



Lecture 5: New Developments

Sarah Oh Lam, J.D., Ph.D.

Senior Fellow, Technology Policy Institute, Washington, D.C.

Spectrum Economics and Market Tools



Lecture V: New Developments

Spectrum Economics and Market Tools

- I. Introduction
 - 1. Spectrum in the News
 - 2. Nobel Prize Winners
- II. Spectrum Economics
 - 1. History of Auctions
 - 2. Spectrum Valuation Methods
 - 3. Spectrum Valuation Factors
- III. Market Tools Part A
 - 1. Reallocation Challenges
 - 2. Secondary Markets
- IV. Market Tools Part B
 - 1. Incentive Auctions
 - 2. Other Tools
- V. New Developments**
 - 1. Satellite Constellations**
 - 2. Local Governance**
- VI. Conclusion

V.I Satellite Constellations

Overview

1. NGSO Low-Earth Orbit Satellites
2. GSO Weather and GPS Satellites

V.I Satellite Constellations

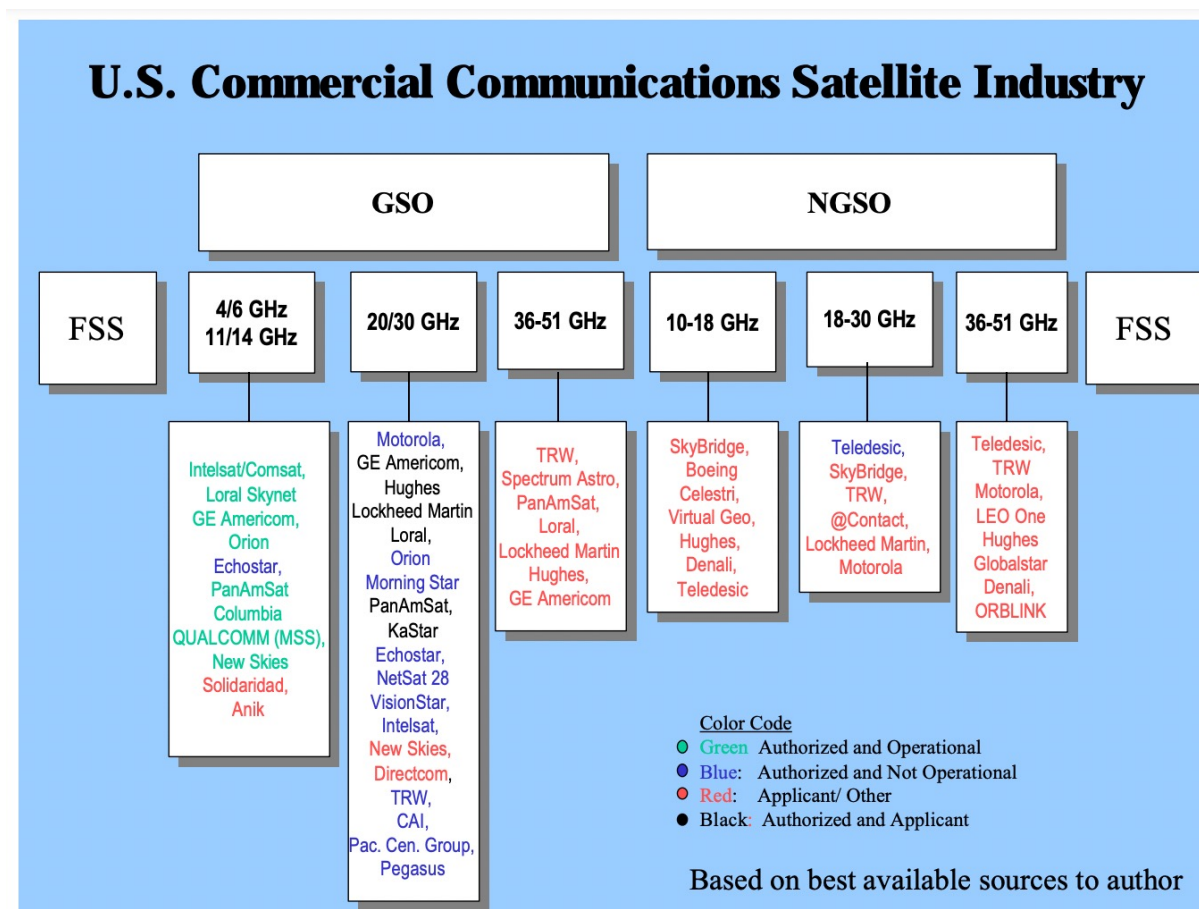


Figure 82. Satellite Operators in GSO and NGSO Bands

Edward M. Davison, Program Manager, Satellite Coordination and Policy, Office of Spectrum Management, ITS/NTIA, "Spectrum Issues Related to Satellite Communications," p. 5, https://its.ntia.gov/media/30236/dav_s.pdf.

V.I Satellite Constellations

Federal Communications Commission

FCC 21-123

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)	
)	
Revising Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems)	IB Docket No. 21-456
)	
)	
Revision of Section 25.261 of the Commission's Rules to Increase Certainty in Spectrum Sharing Obligations Among Non-Geostationary Orbit Fixed-Satellite Service Systems)	RM-11855
)	

ORDER AND NOTICE OF PROPOSED RULEMAKING

Adopted: December 14, 2021

Released: December 15, 2021

Figure 83. NGSO NPRM IB Docket No. 21-456

In the Matter of Revising Spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems and Revision of Section 25.261 of the Commission's Rules to Increase Certainty in Spectrum Sharing Obligations Among Non-Geostationary Orbit Fixed-Satellite Service Systems, FCC IB Docket No. 21-456, RM-11855, Order and Notice of Proposed Rulemaking, Dec. 15, 2021, <https://www.fcc.gov/document/fcc-moves-facilitate-satellite-broadband-competition-0>

V.I Satellite Constellations

Starlink's Constellation Phase I with 1584 Satellites at 550 km Altitude

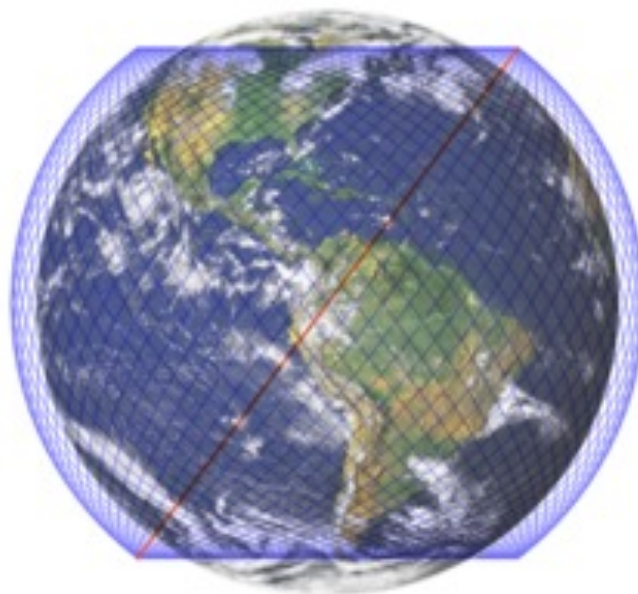


Figure 84. Starlink's Constellation Phase I with 1584 Satellites at 550 km Altitude
Starlink, Constellation Design and Status, <https://en.wikipedia.org/wiki/Starlink>.

V.I Satellite Constellations

Amazon's Project Kuiper's 3,236 Satellite Plan at 590-630 km Altitude

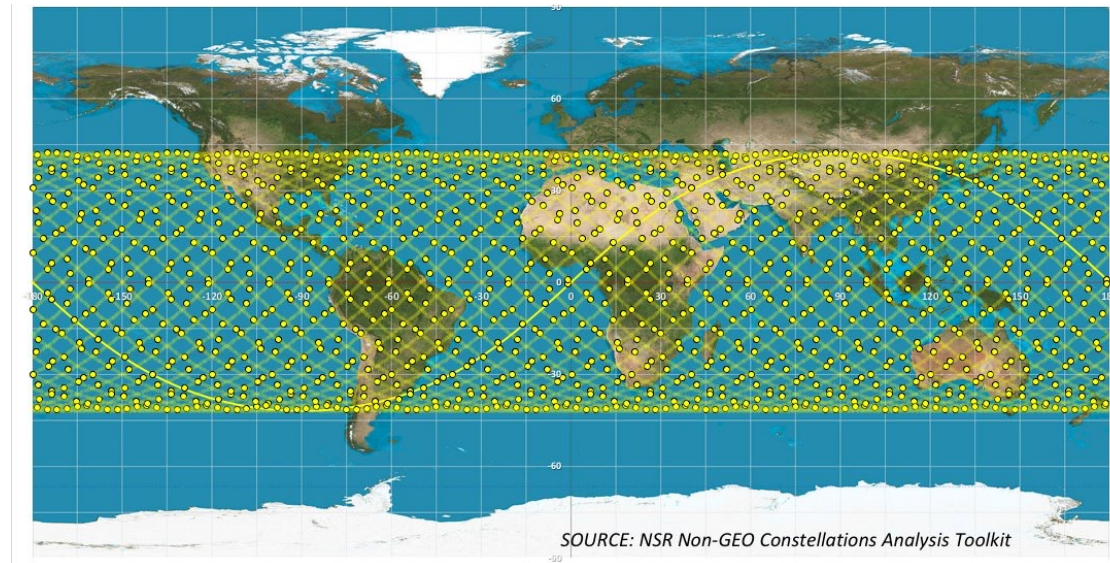


Figure 85. Project Kuiper's 3,236 Satellite Plan at 590-630 km Altitude
Northern Sky Research, Analysys Mason, https://twitter.com/NSR_SatCom;
<https://twitter.com/thesheetztweetz/status/1299032138440994818>.

V.I Satellite Constellations

Federal Communications Commission

FCC 20-54

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)
Mitigation of Orbital Debris in the New Space Age) IB Docket No. 18-313

REPORT AND ORDER AND FURTHER NOTICE OF PROPOSED RULEMAKING

Adopted: April 23, 2020

Released: April 24, 2020

By the Commission: Chairman Pai and Commissioners O’Rielly, Carr, and Starks issuing separate statements; Commissioner Rosenworcel concurring and issuing a statement.

Figure 86. Orbital Debris NPRM In the Matter of Mitigation of Orbital Debris in the New Space Age, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 4156, 4158, para. 3 (2020), <https://www.fcc.gov/document/fcc-updates-orbital-debris-mitigation-rules-new-space-age-0>; <https://docs.fcc.gov/public/attachments/FCC-20-54A1.pdf>.

V.I Satellite Constellations

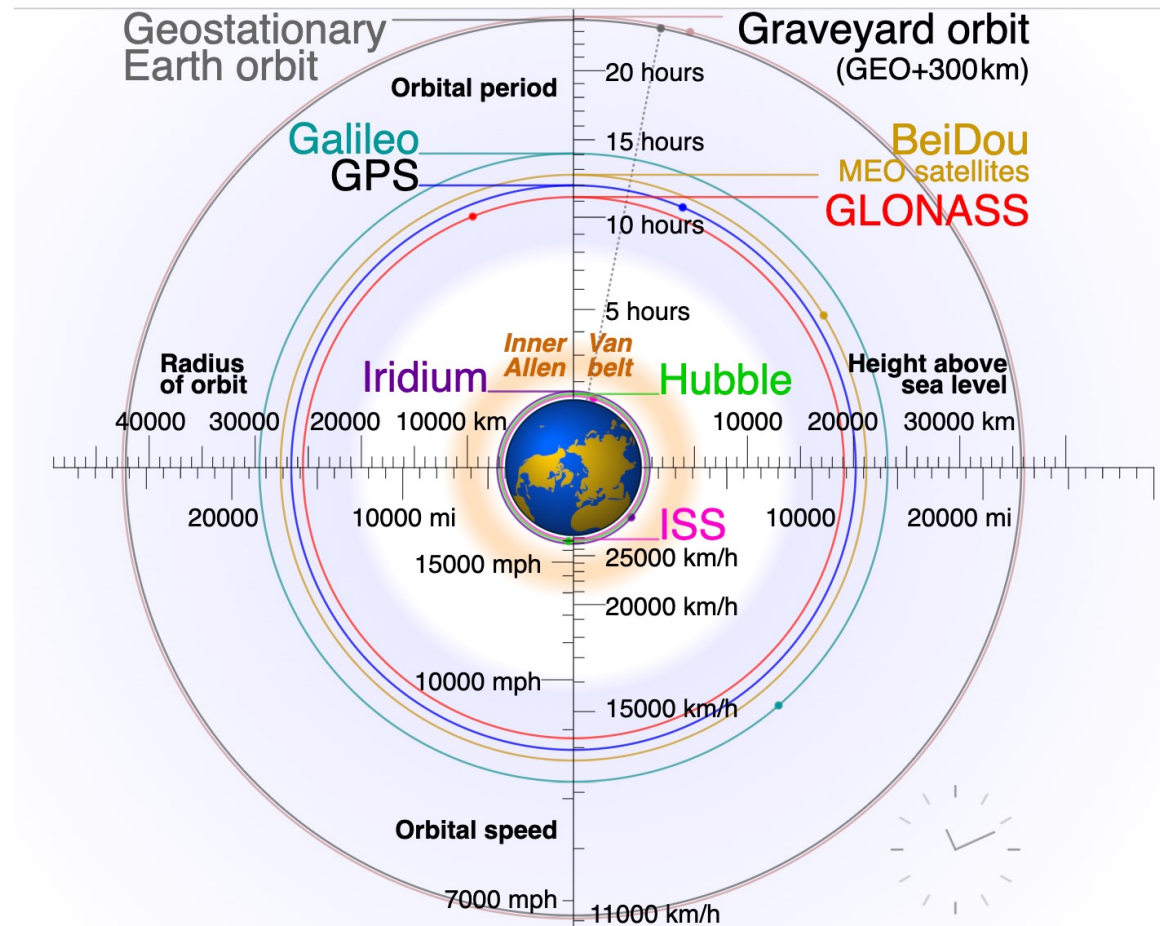


Figure 87. Graveyard Orbit or Orbital Junk
Graveyard Orbit, https://en.wikipedia.org/wiki/Graveyard_orbit.

V.I Satellite Constellations

24-satellite GPS constellation in motion with the Earth rotating

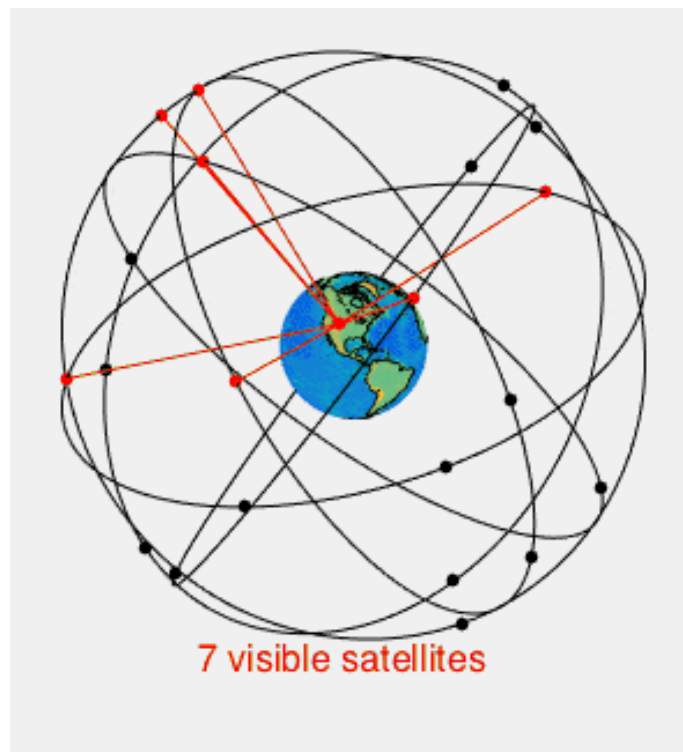


Figure 88. 24-satellite GPS constellation in motion with the Earth rotating
Global Positioning System, https://en.wikipedia.org/wiki/Global_Positioning_System.

V.I Satellite Constellations

Downlink and Uplink on L-Band Ligado Proposal

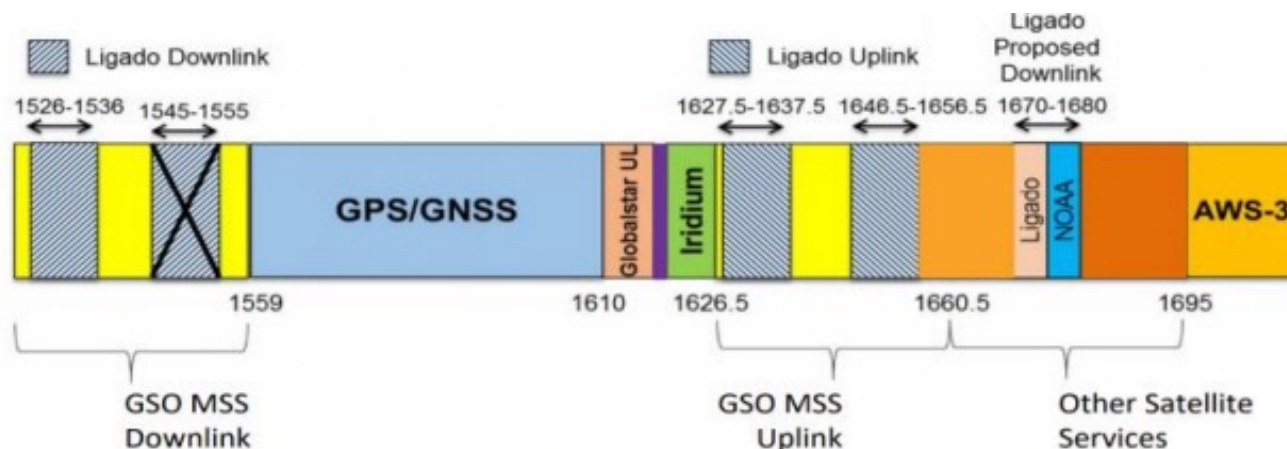


Figure 89. Band Plan for L-Band and Ligado Proposal

Congressional Research Service, “Spectrum Interference Issues: Ligado, the L-Band, and GPS, May 28, 2020, https://www.everycrsreport.com/files/2020-05-28_IFI1558_d707240653ab5b7068590d74023f373f1f7a7172.pdf, citing source, “Impact of Ligado’s Proposal on SATCOM, Aviation and Weather Data Users (Coalition Deck),” Sept. 2019, <https://ecfsapi.fcc.gov/file/10906015584180/Coalition%20Deck%20for%20Sept.%204%202019%20FCC%20meetings.pdf>.

V.2 Local Governance

Overview

I. Private or Enterprise 5G

V.2 Local Governance

Private or Enterprise 5G

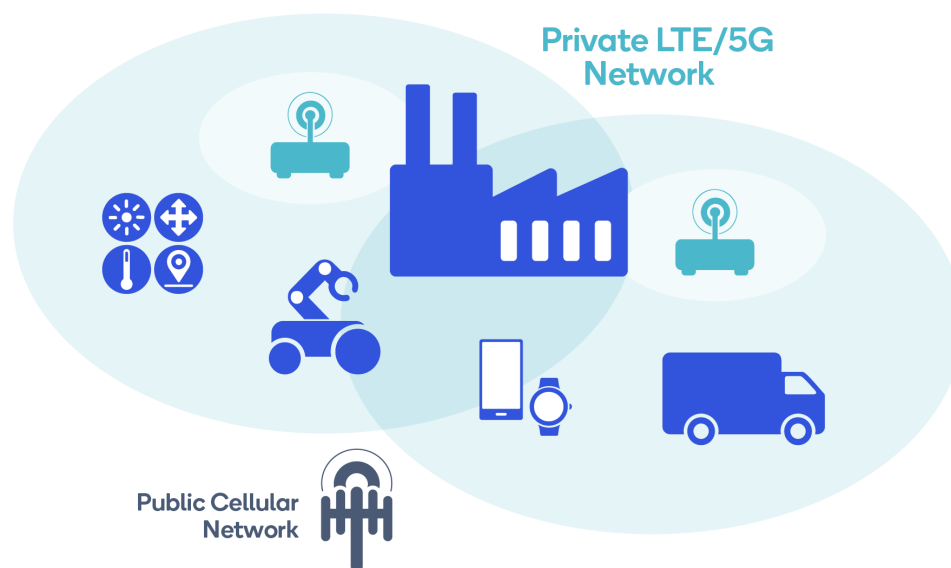


Figure 90. Private LTE/5G Network Diagram

Qualcomm, What is a Private LTE/5G Network?, Aug. 14, 2019,

<https://developer.qualcomm.com/blog/private-lte5g-networks-primer-developers>.

V.2 Local Governance

Private or Enterprise 5G

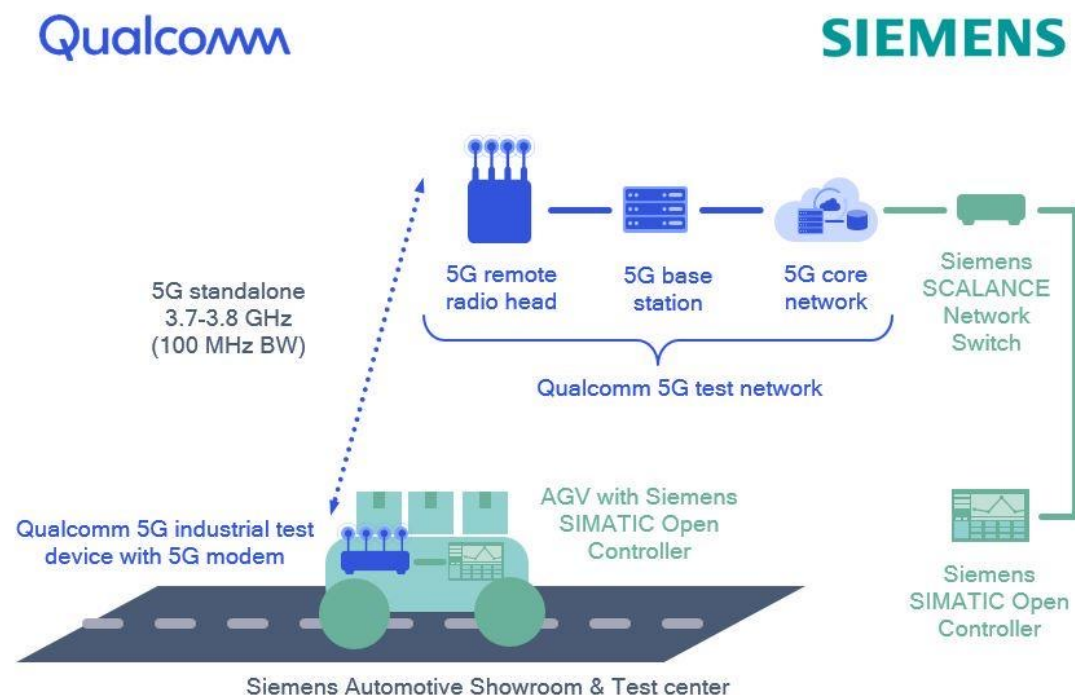


Figure 9I. Private 5G Network for Industrial Applications

Alan Weissberger, Siemens & Qualcomm Create Private 5G Network for Industrial Applications, Nov. 27, 2019, <https://techblog.comsoc.org/2019/11/27/siemens-qualcomm-create-private-5g-network-for-industrial-applications/>.

V.2 Local Governance

Private LTE on CBRS Bands

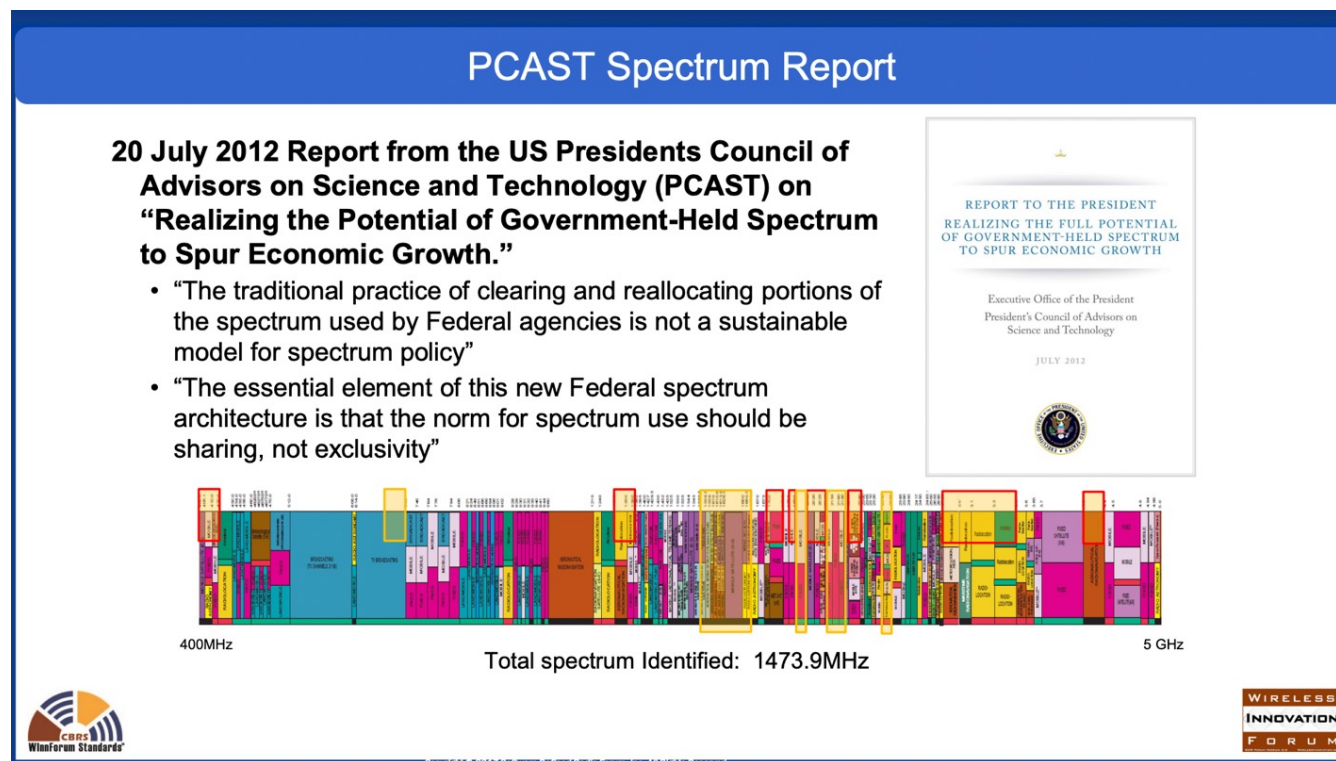


Figure 92. 3.5 GHz Band among the 1.4 GHz of Federal Spectrum Identified by PCAST
Wireless Innovation Forum, Building an Ecosystem for the CBRS Band, May 18, 2017,
<https://www.wirelessinnovation.org/assets/Proceedings/2017Europe/Pucker%20presentation.pdf>.

V.2 Local Governance

Private LTE on CBRS Bands

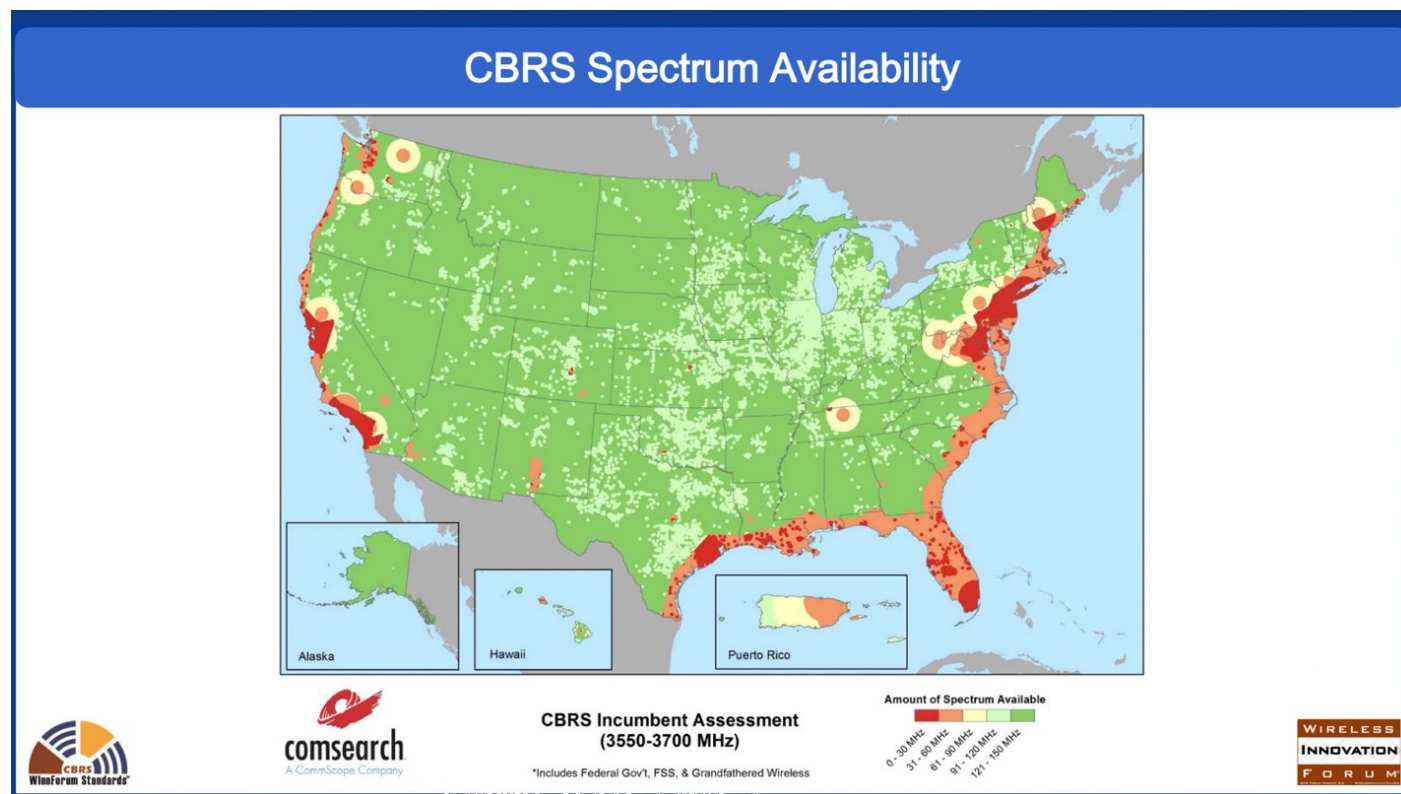


Figure 93. Federal Incumbents in 3.5 GHz using Fixed Services
Wireless Innovation Forum, Building an Ecosystem for the CBRS Band, May 18, 2017,
<https://www.wirelessinnovation.org/assets/Proceedings/2017Europe/Pucker%20presentation.pdf>.

V.2 Local Governance

Private LTE on CBRS Bands



Figure 94. 250+ Participants and 60+ Organizations in CBRS
Wireless Innovation Forum, Building an Ecosystem for the CBRS Band, May 18, 2017,
<https://www.wirelessinnovation.org/assets/Proceedings/2017Europe/Pucker%20presentation.pdf>.

VI.I Conclusion

Spectrum Economics and Market Tools

- I. Introduction
 - 1. Spectrum in the News
 - 2. Nobel Prize Winners
- II. Spectrum Economics
 - 1. History of Auctions
 - 2. Spectrum Valuation Methods
 - 3. Spectrum Valuation Factors
- III. Market Tools Part A
 - 1. Reallocation Challenges
 - 2. Secondary Markets
- IV. Market Tools Part B
 - 1. Incentive Auctions
 - 2. Other Tools
- V. New Developments
 - 1. Satellite Constellations
 - 2. Local Governance
- VI. Conclusion



www.nrao.edu
science.nrao.edu
public.nrao.edu

*The National Radio Astronomy Observatory is a facility of the National Science Foundation
operated under cooperative agreement by Associated Universities, Inc.*