

# Etiquette and Manners in the Unlicensed Wireless Bands

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# Lessons from the Internet

- For Wireless, we have a very good analogue – the Internet
  - It's a commons to a large extent...
- Why does the Internet work so well today?
  - (Aside from lots of black fiber these days)
  - Congestion control (Floyd 2000)
- Equation based congestion control: allocates resources fairly
  - Sources should be TCP-Friendly

# Etiquette vs. Manners

- Etiquette: using a spoon for soup
- Manners: making your guest feel comfortable
- (paraphrased from J. Martin)
  
- TCP congestion control is etiquette, equation based rate control is manners!
- Etiquette Listen-before-talk or rules about how to implement spread spectrum
  - None on U-NII, since many felt they would be too limiting
  - Lots on ISM bands.
- Manners
  - Inverse golden rule “don’t harm anybody worse than they are harming you”. (Shenker 1995)

# Fair Queuing and Fair-Share

- Focal question: What equation should we use for wireless?
- An Internet analogy – queuing protocols
  - Fair-Share/Fair Queuing
    - Guarantees users some minimal guarantees
    - Is robust with respect to “gaming”

# Allocations for Elastic Users

- Assume devices have elastic demands:  $U(p,r)$ 
  - $p$ =power consumption
  - $r$ =data rate
- Given requests for  $r$ 's the system should choose  $p$ 's “fairly”
  - Allocate “information rates” using the formula for fair-share.
  - Fair-Share:  $R_1 < R_2$  then  $P_1 = D(2R_1)/2$  and  $P_2 = D(R_1+R_2)-P_1$

# Value of Fair-Share

- Provides basic performance guarantees – fairness
- No device does worse than all devices had the same demands as it does
- Provides dynamic (and game theoretic) stability.
- “Second best” (1<sup>st</sup> best is not achievable)

# Foundations for Pricing and Reputations

- How do you get devices to provide services for other devices?
  - Such as ad-hoc networks, peer-to-peer file sharing etc.
- Micro-Pricing (Mandayam in progress)
  - Need micro-money and “rule of law” (Johnson et. al. 2000)
- Barter
  - Need long term reputations
  - What do you do with new devices
    - Paying your dues equilibria (Friedman and Resnick 2000)

# Manners for Pricing and Reputations

- Many complex strategic issues
  - Devices that intentionally harm competitors
  - Devices that are intentionally fragile
  - Free riding
  - Social norms and the folk theorem.
- Are there a set of manners that work?
- Can you use a “golden rule”?

# Summary

- Elastic users: allocate power requirements fairly
  - Provide basic guarantees
- Cooperative devices
  - Need to create reputations and manners that lead to efficient and strategically robust outcomes
    - Cooperation should be rewarded
    - Cheaters need to be punished.