Open Spectrum: Economic & Policy

- Future is shared spectrum
- Business/Policy Models for sharing spectrum
- Current trajectory of policy reform
- Research questions/issues
- “Managing shared access to a spectrum commons”
Future is shared spectrum: decoupling of spectrum frequencies from infrastructure investment & applications

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<tr>
<th>Technology (Capabilities)</th>
<th>Smart radio systems, spread spectrum, transition to broadband platform architectures</th>
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<td>frequency agility, expanded capacity for sharing</td>
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<th>Revenue (Customer experience)</th>
<th>Heterogeneous networks (3G/WiFi, wireless/wired, global roaming)</th>
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<td>24/7 availability, simplicity of use, seemless mobility</td>
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<th>Costs (Network provisioning)</th>
<th>Bursty traffic, multimedia services, fat-tailed usage profiles</th>
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<td>lower costs, take advantage intermodal competition</td>
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<th>Policy (Spectrum reform)</th>
<th>Transition to expanded flexible market-based licensing and unlicensed spectrum mgmt regimes</th>
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<td>reduced <em>artificial scarcity</em> due to legacy regulations</td>
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Broadband Wireless Policy & Business Models

**LICENCED**

**Service Provider Model**
*Network-centric*  
*(Traditional Telecoms)*

- Top Down  
- Vertically Integrated  
- Centralized Control

**Key Features**
- Mux users into min spectrum *(spectrum scarce)*  
- Roaming, MVNOs  
- Secondary markets??

**UNLICENCED**

**End-user Equipment Model**
*Edge-centric*  
*(Internet vision)*

- Bottom Up  
- Less Vertically Integrated  
- Distributed Control

**Key Features**
- Open access: viral adoption and rapid diffusion *(spectrum not scarce)*  
- “Commons” shared use rights  
- Etiquettes/Rules

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Trajectory of reform: from regulation \(\rightarrow\) markets

- From Command & Control => Liberalized, tradable, exclusive licenses
- Unlicensed for low-power, low-range uses (<100m)
  - Limited allocation below 3Ghz
  - Underlays and Overlays (??), Dedicated @ 5GHz

### #1: Need exclusive licenses (and secondary markets) to manage when scarce (if not scarce, then unlicensed best...)

### #2: Unlicensed (decentralized, commons) suitable only for managing short distance, low cost of congestion
Research Questions: Is this right policy?

- Allocation of spectrum between “licensed” & “unlicensed”
  - *Future* “opportunity” cost of spectrum?
  - Architectures of (wireless) BB access networks?
  - International harmonization for scale/scope economies means delay costly

- Efficient design of secondary markets
  - Dynamic spectrum allocation markets (who controls?)

- Transition issues: spectrum clearing and allocation (auctions?)

- Unlicensed secondary use rights
  - *Underlays*: power limits and UWB development? Impact of underlays on licensed spectrum innovation?
  - *Overlays*: cognitive radio? Interruptible services

- Etiquettes/protocols for managing open spectrum

All issues require mix of technical, business, and policy analysis.
- Complex stakeholder interests (NIMBY, windfall profits, etc.)
- Uncertain technology & “future proof” policy

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“Managing Shared Access to a Spectrum Commons”

- “Open” does not mean *no* regulation
  - But hopefully, minimal Free? Maybe not, but certainly low cost. Avoid usage fees.
  - Any user? No, only those that conform to “rules.” Could be private commons (e.g., mobile providers share 3G spectrum cooperatively).

- Criteria to evaluate:
  - Technical: avoid unnecessary interference when congestion rare.
  - Economic: promote innovation, invest, competitive strive or technical neutrality while avoiding “Tragedy of Commons”.
  - Political: How future-proof? (Reversibility) Enforcement? (Liability)

- Key technical rules
  - (1) Power restrictions (probably higher than consistent with underlay)
  - (2) Signaling capability (common channel signaling for identity, use, power, location)
  - (3) Contention/allocation mechanism (ERC, preemption)
  - (4) Enforcement (reliably verifiable conformance testing)
  - (5) Reversibility (term limits)

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