) Locating a 2.4-GHz *access point* (AP) close to a microwave can cause undue interference and result in poor RF communications. Take care to keep these APs (and clients when possible) at least 10 feet away from any standard microwave oven. It is therefore recommended to note the location of any such devices on the site map. Also be aware that industrial microwave ovens sometimes have a much higher power than those found in the home or office, possibly creating even more interference. Testing should include RF coverage verification while any microwaves in the local vicinity are in full operation.

In one case, a health-care facility was having trouble with one particular AP that was dropping all associations intermittently. Close inspection of the facility turned up a microwave oven in an area that was not part of the RF-covered area, but was located in a lab adjacent to the AP-covered area. The problem was that the oven was located on the other side of the wall (made from drywall) from the AP, with a total of about 5 feet (and two pieces of drywall) separation. This is why it is important to understand the entire site, including areas where coverage may not be needed. Figure 8-6 shows a site map with potential problem areas labeled.

Figure 8-6 *Hidden Site Problems*



Locations such as emergency rooms and cardiac care in hospitals use sensitive equipment such as *electrocardiographs* (EKGs) and other monitoring systems. Although these devices are not generally a problem with WLANs, take care to locate the radio gear near the devices and to verify that the RF in the area does not cause any interference. One common problem occurs with older plotters and printers. The RF energy can cause slight variations in the print and plotter driver mechanisms, resulting in "glitches" in the patient printouts.

As discussed in Chapter 6, “Preparing for a Site Survey,” all cordless and wireless devices should be inventoried. Phones, speaker, cameras, cordless mice, cordless keyboards, baby monitors, and virtually anything that might be RF related should be noted.

In a warehouse, retail environment, or even an office building, a change of contents can greatly affect the coverage of an AP. Inventory levels often change in a warehouse or retail facility. At certain times of the year (such as early November, when stock levels rise for the holiday shopping season), stock levels in some facilities may reach beyond 100 percent, with material placed in any possible free space, such as directly in front of the AP that provides coverage to the area. This poses a real problem for the survey engineer who is trying to survey when the stock level might be at a low level corresponding to the season. (Many installations occur during the off-season, when facilities are not running at peak capacity.)

Defined User Areas and Densities

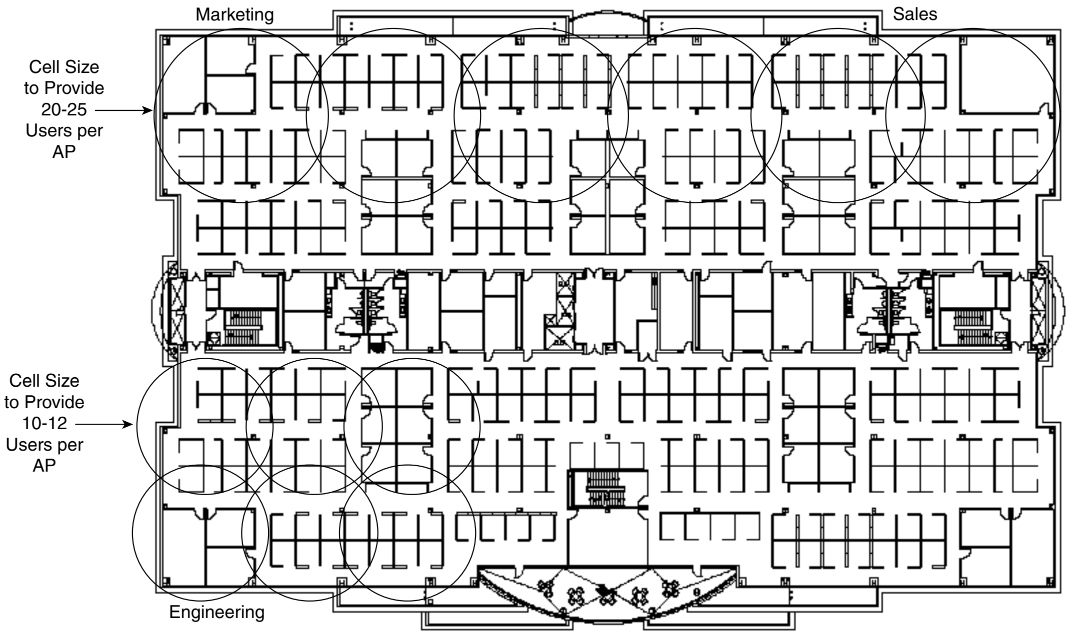
The topic of user density has been brought up many times in this book. As stressed previously, defining user areas and densities is a crucial part of the design and must be on the minds of design engineers and survey engineers at all times. The overall performance of the WLAN system depends on proper user density.

There have been surveys based on nothing but user density. At one very large software company, the buildings were all built in a very similar manner, and with identical internal design and contents. All cubicles were identical, all office construction was identical, and the number of users in a given area was very similar.

For this customer, it was decided that the applications used by nonengineering employees would permit between 20 and 25 users per AP. This provided adequate performance for normal operational network load. The engineers, however, required a bit more performance, and the user density was lowered to between 10 and 15 users per AP.

Based on information such as this, some of the design can be done up front. You can use the site map to determine how large the cell coverage needs to be. For example, a survey determined that a single AP set to default power levels, with dipole antennas, could provide coverage for many more users (based on their seating locations) than the design calls for. In this particular case, the desired coverage turned out to be a small circle on the site map, and was about the size of a coffee cup. From this point, it was a matter of defining how many “coffee cups” were needed (see Figure 8-7). The engineers then selected the power setting to provide the proper coverage for the user density in the appropriate areas. Finally, testing was completed to prove the guesstimations of the coffee cup survey.

Figure 8-7 *Coffee Cup Layout*



If voice is to be used over the WLAN, it is vital to the design to understand the capacity of the AP versus the number of calls that can be carried by one AP at any given time. Typically, a standard 802.11b AP supports only between six and eight calls with the standard compression used in 802.11 *voice over IP* (VoIP) phones. As compression techniques improve, or as the wireless 802.11 VoIP phones move to support 802.11g or 802.11a, the number of calls per AP will increase.

Limitations Affecting Equipment Installations

As with any installation, when installing a WLAN restrictions are always put into place by one or more of the following:

- Customer requirements
- Regulatory limitations
- Environmental concerns

Take care to note any and all restrictions that might be in place. Also document any restrictions in the final site survey report so that the customer understands why a particular method was used (based on a given restriction).

Customer Restrictions

As you have learned in this chapter, understanding the customer's environment is important. Installation limitations can vary widely from customer to customer. Based on the surroundings, imposed limitations might require a survey engineer to make minor changes to a design. For instance, where a 5.2-dBi 2.4-GHz omni antenna is needed to provide coverage, it might not be possible to use one because of the antenna's physical size. A typical 5.2-dBi omni, which is approximately 10 inches or longer, might be too large to hang from a ceiling in a facility such as a school or hospital, for example. A Yagi antenna might work well in a long hallway, but the owner might require that the antennas remain unobtrusive. At 18 inches long and 3 inches in diameter, the 13.5-dBi Yagi does not meet the customer's unobtrusive requirement. In both cases, you need to use different antennas.

Perhaps the customer has required that the equipment be totally out of sight, as would possibly be the case in a museum or theme park. You could place the APs above the ceiling or in isolated locations, but then the antennas become an issue. You will need to verify that the AP supports external antennas and that the antennas available have plenum-rated cables.

Another such issue generally comes up in all locations where there is public access. Antennas and APs must be totally out of sight, hidden, or disguised. In the case of one theme park, all the APs are located in little cupboards, which have hidden and locked doors. The antennas selected were very slim patch antennas, which were attached to the wall and painted to blend in.

In one college, a WLAN system was installed for student use, and the APs selected used standard PCMCIA-type radio cards that plug into the AP. (This is a common design method for APs, and is popular among customers because of the easy radio upgradability for the AP.) The APs were just mounted in hallways near the ceiling. The IT staff of the school started to notice that some APs were no longer handling traffic. Upon inspection, it was found that the radio cards were being removed from their APs. The students had learned that the same radio card used in the AP could be used in a laptop!

An environment such as this university might require some type of enclosure for the AP that can be locked for the sole purpose of maintaining visibility but ensuring security against tampering hands.

Regulatory Limitations

Although discussed at length in Chapter 3, "Regulating the Use of 802.11 WLANs," limitations based on regulatory domain requirements are worth reiterating here. Be sure to address each of the following questions for the specific site in which you are working:

- Is the RF system that is specified in the design legal in this location?
- Are there limitations on the antenna gain (and style) that can be used at this facility?
- How many channels are available for use in this location?

These questions require some investigation so that the system, once installed, meets the local regulatory specifications.

As a reminder, some countries specify a maximum of 20-dBm *Effective Isotropic Radiated Power* (EIRP), which limits antenna choices. Other countries do not permit 5 GHz, or limit the 5-GHz channels that can be used. Still other locations restrict certain channels for use with indoor applications only.

See Chapter 3 for the details of the various regulatory restrictions.

Environmental Concerns

Many WLAN installation areas require special designs. The most common is the plenum area above a ceiling in a standard office environment. As defined in Chapter 3, a plenum area requires that devices meet certain specifications regarding flame and smoke. Many APs use a plastic housing and, depending on the type of plastic, might meet these requirements. However, many plastic devices have not been tested or do not meet the necessary ratings and are not intended for use in these areas. For this reason, several vendors offer a metal housing for the AP.

Similarly, antennas also have environmental restrictions. Most external WLAN antennas on the market today that have been designed for WLAN usage are not plenum rated. This means they cannot be located above most ceilings. The cables on the antennas may use plenum cable, however, which means you can legally attach them to a plenum-rated AP and run the cable through the ceiling to the open air space (below the ceiling) where the antenna itself is located.

Local regulations also address plenum use. In some municipalities, any work done in plenum areas (such as above the drop ceilings) requires a licensed *heating, ventilation, and air conditioning* (HVAC) technician. If the AP is mounted above the ceiling, a licensed HVAC technician must be on site to supervise the installation. But what happens if an AP fails or needs to be replaced or accessed? Most IT professionals are not HVAC licensed. One possible solution (discussed later in Chapter 12, "Installing WLAN Products") is to place the AP inside some type of enclosure that is located in the ceiling, where the cables enter from above the ceiling. The metal box itself, installed by the HVAC professional, isolates the plenum area from the open air space of the room. The AP is now located outside the plenum area, and therefore plenum-rating requirements do not apply to the AP. This setup also obviates the need for an HVAC technician to be on site during AP servicing. In addition, the locked door provides physical security for the AP.

Most WLAN devices are designed to be located in a "friendly climate," meaning areas where the temperature ranges from 0 and 60 degrees Celsius. In addition, a friendly environment is one in which the AP stays dry and clean and vibrations are minimal. If you are putting an AP into a retail store or office building, a friendly climate might very well exist. In many scenarios, however, such as a food distribution center with a large freezer that might reach temperatures of –20 Celsius, or for outdoor installations in climates with extremely cold or hot weather, you need to design the WLAN based on the worst-case conditions.

WLANs are deployed in a wide range of locations, from climate-controlled offices to truck loading docks, outdoor rental car lots, airport tarmacs, shipyards and railyards, and even on board luxury cruise liners, locomotives, and passenger trains. Each location entails slightly different circumstances and therefore requires different survey tactics and installation techniques.

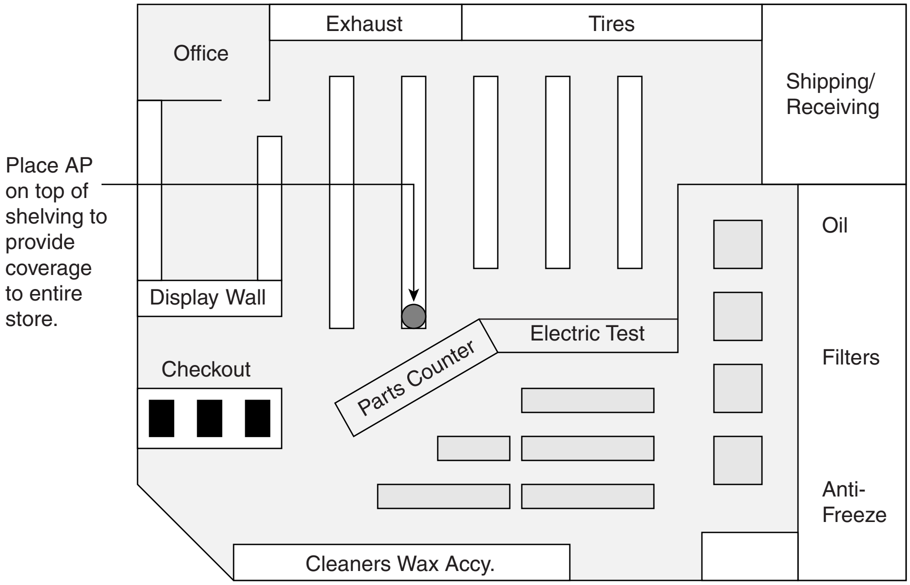
For applications that require the AP to be mounted outdoors, use an AP that has an appropriate *National Electrical Manufacturer Association* (NEMA) rating, or place the AP inside a NEMA type of enclosure. This provides proper weatherproofing to prevent moisture damage and corrosion. Salt water is extremely damaging to most APs, so consider this fact if your WLAN installation area is anywhere near an ocean or sea.

Some WLANs are even used in hazardous areas, including industrial facilities where chemicals are manufactured or stored, locations where painting is occurring (for example, automotive factories), or sites where explosives might be used (mines, for example). At such a hazardous site, use products that meet the site's intrinsic requirements or find suitable enclosures. Check with the customer to determine the level of safety necessary and the degree of isolation required.

Using Cookie Cutter Designs

Although every site differs and a survey for each site should be considered, you might be able to use a cookie cutter approach in some cases. Consider, for example, a chain of small auto-parts stores (see Figure 8-8). These stores are built in a very similar manner and are all about the same size. They also contain very similar products, arranged in a similar way. A single AP positioned in almost any location provides adequate coverage for a store. After you have determined this fact (by a survey), you can establish specific guidelines regarding AP placement and make deployment much simpler.

Figure 8-8 *Cookie Cutter Design for Auto-Parts Store*



In contrast, consider a WLAN deployment for a department store chain. Although the stores might look similar, they vary in both size and content arrangement. In this case, if you were to follow a cookie cutter approach, you would likely end up with some stores having a poorly working WLAN system (and hence a site visit to redesign and reinstall the WLAN). You can avoid this scenario by conducting a thorough survey up front for every store.

Summary

As WLANs continue to increase in popularity and WLAN applications continue to emerge in every type of business, engineers are deploying APs in more types of locations than ever before. But do not be tempted to force fit a device designed for one environment (perhaps a climate-controlled office) into another, perhaps hostile, type of environment (outdoors, for example). To ensure a properly operating WLAN, you must consider and design around site-specific requirements.

WLAN survey and installation teams need to be aware of all regulations that apply to a site, the various applications planned for the WLAN, and the full customer expectations. Among other things, these factors influence which installation techniques will be used. Other site-specific factors that survey and installation engineers need to consider are outdoor versus indoor installation, plenum ratings, vibration, and hazardous areas.