Air Time Fairness (ATF)

Airtime Fairness ensures that every client has equal access to air time, regardless of client capability (Operating system, 802.11 mode, RSSI). The regulated wireless spectrum, where all wireless communication takes place, is shared amongst all clients on the wireless access point as well as neighboring APs on the same channel. The Meraki Auto RF feature suite (Auto Channel & Auto TX) minimize co-channel interference (CCI) which helps ensure neighboring APs are not unfairly utilizing airtime in the coverage area of any single AP. The Meraki Airtime Fairness (ATF) feature ensures that co-existing clients connected to a single AP have equal access to the airtime in the APs coverage area.

Airtime

The figure below shows that for any given packet size, the airtime consumed is dependent on the over-the-air PHY rate, which is itself dependent on RF link characteristics. As an example, the RF link characteristics are different based upon the distance of the client from the access point; A client that is closer to the access point typically operates at a higher data rate than a client farther from the access point. This is because the access point and client are deliberately designed to adapt their transmission rates in order to maintain an optimal quality of the RF link. This is normal behavior between the access point and clients since the client devices are not expected to remain at a constant or equal distance from the access point.

In brief, the RF environment is dynamic. Therefore, the airtime consumed by any single client will dynamically fluctuate over time:

It is easiest to describe that 802.11g clients will fall in the green area of the diagram and 802.11b clients will fall in the blue and orange areas. However, because of rate control, high-performance clients that support high bitrates like those in 802.11n and AC may fall into the blue or orange areas under some circumstances.

Airtime fairness vs Throughput Fairness

As a consequence, two devices each assigned a 10 Mbps rate limit and sending equally sized frames would have unequal air time when their RF link characteristics are different. This could mean that one device is consuming more airtime than it is entitled to, even though that device is not
Airtime Measurements

In order for ATF to operate, airtime (which includes both uplink and downlink transmissions of a client) is continuously measured. Airtime, as described earlier in this article, is the amount of time it takes for a device to send a payload of data. The access point can constrain the airtime for any data frame it sends to or receives from a client through the configuration of transmission opportunity (TXOP). However, the access point can only measure airtime for data frames that it "hears" from each client, as it cannot strictly limit the number of data frames any individual client sends.

Dynamic Airtime Allocation

It is important to note that if a client exceeds the airtime limit, packets will be delayed. However, only packets in the downlink direction are delayed. This is because delaying downlink packets (access point to client) frees up airtime. Dropping or delaying uplink packets (client to access point) does not do anything to free up airtime since the packet has already been transmitted over the air by the client. Once the packet has been on the air, that airtime cannot be reclaimed.

This can mean that a client that is transmitting a lot of uplink traffic can exhaust airtime. This is essentially a denial-of-service attack that is outside the scope of what Cisco Airtime Fairness addresses. More information on this type of attack can be found in our Air Marshal documentation.

EDCA + Airtime Fairness

Airtime Fairness does not replace Enhanced Distributed Channel Access (EDCA). Instead, ATF is applied in conjunction with EDCA. In the downlink direction, the queues that feed the EDCA output buffers are serviced in such a way as to permit airtime to be distributed or allocated differently per client.

The queues are based on the types of users, devices, etc., instead of allowing only traffic patterns to determine medium access time. In other words, the Airtime Fairness solution does not affect onto-the-air prioritization as EDCA is still used on every QoS enabled client. MAC timing is not modified.

EDCA Technology Brief

The 802.11e amendment introduced prioritization through Enhanced Distributed Channel Access (EDCA). EDCA is still obsessively polite but introduces a controlled unfairness in order to enable an advantage in onto-the-air access for some traffic types. Essentially, the mandatory minimum wait time for some traffic types is less than that for other traffic types. Also, the subsequent mandatory randomly selected wait time is less for some traffic types compared to other traffic types. That is, the set of random numbers is fewer for some traffic types.

At a high level, EDCA creates a set of access categories based on traffic type. Traffic classified as voice waits less time than traffic classified as video, which waits less time than traffic classified as best effort, which waits less time than traffic classified as background. Best-effort traffic in EDCA has similar, but not identical, access opportunity to legacy Distributed Channel Access (DCA).
The net effect is that some traffic types access the air sooner than other traffic types (lower wait time equals a higher priority). Each traffic type contends equally for airtime within its corresponding access category, but contention between traffic types and access categories is unequal.

However, this also means that the nature of the traffic itself determines access to the air. There is no way the 802.11 standard can be used alone to segment or partition airtime, and therefore, allow the network administrator to determine or define fairness. This is the issue the Meraki Airtime Fairness solution addresses.