AirMapper™ Site Survey Best Practices

Application Note

The fastest, simplest, easiest way to validate your Wi-Fi network

AirMapper Final Survey

How to Survey Sites Quickly & Easily

INTRODUCTION

Why to Survey

Before a discussion of how to best conduct a site survey with the AirMapper app (and what things to take into consideration) it's important to understand why a site survey should be performed in the first place. At its most basic, a site survey is performed in order to collect empirical data of the RF environment at a site. This can then be used to drive reliable analysis of the wireless network coverage and performance. Whether conducting the survey before the deployment or after, this goal still applies—survey data will be used to understand the RF situation. Leveraging data obtained from a survey, you will be able to take actionable steps to address any network deficiencies found and feel confident that the network is performing optimally. A site survey has a key benefit that planning (also known as predictive modeling or simulation) does not, it is *actual measured data* taken at the location of the network. Planning helps minimize repeated repositioning of APs, but only a survey allows us to state confidently that the results of the plan worked out correctly, that the installation went according to plan, and that the network users will have reliable wireless connectivity and performance.

When to Survey

A site survey can be performed at any time, but the goals and value of a survey will vary depending on when it was conducted. The three general timeframes for conducting a site survey are: pre-deployment, post-deployment, and mid-operation.

A. Pre-Deployment

A pre-deployment survey is done to understand a site's characteristics before installation. There may be an existing network already in place that will be replaced or upgraded, so collecting current survey data on an existing network will help to understand the performance that is intended to be improved with the new network plan. When there is no network in place, the RF nature of a site (and any neighboring networks) can be captured by a site survey to understand what issues will need to be dealt with in the coming deployment and planning cycle.

There is one method of a pre-deployment survey which deserves special mention, and that is "AP-on-a-Stick" (APoS).

AP-on-a-Stick: is a specific type of pre-deployment survey in which a single 'test' access point (AP) is brought along to the site and used to mimic AP coverage. This test AP is typically mounted on a tripod (the 'stick') in an anticipated AP installation location, and the surveyor will walk the area around that AP to understand the limits of coverage and attenuation factors within the building that impact the RF in that area. The AP can then be moved to a new location and the steps repeated. Once several locations have been walked and mapped, the results can be merged to create a virtual heatmap like what one would expect if the network truly had multiple APs in place. One large benefit to the AP-on-a-Stick methodology is that the intended AP model for installation can be used, so a very accurate feel of the AP, antennas, and transmit/receive characteristics can be obtained in the specific building environment.

B. Post-Deployment

AP on a stick

A post-deployment site survey, also referred to as a verification or validation survey, is what most people think of when someone mentions performing a site survey. After a new site design has been completed and APs have been installed (often by contractors), a site survey is performed to confirm the network is performing as expected. There are several network issues that can be found at this stage. If an AP was misconfigured, improperly installed, or misaligned, it can be caught as the coverage maps will look different than predicted in the plan. A post-deployment survey can also help to catch environmental situations that can't be determined from a floorplan. Neighboring APs, office furniture, as well as interfering equipment can all cause network issues but would not necessarily be known during the planning phase. A post-deployment survey is successful when it either confirms that the performance meets the design expectations, or it catches and allows for correction of factors that prevented the network from meeting expectations.

C. Mid-Operation

While often overlooked as a diagnostic tool, a site survey can also be done during normal operation of a network to understand limitations, gather data on systemic issues experienced throughout a site, or to troubleshoot a specific problem area. Such a site survey is intended to capture information to help determine what may have changed at a site compared to known good data (such as a post-deployment validation survey), or to push the limits of the network in a way that wasn't previously considered.

PASSIVE SURVEYS

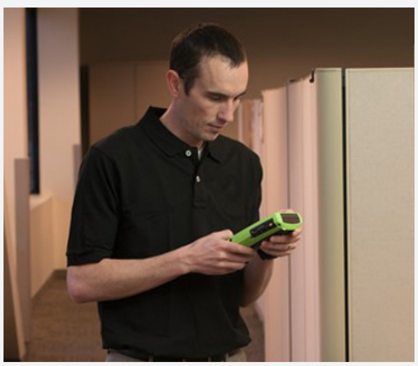
You can't accurately understand an RF environment without knowing everything going on in the air. A passive survey allows the user to understand the effects of all the APs and channel usage at a location so that you can adjust the network to perform optimally.

What It Is

A passive survey captures all information seen in the wireless environment (i.e., the APs that could belong to the site, neighboring APs, anything). Channels, signal strength, noise, SNR and other information for all APs seen are collected and displayed for the site.

When It's Used

A passive survey is typically conducted pre- and post-deployment. Co-channel and adjacent channel interference can be key culprits in low throughput and poor application performance. In the case of a pre-deployment passive survey, data can be used to better plan the channel selection for new APs to avoid co-channel interference with existing or neighboring APs. In the case of post-deployment, a passive survey will help to verify that no co-channel interference is present in the actual design.



Portability and visibility are essential when validating and troubleshooting Wi-Fi.

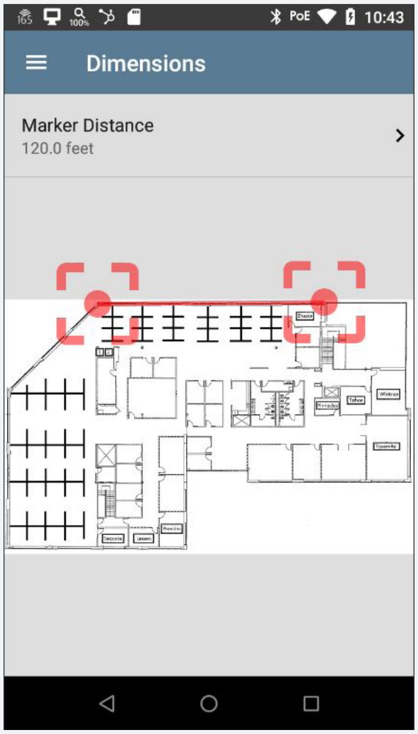
PREPARING FOR A SURVEY

RF is a variable medium, thus other devices and other attenuating sources (such as people in the facility) can change the readings you might get. By collecting all data at the same time on the same walk-through, you can be confident that any oddities or poor performance seen on one survey can be cross-compared reliably to data collected with other end user devices as they were subject to the same conditions. This is more reliable than trying to correlate data from surveys taken at different times, as you cannot be sure whether both surveys reflect the same RF conditions.

PREPARING YOUR SITE PLAN

Importing Your Floor Plan

One consideration when selecting your floor plan image/file is to minimize the amount of unnecessary white space around the outside of your floor plan because excessive white space can take up screen real estate and require zooming in just to see the applicable area. In addition, ensure that your floor plan has enough resolution to capture any key details you will need to see when conducting a survey.



Add a floor plan on AirMapper and calibrate dimensions

How-To: In the AirMapper app on EtherScope nXG, access the AirMapper settings by selecting the menu icon or settings icon at the top of the main app screen. Then tap "AirMapper Settings" and "Floor Plan" to open the Floor Plan list screen to select or load a new floor plan or map of the area to be surveyed. Tap the "+" floating action button (FAB) to access the file manager – you can select a .jpg or.png image from an attached USB drive or internal SD card. Alternatively, you can use the camera app to take a picture of a floor plan; sometimes a posted fire escape plan can make a handy floor plan! If you need to make edits or crop the image file, you can download an image editor app from the Link-Live app store.

Calibrating the Floor Plan

Once imported, the floor plan will need to be calibrated. Calibration of the dimensions of your site ensures that propagation estimations and signal loss interpolation is calculated accurately.

How-To: Select the floor plan name from your list of imported plans, and click on Dimensions. Here you can interactively calibrate the floor plan by moving the two indicators to known locations and entering the corresponding distance between the two points.

PATH SELECTION

The path you choose to walk onsite will influence the data you receive and the reliability of your results. It's important to ensure that the path is well chosen and executed.

Where to Walk

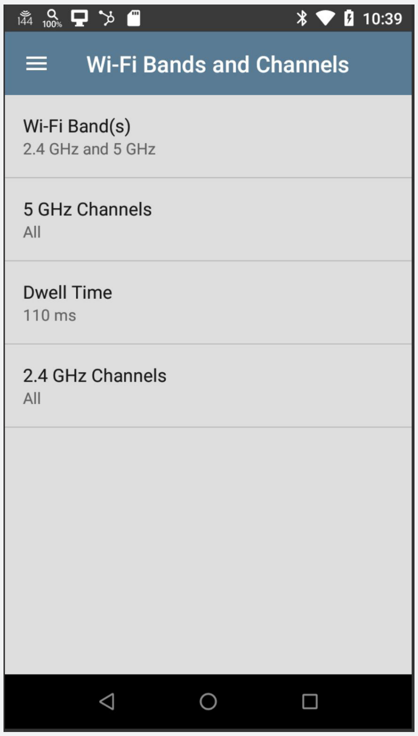
An easy mistake to make is to walk the site using knowledge of where the APs are located or where you expect to get coverage. Path selection is better done by thinking about the users, how they will use the network and where you expect your users to need network access, then consider a path that will give you confidence that your network meets those expectations. This may mean extra time spent collecting data in high-usage areas and less focus on others, with the goal being to get the right data necessary to make critical network decisions.

Some general rules of thumb when walking a site include:

- **Walking Both Sides of Obstacles Whenever Possible**
  - This allows the RF attenuation properties of that obstacle to be accurately reflected in the resulting heatmaps

• **Walk the Edges**

- This applies to rooms, as well as the site. If you're only checking the middle of a room then you have no idea what things look like at the edge, you'd be trusting your signal propagation to 'paint' those areas. It's far better to walk into the corners and along the edges to collect the necessary data.



The AirMapper channel selection

SCAN PATTERN

The scan pattern that AirMapper uses refers to the method, timing, and choice of how the data is collected across the wide variety of wireless channels available. There are many aspects to consider, and there is no right answer, but this section will go through the important considerations to help you make the right choice for your survey needs.

Choosing Your Channels

AirMapper allows you to choose which channels you would like to survey. This will limit your adapter's data collection to ONLY those channels which you choose. The two most obvious schools of thought are "all the channels there are" and "only the channels my APs are on". Both choices have their advantages and disadvantages.

Scanning All Channels: The real benefit to scanning all channels is that you have complete information as this will allow unexpected APs (those on channels you didn't believe APs were installed on) to be caught as well as adjacent channel interfering APs to be identified. Should configuration changes be needed, the information is now available from other channels to aid in decisions for new channel assignments.

Scanning Only Select Channels: Scanning selected channels saves the amount of time each data sweep takes plus ensures data and heatmaps are shown relative to those specific channels that the network is deployed on. This can save time when conducting the site survey.

How to Decide What's Right for You

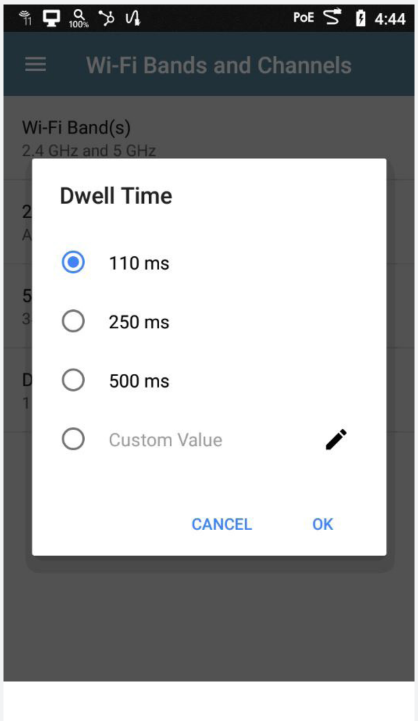
There is no simple right answer, but some of the questions you should ask yourself when configuring the channels to scan are:

• Am I confident that I know which channels do and do not have APs on them?

• Do I believe there are a large number of neighboring networks where I may benefit from understanding adjacent channel data?

• Do I believe I will I need to reconfigure my channel plan as the result of my survey?

If data on channels where your network APs are not installed will not add any useful information for your survey, then it makes sense to limit the scan pattern. If you plan to leverage survey data in a way that will benefit from the additional channel information, or if you're not sure of the answers to these questions, it's best to invest the time and collect all the data.



EtherScope dwell time selection screen

Implications of the Decision

The more channels you choose to scan, the longer it will take to collect one full set of data, thus this will increase the amount of time it takes to complete a site survey. While a few seconds here or there may not seem like much, if you have a large building with many data collection points, a few seconds can quickly add up to an hour or more of additional time on site.

The more data you have, the more prepared you can be for the unexpected. You don't always know heading into a survey what may prove to be important and unimportant. Having survey data across all channels may save time in the long run if valuable insights can be gained from information contained on those channels.

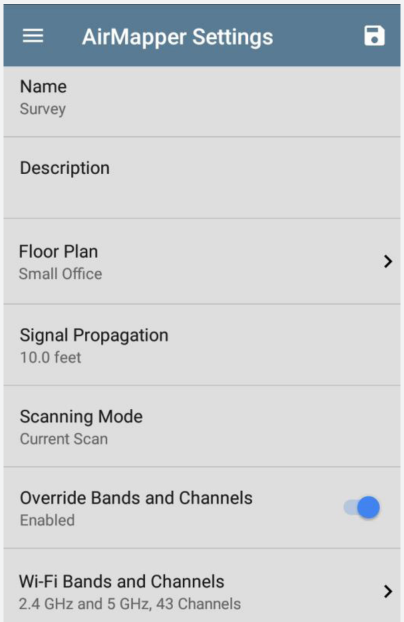
Choosing Your Dwell Time

The dwell time is the amount of time AirMapper spends on a given channel collecting data before moving to the next channel. This is of importance in passive surveys where data is being collected from the AP beacons heard. As the beacon interval is variable in most enterprise AP configurations, it is often valuable to alter the dwell time of AirMapper accordingly. Using the wrong dwell time value could cause AirMapper to miss beacons, which could look like coverage holes on the resulting heatmaps.

How to Decide What's Right for You

There are several factors that can impact the dwell time you choose. Most obvious would be the beacon interval of the infrastructure installed (if any) at the location. If you know that the beacon interval has been adjusted to be longer than the common default of 100ms, you will want to ensure that the dwell time in AirMapper is also adjusted or it may miss beacons during a survey.

In addition to configuration, the amount of traffic on a channel can also impact the regularity of beacons. As a shared medium, a given AP's beacons will often not be perfectly 100ms apart even if they are configured that way. Overlapping Wi-Fi networks or on-channel noise may cause a beacon to be delayed a few seconds. On the whole, this



EtherScope general settings allows the user to specify a subset of channels or bands to be scanned for all applications such as Wi-Fi and Discovery. If desired the user can now select different channels and bands to be scanned as a part of the current survey independent of the general settings.

shouldn't cause beacons to be missed too regularly, but in a very RF heavy environment this lack of regularity of beacons could cause misses and would be a viable reason to adjust the dwell time up a bit to compensate and ensure all beacons are received.

Implications of the Decision

It might seem that there is no downside to increasing the dwell time, but this isn't the case. As the dwell time determines how long the adapter stays on one channel before moving to the next it has a direct impact on how long it will take an adapter to collect a full sweep of data across all configured channels. If your network requires a longer dwell time, it's important to take that into account when collecting data and to ensure that 'wait time' is adjusted to compensate for the new dwell time. Usually a single missed beacon at one data location will not throw off the resulting heatmaps if good data collection practices have been followed in that area (plenty of other data points nearby) as the beacon will be picked up at one of the other collection points, but it is best not to count on luck to save your survey. With the amount of time that needs to be invested to walk a site, it's far better to set the dwell time intelligently from the start to ensure that reliable data is captured.

How-To: To adjust Bands, Channels and Dwell Time, access the General Settings from the left-side navigation drawer. Once you START your survey on the main AirMapper screen, you can still revisit the General Settings to adjust Bands and Channels or Dwell Time. Alternatively, if you wish to keep the general settings in one mode, and have a custom configuration for surveys, you can do so by selecting "Override Bands and Channels" in AirMapper settings. For the best AirMapper results, we recommend setting a Dwell Time of 250ms or greater. For faster AirMapper scans, enable only the band/channels of interest to your installation.

Signal propagation determines how far AirMapper will assume a given reading is applicable

SETTING THE CORRECT SIGNAL PROPAGATION

The signal propagation value determines how far AirMapper will assume a given reading is applicable. As you can't viably walk every square inch of a site, the software will need to do some interpolation to create a heatmap. If this value is set too small, then you will not be left with a complete heatmap but instead with a series of colored dots along your walking path, whereas if this value is set unrealistically large, you will begin to show signal strength reading and values in locations that you didn't survey and can't accurately predict.

Choosing the correct propagation value means understanding the nature of the site. An open convention center or arena may allow for a larger propagation value as there are minimal obstructions within the environment (although care should be taken in highly dense environments to compensate for what happens when the location is full of people). A facility with large numbers of walls and obstructions would be better served with a lower propagation value to avoid giving a false impression of measured signal on the other side of an obstruction. (Note that this can also be mitigated by good path choice).

Ideally the signal propagation value should be chosen before the survey is conducted by consideration of the site as this helps to avoid allowing human bias to influence the choice after the fact when looking at the resulting heatmaps.

How-To: Go to the main AirMapper settings menu to adjust Signal Propagation. This setting is the radius measurement of the sample points.

Tapping AirMapper

CONDUCTING THE SURVEY

Scanning Mode

AirMapper has two modes of scanning for site surveys.

"Current Scan" is the default and preferred way to perform a survey. It allows immediate data collection based on the EtherScope's continuous scanning of the selected bands and channels, and the most recent beacon seen from each BSSID (beacons are aged out after 30 seconds).

The "Scan Once" alternative is a more precise, but more time-consuming mode. Each time a point is selected, all the BSSID information is cleared, and a single scan of the selected channels for the selected dwell time is acquired. This is an exact measurement but in congested environments beacons not seen during the dwell time are not included in that sample point. For that reason, we advise increasing the dwell time to ensure all beacons are captured.

Tap-to-Sample

When walking a site and collecting data points during a site survey, AirMapper uses a methodology called Tap-to-Sample, which writes the most recent scan result to the selected point on the walking path when the user taps.

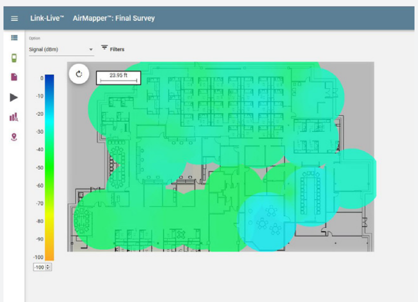
Tap-to-Sample is often considered a more flexible data collection method because data is only logged when the user taps, which by its nature allows for delays, interruptions, and other distractions that may happen during a survey. The last, most recent set of recorded scan data is then written to the location the user taps on.

For optimal results with Tap-to-Sample, the user needs to be sure to allow enough time for a full scan sweep before taping on the map and should ensure that enough data points are recorded for reasonable heatmap extrapolation. Not waiting for a full scan to be completed or collecting too few data points will result in unreliable / untrustworthy heatmaps.

Tap-to-Sample lends itself well to busy or sensitive environments in which the surveyor will frequently need to stop or wait for access to an area or to proceed into a room.

How to walk/collect

Just as important as where to walk is how to walk. While tap-to-sample gives some freedom around not having to maintain a steady walking pace, it's important to ensure that data is collected in an area within a similar time frame that accurately reflects the typical usage of the Wi-Fi network (not at night, when the building is unoccupied, etc.). Be sure that the EtherScope nXG is at a relative height that most clients would be expected as too low or too high won't accurately model what the users will experience.



Link-Live heatmap and details table

How Do you Know if You're 'Done'?

One challenge many people have is knowing when enough data has been collected to have a reliable survey. As with many things there is no hard and fast rule, but there are some things to consider.

> **How-To:** When you have completed your site data collection, hit "STOP", annotate the survey with any notes and name, and tap the cloud icon to upload to Link-Live.

If, after examining the survey visualization in Link-Live, you realize that there are gaps in the collected data, or sample points that were missed in your walk, you can return to the area, call up the AirMapper app, and simply tap "RESUME" to add samples. Then, upload again.

What Does 'Done' Look Like?

One way to look at the issue is the number of data points collected vs. the overall size of the space being surveyed. Also make sure all areas are covered by looking at the resulting heatmap. Remember that Signal Propagation plays a role here, but it's bad practice to change this after the fact to create a good heatmap. You should have considered and set your signal propagation before beginning the site survey, unless an error is found in your chosen value, to avoid changing it just to create a better looking heatmap. In doing so, you are using the tool to 'hide' a lack of information rather than having the necessary data to draw important conclusions. Gaps in coverage on the heatmap, or areas that are primarily determined as covered due to signal propagation radius are locations that should be given close attention. If any such locations lie in key areas of the site, then additional data should be collected in those locations to ensure that an accurate representation of network availability and performance is available.

ANALYZING THE RESULTS IN LINK-LIVE

Analyzing Survey Results

For each data point collected in a survey using the AirMapper app, Link-Live will provide visibility on both RF and Wi-Fi metrics that can be used to identify trouble spots, validate network performance, or troubleshoot known problem areas. Some of the metrics available for analysis are signal strength, noise levels, signal to noise ratio (SNR), max Tx/Rx rates, and interferers.

Signal Strength: Refers to the transmitter power output as received by a reference antenna at a distance from the transmitting antenna. Bad signal coverage is still one of the most common reasons for Wi-Fi connection problems. After all, if Wi-Fi devices can't hear each other then they can't communicate.

Noise Levels: Refers to the ambient or background level of radio energy on a specific channel. This background energy can include modulated or encoded bits from nearby 802.11 transmitting radios or unmodulated energy coming from non-802.11 devices such as microwave ovens, Bluetooth devices, cordless phones, and so on.

Signal to Noise Ratio: Compares the level of the Wi-Fi signal to the level of background noise. The quality and rate of a connection depends directly on the signal-to-noise ratio (SNR) that a receiving device detects. A ratio of 10-15dB is the accepted minimum to establish an unreliable connection; 16-24dB is usually considered poor. Meanwhile, 25-40dB is good and a ratio of 41dB or higher is considered excellent.

Max Tx/Rx Rates: Refers to the max speed at which data is transferred over a communications channel. Data dates don't take into consideration data encoding, modulation, encryption, noise levels, interference, and other factors, but can be used to determine the overall performance of the network. The actual throughput is normally 60-70 percent of the supported Max Rates.

Co-Channel Interference: One of the most common reasons for Wi-Fi performance problems is Co-Channel Interference (CCI), which is what happens when you have too many AP's with overlapping signals working on the same channel. This condition results in every client device and AP in that area having to time share the same channel airtime, which is a problem since Wi-Fi is by nature a half duplex type of communication (only one device can talk at a time).

Adjacent Channel Interference: Another common reason for Wi-Fi performance problems is Adjacent Channel Interference (ACI), which is what happens when you have too many AP's with overlapping signals working on overlapping channel. In the past this condition could only happen on the 2.4GHz band, but when bigger channel widths were introduced ACI also became a problem on the 5.0GHz band.

Cross-Comparing Survey Results

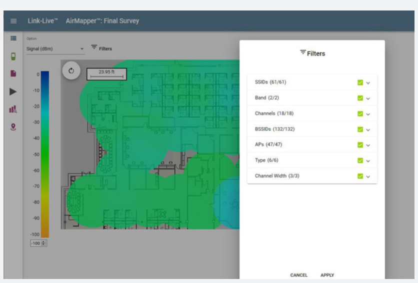
Each piece of data collected in a survey gives insight into different pieces of the overall RF puzzle. By measuring multiple metrics, we now can look across different types of data to try to understand unexpected / poor results we get in one area. Having all this information allows for analysis by comparing the results from different types of data. For example, by measuring Tx and Rx data rates, you may find an area with unexpectedly low performance values.

By looking at your survey data you can begin to understand whether there are numerous neighboring APs in that area all on the same channel. If there are, you may feel that the poor performance is being caused by large amounts of co-channel interference in the area.

If none of your other collected survey data sources show an obvious culprit/reason for the poor performance, you may want to look into more networking related issues such as the configuration of the AP or even the wired connection it's fed by.

Having the various pieces of data and comparing across the data sets allows for better conclusions plus a more in-depth understanding of each of my results.

FILTERING DATA COLLECTION



Multiple filters can be used to customize the visualization

A lot of data is collected during a site survey, with data being important, but not all of it. When analyzing the results, a certain amount of filtering must be done to correctly interpret the data. This is a very delicate balance as filtering too much could risk missing important implications, whereas filtering too little could have the message in the results get lost in a sea of data. Of the various ways to filter data collected in a survey, the most common ones used are SSID, signal level, AP, and channels.

Filtering on APs: Filtering on one or more APs allows you to focus your analysis to a specific set of APs. While filtering is valuable for focusing analysis on items of primary interest, care should be taken not to filter so aggressively that other key data is lost, or that the impact of APs that have been filtered out of the display isn't analyzed.

Filtering on SSID: One means to filter on APs is to select an SSID to filter on, this will allow you to see data only from APs with a specific SSID or set of SSIDs. This is often valuable when looking at coverage or interference data where the desire is to ensure that the installed network is well installed and working correctly. In the case of interference this shouldn't be evaluated only with a filter on, but it's often good practice to sanity check that at the very least you are not interfering with yourself (take care of those areas under your direct control).

Filtering on Signal Level: Filtering on signal level allows those APs whose signal levels were never heard above a specific threshold to be removed from the display. This can be particularly helpful in the case of neighboring APs that are not heard at a high enough level to truly interfere with your network, but whose data could clutter your display if included in the overall data view.

Filtering on Channel/Band: In addition to filtering based upon AP details, filtering can be done on specific channels or bands. This will give specific result analysis on the channel or band of interest. In many cases a network is intended to have full coverage on the 2.4GHz as well as the 5GHz band. Filtering on the band allows easier analysis of each band's data to ensure key metrics are met.

Filtering on Security Type: Filtering on security type allows you to easily identify APs configure to use OPEN, WPA, WPA2, or other authentication methods. This can be very useful when looking for Rogue or unauthorized devices that could provide unsecured access to the network. It can also be used to identify mis-configured APs.

Implications of the Decision

Filtering should be done to better understand and parse the data in question, not to get the results you're looking for. To keep human nature in check, it's often valuable to consider what filters to implement and how to slice and view the data before looking at the results of these filters. This can help to remove the temptations after the fact to filter to get data that looks good rather than filtering to get the best view of the situation.

REPORTING THE RESULTS

A report is often the primary way the results of your survey work will be seen by others. Reports should include all relevant information that is necessary to understand and evaluate the results. The report is often a fine balancing act between providing all necessary information and burying the reader in minutia. While no single table of contents will work for every report, there are some common elements that are valuable in most reports.

A good site survey report should leave the reader with as much necessary knowledge of the network as the person who prepared the report in the first place.

All Relevant Heatmaps

Most wireless designs these days have a variety of driving concerns, more than simple signal strength across the floorplan. As such, heatmaps need to be provided that cover all aspects of the design, highlighting key metrics of the network and proving out that the design meets these metrics (or potentially in the case of a pre-deployment survey highlighting the areas currently failing network requirements to point out areas that need to be improved during the redesign). Failed areas can also help to indicate where other design restrictions (budget, installation locations, etc.) have forced compromises with the initial design requirements. All heatmaps that cover a design requirement should be included, but also any heatmaps that highlight a deficiency, compromise, or weakness in the design. While it is human nature to want to accentuate the positive, pointing out the weaknesses is equally important while preparing a report and getting final signoff. Both sides should be in full agreement about the true nature of the network once reviewing the report. There should be no surprises after the fact.

Explanations and Analysis

Along with these heatmaps should be exhaustive notes and analysis of what the reader is seeing. Key details and concerns/features of the design should be called out and noted by the report. A good site survey report should leave the reader with as much necessary knowledge of the network as the person who prepared the report in the first place. As noted in the relevant heatmaps section, this should reference included heatmaps as necessary to illustrate important points and validate that the work done has covered all bases effectively.

More information at: netally.com/airmapper-site-survey/