



Wireless Futures and spectrum sharing

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Wireless Futures and Spectrum Sharing

- Spectrum sharing as critical enabler
- TVWS and current reform agenda
- Recent and on-going wireless/spectrum research...

Wireless futures and spectrum sharing

- Future is pervasive computing, hence
 - wireless & Internet convergence
 - end-user/edge intelligence/control (& clouds)
 - markets *not* C&C
- Spectrum sharing = *Dynamic Spectrum Access (DSA)*
 - DSA = share in space, time, frequency, etc.

Scarcity → Sharing → DSA

- Scarcity: demand exceeds supply
- Ergo: suppress demand (ration) or increase supply (share)
- DSA enables both
 - Ration: reallocate to higher value uses
 - Share: increase spectral efficiency
- Commercialization DSA → innovation (investment) in...
 - Technology : CR, antennas, congestion mgmt, & other stuff...
 - AND Business models, markets, and policy frameworks
 - About re-engineering the RF usage ecosystem....
 - (Policy the least important element)

DSA is paradigm shifting

- Decoupling of network infrastructure & spectrum
 - DSA “virtualizes” the RF
- Lots of potential benefits
 - Mix-and-match componentization
 - Commoditization of sub-systems (SDR on Dell Hardware)
 - Decouple business innovation (service, market, firm org)
 - Intermodal competition and scalable entry
- Transition to DSA has positive feedbacks
 - Commercialization for one purpose facilitates other uses
 - Lower entry barriers (for innovation of all kinds)

Future of sharing is hybrid

- Mix of technologies, business models, and policies
- Legacy always with us (today's will be tomorrow's legacy)
- No one size fits all solution
- No crystal ball
- Need continuum of spectrum "property rights" options to meet varying needs for interference protection.
- DSA makes it easier to live in hybrid world.
 - Reduces need for harmonization (CR as substitute for standardization)
 - Enables more flexible response to changing interference dynamics.

Spectrum Policy Reform in the U.S.

- SPTF (2002) (see: <http://www.fcc.gov/sptf/reports.html>)
 - Share spectrum more intensively
 - Markets (exclusive licensed & unlicensed) instead of C&C
 - Refine definition of interference protection
- National Broadband Plan (Mar2010)
 - Broadband for everyone, fixed & mobile
 - Spectrum reform for market incentives & new technologies critical
 - Public safety national network
- Presidential Memorandum “500MHz in 10 years” (May2010)
 - Execute on earlier initiatives, including TVWS
 - Incentive auctions for TV spectrum (below 1GHz)
 - Commercial-Federal Sharing
- TVWS 2nd Order (Sep2010)
 - Original TVWS (Nov2008)
 - 2 nationwide (6MHz) channels reserved for wireless microphones
 - Relaxed sensing rules. Dbase-only sufficient.
 - New initiative to use TVWS for rural wireless backhaul

Understanding relevance of TVWS

- Goals:
 - Sharing spectrum more intensively
 - Re-allocate from legacy to more efficient uses (from TV to mobile BB)
 - Lower spectrum access barriers to new tech (CR and DSA)
 - Demonstrate new sharing regimes
- Enable Secondary (unlicensed) Users
 - Overlay (Cognitive radio): identify “holes” in time & space
 - Underlay (UWB): low power in noise floor, spread across 500MHz
- Markets
 - Rural WiFi on steroids (802.11AF)
 - P2p Back haul (semi-licensed?)
 - In-home (ECMA? Uncertain)
 - Other – wireless control, ??
- Relevance
 - Prime real-estate
 - New sharing model (secondary overlay, non-cooperative)
 - Spectrum reform “window of opportunity”

Vision of Future and Recent/On-going Research

- Three recent papers w/ John Chapin
 - Wireless & wired broadband convergence
 - Lehr & Chapin (2009)
 - Wired to platform (IP over fiber, everything over IP)
 - Wireless to many networks, some specialized
 - Hybrid Wireless Future
 - Lehr & Chapin (2010)
 - Sharing across RF bands (e.g., LTE) but also across networks and providers.
 - Unbundle RF from radio and networks to support mix-and-match.
 - Dynamic Spectrum Access (DSA) critical innovation (in tech as well as business models)
 - **SCADA for the Rest of US: wireless control networks for masses**
 - Chapin and Lehr (2010)
 - Market opportunity for TVWS spectrum
 - Rethinking unlicensed spectrum management etiquette
- What's next...
 - Mobile BB & wireless evolution (w/ John Chapin) (MITAS connection...)
 - NSF Future Internet Architecture (FIA): *MobilityFirst* and *Nebula*

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SCADA for the Rest of Us: Unlicensed Bands Supporting Long-Range Communications

John M. Chapin¹ & William H. Lehr²
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- SCADA = Supervisory Control And Data Acquisition
 - Monitoring and control of physical systems
- Outline:
 - Motivation: what is the market opportunity
 - Industry structure: who (how) will the market be served
 - Spectrum policy: how to create unlicensed bands to support long-range communications
 - Conclusions and future direction

SCADA for the Rest of Us (“S4U”)

- Major trend: Cyber-Real World Convergence
 - Wireless essential for communications and control
 - Three markets, largely independent
 - Big SCADA – electric grid, water utilities, chemical plants, etc.
 - In-home automation & wireless connectivity (WiFi, Zigbee)
 - Other mass market uses (S4U)
 - SMEs (small enterprises) and local governments
 - Lots of heterogeneous applications
 - Many small uses, distributed in region
 - Tight cost (W-t-P) constraints
- S4U apps: business not consumption, small w-t-p
 - SMEs: rural health clinic, lawncare company, home delivery
 - Local government: monitor critical infrastructure, smart parolees
 - Commonalities: lots of specialized uses, cannot provision for demand ex ante, require broad coverage

S4U summary....

- SCADA for the Rest of Us: wireless control networks for mass market
 - Lots of heterogeneous applications, many small-scale users
 - Very cost sensitive (limited per device service revenue potential)
 - Low rate, low duty cycle, latency tolerant
- Dual path deployment: service provider & end-user deployment
 - Viral growth for scalability, service model for wide-area resource sharing
 - Mobile providers, yes, but should not be only vector for competition
- Support with a controlled access unlicensed band
 - Enables long range communications in unlicensed spectrum
 - Going beyond Part 15
 - Leverage TVWS database for light weight rule modifications
 - ADCL etiquette may be a solution

Mobility Challenges & the Internet

Spectrum Mobility

- Scarcity: need to share more intensively
- Frequency agility: CR/SDR, LTE, etc.
- Dynamic Spectrum Access

Internet

- Sensing
- Layering
- Transaction mgmt

Network Mobility

- Ad hoc/mesh networking support
- Public safety: situation awareness/force mgmt
- Evolving the *status quo*...User acceptance...

Internet

- Distributed coordination
- Interoperability
- Security/reliability

Content Mobility

- DRM
- Efficient content delivery
- Privacy (access), e.g. health data....

Internet

- Rights mgmt/expression
- First Amendment platform

References

- Chapin, J. and W. Lehr (2010), "SCADA for the Rest of Us: Unlicensed Bands Supporting Long Range Communications," 38th Research Conference on Communications, Information and Internet Policy (www.tprcweb.com), Arlington VA, Sept 2010.
- Lehr, W. and J. Chapin (2010), "On the Convergence of Wired and Wireless Access Network Architectures," *Information Economics and Policy*, vol 22, iss 1 (Mar 2010) 33-41.
- Lehr, W. (2009), "Mobile Broadband and Implications for Broadband Competition and Adoption," a white paper prepared on behalf of Broadband for America, November 2009.
- Lehr, W. and J. Chapin (2009) "Hybrid Wireless Broadband," paper presented at 37th 37th Research Conference on Communication, Information and Internet Policy (www.tprcweb.com), Arlington, VA, September 2009.
- Lehr, W. and N. Jesuale (2008) "Public Safety Radios Need to Pool Spectrum," *IEEE Communications Magazine*, March 2009.
- Chapin, J. and W. Lehr (2007a), "The path to market success for dynamic spectrum access technology," *IEEE Communications Magazine*, Special Feature on Cognitive Radios for Dynamic Spectrum Access, May 2007.
- Chapin, J. and W. Lehr (2007b), "Time Limited Leases for Innovative Radios," proceedings of *IEEE DySPAN2007*, Dublin, April 18-20, 2007 and *IEEE Communications Magazine*, June 2007.

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