



WinnComm '16

Wireless Innovation Forum Conference
on Wireless Communications Technologies
and Software Defined Radio



Spectrum Policy for Wireless Innovators

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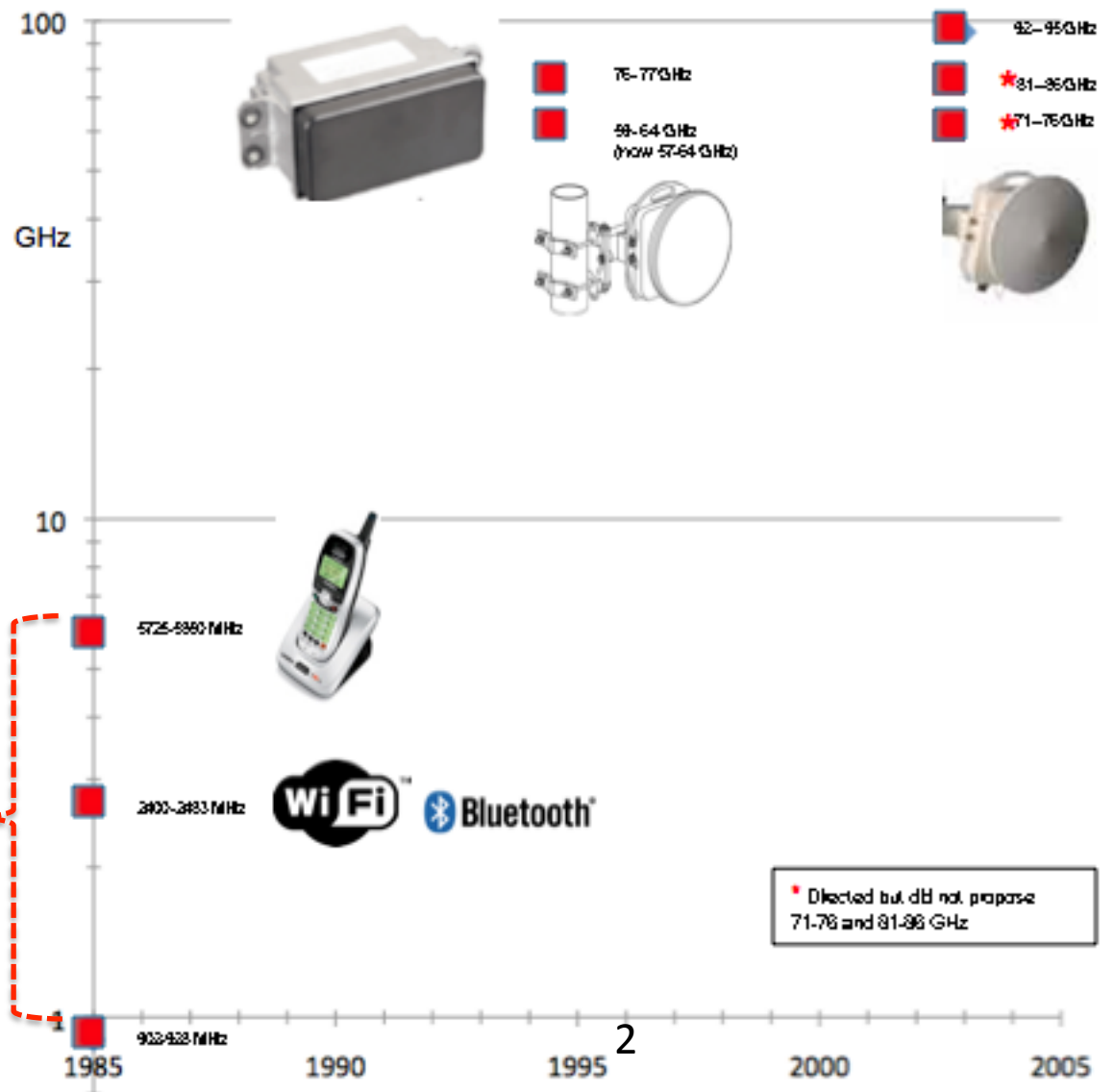


My FCC career:

Creation of regulations that enabled Wi-Fi & Bluetooth 5/85



<https://youtu.be/Z0xhFrCl1HQ>



OUTLINE

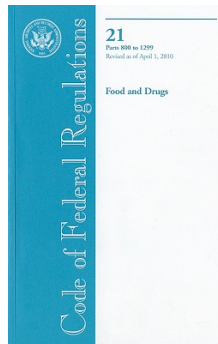
- Why is spectrum important?
- Spectrum & wireless innovation
- How is spectrum regulated?
- Key SDR and CR ongoing spectrum issues

Introduction to Spectrum Policy

- So why is it important?
- Engineer' s viewpoint
- General viewpoint: macroeconomics of communications

Regulation & Spectrum: Engineer's Viewpoint

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



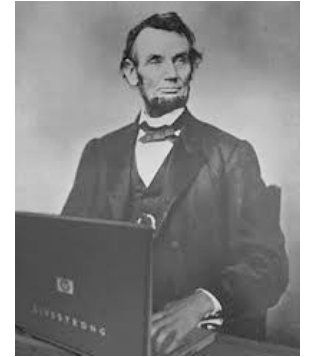
*In wireless, regulations are just as
real as Maxwell's equations!*



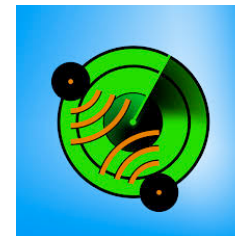
Engineer's Viewpoint

- Regulatory problems can block or delay new technology from practical implementation just as well as poor technical design
- Engineering is more than knowing the science of of field, it includes other issues involved in fielding solutions to real problems including cost and social impacts

Engineer's Viewpoint



- As spectrum at all frequencies becomes usable for civil applications, exclusive military access to spectrum bands is becoming anachronistic in many cases
- Win/Win sharing solutions for military spectrum access becoming essential
 - *e.g.* DARPA SSPARC program



Macroeconomics of Telecom

- Telecom is a large industry in its own right
~ 10^{11} \$ / €
- Is becoming more wireless
- 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 both 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>

Nontelecom
companies evolving
from new telecom

FedEx®

eBay®

amazon.com

travelocity

So why is it important?

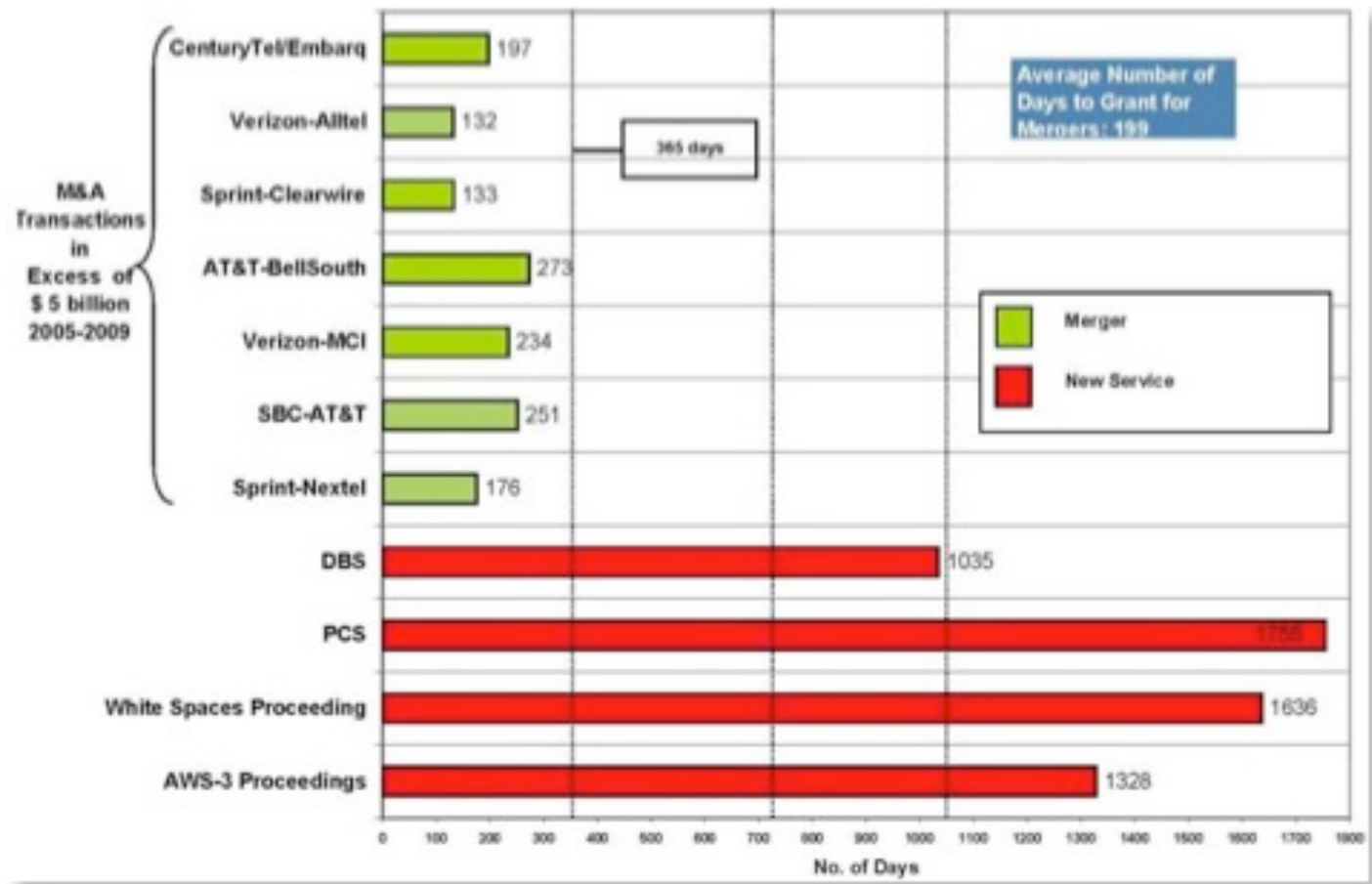
- Spectrum is the key input/ingredient of wireless telecommunications
- Telecommunications is a key input to economies, societies, **and national security**
- Spectrum based technologies are key to today's military operations and generally have to coexist with civil uses of spectrum

BUT, Nobody Needs Spectrum

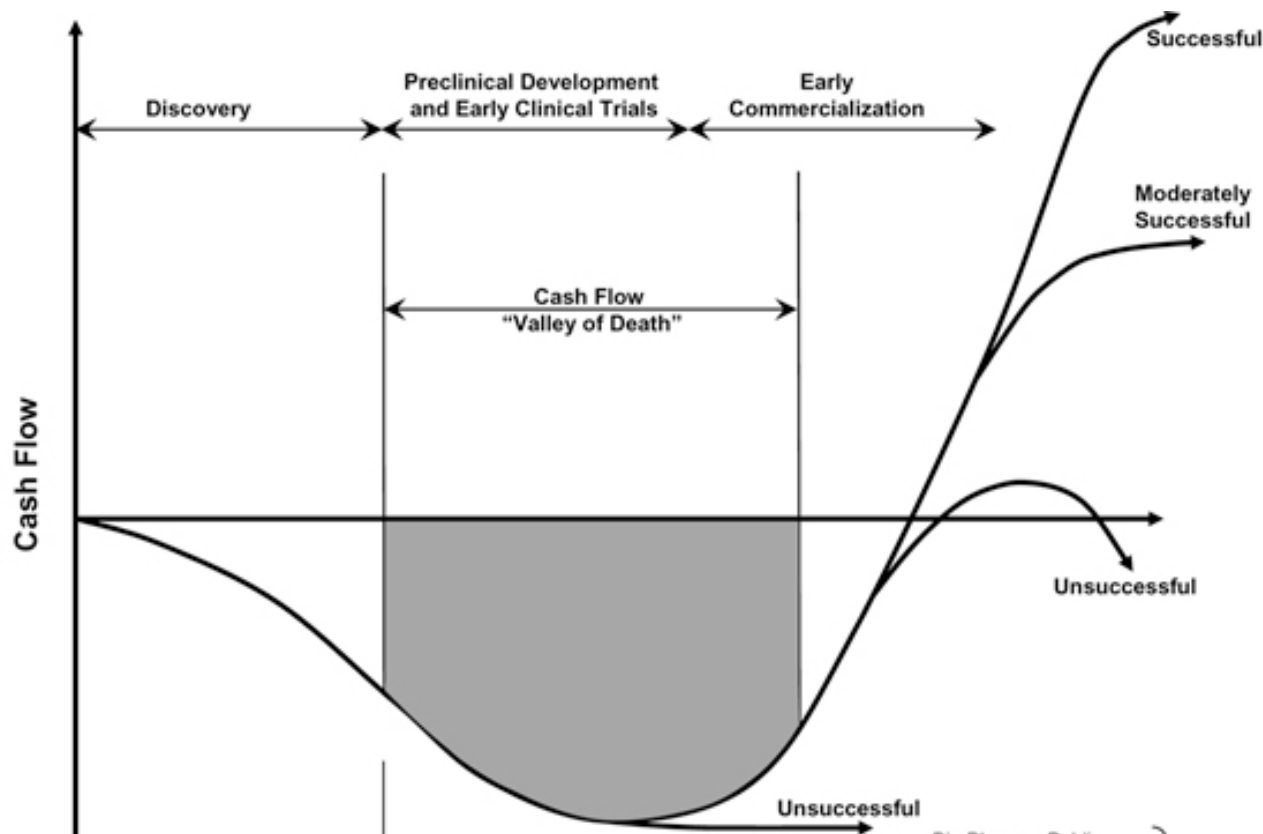
- What is needed is capacity to communicate!
- Wireless communications capacity is a function of both spectrum and technology
- The rational engineer designs systems to perform functions at minimal cost
- If spectrum is free and technology is expensive, what is the rational solution?

New Technology Approvals

Even though
47 USC 157
requires new
technology
issues to be
resolved in
1 year –
FCC doesn't!

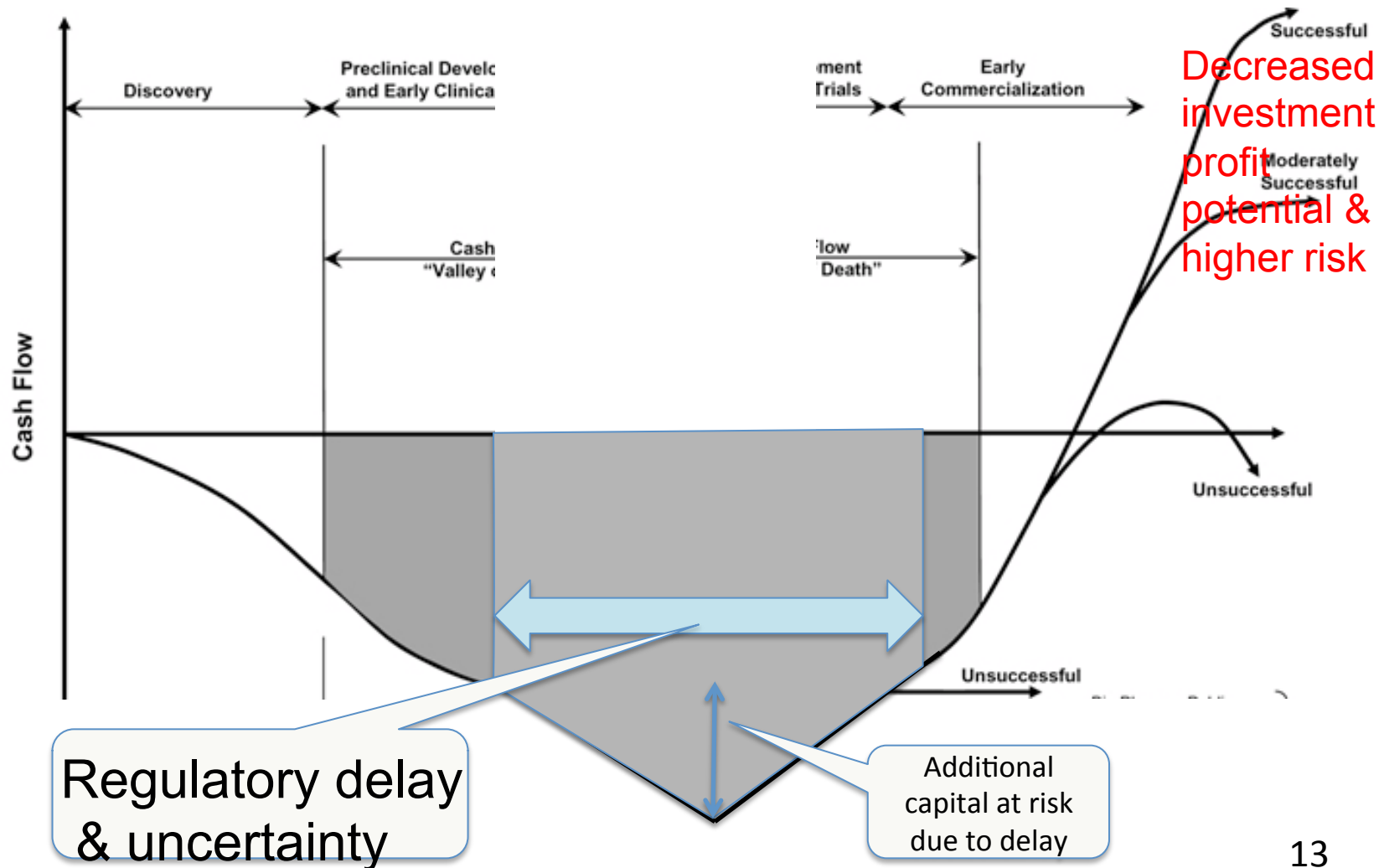


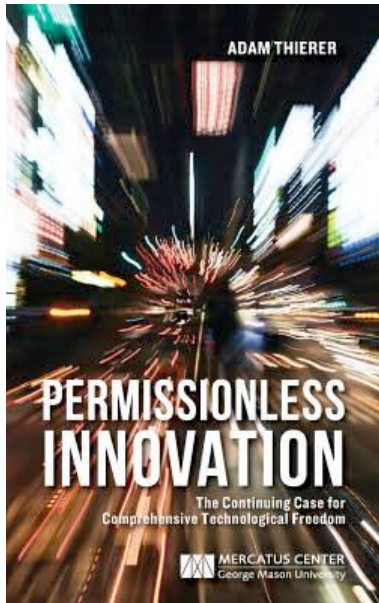
Typical Cash Flow for New Product or Service



Impact of Spectrum Regulation on Innovation:

Wireless “Disruptive Innovation”
May Not Have a Viable Business Plan at Present

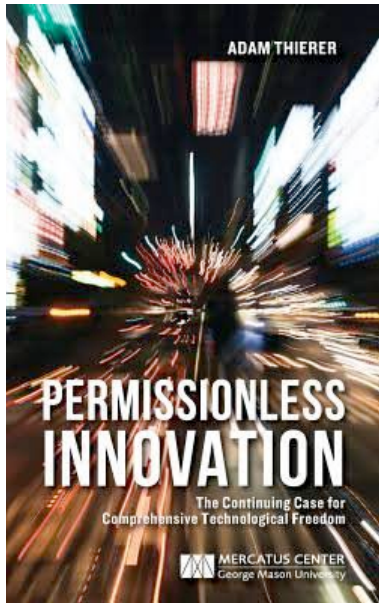




<http://mercatus.org/permissionless/permissionlessinnovation.html>

Permissionless Innovation

- The general nature of innovation in *most* products & services
 - Certainly not at FCC in early decades
 - Rules described what each band could be used for
 - Eligible users
 - Allowed technologies
 - But became FCC trend in 1970s/80s
 - ISM band decision 1985
 - 2G/CDMA decision 1987
- ➔ Proscriptive regulation vice prescriptive**



<http://mercatus.org/permissionless/permissionlessinnovation.html>

Permissionless Innovation

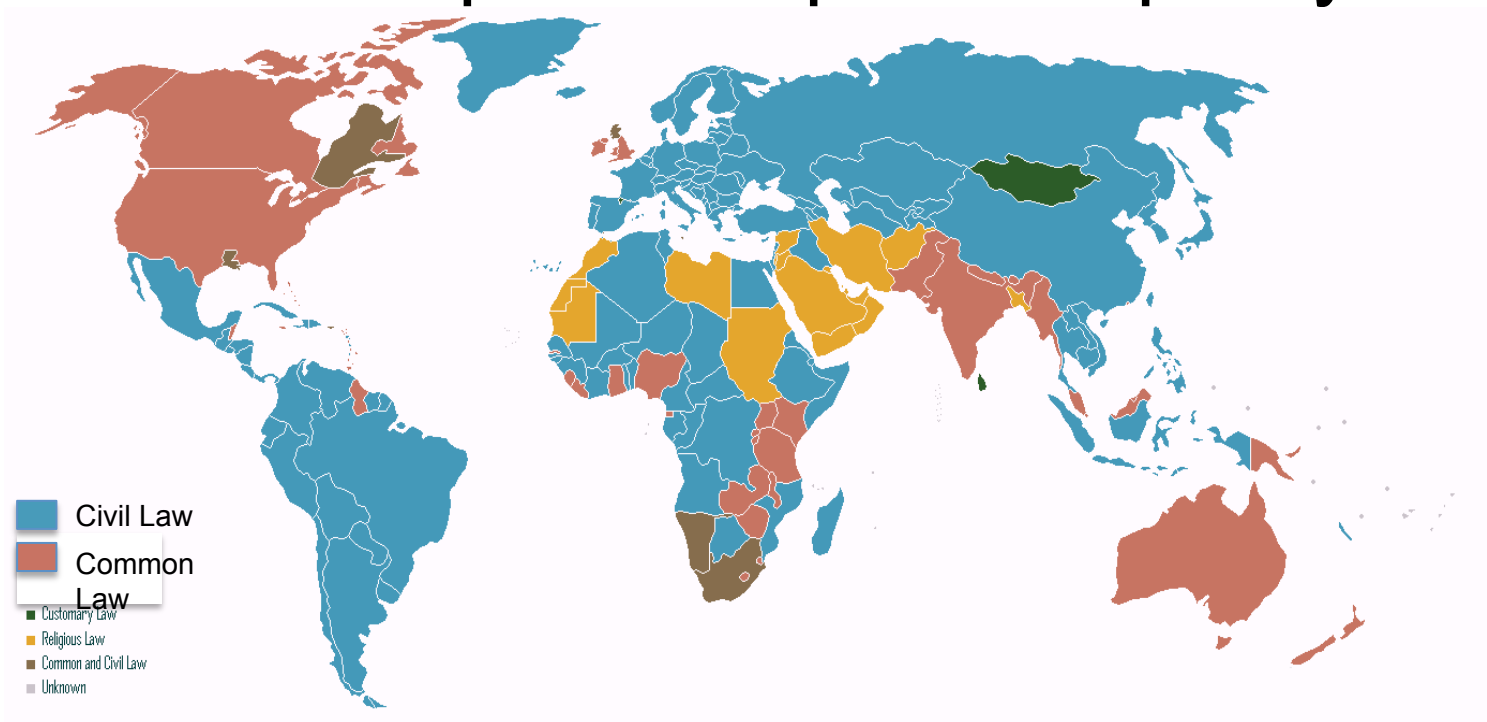
- Very different than *most* US trading partners
 - But correlated with civil law/common law dichotomy!

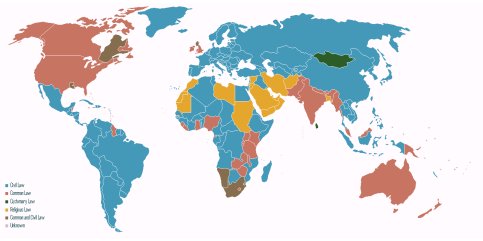


- Permissionless spectrum examples in US
 - Satellite – Part 25
 - ISM bands and many unlicensed bands
 - Cellular bands
 - No physical layer regulation except OOB & f.s.
 - Both fixed & mobile allow

Legal Systems and Their Impact on Regulation

- World has 2 major legal systems that have impacted spectrum policy





Legal Systems and Their Impact on Regulation

- As a *general* rule, civil law countries – *many of which are US allies* - are more prescriptive in their radio regulations while common law countries focus more on enabling new technologies & services
 - Consistent with more general views on role of government

ITU Role



- Essential in certain areas:
 - Aeronautical and maritime mobile - due to international mobility of units and safety issues
 - Satellites - due to international nature of coverage
 - MF and HF – due to international nature of propagation
- Europe and Japan prefer to manage spectrum in lock step with ITU
 - UK more liberal
- ITU efforts in 3G and 4G cellular have had mixed success in achieving common bands across the globe



ITU Role

- Many feel that ITU has a key role in *all* spectrum issues because ITU Radio Regulations are a treaty obligation of ITU's 193 member countries
- In many all nuances of ITU documents are followed
 - Some industrialized countries do this for trade reasons
 - Many developing countries do this to simplify domestic regulation



ITU Role

- But in US domestic spectrum policy ITU influence is limited
 - Because of geography
 - US had fewer bordering countries than most other countries
 - US is often at the forefront of technology and can not wait until ITU's processes deal with innovative technologies
 - Wi-Fi
 - 60 GHz

Geography

The Impact of Borders







US has much simpler geography than European countries

Spectrum Policy & Industrial Policy

- In many industrialized countries spectrum policy is closely coupled to national industrial policy
 - Interest in repeating international success of GSM
 - **Not** considering lessons of HiperLAN outcome
- These countries pick spectrum technology “winners & losers”, subsidize their R&D, and block market access of alternative technology
- Industrial policy has little or no role in US spectrum policy

Comparison of Countries

	Agency	Jurisdiction	R&D?
	Ofcom	Spectrum, broadcasting telecom	No
	UKSSC	National gov't use	
	総務省 Ministry of Internal Affairs and Communications	Spectrum, broadcasting, telecom	Yes
	Industry Canada (Now Innovation, Science and Economic Development Canada (ISED))	Spectrum, nonbroadcast licensing, technical telecom issues	Yes
	Canadian Radio-television & Telecommunications Commission	Broadcast ownership and content, telecom ownership and pricing	No
	Federal Communications Commission	Non-Federal Government spectrum use, telecom, broadcasting	No
	National Telecommunications and Information Administration	Federal Government spectrum use	No

- Different countries have various approaches to organizing regulators
- Regulator involvement in R&D issue is important & controversial



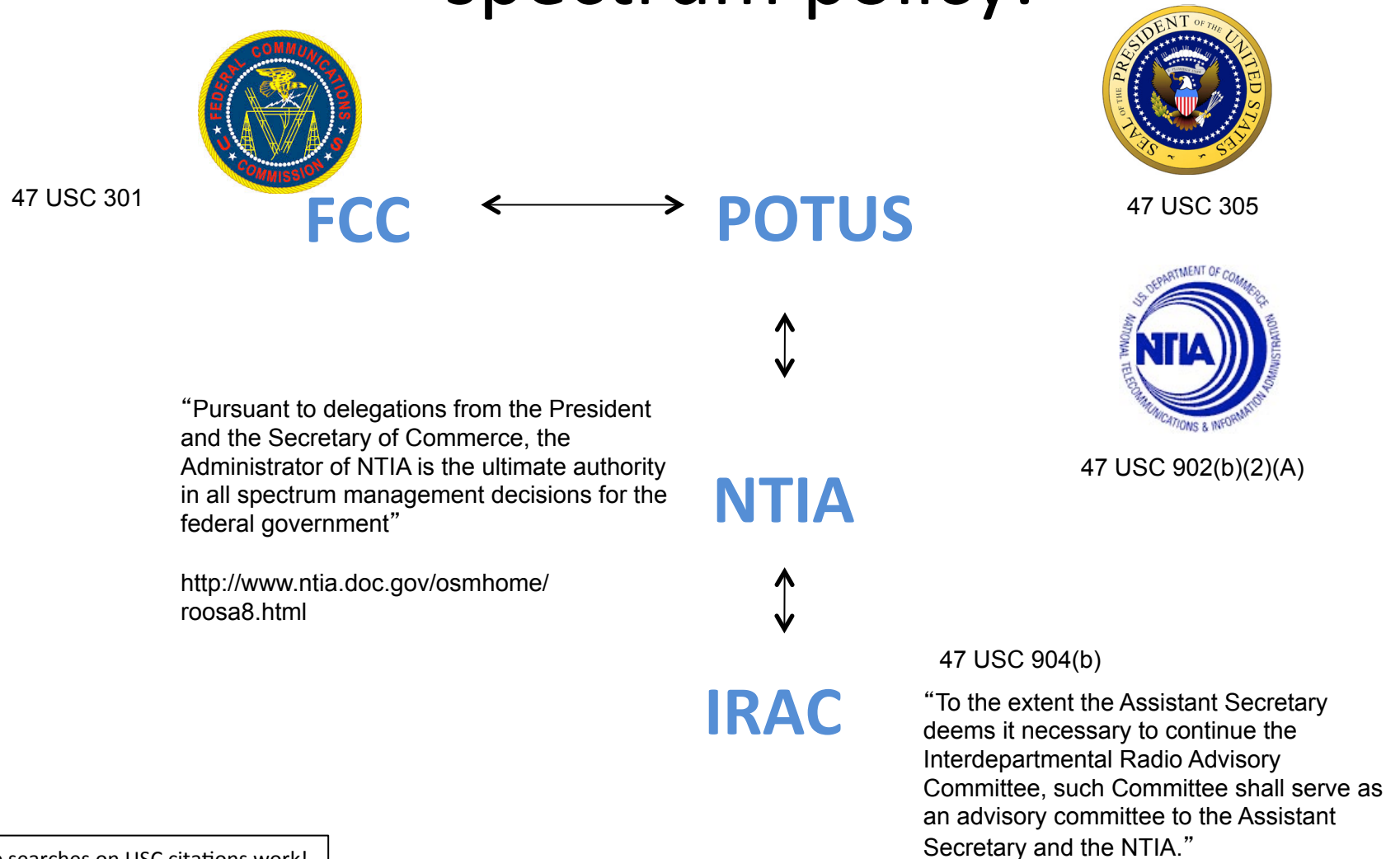
US Flexibility

- ITU Radio Regulations are a treaty obligation of the US, *but*
 - Section No. 4.4 “...administrations may assign frequencies in derogation of the ITU Table of Frequency Allocations on the express condition that harmful interference shall not be caused to services carried on by stations operating in accordance with the provisions of the Convention and of these Regulations.”
 - (Minor issue – Senate has not ratified an update to Radio Regulations in 2 decades)

US and RR 4.4

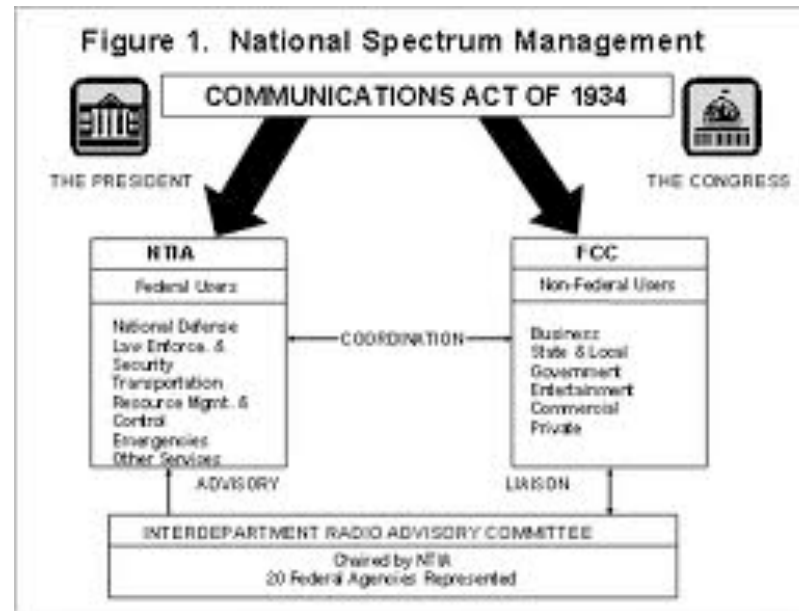
- US does not have to obey ITU allocations and ITU-R recommendations
 - A service will have no impact on other countries *or*
 - Neighboring countries agree in bilateral agreements to accept noncompliant system
- Such arrangements would be impractical in Europe
 - Would be possible in Japan but Japanese regulator has no such interest and views spectrum policy as part of industrial policy

What US Law Says about spectrum policy:



Who's In Charge? NTIA Viewpoint

http://www.ntia.doc.gov/reports/specpolini/pressspecpolini_report2_06242004.htm

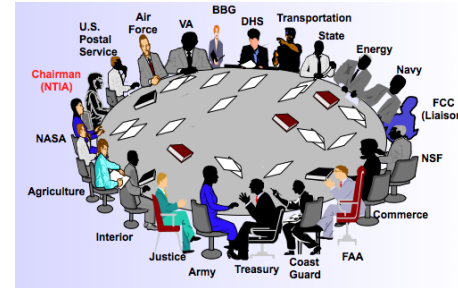


But, what FAA thinks:

“an existing process involving several Federal agencies with an interest in spectrum use, which NTIA oversees under the Department of Commerce.”

<http://edocket.access.gpo.gov/2010/pdf/2010-17767.pdf>

IRAC: The *tatemaie* and *honne*



- In the short term the IRAC is the *de facto* major player in determining of whether a novel spectrum sharing proposal has an acceptable interference risk
 - IRAC members work for individual agencies and have primary loyalty to their employer
- Presently IRAC has major transparency problems and few incentives to accept innovative sharing for federal bands
- Incumbents are a “tough audience” for many civil spectrum proposals
 - Radio Astronomy/passive band sharing often becomes theological rather than technical

Military and Spectrum

- Around the world, militaries are large users of spectrum
- Except in UK, they do not pay for such spectrum use
 - Yet military pays for other items such as fuel, land, airplanes, etc.
- Key challenge: balancing military/national security spectrum use and civil use

US Spectrum Policy



- NTIA/FCC split unusual although UK has lesser known similar split
- FCC is very political and commissioners have little background in spectrum issues
 - Chairman always a friend of POTUS
 - Commissioners usually former Hill staffers
- Corporate mergers get more attention than new technology issues

US Spectrum Policy



- FCC underfunded and losing technical resources
 - Controversial decisions like Net Neutrality not helping
- No interest in 47 USC 157 requirement to act on new technology issues in 1 year
- FCC appears to be throughput limited due to both funding and organizational issues
 - Corporate mergers get high priority
 - Even cellular industry, “prodigal child” at this moment, only gets timely attention on *some* issues

US Spectrum Policy



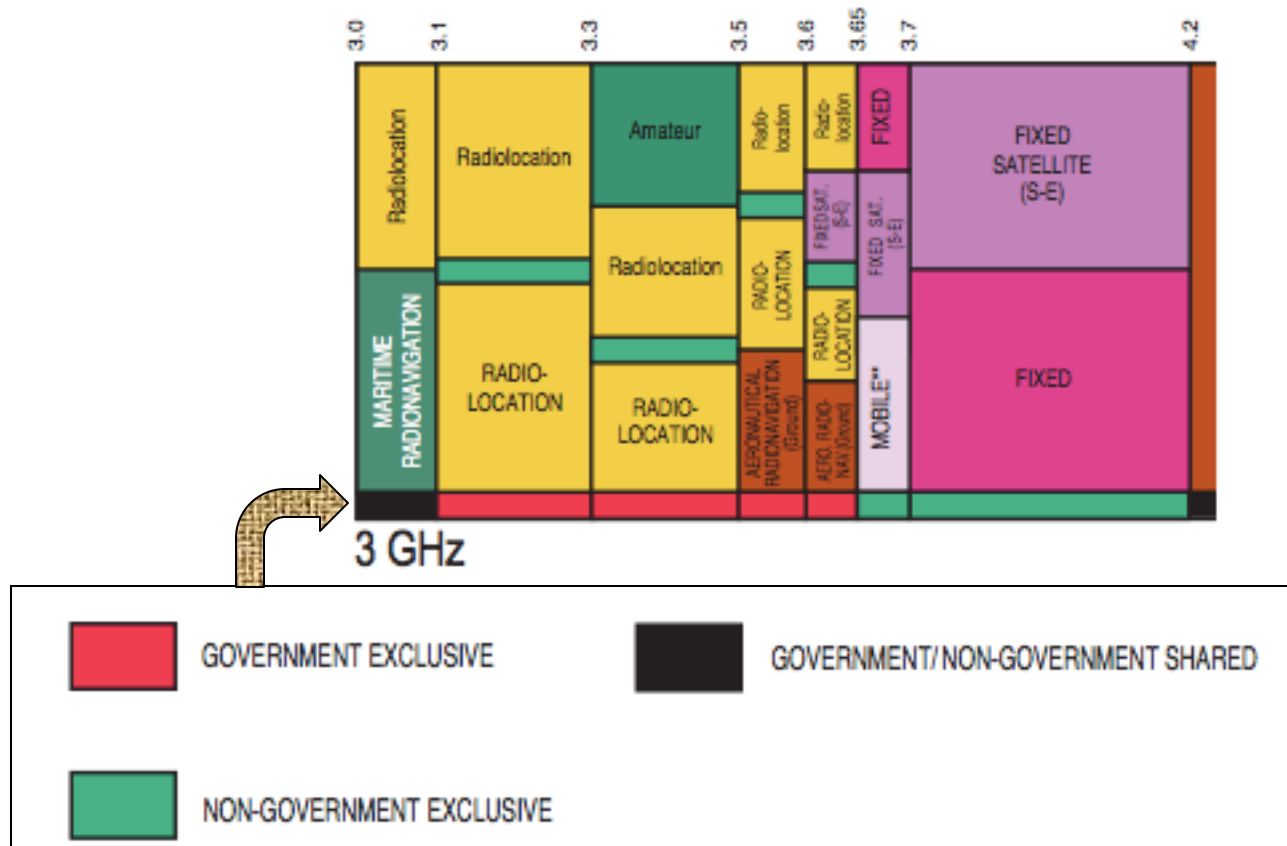
- Since Nixon Administration, IRAC has generally lacked “adult supervision”
- Circa 1960 Coase RAND paper concerns still very applicable – <http://www.rand.org/pubs/drafts/DRU1219.html>
 - IRAC members generally focused on parochial interests of their agency not national goals & priorities
 - Consensus decision model inhibits innovation
- No present incentive for sharing or releasing underused spectrum

US Spectrum Policy



- While NTIA head works under delegated 47 USC 305 authority of POTUS, as an Assistant Secretary of Commerce he is low in DC “pecking order”
 - Can not order DoD or FAA how to spend their own money
 - Limited access to cabinet members
 - PCAST report reform of increased OSTP role appears to have fizzled
- Like FCC, NTIA leadership lacks in depth resources for independent review of technical issues
 - Is NTIA really a regulator of federal spectrum or law firm representing federal users to FCC and Congress?
- NTIA does overrule IRAC – but rarely in practice

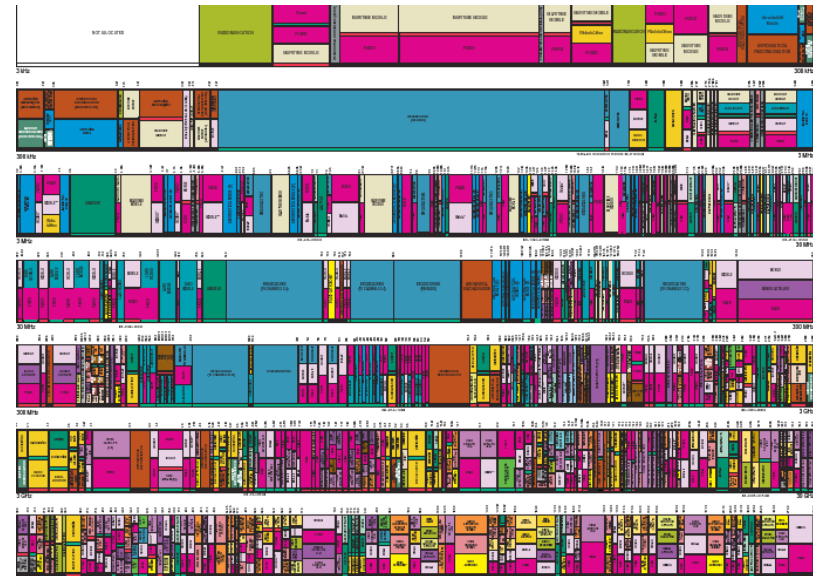
Spectrum Balkanization



The *honne* and *tatemae* of spectrum

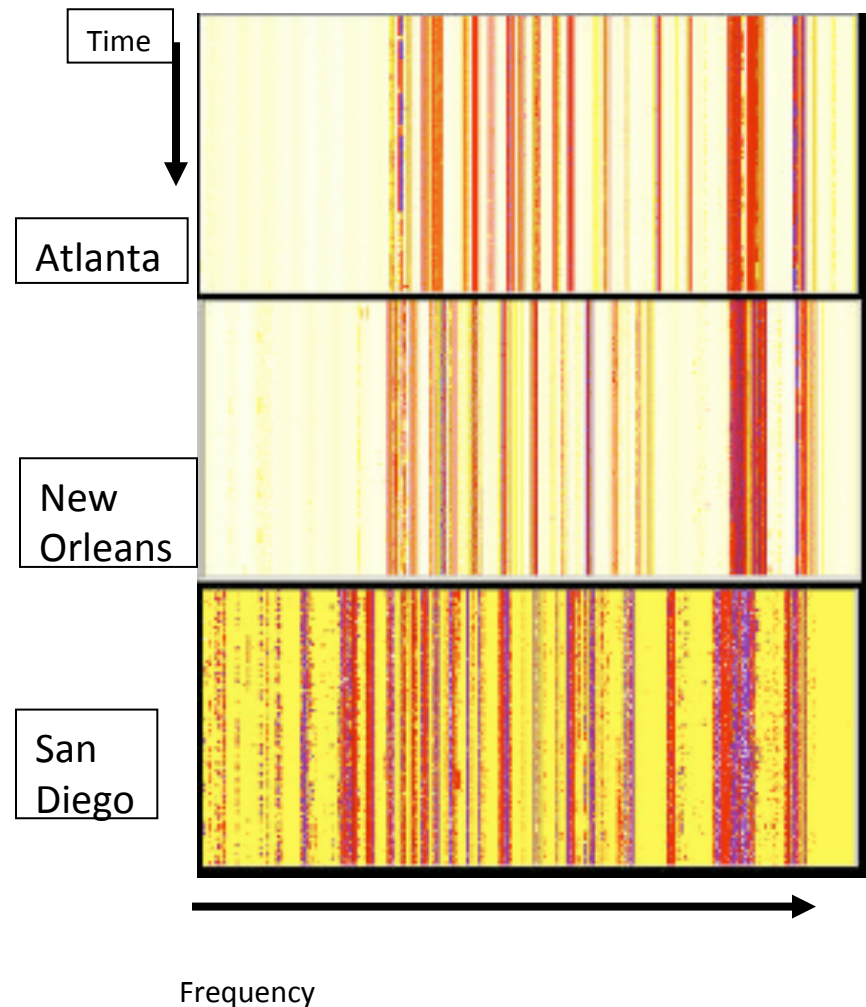
建て前

- While most spectrum is allocated and assigned ...



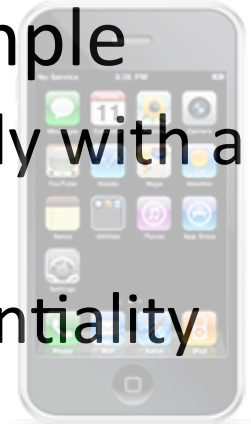
The honne and *tatemaie* of spectrum

- In practice, at a given time and place there is lots of unused spectrum
- Results from:
 - Uneven population density
 - Uneven terrain
 - Allocations and assignments based on peak needs



Possible Spectrum Actions for Innovators

- Only routine approvals – iPhone example
 - For devices and technologies that comply with all existing rules
 - Timely turnaround and possible confidentiality until marketing begins
- Experimental license
 - Must not cause interference
- Waiver request
 - Complies with most rules and will not adversely impact others



Possible Spectrum Actions for Innovators

- Service rule change
 - *e.g.* no present service rules >95 GHz
- Allocation change
 - *e.g.* no present allocations >275 GHz
- Purchase/lease spectrum
 - *Some* bands have great technical/usage flexibility
- Comments on FCC rulemakings

Routine Approvals

- Devices and services comply with *all* existing rules <https://www.fcc.gov/engineering-technology/laboratory-division/general/equipment-authorization>
 - In *most* cases equipment is subject to FCC equipment authorization and technical standards on EMC issues
 - While other countries have interoperability testing rules, FCC doesn't - with rare exceptions
 - FCC Recognized Testing Labs & TCBs handle details in almost all cases
 - Firm seeking approval can negotiate on price and speed
 - Many can handle approvals for multiple countries
 - Approval based on testing of prototype with essentially no production unit sampling
 - Market sampling rare

Experimental Licenses

- Part 5 of FCC Rules
 - Recently liberalized but not all changes effective yet
 - In theory allows any experiment in any band that doesn't cause interference
 - Experiments in bands with *any* federal use coordinated with NTIA and IRAC can be unpredictable
 - Must propose specific frequencies
 - But actual federal spectrum use is not public

Experimental Licenses

- Part 5 of FCC Rules
 - FCC website for applications is mid-1990s vintage and is awkward to use with steep learning curve
 - If you don't do it often, outside help is useful
 - In addition to application, a separate attachment should describe what you are actually doing
 - confidentiality can be requested
 - explain why you think there will be no interference
 - if federal frequencies involved make sure NTIA gets attachment as online system is unpredictable

Waivers

- All federal agencies must consider waivers of their rules that meet the basic intent of rule
- FCC is more liberal than most agencies in the area of radio technical rules
 - While public comment is not required in the case of a waiver request, is common recently
 - Noncontroversial waivers usually processed in 1-2 years

Waivers

- FCC, unlike many foreign counterparts especially in civil law countries, has authority to waive parts of its rules if:
 - (i) The underlying purpose of the rule(s) would not be served or would be frustrated by application to the instant case, and that a grant of the requested waiver would be in the public interest; or
 - (ii) In view of unique or unusual factual circumstances of the instant case, application of the rule(s) would be inequitable, unduly burdensome or contrary to the public interest, or the applicant has no reasonable alternative.

See 47 CFR 1.925

Waivers

- Waivers sometimes a way to solve regulatory issues for technologies that are evolutionary in nature
- Consult a lawyer!

Allocation & Service Rule Change

- Pragmatically, if this product/service is important to you firm hire a lawyer with current experience in this type of issue
 - While legal background is not essential to drafting request, current FCC is easily distracted by megaissues from cellular and broadcasting jurisdiction and advocate well known to key players is important to “keep the ball moving”
 - But even with prominent legal representation nonmainstream requests can linger ...

• *see* <http://www.marcus-spectrum.com/resources/Cited-documents/MJM-aTPRC-paper-2015.pdf>

Purchase/Lease Spectrum

- Although some innovations may be able to use unlicensed spectrum
 - If so, this doesn't apply and only routine approvals needed
- In licensed bands subject to “permissionless innovation” spectrum can often be leased, licenses divided in spectrum or area, and sold
 - While fast leases (seconds/minutes/hours) are *theoretically* possible, current rule details limit such fast turnaround



Comments on FCC rulemakings

- FCC, like other US regulatory agencies, generally make decisions based on:
 - Procedures in 1946 Administrative Procedures Act and 70 years of case law
 - Issuing *Notice of Proposed Rulemaking* (NPRM) with proposal and requesting comments
 - Reviewing those comments
 - Often in parallel with *ex parte* meetings with interested parties and FCC staff/leaders
 - Issuing *Report and Order* with rule changes that explain comments and how they were addressed

Comments on FCC rulemakings

- FCC explicitly has dates for both comments and reply comments (commenting on other peoples' comments)
 - reply comment period usually much shorter even though it can require more work
 - due dates often extended - often at last minute
 - first step in drafting reply comments is usually summarizing comments of others
 - small firms may not need lawyers BUT should be sure they understand concepts

Hiring an Spectrum Lawyer

- Use  ? Use  ?
- Ask other techies with recent experience
- Check analogous FCC issues on ECFS and see which lawyer filed comments that seem cogent and explain issues well
- ECFS can be searched by name of lawyer filing comments, so when you have candidates search for all the comments they have filed recently & review

Hiring an Spectrum Lawyer

- Some, *usually very expensive*, lawyers work for multinational firms which can help you if you need nonroutine approvals in many countries
- The issue is not just who can write the best document, but who can get more timely action
 - Consider a bonus for timely resolution
- In the past some law firms would accept partial payment in equity

30 Second Course on Common Law

A US law book

Law adopted by Congress and signed by President

Court decisions interpreting law and clarifying it

16 § 410

NATIONAL PARKS, ETC. Ch. 1

dedicated, and set apart as a public park for the benefit and enjoyment of the people and shall be known as the Everglades National Park: *Provided*, That the United States shall not purchase by appropriation of public moneys any land within the aforesaid area, but such lands shall be secured by the United States only by public or private donation.

(May 30, 1934, c. 371, § 1, 48 Stat. 816.)

HISTORICAL AND STATUTORY NOTES

References in Text 446, 45 Stat. 1443, which is not classified to the Code.
Act of March 1, 1929 (45 Stat. 1443), referred to in text, is Act Mar. 1, 1929, c.

CROSS REFERENCES

Authority of Secretary of Interior to—
Accept title to lands, see 16 USCA § 410a.
Purchase land, water, and interests therein, see 16 USCA § 410j.
Effect upon rights of Seminole Indians, see 16 USCA § 410b.
Exterior boundaries of park, see 16 USCA 410i.
Protection of scenery, wildlife, and natural features pending establishment of park, see 16 USCA § 410d.

LIBRARY REFERENCES

American Digest System

Forest reservations, preserves, or parks, see Woods and Forests ¶8.

Encyclopedias

Public forests, preserves, and reservations; national forests, see C.J.S. Woods and Forests § 11.

WESTLAW ELECTRONIC RESEARCH

Woods and forests cases: 411k[add key number].
See, also, WESTLAW guide following the Explanation pages of this volume.

NOTES OF DECISIONS

Commercial fishing 2
Estoppel to enforce regulations 6
Power of eminent domain 1
Private lands within park 3
Reservation of mineral rights 4
Validity of appropriations 5

1. Power of eminent domain

United States may acquire lands for national park purposes and may do so by exercise of power of eminent domain. *Halpert v. Udall*, D.C.Fla.1964, 231 F.Supp. 574, affirmed 85 S.Ct. 610, 379 U.S. 645, 13 L.Ed.2d 550.

2. Commercial fishing

There was no basis in National Park Services' representations, federal legisla-

tion or Florida's deed conveying park land to United States to support existence of contract between Florida and United States never to prohibit commercial fishing, and therefore, fishermen had no vested property right, as third-party beneficiaries, in commercial fishing. *Organized Fishermen of Florida v. Hodel*, C.A.11 (Fla.) 1985, 775 F.2d 1544, certiorari denied 106 S.Ct. 2890, 476 U.S. 1169, 90 L.Ed.2d 978.

3. Private lands within park

No constitutional prohibition prevents land in private ownership from being within outer boundaries of a national park, and extent to which United States may exercise jurisdiction over such pri-

Instructor's Preferred (Free) Law Source

- Cornell Law School Legal Information Institute

<http://www.law.cornell.edu/uscode/>

Other subscription sources:

Lexis, WestLaw, - Marketed to law firms



These also include ready access to related FCC decisions, court cases, and earlier versions of laws and regulations

Note: If you need access to commercial service for a short period they *may* offer a free trial

A screenshot of the Cornell Law School Legal Information Institute (LII) website. The header shows the Cornell University Law School logo and the LII / Legal Information Institute text. Below this is the "U.S. Code" section with links for "main page", "faq", "index", and "search". The "Contents and context" section welcomes users to the United States Code and provides a list of bullet points: 1. This version is generated from the most recent official version made available by the US House of Representatives. For exact information about the currency of any particular title as it is published by the House, see the listing on the House server. The date of any text appearing on this site appears in italics at the upper right in every Code section. 2. Each section in the framed version is dated at the upper right corner of the text frame; these date the text itself as we receive it from the House, and are not the date on which we loaded the text. At this point we are not sure how often the House will issue new versions of this information to the public. Any new version issued by the House will in turn be mounted here within 24 hours. (This is not an absolute guarantee. From time to time, and without warning, the House makes changes in the format and structure of the text they make available for download. This can and does cause us to rewrite our own formatting software, hopefully with minimal delay.) In the meantime we suggest the use of the update feature available in each section. 3. Our convenient update service (available onscreen as you look at each section) integrates the services of the House servers and of the Library of Congress Thomas service to supply you with accurate updates to any section which has changed. Below this, it says "A listing of all Titles appears below." and "Find US Code Materials by Title and Section". It then provides instructions: "If you know the citation for the US Code material you want to find, fill in the title and section numbers below. (eg. 22 USC 1501 would be Title 22, Section 1501). You need to fill in both title and section." There are input fields for "Title:" and "Section:" and a "Go to title and section" button.

Administrative Procedures Act of 1946

- 5 USC 553(b):
 - General notice of proposed rule making shall be published in the Federal Register, ...The notice shall include ...
 - (2) reference to the legal authority under which the rule is proposed; and
 - (3) either the terms or substance of the proposed rule or a description of the subjects and issues involved.

Administrative Procedures Act of 1946

Judicial Review

- 5 USC 702
 - A person suffering legal wrong because of agency action, or adversely affected or aggrieved by agency action within the meaning of a relevant statute, is entitled to judicial review thereof.

Administrative Procedures Act of 1946: Judicial Review

- 5 USC 706:

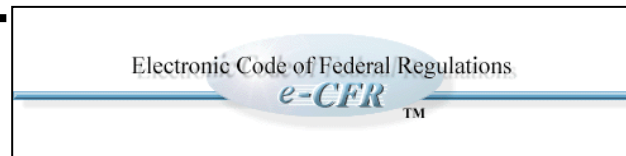
...The reviewing court shall—

- (1) compel agency action unlawfully withheld or unreasonably delayed;
and
- (2) hold unlawful and set aside agency action, findings, and conclusions found to be—
 - (A) arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law;
 - (B) contrary to constitutional right, power, privilege, or immunity;
 - (C) in excess of statutory jurisdiction, authority, or limitations, or short of statutory right;
 - (D) without observance of procedure required by law;

Code of Federal Regulations



- CFR is the codification of all federal regulations in a system starting in New Deal
 - 50 titles, 47 CFR is communications
 - Version in effect *as of today* is available from e-cfr:
 - <http://ecfr.gov>
 - Not aware of any public site for older versions at present



Up to Date CFR Access *Free!!!*

http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title47/47tab_02.tpl

ELECTRONIC CODE OF FEDERAL REGULATIONS



e-CFR Data is current as of February 13, 2014

Simple Search: Enter terms to search for in the form below.
Use the pulldown to restrict the search to a particular region or regions within the text.

Order results by:

Enter a Title Number

To Limit Search to One Current CFR Title
[If left empty, all CFR Titles will be searched]

Search for:

within:

But: does not give rule changes about to go into effect or pending proposals

CFR Structure

Each Part of
Rules has
USC
authority
indicated at
beginning

AUTHORITY: 47 U.S.C. 154, 302a, 303, 304, 307,
336, and 544a.

§ 2.915 Grant of application.

(a) The Commission will grant an application for certification if it finds from an examination of the application and supporting data, or other matter which it may officially notice, that:

(1) The equipment is capable of complying with pertinent technical standards of the rule part(s) under which it is to be operated; and,

(2) A grant of the application would serve the public interest, convenience and necessity.

(b) Grants will be made in writing showing the effective date of the grant and any special condition(s) attaching to the grant.

(c) Certification shall not attach to any equipment, nor shall any equipment authorization be deemed effective, until the application has been granted.

[39 FR 5919, Feb. 15, 1974, as amended at 48 FR 3621, Jan. 26, 1983; 62 FR 10470, Mar. 7, 1997; 63 FR 36598, July 7, 1998]

Each section of
Rules has “audit
trail” to
documents that
created it

“Harmful Interference”

- Key term in spectrum policy
- A term used 8 times in Title III of the Communications Act of 1934
 - Without definition!
- Used in ITU Radio Regulations, FCC Rules, and NTIA “Redbook” with definition that appears to be archaic
- Traditional criterion used by FCC to determine if interference from a proposed change is acceptable

HI: ITU/FCC/NTIA Definition

- “Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [the ITU] Radio Regulations.” 47 CFR 2.1

Definitional Problems

Harmful Interference. Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [the ITU] Radio Regulations. (CS)

- Is HI based on worst case infrequent geometry or x percentile?
- What if interference is small with respect to naturally occurring outages in time or space?
- Incumbents/“haves” prefer *status quo*
 - They have “upper hand” at FCC and NTIA

NTIA on “interference protection criteria”

- 2005 report compiles many precedents

http://www.ntia.doc.gov/osmhome/reports/ntia05-432/IPC_Phase_1_Report.pdf

- NTIA avoided promised Phase 2 with recommendations
- “The payoff in studies is not what you compile, but what you deduce”

NTIA Report 05-432

INTERFERENCE PROTECTION CRITERIA Phase 1 - Compilation from Existing Sources



SDR and Cognitive Radio Issues

- Traditional framework of FCC and ITU regulations assumed that a transmitters had a fixed behavior that was set at factory with only a few parameters under operator control
 - Up until 1980s FCC required most transmitters to have a separate crystal for each frequency used!
 - Motorola fought hard to keep this requirement
- These concepts turned on end by SDR and CR
- Initial promise of CR fought strongly by incumbents
 - CR boosters may have been naive

SDR

- FCC developed SDR rules at request of SDR innovators
 - “Don’t ask for something, you might get it”
 - Industry and FCC didn’t think much about software security implications
 - Was assumed that “big guys play nice”
 - But same rules apply to everyone, even small not nice guys
 - Multiple cases of 5 GHz DFS interference showed software security was not adequate
 - Motorola stonewalled public discussion of some causes through “reverse FOIA”

SDR

- Industry petitioned FCC to make only SDRs marketed as having user changeable software subject to SDR regulation
 - Now few official “SDRs” on market
- Urgent need to develop consensus solution to what regulations are needed for SDRs and when an high rate/high power DAC becomes an SDR

Cognitive Radio

- FCC Spectrum Police Task Force report in 2002 was very optimistic about CR for increasing spectrum use
 - TV white space chosen as “low hanging fruit” since well defined high BW signal, transmitted continuously, high antennas, etc.
 - Resulting decade+ of bickering and no significant operational use shows what happens at FCC for controversial technologies when politics meets technical issues

Cognitive Radio

5 GHz U-NII Band

- The FCC/NTIA/IRAC dynamic:
 - §15.407(h)(2) Radar Detection Function of Dynamic Frequency Selection (DFS). U-NII devices operating with any part of its 26 dB emission bandwidth in the 5.25-5.35 GHz and 5.47-5.725 GHz bands shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems. Operators shall only use equipment with a DFS mechanism that is turned on when operating in these bands. The device must sense for radar signals at 100 percent of its emission bandwidth. The minimum DFS detection threshold for devices with a maximum e.i.r.p. of 200 mW to 1 W is -64 dBm. ... The detection threshold is the received power averaged over 1 microsecond referenced to a 0 dBi antenna. ...
 - §15.407(i)(B)(iv) Non-occupancy Period. A channel that has been flagged as containing a radar system, either by a channel availability check or in-service monitoring, is subject to a non-occupancy period of at least 30 minutes. The non-occupancy period starts at the time when the radar system is detected.
- These rules are optimized for increasing probability of detection with no consideration of false alarms!

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Cognitive Radio

3550-3650 MHz Band

- The FCC/NTIA/IRAC dynamic:
 - How do you find out which channels are being used by ships offshore?
- “We also agree with NTIA that the ESC should be developed, managed, and maintained by a non-governmental entity and should not require oversight or day-to-day input from NTIA or DoD. We note that the rules governing the ESC are technologically neutral and, as such, ESC developers may utilize different sensing techniques that yield the desired result. The sensors comprising an authorized ESC may be infrastructure-based, device-based, or a combination of the two, as long as the ESC complies with the rules and guidelines set forth by the Commission.” https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-47A1.pdf @ para. 383

Cognitive Radio

3550-3650 MHz Band

- *Any* passive sensing system will have location errors, frequency errors, and response time delays
- Sharing system (SAS) must account for worst case errors and doing that limits spectrum availability just as in U-NII DFS!

Cognitive Radio

- Later TDWR interference showed that this hyper conservative criteria was focused on DoD/FAA pulse radars and did not consider NOAA CW radars!
- Incumbents always have the upper hand and federal incumbents have a near impregnable position!

Conclusions

- For better or for worse, innovative wireless technology has a spectrum policy gatekeeper problem in many cases
- Understanding those issues is key to either avoiding them or making their resolution part of the development cycle
 - If you are an academic, consider including some material on this in your wireless curriculum
 - See my articles in *IEEE Wireless Communications* magazine