

The Future of Sharing Satellite Downlink Bands with Terrestrial Communications

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*The views in this presentation are solely those of MSS,
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Outline

- Satellite Terrestrial Sharing History
- Why Current Interest
- MSS/GPS Sharing Issues

Terrestrial/Satellite Sharing is *Not* a New Problem

- Almost *all* FSS allocations are shared with terrestrial fixed and mobile services. 3 – 30 GHz (SHF) FSS bands share with point-to-point radio relay chains <http://www.satcom.co.uk/article.asp?article=18§ion=5>
- Best known origin was ~1970 fight between AT&T and satellite interests over C band (4/6 GHz)
 - Complicated because AT&T was trying to protect from both interference and competition – The most complex policy case!
 - FCC referred issue to National Academy of Sciences/National Research Council committee that developed present basis for sharing in this band and basic precedent

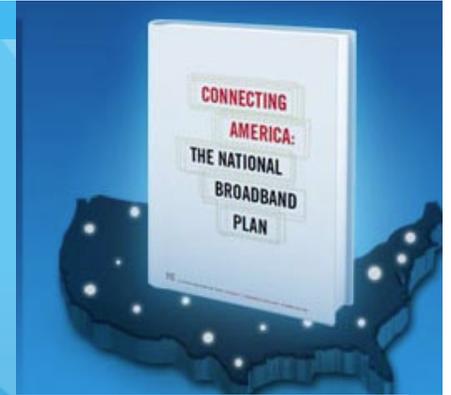


“Transmitters don’t use spectrum, receivers do”

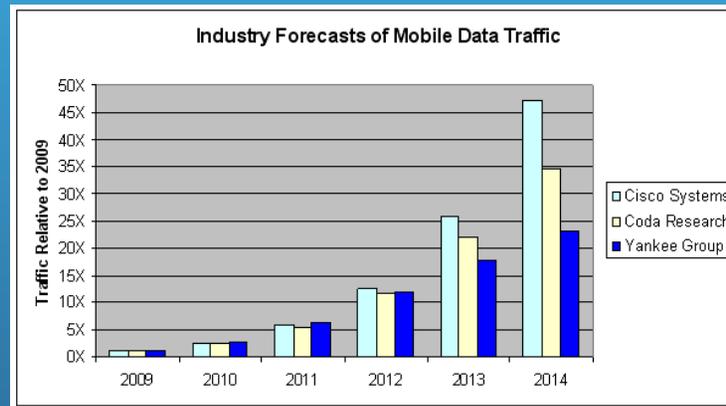
- Total spectrum use often is *not* dominated by transmitter parameter such as modulation efficiency and out-of-band emissions, but in practice by receiver limitations
- FCC has limited receiver regulation authority and uses little of what it actually has
 - NTIA *more* active in receiver regulation in regulating federal users
- Protecting receivers is a **hidden cost** in spectrum policy
 - Dynamic range limitations
 - 3rd IP limitations
 - Filter limitations

This is why analog UHF-TV used every 6th channel!

Why the Increased Interest in Sharing Satellite Spectrum

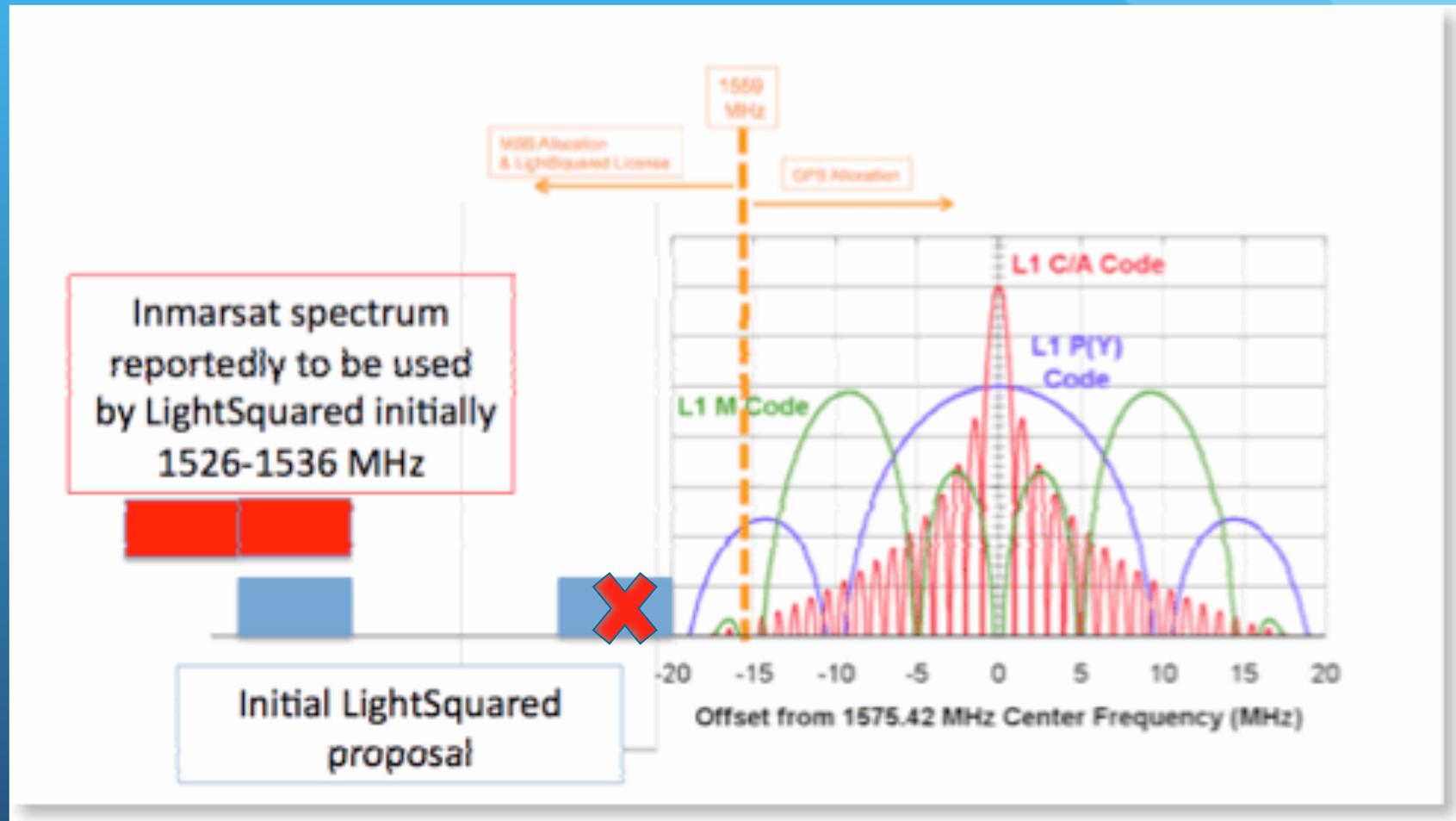


- In our increasing mobile and information centric society there is a growing demand for mobile communications for *both* the private and public sectors



“**Recommendation 5.8:** The FCC should make 500 megahertz newly available for broadband use within the next 10 years, of which 300 megahertz between 225 MHz and 3.7 GHz should be made newly available for mobile use within five years.”

MSS/GPS in the Frequency Domain



US Spectrum Management

Private sector and local government use – “NG”

Federal government use – “G”

47 USC 301



47 USC 305

“Pursuant to delegations from the President and the Secretary of Commerce, the Administrator of NTIA is the ultimate authority in all spectrum management decisions for the federal government”

<http://www.ntia.doc.gov/osmhome/roosa8.html>



47 USC 902(b)(2)(A)



47 USC 904(b)

“To the extent the Assistant Secretary deems it necessary to continue the Interdepartmental Radio Advisory Committee, such Committee shall serve as an advisory committee to the Assistant Secretary and the NTIA.”

US laws can be found at <http://www.law.cornell.edu/uscode/>

Harmful Interference - 1

- Regulatory Risk increases with innovative technologies
 - “The viability of spectrum access for new radio services often centers on whether the new service may cause harmful interference to incumbent services. ... This can lead to delays through protracted rule making proceedings that can create uncertainty and discourage investment.” - FCC, Docket No. 09-157 NOI @ para. 35
 - “Harmful interference” is the traditional determinant of a new technology or service is acceptable
 - While mentioned 8 times in US laws, never defined there

Harmful Interference - 2

“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.”

- Meaning not clear in many cases of today’s technologies
- Virtually all spectrum incumbents oppose any clarification or amendment or examples by FCC/NTIA of what this means
- Incumbents may prefer to use legal, PR, and legislative influence to exsanguinate new entrants rather than address public interest issues
- **NTIA and FCC, as presently structured, may be incapable of timely and transparent adjudication of such issues**

Controlling Terrestrial → Satellite Interference

- Focus today is on downlink issues
 - While FCC has historically focused on limiting maximum erp/eirp to control interference, terrestrial interference is *more* directly related to field strength/pfd on the ground
 - It is the power in the “victim” receiver that really matters
 - When VHF/UHF was focus of usage and regulations, it was difficult to control fs/pfd due to λ so easier to focus on erp/eirp

Reasonable Expectations of Receiver Performance

- To receiver designers receiver vulnerability is often an economic “externality”
 - It may be easier & cheaper to control interference through regulation than through technical robustness
 - This does not recognize the cost to a society of denying spectrum to other users and usages
 - Balancing these issues is a complex balancing of technical and nontechnical issues
 - The reason why FCC is composed of Presidential appointees

**BUT LIGHTSQUARED/GPS ISSUE LIES
ON COMPLEX FCC/NTIA BOUNDARY/
FAULT LINE**



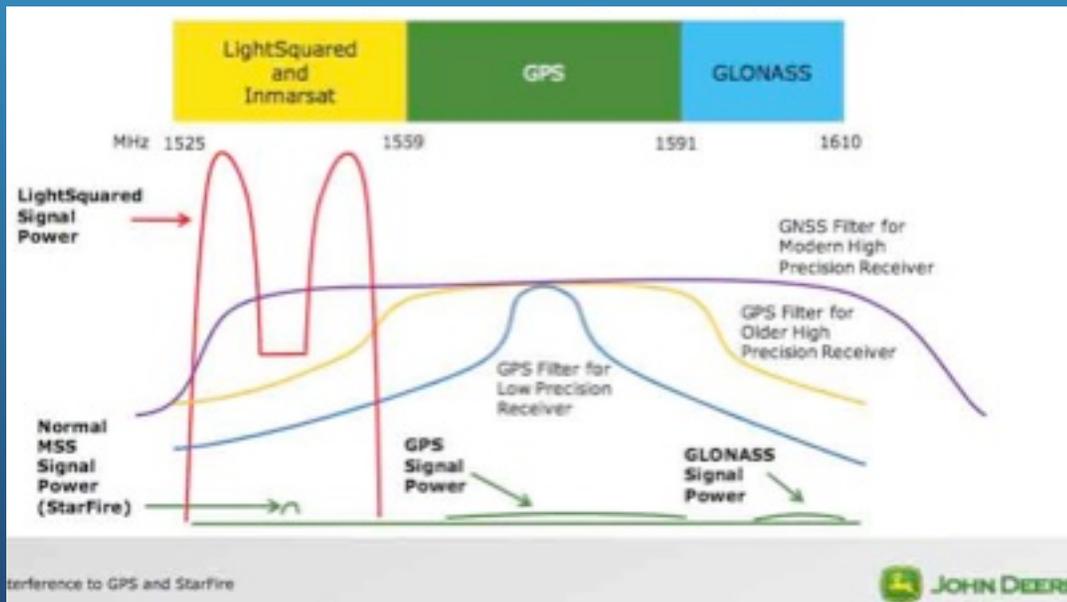
LightSquared/GPS Controversy

- Has exposed the fault lines of US spectrum management
 - Split FCC/NTIA jurisdiction
 - Little or no receiver standards
 - DoD concerns about *all* reallocations
 - FAA desire to become the 3rd national spectrum management agency
 - June 2006 unilateral FAA NPRM to veto licenses in many bands (<http://edocket.access.gpo.gov/2006/pdf/06-5319.pdf>)
 - 20+ years of FM/ILS controversy due to FAA desire to place *whole burden* on FM broadcasters even ignoring ICAO standards due to AOPA opposition
 - FAA UWB/GPS position not even supported by NTIA



Receiver Immunity Expectations

- While ATC authorizations in GPS lower adjacent band date from 2004, there is still no consensus on receiver immunity standards
- John Deere agricultural receiver had odd design with a front end covering 3 bands:



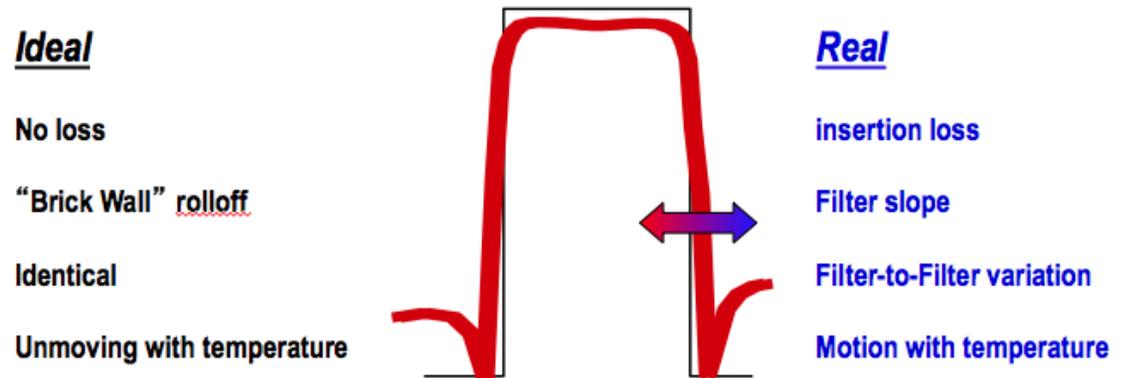
Any terrestrial transmitter in any of these bands would pose a threat to such a receiver design

Is this a rational post-2004 design?

Filters

- Filters for consumer equipment are made in 10^{6+} unit quantities - have low unit cost and high NRE
- Filter manufacturers incur high design costs and “learning curve” production costs to meet actual demands of their customers
 - If existing designs “works” in today’s environment, *neither* filter nor GPS manufacturers have incentive to improve performance to that comparable in other filters in production
- FCC and NTIA have paid little attention to filter improvements & their possible impact on spectrum efficiency

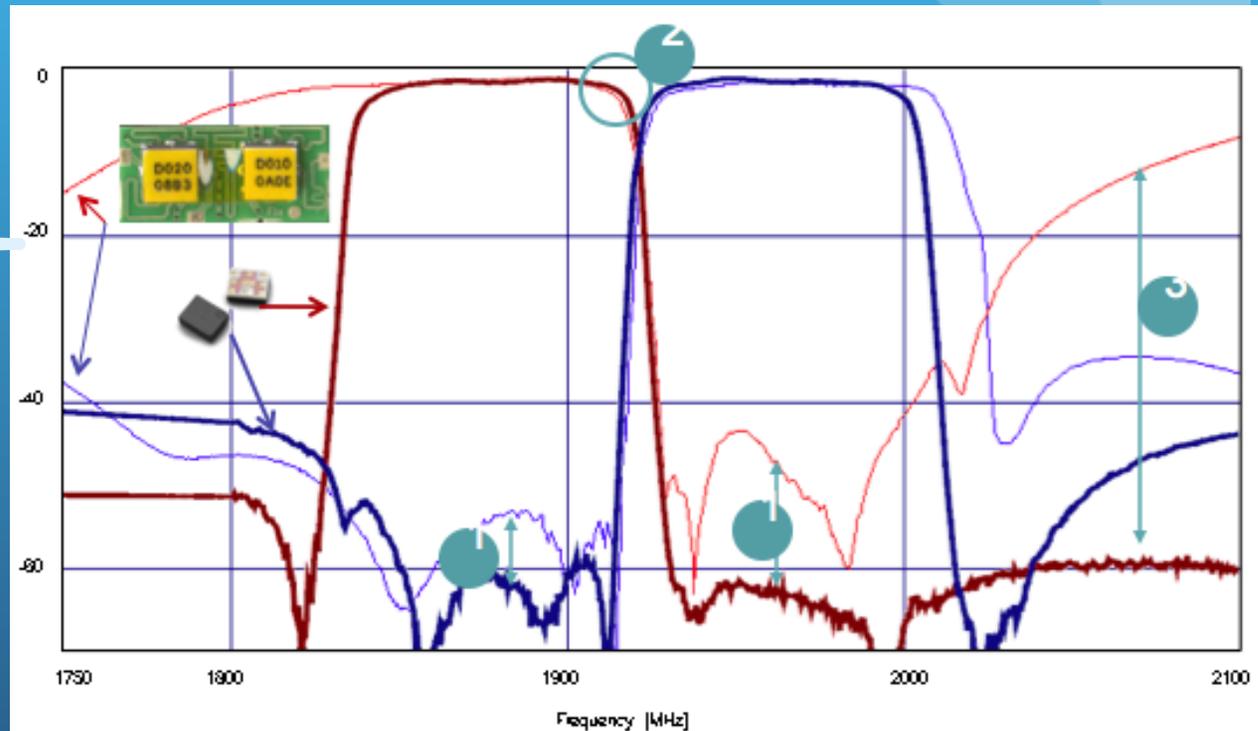
Filters help
but are not
a magic cure



Filter Improvements

- Production filter performance improves in response to regulatory or manufacturer *system* requirements

- Production PCS filter have improvement in last 10 years
- How much have the filters used in the nearby GPS band improved?



PCS duplexer from 2001 vs. product sold today

1. Higher rejection (both Tx and Rx)
2. Lower Insertion loss (including steeper filter skirt and squarer corner)
3. Better out-of-band rejection levels
4. Smaller size (6x12x2 mm > 2x2.5x0.9 mm)

Conclusions

- There is a need for more spectrum and more spectrum sharing to meet societal and economic needs
- MSS/GPS case landed on regulatory fault line in US for several reasons
 - Highlights need for regulatory reform
- Sharing spectrum in the public interest requires all parties to cooperate in making reasonable accommodations in the public interest
 - Regulatory problems can inhibit such cooperation