



Station Load Balancing

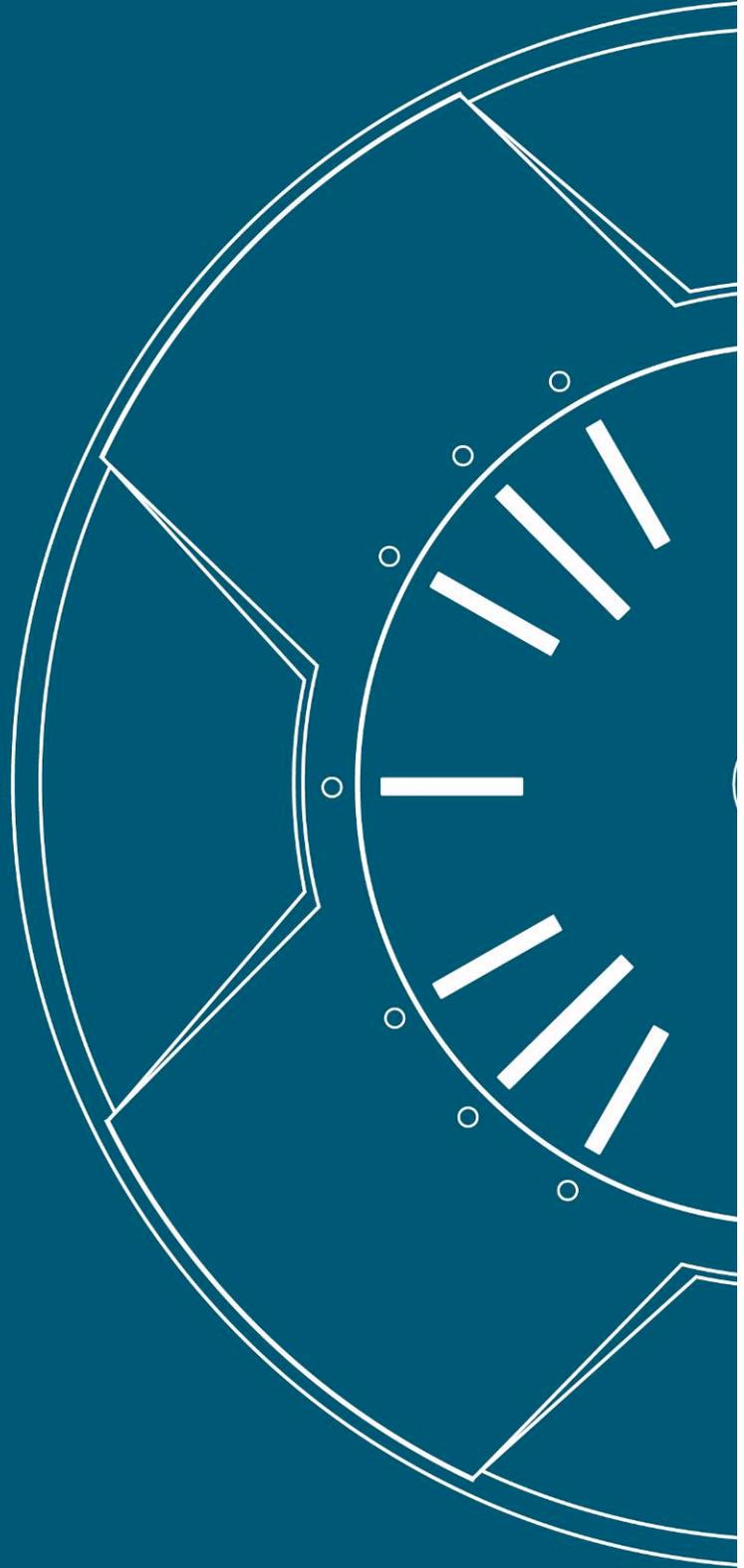


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Background

In Wi-Fi networks, the wireless station decides to which Access Point (AP) it connects. Typically the station will connect to the AP (i.e. radio) that has the strongest signal strength. In a normal network environment, selecting the strongest signal strength will give the station the most possible throughput. However in highly congested environments, the propensity for stations to use signal strength as the main selection criteria may cause network problems.

Wireless is a shared medium. Thus the more users there are on one radio, the less bandwidth there is for each individual user. Having too many stations connect to a single radio can cause network congestion and will produce less than optimum network performance.

As an example, consider a college classroom where a large number of students are using wireless laptops. The APs are mostly likely in the hallway outside of the classroom. Based on the distance from APs and the direction of the antennas, one or two of the radios will naturally have stronger signal strength than the other radios as seen by the students' laptops. As such, most of the laptops will associate to those one or two radios.

In this scenario, all of the students are sharing the bandwidth of one or two radios while a large number of radios will sit underutilized. A better solution would be for the laptops to associate to a larger number of radios and distribute the data traffic across multiple radios rather than just one or two.

Description

The Xirrus Wi-Fi Array supports an automatic load balancing feature designed to distribute Wi-Fi stations across multiple radios rather than just the closest radios with the strongest signal strength. In Wi-Fi networks, the station decides to which radio it will associate. The Array cannot actually force load balancing, however the Array can “encourage” stations to associate in a more uniform fashion across all of the radios of the Array.

The goal of load balancing is to distribute the stations' data traffic to more effectively utilize all of the bandwidth offered by the multiple radios of the Array. The Array does this by coaxing stations to associate to radios with weaker signal strength. There will be a slight degradation in the station connection speed because the station is connected at weaker signal strength. However, this slight degradation is offset by the increase in bandwidth derived by using more radios and having more overall bandwidth available for data transportation.

Figure 1 below shows the station association with no Load Balancing. Figure 2 shows station association with Load Balancing.

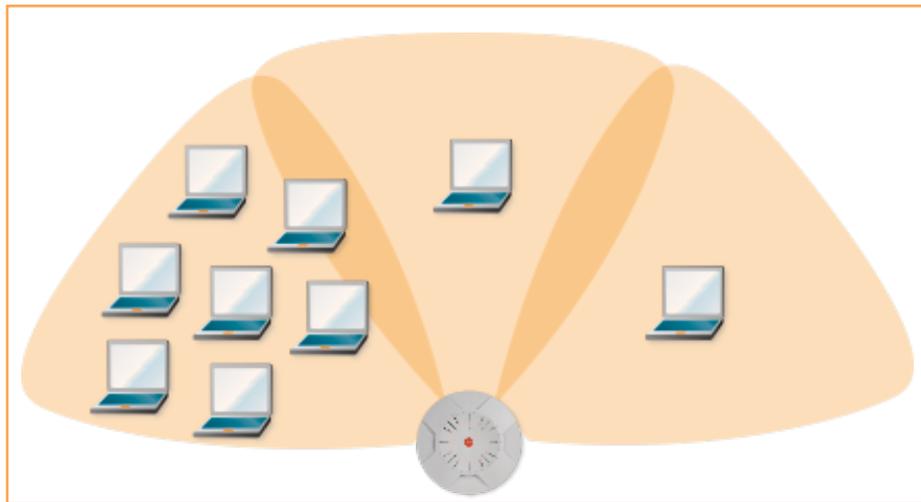


Figure 1: Without Load Balancing

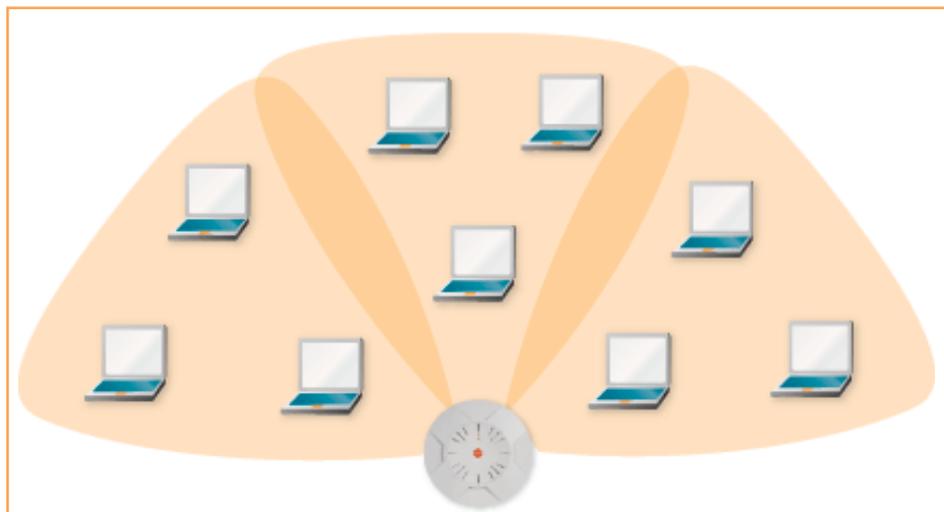


Figure 2: With Load Balancing

The figures above show the logical connections of the laptops. The laptops of course would physically be in the same place they are with load balancing turned on or off.

Benefits

Automatic station load balancing provides several key benefits:

- Improved network performance available to Wi-Fi stations. Since each radio has a defined maximum amount of bandwidth, reducing the number of users on more heavily loaded radios will ensure more average bandwidth available per station.
- Better use of Array radio resources by ensuring more radios are servicing stations and not idle.
- More efficient use of Wi-Fi spectrum by reduction in packet retries and packet errors on heavily loaded radios.
- Enables the Array to influence station connection decisions. Making these decisions centrally as opposed to distributed per station provides greater control over the allocation of resources.

Theory of Operation

A station's wireless adapter sends probe request packets out at regular intervals on all channels to scan for APs and networks in range. When an AP receives a probe request, it sends out a probe response to the station. This probe response consists of information about the AP such as the SSID, required encryption, and other information needed to join that particular wireless network. Figure 3 illustrates stations sending out probe requests to find APs. In response to the probe requests, each radio on a Xirrus Array sends out a probe response.

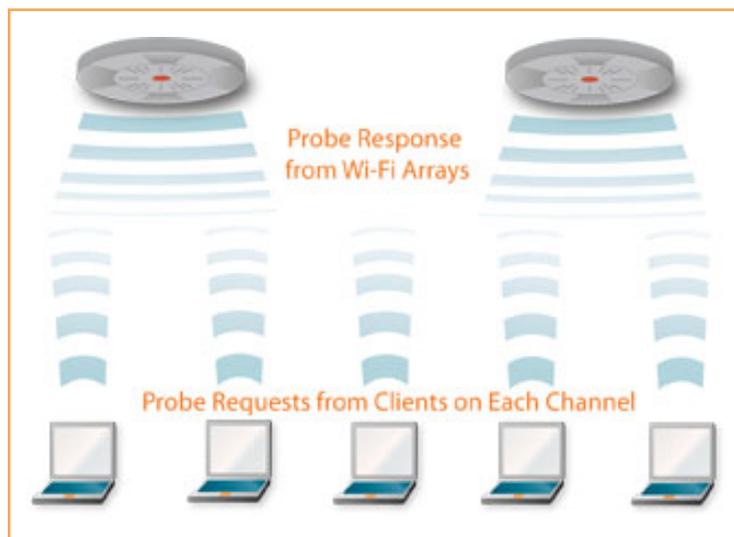


Figure 3: Probe Response from Stations

Upon receiving probe responses from different Access Points, the station will create a table of the available APs and include information about each AP. Based on the information contained in the probe response, the station will decide to which AP it should connect.

Under a typical scenario, all of the stations can connect to a single radio. To alleviate the potential of overloading a single radio, the Xirrus Array alters the typical probe request/probe response process and encourages stations to connect to the network on different radios.

Xirrus Load Balancing Operation

1. The Array listens for probe request for all of the stations.
2. The Array decides to which radio the station should NOT talk. The Array decides if a particular radio is overloaded and should not have any more stations associated to it (i.e. it is over utilized). This decision process is based on a load balancing algorithm that takes 3 key factors into affect:
 - a. The fewer the stations on a radio the better
 - b. The stronger the signal strength the better
 - c. 5GHz channels preferred over 2.4GHz channels
3. Based on these input variables, the Array decides with which radios the station should or should not associate. The goal is to determine to which radio(s) the station can connect and have the best overall network experience.
4. Based on the algorithm mentioned above, the Array will send out probe responses from all of the radios deemed acceptable for the station to associate with (i.e. any radio that is underutilized). Any radio that is already over utilized will not send out a probe response.

If the radio does not send a probe response, the station should not know about the radio and therefore should not send an authentication or association request.

5. If after several seconds the station has still not associated, the Array assumes the station is “sticky” and associate to one of the radios not sending out probe responses (i.e. one of the over-utilized radios). At this point, all of the radios will start sending out probe responses to ensure the station will associate.

The Array cannot force a station to change radios. However, the load balancing technique has the effect of coaxing stations to associate to the desired radio. This technique is most effective the first time a station attempts to associate to the Xirrus Array. Some stations may be “sticky” in terms of moving to other Array radios so if the station has already connected to an Array once, it may fixate on a particular radio.

Interaction with Other Features

The Array has the ability to set a limit on the number of stations that can associate per Integrated Access Point. To set Max Station Association limit, see the Station management section under the IAP/Global Settings menu.

| Station Management | |
|---|---|
| Station Re-Authentication Period (Seconds): | 5 |
| Station Timeout Period (Seconds): | 1000 |
| Max Station Association per IAP (1-64): | 64 |
| Max Phones per IAP (0-16): | 16 |
| Block Intra-Station Traffic: | <input type="radio"/> Yes <input checked="" type="radio"/> No |
| Allow Over Air Management: | <input type="radio"/> Yes <input checked="" type="radio"/> No |

Figure 4: Max Station Association Setting

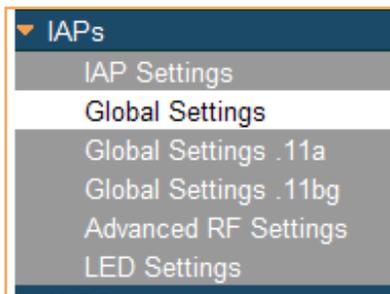
Station association limits set a hard limit on each IAP and sets a maximum on the total number of stations that can associate to each radio. Using a hard limit will guarantee a specific throughput for the stations that connect. However, by using a limit there is a chance that some stations cannot connect at all (i.e any station that tries to associate after the limit has been reached). The Association limit should only be used if there is a reason to limit the total number of users (e.g. high bandwidth requirement for the stations). In general, it is better to use load balancing to maximize user throughput without putting a hard limit on the number of users that can connect.

Load Balancing works transparently with all other Array features.

Configuration

Load Balancing Configuration Using the Web Management Interface (WMI)

1. Go to the IAP / Global Settings menu



2. In the Advance Traffic Optimization section select Load Balancing “On”

| Advanced Traffic Optimization | |
|-------------------------------|---|
| Broadcast Rates: | <input type="radio"/> Optimized <input checked="" type="radio"/> Standard |
| Load Balancing: | <input type="radio"/> Off <input checked="" type="radio"/> On |
| Fast Roaming Mode: | <input type="radio"/> Off <input type="radio"/> Broadcast |
| Fast Roaming Layer: | <input type="radio"/> 2 and 3 <input checked="" type="radio"/> 2 only |
| Share Roaming Info With: | <input type="radio"/> All <input checked="" type="radio"/> In Range |

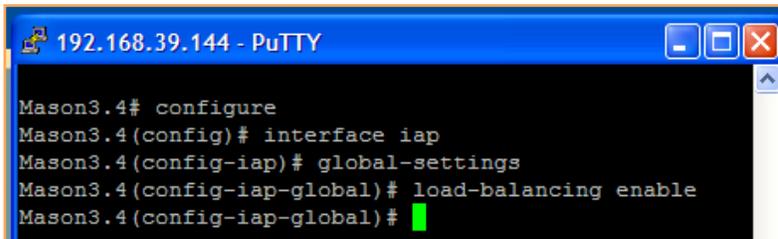
There are no other parameters that need to be set for load balancing.

Notes:

- The default setting for this feature is OFF.
- Once enabled, load balancing applies to all of the radios (i.e. IAPs).

Load Balancing Configuration Using the Command Line Interface (CLI)

1. Access the CLI via SSH or Telnet.
2. Enter Configuration mode by typing “configure” at the command prompt.
3. Go to the IAP Configuration menu by typing “interface iap”.
4. Go to the Global IAP settings by typing “global-settings”.
5. Enable load balancing by typing “load-balancing enable”.



```
192.168.39.144 - PuTTY
Mason3.4# configure
Mason3.4(config)# interface iap
Mason3.4(config-iap)# global-settings
Mason3.4(config-iap-global)# load-balancing enable
Mason3.4(config-iap-global)#
```

There are no other parameters that need to be set for this options.

Notes:

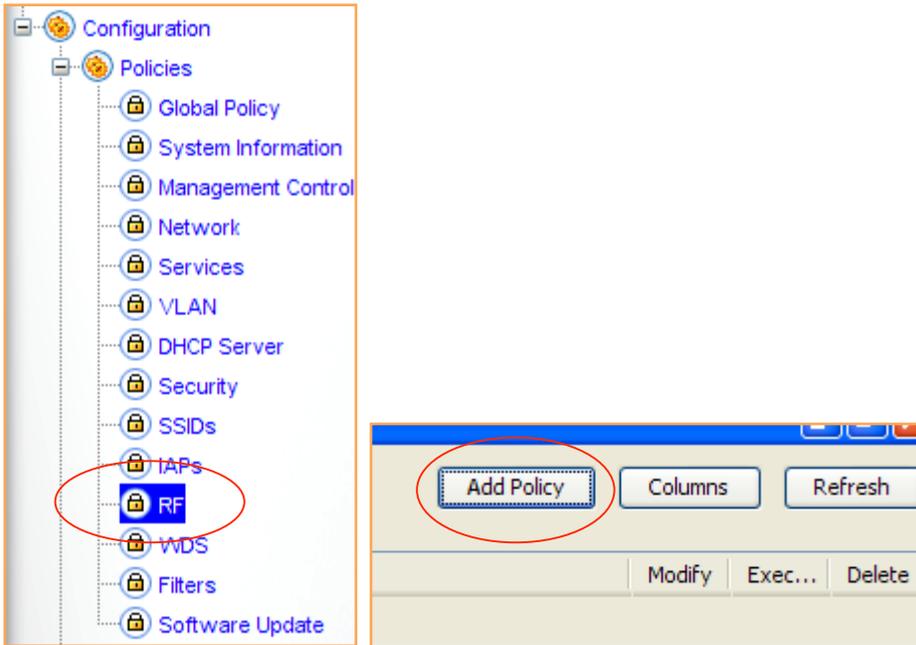
- The default setting for this feature is OFF.
- Once enabled, load balancing applies to all of the radios (i.e. IAPs).

Load Balancing Configuration Using the Xirrus Management System (XMS)

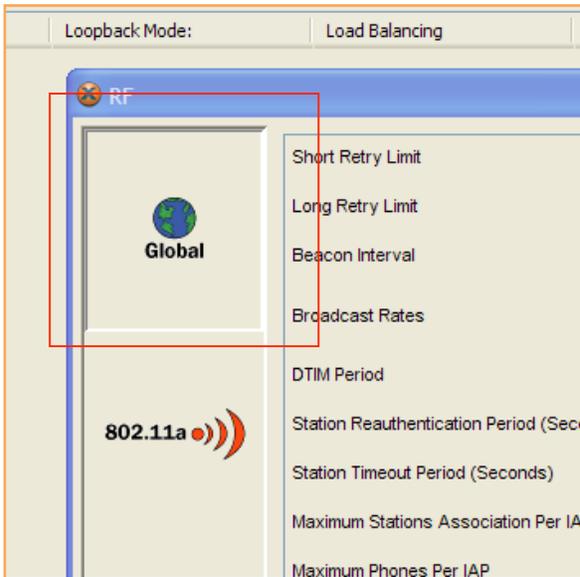
1. Log into the XMS server and select Policies from the Configuration menu.



2. Select the RF menu from the Policy drop-down and select Add Policy.

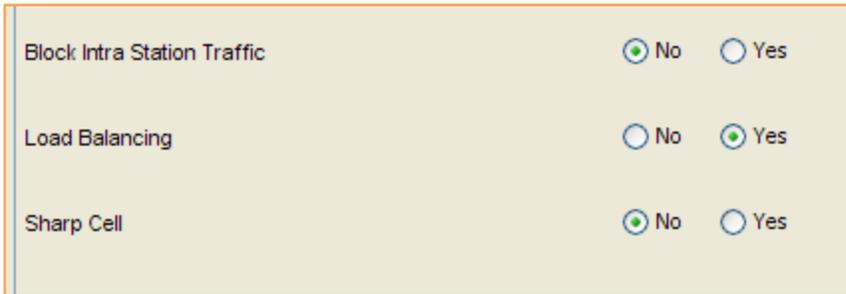


3. In the RF policy window select Global.



4. Give the policy a name and modify any other parameters as needed.

5. Scroll down to the Load Balancing function and select Yes.



| | | |
|-----------------------------|-------------------------------------|--------------------------------------|
| Block Intra Station Traffic | <input checked="" type="radio"/> No | <input type="radio"/> Yes |
| Load Balancing | <input type="radio"/> No | <input checked="" type="radio"/> Yes |
| Sharp Cell | <input checked="" type="radio"/> No | <input type="radio"/> Yes |

6. Click Apply.
7. Execute the policy to apply it to the appropriate Arrays.

Notes:

- The default setting for this feature is OFF.
- Once enabled, load balancing applies to all of the radios (i.e. IAPs).

Results

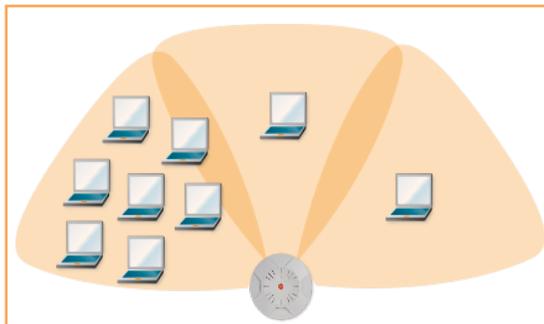
The tables below demonstrate actual station load balancing results using an Array running ArrayOS version 3.4.

For these tests:

- 20 stations were used
- All of the stations were placed approximately 35' from the Array
- Three radios were turned on the Array
- The test was run five times to give a good sampling of the results

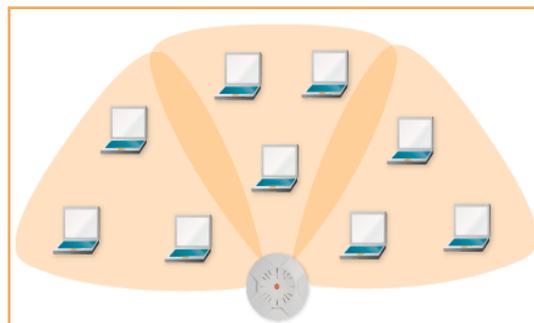
Associations per radio with Load Balancing turned off:

| Run | a1 | abg2 | a2 |
|-------------|-----|------|-----|
| 1 | 10 | 2 | 8 |
| 2 | 11 | 1 | 8 |
| 3 | 9 | 3 | 8 |
| 4 | 7 | 1 | 12 |
| 5 | 10 | 1 | 9 |
| % per radio | 47% | 8% | 45% |



Associations per radio with Load Balancing turned on:

| Run | a1 | abg2 | a2 |
|-------------|-----|------|-----|
| 1 | 8 | 5 | 7 |
| 2 | 8 | 4 | 8 |
| 3 | 8 | 6 | 6 |
| 4 | 7 | 5 | 8 |
| 5 | 7 | 5 | 8 |
| % per radio | 38% | 25% | 37% |



Tips and Recommendations

1. Enabling load balancing on the Wi-Fi Array is typically not necessary if the wireless stations are physically distributed uniformly around the Array. This will naturally result in relatively even distribution of users per Array radio.
2. Load balancing should be used if a single radio frequently has 15 or more stations associated to it and has a disproportionate number of stations compared to the other radios on the Array (generally a 2:1 ratio or greater).
3. Load balancing should be enabled if a disproportionate number of users are expected to be on one side of the Array. For example:
 - Outside a classroom where a large numbers of students will be using laptops.
 - Next to a conference room where employees typically use Wi-Fi.
 - In a convention center if there is a certain area will lend itself to a higher number of laptop users (e.g. Press area).
4. In general, leave the Max Station Associations per IAP setting to maximum (i.e. 64) and use load balancing to get a more evenly distributed mix of stations.
5. Some station devices may roam more frequently with load balancing. Setting the roaming threshold to a larger value may reduce this behavior if it is problematic.