Best Practices for Wireless Site Design

AIRMAGNET®
Wireless Network Assurance

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Site Surveys are needed to ensure the successful and efficient deployment of wireless networks. To understand the need for a survey, you should first understand the basic goal of a wireless network, which is to provide appropriate coverage and throughput to all end users while keeping interference to a minimum.

RF signals are very unpredictable. If an access point is placed in an open environment with no obstacles, the signals usually maintain an omni-directional pattern. However, when obstacles and walls with different characteristics are introduced, the RF signals are disrupted and access point coverage will vary based on location.

Site Surveys determine the signal coverage, throughput requirements, interfering sources, dead spots, potential roaming behavior, etc and this helps determine (1) what wireless equipment to purchase, i.e. how many access points to buy (2) where to deploy access points, and (3) how to configure each access point for optimal coverage for all end users. It can easily be said that without site surveys; it would be difficult to determine the capital investment needed to deploy the wireless network in a timely and efficient manner.

It is important not to generalize every wireless deployment in terms of requirements; for example, an office environment with only data clients using the wireless network for Internet access may tolerate a few dead spots, but this is unbearable in a hospital environment where the doctors/nurses require access to the network to get real-time patient information. Without site surveys it would be virtually impossible to determine if the requirements of each end user are being met.

Site Surveys are required for:

• New installations: To obtain the number of access points required and locations based on predictive performance analysis.

• Existing installations: To verify the number of access points required versus the number actually deployed and validate their location to ensure optimal performance for all end users.

AIRMAGNET'S APPROACH TO WIRELESS SITE DESIGN

Site surveys are used to plan and deploy a new wireless network, as well as reconfigure or verify the performance of an existing network. This document outlines AirMagnet's methodology for both of these site surveying scenarios. This methodology is a result of AirMagnet's consultation with its own customers, and insight into the best practices of infrastructure vendors and other industry leaders.

Phase I: Preparation Phase

Before purchasing any networking equipment or deploying a completely new wireless technology, users should obtain answers to the following questions:

- How many users require wireless service and what applications will they use? Will they need a roaming facility?

- Is wireless access needed for indoors or outdoors or both?
- Are there any known major interfering sources such as radar installations or cafeteria locations?
- What are the security policies and requirements for wireless networks?
- Are any building/floor blueprints available?

Phase II: Planning Phase

Where do I start the wireless deployment? What equipment do I purchase? By knowing the planning capability, users can significantly reduce the time and effort needed to deploy a wireless network. The Air Magnet Planner provides quick visibility into these requirements, such as:

- Estimated number of access points needed and their signal coverage
- Estimated location of the access points
- Estimated interference occurring between the deployed access points
- RF leakage to outside the corporate physical boundaries
- Data speed values for the planned Access Points

In the planning phase it is critical to understand the effects of various building materials and obstacles on the performance of the network. Obstructions between the AP and stations can lead to diffraction, refraction, and reflection of the RF signal and degrade the signal quality or even lead to RF spillage outside the corporate physical boundary. Given the effect that metals can have on signal quality, it is important to note the location of steel and other metal materials in the site infrastructure. AirMagnet Planner assists users in these areas by providing a predictive map of the building's RF environment.

Predictive Mapping Aids Site Design

AirMagnet Planner enables users to load a map of the building or floor, and customize the space using a library of walls, windows, doors, etc. Different wall characteristics (concrete walls, brick walls, glass/metal doors and windows) and interference areas (cubicles, elevator shafts, warehouse with low/medium/high stock) are marked. Access points with the desired channel, transmitted power, antenna and media-type can then be placed manually on the site floor plan at places where they are expected. The predicted map of the RF environment is then simulated, enabling users to tweak AP locations and other configurations until optimal coverage is achieved for all users. Users further have the option of adding, removing or moving APs to different locations, and the operating channel or the transmitted power can be changed to prevent coverage holes, minimize interference and even reduce security risks by preventing RF spillage outside the corporate physical boundary.
Also the AirMagnet "Planner Advisor" can be employed

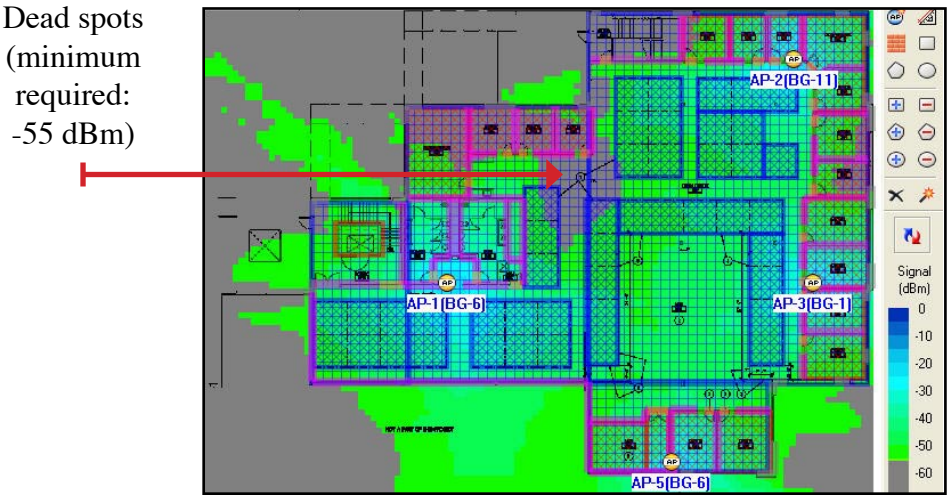

Figure 1: AirMagnet Planner displaying potential coverage holes/dead spots in the wireless network

to automatically model the environment based on the site floor plan. Users mark Wi-Fi coverage areas and areas where APs cannot be placed; specify the minimum signal coverage expected and other parameters. The software then automatically places the required number of APs at the appropriate locations on the floor map, making the process simple and quick.

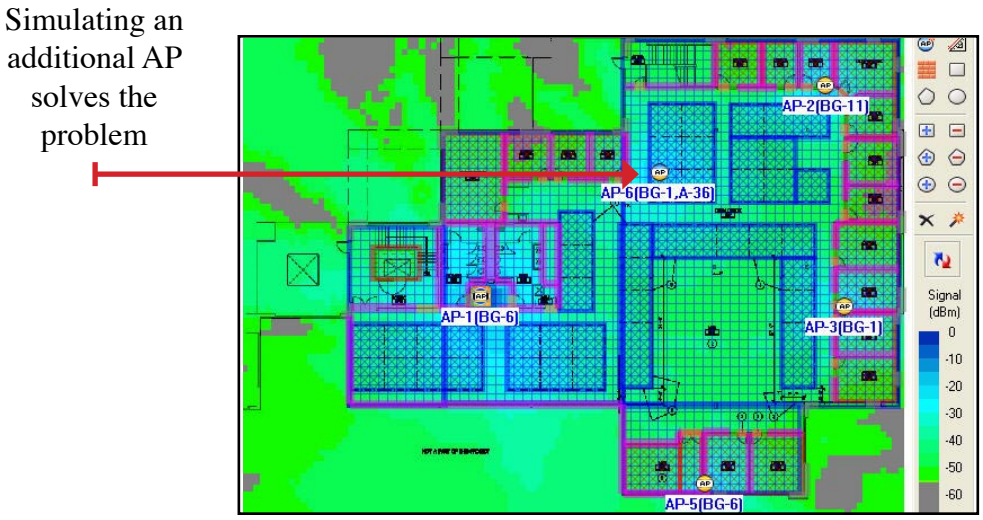

Figure 2: Addition of the 5th access point plugs coverage holes

Reporting Provides Deployment/Purchasing Blueprint

Reporting greatly simplifies the deployment phase. After users have simulated their network for optimal performance, they can generate a comprehensive report that includes the final floor plan and:

- Recommended number of access points needed
- Recommended location co-ordinates for access points
- Name/ MAC address of access points
- Channel/SSID allocated
- Height of the access point/antenna above floor level
- Type of the antenna and its specifications

Phase III: Surveying Phase

Though Wi-Fi Planning tools can predict signal and performance, it is recommended that these results be verified with a field survey before any permanent wireless deployment. The actual RF environment can be affected by the presence of interfering devices (802.11 as well as non-802.11), access points installed by a neighbor and environment changes like adding or moving of a metal shelf. Without an actual field survey, users won't be able to determine the true impact of the RF environment on their network's performance.

The Surveying Phase covers several areas:

- Performing active and passive Surveys
- Managing interference
- Establishing QoS for all end users
- Establishing strict security
- Planning for outdoors, if necessary

Performing Active and Passive Surveys

AirMagnet Survey assists in the pre-installation and post-installation phases by enabling site surveys to be performed without having the access points permanently installed, which saves time and resources. AirMagnet achieves this by offering both Passive and Active Surveys.

• Passive Surveying – In a passive survey, AirMagnet Survey collects RF data from the entire wireless environment. This measures statistics from all APs and wireless sources in the area, providing a good overview of the cumulative wireless environment.

• Active Surveying – During an active survey, AirMagnet Survey actually associates to a specific AP and exchanges data to emulate an end user. This allows surveyors to map out exactly how real-world clients will perform at various locations in terms of connection speed, retry rates, and packet loss.

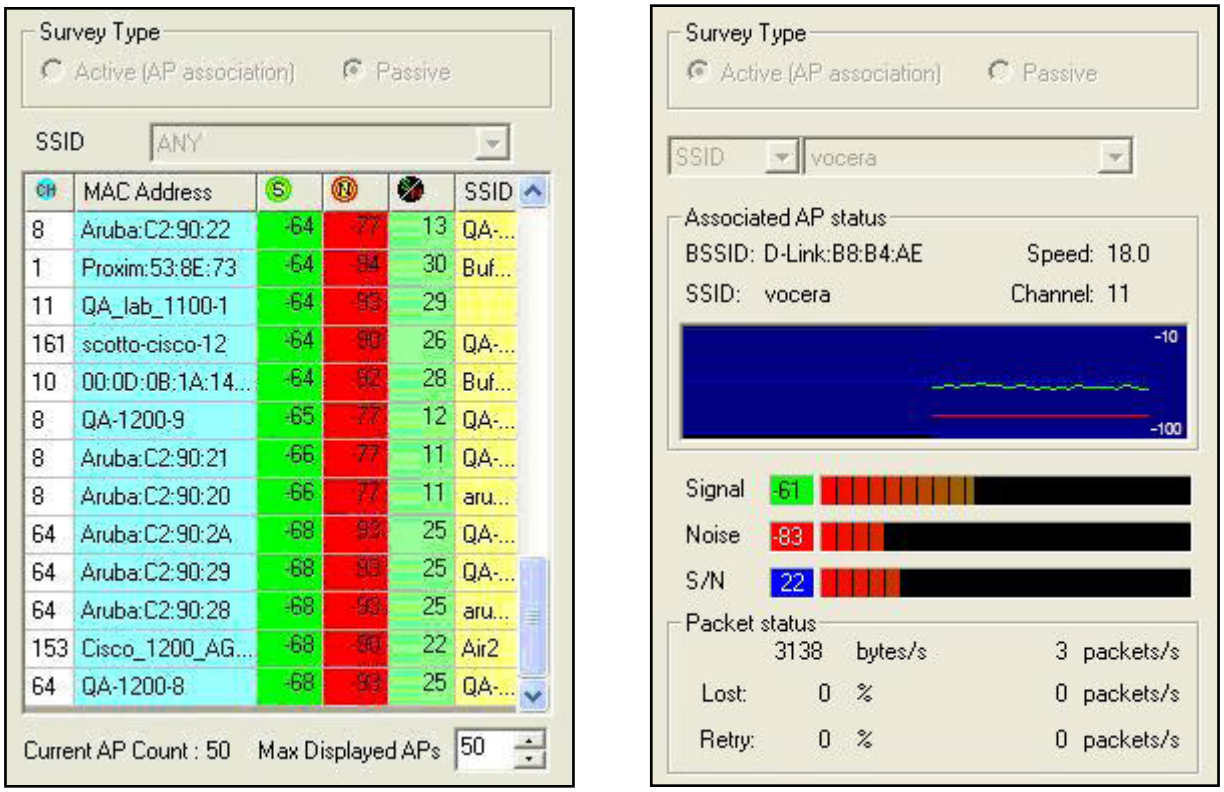

Figure 3: AirMagnet Survey's Passive and Active Survey modes

Will I associate at the required data rate?

For pre-installation surveys, a pilot access point should be placed at a location recommended by the AirMagnet Planner. AirMagnet Survey can then be used to validate the predicted coverage area of the access point. Active surveys will provide actual end-user performance data such as speed, retries and errors. The access point can be moved to alternative locations and additional active and passive surveys can be performed to re-simulate performance. This enables users to test the overall wireless coverage of the network using only one access point.

Post-installation surveys validate or audit the current WLAN deployment in order to enhance the security and performance of the installation. The user should perform a passive site survey for the entire site and a couple of active surveys with the target SSID.

For both scenarios, AirMagnet Survey will provide signal, noise, Signal to Noise ratio, data rate, retry rate, packet loss rate information at every location on the floor.

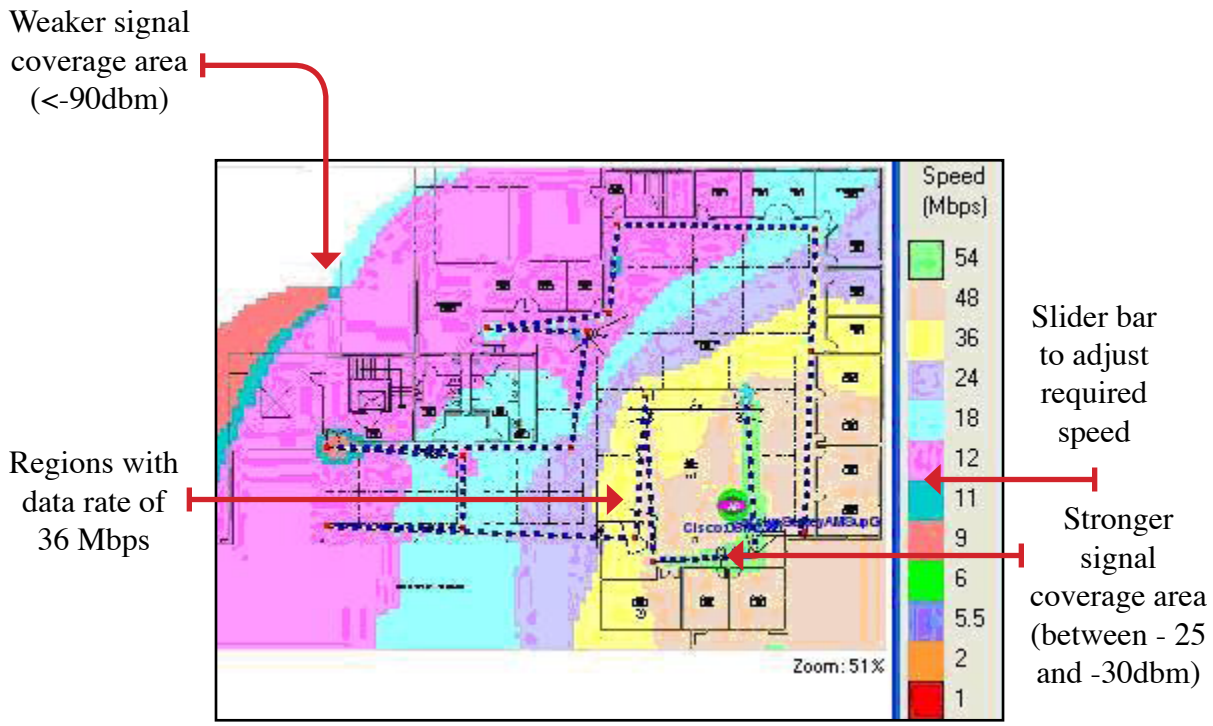

Figure 4: AirMagnet Survey displaying data-rate boundaries

Managing Interference

Few things will rob a wireless LAN of performance more often than RF interference, and coping with its effects is a near universal challenge for anyone who maintains wireless LANs. The RF airwaves constitute the physical, most basic layer of a WLAN upon which all network information must travel. Obviously, any disruption to this fundamental layer negatively impacts the performance of the network. The tricky part of solving interference issues is locating the source of the problem. Often times problems exist because of a combination of several interference sources, including both Wi-Fi and non-Wi-Fi sources. There could be interference from the existing WLAN, a neighbor's WLAN, or sources outside of the 802.11 band.

As an example, we can compare the simplicity of managing signal strength versus managing interference. Signal strength is simply measured from a particular AP to a particular location. If more signal is needed, the

transmit power of the AP can be turned up or a new AP can be added. But either way, only a small number of variables (a single AP to a particular location and adapter) matter. Interference, on the other hand, is more complex. The effects of interference can be additive such that small amounts of interference from several sources can combine to create a large interference at a particular location. This means the network manager needs to account for all possible sources of interference, which would include all APs in the same or neighboring channels.

To make matters worse, interference can come from sources other than Wi-Fi devices such as microwave ovens, cordless phones, RF jamming devices, FHSS devices, Bluetooth devices and many others. This means that to understand interference in the network, one needs to visualize and understand the whole wireless environment. While this can sound like a daunting task, it can actually be done quite easily with the right tools.

AirMagnet enables users to manage interference in several ways:

- View the Overlap Between access points

Any APs that are on the same channel and relatively strong in the same area will interfere with each other. This is a very common source of interference and very easy to visualize with AirMagnet Survey. Recommendations to mitigate this includes, changing one of the APs to a non-overlapping channel (from Channel 1 to Channel 6 for example), reducing the AP transmit power, or moving the AP to a new location. This is the simplest approach to addressing interference, but very effective in many cases.

- Calculate the True Cumulative Interference

As mentioned earlier, the effects of Interference can be additive, allowing lots of small sources of interference to combine into a more substantial problem. AirMagnet Survey will display a color-coded plot showing all the combined interference relative to each access point. This gives the end user a visual cue to the areas where interference could cause performance problems for that AP. This method also takes into account signal from APs on adjacent 11b/g channels. For example, the AirMagnet software can automatically calculate the interference impact of an AP on channel 5 on another AP on channel 6. This provides a much more detailed and accurate view of Wi-Fi interference on a given AP.

- Perform Spectrum Analysis

Interference is not limited to just co-channel interference from other Wi-Fi devices. Interference can come from virtually any device that emits energy in the 2.4 GHz and 5GHz bands of the spectrum. To identify these types of problems and understand their effects on Wi-Fi devices in the environment, it is best to use a tool that provides this information, such as the AirMagnet Survey product. It allows the user to see all the cumulative energy in the spectrum and across all Wi-Fi channels. The solution can automatically identify non-Wi-Fi sources of energy during the survey; identify the type of device that is causing the problem (i.e. there is a microwave oven on Channel 1) and list locations on the floor plan where the devices have been observed during the survey. Users can also gain access to a very important metric - the duty cycle. In very simplified terms, duty cycle is the available capacity for a given section of spectrum. When the duty cycle is at 50%, we can think that the spectrum is half-full (we're optimists). If the duty cycle is at 100%, the spectrum is completely saturated and unusable for signaling purposes. This type of analysis gives users an immediate understanding of the RF physics at play in their environment, and quickly identifies sources of interference that may beyond the boundaries of Wi-Fi.

Users can visualize the RF Physical layer to view the average power level of the RF spectrum for every channel in the spectrum from within the Survey application itself. This is very helpful for planning future channel assignments.

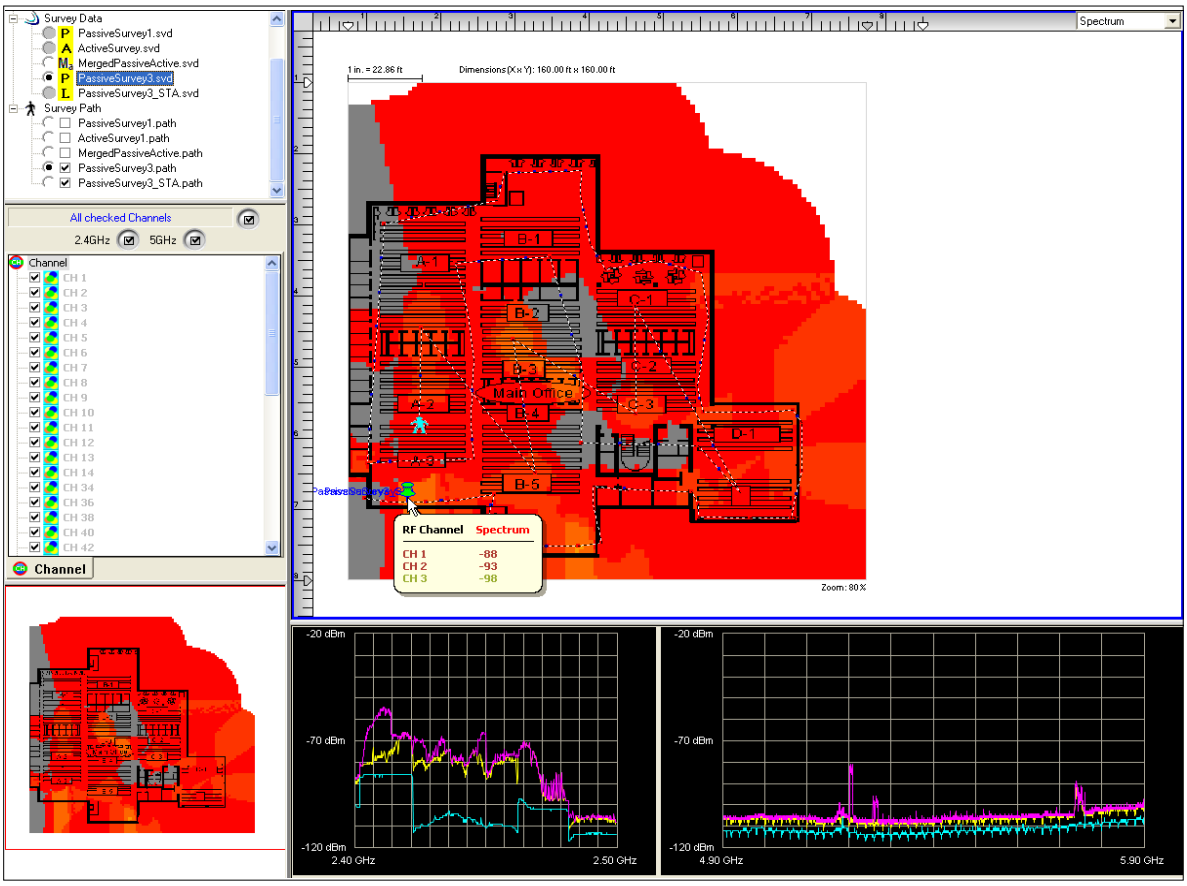

Figure 5: AirMagnet Survey's Spectrum Heat Map

Pinpointing Roaming Areas

Even after successfully associating with an access point, client devices continue to search for newer access points with better wireless services (stronger signal strength, lesser noise and interference). Once an access point with better service is identified, the client station will associate with the new access point, breaking the association with the original access point. This affects the overall performance, as the client may need to go through the re-associations and re-authentication procedure leading to efficient hand-off problems depending on the security mechanism deployed.

Voice over wireless networks are hit harder as the phones roam from one access point to another and undergo new probe, re-association and re-authentication processes. The handoff latency could be anywhere from 400 to 600ms for such phones as they roam resulting in poor voice quality and possibly dropped call.

AirMagnet Survey lists areas on the floor plan where the client devices are most likely to roam between access points.

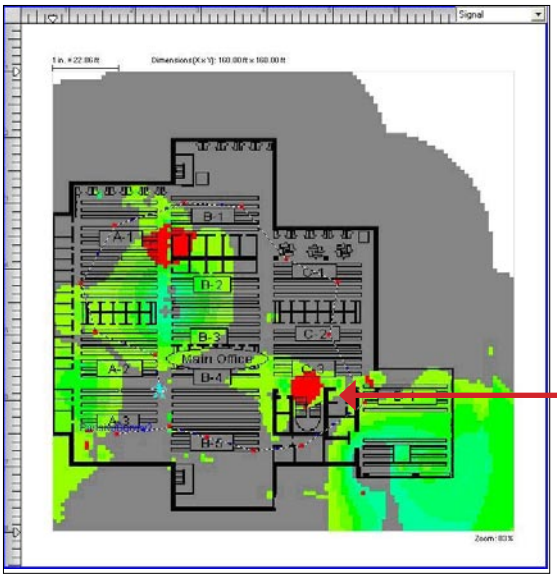

Figure 6: Viewing Client Roaming Areas in AirMagnet Survey

Establishing Optimal QoS for all End Users

It is critical that all network users enjoy an adequate amount of throughput and wireless access points are arranged in a way to logically share the client load. This is why it very important to understand what the applications are being used by clients and what throughput is needed.

To perform a capacity plan, the surveyor should first establish the throughput that each end user will require in order to meet his or her networking needs. Once the average end-user requirements are established, the surveyor can calculate the maximum number of end user clients that should associate with an access point based on the total throughput available from the AP. For example, AirMagnet Survey users can map out a scientific capacity plan and verify if a single access point can satisfy the capacity requirement based on its location and configuration settings.

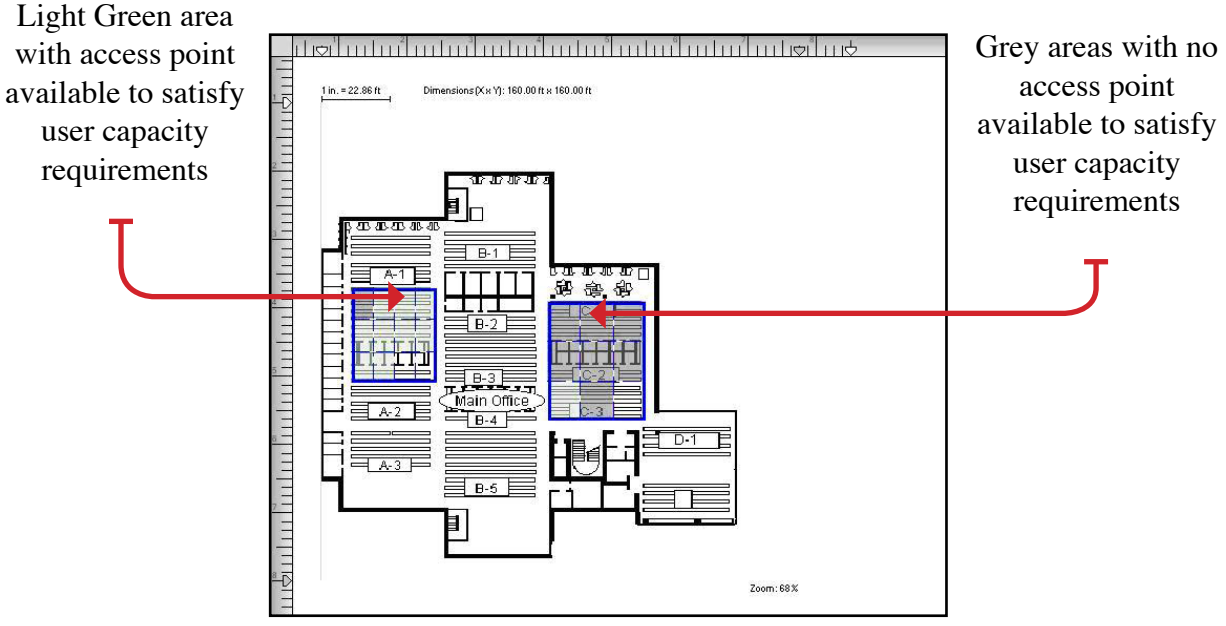

Figure 7: Analyzing user capacity using AirWISE within AirMagnet Survey

During the survey, it may be required to experiment with not only the configuration settings (channel, transmitted power, etc.) and locations of access points, but also consider adding/removing access points. If the surveyor would physically change the setting on each access points or would need to purchase access points, the survey process would be very expensive and time consuming.

AirMagnet Survey allows the user to simulate environment changes, without actually making setting changes on the access point or purchasing equipment. It can also auto-allocate the channel settings to reduce interference

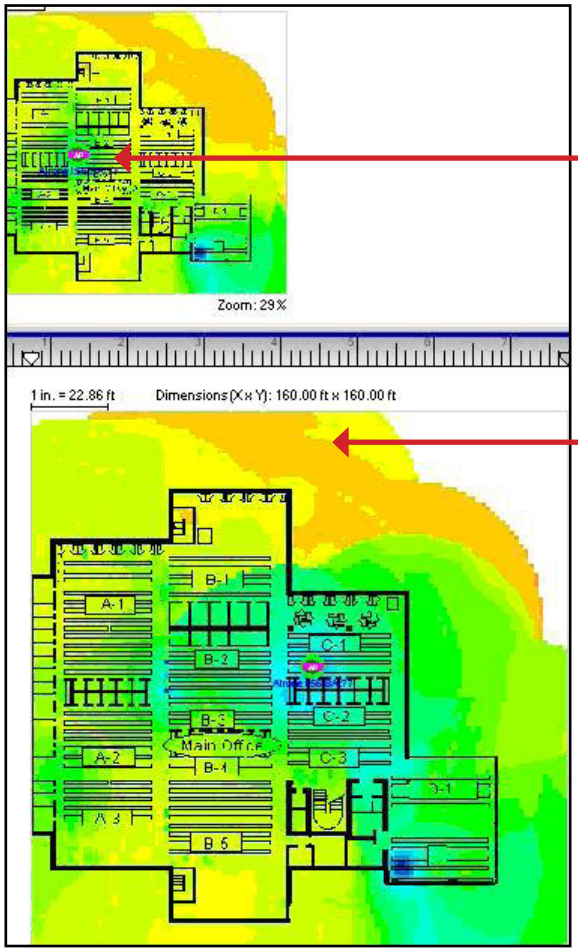

Figure 8: AirMagnet Survey simulating signal coverage for new locations for access points

Do I need access points on each floor?

RF signals travel through and around walls and hence the ability to re-use the services of a single access point for multiple floors. Users can choose to deploy a lesser number of access points or not deploy any on a few floors in a multi-floor building, however without compromising any throughput and coverage requirements.

AirMagnet Survey helps plan for wireless deployments in a multi-floor building and users can observe the access point signal bleed over between various floors.

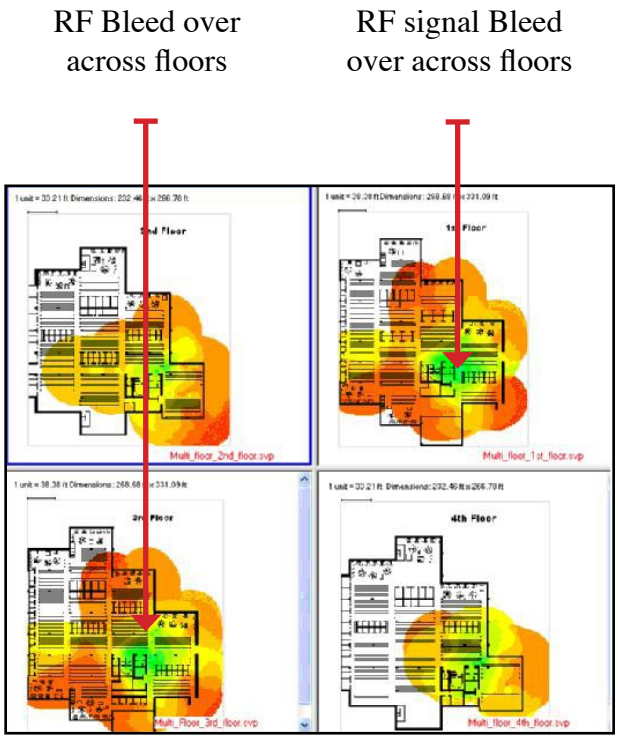

Figure 9: AirMagnet Survey displaying signal bleed over across multiple floors

Establishing Strict Security

While satisfying the performance needs, RF spillage outside the corporate building should be kept to a minimum, unless service is to be provided in the parking lot or an outside area. Taking advantage of the RF leak, unauthorized personnel can gain access to the corporate network from the corporate parking lot or a neighbor's office. Proper physical security measures can be implemented to nullify such unauthorized access. Corporate security policies must be referred for additional information on the security measures to be considered for the deployed wireless network.

AirMagnet Survey users can also locate unauthorized or performance intensive stations during a survey on the floor map.

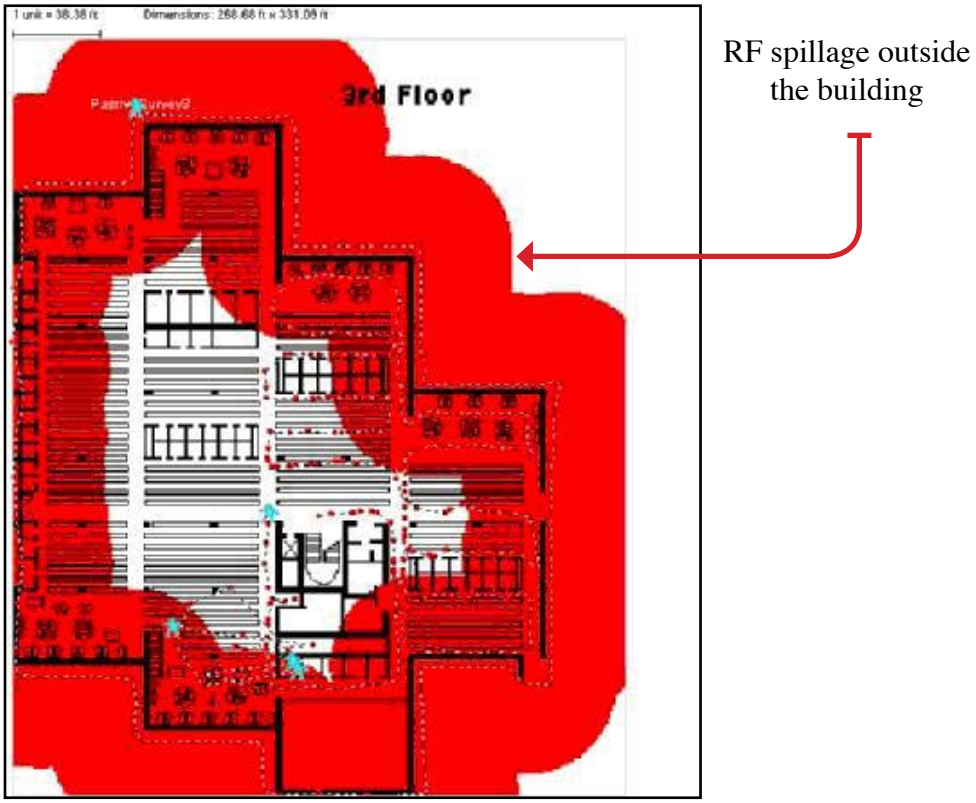

Figure 10: AirMagnet Survey monitoring RF spillage outside the corporate boundary

Planning Outdoor Networks

City and community wireless deployments using existing Wi-Fi technologies, Mesh Networks and WiMax are becoming the norm these days. Outdoor networks bring their own set of requirements and problems to the deployment table. The user now has to deal with buildings, trees, varied terrains, light poles, telephone poles, etc. To make it worse, weather, line of sight between the transmitter and the receiver, free space losses for such deployments play a major role in the performance.

AirMagnet Survey provides a variety of solutions to aid in outdoor wireless deployments. AirMagnet Survey users can perform a site survey for devices operating in the 4.9 GHz spectrum for Public Safety use. Public Safety agencies (Fire, Police and other emergency agencies) use the 4.9 GHz spectrum to transfer videos, maps, missing person images, emergency reports, etc. over a regulated wireless spectrum.

AirMagnet Survey users can leverage NMEA compliant GPS devices to collect location information during the survey. AirMagnet Survey can utilize Microsoft® Mappoint's or Virtual Earth's resources and launch street maps of any city from within the product itself. AirMagnet Survey also allows the user to export the GPS survey data to Google Earth.

If the user site covers a large area of terrain or spans multiple buildings, it allows the user to observe the effects of trees, light poles, telephone poles and other obstacles in the network.

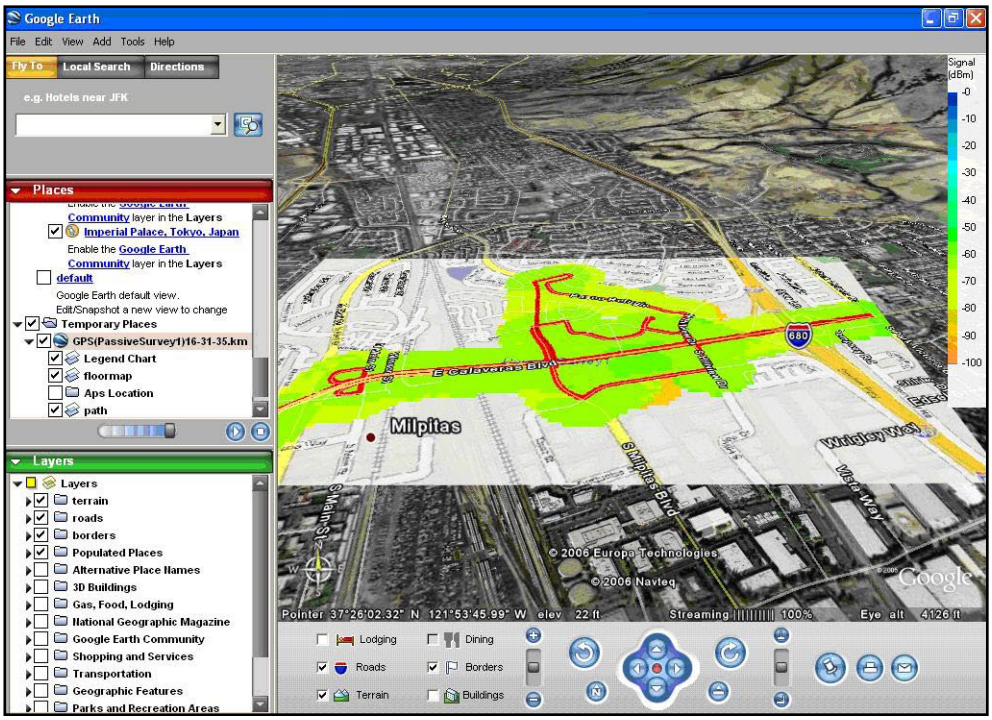

Figure 11: AirMagnet Survey outdoor survey results viewed from Google Earth

Phase IV: Reporting and Sign-off phase

At the end of the site surveying process, the surveyor is responsible for generating the Site Survey report. Without this document, the entire surveying process would be meaningless. The reports should provide detailed information of all factors necessary for a successful deployment, as a different individual could finally install the network. The report will serve as a map for the current recommendations and can also act as a future reference for surveys and other deployment changes. AirMagnet Survey provides the following reports:

- Overall Signal, noise, Signal-to-Noise information based on channel/SSID
- Channel Interference
- Interference between APs
- RF Spectrum information
- User requirements (speed and user capacity per AP)

Phase V: Periodic Surveys

After the wireless deployment, it is critical to perform periodic surveys to account for changes in the environment, interference sources, user behavior, obstacle changes, etc. For example, a new microwave oven in the cafeteria may increase the RF interference in a particular area, calling for changes in the access point settings or relocating the microwave oven. Introduction of new access points by neighbors, may force some changes to be made to the current deployment.

AirMagnet Survey's Diff View feature allows side-by-side visualizing of differences between two separate surveys. This helps show how a site's wireless environment has changed over time. Users can visualize differences in signal coverage, interference levels, noise levels, speed, packet losses, frame retries, etc between two surveys.

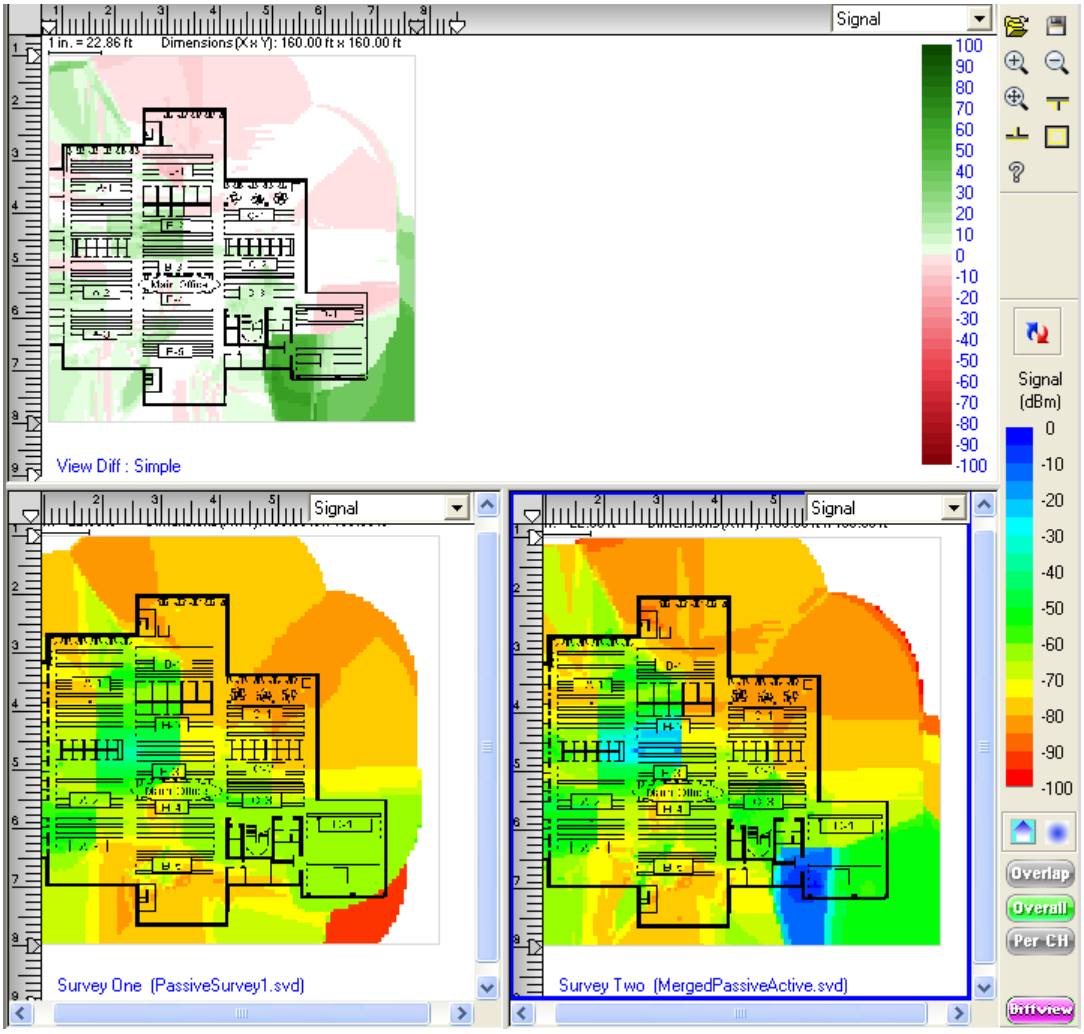

Figure 12: AirMagnet Survey's Diff View displays environment changes over time

Conclusion

Today's wireless service providers, managed-service providers, and network infrastructure vendors all consider site surveys a mandatory and vital part of the wireless LAN deployment process. With the AirMagnet Survey and Planner products, users can be assured of quickly deploying an efficient wireless network to satisfy their business requirements. Users get critical information on the overall signal coverage, real user data from active surveys, user capacity and security of the network.

About AirMagnet, Inc.

AirMagnet Inc. is the leader in security, performance and compliance solutions for wireless LANs. The company's innovative products include AirMagnet Enterprise, the leading 24x7 WLAN security and performance management solution, and AirMagnet Laptop Analyzer — which is known as the "de facto tool for wireless LAN troubleshooting and analysis." Other products provide WLAN site survey and design, RF interference detection, remote diagnostics, and the world's first voice over WiFi analysis solution. AirMagnet has more than 6,000 customers worldwide, including 75 of the Fortune 100. The company, based in Sunnyvale, Calif., has offices worldwide.