

Illinois Institute of Technology Spectrum Observatory



Dennis Roberson

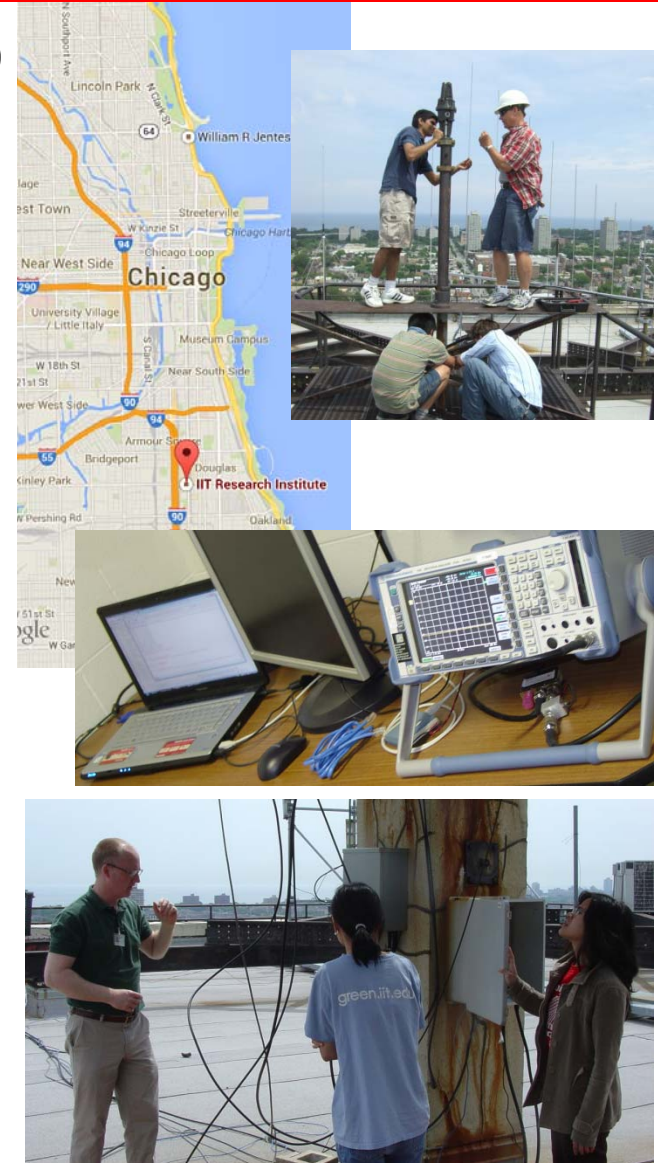
WSRD Workshop #5, 31 March 2014

Overview

- Project History
- Observations
- Current Work
- Importance

Project History

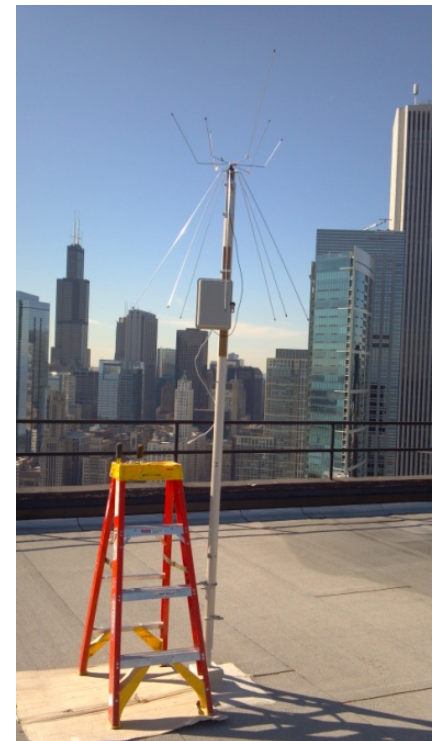
- NSF grants for initial spectrum observatory (2007)
 - Wideband: 30 – 6000 MHz
 - Continuous operation
 - Partnered with Shared Spectrum Company (SSC)
- Goal: Support dynamic spectrum sharing
 - Spectrum usage trends and anomalous events
 - Datasets for DSA and cognitive radio studies
 - Modeling, simulations, analyses
- Spectrum analyzer based system
 - First system implemented
 - Custom RF front-end (SSC design)
- Located on IIT campus
 - ~3 miles south of down-town Chicago
 - 21 story IIT Tower
 - Clear view of Loop



Additional Measurement Systems

- Wideband system offers limited resolution
 - Good overview, but limited by spectrum analyzer's speed
 - Narrow-band + transient/bursty signals problematic
- NSF Grants and other support lead to more systems
- Additional Chicago systems
 - Auxiliary wideband (2 each):
 - 30 – 3000 MHz: Rockwell-Collins, FFT-based sensor
 - 10 – 6000 MHz: CRFS - RFeye sensor
 - Dedicated LMR systems: 460 MHz, 700 MHz, 850 MHz
 - Custom USRP2 based sensors
- Systems at two sites
 - IIT Tower and Harbor Point (east of downtown)

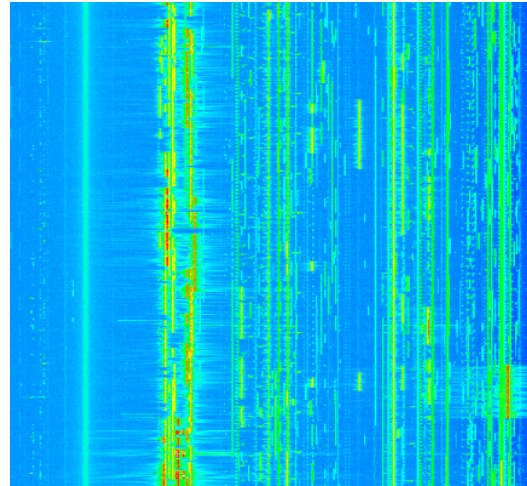
Harbor Point



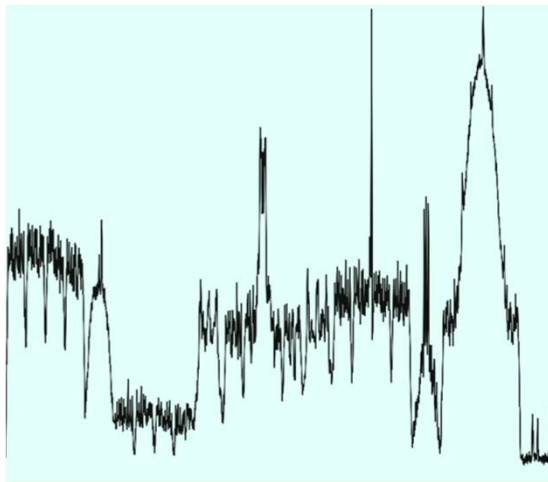
Measurement Device Summary



Long-term wideband
60 s period ■ variable RBW



Auxiliary — 1 s ■
12.5 kHz RBW

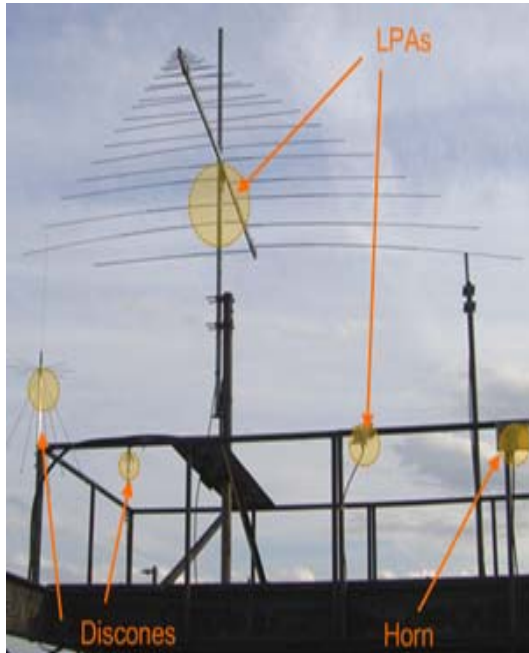


Auxiliary - 2 s
■ 12.5 kHz RBW

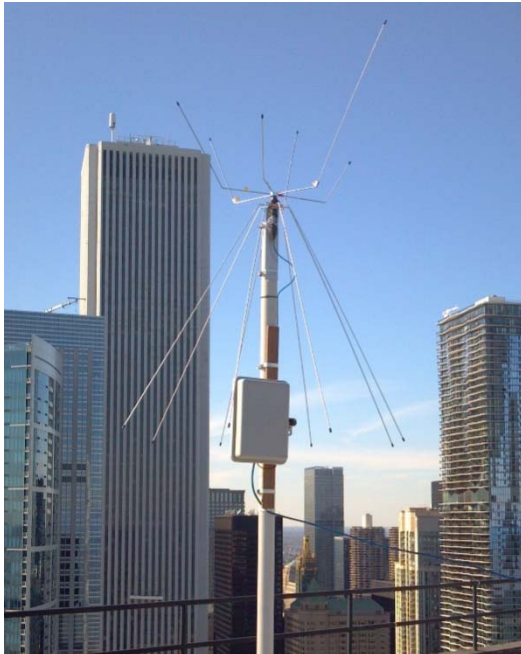


High-fidelity LMR
0.25 s period ■ 6.25 kHz RBW

Chicago Measurement Summary



IIT Tower
(~7 years)



Chicago
Harbor Point



Mobile
(Motorola)

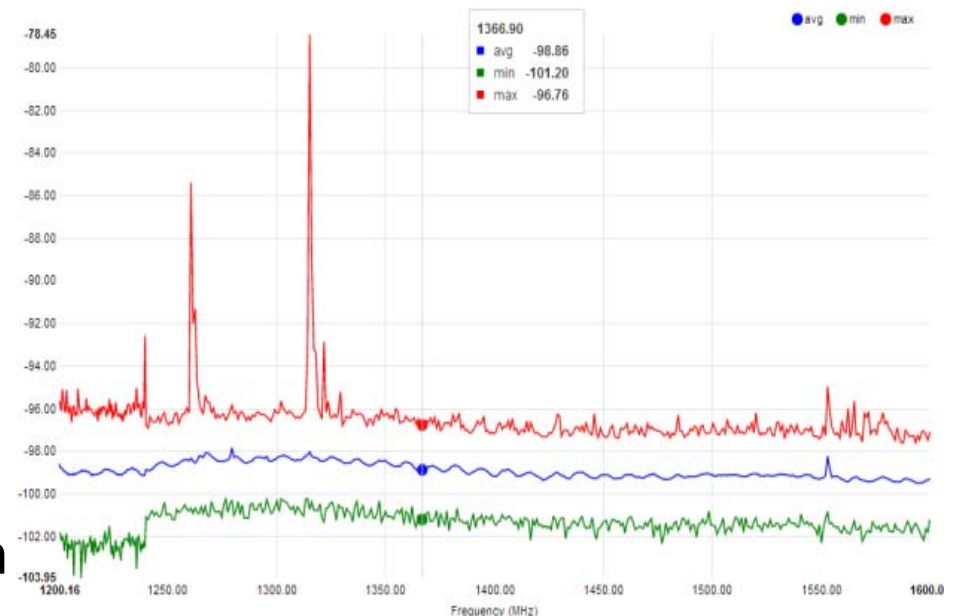
Observations

Spectrum Occupancy Definition

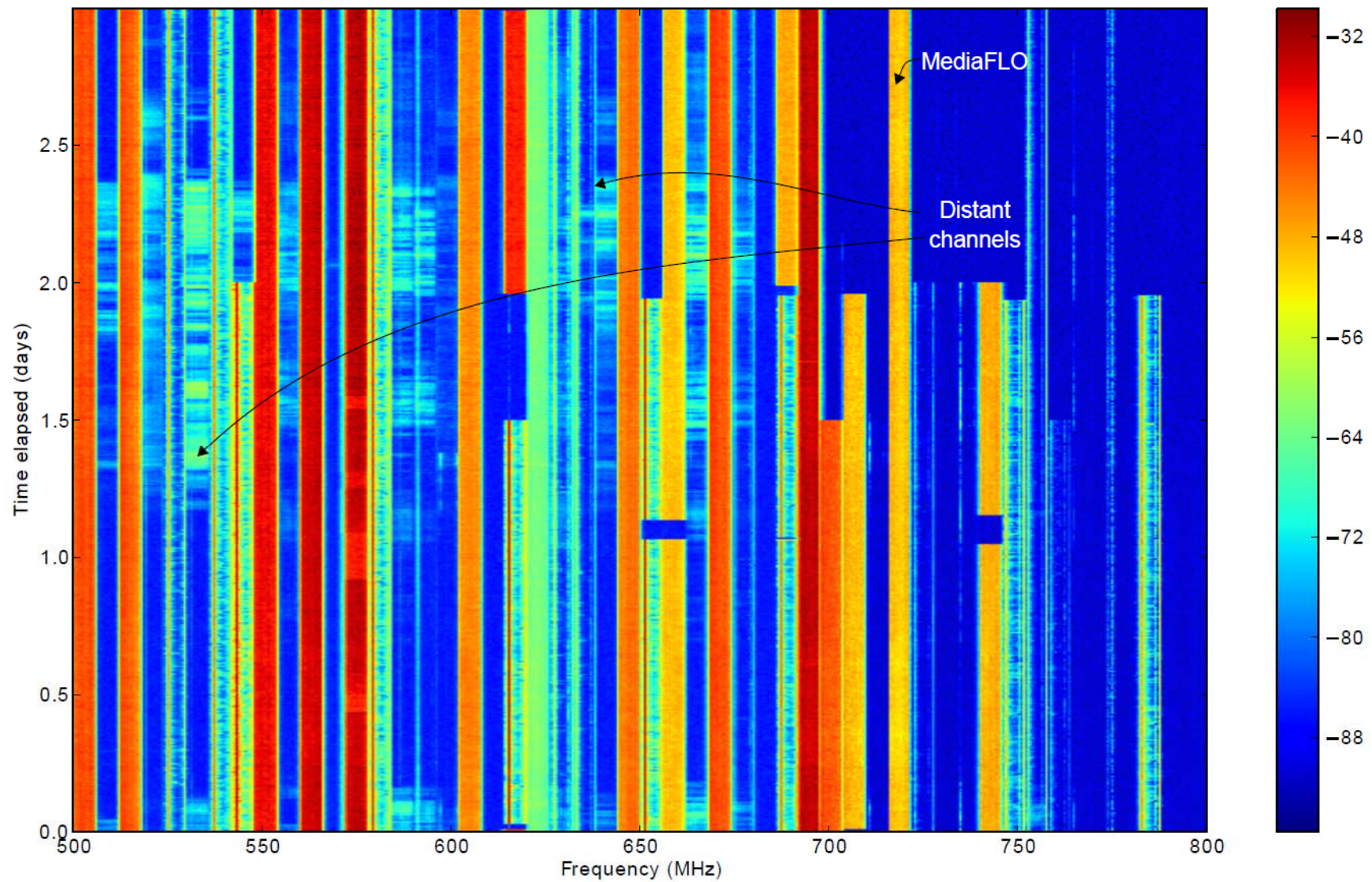
- Occupancy -- average spectrum over time/frequency where detectable power exceeds threshold
 - Energy detection
 - Threshold based on noise floor (constant false-alarm rate)

- Caveats

- Low power signals
- Distant signals (e.g. satellites)
- Shadowing
- Short duration signals
- False-alarms/missed detection
- Point-to-point/directional signals

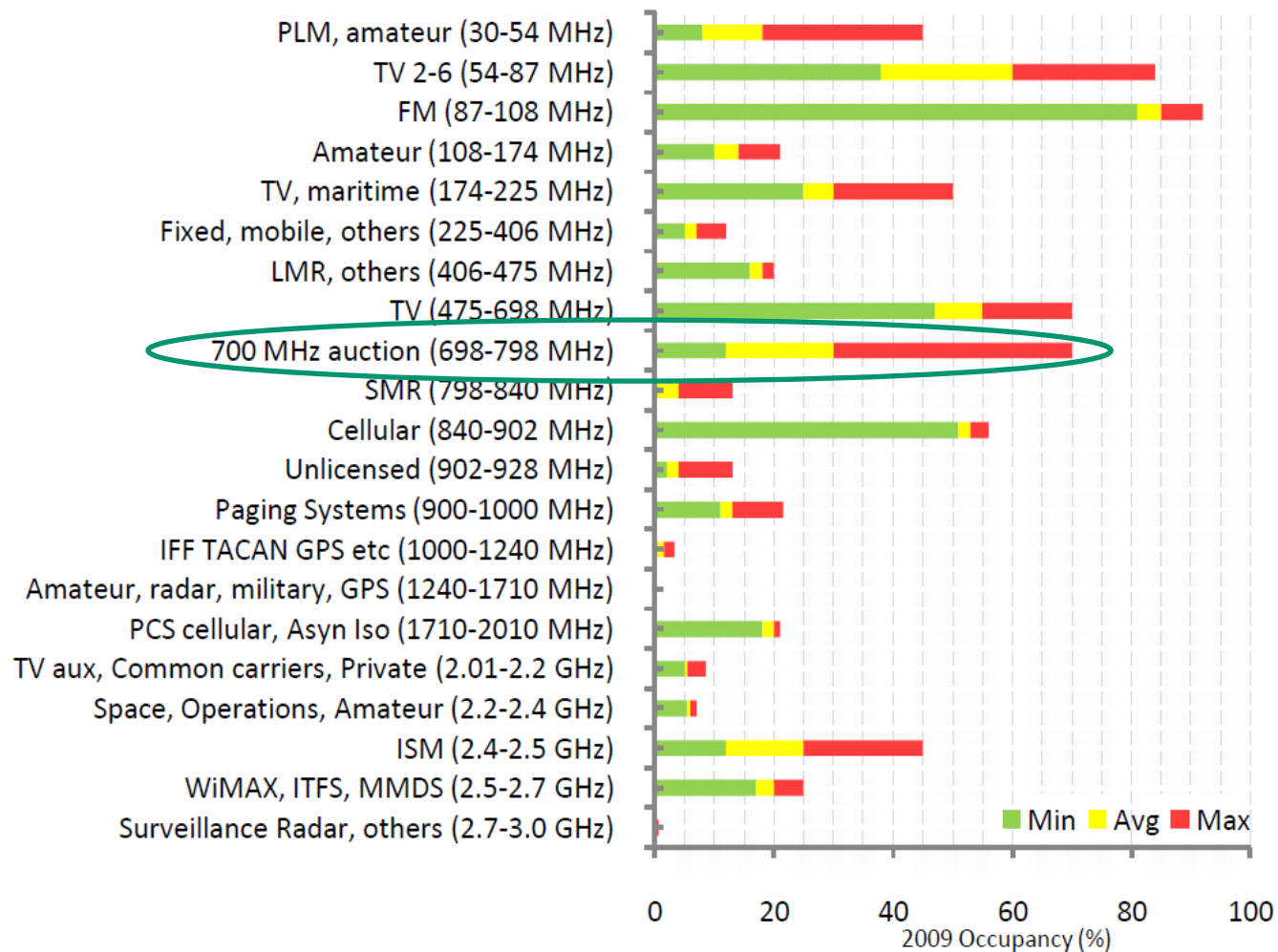


2009 Digital TV Switch-over



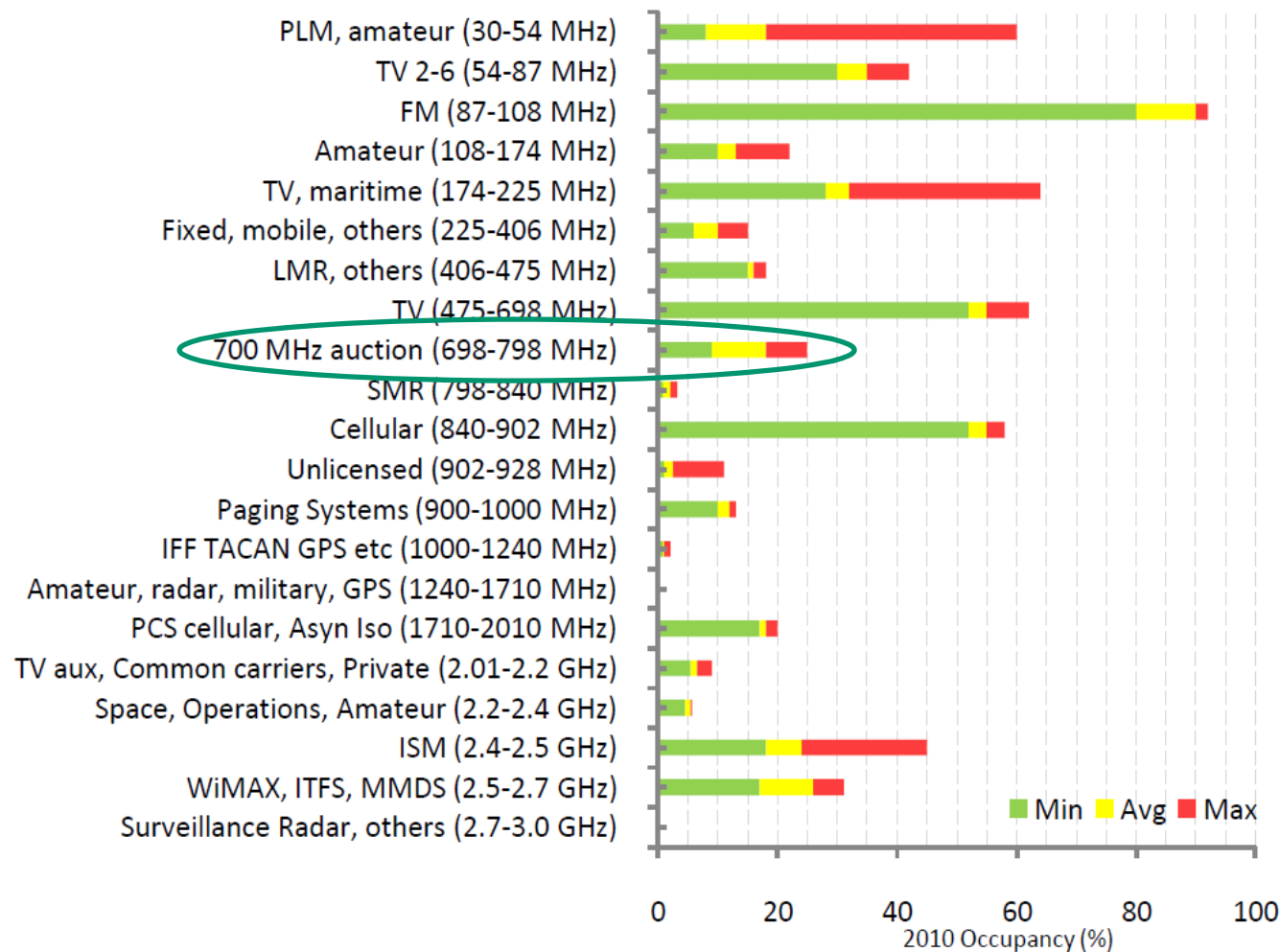
Spectrum Occupancy

14 % average occupancy in 2009 (up to 3 GHz)



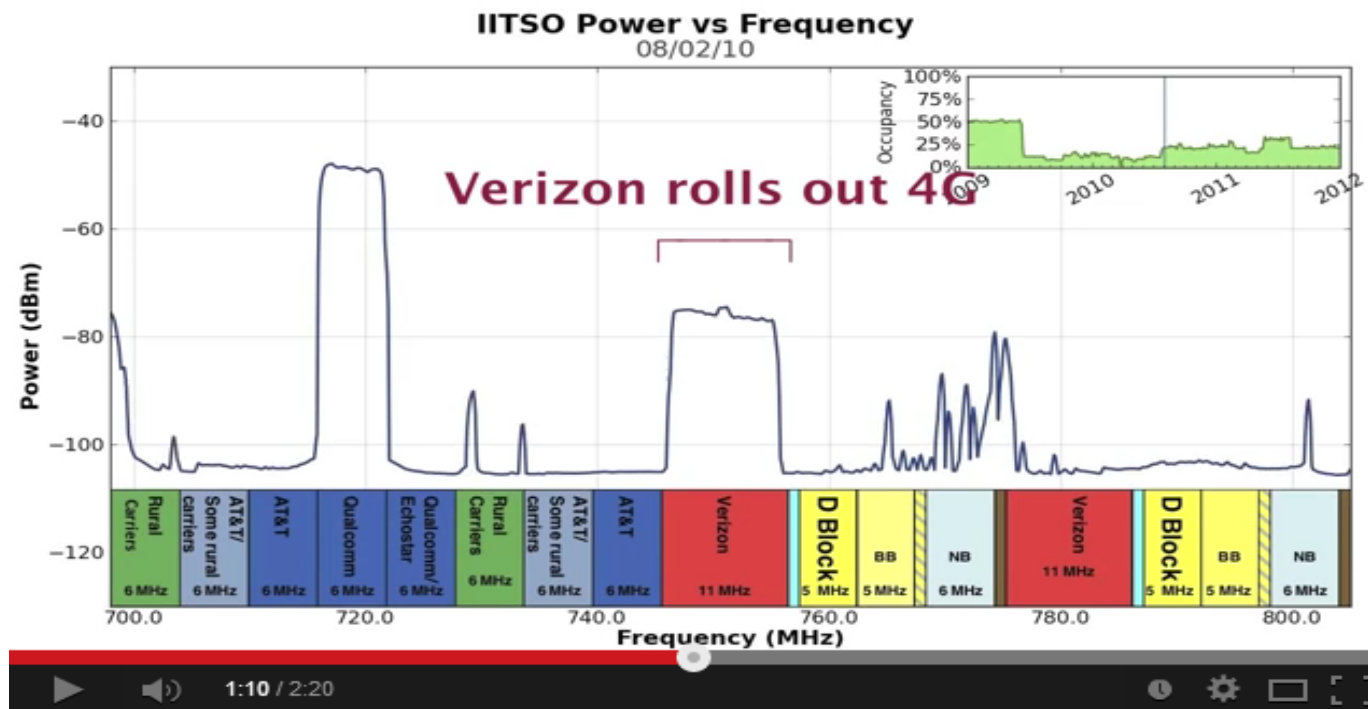
Spectrum Occupancy

15 % average occupancy in 2010 (up to 3 GHz)



Long-term Spectrum Visualization

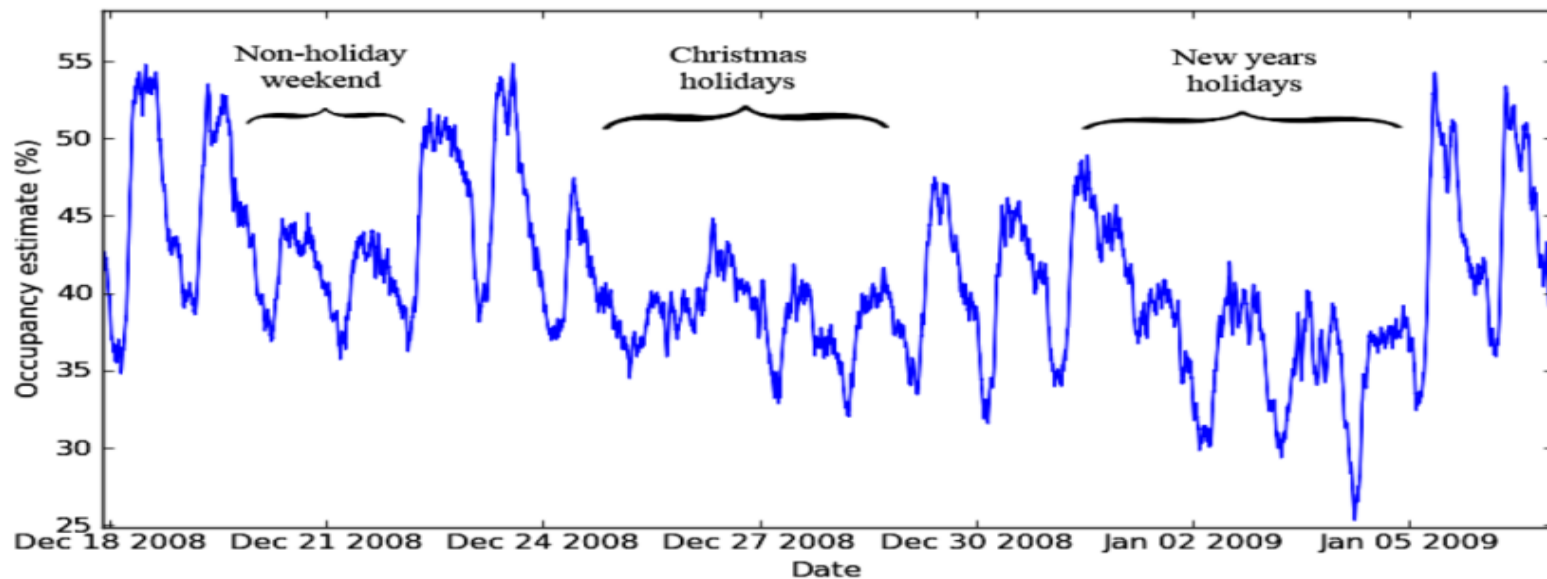
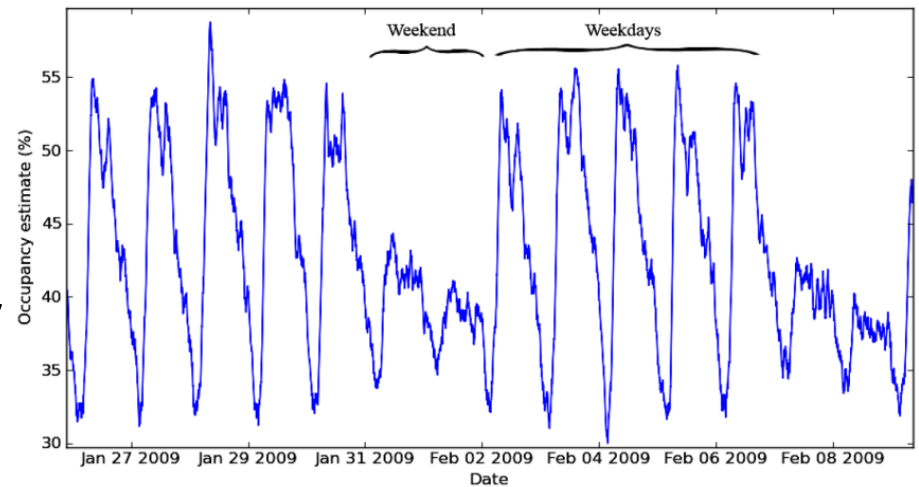
- Three year animated video of spectrum
 - Utilize archive of spectrum data
 - <http://youtu.be/h-Ffq1kCvas>



700MHz Spectrum Measurements

Cyclic Activity

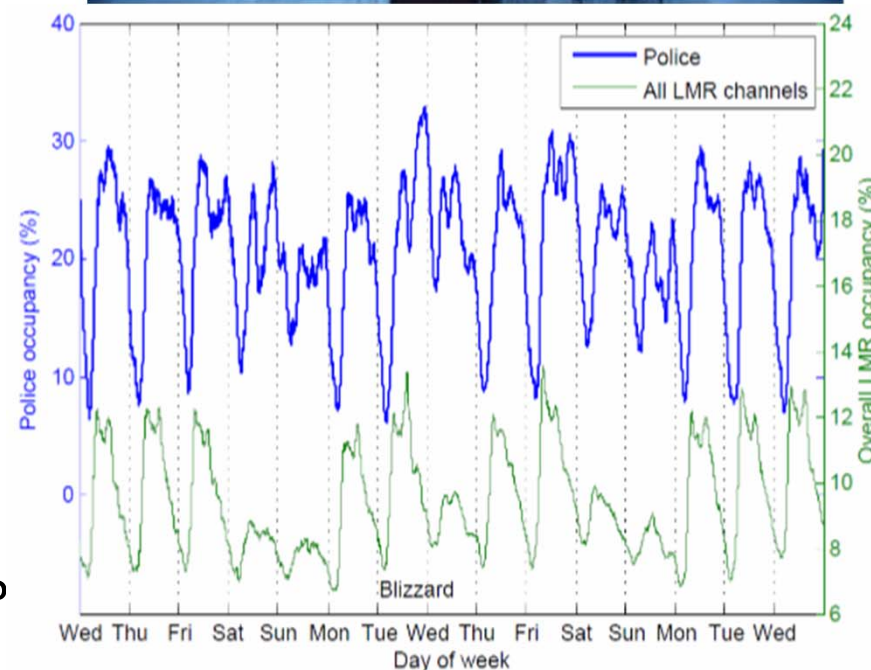
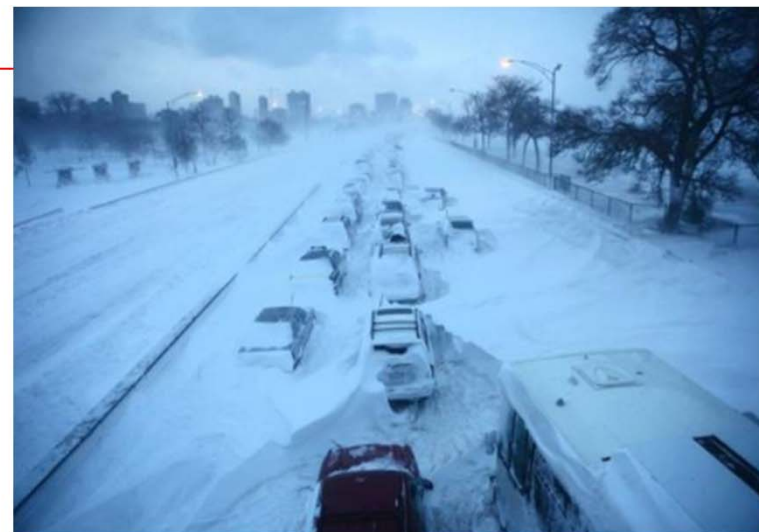
- Cyclical activity levels
 - Daily, weekly and yearly trends have been observed
 - Weekends and nights are readily apparent in several bands
- 450-465 MHz LMR band



Chicago Blizzard (February 2011)



- 20+ inches of snow
 - Third highest snow-fall on record
- LMR used by both public safety (e.g. police, fire, etc.) and commercial users
- 460 MHz LMR occupancy
 - Different characteristics for police
- Snow storm effect
 - Overall occupancy approaches weekend levels
 - Peak in police band occupancy
- Disasters apparent in spectrum
 - Emergency reallocation opportunity?



Current Work

- Multi-site Observatory –
 - Snap Shot Study
 - 2 -> 5 Observation Sites in Chicago
- Aircraft RADAR/LTE Study
 - Radar Altimeter Study
- Global Spectrum Observation Study (WiFiUS)
 - Turku, Finland (Turku University of Applied Sciences)
 - Blacksburg, VA (Virginia Tech)
 - Chicago (IIT)

Importance of Spectrum Monitoring

- Facilitating dynamic spectrum sharing
- Human activity through a spectrum “lens”
- Policy making
 - FCC / NTIA / European Regulators / ITU-R
 - Support for PCAST report / Presidential Memorandum
- Operations
 - Commercial and government
 - Cellular, energy, public safety, broadcast TV/radio
- Interference & Enforcement (intentional and unintentional)

Questions or comments?

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