# Best Practice Design Guide

Site Surveys for Hospitality

December 2020

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# Intended Audience

This document addresses factors and concerns related to performing site surveys in hospitality environments. Many factors can affect both the initial work and final performance. These are considered here along with recommendations for pre-installation and post-installation (validation) work.

This document is written for and intended for use by technical engineers with some background in Wi-Fi design and 802.11/wireless engineering principles.

For more information on how to configure CommScope products, please refer to the appropriate CommScope user guide available on the CommScope support site. https://www.commscope.com/SupportCenter/.

# Overview

This document provides network designers, architects, and WLAN professionals guidance for performing hospitality site surveys using CommScope's RUCKUS networking equipment and software. This document is one in a series of design and deployment guides created for Hospitality.

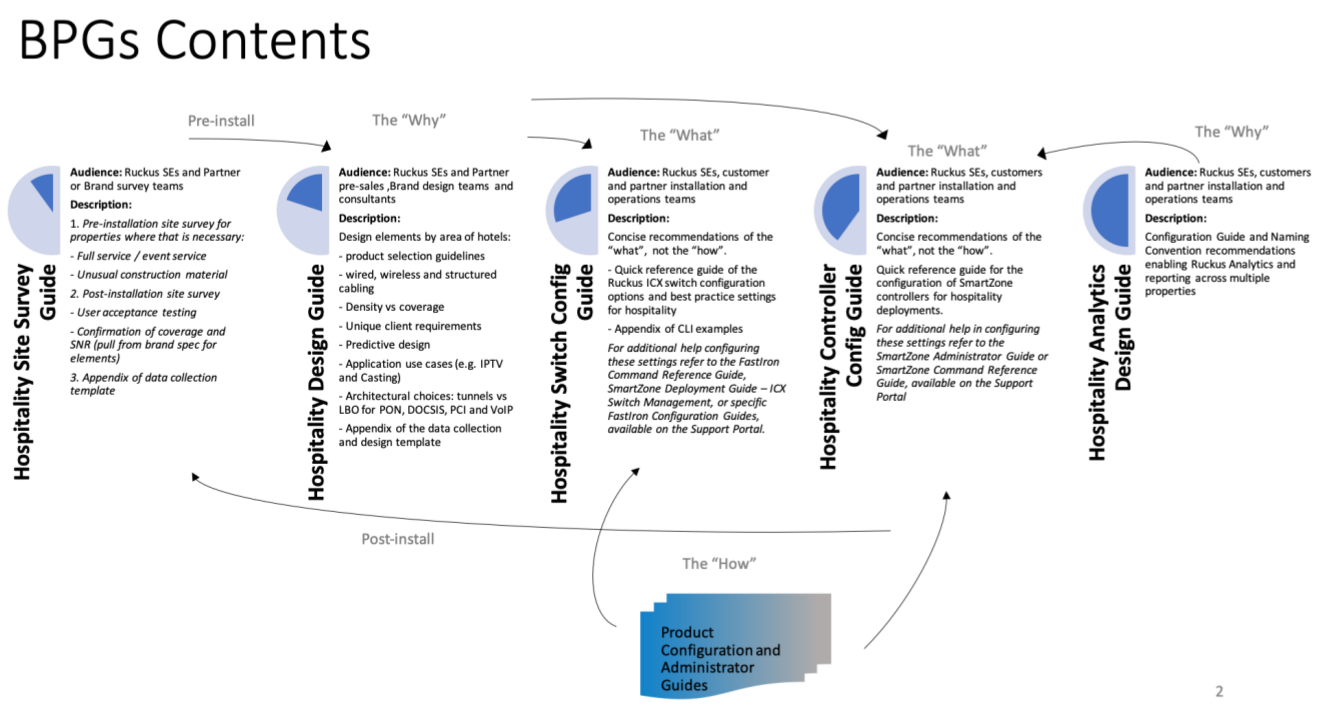


FIGURE 1: SUITE OF DESIGN AND DEPLOYMENT GUIDES FOR HOSPITALITY

This document is intended to provide guidance to Hospitality Managed Service Providers to ensure consistency and optimal performance of deployed RUCKUS WLAN infrastructures across properties.

This document is one in a series of Design and Deployment Guides specific to the Hospitality vertical. Please refer to the other documents to provide a more complete picture. The intended audience for this body of work includes Ruckus Systems Engineers and customer and/or partner installation and operations teams. These documents are intended to primarily cover the "What" and some of the "Why", not necessarily the "How", when it comes to configurations. Ruckus provides separate additional resources, both in the form of online and offline configuration guides, internal/partner support portal knowledge base, and How-to videos posted to YouTube. Partners can always engage Ruckus Systems Engineers or Field Engineers with questions or assistance as needed.

This Site Survey Guide has been created to provide guidance for performing active and passive site surveys for initial design and post installation verification. This document assumes that clear requirements have been defined within the project scope.

## Site Surveys

Site surveys are used to create initial Wi-Fi designs and to validate those designs post installation. Whether a property is upgrading their system to comply with brand guidelines, replacing an aging network, or addressing concerns caused by a bad previous design and install, a good on-site survey is the first step for a successful Wi-Fi project.  A good site survey requires an experienced Wi-Fi professional who is armed with the right tools, comfortable shoes, maybe a hardhat, and definitely a strong flashlight. This is an art, not a science. The effort will draw from many disciplines and powers of observation and in some rare cases, requires coercion and cajoling.

## Hospitality Landscape

Hotel properties vary greatly by size, amenities, and services. All of these affect the network needs and the amount of effort required for a successful project.

Small, low-end properties can be planned and designed from your desk. In general, these smaller properties will not warrant much on-premises introspection. General questions such as the location and availability of cables and location of the MDF can be answered by the GM or maintenance manager. Stay home.

Other properties, such as the ones that grace the covers of travel brochures and populate social media pages, require more attention. These are the full-service destination resorts. They are living, breathing money-making machines. They employ hundreds and can sometimes house more than a thousand guests. They have been called “cruise ships without the ocean”. The demands on the networks at these properties and the variety of floorplans and building materials warrant the time and energy spent on site.

### Building Standards

Common construction standards at many venues allow for reasonable assumptions about material attenuation, room sizes, and AP placement in hotel with common styles. The Wi-Fi designer can use this commonality to their travel advantage. Work smarter, not harder.

Be aware that some locations, particularly those in zones prone to severe weather and California in general, the generally accepted rules don’t apply. Hotels in hurricane zones are built like bunkers. Properties in earthquake zones are built like stronger bunkers. Be aware of the where.  When in doubt, ask.

### Brand and Aesthetic Standards

While brand standards provide guidance for access point and networking switch selection, those standards do little to stipulate cable drops or wall box orientation. Sometimes these defy logic and seem to be at the whim of the cable installer. Often, there will be places where the previous AP/LAN drop location dictates the new design and the Wi-Fi engineer has to accept the AP location and move to the next room.

Through industry consolidation and expansion, there are often properties contained within the portfolio that no longer meet the brand standard or have legacy networks that cannot provide the level of service demanded by new devices.

A good site survey is as much art as it is science and a good Wi-Fi engineer is listening to an army of voices: the GM, facilities manager, banquet manager, IT Director, Director of Finance, the Area Director, and the voice of experience from Project of the Past. They ask competing questions about price vs. performance and optimal design vs. aesthetics. Some examples:

- How will the AP look there? How can I hide or camouflage it?
- How long will it take to install that AP? Do I need special equipment?
- What is the best path for cable? Is a new cable run needed?
- How old is the CATx cable? What shape is the fiber in?
- Where is the nearest IDF? Is the IDF in the right place and is it secure?
- Does any of this require service outages?

### Hospitality Network Challenges

There is always a cabling contractor who knows more about the hotel than the people that work there. My grandfather once told me that if you wanted to understand how something worked, take it apart and put it back together. My first bicycle would disagree. But those cabling guys know everything there is to know about the property. Trust them. Buy them lunch.

I'd say one of the biggest challenges we face as designers is on the topic of blueprints.  There is a fine distinction between floor plans and building drawings. Floor plans are not scaled. They are representations of what is there, and you've seen them in the evacuation plan on the inside of your hotel room door or near the elevator. They don't help us at all. Don't use them. Find the actual plans that are to scale.

If you can get the drawings before you go to the property, print them and draw on them. I tend to look like an adult with a coloring problem when I survey. I use colored pencils and highlighters and stickers and just make a bunch of notes. It's fun and all the cool kids are doing it. I also photograph every AP mounting location and import that as a note into my planning software.

The next challenge is overcoming the incumbent. I flatly reject the idea that I need to re-use existing cable or locations, especially if I am installing new flame-throwing APs. 2.5Gbe or 5Gbe APs should talk on CAT6A cable. When possible, test the cables but don't hesitate to ask for new ones. We are building the future, not the past. Existing cable locations might be nice, but I also don't let them inform my AP location decision. Just because there is a 7982 there does not mean a R750 will be happy there is well. I'm sure if the last designer got it wrong, you will too if you follow their lead. If all the other APs are jumping off bridges, are you going to as well? I didn't think so.

### Existing Network Audit

Before implementing a new wireless network, it is important to understand and get visibility into the existing network, make a detailed assessment and have an updated documentation of the following:

- Existing VLANs and subnet: It is important that any migration be done in such a way that the new system be deployed in a different VLAN from the old system. This is to avoid any potential conflict that may arise between them.
- Existing routes: Existing routes or routing information must be clearly identified and documented so that security risks can be assessed. It is important that infrastructure systems and devices cannot be accessed and compromised by unauthorized users.
- Existing restrictions, access lists and traffic rules: Existing ACLs, permissions and traffic rules should also be clearly identified and documented to assess security risks and also to ascertain there is no interference to proper functioning of the new wireless network.
- Multicast and broadcast traffic in the network: Due to the way multicast and broadcast traffic is transmitted over wireless, the presence of large amount of multicast and or broadcast traffic is bad for Wi-Fi. To audit this, simply use a laptop running a packet capture and connect to the core switch with a mirror port (for capturing multiple VLANs) or access port on the VLAN of interest to capture about 30 minutes or more of traffic and analyze the traffic looking for suspicious devices generating a large amount of multicast or broadcast traffic.
- Quality of cabling and patch panel connections: This may be basic but in hotel environments, many properties have old infrastructure that are of poor quality. Some have cabling exceeding 100 meters and do not have a full site cable test report.
- Types of Ethernet switches (make, model, performance): For wireless networks deployed to be secure and effective, only managed switches that support 802.1q VLAN should be used. Unmanaged switches should not be used. PoE switches should also be used as far as possible. PoE switches are used to power access points directly. Avoid using PoE injectors or DC power supply. Using PoE switches have the advantage of being able to remotely power cycle access points without the need for physical access to the access point.
- Power budget (on POE switches): Power budget has to be considered when deploying access point models which may require more than 15.4 W. 802.11ax access points from most vendors will require 802.3at (PoE+) power supply. However, they may work with 802.3af but with reduced features.

This must also be examined when deploying more access points e.g. one access point per room scenario. The PoE switch must have sufficient power budget to power all the access points connected on it as well as for the switch operation.

Heat dissipation will also be a consideration when using such switches. Many risers are not well ventilated and cannot dissipate heat coming from the switches and may cause the switches to operate at or exceeding their temperature limit. This will lead to early failures and network downtime.

## WLAN Deployment Area Best Practices

### Guest Rooms

In general, for hotel guest rooms, the recommended models of access points are:

- Ruckus H510 802.11a/b/g/n/ac Wave 2, 1 x 1GbE port, RJ-45,4 x 1GbE ports, one PoE-out
- Ruckus H550 802.11a/b/g/n/ac/ax, 1 x 1GbE port, RJ-45,4 x 1GbE ports, one PoE-out
- Ruckus R510 IEEE 802.11a/b/g/n/ac Wave 2, 2 x 1GbE ports, RJ-45, PoE in on one port
- Ruckus R550 IEEE 802.11a/b/g/n/ac/ax, 2 x 1GbE ports, RJ-45, PoE in on one port
- Ruckus ICX 7150 switches with 304 Gbps switching capacity

| Order of Preference | Design | AP location | Remarks |
|---|---|---|---|
| 1. Most preferred | 1 or more access point per room. | Inside the room.<br>Avoid room entrance access panel as far as possible.<br>Ideally desk location or somewhere central within the room. | For optimal coverage in both frequency bands (2.4GHz and 5GHz) |
| 2. | 1 access point for 2 rooms. This depends on whether *either* adjacent *or* vertical signal propagation allows for it. | Same as 1. Access points must be staggered across floors. | 5GHz coverage will likely be restricted to the room with the access point. |
| 3. | 1 access point for 3 to 5 rooms. This depends on whether *both* adjacent *and* vertical signal propagation allows for it. | Same as 2. | Same as 2. |
| 4. Least preferred | 1 access point for 4 to 6 rooms. This depends on test for hidden nodes. If there are no hidden nodes condition (or little) then that would be doable. | On the corridor or hallway.<br>Access points across floors should be staggered too. | Unlikely to have 5GHz coverage within the rooms. |

TABLE 1: DESIGN BEST PRACTICES

**Hallway Areas**

Recommended models for corridor coverage:

- Ruckus R650 802.11ax 4x4:4 with one 2.5Gbps Ethernet port and one 1Gbps Ethernet port
- Ruckus ICX 7150 switches with 304 Gbps switching capacity
- For corridor areas on guest floors, it is recommended to install just a few access points to provide coverage with the focus on the guest lift areas on each floor. These should preferably be installed on the ceiling facing down (either exposed or inside – preferably exposed of course).
- They could also be installed wall-mounted at the end of corridors to provide coverage. This depends on the floor layout.
- In cases where the in-room access points are placed in the guest room entrance access panel, the signal will bleed over to the corridor. So the corridor will get coverage from those access points, in which case, it may not be necessary for any corridor access points at all except for the lift lobby area.
- Corridor access points' signal will likely have strong vertical propagation downwards. This must be tested and factored into the design. If there is strong signal either to the upper floor or lower floor, then the access point location on the upper and lower floors should be different. A staggered design should then be adopted.
- Care must be taken to avoid mounting the access point near to any cellular or mobile antennas. There should be at least 2 meters clearance from any such antennas to avoid possible interference.

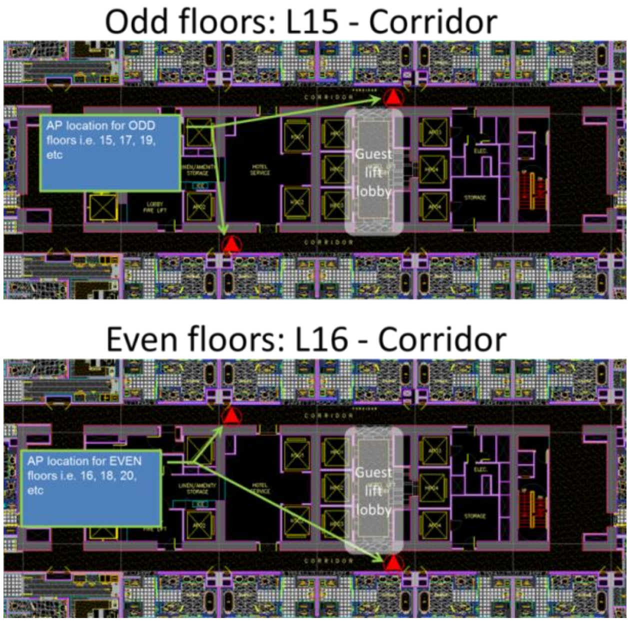


FIGURE 2 - CORRIDOR COVERAGE EXAMPLE

**Public and Outdoor Areas**

Recommended models for such areas will depend on expected user density.

- Ruckus R650 802.11ax 4x4:4 with one 2.5Gbps Ethernet port and one 1Gbps Ethernet port (where user density is expected to be below 200)
- Ruckus R750 802.11ax 4x4:4 with one 2.5Gbps Ethernet port and one 1Gbps Ethernet port (where user density is expected to hit 200 and above)
- Ruckus R850 802.11ax 4x4:4 with one 2.5Gbps Ethernet port and one 1Gbps Ethernet port (where user density is expected to hit 300 and above)
- T610 4ss 11ac W2
- T750 -O 4ss 11ax 4MU streams PoE in + out, SFP, Direct AC power, Omni
- T750 -SE 4ss 11ax 4MU streams PoE in + out, SFP, Direct Vac power, Sector + external antenna option Available 2nd half 2020
- T350 - 2ss 11ax (Available 1st half 2021)
- Ruckus ICX 7150 switches with 304 Gbps switching capacity

This is usually the least difficulty in terms of design, but the same principles and considerations apply.

- Only concurrent dual-band access points are to be used.
- Access points for public areas should be installed preferably ceiling mounted where possible. If ceilings are too high, then wall mounting would be the next option.
- They should preferably be located somewhat centrally within the coverage area.
- They should be preferably located indoors to cover small outdoors sections.
- Orientation and direction of access point is important. You should understand the signal propagation pattern of the access point model and orientate the access point to maximize the signal towards the coverage area. It is important to note that most of the Ruckus access points have a somewhat directional signal pattern. That means the access point should have its front facing the coverage area.
- User density.

  This is a huge consideration for hotels that may have public areas or lobbies which has a high density of users. The sizing for access points will be based on capacity instead of coverage.

  See the sizing guidelines under Meetings and Convention Areas.
- If the user density is expected to be high, then the access points here must be supported by Gigabit Ethernet switches.

### Meeting and Convention Areas

Recommended models for such areas will depend on expected user density.

- Ruckus R650 802.11ax 4x4:4 with one 2.5Gbps Ethernet port and one 1Gbps Ethernet port (for meeting rooms up to 80 users)
- Ruckus R750 802.11ax 4x4:4 with one 2.5Gbps Ethernet port and one 1Gbps Ethernet port (for meeting rooms or ballrooms in excess of 200)
- Ruckus R850 802.11ax 8x8:8 1x1000/2500/5000Base-T, 1x1000Base-T Ethernet ports (for meeting rooms or ballrooms in excess of 300)
- Ruckus R860 Tri-Band (2.4Ghz/5Ghz/6GHz) Concurrent AP 1x1000/2500/5000Base-T, 1x1000Base-T Ethernet ports (for meeting rooms or ballrooms in excess of 300) **Available 2021**
- Ruckus ICX 7150 switches with 304 Gbps switching capacity
- When planning and designing for these areas, we have to consider capacity instead of coverage. The key consideration for such areas is that they are open spaces. This presents a challenge because there is little or no barriers attenuating WiFi signal. Why is this bad? With little or no barriers, signal can travel a longer way. This makes it difficult to use more access points especially in the 2.4GHz frequency band due to the limited (3) non-overlapping channels available.
- All wireless LAN manufacturers will have a maximum concurrent user specified against their access point models. We need to understand that these numbers are maximum theoretical numbers as tested in a “clean” environment totally free of interference.
- As we said that 802.11 protocol works based on CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance), it means that every overlapping frequency is a collision domain. Hence all devices within this collision domain have to exercise the “listen-before-talk” protocol to avoid collision. So every device literally takes turns to transmit.
- With this, there is a tradeoff between bandwidth for each device and the number of devices that can be supported. The more devices there are the less airtime each device will get hence less bandwidth. It will come to a point when devices will start failing to connect or fail to maintain connection because it has been backing off from transmission due to the channel being busy.
- This in fact occurs on the frequency, not the access point. What is meant is this: if you had two access points in close proximity serving 40 users each (hence a total of 80 users) and both operating on the same frequency, say channel 1, all 82 devices (users and access points) takes turns to use the frequency. So

technically the performance of such a setup with two access points has no improvement over one access point (except if the memory capacity of one access point cannot accommodate 80 clients).

- This is also what is known as Exposed Node condition. This is common when you have too many access points installed in such open areas and they are using overlapping or same channels.
- This happens more in 2.4GHz frequency band in such environment because there are only 3 non-overlapping channels that are available. So, in an open environment like a ballroom, when you use more than 3 access points, you will get more co-channel interference from access points using the same frequency within close proximity or within range. In 5GHz/6GHz, there is less of such limitation because there are more available channels.
- We must have the expectation that on any access point the bandwidth each user gets decreases with the number of users getting on the frequency (note I didn't say access point). So, the nature of application used in high density environment has to be considered in the design. In a typical high density environment, we are looking at offering just a few hundred kbps of bandwidth to each user at the peak usage.
- If it is required to provide high bandwidth and consistent bandwidth to a large number of users, then you should consult your vendor's technical expertise to work out a solution. Such solution typically involves a large number of access points and narrow beam directional antennas to limit the coverage areas in order to support the high bandwidth for each user. Ruckus Wireless has a separate deployment guide for very high-density deployments such as stadiums. You may request it through your Ruckus representative serving your territory.
- The wireless performance in the 2.4GHz frequency band in such environments is impacted by co-channel interference from too many access points. 5GHz/6GHz frequency band does not suffer from this issue. This is why to support high user density concurrent dual-band/Tri-Band access points must be used.
- Because there is so much unknown variables with regards to the client types and mix of client types (whether single-band or dual-band client and proportion of each type) we have to make assumptions of the expected number and type.
- Many ballrooms or meeting rooms can be partitioned. The sizing, planning and design should be based on the smallest possible partition.
- Encryption is another factor to consider. In a high-density environment, it is recommended to use open SSID instead of encrypted SSID (the sizing for encrypted connections is different). The sizing guideline here is based on open SSID without encryption.

## Gathering the Requirements and Defining the Scope

The project scope is an essential first step. The scope is the list of measurable objectives that are necessary to achieve the project aim. Work with the facility manager and contractors to define the objectives. Ask lots of questions about how the property sells bandwidth, what applications they put over the top, what future plans they have for services, both internal and external. Figure out what challenges perplex them and what they have tried in the past to remediate them. Are there competing Wi-Fi systems that must be accounted for? Go ask the AV guys to show you their Linksys router.

- What are the coverage requirements?
  - areas that require coverage
  - areas that should have no coverage
  - zones that require special attention
- What devices are you supporting?
  - are there specific device types to design for?
  - how many devices users need to be supported?
  - total devices
  - during normal operation
  - at maximum
  - at peak times?
  - how will this change over the next 3 or 5 years?
- What type of traffic will the WLAN support?
  - coverage only
  - data
  - voice
  - video
  - location services
- What are the security requirements?
  - Captive portal
  - 802.1X
  - DPSK

# Types of Site Surveys

Well-structured WLAN projects start with a predictive survey. This is a desktop exercise using software and a Wi-Fi engineer's experience and expertise to create an initial Wi-Fi design. This should be followed by a pre-deployment onsite survey. Typically, this involves a site survey kit that utilizes an AP on a stick. These are sometimes referred to as APOS surveys. The purpose is to confirm the recommendations made by the predictive survey recommendations and to make adjustments and changes as necessary.

The final step is the post-deployment verification survey. This step is skipped at the project's peril. The purpose of a post-deployment survey to not just demonstrate that all project objectives have been achieved, but also to ensure that the network is performing optimally.

| Survey Performed | All | No APOS | No Predictive |
|---|---|---|---|
| Predictive Design | Yes | Yes | x |
| On-Site (APOS) | Yes | x | Yes |
| On-Site Verification | Yes | Yes | Yes |
| Use Case | • Large installations<br>• Differing skill levels amongst tech team<br>• The physical environment can't be easily represented in a predictive design | • Skilled engineer producing the survey with insights into the site.<br>• Simple sites with unchallenging environments<br>• The site is not constructed or available | • When there are constraints that preclude a predictive design<br>• To gather feedback information for a later predictive design (i.e. attenuation values)<br>• To produce a quote |
| Advantages | • The most accurate and complete<br>• Validates the project fully | • Quicker to implement<br>• The predictive can be accurate enough to go straight to installation<br>• Saves initial costs | • A well done on-site APOS survey will be more accurate than a predictive |
| Disadvantages | • Longer to produce<br>• Increases costs | • A poorly done predictive can lead to installations with errors that are difficult to later correct. | • Time consuming<br>• Increased costs<br>• Potential for more adjustments to meet project goals |
| Recommended? | Best | Only for experienced WLAN designers | Worst Case – Only for experienced surveyors |

TABLE 2: WLAN PROJECT SURVEY TYPES AND DESCRIPTIONS

## Predictive Surveys (Designs)

The predictive design is an important stage of the WLAN project. Its purpose is to answer the key question:

“Can the project aim can be achieved according to the constraints as they have been defined?”

During the scoping process, the number of client devices was determined, and the corresponding data rates to support the required traffic types established. These metrics are used to calculate the quantity of access points required. In most full-service properties today, a 1:1 AP per room design is required. This makes the predictive easier in the determination of how many APs to use, but harder because of the work needed to ensure settings accommodate smooth roaming, mitigate client sticking to APs, and flapping.

A predictive design is made with professional site survey software such as Ekahau Site Survey or NetAlly’s AirMagnet. Though superficial designs are relatively easy to create, the user should undertake vendor training to ensure optimal output from the software. Any design is at best only an estimate of the true WLAN performance, so the more attention paid to the design, the closer the prediction will be to real world performance.

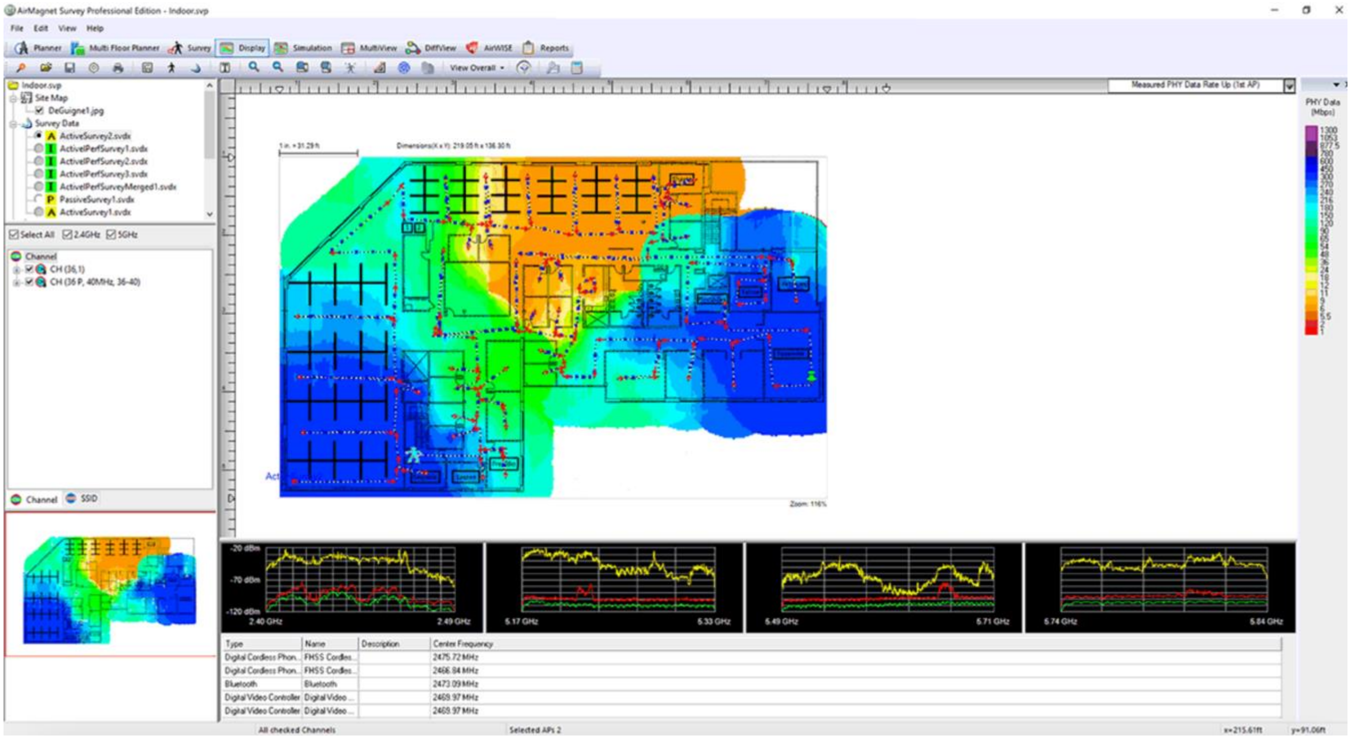


FIGURE 3: AIRMAGNET SITE SURVEY – PREDICTIVE DESIGN. (IMAGE: NETALLY.COM)

### Survey File

The predictive site survey will be carried forward for onsite analysis and used as the basis of the On-Site APOS. It will go through several iterative steps before being finalized. Follow best practices when creating predictive site surveys:

Preparing the Survey File

Prepare the survey file. The accuracy of the final design will reflect the attention to detail in the predictive survey.

- Have real blueprints; site drawings are a useless waste of paper.
- Calibrate the map scale accurately – without calibration the design is useless.
- For multi-floor plans, check that the ceiling height and thickness is correct to accurately account for signal propagation between floors.
- Draw walls accurately and use the correct attenuation.
- Use attenuation zones only if their properties in the software are well understood.


### Placing Access Points

Correctly placing and configuring the access points is vital. Access points operate in both 2.4 GHz and 5 GHz bands. Start your design by working on the 5 GHz plan.

- Consider the type of deployment planned:
  - Coverage/Data only: Generally, traffic is mostly downstream. Place the access points on the map and view the coverage overlap. Consider placing the access points behind or in front of wall to use the attenuation of the walls to assist the design goals.
  - Video/Streaming: As above, however try to avoid using corridors and passageways as this can cause greater co-channel interference, which can affect throughput.
  - Voice: Take care to account for the overlap – when the signal strength or data rate drops below a certain level, the client device should expect to see a new access point increasing in strength.
  - RTLS: Consider placing the access points in corners and do not align them between floors. If using directional antennas, place them to concentrate coverage into narrow zones and set power levels carefully.

- The data rate requirements should also include expected channel width use. It isn't practical to design for 160 MHz channels (Wi-Fi 6). 80MHz channels (Wi-Fi 5 and Wi-Fi 6) are also challenging to implement and frequently disabled.
- Ensure the access points have the orientation correct and determine their power settings. Remember to account for country specific power settings.
- Check the antenna to make sure the correct type is selected, and if a directional antenna is used, ensure the direction of coverage and any down tilt are configured.
- Once the 5GHz plan is balanced, enable selected 2.4 GHz radios to meet the requirements. Activate only the 2.4GHz radios required to meet design objectives.

## Onsite Surveys

### Purpose

Onsite surveys are conducted both pre-deployment to complete the design and post-deployment to verify results and to optimize the network.

APOS and verification site surveys utilize two methods to gather data: Passive Surveys and Active Surveys.

#### Passive vs. Active Surveys

A passive survey is performed to gain insights into the environment and identifies existing access points in the survey area. As with WLAN discovery tools, passive surveys discover access points, with the additional benefit of plotting their location on a map. A passive survey does not associate with an access point. The site survey software either listens to beacons, or broadcasts probe request frames to trigger probe responses, to gather information on the access points. A passive survey does not transfer any data. Only management frames are measured. These are usually sent at, or near to, the lowest data rates available in the BSS.

An active survey is performed to confirm the requirements defined in the project scope, which were designed into the predictive design. These are the performance requirements that the customer has defined and the key metrics to be met when performing an APOS or verification survey.

### Equipment, Tools, and Software

This document provides practical advice on performing APOS and verification site surveys. The following tables outline suitable equipment and represents the tools currently used by Ruckus SE's, partners, and customers. There are, of course, many options to choose from and inclusion in this list is for advice only and does not represent endorsement of any products. Omission from this list does not indicate disapproval.

Ruckus access points running Unleashed code are recommended for APOS site surveys as they can be provisioned over the air, provide DHCP, and have built in speed test capability via the app, allowing simple tests to be performed.

#### The APOS Site Survey Kit

Many WLAN surveyors build a survey kit containing all the practical equipment needed to perform an APOS survey. A survey kit should include:

| Equipment Purpose | Vendor | Product | Requirement | Survey Type |
|---|---|---|---|---|
| Access Point | Ruckus | The same model as is planned for the installation | Required | APOS |
| Tripod or stand | Multiple | Camera Stand<br>Speaker Stand | Required | APOS |
| AP Mounting Bracket | Self-made | Self-made | Required | APOS |
| Ethernet Cables | multiple | Cat6 minimum | Required | APOS |
| Power - Battery | Ventev<br>Terrawave | Any 802.11at/af compatible model. | Required if PoE switch not used | APOS |

| | | | | |
|---|---|---|---|---|
| Power - PoE switch[1] | Ruckus<br>multiple | ICX-7150<br>Any compatible | Required if battery not used | APOS |
| Hard Case | Pelican | Any Compatible | | APOS |
| Locks | multiple | TSA Locks if travelling in USA | Optional, recommended | APOS |
| Digital Camera or Phone | multiple | Any | Optional, recommended | APOS, Verification |
| Laser measurer or other measuring tool. | multiple | Any | Optional, recommended | APOS, Verification |
| Laptop tray | www.connect-a-desk.com<br>www.wlanpros.com | Connect-a-Desk Custom Survey Tray | Optional, recommended | APOS, Verification |
| Site Survey computer | multiple | Laptop<br>MacBook<br>iPad | Required | APOS, Verification |

TABLE 3: WLAN SITE SURVEY KIT COMPONENTS

FIGURE 4: RUCKUS-DESIGNED SITE SURVEY STANDS ON TRIPODS

[1] When surveying with 802.11ax Access Points, ensure the switch delivers full power for the configuration. See Table 4 for details.

**The Ruckus R750 Wi-Fi 6 (802.11ax) Access Point – Power Requirements**

Third party survey batteries and PoE switches should be checked for compatibility with full Wi-Fi 6 (802.11ax) operations. When surveying with the Ruckus R730, note the different power requirements for the available configurations.

| Mode | Power Consumption | System Configuration | Wi-Fi Radios |
|---|---|---|---|
| DC Power, PoH, uPoE (Idle) | 16.1W | • 5Gbps & 1 Gbps Ethernet Enabled<br>• USB Enabled (3W)<br>• Zigbee/BLE Enabled (0.5W) | 2.4 GHz (4x4) enabled<br>5 GHz (8x8) enabled<br>(no clients associated) |
| DC Power, PoH, uPoE (Max) | 31.0W | • 5Gbps & 1 Gbps Ethernet Enabled<br>• USB Enabled (3W)<br>• Zigbee/BLE Enabled (0.5W) | 2.4 GHz (4x4) Tx 20dBm<br>5 GHz (8x8) Tx 22 dBm |
| 802.3at (Max) | 23.8W | • 5Gbps & 1 Gbps Ethernet Enabled<br>• USB Enabled (3W)<br>• Zigbee/BLE Disabled | 2.4 GHz (4x4) Tx 20dBm<br>5 GHz (8x8) Tx 22 dBm |
| 802.3af (Not recommended) | 12.4W | • 5Gbps & 1 Gbps Ethernet Enabled<br>• USB Enabled (3W)<br>• Zigbee/BLE Disabled | 2.4 GHz disabled<br>5 GHz disabled |

TABLE 4: RUCKUS R730 POWER REQUIREMENTS

**Off-the-Shelf Site Survey Kits**

Off-the-Shelf Site Survey Kits are pre- packaged kits that contain most of the tools required for performing a site survey. The advantage of this kind of kit is that you can purchase it and be ready to survey immediately. They are often optimized for portability. The following vendors sell Survey Kits:

- www.wifisurveykit.com
- www.hiveradar.com

For information gathering and recording, tools and software are needed. This table describes tools most commonly used by Ruckus SE's and Partners. As with the previous table, inclusion in this list is for advice only and does not represent endorsement of any products. Omission from this list does not indicate disapproval.

| Equipment Purpose | Vendor | Product | Website | Survey Type |
|---|---|---|---|---|
| Windows Platform | | | | |
| Spectrum Analysis | Metageek<br>Ekahau<br>NetAlly | Chanalyzer<br>Sidekick<br>AirMagnet Spectrum XT | www.metageek.com<br>www.ekahau.com<br>www.netally.com | APOS and Verification |
| 802.11Scan | Metageek<br>Helge Keck | InSSIDer Plus<br>WinFi | | APOS and Verification |
| Site Survey | Ekahau<br>NetAlly | Ekahau Site Survey<br>AirMagnet Survey | www.ekahau.com<br>www.netally.com | APOS and Verification |
| Mac Platform | | | | |
| Spectrum Analysis | Metageek<br>Ekahau | Chanalyzer<br>Sidekick | www.metageek.com<br>www.ekahau.com | APOS and Verification |
| Scan | Metageek<br>Adrian Granados | InSSIDer Plus<br>WiFi Explorer | Recommended | |
| Frame Capture | Adrian Granados | WiFi Signal | Optional | |
| | Adrian Granados | AirTool 2 | Optional | |
| iOS / Android | | | | |
| Spectrum Analysis | Metageek | WiSpy Air (iOS/Andr.) | www.metageek.com | APOS and Verification |

TABLE 5: WLAN TOOLS AND SOFTWARE

### Accounting for BeamFlex

Ruckus access points use the proprietary BeamFlex adaptive antenna technology, which provides additional gain on a per frame basis.

Smart, compact adaptive antenna systems containing multiple elements that electrically manipulate antenna properties so as to create optimal antenna patterns for each device with which they communicate.

Traditional wireless antennas are either "omnidirectional" (radiating signals in all directions) or "directional" (radiating signals in one direction). Ruckus BeamFlex Adaptive Antenna Technology takes a more adaptable approach. BeamFlex technology enables the antenna system within a Ruckus AP to continually sense and optimize for its environment.

This antenna system mitigates radio interference, noise and network performance issues, and improves application flows. The results:

- Increased performance and range
- Crystal clear video and voice communications
- Maximized power efficiency

BeamFlex+ is an enhancement to Ruckus BeamFlex adaptive antenna technology by providing adaptive support to mobile devices. BeamFlex+ enables antennas to adapt to client device orientation in addition to client device location.

BeamFlex describes the transmissions made by a Ruckus access point, BeamFlex+ refers to the improved reception of signals transmitted by wireless clients. The BeamFlex antenna array is designed to minimize the amount of internal electronic noise. This reduction, when combined with the increased sensitivity of the BeamFlex antenna means that clients transmit at higher data rates. This makes the WLAN operate more efficiently.

Remember that, in a live network with Ruckus access points using BeamFlex, you should see data rates higher than you would normally expect for any given RSSI.

### Performing a Survey without Survey Software

Performing a survey without survey software is not recommended. However, if you are in a position where you need to gather data, and do not have the correct software, there are some options. The Ruckus SpeedFlex App can be used to perform tests. In an APOS survey, Unleashed AP’s natively support SpeedFlex tests. More complex networks may have isolation or filtering enabled, which may block SpeedFlex.

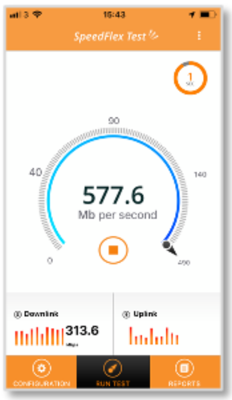


FIGURE 5: THE RUCKUS SPEEDFLEX APP

Run the tests in various locations and record the results on a map. Be careful not to over interpret SpeedFlex results if they seem low. Many factors affect throughput, and without more information it is not possible to effectively pinpoint the cause of any issues.

## Pre-Deployment Surveys

When the final predictive design is approved, it will become an official document of the project plan and locked in. The document is then passed on to the surveyor, who needs to perform an APOS survey to test the true performance of the access points against the predicted coverage. The hope is that the predictive design will be accurate enough to proceed to the installation stage - only an on-site survey can confirm it.

Modern professional predictive design software can estimate access point placement and performance to a highly degree of accuracy. However, the live environment and surroundings may impact the expected performance, and this is something a predictive design cannot account for. If the APOS survey highlights any deviation from the scope requirements, this needs to be reported to the project manager. Rescoping a project or initiating contingency planning is a normal part of a project process, and something that should be encouraged if the circumstances dictate. The longer a project runs, the harder it is to influence the outcome, so the important decisions need to be made as early as possible. The APOS survey should be performed to maximize the chances of the installation being a success.

### Pre-Survey Tasks

Before travelling to the site to perform the survey, ensure everything is in order. Items to check:

- Scaled building plans, not escape plans
- Printout of the predictive design: paper copies of the areas of interest, including access point locations. Use these to take notes on.
- Key contacts: Identify the onsite contact.

Before making the survey, it's a good idea to run though several tasks, which are described below.

#### The Pre-Survey Walkaround

Walk through the site. This will help to plan the survey, determine where to set up the test access points, and identify any potential difficulties. Remember to inspect where the access points are planned to be located and note any potential problems that may have been overlooked. Access points are often relocated due to aesthetics, security concerns, or simply because of the practicalities of mounting and cabling. The walkaround is also a good opportunity to liaise with key people and personnel on site that you may later encounter during the survey.

#### Discovery: Layer 1 Analysis - Spectrum Analysis

Before performing an APOS survey, know if the RF environment is clear. Spectrum analysis gives a view of activity at Layer 1 – the PHY layer. As WLAN equipment operates in unlicensed frequencies, it is possible that non-802.11 devices may be operating in the same area. Best practices dictate that a spectrum capture be performed before or during a survey. There are several spectrum analyzers available to the WLAN surveyor, including those that integrate the spectrum capture into the site survey software. This allows for correlation between spectrum activity and performance metrics and provides valuable insights above a standalone tool. Depending on the level of interference, a standard site survey tool might not work at all because of the total blockage of packets.  A spectrum analyzer is measuring the real time domain signal and not packets being captured as in a protocol analysis.

The following vendors produce Spectrum Analyzers that are commonly used by Ruckus SE's and Partners:

- Ekahau – www.ekahau.com
- Ekahau Sidekick (Windows and MAC) – full integration with Ekahau Site Survey
- Metageek: - www.metageek.com
- Chanalyzer / WiSpy DBx (Windows)– integrates with Ekahau Site Survey
- WiSpy Air (iOS and Android)
- NetAlly: - www.netally.com
- AirMagnet Spectrum XT (Windows) – full integration with AirMagnet Survey and AirMagnet WiFi Analyzer Pro

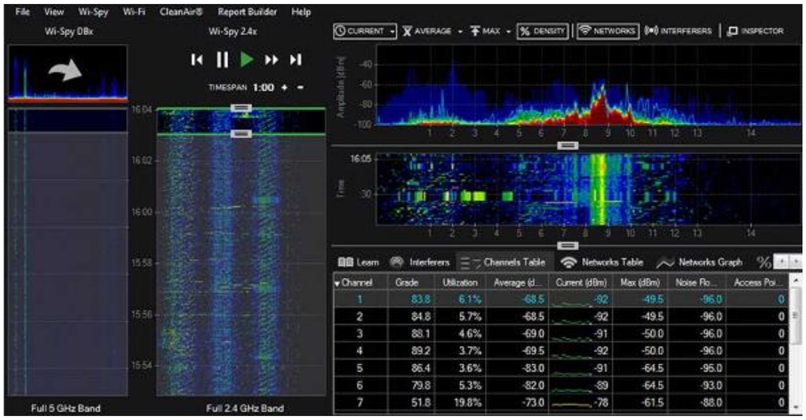


FIGURE 6: METAGEEK CHANALYZER SPECTRUM CAPTURE (IMAGE: METAGEEK.COM)

**2.4 GHz Considerations**

Many manufacturers make simple devices that use low power in the 2.4 GHz band. Devices you may possibly see in this space include:

- Microwave ovens
- IoT devices, including
  - ZigBee
  - Bluetooth and BLE
  - Thread

Most modern WLAN devices are dual band, and many will automatically seek connections in 5GHz, utilizing higher MCS rates and avoiding potential conflicts in 2.4 GHz. Many WLAN designers will plan for most of the client stations to connect on 5GHz in the first instance.

**5 GHz Considerations**

In the 5GHz band, there are fewer non-802.11 sources of interference. One technology that may have an impact on 5 GHz operations is radar. The IEEE designed methods to allow 802.11 devices to share the 5 GHz spectrum with radar – Dynamic Frequency Control and Transmit Power Control, originally defined in the 802.11h amendment.

The use of radar within the 5GHz band is very dependent on the country. Even though there may be no radar in the area being surveyed, any signal that the access point suspects may be radar could trigger a DFS event. Thankfully, it's unusual to find other interfering devices in 5GHz frequencies.

**Spectrum Capture**

Run the spectrum capture for as long as possible in as many areas as possible. Then look for standard patterns of behavior:

- the Noise Floor should be around -100dBm
- DSSS/HR-DSSS transmissions will show as a dome shape across 22MHz channels.
- OFDM transmissions will show as a flat-top across 20 MHz channels in 2.4 GHz, or 20, 40 or 80 MHz channels in 5GHz

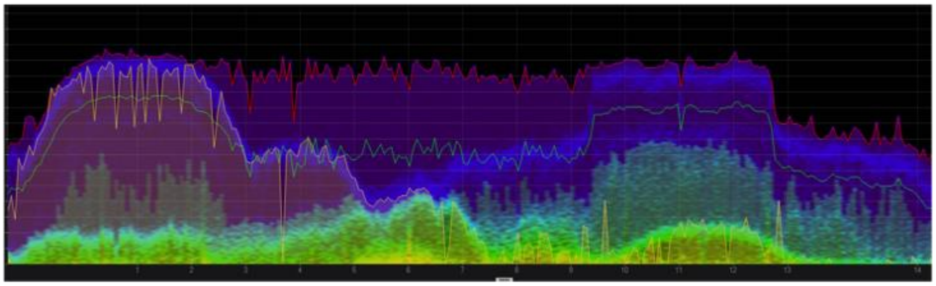

FIGURE 7: DSSS/HR-DSSS AND OFDM TRANSMISSIONS IN CHANALYZER

Look for any signals from sources of interference:

- Interferers will show as spikes, multiple spikes, or other anomalous shapes over narrow and large frequency ranges
- Interferers tend to have higher Duty Cycles - taking up disproportionate amounts of airtime

Some devices will have more of a disruptive effect on an 802.11 network than others, depending on the power used, the operating frequency and bandwidth, the duty cycle, and if there are any avoidance mechanisms built in.

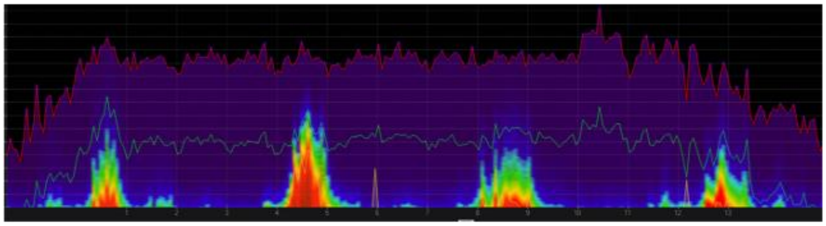

FIGURE 8: 2.4GHZ VIDEO CAMERAS IN CHANALYZER

**Discovery: Layer 2 Analysis - WLAN Discovery**

Whereas a spectrum capture provides an understanding of Layer 1 (the PHY Layer), insight into Layer 2 (the MAC Layer) is derived by analyzing the 802.11 operations in the surrounding area.

**Greenfield vs Legacy**

A site is described as greenfield when there are no other access points apart from the ones you are deploying. However, most WLAN installations take place in environments where there are neighboring access points. It's useful to know what access points are operating in the area and if they are likely to have any effect on the installation. For this,use WLAN Discovery tools.

**WLAN Discovery Tools**

WLAN discovery tools operate by listening for Beacons – a process known as passive scanning. Some perform active scanning – sending probe requests to capture probe responses. There are many tools available to perform a Layer 2 scan.

The following vendors produce Layer 2 scanning tools that are commonly used by Ruckus SE's and Partners:

- Metageek: - www.metageek.com
- InSSIDer (Windows)
- Helge Magnus Keck:
- WinFi (Windows) -
- Adrian Granados: - https://www.adriangranados.com
- WiFi Explorer (macOS)
- NetSpot: - https://www.netspotapp.com/
- NetSpot (Windows and macOS))

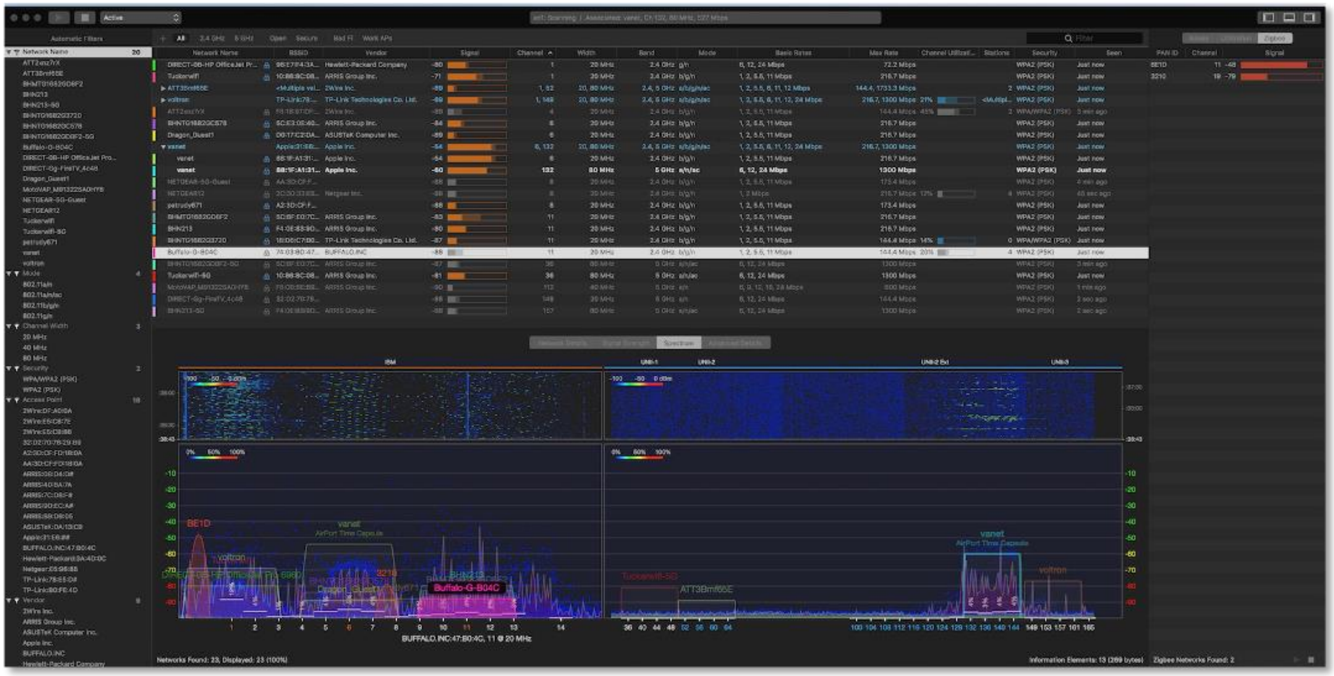

FIGURE 9: WIFI EXPLORER (ADRIAN GRANADOS)

2.4 GHz commonly uses 20 MHz channels. Though an access point may advertise 40 MHz capability, it is unlikely to be used as many device manufacturers did not include 40 MHz capabilities on 2.4GHZ chipsets.

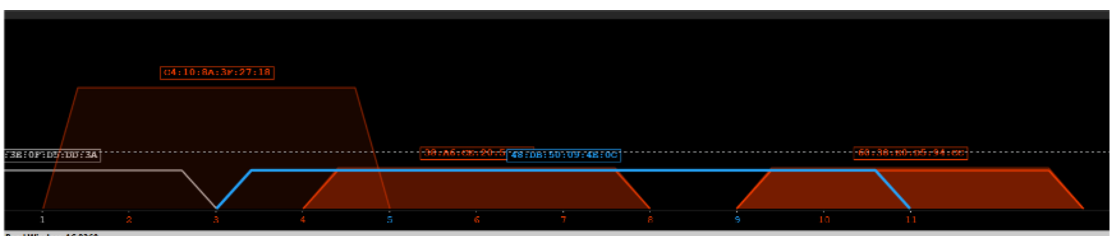

FIGURE 10: 40 MHZ CAPABILITY ADVERTISED IN 2.4GHZ

**Integrated Layer 2 Discovery**

Site survey and spectrum analysis software typically contain integrated discovery tools that will identify all access points in the vicinity. Many WLAN surveyors use a combination of tools and a simple Layer 2 discovery app may be preferable when looking for a quick summary of the access points in an area.

Run Layer 2 discovery tools in all areas being surveyed. Look out for:

- Co-Channel and Adjacent Channel interference
- Channel saturation
- RSSI Values of interferers
- Rogue Access Points
- Channel width advertised
- Channel width used

When surveying with access points using default settings, the access point settles on a channel automatically. This may need to be changed depending on what discovery reveals. If there are excessive devices in the area, ensure they are fully recorded and the information is sent back to the WLAN design team for review.

**What Signals Matter?**

An RSSI threshold/range should have been specified in the first part of the design phase in order to meet the project goals. Competing signals can affect the WLAN. If not, use the following generic values as a guide.

- RSSI above -65dBm – this should provide all the operational requirements. Look for the boundaries where this signal is reached.
- RSSI between -65dBm and -85dBm – any signals from outside access points that are recorded in this range will cause co-channel and /or adjacent channel interference. The channel plan may need to be adjusted.
- RSSI below -85dBm – these signals should not affect WLAN operations.

This is sometimes referred to as 'Want, Don't Want, and Don't Care.' Only an onsite survey will fully confirm these values.

**Self-Healing Access Points**

Ruckus access points use advanced self-healing methods to avoid interference and operate optimally. During an onsite survey, the access point may frequently change channels, causing problems connecting to it over the air. The could be caused by non-802.11 interference from devices that have a high duty cycle, which take up disproportionate amounts of air time and prevent the access point from transmitting.

## Setting up the Access Point

To perform the Site Survey, you will need to set up your Access Point. When configuring the Access Point you have two methods available.

- Unleashed app
- GUI

Though the Unleashed access points do have a GUI, the app provides a much simpler and more effective way to configure the access points. The app is available for Apple and Android devices. The minimal configuration settings only should be applied - only those settings required to perform the survey.

FIGURE 11: THE UNLEASHED MOBILE APP

### Using the Unleashed Mobile App

1. Power on the access point and connect to the Configure.Me-[xxxxxx] wlan.

- Select Typical Install
- Give the access point a manual (static) IP address and configure the DHCP server. This can be enables later from the GUI this step is missed.
- Change the WLAN settings if required.
- Create an admin password.
- Select Finish. The access point will restart.

Confirm connectivity by performing a speed test from the Unleashed app. At this stage the access point that is providing WLAN service, devices can associate to it, and performance tests can be run using the app. The survey can now begin.

### Placing the Access Points

Refer to the access point placement plan that was created during the predictive design. Place the access point as close to the position on the map as possible. Ensure the access point is oriented correctly and place it at the right height. The access point it will be effectively unattended during parts of the testing. Take care to ensure any part of the survey kit and associated cables do not present a safety issue to anyone who may be passing. Screening tape or labels can be easily added to help alert people to possible hazards.

## Performing the APOS Survey

The APOS survey is an Active Survey, intended to confirm the requirements defined in the project scope and in the predictive design. A passive survey creates a baseline.

### Performing a Passive Survey

Modern survey software does allow both frequencies to be surveyed at the same time. It is often useful to treat 2.4 GHz and 5 GHz as separate projects and to perform the survey first in one frequency and then repeat in the other. This is a matter of choice and a discussion of the benefits of each method is beyond the scope of this document. If you feel a dual survey may be required, then you should discuss this option with the project manager / predictive design designer.

### Performing an Active Survey

An active survey is performed to confirm the requirements defined in the project scope and in the predictive design. If the predictive design has been created by an experienced designer with a high degree of attention to detail, then it is reasonable to expect the on-site performance to be close to the model. In this case it may not be necessary to survey with an access point in every location. Once the first few access point locations have been surveyed, if the recorded coverage is very close to the predicted, it is reasonable to only survey every other or third access point location. If the coverage starts to diverge from the predictive, then more survey locations may need to be checked. Always survey the higher priority locations.

### Site Survey Procedure

Before you begin, ensure there is a backup of the survey file. Begin the survey and perform the following steps:

- Check the map scale. Use your measuring tool to measure a distance that corresponds to points on the map. The larger the distance you measure, the more accurate the graphics will be.
- Ensure you are oriented with the map correctly. It's easy to lose track of where you are while walking and end up clicking your survey points on the wrong part of the map.
- Save your survey often. Equipment can sometimes fail – the battery could run out, or conflicting software may cause a crash, so ensure you save often to reduce any potential data loss to a minimum.
- Walk slowly and accurately, at a constant pace. Make sure you cover the area completely. Your survey path will be recorded in the survey and may be checked to ensure the integrity of the data.
- Click often and know how to pause, stop, and start a survey.

**Cabling Considerations**

Access points connect to cables. A detailed discussion of the cabling and infrastructure components of a WLAN installation is outside the scope of this document, however there are some important cabling considerations. If the cabling is not being managed as part of the wider WLAN installation, note the following:

- You may be specifying cable locations for later use.
- Cabling should be installed to the latest version of:
  - International Standards
    - *ISO/IEC 11801-1 Generic Cabling for Customer Premises: General Requirements or**
  - North American Standards
    - *ANSI/TIA 568 Generic Telecommunications Cabling for Customer Premises**
    - *ANSI/TIA 568 Commercial Building Telecommunications Cabling Standard**
    - *TSB-162-A Telecommunications Cabling Guidelines for Wireless Access Points**
- A report should be available showing the cabling plant passed the latest:
  - International Standard
    - *ISO/IEC 11801-1 Generic Cabling for Customer Premises: General Requirements* or*
  - North American Standards
    - *ANSI/TIA Balanced Twisted-Pair Telecommunication Components Standard**
    - *ANSI/TIA Optical Fiber Cabling Components Standard**
- You may be making use of existing cabling. It is a best practice to ask for a copy of the structured cabling manufacturer's warranty to verify performance.
- If you are deploying N-Base-T (2.5GBaseT and 5GBase-T) on the copper cabling plant; there will be additional steps *if* the cabling plant is not certified to Category 6A. A certified Category 6A cabling plant supports 2.5GBase-T, 5GBase-T and 10GBase-T.
- In the event the existing cabling plant is below Category 6A performance (Category 5e and Category 6) and you are deploying N-Base-T; a qualified cabling technician should verify performance. Many newer Access Points use N-Base-T which uses a higher frequency than 1000Base-T. Higher frequencies cause cable to cable noise (a.k.a Alien Cross-Talk or ALSNR – Alien Level Signal to Noise Ratio). Alien Cross-Talk can affect the performance of N-Base-T on a Category 5e and Category 6 system.
- A qualified cabling technician can assess the risk of supporting N-Base-T with Category 5e and Category 6. Bundles of cable within the horizontal pathway and within the rack are major contributors to ALSNR failures. The risk assessment steps include:
  - The network administrator identifies the links intended to be used for N-Base-T

- The technician uses the charts below to assess the risk based on a cable's length and the length of the bundle
- If links marked for N-Base-T use are a risk of failure; the technician should conduct a sampling test to verify performance

- Refer to these standards for more detailed recommendations to identify risk and mitigate failures:
  - *ISO/IEC TR 11801-9905 "Guidelines for the use of installed cabling to support 2.5GBase-T and 5GBase-T"* or*
  - *TIA TSB-5021 "Guidelines are for the Use of Installed Category 5e and Category 6 Cabling to support 2.5GBase-T and 5GBase-T."**
- In the event of ALSNR failures there are mitigation steps. There are internal electrical parameters of Category 5e and Category 6 that can cause a failure and there are external (Alien-Cross Talk) parameters that can cause a failure on N-Base-T:
  - External mitigation procedures include:
    - Separating equipment cords
    - Unbundling the horizontal cable
  - Internal mitigation procedures include:
    - Replace equipment cords with Category 6A patch cords
    - Reconfigure the cross-connect as an interconnect
    - Replace jacks with Category 6A jacks
    - Replace patch panel with a Category 6A patch panel

**Reference:** N-Base-T Alliance white paper

*ISO/IEC and ANSI/TIA standards can be purchased from IHS Standards Store

| | | Victim cable length | | |
|---|---|---|---|---|
| Class D[2] | Speed | 1 m - 20 m | 20 m - 75 m | 75m - 100m |
| Bundled distance up to 20m | 2.5G | Low | Low | Low |
| | 5G | Low | Low | Medium |
| Bundled distance 20m to 75m | 2.5G | N/A | Low | Medium |
| | **5G** | **N/A** | **Medium** | **High** |
| **Bundled distance 75m to 100m** | **2.5G** | **N/A** | **N/A** | **Medium** |
| | **5G** | **N/A** | **N/A** | **High** |

| | | **Victim cable length** | | |
|---|---|---|---|---|
| Class E[3] | Speed | 1 m - 20 m | 20 m - 75 m | 75m - 100m |
| Bundled distance up to 20m | 2.5G | Negligible | Low | Low |
| | 5G | Negligible | Low | Low |
| Bundled distance 20m to 75m | 2.5G | N/A[4] | Low | Low |
| | 5G | N/A | Medium | Medium |
| Bundled distance 75m to 100m | 2.5G | N/A | N/A | Medium |
| | 5G | N/A | N/A | High |

[2] ALSNR Risk for Class D (Category 5e)
[3] ALSNR Risk for Class E (Category 6)
[4] N/A = Will likely not work

Before deploying fiber circuits it is important to verify performance. The table below gives guidelines about supportable distances of various types of SYSTIMAX fiber:

| Application Supported | LazrSPEED®300 OM3 | LazrSPEED®550 OM4 | LazrSPEED® 550 OM5 |
|---|---|---|---|
| 1 GbE distance | 1,020 m @ 850nm<br>600 m @ 1,300nm | 1,110 m @ 850nm<br>600 m @ 1,300nm | 1,110 m @ 850nm<br>600 m @ 1,300nm |
| 10 GbE distance | 300 m @ 850nm | 550 m @ 850nm | 550 m @ 850nm |
| 40GBase-SR4 | 100 m @ 850nm | 215m @ 850nm | 215m @ 850nm |
| 40G-BiDi | 100 m @ 850nm | 150 m @ 850nm | 210 m @ 850nm |
| 40G-SWDM4 | 240 m @ 850nm | 350 m @ 850nm | 460 m @ 850nm |
| 100GBase-SR4 | 70 m @ 850nm | 130 m @ 850nm | 130 m @ 850nm |
| 100GBase-eSR4 | 200m @ 850nm | 300 m @ 850nm | 300 m @ 850nm |
| 100Base-SWDM4 | 75 m @ 850nm | 140 m @ 850nm | 180 m @ 850nm |
| Singlemode | TeraSPEED®<br>OS2 | | |
| 40G FR | 2km | | |
| 40G LR4 | 10km | | |
| 40G ER4 | 40km | | |

TABLE 6: SYSTIMAX FIBER SPECIFICATIONS

Fiber optic cabling links can be adversely affected by dirt and debris on the end face of the connector. It is a best practice that a qualified cabling technician use a video inspection probe to inspect the end face before you connect to prevent permanent damage to the end face. If there is dirt or debris on the end face refer to CommScope's *Inspection and Cleaning instructions 412-19087* for detailed recommendations.

- Only use industry recommended fiber optic cleaning supplies
- If you have the benefit of a 1:1 design, consider stripping the APs across multiple IDF switches so you are never faced with a single point of failure.

### Surveying for Loss

The purpose of this part of the survey is to confirm the loss of access point signal due to the site environment.

- Place the access point and plot coverage carefully in all areas. Show the RSSI boundaries to the edge of the coverage area and the loss incurred in the immediate area cause by walls, doors, etc.
- Perform both passive and active surveys.

### Surveying for Access Point Placement

This is the worst-case scenario, as it implies that there is a serious discrepancy in the planning stage. However, for a coverage-only installation where capacity is not a requirement, it may be acceptable as there is no concern about a large number of access points and devices.

- Locate the access point in the first installation position and record the signal.
- Use a second access point in a neighboring position and measure the signal.
  - If you only have a single access point, freeze the access point in the design and move it to the new location.
- As you move away from the first access point, you should aim to pick up the signal of the next access point. Depending on your installation requirements, that should occur between -85dBm and -65dBm.
- Perform both passive and active surveys.

### Surveying for Antenna Coverage

Directional antennas can be difficult to model in predictive surveys, so it is sometimes necessary to conduct a survey to test different antenna options.

- Locate the access point in the first installation position and record the signal.
- Change the antenna and repeat.
- Ensure you record the access point in each configuration state, so you can effectively compare results.
- Perform both passive and active surveys.

## The Verification Survey

Once the equipment has been installed and configured, it is necessary to make a report detailing the performance characteristics of the network. In the previous sections, predictive designs and on-site APOS surveys were discussed. If best practices have been followed, then both types of survey were used to produce the installation plan and the project should be progressing well. The final stage is to verify the installation by performing a verification survey. The aim of the verification is to answer the key question:

"Has the project aim been achieved according to the constraints as they have been defined?"

The verification survey is a crucial step in the project plan as it confirms that the network is performing as per the requirements set out in the scope.

If there are any parts of the installation that do not meet the requirements, then final adjustments can be made to the network. At this stage any changes needed to meet the performance requirements should be minor.

Once the requirements have been met, and can be demonstrated to have been met, the project end has been reached and can be closed. This is an important step, as any future work should now be classed as ongoing maintenance and under the customer's own management process. If the project hasn't been closed formally, there can be a tendency for end users to treat ongoing maintenance as a warranty issue. This places a strain on the support and engineering resources of the supplier company – either the Partner staff, or Ruckus SE's and support, where they are called on to lend support for performance and configuration issues that aren't directly related to the project goals. It is important to understand when a project has been successful and closed.

Of course, genuine issues do need to be addressed and rectified and Ruckus Networks is fully committed to providing a superior support experience when needed.

### Preparing for the Survey

The verification survey is performed once the installation is complete. It may be the case that the survey must take place immediately after the installation, before the network is opened to the users. In this case, the survey will be performed when the network is not under load. Be mindful of the fact that the addition of users, especially in high density environments, can impact the performance of the network. Ideally, the verification survey should be performed when the network is operating under normal use.

- Survey when the network is use
- Account for users
- Survey for the requirements defined in the project scope
    - RSSI
    - Data Rates
- Throughput

Check with the system administrator if there have been any changes to configuration settings that may affect survey results (E.g., the AP power has been reduced).

### Performing the Survey

As with the APOS survey, take a spectrum capture to rule out any Layer 1 issues before starting the survey. If you have software that integrates spectrum capture, you can capture spectrum data during the survey.

The verification survey is, by its nature, an active survey as the survey is from a client's perspective. Bear in mind the following:

- When walking the survey, replicate a client's behavior. If they would normally be stationary (for example in an arena) make more stop-and go measurements. If they are more mobile, then make a continuous survey as you move.
- Run a continuous ping throughout the survey to record data rates in use.
- Throughput tests are best made in several locations.

### Reporting the Survey Results

The site survey report demonstrates that the project scope requirements have been met. The report should contain simple, fact-based information.

#### Generating a Report

Most site survey software has an option to create a report based on the survey results. Reports can be generated, saved in different formats, and edited for distribution. The report should contain specific metrics that compare with expected measurements to assess if the project has met its goals. If any problems in the installation were identified, the report can be used as a basis to make corrections.

Rather than filter the information before exporting, export as much data as is practical. Delete what's not required.

- If you don't have integrated spectrum capture, add an extra section and import the spectrum data
- Include photographs
- Any added comments should be factual and not open to interpretation.

If the survey report shows that all the criteria have been met, it will be carried forward to the project closure meeting.

**Ruckus solutions are part of CommScope's comprehensive portfolio for Enterprise environments (indoor and outdoor).**

We encourage you to visit **commscope.com** to learn more about:

- Ruckus Wi-Fi Access Points
- Ruckus ICX switches
- SYSTIMAX and NETCONNECT: Structured cabling solutions (copper and fiber)
- imVision: Automated Infrastructure Management
- Era and OneCell in-building cellular solutions
- Our extensive experience about supporting PoE and IoT

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