

White Space & Cognitive Software Defined Radio



Transformation
through Partnerships

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Business Operations & Regulatory Affairs

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- Adaptrum was founded in 2005 by world-leading experts on wireless communications.
- Adaptrum was an active participant in the FCC TV Whitespace Device Rule-Making And Device Tests.
- Working on FCC Certification & Larger Trials
- Not just FCC White Space.....Flexible!

- Spectrum
 - Spectrum Options: FCC white-space, unlicensed/licensed, government NTIA, broadcast-flex use, public safety, 700, etc.
 - Bands below 1 GHz initially: Can scale to higher frequencies
 - QoS and multi service built-in from the beginning, (4G)
- Real Networks
 - Unlicensed wide-area network: WiFi like organic built-out
 - “Licensed” or “assigned” or “shared” High-Power Networks for “Mid Grid” and/or “Mission Critical” communications.
 - Real-time autonomous resource and interference management
 - Self organizing and optimizing

- TDD OFDMA, LTE or Wi-Max
- Frequency range: 50 – 1000 MHz (tunable)
- Signal bandwidth: 1 MHz – 10 MHz (tunable)
- Data throughput: up to 16 Mbps (6 MHz channel)
 - Adaptrum Bandwidth Efficiency: $5.65 \text{ MHz} / 6 \text{ MHz} = 94\%$
 - Uplink and downlink flexibility
- White Space Transmit power: 100 mW – 1 W (conducted)
- Adaptive Modulation based on link quality and link profile
- Network topology (PMP) Fixed, Nomadic and Mobile
- Antenna: MIMO PCB Bowtie, Mesh Panel etc.

Adaptrum Pre-Production System ACRS 1.0

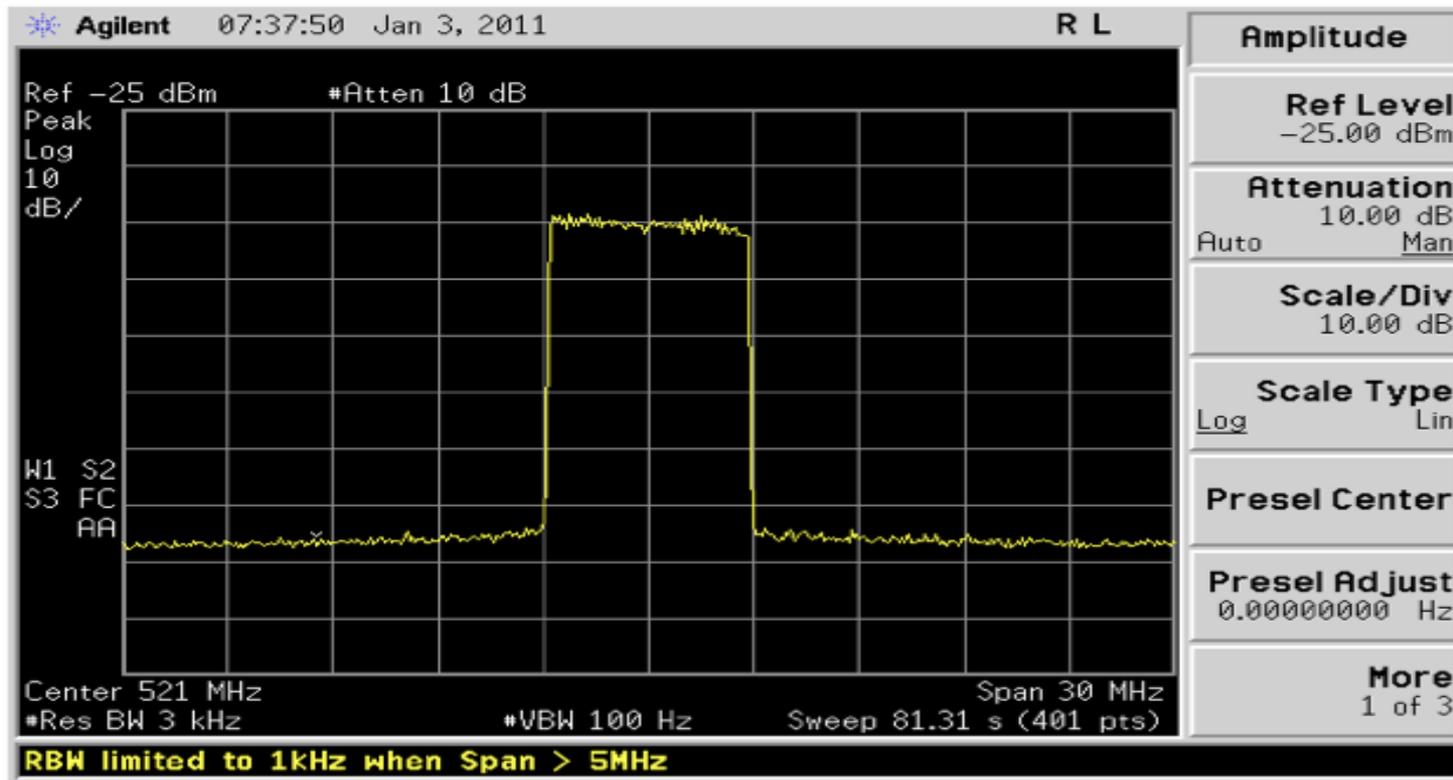




First Cognitive Radio White Space Chip Set Product

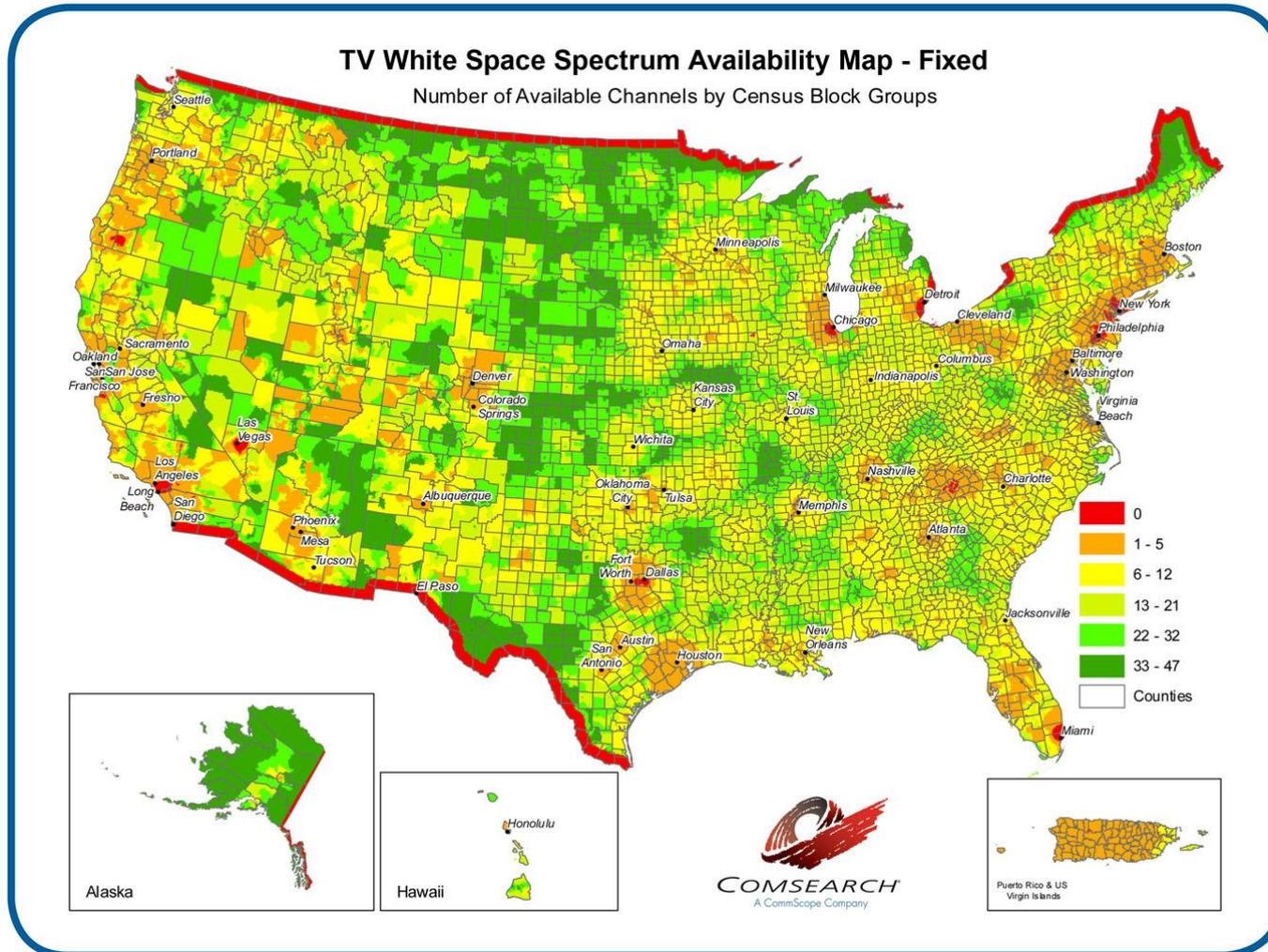


Example transmit signal spectrum (TV Channel 22)



Measured using Agilent E4405B spectrum analyzer
Channel 22 (518-524 MHz) is a whitespace channel in Milpitas, CA

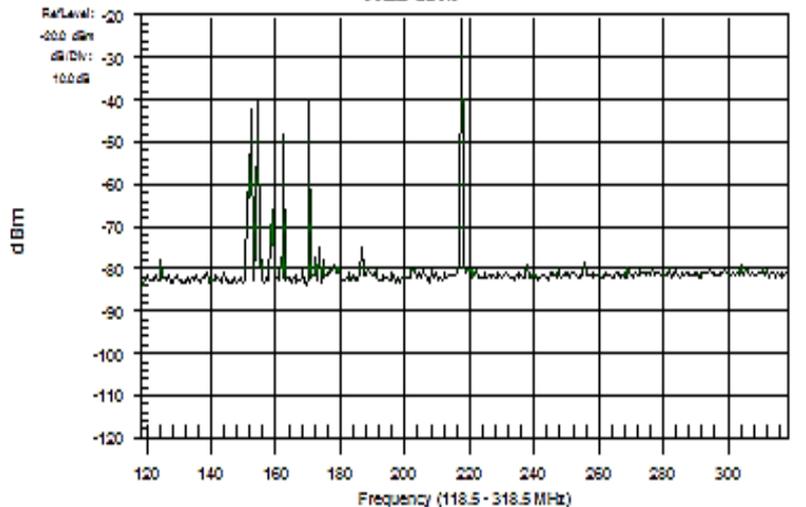
- We work with all database requirements and if necessary, specific “Regulator” or NTIA assigned bands.
- Can provide “Spectrum Sensing” as a regulatory requirement if needed. (Built into our product)
- Some interesting work to be done sensing Federal users which would allow “sharing”.



Shared Spectrum, Georgia Tech, More to come CRFS!

Spectrum Analyzer

FRED-S2 NF



CF: 218.5 MHz
 RBW: 10 kHz
 MaxHold: ON
 Sd:
 Min Sweep Time: 1.00 Mill Sec
 Date: 07/14/2011
 Model: MS2711D

Frequency (118.5 - 318.5 MHz)

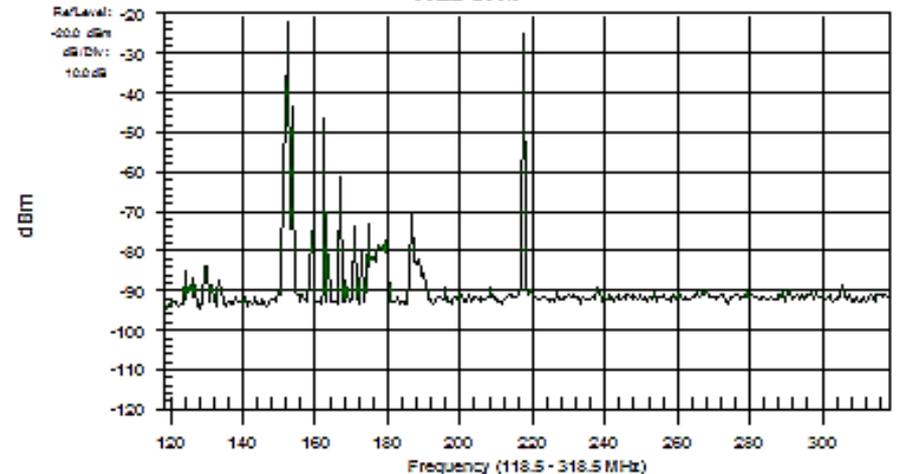
SPAN: 200.00 MHz
 VBW: 3 kHz

Attenuation: 20 dB
 Detection: Pos. Peak

Time: 12:16:55
 Serial #: 00624209

Spectrum Analyzer

FRED-S1 NF



CF: 218.5 MHz
 RBW: 10 kHz
 MaxHold: ON
 Sd:
 Min Sweep Time: 1.00 Mill Sec
 Date: 07/14/2011
 Model: MS2711D

Frequency (118.5 - 318.5 MHz)

SPAN: 200.00 MHz
 VBW: 3 kHz

Attenuation: 10 dB
 Detection: Pos. Peak

Time: 12:01:49
 Serial #: 00624209

- USA Strategic Opportunities.
 - Existing Missions & Objectives.
 - False Rhetoric on Spectrum Crisis/Crunch/Lies
 - Smart Grids or Dumb Grids?
- Lack of infrastructure is the real problem.
- Fallow Spectrum (Allocated, Assigned, Ignored?)
 - Lack or real spectrum inventory retains status quo...
 - Spectrum Accountability is required
- How do we put the pieces together to solve these problems?
- Spectrum Sharing & Infrastructure Sharing

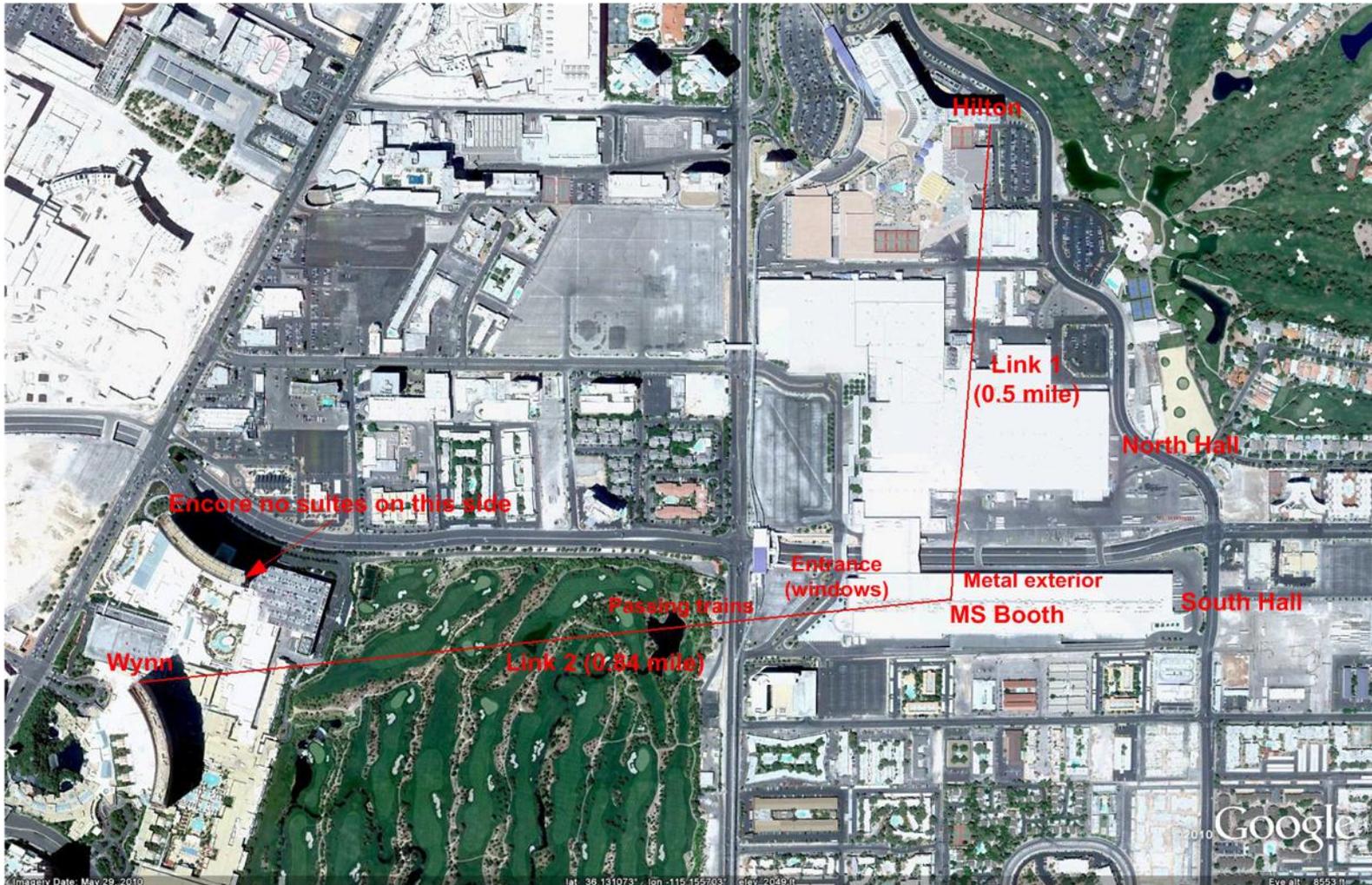
- 216 – 217 MHz could be an option through FCC Waiver
- 218 – 219 MHz is to be auctioned, very low commercial value, can be used until auction
- 220-222 MHz LMR
 - Availability TBD
- 454 / 459 MHz Paging
 - Availability TBD
- 757/787 Guardbands
 - Spectrum is available, requires additional towers
- 901,930, 941 MHz Paging Bands
 - Spectrum is available, requires additional towers

- Adaptrum provided base station and client device
- Tests were performed in Boulder
- Next steps under Notice Of Information (NOI) now
- Real world deployments logical next step
- Which bands?
- Which areas?
- Idaho National Labs?
- Real utilities?

- NTIA has many potentially unused bands below 450 MHz that will meet the link budget (especially in less dense areas?)
 - 138 – 144 MHz
 - 328 – 335 MHz
 - 380 – 400 MHz
 - 410 – 420 MHz
- Could DOE submit request to NTIA/FCC on behalf of Utility?
 - Request for any channel anywhere below 1 GHz (500 kHz up to 10 MHz.)
 - Start with STA immediately with request to convert to permanent (e.g. State of Wisconsin, etc.)
 - May require joint use during a federal emergency and / or lease payments based on market value –OMB test idea? **VALUEABLE!**













“In addition to the smart meters at the edge of the network, remote telemetry including, line sensors and circuit switching equipment are required to link the central grid “brain” to complete the fully intelligent grid.”

MAYOR’S TASK FORCE REPORT:

Electric Service Reliability in the Houston Region

April 21st, 2009

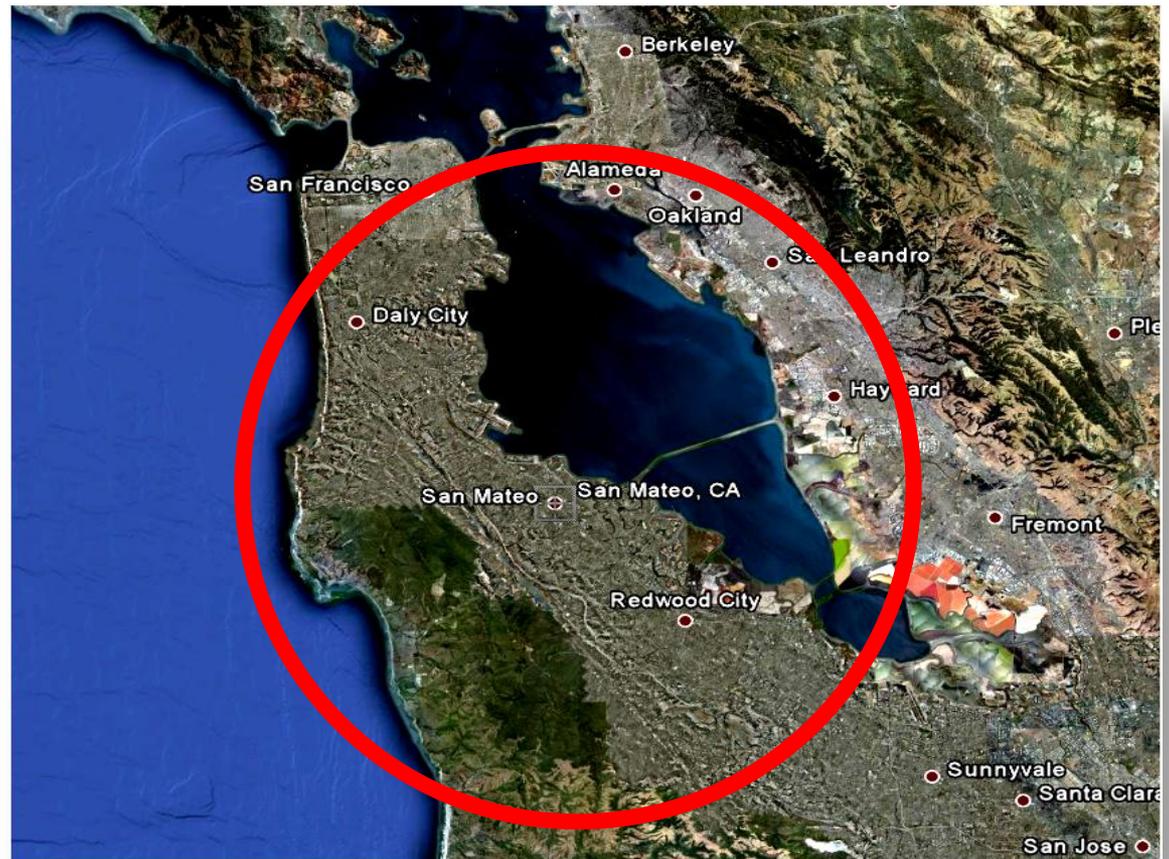
Carrier-provided wireless services have inadequate coverage, uncertain recovery during adverse events and service disruptions due to competing uses.”

“Unlicensed spectrum [will be used] only for applications that do not represent critical grid-control.”

Source: Sempra Energy Utilities response on October 2, 2009 to FCC on the Implementation of Smart Grid Technology, NPB Public Notice DA 09-2017 released

VHF benefits

- 20 Miles vs. 4
- 1,250 sq. miles
- Less towers
- Less Capex
- Less Opex



- GIVE “STATUS QUO” CARRIERS MORE SPECTRUM
 - 100 MHz on top of 280 = 36% Increase network capacity
 - Estimates say 10x or 1,000% increase in capacity demand (5Yr)
- FORCE THEM TO ACCOUNT FOR SPECTRUM USE AND INFRASTRUCTURE INVESTMENT
 - How much do they control specifically, how much do they us?
 - If a typical reduction is split into 3, 1.7x reduction in cell radius, capacity increased by factor of 3 or 300%
 - Do this again (3x3) and you have increase of 900% (Same Spectrum- No new allocations!)

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