White Spaces in the United States: Evolution and the Impact of Regulatory Policy

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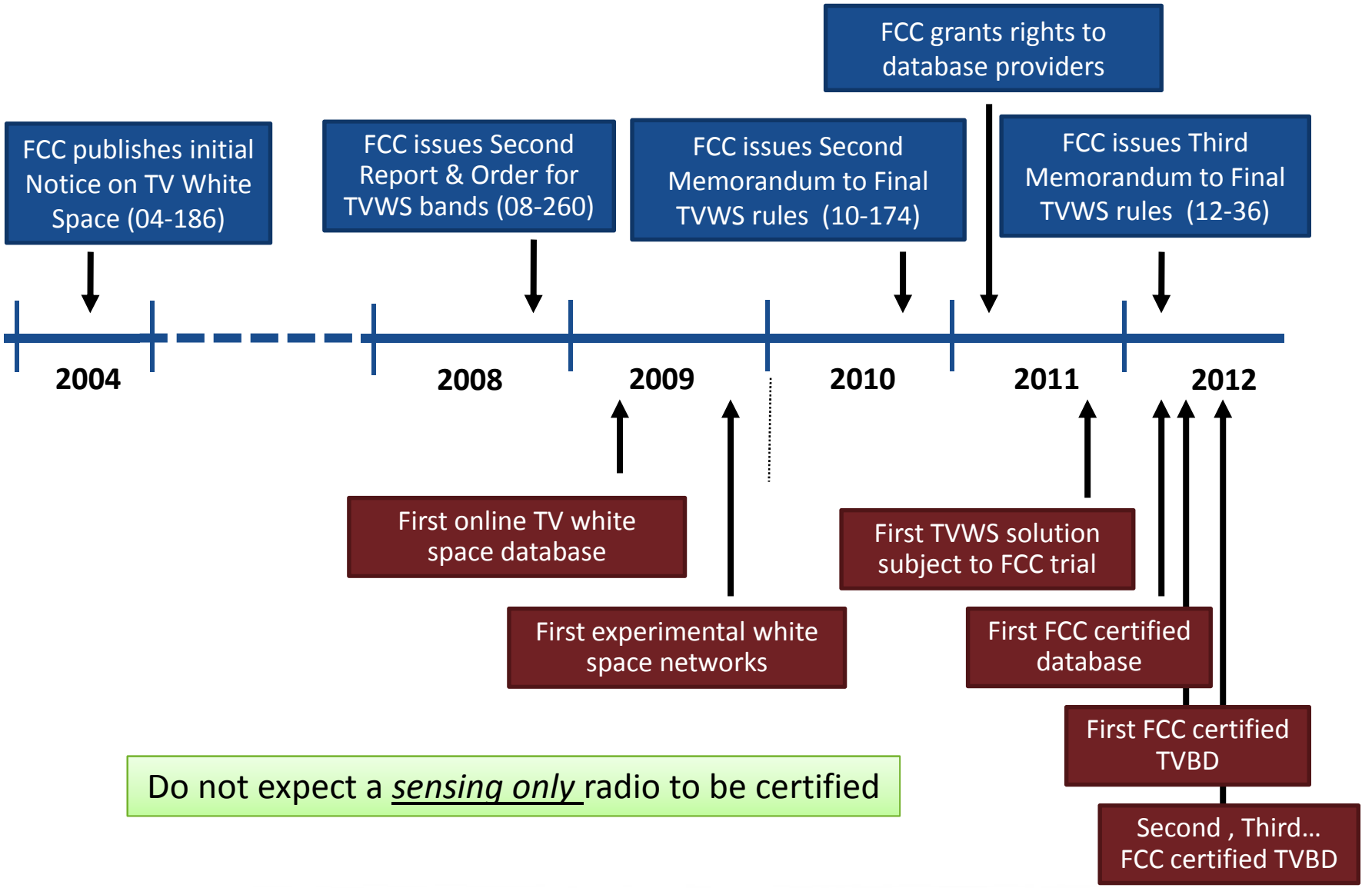
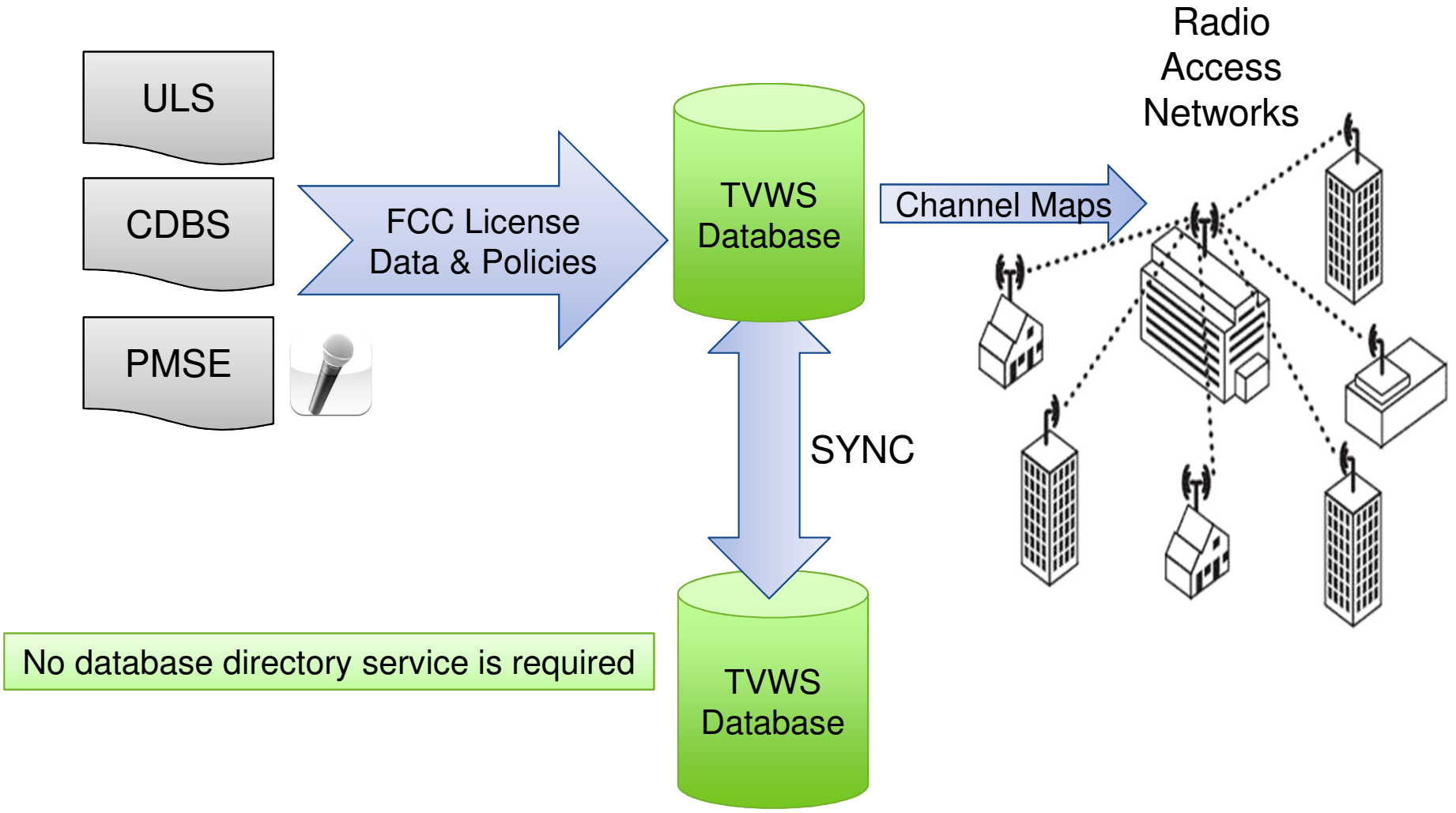
Evolution

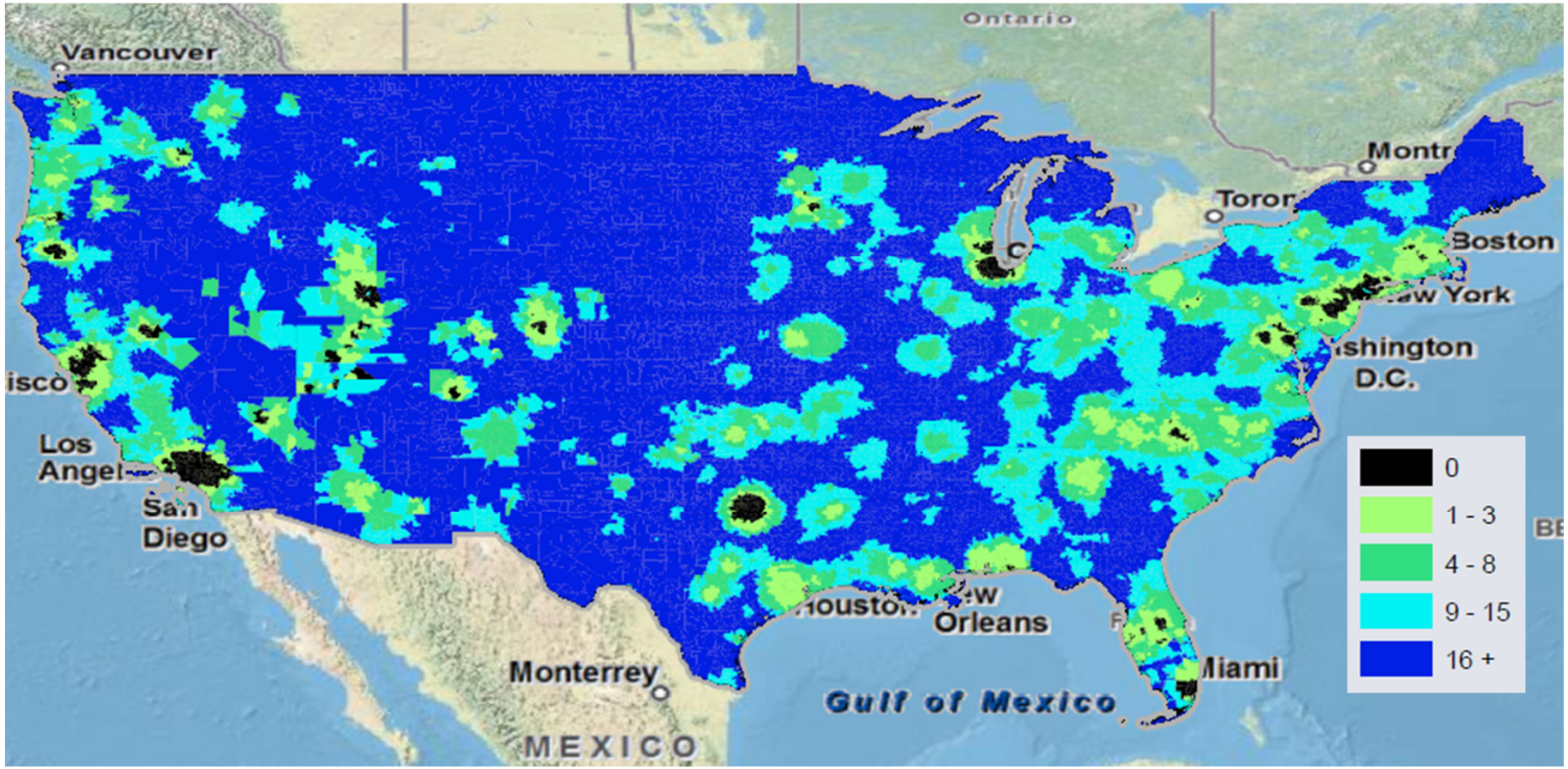


Do not expect a *sensing only* radio to be certified

TV White Space in The USA



TV White Space in The USA



Fixed Device (4W) Channel Availability, 10 meter antenna height

Responsibilities of the Database Operator

- The US rules are defined by the FCC, and agreed to by Primary Users
- The Database Administrator is “authorized” by the regulator to protect incumbent operations, e.g. TV
  - Enables other opportunities
- The Radio equipment and the Database are validated/certified to comply with the rules and avoid interference with the incumbent operations
- Database Administrators are not *enforcers*
- Database Administrators can offer and integrate other services

Device Types:

Fixed

- 4W maximum EIRP (1W conducted)
- Professionally installed
- "Master" or "Hub" - can provide channel maps to other device types
- Can't use channels adjacent to protected channels
- Contact Verification Signal

Personal/Portable Mode2

- Geo-location capability (+/- 50 meter accuracy)
- "Master" or "Hub" - can provide channel maps to P/P Mode 1 devices

Personal/Portable Mode 1

- No location capability
- "Slave" or "Spoke" – uses same channel map as "Master"
- Tethered to Fixed or Mode 2, i.e. no multi-hopping

Personal Portable Power Limits -

- 40mW EIRP – CAN use channels adjacent to protected channels
- 100mW EIRP – CAN'T use channels adjacent to protected channels

Recent Improvements - HAAT

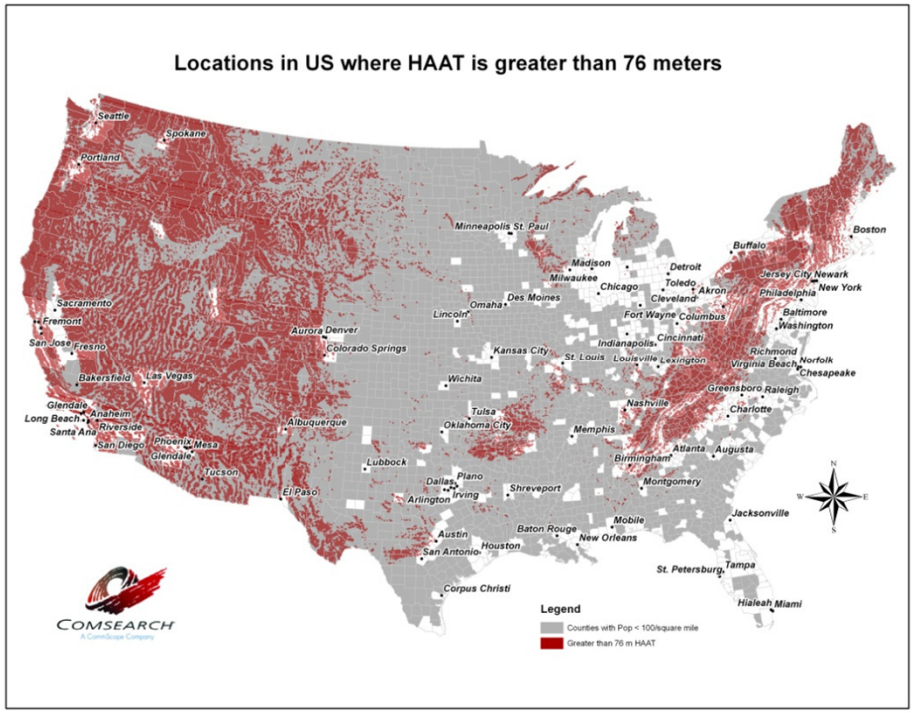
Height Above Average Terrain Limit increased from 76 metres to 250 meters

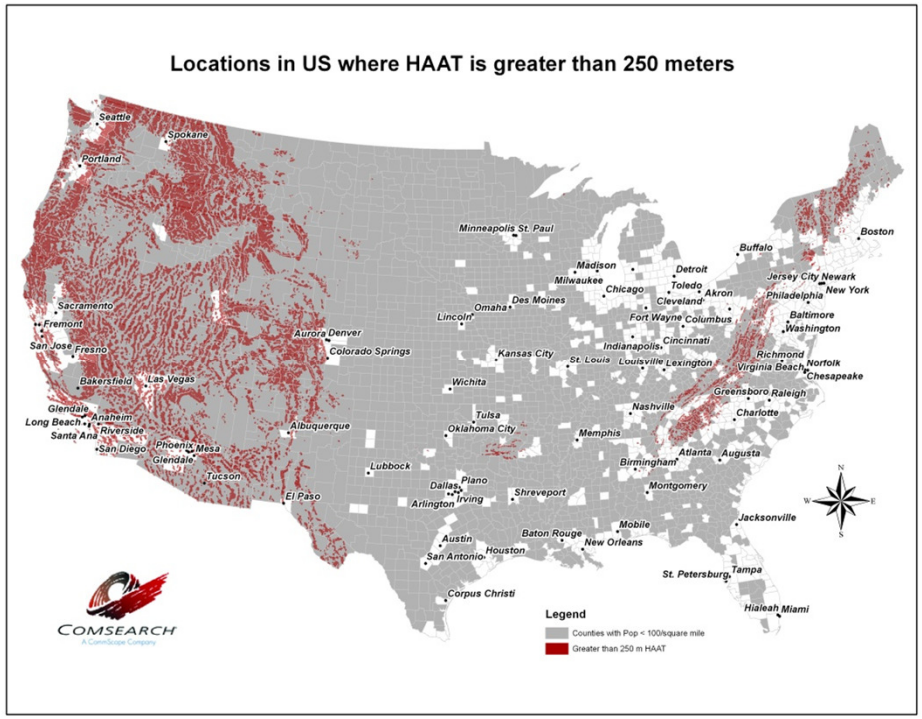
Antenna HAAT	Required separation (km) from a protected contour	
	Co-channel (km)	Adjacent channel (km)
< 3 meters	4.0	0.4
3 to 10 meters	7.3	0.7
10 to 30 meters	11.1	1.2
30 to 50 meters	14.3	1.8
50 to75 meters	18.0	2.0
75 to 100 meters	21.1	2.1
100 to150 meters	25.3	2.2
150 to 200 meters	28.5	2.3
200 to 250 meters	31.2	2.4

1. The antenna height above ground for a fixed TVBD may not exceed 30 meters.
2. Distances determined using the FCC's TM-91-1 model, similar to the HATA suburban.

Caution ! Diminishing returns with higher antenna sites

Recent Improvements - HAAT





Significant Improvement - reduced prohibited areas by <75% and allows use of many more strategic tower sites.

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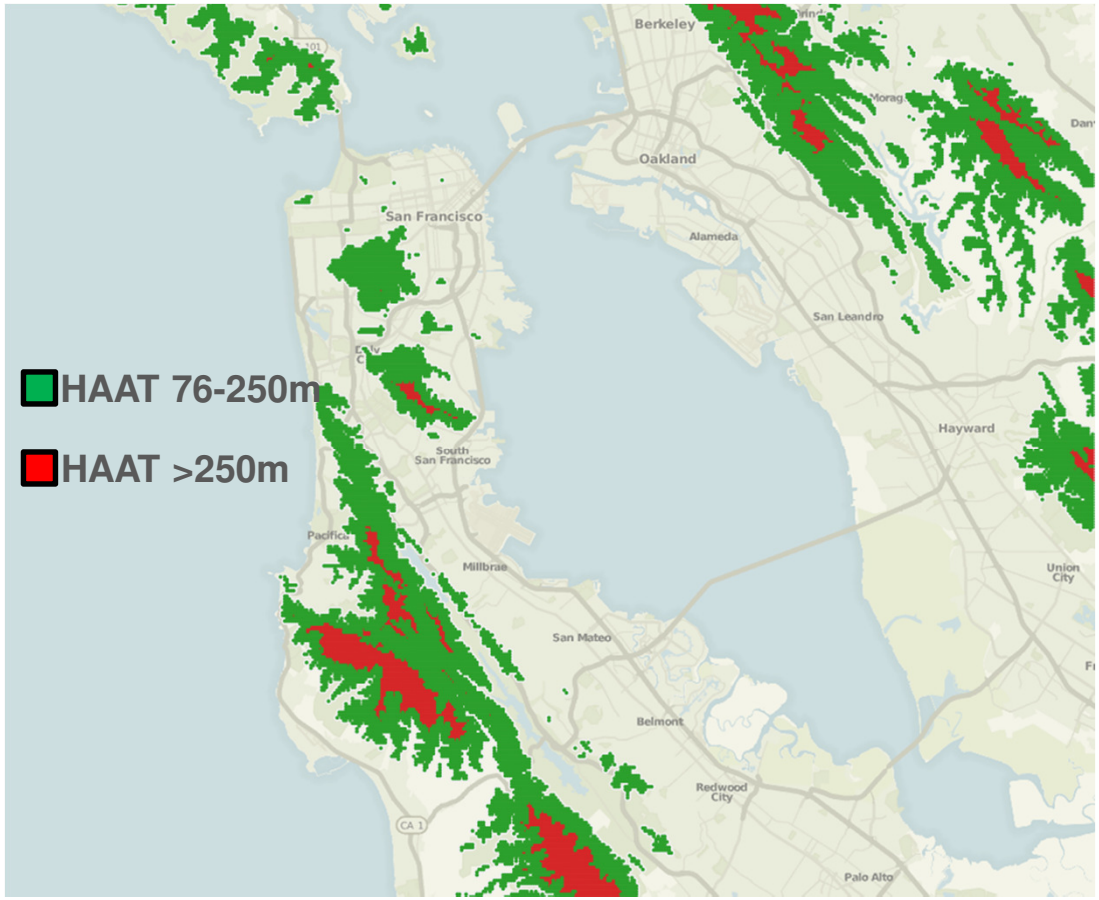

San Francisco, CA and surrounding areas are more usable

Practical Improvements – Out of Band Emissions Limits

- Now absolute (fixed), NOT relative to in-band power
- Equivalent to the old limits for devices operating at max power
- Simplifies compliance measurements - can be measured directly

Type of TV bands device	Power limit (6 MHz)	PSD limit (100 kHz)	Adjacent channel limit (100 kHz)
Fixed	30 dBm (1 Watt)	12.6 dBm	-42.8 dBm
Personal/portable (adj. channel)	16 dBm (40 mW)	-1.4 dBm	-56.8 dBm
Sensing only	17 dBm (50 mW)	-0.4 dBm	-55.8 dBm
All other personal/portable	20 dBm (100 mW)	2.6 dBm	-52.8 dBm

OOBE in adjacent channel must still be suppressed by -55db - eliminates some technologies and extremely challenging for others, e.g. OFDM.

Although quite different, the flexibility in emissions limits afforded by ECC Report 159 is quite appealing.

Opportunities for Improvement

- Out of Band emissions requirements
- *Certainty* in the future availability of white space
- Critical mass of white space spectrum in populated areas
- Avoid unnecessarily complex rules
- Can TV White Space model be used for other bands ?

Perspectives on Standardization

FCC requirements do not specify the use of a protocol standard or specific technology

- Support for IETF PAWS protocol is growing
- 802.19 has practical value - expect more alignment and possible adoption as WS ecosystem(s) mature
- 802.11af and 802.22 focus on MAC/PHY - FCC rules are technology agnostic
- SE43 ECC Report 159 is influential

Conclusion

Thank You

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