TRISPEC

Engineering the how.

WiFi 6: 802.11ax Primer For WISPS

What's New, What it Means for You & Your Operation

Axel Kussmann, M.Sc. P.Eng

Trispec Communications

Trispec, WISPS, Me

TRISPEC
Engineering the how.

- Serving the WISP market for over 20 years
- Point to point links, point to multipoint networks
- Fibre, IPTV, Cable/DOCSIS, Antennas… you name it!
- Me: B.A.Sc. In Electrical Engineering from the University of Waterloo, M.Sc in Radio Communications and High Frequency Engineering from Leeds University
- Last mile wireless startups, Motorola, Engineering consulting, Bell

What's New in 802.11ax Compared to 802.11ac

TRISPEC

Engineering the how.

What's New in 802.11ax Compared to 802.11ac

TRISPEC
Engineering the how.

- IT'S FASTER!

The End

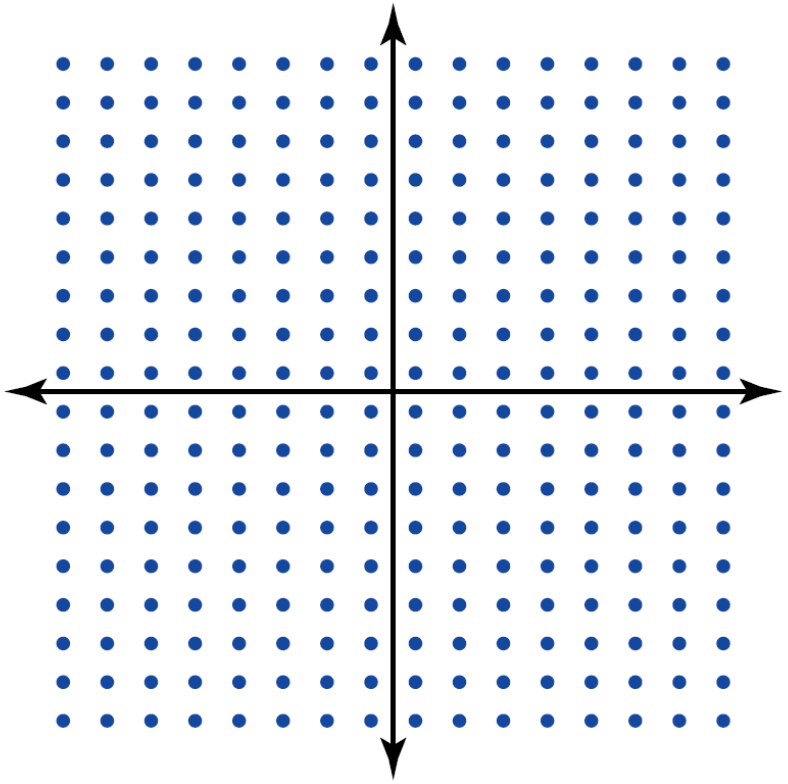
TRISPEC

Engineering the how.

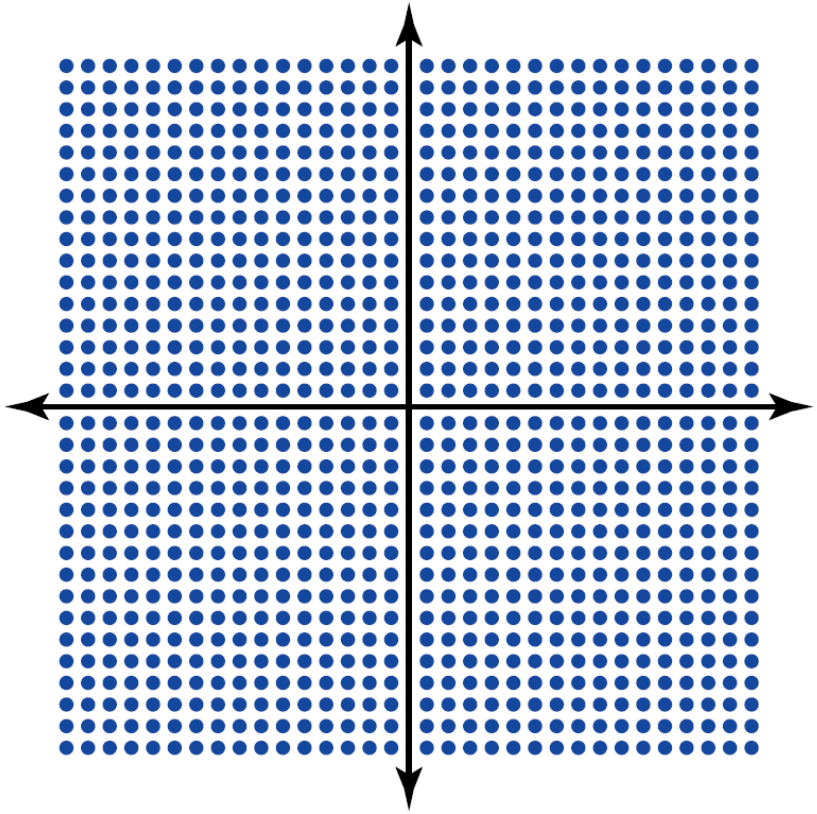
Thank-you!

1024QAM – it actually is faster

TRISPEC
Engineering the how.



256 QAM

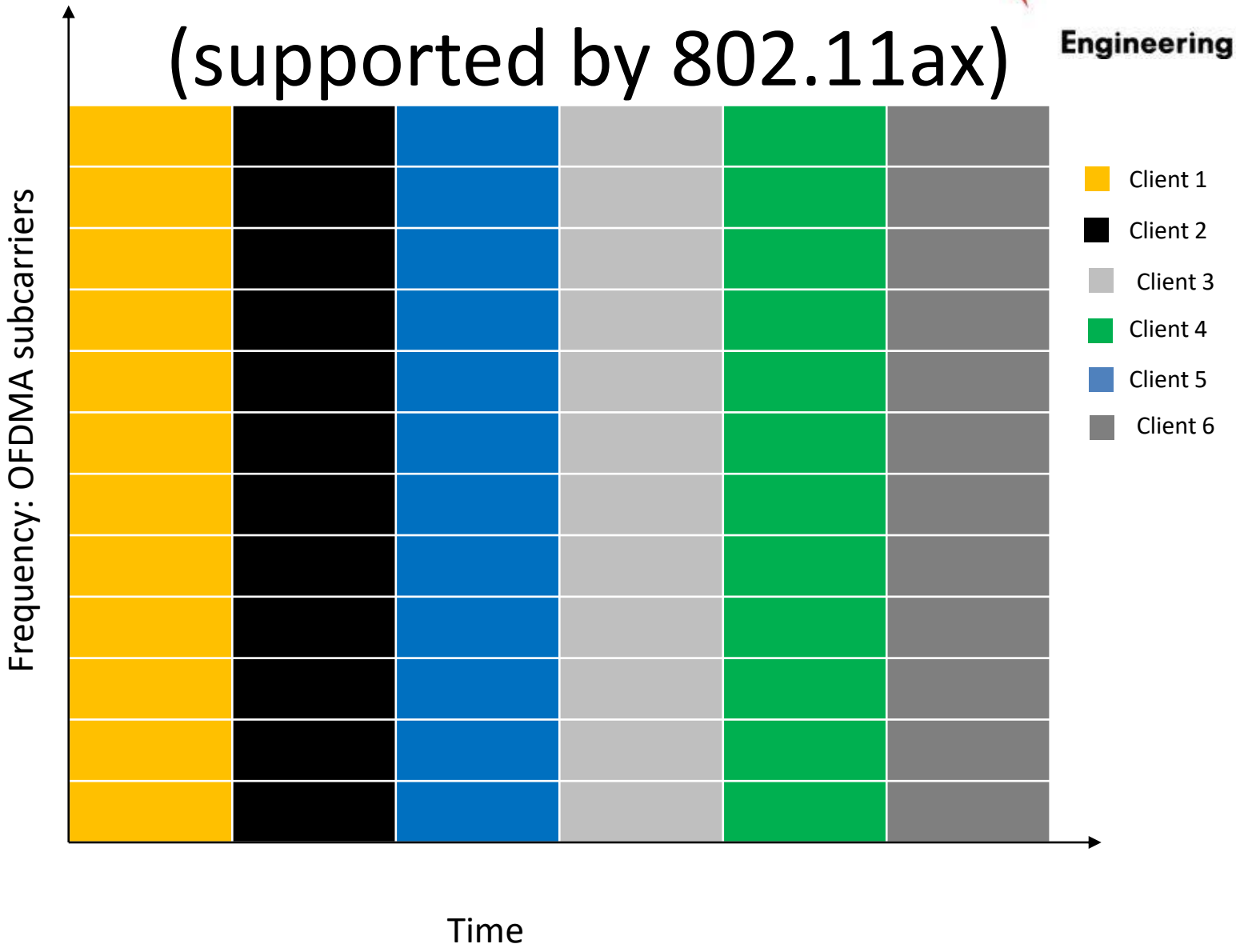


1024 QAM

- 10 bits per symbol vs 8 bits per symbol => 20% increase in speed
- Only useable in high SNR environment, also limited to 20MHz or greater channel and by subcarrier resource unit configuration

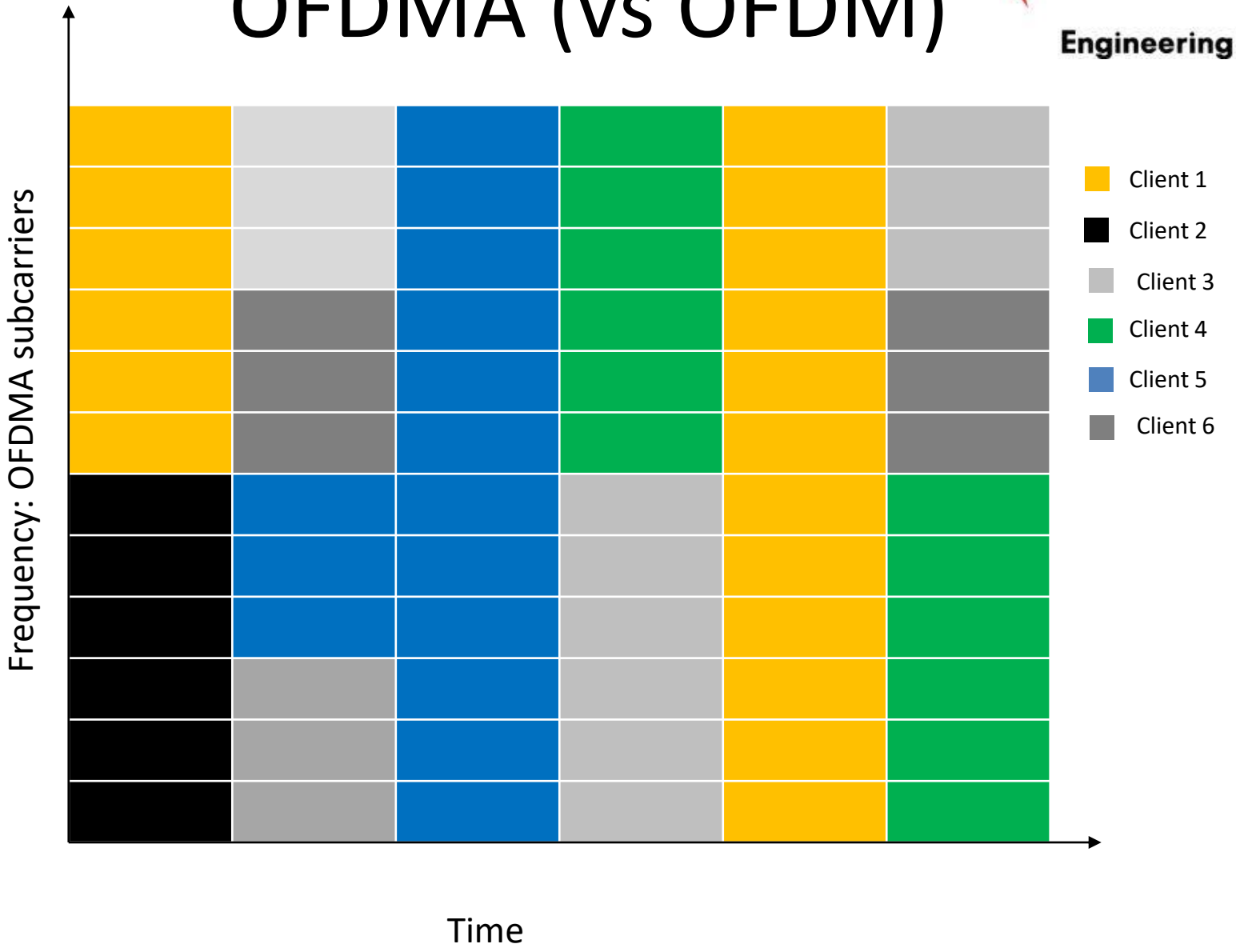
OFDM (supported by 802.11ax)

TRISPEC
Engineering the how.



OFDMA (vs OFDM)

TRISPEC
Engineering the how.

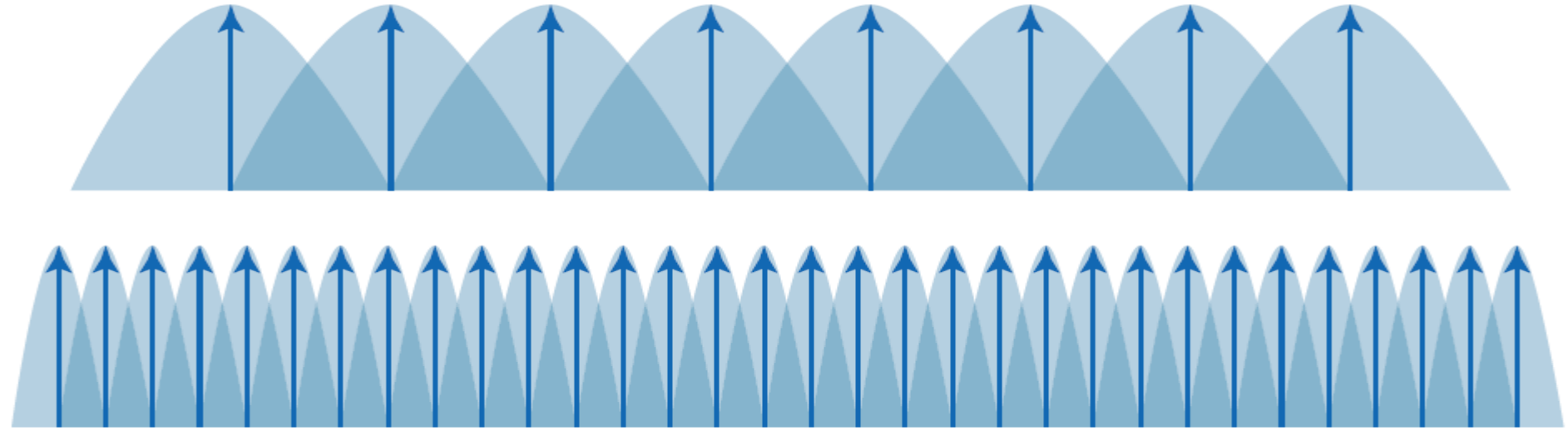


Subcarriers and Symbol Time Differences

TRISPEC
Engineering the how.

- 802.11n/ac has symbols that are 3.2 microseconds long => 64x 312.5 kHz subcarriers*
- 802.11ax increases the symbol time to 12.8 microseconds => 256x 78.125 kHz subcarriers*

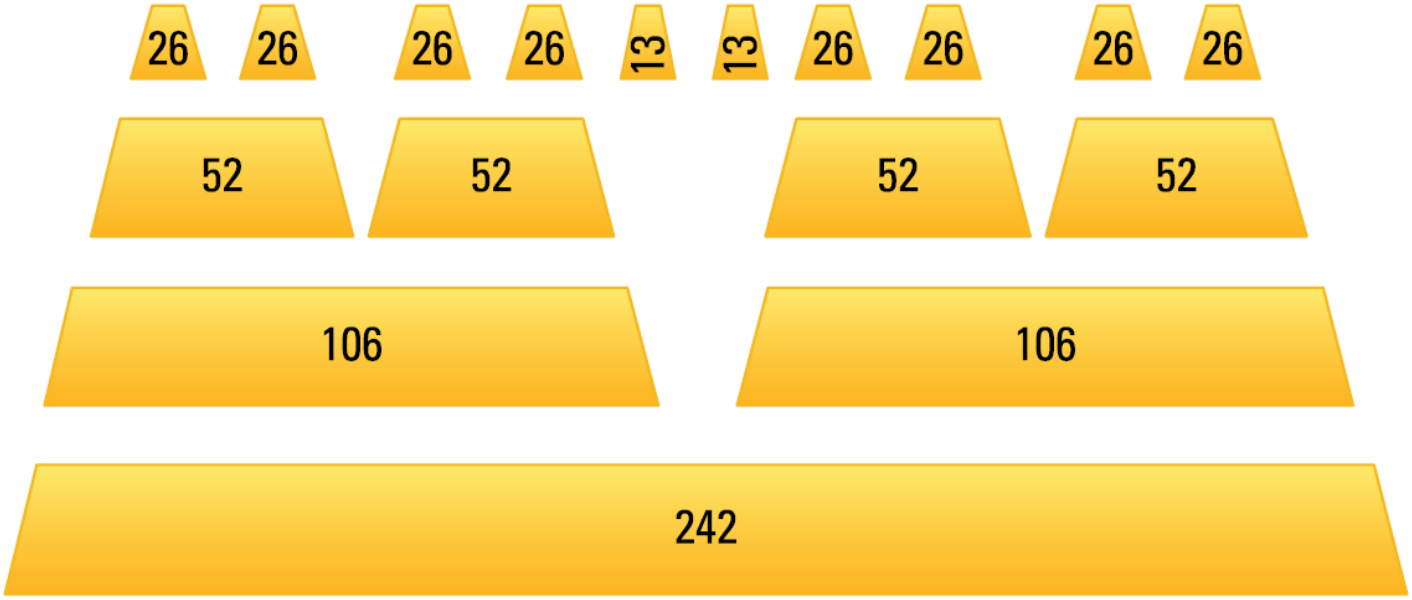
*20 MHz channel



Resource Units

TRISPEC
Engineering the how.

- Resource units are groupings of the subcarriers; the largest of which is a 242 subcarrier RU (for a 20MHz channel)
- The AP can decide what combination of 26, 52, 106 and 242 subcarrier RUs (which correspond to subcarriers sized 2, 4, 8 and 20MHz) to use



RU Combinations

TRISPEC
Engineering the how.

RUs	20MHz	40 MHz	80MHz	160MHz	80+80MHz
996x2 subcarriers	n/a	n/a	n/a	1 client	1 client
996 subcarriers	n/a	n/a	1 client	2 clients	2 clients
484 subcarriers	n/a	1 client	2 clients	4 clients	4 clients
242 subcarriers	1 client	2 clients	4 clients	8 clients	8 clients
106 subcarriers	2 clients	4 clients	8 clients	16 clients	16 clients
52 subcarriers	4 clients	8 clients	16 clients	32 clients	32 clients
26 subcarriers	9 clients	18 clients	37 clients	74 clients	74 clients

Conclusions & Important Points About MU-OFDMA

TRISPEC
Engineering the how.

- 20MHz channels will be most common in real-world 802.11ax deployments.
- While each transmission opportunity (TXOP) can be shared between clients (multiple downlink or multiple uplink through uplink synchronization), uplink does not occur at the same time as downlink traffic. Uplink is scheduled through Trigger Frames
- A 20MHz channel using 26 subcarrier RUs could serve 9 clients per TXOP – this is the best use case for the advantages of this technology feature.

MU-MIMO

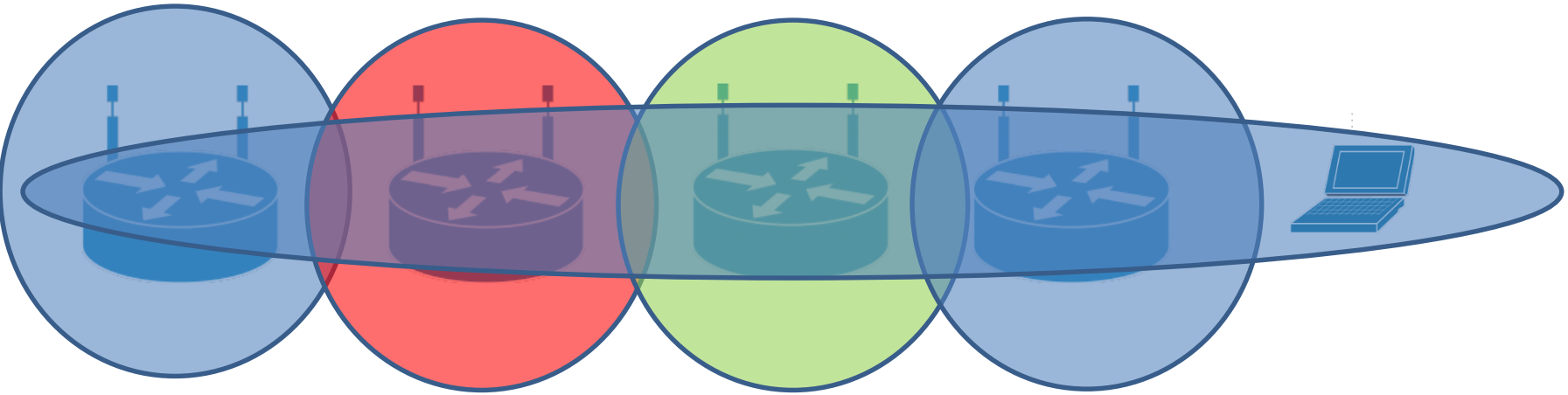
TRISPEC
Engineering the how.

- MU-MIMO enables multiple frames to be sent to different receivers using the same time/frequency resources via beam-forming. The receivers must be spatially distributed for the beams to be able to discriminate between them and make use of this efficiency
- MU-MIMO has been around in WiFi since 802.11ac, but not many client devices can enable it.
- 802.11ax improves MU-MIMO by reducing overhead and increasing the amount of users it can serve simultaneously from 4 to 8
- The minimum RU size for MU-MIMO is 106 subcarriers. While MU-MIMO can co-exist with MU-OFDMA, this is not expected to be widely implemented
- Best use case for MU-MIMO in 802.11ax: Low-user density, high-bandwidth applications (with large frames)

BSS Colouring for Spatial Reuse

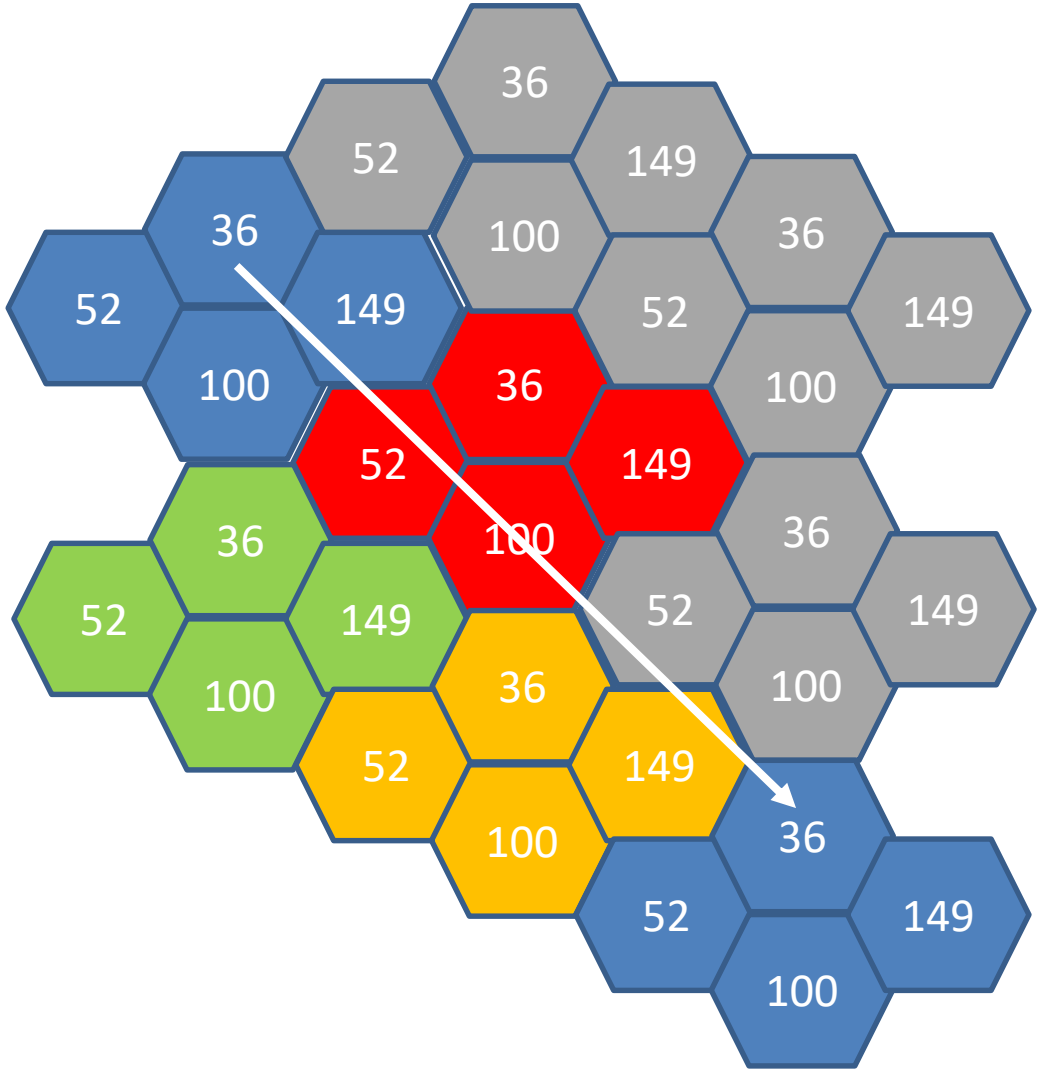
TRISPEC
Engineering the how.

- OBSS (Overlapping Basic Service Set) is a primary source of co-channel interference
- OBSS is often caused by clients, even when good planning has kept APs from interfering with each other
- In legacy 802.11 a/b/g networks, TCP throughout only achieves 40-50% of advertised rates; this is approximately 60-70% in 802.11ac



BSS Colouring in Action

TRISPEC
Engineering the how.



- The PHY header includes colour bits to differentiate each BSS
- Only when the colour matches its own BSS will a radio defer its transmission as the media is ‘busy’
- Non 802.11ax radios won’t have awareness of the BSS colour, so 802.11a/b/g/n (or older) clients will not be able to take advantage
- Note this will only reduce the problem of contention. The red channel 36 will still be a source of noise for the blue, green and orange 36s

Other Features in 802.11ax

TRISPEC
Engineering the how.

- Support for both 5GHz **and** 2.4GHz! Range/propagation, legacy devices.
- Target Wake Time: enables power saving and better resource scheduling by scheduling when clients should 'wake-up' and talk to the AP. This is useful for IoT, low bandwidth low power applications as well as mobile devices. This feature may be supplanted in devices by Bluetooth Mesh, Thread, Zigbee or other means
- New PHY headers set up initial communication:

HE SU	HE MU	HE ER SU	HE TB
Single User Transmissions	Multi-User (MU-MIMO & MU-OFDMA)	Extended Range, Single User	Responds to Trigger Frames; used for Uplink exclusively

What does it mean for WISPs?

TRISPEC

Engineering the how.

What does it mean for WISPs?

TRISPEC
Engineering the how.

- Not necessarily a compelling use case for the average in-home user
  - Most enhancements revolve around high-efficiency for high density. While smart-homes and IoT devices can push a household into this realm (20 devices), this might or might not represent your average customer… will it be worth the price bump?

What does it mean for WISPs?

TRISPEC
Engineering the how.

- Not necessarily a compelling use case for the average in-home user
  - Most enhancements revolve around high-efficiency for high density. While smart-homes and IoT devices can push a household into this realm (20 devices), this might or might not represent your average customer… will it be worth the price bump?
- BSS coloring and other PHY layer enhancements will improve some outdoor deployment scenarios: depending on deployment/application. Client radios will need to be 802.11ax upgraded as well as the APs, the SNR needs to be very high to see 1024QAM, careful planning is needed to make BSS Coloring work properly.

What Do WISPS Really Need in a WiFi Router?

TRISPEC

Engineering the how.

What Do WISPS Really Need in a WiFi Router?

TRISPEC
Engineering the how.

- If end users want faster speeds through higher QAM rates, they need better signal. This might be achievable through a router with more antennas (moving from 3x3 to 4x4 or 8x8), but it might not, depending on the environment
- Manageability and aesthetics will be increasingly important.