

Technology

& the "Spectrum Crisis"

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My Career @ FCC Spectrum Openings I Proposed* & Directed



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Macroeconomics of Telecom

 Telecom is a large industry in its own right ~ 10⁸ \$ / € or 10¹⁰ ¥

Telecom is a basic commodity in today's economies



ICT also contributes macro-economically to productivity growth and increased competitiveness of the European economy as a whole, and thus is a factor in growth and job creation. -- COM(2006) 334

 New telecom services can <u>both</u> enable whole new nontelecom industries and improve efficiency of existing ones

• Example 15/10/06 *Washington Post* article describes economic impact of cell phones on fisherman and farmers in rural India as a result of better access to market pricing. http://letters.washingtonpost.com/W9RH02534803A09CEF27F33AE5DD00

WCA 2/25/10

travelocity

Wireless is Different!

 Around the world - for better or for worse - wireless is more regulated than most other technologies

In wireless, regulations are just as

real as Maxwell's equations!

WCA 2/25/10

Basic Spectrum Issues

- "Free spectrum is always cheaper than efficient technology" - Marcus' 1st Law of Spectrum
- No one needs "spectrum" people needs way to communicate
- The amount of spectrum needed for a given communication capacity is a function of **both** technology and investment
- Consensus standards development has many advantages but can have a negative impact on innovation

"Spectrum Crisis"

- Until 15 years ago spectrum was allocated and assigned by administrative means
 - Similar to the distribution of resources in the Soviet economy
 - Probably the real cause for the end of the Cold War was the collapse of the Soviet economy
- Many may yearn for the days when spectrum was assigned based on who had the most political influence
- But marketplace system is really best for Silicon
 Valley-style innovative technology & entrepreneurs
 - It is no accident that Qualcomm is a US company!
 - It would have been impossible in Europe & Japan

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Tragedy of the Commons

- Does use of common resources by multiple people always lead to wasteful use?
- Are land analogies with spectrum really useful?
 - Why don't we discuss Scottish and Scandinavian concepts of land ownership?
- Many predicted years ago that Wi-Fi was destined to a disaster due to TOC.
- Why don't people also consider "Rinkonomics":
 - "An important quality of collision is mutuality. If I collide with you, then you collide with me. And if I don't collide with you, you don't collide with me. In promoting my interest in avoiding collision with you, I also promote your interest in avoiding collision with me."

http://www.econlib.org/library/Columns/y2006/Kleinorder.html

Hamble Common, Hampshire, UK





SDR & Cognitive Radio



- SDR is a growing trend in wireless systems and FCC was able to get ahead of the curve and set up rules in a timely way
- CR is much more controversial
 - In reality significant spectrum in space and time is idle
 - Inevitable result of terrain and uneven population density
 - Opportunistic use would put this spectrum to use
 - "Cyclostationary detectors" can detect spectrum use at much low levels than receivers can detect signals
 - Eliminates much of "hidden node problem"

Cognitive Radio

- In reality, at a given time and place, most spectrum is not used.
 - Inevitable result of uneven terrain, uneven population density, and allocations based on peak demand
- With increasing demands for spectrum to support a mobile information centric society we need to "think outside of the bun"
- But, incumbents are entitled to protection from "harmful interference"



"Harmful Interference"

- Mentioned in legislation, but only definition is ITU definition probably predating WWII
 - Meaning unclear in mobile scenarios with changing geometries and with variable propagation, *e.g.* multipath and weather-related fading
- Major incumbents oppose any clarification
 - Net impact is that incumbents with greater resources are encouraged to use "abuse of process" to wear down innovators by "burning" their resources and force desperate compromises for market access
 - "Public interest" is often a minor decision factor

"Harmful Interference"

Before the Federal Communications Commission Washington, D.C. 20554

NOTICE OF INQUIRY

In the Matter of

Distantion of

Fostering Innovation and Investment in the Wireless Communications Market GN Docket No. 09-157

A National Broadband Plan For Our Future

GN Docket No. 09-51

Adopted: August 27, 2009

Released: August 27, 2009

Comment Date: September 28, 2009 Reply Comment Date: October 12, 2009

By the Commission: Chairman Genachowski and Commissioners Copps, McDowell, Clyburn and Baker issuing separate statements.

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- FCC deliberations and adjudications on HI are the largest single barrier to both innovative radio technology & the capitol formation which is necessary for its development
- New FCC leadership seems interested in reform here

Get involved in Docket 09-157 "Wireless Innovation" !!!!

http://fjallfoss.fcc.gov/edocs_public/attachmatch /FCC-09-66A1.pdf

Types of Spectrum Sharing

- Two precedents:
 - Gen I Sharing based on worst case limits or a priori coordination
 - Wi-Fi in 2450-2490 MHz band
 - Amateur radio in 420-450 MHz band
 - **Gen II** Dynamic Frequency Selection/DFS (Passive monitoring of G bands)
 - U-NII 5.25-5.35 & 5.47-5.725 MHz
- Both use G equipment that was not designed with sharing in mind and do not interact in any way to parties seeking sharing
- Current sharing approaches use only a small fraction of idle spectrum

Cognitive Radio Technical Issues

• "Hidden Node Problem"

- Can be defeated by high processing gain CR detectors much more sensitive than incumbents' receivers, *e.g.* cyclostationary receivers
- Analysis of impact depends on propagation issues rarely measured: spatial correlation of path losses in a local area
 - Given power at one location, what is the distribution of power nearby

 No one has the market incentive to do such measurements!





Cognitive Radio Policy Precedents

- 5 GHz UNII DFS
 - Allows use of spectrum used by radars
 - Rules adopted by both ITU and FCC
 - If radar is detected for even 1 µs, channel can not be used for the next 30 minutes
 - Classical issue of Pr(D) vs.
 FAR
 - Treaty nature of ITU rule complicates revision

- TV Whitespace
 - FCC allows cognitive radio use of vacant TV channels, BUT
 - Device must both check for detectable signal at a very low level and consult a map/database with unrealistic coverage predictions based on dated propagation model
 - 15 months after adoption some details still unresolved

New Sharing Alternatives

- Wireless industry has traditionally sought full duplex paired spectrum with 1000 ms/s availability
 - Such "green field" spectrum is very scarce now
- Novel sharing approaches can access new spectrum for practical systems that take advantage of
 - Packetized technology
 - Dynamic use of available spectrum
 - Asymmetric nature of most spectrum growth

See:

www.marcusspectrum.com/documents/MJMNGp aperIRAC809.pdf

Conclusions

- FCC reform is essential to allow significant wireless innovation & entrepreneurship
- Current FCC leadership seems interested while spectrum incumbents favor *status quo*
- Get involved in reform efforts!
- Think about new ways of accessing spectrum in a shared environment that both respect rights of incumbents and provide new service for the public

Surf over to my website and blog –