



ATLANTA, GA
OCTOBER 11-14

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UNLEASH THE POWER OF LIMITLESS CONNECTIVITY



2021 Fall
Technical Forum
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Wireless Access Network

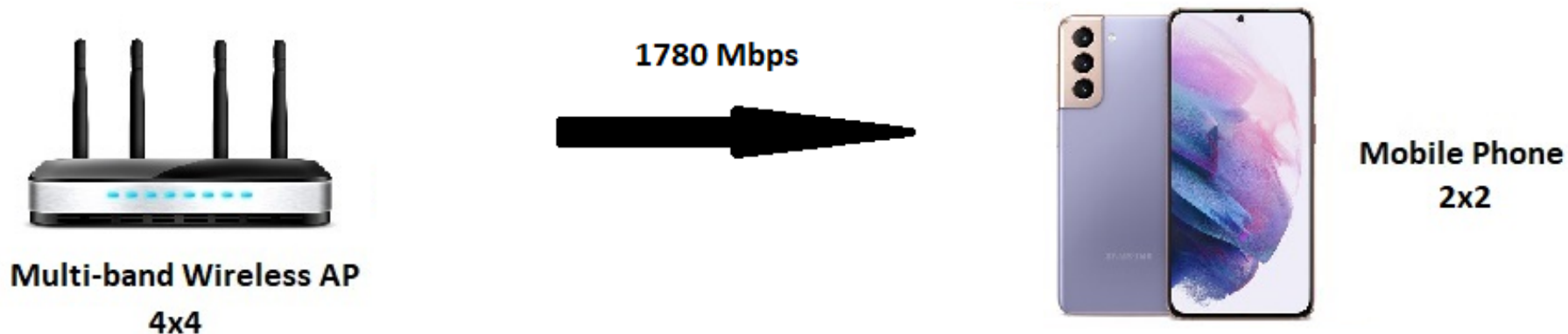
Why 6 GHz Standard Power Wi-Fi Is The Game Changer For Residential Use In The US

J.R. Flesch

Director, Advanced Technology, Home Networks
Commscope

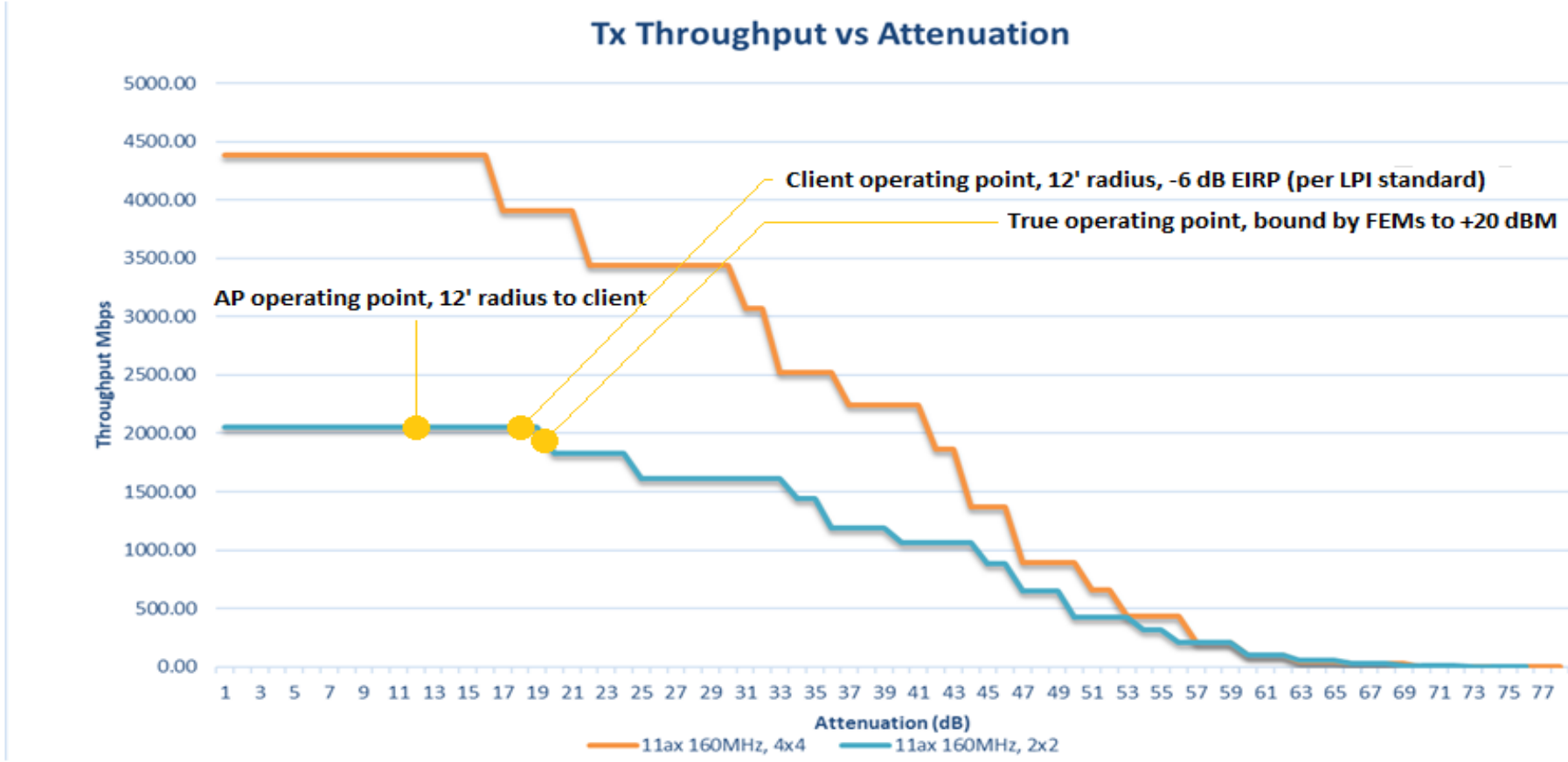
Asymptotic Achievable Bitrate for 2x2 6E clients

6E delivered TCP bitrate @ 12' range

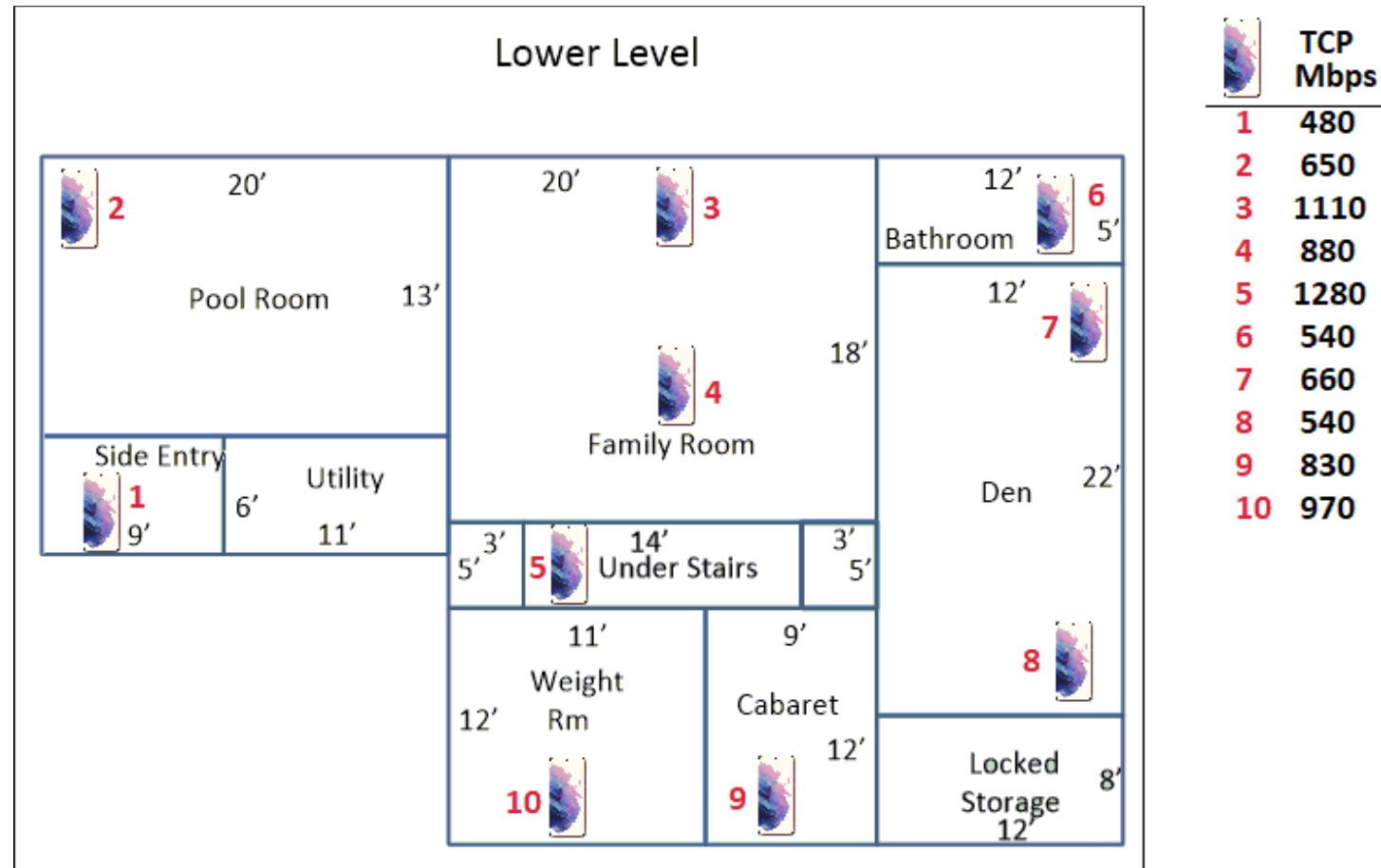


Goodput @ this range is 2050 Mbps UDP. The implementation scaling factor is 0.868, which includes accounting for TCP overhead.

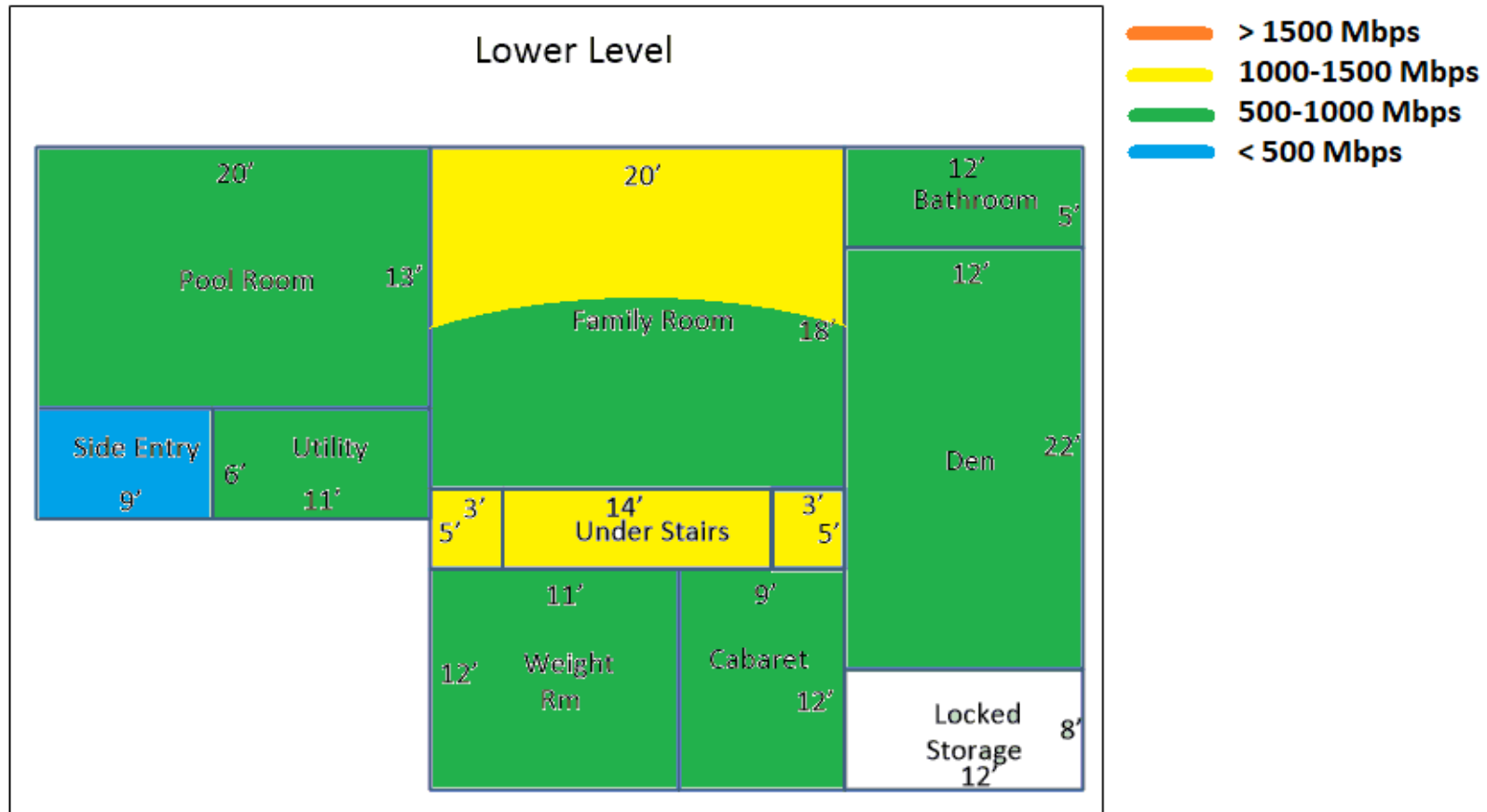
6E LPI Link Budget Differentials, AP to Client



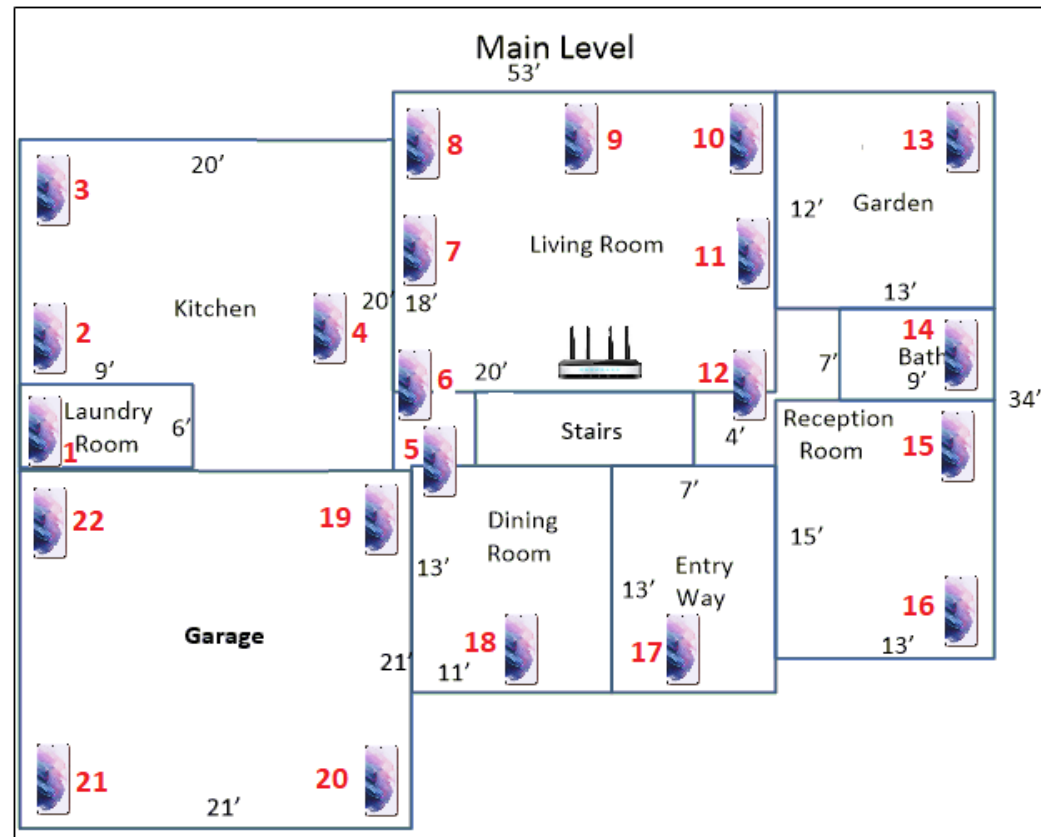
Lower Level Wi-Fi House LPI Client Operational Bitrates



Lower Level TCP Bitrate Heat Map

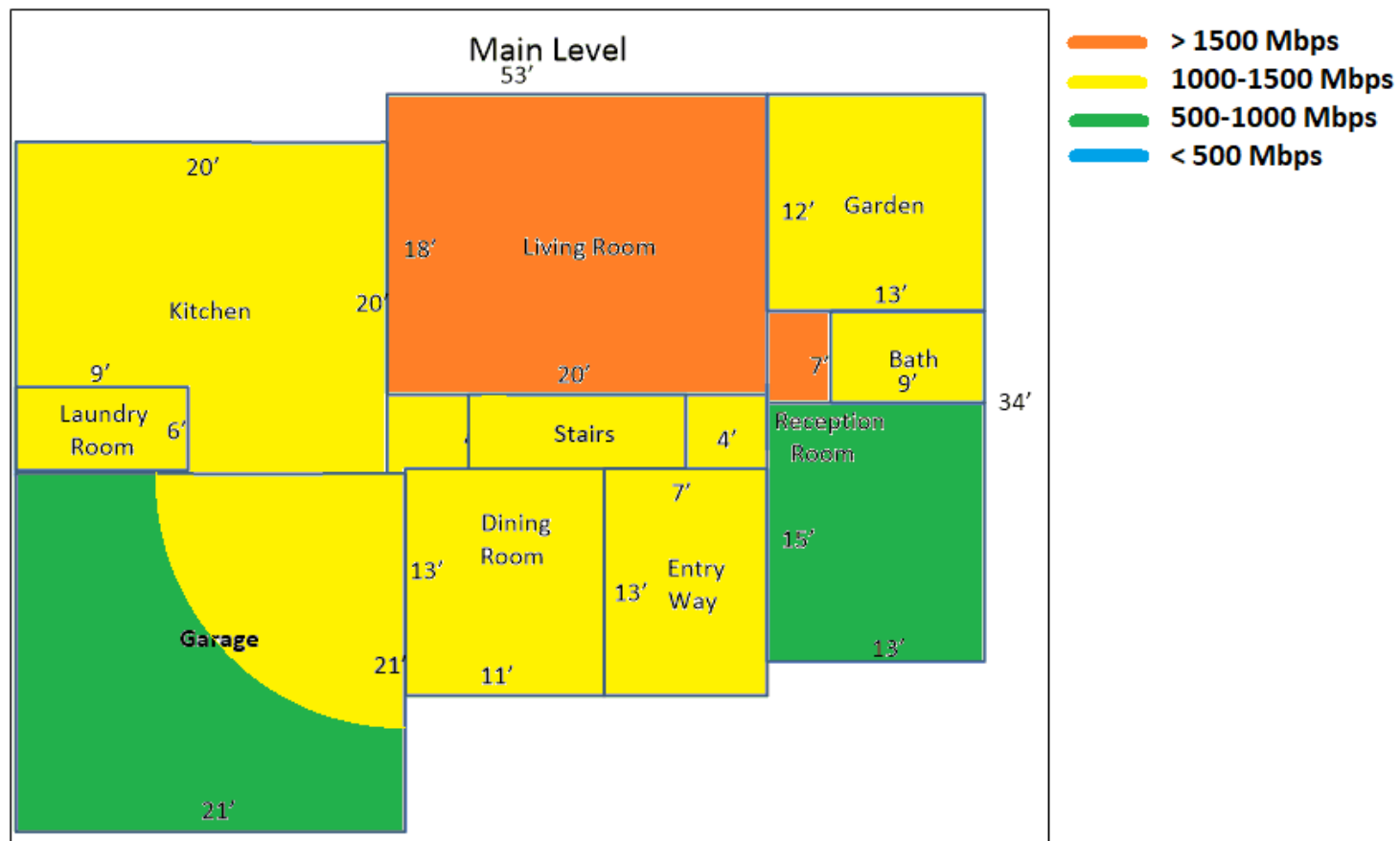


Main Level Wi-Fi House LPI Client Operational Bitrates

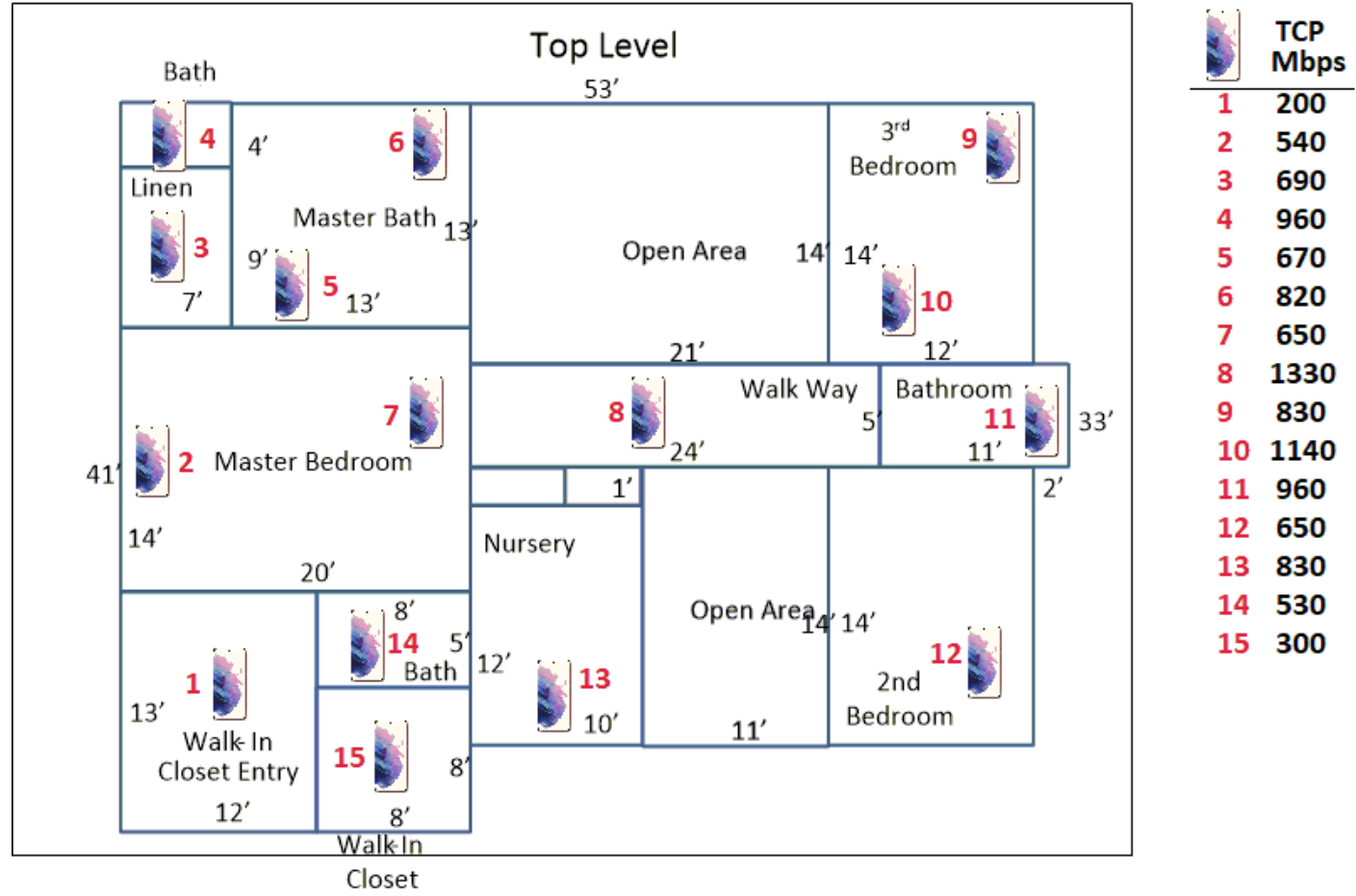


Client	TCP Mbps
1	1310
2	1140
3	1330
4	1470
5	1450
6	1480
7	1780
8	1610
9	1750
10	1440
11	1550
12	1600
13	1360
14	1450
15	680
16	780
17	1140
18	1320
19	1300
20	680
21	850
22	870

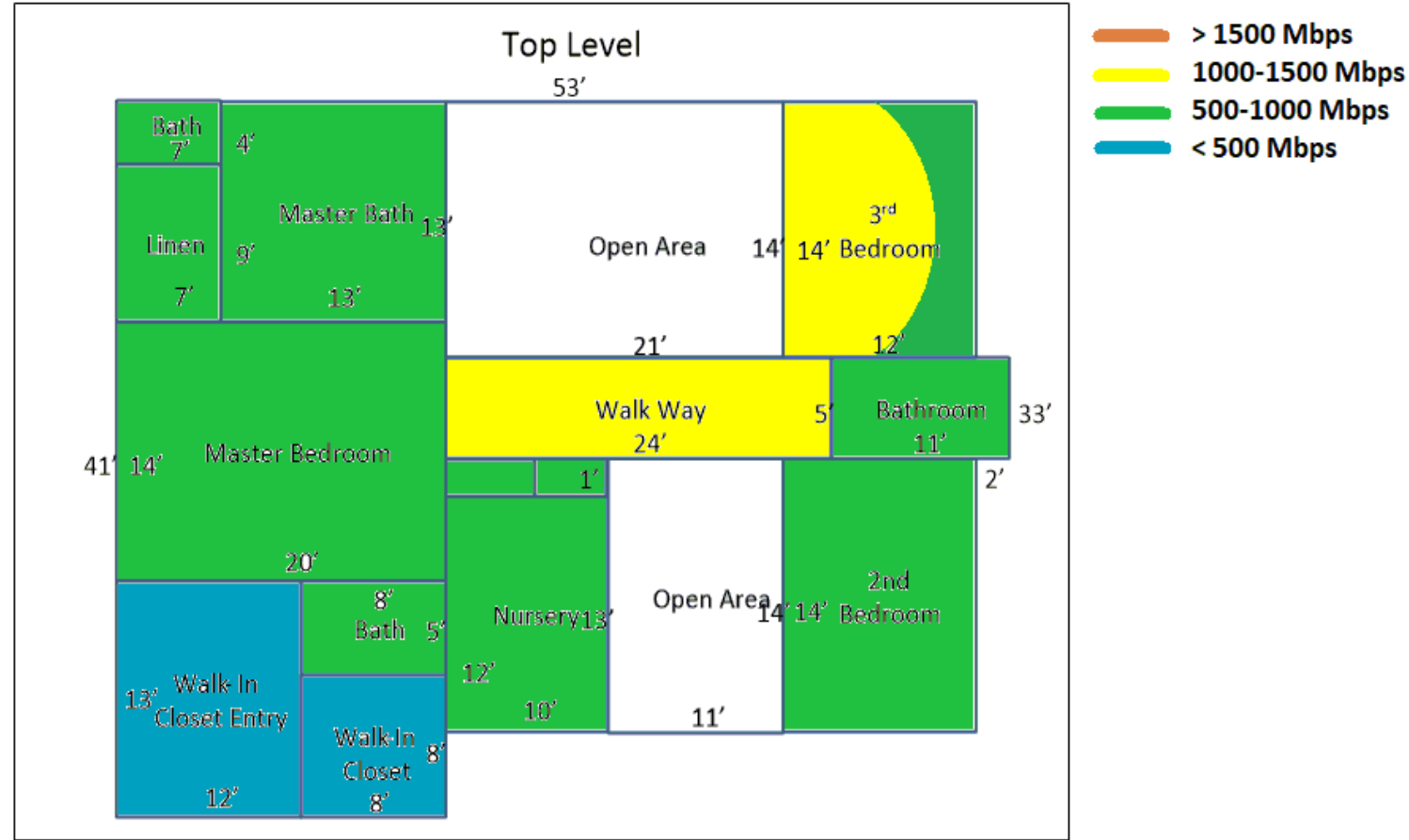
Main Level TCP Bitrate Heat Map



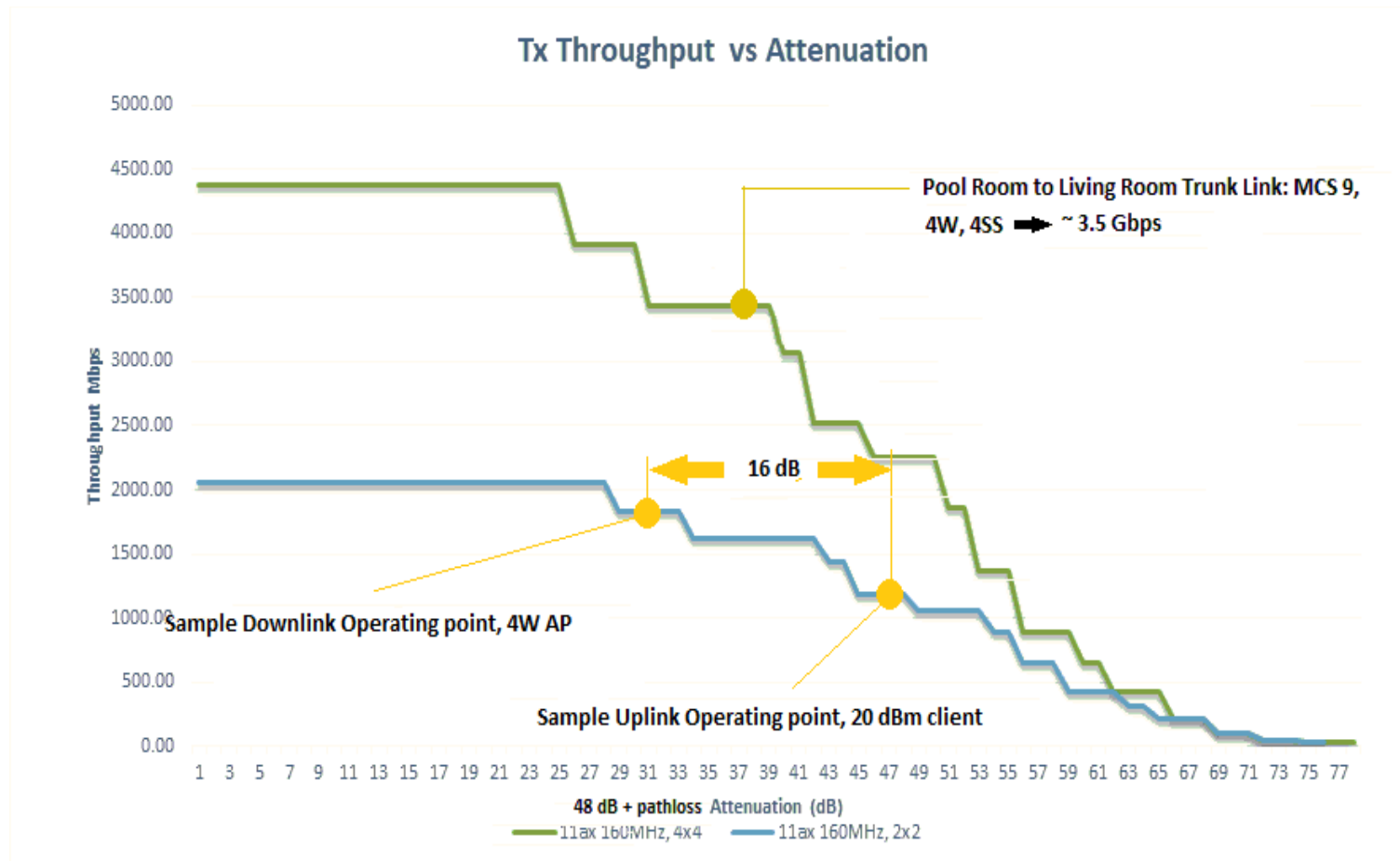
Top Level Wi-Fi House LPI Client Operational Bitrates



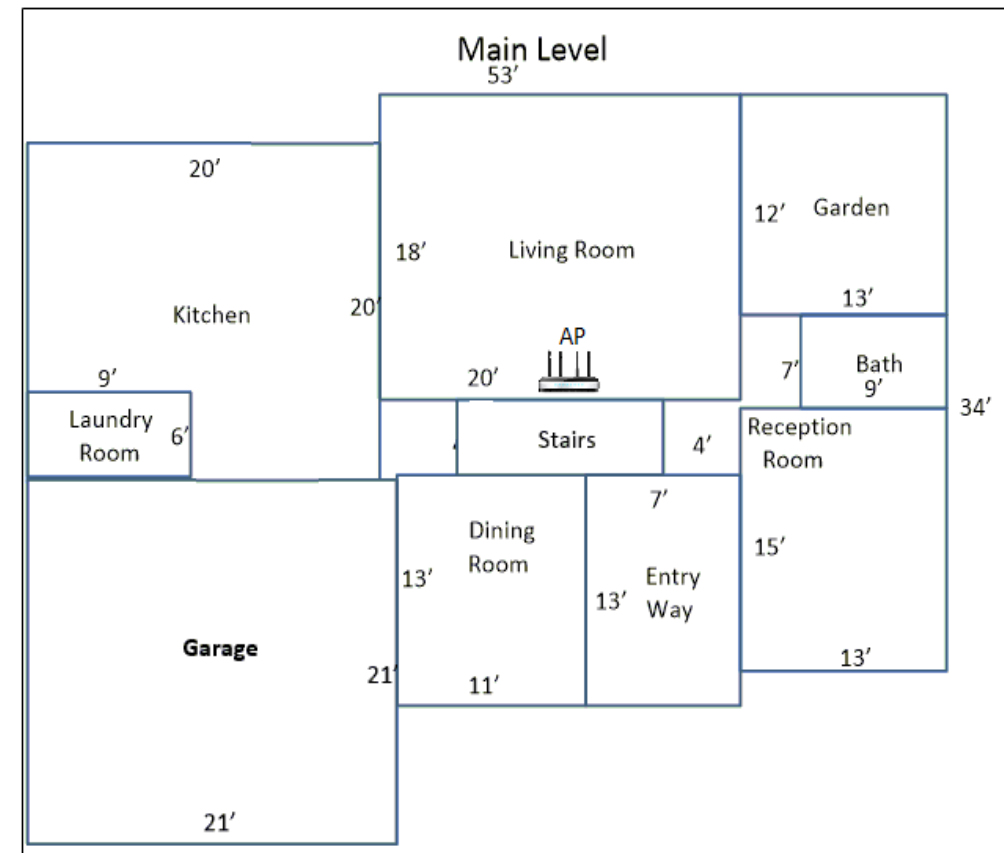
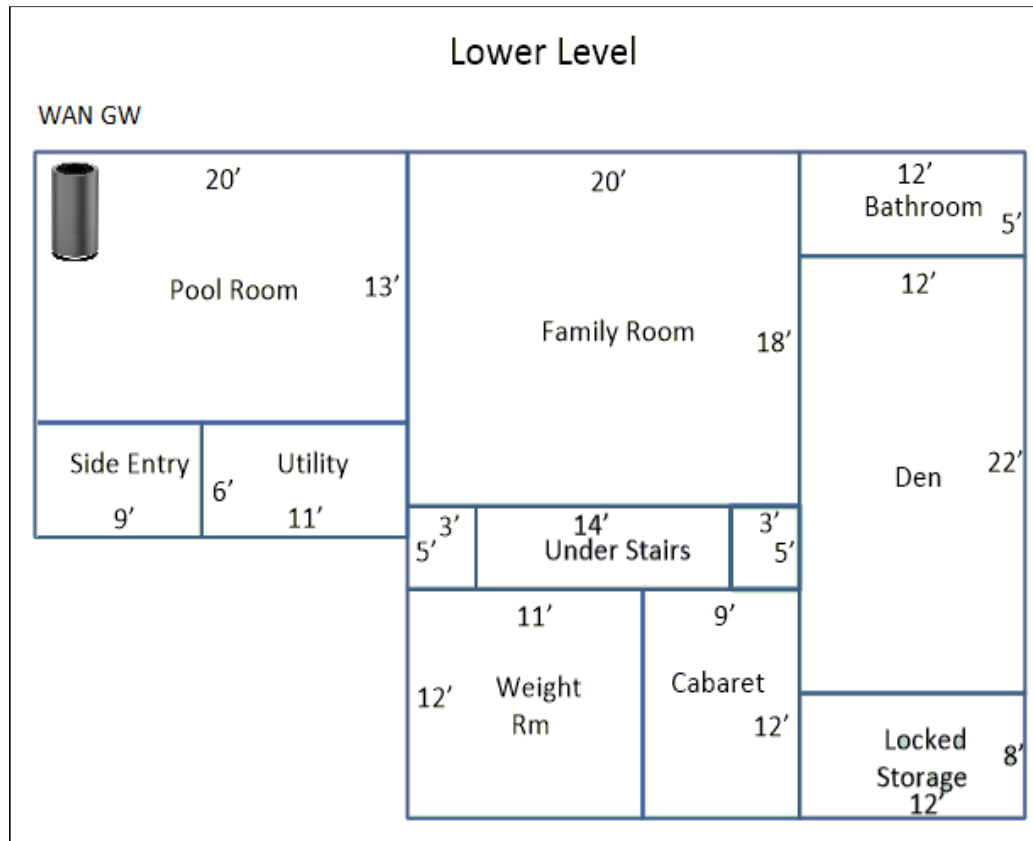
Top Level TCP Bitrate Heat Map



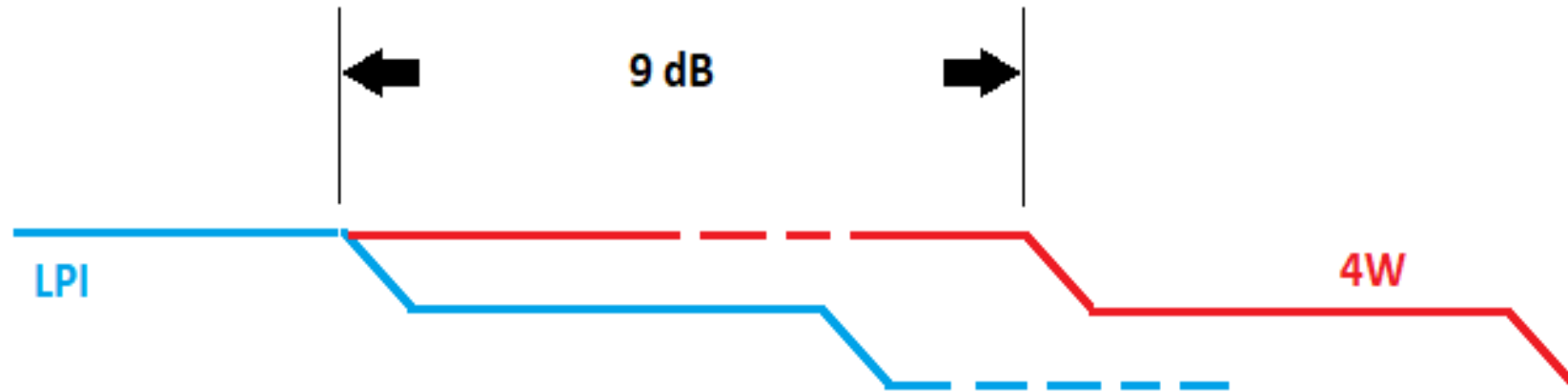
4W Trunk Performance; 2x2 Client Link Budget



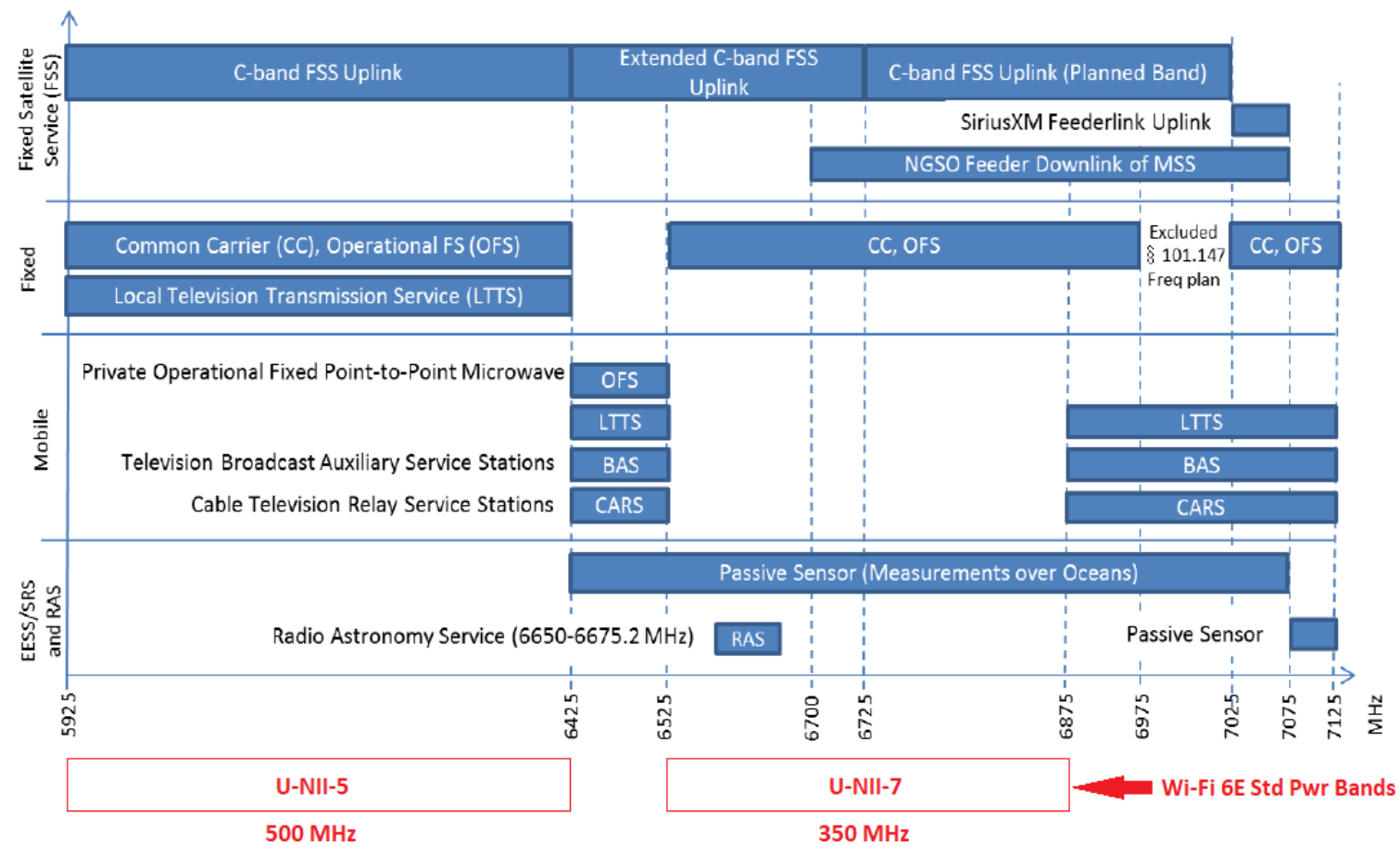
4W Extender 4x4 Trunk Endpoints



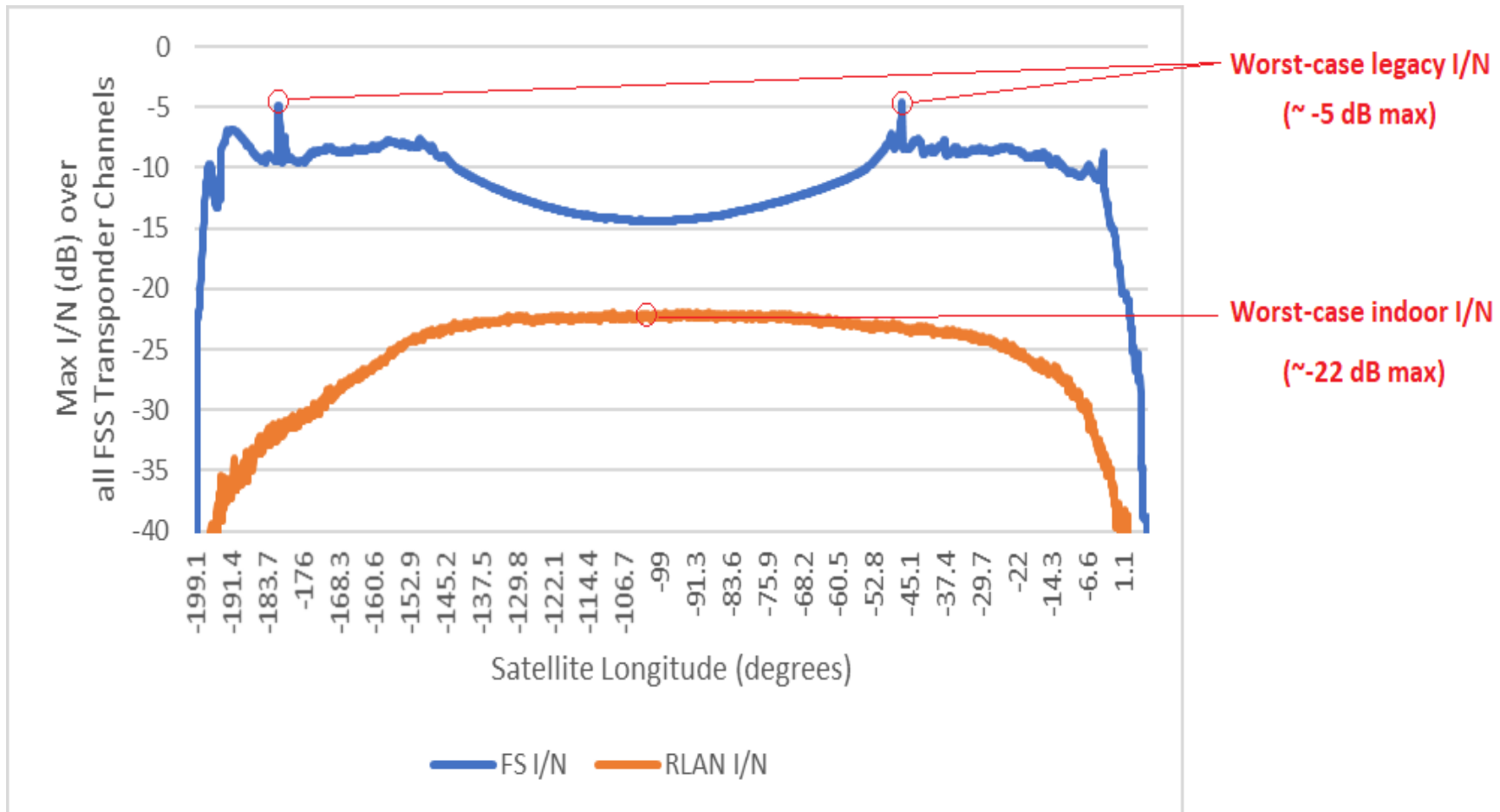
Effect of Increasing EIRP from LPI to 4W (Std Pwr)



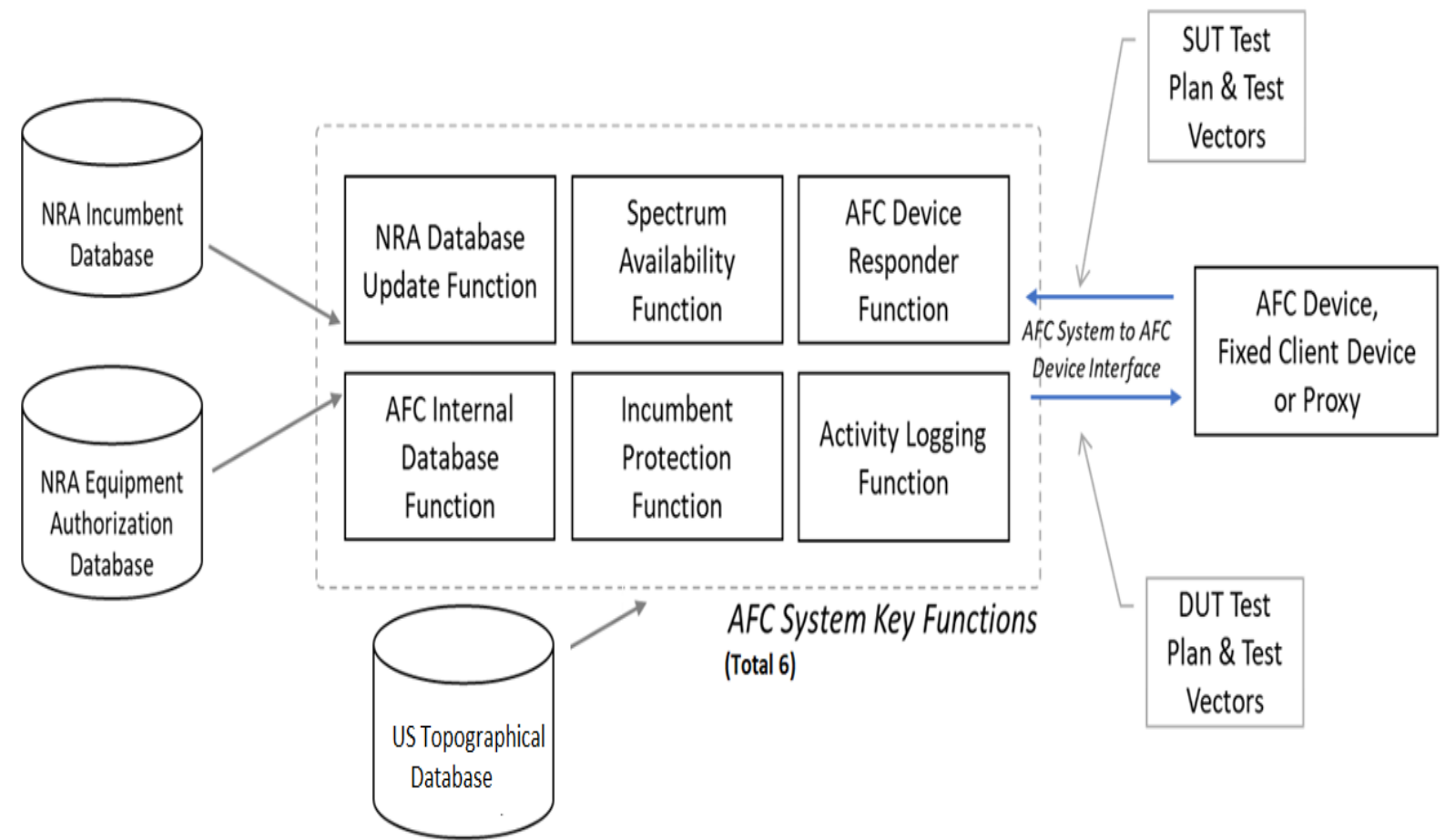
Spectrum Contenders for 6 GHz



Rationale for Dismissing FSS Interference



Cloud AFC System Componentry



Cloud AFC System Componentry (Cont.)

Architecture/Function Parsing

- NRA (Nat'l Regulatory Authority) Database Update Function
 - DB of incumbent links w/locations, descriptors and credentials (maintained)
- AFC Device Responder Function
 - Duplex cloud link (URL based) which provides HTTPS/JSON portal for AFC device comms
- Spectrum Availability Function
 - Generates payload for response messages to devices (incl. error msgs)
 - Invokes Incumbent Protection Function and Logging Function
- Incumbent Protection Function
 - Math engine to do interference calculations (both CCI and adjacents) and recommend permissible channels (and operating power levels)
- Logging Function
 - Creates/maintains “non-repudiable ledger” of AFC transactions
- AFC Internal DB Function
 - Largely parametric details on incumbent installations (as antenna pattern specs and related)

AFC Cloud Portal Messaging

- Northbound (device to cloud)
 - Available Spectrum Inquiry Request
 - Unique ID
 - Device Descriptors
 - Location Detail
 - Inquired Freq Range (MHz) and/or
 - Inquired Channel Numbers
 - Minimum Desired Power (dBm or dBm/MHz)
 - Vendor Extensions
- Southbound (cloud to device)
 - Available Spectrum Inquiry Response
 - Unique ID (per upstream request)
 - Allowable PSD by Freq Range (dBm/MHz) and/or
 - EIRP by List of Channels
 - Expiration time for provided ops (GMT)
 - Response Codes (P/F and error codes)*
 - Vendor Extensions

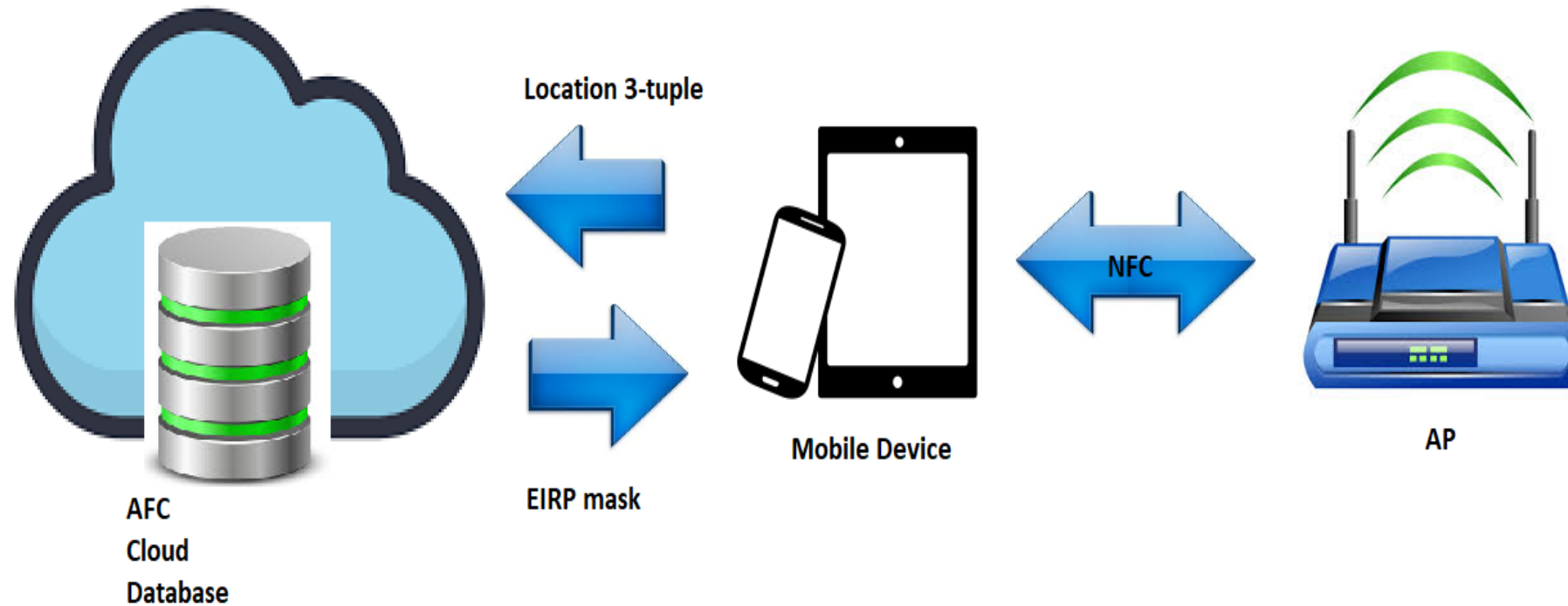
*Pass/Fail, with codes 100-199 being reserved for errors related to message formation, authentication, etc and 300-399 for tech editing concerns (like requesting inappropriate/wrong channels)



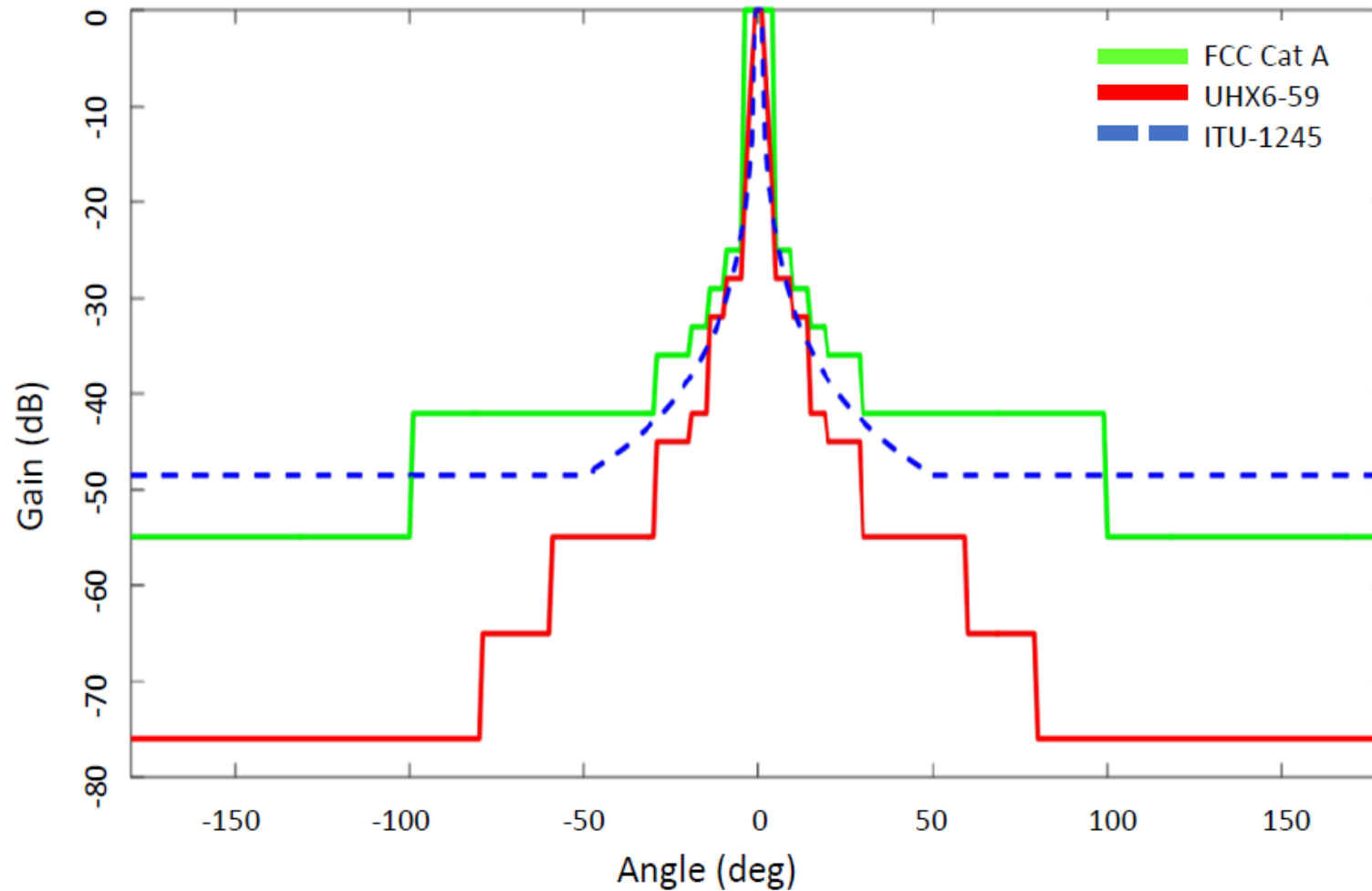
AFC Messaging Supplemental Detail

- **Device Descriptor** is a 3-tuple: serial #, FCC ID# and (for US) a text string “47_CFR_PART_15_SUBPART_E” (would be different for other countries)
- **Location** is longitude, latitude and height (as degrees relative to the central meridian, degrees relative to the equator and meters above local terrain). The location footprint of the AP(s) in question may be expressed as an ellipse or 1 of 2 versions of a polygon area. Uncertainty self-certified (but reported) and an enumerated field describes whether the unit is indoor or out.
- **Inquired Freq Range** is as “a-b” where a, b are in MHz
- **Inquired Channels** is an explicit list of requested channel numbers

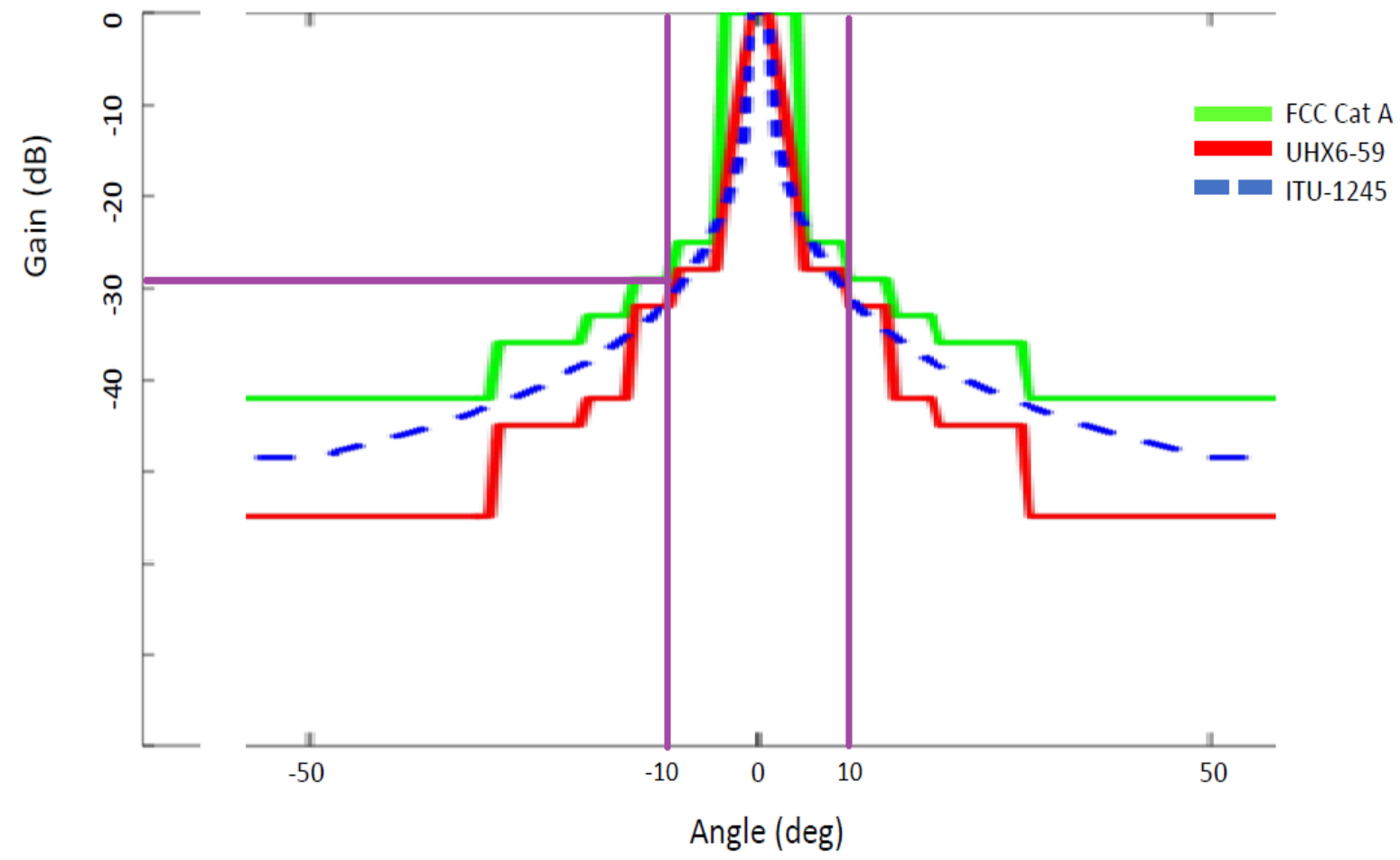
Use of AP Proxy to Facilitate Cloud Communications



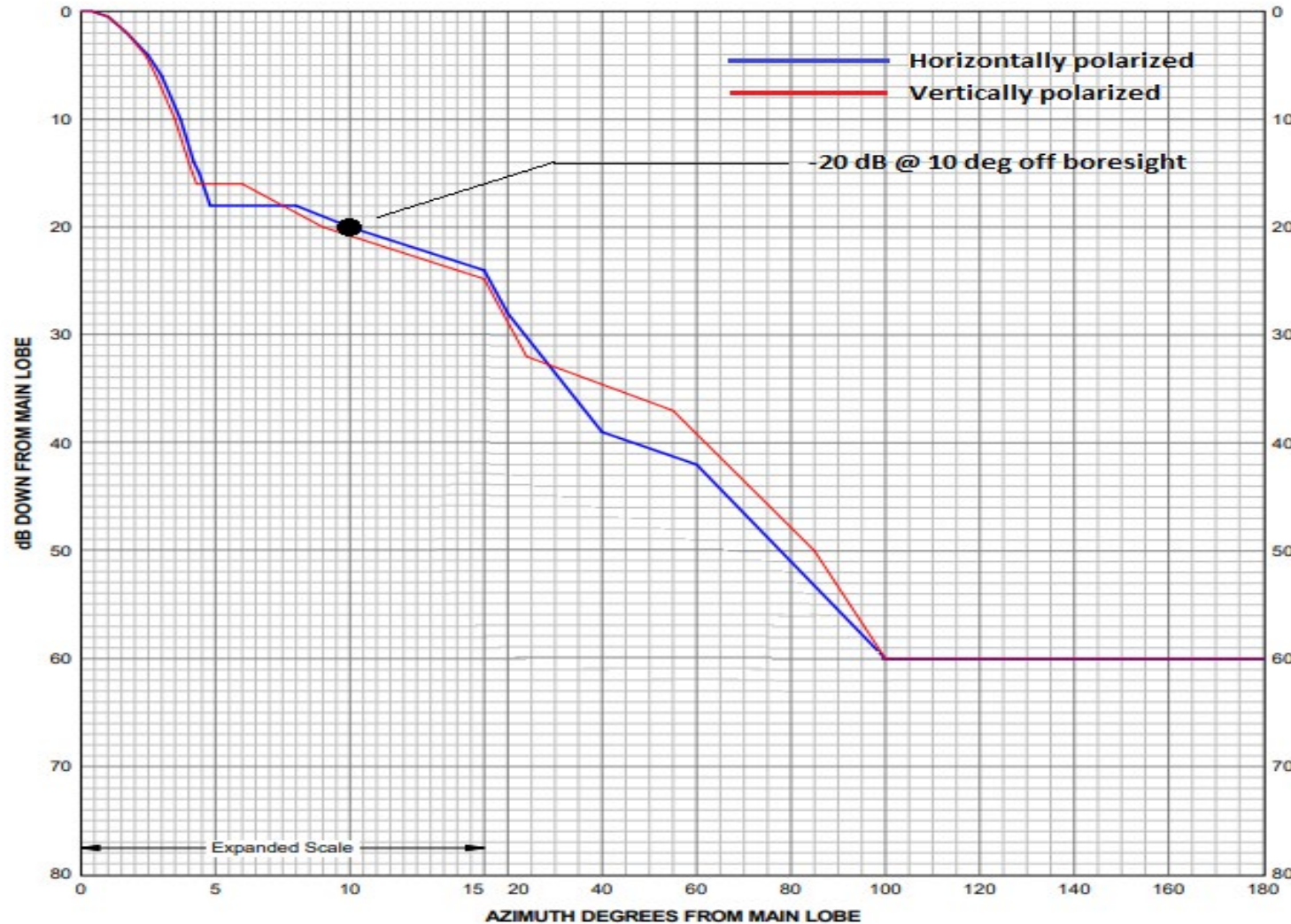
Common FS Antenna Apertures (Azimuth)



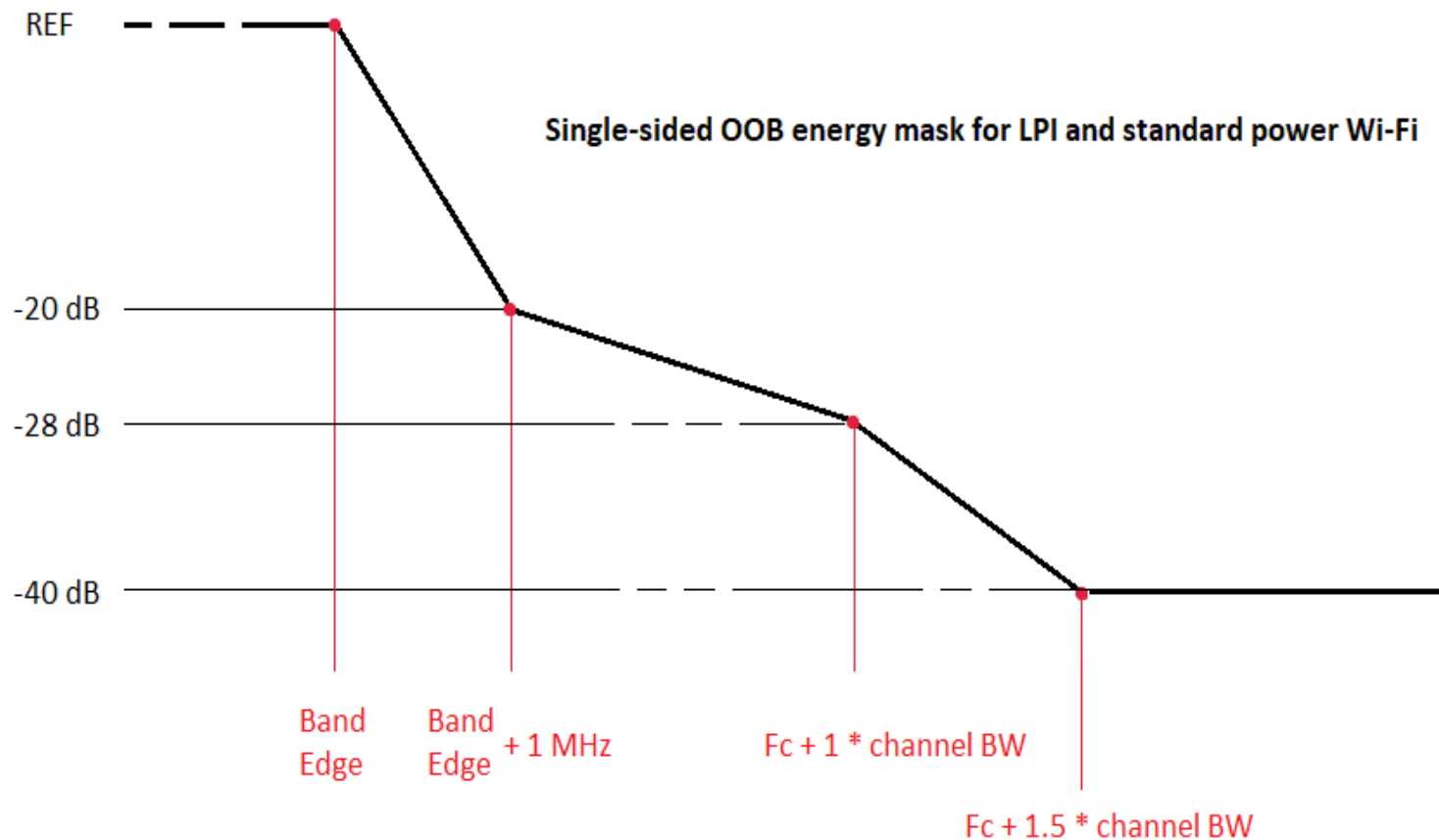
Zoomed Perspective Showing Look Angle Selectivity



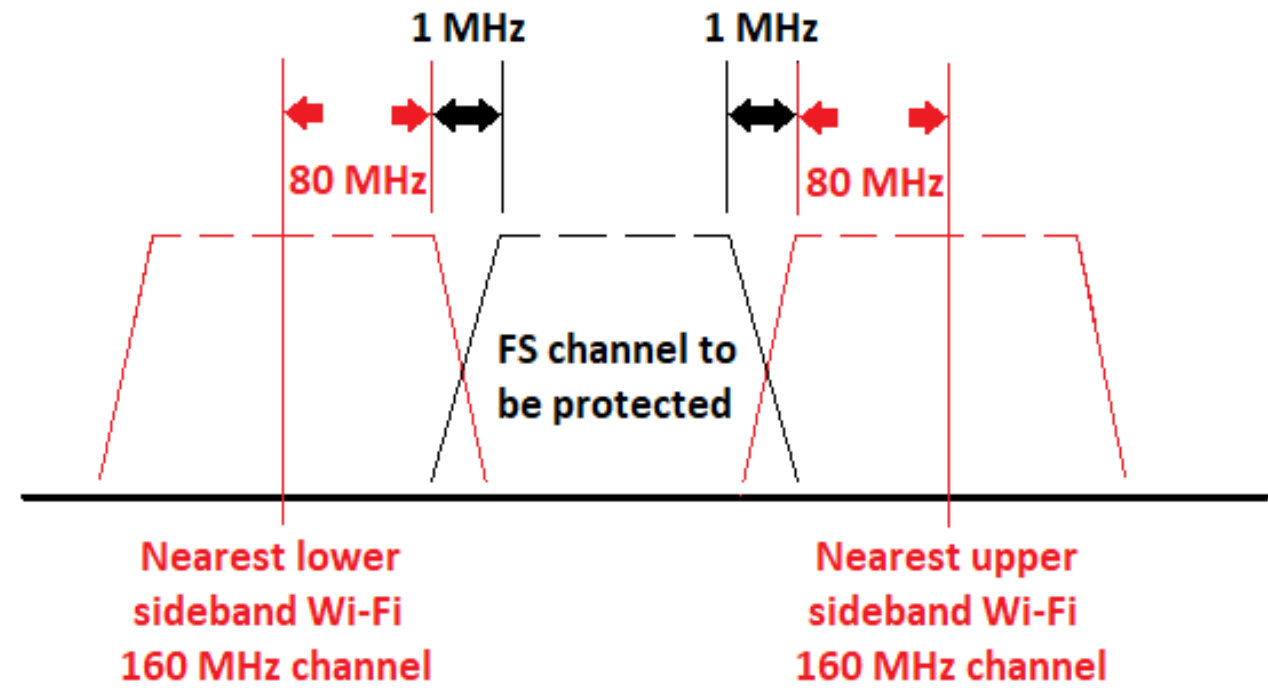
Low Use Incidence "Cheap" FS Antenna Aperture (.9m)



FCC Requirements for Wi-Fi Adjacent Channel Performance

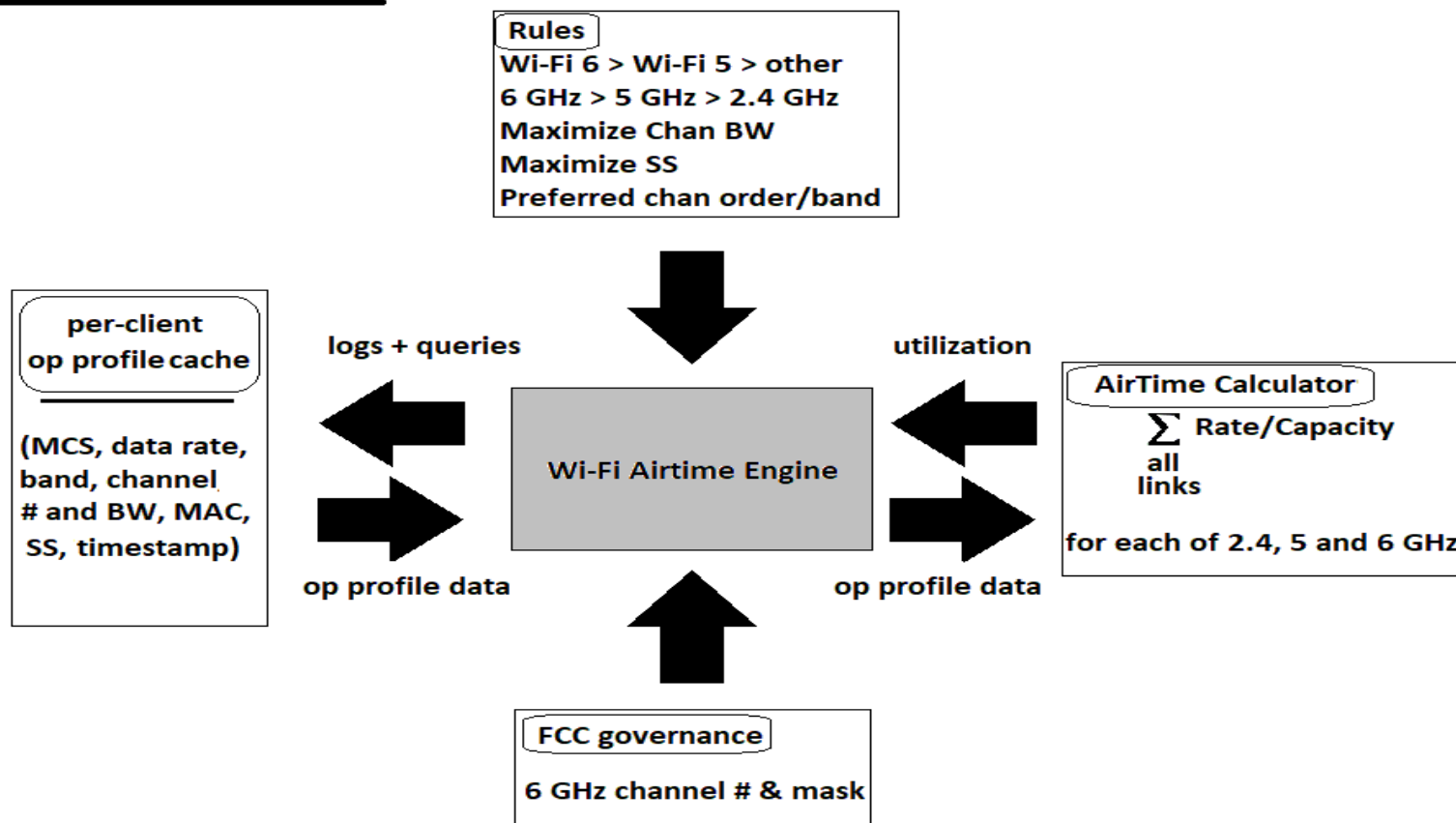


Anticipated Guard Bands for FDM of Wi-Fi and FS

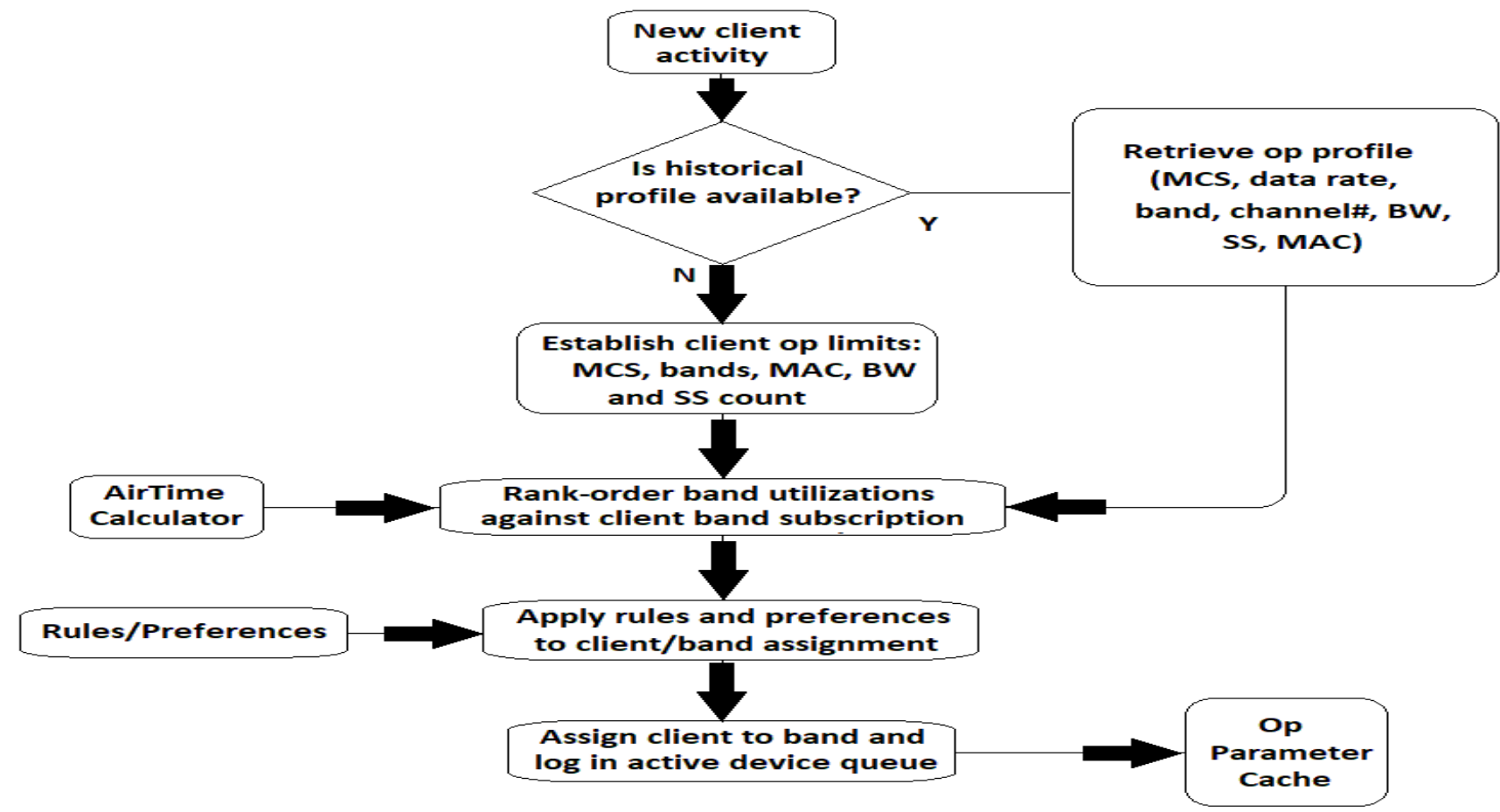


AP WAE Considerations for Client Band Mounts

WAE Block Diagram:



WAE Process for Mounting Clients into Wi-Fi Network

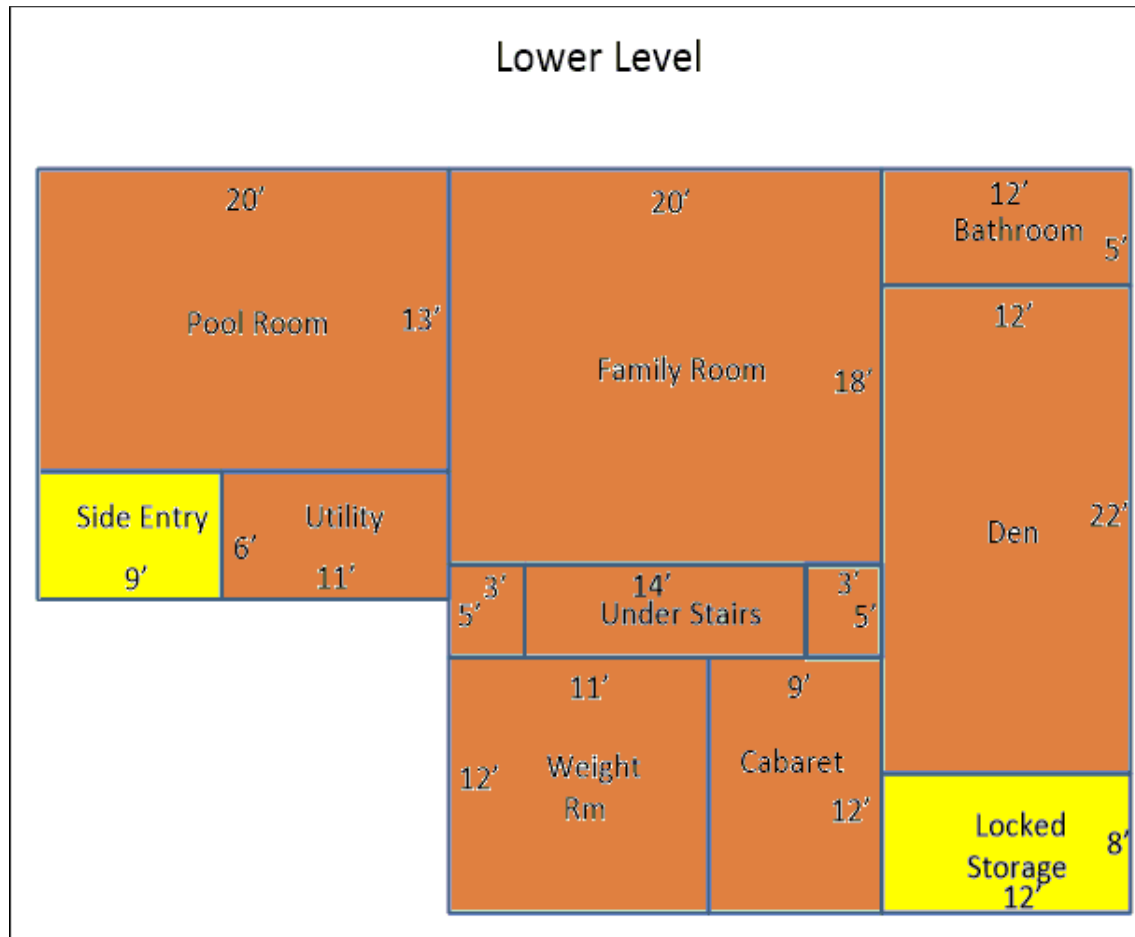


Some Necessary Coexistence Operational Overhead

Background Channel Scanning

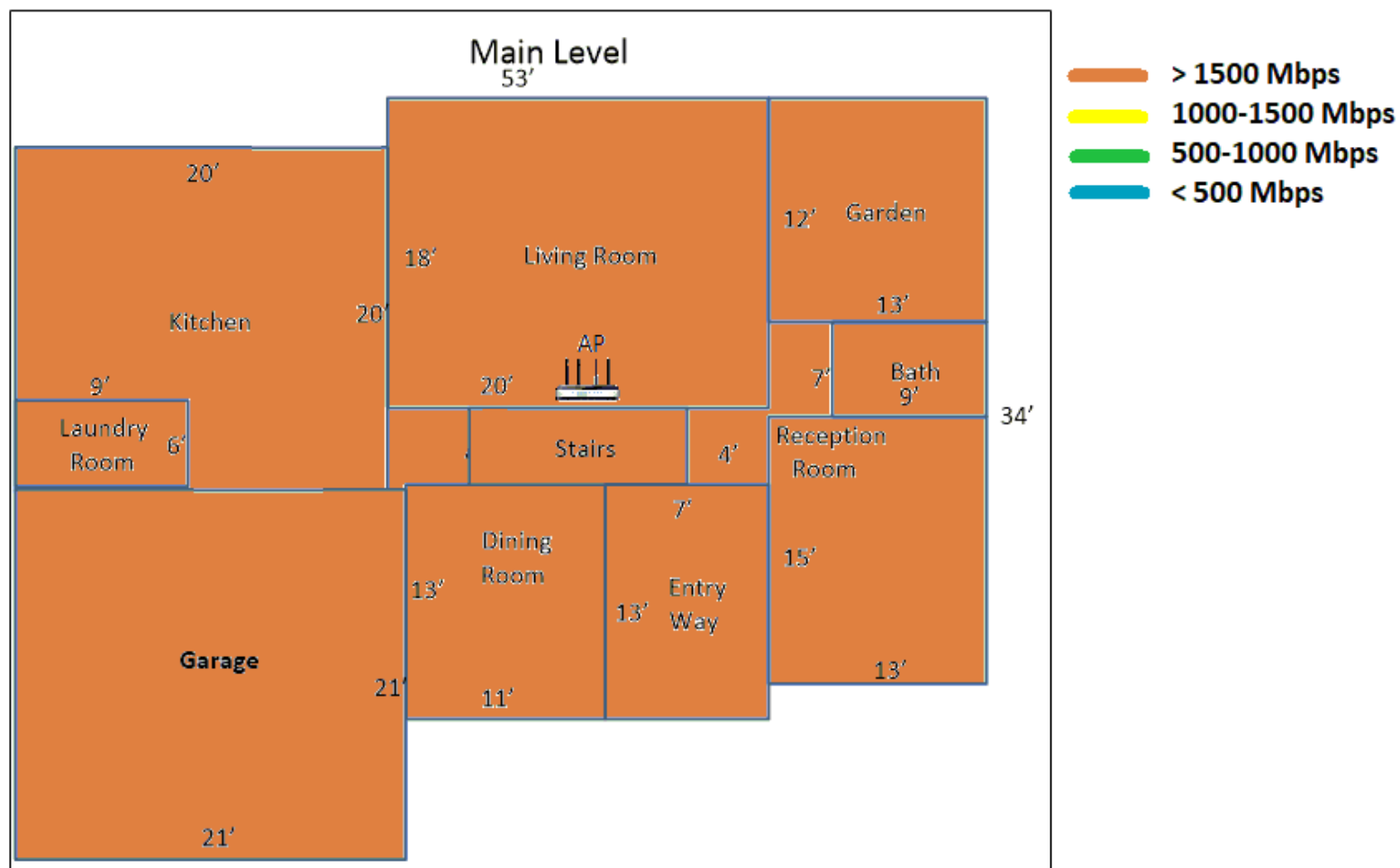
- * Particularly important for 6 GHz due to the potential for unlicensed channel competition from NRU elements
- * May be optimized for data “freshness” versus overhead burden and historical profiles of competing signals
- * Builds a perspective of CCI based upon channel, BW and detected energy level
- * Provides for Vendor Differentiation as regards clarity, utility and airtime cost

Lower Level 2x2 Client Coverage w/4W Mid-Home AP

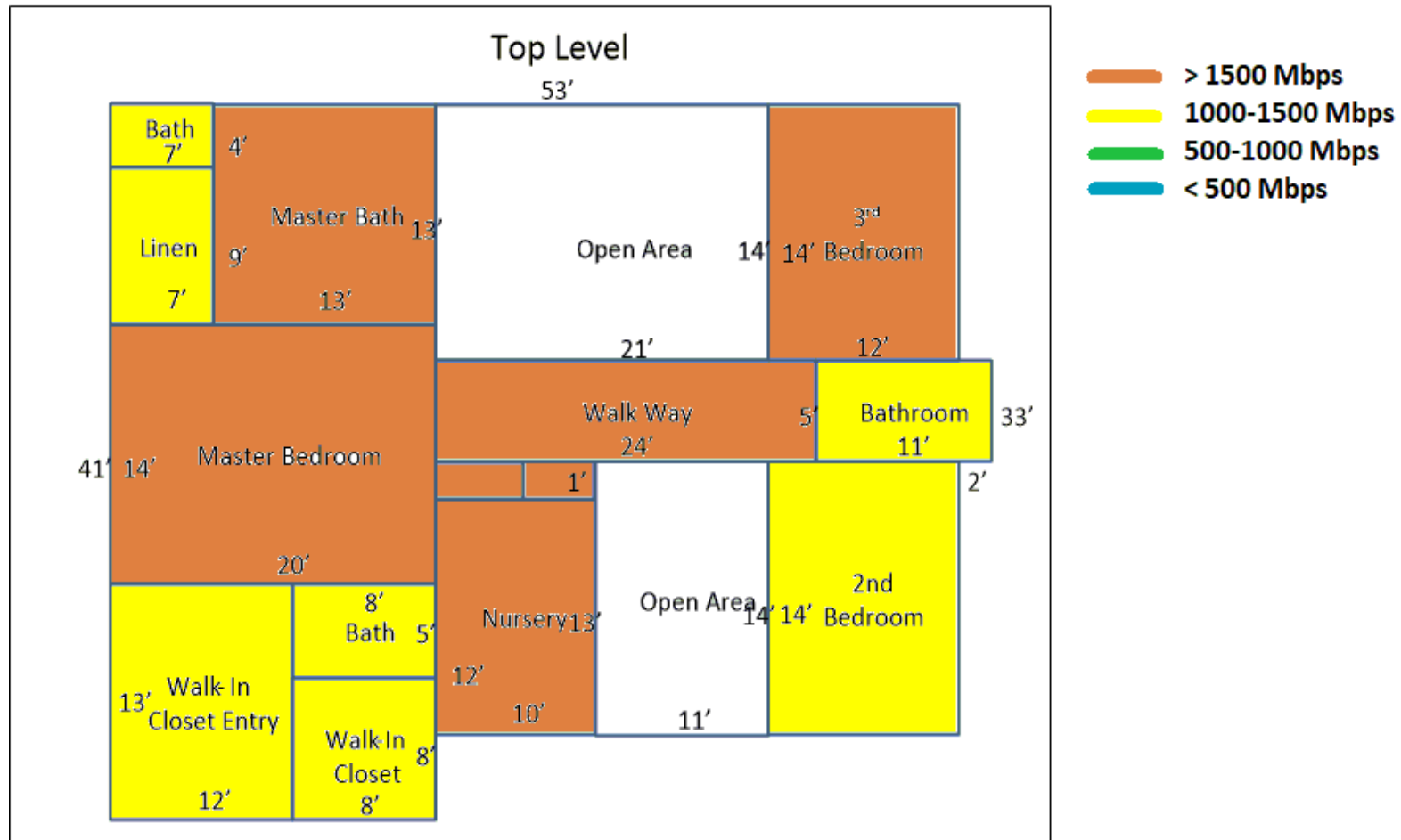


- > 1500 Mbps
- 1000-1500 Mbps
- 500-1000 Mbps
- < 500 Mbps

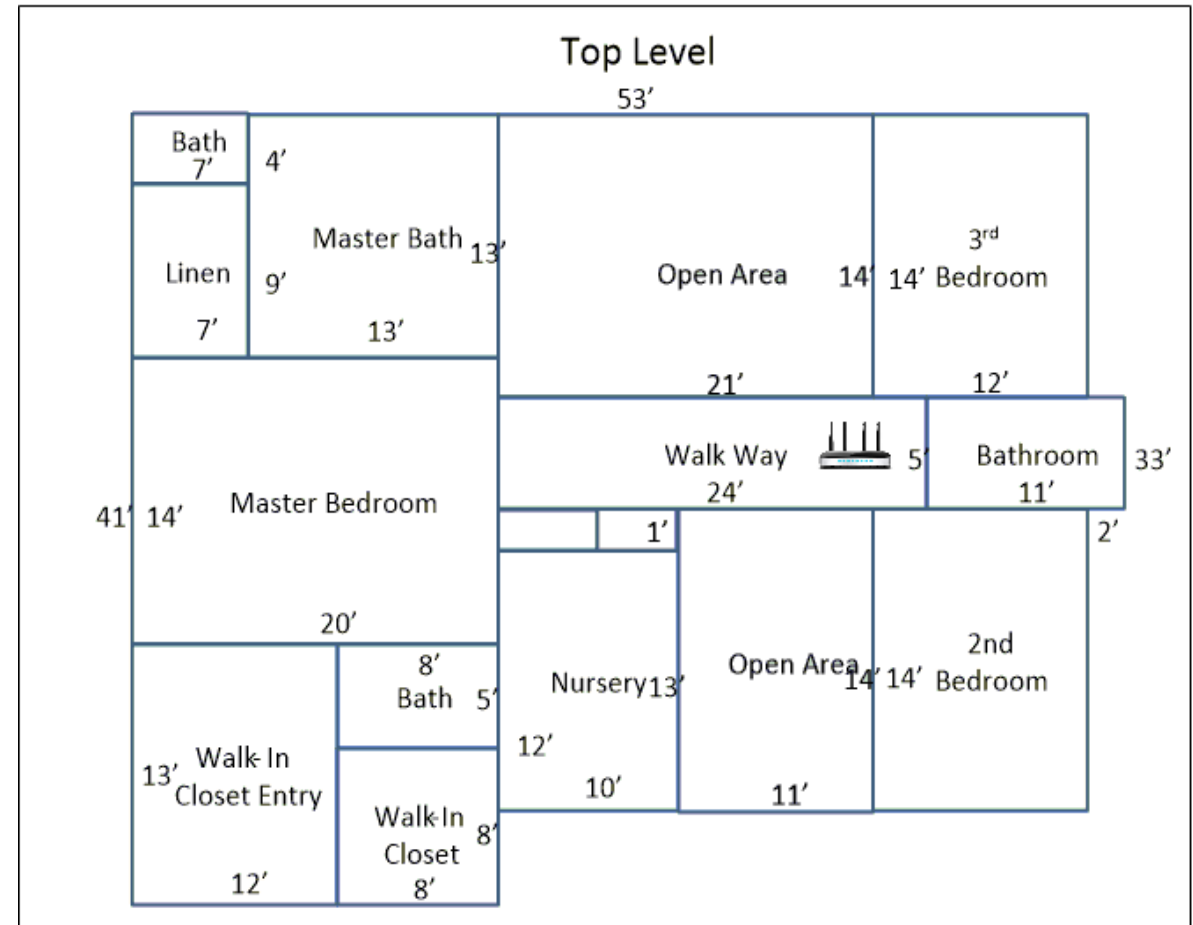
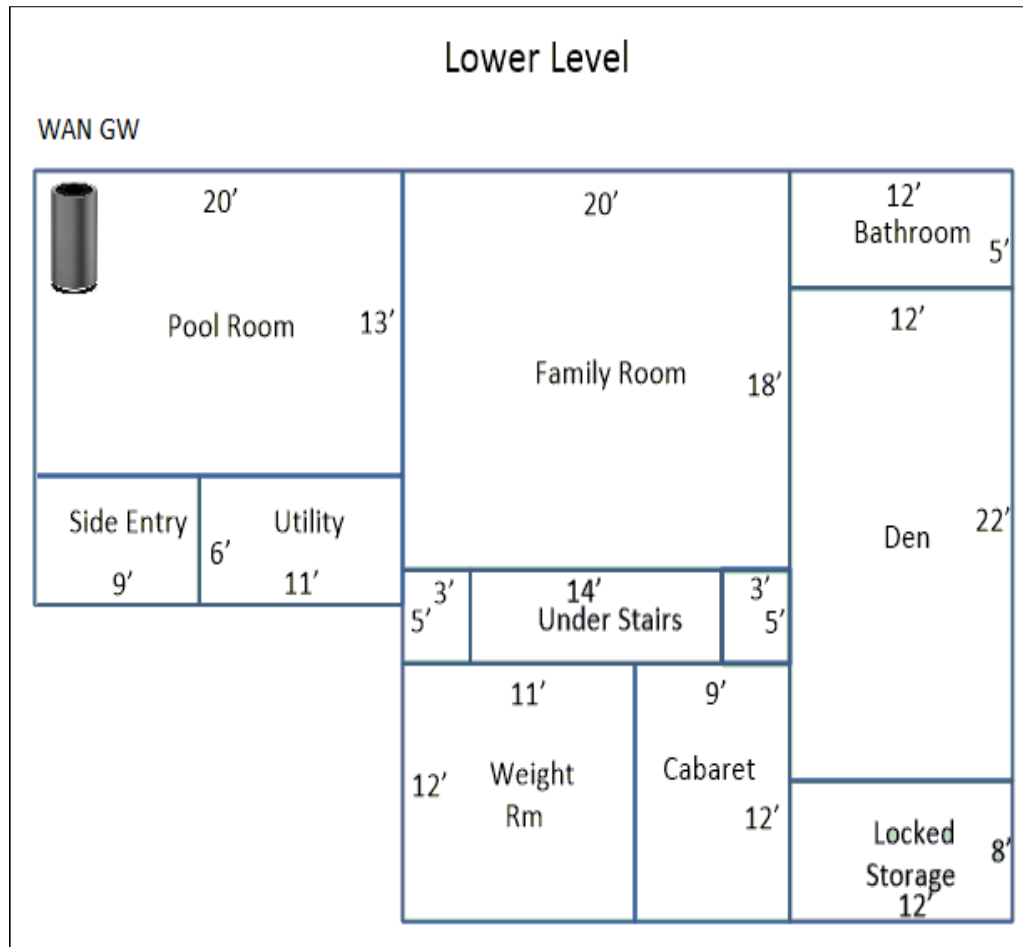
Main Level 2x2 Client Coverage w/4W Mid-Home AP



Top Level 2x2 Client Coverage w/4W Mid-Home AP



Repositioning Extender to Top Floor, Opposite Third



Effect of the Repositioned Extender

- * With the exception of the locked storage region in the basement, all areas of the home are blanketed with an average of 1.7 Gbps (so all are orange colored).
- * A client device in the locked storage area would still prefer to associate with the top floor extender, but its coverage would drop to ~ 1.25 Gbps TCP.
- * The farther trunk throw to the extender (now up on the 3rd floor), reduces its duplex 4x4 bitrate to 2.5 Gbps (versus the 3.5 for a midpoint extender).

Removing the Extender Altogether

Now the entire home is services from the 4W WAN gateway

- * Examining the worst-case location, in the far corner of the 2nd bedroom upstairs to establish minimum expected bitrate service:
- * 62' of 3D service radius + 2 floors + 3 walls worth of path loss
- * Downlink bitrate still > 1 Gbps (1030 Mbps).
- * Uplink bitrate ~ 275 Mbps – so client remains enfranchised in the network



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Thank You!

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