October 2017

Policy Brief
Spectrum Approaches for Community Networks

Internet Society

Introduction

The Internet Society's goal is to make the Internet available for everyone, everywhere.[1] The Internet currently reaches three (3) billion users, meaning that over half of the world's population remains offline.[2] This connectivity "gap" exists in urban, rural, and remote unserved and underserved areas of many countries, particularly developing and least-developed countries.[3] Historically, this includes the challenge of extending connectivity infrastructure and affordable services to end-users (often times referred to as the problem of "the last mile"), and the challenge of attracting and enabling people to be online.

Factors that contribute to these challenges are well understood: lack of affordable access to backbones, barriers to entry (licensing, taxes, spectrum allocation practices), low population density, high deployment costs, low economic capacities of some populations, limited availability of locally relevant content, and issues with technical skills.[4] The connectivity "gap" needs to be closed. By closing this gap, economic and social benefits can be brought to communities across the globe.[5] One way to help close the gap is through community-based connectivity projects[6], particularly through community networks, network infrastructures built, managed, and used by local communities.

To truly connect everyone, everywhere, community networks must be recognized as a viable way for the unconnected to connect their communities. This is a paradigm shift where the focus is on allowing communities to actively connect themselves. To achieve this paradigm shift, policy makers and regulators should recognize that connectivity can happen from the "village" or "community" out – where the last mile is essentially a "first-mile," where citizens build their own networks. Community networks are complementary to traditional, commercial telecommunications networks.

Policy and regulatory factors to enable community networks to succeed include innovative licensing, funding opportunities that can include, but are not limited to, traditional universal service funds (USF), and access to spectrum. The focus of this paper will be on the importance of enabling access to spectrum,[7] including utilization of currently unused spectrum, recognizing that other challenges to community networks also exist.

Key Considerations

What are Community Networks?

A community network starts with a local group of people who want to bring communications to their local village or town or who want to enable communications for other local services. This group or "community" may grow over time as interest develops in changing local circumstances. The local community network generally is a "local community join[ing] together to pay for the common infrastructure based on the value realized by the community as a whole."[8] Community networks are built and operated by people in the community; they are the result of people working together, combining their resources, organizing their efforts, and connecting themselves to close connectivity and cultural gaps. These networks are often small in scope, usually serving communities under 3,000;[9] but, some serve more than one village or community. For example, guifi.net, a community network located predominantly in Spain, and with nodes in Africa, Asia, Latin America, and Europe, is estimated to serve more than 50,000 people.[10]

From an infrastructure perspective, some community networks rely on wireless and optical fiber technologies, and often feature a distributed architecture.[11] For example, some networks are Wi-Fi only, others are mesh networks or simple 2G networks providing voice and SMS services, and others are municipal networks, like Freifunk in Germany.[12] From a regulatory and policy perspective, community networks change the focus on "the last mile;" these networks, built from the "bottom-up" are "the first mile,"[13] not the last mile. This means that connectivity starts in a community.

Experience has shown from existing community networks that there are numerous benefits to the community. The cost of deploying community networks can be low. Often, the technology required to build and maintain the network is as simple as an off-the-shelf wireless router.[14] In other cases, it is more difficult and requires changes to firmware, hardware, and software. The bottom-up organization of community networks yields benefits and local buy-in as well, including:

- Benefiting end-users and the community networks themselves with cost-oriented approaches;
- Providing service that is tailored to the unique needs of the community;
- Empowering local people, and thereby encouraging involvement in other grassroots efforts, community affairs, and political processes;
- Encouraging digital literacy;
- Providing a "stepping stone" for people to become part of the global economy;
- Creating new working opportunities; and
- Promoting the virtuous cycle by improving both access to and creation of local content and services.[15]

As noted earlier in this brief, community networks are complementary access networks. They provide local access where traditional or commercial networks do not reach or serve particular areas, or where commercial operators do not find it economically viable to operate in particular areas. They represent a viable way to connect areas "that are unattractive to telecommunication operators and governments."[16]

We believe that community networks should be viewed as a connectivity option that provides access and connectivity to people, where, as mentioned earlier, a network is built *in* and *for* that local community, area, or region. For the most part, the areas that benefit from community networks would be ones that were previously unconnected, or they are communities where connections were unaffordable. Where traditional networks with limited services do reach such communities, community networks are complementary to traditional networks.[17]

The Critical Importance of Access to Spectrum

It is widely recognized that access to information and communications technology ("ICT") creates social and economic benefits.[18] This is reflected in the United Nations Sustainable Development Goals, which includes "significantly increas[ing] access to [ICT] and striv[ing] to provide universal and affordable access to the Internet in least developed countries by 2020."[19]

ICTs provide the basis for opportunity and success in today's global economy, and enable critical social benefits as well. From e-commerce to e-health, from emerging industries and technologies to distance learning, from social and political engagement to public safety, ICTs are the backbone of contemporary societies.

Access to affordable and available spectrum is a foundational principle for ensuring access to ICTs and future network development.[20] For every community to reap the social and economic benefits of ICTs, policy makers must ensure that adequate spectrum is available for community networks, citizens, and other entities seeking to develop networks and provide access to ICTs. Ensuring adequate spectrum will be the difference between new ICT applications flourishing or languishing, and will be the difference between community networks providing much needed access to under-served communities. Without spectrum, these communities and citizens will not benefit from modern-day developments.

Challenges

Ensuring access to spectrum is a significant challenge[21] to connecting unconnected areas via community networks. Community networks critically rely on the availability of spectrum; the scarcity or perceived scarcity of spectrum threatens the networks' ability to operate and deliver services. Too often the notion of scarcity has been an argument that stalls competition and delays all manner of network deployment.

Ensuring that adequate spectrum is available for community networks is a key policy principle for expanding Internet access. However, there are several challenges that inhibit the ability of community networks to gain adequate access to spectrum:

- ***Spectrum is viewed as scarce.*** Spectrum is a finite, public resource. Many believe that rather than focusing on scarcity, we should consider spectrum to be a common resource to be managed efficiently and effectively.
- ***Traditional regulations have led to inefficient use of spectrum.*** Regulators often favor exclusive and broad licenses, which can result in lack of coverage in some areas and fewer options for multiple and innovative service provision and spectrum usage.
    - **Exclusive Licenses:** Traditional licensing favors exclusive use, as opposed to shared use. Exclusive use licenses provide one licensee unfettered use of a particular swath of spectrum. This can result in large portions of spectrum being unused or underutilized.
    - **Broad Licenses:** Many licenses cover large geographic areas; however, the incumbent service providers that have the rights to these broad licenses may not have the economic incentives to build out their networks to utilize fully all of the spectrum licensed to them. This also can result in large portions of spectrum being unused or underutilized.
- ***Access to spectrum is expensive.*** Spectrum rights come at high costs. For example, many regulators auction spectrum rights to the highest bidder, and many charge high regulatory fees for spectrum. Often, community networks do not have the funding or financial ability to pay for spectrum rights. Furthermore, because incumbent service providers have made sizeable investments in obtaining spectrum rights, they often have an expectation of exclusive use of that spectrum that is difficult to combat.

Guiding Principles

To close the gap between *more connected* urban areas and *unconnected* rural areas, policy makers are urged to consider the benefits of community networks, and ensure that these networks have adequate access to spectrum. Below are a number of ways that community networks may gain access to spectrum. Policy makers should look to these examples when considering how community networks can allow the unconnected to connect.

Utilizing Unlicensed Spectrum

Unlicensed spectrum is spectrum that is not tied to a regulatory license. Users may utilize this spectrum with minimal regulatory requirements, and without the need to pay the high costs of obtaining a spectrum license.[22]

Examples of community networks utilizing unlicensed spectrum include:

- **Chancay-Huaral Project**—The operations of the Chancay-Huaral Project in Peru in the 2.4 GHz band were confined to indoor spaces and were subject to strict power restrictions. To build the community network, the project obtained special permission from the regulator.[23] Taking this regulatory step was critical to the project and represented a step-forward in collective collaboration between the project and the regulator to enable connectivity.

- **guifi.net**—guifi.net, predominantly located in Spain with nodes in many regions, is the world's largest community network. As of September 2017, guifi.net boasted more than 33,700 operating nodes, serving more than 50,000 people. Wi-Fi was the first technology to be used in the network, and remains the most popular.[24]

- **Pamoja Net**—This community network is located on the island of Idjwi in the Democratic Republic of Congo. The island was largely unconnected—it was difficult to even place calls or send texts from the island to the mainland. With wireless technology, Pamoja Net provides public access Internet on the island on a pay-as-you-go basis. As of Fall 2016, Pamoja Net had over 200 users per month.[25]

- **Wireless for Communities (W4C)**—The Digital Empowerment Foundation (DEF), partnering with the Internet Society, runs a program called Wireless for Communities (W4C). Launched in 2010, W4C started with helping to create wireless mesh networks in three communities in India; today, it has helped to build community networks in over 100 communities across India. These community networks currently use low-cost Wi-Fi equipment to utilize unlicensed spectrum bands (2.4 GHz and 5.8 GHz). Importantly, W4C focuses on rural and remote communities where traditional commercial networks do not reach—telecom dark areas. The W4C project has been made possible by the government not requiring operators in the 2.4 and 5.8 GHz bands to obtain a license to use the radio spectrum.[26]

Sharing Licensed Spectrum/Dynamic Spectrum Access

Recent technological developments have opened the possibility of sharing spectrum, which would allow community networks in rural unserved or underserved areas to use already-licensed spectrum on a secondary basis.[27] An example of this is using the "unused" spectrum in the television bands—known as television white spaces (TVWS)—to provide Internet access. Another example is the Citizens Band Radio Service (CBRS) in the United States where spectrum currently occupied by incumbent users, in this case the U.S. Department of Defense and fixed satellite services, is shared on a secondary and tertiary basis, by licensed users and lightly-licensed users.

Examples of sharing licensed spectrum in unserved or underserved areas include:[28]

- **Citizen Connect**—Microsoft has backed numerous TVWS initiatives, including Citizen Connect in Namibia, which has successfully connected large portions of northern Namibia. Microsoft has described that "[t]he ultimate plan is to provide a network of broadband internet connectivity across the country, utilizing the unlimited potential of White Spaces broadband."[29]

- **Cape Town TVWS Trial**—Google backed the Cape Town TVWS Trial in South Africa in 2013. The trial utilized a database that calculated channel availability so as to avoid harmful interference; there was no measurable interference during the trial. The resulting recommendations included urging regulators to implement policies that would enable TVWS devices.[30]

- **Project Kgolagano**—Microsoft also backed a TVWS pilot project in Botswana. This project, launched in 2015, aims to provide internet connectivity and telemedicine services to local hospitals and clinics. This project was specifically authorized by the regulator in Botswana.[31]

- **TVWS Experimental Licenses in India—**In 2016, the Indian government issued 8 experimental licenses in the 470-582 MHz band to carry out experiments of TVWS-type rules and regulations.[32]

- **Malawi TVWS Pilot Network—**In Malawi, the regulator partnered with a university to conduct a TVWS trial, connecting hospitals and schools in rural areas where there is "unavailability or poor broadband performance from the currently available commercial ISP services." The results showed that TVWS in the UHF band demonstrated 2.6 times better data rates than other fixed broadband services.[33]

- **CBRS in the United States –** The Federal Communications Commission (FCC) is in the process of authorizing CBRS in the United States. This is a novel spectrum allocation structure that uses dynamic allocation technology to enable three tiers of users to share spectrum. The U.S. military and some fixed satellite services are incumbent users of the band and have priority rights for use of the band. Using database-driven spectrum access, priority access licensees have secondary rights to the incumbents. Finally, and importantly, a General Authorized Access tier is permitted to use spectrum opportunistically, subject to protection of the two other tiers. This structure captures the benefits of incumbent protection, licensed use, and lightly-licensed opportunistic use, to drive efficient use of spectrum to a higher order.

Innovative Licensing

Innovative approaches to spectrum management can present opportunities for community networks to gain access to spectrum. One example of innovative licensing is a "social purpose" license,[34] which is an exclusive service license granted in rural unserved or underserved areas to non-traditional network operators, such as community network operators. With "social purpose" licenses, regulators set aside specific licenses for non-traditional operators, which removes the competitive nature of licensing, and prioritizes spectrum use for non-commercial purposes. For some of these social purpose licenses, many community network experts believe that reducing spectrum fees would greatly assist community network development in their regions.

The following examples of innovative licensing, including the use of "social purpose" licenses, are instructive:[35]

- **India—**A recent Supreme Court decision held that "spectrum, such as TV white spaces (TVWS) or 5GHz spectrum, could be allocated on a license-exempt or unlicensed basis as long as such a policy is 'backed by a social or welfare purpose' such as using connectivity to increase social and economic inclusion."[36]

- **Mexico—**Mexico's regulator, Instituto Federal de Telecomunicaciones (IFT), has set aside 2x5 MHz of paired FDD uplink and downlink spectrum (824-849 and 869-894 MHz) specifically for social purpose use.[37] To use these bands, the community served must be less than 2,500 people, or be an indigenous region or otherwise designated for such use. Since the introduction of these social purpose licenses, Rhizomatica, an organization that creates community owned and operated networks in rural Oaxaca, Mexico, has taken advantage of the new regulations for the benefit of more than 10 rural communities.[38] Rhizomatica's founder, Peter Bloom, said this of Mexico's adoption of Social Purpose licenses:

"Rural areas have traditionally been no-go areas for incumbent telcos, and this forward-looking approach by the [IFT] allows other actors, including the communities themselves, to provide affordable access to communication services by having direct access to spectrum. This will lead to more people being connected which will bring both social and economic benefits to underserved areas. If the role of regulators is to maximize the benefit that society obtains from the use of radio spectrum, then this is a step in the right direction."[39]

- Brazil—Brazil's regulator, ANATEL, recently, approved a new regulation on radio equipment that eliminates licensing requirements for providers having less than 5,000 users. Providers simply need to communicate that they would like to start network activity, but are not obliged to obtain a multi-media communications service license.[40]

Experimental licenses are also another key way for community networks to obtain access to spectrum. These licenses allow regulators and policy makers to make gradual changes in the way they facilitate development of communications in formerly unserved and underserved communities.

Recommendations for Community Networks

The recommendations below are focused on actions that some community networks have taken. These recommendations are meant to be considered 'food for thought" for community networks to help shape a more innovative policy and regulatory environment to enable and support their efforts:

- Reach Out to Existing Community Networks for Advice: Create your own "human" network by reaching out to existing community networks to ask them how they created change and overcame cultural factors that can hinder network development. We have found that community networks are keen to share their experience with others.[41] Guifi.net for example recommends creating an independent oversight organization.
- Identify Regulatory and Policy Changes in Your Country: Work with existing community networks to create a check-list of policy and regulatory changes you may need to address to facilitate community network development in your country.
- Engage with the Regulator or Ministry in Your Country: Change starts with dialogue to create that change. By engaging with and educating policy makers and regulators, community networks and citizens involved in community network development can educate and also learn how to change current policies and regulations.
- Ask for Training: Expert organizations provide network, radio frequency, shared infrastructure, and community and capacity building training.[42]
- Attend Local, Regional, and International Community Network Events: Training, sustainability, and informational events for community and local access networks exist in many countries and regions, as well as globally. These convening events should not be underestimated as they have created local and national partners, and created "real time" human networks to help sustain technical networks and obtain project funding.

- **Work with Existing Anchor Institutions:** Existing anchor institutions (e.g., health centres, libraries, and schools) and community organizations can be key allies and provide space for training, network hosting, and local content development.
- **Engage with Internet exchange point (IXP) and network operator group (NOG) communities** as they are bottom-up community based, and help build bottom-up community based connectivity infrastructure.

Recommendations for Policy Makers and Regulators

The recommendations below are focused on actions that policy makers and regulators can take to begin to shift mindsets to consider community networks a viable form of connectivity. It is important that communities collaborate with policy makers as they have a key role to play in identifying their specific needs and in explaining how these can be best served. It is important to note that these recommendations are not meant to be exhaustive, but to start the conversation to enable innovative regulatory and policies to:

- *Include Community Network Experts in Regulatory Proceedings*: Regulators and policy makers can learn a great deal from community network experts. Including the perspective of these experts will balance out access discussions, provide new perspectives on network development, and avoid exclusion of an important community of expertise and practice.
- *Increase Regulatory Transparency*: Regulators should ensure that their rules are publicly available and that they are easy to understand and to access. Regulatory transparency will provide organizations the certainty they need to make investments in community networks. One way for regulators to achieve regulatory transparency is to hold public meetings and to publish their rules and regulations online.
- *Ensure Regulatory Fairness:* Regulators should abide by regulatory "best practices" and commit that rules and regulations will be clearly established and followed. Ensuring that regulators do not act in an arbitrary or capricious way will increase incentives for investment on both traditional networks and community networks. It will also help to reduce traditional operators' reservations regarding new and innovative spectrum management tools, and help to ensure that cooperative citizen initiatives are not discriminated against.
- *Increase Regulatory Flexibility:* Regulators should consider non-traditional spectrum management tools in an effort to better utilize scarce spectrum. Several such tools are described above in the *Guiding Principles* section, including
    - **Utilizing and offering unlicensed/licensed-free spectrum:** To promote community networking opportunities, policy makers should ensure the availability of unlicensed, Wi-Fi spectrum, and regulators should fully exempt Wi-Fi spectrum from licenses and fees. While many countries have forward-thinking Wi-Fi policies, many do not.[43] While policy makers should continue to understand the value of licensing spectrum,[44] they should also ensure the availability of unlicensed spectrum.
    - **Spectrum sharing:** Policy makers should allow and create incentives for spectrum sharing. To overcome hesitance on the part of incumbents to engage in sharing, policy makers should help to ensure, among other things,

that each spectrum user has clearly defined rights and obligations, and that the multiple uses of the spectrum are compatible.[45] To further promote the efficient use of spectrum, policy makers could require sharing where licenses are not fully built-out; allow networks to achieve build-out milestones via sharing; consider a reduction in regulatory fees or an extension of a licensing term for operators who share; or adopt similar incentives to prevent idle spectrum.

- Innovative Licensing: Policy makers should consider innovative licenses to enable community networks to have access to spectrum. In granting innovative licenses, regulators should recognize that community network operators are different than traditional operators, and require an easy, transparent, and streamlined process for obtaining licenses, with less severe technological requirements. Regulators should consider including community network experts on regulatory policy-making advisory panels to help bring increased perspective to policy and regulatory decision-making.

- *Lower Costs of Spectrum Based on Special Circumstances:* As discussed, there are high costs associated with spectrum rights. High spectrum fees and auctions present challenges for community network operators. Regulators should consider reducing these costs for operators like community network operators, either through bidding credits where spectrum rights are auctioned, or reduced spectrum fees.

- *Increase Spectrum Allocation Transparency and Availability:* Given the importance of understanding how spectrum is allocated and assigned, spectrum authorities and regulators should make information readily available and provide transparency with respect to licensed spectrum, assignments and allocations, and where spectrum is available.[46] As many operators may not be using spectrum across their licensed geographic allotments, identifying where community networks could use, lease, or otherwise share that spectrum also is critical.[47]

- *Public Funding for Community Networks:* Consider revising universal service funds to include community networks and/or create new public-private-partnership funding mechanisms that prioritize community networks and other small- and medium-sized enterprises providing local access to assist with start-up and network deployment.

Recommendations for Network Operators

Additionally, network operators[48] can and should help community networks both access spectrum and put that spectrum to use in connecting the unconnected. To do so, network operators should:

- *Enter into Roaming Agreements with Community Networks at Fair and Reasonable Rates:* For community networks' users to have a seamless service experience, it will be important for community networks to enter into roaming agreements with network operators where the community network does not reach. Many carriers should enter into these agreements at fair and reasonable rates, taking into consideration the unique mission and role of community networks.

- *Equipment and Training Partnerships:* From a future network user perspective, network operators may find that partnering with community networks – training or equipment partnerships – builds stronger future communities. Partnerships like these strengthen human and technical network infrastructures and builds future digital skills/citizens in communities.

- *Share Spectrum:* One way that network operators can help community networks access spectrum is to be open to sharing their own spectrum. Traditional network operators and community networks could enter into independent spectrum sharing agreements that clearly define each party's rights and obligations. Another way to support community networks is for network operators to be supportive of them as a legitimate form of connectivity, particularly when asked by regulators and policy-makers about their importance and the need for sharing, secondary, or license-free use of spectrum.

- *Make Backhaul Available to Community Networks at Fair and Reasonable Rates:* Backhaul infrastructure is critical to connect traffic from the community network to regional and larger global networks. Access to such infrastructure can be costly. There are a number of new technologies and methods to reduce the traditional backhaul expense;[49] however, access to the backhaul infrastructure of network operators could greatly benefit community networks. Network operators should consider making their backhaul available to community networks at fair and reasonable rates.

- *Infrastructure Sharing:* Consider allowing community networks to co-locate equipment, peer at Internet exchange points (IXPs) for a reduced fee, and share towers, ducts, and other relevant infrastructure. Some monthly tower leases are more than the cost of purchasing and installing a tower in some countries.

- *Give Special Consideration to Community Networks Regarding Interconnection Agreements:* Interconnection is key to the success of community networks, as it allows communications from a single community network across other networks, truly connecting the unconnected. Network operators should enter into interconnection negotiations with community networks understanding the unique mission and role of these entities, and should be sensitive to the fact that many community networks may not have the background or legal resources that other carriers might. Many carriers should be willing to offer community networks minimal interconnection fees that are fair and reasonable.

Additional Resources

Amelia Yeo, *Wireless For Communities (W4C) – Best of a breed*, Internet Society (June 18, 2015), https://www.internetsociety.org/blog/2015/06/wireless-for-communities-w4c-best-of-a-breed/

Jane Coffin, *Bringing the world online*, Internet Society Blog (June 24, 2016), https://www.internetsociety.org/blog/2016/06/bringing-the-world-online-meet-the-people-who-are-making-it-happen/

A Policy Framework for Enabling Internet Access, Internet Society (Sept. 14, 2016), https://www.internetsociety.org/resources/doc/2016/a-policy-framework-for-enabling-internet-access/

Jane Coffin, *You Can Build the Internet*, Internet Society Blog (Dec. 2, 2016), https://www.internetsociety.org/blog/2016/12/you-can-build-the-internet/

Simon Forge, Robert Horvitz and Colin Blackman, *Perspectives on the value of shared spectrum access.* Final Report for the European Commission, https://ec.europa.eu/digital-single-market/sites/digital-agenda/files/scf_study_shared_spectrum_access_20120210.pdf

Rekha Jain, *Measuring the Perceived Impact of Internet on Individuals in Rural India* https://web.iima.ac.in/assets/snippets/workingpaperpdf/14953301232016-03-61.pdf

Raul Katz, *Assessment of the Future Economic Value of Unlicensed Spectrum in the United States,* http://dynamicspectrumalliance.org/assets/Katz-Future-Value-Unlicensed-Spectrum-final-version-1.pdf

Osama Manzar, *Build the Internet: Training Barefoot Network Engineers*, Internet Society Blog (Dec. 2, 2016), https://www.internetsociety.org/blog/2016/12/build-the-internet-training-barefoot-network-engineers/

First Summit on Community Networks in Africa, Internet Society (Feb. 21, 2017), https://www.internetsociety.org/events/first-summit-community-networks-africa

Carlos Rey-Moreno, *Supporting the Creation and Scalability of Affordable Access Solutions: Understanding Community Networks in Africa*, Internet Society Report (May 2017), https://www.internetsociety.org/resources/doc/2017/supporting-the-creation-and-scalability-of-affordable-access-solutions-understanding-community-networks-in-africa/

Dynamic Coalition on Community Connectivity (DC3), https://comconnectivity.org/article/dc3-working-definitions-and-principles/

Wi-Fi Forward Alliance: http://wififorward.org/resources/, http://wififorward.org/wp-content/uploads/2017/06/Communities-and-Wi-Fi-Survey-January-2015.pdf, http://wififorward.org/wp-content/uploads/2017/06/Value-of-Unlicensed-Spectrum-to-the-US-Economy-overview.pdf

End Notes

1 The Internet Society's goal supports the United Nations Sustainable Developments Goal of achieving universal and affordable access to the Internet. *See* Sustainable Development Goal 9, United Nations Sustainable Development Goals, https://sustainabledevelopment.un.org/sdg9.

2 *Internet Society Global Internet Report 2015: Mobile Evolution and Development of the Internet*, Internet Society, at 9, 119 (2015) https://www.internetsociety.org/globalinternetreport/2015/

3 Land-locked developing countries (LLDCs) and small island developing states (SIDS) are included here in this definition.

4 See Leandro Navarro, et al., *Advances in Wireless Community Networks with Community-Lab Testbed*, at 1 (2016), http://dsg.ac.upc.edu/node/734.

5 See *Internet Society Global Internet Report 2015*, https://www.internetsociety.org/globalinternetreport/2015/ at 9 (describing the benefits of the mobile Internet), See also *Ericsson Mobility Report* (June 2017): https://www.ericsson.com/assets/local/mobility-report/documents/2017/ericsson-mobility-report-june-2017.pdf

6 Local access projects of all kinds are a key way for communities to connect. Community networks are a type of local access project.

7 The focus of this brief is on spectrum options for community networks. Access to spectrum is one of many factors that can help minimize digital divides. Innovative regulatory options like use of Universal Service Funds (USF) or experimental licensing are some additional factors that can help. One example of policy makers utilizing USF to aid community networks is in the United States, where USF funds are available to community networks (also known as cooperatives). For example, the Community Connect Program provides grants "[t]o promote broadband service in extremely rural, lower-income American communities where it currently does not exist, and to promote 'community-oriented connectivity' that would stimulate economic development and enhance educational and health care opportunities." *Lands of Opportunity: Bringing Telecommunications Services to Rural Communities,* FCC (July 2006), https://www.ruralcenter.org/sites/default/files/Ruralbook120204%5B1%5D.pdf. These grants are available to Indian tribes and tribal organizations, and cooperatives, among other types of entities. *Id.*

8 *Community Connectivity: Building the Internet from Scratch,* Annual Report of the UN IGF Dynamic Coalition on Community Connectivity, at 11 (Luca Belli ed., Dec. 2016), http://bibliotecadigital.fgv.br/dspace/handle/10438/17528 ("*Community Connectivity*").

9 *Id.* ("We go there because no private, cooperative or state telecommunications agencies are concerned with providing internet access in these places. They are always the last priority and their turn never comes around. Also, it's much easier to build a community network in a small town than in a big city.").

10 See Internet Engineering Task Force (IETF), Request for Comments (RFC) 7962 on Alternative Network Deployment.

11 *Community Connectivity* at 8, 34, 61 & n.45, 112; *Broadband in Brazil: Past, Present and Future*, at 137 (Peter Knight, et al. eds., 2016), https://www.academia.edu/30187528/Broadband_in_Brazil.pdf?auto=download; Roger Baig, et al., *guifi.net, a crowdsourced network infrastructure held in common*, Computer Networks, at 8 (2015), http://dx.doi.org/10.1016/j.comnet.2015.07.009; Joao Pessoa and Leila Nachawati, *AlterMundi: "Community networks embody the original spirit of the internet,"* Association for Progressive Communications (Nov. 23, 2015), https://www.apc.org/en/node/21346/.

12 Freifunk.net, https://mbem.nrw/de/das-ist-freifunk.

13 "'First Mile' refers to the development of local telecommunications infrastructure that benefits local communities, in contrast to how local infrastructure is often referred to as 'last mile' development that benefits centralized, urban-based telecom corporations and governments." *Indigenous People and Mobile Technologies,* at 111 (Laurel Evelyn Dyson et al., eds.) (2015).

14 *See* Roger Baig, et al., *guifi.net, a crowdsourced network infrastructure held in common*, at 1.

15 Aaron J. Meyers, *Improving Access to Telecommunications in Rural Area of Developing Countries: Consumer Cooperatives and the Millennium Challenge Corporation*, Institute for International Law and Justice, at 2 (June 17, 2008), http://www.iilj.org/wp-content/uploads/2016/08/Meyers-Improving-Access-to-Telecommunications-in-Rural-Areas-of-Developing-Countries-2008.pdf; Dr. Carlos Rey-Moreno, Supporting the Creation and Scalability of Affordable Access Solutions: Understanding Community Networks in Africa, Internet Society Report (May 2017); *Community Connectivity*, at 33.

16 Carlos Rey-Moreno, *Supporting the Creation and Scalability of Affordable Access Solutions: Understanding Community Networks in Africa*, Internet Society Report (May 2017)., https://www.internetsociety.org/resources/doc/2017/supporting-the-creation-and-scalability-of-affordable-access-solutions-understanding-community-networks-in-africa/

17 Local communities can develop network infrastructures through cooperatives, creating abundant and inexpensive connectivity in the "first mile," assisting local socio-economic development.

18 The United Nations International Telecommunication Union's (ITU) Development sector (ITU-D) Recommendation 19, *"Telecommunications for rural and remote areas,"* highlights the nexus between development, access, and the importance of access to spectrum: "in remote and rural areas, spectrum use might be improved by the use of new spectrum-access approaches." *Telecommunications for rural and remote areas*, Recommendation 19, ITU-D, at 554, https://www.itu.int/en/ITU-D/TIES_Protected/WTDC14/WTDC14-FinalReport-E.pdf.

19 Sustainable Development Goals, United Nations, https://sustainabledevelopment.un.org/post2015/transformingourworld.

20 *See European Legal Framework for CNs, Deliverable Number: D4.1, Version 1.0*, netCommons, at 17 (Dec. 22, 2016), *available at* https://www.netcommons.eu/sites/default/files/d4.1_v1.0.pdf (explaining that "[a]n issue of utmost importance for wireless [community networks] is the one of 'spectrum management'").

21 There are a number of other challenges facing community networks that are not covered by this policy brief.

22 See Richard Thanki's 2009 studies on the economic impact of unlicensed spectrum, *The economic value generated by current and future allocations of unlicensed spectrum*, for additional information on data on the benefits of unlicensed spectrum. *See* https://ecfsapi.fcc.gov/file/7020039036.pdf; *see also The Economic Significance of Licence-Exempt Spectrum to the Future of the Internet (*2012), https://www.microsoft.com/en-us/research/wp-content/uploads/2016/02/spectrum-economic-significance-of-license-exempt-spectrum-report_thanki.pdf.

23 Hernan Galperin, *Wireless Networks and Rural Development: Opportunities for Latin America*, MIT, Information Technologies and International Development, at 51-52 (2005).

24 *Guifi.net – The technological project*, guifi.net (Dec. 19, 2016), https://guifi.net/en/technological-project; Davide Vega D'Aurelio, et al., *A technological overview of the guifi.net community network*, Computer Networks (2015), How Catalan villages built independent broadband networks, *Financial Times* (Sep. 26, 2017) https://www.ft.com/content/b15e9552-722a-11e7-93ff-99f383b09ff9.

25 *Pamoja Net—A Community Commons*, Project First Light (Sept. 22, 2016), https://firstlight.fjordnet.com/pamoja-net-a-community-commons/; *Bringing the Internet to Africa's Forgotten Island*, Fjordnet.com, https://www.fjordnet.com/workdetail/bringing-the-internet-to-africas-forgotten-island/.

26 Wireless for Communities, Digital Empowerment Foundation, http://wforc.in/; Satya N. Gupta et al., *Unlicensed Spectrum Policy Brief for Government of India*, The Centre for Internet & Society, at 14 (June 24, 2012), http://cis-india.org/telecom/unlicensed-spectrum-policy-brief-for-govt-of-india; Osama Manzar, *Build the Internet: Training Barefoot Network Engineers*, Internet Society (Dec. 2, 2016), https://www.internetsociety.org/blog/development/2016/12/build-internet-training-barefoot-network-engineers.

27 Spectrum that is licensed to a particular user (the primary user) can be utilized by another user (a secondary user) when the primary user is not utilizing the spectrum. Secondary uses of spectrum are variable, and can include geographic sharing or temporal sharing.

28 These are examples of TVWS technology being used to connect the unconnected. Spectrum sharing, however, should be viewed as one way that policy makers can enable community networks to have access to spectrum.

29 White Spaces Database, Microsoft, http://whitespaces.microsoftspectrum.com/.

30 *Studies on the Use of Television White Spaces in South Africa: Recommendations and Learning from the Cape Town Television White Spaces Trial*, Tertiary Education and Research Network of South Africa, at 7, http://www.tenet.ac.za/tvws/recommendations-and-learnings-from-the-cape-town-tv-white-spaces-trial; *see also* Craig Wilson, *Inside SA's 'white spaces' broadband trial*, TechCentral (Jan. 10, 2013), https://www.techcentral.co.za/inside-sas-white-spaces-broadband-trial/37383/.

31 Project Kgolagano, Worldwide Commercial Deployments, Pilots, and Trials, Dynamic Spectrum Alliance, http://dynamicspectrumalliance.org/pilots/#africa

32 Press Release, Dynamic Spectrum Alliance, *Dynamic Spectrum Alliance Welcomes the Indian Government's Issuing of Eight Experimental Licenses in the 470-582 band for TV White Space Trials* (March 17, 2016), http://www.realwire.com/releases/Dynamic-Spectrum-Alliance-welcomes-the-Indian-Governments-issuing-of-eight.

33 C. Mikeka, et al., *Malawi Television White Spaces (TVWS) Pilot Network Performance Analysis*, Journal of Wireless Networking and Communications, at 27 (2014); *see also Studies on the Use of Television White Spaces in South Africa*, at 30.

34 The Rhizomatica projects in Oaxaca, Mexico were awarded a social purpose license to operate their network because of its nature as an indigenous region.

35 These are examples of innovative licenses in general, not necessarily related to community networks. However, policy makers can ensure that community networks have access to spectrum through innovative licensing.

36 Press Release, Dynamic Spectrum Alliance, https://www.realwire.com/releases/Dynamic-Spectrum-Alliance-welcomes-the-Indian-Governments-issuing-of-eight

37 "Paired" spectrum refers to spectrum that is organized and allocated as a pair—with one block of spectrum being used for uplink and one block of spectrum being used for downlink. The frequency pair is separated to adequately isolate the two signals. *See* Telecom ABC, http://www.telecomabc.com/p/paired-spectrum.html.

38 Rhizomatica currently provides service in 20 communities with a total population of 24,299 inhabitants and 3,000 users. Spectrum allocated under these social purpose licenses can be auctioned for commercial purposes in a variety of population zones, meaning that once licensed it can be used for social purposes and auctioned commercially. *See also* Steve Song, *How to Let GSM Serve the People that Other Networks Can't Reach*, Many Possibilities (Apr. 17, 2015), https://manypossibilities.net/2015/04/how-to-let-gsm-serve-the-people-that-other-networks-cant-reach/; Leandro Navarro, et al., *Advances in Wireless Community Networks with Community-Lab Testbed*, at 2; What We Do, Rhizomatica, https://www.rhizomatica.org/what-we-do/.

39 Steve Song, *How to Let GSM Serve the People that Other Networks Can't Reach*.

40 Anatel, http://www.anatel.gov.br/institucional/component/content/article?id=1655.

41 For example, the IGF Dynamic Coalition on Community Connectivity, which is DC-3, published a Declaration on Community Networks during the IGF 2016, Guadalajara, Mexico. *See Declaration on Community Connectivity (July 7, 2017),* https://comconnectivity.org/article/dc3-working-definitions-and-principles/.

42 Some of these organizations include: the International Telecommunication Union (ITU), the Association for Progressive Communications (APC), the International Center for Theoretical Physics (ICTP), and the Internet Society (ISOC).

43 For example, "[i]n Nigeria, WiFi is free for private use but a license is required for commercial use. Senegal similarly requires users to apply for a license for point-to-point WiFi links." Steve Song, *A Look at Spectrum in Four African Countries*, Many Possibilities (March 31, 2014), https://manypossibilities.net/2014/03/a-look-at-spectrum-in-four-african-countries/.

44 *5G Spectrum, GSMA, Public Policy Position*, GSMA, at 5 (Nov. 2016), http://www.gsma.com/spectrum/wp-content/uploads/2016/06/GSMA-5G-Spectrum-PPP.pdf.

45 *New Approaches to Spectrum Management*, OECD Digital Economy Papers, No. 235, at 21, (2014), http://dx.doi.org/10.1787/5jz44fnq066c-en.

46 For example, Canada's spectrum manager—the Minister of Industry—is "responsible for developing national policies for spectrum utilization and ensuring effective management of the radio frequency spectrum resource." Under this effort, Canada considers "the need to provide spectrum access for new services and technologies, including backhaul applications; the impact of such a framework on all stakeholders; and . . . [its] policy objective . . . to maximize the economic and social benefits that Canadians derive from the use of the radio frequency spectrum resource." Canada recently reviewed the spectrum utilization related to backhaul, with these guiding principles in mind. *See Decision on Spectrum Utilization Policies and Technical Requirements Related to Backhaul,* Industry Canada (Dec. 18, 2014), http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10880.html/.

47 In the United States, the Vermont Telecommunications Authority has contracted with a wholesale cellular service provider to provide "innovative micro-cell coverage in previously unserved parts of rural Vermont." With that project, the wholesale cellular

service provider is contracting with one national carrier to use that carrier's spectrum. Additionally, the wholesale carrier has roaming agreements with other carriers. *See* http://www.telecomvt.org/Cell_Service_CoverageCo.php,

48 Operators here means mobile, fixed, and other infrastructure and content operators.

49 Hernan Galperin, *Wireless Networks and Rural Development: Opportunities for Latin America*, at 48, 53.