

FCC Workshop: Spectrum Efficiency and Receiver Performance



March 12 -13, 2012

Julius Knapp, Chief
Office of Engineering and Technology

Note: The views expressed in this presentation are those of the author and may not necessarily represent the views of the Federal Communications Commission



Mobile Demand Is Creating a Spectrum Crunch

- Mobile wireless creates opportunities for innovation, investment and jobs
- Additional spectrum is critical to the sustained growth of wireless broadband
- President set goal of providing an additional 500 MHz of new spectrum for wireless broadband services



24/7



24X



120X

UNITED STATES FREQUENCY ALLOCATIONS THE RADIO SPECTRUM

RADIO SERVICES COLOR LEGEND

- | | | |
|--|--|---|
| ■ AERONAUTICAL MOBILE | ■ INTERNATIONAL | ■ FREEDOM SERVICE |
| ■ AERONAUTICAL MOBILE SATELLITE | ■ LAND MOBILE | ■ REDETERMINATION SERVICE |
| ■ AERONAUTICAL NAVIGATION | ■ LAND MOBILE SATELLITE | ■ FREEDOM |
| ■ BROADCAST | ■ MARITIME MOBILE | ■ RADIOLOCATION SATELLITE |
| ■ BROADCAST SATELLITE | ■ MARITIME MOBILE SATELLITE | ■ FREEDOM |
| ■ BROADCASTING | ■ MARITIME NAVIGATION | ■ FREEDOM SATELLITE |
| ■ BROADCASTING SATELLITE | ■ METEOROLOGICAL AID | ■ SPACE OPERATION |
| ■ DETERMINATION SATELLITE | ■ METEOROLOGICAL SATELLITE | ■ SPACE RESEARCH |
| ■ FIXED | ■ MOBILE | ■ UNKNOWN FREQUENCY AND THE SILENCE |
| ■ FIXED SATELLITE | ■ MOBILE SATELLITE | ■ UNKNOWN FREQUENCY AND THE SILENCE SATELLITE |

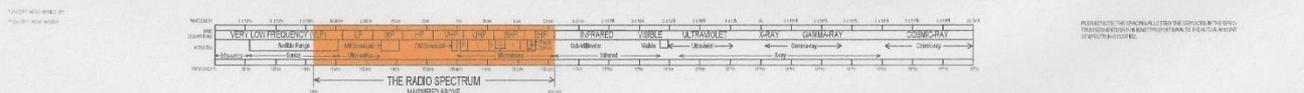
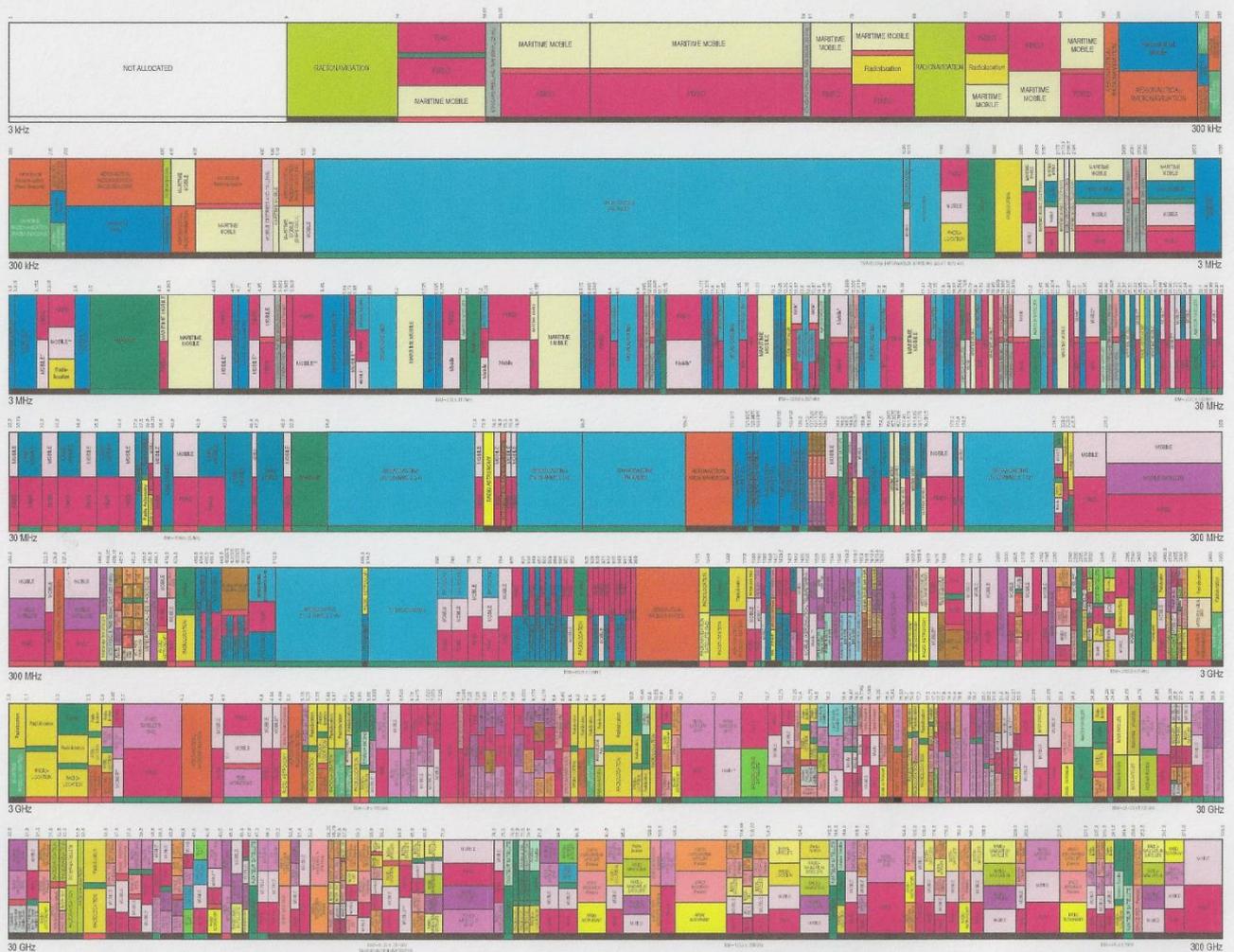
ACTIVITY CODE

- | | |
|---|---|
| ■ GOVERNMENT EXCLUSIVE | ■ GOVERNMENT-NON-GOVERNMENT SHARED |
| ■ NON-GOVERNMENT EXCLUSIVE | |

ALLOCATION USAGE DESIGNATION

SERVICE	EXAMPLE	DESCRIPTION
Primary	Fixed	General License
Secondary	Mobile	Not Digital with lower class factors

The table is a graphic representation of the Table of Frequency Allocations used by the FCC and is not intended to be used as a substitute for the actual Table of Frequency Allocations. It is intended to provide a visual overview of the radio spectrum. The table is subject to change without notice.



RESOURCES: THE UNALLOCATED FREQUENCIES IN THE 300 MHz BAND ARE RESERVED FOR FUTURE USE AND ARE NOT INTENDED FOR CURRENT USE.

There Are Many Types of Receivers – Each Different



Microwave



Astronomy



TV



AM/FM



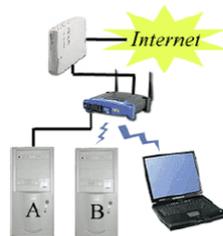
Cell Phones



Family Radio



Fixed Satellite



Wi-Fi



Cordless Phones



Mobile Radios



Video Surveillance



Medical



Smart Meters

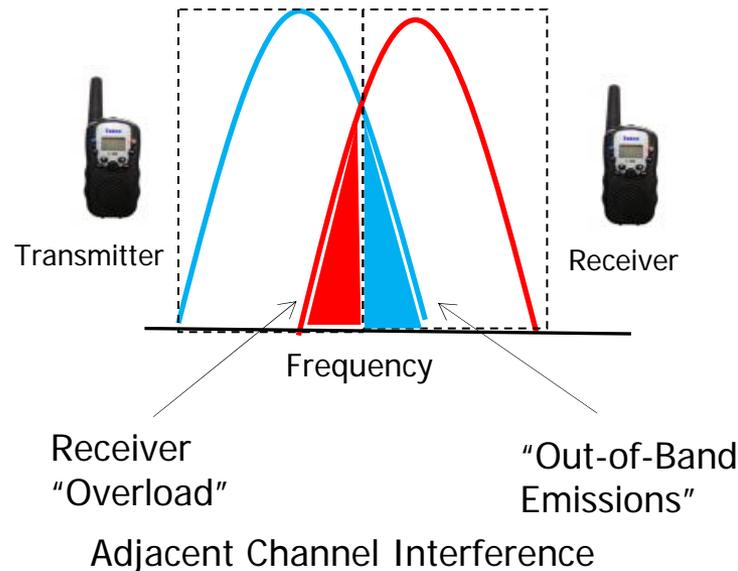


Satellite TV

What Do We Mean By Receiver Performance?

Interference Performance

- Adjacent channel rejection
- Spurious response rejection
- Intermodulation immunity
- Image frequency rejection
- Desensitization

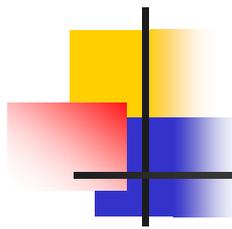


Usage Performance

- Distinction: how well receiver operates
- Metrics Differ:
 - Voice – articulation index
 - Video – resolution, noise, etc
 - Data – speed, latency, jitter
- Sensitivity
- Data Throughput
 - Processing
 - Error Correction



Receiver Performance Issues Are Not New



- Examples:
 - Past: FM radio to TV channel 6; FM radio with aeronautical receivers; federal land mobile and garage door openers;
 - Recent/Current: TV White Space; 3650 MHz – FSS; TDD AWS-3 – AWS-1; WCS –SDARS; MSS-GPS
 - Resolution historically required (lengthy) public process
- New approaches focusing on spectrum efficiency and receiver performance:
 - May enable more assured deployment of service
 - Reduce the necessity for involvement of regulators



Past Commission Action

- May 2003: Receiver Standards Notice of Inquiry, based on recommendations of the Spectrum Policy Task Force
- May 2007: Proceeding terminated without prejudice
- August 2009: Wireless innovation Notice of Inquiry:
 - “How should receiver standards be taken into account for purposes of repurposing spectrum, such as the case where protected incumbents are using legacy receivers that could be replaced with newer, state-of-the-art equipment offering superior performance that would facilitate the introduction of new services?”
 - Nearly 300 comments - - most did not focus on receivers

Radars Frequency Bands

U.S. Radar Operating Bands, Radio Services, and Allocation Status

Frequency Band (MHz)	Radiolocation	Radionavigation	Aeronautical Radionavigation	Maritime Radionavigation	Meteorological Aids	Earth Exploration-Satellite
216-225 ¹	Sec					
420-450	Pri					
890-902	NIB					
902-928	Pri					
928-942	NIB					
1215-1240 ²	Pri					Pri Pri
1240-1300 ²	Pri		Pri Pri			Pri Pri
1300-1350	Sec					
1350-1370	Pri		Pri Pri			
1370-1390	Pri					
2310-2320	Sec	Pri				
2320-2345	Pri	Pri				
2345-2360	Sec	Pri				
2360-2390 ³	Pri					
2390-2417	NIB					
2417-2450	Sec					
2450-2483.5	Sec	Sec				
2483.5-2500	Sec					
2700-2900	Sec		Pri Pri		Pri	
2900-3000	Sec			Pri Pri	Pri	
3000-3100	Sec			Pri Pri		
3100-3300 ²	Pri	Sec				Sec Sec
3300-3500	Pri	Sec				
3500-3650 ⁴	Pri	Sec	Pri			
4200-4400			Pri Pri			
5250-5350 ²	Pri	Sec				Pri Pri
5350-5460 ²	Pri	Sec	Pri Pri			Pri Pri
5460-5470	Sec	Sec	Pri Pri			
5470-5600	Sec	Sec		Pri Pri		
5600-5650	Sec	Sec		Pri Pri	Pri Pri	
5650-5925	Pri					
8500-8550	Pri	Sec				
8550-8650 ²	Pri	Sec				Pri Pri
8650-8750	Pri	Sec				
8750-8850	Pri	Sec	Sec Sec			
8850-9000	Pri	Sec				
9000-9200	Sec	Sec	Pri Pri			

U.S. Radar Operating Bands, Radio Services, and Allocation Status

Frequency Band (MHz)	Radiolocation	Radionavigation	Aeronautical Radionavigation	Maritime Radionavigation	Meteorological Aids	Earth Exploration-Satellite
9200-9300	Sec	Sec				
9300-9500	Sec	Sec	Pri Pri		Sec Sec	
9500-9800 ²	Pri	Sec				Pri Pri
9800-9975	Pri	Sec				
9975-10025	Pri	Sec				Sec Sec
10025-10500	Pri	Sec				
10500-10550	Pri	Pri				
13250-13400 ²			Pri Pri			Pri Pri
13400-13750 ²	Pri	Sec				Pri Pri
13750-14000	Pri	Sec				
14000-14200			Pri Pri			
15400-15700			Pri Pri			
15700-17200	Pri	Sec				
17200-17300 ²	Pri	Sec				Pri Pri
17300-17700	Sec					
24050-24250	Pri	Sec				Sec Sec
24250-24450			Pri			
24450-24650			Pri Pri			
24750-25050			Pri Pri			
25050-25250			Pri			
31800-33400			Pri Pri			
33400-35500	Pri	Sec				
35500-36000 ²	Pri	Sec				Pri Pri
59000-64000	Pri	Pri				
66000-71000			Pri Pri			
76000-77000	Pri	Pri				
77000-78000	Pri	Pri				
78000-79000	Pri	Pri				Pri Pri
79000-81000	Pri	Pri				
92000-94000	Pri	Pri				
94000-94100 ²	Pri	Pri				Pri Pri
94100-95000	Pri	Pri				
95000-100000	Sec		Pri Pri			
126000-134000	Pri	Pri				
134000-142000	Sec	Sec	Pri Pri			
144000-149000	Pri	Pri				
190000-200000			Pri Pri			

Source: Department of Commerce Report May 2000 - Federal Radar Spectrum Requirements



Communications Act:

Sec. 302a. Devices which interfere with radio reception

(a) The Commission may, consistent with the public interest, convenience, and necessity, make reasonable regulations:

(1) governing the interference potential of devices which in their operation are capable of emitting radio frequency energy by radiation, conduction, or other means in sufficient degree to cause harmful interference to radio communications; and

(2) **establishing minimum performance standards for home electronic equipment and systems to reduce their susceptibility to interference** from radio frequency energy. Such regulations shall be applicable to the manufacture, import, sale, offer for sale, or shipment of such devices and home electronic equipment and systems, and to the use of such devices.

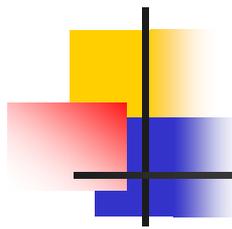


Payroll Tax Legislation

Study on Receiver Performance and Spectrum Efficiency (Sec. 6408)

The Comptroller General shall conduct a study to consider efforts to ensure transmissions systems are designed and operated so that reasonable use of adjacent spectrum does not compromise such systems. The study must consider:

- The value of improving receiver performance
- Operation of services in adjacent spectrum and narrowing guard bands
- Role of manufacturers, licensees and government users with respect to transmissions and the use of adjacent spectrum
- Feasibility of self-compliance
- Value of the FCC and NTIA to establish requirements or standards for adjacent spectrum services.



Agenda

- **Session 1: Introduction – Role of Receivers in Spectrum Efficiency**
- **Session 2: Receiver and Interference Basics**
- **Session 3: Receiver Ecosystem**
- **Session 4: Experiences and Lessons Learned**
- **Session 5: Receiver Performance and Industry Standards**
- **Session 6: Policy Alternatives**
- **Session 7: Panel Discussion**



Conclusion

- Goals:
 - Understanding/education
 - Learn from experiences - - but not a forum for resolving pending issues
 - Identify possible ways ahead - - preferably market-driven policies

- We encourage participation through questions from audience and web