"Reaching the Rest of Us: Public Spectrum for Public Access"

Libraries lead in providing public access via TV WhiteSpace to help bring billions of new users into global digital conversation

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Abstract:

A promising global scenario has emerged wherein public libraries and other community centers have begun using TV WhiteSpace(TVWS) and other license free spectrum technologies to provide internet access and services for the greatest number of first time users in the shortest time at the least cost. The service opportunities and policy challenges in this approach can be found by exploring the benefits of a pubic access approach, the roles of libraries as value add providers, and the connectivity capabilities of TV WhiteSpace.

Keywords: public access, TV WhiteSpace (TVWS) spectrum, connecting next billion, WiFi

Introduction:

This paper attempts to make the case for public support of libraries and other community centers in the use of open license exempt wireless frequencies in the TV broadcast bands as public domain spectrum to support the provisioning of public access in every community in every country. It further hopes to encourage individual libraries and library associations to assume community and national leadership roles in the evaluation and use of emerging technologies to expand public access and to help achieve global universal service.

Opportunity: Global/Local Leadership

It is amazing how persuasive it is when something actually works. Having libraries engage in showing (even modestly) what is possible in this new TV White Space environment is the most persuasive way to get others up and running," - GLN advisor and internet pioneer, Vint Cerf.

A promising global scenario has emerged wherein public libraries and other types of community centers, using TVWhiteSpace(TVWS), WiFi and other license free spectrum technologies can provide internet access and services for the greatest number of first time users in the shortest time at the least cost. The service opportunities and policy challenges in this approach can be found by exploring the benefits of pubic access, the roles of libraries as value added providers, and the new connectivity capabilities of TV WhiteSpace.

"Libraries should be used to initiate universal and affordable infrastructure in developing countries and underserved communities in developed countries." -Internet Governance Forum's Dynamic Coalition on Public Access[1]

The UN's 2030 Sustainable Development Goals(SDG's) include bringing the estimated 4 billion people, currently without internet connections, online. At the same time prioritizing digital literacy skills and affordability of access to the internet so that everyone is able to participate in the information society. To "*significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020.*"[2]

Public Access: Key Strategy

In determining which strategies can be most effective in providing connectivity to the next billion(s), a wide array of infrastructure, end user technologies and financing models may combine in different ways in each country or even each locality to guide public and or private investment decisions. Similar expenditure decisions also occur at any level, from the individual to the national.

Public Access represents the most economical, expedient and equitable way to reach the greatest number of new users. Libraries or other community centers can be connected at a fraction of the cost of reaching every premise. These public access facilities provide low fee/ no fee basic access "entry points" and when combined with support services, can drive demand for commercial services. This was demonstrated in the early days of the World Wide Web in the 1990's when millions experienced streaming media delivered through first generation broadband at a library and who then subsequently demanded the same always-on faster service at their homes and businesses.

Connectivity is necessary but insufficient. In his April address, World Bank President Jim Yong Kim declares: *"Two things we know for sure will be needed: connectivity for everyone and also the ability of people to engage in that new digital world. We have to move quickly*

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[1] http://review.intgovforum.org/igf-2015/dynamic-coalitions/dynamic-coalition-on-public-access-in-libraries-dc-pal/

[2] http://www.globalgoals.org/global-goals/innovation-and-infrastructure/

on connectivity, but we have to move equally as fast in making sure that people are able to take advantage of that connectivity."[3]

Libraries: Acknowledged Community ICT Hubs

Libraries and Telecenters have proven 6 times more effective than internet cafes in helping new users get started. Global Impact Study: libraries, telecenters, cybercafés, – comparing public access ICT venues.[4] Even in developed broadband markets, new users generally need startup support, but any preexisting hub or facility that already serves as community center is a logical place to develop first step public access infrastructure. IFLA agrees, "*Where libraries do not exist, information and documentation centres should be recognized as a vehicle for ensuring universal access."*[5]

Led by IFLA, the Internet Governance Forum's Dynamic Coalition on Public Access in Libraries recently published a comprehensive list of principles that encourages national roles for libraries and library associations in policy, accessibility, skills development and local content development. The first principle relates to Infrastructure. *"Libraries should be used to initiate universal and affordable infrastructure in developing countries and undeserved communities in developed countries."*

In the context of the 2030 SDG's, the US State Department, in partnership with the World Bank and International Monetary Fund in late 2015, adopted the goal to connect the next 1.5 billion people in the world by 2020 known as the Global Connect Initiative(GCI).[6]

The early work of IFLA, EIFL, IREX/Beyond Access, the Gigabit Libraries Network(GLN) and others has influenced new thinking on the potential for libraries worldwide as the archetype of community ICT access centers. This is welcome if overdue recognition of libraries as most natural in providing communities with public access as a highly effective approach to bringing 100's of millions and even billions of new users online.

The evidence of the success of these efforts to influence access policy can be found in the supporting GCI documents, *Principles and Global Actions*, where libraries are highlighted and prioritized for their roles in providing public access with added services that better enable productive uses of the internet.

Libraries are specifically mentioned in two among seven guiding GCI principles: "*We should encourage public access, as for example in public libraries and community centers, among others;*" and its close companion: "*We should foster digital literacy, enable and promote the development of locally relevant content, applications, and services as they are essential to widespread adoption of the Internet and increase its social and economic value to people, families, and communities;*".[7]

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[3] http://blogs.worldbank.org/voices/end-poverty-there-must-be-digital-connectivity-all
[4] http://www.globalimpactstudy.org/2013/07/global-impact-study-final-report-findings-released/
[5] http://www.ifla.org/files/assets/hq/topics/info-society/documents/handout-principles-on-public-access-in-libraries.pdf
[6] http://blogs.worldbank.org/voices/end-poverty-there-must-be-digital-connectivity-all
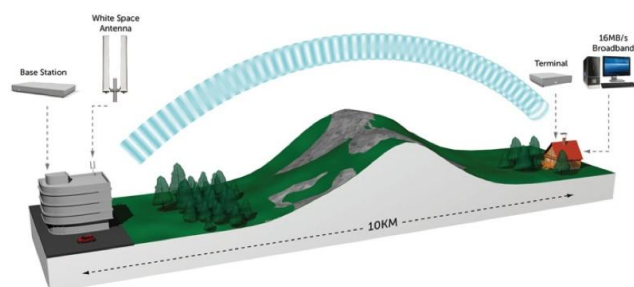[7] https://share.america.gov/wp-content/uploads/2016/04/1.-GCI-Connectivity-Principles-FINAL.pdf

TV WhiteSpace: New Open Public Spectrum

The missing "link" in many developing countries has been a lack of affordable communications and electrical infrastructure. TVWhiteSpace, while not a total solution, creates a powerful component in rapidly and inexpensively extending the overall wireline and wireless connectivity ecosystem in the here and now. All networks have edges and gaps. The unique capabilities of TVWS allow any network to be expanded on wide area scale.

TV WhiteSpace, TVWS or simply WhiteSpace, is the name for unused wireless frequencies in the old analog TV broadcast bands known as VHF (Very High Frequency) and UHF (Ultra High Frequency). The conversion to digital TV broadcast has opened up large amounts of extremely valuable spectrum for data communications. The special characteristics of WhiteSpace as a public domain communications medium are like traditional WiFi, but have connection range measured, not in 10's of meters but in hundreds or even thousands of meters.[8]

TV White Space(TVWS)

- **Long range DIY wireless data communications
Using free public spectrum in TV bands**

WhiteSpace is also special for its non-line-of-sight and penetrative capabilities allowing signals to pass through obstructions like trees and buildings and even over small hills. WhiteSpace is open shared spectrum but requires no fees, permits or even towers to establish direct data links between locations kilometers apart.

TV band spectrum (all spectrum) originates as public property, the public airwaves. Due to TVWS' special properties it is recommended at least a portion of these extremely valuable radio frequencies be retained for open public use, like traditional WiFi. According to US-based Public Knowledge, *"TVWS represent a major advance in wireless technologies and "next generation" WiFi and unlicensed services."*

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[8] https://en.wikipedia.org/wiki/White_spaces_(radio)

TVWS transceivers require very low power and so more amenable to places lacking electrical infrastructure through use of alternative energy sources like solar and wind power.[9]

Libraries that have direct internet connections have begun to expand their service areas, using TVWS to enable new remote public library access points, as is being demonstrated in the Libraries WhiteSpace Project.[10] In some cases, like in Kenya, TVWS is used to provide or upgrade broadband connectivity to libraries and schools themselves.[11]
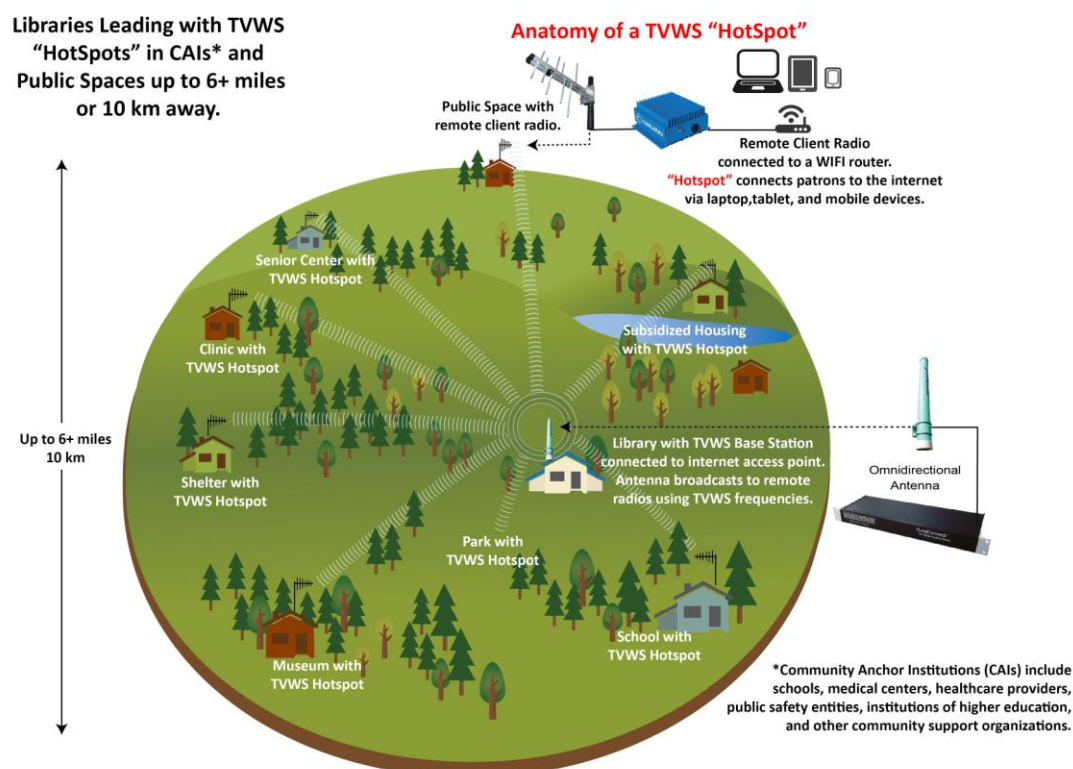

Figure 1. Lbraries Leading with TVWS. Modified Infographic from TVWS Equipment Manufacturer and Collaborator Carlson Wireless Technologies

Since 2014, libraries in the U.S. have been early adopters by undertaking pilot TVWS projects and with generally positive results. All are providing a wide range of helpful experiences that also make the point that every situation, like every community, is a unique combination of circumstances(topology, population density, existing infrastructure, socio-economic levels, etc.) and local priorities. And that the only way to realize the potential value of this low cost, "weightless" infrastructure is to test it in one's own environment.

Cases: Those who pioneer

Manhattan, Kansas Public Library was among the first to pilot a Library WhiteSpace Project in the U.S. *"We feel it is important to explore this technology in a changing library landscape. The possibility of extending the reach of our library's service community was very attractive. The potential to reach out and offer our services to underserved populations was also attractive,"* says library IT Director Kerry Ingersoll.

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[9] ibid

[10] http://giglibraries.net/page-1712342

[11] http://www.idgconnect.com/abstract/10392/mawingu-usd3-kenyan-internet-tv-white-space-sun

In less than 2 years, new remote library access points have become so heavily used, even without marketing, that they sometimes handle as much data as does the central facility. This has increased the value of the library to its community and to the city government, especially the Park and Recreation Department, whose facilities now have a new popular amenity, library WiFi.

The Manhattan Library's TVWS deployment plan was straightforward: install the base station in the central library and three remote units in public spaces like parks and playgrounds. One of the units was originally shared between the public swimming pool in summer and the ice skating rink in winter, but both locations exhibited so much year round that the library simply added another remote access point.

However, the initial set up gave proof of portability, which demonstrated an capability to relocate remote hotspots in times of crisis or disaster. In turn, this evidence led the library to make contact with local emergency management department to share information and initiate collaborative disaster planning efforts.

The notion of using TVWS as a resource to increase resilience to disaster arose in the Gulf Coast where the **Pascagoula, Mississippi School District**, having endured the devastating storm Katrina in 2005, wanted to be more prepared for the next one. The idea for a portable TVWS-enabled remote access point, ready at a moment's notice, to move to damaged areas as a pop up hotspot for disaster communications relief and recovery, has established a powerful dual use rationale.[12]

When the school district was evaluating locations for siting of remote units, it drove a portable remote unit around checking signal strength at various places across the city. Where the connections were strongest they made marks on the street to indicate optimal placements in the event of a crisis.

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[12] https://www.facebook.com/PSDTVWS

The **Philippines,** where early stage testing had been permitted in 2013, had just experienced its own monster typhoon and many areas were leveled by the storm. TVWS trial units were quickly transferred to hardest hit areas to provide communications zones as WiFi hotspots to support urgent family reunification needs as well as general community recovery efforts. Microsoft Asia subsequently wrote up the actions with recommendations for creating response "kits" using three WiFi/TVWS units, a VSAT and solar stations as a complete package, "TV WhiteSpace in Disaster Response in the Philippines".[13]

The **Delaware State Library** has begun investigating TVWS capabilities to extend library access and also working with small businesses in parts of the state underserved by ISP's to develop new approaches to connectivity.

Delaware has been one of the state level pilots in the US where the office of the State Librarian and the University of Delaware are leading an ambitious state wide initiative to determine the feasibility of deploying TVWS hubs at every library facility in the state. *"The WhiteSpace Pilot will extend our successful Job Centers @ Delaware Libraries services to further support business growth and entrepreneurship in Delaware,"* says Dr. Annie Norman, State Librarian of Delaware. **Pennsylvania Library** has initiated a new three system pilot project and the **Ohio Library** is offering generous matching grants to qualifying libraries in the state.

The **Maine Library** has announced a partnership with Axiom Technologies in an ambitious proposal to install TVWS-enabled wireless access points (WiFi) on the roofs of all 230 libraries in Maine. Axiom has also been awarded a grant from Microsoft to explore use of TVWS to provide low cost internet in economically challenged areas of the state.[14]

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[13] https://s3.amazonaws.com/oi2_kf_prod/attachments/132a206b-1739-45fc-8079-eac64abd039a.pdf
[14] http://www.govtech.com/dc/articles/Maine-County-Receives-Microsoft-Grant-to-Provide-Internet-to-Rural-Homes.html

Delta County, Colorado Library District found that TVWS technology can punch through with broadband internet where other wireless solutions are unable to penetrate tree canopy, buildings and other obstructions. *"TVWS systems are very easy to set up and a cost effective connectivity option particularly in rural areas where Fiber, DSL, cable services are not available,"* -John Gavan fmr library IT mgr.

Delta County Library project started as simple plan to install one remote unit in the town park of Paonia, CO and another on top of a three story office building to provide access for their block long main street. However, while the project was still in trial and though it had performed beyond expectations, the library lost budget needed to purchase the gear. Instead of giving up and returning the hardware, a resourceful library director reached out to the town to raise the US$6k total system cost via an online Kickstarter crowd funding campaign that not only raised the needed cash but also raised awareness and support for an innovative effort by the library to expand service in their community.[15]

Paonia CO, Public Library with omni-directional (green) TVWS base station antenna.

The remote unit in a city park has come to serve the vendor transaction communication needs during the weekly market and the main street hotspot was used to enable a street concert webcast by the local radio station. Neither of these uses was anticipated. Creativity and discovery have been hallmarks of the Libraries WhiteSpace Project.

All projects where GLN has been involved have been encouraged to document their projects from beginning through to completed installation. The Pascagoula project created a FaceBook and documented each step.[16] Manhattan, KS created and posted a "Pro's and Con's document.[17] The Delaware State Library created a slide show to give a presentation to the Chairman of the FCC. Paonia, CO project created a dedicated web page.[18]

With support from a 2015 grant from the Knight Foundation, GLN developed preliminary analysis tools and checklist resources to help interested libraries to become acquainted with

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[15] https://www.kickstarter.com/projects/1360234848/library-sponsored-public-hotsots-for-paonia-co
[16] https://www.facebook.com/PSDTVWS
[17] https://plus.google.com/107631107756352079114/posts/L4Y8ci8sG5Y
[18] http://www.deltalibraries.org/super-wi-fi-pilot/
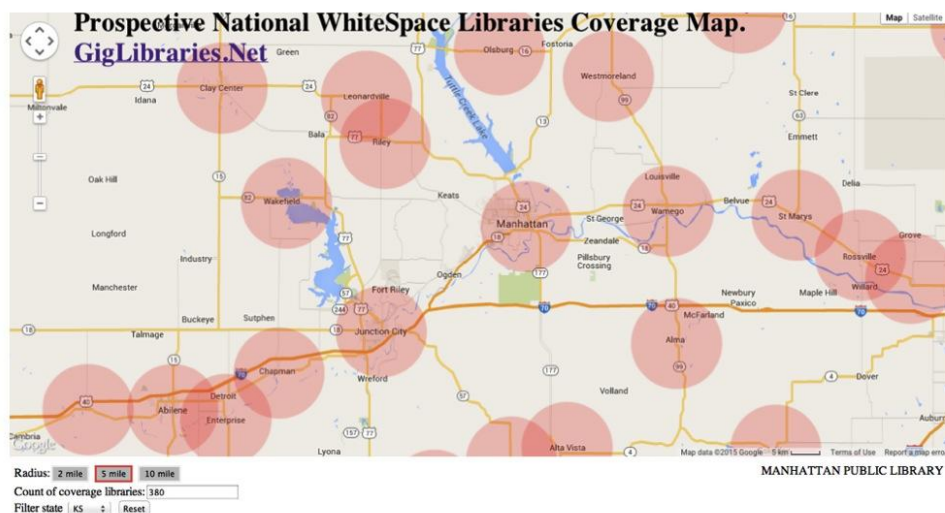
the capabilities of TVWS equipment. A two minute overview video[19] has proven effective in helping establish a basic grasp of concepts and capabilities. In partnership with the Chief Officers of State Library Agencies (COSLA), GLN co-produced seven webinars on various aspects of WhiteSpace use which are archived and available for play on the COSLA website.

For US libraries, GLN created a Prospective Coverage Map[20] based on over 16,000 library coordinates provided by the Institute of Library and Museum Services(IMLS). Users can filter by state and by possible coverage range for TVWS enabled remote units to help evaluate potential community hotspot locations.

The map is "zoomable" with an area around each library being selectable by two, five and ten mile radius circles to give a rough approximation where client units might be installed to create remote connections. Two miles is considered an almost sure connection. Five is highly likely and even ten miles away is possible in ideal conditions.

Screen capture from mapping tool shows section of Kansas covering ~20 library sites.
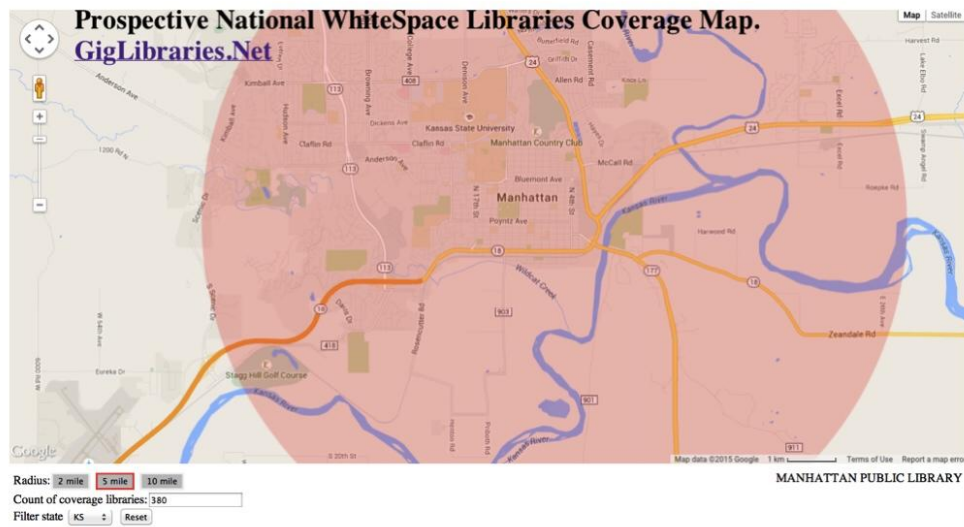Zooming in shows detail to aid site selection for library remote hotspots.

[19] https://www.youtube.com/watch?v=SofOEsh3BNU
[20] http://wsgmaps.droppages.com

Locate proposed remote sites for initial analysis

Singapore--- based Power Automation and A*STAR's Institute for Infocomm Research (I2R) are working with the Gigabit Libraries Network to conduct TV WhiteSpace trials in rural Malaysia and the Philippines. *"This partnership will promote education and information access through enhanced connectivity at community libraries and neighborhood schools to bring greater benefits to those being served,"* says Project Director See Gim Kerk of Power Automation, a JV between Singapore Power and Siemens.

A major project, proposed for **India,** calls for using TVWS base stations, located at regional government facilities with fiber end points, to support remote WiFi clusters in surrounding villages in over 500,000 communities.[21]

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[21] https://arxiv.org/pdf/1603.01999.pdf

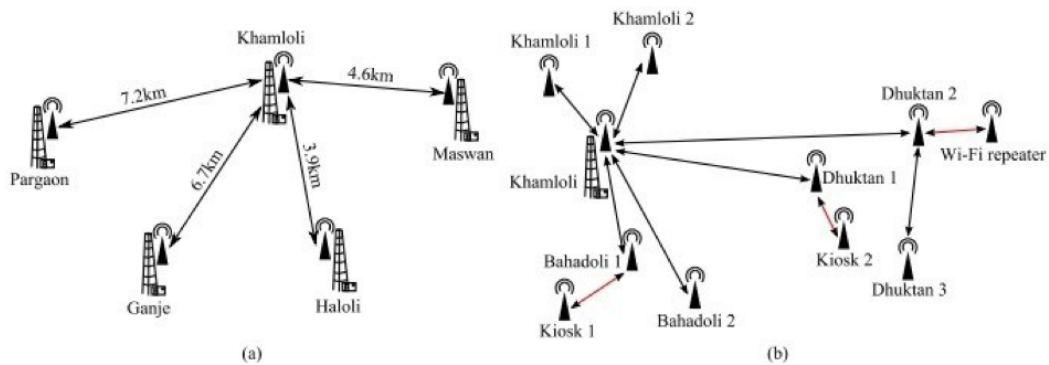**Eg. Proposal by Indian Institute of Technology using TV WhiteSpace / WiFi Clusters to connect 500,000 villages in India**

image by Kumar & co.

Libraries anywhere interested in pursuing projects should consult their national regulator to determine the status and availability to use or test TVWS equipment. Even trial stages create leadership opportunities for libraries to explore equipment capabilities as well as institutional partnerships. Seeking out preexisting projects to determine potential for libraries to add value is an obvious step, especially where the pilots are already connecting neighboring schools.

A list of dozens of TVWS projects in a wide range of uses across five continents can be found on the "Pilots" page[22] of the Dynamic Spectrum Alliance, *"a global, cross-industry alliance focused on increasing dynamic access to unused radio frequencies."* Various project partners are listed and should be available and interested in adding a library component onto existing projects or even discussing new ones. Wireless ISP's generally make knowledgeable partners.

Barriers to adoption include: lack of national enabling rules, inadequate back end connections, lack of minimal technical skills, overly optimistic performance expectations, vendor evaluation, spectrum availability in highest density areas, carrier resistance, budget constraints, lack of political support.

Policy priorities: Universal Service and Shared Public Spectrum

Smart spectrum allocation and enhanced USAF programs are two key enabling policy areas vital to realization of a "WhiteSpace Library" approach to expanded public access. These

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[22] http://dynamicspectrumalliance.org/pilots/

policy domains are typically the responsibility of national telecommunications regulators who generally oversee both.

This extract from the preamble to the April 2016 GCI Global Actions list is also revealing: "*Countries are using universal service funds to expand access to their remote communities and underserved populations, bringing affordable access to millions of people. Programs to extend 3G, (etc) wireless access; to deploy Wi- Fi hotspots in community centers, libraries, schools, and clinics; and to leverage emerging technologies for reaching remote communities, will greatly expand broadband communications access.*"[23] This extremely laudable objective for national USAF programs opens the door to wider community collaborations with schools, clinics and other public institutions to aggregate their demand into significant market influence.

USAF programs should be enhanced/expanded to support connecting these centers while also enabling open shared infrastructure for public and commercial use. Yet, the first obligation of USAF fees should be in support of universal service with public access being most economical and equitable way to provide it.

As the Global Impact Study wisely concludes: "*Governments and donor organizations should continue to make public access availability a strategic consideration, particularly in rural areas and where widespread private access is not feasible in the near future.*"[24]

Expediting rules to accelerate trials, if not adoption, should be a national priority in the service of local/national public access strategies. TVWS can leverage backhaul end points to quickly and inexpensively distribute regional scale connectivity.

Even though there is no "one size fits all" spectrum regime for all countries, regulators play a crucial role in determining effective policies to enable TVWS and other spectrum sharing rules. No other telecom infrastructure has proven its ability to reach as far as quickly and for so little investment as WhiteSpace.

Beyond national telecom authorities, "*Finance ministers play a critical role in connecting the unconnected,*" said World Bank President Kim. "*They should also make sure that funds set aside to bring telecom services to remote areas are spent for that purpose.*"

Demonstrating economic impact, new attention from finance ministries offers promise of wider support as per the April 2016 annual report and meeting of the World Bank, "*Ministers of finance have a key role to play in expanding connectivity. They can help repurpose universal service funds to expand access to broadband, and can use their financing power to shape more streamlined and integrated e-government platforms and solutions across government agencies and public sector institutions.*"[25]

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[23] https://share.america.gov/wp-content/uploads/2016/04/GCI-Global-Actions-FINAL.pdf
[24] http://www.globalimpactstudy.org/2013/07/global-impact-study-final-report-findings-released/
[25] http://blogs.worldbank.org/ic4d/unleashing-transformative-power-internet

Conclusion: Global Collaboration for Local Implementation

The world's 320,000 public libraries, in aggregate, are positioned as the global institutional leader in providing of no-fee/low fee public access plus instruction, tech support and devices.

Each individual public library is already in the business of providing access to their communities. Building on that traditional and near universal library service creates a several exciting opportunities. One is to use new TV band wireless communications to either initially provide or upgrade connectivity to libraries or to use those WhiteSpace technologies to extend existing connections farther out into their communities as new remote library access points or "micro branches".

A second opportunity is to formally declare and align with the global goal of bringing first time access to billions, in both developing and developed markets, since people without access can be found in every country.

The challenge cannot be overstated. According to the ITU, over 4 billion are still offline as of the end of 2015. A more recent report by A4AI emphatically notes that unless there is dramatic acceleration in progress, only *"16% of people in the world's poorest countries, and a mere 53% of the world as a whole, will be connected by 2020."*[26]

A special opportunity exists for national library associations to reach out to their respective telecom regulators for guidance on availability of TVWS equipment in each country and to advocate for increased allocation of radio spectrum for license free use generally and in support of public access specifically. A complementary opportunity exists to advocate for enhanced/expanded universal service funding in the service of un/underserved markets. In the US, thanks to the e-rate program under USF, *"virtually all schools and libraries have Internet access."*[27]

Helping bring new billions of people online is not only a worthy goal to endorse and support, it also provides an open global collaboration for libraries anywhere to join in a common worldwide campaign for universal access.

In the words of H. Nwana, former head of spectrum at UK telecom regulator, Ofcom: *"The prospects for TVWS to play a key role in helping connect the next 4 billion people cannot be overstated. Except for perhaps Wi-Fi itself, no wireless data communications technology has offered so much capability for so little cost. Who better and more trusted than the world's 320,000 libraries, as intermediate end points in telecom infrastructure buildout, to act as test lab and access point in communities everywhere. The impact of this in America and the rest of the world is incalculable!"*[28]   Indeed! Who better?!

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[26] http://a4ai.org/2015-16-a4ai-affordability-report-out-today/
[27] https://www.fcc.gov/general/universal-service-program-schools-and-libraries-e-rate
[28] https://www.newschallenge.org/challenge/libraries/winners/library-led-50-state-field-test-of-tv-white-spaces-tvws-potential-to-support-100-000-new-distributed-library-wi-fi-access-points#comments-section