

TV White Space in the Real World

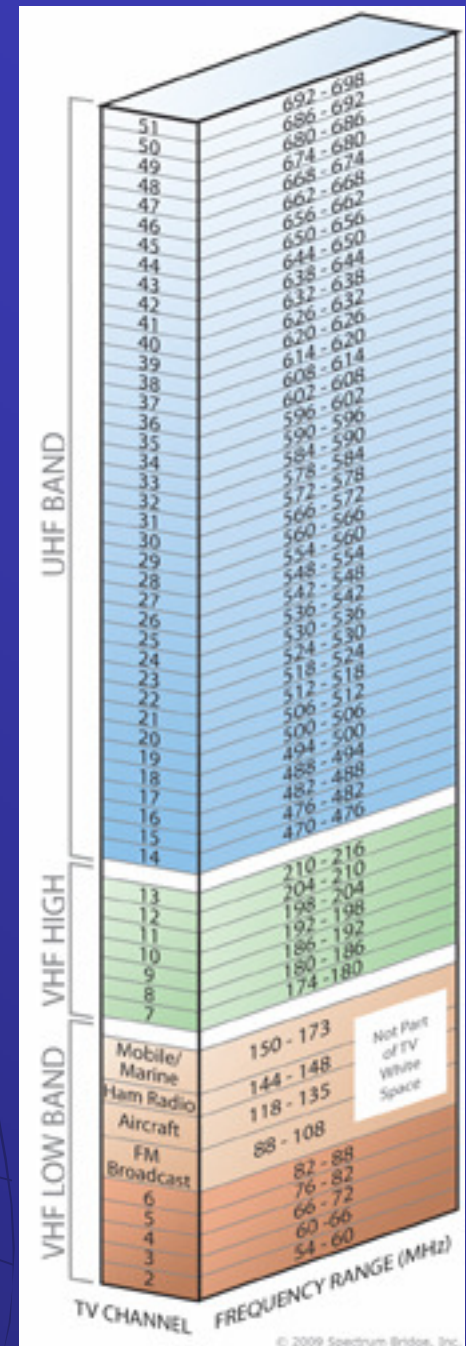
Update on TVWS Trials

James Carlson CEO, Carlson Wireless

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CARLSON

Cutting Edge Technology



About Carlson

- ◆ Carlson Wireless
 - Designer, manufacturer of fixed-wireless equipment for broadband and backhaul
 - Located in Northern California
 - TV white-space product: RuralConnect IP
- ◆ Jim Carlson, CEO
 - Radio engineer with 25+ years experience

Purpose of Trials

- ◆ Develop best possible product
- ◆ Improve and refine product based on real-world scenarios
- ◆ Test product under challenging conditions
- ◆ Demonstrate the vast potential of the technology to offer real connectivity solutions

About Carlson Trials

- ◆ 8 experimental licenses granted
 - Different stages of development
- ◆ All 8 projects are:
 - Serving rural communities
 - Challenged by rugged terrain, heavy foliage and low teledensity
 - Seeking *real* NLOS product
 - Many committed-but-unservable customers that can be reached for the first time via TV white space

Rural New England



Rural New England

- ◆ Low teledensity = low fiber miles
- ◆ Active role for WISP's in CT, MA and VT
- ◆ Hilly, forested landscape
- ◆ Hundreds of "failed installs" in Vermont, Connecticut and Massachusetts
- ◆ Pressure from the community to serve all
- ◆ State and local gov't active and supportive
- ◆ Vermont Gov Peter Shumlin personally behind rural connectivity

Rural Central Florida



Rural Central Florida

- ◆ Well stimulus funded
- ◆ Public-private partnership
- ◆ Unserved communities in central Florida area
- ◆ 12,000 users not servable via uwave
- ◆ Dense foliage and low teledensity
- ◆ Exp. license recently granted

Rural Oklahoma



Oklahoma WISP

- ◆ WISP with hundreds of failed installs in three Oklahoma counties
- ◆ Using water tower to hit failed microwave sites
- ◆ Also, local TV station offers tower for interference test
- ◆ General 3.65 service WiMAX with Omni

Vergennes, Michigan



Vergennes, Michigan

- ◆ WISP newly formed to serve three bedroom communities outside Grand Rapids
 - Vergennes, Ada, Lowell
- ◆ Scattered homes on large properties
- ◆ Thickly forested with poor cell phone service
- ◆ Known as “radio black hole” by area public safety officials
- ◆ Hybrid network with WiMAX, TVWS and femtocells
- ◆ More info: [“Community-Driven Innovation in Vergennes, Michigan”](#)

Cordova, Alaska



Cordova, Alaska

- ◆ Rural Telephone Cooperative
- ◆ Remote island community surrounded by mountain ranges
- ◆ Current phone service since 1996 using Carlson Optaphone narrowband VHF
- ◆ Testing TVWS radios with VoIP + BB solution

Klamath, California Yurok Reservation



Klamath, California Yurok Reservation



Yurok Reservation

- ◆ Carlson's first, most mature TVWS trial
- ◆ Deliberately selected
 - Most challenging proving ground we could find
- ◆ Local unserved community
- ◆ 40+ square miles along Klamath River
- ◆ Very rugged terrain, heavily forested
- ◆ Sparsely populated
- ◆ Educational for us on extreme multipath
- ◆ Cultural constraints against visible infrastructure

Problem

- ◆ Scattered population not well served.
- ◆ Tribe originally planned with 900 MHz but after testing “near” line of sight, the amount of towers and repeaters grew to a culturally unacceptable and cost prohibitive number

Solution

- ◆ We picked locations for 3 major access points that could be hidden in trees.
- ◆ We found that the VHF/UHF allowed the signal to reach into obscured areas well

Results for Product Development

- ◆ Discovered that sharp canyons created significant multipath
- ◆ This required a more robust equalization algorithm

Results for Community

- ◆ Currently installing fire station, elementary school and office building
- ◆ Huge & immediate improvements for the community
 - [“Yurok Tribe Deploys Public Safety Line through New White Space Technology”](#)
 - [“Arcata Communications Company Launches “Super Wi-Fi” on Yurok Tribe Reservation”](#)

Spectrum Bridge Trials

- Carlson has worked with SBI for database management during development of prototype for RuralConnect IP
- Prototype of RCIP instrumental in these trails
- Wilmington, North Carolina
- Claudville, Virginia
- Plumas Sierra Rural Electric Co-op, Portola, California

Wilmington, North Carolina – Public Safety and Last-Mile Solution

- ◆ Urban/suburban environment
- ◆ Designed to demonstrate “smart city” applications
- ◆ Internet access to local community via public Wi-Fi hotspots, remote cameras on evacuation routes, water sensors, and remote control of city lights in parks
- ◆ Cost of project was affordable because of true NLOS performance
- ◆ Demonstrated operation in urban area without causing interference to TV broadcasters

Claudville, Virginia – Last-Mile Solution

- ◆ Rural and remote area of Virginia
- ◆ Deployment ranges typically a 2-mile non-line-of-sight (NLOS) radius
- ◆ Operates with 1/10 to 1/15 the nodes of Wi-Fi
- ◆ Internet access to a school, to local community via public Wi-Fi hotspots, and to residences via subscriber stations
- ◆ VHF–H channel band (Channels 7-13)

Plumas-Sierra Rural Electric Co-op

- ◆ Rural, mountainous and sparsely populated
- ◆ Geographically challenging 5 mile paths
- ◆ Plumas-Sierra Rural Electric Cooperative (PSREC) demonstrate cost effective Smart Grid applications
- ◆ Components included: monitoring and control of utility infrastructure including BB connectivity to substations, remote monitoring of electric use to consumers, and Internet access to several remote locations

Rice University Trials

- ◆ Carlson consults for university conducting trials
- ◆ Rice University
 - Houston, Texas first urban home served.
 - Coming soon: Argentina test phase

Rice University Trials

- Prof Edward Knightly leads the [Rice Networks Group](#).
- Deployment, operation, and management of a large-scale urban wireless network in a Houston under-resourced community.
- This network, [TFA Wireless](#), is serving over 4,000 users in several square kilometers and employs custom-built programmable and observable access points.

Conclusion

- ◆ Preliminary testing shows 80+% of the typical “failed installs” can be supported with TVWS
- ◆ 250,000 immediate clients can benefit (WISPA clients)
- ◆ Data throughput much more acceptable with two channels bonded together
- ◆ Price point still above major market acceptance

Thank You

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VHF/UHF and Microwave products