

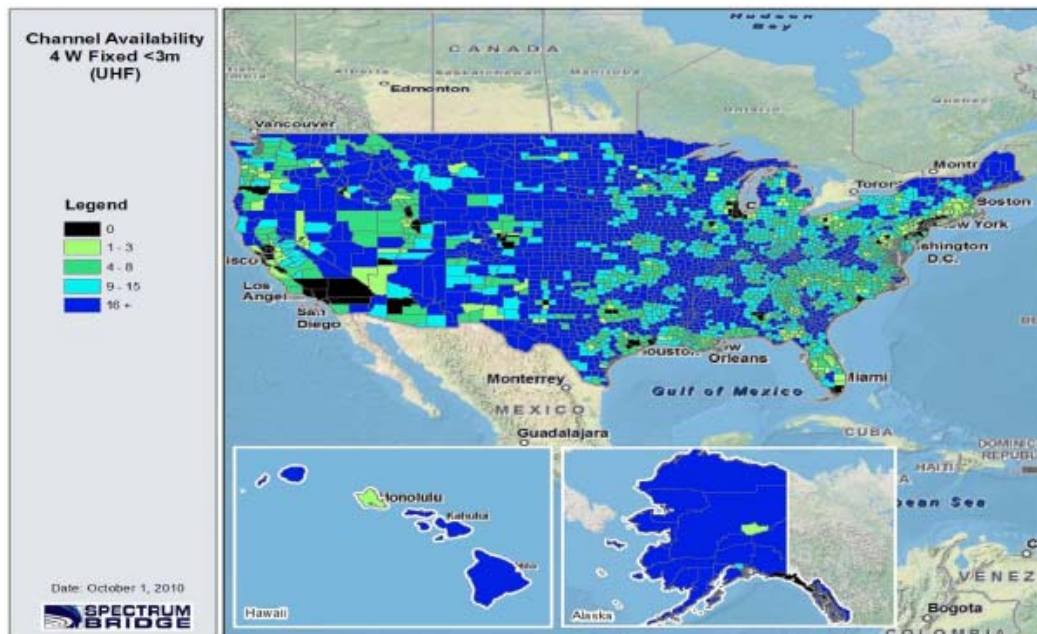
A breakthrough: Repurposing the TV White Spaces using database-driven cognitive radios

The electrical utility industry has seen a rapid increase in the need for wireless bandwidth with the advent of more intelligent field devices and federal directives for a smarter grid. Improving system monitoring, increasing system efficiency, and proactively controlling critical systems are some of the business forces driving the need for wireless bandwidth.

Two areas that electrical utilities are actively focusing their efforts for automated control are in Advanced Metering Infrastructure (AMI) and Distribution Automation (DA); with the bandwidth and coverage requirements to effectively communicate with wireless AMI collectors being a key driver for faster and larger wireless systems. Both AMI and DA communications present point-to-multipoint propagation issues since their antennas are rarely located higher than 20 feet above ground level (AGL). Traditional line-of-sight frequency spectrum like the 900 MHz ISM band have trouble reaching AMI and DA points and commercial cellular systems rarely have ubiquitous coverage in rural areas. Plus, utilities tend to be wary of using commercial communications for automatic switching schemes due to other reliability concerns. Thus, the focus on finding spectrum for these systems has moved to the higher propagation capable VHF and UHF spectrum, which traditionally has not been used for broadband communications. The search for solutions in this spectrum and viable products can be technically difficult and costly, especially if it includes purchasing spectrum on the secondary market.

One potential bright spot is the FCC's decision to make a significant amount of TV White Spaces spectrum available for unlicensed communications, including broadband data, for businesses and consumers. The TV White Space refers to a portion of the broadcast television spectrum that is not used by a licensed service in a particular area. Broadcast TV channel 2 (54–60 MHz), channels 5–6 (76–88 MHz), channels 7–13 (174–216 MHz), channels 14–36 (470–608 MHz) and channels 38–51 (614–698 MHz) are unused in varying degrees throughout the United States. Since each TV channel is six megahertz wide, this represents a significant quantity of bandwidth in frequency bands that have excellent propagation characteristics well suited for long distance high-bandwidth Super Wi-Fi type technology.

The map below developed by Spectrum Bridge, Inc. outlines the availability of TV channels across the USA. There are several open TV channels in most geographic areas, especially in rural areas.



The challenges that come with repurposing the TV White Spaces spectrum are multifaceted. These challenges include protecting the encumbered licensed services; allowing for new permanent and temporary licensed services; and developing commercially viable unlicensed products that will not interfere with the dynamically changing licensed services. The method to overcome these challenges selected was to create FCC sanctioned managed databases that actively provide current licensee parameters to database-driven unlicensed cognitive radios, which have the ability to change their frequency band as needed to accommodate the licensed services. This approach, while feasible, is complicated by the fact that the cognitive radios must be able to provide their GPS location to the data base to receive pertinent localized licensed service data.

In January 2011, the FCC adopted rules governing the use of unlicensed Television Band Devices (TVBDs) that will be allowed to operate in TV white spaces. These rules created two categories of TVBDs:

1. Fixed Operation, with operation permitted on channels 2-51 (excluding 3, 4, and 37),
2. Personal/portable Operation, with operation permitted on channels 21-51 (excluding 37).
Personal/portable TVBDs may be capable of up to three modes of operation:
 - a. Mode I operation under the control of a fixed or Mode II TVBD that determines the available channels,
 - b. Mode II operation capable of determining available channels at its location using geo-location and database access,
 - c. Sensing-only operation using spectrum sensing only to determine channel availability.

Central to the use of TVBDs is the TVBD database(s), which are to be privately owned and operated services that will be administered by FCC designated entities. All Fixed and Mode II TVBDs must be able to access the database at least once a day to identify the current usable local channels. Mode II TVBDs have the additional requirement to re-check the database if its location changes by more than 100 meters during operation. Mode I TVBDs, which do not have direct internet connectivity capability, are required to receive channel availability information from a fixed or Mode II TVBD at least once every 60 seconds.

Over the last year, the FCC Office of Engineering and Technology (OET) and the communications industry have been working to resolve possible co-channel interference challenges. This has included testing the database(s) accuracy and accessibility, and to do field trials to verify that licensed services are not experiencing interference. One notable trial of this spectrum and related technologies is underway to demonstrate how well TV white spaces can be adapted for Smart Grid technologies. The trial is a partnership between Plumas-Sierra Rural Electric Cooperative (PSREC) Spectrum Bridge, Inc., one of the FCC appointed TVBD database administrators, and Google, Inc.

A key breakthrough for commercially moving forward using the TV White Spaces occurred December 22, 2011 when FCC Public Notice DA 11-2043 announced the approval of the first television White Spaces database and type tested device in a limited geographic area, Wilmington, North Carolina and the surrounding county. A link to the actual Public Notice is http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-11-2043A1.doc.

An unofficial FCC News announcement excerpt is below:

Washington, D.C. – Washington, D.C. – Today, the Federal Communications Commission issued a Public Notice announcing that the Office of Engineering and Technology (OET) has approved

Spectrum Bridge Inc.'s television white spaces database system, which may provide service to devices beginning January 26, 2012. OET has also approved a device by Koos Technical Services, Inc. (KTS) as the first product allowed to operate on an unlicensed basis on unused frequencies in the TV bands. The KTS device will operate in conjunction with the Spectrum Bridge TV band database.

While this FCC announcement is a breakthrough towards the repurposing of the TV White Spaces spectrum, there are several open issues that still need resolution. One of the key technical areas to be resolved is how well does the database protect temporary licensed services from interference caused by the new unlicensed TVBD services. Most of the licensed services are regular licenses that the database will have static data to provide to the TVBD's. However, operators of multichannel video programming device (MVPD) receive sites, wireless microphone users and operators of temporary Broadcast Auxiliary Service (BAS) will be required to specifically register their dynamically changing sites to receive protection from the unlicensed TV Band devices. The TVBD database registration process still needs to be verified to be working properly in a "live" situation. Plus, the FCC's registration procedures for venues where large numbers of unlicensed microphones are still under development, but are expected to be finalized in the near future. This is why the approval of the database and the technology is currently limited to a small geographic area for now.

Provided that the above stated technical issues can be resolved, the FCC will roll this unlicensed service authorization out to the rest of the United States. This service will provide opportunities for deploying privately owned broadband systems using frequency bands that will have the ability to propagate to locations without line-of-sight to the master radio.

One last major commercial issue to be resolved is that there is currently only one device type tested and approved for this unlicensed service. However, there are many radio vendors that have stated that they are currently developing product specifically for use on this spectrum. Unfortunately, the timeline for commercially viable multiple vendor radio options is still a large unknown. The speculation of what types of products will be offered for use in this spectrum has varied in discussions on this matter. The most popular assumption is that consumer grade fixed and mobile TVBD's will be prevalent in the UHF spectrum, but due to the physical size of the antennas, the VHF spectrum will be relegated to utility and industrial applications only.

What this means is that many electrical utilities will probably have a new lower cost unencumbered VHF communications option for their system automation roadmaps that is well suited for private broadband communications to multipoint applications in hard to reach locations on their poles. This is especially true for rural deployments, where there are more unused TV White Spaces available and commercial broadband services are very limited. If this new unlicensed VHF broadband service does become commercially viable, this would be a huge breakthrough for electrical utility AMI and DA communications. However, as the old proverb says, "The proof is in the pudding", so will be prudent to see where this new possible opportunity heads in the future.

About Power System Engineering

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Charles manages the team that facilitates the evaluation, procurement and implementation of strategic communications infrastructure technologies for PSE utility clients following smart grid technology roadmaps. Charles has been working in the electrical utility industry for 20 years in various communications and application technologies. He has a Bachelor of Science degree in Electrical Engineering from the University of Wisconsin – Madison.

