



WiNG 5.x Cheat Sheet

SMART-RF

July 2011
Revision 1.0

MOTOROLA and the Stylized M Logo are registered in the US Patent & Trademark Office.

Symbol is a registered trademark of Symbol Technologies, Inc. All other product or service names are the property of their respective owners.

© 2011 Motorola, Inc. All rights reserved.

Table of Contents

- 1. Overview:..... 4
 - 1.1 Brief Review:..... 4
- 2. Smart-RF Settings: 4
 - 2.1 Factory Default: 5
 - 2.2 Section Analysis: 7
 - 2.2.1 Group-by – Financial Institution example:..... 7
 - 2.2.2 Sensitivity 9
 - 2.2.3 Assignable-power..... 9
 - 2.2.4 Channel-list / width..... 9
 - 2.2.5 Smart-ocs-monitoring 10
 - 2.2.6 Interference-recovery 12
 - 2.2.7 Neighbor-recovery 12
 - 2.2.8 Coverage-hole-recovery..... 13
- 3. Environment Types and Examples..... 13
 - 3.1 Warehouse / DC's..... 14
 - 3.2 Office / Cubicle Spaces..... 16
 - 3.3 Retail Space 16
 - 3.4 High Density Environments..... 17
 - 3.5 Medical 17

1. Overview:

The Smart-RF feature is a powerful tool in mitigating day-to-day RF anomalies in most WLAN environments. With the release of WiNG 5 and the Off-Channel-Scanning capabilities, Smart-RF has become the “best of” automated RF management utility for ensuring a stable environment.

However, there are many settings to Smart-RF, most of which have been given very reliable default values arrived at after a relatively long history of Smart-RF and many deployments. Yet at times there may be reasons to modify default values in order to ensure the best automated management given a particular environment.

This document intends to aid in understanding some of these settings, and when or why they may be changed based on a particular deployment. This document is not all-inclusive and additional fine-tuning by the engineer may be necessary.

1.1 Brief Review:

“Self Monitoring at Run Time – RF” (SMART-RF) has been around since early versions of WiNG and has completely evolved in WiNG 5.x due to the new Off-Channel-Scanning (OCS) abilities. The main objectives of Smart-RF are:

- Interference Recovery – Mitigation of interference and noise from neighbour devices, outside 802.11 sources and environmental noise.
- Neighbour Recovery – Mitigation of cell outages / neighbour anomalies based on neighbour device failure or neighbour antenna failures.
- Coverage Hole Recovery – Mitigation of coverage issues for clients by power adjustments based on degradation of client SNR.

Whereas earlier versions of Smart-RF required a repeated calibration phase, due to OCS calibration is no longer a requirement. Calibration runs automatically when the Smart-RF policy is applied and enabled on a device, but due to OCS, the Smart-RF environment continually monitors and adapts during run-time.

2. Smart-RF Settings:

Smart-RF has three basic sensitivity settings with take much of the guess work out of configuring. These are:

- Low
- Medium
- High

A fourth basic setting, “Custom” allows more customized configuration. The three basic “canned” settings adjust the aggressiveness in Smart-RF scanning, data collection and anomaly mitigation. For instance, a setting of “Low” makes Smart-RF less aggressive – taking fewer samples during off-channel-scanning, remaining off-channel for less time, etc. Whereas a “High” setting makes Smart-RF very aggressive, collecting more samples, remaining off-channel

longer, etc. The deployment, client types and environmental factors determine why you may go with a particular setting.

2.1 Factory Default:

Below is the factory default configuration of Smart-RF is policy is simply created and applied with no modifications. We will look at sections of this default configuration and explain their purpose and reasons why they may be given a custom configuration:

Smart-RF Default Settings

```
smart-rf-policy default-rf-policy
enable
no group-by area
no group-by floor
no auto-assign-sensor
sensitivity medium
assignable-power 5GHz min 4
assignable-power 5GHz max 17
assignable-power 2.4GHz min 4
assignable-power 2.4GHz max 17
channel-list 5GHz
36,40,44,48,52,56,60,64,100,104,108,112,116,120,124,128,132,136,140,149,153,157,161,165
channel-list 2.4GHz 1,6,11
channel-width 5GHz 40MHz
channel-width 2.4GHz 20MHz
smart-ocs-monitoring
smart-ocs-monitoring off-channel-duration 5GHz 50
smart-ocs-monitoring off-channel-duration 2.4GHz 50
smart-ocs-monitoring frequency 5GHz 6
smart-ocs-monitoring frequency 2.4GHz 6
smart-ocs-monitoring sample-count 5GHz 5
smart-ocs-monitoring sample-count 2.4GHz 10
smart-ocs-monitoring extended-scan-frequency 5GHz 5
smart-ocs-monitoring extended-scan-frequency 2.4GHz 5
smart-ocs-monitoring power-save-aware 5GHz dynamic
smart-ocs-monitoring power-save-aware 2.4GHz dynamic
smart-ocs-monitoring voice-aware 5GHz dynamic
smart-ocs-monitoring voice-aware 2.4GHz dynamic
no smart-ocs-monitoring client-aware 5GHz
no smart-ocs-monitoring client-aware 2.4GHz
interference-recovery
interference-recovery noise
interference-recovery noise-factor 1.5
interference-recovery interference
```

```
interference-recovery client-threshold 50
interference-recovery channel-switch-delta 5GHz 20
interference-recovery channel-switch-delta 2.4GHz 20
neighbor-recovery
neighbor-recovery power-threshold 5GHz -70
neighbor-recovery power-threshold 2.4GHz -70
coverage-hole-recovery
coverage-hole-recovery interval 5GHz 30
coverage-hole-recovery interval 2.4GHz 30
coverage-hole-recovery coverage-interval 5GHz 10
coverage-hole-recovery coverage-interval 2.4GHz 10
coverage-hole-recovery snr-threshold 5GHz 20
coverage-hole-recovery snr-threshold 2.4GHz 20
coverage-hole-recovery client-threshold 5GHz 1
coverage-hole-recovery client-threshold 2.4GHz 1
interference-recovery channel-hold-time 1800
neighbor-recovery power-hold-time 0
no neighbor-recovery dynamic-sampling
neighbor-recovery dynamic-sampling threshold 5
neighbor-recovery dynamic-sampling retries 3
```

2.2 Section Analysis:

This document will touch on important aspects of the Smart-RF configuration, but will not explain every component of the Smart-RF config. Additionally, specific configuration of all the components of a Smart-RF policy is beyond the scope of this document. Please see the Sales Enablement Guides page in reference section of this document for How-To's and Feature Guides related to Smart-RF.

2.2.1 Group-by – Financial Institution example:

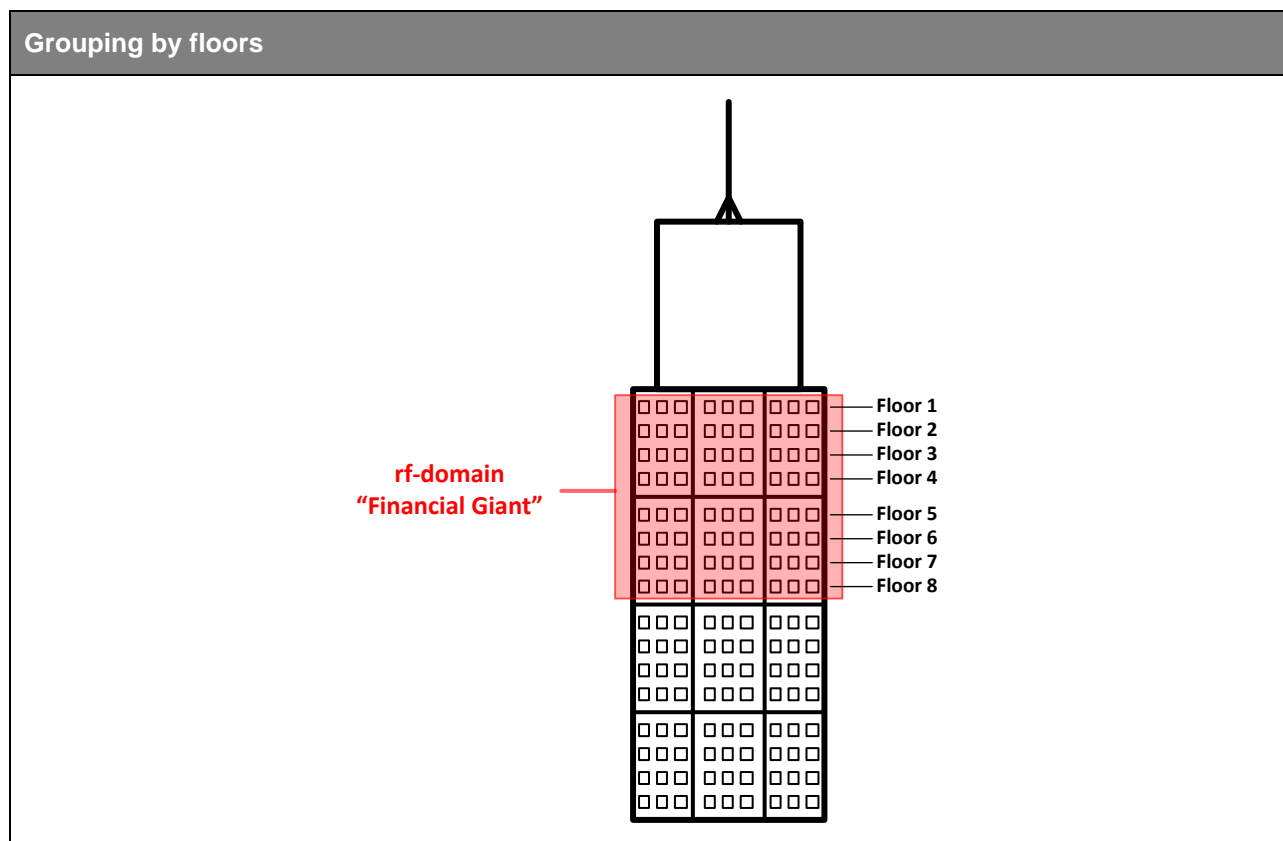
```
no group-by area
```

```
no group-by floor
```

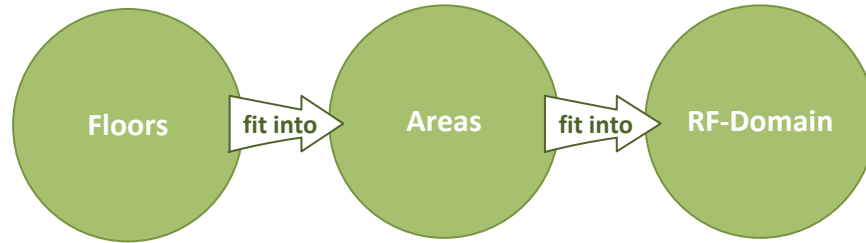
The group-by sections are related to statistics gathering and display. By default, there are no areas or floors configured in an rf-domain. However in a large rf-domain we may determine that for the sake of collecting statistics and for easier troubleshooting, we would like to create additional “containers” in our rf-domain; these would be “areas” and “floors”. When we use these

“group-by” methods, it causes the AP’s to only form neighbour relationships based on the grouping.

As an example, let’s say we have a large office building deployment – a financial firm that resides on 8 floors of a high-rise building. In most cases we would simply want to make this a single rf-domain, encompassing all 8 floors. However, in troubleshooting a client connectivity problem, we will have statistics for that client across the entire rf-domain; all 8 floors. Determining where this client is and what access points we wish to take packet captures from may prove to be very cumbersome. If we partition the deployment into 8 individual floors and then group the access points by the floor they reside on, we can then collect Smart-RF statistics per floor, making management and troubleshooting much easier. This will cause the AP’s to form neighbour relationships with the floors they have been assigned to and for Smart-RF to make calculations based on those floor / neighbour relationships.



In any large rf-domain deployment with many devices, it is recommended to create areas and then if necessary, floors as well if statistics relative to location are desired. The hierarchy for these elements is:



It is important to understand that floors and areas give us containers that give us a visual organization to many devices in a large rf-domain and give us Smart-RF statistics relative to those containers and the neighbor relationships formed within those containers.

2.2.2 Sensitivity

`sensitivity [low] [medium] [high] [custom]`

Basic Settings

Sensitivity

Low Medium High Custom

This section sets the aggressiveness of Smart-RF scanning / sampling. Depending on which option is selected, various elements in the rest of the Smart-RF config will be automatically set to a predetermined value. Those values will then appear unavailable for further configuration (grayed out). Selecting custom gives the user access to configure all elements.

The default value when a new Smart-RF policy is created is “**Medium**”, which is adequate for most environments. However, examples of other environment settings will be covered in the “Environments” section of this guide.

2.2.3 Assignable-power

```

assignable-power 5GHz min 4
assignable-power 5GHz max 17
assignable-power 2.4GHz min 4
assignable-power 2.4GHz max 17

```

This configures the minimum and maximum values that Smart-RF will use when adjusting power on the radios, per band

2.2.4 Channel-list / width

```

channel-list 5GHz
36,40,44,48,52,56,60,64,100,104,108,112,116,120,124,128,132,136,140,144,148,152,156,160,164,168,172,176,180,184,188,192,196,200,204,208,212,216,220,224,228,232,236,240,244,248,252,256,260,264,268,272,276,280,284,288,292,296,300,304,308,312,316,320,324,328,332,336,340,344,348,352,356,360,364,368,372,376,380,384,388,392,396,400,404,408,412,416,420,424,428,432,436,440,444,448,452,456,460,464,468,472,476,480,484,488,492,496,500,504,508,512,516,520,524,528,532,536,540,544,548,552,556,560,564,568,572,576,580,584,588,592,596,600,604,608,612,616,620,624,628,632,636,640,644,648,652,656,660,664,668,672,676,680,684,688,692,696,700,704,708,712,716,720,724,728,732,736,740,744,748,752,756,760,764,768,772,776,780,784,788,792,796,800,804,808,812,816,820,824,828,832,836,840,844,848,852,856,860,864,868,872,876,880,884,888,892,896,900,904,908,912,916,920,924,928,932,936,940,944,948,952,956,960,964,968,972,976,980,984,988,992,996
channel-list 2.4GHz 1,6,11
channel-width 5GHz 40MHz
channel-width 2.4GHz 20MHz

```

The available channels Smart-RF can select from when making channel modifications and channel width settings.

Within the 5GHz band, UNII-2 and UNII-2 extended frequencies must comply with FCC regulations for Dynamic Frequency Selection (DFS) and Transmit Power Control (TPC). This requires that if a WLAN device is going to move to a channel in those frequencies, it must first monitor the channel for the presence of radar, as would be used at an airport, and if radar is detected, the AP must select a different channel. With this in mind, since we have so many channels available in the 5GHz range, it doesn't hurt to limit some of these channels or remove them entirely so that extra time in monitoring the channel does not affect the Smart-RF environment. In a low density warehouse environment where coverage is more important than capacity (thus fewer AP's being installed with perhaps higher-gain antennas), there is no real need for all the additional channels UNII-2 / extended buy us. There are still 8 channels available between UNII-1 and UNII-3, which don't require the DFS / TPC scanning to take place. This makes for speedier transitions in the Smart-RF changes.

Now, with the above statement being made, also consider the 40MHz channel-width of the 5GHz range. This will effectively bring the total available channels down to 4 or 5 – still plenty for low density environments, but with more chance of co-channel interference as well. Thus, one may opt to utilize UNII-1, 2 and 3, but not UNII-2 extended yielding a happy-medium.

2.2.5 Smart-ocs-monitoring

```
smart-ocs-monitoring
```

```
smart-ocs-monitoring off-channel-duration 5GHz 50
```

```
smart-ocs-monitoring off-channel-duration 2.4GHz 50
```

```
smart-ocs-monitoring frequency 5GHz 6
```

```
smart-ocs-monitoring frequency 2.4GHz 6
```

```
smart-ocs-monitoring sample-count 5GHz 5
```

```
smart-ocs-monitoring sample-count 2.4GHz 10
```

```
smart-ocs-monitoring extended-scan-frequency 5GHz 5
```

```
smart-ocs-monitoring extended-scan-frequency 2.4GHz 5
```

```
smart-ocs-monitoring power-save-aware 5GHz dynamic
```

```
smart-ocs-monitoring power-save-aware 2.4GHz dynamic
```

```
smart-ocs-monitoring voice-aware 5GHz dynamic
```

```
smart-ocs-monitoring voice-aware 2.4GHz dynamic
```

This section relates to all the details for off-channel scanning; i.e. how long to remain off-channel, sample count each time an off-channel scan is performed, etc.

Specific to this section, let's look at the "extended-scan-frequency", "power-save-aware" and "voice-aware" settings.

2.2.5.1 Off-channel-duration

How long Smart-rf will remain off-channel when it performs a scan. In most cases do not change these settings from the default. However, doing so will give a longer sample period in which more data can be gathered regarding the surrounding environment. In a noise environment where many outside sources are suspect, it may help to extend the off-channel duration.

2.2.5.2 Frequency

This refers to the frequency in which “**smart-ocs-monitoring**” changes channels for an off-channel scan and is specified in seconds. In the output above the setting is every 6 seconds; this default value will change depending on what Smart-RF “**sensitivity**” is set to.

2.2.5.3 Sample-Count

This simply refers to the number of samples to take before reporting to the smart-master (rf-domain manger). The defaults are 10 samples for 2.4GHz and 5 samples for the 5GHz band. You can conclude from this how long it will take each smart-client to report to the smart-master the results of the 2.4GHz band based on our “**frequency**” x “**sample-count**” x “**# of channels**” ($6 \times 10 \times 3 = 180$ seconds). The same calculation can be done to determine the time for the 5GHz band.

2.2.5.4 Extended-scan-frequency

Each Smart-RF client device will maintain a list of the 12 “most-audible” neighbor devices. When an off-channel scan is performed, it will be relative to the list of neighbors; neighbor channels, neighbor RSSI, attenuation, co-channel interference, etc.

Smart-RF will perform an off-channel scan of a single channel every 6 seconds, giving us a total of 10 off-channel scans in a one-minute period. Every *n*th time, as stipulated by the extended-scan-frequency value, the Smart-RF client will perform an extended scan of the environment as a whole, including outside noise factors, etc. We don't want to perform this extended scan every time or the client becomes overwhelmed in processing all the received data and inhibits the effectiveness of Smart-RF as well as serving wireless clients. In a very noisy environment, where there may be many contributing and varying sources, the extended-scan may be performed a little more frequently.

2.2.5.5 Power-save-aware

This setting allows Smart-RF to detect power-save clients and take them into consideration when performing off-channel scans. With the default setting of “dynamic” Smart-RF will consider wireless clients in a PSP state and may opt to postpone the off-channel scan until the wireless client awakens at the DTIM interval. If set to “strict”, the Smart-RF client will not perform its off-channel scan when PSP clients are detected.

This setting may be set to “strict” in an environment where off-channel scanning may interfere with the DTIM and clients waking to receive data. For example, warehouse environments related to logistics / shipping where there may be hundreds of scanner clients scanning thousands of packages in a given shift. These clients alternate between power-save mode and awake constantly and thus, it would be beneficial to set power-save-aware to “strict”.



2.2.5.6 Voice-aware

As with power-save-aware, voice-aware allows Smart-RF to delay off-channel scanning when voice clients are present. In a mixed client environment, the default setting of “dynamic” would be sufficient, but in a wlan dedicated to voice, the setting should be set to “strict”.

2.2.6 Interference-recovery

```
interference-recovery
interference-recovery noise
interference-recovery noise-factor 1.5
interference-recovery interference
interference-recovery client-threshold 50
interference-recovery channel-switch-delta 5GHz 20
interference-recovery channel-switch-delta 2.4GHz 20
```

Interference-recovery performs channel changes when noise from neighboring devices or outside interference is detected and the delta between the current channel energy and the perceived energy from other signals falls below a threshold.

Of importance here are the “**client-threshold**” and “**channel-switch-delta**” settings. Client-threshold simply means that if our Smart-RF client AP has n clients (50 by default) or more connected at the time a channel change is needed, the change will not take place. The channel-switch-delta is the minimum expected between the perceived energy on the current channel compared to that of the best possible alternate channel. This setting should never be below 20dB (the default).

2.2.7 Neighbor-recovery

```
neighbor-recovery
neighbor-recovery power-threshold 5GHz -70
neighbor-recovery power-threshold 2.4GHz -70
```

Optimal radio power settings are arrived at by determining the attenuation of all neighbors for a given radio. A Smart-RF probe is transmitted by Smart-RF clients and then the RSSI of each neighbor response is sent to the Smart-rf master (rf-domain manager). Based on “**smart-ocs-monitoring sample-count**” an average rssi for each neighbor is determined and from that the overall attenuation of the neighbors. The attenuation + “**neighbor-recovery power-threshold**” (in case of the default, -70) is our power setting. So if a neighbor attenuation is calculated at 80 and the threshold is set at -70, radio power will be set at 10 ($80+(-70) = 10$).

In environments that have excessive obstructions where neighbors may not be heard as well, the “**power-threshold**” setting may be set a little hotter (for instance, up to -65 from -70) in order arrive at a better overall power setting. An example of this will be discussed in the “Environment Types” section of this document.



2.2.8 Coverage-hole-recovery

`coverage-hole-recovery`

`coverage-hole-recovery interval 5GHz 30`

`coverage-hole-recovery interval 2.4GHz 30`

`coverage-hole-recovery coverage-interval 5GHz 10`

`coverage-hole-recovery coverage-interval 2.4GHz 10`

`coverage-hole-recovery snr-threshold 5GHz 20`

`coverage-hole-recovery snr-threshold 2.4GHz 20`

`coverage-hole-recovery client-threshold 5GHz 1`

`coverage-hole-recovery client-threshold 2.4GHz 1`

“**interval**” is the interval in which coverage-hole detection takes place; every 30 seconds by default. This interval may need to be lowered in environments where coverage is king (low cell-count, large cell-size), such as warehouses. “**coverage-interval**” is the interval in which the coverage-hole detection takes place when mitigation (recovery) is in process. In other words, when a coverage-hole has been detected and recovery is taking place, detection becomes more aggressive in determining whether the coverage-hole still exists or not.

“**snr-threshold**” is the minimum signal-to-noise ratio heard from wireless clients before recovery takes place. This number should never be set below 20dB and when clients are detected with an SNR that falls below this, recovery will take place.

Finally, the “**client-threshold**” is the number of clients detected that fall below the snr-threshold before recovery is initiated. This setting may very well be modified, as it may not be desirable to adjust power every time a single client falls below the threshold. When the Smart-RF policy is set to a “low” sensitivity, this client-threshold defaults to 5 clients, rather than 1.

Coverage-hole-recovery typically will not be utilized in high-density environments where cell-sizes are low and cell-count is high. There typically will be no need for coverage-hole recovery in these cases as there are so many access points on which clients can be distributed.

3. Environment Types and Examples

Of course many different types of environments exist with varying types of clients. Below are some typical examples:

- Warehouse / Distribution Centers (DC)
 - Grocery distribution centers
 - Shipping Ground and Air hubs (UPS, DHL, FedEx)
 - Scanners / VoWifi
- Office space (cubicle farms)
 - Conference rooms
 - Laptops

- Mobile Devices
- Retail Space
 - Small: 1-3 AP's typically
 - Drug store / pharmacies
 - Strip mall clothing stores
 - Large: 20+ AP's typically
 - Home improvement stores (Lowe's, Home Depot)
 - Electronics Stores (Best Buy, Fry's)
 - Scanners
 - Point-of-sales / printers
 - Consumer demo inventory (X-Box, PlayStation, wireless audio, etc.)
- High Density
 - Higher Ed Lecture Halls
 - Convention Centers
 - Laptops
 - Mobile Devices
 - Tablets
 - Smart Phones
- Medical
 - VoWifi
 - Laptops

3.1 Warehouse / DC's

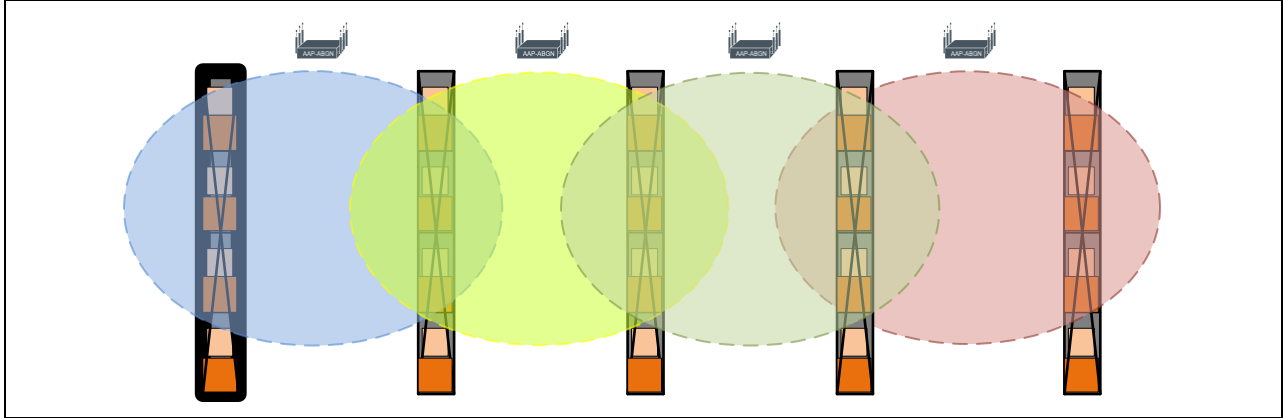
These environments are typically designed around coverage rather than capacity, as the client devices themselves have low-volume applications (telnet / ftp based, typically), and are dispersed over large areas. Additionally, while there will be dispersion of clients throughout the environment, they generally will be collected in specific areas relative to process, such as a specific shipping area as opposed to a specific receiving area.

By nature and geography, large environments like this do not tend to have a lot of outside interference. Client count may be relatively high per AP (due to lower cell count), yet some clients may be fairly dispersed, thus it may be necessary to allow a few or even a single client to influence adjustments related to power ("**coverage-hole-recovery client-threshold**").

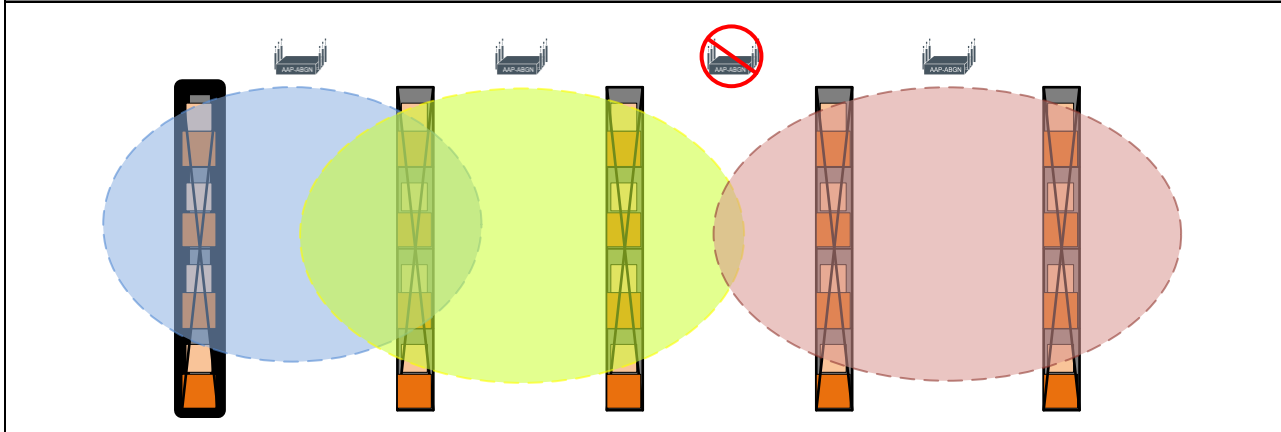
One specific setting to consider modifying is "**neighbor-recovery power-threshold**". The default setting at a "medium" sensitivity is -70dBm and this goes into the calculation of the power setting for the radio. Recall from the "**neighbor-recovery**" section that we determine the attenuation of each neighbor to a Smart-rf client, take the average attenuation and sum it with this "**neighbor-recovery power-threshold**" to determine the power setting.

Consider a warehouse with tall (25-foot) racks for inventory. One example is your typical home-improvement retailer, where the racks are tall and usually full with inventory. Since the racks rise so high and the inventory interferes with hearing our neighbors, adjusting our "**neighbor-recovery power-threshold**" to a "hotter" setting influences a higher power setting. For example, if we set "**neighbor-recovery power-threshold**" to -65 and determine (as in our previous example) that the attenuation to our neighbors is 80, then we will arrive at a power setting of: $80 + (-65) = 15$, up from "10" it would have been if we had our "**neighbor-recovery power-threshold**" set to -70.

Example: Neighbor-recovery Power-threshold



Example: Neighbor-recovery Power-threshold



3.2 Office / Cubicle Spaces

Of all the different “cube-farm” environments I have ever seen, there always seems to be two common floorplans. The first is a fairly open environment with many cubicles and open aisles leading through them, in a relatively large open space. The second is very similar, but with big obstacles in the middle of the floor space; the elevator shaft and stairwells; of the two, the latter is probably the most common.

Needless to say, these are fairly simple environments to design for and from a Smart-RF perspective, you will typically just set a sensitivity setting (usually the default of “medium”). The primary factor that may come into play here is client type(s), which is going to influence the design of cell density, which in turn will influence Smart-RF settings. However in most cases, not much needs to be modified from the default settings.

3.3 Retail Space

Retail is a many-headed beast; some retailers are large and have very large stores while other retailers are large – and have many small stores. More often than not, retail space is going to suffer from interference either induced by neighboring businesses or from other rf-sources (not 802.11).

In small environments, “**neighbor-recovery**” isn’t really a factor, as it takes a minimum of four access points to perform effective neighbor recovery. Thus, this can be disabled completely. Obviously for larger retail locations with a higher cell count, “**neighbor-recovery**” is necessary.

“**interference-recovery**” is the metric that may require more attention for these environments. Recall that the “**client-threshold**” metric is set to 50 by default. However it is rare that a retail environment will have 50 clients, let alone on a single AP so this setting might need adjusting to better fit what is needed for the site. Recovery may be desired unless 10 clients are connected at once, making the threshold more realistic for the application. In an environment such as an electronics retail store, there will be many different types of

interference; non-802.11 from items that may use some sort of proprietary communication method (like wireless audio) to co-channel interference based on a variety of demo devices (game consoles, computing devices, smart phones, etc.). So design (cell pattern), “**client-threshold**” and “**channel-switch-delta**” may all be manipulated to optimize the environment. For most retail shops, it may simply be a matter of compensating for the surrounding interference from neighboring businesses, which would be accomplished by default settings in most cases. The more demanding environments of course will require more attention.

3.4 High Density Environments

HD environments are typically comprised of high AP-count, and low cell size to accommodate capacity and through put. Naturally this scenario lends itself to higher chances of co-channel interference. “**neighbor-recovery**” is going to determine the optimal power settings in these environments, lowering power to the best setting based on neighbor reports.

“**coverage-hole-recovery interval**” may be raised, depending on the density of the environment cells, but default settings should suffice in most cases. One setting that very well may need to be modified is “**coverage-hole-recovery client-threshold**”; you do not want this number being set too low, causing Smart-RF to react to every little dip in client RSSI / SNR. In settings such as higher education, the environment is typically designed with minimum through-put and average client / AP metrics in mind. From this, one might determine a percentage of the average client count to set the “**client-threshold**” setting to; i.e. with an average of 50 clients per AP, at least 10% (5 client devices) would have to suffer before the AP made adjustments to power.

3.5 Medical

Coverage holes are common in health clinics and hospitals. This is due to equipment such as x-ray machines, MRI's, etc. that are typically located in shielded rooms. These rooms cause voids in coverage. Also, many clinics do not have high personnel count, so the voids may affect only 1 or 2 clients, but that may be enough to impact normal operations.

Start with the default settings for Medium sensitivity and consider (if needed) changing “**client-threshold**” count (lowering) and “**snr-threshold**”. “**client-threshold**” may need to be set to 1 or 2 so that 1 or 2 users experiencing problems can influence the coverage hole recovery process. Likewise, setting a slightly higher “**snr-threshold**” will cause Smart-rf to work harder at keeping those clients in the best signal possible.