Spectrum Policy Task Force

Findings and Recommendations

February 2003

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Outline

- **Introduction**
- Spectrum Policy Reform: The Time is Now
- Major Findings and Recommendations
- Interference Avoidance
- Spectrum Usage Models
- Promoting Access to Spectrum

Introduction

- **Task Force Goals and Objectives**
  - **Improve the way that the radio spectrum is "managed" in the U.S.**
  - **Identify and evaluate changes in spectrum policy to increase the public benefits derived from use of radio spectrum**
  - **Provide specific recommendations to FCC for ways in which to evolve the current "command and control" approach to spectrum policy into more integrated, market-oriented approach**
    - **greater regulatory certainty**
    - **minimizing regulatory intervention**
  - **Assist the Commission in addressing ubiquitous spectrum issues**
    - **interference protection**
    - **spectral efficiency**
    - **effective public safety communications**
    - **international spectrum policies**

Introduction

- **Task Force has begun process of reexamining 90 years of spectrum policy to ensure that Commission's policies evolve with the consumer-driven evolution of new wireless technologies, devices, and services.**

- **First ever comprehensive and systematic review of spectrum policy at the FCC.**

- **Team of high-level, multi-disciplinary professional FCC staff – economists, engineers, and attorneys – from across the Commission's Bureaus and Offices**

- **Catalyst for further advancement of spectrum policy at the FCC.**

Introduction

Task Force Chronology

- **June**
  - Spectrum Policy Task Force Established
  - Public Notice Seeking Comments on Spectrum Policy Issues
- **July**
  - Received and Reviewed 200 Public Comments Received in Response to Public Notice
- **Early August –** All-Day Public Workshops
  - 1 August: Unlicensed Devices and Experimental Licenses
  - 2 August: Interference Protection
  - 5 August: Spectrum Efficiency
  - 9 August: Spectrum Rights and Responsibilities
- **September –** Task Force Findings and Recommendations
- **October –** Draft Report
- **November –** Report Presented to Commission & Released
  - Commission-Level Public Notice seeks comment:
    - Comments due January 27, 2003; Reply Comments Due February 28, 2003

Introduction

Disclaimer

The Spectrum Policy Task Force Report drafted by FCC staff and was not voted on or approved by the Commission.

- **Neither the Report nor any of the recommendations contained therein necessarily reflect the views of the Commission.**
- **While the speaker had a key role in SPTF, he does not speak for the task force**

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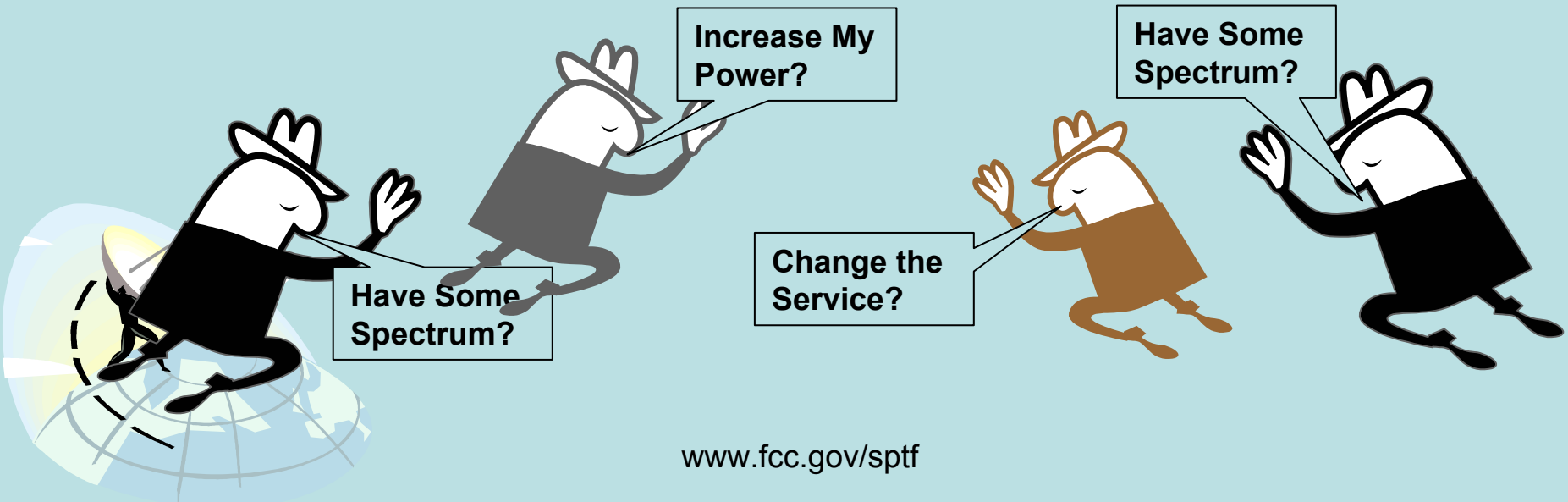
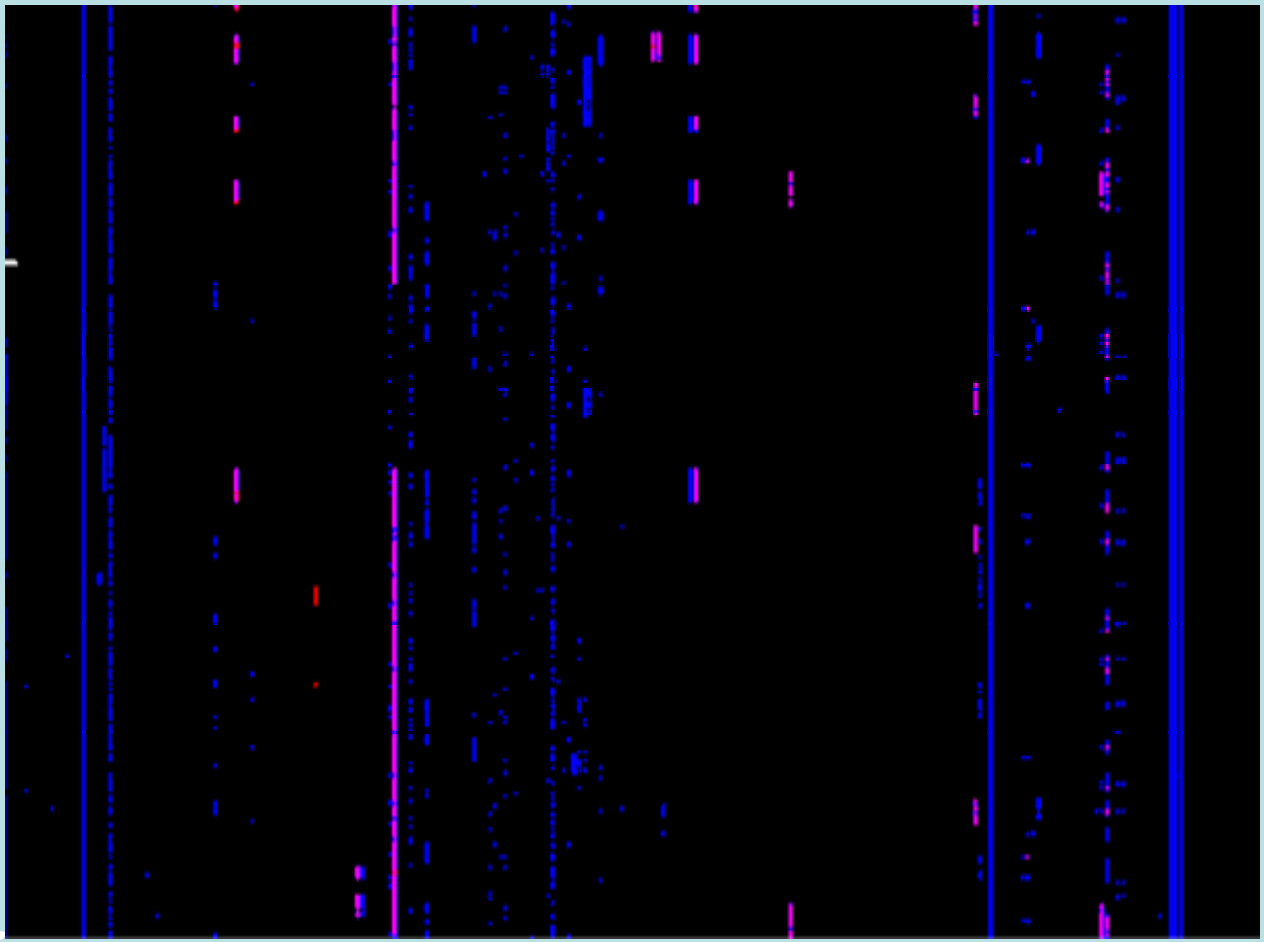
Oh, FCC May I …


Increase My Power?
Have Some Spectrum?
Have Some Spectrum?
Change the Service?

Historic Spectrum Policy Assumptions

- Unregulated radio interference will lead to chaos
- Spectrum is scarce
- Technological options were few and changed slowly
- Government "command and control" is the only way to avoid chaos; and
- The "public interest" centered on service providers use rather than consumers

Spectrum Scarcity?



Spectrum Observations in Multiple Cities

Atlanta

New Orleans

San Diego

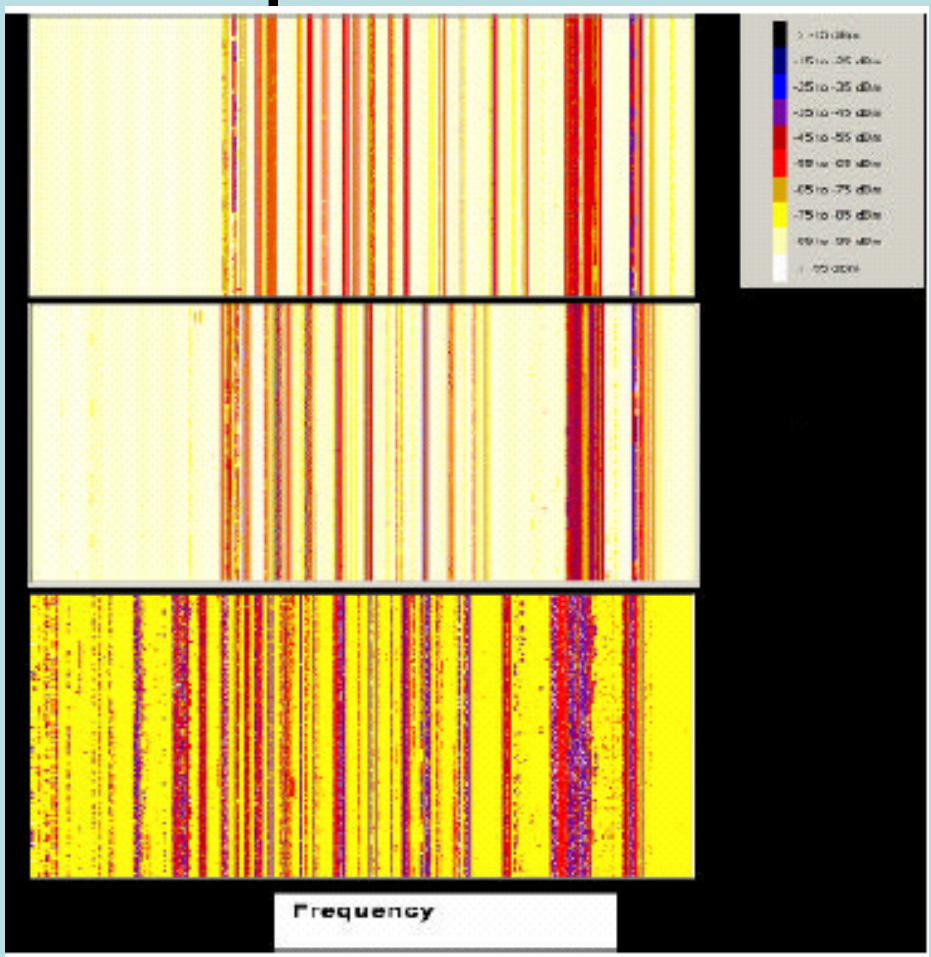


Figure 1: Occupancy of approximately 700 megahertz of spectrum below 1 GHz

www.fcc.gov/sptf

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- ➢ **Spectrum Policy Reform: The Time is Now**
- ➢ Major Findings and Recommendations
- ➢ Interference Avoidance
- ➢ Spectrum Usage Models
- ➢ Promoting Access to Spectrum

Spectrum Policy Reform: The Time is Now

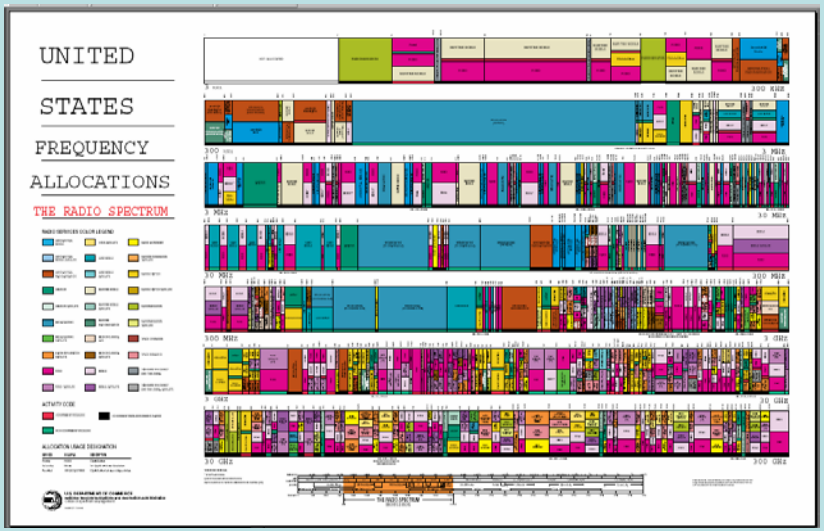
- Technological advances are enabling changes in spectrum policy
  - Technology providing potential answers to current spectrum policy challenges.
    - increased use of digital technologies
      - Increase potential throughput of information
      - Interference management:
        - » digital signals inherently more robust, and resistant to interference, than analog signals
        - » digital signal processing techniques, such as coding and error correction, more effective at rejecting interfering signals
    - development of software-defined radios
      - operating parameters in radios (such as operational frequency and modulation type) determined by re-programmable software
      - also called “smart” or “opportunistic” technologies because, due to their operational flexibility, can search the radio spectrum, sense the environment, and operate in spectrum not in use by others
      - by operating in “white” – or unused – spaces in the spectrum, can enable better and more intensive use of spectrum

Spectrum Policy Reform: The Time is Now

- Increased <u>access</u> can mitigate scarcity of spectrum resource

  – Most “prime spectrum” has already been assigned to one or more parties, and it is becoming increasingly difficult to find spectrum that can be made available either for new services or to expand existing ones.

  – Improving access to the spectrum can be achieved through permitting licensees greater flexibility and other means.



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Major Findings & Recommendations

- Technology advances create potential for radio systems to use spectrum more intensively and to be more tolerant of interference.
  - SDR is a key implentation technology
  - Implement new paradigm for interference protection

- In many bands, spectrum access more significant problem than physical scarcity, in large part due to legacy command-and-control regulation.
  - Preliminary data and general observations indicate many portions of spectrum not in use for significant periods of time, and spectrum use of “white spaces” (both temporal and geographic) can be increased significantly.
  - Additional information and measurement needed to more accurately quantify and characterize spectrum usage and availability.

- Spectrum policy must evolve towards more flexible and market-oriented regulatory models to increase opportunities for technologically innovative and efficient spectrum use.
  - Eliminate regulatory barriers to increased spectrum access
  - A balance of several regulatory models for spectrum use are needed

Major Findings & Recommendations

- Regulatory models must be based on clear definitions of rights and responsibilities of both licensed and unlicensed spectrum users, particularly with respect to interference protection.

- No single regulatory model should be applied to all spectrum:
  - pursue balanced spectrum policy that includes both the granting of exclusive spectrum usage rights through market-based mechanisms and creating open access to spectrum "commons," with command-and-control regulation used in limited circumstances.
  - Migrate from current command and control model to more market-oriented exclusive rights model and unlicensed device/commons model

- Implement policies in both newly allocated bands and in spectrum that is already occupied, but appropriate transitional mechanisms should be employed to avoid degradation of existing services and uses).

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Interference Avoidance

Recommended Methods of Interference Control

- Adopt a more quantitative approach to interference management based on the concept of "interference temperature."
  - Interference temperature metric would establish maximum permissible levels of interference, characterizing the "worst case" environment in which a receiver would be expected to operate.
  - Would encourage designers to plan for realistic environments
  - Different threshold levels could be set for each band, geographic region or service -- set only after review of the condition of the RF environment in each band.
    - **systematic study of the RF noise floor necessary**

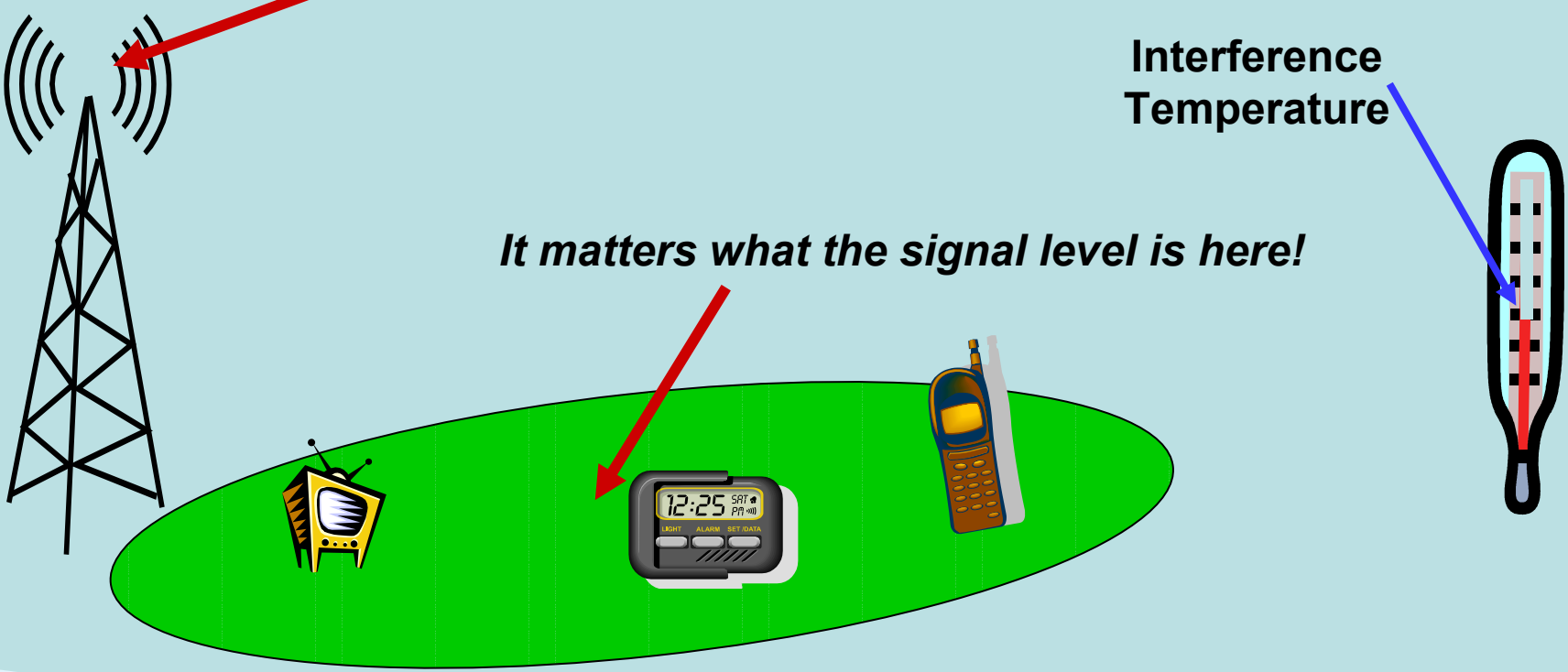
- Receiver performance requirements for some bands and services, through incentives, mandates, or some combination of incentives and mandates.

Interference Avoidance

It doesn't matter what the signal level is here!

Interference Temperature

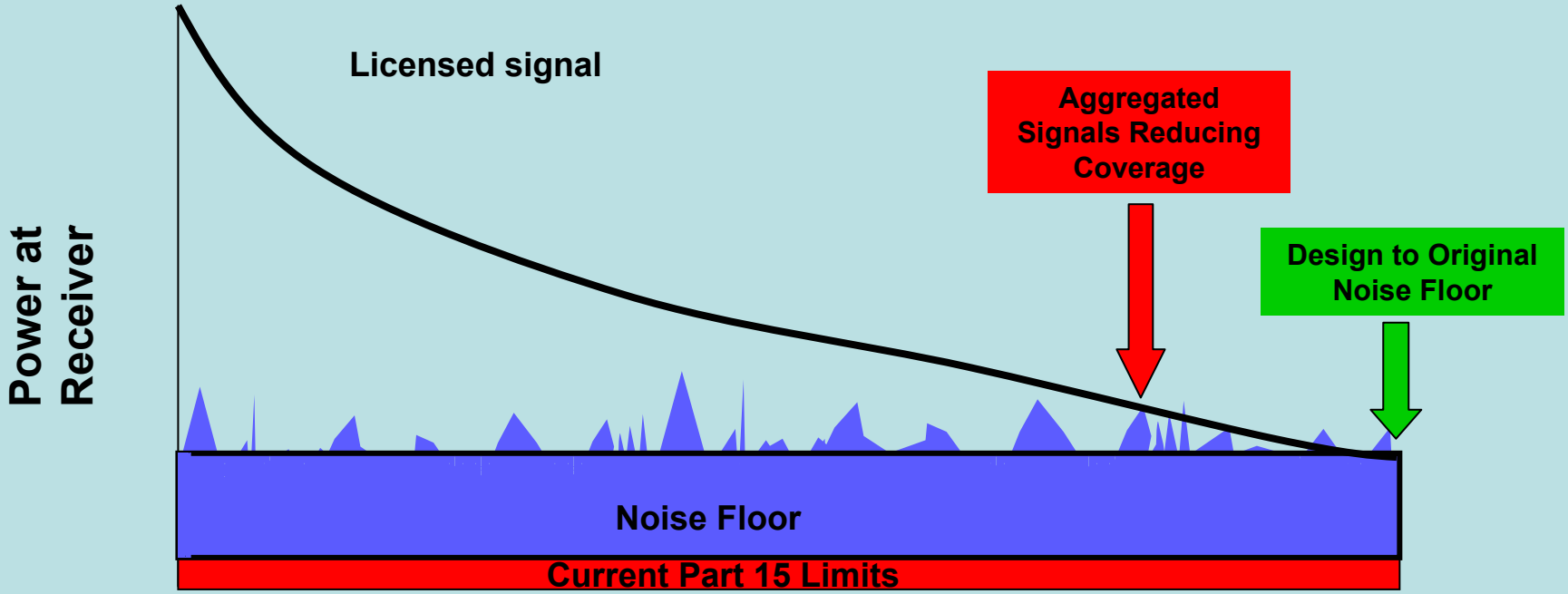
It matters what the signal level is here!



Define "interference temperature" – total RF energy from both ambient noise and other sources

Interference Avoidance

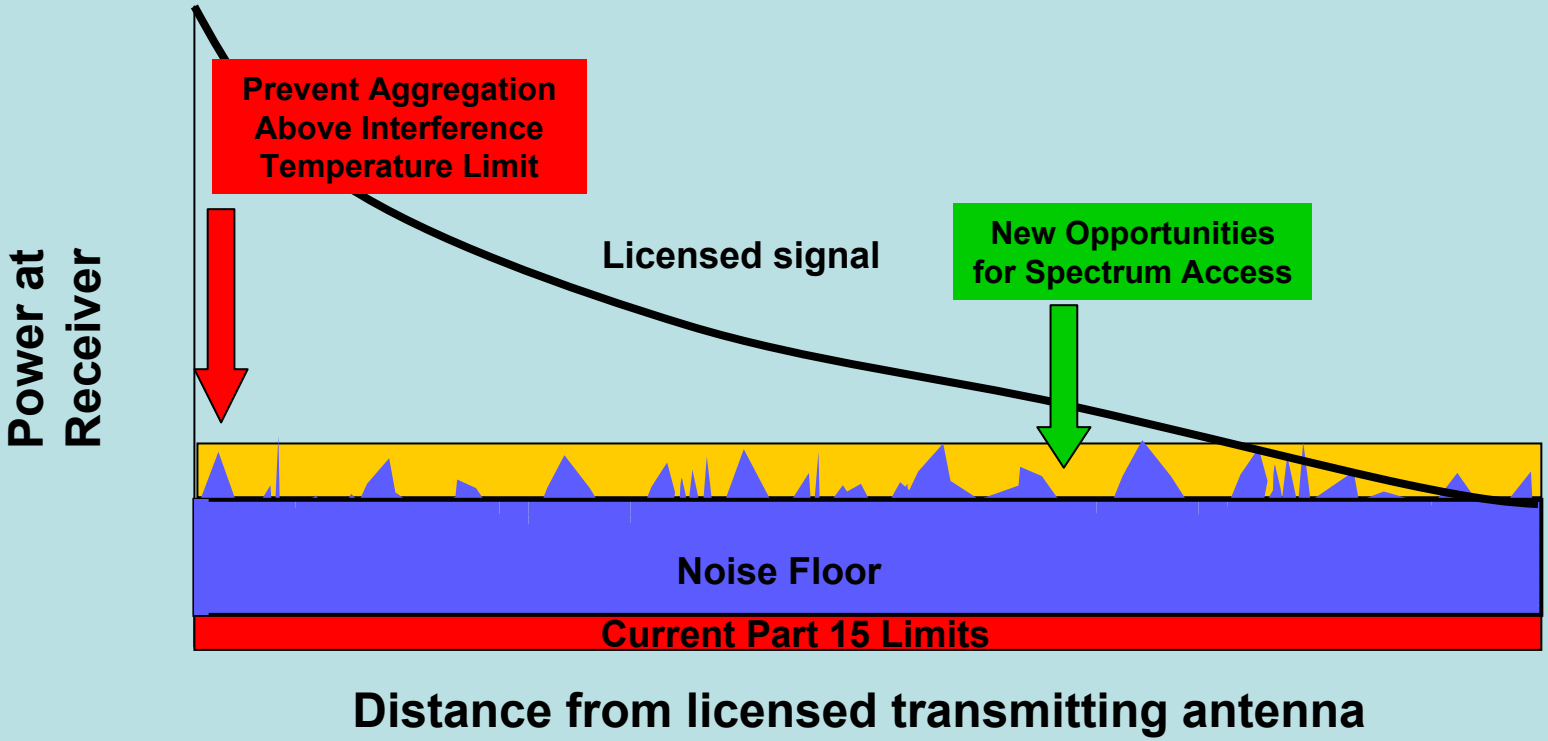
Tolerance of Interference - Today



- **License Holders Design System to Operate down to the Noise Floor**
  - **Any additional interfering signals (including aggregation of unlicensed devices) can cause degradation**

Interference Avoidance

Tolerance of Interference - Future



- **Quantify acceptable levels of interference**
  - **More Certainty for Licensees**
  - **More Opportunity for Consumer Devices**

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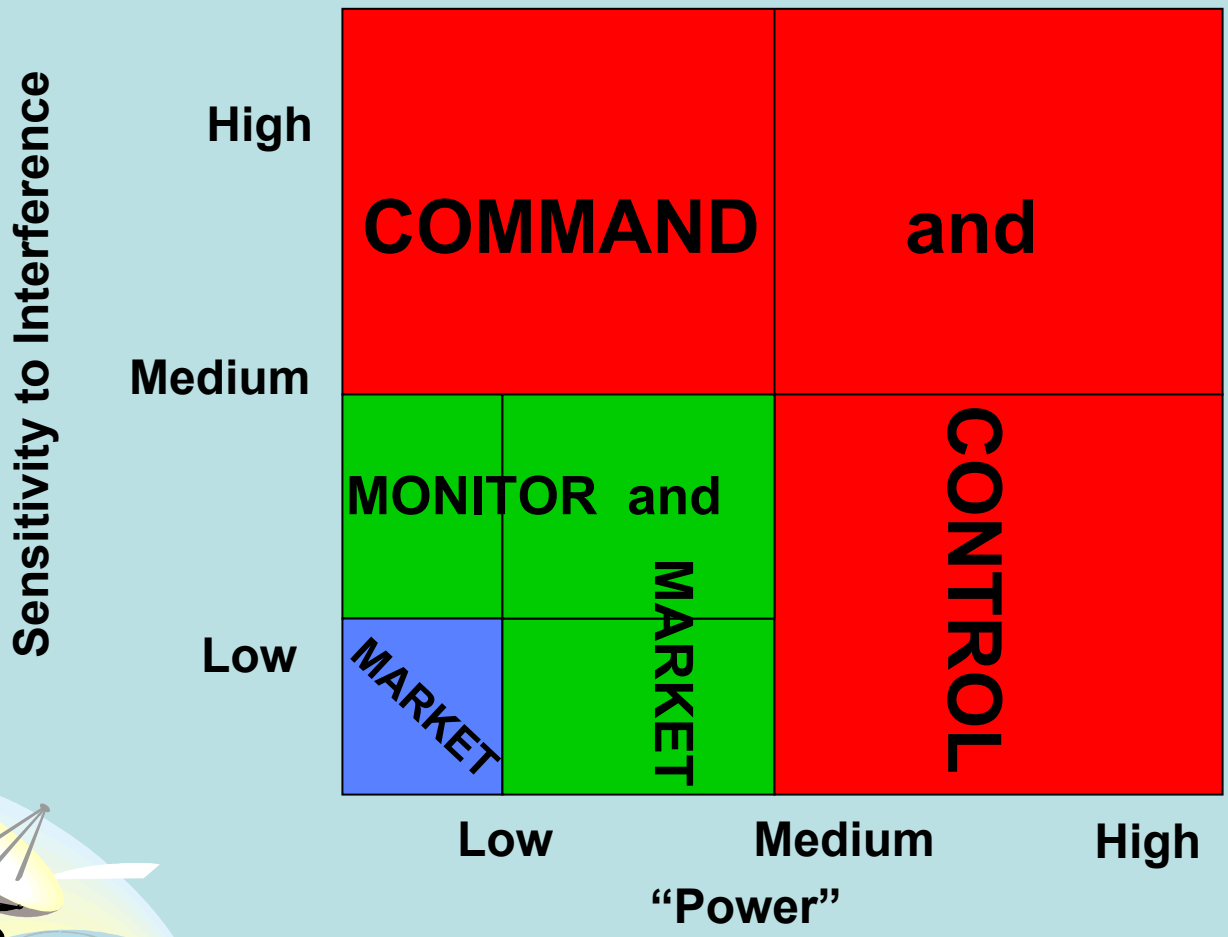
Spectrum Usage Models

- One size does not fit all -- balance among three general models for assigning spectrum usage rights:
  - "Exclusive use" model. Licensee has exclusive and transferable flexible use rights for specified spectrum within a defined geographic area, with flexible use rights governed primarily by technical rules to protect users against harmful interference.
  - "Commons" model. Allows unlimited numbers of unlicensed users to share frequencies, with usage rights governed by technical standards or etiquettes but with no right to protection from interference.
  - "Command-and-control" model. Traditional process of spectrum management in the US, currently used for most spectrum within the Commission's jurisdiction, in which allowable spectrum uses are limited based on regulatory judgments.

Spectrum Usage Models

Current State of the Spectrum



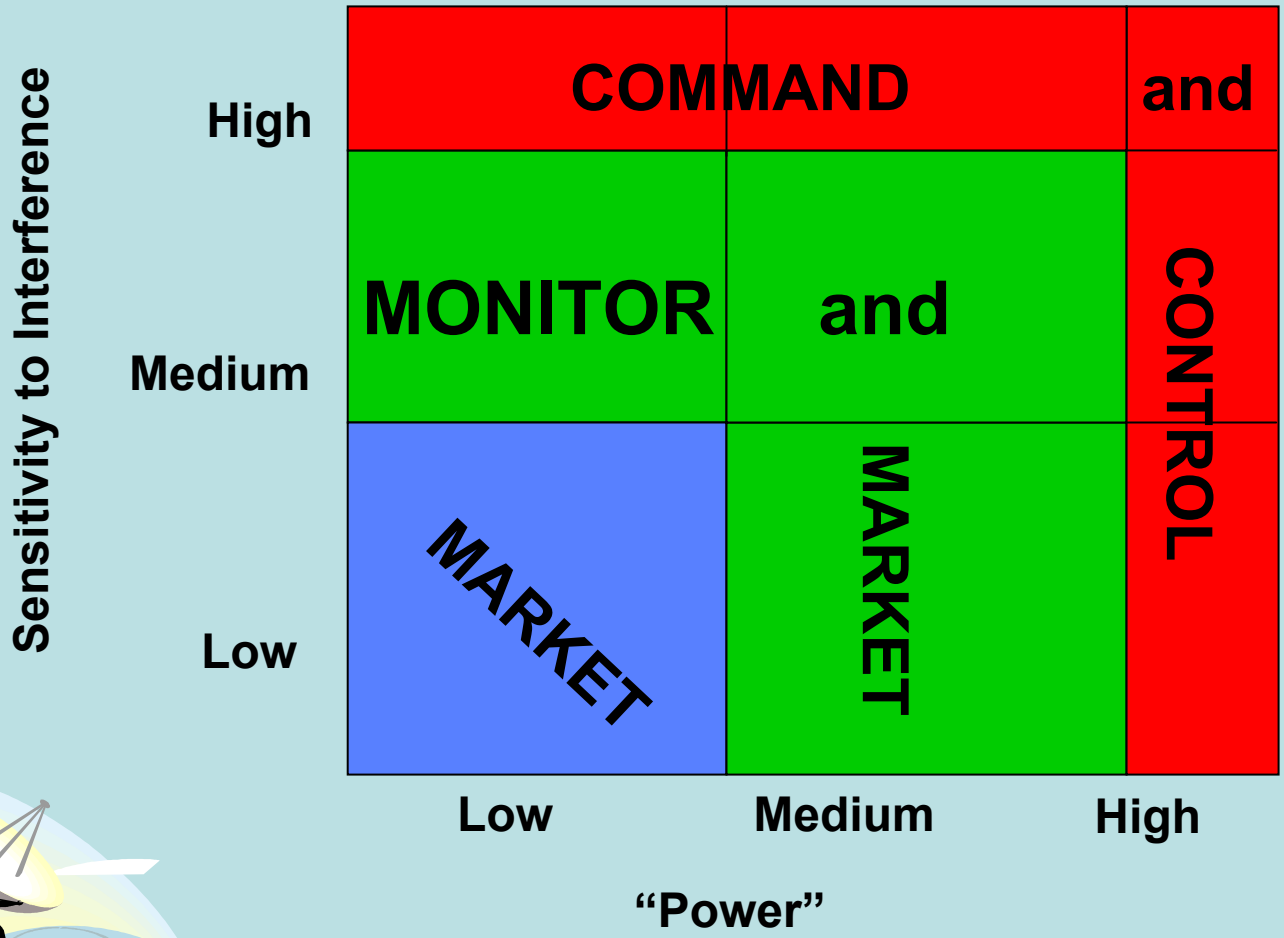
Uses & Users Limited by Regulation

Flexible, Market-Based Services

Unlicensed, Market-Based Devices

Spectrum Usage Models

Evolve into This



Uses & Users Limited by Regulation

Flexible, Market-Based Services

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- ➢ **Promoting Access to Spectrum**

Promoting Access to Spectrum

- Designate additional bands for unlicensed spectrum use
  - better optimize spectrum access and provide room for expansion in the fast-growing market for unlicensed devices and networks

- In licensed spectrum bands, pursue secondary markets policies that encourage licensees to provide access for “opportunistic” uses above the interference temperature threshold through leasing of spectrum usage rights.

- Explore the possible granting of “easements” for some opportunistic uses in new spectrum bands, but be sensitive to the potential impact on planning and investment by licensed users.

Promoting Access to Spectrum

Part of Maximizing Spectrum Efficiency

Efficiency

Access Limited

- Improve access through time, frequency, bandwidth and space
- Permit other users or uses -- <u>flexibility</u>
- Discourage inefficient use

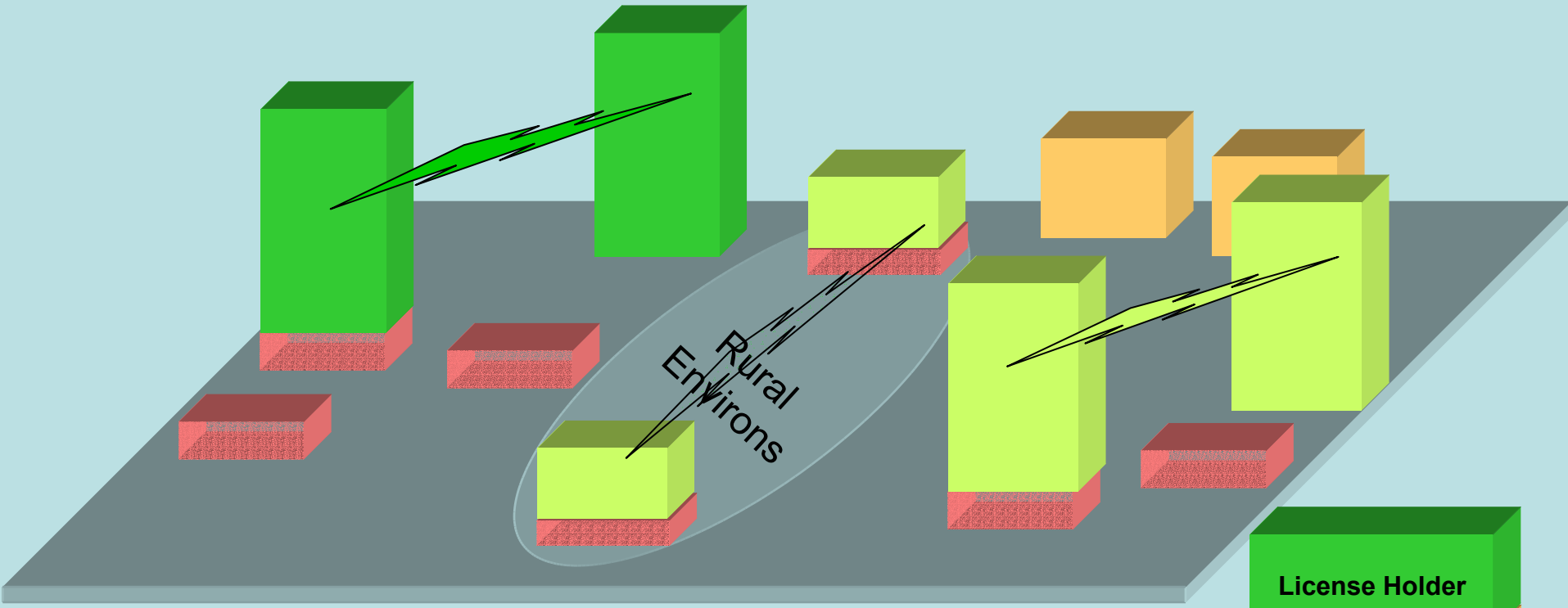
Throughput Limited

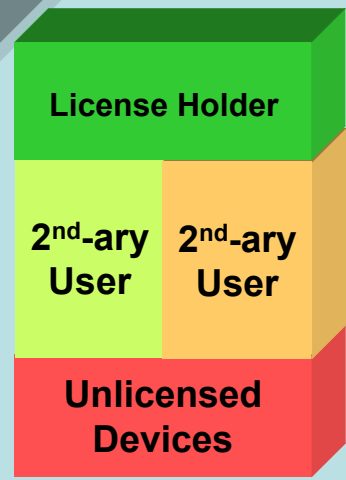
- Group like systems
- Adjust regulations as technology develops

- Currently spectrum is access limited
- Eventually spectrum may be throughput limited -- not there yet

Promoting Access to Spectrum

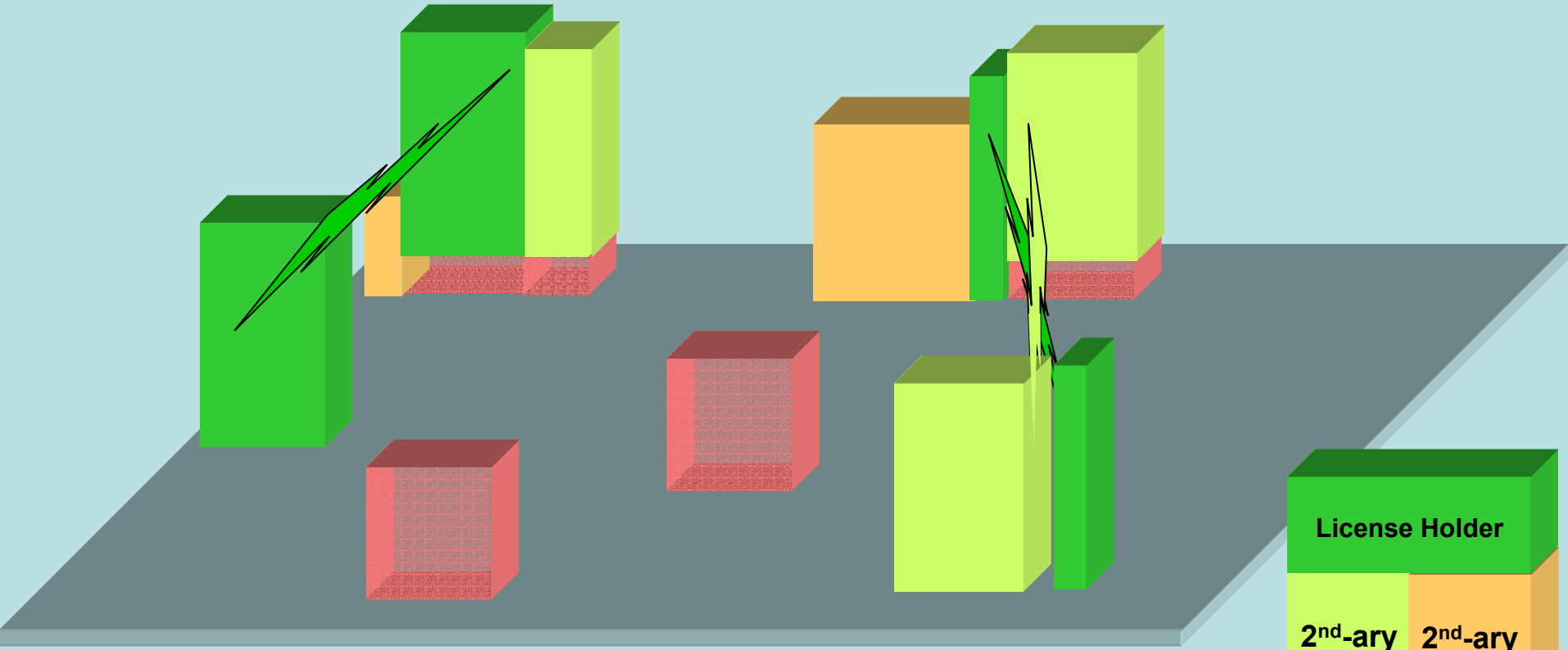
In the Space Dimension





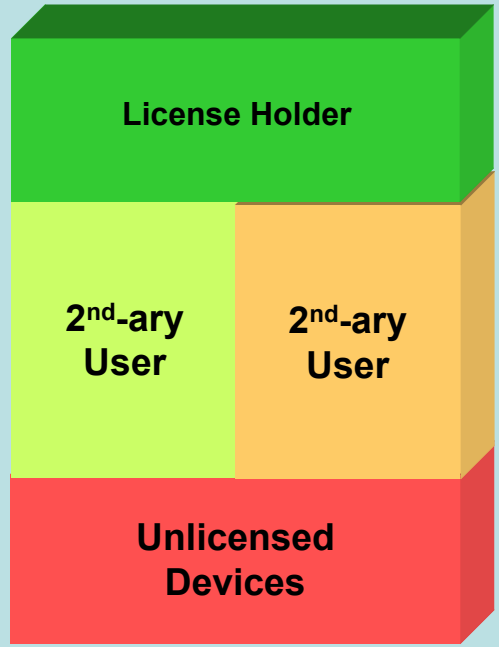
Promoting Access to Spectrum

In the Time and Space Dimensions



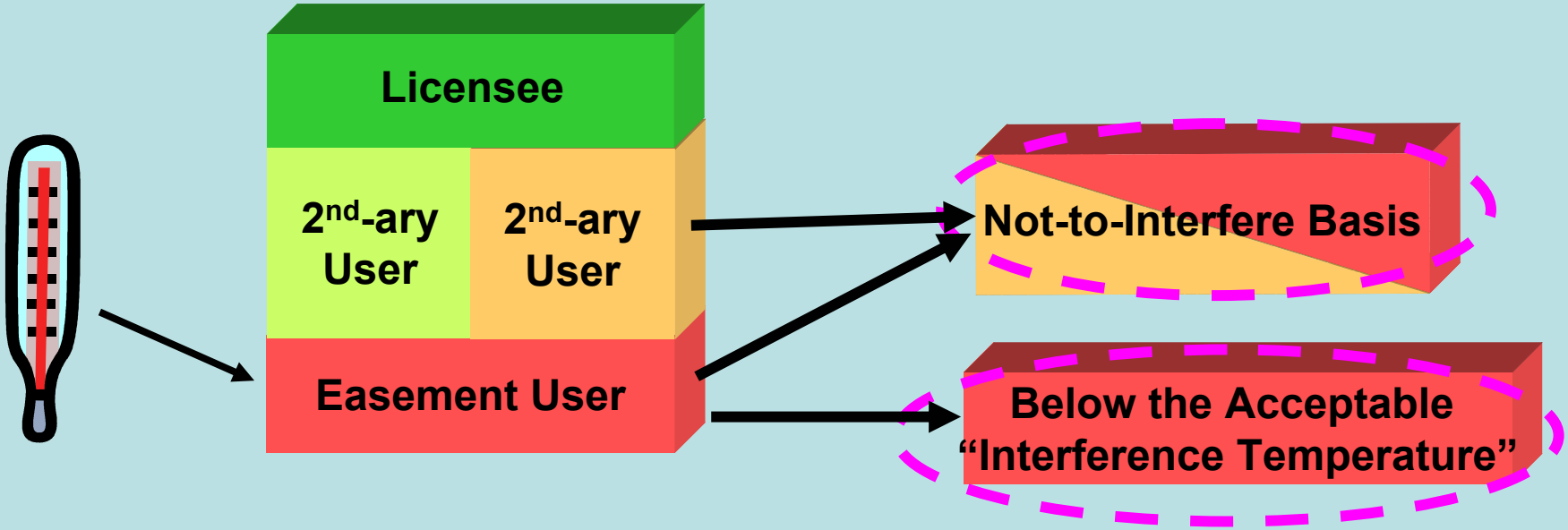
Promoting Access to Spectrum
By Consumer Devices

- Methods for additional spectrum access for consumer devices:
  - Unlicensed devices operate below acceptable interference temperature and/or
  - Consumer devices can operate at higher power than interference temperature
    - Secondary Market approach
      - Device operates as a Secondary User based on agreement with Licensee
      - Negotiate directly with Licensee or through private intermediary (*e.g.*, band manager) that manages secondary uses
    - Easement approach
      - Device operates on a not-to-interfere basis using standard protocols; no negotiation required
      - FCC or frequency coordinator administers interference issues



Promoting Access to Spectrum

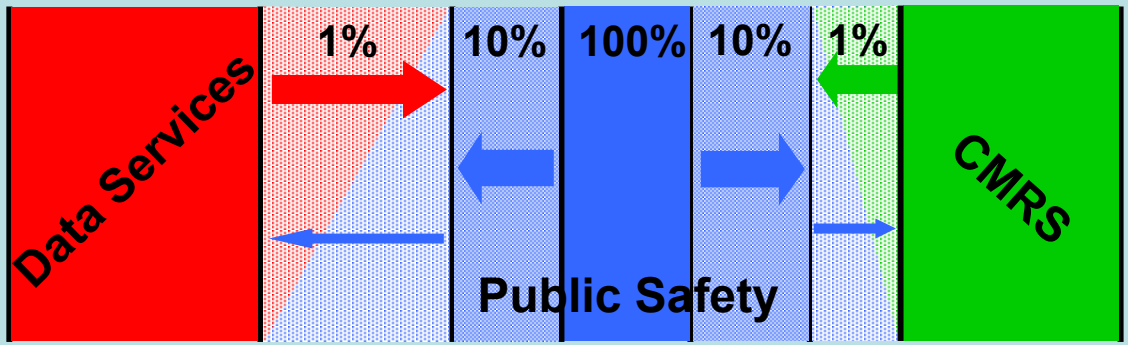
The New Model

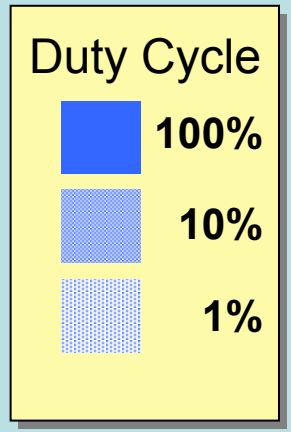


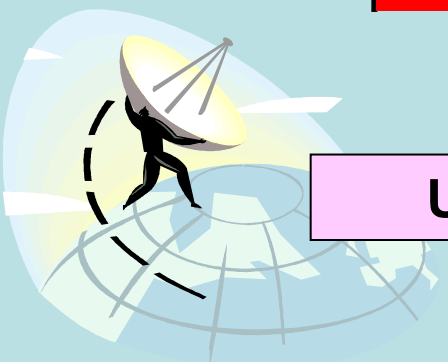
Promoting Access to Spectrum

Through Increased Flexibility

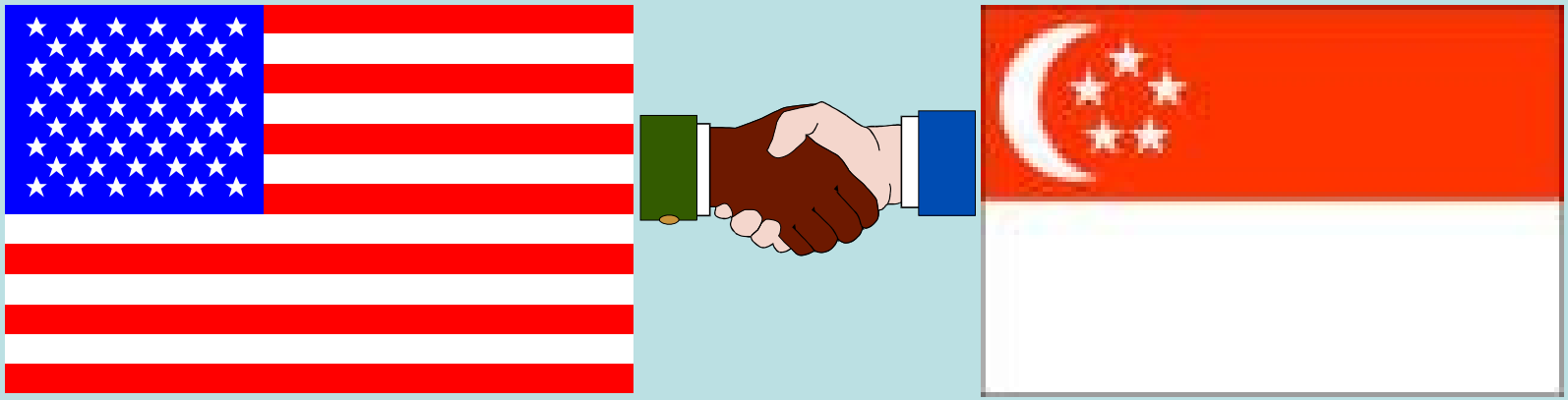
Illustration: Public Safety & Dynamic Spectrum Use







Use of public safety spectrum is highly variable



FCC looks forwards to continued cooperation with IDA and Singapore industry for mutual benefit