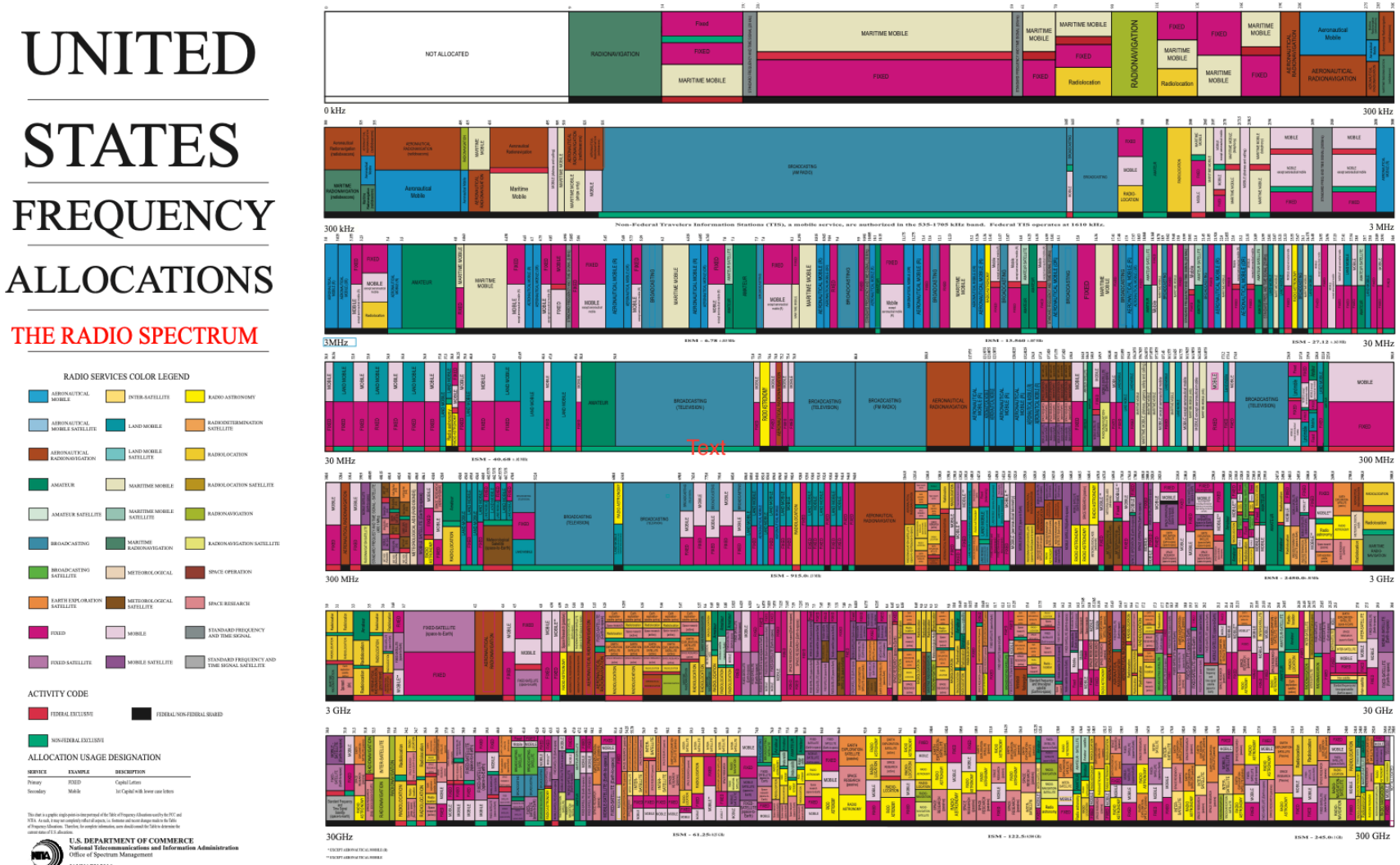
Spectrum Economics

USTTI RF Spectrum Management Course
November 19, 2020

Giulia McHenry
Chief, Office of Economics and Analytics, FCC
Giulia.McHenry@fcc.gov

Spectrum is a Limited Resource



Spectrum Value

- Spectrum is an input for the provision of wireless services that support commercial services, public uses and even private purposes.
- Several types of spectrum value derived from services
  - Economic value of license is equal to the present value of profits from services delivered by spectrum
  - Consumer surplus is the additional value, above what they pay that consumers derive from wireless services
  - Social or public sector value created by the use of spectrum for public goods
  - Economic value enabled by spectrum based services
- Scarcity (finite nature) of spectrum and value of wireless services leads to high market value and demand for spectrum

Escalating Demand and Value

- Wireless communications and broadband have dramatically increased demand for spectrum
- Up until 25 years ago
  - Less congestion in the airwaves
  - Relatively few commercial applications
    - Broadcasting – TV, radio
    - Satellite
- Emergence of higher valued spectrum-based services (e.g. wireless broadband) increased value

Increasing Demand is Certain

- Surging demand for spectrum-based services
  - 5G
    - Requires mix of low, mid and high band spectrum
    - Demanding wider bandwidths
  - By 2023…
    - Mobile data traffic grow at compound annual rate of 42%
    - Mobile traffic will group 8-fold from 2017
- More uses and users imply more scarcity
  - Licensed broadband services
  - Unlicensed / licensed-exempt (i.e. Wi-Fi) services
  - Public sector/government services
    - Emergency response, crime prevention, aviation, weather satellite, defense, space exploration, etc.

Increasing Spectrum Supply

- Demand and scarcity driving search for more usable spectrum and intensity of use
- Advances in 5G are increasing effective supply of spectrum for wireless broadband
  - Increasing opportunities above 3 GHz, especially millimeter wave
  - Increasing opportunities for sharing
  - Increasing potential of unlicensed spectrum
  - Improving efficiency and spectrum reuse

Maximizing Spectrum Value

- With explosive growth in mobile communications, industry and governments appreciate economic value of spectrum
  - Enables economic activity, growth and innovation
  - Critical to profitability of mobile industry
  - Creates revenues from sale of spectrum licenses
- Regulators face pressure to make spectrum available for commercial use and ensure government has spectrum necessary for operations

Maximizing Spectrum Value

- Policymakers' goal is to ensure that all spectrum is put to highest and best use
  - Balancing array of interests and users: commercial, government, public
  - Protecting incumbents and fostering innovation
- Two underlying questions
  - How to maximize economic and social benefits from spectrum (i.e., economic and social value)?
  - How should spectrum be managed?

Spectrum Management

- Spectrum management/assignment approaches have evolved with technology and notion of spectrum value
- Combination of approaches typically applied
  - Command and control of specific use rights
  - Market based trade of flexible use rights
  - Commons (unlicenced, rule-based)
- Several hybrid models also exist

Command and Control

- Regulator pre-determines service type and user(s)
  - Limits spectrum trading or repurposing
  - Fees sometimes assessed to recover administrative costs
- In U.S., still applied to historic uses and where competitive markets unlikely:
  - Broadcasting (historically, now limited trading)
  - Government users
  - Satellite earth stations
- Difficult to ensure spectrum put to highest valued use, so commercial spectrum will be less valuable
- Model may still be appropriate where markets unlikely, but there are social benefits to a service

Flexible Rights of Use

- Flexible use and market-based trade
  - Licensee determines use, subject to minimum technical requirements (i.e. technology neutrality)
  - Free to transfer spectrum to another user (and sometimes service) and keep profits
- Initial rights awarded through competitive bidding (auctions)
  - Payments may be lump sum or fee-based
  - Resale rights creates a secondary market for spectrum
- Flexibility allows spectrum to flow to users with highest value
- Examples:
  - Commercial mobile services
  - Other telecom services

Spectrum Commons

- Rule-based usage for all users who meet requirements
- Useful for applications where potential interference is low (i.e., short-range, low power), so exclusivity not necessary
- No exclusive right to spectrum implies no market value for spectrum, but may enable immense economic activity
  - Widely available, low cost technology
  - Opportunity for innovation
  - E.g., Wi-Fi, LTE-U, Bluetooth
- Challenge: Must allocate sufficient unlicensed spectrum to limit congestion and enable services, while balancing with other resource needs.

Drivers of Economic Spectrum Value

Type of Service
Scope of Service
Quality of Service

Build out Cost
Handset Cost
Operating Cost

$$NPV_i = \sum_{t=0}^{n} \frac{R_{it} - C_{it}}{(1 + r_{it})^t}$$

Uncertainty
- Interference
- Negotiation
- Security

Cost of Delay
- Deployment timing

Drivers of Spectrum Value

- Net Profits From Deploying a Band of Spectrum are Determined by Four Broad Factors:
  - Net Profits = Revenues
    - Capitol expenditure
    - Operating expenditure
    - Cost of capital

- Two Additional Factors Determine the Present Value:
  - Timing of revenues and costs
  - Risk and uncertainty

- User's Willingness to Pay is Based on Relative Value of Alternative Assets (Lower Bound)

Drivers of Spectrum Value

- Value of a specific spectrum license likely to vary by a number of specific factors, including:
  - Frequency and associated technical characteristics
  - License rules, feasible services, certainty
  - Geography and size of coverage area
  - Availability of equipment: harmonization, similar bands
  - Spectrum supply (current and future)
  - Socioeconomic factors, including demographics, population density, income, political climate
  - Regulatory climate, including risks, costs of doing business
  - Other factors

Determining Spectrum Value

- To estimate value of licensed commercial spectrum, can apply combination of typical valuation techniques:
  - Discounted cash flows (DCF)
  - Market comparables
  - Cost savings DCF
  - Econometric modeling
- Nature of spectrum can make this very complex
- Only applies to licensed commercial spectrum. Excludes:
  - Economic activity enabled by spectrum (licensed and unlicensed)
  - Consumer welfare
  - Non-commercial uses (government, educational, other public)

Spectrum Enabled Value

- Spectrum based services also add value to economy
  - Equipment manufacturing/spending
  - Spending on unlicensed spectrum services/equipment
- Users of the services in turn create value and generate income – contribute to Internet services/app economy
- Economic benefits enabled by unlicensed and licensed spectrum difficult to quantity. Proxies to consider:
  - Investments on R&D and equipment
  - End-user market revenues
  - Size of economies that use services

Public Sector and Social Value

- Public sector benefits even more difficult to quantify
- Countries take different approaches to ensuring sufficient spectrum available for government commercial. Examples:
  - U.S. sets aside specific spectrum allocations for government
    - Repurpose spectrum for commercial use as needed, compensating impacted government spectrum users
  - U.K. imposes market-based rates for public users, requiring that government pay market rates and access spectrum markets
  - Challenges to both approaches
- Many countries face question of how to incentivize public users to use spectrum "efficiently"

Thank you!