What is BSS Load?

The QBSS Load Element originated in IEEE 802.11e for Quality of Service.

QBSS Load Element is simply shown as "BSS Load" in the standard today.

Beacons and Probe Responses contain the BSS Load Element to show the AP's primary channel utilization and station count. (1)

1. IEEE 802.11-2024 Table 9-62 (p. 779) and 9-69 (p. 807)

BSS Load Components

BSS Load Element uses the following format (2):

- <u>Element ID</u> - The designated tag number
- <u>Length</u> - The tag length in octets
- <u>Station Count</u> - Number of STAs associated to the AP
- <u>Channel Utilization</u> - % of time medium was busy, expressed from 0-255
- <u>Available Admission Capacity</u> - medium time available in 32 microsecond units

2. IEEE 802.11-2024 9.4.2.26 BSS Load element

In Wireshark, it looks like this:

```
∨ Tag: QBSS Load Element 802.11e CCA Version
    Tag Number: QBSS Load Element (11)
    Tag length: 5
    QBSS Version: 2
    Station Count: 4
    Channel Utilization: 36 (14%)
    Available Admission Capacity: 26838 (858816 us/s)
```

Other BSS Load Elements

Extended BSS Load- An optional VHT (802.11ac) flavor of BSS Load found after VHT capabilities, operation and Tx Power Envelope elements in beacons and probe responses.

Differences from BSS Load:

- Includes the MU-MIMO STA count, not all STAs.
- Includes spatial stream underutilization fields
- Includes Observable *Secondary* 20,40, and 80 MHz Utilization fields
- Does not include Available Admission Capacity

Most notably, we could see beyond primary channel utilization with this element.

Other BSS Load Elements

HE BSS Load - An optional HE (802.11ax) flavor of BSS Load found after the HE operation and MU ECDA report elements in beacons and probe responses.

Differences from BSS Load:

- Includes the HE STA count, not all STAs.
- Includes frequency underutilization, spatial stream underutilization fields
- Does not include Available Admission Capacity

I haven't see either of these elements in a beacon/probe response so unsure if these elements were ever widely used. :(

Channel Utilization Formula

The (primary) channel utilization field is scaled 0-255, where 255 is 100% utilization.

IEEE 802.11-2024 defines this formula as:

$$\frac{\text{Channel busy time (microseconds)}}{\text{Channel Utilization Beacon Intervals x beacon period x 1024}} \times 255$$

where beacon intervals are the consecutive intervals where the AP measures channel busy time and the default beacon period is 100 TUs. (102.4 ms)

Note: I see beacon interval and period usually used interchangeably, but there may be semantic differences

Wi-Fi Explorer Comparison

Here this network shows 10% utilization:

Network Name	Channel Utilization	Channel	Vendor	^	Signal
Home🔒	10% ▇▇▁▁	36	m Meter		-38 dBm ▇▇

In Advanced Details, you can see the live BSS load element readings.

ID ^	Length	Information Element	Details
11	5 bytes ⌄ ◇	BSS Load	*Stations: 2, Channel Utilization: 14%*
		Element ID:	11
		Length:	5 bytes
		Station Count:	2
		Channel Utilization:	14% (36)
		Available Admission Capacity:	0

If the channel utilization value is 36/255, then that percentage rounds to 14%.

These values change rapidly from moment to moment.

Wireshark I/O Graph

This graph shows the beacon channel utilization values over time. I filtered and the AP and SSID.

Graph Name	Display Filter	Y Axis	Color	Y Field	Style	Y Axis Factor
Channel Utilization	(((wlan.fc.type_subtype in {0x08}) && (wlan.addr_resolved == "AP-STA"))) ...	AVG(Y Field)	🟧	wlan.qbss.cu	Bar	1

Now we can see the values out of 255 to understand channel utilization over time.

Wireshark I/O Graphs: iPhone Test QBSS.pcapng
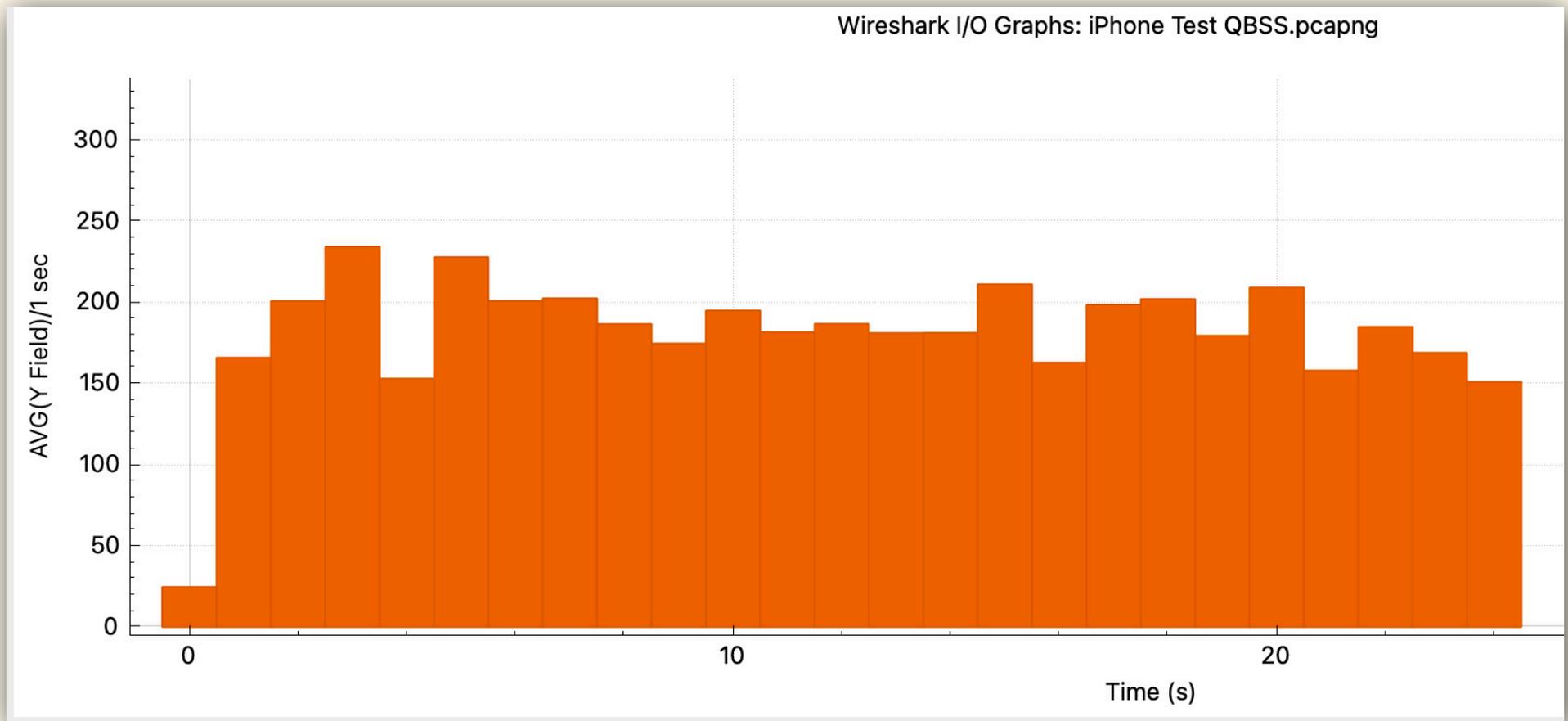
Wireshark I/O Graph

However, by default the interval is 1 second.

Mouse ● drags ○ zooms   Interval 1 sec ⬍
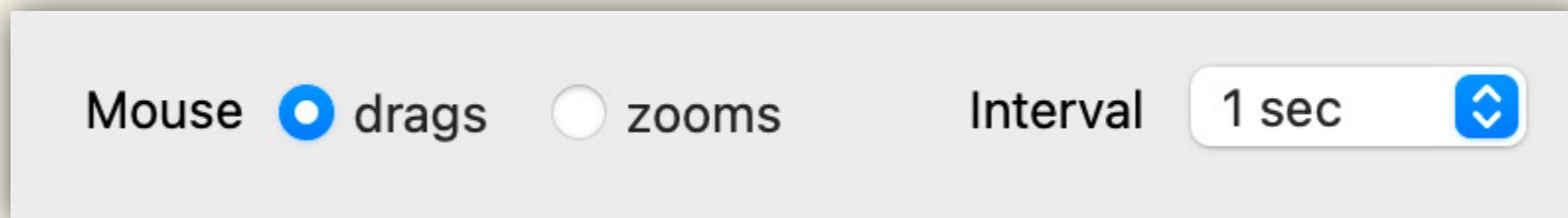
If we change this to 100us (as close as we can get to the beacon interval of 102.4us), this looks more interesting.

Wireshark I/O Graphs: iPhone Test QBSS.pcapng
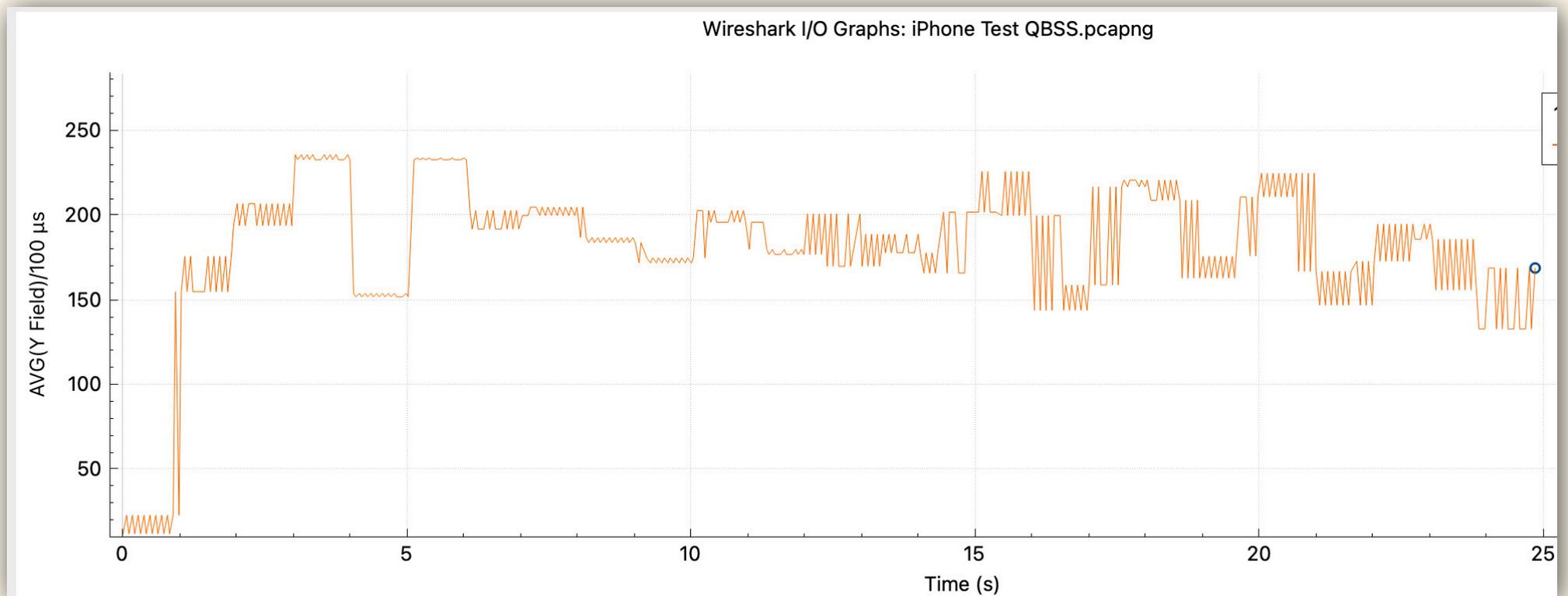
Note: I also changed this to Line instead of Bar so it's easier to see.

Conclusion

Survey tools use the BSS Load Element to show channel utilization per AP.

These measurements are only as accurate as the AP measuring them, unless other physical means are used to measure utilization.

For example, I've seen APs show zeros for available admissions capacity.

```
Tag: QBSS Load Element 802.11e CCA Version
   Tag Number: QBSS Load Element (11)
   Tag length: 5
   QBSS Version: 2
   Station Count: 2
   Channel Utilization: 23 (9%)
   Available Admission Capacity: 0 (0 us/s)
```
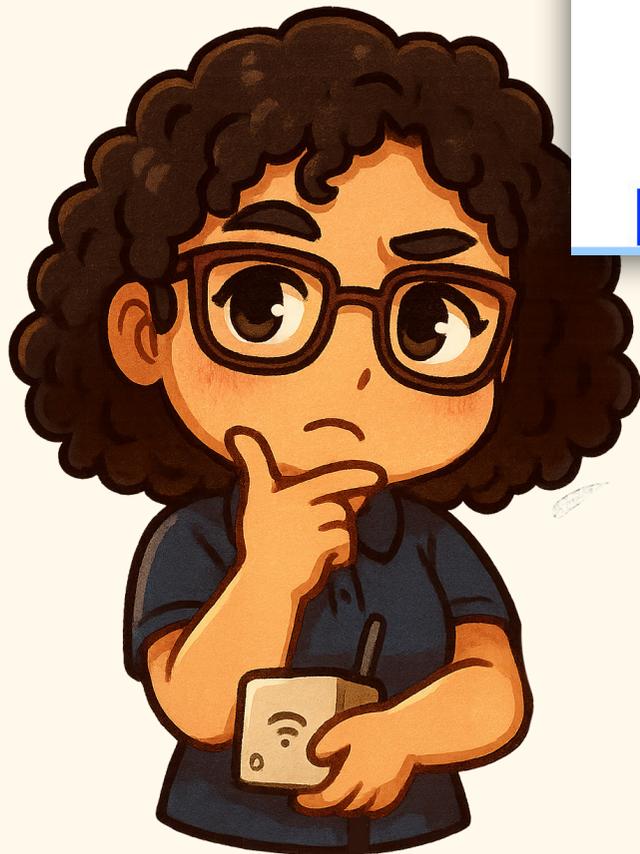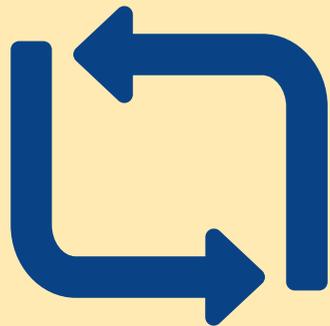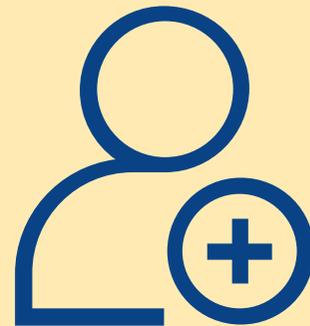
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