

## Smart Client Load Balancing

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## Smart Client Load Balancing

Smart Client Load Balancing is an effective way to optimize per client performance in dense AP environments.

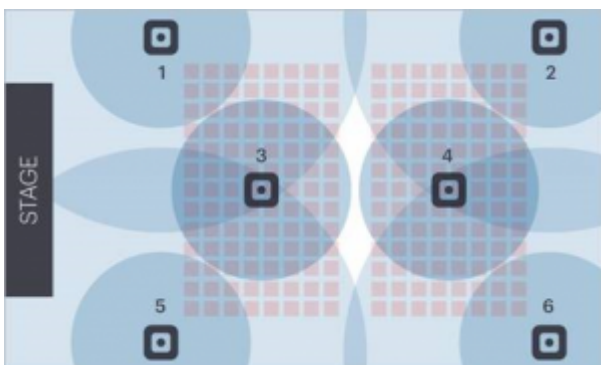
**Note:** Smart Client Load Balancing is enabled on a per-SSID basis, under CONFIGURE > SSID > RF Optimization. Its parameters, however, are configured on a per-AP basis, under CONFIGURE > Radio Settings.

In the 802.11 world, the WiFi client decides which access point and band to connect and when to make the transition to a better one. There are no set standards for this decision-making process so each WiFi chip vendor and client manufacturer may use different algorithms. Most use the simplest approach of connecting to the AP/Band with the strongest signal and looking for a better AP only when the current signal strength falls below a set threshold. This method works in a traditional AP deployment model where APs are not close together but is sub-optimal in dense AP environments.

In high-density user environments (Auditoriums, Lecture Halls, Conference Centers, Company meetings etc.) where APs are densely deployed to provide bandwidth to all clients, a client sees multiple APs with very good signal strength. Most clients will connect to the AP/band with the best signal strength resulting in a few heavily loaded APs.

An AP's radio resources are shared among the clients associated with it. An AP with a large number of users will get a small percentage of the radio's time. The more users, the less amount of radio time each client gets. Radio time can directly relate to client throughput and user experience. Users would have a better experience if they were connected to an AP with fewer associated clients even though they were connected at lower signal strength (lower data rate.) In a dense AP deployment, the signal strength and data rate reduction would be nominal.

The example below shows a conference hall with six APs. In the figure, the dark shaded circles represent the excellent coverage area of the AP. The larger, lighter shaded circles represent the area covered by very good signal from the AP. When clients are left to their own devices, they will connect to the AP with the best signal strength. In this scenario APs 3 and 4 (the two APs in the middle) will have 80 associated clients each. The AP in the room's perimeter will have approximately 12 clients each.



In the classic scenario where clients connect to the AP with the best signal strength (dark blue circle), APs 3 and 4 would both have approximately 80 clients associated, while the APs at the edges have approximately 12 each.

To evenly distribute the client load we can modify the client's AP selection criteria from selecting the AP with the best signal strength to selecting an AP based on

1. Good signal strength (not the best)
2. The current number client load AP

This will distribute overall client load more evenly with approximately 35 clients per AP.

Even though some clients (~25 each on AP3 and AP4) will be connecting at a lower data rate when they move off of APs 3 and 4, the users will have a better experience because they are getting 1/35 of the radio's time instead of 1/80 (as will every client on APs 3 and 4). The clients on APs 1, 2, 5, and 6 will be impacted negatively, but the throughput for the room overall will greatly increase because of the balanced resources.

AP	Excellent Signal (Dark Blue Area)	Balanced Clients
1	12	35
2	12	34
3	80	35
4	80	35
5	12	34
6	12	35

While we cannot change how a client selects an AP, we can try to influence them and try to persuade them to select a different AP so that all of the APs in a neighborhood have a balanced number of clients.

Note: The 802.11k standard is designed to will help balance the client load on APs, unfortunately at this time only a few of the clients support for 802.11k.

## How Smart Client Load Balancing Works

When Smart Client Load Balancing is enabled, and a client attempts to connect to an AP for the first time (Association) or to roam to the AP (Reassociation), the associating AP determines if it has sufficient capacity to support an additional client. It does this by comparing the number of clients it currently has associated to the Minimum Client Threshold parameter.

Suppose the AP configuration has

- Min Client threshold-30

- Min Client Count Difference-5

If the client wants to associate with an AP whose current client count is less than 30, the client will be allowed to associate. If the AP's client count is 30 or more, the Smart Client Load Balancing algorithm kicks in. It starts out by evaluating its neighboring APs to see if they are able to take on another client. To do this the AP uses its AP Neighbor Table.

## AP Neighbor Tables

An AP Neighbor Table is built when the AP scans the channels for radio management or WIPS purposes. If an AP does not have a dedicated third radio for scanning, background scanning must be enabled. While the AP is scanning the channels, it listens for the beacons of nearby APs and reads the proprietary Information Element (IE), which contains the neighboring AP's client count. The AP compiles a list of the neighboring APs' BSSID and the client count as shown in the following table.

AP BSSID	AP Client Count
Arista_BB:BB:BB	26
Arista_CC:CC:CC	28
Arista_DD:DD:DD	32
Arista_EE:EE:EE	30
Arista_FF:FF:FF	36

## Client Count Threshold

When a client wants to associate to an SSID on the 5GHz radio of AP Arista\_AA: AA: AA it sends an association request. When the AP receives this request, it determines how many clients are already associated on that radio. Let's suppose that AP Arista\_AA:AA:AA has 36 clients associated to that radio. Because the AP's client count (36) is greater than the Client Count Threshold (30), it will run the smart client load balancing algorithm to determine what to do.

## Can Neighbor AP Accept A Client

To determine if a neighbor AP can support an additional client, the associating AP evaluates each AP in its AP neighbor table and assigns an accept vote if either of the following two criteria are met:

- Is AP's neighbor client count less than the minimum client count threshold?
- If AP's neighbor's client count is greater than the minimum client count threshold, and is the difference between the client count greater than the minimum client count difference threshold?

If the answer to either of these questions is yes, the AP is deemed acceptable.

Applying these criteria to the AP neighbor table above we see that two APs (Arista\_BB: BB: BB and

Arista\_CC: CC: CC) meet the first criteria because each has a client count less than 30. AP Arista\_EE:EE:EE meets the second criteria because even though its client count is above the minimum client count threshold, the difference between its client counts (30) and Arista\_AA: AA: AA client count (36) is greater than the minimum client count difference threshold (5).

$$36 - 30 = 6 > 5$$

AP BSSID	AP Client Count	Meets Condition 1	Client Count Difference	Meets Condition 2	Accept / Reject
Arista_BB:BB:BB	26	Yes	-	-	Accept
Arista_CC:CC:CC	28	Yes	-	-	Accept
Arista_DD:DD:DD	32	No	4	No	Reject
Arista_EE:EE:EE	30	No	6	Yes	Accept
Arista_FF:FF:FF	36	No	0	No	Reject

Once the associating AP determines which neighbor APs are acceptable alternatives, it check to see if at least half of the neighboring APs in its list are acceptable. In this case three out of five are acceptable so the associating AP will reject the client association in an attempt to encourage it to associate to a better AP.

It responds to the client's association request with an 802.11 status code 17 – Association denied because AP is unable to handle additional associated stations. This informs the client that this is not a suitable AP at this time. If the client has intelligence, it will select another AP.

If less than half of the neighboring APs were acceptable, the client would be allowed to associate.

Not all clients have the intelligence to select a different AP when it receives a status code 17. Some clients will continue to attempt to associate to the same AP because it has the strongest signal strength. To account for these desperate clients a counter is started for clients that are rejected with a status code 17. If a client tries to associate again and again within the Desperate Client Interval, it will be allowed after its attempt counter equals to the Max Association Retries.

Once a client is declared a Desperate Client it maintains that status for 24 hours. During this 24-hour period the client will be allowed to associate to the AP bypassing the Smart Client Load Balancing algorithm.

## Fine-Tuning the Smart Client Load Balancing Parameters

Smart Client Load Balancing is a pre-association client steering. It acts when a client attempts to associate with an access point (association or re-association); it does not kick existing clients off an access point. An access point that is loaded rejects a client's association request when there exists a neighbor access point

that is not loaded. So the parameters specific to Smart Load Balancing are the load (i.e. number of clients, in this context) on an access point and the minimum client count difference between this access point and its neighbor.

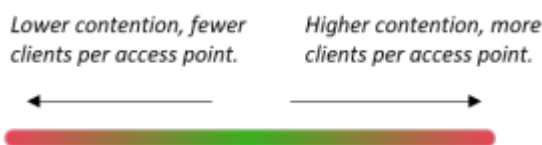
## Smart Client Load Balancing Parameters

These parameters are under **Configure > Radio Settings > Advanced Radio Settings > Smart Load Balancing**.

### Minimum Client Load

An access point runs the load-balancing algorithm only if the number of clients currently associated with it exceeds this threshold. So if the Minimum Client Load is 30, an access point honors clients' association requests until it has 30 associated clients, and runs the smart load-balancing algorithm for subsequent association requests.

If your network is experiencing high contention, it could be because access points are loaded. Consider reducing this threshold to ease the load on individual access points by distributing clients more evenly among access points. Reducing this threshold will result in a lower number of clients per access point.

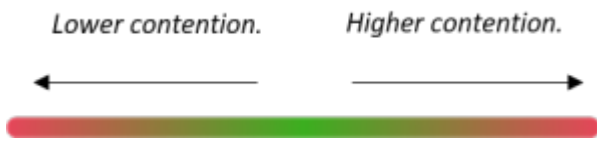


### Minimum Client Load Difference

Consider the difference between the number of clients associated with an access point and the number of clients on its neighbor. When this difference drops below the Minimum Client Load Difference value, then the neighbor access point is considered unable to take on an additional client. The idea is that for an access point to direct a new client to a neighbor, the neighbor access point has to be significantly less loaded. For example, a value of 5 for this parameter means that an access point with 30 clients will not direct new clients to a neighbor access point with 26 clients (see [Can a Neighbor AP Accept A Client?](#) for details).

**Note:** The Minimum Client Load Difference cannot have a value lower than 2. This is because directing new clients to a neighbor access point that has almost as many clients simply *shifts* the load; it doesn't balance the load evenly.

If the Minimum Client Load Difference is kept too large, fewer new clients will be directed to neighbor access points, possibly causing high contention. Consider reducing the value of this parameter to mitigate contention.



## Client Steering Common Parameters

These parameters are under **Configure > Device Settings**.

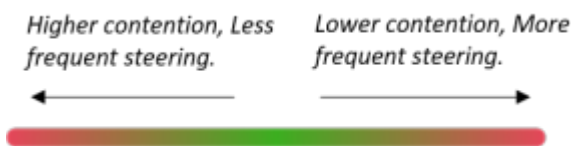
**Note:** The Client Steering Common Parameters are common to all types of steering. Changing any of these parameters affects all types of steering. If there is a specific steering type that you are looking to optimize, we recommend that you change parameters specific to that steering type before you change the common parameters.

### Steering Attempts Threshold

APs must not steer clients too frequently. Clients that are moving or happen to be in the coverage overlap region of two APs could “ping-pong” between the two APs because of constant back and forth steering. This is wasteful signaling and could cause poor user experience.

The Steering Attempts Threshold parameter determines the maximum number of attempts to steer a client allowed in a 10-minute window. The default value is 2. So, if an Arista AP has attempted to steer a client twice in 10 minutes, the client enters a configurable Steering Blackout Period (default 15 minutes), *regardless* of whether the steering was successful.

If your network is experiencing high contention, check if the Steering Attempts Threshold value is too low. Setting this value too low will cause a client to enter the Steering Blackout Period with fewer attempts, which could prevent loaded access points from steering clients to lesser loaded neighbors. Too large a value for the Steering Attempts Threshold can cause some clients implementations to “blacklist” an SSID.

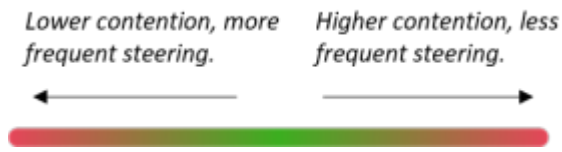


### Steering Blackout Period

The Steering Attempts Threshold parameter determines the maximum number of attempts to steer a client allowed in a 10-minute window; a client enters the Steering Blackout Period once the AP has exhausted that number. The AP then does not attempt to steer a client until the Steering Blackout Period has elapsed.

If your network is experiencing high contention, consider decreasing the Steering Blackout Period. A higher Steering Blackout Period means that a longer time must pass before an AP can steer a client, which

could prevent loaded access points from steering clients to lesser loaded neighbors. Too low a value for the Steering Blackout Period could cause frequent and unnecessary steering.



## Recommendations

- Enable Guest and Data SSIDs to balance performance.
- Do not enable SSIDs that support real-time applications.
- If you have legacy clients that do not use response code 17 in the AP selection process, keep the Max Association Retry count low.

## Smart Client Load Balancing Notes

- Acts when client attempts to join an AP (association or reassociation), does not kick clients off of an AP.
- Balance decisions based on AP client count (associating AP and neighboring APs).
- Not enabled by default.
- Enabled per SSID, acts per channel.
- Parameters are set per band (device template).
- Requires background scanning.
- AP builds Neighbor AP list based on AP beacons heard during scans.
- Recommended for Data and Guest SSIDs.
- Not Recommended for SSIDs supporting real-time applications (video and voice).