Why Integrate Wi-Fi® 6 into Your Next Design

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SECURE CONNECTIONS FOR A SMARTER WORLD

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AGENDA

- Brief History of Wi-Fi
- Wi-Fi 6 Key Features
  - OFDMA
  - MU-MIMO
  - Higher Rates
  - Target Wake Time
  - OBSS-PD
  - Range Extension
  - 8x8 Sounding Feedback

Brief History of Wi-Fi

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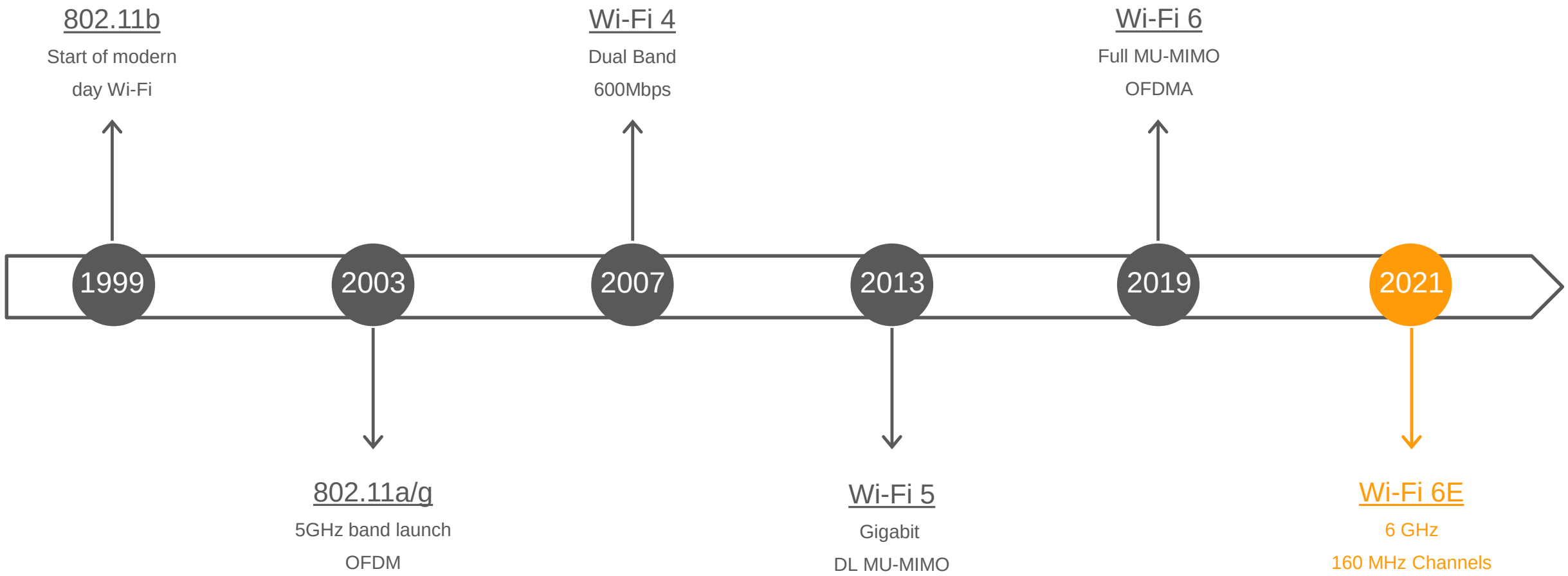
802.11 TIMELINE – OVER 20 YEARS!



Wi-Fi 4 VS 5 VS 6

Feature	Wi-Fi 4	Wi-Fi 5	Wi-Fi 6
Channel Bandwidth	20, 40 MHz	20, 40, 80, 80+80, 160 MHz	20, 40, 80, 80+80, 160 MHz
Frequency Bands	2.4 & 5GHz	5 GHz	2.4 & 5 GHz
Maximum Date Rate	450 Mbps*	2.34 Gbps*	9.6 Gbps*
Highest Order Modulation	64-QAM	256-QAM	1024-QAM
Spatial Streams	4	4	8
Associated 802.11 spec	802.11n	802.11ac	802.11ax

* Depends on number of spatial stream and channel bandwidth used.

Wi-Fi 6 Key Features

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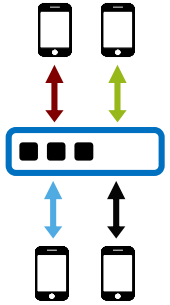
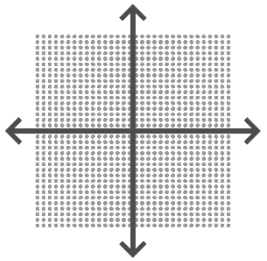
Wi-Fi 6 TOP FEATURES

OFDMA

MU-MIMO



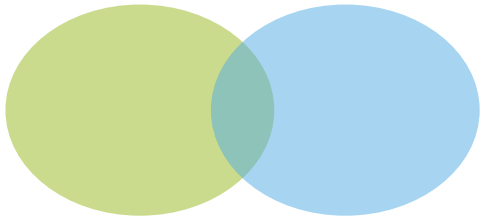
Higher Rates



2.4 / 5GHz

Target Wake Time

BSS Coloring



Wi-Fi 6 & IOT

- The growth of IoT devices integrated into the home continues to accelerate
  - Gaming, Voice Assistance, Smart Home, Work-From-Home

- These devices need reliable, secure and long-lasting connections

- Wi-Fi 6 provides the path to a better user experience:
  - OFDMA: Improving network efficiency by 60% over Wi-Fi 5, OFDMA enables simultaneously updates to/from IoT devices, and can effectively manage multiple Wi-Fi voice calls while supporting music streaming and lower bandwidth applications like internet browsing.
  - MU-MIMO: Doubling the throughput for high bandwidth applications, MU-MIMO can lower wait time during heavy uses cases (e.g. work from home) and improve gaming experience with higher bandwidth and lower latency
  - Higher data rates: Transfers data >30% faster than Wi-Fi 5 leaving more airtime for other devices and applications
  - TWT: Allows a client to negotiate a sleep schedule resulting in longer battery life and less contention
  - 2.4GHz support: Apply all the advantages of Wi-Fi 6 to 2.4GHz band.
  - BSS Coloring: Enables clients to more efficiently use their available bandwidth when neighboring traffic is present (e.g. non-managed MDUs)

- Providing a more efficient, higher capacity network, Wi-Fi 6 enabled products will soon become your new favorite devices

Wi-Fi 6 EXPANDED FEATURE SUMMARY

Feature	Advantage	WFA AP	WFA µAP	WFA STA
DL OFDMA	⇧ efficiency, ⇩latency	M (Tx)	O (Tx)	M (Rx)
UL OFDMA	⇧ efficiency, ⇩latency	M (Rx)	O (Rx)	M (Tx)
DL MU-MIMO	⇧ capacity & per user data rate	M (Tx)	O (Tx)	M (Rx)
UL MU-MIMO	⇧ capacity, ⇩latency	O (Rx)	O (Rx)	O (Tx)
1024 QAM	⇧ per user data rate by > 38% over Wi-Fi 5	O	O	O
2x/4x HE-LTF	⇧ throughput & robustness	M	M	M
1x HE-LTF	⇧ throughput & robustness	O	O	O
Beamforming	⇧ rate at range	M	O	M (BFee)
Target Wake Time (TWT)	longer battery life for clients	M	O	O
OBSS-PD (aka BSS Coloring)	⇧ spectral efficiency	M	M	M
Operational Mode Indication (OMI)	Allow clients to opt out of MU	M	M	M
Dual Carrier Modulation (DCM)	⇧ range & robustness	O	O	O
Extended Range (RE)	⇧ range @ lower rates	O	O	O
8x8 Sounding Feedback	⇧ range & DL MU-MIMO robustness	O	O	O

OFDMA

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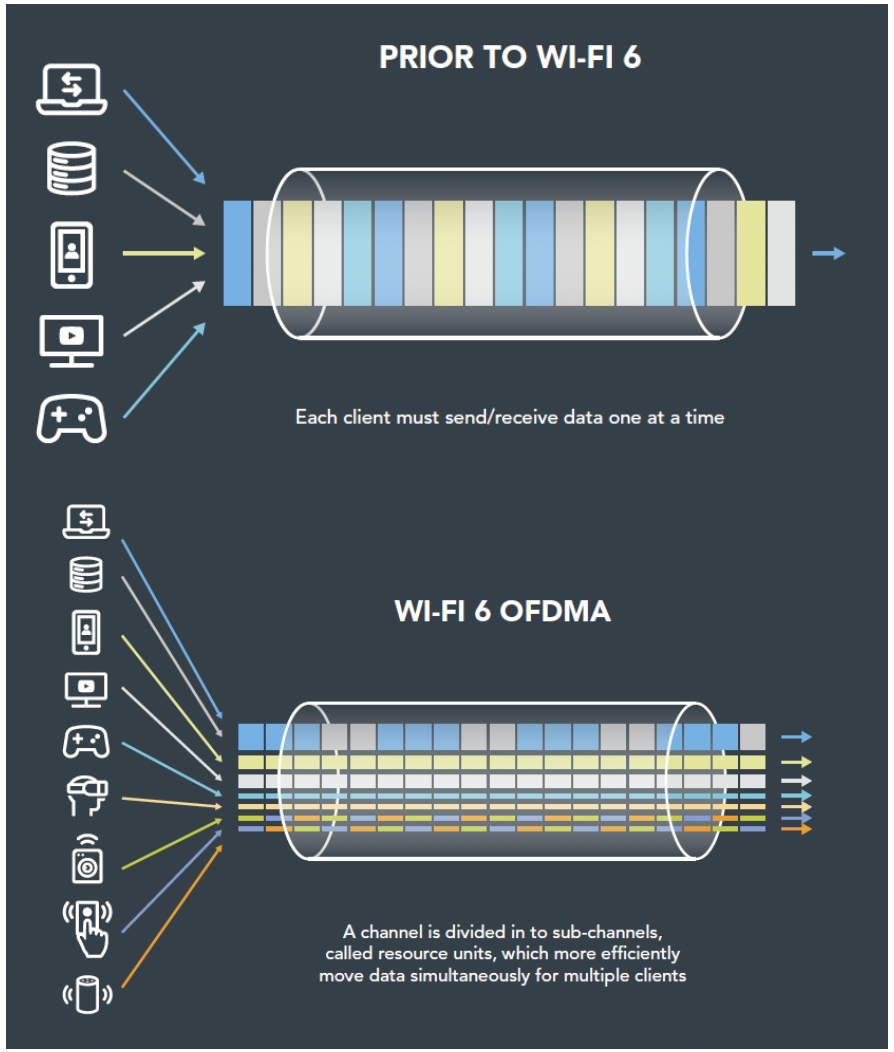
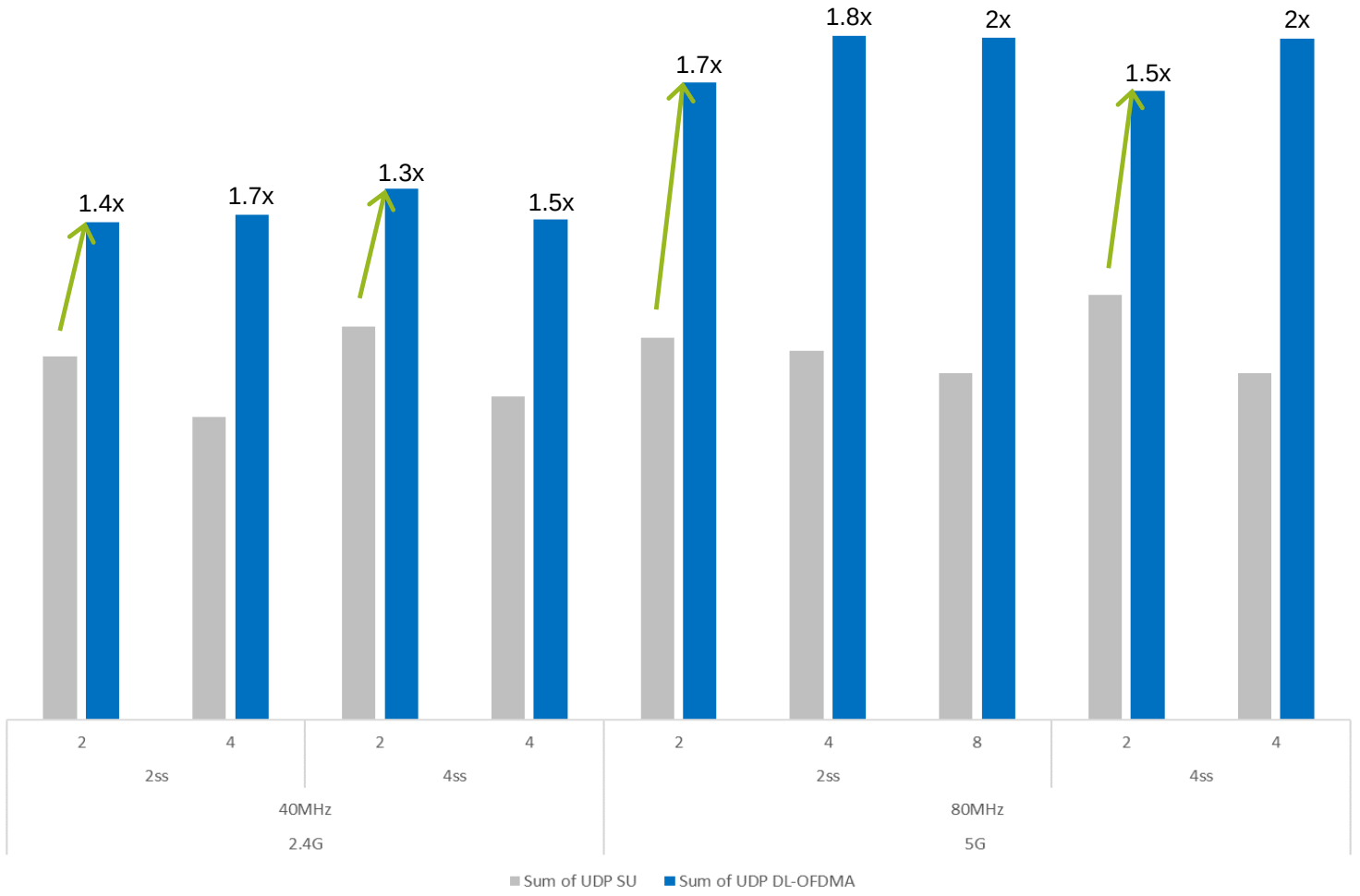
ORTHOGONAL FREQUENCY-DIVISION MULTIPLE ACCESS



- OFDMA is the ability to simultaneously pass traffic between an AP and multiple STAs using frequency diversity
  - A channel is split into resource units (RUs) and a STA is allocated an RU(s) depending on its throughput requirements relative to other STAs in a given OFDMA group
  - Support of up to 16 users provides the best combination of performance and scheduling complexity
- OFDMA Advantages
  - By combining the protocol overhead of multiple packets into a single packet, OFDMA:
    - Increases the efficiency of a network
    - Lowers per client latency
- OFDMA is ideally suited for smaller packets which is the majority of Wi-Fi traffic
  - Lowers contention in a home with multiple IoT devices, streaming music, Wi-Fi calls and internet browsing all happening simultaneously

88W9064 DL UDP OFDMA

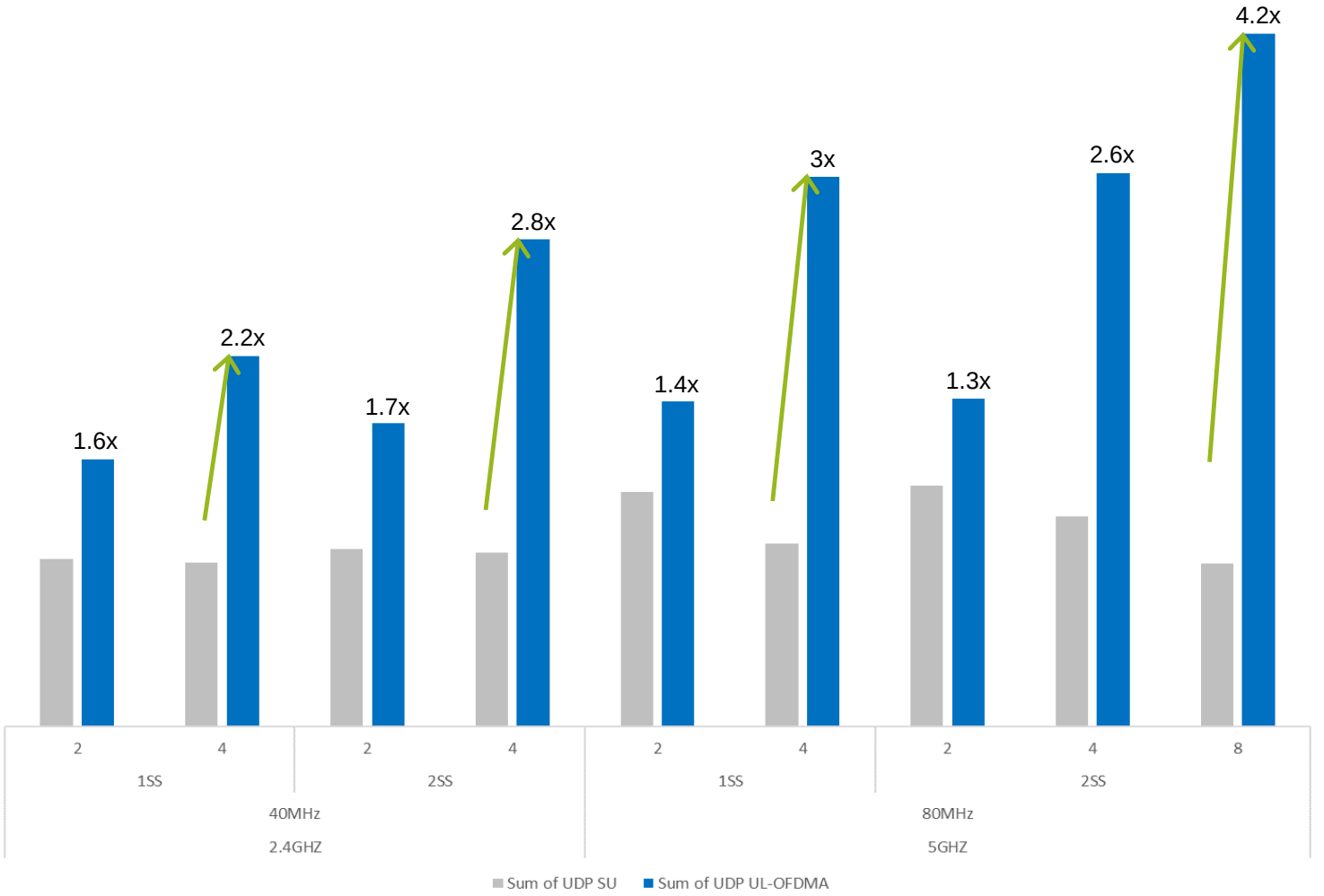
Average Efficiency Gains > 60%



- Shield Room OTA
- WPA3
- No Aggregation

88W9064 UL UDP OFDMA

Up to 4x increase in throughput



- Shield Room OTA
- WPA3
- No Aggregation
- Basic Trigger

Multi-User MIMO

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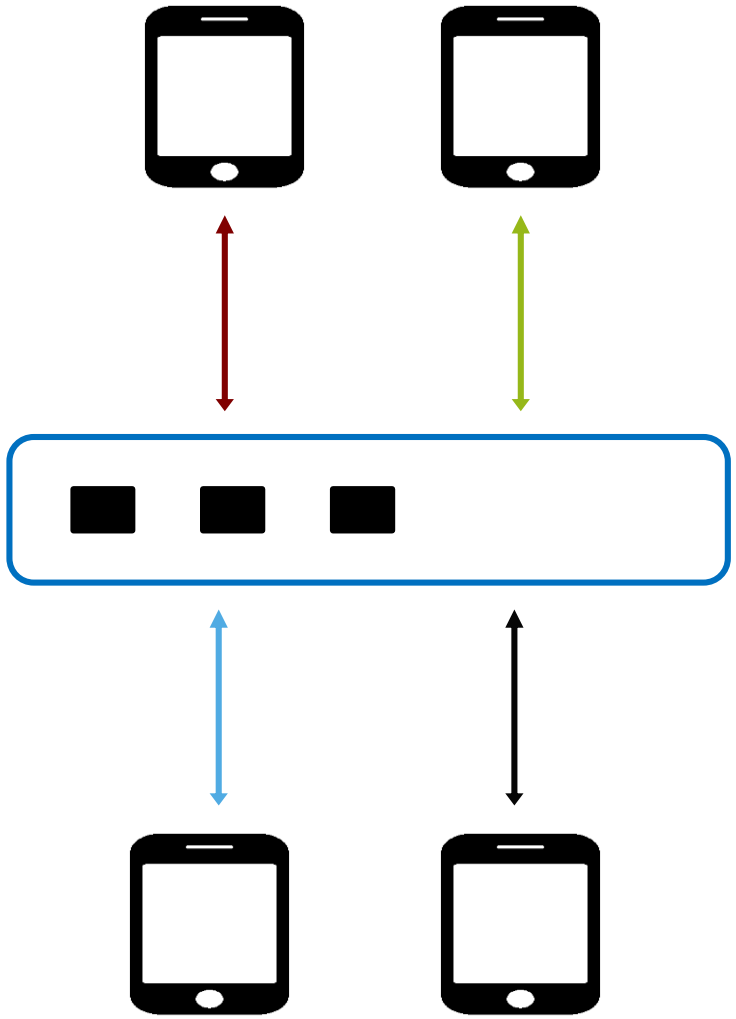
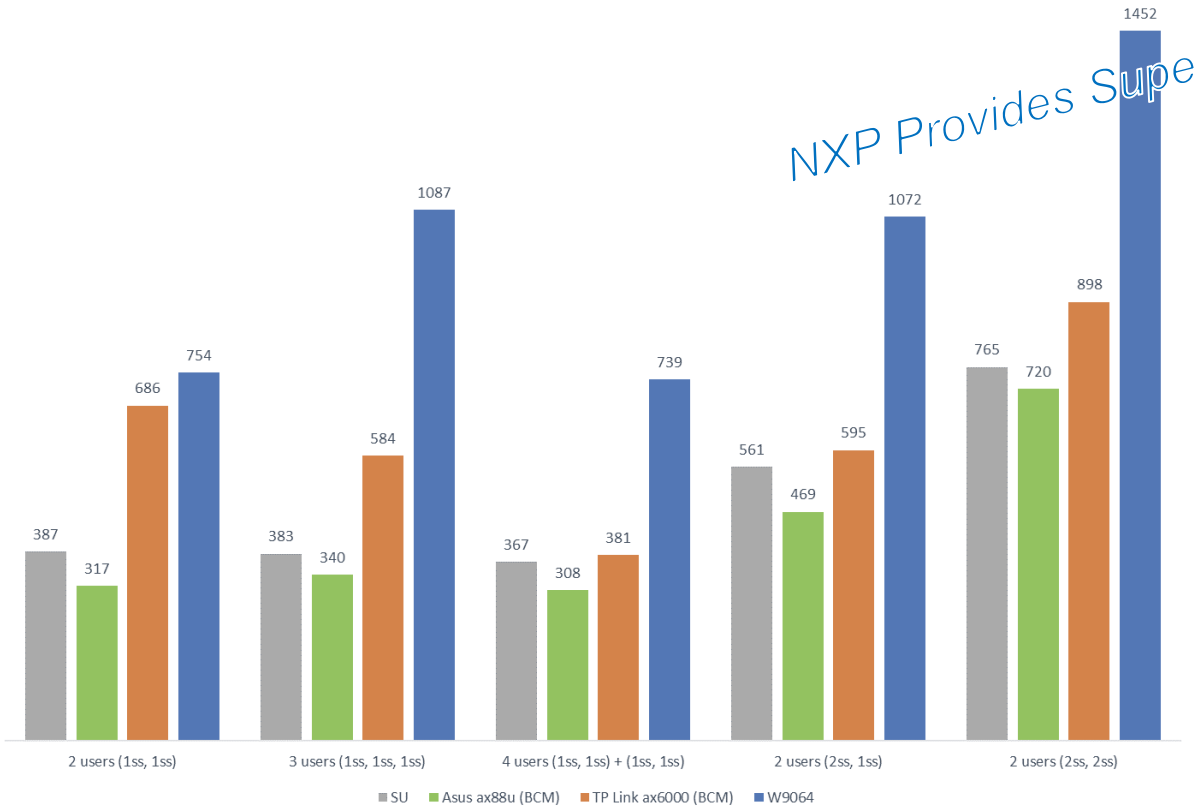
MULTIPLE USER (MU) MIMO



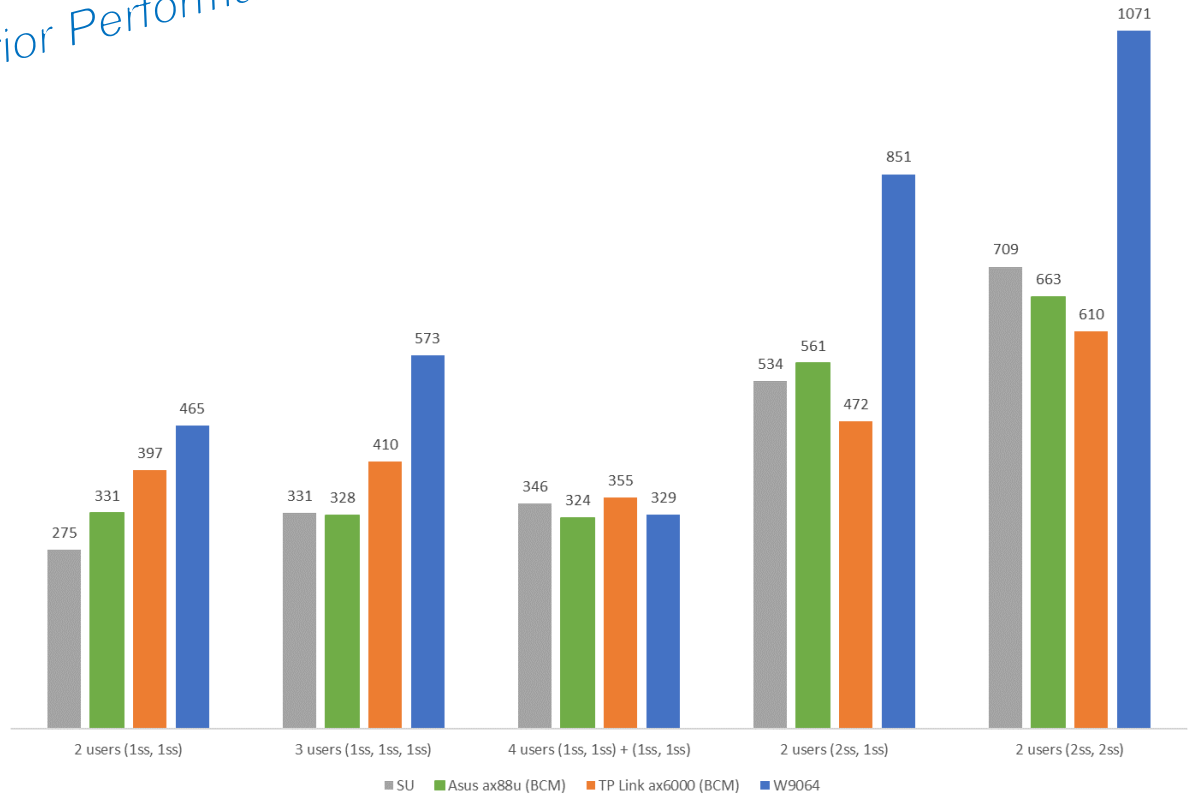
- MU-MIMO is the ability to simultaneously pass traffic between an AP and multiple STAs using spatial diversity
  - Downlink(DL) is AP to STA
  - Uplink (UL) is STA to AP
  - A 4x4:4SS AP can support up to four 1x1 STAs
- DL MU-MIMO Advantage
  - Increases per STA throughput and lowers contention in the network resulting in a capacity increase
- UL MU-MIMO Advantage
  - Lowers per STA latency while also increasing the channel capacity
- MU-MIMO is ideally suited for large bandwidth applications running concurrently
  - Better U-HD video streaming (e.g. Netflix) experience for home users; especially in contentious environments
  - Less wait time during heavy uses cases (e.g. work from home) while pulling/pushing cloud data
  - Lower latency and higher bandwidth for Cloud applications (e.g gaming, car-to-cloud)

DOWNLINK (AP -> STA) MU-MIMO

Wi-Fi 5 UDP 5G

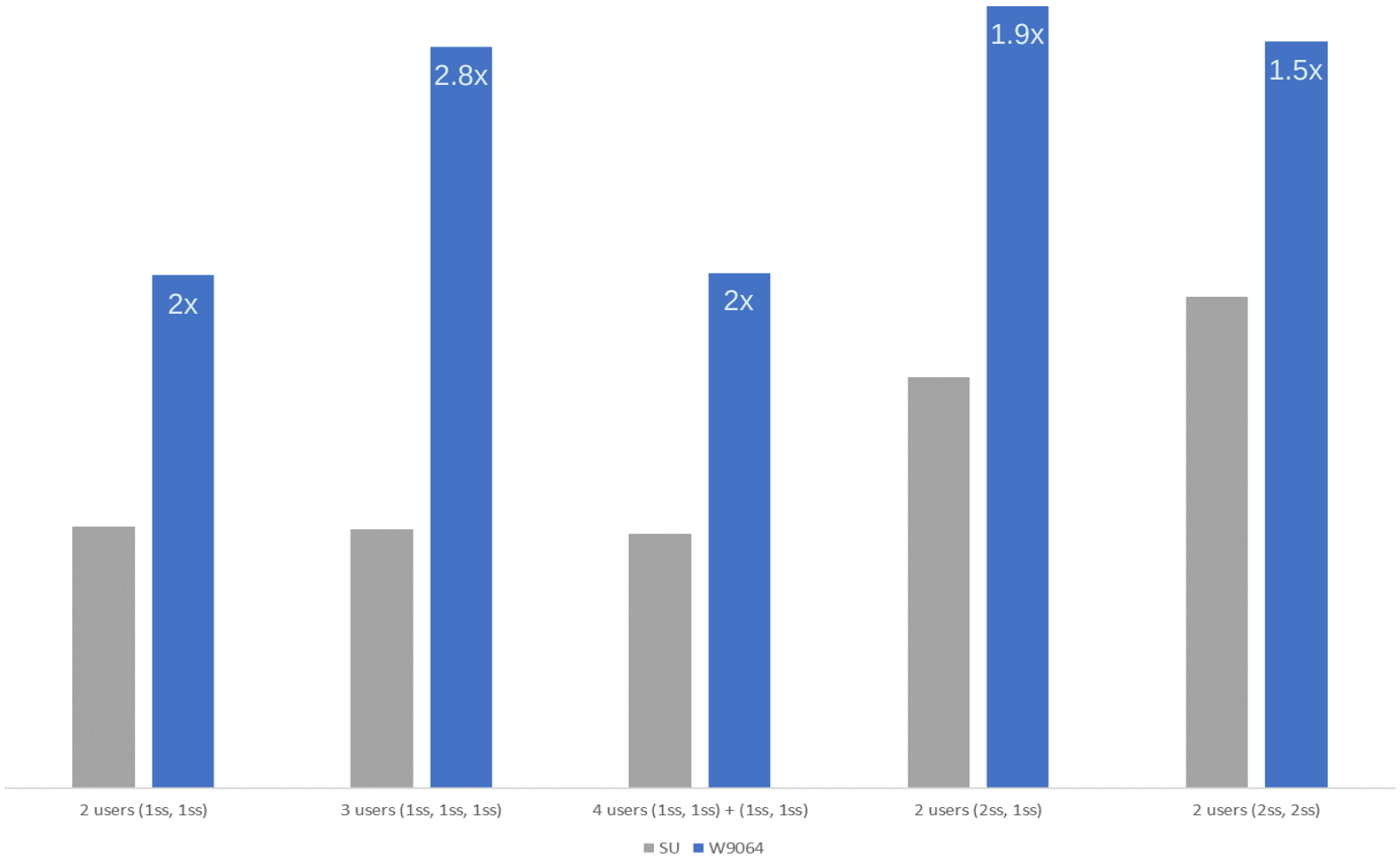


Wi-Fi 5 TCP 5G



- Shield Room OTA
- 1x1: Acer laptop
- 2x2: Intel AX200

Wi-Fi 6 DL MU-MIMO OTA UDP PERFORMANCE



Commercially available Wi-Fi 6 APs do not support MU-MIMO currently

Higher Rates

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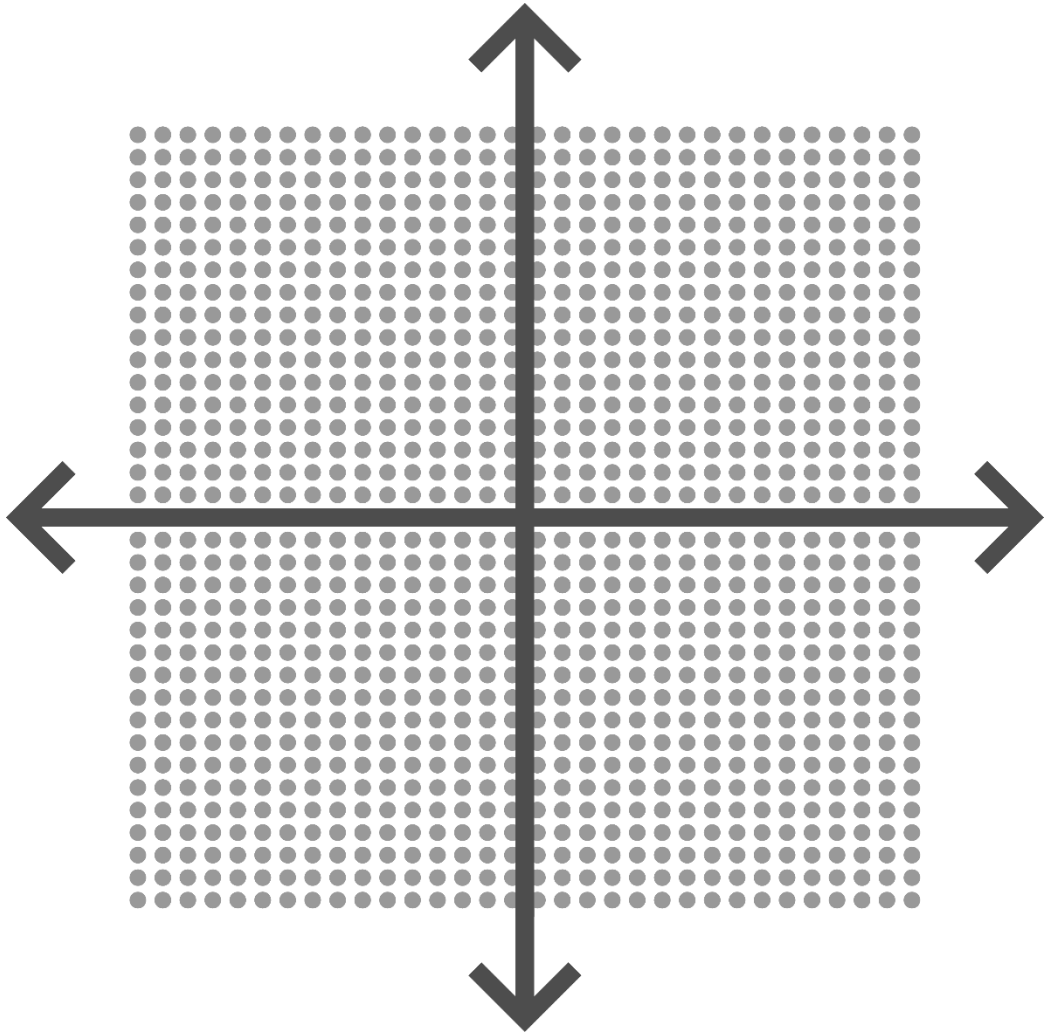
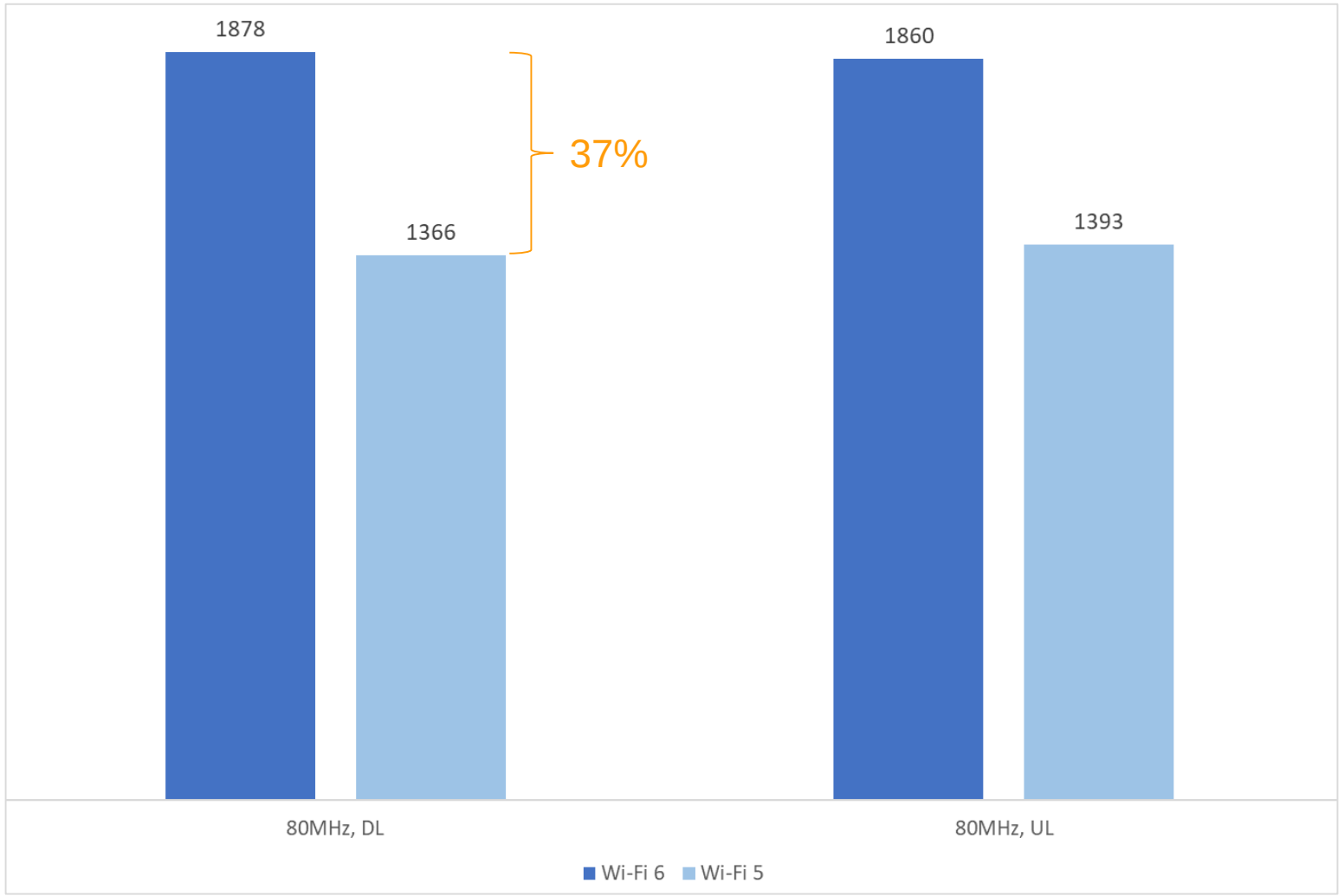
1024-QAM



- 802.11ax introduced 1024 Quadrature Amplitude Modulation (QAM)
  - 802.11ac supports up to 256-QAM
  - 1024-QAM encodes more data in the same amount of spectrum
- Up to 38% increase in data rate at close range with Wi-Fi 6
- Wi-Fi 6 data transfers can occupy less air-time lowering channel contention and leaving capacity available for older clients

Wi-Fi 6 VS Wi-Fi 5 OVER-THE-AIR THROUGHPUT



- UDP
- WPA2+AES
- AMPDU + AMSDU 11K

Target Wake Time

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TARGET WAKE TIME (TWT)

- A Wi-Fi 6 AP can negotiate the TWT function with participating STAs to define a specific time or set of times for individual stations to access the medium.
  - The TWT STAs and the AP exchange information that includes an expected activity duration.

- Two TWT modes
  - Individual: STA and AP negotiate start time of sleep period and wake interval.
  - Broadcast: Allows an AP to set up a shared TWT session for a group of STAs and periodically specify the TWT parameters set within Beacon frames.

- TWT Advantages:
  - Can significantly improve battery life versus current power save modes
  - Reduces contention as IoT clients wake up less often
  - Allows AP to schedule uplink traffic

OBSS-PD
(aka BSS coloring)

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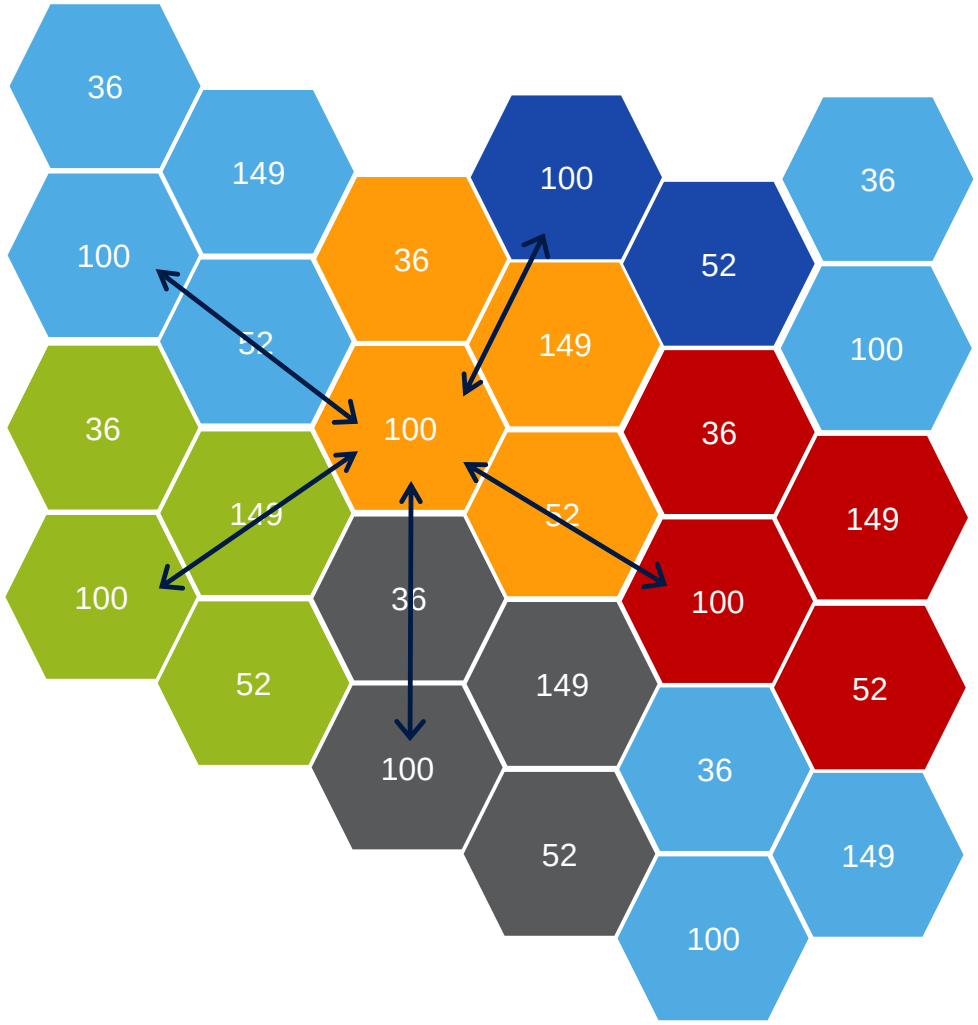
OVERLAPPING BASIC SERVICE SETS – PACKET DETECTION



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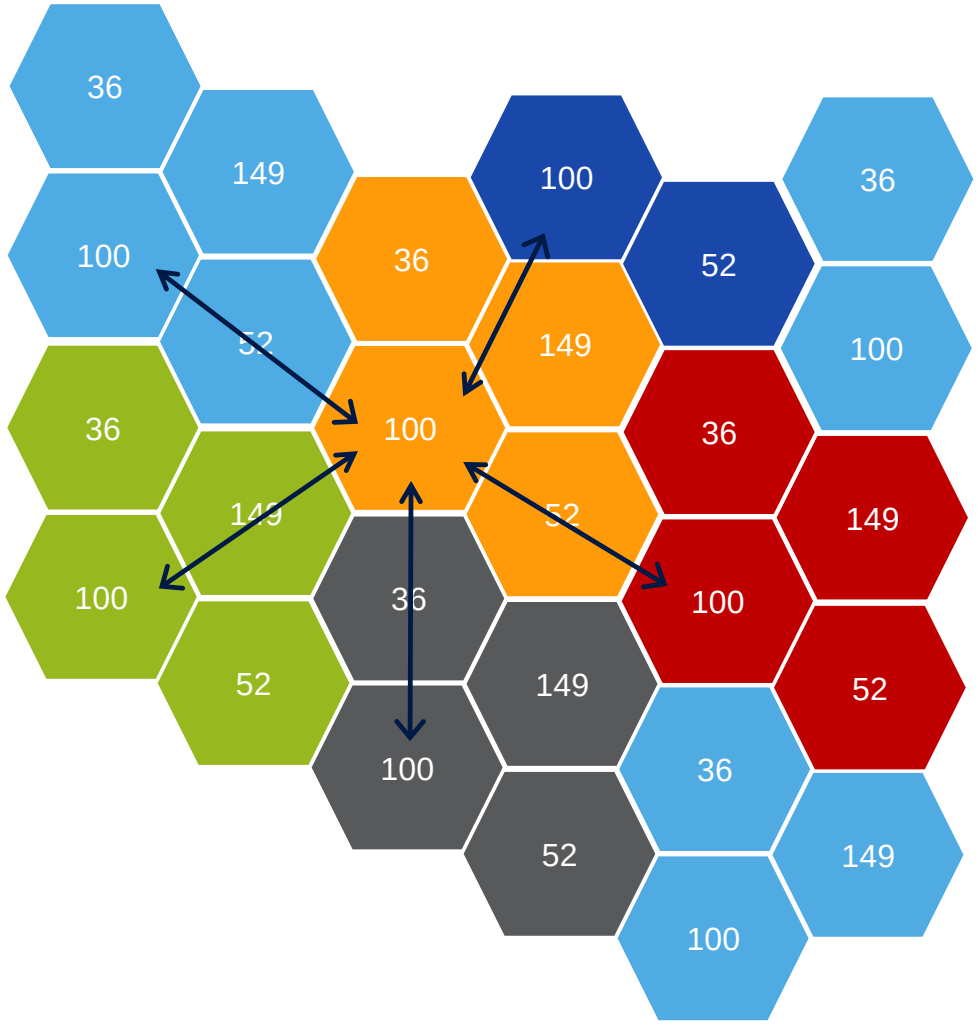

- OBSS-PD, aka BSS coloring, is a spatial re-use technique that enables an AP or STA to identify if contenting traffic is from an Overlapping BSS.
  - Self BSS (aka MYBSS) is assigned a “color”
  - AP sets signal power detection threshold for OBSS traffic and the TX power of the AP/STA is reduced to avoid interfering with the OBSS
  - If the traffic signal level is below the OBSS threshold and does not match the BSS color, the AP/STA can transmit
- Legacy packets do not support BSS coloring
  - May still conduct an OBSS-PD approach by using the MAC Header info to determine the traffic is from OBSS or SBSS
- OBSS-PD improves spectral efficiency to increase system capacity and lowers latency variation
  - An AP or STA is less likely to have their TX opportunity delayed by a friendly/far client or rogue STA

Range Extension

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Wi-Fi 6 EXTENDED RANGE

- 802.11ax defines an extended range packet format to increase coverage; especially in outdoor deployments

- In addition, Dual Carrier Modulation (DCM) has been introduced
  - DCM replicates the same information on different subcarriers to improve robustness of the Wi-Fi 6 link

- The defined data rates are all below 6Mbps
  - 3.6 Mbps (ER for 20MHz MCS0 + Dual Carrier Modulation)
  - 3.2 Mbps (ER + RU106 in 20MHz MCS0)
  - 1.6 Mbps (ER + RU106 in 20MHz MCS0 + DCM)

- Extended range capabilities can increase the range of a Wi-Fi link by more than 50%

8x8 Sounding Feedback

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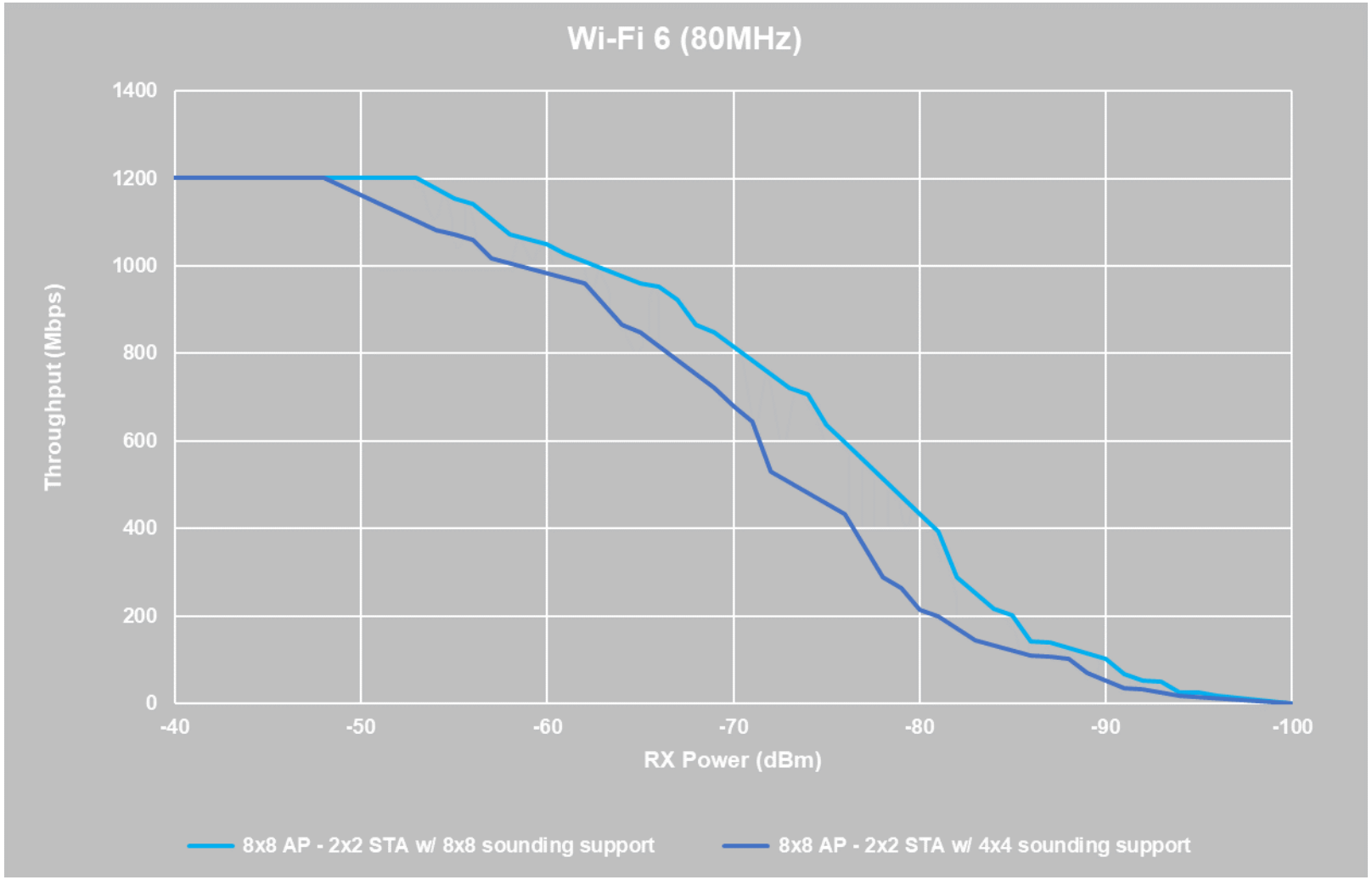
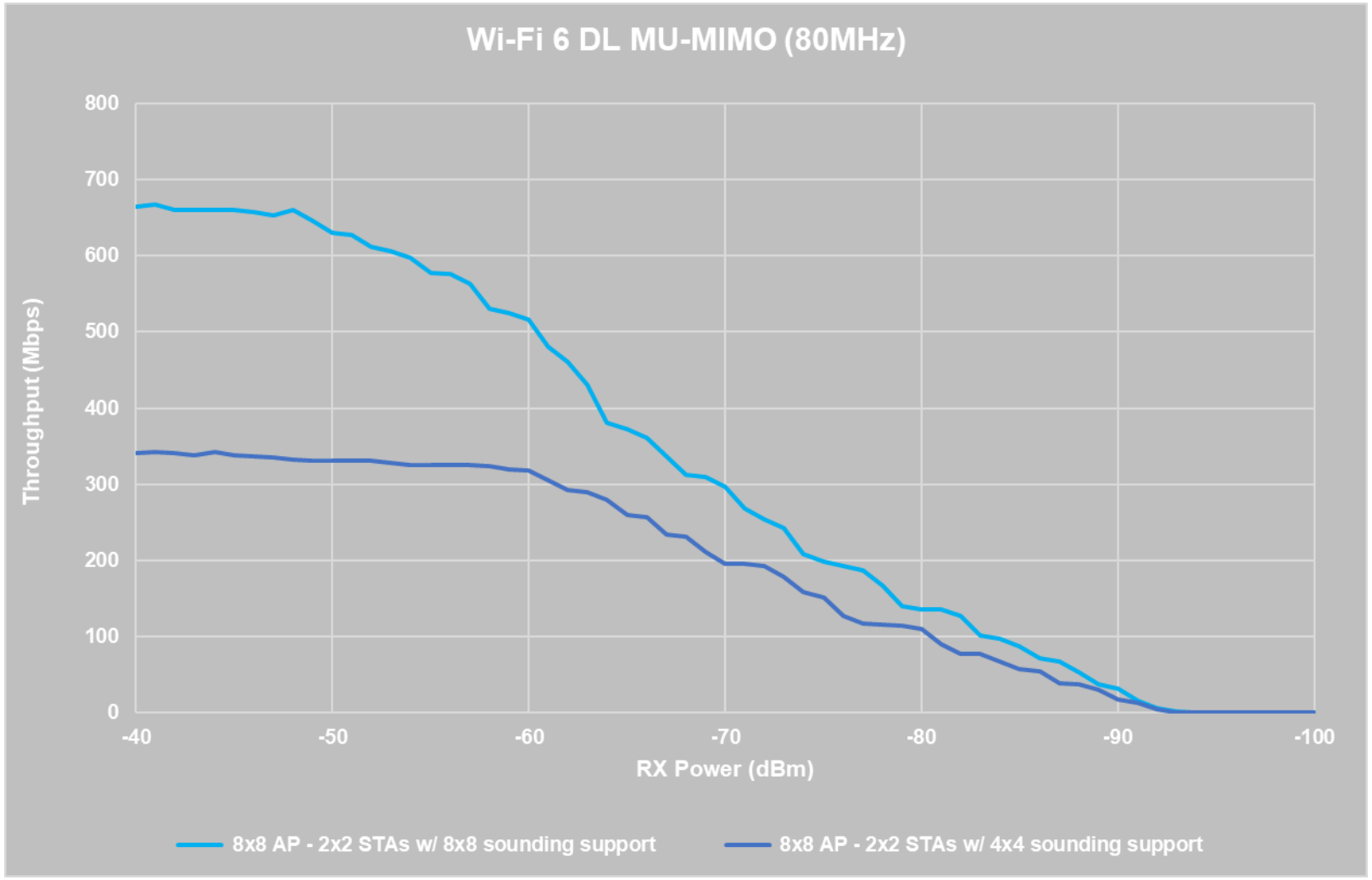
8X8 SOUNDING FEEDBACK

- To support TX Beamforming and DL MU-MIMO, the STA has to measure and communicate channel information through a channel **Sounding** process.
- Wi-Fi 6 added support for 8x8 APs; however, it is **optional** for STAs to provide sounding feedback to APs larger than 4x4 so 8x8 performance will not be realized by all STAs.
- NXP solutions support 8x8 sounding to take full advantage of 8x8 AP->STA performance benefits:
  - Increases rate over range by > 5dB
  - Increase DL MU-MIMO throughput >50%

8X8 SOUNDING FEEDBACK – INCREASED RANGE



8X8 SOUNDING FEEDBACK – INCREASED DL MU-MIMO THROUGHPUT



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