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Federal Communications Commission
Office of the Secretary

Cognitive Radio Technologies in the Public Safety & Governmental Arenas

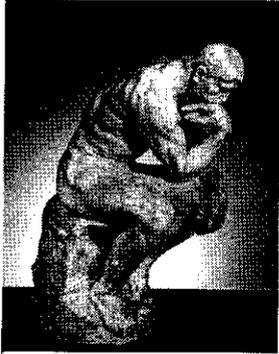
Michael Marcus, Sc. D.

Office of Engineering and Technology
Federal Communications Commission

Cognitive Radio Workshop 5/19/03

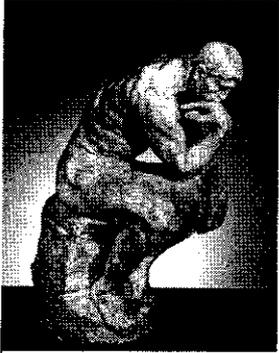
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List A B C D E

Overview



- Special Needs of Public Safety and some Governmental Spectrum Users
 - Use of Multiple Technical Standards
 - High Peak-to-Average Usage
 - Importance of Instantaneous, Highly Reliable Communications When Needed

Overview



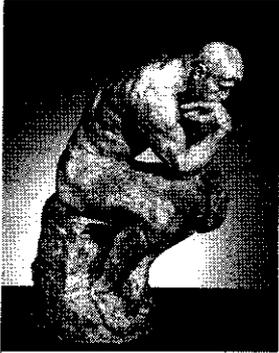
- Possible Role for Cognitive Radio Technologies
 - Improving Interoperability
 - Increasing Spectrum Availability Through Interruptible Spectrum



Interoperability Problems



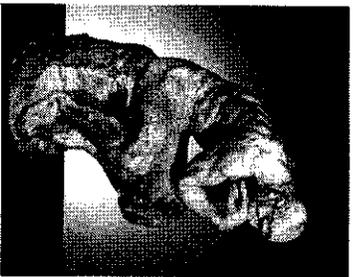
- In US public safety is generally a local jurisdiction and our federal system has lead to decentralized decision making for PS communication system design
- PS licensees have a wide variety of bands available (VHF-Low, VHF-Hi, 220 MHz, UHF below 800, UHF-800, etc.) and a growing number of modulation choices



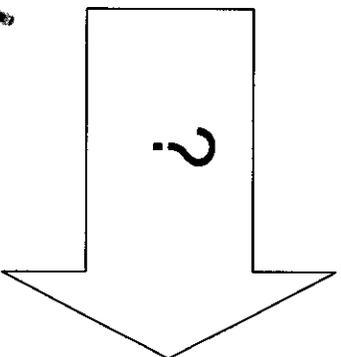
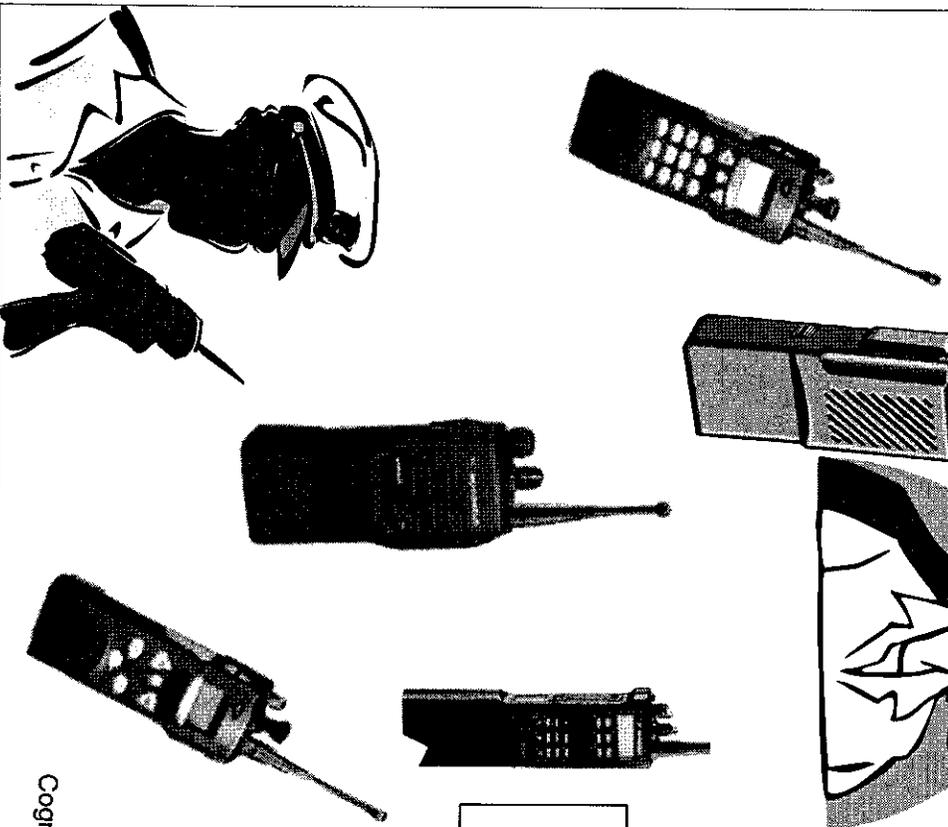
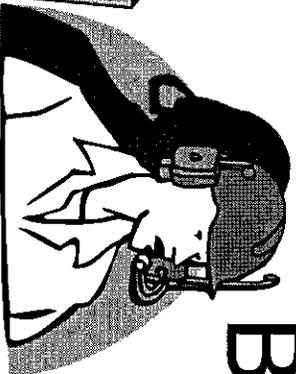
Interoperability Problems

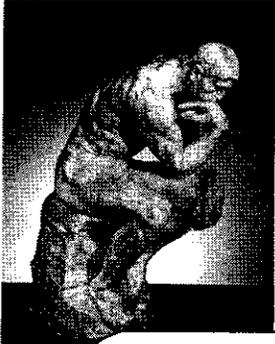


- Nature of PS communications includes unexpected events where PS units from multiple jurisdictions must come together quickly and interoperate effectively



Will multiple standards lead to a PS Tower of Babel?





How Cognitive Radio Technologies Might Help



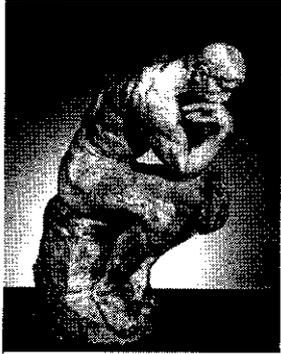
User Formats:

173.2/181.5 MHz FM

867.075/822.075 MHz
APCO 25

**COGNITIVE RADIO INC.
Translating Bridge Repeater
MODEL 2005**

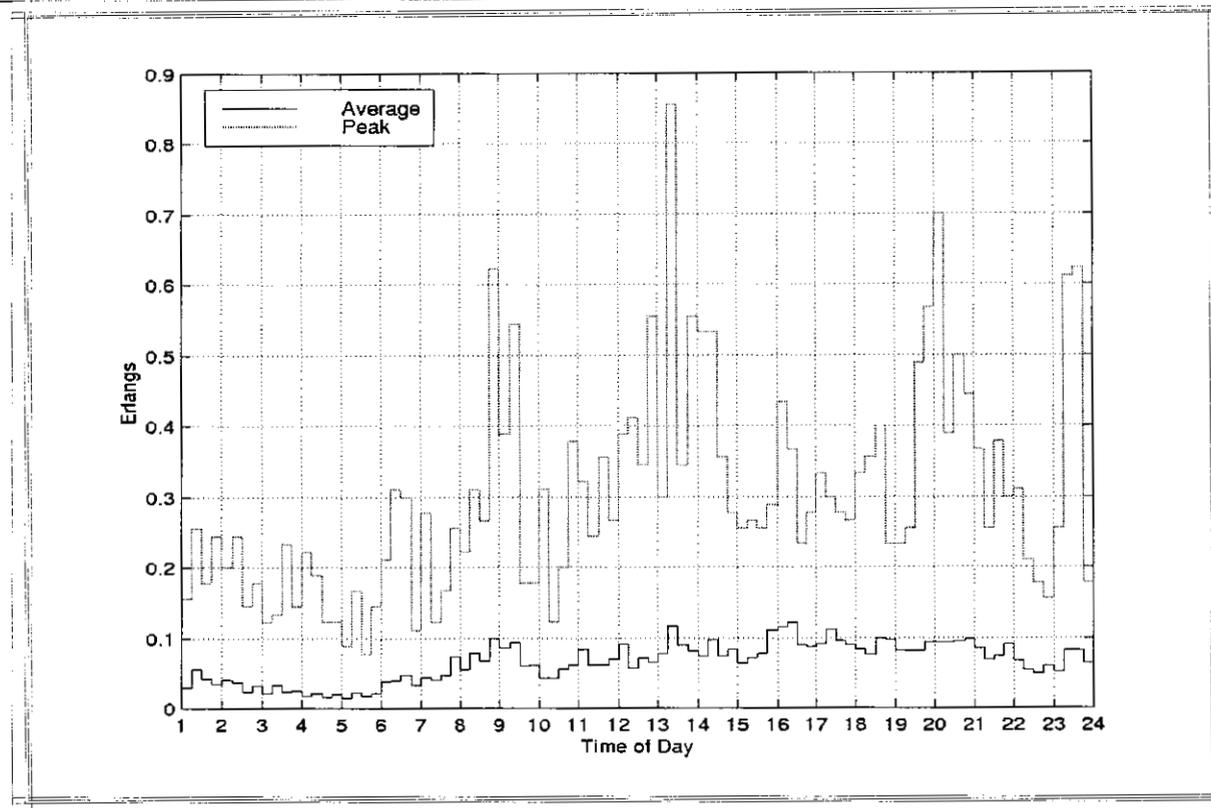
- Cognitive radios could be programmed for, or possibly recognize themselves, different frequencies and modulations used by PS users at an emergency location and act as a repeater bridge



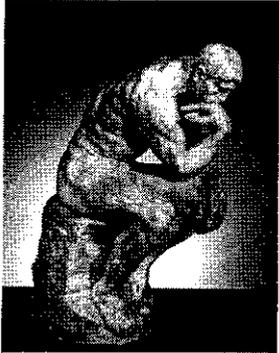
Interoperability & Cognitive Radio Technologies



- Are there any present FCC technical rules or policies that discourage investment in the development and use of cognitive radio technologies to address interoperability issues?
- Should FCC take a more active role in this area?



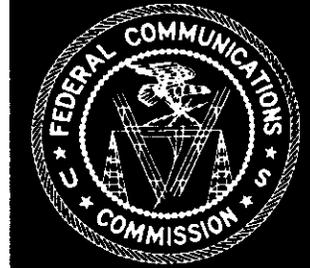
- **Spectrum Policy Task Force recommended exploring methods that recognize that PS communications have a high peak-to-average ratio and the critical need to meet peak demands while giving the option of use by others during nonpeak periods**



Interruptible Spectrum



- Conventional technology has required dedicated allocations full time in order to meet critical peak demands of public safety
- Cognitive radio technology may allow new options



- Cognitive radio technologies may create new options and new challenges
- Leasing spectrum to others during periods of low demand might create income for local governments and provide spectrum for other sectors
 - On 5/15 Commission adopted secondary leasing policies for many users and has begun exploring such for PS users



Possible Role of Cognitive Radio Technologies



- **BUT**, recognizing the special nature of PS communications:
 - There must be a reversion mechanism so that PS users can reclaim spectrum when needed for its primary use
 - Mechanism must be ultrareliable and fast



**Commercial user pays public sector user
for spectrum use subject to interruption**

\$\$\$

*Public sector demand overflows into
interruptible commercial block at times
of peak public sector demand*

Full Time
Commercial
Block

Commercial
Block Subject
To Interruption
By Public Sector
User

Full Time
Public
Sector
Block

Meets requirements
99% of time

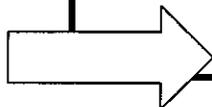
← kHz

*Commercial user "retreats" to full time commercial
block during times of peak public sector demand – either
degrades service quality or low price customers given lower
service quality during interruption*



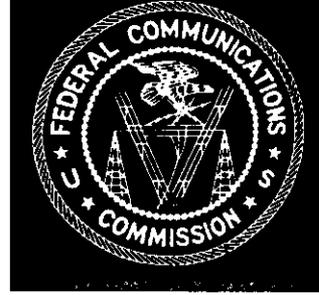
Some options for implementing interruptible spectrum

Option	Description	Reliability for Public Sector Interruption	Reliability for Commercial User	Complexity
I	Transmit until told to stop by public sector user	Low	High	Low
II	Handshaking on order wire before each transmission	High	Medium	High
III	Carrier sense multiple access (CSMA)	Low	High	Low
IV	Turn off signal from public sector user with acknowledgement	Medium	Medium	Medium
V	Beacon signal for positive control	High	Medium	Medium





A Possible Extension to Federal Government Users



- If reliable technology can be found, would Federal Government users be interested in making some of their spectrum in urban areas, which also has high peak-to-average ratios, available to PS users on a similar basis?



Some Questions About Interruptible Spectrum



- Status of the technology?
- Are there any FCC technical rules or policies that –
 - Stand in the way of realizing the potential of cognitive radio technologies to implement interruptible spectrum?
 - Should be amended to help facilitate achieving that potential?