Defining the Harm in Harmful Interference

National Spectrum Management Association

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Introduction

- Concept of “harmful interference” is fundamental to spectrum management
  - governs in-band sharing (primary/secondary/unlicensed)
  - sets relationships among same-service users
- Definition of “harmful interference” is vague and subjective
  - past attempts to add rigor and predictability
- But a quantitative, forward-looking, predictable definition may not be feasible.
Most Spectrum Is Heavily Shared
“Harmful Interference” Governs Sharing

- **Primary users** protected against harmful interference from all other users.
- **Co-primary users** may not cause harmful interference to each other.
- **Secondary users** may not cause harmful interference to primary users, must accept harmful interference from primary users.
- **Licensees in same service** may not cause harmful interference to each other.
- **Unlicensed users** may not cause harmful interference to primary or secondary users, must accept harmful interference from everybody.
“Harmful Interference” Defined

- **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.  
  47 C.F.R. § 2.1.
Parsing the Definition

1. As to radionavigation/other safety services: *interference which “endangers the functioning”*
   - safety service defined as:
     “[a]ny radio-communication service used permanently or temporarily for the safeguarding of human life and property.” 47 C.F.R. § 2.1.

2. As to other services: *interference which “seriously degrades, obstructs, or repeatedly interrupts.”*
Problems with Definition – Structural

- Phrased in terms of effects, not causes
  - cannot tell in advance whether given interference is “harmful”
  - definition is backward-looking, applies after the fact
- Safety/non-safety cross-over cases, e.g.:
  - 911 calls by cell phone
  - OnStar (emergency calls by satellite)
  - amateur radio during emergencies
  - these should qualify as “service used . . . temporarily for the safeguarding of human life and property”
  - but how to identify calls for heightened protection?
Problems with Definition – Application

- Criteria in definition that make interference “harmful” are vague and subjective:
  - “endangers,” “seriously degrades,” “obstructs,” “repeatedly interrupts”
- Some experts seek an objective, quantitative definition
  - would eliminate subjective judgment
  - would determine harmful interference in advance
  - different observers would reach same conclusion
- Will argue here that forward-looking objectivity is neither possible nor desirable.
Prior Attempts

- FCC Spectrum Policy Task Force saw need for objective/prospective definition:
  
  “[Harmful interference] is not defined in technical terms, making objective measurement difficult. . . . [T]he Commission needs to define interference rights more clearly on a prospective basis.” SPTF Report at 18-19 (Nov. 2002)

- “Interference temperature” proceeding:
  - “It is essential to quantify harmful interference . . . .” Notice of Inquiry ¶ 27 (Nov. 2003)
  - docket drew fewer than 100 filings, little convergence
Proceedings for New Technologies

- Nearly all spectrum below 50 GHz is licensed or in use
- New applications must squeeze into occupied spectrum
- Key question: whether newcomer will cause harmful interference to incumbents
  - forces reality-based interpretation of “harmful interference”
  - requires translating abstract terms of definition into practical decisions.
Recent Examples

- Rulemakings adopted:
  - TV white space
  - U-NII expansion
  - broadband over power line
  - ultra-wideband

- Waivers granted:
  - UltraVision (80-600 MHz)
  - Multispectral Solutions (5925-7250 MHz)
  - Curtis-Wright (960-3650 MHz)
  - SafeView (24.75-30 GHz).
Entire Proceeding on One Slide

- **Main debate:**
  1. Newcomer claims no risk of harmful interference to incumbent
  2. Incumbent claims certainty of harmful interference

- **Secondary debate:**
  - each side claims its application offers greater public interest.
Rarely Black or White – Mostly Gray

- Parties frame harmful interference:
  - certain to occur (incumbents) vs. impossible (newcomers)
- In practice, rarely yes/no, usually a matter of probabilities
  - victim might see $X\%$ impairment $Y\%$ of the time
  - numbers are seldom zero or 100
  - in recent cases, numbers have been small
- Both opponents and proponents overstate their claims
  - costs credibility, damages parties’ own interests.
Incumbents’ Exaggerations

- My service is vital to the public interest
  - therefore entitled to maximum protection
- I paid for my spectrum, so no one else can share it
- I can show incoming interference by:
  - stringing together worst-case possibilities
  - using implausible transmitter-receiver geometries
  - calculating with no other sources of radio noise ("Jurassic assumption")
  - burying unstated safety margins in my calculations
- “Any small risk of any interference to my service is harmful interference.”
Newcomers’ Exaggerations

- My proposed service is vital to public safety/homeland security, rural broadband, "third pipe" competition...
  - public interest justifies some risk of interference
- I can show my application won’t cause interference by:
  - downplaying the likelihood of interfering geometries
  - overstating the effects of ambient radio noise
  - underestimating victims’ receiver characteristics
  - overstating victims’ tolerance of brief interference
- My new technology should get the benefit of the doubt
Factors in “Harmful Interference”

- Whether to call a given degree of interference “harmful” depends on context:
  1. public interest in victim service vs. interfering service
  2. whether new application can work in less critical spectrum
  3. whether new application can be made less interfering
     - e.g.: lower power; lower duty cycle; frequency coordination; ability to sense and avoid victim devices
  4. sensitivity of victim equipment to interference
     - whether reasonably designed to be robust
     - whether can tolerate occasional interruptions
  5. whether an interfering device can be shut down.
From Criteria to Numbers

- An interfering signal of $W$ microvolts/meter/kHz translates (roughly speaking) to $X\%$ impairment $Y\%$ of the time
  - numbers vary widely for different incumbent services
- Public safety services: must choose $W$ for $X = 0, Y = 0$
- Other services: how to choose values of $X$ and $Y$?
  - values reflect minimum acceptable victim performance
  - depend on criteria from previous slide
- Choices of $X$ and $Y$ determine $W$ for each pair of services
- Result: The only practical way to define harmful interference is in terms of its practical consequences.
Conclusion

- An effective definition of harmful interference can be neither quantitative nor prospective
  - no single quantitative definition can give the right answer in every instance
  - no prospective definition can properly account for as-yet-unknown technologies
- Regulators must continue to evaluate on a case-by-case basis
  - but could be more transparent about the decision-making criteria they apply.
Thank you!

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