Spectrum Management

CYBR 4400/5400: Principles of Internet Policy, Lecture 4-1

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Course Feedback (Anonymous Quiz, No Points)

Course Learning Goals

Policy Understanding	Describe core problems and policies impacting telecommunications and the Internet
Analytical Review	Develop and apply an interdisciplinary framework to critically evaluate efficacy of past and current policy
Writing and Verbal Skills	Write and articulate clear, well-reasoned positions on current policy issues and debates

Today's Lecture

- Course Feedback — Thank you!
- Midterm Results — Nice work!
- Current Events
  - Did Title II Reduce Investment?
- Reading Quizzes
- Roadmap for Unit #4
- Spectrum Management Lecture

Reading Quizzes

- Bring laptops to class for reading quizzes on key concepts, terms, and methodologies
- If you are going to miss class:
  - Notify me by email that you will be absent in advance (for illness-related, email can be sent morning of class)
  - Complete 2-page summary of required reading for the missed class
    - Notes demonstrate you have read entire reading assignment
    - Email to me within 48 hours (i.e., by 9 am two days later).
- This is not intended to encourage you to attend class if sick!

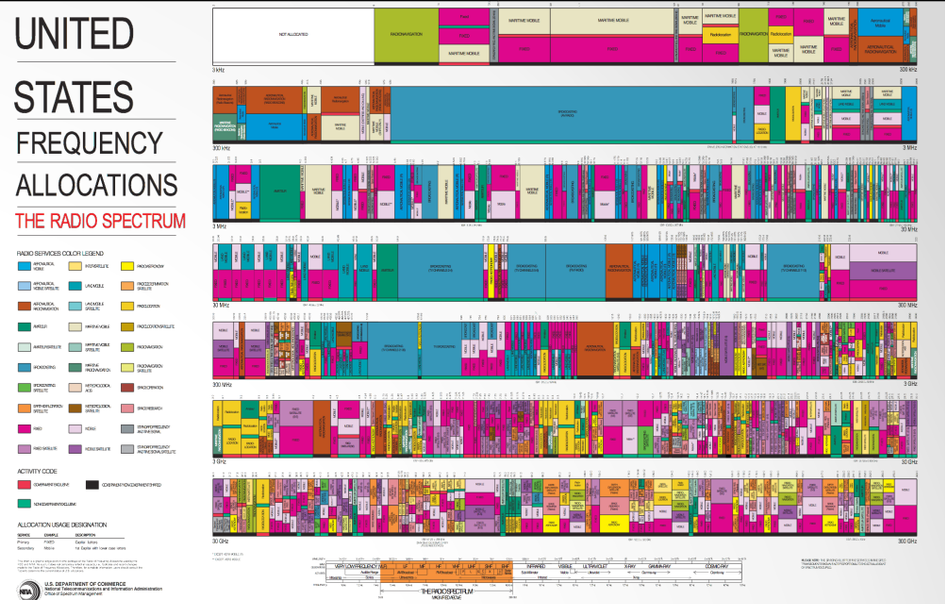
Unit #4 Roadmap

- Learning outcomes
  - Explain need for regulation of spectrum and how it has been regulated in the past
  - Understand modern spectrum management practices applied to support mobile wireless applications
  - Explain economics of spectrum scarcity, and how this impacts regulation

Spectrum Management

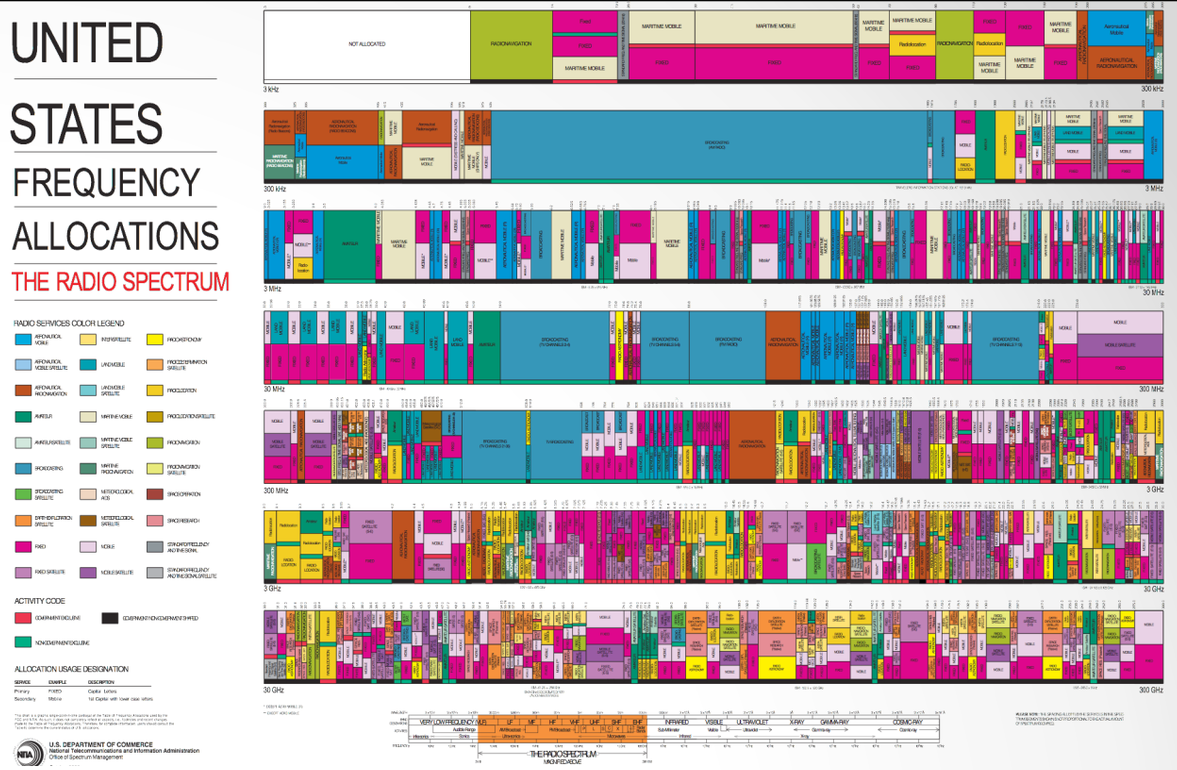
"The wireless telegraph is not difficult to understand. The ordinary telegraph is like a very long cat. You pull the tail in New York, and it meows in Los Angeles. The wireless is exactly the same, only without the cat."

Wireless and Spectrum



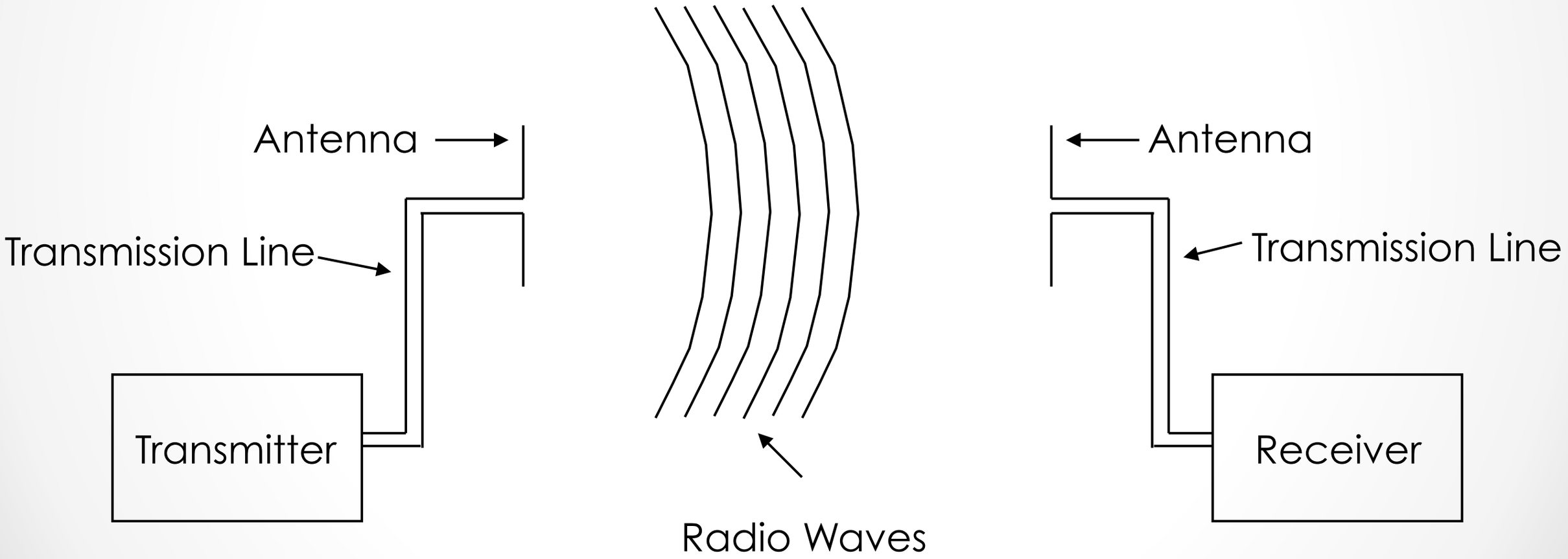
- What are the principles of regulation?
  - Licensing the crowded “public” airwaves
- How is it assigned?
  - Administrative hearings and auction designs
- What can I do with it?
  - Goldman Sachs View of the Wireless Future
- How do we share spectrum?
  - Interference and “unlicensed” bands

What Is Spectrum?

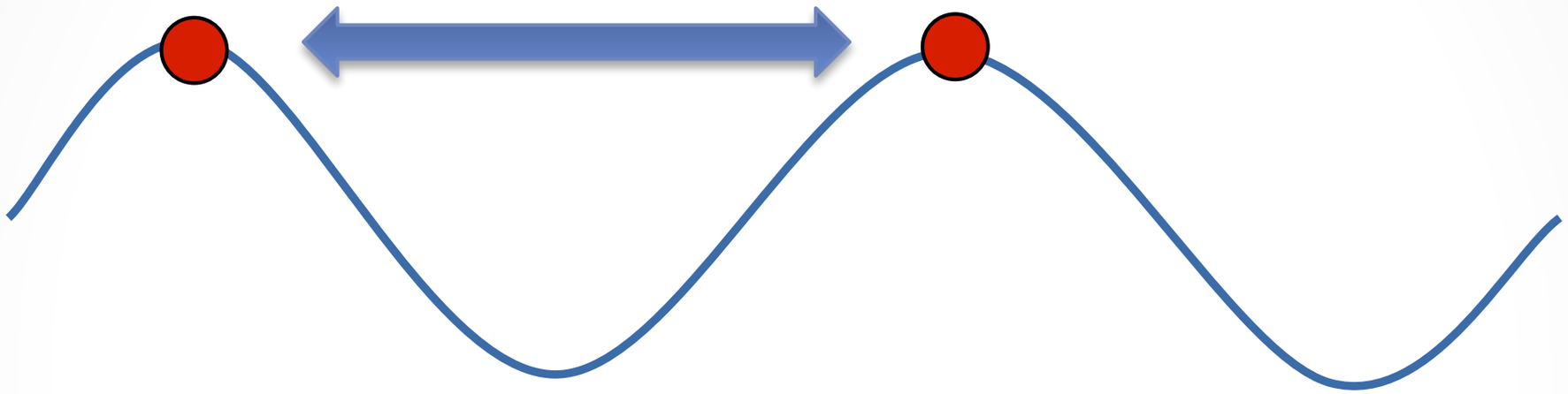


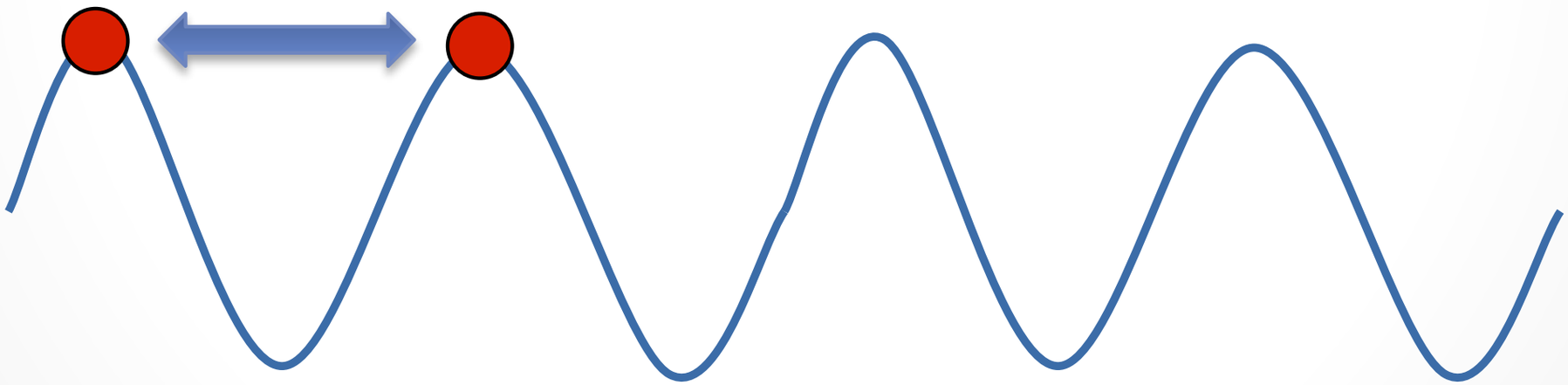
- Spectrum = conceptual tool to organize a set of physical phenomena
- Electric and magnetic fields produce (electromagnetic) waves that move through space at different frequencies
- Set of all possible frequencies called the “electromagnetic spectrum”
- Subset of frequencies between 3 KHz and 300 GHz is known as the “radio spectrum” or “radio frequency (RF) spectrum”

Basic Radio Communication System



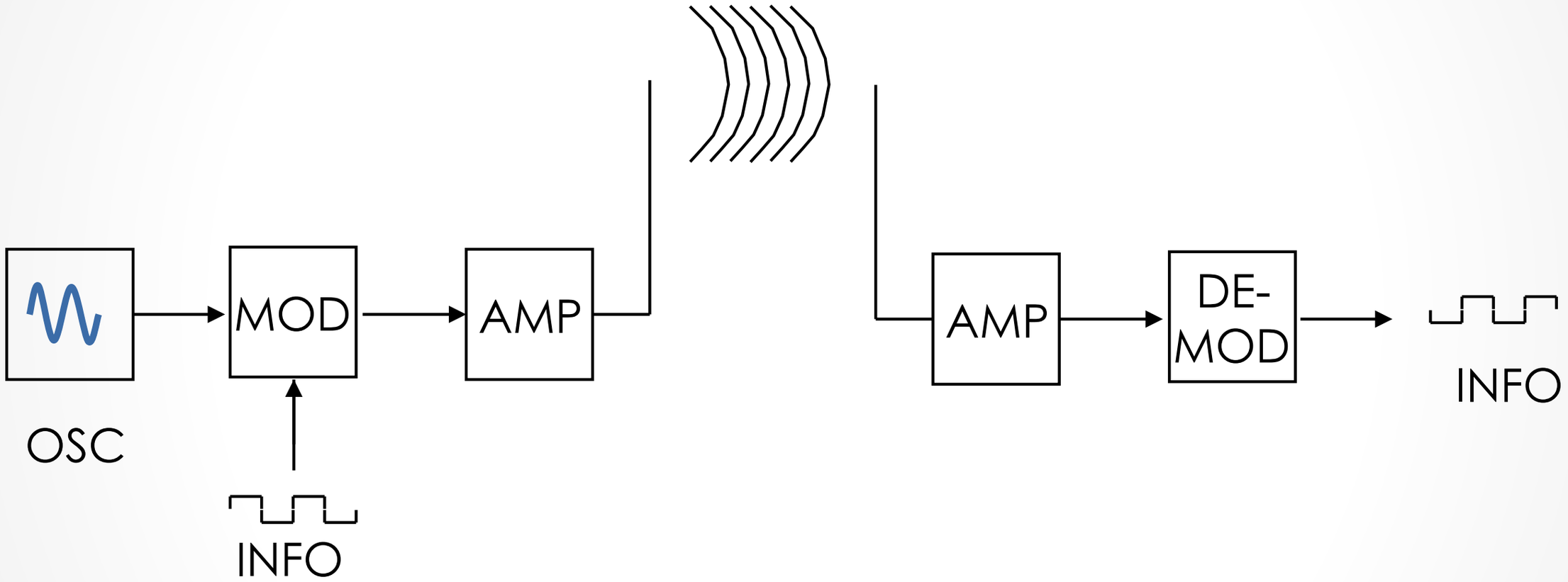
Relationship Between Frequency and Wavelength





Note: In addition to their frequency or wavelength, radio waves are also characterized by their amplitude and phase

Transmitter and Receiver – Basic Building Blocks



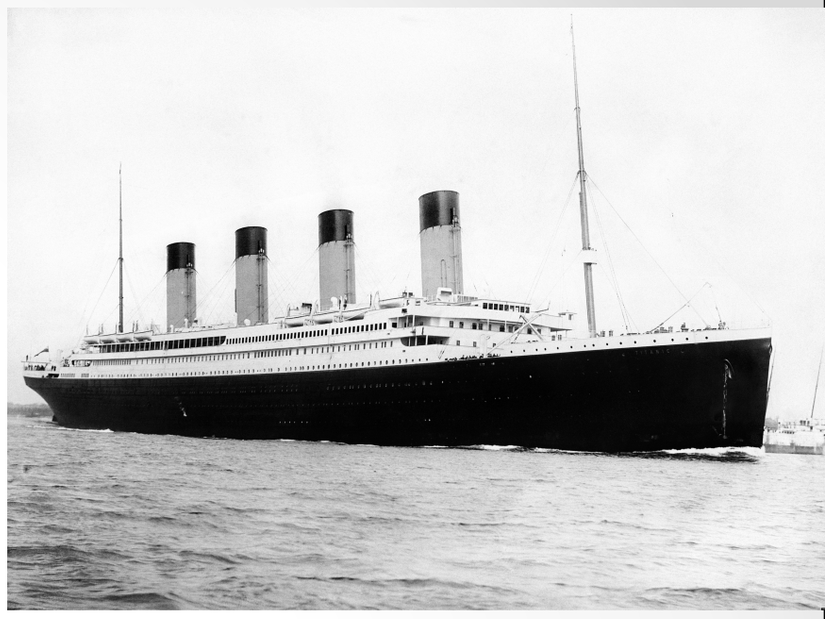
Nature of Spectrum

- Unique Natural Resource
- National and International Resource
- Infinitely Renewable
- Can Be Polluted Like Air or Water
- Scarcity of the Resource – Economic Value

Basis of Spectrum Regulation

- No "ownership" of spectrum
  - A public resource
- Need to prevent "harmful" interference
- Spectrum is a "scarce" resource

Early Regulations



- Radio Act of 1912
  - Equipment using spectrum (e.g., for radio stations) must be licensed by the federal government
  - Seagoing vessels must monitor distress frequencies
- Herbert Hoover created market-based allocation system (by approving radio system transactions) during the early 1920s as Secretary of Commerce
  - Stopped issuing licenses when market was full
- In 1926, court overturned Hoover's extralegal system in *Zenith* decision

Herbert Hoover

Early Regulations (cont'd)

- Radio Act of 1927
  - Established Federal Radio Commission
  - Regulate access to spectrum under "public interest, convenience, and necessity" standard
  - Public owns spectrum
- 1927 Act represented political equilibrium among regulators and industry
  - Restricted entry by only utilizing 5% of AM radio market capability
  - "Broadening of the band was disposed of with a finality which leaves little hope for the revival of that pernicious proposition…"

Rationales for Regulation of Spectrum

- Managing interference: a negative market externality (Khan Academy link)

- Rent Seeking

  - "Pirates" and "wave jumpers" after *Zenith* decision in 1926 that eliminated Hoover's extralegal solution and created the "breakdown" period

- *Oak Leaves* decision: judge applied homesteading principle to find a common-law remedy to "tragedy of the commons" (Khan Academy link)

  - Established priority-in-use rule (property rights)

Interference: Negative Externality

- Managing interference
  - Application of Coase Theorem : if trade in an externality is possible, and there are sufficiently low transaction costs, bargaining will lead to an efficient outcome regardless of the initial allocation of property
  - If FCC specifies property rights, parties should reach an efficient outcome

Other Rationales for Regulation of Spectrum

- Consumer preferences
  - Consumer's do not know what is in their own long-term interest (i.e., paternalism argument)
- One person's consumption of broadcast content may affect another person's well-being (i.e., externality argument)
  - Negative externalities from violence on TV
  - Positive externalities from children's TV

Condensed Timeline

- Radio Act of 1912 authorized Secretary of Commerce to license users of equipment that communicated via spectrum

- Radio Act of 1927 established the Federal Radio Commission and that spectrum belongs to the public such that licensees have no property right to continue using it

- Communications Act of 1934 established the FCC and incorporated the Radio Act of 1927 into Title III