The bridge to possible

Lessons Learnt from Cisco IT's Wifi 6E Deployment

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BRKCOC-2526

Cisco Webex App

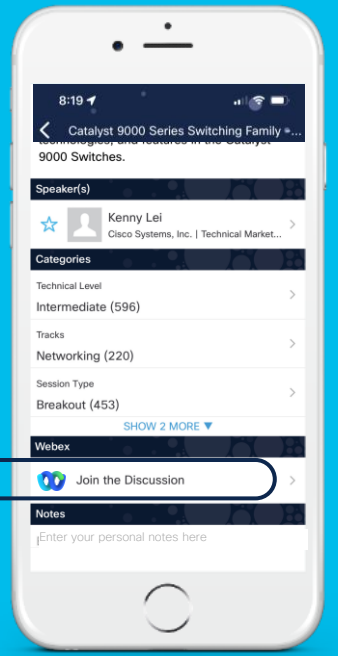
Questions?

Use Cisco Webex App to chat
with the speaker after the session

How

1. Find this session in the Cisco Live Mobile App
2. Click “Join the Discussion”
3. Install the Webex App or go directly to the Webex space
4. Enter messages/questions in the Webex space

Webex spaces will be moderated until February 24, 2023.



Agenda

1. Quick Overview of Cisco IT
2. Quick WiFi 6 and 6E overview
3. RF Design for 6Ghz
4. Mobility & Other Design Considerations
5. Cisco DNAC Assurance
6. Closing Remarks

Quick Overview of Cisco IT

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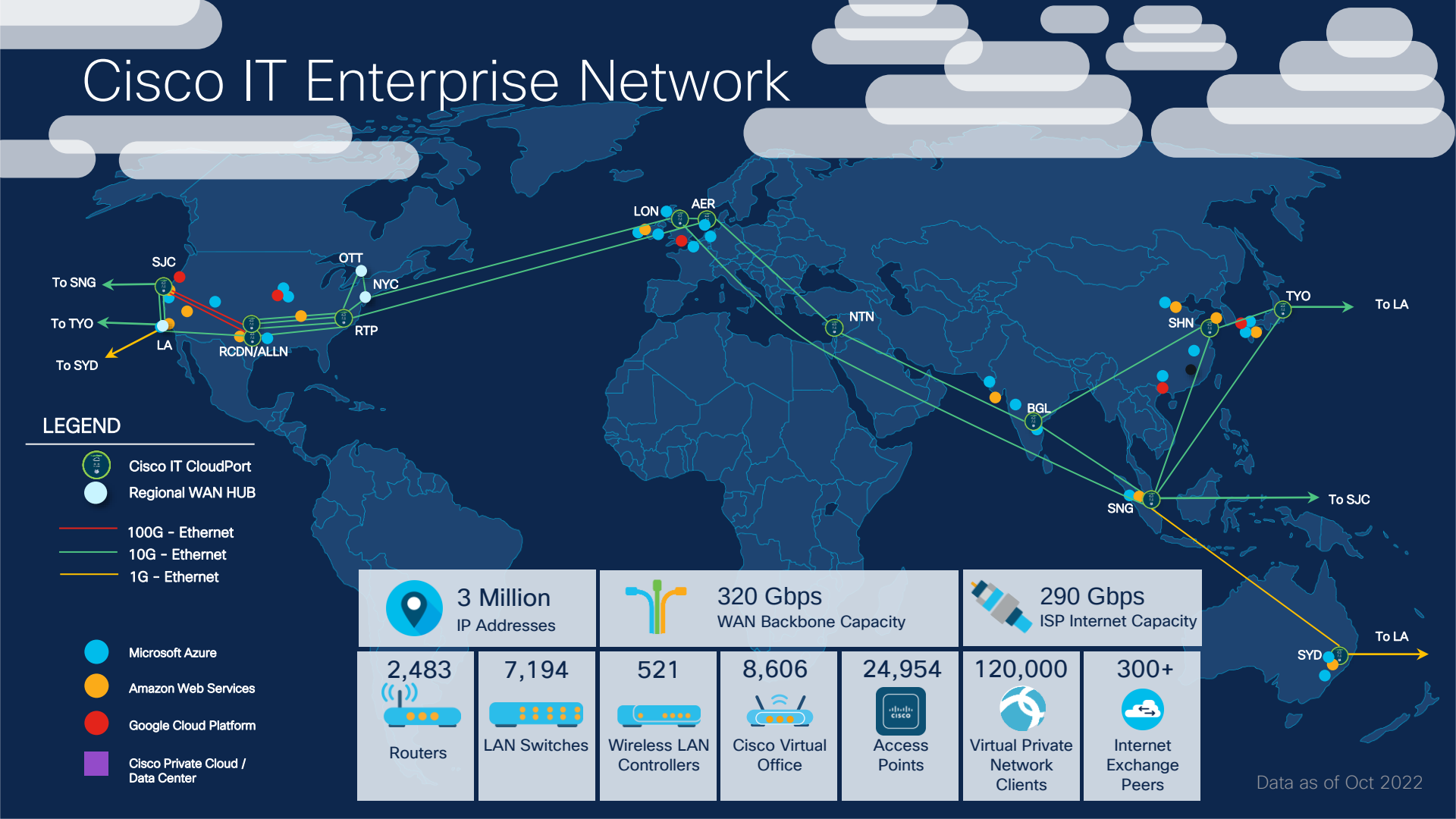
Cisco IT Enterprise Network



LEGEND

- Cisco IT CloudPort
- Regional WAN HUB
- 100G - Ethernet
- 10G - Ethernet
- 1G - Ethernet
- Microsoft Azure
- Amazon Web Services
- Google Cloud Platform
- Cisco Private Cloud / Data Center

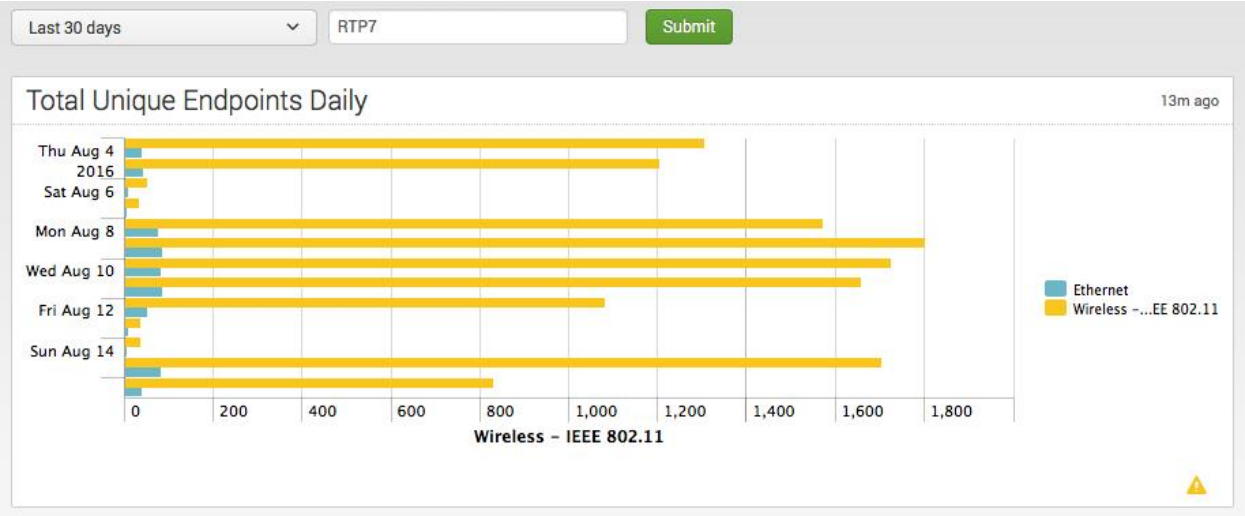
3 Million IP Addresses	320 Gbps WAN Backbone Capacity	290 Gbps ISP Internet Capacity

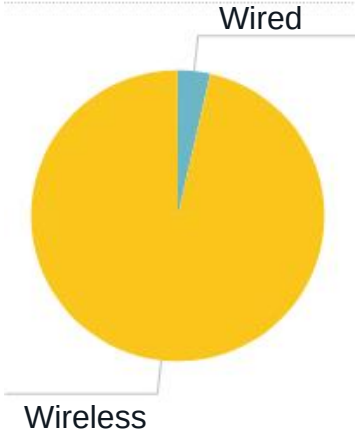
2,483	7,194	521	8,606	24,954	120,000	300+
Routers	LAN Switches	Wireless LAN Controllers	Cisco Virtual Office	Access Points	Virtual Private Network Clients	Internet Exchange Peers

Data as of Oct 2022

Case study: RTP Campus Network

Circa 2016

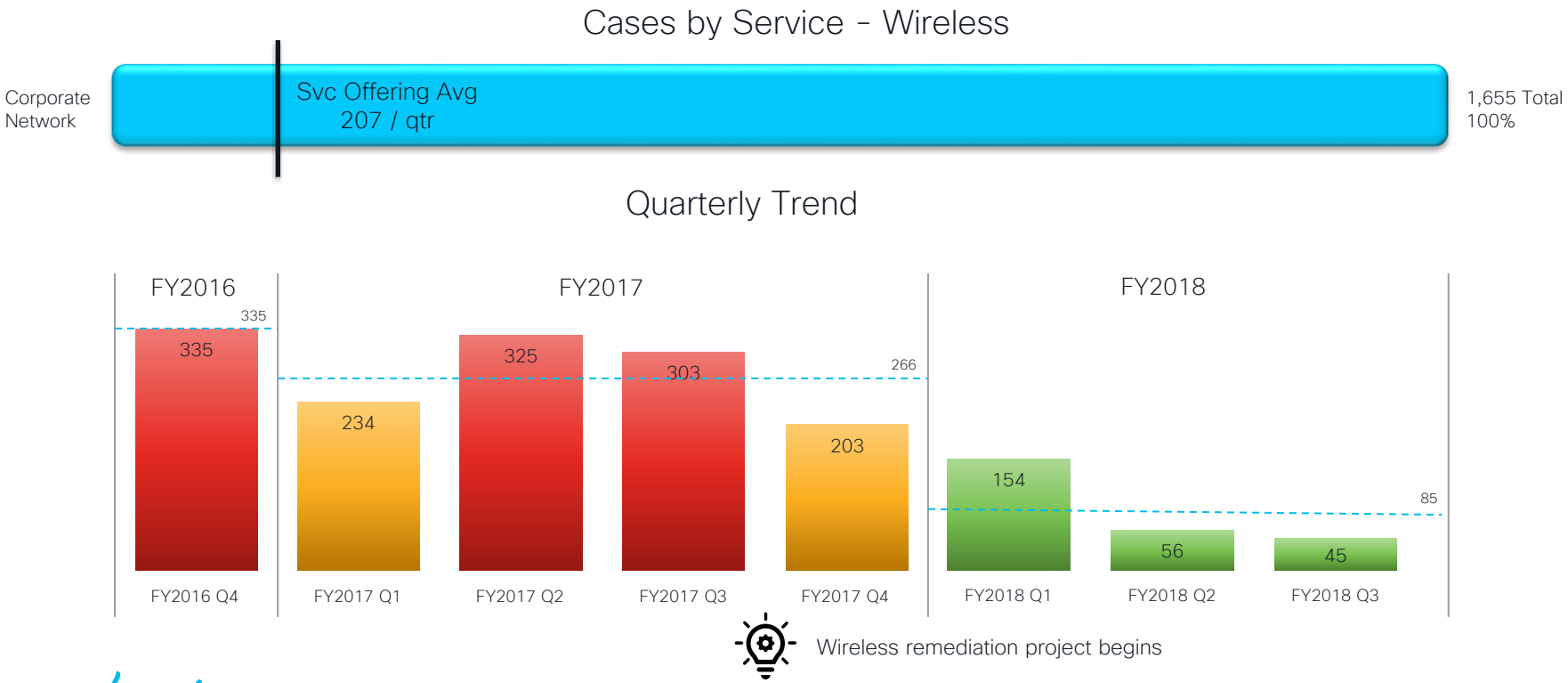




- RTP7/8/9 campus had about 2,587 people at that point in time.
- Total number of Ethernet ports available: 14,882 (inc APs, Badge readers etc). Desktop ports – 12,909
- Number of IP Phones connected via wired: approximately 1,636 / (46 TP Endpoints)

Case Reductions

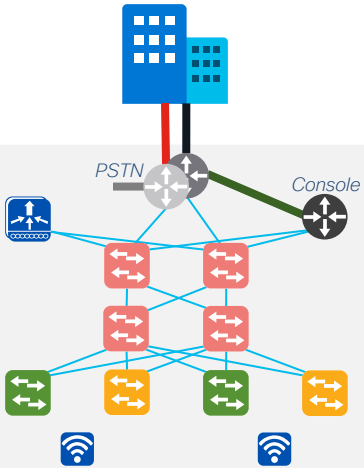
Results of configuration compliance and best practices for wireless

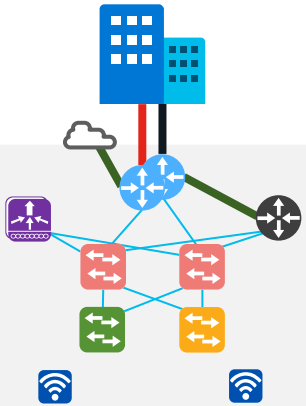


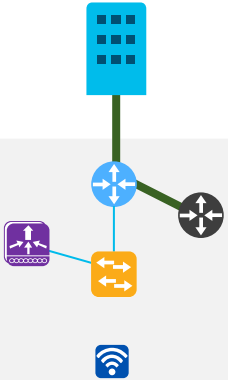
Cisco IT DNA Network Service Catalog

Global Standardized Topologies & Customer Zero Environments

Platinum	Gold	Silver	Bronze	Customer Zero
TAC | 24x7 Contact Ctr | CCIE Lab | IT DC | CBC | Campus	Regional TAC | Regional head office | Eng. DC | Innovation Ctr	Non-critical business functions | Some demos	Light weight | Service office space	Emerging Technologies | New Products | ~5% of Infrastructure







Campus

- SDA Multisite Fabric
- Native IPv6 Building
- DNAC Assurance + TE Enterprise

Branch | Remote

- Viptela SDWAN
- Meraki Virtual Offices
- TE Endpoint

KEY

- Private Line (2nd SP)
- MPLS / Private Line
- Internet (DIA)
- Landlord Internet

4331 | Cat 9500 | Cat 9300 | C9800-L or 3504 | Meraki

4451 | Cat 9400 | C9800-80/40 or 5520 | CW9164, C9130AX or AP4800

Wireless Migrations Take Time

Quick Wifi 6 and 6E Recap

Wi-Fi 6(E) Gain Points

6 GHz Frequency

- Up to 59 new channels (in some countries)
- First greenfield Wi-Fi environment since original standard

Multi-User Modes

- OFDMA & UL/ DL MIMO
- Gains are seen with significant client density and high CU

9130 Tri-Radio

- Cisco IT prefers 8x8 mode
- 8x8 radio mode to raise SNR via spatial multiplexing
- Dual 4x4 mode adds additional coverage cell on oversubscribed APs

WPA3

- WPA3-Enterprise seamless adoption
- Opportunistic Wireless Encryption (OWE) deprecates open auth
- Simultaneous Authentication Of Equals (SAE) deprecates PSK
- Mandatory for 6E

BSS Coloring / Spatial Reuse

- Controlled Co-Channel Interference
- Helps with dense and overlapping deployments

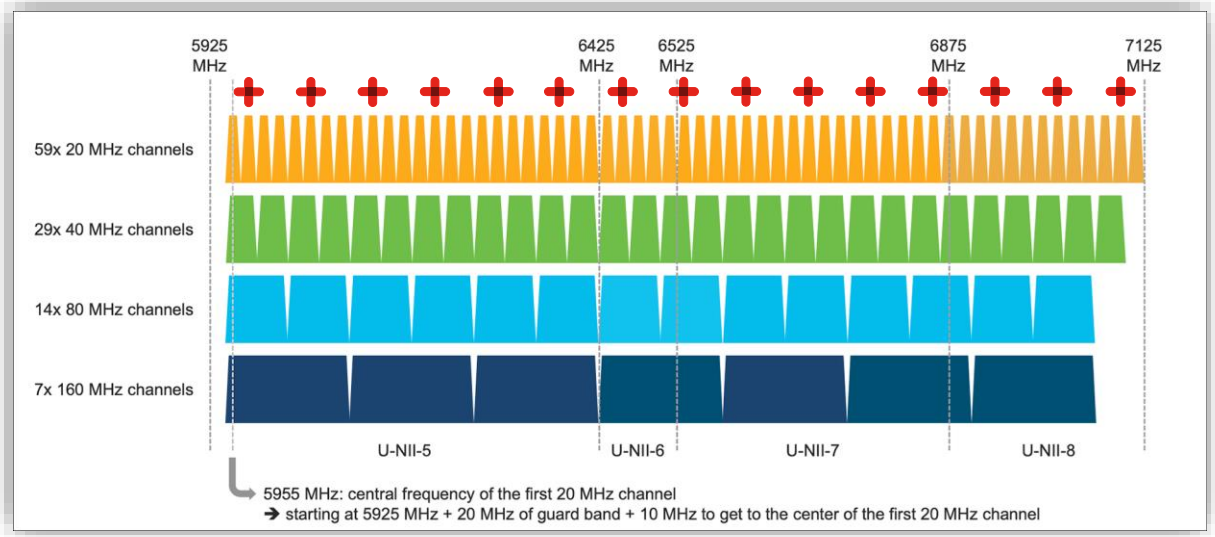
New Data Rates (MCS 10 & 11)

- Requires ≥ 35 dB SNR
- Client capabilities heavily influence actual data rate

Target Wake Time

- Improved battery life and power efficiency
- Possibility to enhance QoS mechanisms

Wi-Fi 6E | 6 GHz Channel Overview



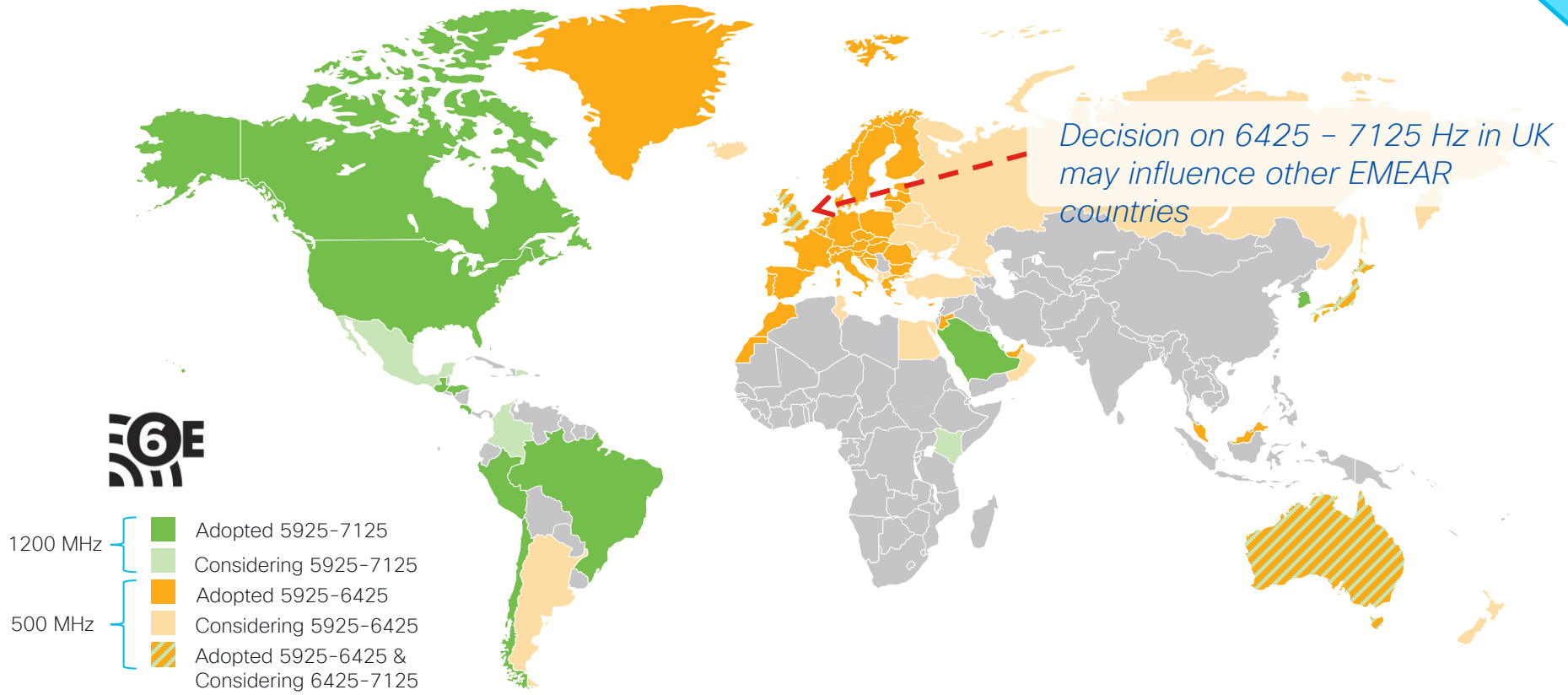
Only 15 Preferred Scanning Channels (PSC) for in-band probing

- 1.2 GHz or 500 MHz of new spectrum
- Up to 59 new non-overlapping channels
- No backwards support for 11a/b/g/n/ac devices
- Some incumbent services, but not many compared to other bands

Wi-Fi 6E: The Next Great Chapter in Wi-Fi White Paper
https://www.cisco.com/c/en/us/solutions/collateral/enterprise-networks/802-11ax-solution/nb-06-wi-fi-6e-wp-cte-en.html?oid=wprwls024270

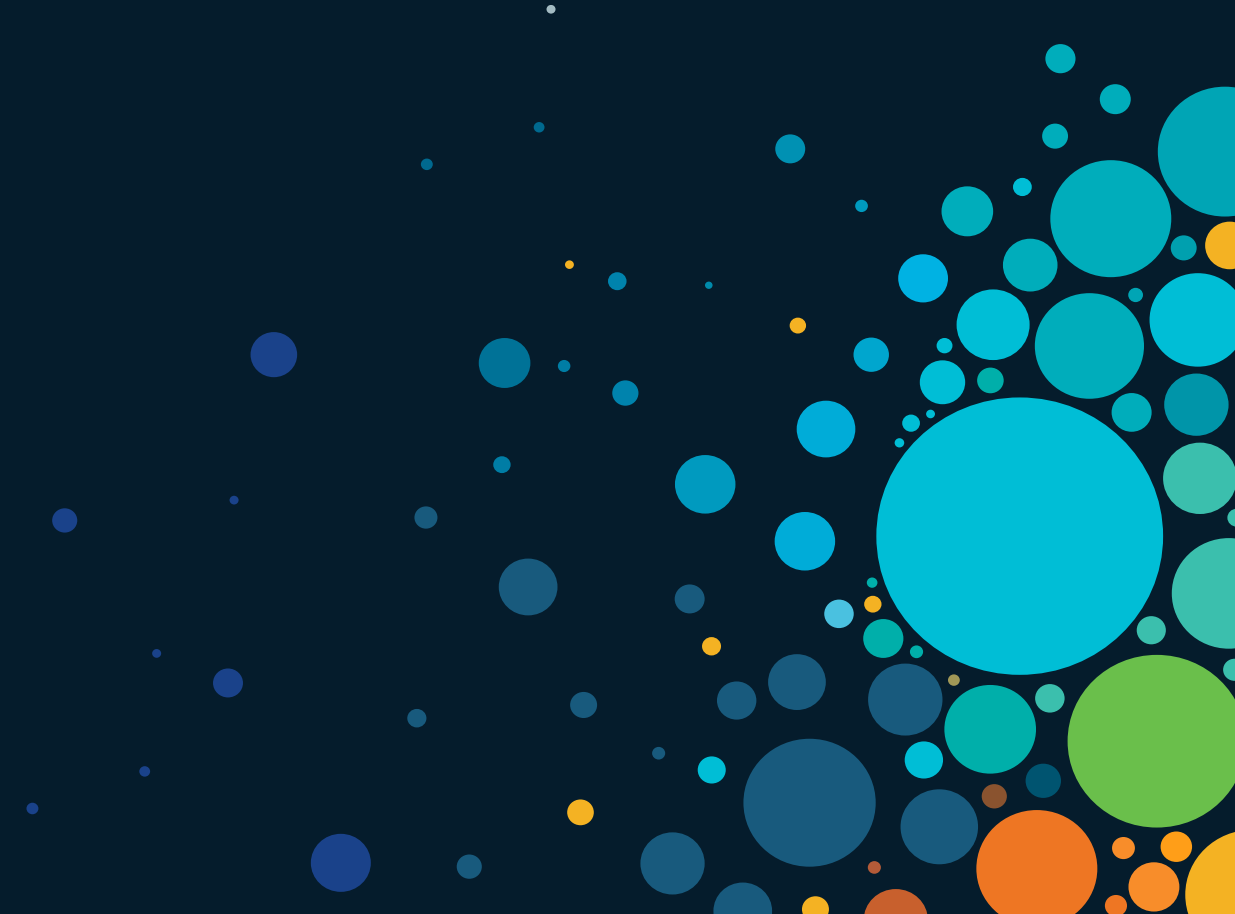
Global 6E Adoption

May 2022



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

Wireless RF Design



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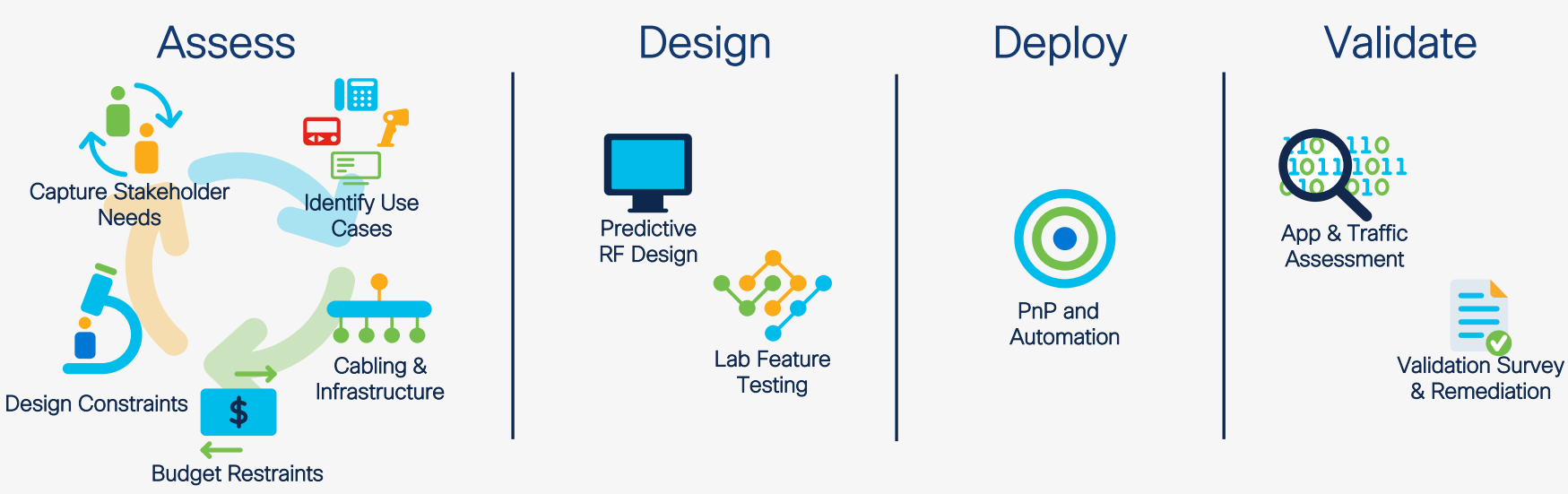
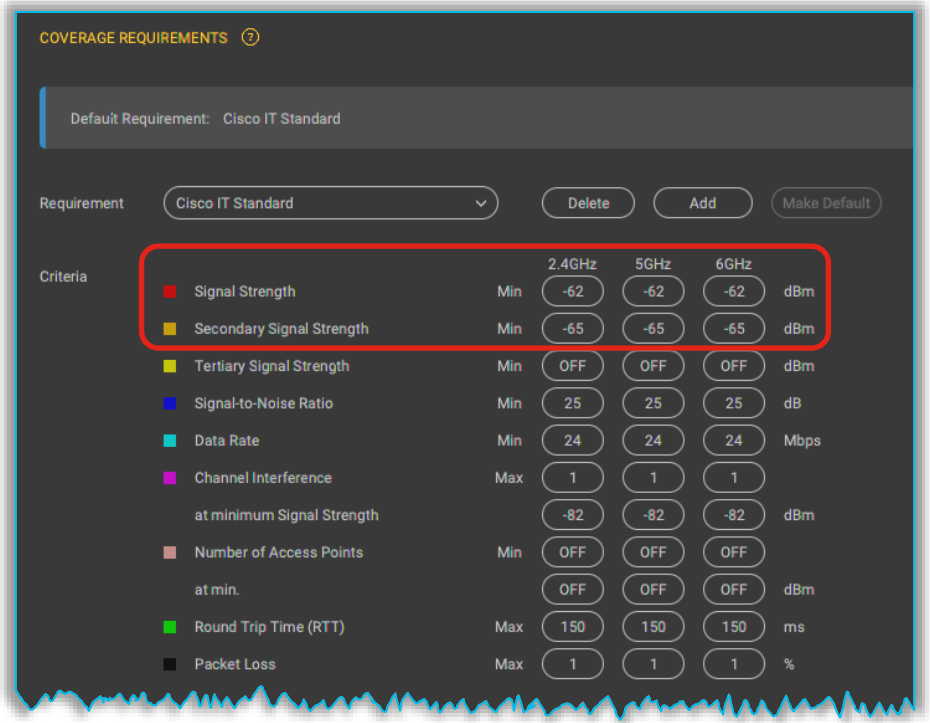
High-Level Wireless Design Approach



TIP

Requirements + *Constraints* = *Design Parameters*

Ekahau AI Pro – Cisco IT Configuration



Cisco IT predictive design settings and site survey targets (indoor designs)

Final Note on Ekahau … AP Tx Power

- 5 GHz
  - Match Tx-Power to weakest client
  - Typical mobile device range: 9 – 14 dBm
  - Ideally, near low/middle of AP range
- 2.4 GHz
  - 3 to 6 dB lower than 5 GHz Tx Power
- 6 GHz
  - Tx power near 10 dBm
  - Ideally, near low/middle of AP range

Reference AP Data Sheet for Tx Power range. Shown: 9136 Data Sheet.

	2.4 GHz	5 GHz	6 GHz
Available transmit power settings	• 23 dBm (200 mW) • -4 dBm (0.39 mW)	• 26 dBm (400 mW) • -1 dBm (0.79 mW)	• 23 dBm (200 mW) • -4 dBm (0.39 mW)

Coverage is easy, Capacity is the real challenge.

- Device lifecycles in a BYOD world can be short, difficult to forecast.
- Application requirements, demands, and device capabilities are ever-changing.
- As user device counts increase, so do the RF demands and challenges.
  - Plan for smaller cells, and more of them.
- More access points are not exclusively the answer.
  - At times, more APs can introduce more issues if not careful.
  - Evaluate where external/directional antennas may be needed.
  - Determine where APs or antennas can be mounted and any challenges / restrictions.
- Open office designs are prevalent, but expand RF footprint per AP.

RRM Configuration Parameters

Customer Zero carpeted-office deployments

Configuration > Radio Configurations > RRM

Use AI-Enhanced RRM, where possible

24 Mbps lowest data rate / only mandatory rate

Legacy channel width … 20 MHz
Wi-Fi 6E channel width … up to 80 MHz (and enforce PSC)

TPC at default values

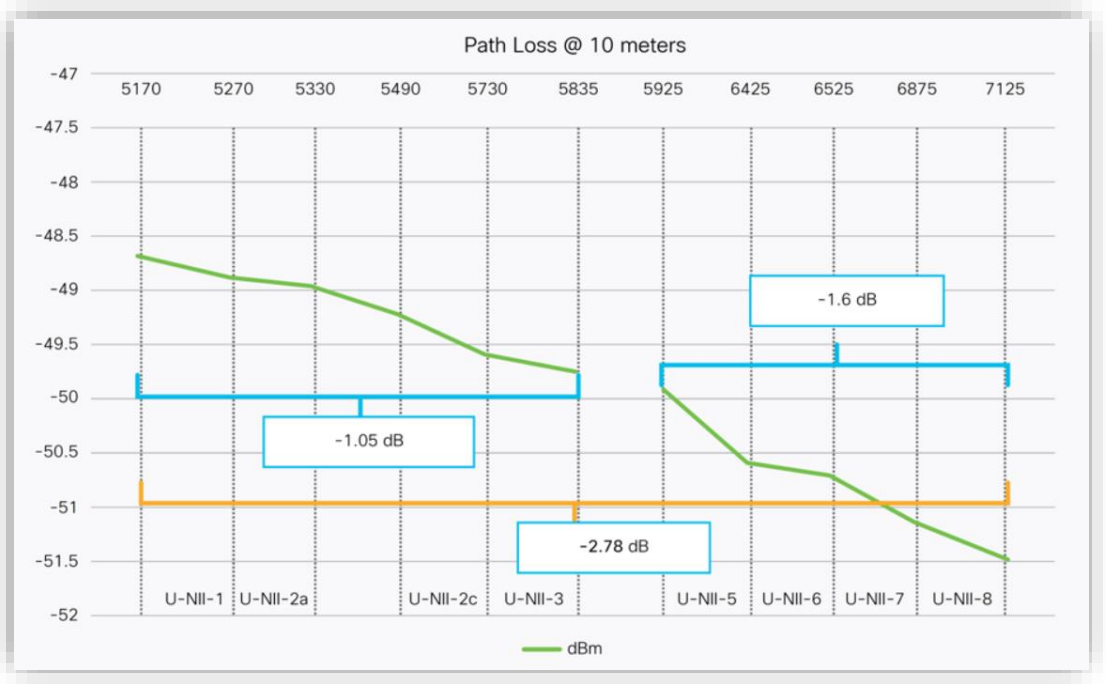
9130s in 8x8 mode is preferred
(though DNAC-version dependent)

Understanding 6E RF and Predictive Design

Additional Free Space Path Loss in 6 GHz band

Just under -3dB loss from start 5GHz to end 6 GHz

Remember, attenuation through objects is higher, too



Wi-Fi 6E: The Next Great Chapter in Wi-Fi White Paper
https://www.cisco.com/c/en/us/solutions/collateral/enterprise-networks/802-11ax-solution/nb-06-wi-fi-6e-wp-cte-en.html?oid=wprwls024270

Our Predictive design – based on 1:1 swap

AP power level 10 dBm, 40 MHz (-ROW domain), Primary & Secondary Signal Strength

5Ghz

6Ghz

Understanding 6E RF and Predictive Design

Prepare for channel bonding – no more SNR penalties when bonding channels

Cisco IT primarily uses 20 MHz in 2.4 & 5 GHz (High AP Density)

However, in 6E bonded channels are more desirable and attainable

- Bonded channels broadcast louder
- Power Spectral Density compensates for SNR hits

```
Serving Frequency: (Slot 3) 5975Mhz channel: 5 20MHz
Configured TX Antenna Selection: [ a b c d ]
Configured RX Antenna Selection: [ a b c d ]
Number of Transmit Antennas: 4
Configured Antenna Gain(dBi): 6
Legal Antenna Gain in use(dBi): 6
Configured Level: 1
Configured TxPower(dBm): 10
Total Supported Power Levels:6
```

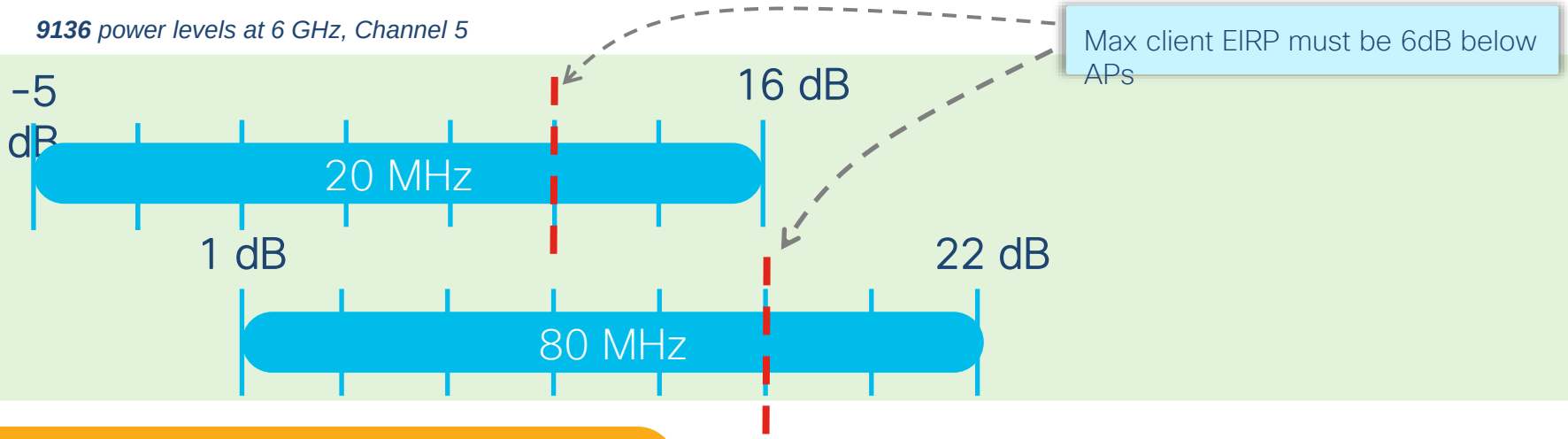
```
Serving Frequency: (Slot 3) 5975Mhz channel: 5 80MHz
Configured TX Antenna Selection: [ a b c d ]
Configured RX Antenna Selection: [ a b c d ]
Number of Transmit Antennas: 4
Configured Antenna Gain(dBi): 6
Legal Antenna Gain in use(dBi): 6
Configured Level: 1
Configured TxPower(dBm): 16
Total Supported Power Levels:8
```

Comparing Tx power at 20 and 80 MHz (6E, Ch. 5)

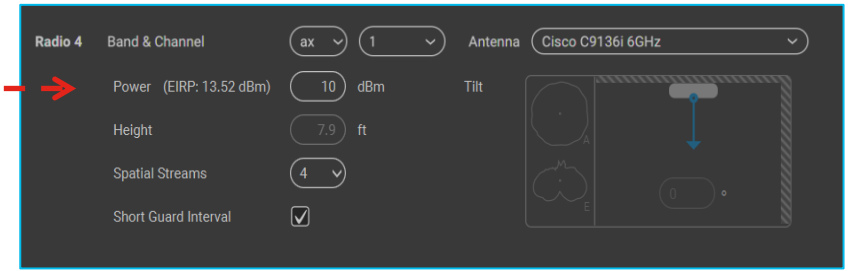
Understanding 6E RF and Predictive Design

Max client and AP EIRPs – Least-common-denominator design

***9136** power levels at 6 GHz, Channel 5*



- Hope for 80 MHz channels
- But design for 20 MHz with 10 dB max client Tx power



Network Discovery in 6E

Legacy bands will drive 6 GHz discovery

Out-of-Band Discovery

Reduced Neighbor Report IE

- Sent from 2.4 or 5 GHz radio on same AP
- In Beacons and Probe Responses
- Tells client channel and 6 GHz SSIDs available

In-Band Discovery

Passive Scanning

- Unsolicited Probe Responses
- FILS condensed beacons

} AP sends every 20 ms

Active Scanning

- Preferred Scan Channels (15 total)

Beacon frame

```
Tag: Reduced Neighbor Report
    Tag Number: Reduced Neighbor Report (201)
    Tag length: 17
  Neighbor AP Information
      .... .... .... ..00 = TBTT Information Field: 0
      .... .... .... .0.. = TBTT Filtered Neighbor AP: 0
      .... .... 0000 .... = TBTT Information Count: 0
      0000 1101 .... .... = TBTT Information Length: Nei
--->  Operating Class: 133 (Channel Width)
--->  Channel Number: 177
    TBTT Information
        Neighbor AP TBTT Offset: 49
--->    BSSID: [redacted]
--->    Short SSID [redacted]
      > BSS Parameters: 0x4c
        PSD Subfield: -1.0 dBm/MHz
```

Cisco IT's Plans for Wi-Fi 6E

1:1 swap (9130 to 6E AP)

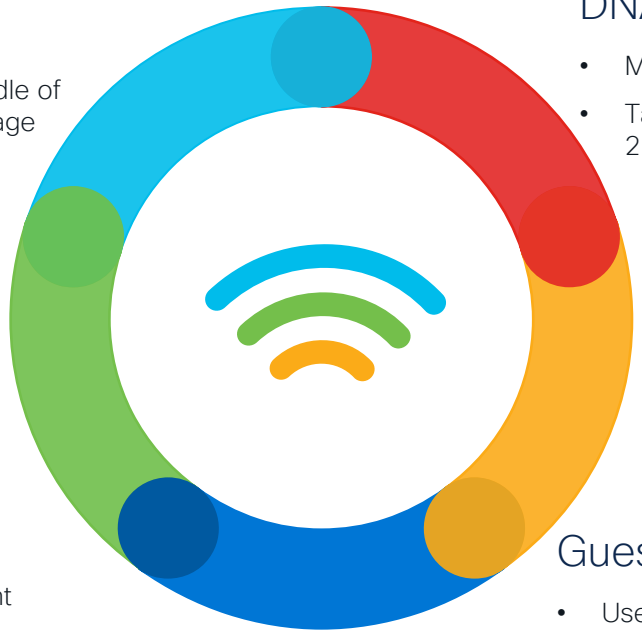
- Radio patterns are similar
- If current 5 GHz power levels are near middle of range, the 6 GHz will provide similar coverage cell

RF Planning

- Predictive design with 80 MHz channels at 10 dBm Tx power
- Allow RRM to set up to 80 MHz channels
- Use AI RRM (requires DNAC 2.2.3.4/Groot)

WPA3

- Initial testing indicates no client compatibility concerns.
- Transition mode available though.



DNAC

- Measure adoption & value with Wi-Fi 6E dashboard
- Targeting Cisco DNA Center release later than 2.3.3.x for full config support

SSID Config

- 6 GHz-only deployments are not possible: Clients need 2.4 / 5 GHz SSIDs for roaming
- Corp SSID to be 5Ghz and 6Ghz only.

Guest

- Use OWE for L2 auth followed by traditional CWA at L3

Some Outcomes and Considerations

Wi-Fi 6E Value Is Influenced By …

Wi-Fi 6 client percentage

- Strong client adoption is seen
- We expect most networks are around 50% Wi-Fi 6 clients, even lower 6E (for now)

Density of clients and AP cells

- MU modes have highest impact in networks with high CU and high client density

Existing network performance

- Greatest Wi-Fi 6(E) gains will be seen in legacy networks with poor performance

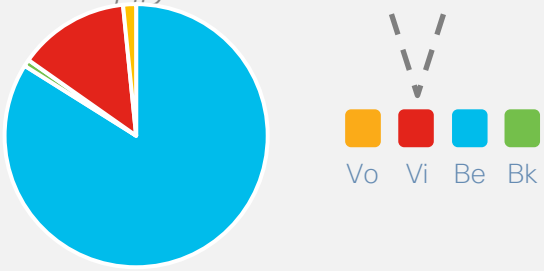
Client feature support

- Example: while Wi-Fi 6(E) MCS may be higher, raw data rate may be lower due to SS limitations

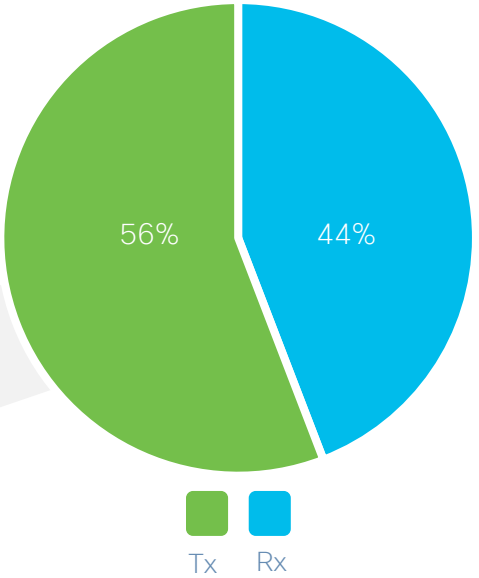
Our Wi-Fi 6 Traffic Analysis
SJC CZ Campus

- *DNAC provides graphical view of Tx efficiency by 802.11 UP for Good RSSI Clients (>-55 dBm)*
- *Wi-Fi 6 and Legacy traffic are nearly equal in performance*

Tx Data Bytes by UP



Total Data Bytes



Wi-Fi 6 Data Rate Analysis

SJC 20-22, Oct. 4 at 3 PM, 421 Wi-Fi 6 Clients

Most Wi-Fi 6 clients have good RSSI

Most good RSSI clients use their highest MCS

But, Wi-Fi 6 clients max out at 2 Spatial Streams, leading to slightly lower data rate than Wi-Fi 5 clients with 3 SS

Capability	Max MCS	Data Rate
Wi-Fi 5	MCS 9, 3 SS	288.9 Mbps
Wi-Fi 6	MCS 11, 2 SS	286.8 Mbps

Key Takeaways:

- While the majority of our clients are Wi-Fi 6, client capabilities in the new band lag legacy clients
- Our network design is proving highly effective at maximizing client potential

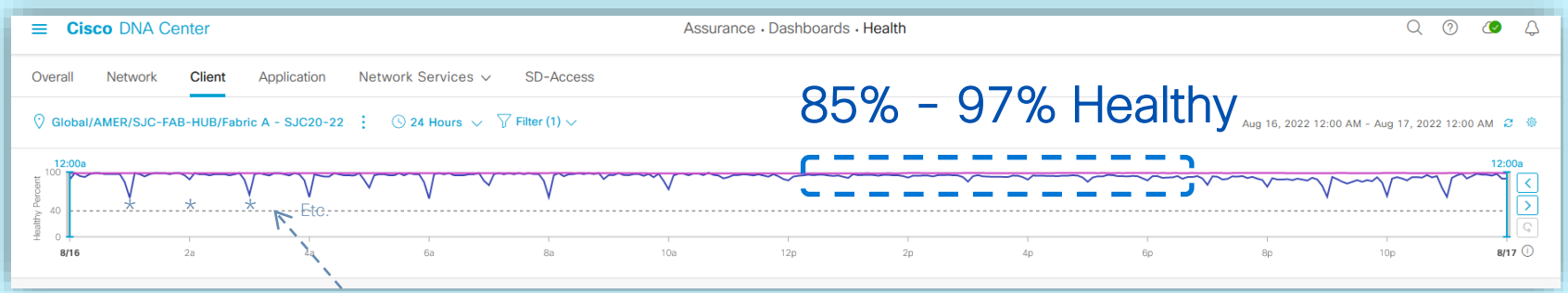
A look at our network with DNAC Assurance

SDA Fabric A - SJC20 – SJC22

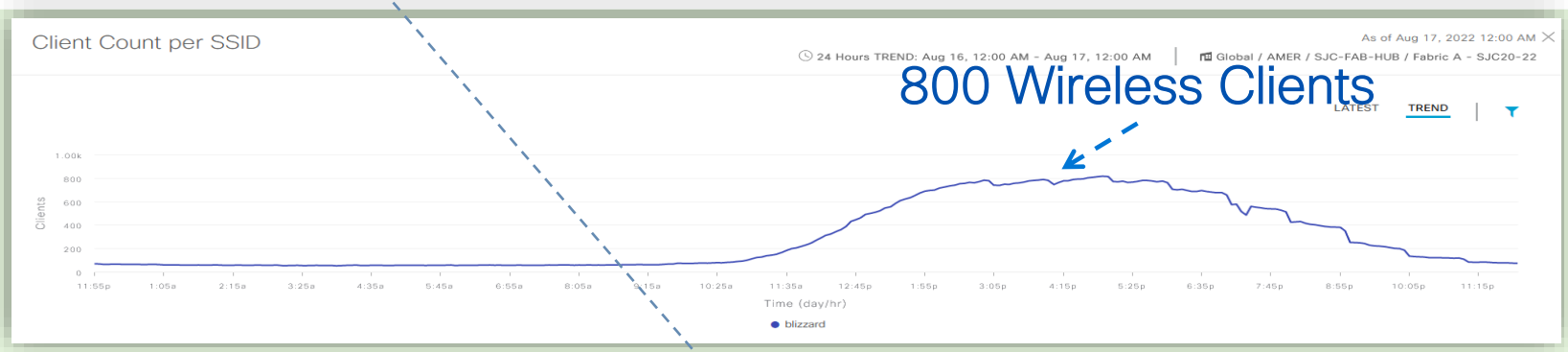
DNAC Assurance

Assurance · Dashboards · Health

HEALTH SCORE

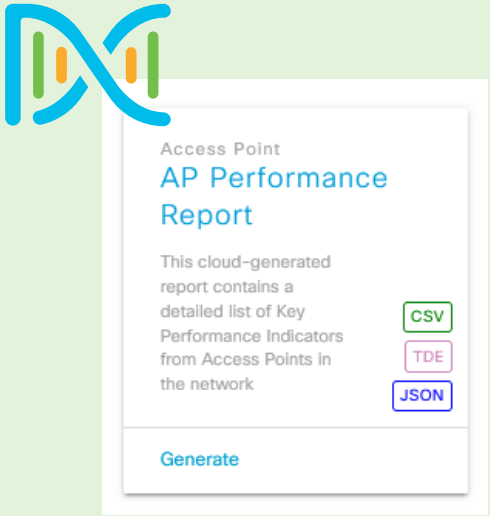


CLIENT COUNT



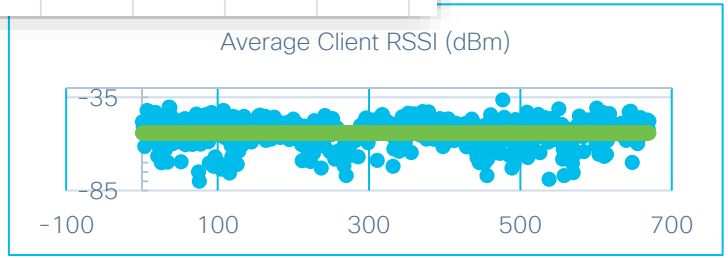
*Idle client timeouts

SDA Fabric A – SJC20 – SJC22
DNAC Assurance



- Reports are metric-rich
- Good for historical data and custom analysis
  - Example: combining RSSI + SNR data to estimate noise floor

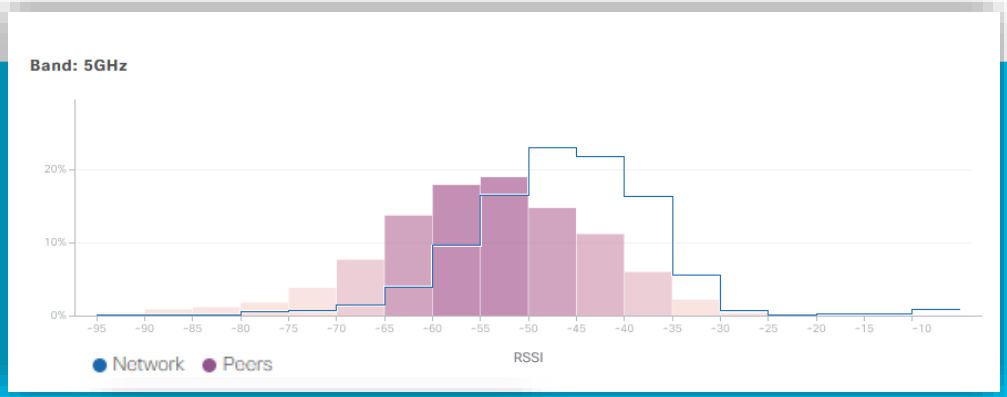
	A	B
1	Filters	
2		
3	Location	Global/AMER/SJC-FAB-HUB/Fabric A - SJC20-22
4	Band	5 GHz
5	Start Time	2022-08-16 12:00:00.000 PM EDT
6	End Time	2022-08-16 20:00:00.000 PM EDT
7		



SDA Fabric A – SJC20 – SJC22

Comparison to our peers

Assurance · AI Network Analytics · Peer Comparison



Interference
0% - 10%

Network	98.72%
Peers	96.73%

Packet Failure Rate
0.0% - 5.0%

Network	100.00%
Peers	98.30%

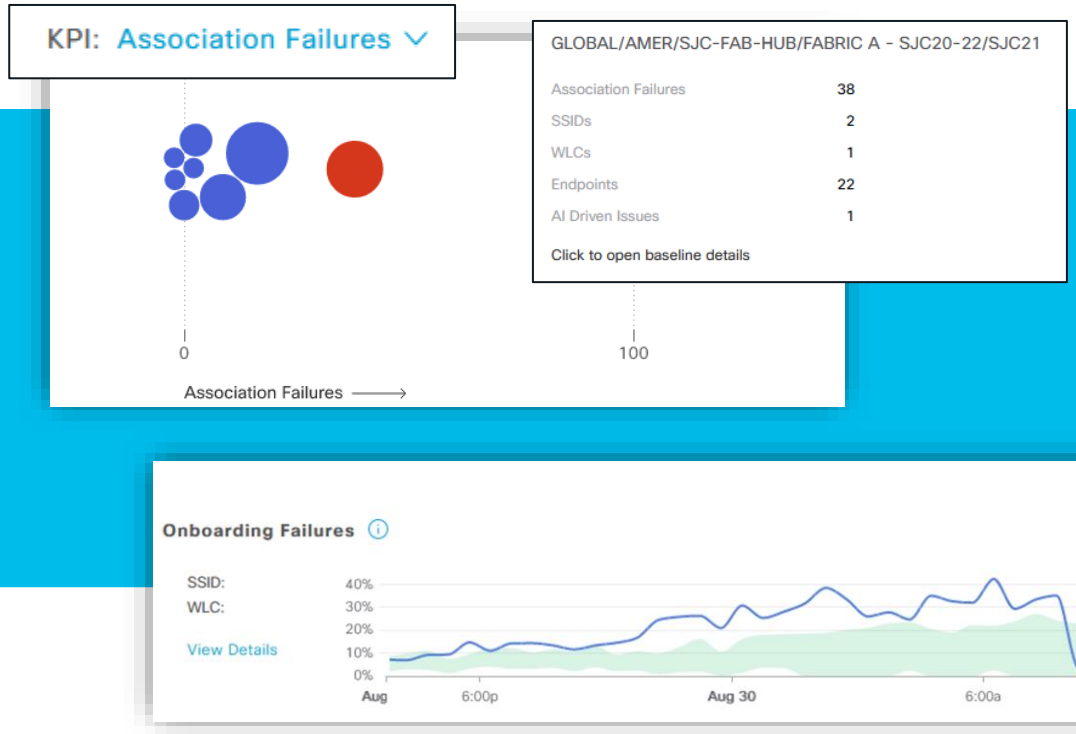
Our clients have higher RSSIs than peers

At same time, our interference and Packet Failure Rates are slightly below our peers

SDA Fabric A – SJC20 – SJC22

Comparison between segments of our own network

Assurance • AI Network Analytics • Baselines



- AI/ML Baseline Data helps us identify deviations from normal failure amounts
- Also allows comparison between buildings and floors within same network

Closing Remarks

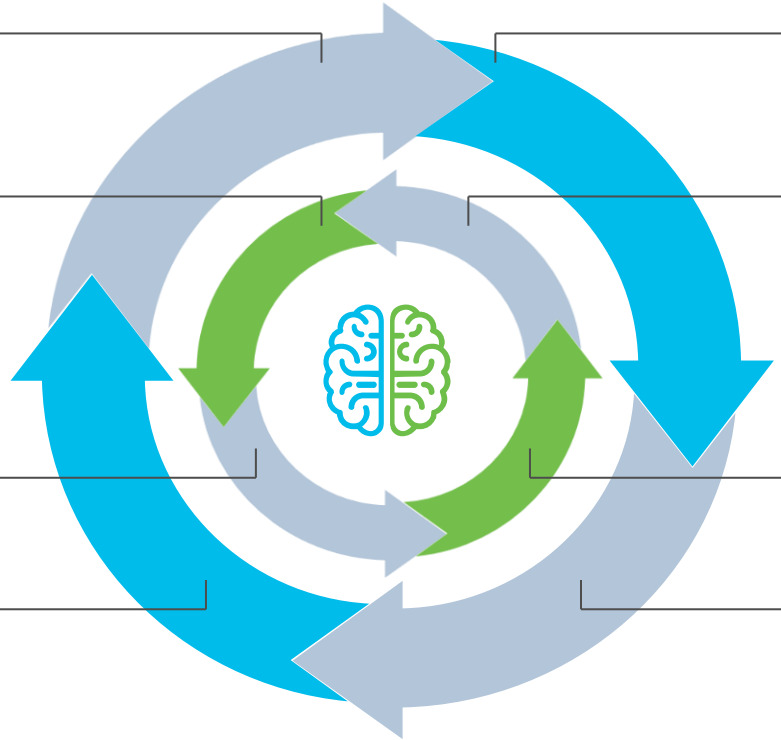
Quick Recap & Final Thoughts

Requirements
Understand RF, device, and app requirements

Day 2+ Operational Considerations
Automation at scale and Assurance insights. Cisco DNA Center a factor.

Wi-Fi 6E
Time to start learning and planning for 6 GHz designs.

QoS
Consider wired + wireless QoS and associated details



Density Needs
Plan for more cells, but consider directional antennas as needed.

Redundancy
Plan for appropriate redundancy at multiple points from radio access to WLC to wired layers.

Continuous eval
Continue to determine and refine requirements and needs

Client Mobility
Facilitate seamless handover for optimal roaming performance

Complete your Session Survey

- Please complete your session survey after each session. Your feedback is very important.
- Complete a minimum of 4 session surveys and the Overall Conference survey (open from Thursday) to receive your Cisco Live t-shirt.

- All surveys can be taken in the Cisco Events Mobile App or by logging in to the Session Catalog and clicking the "Attendee Dashboard" at https://www.ciscolive.com/emea/learn/sessions/session-catalog.html

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