Spectrum Policy Task Force

**Findings and Recommendations**

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Presentation to the
International Symposium on
Advanced Radio Technologies
March 2003

Outline

➤ **Introduction**

➤ Spectrum Policy Reform: The Time is Now

➤ Major Findings and Recommendations

➤ Interference Avoidance

➤ Spectrum Usage Models

➤ Promoting Access to Spectrum

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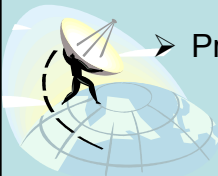
Introduction

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

- **<u>First</u> ever comprehensive and systematic review of spectrum policy at the FCC.**

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

- **<u>Catalyst</u> for further advancement of spectrum policy at the FCC.**

Oh, FCC May I …
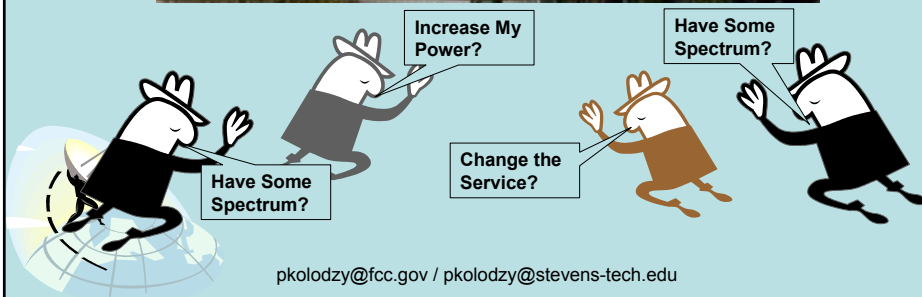
Introduction
Disclaimer

The Spectrum Policy Task Force Report drafted by FCC <u>staff</u> 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.
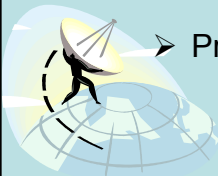

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➢ **Spectrum Policy Reform: The Time is Now**

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Spectrum Policy Reform: The Time is Now

- Increasing <u>demand</u> for spectrum-based services and devices is straining longstanding and outmoded spectrum policies.

  – Demand propelled by a host of factors:
    - economy has moved towards communications-intensive service sector
    - American workforce is increasingly mobile
    - consumers have been quick to embrace the convenience and increased efficiency of multitude of wireless devices available today
    - advances in technologies have significantly increased diversity of service offerings and have qualitatively improved existing services and devices, particularly for Internet and wireless data, which can be delivered at faster rates.
    - businesses and homes with multiple computers growing and users installing local area networks to share resources

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Spectrum Policy Reform: The Time is Now

- <u>Technological advances</u> are enabling changes in spectrum policy
  – Technology providing potential answers to current spectrum policy challenges.
    - increased use of <u>digital technologies</u>
      – 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 <u>software-defined radios</u>
      – 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.
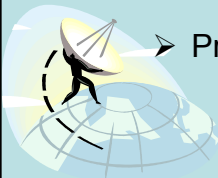

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Major Findings & Recommendations

- <u>Technology advances</u> create potential for radio systems to use spectrum more intensively and to be more tolerant of interference.
  - Implement <u>new paradigm</u> for interference protection

- In many bands, spectrum <u>access</u> 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.
  - <u>Additional information and measurement needed</u> to more accurately quantify and characterize spectrum usage and availability.

- Spectrum policy must <u>evolve</u> towards more <u>flexible and market-oriented regulatory models</u> to increase opportunities for technologically innovative and efficient spectrum use.
  - Eliminate regulatory barriers to increased spectrum access

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Major Findings & Recommendations

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

- No single regulatory model should be applied to all spectrum:
  - pursue <u>balanced spectrum policy</u> 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.
  - <u>Migrate</u> from current command and control model to more market-oriented exclusive rights model and unlicensed device/commons model

- <u>Implement</u> policies in both <u>newly allocated bands</u> and in spectrum that is already occupied, but <u>appropriate transitional mechanisms</u> 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 <u>quantitative approach</u> to interference management based on the concept of "interference temperature."
  - <u>Interference temperature</u> metric would establish maximum permissible levels of interference, characterizing the "worst case" environment in which a receiver would be expected to operate.
  - Different threshold levels could be set for each band, geographic region or service -- set only after <u>review of the condition of the RF environment</u> in each band.
    - **systematic study of the RF noise floor necessary**

- <u>Receiver performance requirements</u> for some bands and services, through incentives, mandates, or some combination of incentives and mandates.
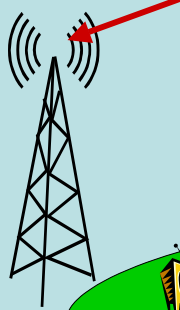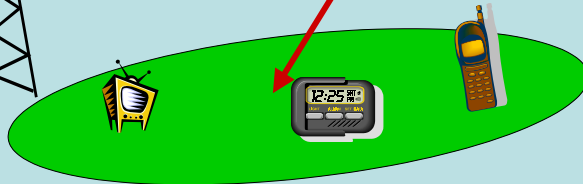
Interference Avoidance

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

Interference
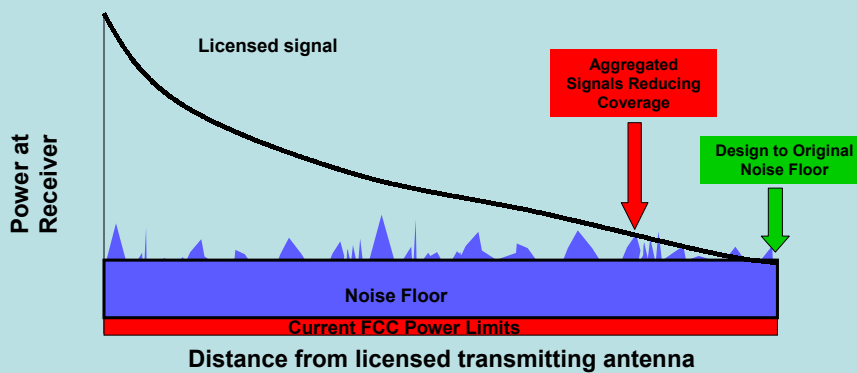Temperature

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

Licensed signal

Aggregated Signals Reducing Coverage

Design to Original Noise Floor

Power at Receiver

Noise Floor

Current FCC Power Limits

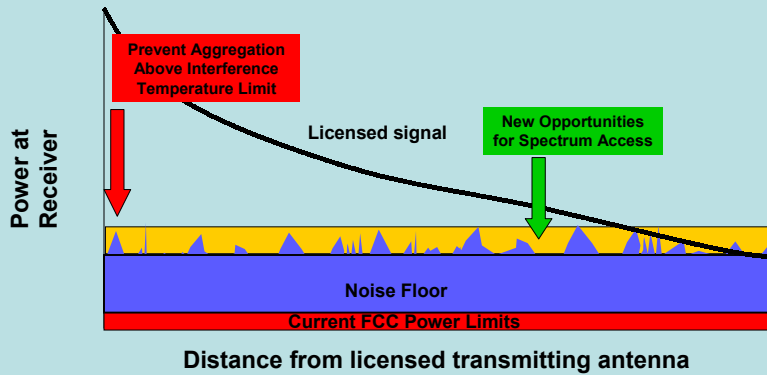**Distance from licensed transmitting antenna**

- **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

Power at Receiver

Prevent Aggregation Above Interference Temperature Limit

Licensed signal

New Opportunities for Spectrum Access

Noise Floor

Current FCC Power Limits

Distance from licensed transmitting antenna

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

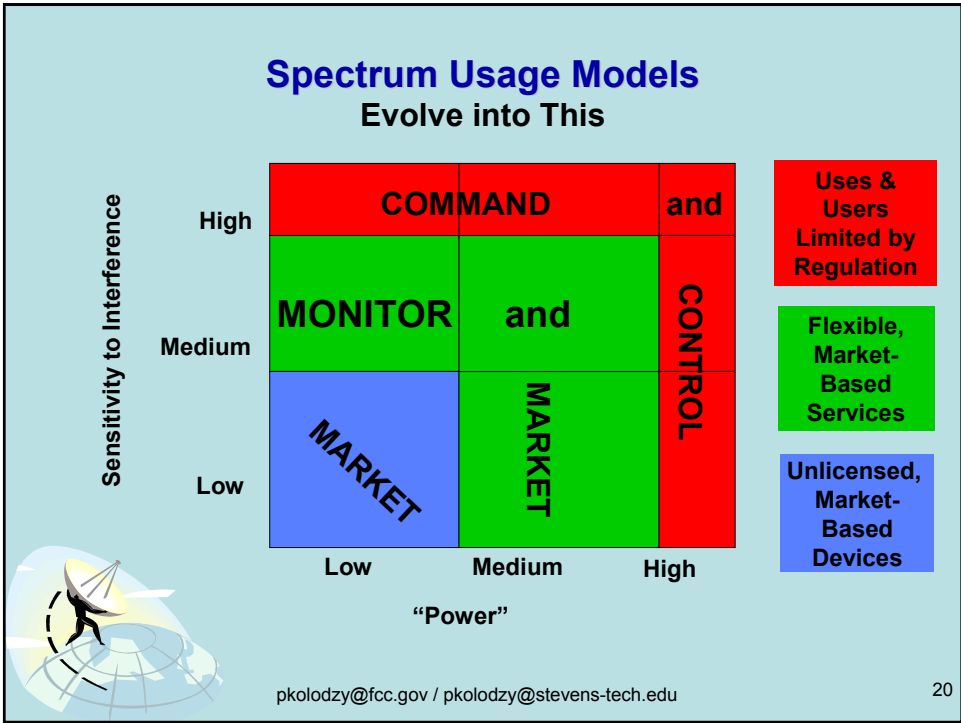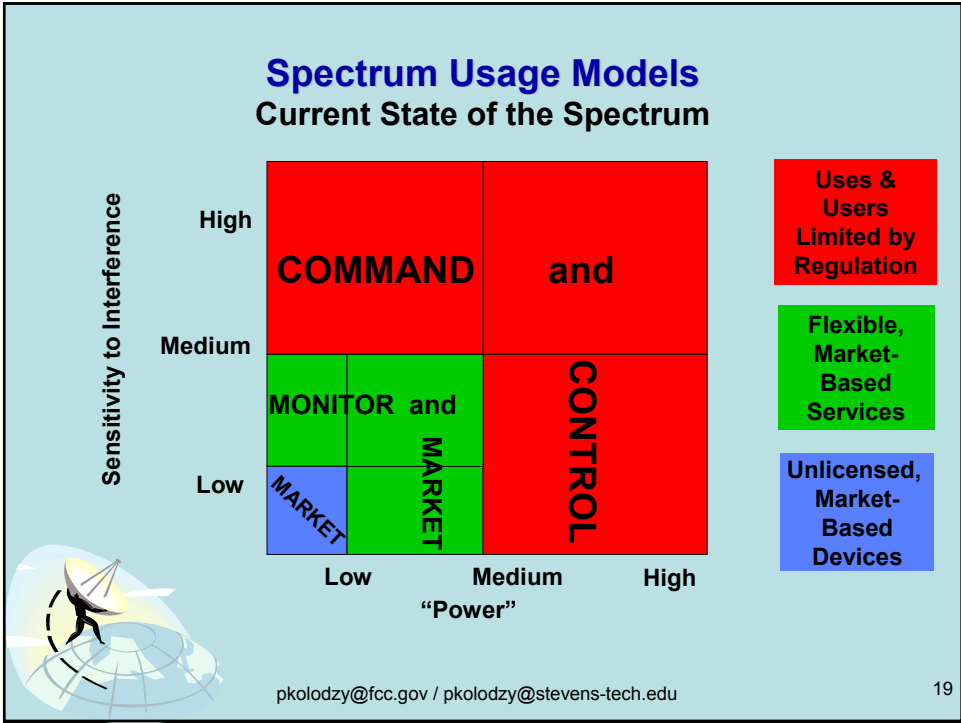## Outline

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✓ Major Findings and Recommendations

✓ Interference Avoidance

➤ **Spectrum Usage Models**

➤ Promoting Access to Spectrum

Spectrum Usage Models
Current State of the Spectrum

Sensitivity to Interference

High

Medium

Low

COMMAND   and

MONITOR and

MARKET

MARKET

CONTROL

Low   Medium   High

"Power"

Uses & Users Limited by Regulation

Flexible, Market-Based Services

Unlicensed, Market-Based Devices

Spectrum Usage Models
Evolve into This

Sensitivity to Interference

High

Medium

Low

COMMAND   and

MONITOR   and

MARKET

MARKET

CONTROL

Low   Medium   High

"Power"

Uses & Users Limited by Regulation

Flexible, Market-Based Services

Unlicensed, Market-Based Devices
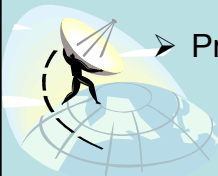
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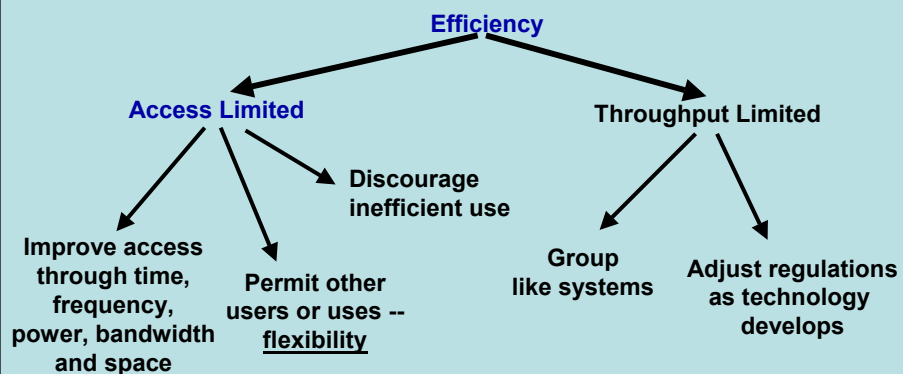➢ **Promoting Access to Spectrum**

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Promoting Access to Spectrum
Improving Spectrum Efficiency

Efficiency

Access Limited

Throughput Limited

Discourage inefficient use

Improve access through time, frequency, power, bandwidth and space

Permit other users or uses -- flexibility

Group like systems

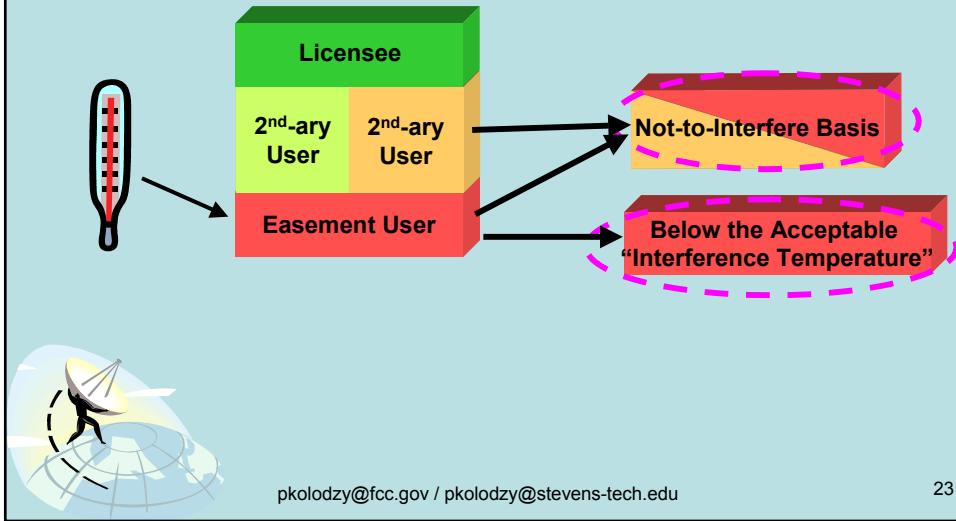**Adjust regulations as technology develops**

- **Currently spectrum is access limited**
- **Eventually spectrum may be throughput limited -- not there yet**
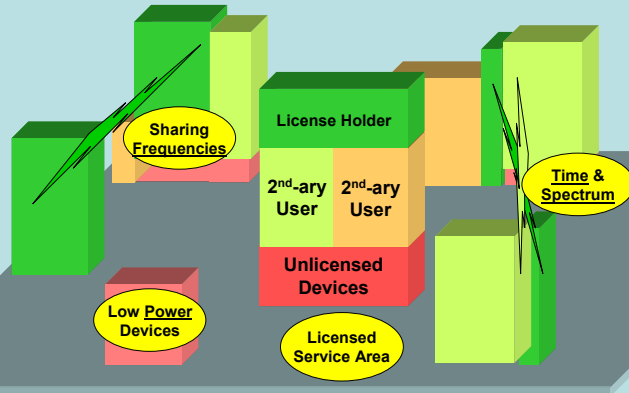
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Promoting Access to Spectrum
The New Model

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Promoting Access to Spectrum
In the Space Dimension

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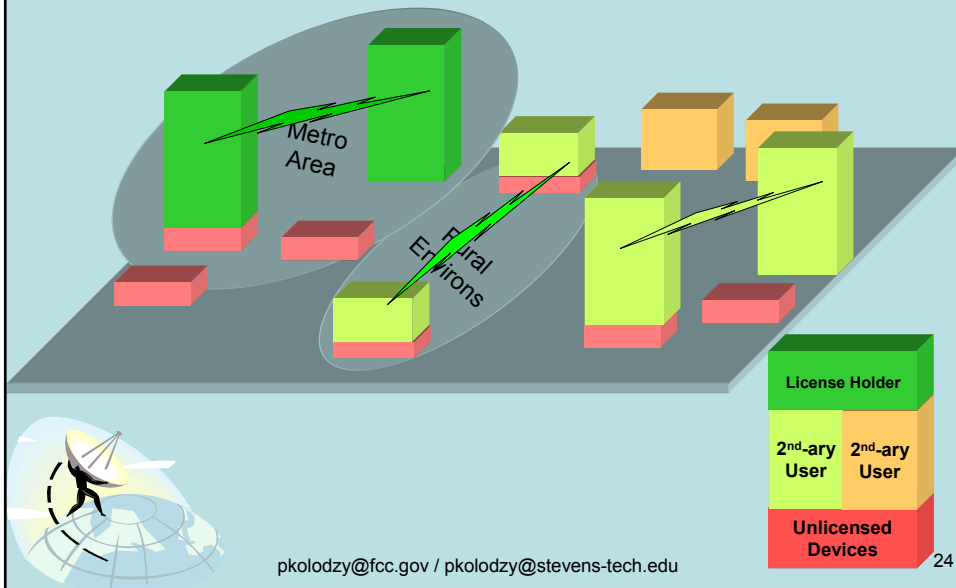
Promoting Access to Spectrum
In All Dimensions

Sharing Frequencies
License Holder
2nd-ary User | 2nd-ary User
Unlicensed Devices
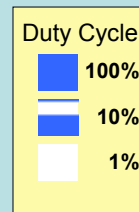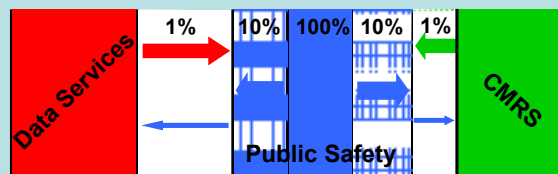Time & Spectrum
Low Power Devices
Licensed Service Area

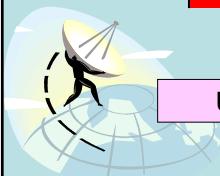pkolodzy@fcc.gov / pkolodzy@stevens-tech.edu

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Promoting Access to Spectrum
Through Increased Flexibility
Illustration: Public Safety & Dynamic Spectrum Use

Data Services | Public Safety | CMRS

Data Services
1% | 10% | 100% | 10% | 1%
Public Safety
CMRS

Duty Cycle
100%
10%
1%

Use of public safety spectrum is highly variable

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What's Next?
For Advanced Radio Technology Community

- **Determine Viability of Technology for:**
  – Monitoring Interference Temperature
    - Benign Environs
    - Complex Environs
  – Adaptation Techniques
  – Opportunistic Spectrum Access
    - Space
    - Time

- **Start Thinking about Wireless Cyber-Security**

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Thank you!

Questions?

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