Dorm Deployment Guide

Revised: May 23, 2017,

Scope

This document will outline recommendations for wireless deployments in Dorm room style environments. These recommendations are based on best practice deployments within the design parameters that the product is expected to operate in. These best practice recommendations come from real world deployments where the writers performed physical site visits, observations and use of a RF predictive and actual survey data. Recommendations should be reviewed, planned and deployed using best practice models for wireless network deployments. Each wireless deployment is unique and these recommendations have been generalized. Prior to implementation it is the recommendation of the authors to review plans with a Cisco Certified Wireless LAN Professional.

Deployment Plan

A solid well vetted plan will provide the basis for a successful deployment. The plan should include success criteria, a deployment model, scope of work to be done and a trained and skilled team to execute the plan. The following steps are meant to be used as an example, each deployment can be unique and require more or less steps. The steps are, Define Success criteria, walk through the facility, select deployment model, produce a predictive survey / plan, audit infrastructure, audit physical plant, assess plan. This can be an iterative process by altering the deployment model in the predictive stage to fit all of the project constraints. After a plan is agreed on then execute the plan and follow up with a validation survey.

Success Criteria

Without an end goal, nothing gets accomplished. Success criteria is critical to meeting expectations of the project stake holders. The success criteria should be simple and measurable, written down and agreed on by project stake holders, implementation team and the operations team. Success criteria should be defined before equipment is ordered and deployment models selected. Success criteria should include average signal strength as measured on the floor but also client signal strength seen at the AP, average throughput measurement per client, average number of clients expected to be serviced in a given cell as well as the number of "Cells" overlapping in any given location. A strategic decision should be made as to which Wi-Fi band is the Design Priority (2.4 GHz or 5 GHz) as the measurements will be different for each. Best Practice is to design for 5 GHz which provides much higher capacity, most recent devices available today support 5 GHz operation.

"Success Criteria Statement Example": "Success of the project is in all designated coverage areas with a minimum of 2 AP at -65 RSSI and average data rate of 150 mbps."

Deployment Model

Deployment model selection is choosing what architecture you will use for deploying wireless services in the designated area, in the case of this document a Dorm or Residence facility. More on Dorm style deployment models below. No matter which deployment model is selected the steps for deployment are all the same and none can be skipped or short changed on.

Walk Through

The walk through is not just a site visit, but a valuable data gathering excursion. During the walk through, the physical plant audit and infrastructure audit can be done. Pictures (lots) should be taken - as these later can provide important details you may not have written down or thought of at the time of the visit.

You will need floorplans - get these electronically before arriving on site. At the site, for the walkthrough, you will need a set printed on which you can make notes or when you arrive you will need a set of floorplans printed out.

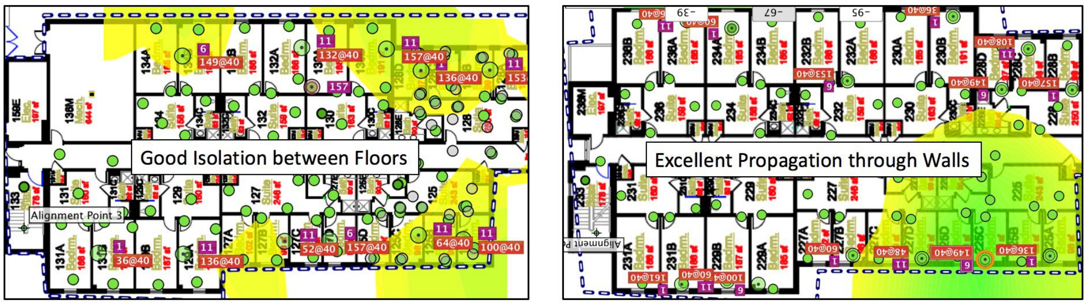
One of the most important aspects of a Walkthrough is to measure the existing RF and how it interacts with the physical structure. Even in like styled buildings, construction methods, codes, and materials will change over the years with older buildings being much more opaque to RF than newer buildings and materials in general. Differences in propagation from one building to the next is often the root cause in performance variations from building to building.

At a minimum, you should have a way to measure the RF Coverage (Fluke AirCheck, Netscout G2, a laptop based Wi-Fi scanner, Survey Tool i.e. Ekahau PSS). These tools are not likely calibrated with one another - so make certain that you understand the difference between same types of tools. Better yet, use the same tool for all your measurements. The Iphone's airport scan utility and your favorite android application can give you a reality check on how they interpret the signal as well - and provide real client data for comparison with your other measurements.

In addition to the RF tools mentioned above you will need a set of floor plans that can be marked up with notes. Getting those plans in electronic format is also going to be necessary for follow up or planning, so collect that at the time of the walkthrough as well. And, a measuring device. Laser measurement devices are not very expensive ($110-$150) for a model that measures accurately to 100 meters. You will want to verify the scale on the floorplans by taking some nice long measurements in a hallway, or along an outside wall. This will allow you to validate your drawings scale and accuracy later.

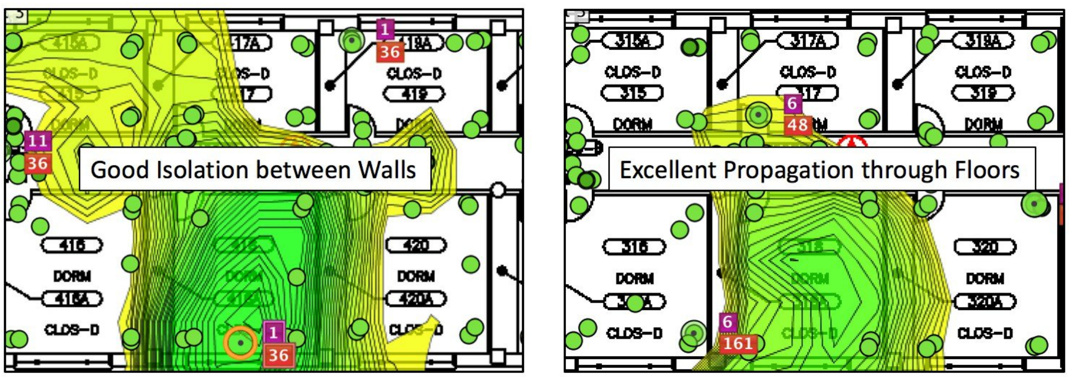
You will want to capture some measurements to understand the RF Densities of walls and floors at a minimum. Using one of the above tools - you can easily measure both sides of a wall or a floor in a couple of places and understand the characteristics of the individual site. This will prove valuable when making decisions about which deployment model to use. See examples below, as structures can be and often are very different. Measuring one building and building a cookie cutter deployment model can prove costly if something changes that you are not aware of.

Figure 1: Measurements from a building with 30 dB floors, and Thin walls



2nd Floor – Coverage from 1st Floor   2nd Floor Coverage from 2nd Floor AP

Figure 2: Measurements from a building with thin floors, and 30 dB walls



4th Floor – Coverage from 4th Floor   3rd Floor Coverage from 4th Floor AP

Predictive Plan

Using a Predicative survey tool enter data gathered from the walk through create a model of the desired deployment model. This can be an iterative process, ensure to tune the tool for your success criteria. During the predictive process, be conservative on the output power of the APs and attenuation factors of the walls. It is recommended when modeling with predictive AP's that you use a medium power level - choose 11 dBm (13 mW) as the power setting. This conservative factor will allow elasticity in the RF network for tuning and mitigating changes that occur after installation.

Infrastructure Audit

Access layer assessment for switch port and Power over Ethernet capacity is important, also review uplinks to the core, access layer VLANs and L3 Hops. Infrastructure requirements must also cover the potential for increased bandwidth requirements due to the additional access provided in the dorms. Wireless is an access method, but the to the students it is the internet, so when there is a delay getting to the internet it's an issue with the wireless. Many times, a new Wireless network is deployed, with little to no increase in performance for devices due to bottle necks up stream in the core or internet edge of the network.

Physical Plan Audit

Verify physical plant can handle the increased demand by the project, cabling, power and cooling requirements. This will include the potential increase for PoE budget on the Ethernet switches heat dissipation in the closets and cabling upgrades, re-pulls, and so on.

All access closets should be marked on the floor plan and notes made on available equipment and open ports during a walkthrough, even if the purpose is not initially to augment or reposition AP's. If you are adding or replacing AP's, then ensuring cable paths and distances becomes part of the design process.

Assess Plan

Review the predictive plan, account for a margin of error and validate with the success criteria. If the plan is or will not be successful, revisit the predictive plan and make needed adjustments. This may include - adding more AP's, repositioning existing AP's, or revisiting the criteria for success if it is not possible within design constraints.

Validation Survey

The only way to validate the success criteria was met, is to validate with a site survey. This is a passive or active walk around survey gathering a sufficient amount of RF Data to analyze. If the success criteria included a network performance metric, then you will require an active style of validation survey that measures performance of the network at the same time as it is measuring signal and spectrum. This is one of the most critical steps in the deployment and should not be short changed. This is the validation that all has gone according to plan. If this step is skipped chances are it will be performed at a later date with an increased cost associated. The validation survey should also include a client performance component of the survey. This is where not just the RSSI is measured but also the client's ability to communicate, in most survey tools there is an active mode that will allow not just signal metrics to be gathered but also performance data in the form of iPerf.

Note Prior to performing a network validation test, ensure that the installation is tuned and controller configurations are set for the production environment.

Performance validation needs to be approached carefully, depending on the tool employed to gather the performance data all care needs to be taken to ensure that the results are not influenced by outside factors, like network congestion or server performance. It is not recommended to use an internet based tool like speedtest.net, although it is a good indicator of local network to internet performance, there are many factors that may skew the results. The host for the speed test, iPerf, test should be on the local campus network on a wired network that is on the same Layer 2 segment as the client under test. This will test the performance of the wireless and eliminate any issues introduced by the campus network. If time and resources permit a second host could be placed just before the outbound internet link to test the wireless and campus network as a system. The host for the test should also be dedicated to that purpose to reduce the risk of another application causing poor performance results, and the host should be scaled to handle the anticipated load.

Deployment Models

Two basic models for deployment, enterprise class and nearfield. Enterprise class is utilizing Enterprise class access points like the Cisco AIR-AP2802 or AIR-AP3802 series access points. These access points offer a wide range of features including Client Link for implicit beamforming, Clean Air for spectrum visibility and XoR Radio for Flexible radio assignment to better balance the 2.4 GHz and 5GHz spectrum coverage.

Near field; this author is choosing to use the term near field to describe the client relationship to the AP, this is not related to the more commonly known NFC or Near Field Communications protocol. Near field deployment model is leveraging value based access points like the AIR-AP1810w or AIR-AP1815w in a one per room deployment model. The near field AP is specifically designed to be in close proximity to the client and operate at a lower output power encouraging higher speed connections and reducing the interference footprint for neighbors. These are desirable attributes that together consume less airtime providing a more efficient and higher capacity result.

Enterprise Class

Requirements

Infrastructure requirements are:

- POE
- Switch Configurations

Benefits

1. Potentially fewer APs. Depending on the RF attenuation in the facility, there is the potential that a well-planned RF Design will result in meeting the success criteria while reducing the total number of access points.
2. Higher class AP has better performance. Using Access Points like, AP-3802 or AP-2802 provide benefits that are not available with the AP-1810w series. Two of the key features are ClientLink, CleanAir and Flexible Radio.
   a. Client Link Cisco's implementation of implicit beamforming. What this means is we can use the four transmitters in the Access Point to direct the signal to where the client is and improve the SNR, driving higher speeds and less airtime consumption and higher overall efficiency/capacity within the cell. The benefit of implicit beamforming over explicit is the client does not need to support sounding frames. Based on internal testing with 100 Clients on an Access point there is approximately a 15% increase in performance with Clientlink enabled.
   b. Flexible Radio is an XoR Radio that is supported in AP-2802/AP-3802 only. The XoR radio can provide benefits from its flexibility to be used in different modes as a b/g/n radio, a/n/ac radio or monitor mode radio without impacting the operation of the second radio in the access point. The ability to change the mode of the XoR or Flexible Radio, will allow the organization to be better tune the 2.4GHz frequencies without turning an asset off.
   c. Clean Air is embedded spectrum analysis technology that allows for a higher fidelity of the RF environment. This allows the AP and Controller to better identify, noise and interference, with proprietary algorithms the AP can identify what may be transient noise/interference like Bluetooth or permeant. This provides better judgment on channels and helps network administrators track down the source of the interference.

Risks

1. No Switched Ethernet ports for rooms
2. Potentially new cable pulls

Near field

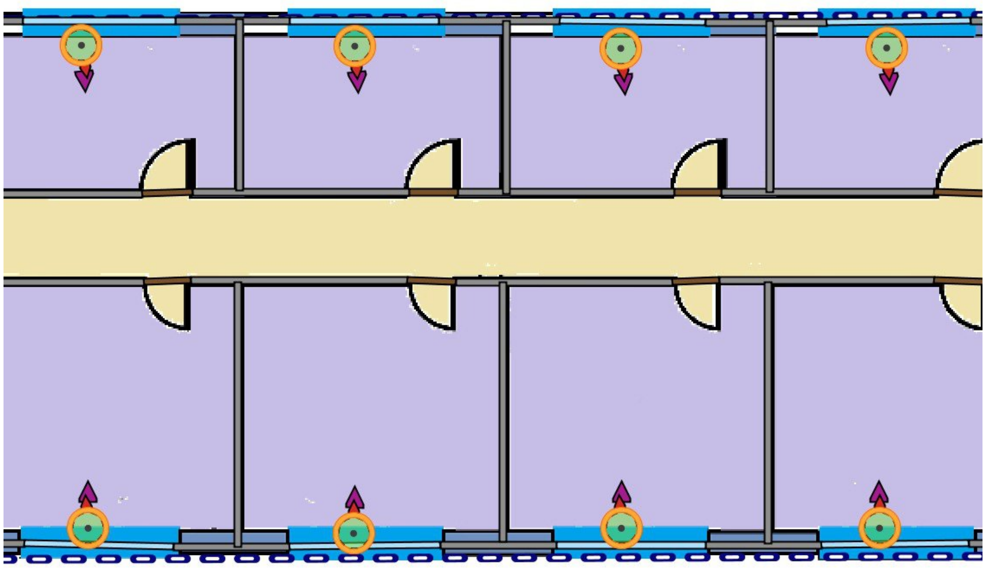
The Near field deployment model is a model in which the APs are placed in every room so that the clients are "Near" the access point. There is a trend to try and value engineer the deployment and place a unit every other room. There are a series of risks associated to this style of near field deployment that need to be mitigated.

The AP 1810 and AP1815 both feature extra switched Ethernet ports for wired equipment in the room. Each AP has 3 ports that can be used to provide Ethernet services and can be used to reduce the number of wired ports required for each room if your installation requires wired ports today, if not - it preserves the ability to provide them without further cabling investment in the future. With the introduction of the 181xW series AP, we now have a concept of Remote LANs on the controller. This allows two deployment modes for the switched Ethernet traffic. Local Mode (Ethernet traffic delivered to the controller over a CAPWAP tunnel) or flex connect mode, Ethernet traffic dropped locally to the AP. FlexConnect can be configured to switch all traffic at the core, or push that job out to the local access switch to the AP/Clients. The 1810W and 1815W deployment guides explain how to configure both modes.

One per room

This deployment mode is easy to build a specification to count the number of resident rooms that equals the number of Access Points required.

Figure 3: One Per Room Layout



Benefits

1. Ubiquitous services in all rooms, Wireless / Wired.
2. Close proximity to clients.
3. Reduced RF Noise (lower TX power requirement).
4. Lower Client/AP ratio (Which mitigates lower maximum possible clients speed due to less spatial streams available than on an enterprise deployment model).

Risks

1. Increased infrastructure requirements (if individual rooms do not already have wired drops, else the same requirements)
2. Reduced maximum client Capacity/Performance 2x2:2 radios vs 4x4:3 in enterprise style deployment.
3. May require augmentation for hallways, entry ways and common areas.

Infrastructure Requirements
This mode requires more infrastructure to support it as the AP count is more dense. This will impact the Wireless LAN Controller total AP count (license, and the limits of the particular WLC model) and potentially additional cabling and power if not already

present. The infrastructure audit portion of the project should focus on capacity of Power in the closet for the number of APs , Switch port count and cable drop to the room

Best Practices

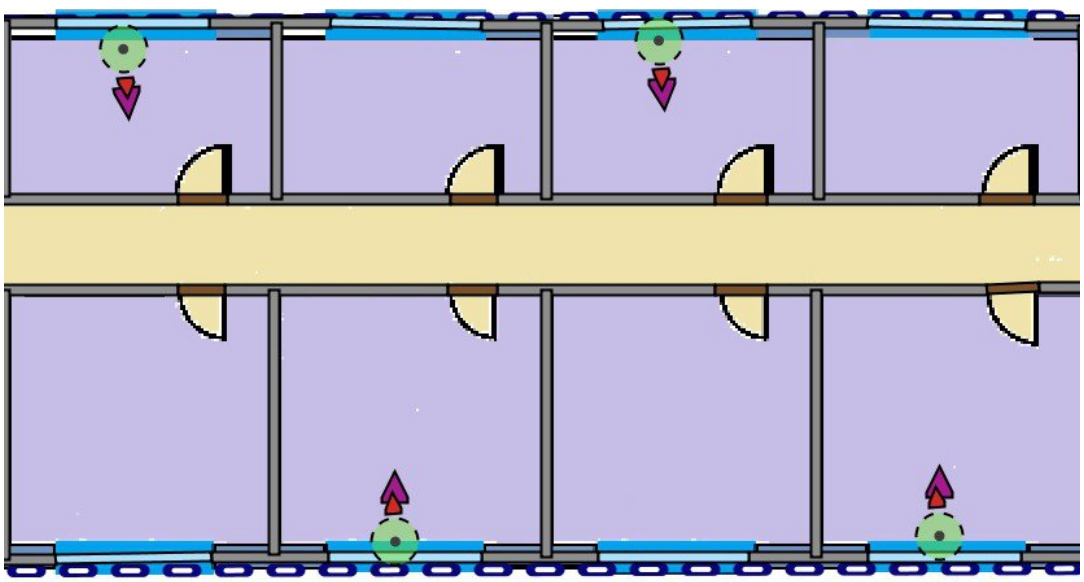
1 Standardize mounting locations.
2 Don't place objects in front of access point, as tempting as it might be to hide the access point behind a refrigerator or dresser etc., each object placed in front of the access point will most likely affect the RF.
3 Balance 2.4GHz space. Turn off on some radios or turn down the power real low.

Alternating Room

Benefits

1 Reduced infrastructure requirements compared to One Per Room.
2 Reduced AP count on WLC .
3 Within the right structure, can reduce overall numbers of AP's without compromising capacity.

Figure 4: Alternating Room Layout



Risks
May Require Hallway coverage / common area coverage.

AP Placement is critical for either horizontal or vertical room coverage, care must be taken to properly measure, model and deploy. See Best Practices in this section below.

Requirements

1 Infrastructure requirements, POE , Switch ports.
2 RLAN deployment modes.

Best Practices

1. Standardize mounting locations. (See above)
2. Do not place objects in front of Access Point. Keep furniture from covering the access point. Large objects introduce attenuation to the signal, items like refrigerators can cause scattering of the signal and degrade performance. This may manifest in lower than expected data rates even though the RSSI values are high.
3. Know intimately RF attenuation of Wall / Ceiling structures. When designing for room coverage horizontally or vertically then understanding the penetration loss of signal through the materials is critical. When surveying, pre-and post-deployment, take in account AP position on the Wall, and client position in adjacent rooms, both horizontally (Same Floor) and Vertically (above and Below).
4. Balance 2.4GHz, turn down TX Power, turn off some radios to prevent Co-Channel Interference (CCI).
5. Leverage RF Profiles to control 2.4GHz, disable all 802.11b unless you still have a real legacy 802.11b device (and consider replacing those as soon as possible)

6 Do not assume the same deployment model previously used will improve coverage and performance. Vertical stacking of APs can create coverage holes for horizontally adjacent rooms. See Figure 5, Figure 6, and Figure 7 for the RF gaps in the same rooms up the stack due to vertical stacking of the in-room APs.

Figure 5: 1st Floor Stacked APs

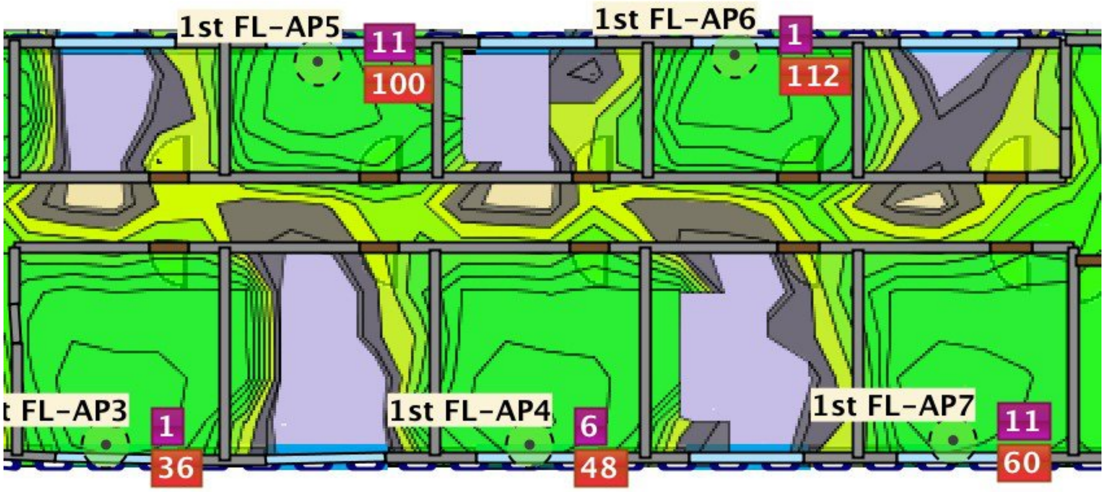


Figure 6: 2nd Floor Stacked APs

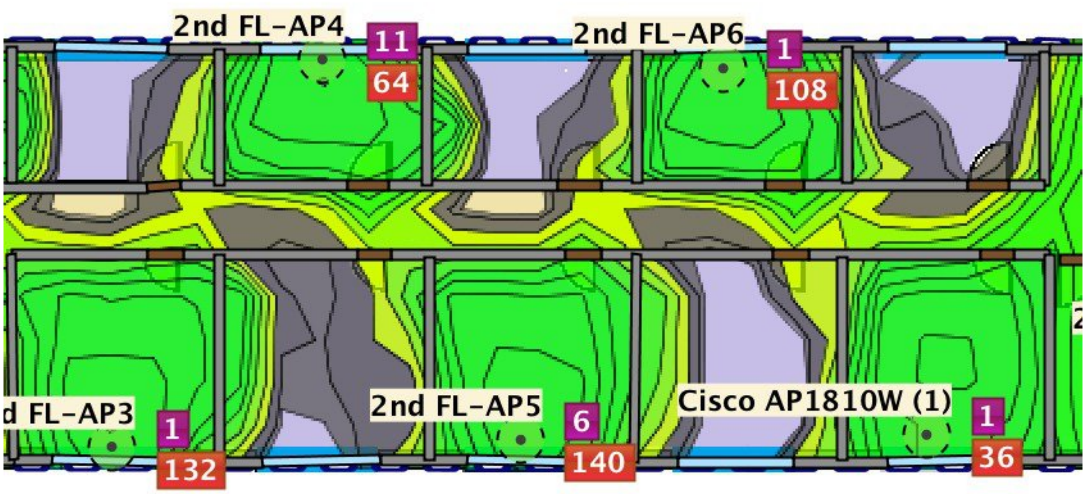
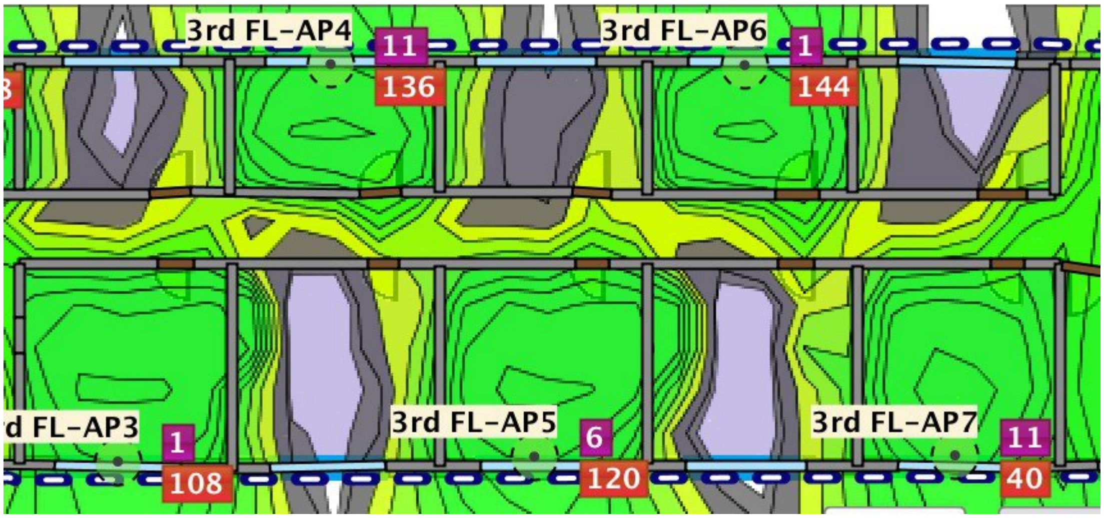


Figure 7: 3rd Floor Stacked APs



Client Requirements:

Coverage Requirements

Adequate coverage for the client is derived from documentation by the clients. With the majority of clients at Colleges and Universities being manufactured by Apple use their requirements as guidelines. See: https://support.apple.com/en-us/HT206207

In summary :

1. OS X always defaults to the 5GHz band over the 2.4GHz band, as long as the RSSI for a 5GHz network is -68 dBm or better.
2. OS X clients monitor and maintain the current BSSID's connection until the RSSI crosses the -75 dBm threshold. Once that threshold is crossed, OS X initiates a scan to find roam candidate BSSIDs for the current ESSID.
3. OS X selects a target BSSID whose reported RSSI is 12 dB or greater than the current BSSID's RSSI. This is true even if the OS X client is idle or transmitting/receiving data.

Other clients may have specific coverage or data rate requirements. The Sony PlayStation 4, as an example, is a 2.4GHz only device and requires 1 meg data rate to be enabled in order to connect, but then supports 802.11g data rates.

Note Enabling 1 Mbps as a minimum or supported data rate will reduce the available bandwidth at 2.4 GHz to roughly 50% of what's available if all of the 802.11b data rates are simply disabled. 802.11b legacy data rates require 802.11g protection mechanism's, which will double the management overhead signaling required. There quite likely are NO true legacy 802.11b clients left in your dormitory installations. Verify this on the WLC GUI home menu under connected protocols. Marking 1,2, 5.5 and 11 Mbps data rates as disabled is current "Best Practice"(See Wireless Lan Controller Best Practices/Data Rates below.)

Application Requirements

The dorm environment is a mix of study space and entertainment space. Understanding the applications that will in use in this environment will help size and engineer the network correctly. In most dorms access to applications like Learning Management

Systems, Internet Video services like YouTube, Netflix, Hulu and SlingTV, local and campus print services and gaming networks, like XBOX Live. Each of these networks and devices have different bandwidth and RF Band and data rate requirements.

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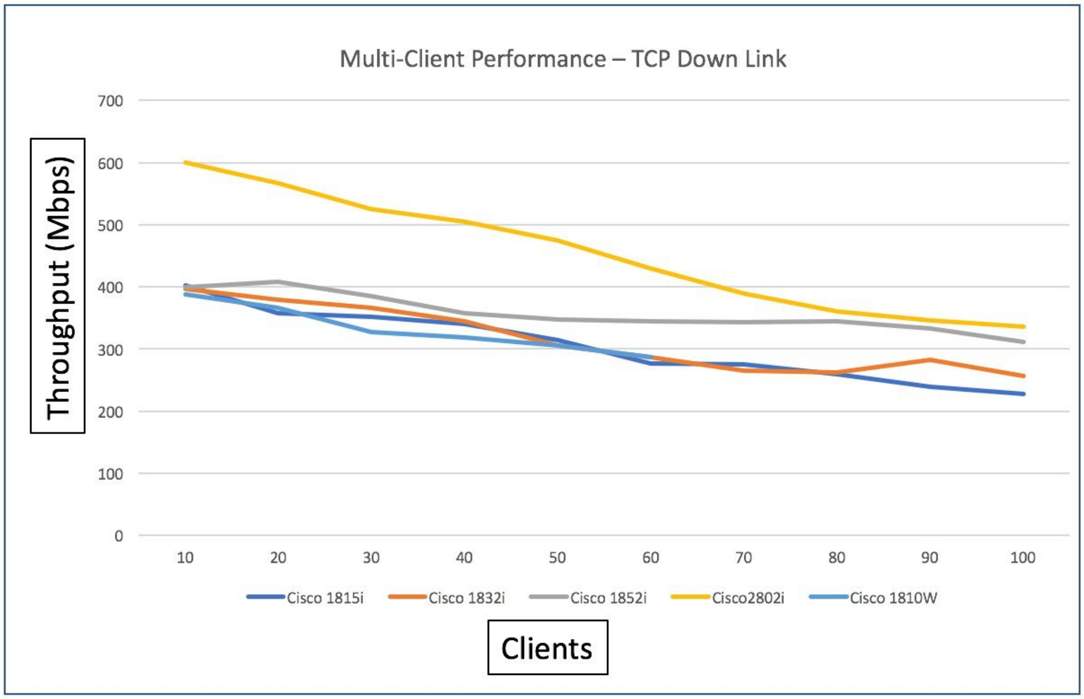
Figure 8: Average throughput per application type

Application – By Use Case	Throughput – Nominal
Web - Casual	500 Kbps
Web - Instructional	1 Mbps
Audio - Casual	100 Kbps
Audio – Streaming Music	1.5 Mbps
Video - Browser	1.5 Mbps
Video – HD Streaming	5Mbps
Printing	1 Mbps
File Sharing - Casual	1 Mbps
File Sharing - Instructional	2-8 Mbps
Online Testing	2-4 Mbps
Device Backups	10-50 Mbps

Keeping data rates in the higher range will help with throughput required by the applications see an example in Figure 8

Figure 9: Throughput results with up to 100 clients



In Figure 9 above all of the Cisco AP's support 2 Spatial Streams except the Cisco 2802i which supports 3 spatial streams. The inclusion of some 3 spatial stream capable clients along with enterprise class AP features (Client Link) explains the higher throughput achieved. What's important to understand from this is that adding more clients to a single cell ,means that more clients will share essentially the same or declining Total throughput Capacity (due to management overhead to more clients). What does this mean for average throughput per client? Well, a Cisco AP1815 with 10 clients is seeing total throughput of 403 Mbps or a potential of 40.3 Mbps per client. At 20 Clients we drop to 358 Mbps Total Throughput or an average of 17.9 Mbps / client.

Note The above graphic and interpretation of throughput speeds is presented to demonstrate that bandwidth is shared between all clients on a single cell only. This does not mean that each clients will receive equal throughput as there are many factors that govern an individual clients performance. How a particular client performs within a wi-fi cell can and is affected by things like distance from the AP, interference from other cells/clients, and client capabilities just to name a few.

In general, most users are happy as long as their internet response time isn't slow (arguably subjective). Designing for a dormitory a budget of 20 Mbps per client with low jitter/packet loss rates will keep everyone pretty happy. The 1810/1815 are more than capable of satisfying this requirement with 10-20 students sharing an AP provided they are within the cells RF coverage footprint. The more attenuation that is applied to the signal (walls, floors, humans and their things), the lower the signal to noise ratio will fall. Poor SNR results in lower achievable data rates and higher airtime consumption which equals lower overall capacity. This is exactly why the Near Field deployment model is successful in so many diverse building styles. Close - nearfield proximity to the clients maximizes supported data rates with the clients, increases airtime efficiency, and reduces the overall contribution of noise.

Wireless LAN Controller Best Practices

WLC Configurations will differ by building type and deployment model used, however the following pagraphs will give you the best practices, how to determine which apply to your specific situation and why.

For a complete list of current Wireless Best Practices, see Enterprise Best Practices for IOS devices on Cisco Wireless Lan . This guide has been recently updated and focuses on Best Practices in general, and specifically in regard to Apple and Cisco's partnership regarding our devices.

AP Grouping Recommendations

It is recommended to configure an AP Group per bldg., per floor, per AP Type being deployed in the dorms. This gives you the most granular control over individual adjustments being applied to like roles/areas on like AP's. If the initial RF configurations are essentially the same, using the same RF profile for all AP Groups is just fine. Having the option to change an RF Profile assignment to individuals in the future is preserved by having the groups formed. If a particular area's role or requirements change in the future - you can make needed changes to a new RF Profile and simply assign it to the AP groups where it is needed.

This approach will create many AP Groups which could conceivably be difficult to manage. A compromise approach is to build an AP group per building per AP type. This still allows for adjustments based on individual building properties and SSID requirements, while minimizing the number of AP groups added. In some situations, you may still wish to add a specific floor or even room's AP's to their own group which can still be done at any time in the future. You are always free to reassign any AP to another group at any time the only rule is that an AP may not belong to more than one group at a time.

Why would we need granular control? In a campus wide deployment for instance, all the APs may be the same physical model but will be used to solve a variety of different challenges encountered with different functional roles that span the gap between RF Coverage and RF Capacity.

- A lecture Hall may have many AP's in the same room at close distances in order to provide enough bandwidth within the room for a high concentration of clients (150-500 or more]. Applications may include dedicated presentation mirroring, testing applications, Streaming video to the desktop, as well as youtube and twitter. RF Configuration requirements will be specific to High Density Client deployment scenarios in order to satisfy the requirements.
- A Classroom environment is a smaller area than a lecture hall, and will have much fewer clients. But, there will be a pattern that repeats itself in every room within the building. The AP placement will likely be a single AP serving a single or multiple rooms depending on the building. In addition, introducing interior walls and structure into the RF path results in longer RF distances between AP placements and different configurations from a lecture hall will be required.
- The hallways and entrances of the buildings in both of the above roles need to handle primarily roaming (highly mobile) client capacity between bells, but still allow for crisp hand off to adjacent classrooms or lecture halls before the next bell.
- Dormitory's where students live and play and Wi-Fi is used for all manner of communications, entertainment and scholastic pursuits. Multiple small rooms with walls and structure separating them with relatively low client count within. Will likely not need the same level of tuning as the above examples – however you will still want optimize data rates and power to ensure good separation of cells and balanced utilization.

All four scenarios listed above differ in the deployment goals significantly on everything from the number of AP's and their expected coverage areas, to differences in client density and the types of applications that need to be delivered. Even within a single dormitory building using all AIR-AP3802i in an enterprise style deployment, both the rooms and the common areas represent two different deployment types. Here you have the same AP model being assigned to two different coverage tasks/expectations.

Near field deployments will require a mix of AP types, value based 181xW series for in dorm room coverage, with enterprise grade 3802 series for common and high traffic areas. This is a Macro/Micro type model, in which the Macro cell will be tasked with providing coverage in all common areas which are larger and tend to have less walls in the path of intended coverage, and a Micro cell structure - lots of little coverage areas defined by RF Barriers. The Macro's job will be to handle transient traffic en route to and between Micro coverage areas. The two types of coverage have different goals and configurations to enforce. Best to keep them separate.

Data Rate settings–Roaming and Load Balancing

In a Dormitory or Multi-dwelling facility the ratio of AP to Client count is not as impacting as say an open enterprise office environment with real time voice and video. The key concern about selecting good minimum data rates is to optimize the efficiency of the network by encouraging and enforcing client connections to AP's that are closest to them. Selecting a relatively high minimum data rate in a dense environment enforces client selections of higher data rates which improves airtime utilization. This efficiency equals higher capacity and lower latency throughout the surrounding cells. A minimum data-rate of 18 Mbps with no supporting data-rates below effectively tells a client that they must complete association and use a minimum data-rate of 18 Mbps or it will not be heard.

If the selected data rate is too low, then you will have clients holding onto AP's that are far away from them rather than roaming to a closer AP. This creates interference, and the lower data rates waste airtime since the radios must be on the air longer for the same size transaction.

If the data rate selected is too high, then you will create coverage holes between cells within the coverage area - a Higher data rate effectively reduces the cells coverage area by requiring higher levels of signal to function. As you get closer to the AP - higher data rates are possible. Using 18 Mbps as an example only - with no data rates supported below effectively reduces the overall coverage of the cells by regulating access. The minimum mandatory data rate (18 Mbps) will not be heard as wi-fi beyond a certain distance from the AP as the signal level will have dropped to low for demodulation. This ensures that a client can not hear the beacon of an available AP until it gets close enough to demodulate it. Increase the data rate to 24 Mbps - and the effective cell grows smaller, decrease it to 9 Mbps and the cell edge moves farther away from the AP and the coverage area becomes larger.

The data rate used by a client or an AP in either direction is a function of signal to noise ratio (SNR). Clients and AP's alike are built to lower or raise the data rate in response to changing conditions on the over the air link. Each data rate has a minimum SNR that it must have to support the conversation. All of this is automatic and beyond our control - particularly with the clients side. However, we can enforce some control from the network.

Data rates can be configured in 1 of 3 states:

- Mandatory–the client MUST support the data rate and operate at the minimum or above in order to associate
- Supported–the AP supports it and the client may use it to communicate with the AP
- Disabled–the AP does not support it and if disabled will not answer a client using that data rate

The "First" Mandatory data rate that you select determines what speed all of the beacons and other management traffic use. The second mandatory data rate that you set (always higher) serves as the default multicast data rate if you are not using the default which is auto. Any rates that are supported below the Mandatory data rate - should be set to disabled. Enabling lower data rates encourages sluggish roaming by allowing the client to hang on to the AP when it really should be roaming.

Note In all cases for 2.4 GHz - data rates 1,2,5.5, and 11 should always be disabled - you will only have true legacy 802.11b devices if you're a hospital, warehouse, or retail chain most likely.

Note The above three settings apply only to legacy data rates - and not to the HT or VHT rates. This is because all HT and VHT clients and AP's only use the 802.11a protocol for management traffic and beacons - this is by design to accommodate backward compatibility. It is not necessary, or advised, to adjust the HT /VHT permitted data rates. Let the clients figure those out for themselves.

The data rates that you select are dependent upon your deployment style. With strong 5 GHz coverage (-60 dBm cell edge) - the first mandatory rate can easily be 18-24 Mbps with 12 and below disabled. In higher density environments 24, 36, and even 48 have been used to help the clients spread out on the available AP's.

So, how do you select the correct data rate? Start conservatively.

In a nearfield deployment the goal is to keep the AP and the clients near one another - so a fairly aggressive data rate should be supported. If your deployment is a combined enterprise (hallways and common areas) and nearfield (individual room coverage) then you only need enough coverage for a room ad a slight overlap with the hallway with the door open- and a very high data rate will work fine. However, if you are also covering hallways from the rooms - then you will need to take that into account and a lower data rate will be called for. What you want to achieve is a good and well enforced overlap with the next cell to facilitate good roaming. Here's an example of how to tune this in:

- Start with 12 Mbps as the first mandatory data rate.
- Monitor coverage hole alerts (first likely configure coverage hole threshold,the default is -80 you likely want -75). This alerts on clients that are below the coverage threshold as seen by the AP. If your getting coverage holes on interior spaces (it is common to get alerts on AP's near entrances - people do leave) then reduce it to 9 Mbps.
- You can also monitor which AP's clients are connected to using Prime and CMX - and if you see clients skipping through 2 available AP's and attached to the 3rd - then the data rate is too low for your deployment. You would want to increase the data rate one step to 18 Mbps.
- Even better, do your post deployment survey and check your roaming and coverage and adjust up or down based on those results (Strong coverage = -60 dBm at 5 GHz as a lot of clients are hard of hearing). If you do an active survey and maintain a ping to the network on the internal adapter you would be looking for increased packet drops in cell overlap areas.

In a dormitory near field deployment the goal would be to ensure that clients are connecting to available AP's at a sufficiently high data rate. Given the above example - it's a process of tuning. Tuning is not necessarily required - however once you fine tune the configuration -you will enjoy a lot of trouble free existence. Obviously we are discussing one building, area, or floor. And the configuration your configuration results may well apply to multiples, but it likely doesn't apply to every conceivable installation under your control - hence the reasons for using AP groups and RF Profiles.

RF Profile Recommendations

RF Profiles are used to provide granular control over the RF behavior of specific AP's within a group. These will be applied to the AP Groups to tune the RF for best performance for the environment. Below is an example of how in a Dorm environment RF profiles may be created. The table below will describe changes that need to be made to the default settings in a RF Profile. These recommendations are a starting point and finer tuning may be needed based on your post deployment survey results. RF profiles are Band specific, one will need to be created for the 5GHz band or a/n/ac protocols and one for the 2.4GHz band or b/g/n protocols. These settings are an example only, your deployment may require different settings.

The RF profile 1810wDorm 9802.11a/802.11b) are for the nearfield AP's within the rooms. The 3802Dorm profiles are for the enterprise coverage in common areas.

RF Profile Name	Band	Legacy Data Rates Disable	Legacy Data Rates Supported	Legacy Data Rates Mandatory	TPC–Min	TPC–Max
1810wDorm–5GHz	802.11a	6,9	*18/12, 36, 48, 54	*12/18, 24	10	17
1810wDorm–2.4GHz	802.11b	1,2,5.5,6,11	9, 18, 36, 48 ,54	12, 24	-1	7
3802Dorm–5GHz	802.11a	6,9	18, 36, 48, 54	12, 24	10	17

RF Profile Name	Band	Legacy Data Rates Disable	Legacy Data Rates Supported	Legacy Data Rates Mandatory	TPC–Min	TPC–Max
3802Dorm–2.4GHz	802.11b	1,2,5.5,6,11	9, 18, 24, 36, 48, 54	12	10	17

RLAN Configuration Best Practice

RLAN is a concept of delivering a similar experience to the wired ports of 18xxW series Access Point as the wireless client gets. In RLAN Local Mode the wired traffic is tunneled in the CAPWAP data tunnel back to the controller and managed centrally similar to WLAN Local Mode traffic. If the access point is put in Flexconnect mode , then the wired traffic can be dropped locally, similar to the WLAN traffic that may be in "Locally Switched" mode.

This is a very big subject and an excellent guide is found here in the Enterprise Mobility 8.1 Design Guide.

Refer to Chapter 7 FlexConnect. Of note, locally switched Ethernet ports on the AP1815 may be desirable for in room Gaming, Printing, and other traffic you simply don't want to or need to run through the core of the network. Configuration information can be found at AP 1815 Wall Plate Deployment Guide, along with good definitions of what can and can not be done on the AP 1815's Ethernet ports.

AP Placement Recommendations

In near field Deployment:

Ap's shouldn't be placed behind any obstructions, nor near any metal as this can adversely affect signal propagation and negatively impact performance. Line of Sight (LOS) installation in which the clients and the AP can see one another un-obstructed will perform at peak efficiency.

In situations where LOS is not possible, it is particularly important to re-check (post survey) results. At the very least you will know how the obstruction impacts performance and propagation and the documentation of this may just help the case to avoid it all together.

Avoid placing AP's on opposite sides of the same wall. Placement should always be staggered or offset as much as possible to avoid self interference by other AP's.

In Enterprise Deployment

In hallways, only to cover hallways. Do not place APs in a line down a hallway and expect good coverage in the rooms. This type of deployment at a minimum will require additional configuration to force coverage where it is needed. This generally involves increasing power to force coverage through obsticals and reach your coverage goal. The hallway itself acts as a wave guide - which causes reflections off the walls and dramatically increases co-channel interference. This may not be immediately apparent in 5 GHz channels, but will immediately diminish 2.4 GHz interference. High Channel utilization and poor throughput will be apparent once users are on the network. which in turn will increase co-channel interference.

When installing in buildings that have features such as large open attriums, with floors terminating on the atrium, special care will be needed to ensure that coverage for each cell does not seriously overlap within the Atrium.

In all cases, a good active site survey, or an accurate predictive model should be used to verify placement options and ensure that interference is kept to a minimum.

Summary

- Building a plan based in Data Driven Decisions is essential to deploying a solution that will meet your organizations present needs as well as expected (and unexpected) growth in the future. Measuring and demonstrating success start's with defining the "Criteria for Success" which will drive resulting architectural choices and deployment model selections that meet your needs.
- Determining which deployment model you will choose is based on the stated criteria for success and the physical attributes of the intended deployment locations. Generalizations about construction types and how the RF will "generally" interact are can only be validated using actual observations. It certainly is possible to categorize a group of facilities based on floor plan, methods of construction, and age based on measurements from one location. It can be expensive to be wrong once implemented and operational. It is recommended to do at least a physical site visit to each location to quickly assess any potentially problematic differences.
- Validating that the success criteria has been met, can only be done by objective measurement and observation. This becomes even more critical, if you are contracting the work to be performed. A clear agreement should be in place which details the tools, metrics and method used to demonstrate that the success criteria has been met.
- Wireless technologies continue to advance in the market place. New protocols, advanced standards, and better clients that support them make achieving excellent performance and happy users easier and less expensive to achieve than ever before. Ensuring that you are familiar with the options and the recommended best practices which have been developed through real world experiences and learnings achieved in like environments.

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