Spectrum Economics

USTTI RF Spectrum Management Course
November 19, 2020

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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

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

- Type of Service
- Scope of Service
- Quality of Service
- Build out Cost
- Handset Cost
- Operating Cost
- 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!