Optimizing interference: The role of receivers

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WSRD Workshop IV, Panel 2.3, *Spectrum Management Reform*
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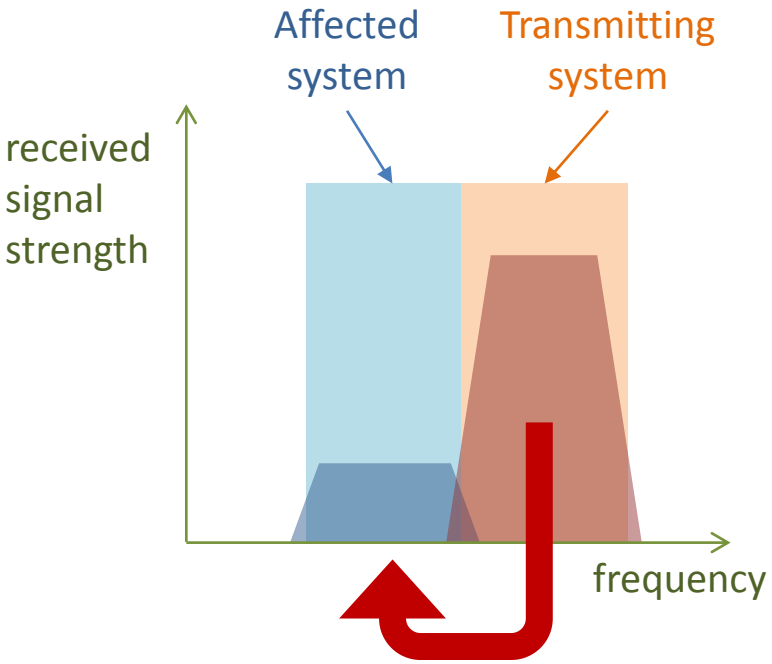
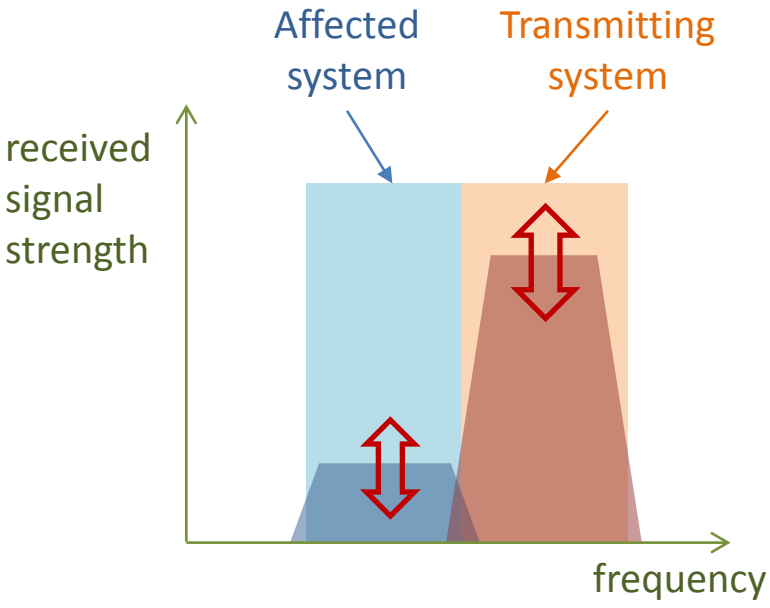
When can an operator stop a frequency neighbor from transmitting (at legal levels) inside that neighbor's assignment?



"Harmful Interference"

- ☐ Always
- ☐ Sometimes
- ☐ Never
- ☑ Don't Know

What would improve interference optimization?



- ☑ Less ambiguous rights
- ☑ More efficient bundles
- ☑ Better adjudication
- ☐ Clone Fred Kahn

Why Bother?

Everybody wants more wireless

- So packing services more tightly in frequency, space, time

"Receiver performance was a significant issue affecting access to the spectrum for new services" (FCC TAC 2011)

- 800 MHz public safety, WCS/SDARS, television, AWS-1/BAS, AWS-1/AWS-3, 3650-3700, LightSquared/GPS, ...

The Hard Problem: different services in adjacent bands

- GPS/LightSquared (noise vs. interference limited)
- T-Mobile/M2Z (AWS-1/AWS-3: FDD vs. TDD)

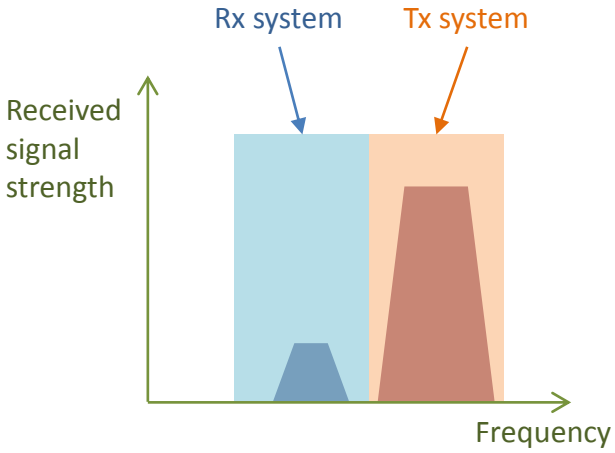
The problem?

“Harmful interference”

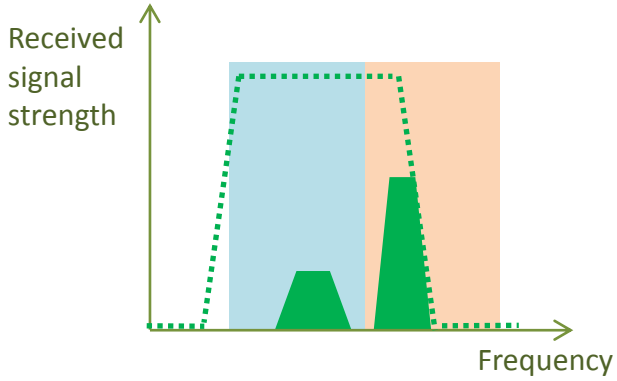
is regulated using transmitter rules

but is due to both transmitters and receivers

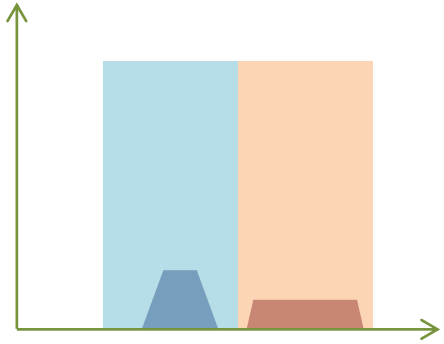
The transmit/receive trade-off (1)



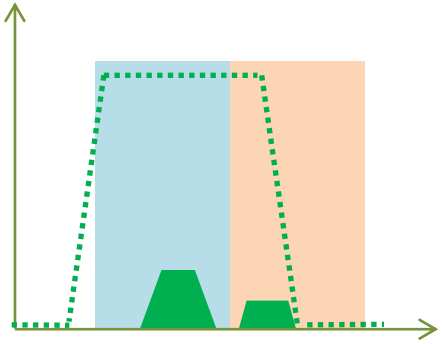
Low selectivity



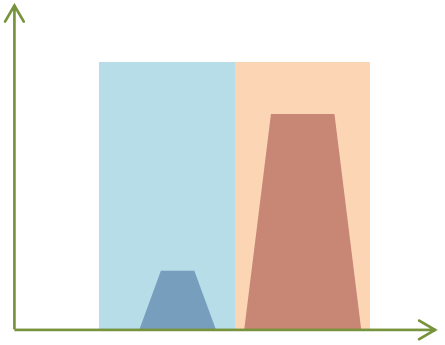
(1) Reduce Tx signal



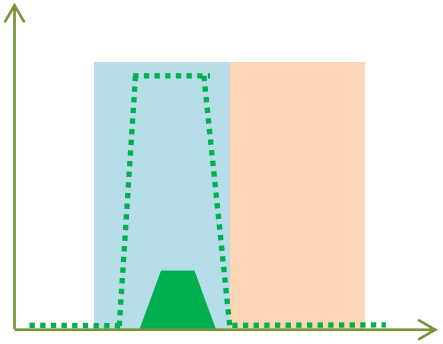
After Tx power reduction, still low selectivity



(2) Improve Rx filters



Same Tx power, better selectivity



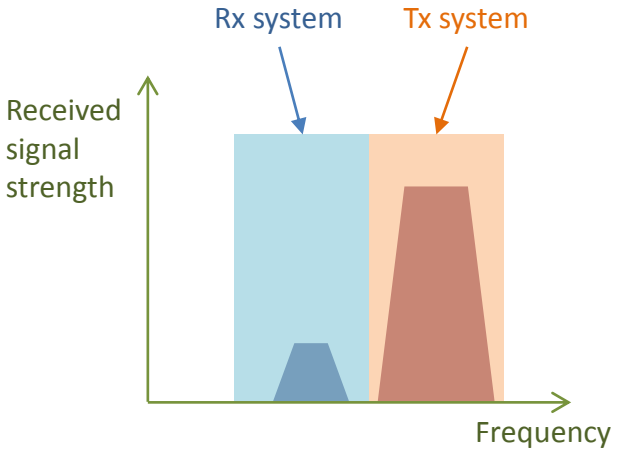
Usual response: “Receiver Standards”

i.e. Government-mandated receiver specs

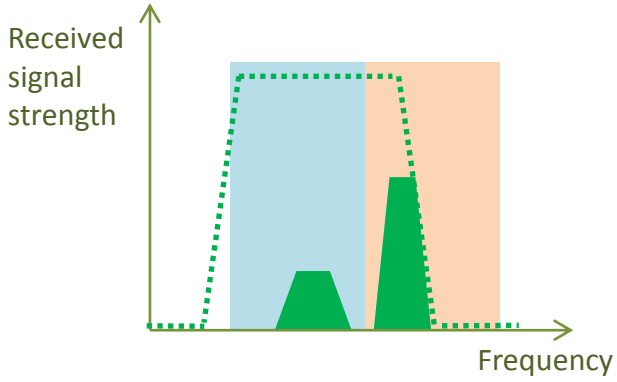
Repeatedly suggested, seldom used

- FCC doesn’t want to get involved
  - Lots of scenarios, variables
  - Manufacturers jealous of their autonomy
  - Questionable statutory authority
- Wireless is a systems game

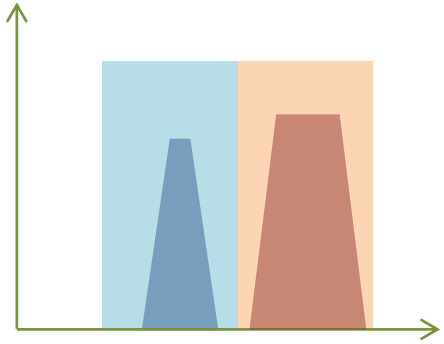
The transmit/receive trade-off (2)



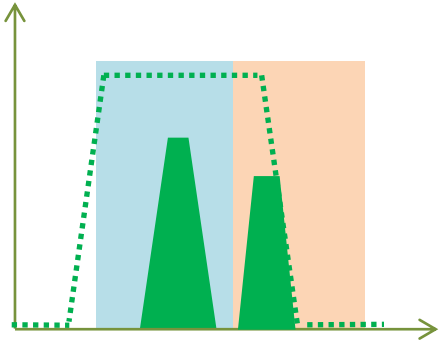
Low selectivity



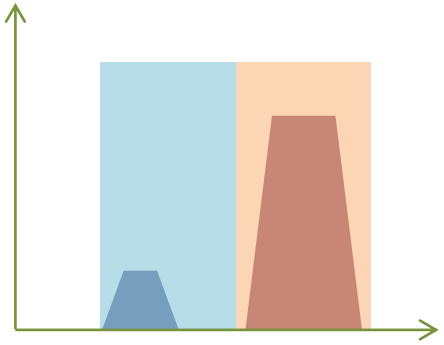
(3) Improve C/I



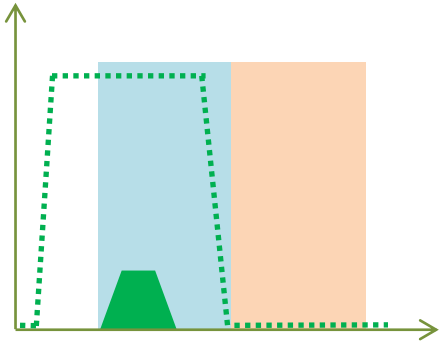
Increase Rx level, still low selectivity



(4) Own Guard Band



Move Rx center freq, still low selectivity



Alternatives to Receiver Mandates

FCC SPTF Interference Temperature (2002)

- Metric to establish maximum permissible levels of interference

Matheson's Electrospace (2005), Webb's Ofcom SURs (2008), Kwerel & Williams "must self-protect" (2011)

- *Probabilistic* transmission *permissions* and receiver *protections*

Stine's Model-based Spectrum Management (2011)

- Loose coupling between spectrum management and RF systems using Spectrum Consumption Models

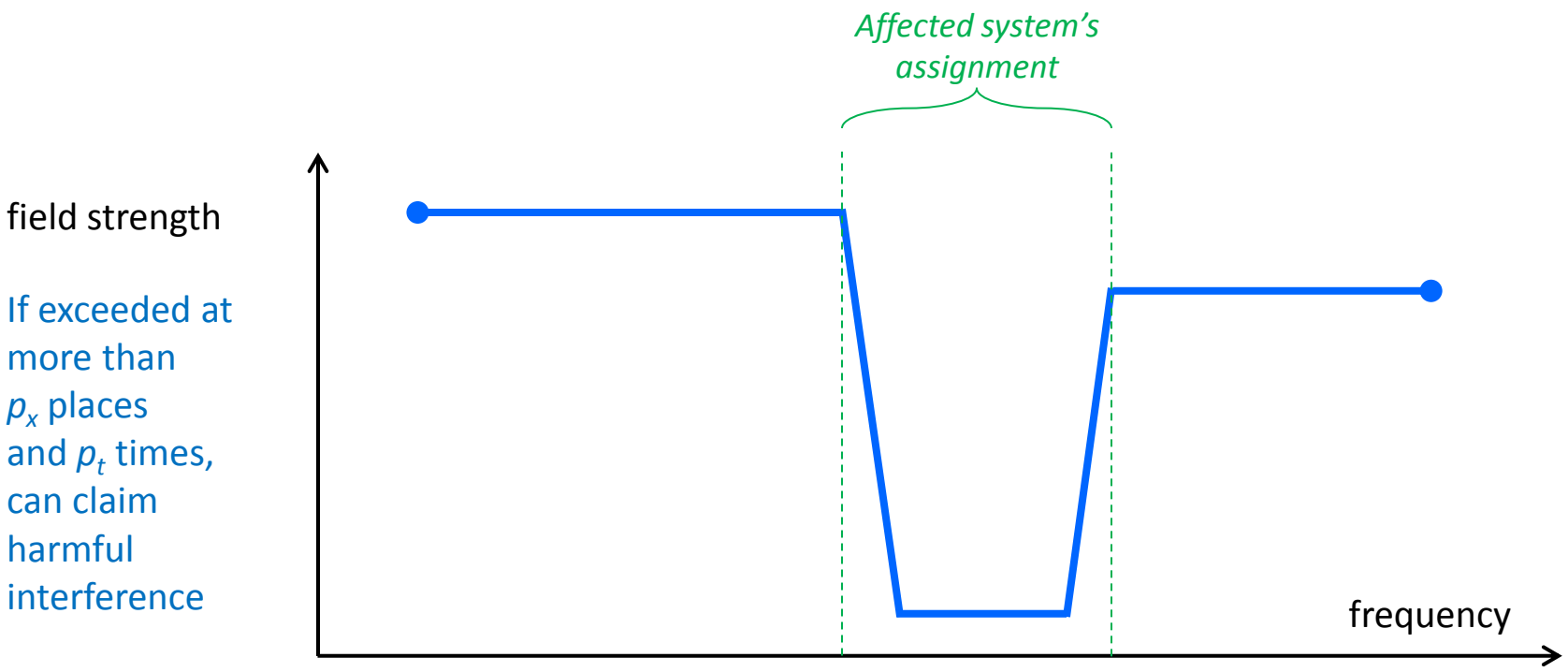
PCAST Spectrum Report, FCC TAC Spectrum & Receivers WG (2012)

- Interference limits policy: approaches that describe the environment in which receivers must operate
- Harm claim thresholds: an interference limits policy

Harm Claim Thresholds

Explicit, up-front statement of the interference that must be exceeded before receiving system can bring a harmful interference claim

- Operator can deploy any receiver they like
- but can't claim harmful interference if neighbor is below the threshold



Law & Econ Questions

Coasian bargains seem rare in spectrum, even among commercial players

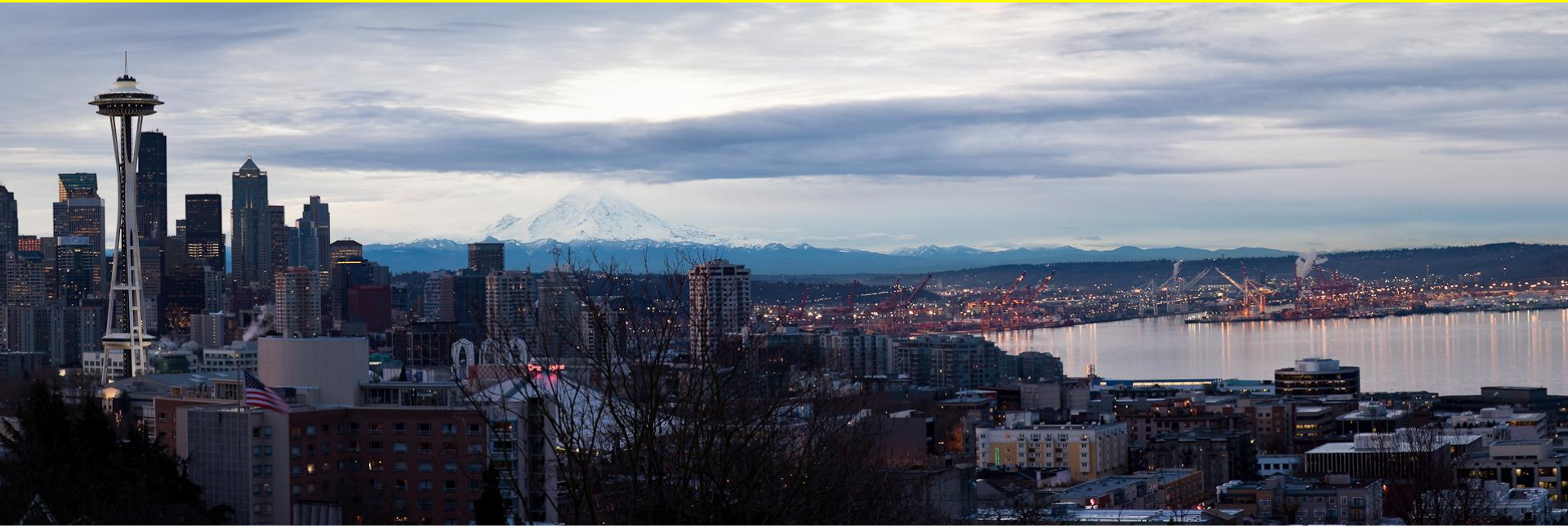
- If yes, why?
- How close do current rights assignments come to the social welfare optimum?
- Remedies: injunction or damages?

Relative merits of the four fixes

- Less ambiguity, more efficient bundles, better adjudication, institutional reform

Questions for interference limits policy / harm claim thresholds

- Would clearer rules improve trading of interference rights?
- What happens when Tx permissions and Rx protections conflict?
- Dealing with decoupled receivers and untrusted systems?
- Part 15.5 (b) “no harmful interference is caused ” by UL to UL?



Thank you

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