The bridge to possible

New Generation Wi-Fi networks

Cisco Wi-Fi networks for today, tomorrow

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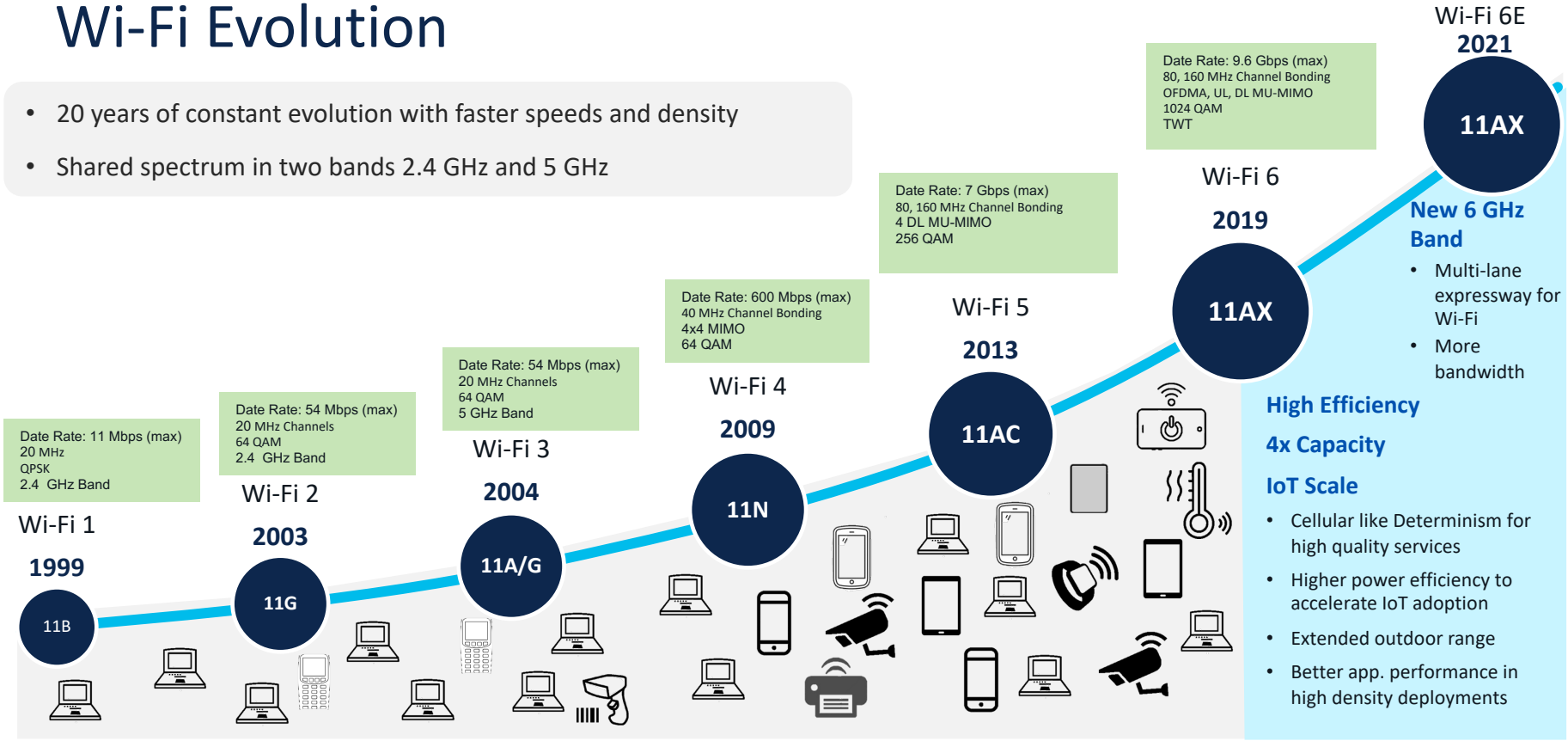
Wi-Fi Evolution

- 20 years of constant evolution with faster speeds and density
- Shared spectrum in two bands 2.4 GHz and 5 GHz



Wi-Fi 6

Why Wi-Fi 6: 6 Reasons

Higher capacity

Up to 4x increase

Improved security

Augmented
with **WPA3**, RF Snapshots

Reduced latency

Deterministic
scheduling

Power efficiency

Up to 3x
better device battery life

Greater IoT scale

Better 2.4GHz Coverage

Improved interference mitigation

Better QoE

Wi-Fi 6 - **Enhanced** experience for every vertical

Education

AR/VR/XR learning, e-learning, digital educations

Public Venues

High resolution video, cellular offload, Wi-Fi calling, Sidelines communication

Hybrid Workspaces

Digital collaboration (video conference, digital white boards, etc.), teleworking

Healthcare

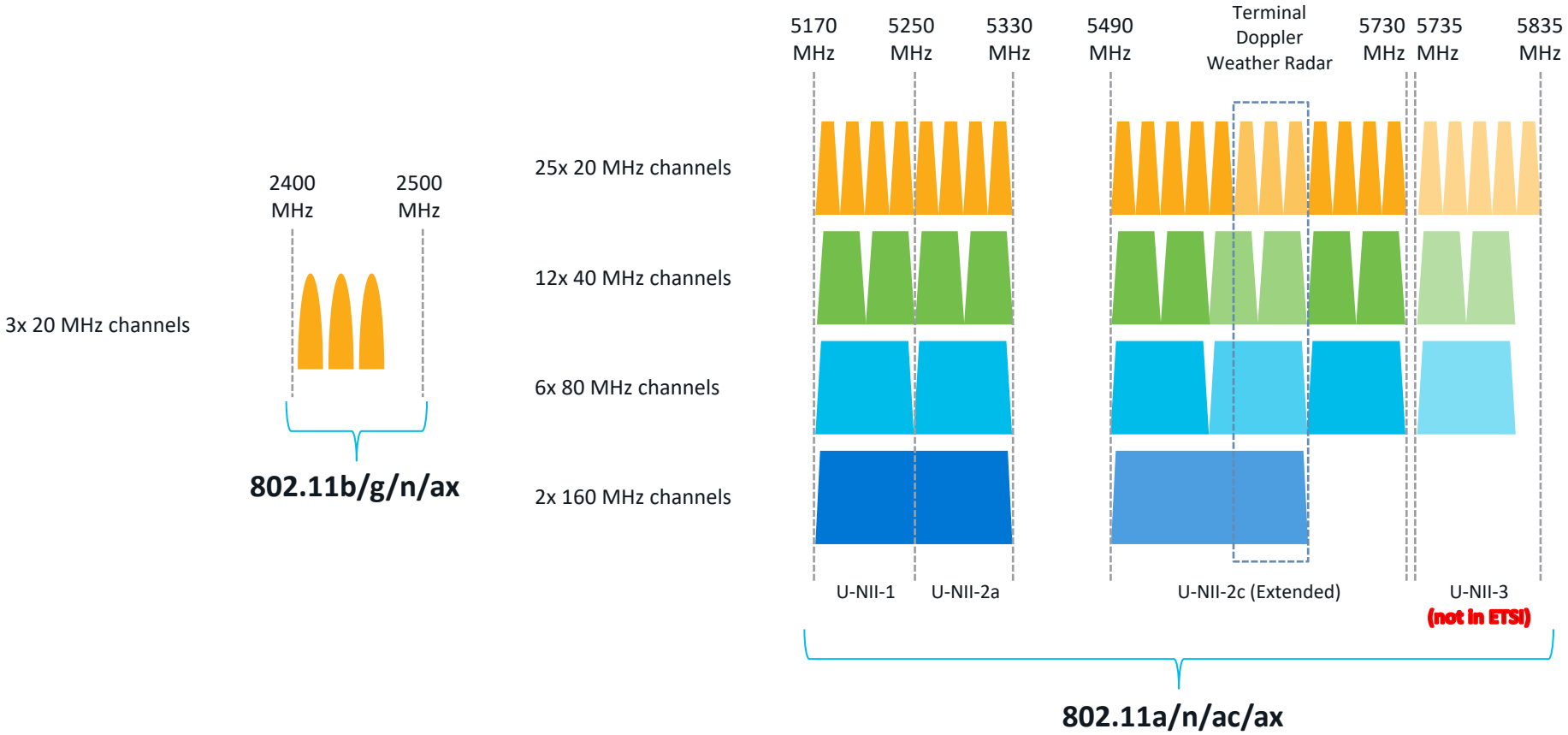
Telemedicine, robotics, smart IoT devices and wearables, asset tracking

Manufacturing

Automated and digitized operations and supply chain, robots

Capacity — High Density — Performance — Low latency

The 2.4 GHz and 5 GHz bands today

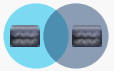


IEEE 802.11ax Wi-Fi 6 - Enhancements

Uplink and Downlink Orthogonal Frequency Division Multiple Access (OFDMA): Increases network efficiency and lowers latency for high demand environments

Packet latency improvements

Multi-User Multiple Input Multiple Output (MU-MIMO): allows more data to be transferred at once and enables an access point to transmit to a larger number of concurrent clients at once



Channel Reuse With BSS Color

Parallel processing: enables greater capacity by allowing MU-MIMO and OFDMA to function in UPLINK and DOWNLINK mode

Parallel transmissions

1024 Quadrature Amplitude Modulation Mode (1024-QAM): increases throughput in Wi-Fi devices by encoding more data in the same amount of spectrum

Faster Speed more Radios and 1024 QAM

Target Wake Time (TWT): significantly improves battery life in Wi-Fi devices, such as Internet of Things (IoT) devices

Better Battery Life

802.11ax is all about high efficiency wireless

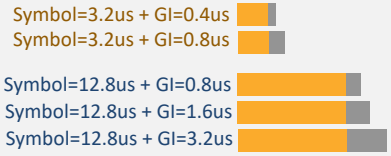
These improvements are Wi-Fi 6 enhancements to make every microsecond “On THE AIR” matter.

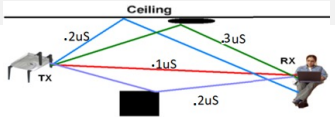
- .11ax High Efficiency Wireless (HEW) is all about optimizing the time spend “ON THE AIR” and how much information is on the air during any given Micro Second “uS”
- Four things determine Air time efficiency
  1. **Data rate (Modulation density)** or **QAM** - (how many Bit’s per Radio Symbol) 64 QAM is more robust but 1024 QAM is a lot faster
  2. **Number of spatial streams and spatial reuse** (introduction of OFDMA and Resource Units) and UL/DL MU-MIMO
  3. **Channel bandwidth** – How Many frequencies can we modulate at one time
  4. **Protocol overhead** – Preamble/Ack/BA, Guard Interval “GI” etc.

Guard Interval

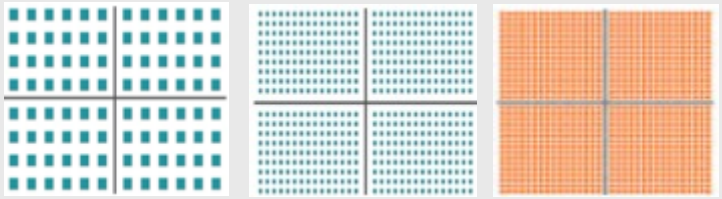
802.11n/ac - GI of 400nS & 800nS (shorter = faster rates)

802.11ax - GI is 0.8, 1.6 & 3.2 uS (longer = outdoor use)



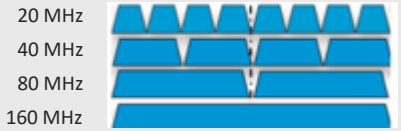


Modulation density gains



802.11agn 6b/symbol	802.11ac **8b/symbol**	802.11ax **10b/symbol**

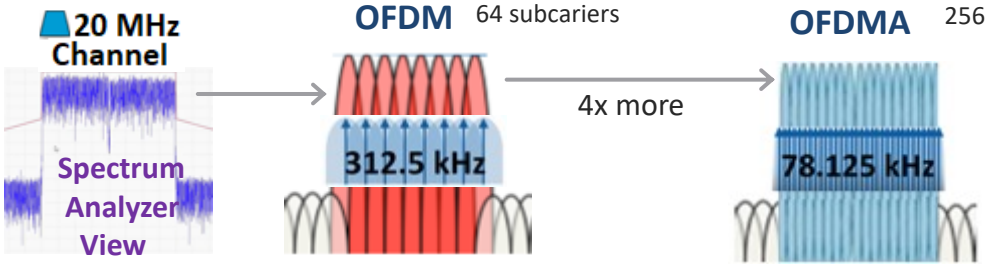
Wi-Fi channel width



Note: Channel Bonding reduces range as the power is spread out with each additional 20 MHz adding a 3 dB penalty in SNR and the greater the QAM the harder it is for the receiver to decode therefore it is more sensitive to noise.

Understanding an OFDM and OFDMA

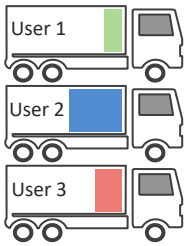
Both divide into sub-channels (carriers) but **OFDMA has more** and the concept of **resource units**.



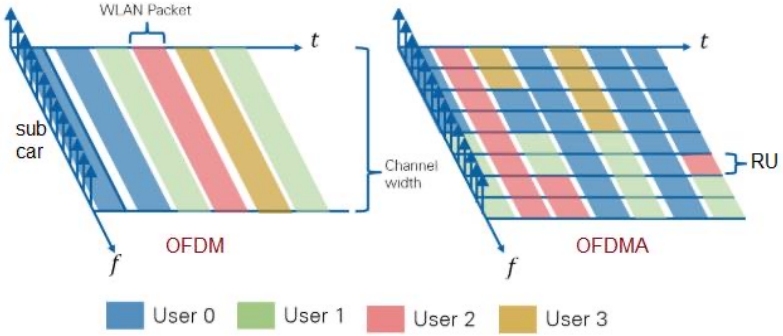
OFDMA divides the same 20 MHz spectrum into many more smaller subcarriers that can carry small packets faster.

Using Resource Units (RU) it allows each subcarrier to handle multiple users

OFDM divides the available spectrum into sub-channels that can be independently modulated and demodulated but each subcarrier has data for only one user at a time - OFDMA = more users at a time.

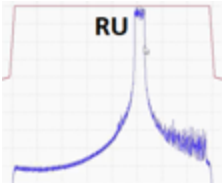


OFDM



OFDMA

[20 MHz]



Spectrum efficiency

All packets big and small get processed **MUCH FASTER**

Multi-User MIMO (MU-MIMO)

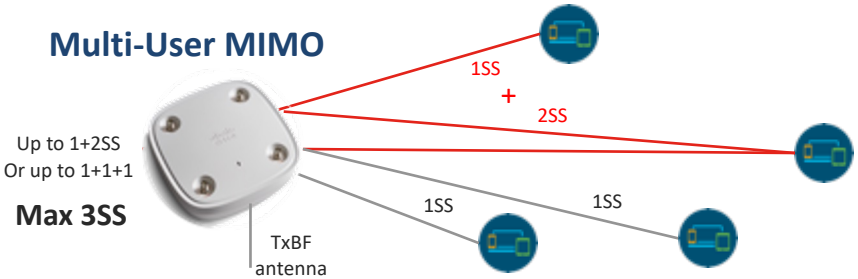
In 802.11ac MU-MIMO Clients are able to benefit in the **downstream link** higher aggregate throughput, better decoding, reducing interference

Single-User MIMO

Each Frame is sent to one client at a time

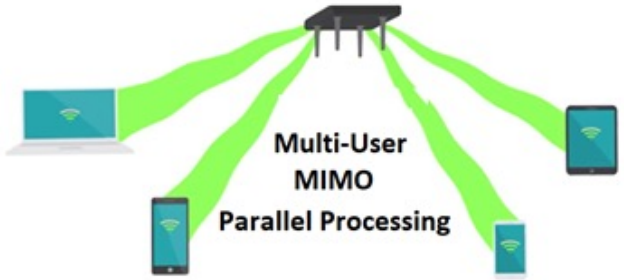
Multiple Streams to 1 client

Multi-User MIMO



Data can be directed to Different clients in Concurrent streams in a 1+1, 1+1+1 or 1+2 stream combination

802.11ax drives Performance into the clients



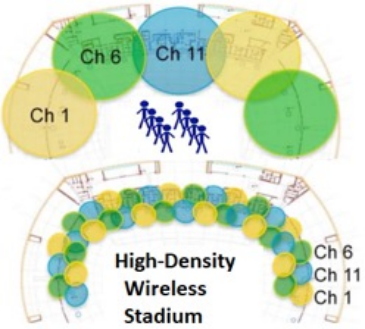
- 8 MU-MIMO transmissions (users in a group) up from 4
- **MU-MIMO client benefit in Downstream and Upstream**
- MU Station UL and DL ACKs come back in parallel **USING OFDMA**
- AP steer beams to different users (creating groups and managing)
- Each MU-MIMO transmission may have its own MCS rate

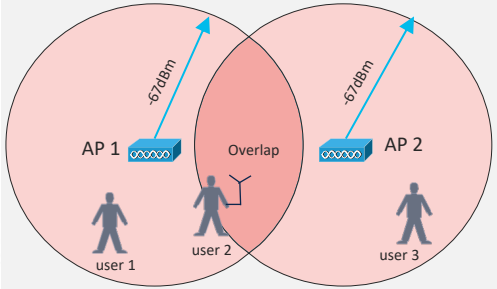
BSS Coloring – Spatial reuse and addressing interference

Issue with limited channels

2.4 GHz - only 3 non-overlapping channels

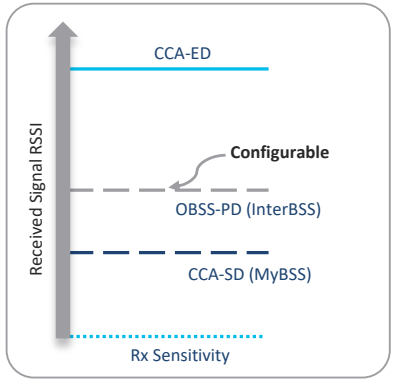
5 GHz - more channels (reduced with channel bonding)



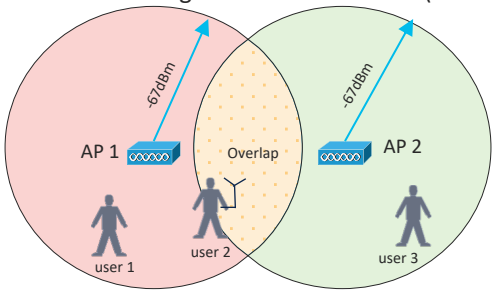


- The limiting factor is co-channel interference “CCI”.
- Frequency reuse is high! Cells using the same channel can be too close (and this is sometimes unavoidable)
- **OBSS CCI - High density clients running too much Tx pwr**
- Wi-Fi CCA is very sensitive, so clients have to back-off and wait
- Directional antennas and **Cisco’s RX-SOP** (adjustable squelch) is used today, but not dynamic and **requires RF experience**

Overcomes the limits of CCA

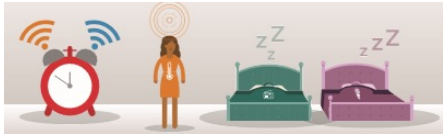


- Each BSS (AP) uses a different “color” (6 bits in the preamble)
- Each user (station) learns its BSS color upon association, andother BSS’s as OBSS
- Stations detecting the same BSS color (intra-BSS) use a lower RSSI threshold
- Stations detecting a different BSS color (Inter-BSS) use a higher RSSI threshold



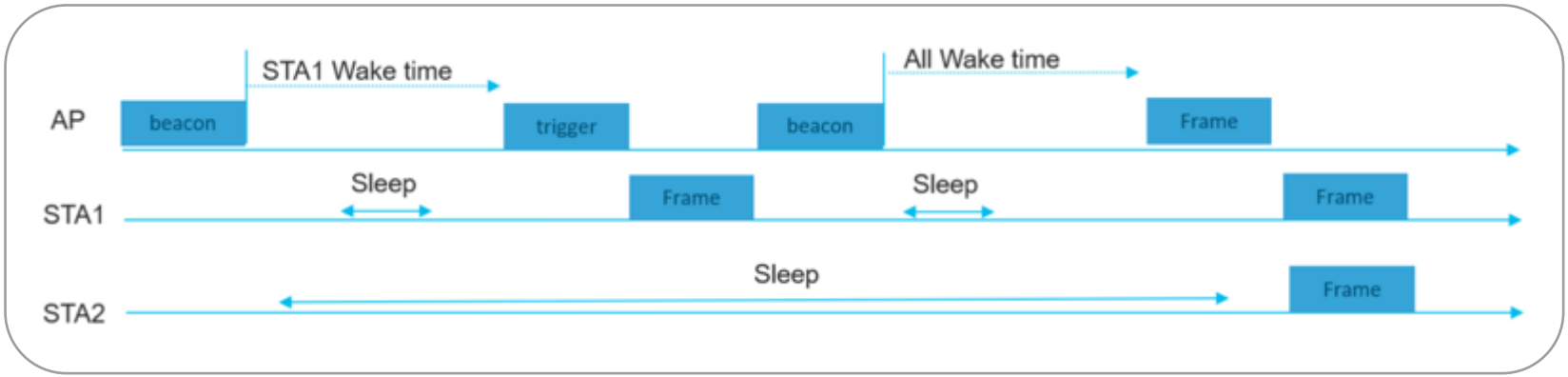
The closer the client is to the AP, THE LOWER it’s transmitted power can be

Target wake time – Putting devices to sleep



Target Wake Time (TWT) provides an effective mechanism to schedule transmissions in time

- With Target Wake Time (TWT), the AP can schedule phones and IoT devices sleep for long durations (**up to 5 years**) and then wake the individual device up.
- Devices can be configured to wake up as a group to communicate at the same time sharing the channel for increased network capacity and reduced battery drain.
- Use of BSS Color field and UL/DL flag in preamble to enable intra PPDU power Saving

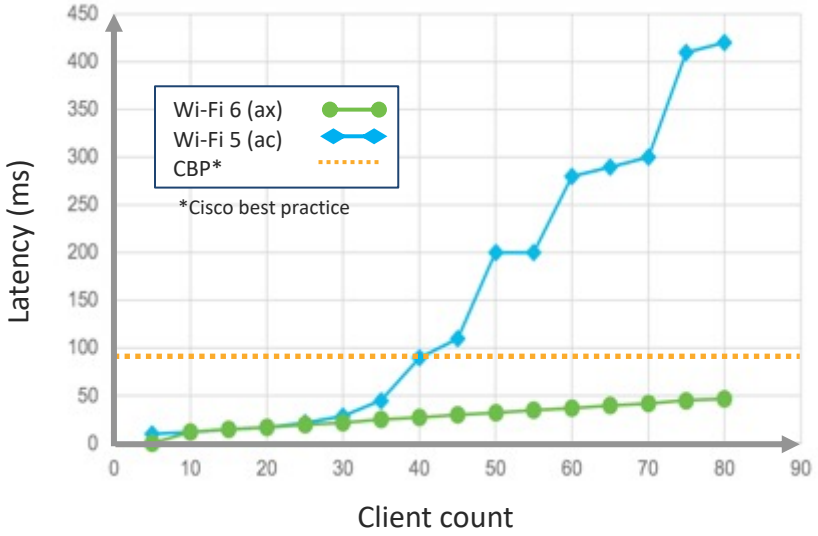


Phones, IoT devices can sleep conserving battery life and then wake to take advantage of multi-user transmissions, and coexist in high-density RF environments

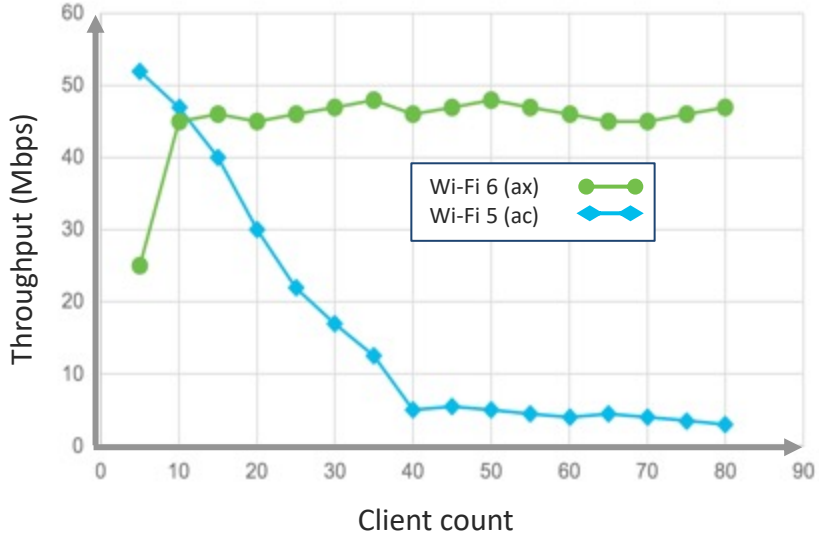
802.11ax (OFDMA) provides determinism at scale:

Enabling high-quality voice/video/data services cost effectively

Linear **VOICE** delay



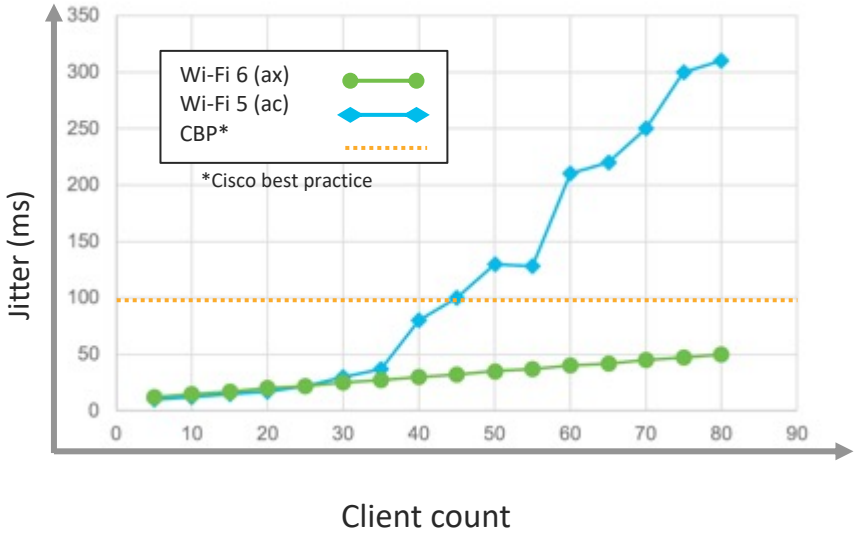
Consistent **DATA** throughput

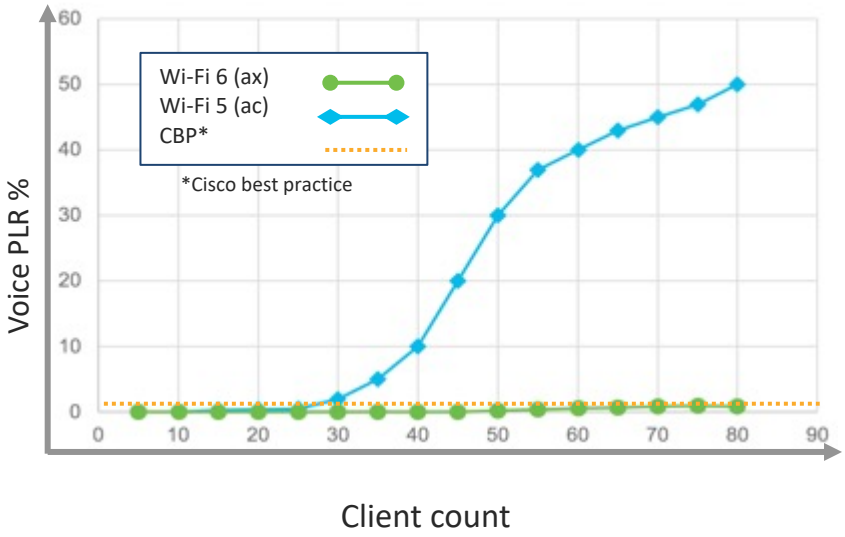


802.11ax is not only cost-effective and ubiquitous but is now capable of delivering SLAs

802.11ax provides higher VOICE/VIDEO capacity

Lower Jitter and PLR (Packet Loss Rate) at increased density

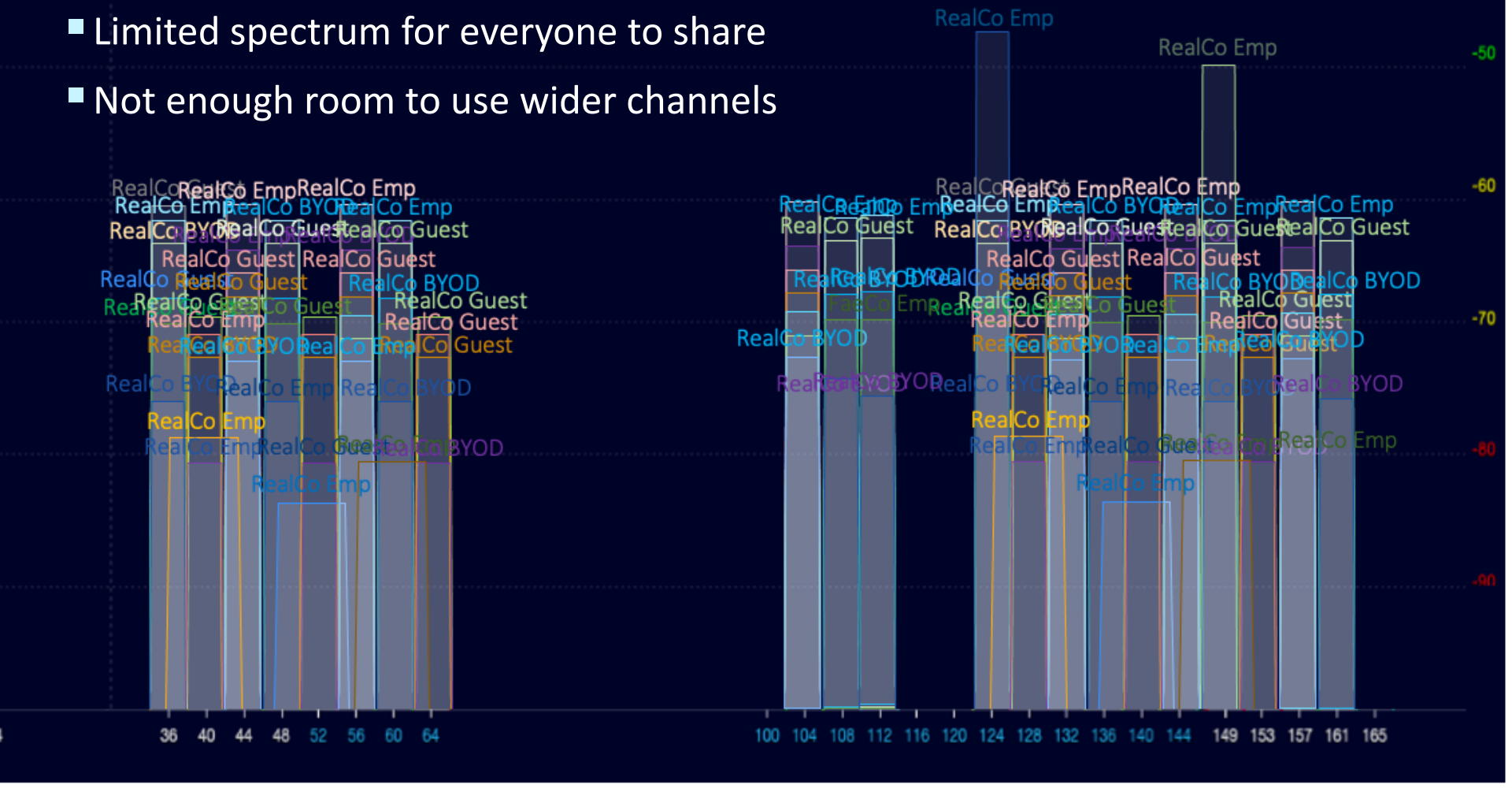




802.11ax can achieve up to 3x the VOICE capacity over 802.11ac in High-Density (HD)

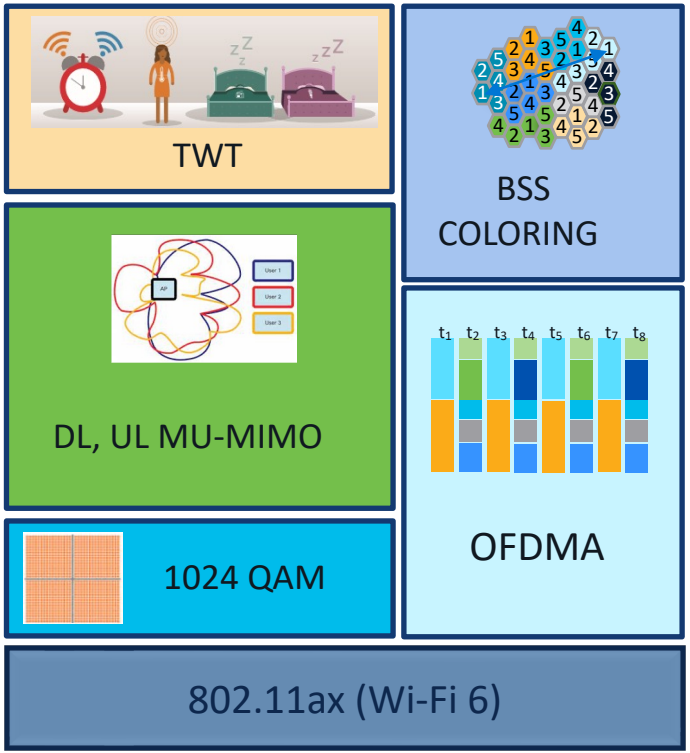
Wi-Fi 6E

- Limited spectrum for everyone to share
- Not enough room to use wider channels



Wi-Fi 6E

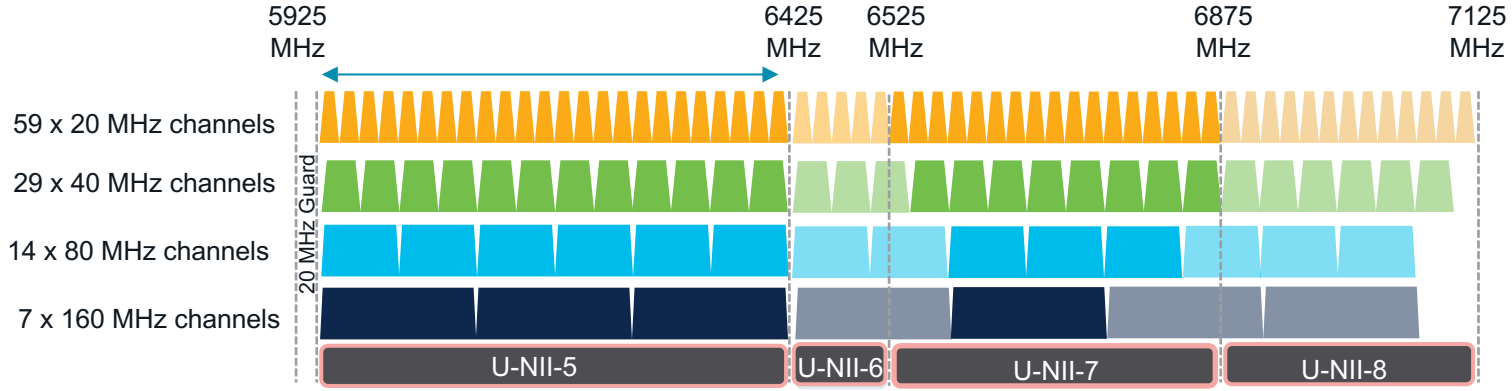
Wi-Fi 6 and 6GHz are friends!



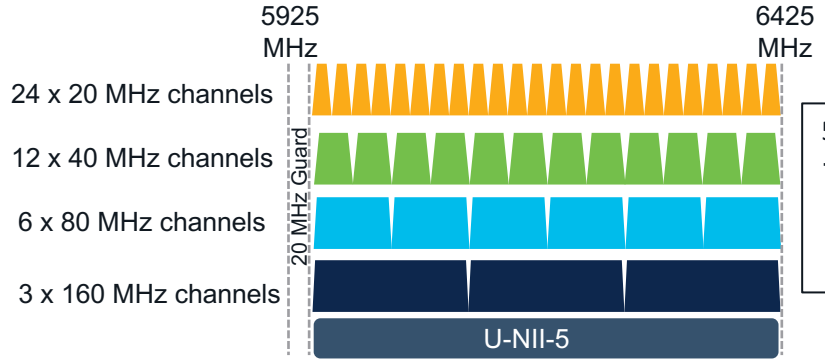
1. **Additional Spectrum**
   1200 MHz (5.925 to 7.125 MHz) – US
   500 MHz (5.925 to 6.425) - EU
2. **Security Upgrade**
   WPA3 and OWE **Mandatory**
3. **Clean RF**
   (Fixed Mobile Service Operators in UNII-5 and UNII-7)
4. **No Legacy (Slow) Devices**
   Improves performance
5. **6 GHz WLAN Discovery**
   Airtime Efficiency
6. **Wider RF Channels**
   80 MHz channels are now a reality

The new 6 GHz band :

United States
1200 MHz



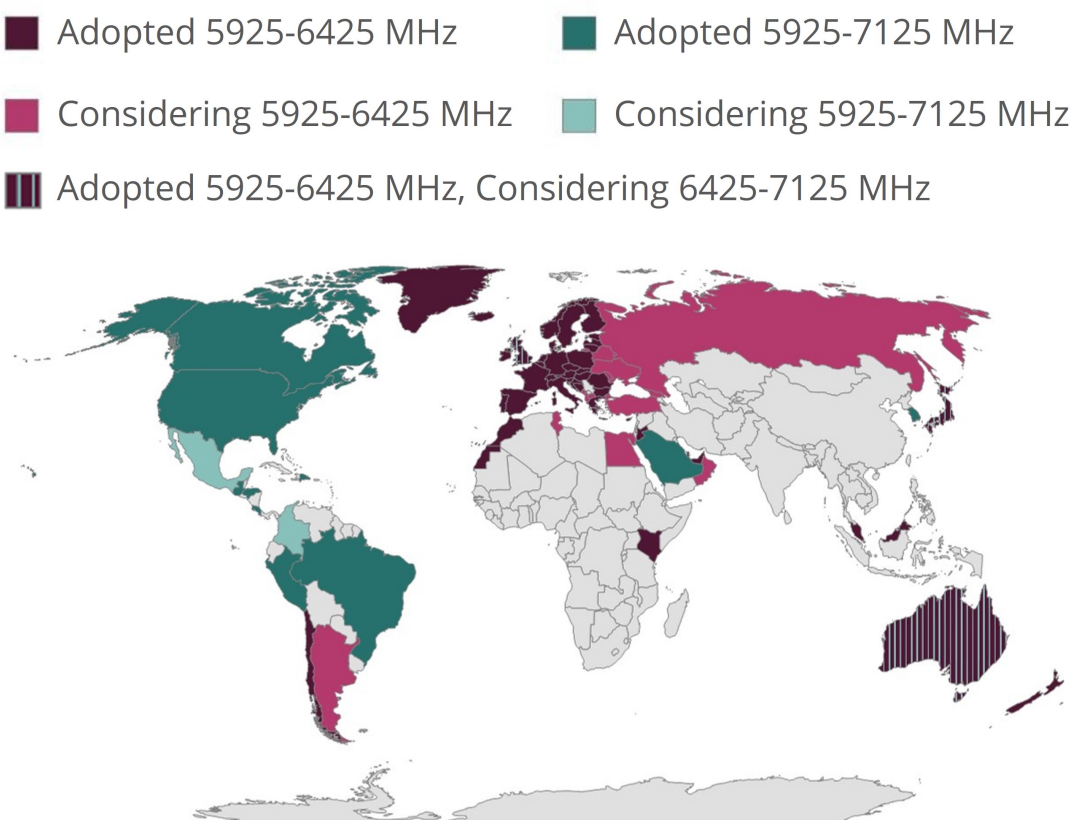
Europe/CEPT
500 MHz



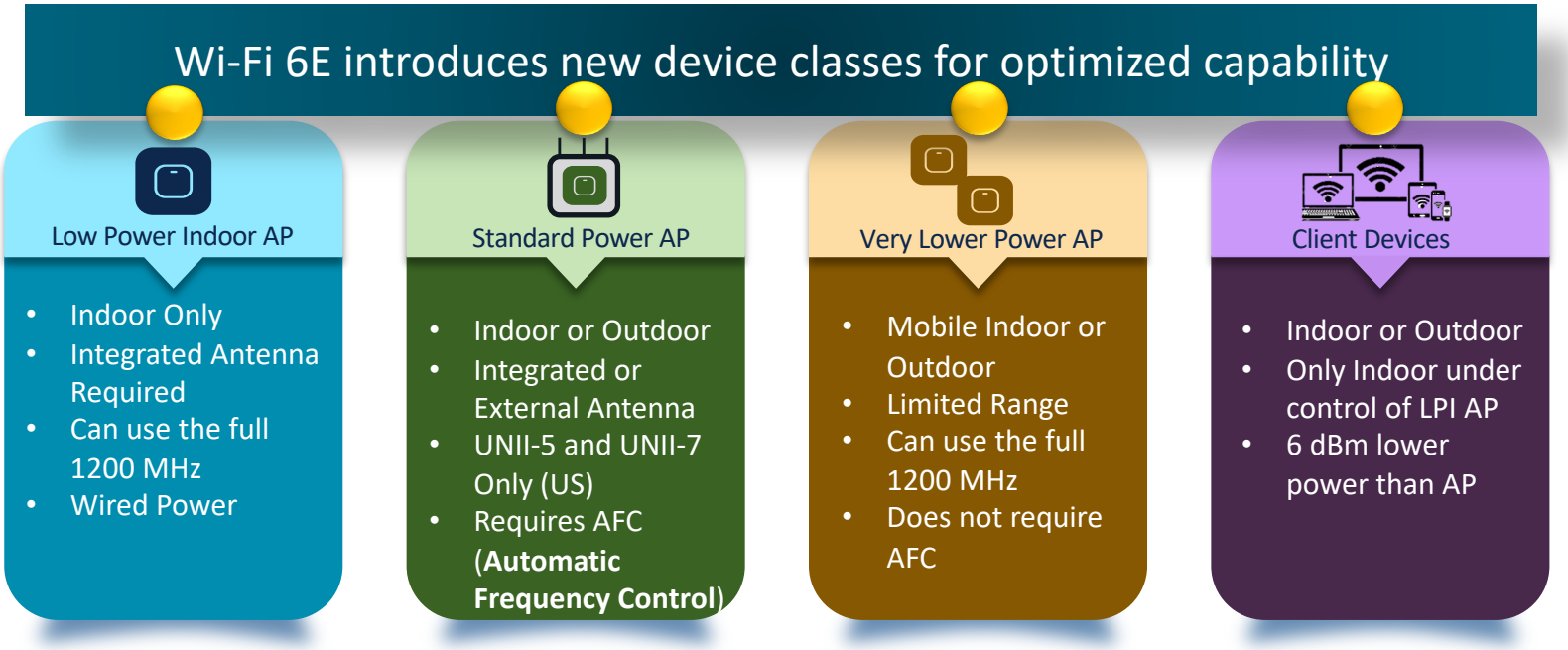
5955 – Central Frequency of the first 20 MHz channel
→ Starting at 5925 MHz +
20 MHz of guard band +
10 MHz to get to the center of the first 20 MHz channel

Global availability of 6 GHz band for Wi-Fi

(https://www.wi-fi.org/countries-enabling-wi-fi-6e)

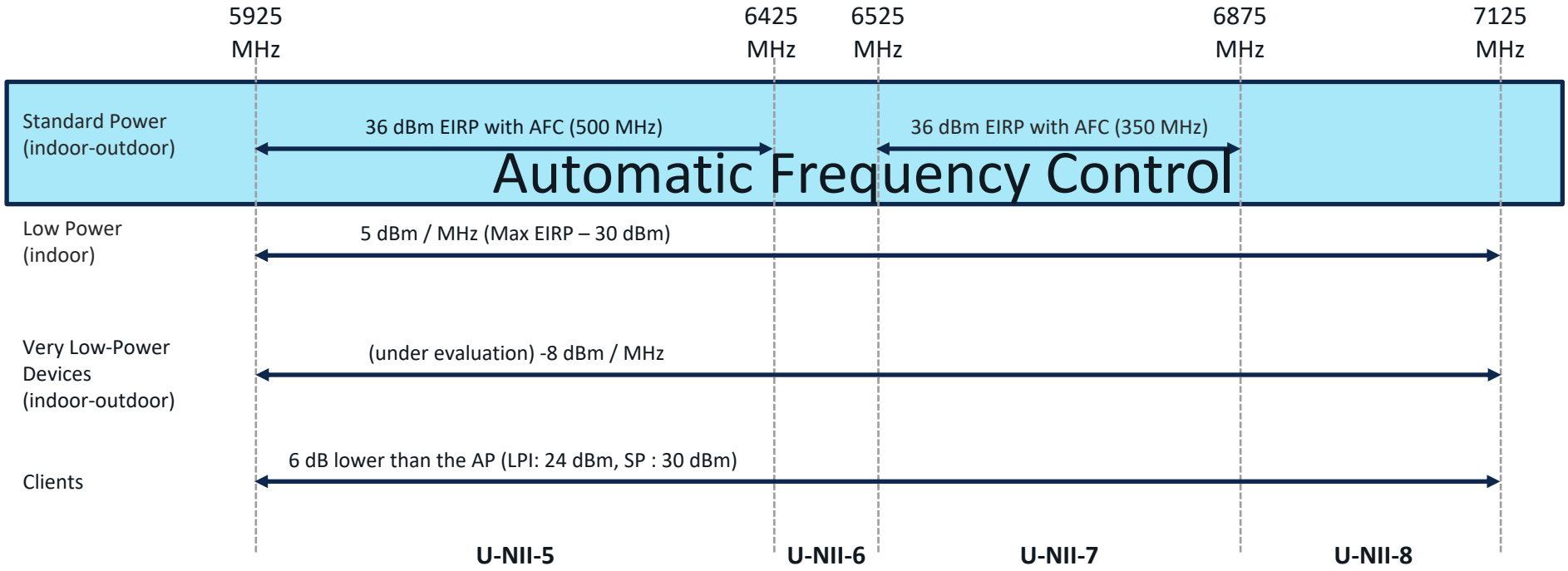


6 GHz – New Device Classes

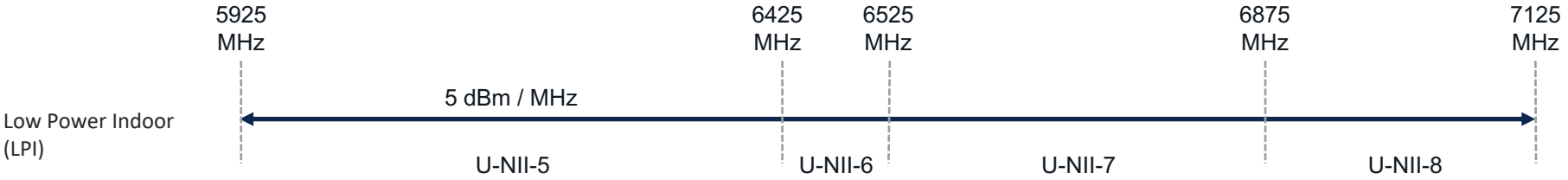


Regulations vary by country

The new power levels



Low-Power Access Points (indoor)



6 GHz power is measured as **Power Spectral Density (PSD)** a Maximum of 5 dBm/MHz is permitted for LPI

5 dBm = 3.162278 mW

3.162278 mW x 20 MHz = 63.24556 mW = 18 dBm
3.162278 mW x 40 MHz = 126.4911 mW = 21 dBm

Client power also has a PSD rule of 6 dB less than the AP's max EIRP

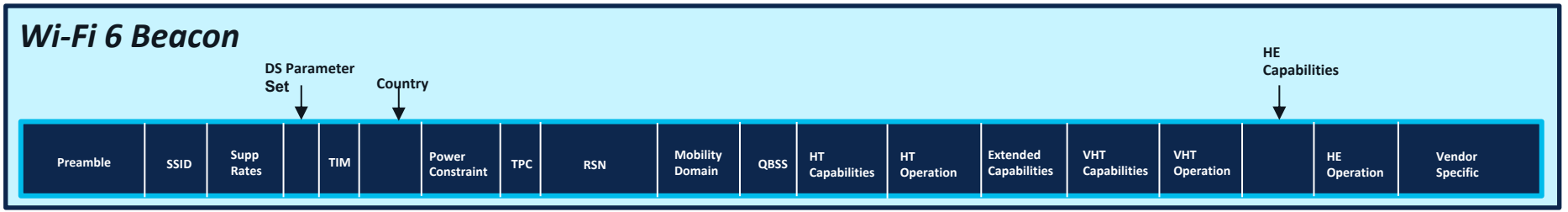
Note: Indoor AP's with an external antenna, must operate under the Standard Power rules, LPI only applies to I models

Channel BW	AP EIRP	Client EIRP
20 MHz	18 dBm	12 dBm
40 MHz	21 dBm	15 dBm
80 MHz	24 dBm	18 dBm
160 MHz	27 dBm	21 dBm

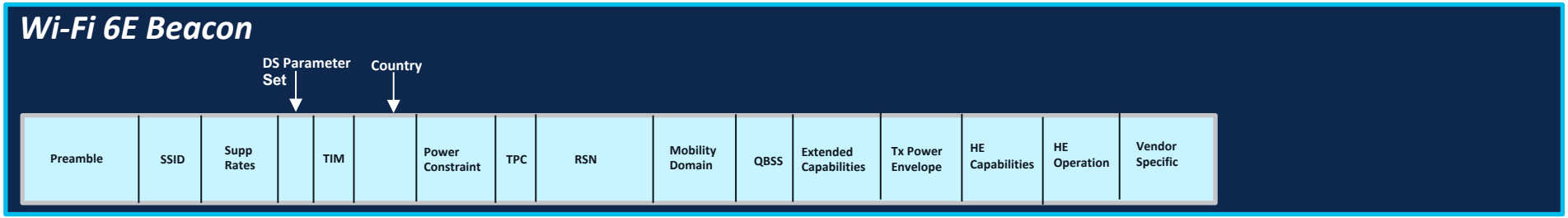
Wi-Fi 6E
some protocol specifics

Wi-Fi 6E Beacon Changes

Legacy HT/VHT Information Element Removed



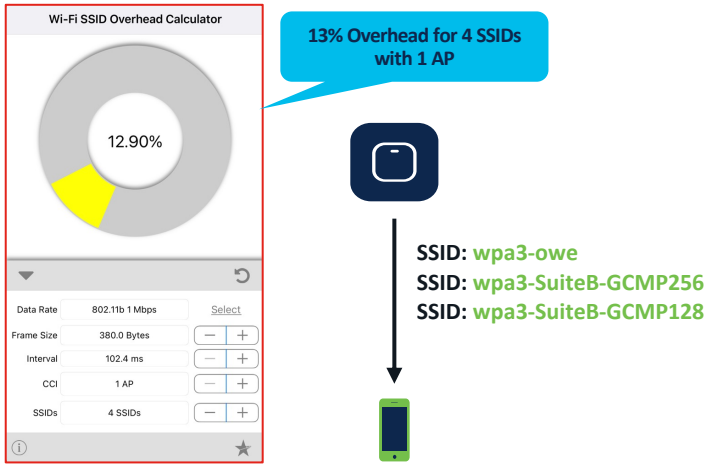
Comparison of Wi-Fi 6 and Wi-FI 6E Beacon Frame

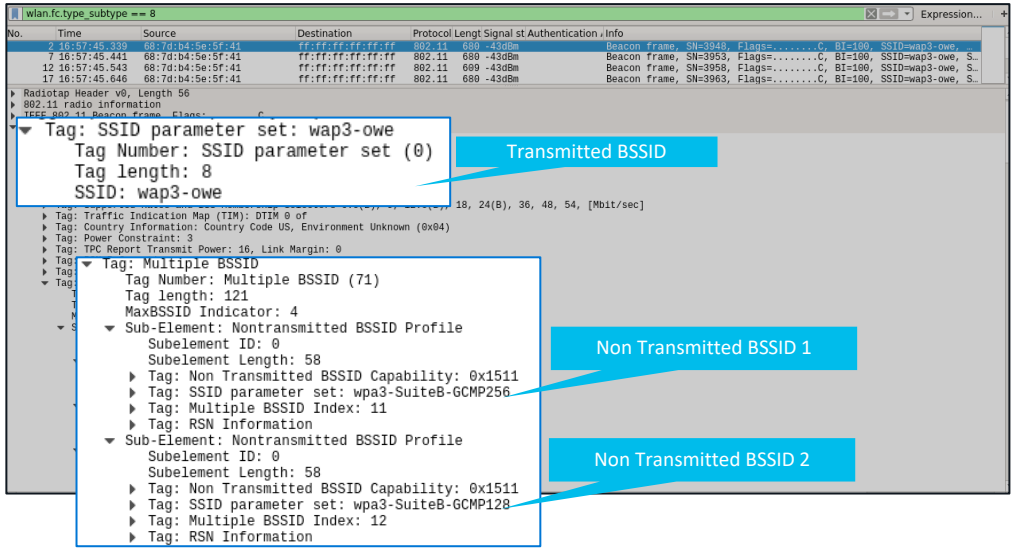


Reduced Beacon Size

Multiple BSSID

- Capability originally specified in 802.11v
- Combines multiple SSID information in a single beacon frame





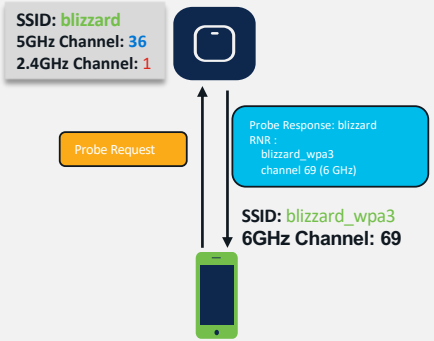
- Conserves Air Time
- Mandated in Wi-Fi 6E

Wi-Fi 6E - New AP Discovery Mechanisms

Out of Band

Reduced Neighbor Report

Co-located Discovery



In Band

Passive Scan:

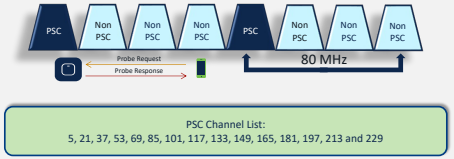
Fast Link Setup (FILS) Discovery Frames

Unsolicited Probe Response Frames

Reduced probe requests with probe response
BROADCASTs every 20ms, with all info as beacon

Active Scan:

Preferred Scanning Channels (PSC)



Wi-Fi 6E Security

Wi-Fi 6E uplevels security with WPA3 and OWE

No backward compatibility with Open and WPA2 Security

Requires Protected Management Frame (PMF) in both AP and Clients

WPA3 and Enhanced Open Security made mandatory for Wi-Fi 6E certification

WPA3 provides a greater value proposition than WPA2 for enterprise Wi-Fi networks

Enhanced security for open Wi-Fi networks with encryption of unauthenticated traffic

Robust password protection against brute-force dictionary attacks

Superior data reliability for sensitive information with 192-bit encryption

Wi-Fi 6E – Client Eco System

Wi-Fi 6E Client Device Eco System

Wide range of client support ..

Samsung Galaxy Ultra S21/S22

Samsung Galaxy Z Fold

Google Pixel 6 /Pro

Xiaomi Mi 11 /Ultra

ASUS Zenfone 8 and 8 Flip

Motorola Edge (2021)

Samsung Galaxy Tab S8, S8+

Laptops with Intel AX210/AX211/AX411 Chipset

Redmagic 6s Pro

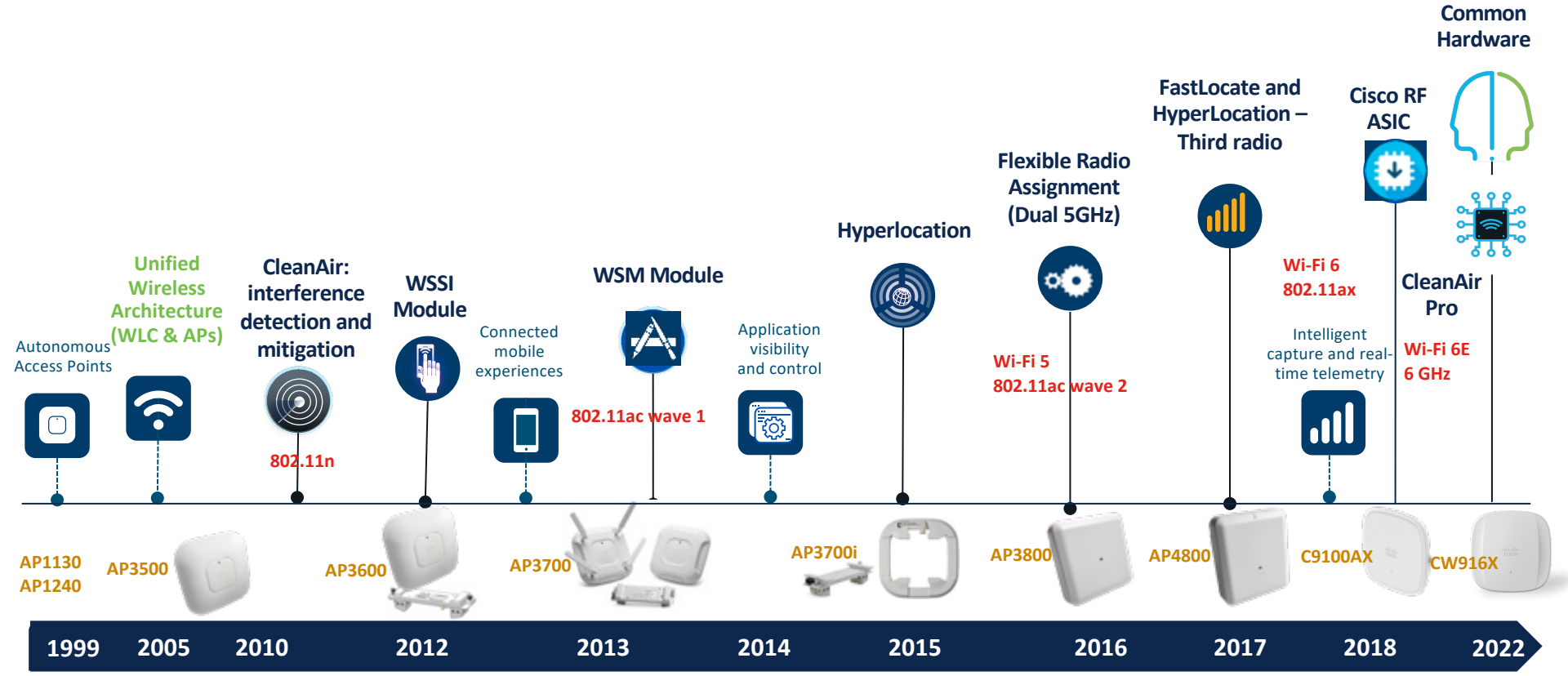
Wi-Fi 6E Chipsets

with more coming soon …..

Cisco Catalyst Wi-Fi 6/6E Access Points

Cisco Wi-Fi innovations

For every major change in WLAN over the last 20+ years



Cisco’s complete Wi-Fi 6E and Wi-Fi 6 wireless stack

Enabling next-generation mobility powered by Wi-Fi 6/6E

Cisco Catalyst™ 9800 Series Wireless Controllers

Cisco Catalyst 9100 Access Points

Industry’s best and broadest Wi-Fi 6/6E portfolio

Managed by

Cisco DNA Center

Translate business intent into network policy and capture actionable insights

Digitized by

Cisco Spaces

Digitize people, spaces, and things

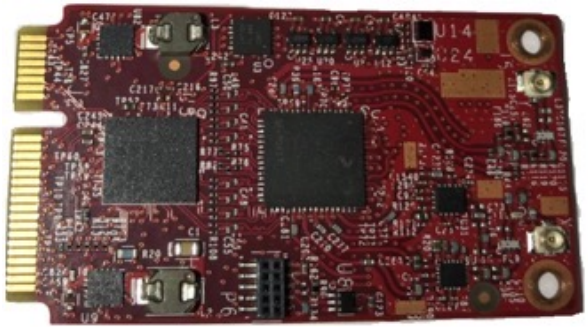
Full-stack network intelligence

Why the Cisco RF ASIC?
Cisco Secret Sauce-meets- Portable Feature Parity

RF ASIC

Services/Features need Spectrum Information	
Location Services	Requires 4 AP's at greater than -75 dB
RRM	Must constructively coordinate the spectrum
CleanAir	Identify and manage non Wi-Fi interference sources
aWIPS/WIDS	Effective security monitors all threat vectors
Rogue Detection	Must monitor all channels for clear resolution
DFS Detection	Highly Regulated, very Important
IoT	Are you the party to whom I have called?

cisco Technology



Cisco custom silicon
Real-Time spectrum analysis

RF ASIC not Available on C9105/C9115

With Cisco Catalyst Wireless, extend security to infrastructure

Interference/Rogue detection

RF Snapshots

WPA3

Wi Fi ALLIANCE

Standards compliant, enhanced security on open Wi-Fi

Enhanced threat detection with ETA

Enhanced device classification and segmentation

Secure and trustworthy systems

Cisco Catalyst 9100 –
The most secure wireless access points

Trustworthy systems help ensure that your IT Infrastructure is secure

- Plug and Play SUDI support:
  Two-way trust
- Image signing:
  Authentic OS

- Secure boot:
  Boot sequence check
- Hardware authenticity:
  Genuine hardware

Cisco Catalyst Wi-Fi 6 portfolio

Ideal for small to medium-sized deployments › Mission critical › Best in Class | Outdoor

9105AX

- 2x2 + 2x2
- MU-MIMO, OFDMA
- Spectrum intelligence
- IoT ready
- 1x 2.5 mGig (WP)
- TWT

9115AX

- 4x4 + 4x4
- MU-MIMO, OFDMA
- Spectrum intelligence
- 1 x 2.5 mGig | 1 x 5 mGig
- TWT

Powered by Cisco RF ASIC

9120AX

- 4x4 + 4x4
- Cisco RF ASIC for Next Gen CleanAir
- Dual 5GHz, Next Gen HDX
- IoT ready
- 1 x 2.5 mGig
- TWT

Powered by Cisco RF ASIC

9130AX

- 8x8 + 4x4; 4x4 + 4x4 + 4x4
- Tri-radio: Dual 5GHz + 2.4GHz
- Cisco RF ASIC for Next gen CleanAir
- Full iCap with data packets
- Dual 5GHz, Next Gen HDX
- IoT ready
- Smart Antennas supporting up to 8x8
- 1 x 5 mGig
- First 8x8 AP with external antennas
- TWT

9124AX

- 4x4; 4x4 + 4x4
- Dual 5GHz + 2.4GHz
- Cisco RF ASIC for Next gen CleanAir
- Full iCap with data packets
- Dual 5GHz, Next Gen HDX
- IoT ready
- 1 x 5 mGig, SFP
- TWT

Bluetooth 5 | USB | Integrated or External Antenna | Cisco DNA Assurance with iCAP

The Cisco Catalyst Wi-Fi 6E portfolio

Ideal for small to medium-sized deployments → **Best in class, flexible** → **Mission critical, resilient**

Catalyst® 9162I*

- 2x2, 2x2, 2x2
- 2.5 Gbps Multigigabit
- DC power
- IoT radio/Bluetooth 5.x
- 4.5W USB

Catalyst 9164I

- 2x2, 4x4, 4x4
- 2.5 Gbps Multigigabit
- DC power
- IoT radio/Bluetooth 5.x
- 4.5W USB

Catalyst 9166I

- 4x4, 4x4, 4x4 (XOR 5/6)
- 5 Gbps Multigigabit
- DC power
- IoT radio/Bluetooth 5.x
- 4.5W USB
- Full Intelligent Capture
- Zero-wait Dynamic Frequency Selection (DFS)
- Environmental sensor

Catalyst 9136I

- 4x4, 8x8, 4x4
- Dual 5 Gbps Multigigabit, active failover
- IoT radio/Bluetooth 5.x
- 9W USB
- Full Intelligent Capture
- Zero-wait DFS
- Environmental sensor

Full radio capability (6 GHz @ LPI) on single 30W PoE+.

AP power optimization | Dedicated radio for CleanAir® Pro | Same bracket, same industrial design

Wi-Fi 7: IEEE 802.11be

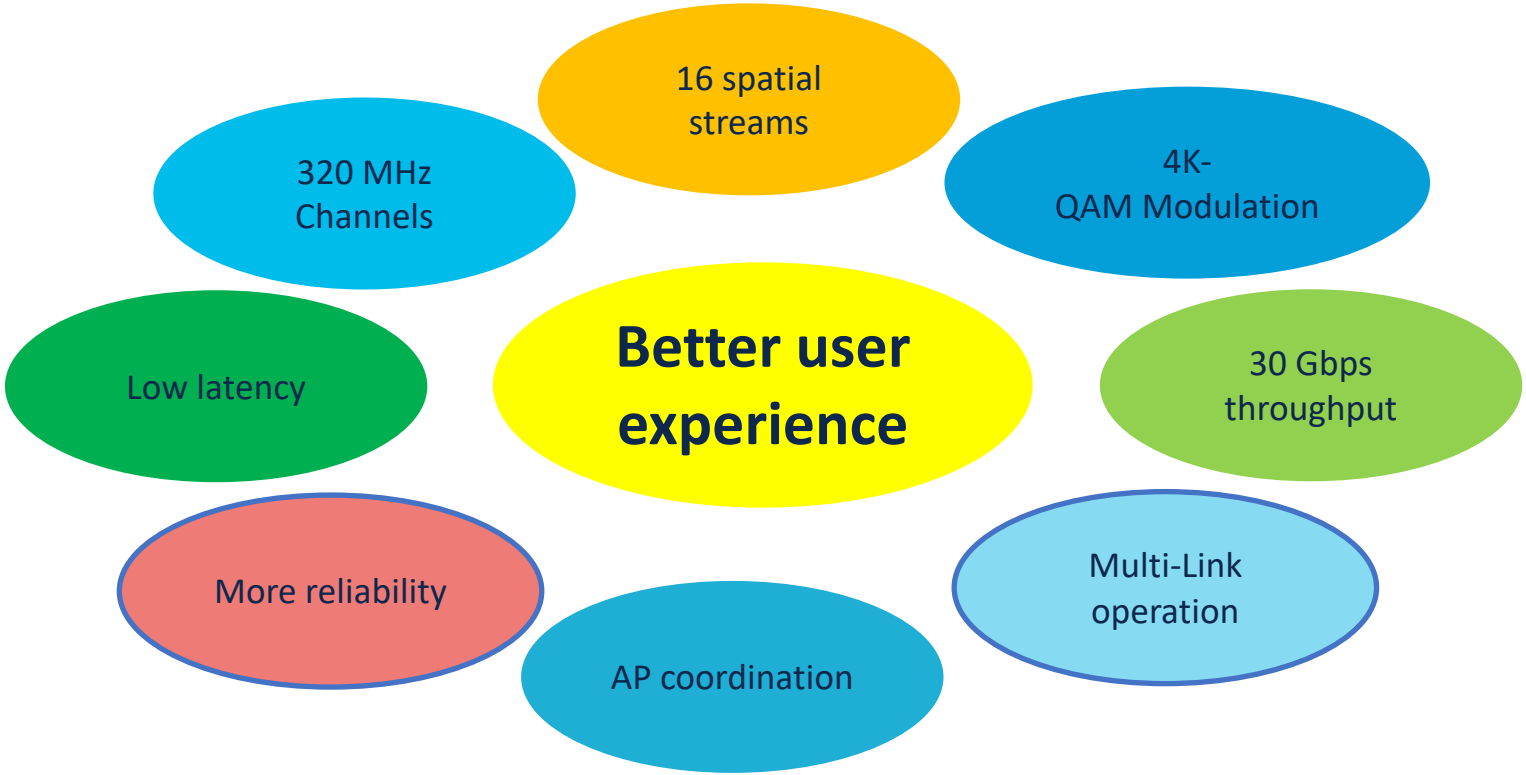
Sometimes is *not* about revolution...

… it's about evolution

Wi-Fi 6 meets your requirements *today*

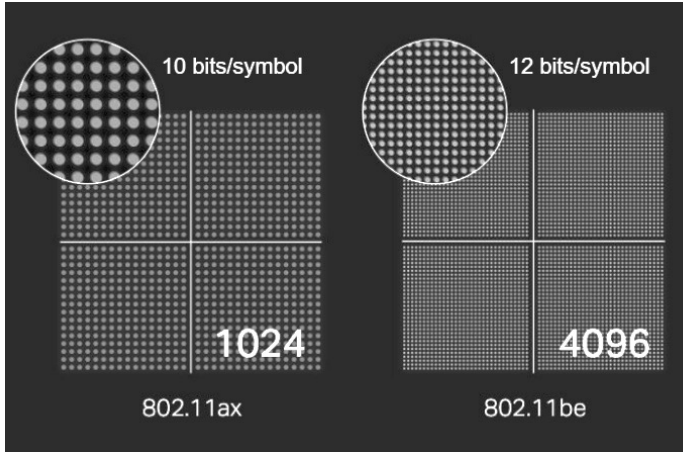
Wi-Fi 7 will meet your requirements *tomorrow*

Wi-Fi 7: Wi-Fi 6E and so much more!



What Wi-Fi 7 brings to the table?

- Wi-Fi 7 will be in 4K QAM and 16 SS support
- 12 bits/Symbol
- Increased throughput - higher MCS 12 & 13 support



QAM

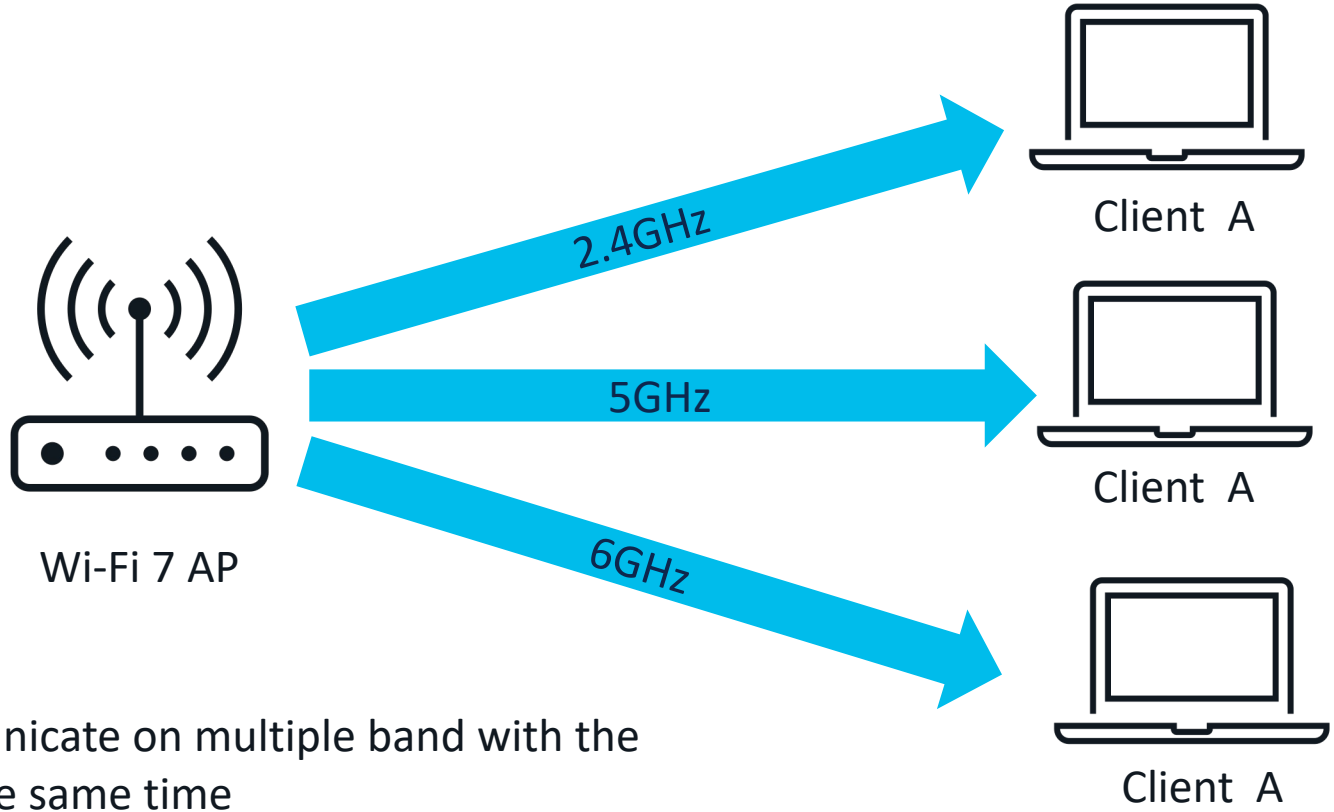
1K

will be

QAM

4K

Wi-Fi 7: Works simultaneously on all bands



MultiLink

Ability to communicate on multiple band with the same client at the same time

How did we get to Wi-Fi 7?

2007

- Wi-Fi 4 (802.11n) ~0.6Gbps
- Use of multiple antennas for high speed

2013

- Wi-Fi 5 (802.11ac) ~3.5Gbps
- Aimed for moving large mount of data from wireless devices

2019-2022

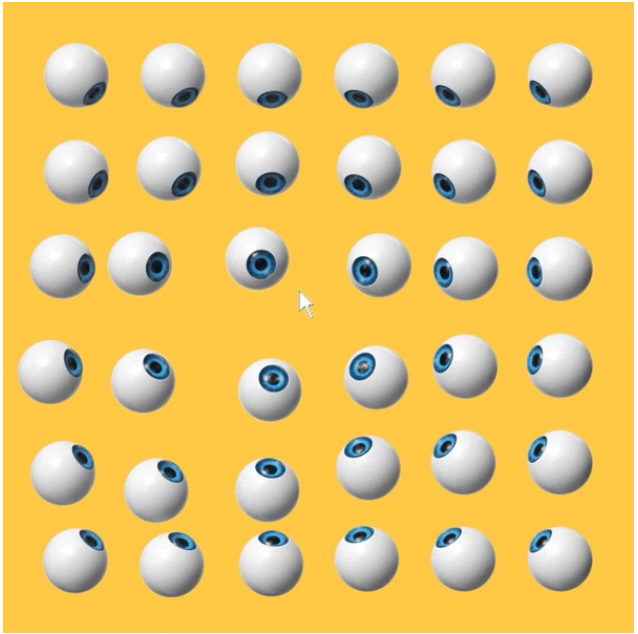
- Wi-Fi 6/6E (802.11ax) ~9.6Gbps
  - Improves co-ordination of data transfer between client devices and AP

~2024

- Wi-Fi 7 (802.11be) ~46Gbps
  - Bring developed for extremely high throughput over the wireless medium

Cisco as One – tracking Wi-Fi 7

- Tracking the IEEE organization very closely as they finalize Wi-Fi 7 draft standard
- Working together as Cisco to track client device vendors for Wi-Fi 7 development
- Keeping everyone in loop as the industry moves towards newer standards



THANK YOU!