Can Policies and Regulations Really Impact 5G Deployment?

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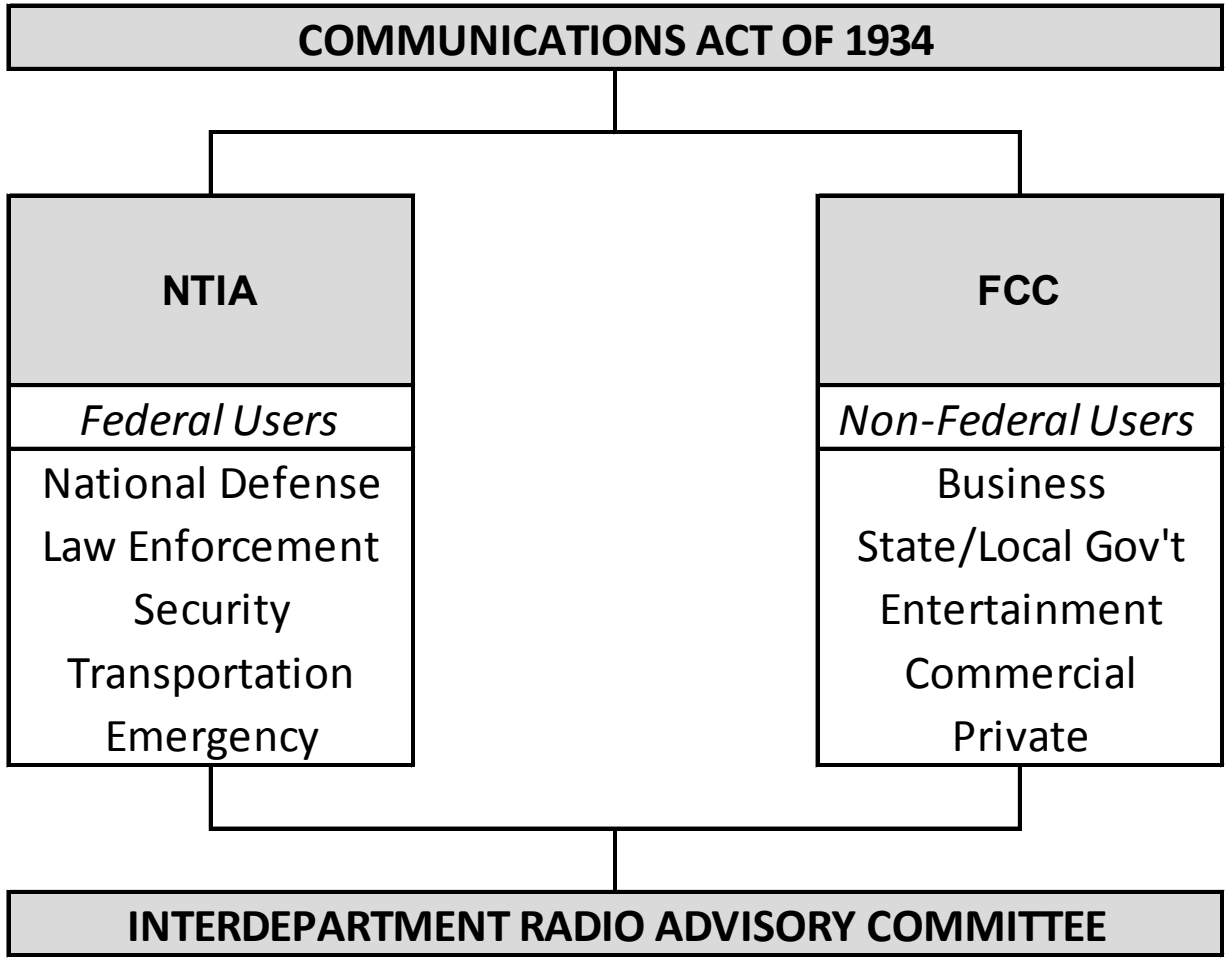
Themes

- US-focused discussion, but problems are similar everywhere
- Spectrum allocation
- Small cell deployment
- Impact on competition
- 5G and security

Spectrum

Who is in charge?



+ WRC designations

Licensed Spectrum Summary – USA and Selected Countries

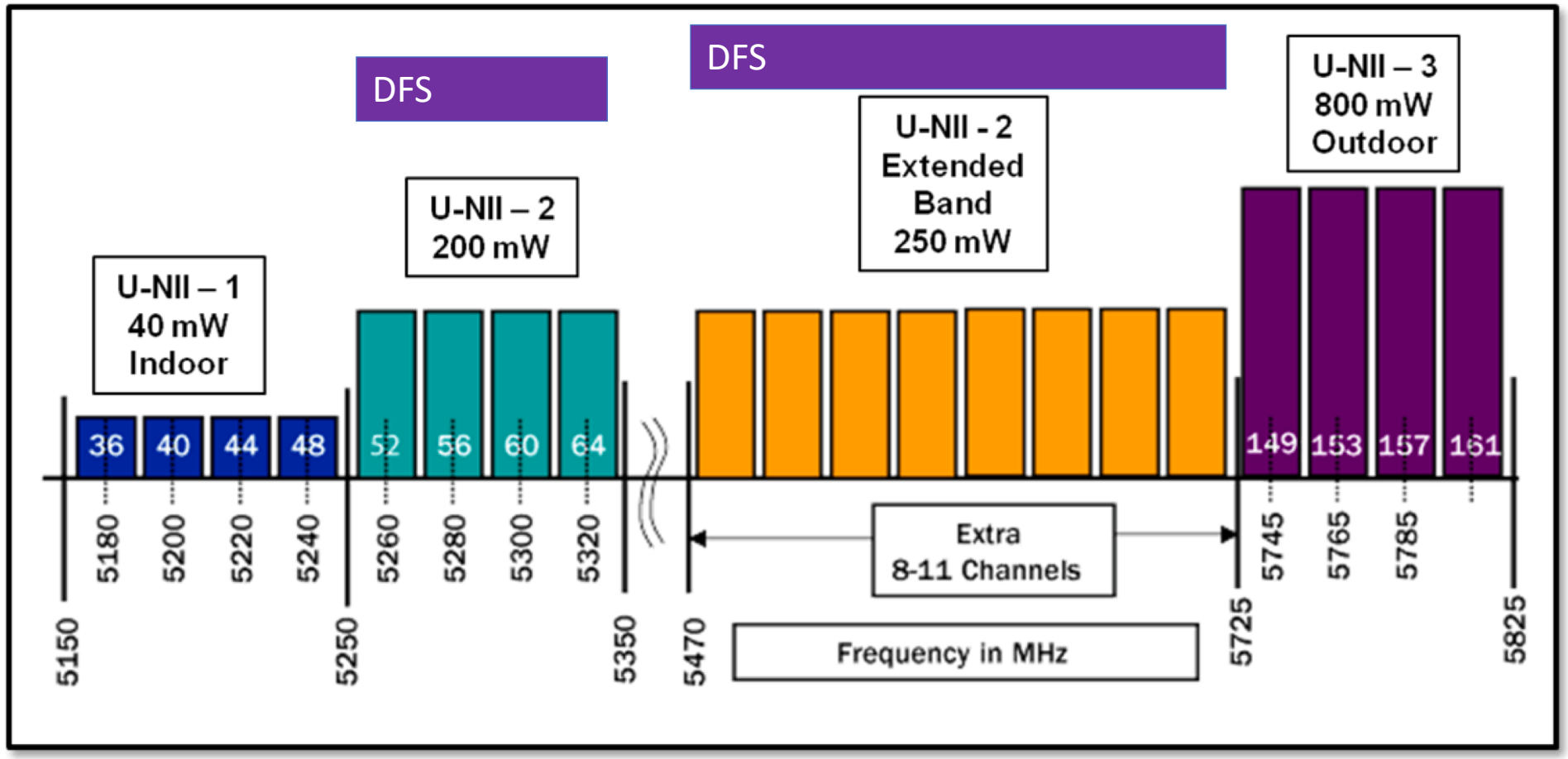
Country	Current	Pipeline	Current + Pipeline
USA	608	55+	663+
Australia	478	230	708
Brazil	554	0	554
China	227	360	587
France	555	50	605
Germany	615	0	615
Italy	540	20	560
Japan	500	10	510
Spain	540	60	600
U.K.	353	265	618

Unlicensed Spectrum Summary – USA and Europe

Band	Current	Pipeline	Current	Pipeline (Unknown)
TV White Spaces [Unl1]	0 - 150	+	-	
863-870 MHz	-	-	7 [Unl2]	
902-928 MHz	26 [Unl3]	-	-	
1880-1930 MHz	10 [Unl4]	-	20 [Unl5]	
2400-2483.5 MHz [Unl6]	83.5	-	83.5	
3550-3700 MHz	50 [Unl7]	100 [Unl8]	-	
5150-5350 & 5470-5825 MHz [Unl9]	555	-	555	
5350-5470 & 5850-5925 MHz	-	195 [Unl10]	-	
	724.5 - 874.5	295+	665.5	

Feb. 2013

5.8 GHz band is complex

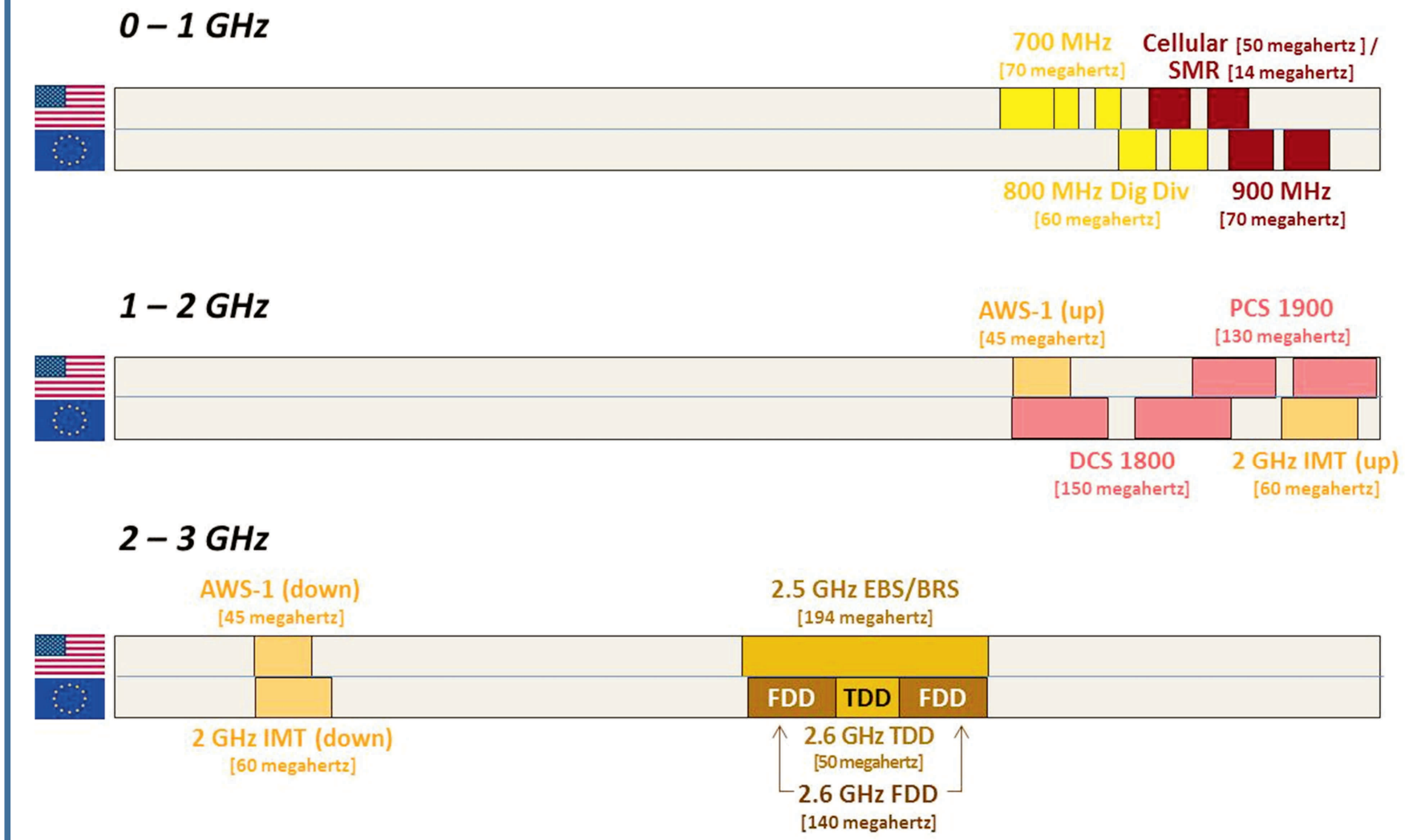


LTE band support varies

Frequency Bands

Name	# of countries in use	# of carriers in use	# of devices with support
B1 (2100)	12	20	3651
B2 (1900 PCS)	11	19	1609
B3 (1800 +)	93	205	4280
B4 (1700/2100 AWS 1)	20	41	1701
B5 (850)	11	13	2478
B6 (UMTS Only)	0	0	48
B7 (2600)	53	118	3319
B8 (900)	10	15	2088
B9 (1800)	1	2	74
B10 (AWS 1+3)	0	0	0
B11 1500 Lower	1	1	46
B12 (700 ac)	4	9	777
B13 (700 c)	4	4	543
B14 (700 PS)	0	0	0
B17 (700 bc)	10	16	1230
B18 (800 Lower)	1	1	410
B19 (800 Upper)	1	1	577
B20 (800 DD)	49	98	1833
B21 (1500 Upper)	1	1	123

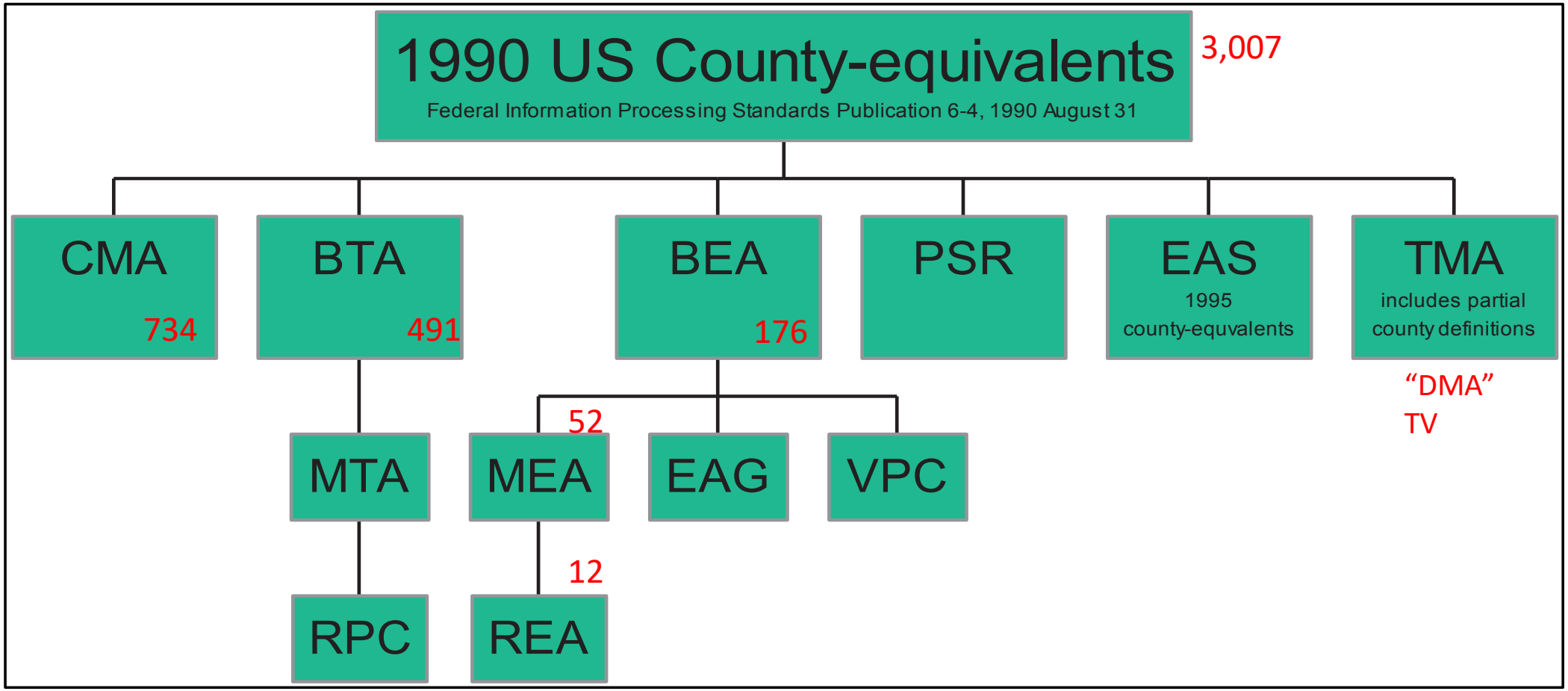
https://www.frequencycheck.com/interfaces/lte



***Note**: This figure represents only the most commonly deployed bands in the EU and US as of the date of this paper. Thus, it does not include the AWS-4 and WCS bands recently made available in the US, which are not yet deployed and generally do not have a comparable counterpart in Europe.*

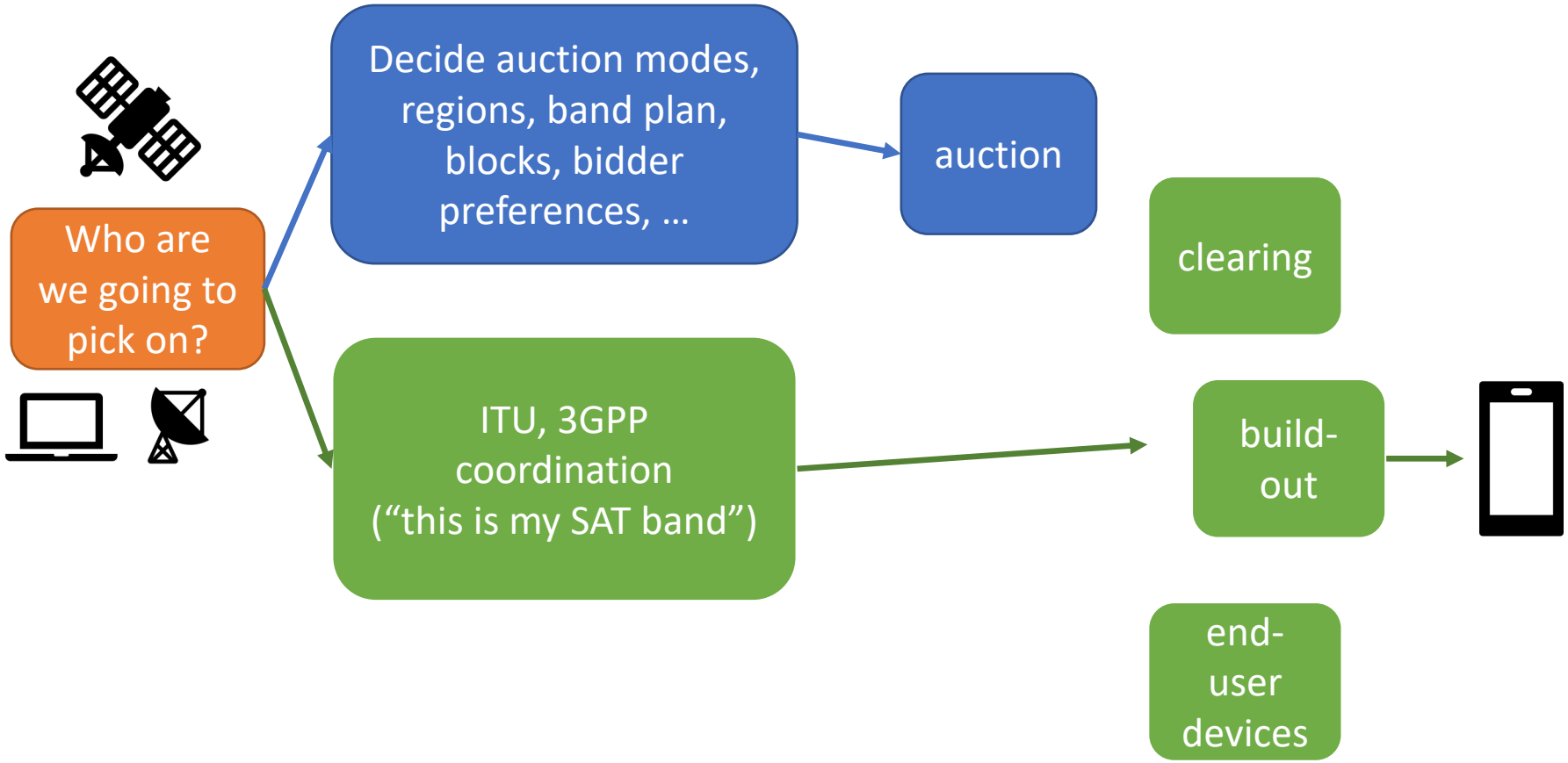
FCC license areas

Exhibit AIII-1: FCC License Territory Relationships



Source: FCC website

Why does it take so long?



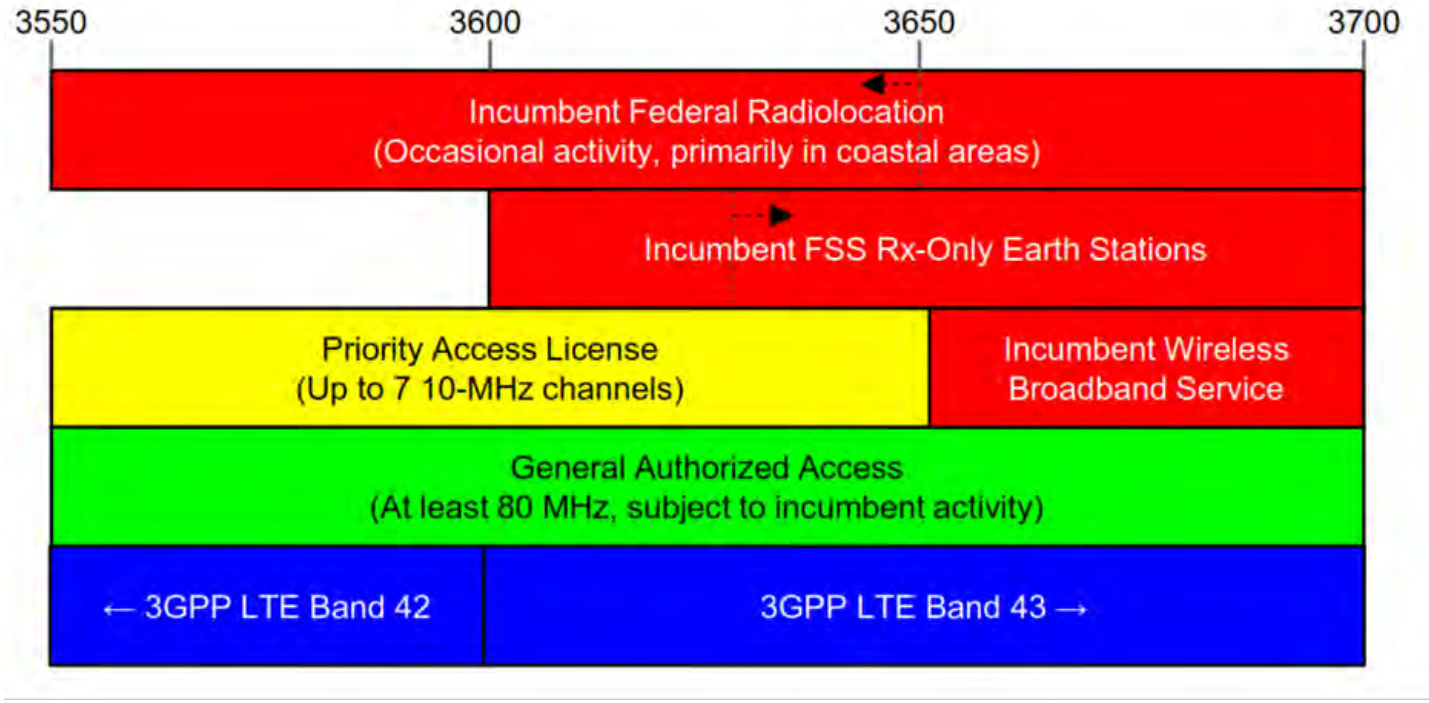
It takes a long time to convert spectrum

Exhibit 16: Time to Reallocate Spectrum

Band	First Step	Available For Use	Approx. Lag Time
Cellular	1970	1981	11 years
Broadband PCS	1989	1995	6 years
EBS/BRS	1996	2006	10 years
700 MHz	1996	2009	13 years
AWS-1	2000	2006	6 years
600 MHz	2010	2018	8 years

Source: FCC.

3.5 GHz band



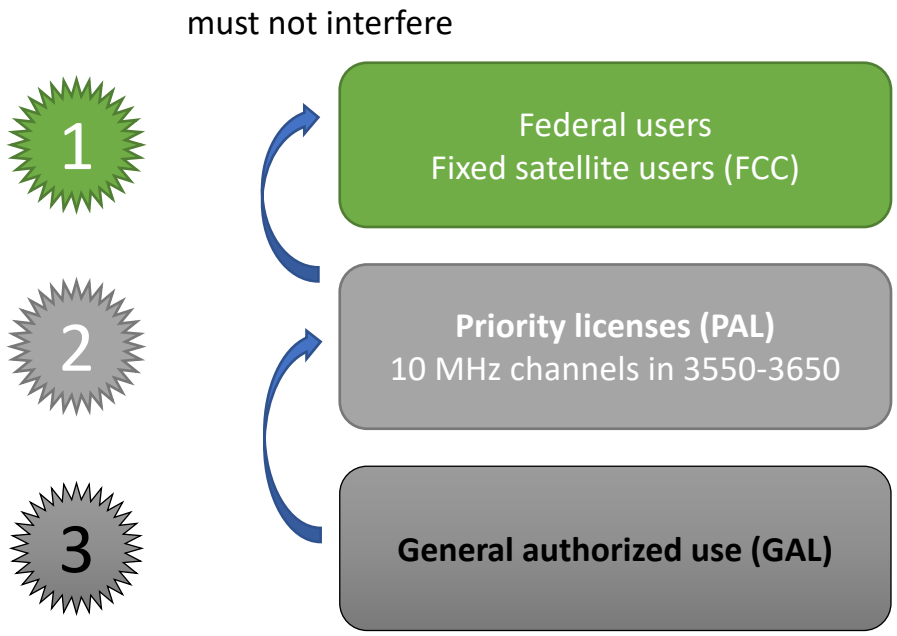
Band 42: TDD, 3.4-3.5 GHz

Band 43: TDD, 3.6-3.65 GHz

Source: Google

FSS: C Band (3.625–4.200)

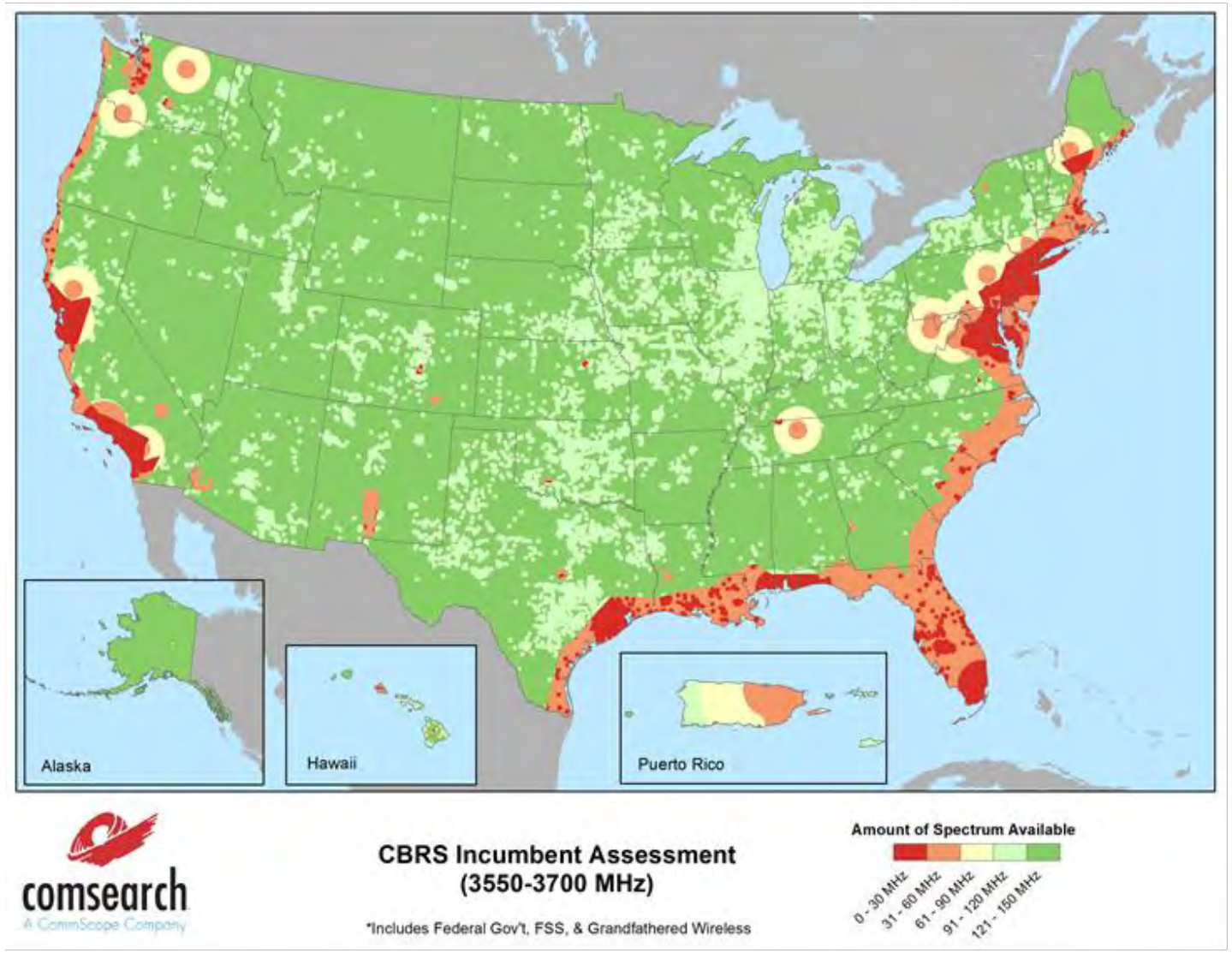
3.5 GHz user classes



census tract
≤ 70 MHz
3-year licenses
assigned via SAS

ESC (environmental sensing capability) allows commercial use in coastal and Great Lakes region

CBRS availability



Source: CommScope

mmWave bands

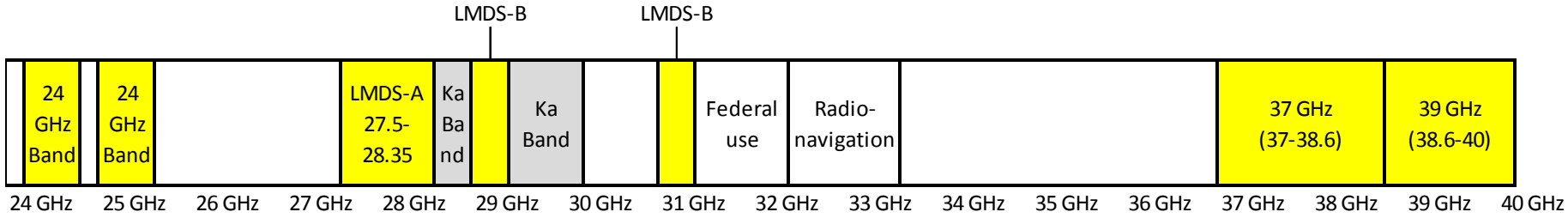
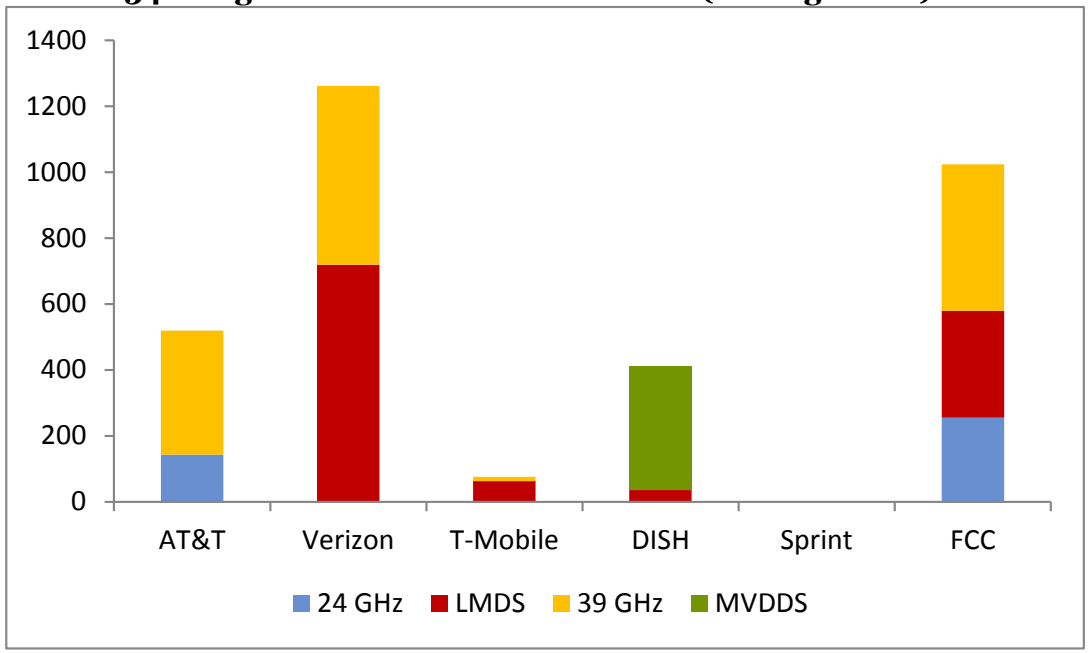


Exhibit 34: Largest mmWave Licenseholders (Average MHz)



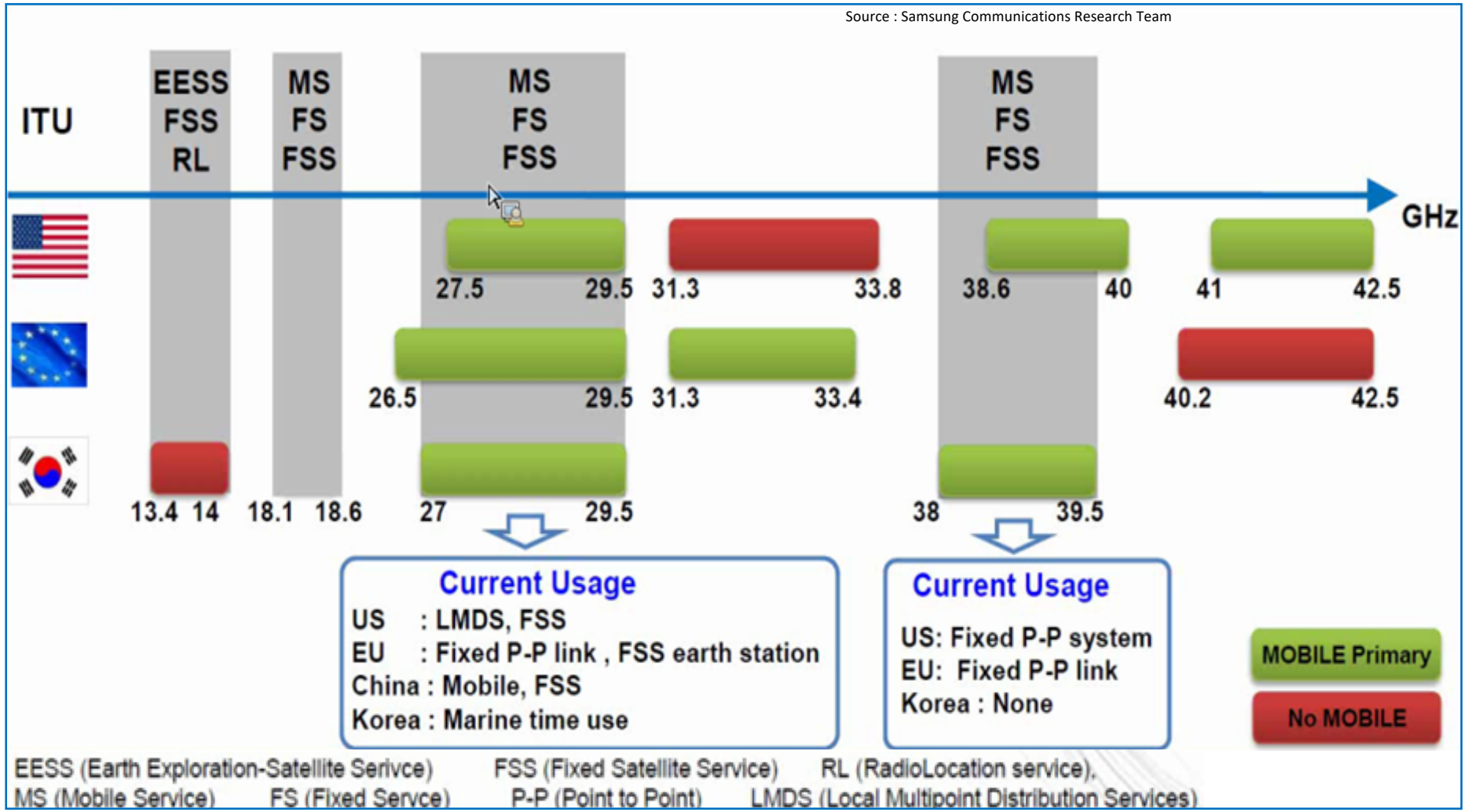
Note: Allocates FiberTower licenses to AT&T and Straight Path and XO (Nextlink) licenses to Verizon.
Source: FCC, company reports, AllNet and Wells Fargo Securities.

Unlicensed:
64-71 GHz
70-80 GHz (new uses)

Satellite:
24.75-25.25 GHz (FSS earth)
40—42 GHz
48.2—50.2 GHz

mmWave bands for mobile systems (non-satellite)

Band	Available	Currently used	Frequencies	Area, format	Blocks
12.2-12.7 GHz	500 MHz	Licensed to DISH (2004 & 2012)			
24 GHz (UMFUS)	900 MHz	FiberTower, AT&T	24.25–24.45, 24.75–25.25 GHz	PEA clock	7 x 100 MHz (after 28 GHz)
28 GHz (LMDS)	0.9 GHz	Verizon (via XO)	27.5–28.35 GHz	County SMR	2 x 425 MHz (Nov. 2018)
37 GHz	1.6 GHz	Greenfield, federal use			6 100 MHz
39 GHz	1.4 GHz	FSS (unused), 14 blocks of 50+50; StraightPath (VZ)			
57-71 GHz (V-band)	14 GHz	unlicensed (WiGig)			
71-76 + 81-86 GHz (E-band)	10 GHz	light license			



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- Note: The Commission's Fixed Microwave (Part 101) and Satellite Communications (Part 25) service rules govern most of US Mobile allocations shown above

Small cell deployment

Two perspectives on small cells

Carrier

- 5G deployment provides public benefit
- enables smart city deployments
- needed for US competitiveness
- cities and tribes just extorting money
- fees should reflect cost of permitting
- Federal preemption, please!

Municipalities

- carriers are not charities
- not a major cost factor
- what about digital inclusion?
- concerns about visual blight
- it’s my city!

Reviews

- The FCC (or states) don't approve cell towers or small cells → largely, local issue
- National Environmental Policy Act ("NEPA")
- National Historic Preservation Act ("NHPA")
- Tribal review, according to AT&T
  - "last three years AT&T has spent $13 million in tribal fees"
  - "CTIA and WIA have explained that tribal review takes, on average, about 110 days"

Broadband Deployment Advisory Committee (BDAC)

- Established April 2017
  - *Model Code for Municipalities*
  - *Model Code for States*
  - *Competitive Access to Broadband Infrastructure*
  - *Removing State and Local Regulatory Barriers*
  - *Streamlining Federal Siting*
- Membership: 30 members, 3 of which represent municipalities
  - rest carries, industry associations, conservative academics
- Significant leadership and membership churn
  - mayor of San Jose resigned
- Goal: develop model agreement and guidelines for small-cell deployments
  - non-binding, but related to pole attachment rules

Small cell deployments

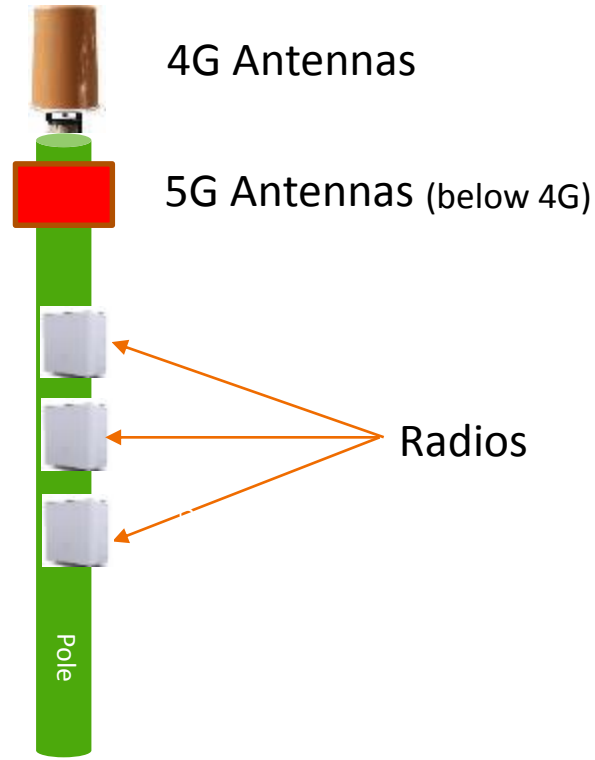
- "A wireless facility where each antenna, *excluding associated equipment*, comprises no more than three cubic feet in volume." (AT&T)
- "17% of AT&T costs to deploy each small cell node are directed to NEPA and NHPA compliance" (AT&T)

~ 3 ft^3

Typical Urban Deployment

4G Antennas: ≈3 ft^3/ea

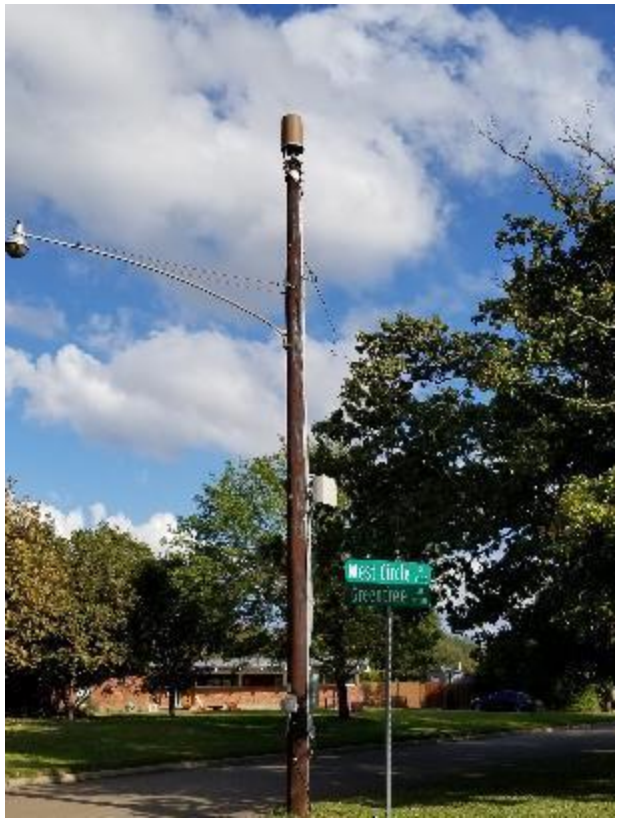
5G Antennas: <3 ft^3/ea



AT&T examples of small cells

Boston

Dallas



5G small cell – deployed reality

Indianapolis

Example: San Jose (April 2018)

Zone 1

Enclosure Size (Including Space For Antennas)	*Effective Radiated Power (ERP) Output* 0-20 Watts	21-100 Watts	101-360 Watts
0-30 Cu. Ft.	$ 2,625	$ 5,250	$ 10,875
31-125 Cu. Ft.	$ 5,063	$ 6,938	$ 13,313

Year 1:	$1,500	Year 6:	$1,545	Year 11:	$1,794
Year 2:	$1,500	Year 7:	$1,592	Year 12:	$1,848
Year 3:	$1,500	Year 8:	$1,640	Year 13:	$1,904
Year 4:	$1,500	Year 9:	$1,690	Year 14:	$1,962
Year 5:	$1,500	Year 10:	$1,741	Year 15:	$2,021

60 day processing

Impact on Competition

5G as hope for facilities-based competition

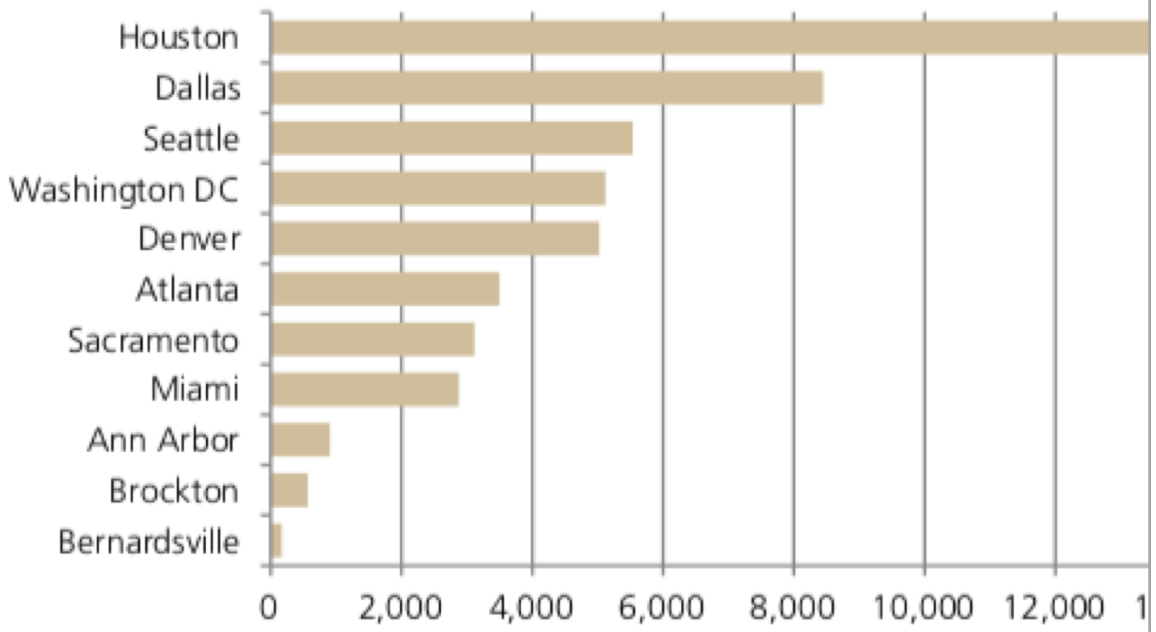
Verizon completed its pre-standard 5G fixed wireless trials that it conducted with friendly users in 11 markets across the country. The company is now shifting its focus to deploying its pre-standard fixed 5G in the three to five cities where it will launch commercial services later this year. One of those cities is Sacramento, California, but the rest are still unknown.

Starry hopes to challenge existing, in-home, wired internet suppliers in downtown areas with its 200 Mbps fixed wireless service, which it is selling for $50 per month. Starry's proprietary, active phased array technology is based on the IEEE's 802.11ac Wi-Fi standard and works in the licensed 37.0-38.6 GHz band in all of its chosen markets.

Opening the Door to be A Real Alternative to Fixed Broadband

The New T-Mobile will be laser-focused on improved broadband connectivity at a lower price – including for rural consumers. Today, 48% of American households lack competitive choice for in-home broadband exceeding 25Mbps and 79% of households lack competitive choice for in-home broadband exceeding 100Mbps. The New T-Mobile will change this! Our nationwide 5G network will open up exciting possibilities to disrupt the in-home broadband market with innovative services and we know that fast competitors will force the market to respond with lower prices. Faster speeds. Instant savings. Much-needed choices. Only the New T-Mobile can fundamentally disrupt broadband and eliminate your unnecessary wired broadband bill month after month.

Financial model



Source: UBS estimates

Figure 4: Fixed 5G model

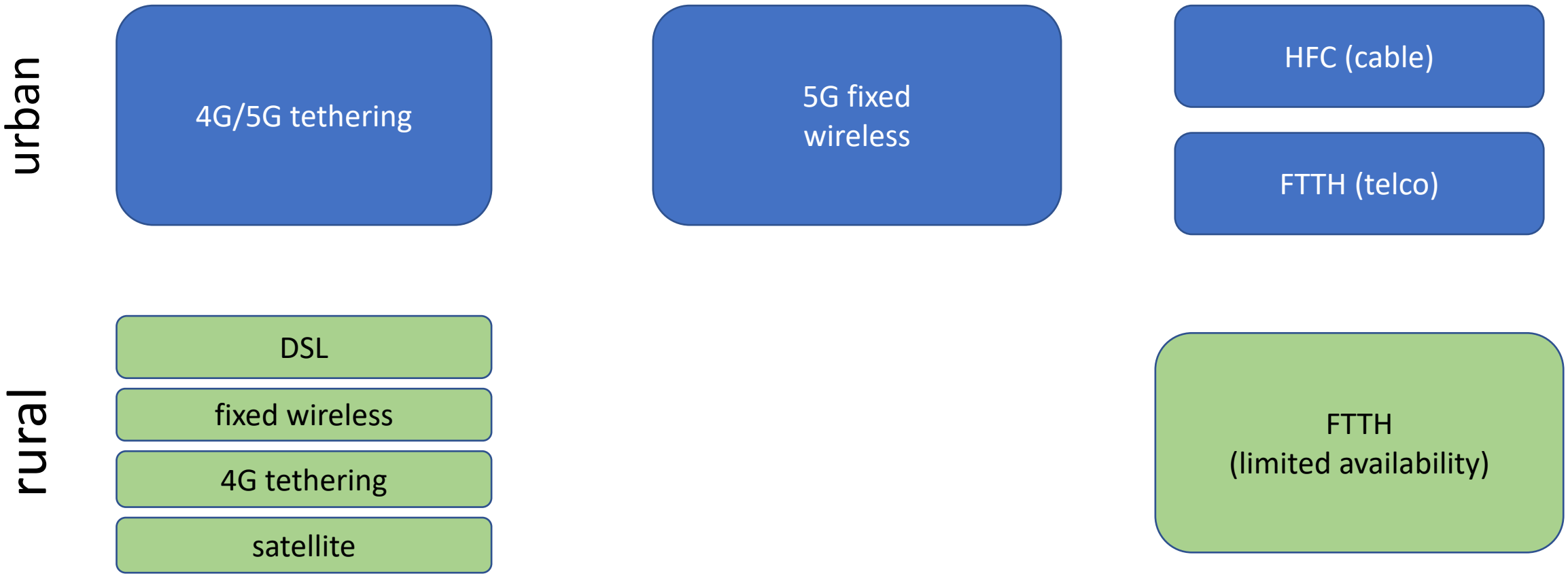
Small cell assumptions	
Region	Sacramento, CA
Population	495,234
Land area (miles^2)	98
Housing units	186,881
Population per household	2.65
Population density (per mile^2)	5,058
Household density (per mile^2)	**1,909**
Small cell propagation (radius in feet)	1,000
Small cell coverage (feet^2)	3,140,000
Households available per small cell	**215**
% of city covered with small cells	50%
Small cells in region	3,115

Financial assumptions	
Household penetration	20%
HHs per small cell in Sacramento, CA	43
Max. HHs covered / small cell	30
Asset life (years)	15
Tax rate	35%

Cost to install	**Per Small cell**	**Per Sub**
Antenna, radio, other equipment	300	10
Installation cost	0	0
Cost to connect (success based)		
CPE	6,000	200
Installation cost (line drop)	3,000	100
Selling & Marketing	3,000	100
Total cost per gross addition	9,300	410

P&L per sub	
Revenue	75.0
Backhaul cost	16.7
Small cell rental cost	10.0
Other cost of service	7.0
Total cost of service	33.7
Gross profit	**41.3**
Gross profit margin	*55.1%*
SG&A	11.3
EBITDA	**30.1**
EBITDA margin	*40.1%*
Depreciation	1.7
EBIT	**28.4**
Tax	9.9
NOPAT	**18.4**
Capex	7.5
Free cash flow	**12.7**
Free cash flow margin	*16.9%*
Cost to acquire sub	**410.0**
Monthly IRR	1.1%
Annual IRR	**13.9%**

Competition models, 2020+



FCC, 5G and security

2017: 5G security NOI (Feb. 2017)

In the Matter of	)	
	)	
Fifth Generation Wireless Network and Device Security	)	PS Docket No. 16-353
	)	

9. As the Commission indicated in the *Spectrum Frontiers Report and Order,* we seek to promote 5G security through a "security-by-design" approach to 5G development,[11] and we believe it is important that *all* stakeholders – service providers, software developers, and device manufacturers alike – work toward a comprehensive long-term strategic framework. We seek comment on the premise that, by utilizing the "confidentiality," "integrity," and "availability" (CIA) principles,[12] a firm may avoid or mitigate 5G network and device data security risk through strong, adaptive, protections against unauthorized use, disclosure, and access. What are the benefits and limitation of a security-by-design approach and of employing CIA principles?

inquiry, which was published in the *Federal Register* on January 25, 2017. Pursuant to the Bureau's existing authority, including Section 1.113 of the Commission's rules,[3] the undersigned hereby sets aside and rescinds that notice of inquiry. The notice of inquiry will have no legal or other effect or meaning going forward and, as a result, there is no longer a comment cycle associated with that document and we hereby terminate this docket.

2. **ACCORDINGLY, IT IS ORDERED**, pursuant to Sections 0.191, 0.392, and 1.113 of the Commission's rules, 47 CFR §§ 0.191, 0.392 and 1.113, that the *Notice of Inquiry*, DA 16-1282, **IS SET ASIDE** and the above-captioned docket **IS TERMINATED**.

Conclusion

- Spectrum policy gets messier
  - most 5G action seems to be at 3.5 GHz, not mmW
  - can we make mobile vs. satellite discussions more rational?
    - little economic impact analysis
- Towers: *not in my backyard* → small cells: not on my lamp post (without a fee)
  - danger of carrier overreach
- Impact of 5G on competition: HFC or another BPL?
- Should there be other regulatory interventions
  - security? interoperability (bands)? receiver requirements?