



Radio Frequency and Site Survey

This chapter defines and explains radio frequency (RF) and RF requirements within the wireless network infrastructure needed to build a wireless IP Telephony system in an enterprise environment. In addition, this chapter examines in detail the site survey requirements and provides recommendations for performing an adequate site survey, including tools, parameters, and parameter values.

Wireless IP Telephony networks require careful RF planning, which begins with the successful completion of a thorough voice site survey to determine the proper level of wireless coverage and to identify sources of interference. Once the site survey has been performed, you can then determine AP placement and antenna selection and configure the wireless network infrastructure.

The following sections describe the nature of RF, site surveys, and the proper settings and environments for wireless telephony:

- [RF Overview, page 2-1](#)
- [Site Survey Verification, page 2-2](#)
- [Recommended Environment for the Cisco 7920 Wireless IP Phone, page 2-3](#)
- [Conducting a Site Survey, page 2-6](#)

RF Overview

Before beginning any WLAN deployment, the network administrator should first complete a site survey of the environment where the WLAN devices will be deployed. The site survey should help to determine the number of APs required to provide RF coverage and the correct AP configurations. It should also take into consideration which types of antennas will provide the best coverage, as well as identifying sources of RF interference.

It is important to keep in mind that two physical environments rarely have the same RF characteristics. For this reason, any discussions of RF in this document are generalized, and network administrators might have to adjust the information to their specific RF environment and requirements.

Although many network administrators have already performed RF site surveys for their initial data WLAN deployments, the Cisco 7920 Wireless IP Phone has somewhat different roaming characteristics and different coverage requirements than Cisco Aironet NIC cards. Therefore, network administrators must perform a second site survey for voice to prepare for the performance requirements of the Cisco 7920 Wireless IP Phone. This second survey gives network administrators the opportunity to tune the APs to ensure that the Cisco 7920 Wireless IP Phones have enough RF coverage and bandwidth to provide proper voice quality.

Site Survey Verification

This section describes some of the tools, methods, and recommendations for performing the site survey.

**Note**

Before you begin a site survey, Cisco recommends that you read this entire document to become familiar with all the differences between data and voice RF network requirements.

Site Survey Tools

Cisco produces some tools to perform the site survey for the Cisco Wireless IP Phone 7920 and the Cisco Aironet Client Utility for Cisco 340, 350, and CB20A wireless cards. The CiscoWorks Wireless LAN Solution Engine (WLSE) has an assisted site survey utility that can aid in the deployment of wireless networks for enterprises. Although CiscoWorks WLSE is highly effective, Cisco recommends that you use a third-party tool for very dense deployments or environments that have a high amount of interference. Third-party tools such as AirMagnet also provide additional detailed information that can aid in performing site surveys. After using a third-party site survey tool, Cisco recommends that you perform an additional site survey verification with end-use devices (in this case, Cisco 7920 Wireless IP Phones) because each client card can behave differently, depending on factors such as antenna gain and application limitations. This document describes certain important site survey data that you can obtain using both the Cisco 7920 Wireless IP Phone and the Cisco Aironet Client Utility for laptops.

RF Recommendations

You should perform a site survey to determine the number of APs required to provide RF coverage. The survey should take into consideration which types of antennas provide the best coverage, as well as where sources of RF interference exist. However, prior to beginning a site survey or deployment, perform an RF walkthrough to identify and mitigate sources of non-802.11 RF interference and rogue APs. Repeat the RF walkthrough periodically throughout the site survey and throughout the life of the deployment. Cisco has automated tools to assist with the site survey. (For information on those tools, see [Conducting a Site Survey, page 2-6](#).)

For additional information on RF design considerations, refer to the chapter on WLAN Radio Frequency (RF) Design Considerations in the *Cisco Wireless LAN Design Guide*, available at

<http://cisco.com/go/srnd>

Channels

To improve roaming characteristics and to ensure proper functionality of the Cisco 7920 Wireless IP Phone, Cisco recommends that you use only non-overlapping channels to program the APs. For information on non-overlapping channels, see [Cisco 7920 Wireless IP Phone Site Survey Tool, page 2-6](#).

When you configure the AP, Cisco recommends that you *disable* the option to search for the least-congested channel. Cisco recommends that administrators manually set all RF channels according to the data gathered during the site survey and site survey verification steps. For details on configuring the AP settings, see [AP Configuration \(for Installation\), page 7-2](#).

If you use the option to select the least-congested channel, the AP will change to a different channel every time its power is reset, thus leaving no predictability and negating the time and effort spent on the site survey. Random selection of channels causes roaming times to increase because the phone has to scan all channels rather than a smaller subgroup of active channels.

Every regulatory domain specifies different allowable radio channels. Observe the following guidelines when selecting which channels to use:

- Always use channels that are a minimum of five radio channels apart so that they do not overlap. (For example, use channels 1, 6, and 11 or use 2, 7, and 12.) This practice reduces the ambient noise on each channel.



Note In this document, channel sets are groups of channels that overlap (such as 1, 2, 3, 4, and 5).

- Use the same non-overlapping channels throughout your deployment. This practice decreases roaming times.
- Always use diversity antennas for both indoor and outdoor environments. This practice tremendously reduces the effects of multipath interference.
- Refer to [Site Survey RF Recommendations, page B-1](#), for best practices in RF deployments and for information on how to avoid common problems.

Recommended Environment for the Cisco 7920 Wireless IP Phone

This section describes the environment needed for a successful voice deployment. The environment will change when used for both data and voice.



Note

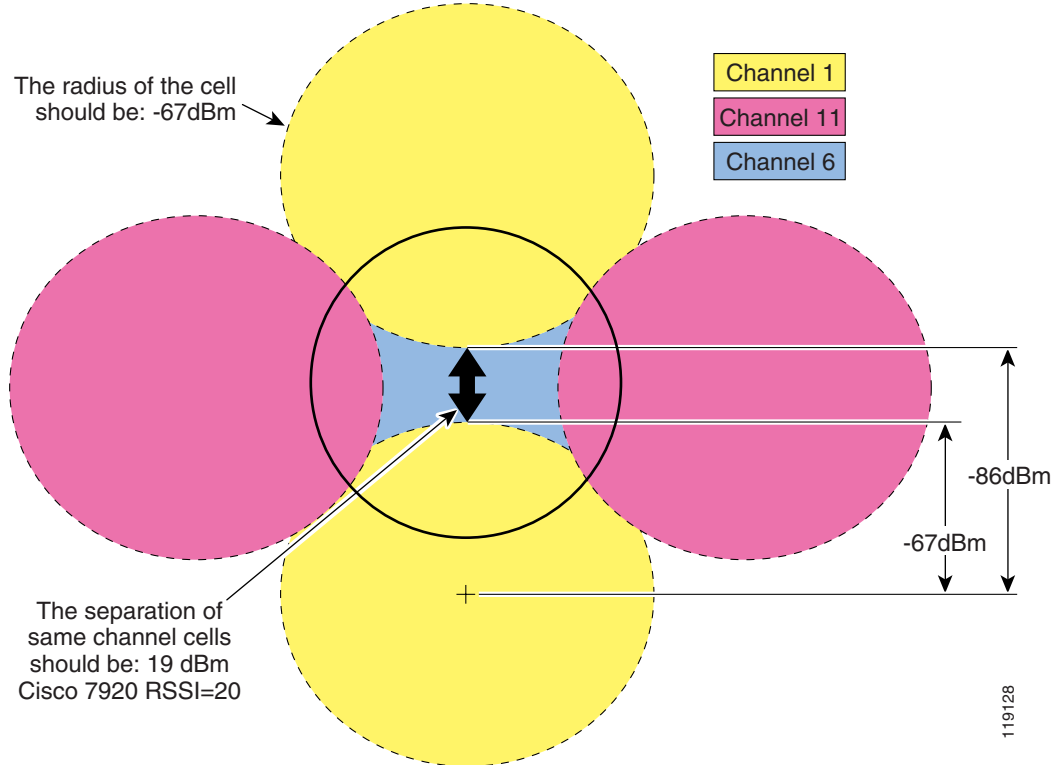
You must test the values listed here, both during the site survey and when the network is enabled for all users.

Observe the following guidelines when setting up the environment for the Cisco 7920 Wireless IP Phone:

- Deploy a minimum of two APs on non-overlapping channels, with a Received Signal Strength Indicator (RSSI) that is greater than 35 at all times in the phone's site survey utility.
- Deploy no more than one AP per overlapping channel set, with a received signal strength indicator (RSSI) that is greater than 35.
 - Although APs might appear to have an RSSI that is less than 35 (on overlapping APs), this situation can still cause interference and should be minimized as much as possible. (This interference or noise will degrade voice quality.)
 - Noise is additive. Having three extra APs on the same channel, all with low RSSI, can be as harmful as a single extra AP with a higher RSSI.

[Figure 2-1](#) shows a typical deployment, with a 15% to 20% overlap of a given AP's cell from each of the adjoining cells. This configuration provides almost complete redundancy throughout the cell, thus complying with the above requirements.

Figure 2-1 Cell Overlap Guidelines



- Two of the APs (including the one with which the wireless phone is associated) must have an RSSI that is greater than 35 (which is equivalent to a receiver threshold of -67 decibels per milliwatt) and a channel utilization QoS Basis Service Set (QBSS) load that is less than 45. This requirement provides for smoother roaming and a backup AP if one of the APs suddenly becomes unavailable or busy.

The QBSS load represents the percentage of time that the channel is in use by the AP. The overall channel load might be much higher than the QBSS load because several APs could be sharing the same RF channel and background or environmental noise could add to the load too. The Cisco 7920 Wireless IP Phone uses the QBSS load in its roaming algorithm. The measured QBSS load will vary, depending on the time of day when you perform the site survey. For example, at night (when the network is largely idle), the QBSS load will usually be very low. Therefore, you should perform the site survey during peak hours. You can reduce the QBSS load by adding APs as needed.



Note The RSSI and channel utilization values can be read directly from the Cisco 7920 Wireless IP Phone site survey tool (identified in the section below). [Table 2-2](#) shows the relationship between decibels per milliwatt (dBm, the industry standard values) and RSSI (relative values for the Cisco 7920 Wireless IP Phone). You can use these values to identify signal strength through the use of other site survey tools.

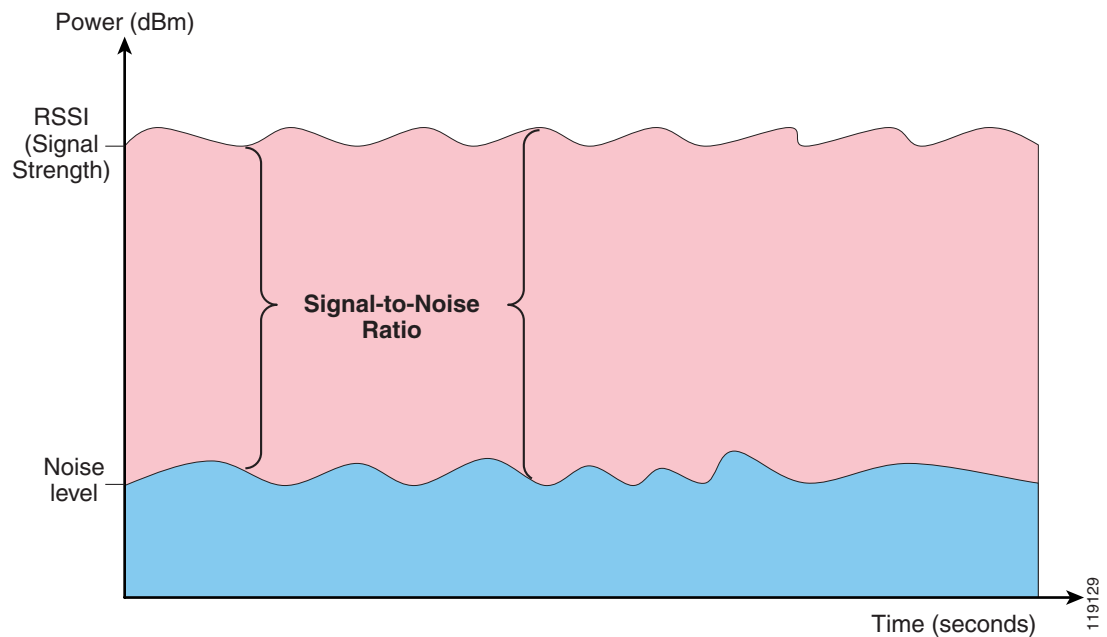
- Maintain at least 11 Mbps of available link speed at all times for data clients as well as voice clients.
- Maintain an AP coverage overlap of at least 15% to 20%.

**Note**

In certain situations, data rates below 11 Mbps must be enabled for legacy devices. This lower speed will affect voice quality and the RF environment, and it is not the recommended setting. If you have to enable both 11 Mbps and 2 Mbps, these low speeds will reduce the number of simultaneous calls that each AP can handle and will also increase the overlap because they will extend the range of the APs.

- Maintain a packet error rate (PER) no higher than 1% (or a success rate of 99%).
- Maintain a minimum signal-to-noise ratio (SNR) of 25 dB (see [Figure 2-2](#)).

Figure 2-2 Signal-to-Noise Ratio



- Try to use the same transmit power on the AP and on the phones. If the transmit power of the APs varies, set the transmit power of the phones to the highest transmit power of the APs.

**Note**

If enabled on the AP, Dynamic Transmit Power Control (DTPC) allows the AP to broadcast its transmit power, and clients can automatically configure themselves to that power while associated with that AP. The Cisco IOS command for enabling DTPC is **power client** and was first introduced in Cisco IOS version 12.2(4)JA. Beginning with firmware version 1.0(8), DTPC is enabled on the Cisco 7920 Wireless IP Phone, and the phone will automatically adjust its transmit power to the client power level configured on the AP to which it is associated.

- All AP antennas must use diversity. For more information, refer to [Site Survey RF Recommendations, page B-1](#).
- APs in an optimal setting can handle seven G.711 or eight G.729 concurrent phone calls. If more concurrent phone calls are needed in a single location (a high usage area, for example), plan to have load-balancing APs available during the site survey. Overlapped basic service sets (BSSs, or APs sharing the same RF channel) reduce the number of concurrent phone calls per AP.

Conducting a Site Survey

The site survey process includes the following steps.

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- Step 1** Identify areas in the physical environment where there is non-802.11 RF interference. Interference sources include, but are not limited to, microwave ovens, Bluetooth transmitters, Frequency Hopping Access Points (FHAPs), and cordless phones. Interference from these devices can lead to choppy voice.
 - Step 2** Identify and eliminate rogue APs by using sniffers or the Cisco Structured Wireless-Aware Network (SWAN) architecture, which can automatically (and on an ongoing basis) detect rogue APs and non-802.11 interference. For more information on Cisco SWAN, visit http://www.cisco.com/en/US/netsol/ns340/ns394/ns348/ns337/networking_solutions_package.html
 - Step 3** Determine the proper AP location and transmitter power levels so that the RF footprint of APs provides sufficient coverage for operation of the Cisco 7920 Wireless IP Phones. Make sure there is sufficient signal strength overlap so that the phones can roam between APs without dropping calls. Also make sure there is a sufficient signal-to-noise ratio (SNR) so that voice packets can be received despite any interference.
 - Step 4** Survey multiple floors together to ensure that coverage from one floor does not negatively impact other floors.
 - Step 5** Check roaming behavior to ensure that common roaming locations are not over a Layer-3 network.
 - Step 6** Install and configure the APs, verify coverage and SNR, and validate the network by making phone calls.
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Cisco 7920 Wireless IP Phone Site Survey Tool

The site survey on the Cisco 7920 Wireless IP Phone is a display of information about the APs currently within range of the phone. It can be accessed by selecting **Menu > Network Config > Site Survey**. The survey displays a list of APs within range with the same Service Set Identifier (SSID) and security settings as the phone. The last two numbers (37 and 5 in [Example 2-1](#)) are RSSI and channel utilization values that are needed for a successful deployment. RSSI is the strength of the signal being heard by the phone. The QBSS value, or channel utilization, is the associated AP's use of the channel, which affects the phone's roaming decision. The section on [Recommended Environment for the Cisco 7920 Wireless IP Phone, page 2-3](#), listed recommended values for both RSSI and channel utilization, and those values should be used for the site survey verification. [Example 2-1](#) shows the type of information displayed on the phone.

Example 2-1 Site Survey Reading

1(C), SSID..., 37, 5

1 = The AP channel number (channel 1)

C = The channel state (see [Table 2-1](#))

SSID = The SSID of the AP

37 = The RSSI value

5 = The AP channel utilization value (also known as the QBSS load value)

For each AP, you can display more information by pressing the Detail soft key. The display will give all the above information plus the full SSID and the MAC address of the AP. If more than one AP is current (C), you can determine which is the connected AP by looking at the AP detail, where a (C) will be listed after the MAC address. If this condition occurs (meaning that there are two or more APs detected on the same channel), all but one AP should have a signal strength below 35, although ideally all will have RSSIs as low as possible.

Table 2-1 lists the AP channel state codes.

Table 2-1 Channel States Reported by the Cisco 7920 Wireless IP Phone Site Survey Utility

Channel State	Relationship of AP to Cisco 7920 Wireless IP Phone
C	Current: The channel to which the Cisco 7920 Wireless IP Phone is currently associated.
A	Available: Active channel is available and is a possible candidate for roaming.
N	Non-overlapping: If the Cisco 7920 Wireless IP Phone is currently associated with CH6, then the non-overlapping channels are: 1 and 11 for North America; 1 and 11 or 12 or 13 for Europe; 1 and 11 or 12 or 13 or 14 for Japan.
O	Overlapping: If the Cisco 7920 Wireless IP Phone is currently associated with CH6, then the overlapping channels are 2,3,4,5,7,8,9, and 10.
I	Incompatible

As a standard, RF values are measured in decibels per milliwatt (dBm). Table 2-2 shows the correlation between the dBm rating and the corresponding RSSI value for the Cisco 7920 Wireless IP Phone.

Table 2-2 Comparison of dBm and RSSI Values for Cisco 7920 Wireless IP Phones

RSSI	5	10	15	20	25	30	35	40	45	50	55	60	65	70
dBm	-98	-97	-89	-83	-79	-75	-67	-61	-57	-49	-44	-41	-38	-34

Table 2-3 shows the dBm ratings and the corresponding RSSI values for the Cisco Aironet 350 Series Access Points. The RSSI is labeled with a % sign in the Cisco Aironet Client Utility (ACU).

Table 2-3 Comparison of dBm and RSSI Values for Cisco ACU Client Adapters

RSSI	0	5	10	15	20	25	30	35	45	50	55	60	65	70	75
dBm	-113	-108	-103	-97	-92	-87	-82	-77	-62	-58	-50	-47	-43	-39	-33

Using the Cisco 7920 Wireless IP Phone Site Survey Tool

Observe the following guidelines when using the Cisco 7920 Wireless IP Phone Site Survey Tool:

- Configure the Cisco 7920 Wireless IP Phone with the same SSID, encryption, and authentication settings as the APs.
- Once the phone is associated with the WLAN, navigate to the Site Survey menu on the Cisco 7920 Wireless IP Phone by selecting **Menu > Network Config > Site Survey**.

- Walk through all areas where phones will be in use, and take readings in each area. During this stage of the verification, Cisco recommends that you approach important areas from different directions to check the roaming possibilities from different perspectives.
- Adjust the AP and antenna placement, as well as the AP power settings, to comply with the [Recommended Environment for the Cisco 7920 Wireless IP Phone](#), page 2-3.

Using the Cisco Aironet Client Utility Site Survey Utility

You can use the Cisco Aironet Client Utility (ACU) in conjunction with the Cisco 7920 Wireless IP Phone to adjust the WLAN for voice applications. For instructions on how to use the Cisco Aironet Client Utility, refer to the *Cisco Aironet 340, 350, and CB20A Wireless LAN Client Adapters Installation and Configuration Guide for Windows*, available at

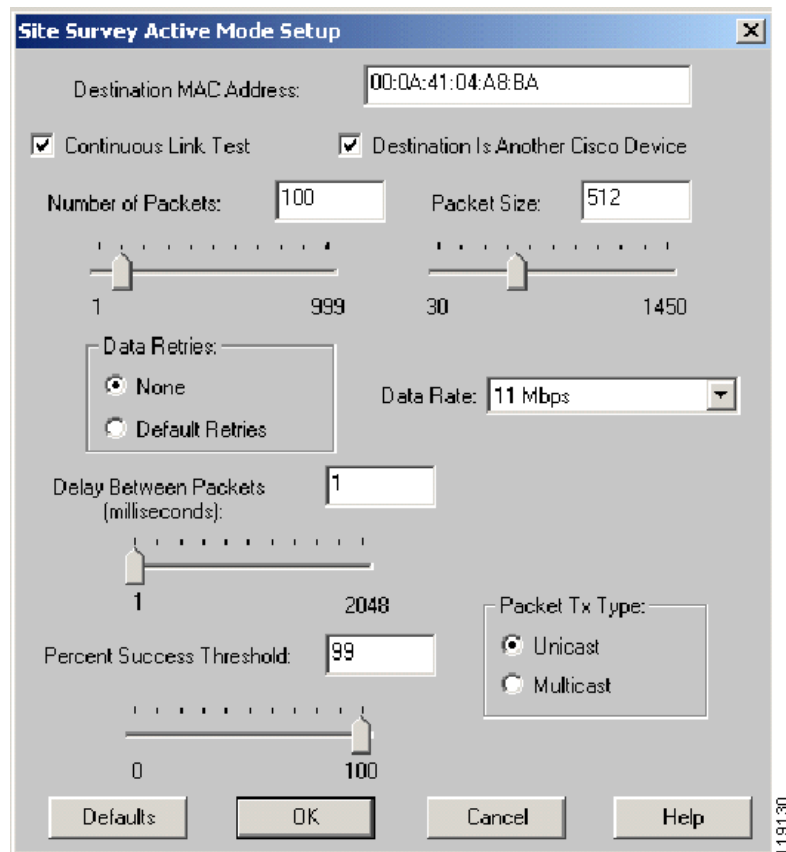
<http://www.cisco.com>

Use the following steps to set up a site survey in Active Mode.

Step 1 Use the following settings, shown in Figure 2-3:

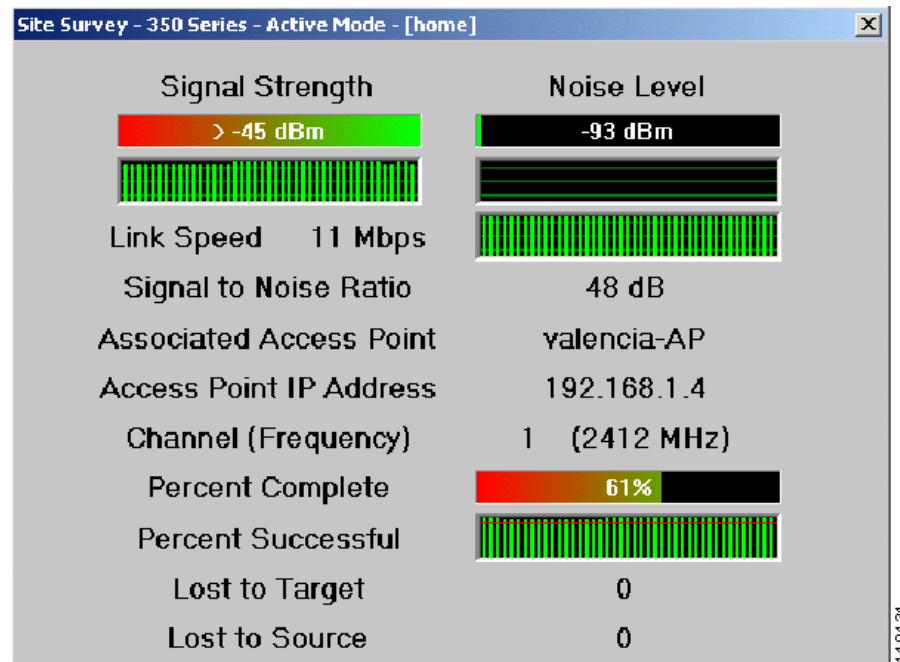
- Data Rate: 11 Mbps
- Percent Success Threshold: 99

Figure 2-3 Cisco ACU Site Survey Screen



- Step 2** Click **Start** and walk through the coverage area. Verify the following values to ensure acceptable coverage for the Cisco 7920 Wireless IP Phone (see [Figure 2-4](#)):
- Signal-to-noise ratio (SNR) should not drop below 25 dB. Anything less might not provide a robust 11 Mbps data rate.
 - The Percent Successful bar should not drop below the 99% threshold set up in [Step 1](#).

Figure 2-4 Output from Cisco ACU Site Survey Utility



- Step 3** To check for the percentage overlap, walk through the full coverage area for each AP to find the locations where the SNR is no longer in the acceptable range, and mark those locations on a site plan.
- Step 4** Conduct this test for each AP sequentially, and check the coverage overlap of each cell. If the overlaps are too great, begin by lowering the transmit power on the AP. If necessary, adjust the location of the AP or the type of antenna used on that AP.

