

2017 SPECTRUM DEVELOPMENTS

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Overview

- **Spectrum Always a Key Issue**
- **The Current (and potential future) Players**
- **The FCC Broadcast Spectrum Incentive Auction**
- **Licensing to Address Commercial Spectrum Needs**
- **Sharing to Address Commercial Spectrum Needs**
- **Other Hot Topics**

Spectrum Issues Front and Center

- **Increasing reliance on mobile for voice, video and data**
 - ~50% of U.S. households are now wireless-only
- **Global demand will skyrocket with 5G/Internet of Things development**
 - Mobile data traffic increased 63% from 2015 to 2016
 - By 2021, traffic expected to increased more than 7x (47% CAGR)
 - 49 exabytes/month v. 7.2 exabytes/month (Note: one exabyte = 1 billion GBs)
 - 71% of global population will be mobile users by 2020
- **Both licensed and unlicensed spectrum have enormous value**
 - Licensed spectrum generated >\$400B in U.S. economic activity in 2013
 - Unlicensed added \$222B of value to U.S. economy in 2013
- **Prevailing Goals of U.S. Spectrum Policy**
 - Make more spectrum available for mobile broadband
 - Enhance spectrum efficiency

The Current FCC



- **Chairman**
 - Ajit Pai (R) (term expired June 2016 – permitted to serve until Congressional 2017 adjournment)
- **Commissioners**
 - Mignon Clyburn (D) (term expires June 2017)
 - Michael O’Rielly (R) (term expires June 2019)
 - Two seats vacant – one R and one D

Other Major Federal Players



Congress

- Has power to dictate spectrum policy



The White House

- Influential spectrum policy role when it wants
- OSTP/CTO plays a coordinating role



NTIA

- Manages all federal government use of spectrum

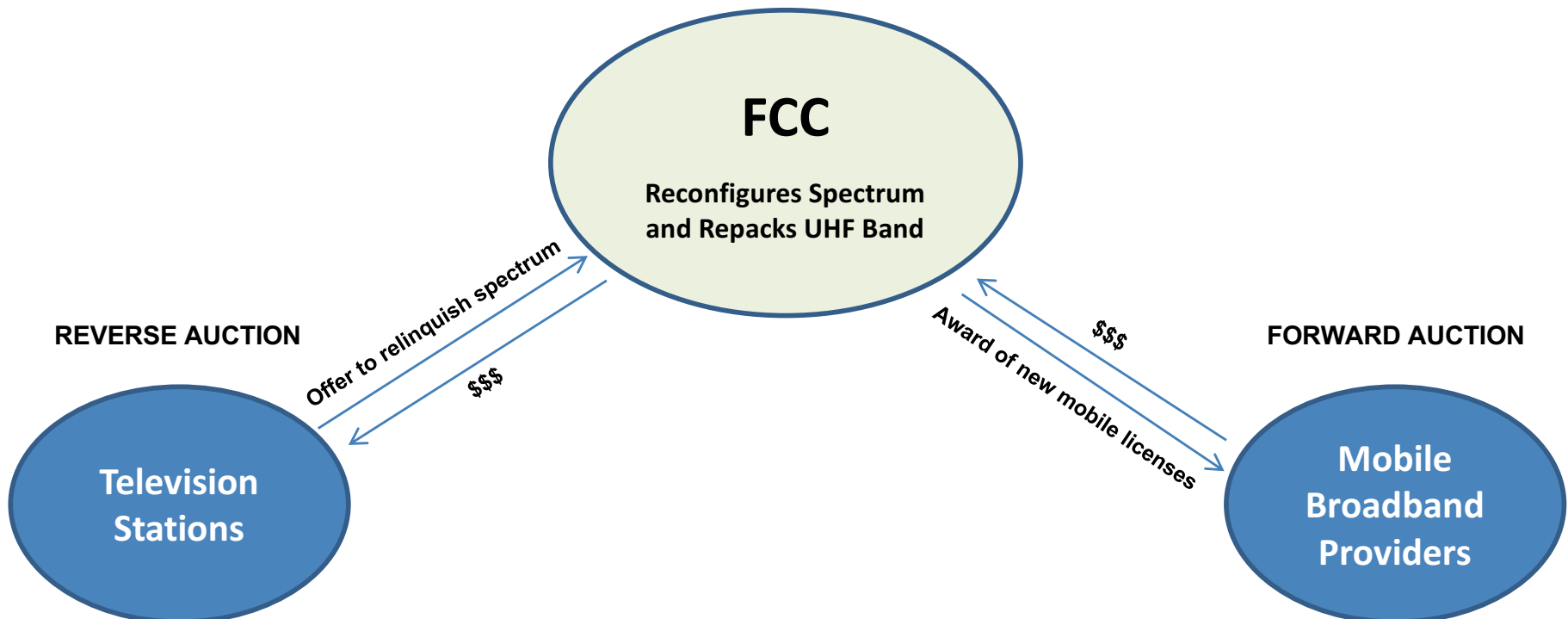


DoD and other agencies

- Mission-critical and other incumbent systems

What Just Happened???

The 600 MHz Broadcast Spectrum Incentive Auction



Incentive Auction – The Basics

- **Three interdependent elements:**
 - **Reverse Auction** – descending clock auction determined which TV stations would be paid to clear, and how much they would receive
 - “Repacking feasibility” check every round – determined prices paid to stations
 - **Forward Auction** – ascending clock auction (plus assignment phase) determined which wireless bidders get new licenses, and for how much
 - Bidders expressed demand in clock rounds at prices specified by the FCC
 - **Repacking** – remaining stations rearranged with a smaller TV band
- **Reverse Auction Options for full-power and Class A TV stations:**
 - Relinquish spectrum and exit over-the-air broadcast business
 - Relinquish spectrum and share a channel with another station
 - Move from UHF to VHF or from High-VHF to Low-VHF
 - Sit out / drop out and be relocated
- **Forward Auction Options for wireless providers:**
 - No spectrum aggregation limit
 - Some spectrum reserved for bidders other than AT&T and Verizon in most markets

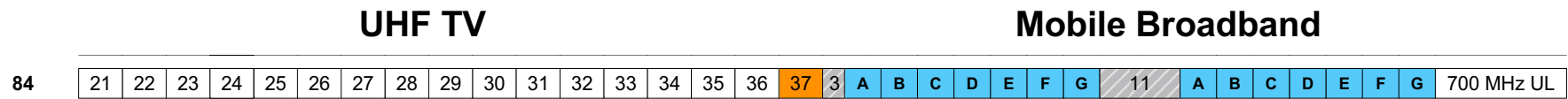
Incentive Auction – Timeline

- **3/29/2016: TV stations made “initial commitments” to accept opening prices**
- **5/31/2016: Reverse auction bidding began in “stage one”**
- **1/18/2017: In “stage four,” forward auction satisfied “final stage rule”**
- **2/10/2017: Forward auction clock phase concluded**
- **3/30/2017: Bidding in assignment phase concluded**
- **4/13/2017: Results and final channel assignments announced**
- **Repacking to occur over the next 39 months (until July 2020)**

Incentive Auction: Results and Implications

- **Four “stages” were ultimately needed to achieve equilibrium**
- **84 MHz of spectrum cleared**
 - 70 MHz licensed, 14 MHz for unlicensed and wireless mics
 - Less than the FCC’s original goal
- **Forward auction generated \$19.3 billion**
 - **Second highest grossing auction in FCC history**
 - \$1.31 avg. price/MHz-pop sold in top 40 markets
 - \$0.93 avg. price/MHz-pop nationwide
 - T-Mobile and DISH Network the biggest winners – acquired spectrum nationwide
 - 50 winning bidders in total
- **\$10 billion to be paid to winning broadcast stations**

600 MHz Band Plan



Key: Blue = New 600 MHz Band blocks
 Grey = Duplex Gap/Guard Bands
 White = Post-Auction UHF TV Band
 Orange = Channel 37 (protected)

- New mobile broadband licenses (in blue) are 5x5 MHz paired
- 84 MHz for mobile broadband / Remaining UHF band in white
- Unlicensed use permitted in guard bands, duplex gap, and TV Whites Spaces
- Wireless mics can get licenses in a portion of the 11 MHz duplex gap

What Did We Learn?

- **Never try to predict auction outcomes**
- **Low-band spectrum may not be worth what we thought**
 - What might that mean for future auctions?
- **Two-sided incentive auctions can work**
 - Congress may try again
 - The length of the auction process is a concern

New Sharing Paradigms

- **3.5 GHz – Citizens Broadband Radio Service**
- **mmW Spectrum Above 24 GHz (Spectrum Frontiers)**
- **Wi-Fi / LTE-U / LAA**
- **5 GHz**
- **New Legislative Efforts**

3.5 GHz (3550-3700 MHz)

- **April 2015: FCC created new “Citizens Band Radio Service”**
 - Flexibility in access model based on need for IX protection
 - Coordination between FCC, NTIA and DoD produced smaller exclusion zones
 - Small cells and sensing technology provide roadmap for nationwide commercial use
- **Three-tier access modeled after PCAST**
 - Incumbent Access: federal military radar (3550-3650 MHz) and grandfathered users
 - Priority Access Licenses (PALs): 10 MHz, census tract, 3-years (protected from GAA)
 - General Authorized Access (GAA) : up to 80 MHz + opportunistic (no IX protection)
- **Spectrum Access System (SAS) – frequency coordinator**
 - Protect higher tier users and optimize co-existence between PALs and GAA users
 - FCC conditionally approved seven entities as SAS Administrators in Dec. 2016, subject to further testing
- **May 2, 2016: FCC order finalized CBRS rules**
 - PALs must “use it or share it” – affirms preference for GAA
 - PALs may engage in some secondary market transactions
- **Chairman Pai and Commissioner O’Rielly have indicated they will modify the 3.5 GHz scheme**

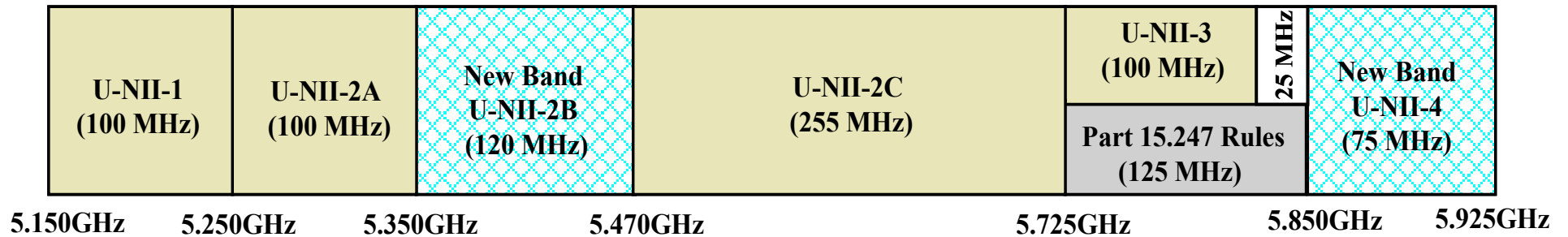
Spectrum Frontiers Rulemaking

- **Coincides with momentum toward 5G wireless**
 - High-bandwidth content with speeds in excess of 10 gigabits per second (GB/s)
 - Latency reductions to less than one-thousandth of a second
 - Lots of activity in 5G development worldwide
- **July 2016 FCC *Report and Order***
 - Established “Upper Microwave Flexible Use Service” under a new Part 30 of FCC Rules
 - Adopted rules to make nearly 11 GHz of mmW spectrum available for mobile and fixed wireless use
 - 28 GHz, 39 GHz, and upper 37 GHz bands available on a licensed basis
 - 64-71 GHz band will be unlicensed, and lower 37 GHz band will be licensed by rule
- **Second Report and Order and Order on Reconsideration expected ~ 3Q 2017**
 - Further Notice proposed to identify a potential 18 GHz of additional spectrum in the 24-25 GHz, 32 GHz, 42 GHz, 48 GHz, 51 GHz, 70 GHz, and 80 GHz bands to be made available in the future
 - Parties filed 13 Petitions for Reconsideration of the Report and Order, addressing issues such as technical parameters, sharing and operability in the lower 37 GHz band, siting of future earth stations, and the cybersecurity reporting requirement

Wi-Fi / LTE-U / LAA

- **Wi-Fi**
 - IEEE 802.11 standard; embedded base of > 1 billion devices
 - ~ 63% of U.S. households are equipped with Wi-Fi
 - Over 60% of mobile device traffic now offloaded to Wi-Fi globally
- **Carrier Alternative: LTE-Unlicensed and License Assisted Access**
 - Bonds unlicensed band to licensed band – a type of carrier aggregation
 - Would share spectrum with Wi-Fi; provides greater throughput than Wi-Fi
- **LTE-U devices submitted for Part 15 certification w/o standard**
 - Opponents (NCTA, Wi-Fi Alliance) concerned that LTE-U will interfere with Wi-Fi
 - Wi-Fi Alliance worked with LTE-U on common testing parameters
 - FCC OET authorized the first devices in the 5 GHz band in Feb. 2017
- **LAA was developed through 3GPP process**
 - LAA devices use listen-before-talk (LBT) contention protocol to co-exist with Wi-Fi devices
 - 3GPP determinations on LBT standards not completed

5 GHz Unlicensed



- **2014: FCC substantially modified use of the 5 GHz U-NII band**
 - More U-NII-1 power for outdoor hotspots; new U-NII-3 OOB limits protect FAA
 - Consolidated the rules applicable to U-NII-3 and set device certification deadline
- **March 2016: FCC Recon Order**
 - Relaxed U-NII-3 OOB limits to help WISPs – automakers have asked for recon
 - Allowed more time for manufacturers to come into compliance with new rules
- **Next up: FCC refreshing the record on U-NII-4 (195 MHz)**
 - Main U-NII-4 Issue: can DSRC share with Wi-Fi and other unlicensed uses? FCC testing prototype devices

A Few Other Hot Topics

- **The MOBILE NOW Act**
- **Ligado (formerly LightSquared)**
- **Higher Ground**

MOBILE NOW Act

- **Making Opportunities for Broadband Investment and Limiting Excessive and Needless Obstacles to Wireless (MOBILE NOW) Act**
 - Jointly sponsored by Sens. Thune (R-SD) and Nelson (D-FL), reintroduced on the first day of this Congress
 - Intent to facilitate 5G development
- **Major Components**
 - Codifies 2010 policy to free up 500 MHz for commercial use by 2020
 - Incentives for federal agencies to relinquish or share spectrum
 - Further NTIA evaluation of six bands between 24 GHz and 86 MHz
 - “Dig Once” policy for federal agencies
- **Prospects**
 - Voted out of Senate Commerce Committee on Jan. 24, 2017
 - Hotline in process, but held up over renomination of former FCC Commissioner Jessica Rosenworcel

Ligado (formerly LightSquared)

- **Under new control following bankruptcy**
 - Still holds L-Band satellite spectrum with ATC capability
- **Original terrestrial commercial mobile proposal**
 - Uplink at 1627.5-1637.5/1646.7-1656.7 MHz
 - Downlink at 1526-1536/1545-1555 MHz (also leasing 1670-1675 MHz)
 - GPS interests at 1559-1610 MHz objected to proposed terrestrial use, especially 1545-1555 MHz closest to GPS
 - 2012: proposed to forego 1545-1555 MHz in exchange for access to 1675-1680 MHz
- **Late 2015: reached agreement with commercial GPS interests**
 - Agreed to limit power on all L-Band spectrum it intends to use terrestrially
- **Dec. 31, 2015: Ligado filed applications with FCC to effectuate GPS deal and commence a rulemaking to gain access (per auction) to 1675-1680 MHz**
 - Comments on license modification and 1675-1680 MHz proposal were filed in 2Q 2016
 - Even if successful, additional FCC rulemaking proceedings would still be needed

Higher Ground

- **January 18, 2017: FCC Order granting Higher Ground application**
 - Blanket earth station license to operate up to 50,000 SatPaqs on a non-interference basis, subject to a variety of conditions, in the 5925-6425 MHz (Earth to space) and 3700-4200 MHz (space to Earth) bands
 - Higher Ground must maintain remote control of all SatPaqs and be able to override or shutdown any interfering SatPaqs. Can only deploy 5,000 SatPaqs in the first year following authorization
- **Enterprise Wireless Alliance, Utilities Telecom Council, Fixed Wireless Communications Coalition, APCO International filed Applications for Review**
 - FWCC also filed a Motion for Stay of the January decision granting the application

Questions?

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