Small and Rural Libraries Leading via TV Whitespace Networking Technology

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Abstract
This article describes TV Whitespace (TVWS) technology and the role it can play in addressing access and inclusion, developing distributed programming, and supporting crisis response. Focus is placed on the Pacific Northwest as a context for TVWS and the ways in which small and rural communities are uniquely suited to implement TVWS networks. A series of steps are provided for libraries interested in exploring the design and implementation of a new network. Finally, a preview of expected costs and anticipated performance is discussed.

Introduction

The Pacific Northwest is characterized by diverse landscapes including urban, suburban, rural, and Tribal settings. In the Pacific Northwest, like much of the United States, many communities struggle with bringing basic broadband access to their citizens in addition to creating public spaces that provide Wi-Fi connections. According to the United States' National Telecommunications and Information Administration (NTIA), "79 percent of Washington State residents, 80 percent of Oregon residents and 81 percent of Idaho residents were online last year. That compares with 75 percent of all Americans. Still, roughly 2.5 million people across the three states didn't use the Internet" (NTIA, 2016). Libraries are on the front lines of these challenges due to the strong role they play in providing millions of people with access to the internet, (Horrigan & Duggan, 2015), (Inklebarger, 2015). The reliance on libraries for internet access is directly correlated with the lack of free internet access in many communities (Pew Research Center, 2015). The dependence upon libraries is exacerbated by the reality that WiFi signals and Broadband connections only connect users within the boundaries of the library building. In 2014, the Association of Tribal Archives, Museums and Libraries prepared a report, *Digital Inclusion in Native Communities: The Role of Tribal Libraries*, which discusses the challenges Tribal Libraries face in providing access to their community members (Jorgenson, M., et al).

TV Whitespace (TVWS) offers one new technology capable of expanding libraries' ability to extend their Wi-Fi signals beyond the library building (and beyond library hours) to public spaces such as subsidized housing, schools, clinics, museums, senior centers, and other community anchor institutions. By implementing a TVWS network, libraries have the potential to support access and inclusion in new ways. In this article, we describe TV Whitespace technology and answer several common questions about its implementation. We extend two discussions that emerged at the 2017 Pacific Northwest Library Association's annual conference in Post Falls, ID (Rebmann & Means, 2017) and in an article we wrote as a primer for understanding the basics of the technology (Rebmann, Te, & Means, 2017).

What is TV Whitespace?

Koerber (2016) found that when libraries implement technology upgrades there can be significant positive

impact on programs and services. TV Whitespace (TVWS) represents one technology upgrade that libraries can introduce to improve access and inclusion in their communities. TVWS spectrum refers to radio frequencies that were released by the Federal Communications committee in 2008 to provide license-free access for the public. These frequencies were unused and released with the goal of supporting public access to data and broadcast communications.

TVWS is unique in that it does not require line-of-sight to support signals. Frequencies associated with TVWS reside in the lower radio frequency bands. For this reason, signals can travel for several miles and oftentimes pass through geographic and community obstructions such as trees or buildings. Frequencies located in the higher radio frequency bands (such as those associated with traditional WiFi) can be blocked by similar obstructions. In addition to these technological benefits, TVWS is powerful due to its role as a publicly accessible communications technology. Through its regulatory agency, the Federal Communications Commission (FCC), TVWS is not owned or controlled by a private entity. Therefore, access to TVWS is and shall remain freely available.

How can TVWS benefit communities in the Pacific Northwest?

WiFi, with a reach measured in 10s of meters, provides great service for users within or very close to the library building. WiFi, with a reach measured in 10s of meters, provides great service for users within or very close to the library building. By contrast, the range of TVWS-enabled networks is measured in 100s or even 1000s of meters (Chavez et al, 2015), thus augmenting the number of patrons libraries can serve via wireless connections to the internet. TVWS can work as a conjugate to WiFi, thus allowing libraries to extend their wireless networks of internet access. This strategic extension of WiFi into new community spaces augments the number of patrons able to access library programs/services and the internet.

The FCC defines Community Anchor Institutions (CAIs) "as schools, libraries, hospitals and other medical providers, public safety entities, institutions of higher education, and community support organizations that facilitate greater use of broadband by vulnerable populations, including low-income, the unemployed, and the aged" (FCC, 2011, p. 38). As part of their role as CAIs, libraries can leverage TVWS to provide convenient WiFi access for the community in new places never before served. Parks, shelters, playgrounds, senior centers, and post offices are just a few places that can serve as candidates for new library hotspot locations.

Libraries can likewise partner with K-12 schools to close the "homework gap," or work with healthcare providers to create connections to the homes of patients for services such as remote patient monitoring. The portability of access points can support distributed programming and wireless connections to community-based activities and events. Still in its nascent stages, TVWS has the potential to improve disaster response also due to the portability of TVWS hotspots. By moving with populations in crisis, TVWS hotspots can provide essential digital access to people under evacuation.

Small and rural libraries have an advantage with TVWS in that their communities enjoy the availability of many channels and less competition for those channels with independent broadcasters or private media companies. Yet, smaller communities face the challenge of having broadband connection rates that meet requirements for TVWS implementations. Successful networks require a minimum (backhaul) connection rate of at least 20 megabits per second (Mbps). An important first step for libraries is to work with

their information technology (IT) staff to determine their connection rate and the channel availability in their area.

Determining channel availability and coverage in your area

Several equipment suppliers provide access to tools and resources to help individuals determine channel availability and coverage in their area. For example, Spectrum Bridge provides a tool to search for open channels based upon user-provided information. See the Spectrum Bridge site here: http://whitespaces.spectrumbridge.com/whitespaces/home.aspx. On the Spectrum Bridge site you can enter the name of your town or zip code into the database for instant results. Important to remember is that you'll be searching for fixed devices, as mobile devices are not yet available.

Once you determine that channels are available in your area, you might wonder how far the new signals may extend or the amount of throughput that can be expected. In our experience with several library pilot and subaward sites, libraries can expect 3-15 megabits per second (Mbps) for each channel for up to seven miles. Performance depends strongly on equipment configuration, vendor, and community topology.

Once you understand the distance that TVWS signals can travel you might wonder whether a TV Whitespace Network can create a seven-mile WiFi hotspot. In fact, TVWS networks do not create a seven-mile radius WiFi hotspot but libraries will be able to use the technology to locate new remote library WiFi hotspots, of traditional range, up to seven miles away. Remote library hotspots with closer proximity to the TVWS antenna will enjoy better performance.

Design and implementation of a TVWS network at your library

Once a library decides that they are committed to the design and implementation of a TV Whitespace network, they should take the following steps:

1. Identify and quantify their current fiber-based connection to the internet and several community spaces where internet access is needed.
2. Make sure that the library's backhaul (broadband connection rate) is at least 20 megabits per second (Mbps) or faster.
3. Work with a TVWS equipment supplier to install a TVWS base station that is integrated with their wired connection to the internet. This step allows the library to gain access to public TVWS frequencies by which they can broadcast and receive internet connections from paired TVWS-enabled remote hotspots.
4. Place TVWS-enabled remote hotspots in (previously identified, community) locations where internet access is needed by underserved populations.

Publicize the new TVWS-enabled remote hotspots that now provide WiFi connections to patrons in community spaces previously out of the library's WiFi-enabled reach.

Expectations of cost and performance

Our Institute of Museum and Library Services (IMLS) grant supported the provision of five $15,000 subawards to cover installations of TVWS networks in five communities. During the course of the grant, we found that there was wide variability in terms of cost due to idiosyncrasies associated with library-driven network designs and configurations. Despite these differences, the subawards covered basic installations. Although there is an initial equipment investment, access to TVWS frequencies is free and requires no ongoing subscription fees (Chavez, et al., 2015).

Installation times also vary across project designs (and seasonal weather) but simple configurations of a base station and several remote units generally require no more than a week to install. Installations typically proceed along two phases. Phase 1 of creating a new TVWS network involves essential equipment installation while a second phase involves setting up the system to accommodate the new nodes (hotspots) on the local network.

TVWS networks are characterized by their stable and reliable performance. A critical component of the IMLS project mentioned above includes efforts to quantify increases in library network usage associated with the technology implementations. Also to be evaluated will be the attention and support needed to keep the equipment stable over long periods of time. We will publish our results as they emerge.

Conclusion

TVWS installations have been piloted by libraries in Mississippi, Colorado, Kansas, and Delaware. The Institute of Museum and Library Services recently provided funding for our team to provide subawards for several new networks in Maine, Georgia, South Dakota, Yakama Nation (Washington), and Nebraska. Libraries in the Pacific Northwest (particularly small and rural organizations) are well-placed to explore the potential impact TVWS might have on access and inclusion in their area. Partnerships with other community-based organizations can create opportunities to close the homework gap, design innovative (distributed) programming, and take a leading role in crisis response.

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