Guide for Performing a Wireless Site Survey

2.4 GHz IEEE 802.11g/802.11b/802.15.4

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Introduction

This guide provides a review and expands upon the concepts discussed in a Guide for Performing a Site Survey released in 2004. We will review the characteristics of RF and IEEE 802.11b/g (Wi-Fi) and introduce specifications for IEEE 802.15.4 (ZigBee).

When deploying a wireless networks it is very difficult to determine the propagation of radio waves and detect the presence of interfering signals without the use of test equipment. Even if you're using omni-directional antennas, radio waves don't really travel the same distance in all directions. Instead walls, doors, elevator shafts, metal shelving, water tanks, people and other obstacles cause the radio frequency (RF) pattern to be irregular and unpredictable. As a result, it's often necessary to perform a wireless site survey, which maps the radio frequencies in order to fully understand the behavior of the radio waves within a facility before installing wireless equipment.

The purpose of a wireless site survey is to supply enough information to determine the number and placement of access points, gateways and repeaters necessary to provide adequate coverage and network performance throughout the facility. The wireless site survey also detects the presence of interference coming from other sources that could degrade the performance of wireless equipment.

This wireless site survey guide will outline the process for successfully developing a site survey in order to maximize wireless coverage, performance and customer satisfaction.

Wireless Characteristics

When conducting a wireless site survey there are several wireless characteristics of RF to keep in mind:

Coverage Area – With standard omni-directional antennas, RF waves will radiate in all directions. Radiation patterns include penetrating adjacent floors above and below the wireless transmitter (WAPs, ZigBee Gateways and ZigBee Repeaters). However, physical obstructions and building materials will reduce the maximum coverage area. For example, drywall construction allows greater range than concrete blocks, and metal or steel construction is a total barrier for radio signals. Avoid placing WAPs in locations where a metal barrier is between the sending and receiving antennas, which include metal shelving, metal pillars and metal beams.

Data Rates – Throughput and Range are inversely proportional within an 802.11b/g network. The client is responsible for maintaining the maximum throughput possible. As the distance between the WAP and the client increases the signal strength is reduced and the client can no longer maintain higher data rates. As a result, the client will

automatically reduce the data speeds to match the signal strength. If the signal can no longer be heard, the client will drop the connection with the WAP and attempt to re-associate with another WAP.

Data Rates within a ZigBee Network remain constant throughout the network.

RF Channels/Interference – The IEEE 802.11b/g and 802.15.4 standards use Carrier Sensing Multiple Access (CSMA) protocols, which dictate wireless devices stop transmitting when it senses other "devices" are transmitting. As a result, if there are several devices in the area using the same frequency (or channel) the wireless network traffic can become congested waiting for a clear opportunity to transmit.

Within a Wi-Fi network there are only three non-overlapping channels: 1, 6 and 11. For ZigBee each of the 16 channels are non-overlapping. While channel separation is great within a ZigBee only network, it is a concern when overlaying it with an 802.11b/g network. When both RF technologies are used within the same facility there are only four ZigBee channels which do not overlap 802.11 frequencies. The non-overlapping ZigBee channels within a Wi-Fi network include 15, 20, 25 and 26, shown below in Figure 1: Channel Allocations .

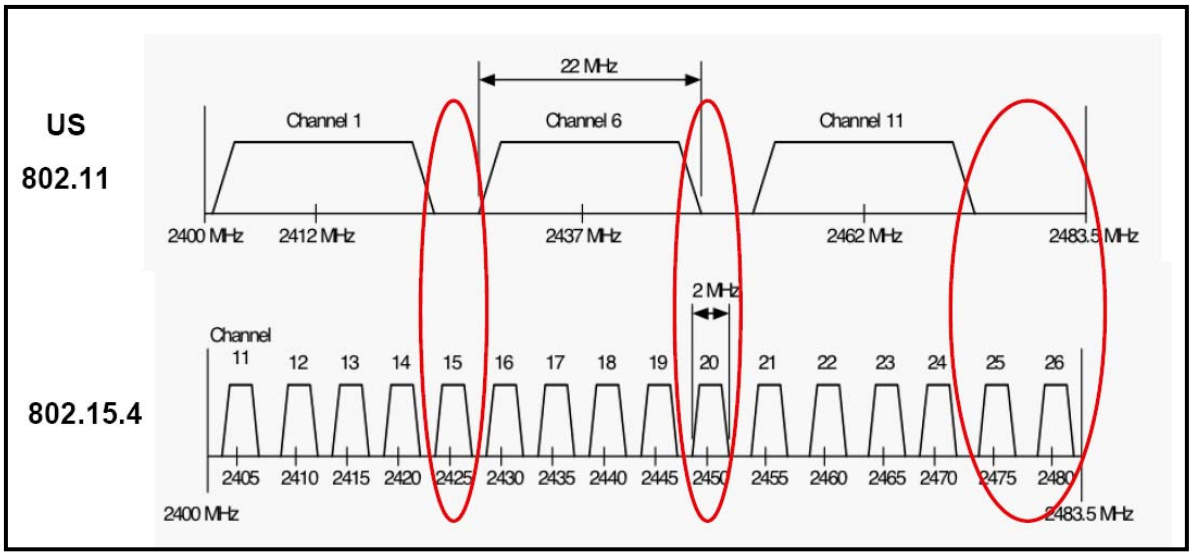

FIGURE 1: CHANNEL ALLOCATIONS

In addition to other WAPs causing interference; cordless phones, Blue Tooth devices, microwaves, baby monitors and many other devices all use or generate signals within the same 2.4GHz spectrum. During the wireless site survey you should take note of these devices, informing customers of potential interference issues which can help set customer performance expectations. If 2.4GHz cordless phones cause system performance issues, one recommendation might be to simply replace the 2.4GHz phones with either 900MHz or 5.8GHz cordless phones, which will not interfere with Wi-Fi and ZigBee devices.

AMX Site Survey Tools

Using the site survey tools designed within the 802.11g CF card, the MIO-R4 ZigBee remote control and/or the AMX ZigBee Gateway you can identify active Wi-Fi access points (802.11g CF card) or ZigBee Gateways (MIO-R4 & AMX ZigBee Gateway) in the area along with channel allocations, SSID/PAN ID information and Security Information, shown below in Figure 2: 802.11G Site Survey Utility.

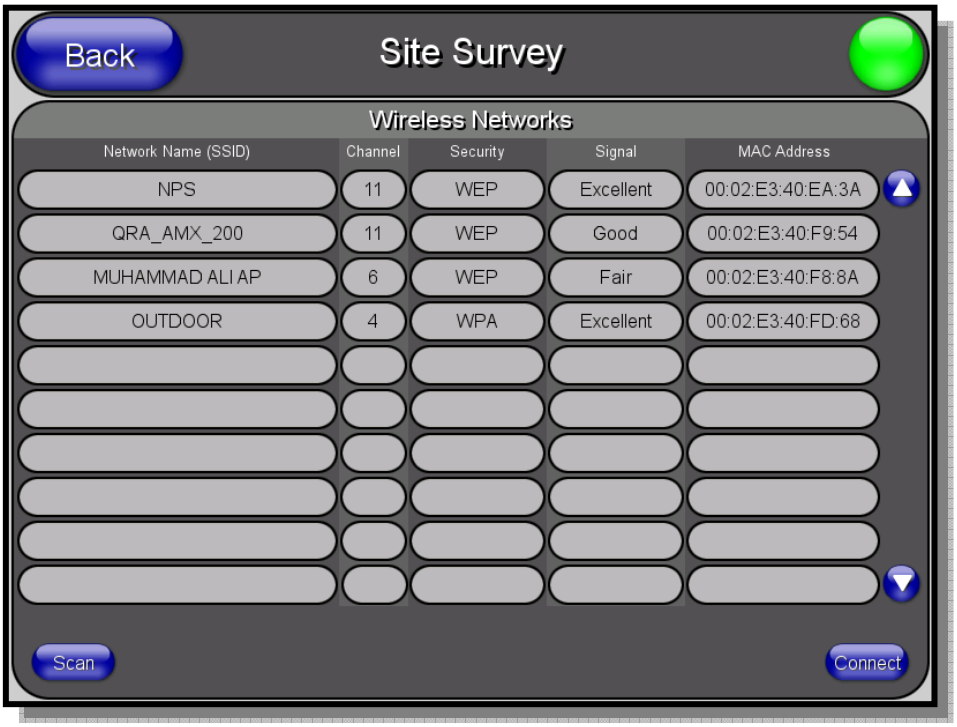

FIGURE 2: 802.11G SITE SURVEY UTILITY

Creating a Channel Allocation Map

With this information documented, you can develop and recommend a channel allocations map for either a Wi-Fi network, ZigBee network or both. Figure 3 shows an 802.11b/g channel allocation map with non-overlapping channels for each area within a building, which will maximize the wireless network performance. For installations where both Wi-Fi and ZigBee are deployed you will need to complete one channel allocation map for each wireless technology.

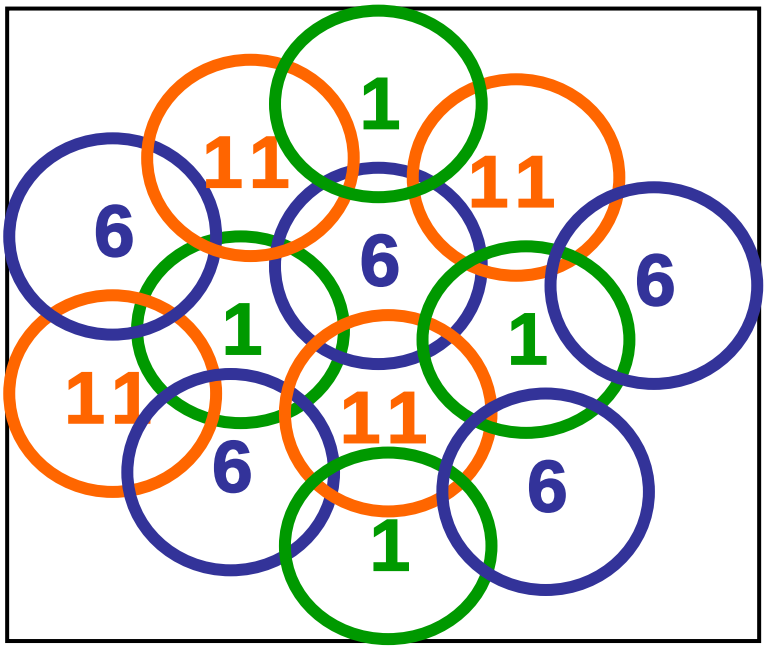

Figure 3: Channel Allocation Map

NOTE: Each ZigBee Gateway and all devices connected to it must be configured on the same channel. Multiple ZigBee Gateways can be located in close proximity using different non-overlapping channels and different PAN ID's. As a result, your Wi-Fi network might have three access points using all channels 1, 6 and 11, but your ZigBee network might include one ZigBee Gateway and three Repeaters all connected on channel 26.

Steps for Performing a Wireless Site Survey

When conducting a wireless site survey for a large enterprise deployment the following general steps listed below should be considered. These general principals can be applied to smaller installations.

1. **Floor Diagrams.** Before starting the site survey locate a set of building blueprints; an example is shown below in Figure 4. If no blueprints are available, prepare a floor plan drawing that depicts the location of walls, doors, walkways, etc.

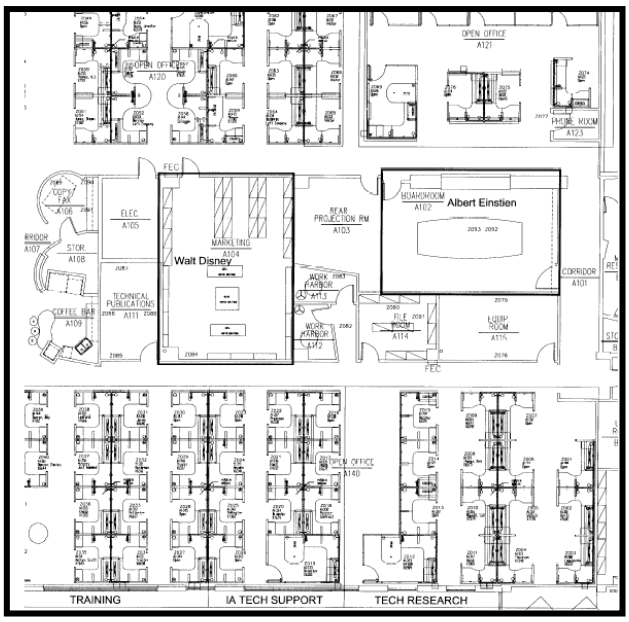

FIGURE 4: FLOOR BLUEPRINT

2. **Walk Through.** Be sure to walk through the facility before performing any tests to verify the accuracy of the facility diagram. This is a good time to note any potential barriers that may affect the propagation of RF signals. For example, a visual inspection will uncover obstacles for RF such as metal racks and partitions, items which blueprints generally don't show.

3. **Identify Fixed and Mobile Areas.** On the facility diagram, mark the areas of fixed and mobile users. In addition to illustrating where mobile users may roam, indicate where they will not go. You might get by with fewer access points if you can limit roaming areas.

4. **Determine Preliminary Access Points Locations.** Consider the location of wireless users and range estimations of the wireless LAN products and approximate the locations of access points that will provide adequate coverage throughout the user areas. Plan for some overlap among adjacent access points, but keep in mind that channel assignments for access points will need to be far enough apart to avoid inter-access point interference.

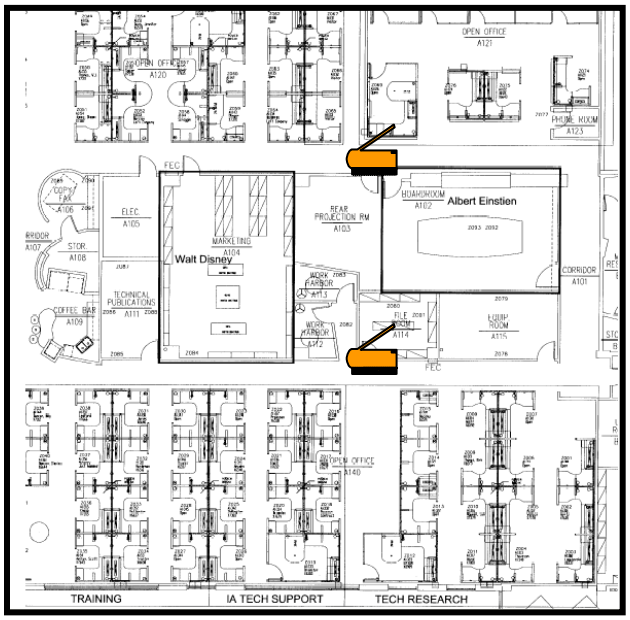

FIGURE 5: POTENTIAL WAP LOCATIONS

To maximize range, access points should be mounted near the ceiling on vertical posts or metal supports above ceiling tiles. Be sure to recognize suitable locations for installing the access point, antenna, data cable and power line. Also think about different antenna types when deciding where to position each access point. An access point mounted near an outside wall, for example, could be a good location to use a directional antenna to increase security. The directional antenna will direct the RF signal inside the facility, and minimize RF leaking into the parking lot.

5. **Verify Access Point/Gateway/Repeater Locations.** This is when the real testing and configuration begins. Using the site survey tools designed in the AMX 802.11g CF card and the MIO-R4 remote control you should walk the facility taking notes of competing access points/gateways/repeaters and any dead spots which may not have been identified during the planning stage. It may be necessary to change the location of the WAP, add a WAP and/or change the channel allocation map due to competing access points.

   Accessing the browser-based configuration tool on the AMX ZigBee Gateway can also provide you a quick overview of the connected ZigBee devices displaying their connection status and delay times. Delay times indicate how quickly their messages are being transmitted. In our application, if a customer presses the mute button they expect the end device to be muted within 100ms. If delay times are greater than 100ms our customers won't accept the lack of performance. As a result, if connected devices show a greater than 100ms delay the configuration utility will indicate the end device is out of specification by highlighting it in red. When you come across a device in red you have two options: inform the customer of the potential delay or add a new gateway which will resolve the delay times.

   Documentation: Channel Allocation and Mounting Positions. Once you're satisfied with the planned locations of access points/gateways/repeaters, mark down the channel allocations and mounting positions, which will be used by the installers to deploy the network.

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