

A Day in the Life of the RF Spectrum

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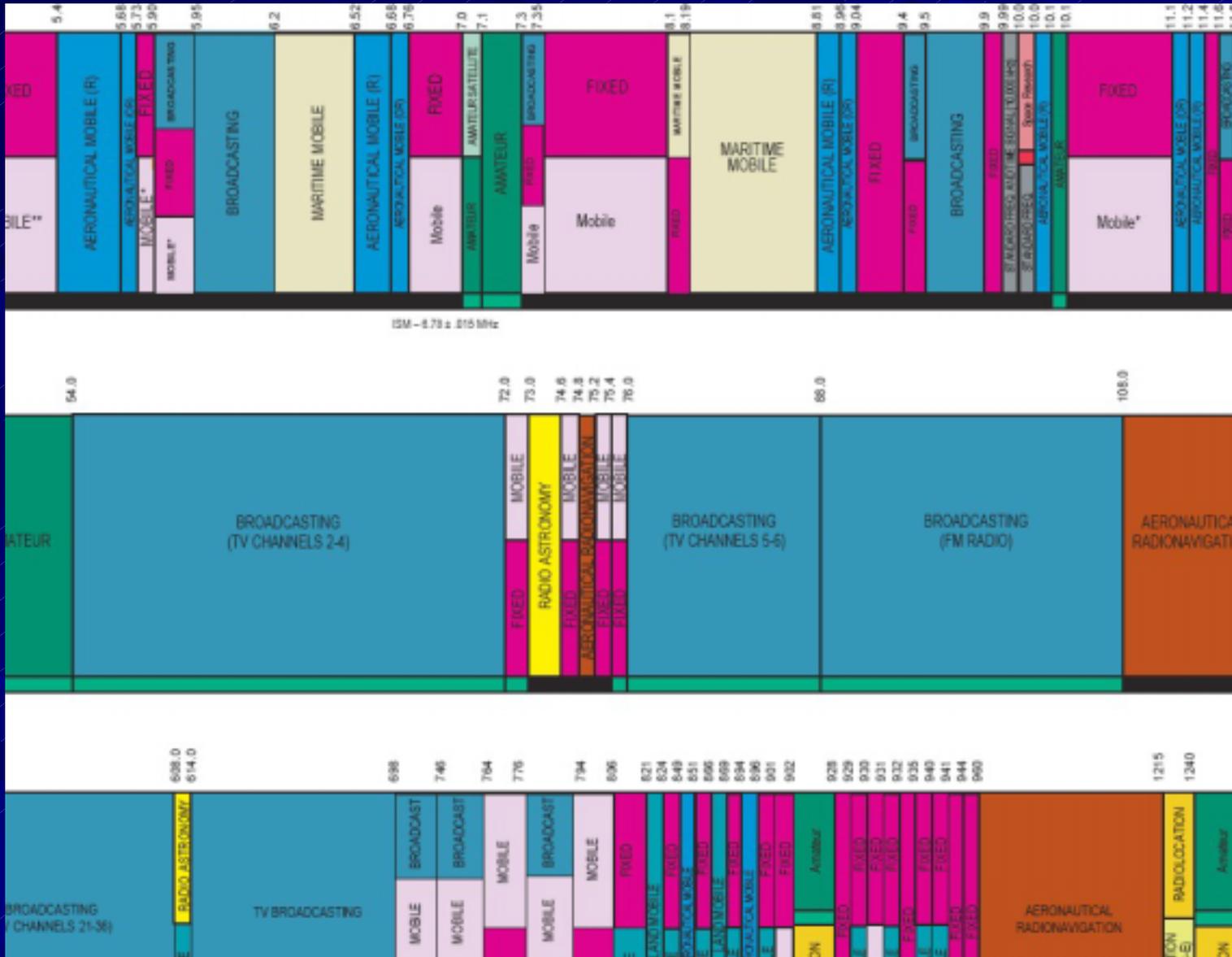
MS Master Thesis Overview for CFP

1/26/05

Overview:

- In the United States, most spectrum space seems to have been allocated
- Is it being used? Clearly No.
- Why not?
- What technological innovations can do for the problem
 - Cognitive Radio
 - Usage-based survey, not Energy-based.

US Spectrum Allocation



History:

How did we get ourselves into this situation!!??

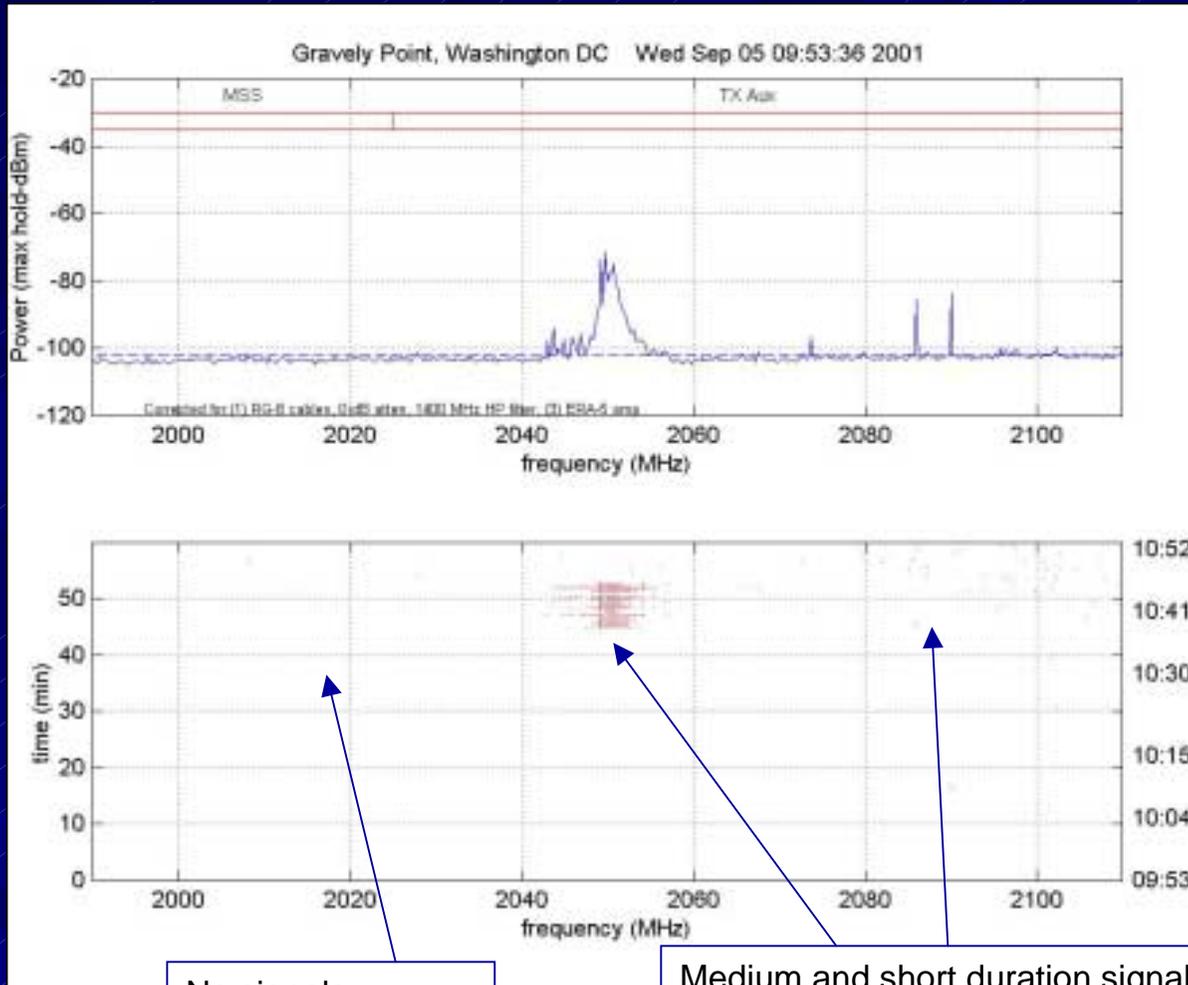
■ Communications Act of 1934

- FCC & Office of Spectrum Management (U.S. Dept. of Commerce)
- Arose of the chaos of birth of radio broadcasting
- Based upon the technology of the time
- LARGELY unchanged since 1934.

What to do about perception of “scarcity”

- Have expensive auctions (Market Driven)
- Retire Older/Legacy Services
 - HDTV replacing TV, turn over military bands, etc.
- Or, ask the question:
“How much is actually being used.”
- Answer
“Not Much”

Typical Spectrum Occupancy Measurement



No signals

Medium and short duration signals

Radio Evolution

- Tube, Analog Radios
- Solid State, Analog Radios
- Digital Radio
- Software Radio
 - “Cognitive Radio” coined by Joseph Mitola
 - Agile, smart, adaptable radio platforms which can reinvent themselves using software driven algorithms
 - It should be possible to dynamically, cooperatively discover what is there and how a particular piece of RF spectrum is/is not being used.

Cognitive Radio Usage

- Thus far, proposals to use cognitive radios to measure energy alone.
- These ask the question:

“Is something being broadcast there or not. If not, re-use. Else, don’t.”

- Mired in social, legal, concerns...
(we’re interested in the technical issues, of course)

Energy-Based Shortcomings

- Measuring RF energy alone does nothing to answer these questions:
 - What kind of information is being broadcast
 - What are the technical characteristics?
(Modulation scheme, tolerance to outside interference, extraneous information)
 - What is the signal's profile in time, space, frequency?
 - *IS ANYBODY LISTENING?*

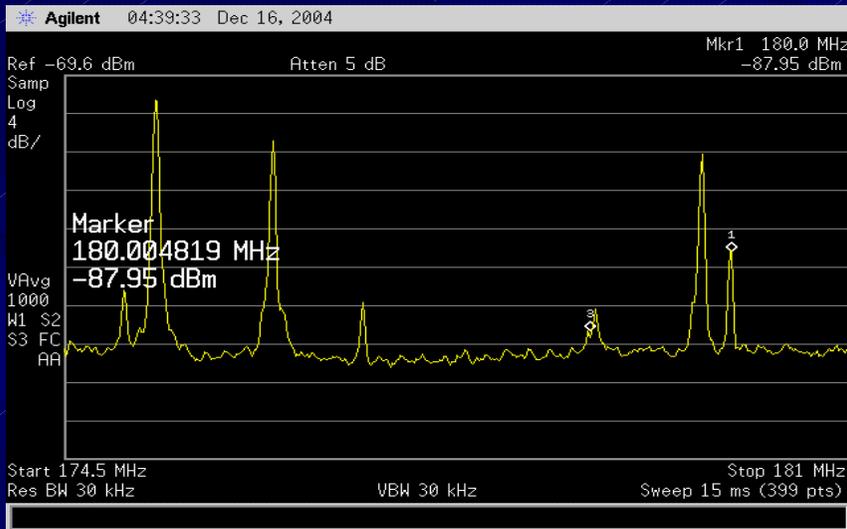
New Thinking in RF Management

- It is ONLY possible to interfere with someone who is LISTENING. It has nothing to do with who is TRANSMITTING
- Ideally, measured used spectrum space should be flat when all space is used
- How flat is it currently? Not very.
- Can we change the authorization strategy? The ideal situation is to use spectrum in a new way

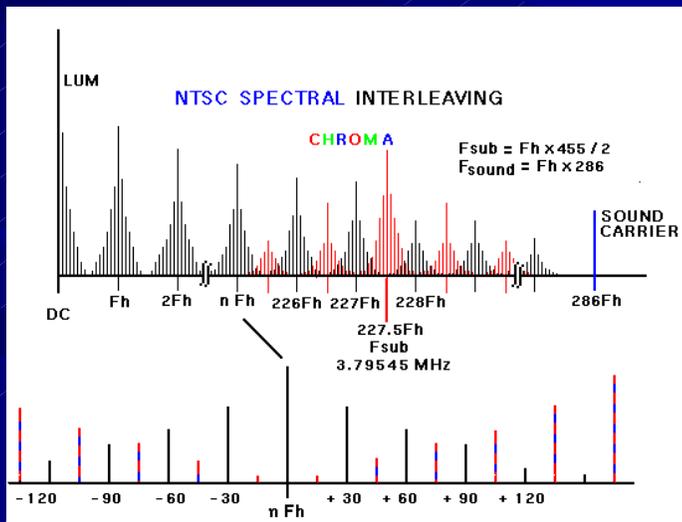
A Day In the Life of the RF Spectrum

- This thesis proposes to measure spectrum to reveal its use through signal recording and analysis.
- This will lead to a better understanding of spectrum usage, and hopefully be a platform on which to build better cognitive radio systems
- Tools: Spectrum analysis, ideally use of GNU-Radio platform

Examples: TV Channel 7

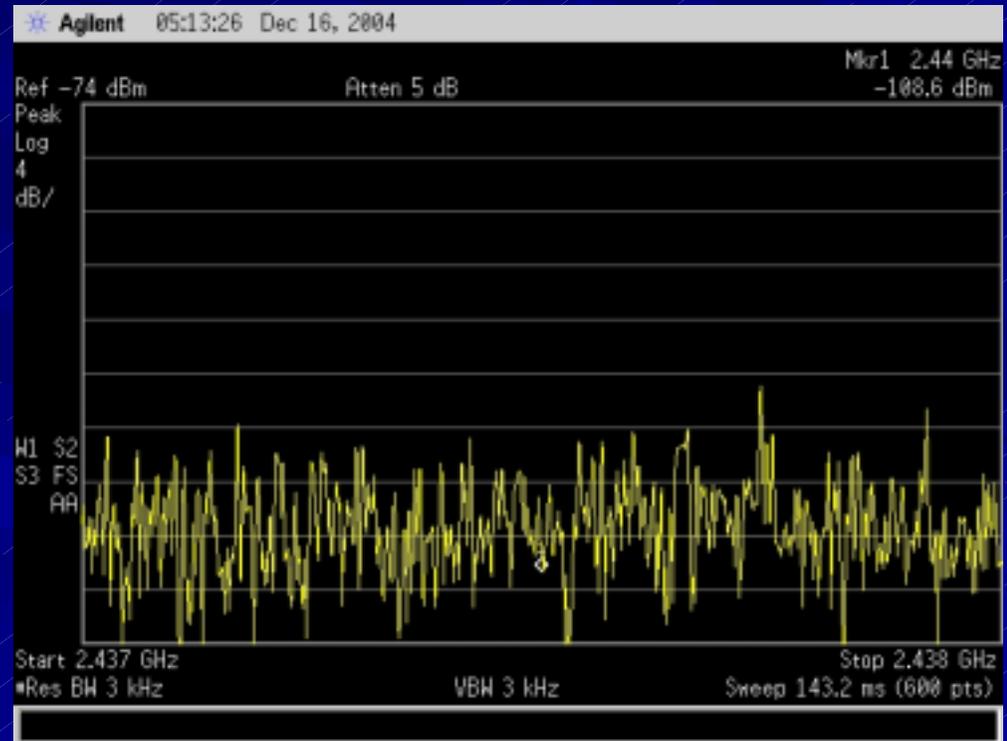


- Has a fairly clear energy signature
- There are known ways to interleave



Examples: 802.11

- Wideband Signal, obviously digital, varies greatly with time



Examples: Cell Phone

- GSM (1900 MHz, TDMA)
- Different channels use known offsets

