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Author(s): Jamie Alexander Greig

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WIRELESS MESH NETWORKS AS COMMUNITY HUBS

Analysis of Small-Scale Wireless Mesh Networks and Community-Centered Technology Training

Jamie Alexander Greig

ABSTRACT

This paper addresses two policy questions. Firstly, how might evolving technologies associated with broadband networks enhance or hinder marginalized or underserved population groups' effective use and access to information resources? Secondly, how can we foster public hybrid broadband, situating broadband networks within existing communities, as a means to promote digital self-determination? This study finds that wireless mesh technology initiatives can create and foster community engagement through infrastructure deployment, maintenance and use; combat myths regarding marginalized demographics and technology, and provide marginalized communities with an opportunity to become decision-makers regarding communications technology infrastructure development.

Keywords: mesh-networks, community training, Telecommunications, wireless internet, community technology

As the world becomes increasingly more digital, it has become apparent that online access, speed, and cost-of-service are playing a crucial role in our everyday lives.¹ Underpinning these requirements, however, is the infrastructure that determines each of these attributes. Academics, government institutions, and the public have become increasingly more aware of the need to develop solutions in order to provide digital infrastructure to underserved communities.²

With 10 percent of all Americans and 39 percent of rural Americans lacking access to 25 Mbps/3 Mbps service,³ those involved in improving

Jamie Alexander Greig: The University of Tennessee, Knoxville

1. DiMaggio et al.

2. Kenner.

3. Federal Communication Commission.



access to robust service are exploring innovative options not just to provide infrastructure but also to include local communities in decision-making processes as well as in the design, implementation, and adoption stages.⁴

During a 2-day workshop, organized by The Institute for Information Policy at Penn State University in June 2016, with the goal of identifying a “national broadband research agenda,” experts from academia and government produced a report titled “broadband 2021.”⁵ Included in this report were various avenues for future research exploration and questions that would help influence the understanding of the broadband landscape going forward. One of the themes that emerged from this workshop, and subsequent report, was that of emerging technologies and their ability to engage with traditionally marginalized or underserved communities. This study takes that theme and applies it to the implementation of small-scale wireless mesh networks and the integration of community-based technology training initiatives. Specifically, it focuses on how community-based technology training aims to affect commonly held narratives regarding marginalized or underserved communities and technology.

Many community networks around the world⁶ are utilizing a decentralized, cooperative approach to broadband infrastructure. According to these organizations, this use of community leadership and expertise, as well as new approaches to integrating digital technology into communities, is helping to foster both community engagements as well as encouraging community members to become involved in their infrastructure choices. Community-based training initiatives have been shown to improve marginalized communities’ relationships with communication technology, as in the study by Hendry et al. (2011), which analyzes the integration of digital communications technology into a homeless youth drop-in center,⁷ as well as to counter myths or false narratives regarding certain demographics and their relationship to technology, as shown by Saunder’s 2012 examination of the effects of digital technology on indigenous teacher training and classroom relationships.⁸

This study analyzes community-centered training programs provided by the Detroit Community Technology Project⁹ (DCTP) by examining

4. Ashmore, Farrington, and Skerratt.

5. Broadband 2021.

6. See guifi.net (Catalonia)/Freifunk (Germany)/Wireless Belgie (Belgium) and AWMN (Athens, Greece).

7. Hendry et al.

8. Saunders.

9. <https://www.alliedmedia.org/dctp>. Accessed October 31, 2017.

data, in the form of organizational documents as well as interviews with staff/community members, to identify core programmatic themes. DCTP integrates wireless mesh-network training into its community technology training. Analyzing technological choices as well as community partnerships and training methods, this study aims to provide answers to two of the key questions that emerged from the Broadband 2021 report. This examination of community-centered training and the integration of wireless mesh-network solutions can help aid policymakers and organizations in developing community-centered communication technology initiatives.

Research Questions

RQ1: Looking to the future, how might evolving technologies or interfaces or platforms associated with broadband networks enhance or hinder certain population groups' effective use and access to information resources?
 RQ2: How can we foster public hybrid broadband, focusing not only on the technological infrastructure of the network but also situating broadband networks within existing communities as a means to promote digital self-determination for marginalized¹⁰ and other disadvantaged groups?

Mesh Networks and Local Communities

Traditionally fixed wired broadband has been the most commonly implemented form of high-speed network infrastructure.¹¹ In 2017, fiber broadband, with a 43.2 percent global market share, surpassed DSL as the most common fixed broadband platform. Fiber network deployment grew 55.6 percent worldwide year over year in 2016. According to research firm Kagan, a unit of S&P Global Intelligence, fixed fiber broadband connections are on track to reach one billion subscriber lines by year-end 2021. China and

10. For the purpose of this study "marginalized or disadvantaged communities" are defined as: Socially excluded groups of people for different reasons, such as age, physical or mental disabilities, economic status, access to education, or live in isolated places or depressed areas. See Passarelli, Straubhaar, and Cuevas-Cerveró.

11. "Global Fiber Broadband Penetration Surpasses DSL, On Track for 1 Billion Connections." Accessed October 31, 2017. <http://www.telecompetitor.com/research-global-fiber-broadband-penetration-surpasses-dsl-on-track-for-1billionconnections/>.

the United States, respectively, represent the two largest fixed broadband markets with a combined worldwide market share of 46.9 percent.

Despite the dominance of fixed fiber broadband, wireless networking solutions have been utilized in areas where fixed line deployment is challenged by geography or cost-of-service. The emergence of wireless¹² technology, specifically in developing nations, enables infrastructure developers to bypass the cost and geographic issues associated with fixed line deployment. Wireless mesh networks have emerged as a low-cost and resilient method of delivering community-based high-speed Internet deployment.¹³

Wireless mesh networks, as opposed to other types of wireless multi-hop networks, are composed of two types of nodes: wireless access points (*routers*) and mobile wireless clients.¹⁴ Routers connect with each other through wireless links, and act as wireless access infrastructure to wireless clients. The initial service access points are usually fixed wired links and act as gateways for the other routers and for the clients. The difference between mesh networks and other kinds of networks is that mesh networks use a particular kind of protocol, called dynamic routing, for moving information from one place to another.¹⁵ This protocol involves each device on the network communicating with the others to determine what to do with received data; to keep it or to pass it on.¹⁶ A mesh network is built by installing an open-source mesh software package on wireless-enabled devices and then connecting them to other nearby meshing devices. The more the devices that are part of the mesh network, the more flexible the network becomes. Any mesh device can be the hub or central point in the network—or the network can have no central point. A dynamic mesh network, unlike a more “static” traditional network, constantly adapts to new conditions.¹⁷ It automatically adjusts its pathways to integrate new nodes that join the network and has the flexibility to reroute information when a node leaves the network.

Ultimately, the benefit of this network arrangement is that the network functions autonomously. If the network is cut off from an outside source, it still functions as an internal communication system and in order for the

12. Qadir et al.

13. Canali et al.

14. Lee, Chansu Yu, and Suh.

15. See *Tips in Designing Network on Hub-and-Spoke, Full-Mesh, or Partially-Mesh setup*. Accessed October 31, 2017. <http://www.dsreports.com/faq/14349>; and *(Re)Building Technology Build-it-ourselves Community Networks*. Accessed October 31, 2017. <http://communitytechnology.github.io/>.

16. Peng et al.

17. Majumder and Roy.

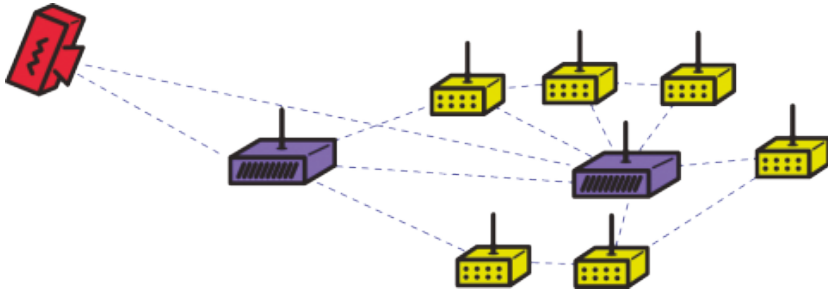


FIGURE I Mesh-Network Diagram.

network to stop functioning every node must be taken offline. It is therefore extremely resilient to external infrastructure damage as well as being able to provide communities with digital communication regardless of access to a wider network. For those cash-poor communities where access to a private or public Internet provider may be unaffordable, community-based mesh networks can still provide basic infrastructure connectivity.¹⁸

Mesh networking enables innovative community applications, including those used in projects, such as guifi¹⁹ and Red Hook Wifi,²⁰ in which users in a community (neighborhood, city, rural area, etc.) can choose to share their communication facilities (wireless access points) and form a wireless multi-hop network to be used by other community members. This allows communities to share the cost of network deployment and use as well as the ability to share community-related resources. These shared resources distributed over the mesh network can come in the form of community radio, community-designed applications or even the posting/listing of community events.²¹

Red Hook WiFi

The Red Hook Digital Stewards are young adult residents of the New York City Housing Authority's Red Hook Houses.²² The Red Hook Initiative (RHI) centered around a training program where community technology "Stewards" have built and maintain a resilient community network

18. Pedraza, Ruiz, and Ballesteros.

19. <http://guifi.net/>. Accessed October 31, 2017.

20. <http://rhicenter.org/programs/community-building/red-hook-wifi/>. Accessed October 31, 2017.

21. Antoniadis et al.

22. Free Network Foundation.

that serves the geographically separated low-lying Brooklyn community of Red Hook, prone to flooding and vulnerable to communication breakdowns. When Hurricane Sandy hit the Eastern Seaboard of the United States in 2012 and the neighborhood flooded, the network kept running as a lifeline to volunteer and donation response efforts,²³ and also for a time served as a platform for the Federal Emergency Management Agency's operations in the area.

guifi.net

Catalonia's guifi.net, one of the world's largest community wireless networks (CWNs) with approximately 60,000 users and 25,000 nodes, operates on a community foundation-based ownership model. Subscribers do not pay for bandwidth, but rather donate on a voluntary basis to the Guifi foundation. The network started about 15 years ago in an outlying exurb of Barcelona that lacked broadband service options. Though the area now has commercial offerings, the network continues to grow, even into major cities, and is now expanding to other parts of the world, including a partnership with the Free Network Foundation in Kansas City, Missouri.²⁴ Guifi incorporates a range of different hardware and firmware and technology options, allowing different localities to adapt a system design to meet their needs and available resources. Local businesses, ranging from tech companies to TV repair shops and satellite dish installers, learn how to set up network nodes, harness the foundation's bandwidth, and set up service contracts with local users, then pay a percentage of their earnings back to the foundation. Local governments occasionally help to kick-start the process by donating space on a hilltop for a big bandwidth pipeline to serve the area, or with a bit of start-up funding. Money does not flow to a big telecom conglomerate, but to local entrepreneurs and start-ups who do maintenance, troubleshooting, and computer help for local users, including local schools and community groups.

Freifunk

Germany's Freifunk network started in Berlin and continues to grow there; there are also now Freifunk networks in several cities and towns

23. *Red Hook's Cutting-Edge.*

24. Free Network Foundation.

throughout the country.²⁵ Participants get involved via the meetup model, learning about the network through outreach efforts like YouTube videos and engaging in hands-on skills sharing. Freifunk's participants are mostly from technologically well-resourced communities, and have been able to produce much useful documentation of the process of setting up "mesh" routing protocols. Whereas many of the larger community networks use hybrid technologies to build easy-to-join systems, the Freifunk networks use a dynamic routing protocol, which is fully decentralized and resilient (it can route around node failures). The mesh protocol is an embodiment of the network's principles of openness, as the Freifunk router firmware allows all users to anonymously join and share bandwidth if they wish.

Wireless België

Wireless België is one of the largest community networks in Europe and is currently focused on developing resilient mobile communications systems for deployment at large public events.²⁶ Belgium is home to a series of large music festivals; in 2011, 60,000 people attended a gathering near Brussels where a sudden storm hit, killing five concertgoers and causing chaos and panic.²⁷ Resilient communication systems at festival sites could save lives in the future, enabling organizers to put out emergency bulletins and evacuate if necessary. Wireless Belgium is exploring ways to adapt its network as a resilient, decentralized platform which could be installed quickly at festival sites and would keep running even if major centralized networks experience congestion or failure.

Athens Wireless Metropolitan Network

The Athens Wireless Metropolitan Network was one of the first decentralized community networks to operate at scale.²⁸ Originally started as an alternative to expensive and unreliable commercial offerings, the network now covers most of the Greek peninsula and several islands,

25. See wiki.p2pfoundation.net/Athens_Wireless_Metropolitan_Network. Accessed January 22, 2018.

26. See <https://www.alliedmedia.org>. Accessed October 31, 2017.

27. *Pukkelpop Storm*.

28. See <https://www.alliedmedia.org/tracks-practice-spaces-network-gatherings>. Accessed October 31, 2017.

with new offshoots starting in many underserved rural areas. The new Sarantaporo.gr village network is documenting its process of building broadband infrastructure as a method of supporting local economic development. According to local organizers, villagers had not intended to create a network initially, but found that in order to build a community website they first had to ensure that locals could get online. With the new wireless network, young people are returning to the village and helping farmers and other local groups build cooperatives for sharing skills, processing goods, and bringing them to market. With the Greek national economy experiencing a series of shocks over the last decade, local groups are increasingly interested in using technology to take economic development into their own hands.

Prior Research

Research in the area of community-based wireless networks has been varied. Some researchers have examined the topic from a Digital Divide Perspective.²⁹ Research in this area analyzes whether or not CWNs are effective at closing the divide between those who have digital access and those who do not. Scholars in this area apply various theoretical frameworks, such as social informatics,³⁰ critical theory,³¹ actor network theory,³² as well as others, in order to assess the impact of community-owned wireless networks on the digital divide.

Others have examined CWNs and their connection to community-based technology organizations through resource mobilization theory.³³ This theory posits that organizations, primarily in the social movement area, seek to utilize resources such as public infrastructure in order to advance their agendas. Research in this area attempts to identify how resources, in this case CWNs, are used by social movement organizations and in what way they are used to promote the organization's aims and purposes.³⁴

29. See Ortiz and Tapia, "The Digital Divide Discourse"; Tapia, Stone, and Maitland; Tapia and Ortiz, "Municipal Responses"; Tapia, Maitland, and Stone; Tapia, Maldonado, and Ortiz; and Servon.

30. Tapia and Ortiz, "Deploying for Deliverance."

31. Feenberg.

32. Van Oost, Verhaegh, and Oudshoorn.

33. Jenkins.

34. Shaffer.

Rationale and Purpose

This study, instead of focusing on CWNs through a theoretical lens, aims to identify, through examination of a community technology training program in Detroit, how evolving technologies, in this case wireless mesh networks, when embedded into a community-based technology initiative may enhance or hinder certain population groups' effective use and access to information resources. Furthermore, this study hopes to identify how DCTP's Digital Steward's program, as a community situated initiative, promotes digital self-determination for indigenous and other disadvantaged groups.

DCTP: Background (Community Wireless and Digital Stewards Program)

The DCTP originated in 2008 with Allied Media Project's (AMP) "media lab" and "how-to track."³⁵ In 2009, "how-to track" evolved into "DIY technology track," a space that was used to help explain various media production technologies to community members and provide hands-on opportunities to discover how these technologies work.

In 2012, AMP launched the Digital Stewards Program in partnership with the Open Technology Institute (OTI). This community-based technology training program focused on delivering community wireless mesh-network installation and use training to low-income and marginalized communities in Detroit. DCTP emerged from the Digital Stewards Program and networks cultivated at the "media lab" as a way to organize the deployment of communications technology programs and initiatives in Detroit. It was officially formed in 2014 to encompass broader community technology education and organizing work and share best practices and has gone on to deploy its programs and initiatives, specifically the Digital Stewards Program, in multiple regions in the United States and around the world. These best practices have also been adopted by other community-based organizations as a means to deliver community-based technology training and solutions to lack of adequate Internet access and adoption.

35. See <https://www.alliedmedia.org>. Accessed October 31, 2017.

TABLE 1 DCTP's Accomplishments

Codeveloped the Digital Stewards Curriculum ^a
Codeveloped the Community Technology Field Guide ^b
Partnered with OTI to launch and operate the Digital Stewards Program
Facilitated the vision and goal development of Code for Detroit
Consulted on agenda development for community technology gatherings in San Francisco, Chicago, and Detroit
Presented work and best practices to national and international audiences, including the 2014 Code for America Summit, the 2013 International Summit for Community Wireless, and the 2015 Rights Con in the Philippines
Influenced the development of the Allied Media Conference “practice-space” model ^c and the DiscoTech ^d model through our community-based educational approach
Convened the international Community Technology Network Gathering ^e at the 2015 Allied Media Conference
Developed the How-To DiscoTech guide ^e
Developed and managed Detroit Future Media ^e
Codeveloped the International Seed Grants Program, supporting 11 international community wireless projects ^e
Developed the Opening Data Zine ^e
Codeveloped the (re) building technology zines and github resource portal
Launched the Data Justice Campaign ^f
Led the development of the Teaching Community Technology Handbook Consulted in the implementation of Digital Stewards in New America Foundation's RISE NYC project

^aSee <https://www.alliedmedia.org/detroit-future>. Accessed October 31, 2017.

^bPhillips and Hardy.

^cMerriam.

^dCommunity member: Document analysis.

^eDCTP Staff member: Study interview.

^fCommunity member: Document analysis.

TABLE 2 Location's That Have Adopted DCTP Principles

São Paulo, Brazil
Jose de la Quintana, Argentina
Eenhana, Namibia
Bangalore, India
Minsk, Belarus
Itatiaia, Brazil
East Timor
Nigeria
Nicaragua
Dominican Republic of the Congo
Tunisia
Myanmar

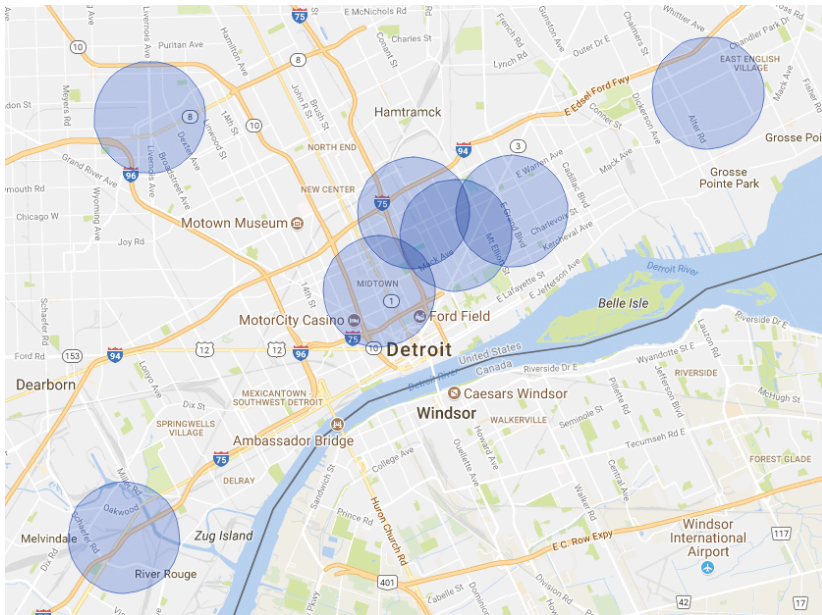


FIGURE 2 Location of DCTP Wireless Mesh Networks.

So far, six CWNs have been deployed, or prototyped, in five Detroit neighborhoods.

DCTP: Digital Stewards

AMP partnered with the OTI,³⁶ a global leader in using wireless technology for human rights, to launch the Detroit Digital Stewards Program. AMP and OTI produced a pilot version of the program in the fall of 2012, then designed a 20-week version which was integrated into the Detroit Future Media training program.³⁷

This training prepares teams of community organizers, people with construction skills, and tech-savvy individuals to design and deploy communications infrastructure with a commitment to the “Detroit Digital Justice Principles.”³⁸

36. See <http://www.newamerica.org/oti/>. Accessed October 31, 2017.

37. See <https://www.alliedmedia.org/detroit-future>. Accessed October 31, 2017.

38. See <https://www.alliedmedia.org/djc/principles>. Accessed October 31, 2017

TABLE 3 Detroit Digital Justice Principles

Access
Digital justice ensures that all members of our community have equal access to media and technology, as producers as well as consumers.
Digital justice provides multiple layers of communications infrastructure in order to ensure that every member of the community has access to life-saving emergency information.
Digital justice values all different languages, dialects, and forms of communication.
Participation
Digital justice prioritizes the participation of people who have been traditionally excluded from and attacked by media and technology.
Digital justice advances our ability to tell our own stories, as individuals and as communities.
Digital justice values nondigital forms of communication and fosters knowledge sharing across generations.
Digital justice demystifies technology to the point where we can not only use it, but create our own technologies and participate in the decisions that will shape communications infrastructure.
Common Ownership
Digital justice fuels the creation of knowledge, tools, and technologies that are free and shared openly with the public.
Digital justice promotes diverse business models for the control and distribution of information, including: cooperative business models and municipal ownership.
Healthy Communities
Digital justice provides spaces through which people can investigate community problems, generate solutions, create media, and organize together.
Digital justice promotes alternative energy, recycling and salvaging technology, and using technology to promote environmental solutions.
Digital justice advances community-based economic development by expanding technology access for small businesses, independent artists, and other entrepreneurs.

- *Digital justice integrates media and technology into education in order to transform teaching and learning, to value multiple learning styles and to expand the process of learning beyond the classroom and across the lifespan.*

The Digital Stewards learn about mesh wireless technology then train neighbors to form their own local network and share an Internet connection. As a result of the inaugural Digital Stewards program, five Detroit neighborhoods are now equipped to build and maintain their own wireless communications infrastructure or mesh networks. The Detroit

Digital Stewards program has been initiated in Detroit, District of Colombia, Brooklyn, Sayada (Tunisia), and Dharamshala (India).

According to DCTP, the Digital Stewards are, “technologists, organizers, Detroiters, activists, and elders exploring and learning new technologies with the goal of supporting community-owned wireless infrastructure (Wi-Fi networks).” Their meetings include planning, building, and organizing CWNs in Detroit neighborhoods and are open to anyone interested in learning about and participating in community technology projects.

In Detroit, the program has trained over 25 neighborhood leaders to build their own CWNs and have implemented CWNs in the Morningside, Poletown, Field St., the Boggs School, and Ewald Circle areas of Detroit. In Southwest Detroit, it has also helped to construct, and currently maintains, the CassCo mesh network in Detroit’s Cass Corridor.

DCTP: CassCo Community Wireless Internet

The CassCo Community Wireless Internet network can both distribute Internet connections as well as act as a local network or “Intranet.” On the Intranet, neighbors can communicate and share information without the Internet, using the mesh network to house community radio apps, an offline searchable version of Wikipedia, store music and movies for people to share, have a local chat and phone service.

DCTP has been training community technologists to build and maintain the CassCo CWN, as well as imagine ways in which this network can be used to connect people with each other. The first application to be launched on the CassCo network was the Detroit Music Box. This application is used as a neighborhood radio station to broadcast stories and media from people living in the Cass Corridor. According to DCTP, community members involved in this project ranged in ages from young to old and across demographic ranges. Although no specific demographic statistics were collected. The shows combine music from the neighborhood, audio from the streets, and interviews with neighbors to make a feature track that, “asserts an identity and vision for Detroit.” The Cass Corridor is the area bounded by Warren to the north, Woodward to the east, Mack Ave. or Martin Luther King Jr. Boulevard to the south, and the Lodge to the west.

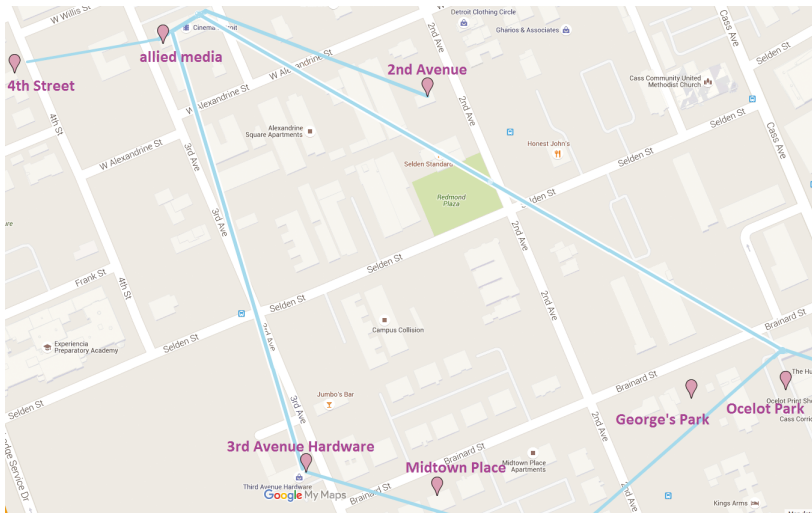


FIGURE 3 CassCo Community Wireless Internet Service Area.

DCTP: Narratives and Themes

Methods

Data were gathered for this study in the form of transcribed interviews and organization provided documents. Seven members of DCTP's staff, including leadership team members and technology trainers, were interviewed over the course of 2 days at the Highlander Research and Education Center in Jefferson County, Tennessee, in September 2017. The interviews with these staff members included both unstructured individual interviews as well as group discussions. These interviews and discussions centered around the topics of organization purpose, aims, and impacts. These interviews and discussions were recorded and transcribed for further analysis. Documents provided by DCTP were training and organization documents including Digital Steward and community member testimonies gathered via the organization's Github site. These documents contained data collected by the organization regarding their community members and Digital Stewards thoughts on the organizations purpose, aims, and community impacts. After gathering data from these interviews, as well as the documents provided by DCTP, the analytic process is comprised of three stages. A systematic thematic content analysis was conducted to reveal the structure and main themes. Content analysis, in this form, is helpful as it involves as process of forming and consolidating

thematic categories and can be used to analyze large volumes of data.³⁹ The thematic content analysis was conducted according to the principles of qualitative content analysis laid out by Sharan B. Merriam in 1998.⁴⁰ During the first stage, initial reading, data were read through until research personnel were familiar with the general contents of the data. The next stage, first coding round, involved identifying general themes that would be consolidated in the third stage. During this second stage, the general themes of “narrative disruption” and “organization aims/purpose” were identified. “Narrative disruption” was identified as a repeated theme throughout DCTP data. This theme represents the organizations primary philosophy regarding countering commonly held myths regarding certain demographics and technology. The second theme related more generally to the organizations’ overall aims and purpose. At this stage, data, reflecting each of these themes, were assigned to either of the categories. During the third coding round, data within each of the themes were consolidated into thematic categories.

“Narrative Disruption” categories

- Economic and social benefits of technology
- Safety and privacy
- Cost and quality
- Technology and age
- Technology and gender
- Technology and education

“Aims and Purpose” categories

- “Cultivating a healthy digital ecology” versus “closing the digital divide”
- Design technological solutions for “everyone” not just “anyone”
- Understand communities as “producers of tech” not just “consumers of tech”
- Design Digital Literacy Programs that thrive through/as a result of intergenerational relationships within the classroom
- Understand and utilize the talent and expertise within communities
- Apply the “Concept of the Commons” to tech and communications infrastructure and airwaves
- Understand that lives are at stake when it comes to policies around data communications and plan, accordingly

39. Phillips and Hardy.

40. Merriam.

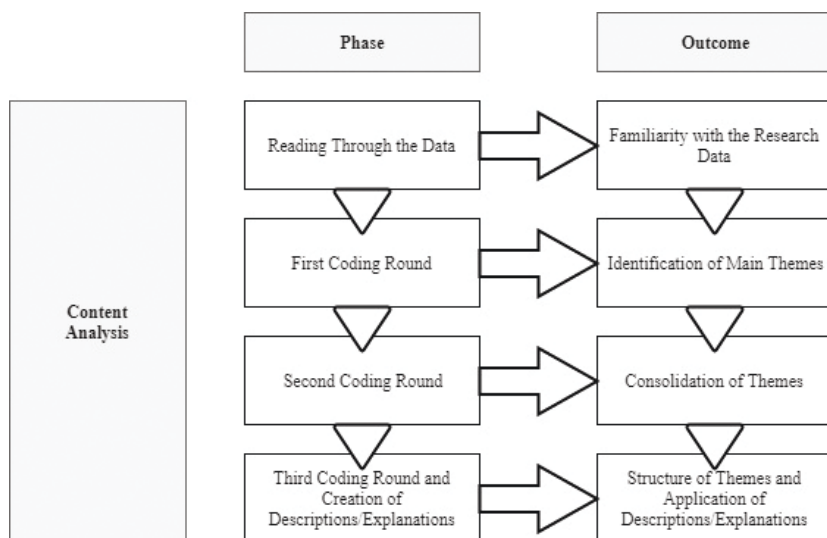


FIGURE 4 Stages of Thematic Content Analysis.

Results

Disrupting Dominant Narratives

Analysis of data regarding DCTP identified that one of the primary aims of this community training program was to attempt to disrupt or counter commonly held narratives (or “myths”) regarding marginalized communities and technology. These narratives are perceived by community members and DCTP staff to be commonly held by policymakers and are incorrect. After identification of these narratives community members and DCTP staff hope to counter them through community outreach/training as well as advocacy campaigns.

Economic and Social Benefits of Technology

A myth encountered by DCTP staff and community members, when addressing the issue of technology as a community benefit, is the narrative that technology, isolated from other forms of social change, will provide an immediate fix for youth in low socioeconomic status (SES) Detroit communities. Community members referred to the idea that, “Technology education will save our youth.”⁴¹ This included the belief among policymakers, encountered by staff and community members that

41. Community member: Document analysis.

teaching coding skills, self-directed learning, and so on, will “automatically solve youth-related issues.”⁴² DCTP staff stated that the issues encountered by low-SES youth go beyond those that can be fixed “purely by teaching technology-based skills.”⁴³ The issues of “drug addiction, criminal history, and social isolation,”⁴⁴ as examples, can all be contributing factors that need to be addressed in addition to providing low-SES youth with practical technological skills.

When discussing the idea of Detroit becoming a hub for technology companies, staff and community members expressed apprehension in terms of the impact this will have on low-SES areas of Detroit. These staff and community members did not believe that the narrative that “the economic and social benefits of the tech industry will trickle down”⁴⁵ was something that would occur in Detroit without the involvement and inclusion of disadvantaged community members. Staff members, in particular, stated that economically disadvantaged communities and neighborhoods will benefit from tech sector growth only if these communities and neighborhoods are “integrated into the implementation of tech sector growth.”⁴⁶ DCTP staff and community members cited the examples of Comcast, Rocket Fiber, and WOW as broadband providers who had specifically targeted high-SES areas of Detroit for fiber broadband expansion, specifically, business districts. Staff and community members stated that this kind of tech sector investment would only lead to “further segregation of low-SES communities.”⁴⁷

When discussing tech sector investment another narrative that DCTP staff and community members/stewards stated they felt was incorrect was that “internet access will solve the problems of unemployment and poverty.”⁴⁸ They stated that there was a belief among policymakers that the economic disadvantages within low-SES communities in Detroit either “exist primarily due to lack of adequate internet service”⁴⁹ or “can be fixed by expanding high-speed internet service.”⁵⁰ DCTP staff and community

42. DCTP staff member: Study interview.

43. Ibid.

44. Ibid.

45. Ibid.

46. Ibid.

47. Community member: Document analysis.

48. DCTP staff member: Study interview.

49. Community member: Document analysis.

50. Ibid.

members stated that while lack of Internet access is a factor affecting disadvantaged communities it exists alongside “multiple other socio-economic factors that also need to be addressed.”⁵¹

Other topics related to the idea that technology would create social and economic benefits for low-SES Detroit communities were the narratives that “private technology companies can replace public services and people”⁵² and “an app will fix it.”⁵³ On the topic of private technology companies and public services/people, DCTP staff and community members stated that the removal of public services, such as public transportation, and their replacement with examples such as Uber or other car-sharing Internet-based services would “negatively affect communities that both rely on these services and cannot financially, or are not prepared socially, to transition to the private alternative.”⁵⁴ DCTP staff and community members also stated that they do not believe that social problems, such as lack of access to a doctor, can be fixed merely by creating an app. They stated that there will inevitably be demographics of people who “will not be reached by a technology-only centered solution to lack of social services.”⁵⁵

Safety and Privacy

DCTP staff and Digital Stewards identified a myth among policymakers that “Surveillance technologies will make us safe.”⁵⁶ They stated that there appeared to be a belief, particularly among those involved in law-enforcement policy, that “if you are not doing anything wrong you are not being surveilled and you have nothing to fear or worry about.”⁵⁷ Apprehension toward this narrative by DCTP staff and stewards centered on their worry that immigrant members of their community could be targeted as a result of increased technology use and surveillance. They discussed how this meant they had to alter their plans in terms of mesh-network implementation to ensure that they would not be subject to data-gathering requests that could be used to target these community members. In terms of their recommendations to communities seeking to employ community-based Internet systems, DCTP staff and stewards

51. DCTP staff member: Study interview.

52. Community member: Document analysis.

53. Ibid.

54. Ibid.

55. DCTP staff member: Study interview.

56. Community member: Document analysis.

57. Ibid.

recommended that community members be aware that, while it is true that “the same standards of privacy established in the real-world cannot be expected in an online environment,”⁵⁸ they can integrate into their system measures to avoid data capture, such as not hosting files on a community server, in order to secure the privacy of their residents.

Cost and Quality

It is the belief of DCTP staff and community members that residents in their communities should not accept “lower quality communications because of their economic disadvantage”⁵⁹ or that they “aren’t paying full price.”⁶⁰ For DCTP staff, one of the founding principles of community-based technology is that “technology should be built and priced for all not just for some.”⁶¹ This means creating shared resources and systems that can be utilized by all community members regardless of SES. Another narrative that ties into this philosophy, and that they aim to contradict is that “upgrading is necessary and old tech is obsolete.”⁶² DCTP staff members aim to utilize existing infrastructure and technology where available. This could mean “installing new firmware on old routers instead of buying unnecessary new ones”⁶³ or “utilizing the infrastructure around us, such as buildings, rather than building towers or other new infrastructure.”⁶⁴

Technology and Age

Some of the trainers in the DCTP staff stated that there was a belief among technology educators, in “traditional learning environments,” that “if you give the economically disadvantaged youth internet access, time, and resources—they will just waste time and take advantage of the opportunities.”⁶⁵ When discussing traditional classroom environments, DCTP staff believed that a lack of classroom interaction meant that technology can be “situated but not integrated effectively.”⁶⁶ In their learning environments,

58. DCTP staff member: Study interview.

59. Ibid.

60. Community member: Document analysis.

61. DCTP staff member: Study interview.

62. Ibid.

63. Ibid.

64. Ibid.

65. Ibid.

66. Ibid.

such as the Data Discos, DCTP trainers aim to set up the learning environment to be interactive and allow users to identify which technology suits their need. This “exploratory learning” they stated initiates “dynamic learning” instead of “passive use.”⁶⁷

In terms of other age-related technology myths, some community members felt that they had been stigmatized by the narrative that “the Internet is too complicated for older people.”⁶⁸ For older community members, this had included being “spoken down to”⁶⁹ while trying to gain technology knowledge as well as “sensing quickly that technology learning environments were designed to cater to younger learners.”⁷⁰ The DCTP technology trainers mentioned that they specifically “flip” their classroom so that demographics “traditionally left behind, such as older learners or those who require longer learning processes, are the ones that lead the pace of the learning environment.”⁷¹

DCTP staff and community members also stated that gender stereotypes, such as “women are not as good with Tech”⁷² or “because the tech sector is dominated by men this means that women either do not understand tech as well or do not have the desire to work in the field,”⁷³ were something they looked to overcome. For DCTP staff, this meant a commitment to promoting female technologists into leadership roles and “focusing on developing female technology creators and leaders within our communities in order to promote and empower women and nongender-binary folk as technologists.”⁷⁴

Technology and Education

Many of the Digital Stewards and DCTP trainers who had come from a background in technology education, such as higher education degrees in fields like IT and Computer Science, had experienced a belief that “it takes certain education levels to understand or fix technology.”⁷⁵ They stated that one of their primary aims, in dispelling this myth, was to show that

67. Ibid.

68. Community member: Document analysis.

69. Ibid.

70. Ibid.

71. DCTP staff member: Study interview.

72. Community member: Document analysis.

73. DCTP staff member: Study interview.

74. Ibid.

75. Ibid.

“many technology related subjects can be taught in a way that the ordinary community member can understand.”⁷⁶ They felt that often people in the technology sector state that “technology is fragile and not serviceable by the general public.”⁷⁷ DCTP staff and Digital Stewards stated that this was a narrative used mainly to sell new products or to convince people that in order to fix technology you have to “pay a specialist to do it.”⁷⁸ Through their training materials, DCTP aim to show that community technology can be understood and learned by community members rather than specially trained external individuals and that “the general public can understand as well as control the production of technology.”⁷⁹

Organization/Community Aims

In addition to attempting to disrupt or counter the earlier narratives, DCTP staff, Digital Stewards, and community members also expressed the following specific aims:

“Cultivating a healthy digital ecology” versus “closing the digital divide”

For many of the DCTP staff and community members, the “issues of connectivity in Detroit” are “not just connected to one type of inequality.”⁸⁰ Therefore, they stated that the “inequalities of digital access and digital literacy” can’t be addressed “in isolation from other types of inequality,” such as “the education system, local and global economies, governance and other infrastructure systems.”⁸¹

DCTP staff expressed their belief that “broadband should be looked at in all the ways it is connected to community members lives.”⁸² Staff members and Digital Stewards used the metaphor of “the ecosystem” because they stated it, “captures the resilience and interconnectedness of parts that make a healthy and living whole.”⁸³

In describing how DCTP aimed to implement this strategy, a member of DCTP’s leadership team stated that, “to scale this work, it requires the efforts of all those involved in the Digital Ecosystem, which includes

76. Ibid.

77. Ibid.

78. Ibid.

79. Ibid.

80. Community member: Document analysis.

81. Ibid.

82. DCTP staff member: Study interview.

83. Ibid.

government, business and emerging entrepreneurs, the education system and community organizations doing community organizing.”⁸⁴

Design technological solutions for “Everyone” not just “Anyone”

DCTP staff members referred to the concept that “technology designed for ‘anyone’ without consideration of the barriers and experiences of marginalized peoples’ will be primarily used by the technologically privileged.”⁸⁵ They expressed the concept of “technological privilege” as being technology designed without consideration of the “resources, both financial and social, required to adopt and use that technology.”⁸⁶ In their design and testing phases, DCTP integrates “participatory design throughout the process, not just the user testing phase.”⁸⁷ This means including community members in every stage of technology “integration, implementation, adoption, and continued use.”⁸⁸ Community members stated that they “often felt abandoned by technology companies”⁸⁹ who “sell products to the community but then offer little in terms of continued support.”⁹⁰ The Digital Stewards program was designed specifically to “integrate technologists into communities and of communities so that there would be a constant support mechanism when required.”⁹¹

Understand communities as “producers of tech” not just “consumers of tech”

DCTP staff and Digital Stewards stated that they had witnessed community technology production as having both “self-transformative” and “community transformative” effects. Specifically, they referred to this occurring during the “process of making media & tech.”⁹² DCTP staff and community members expressed their belief that “communities are more than capable of ownership and governance of technology”⁹³ given their experience with neighborhoods in Detroit. This was based on their experience with “talent residing in each and every neighborhood”⁹⁴ and their

84. Ibid.

85. Ibid.

86. Ibid.

87. Ibid.

88. Ibid.

89. Community member: Document analysis.

90. Ibid.

91. DCTP staff member: Study interview.

92. DCTP staff member: Study interview.

93. Community member: Document analysis.

94. Ibid.

belief that “neighborhoods have the expertise of what solutions are needed for the problems they face.”⁹⁵

Design Digital Literacy Programs that thrive through/as a result of intergenerational relationships within the classroom.

Through DCTP’s educational experience, they have learned that there are “discrepancies based on age, and sometimes learning levels.”⁹⁶ This may lead to “segregated classrooms and, create hierarchies” of “those that are ‘smart’ and those that are ‘slow’.”⁹⁷ DCTP staff members support “inter-generational and multi learning level classrooms that reflect the ‘real world’.”⁹⁸ DCTP Digital Stewards believe that “teaching and learning as a diverse community” prepares communities to thrive in a world that does not function as a “school of fish.”⁹⁹ A DCTP technology trainer expressed this approach as, “Understanding the different ways people perceive and process information and taking into account the different physical and emotional needs of learners are key to setting up a positive and fruitful relationships.”¹⁰⁰ DCTP works to “solve problems, with community member involvement, collectively using media and technology.”¹⁰¹ In this process, “community members are producing new knowledge and resources, restoring relationships across generations, and healing neighborhoods.”¹⁰²

Understand and utilize the talent and expertise within communities

A DCTP staff member stated that, “We are the leaders we’ve been waiting for.”¹⁰³ This was reflected through community groups like the Digital Stewards and the Detroit Digital Justice Coalition. Through these initiatives, DCTP has “utilized expertise that comes directly from the community.”¹⁰⁴ According to DCTP technology trainers and Digital Stewards, “neighborhood technologists bring their skills to the table in various ways” such as “open sourcing their curricula” as well as “application building skills and digital and tech knowledge through intergenerational learning opportunities.”¹⁰⁵ They cited the example of “Data DiscoTechs” as a “prime

95. Ibid.

96. DCTP staff member: Study interview.

97. Ibid.

98. Ibid.

99. Ibid.

100. Ibid.

101. Ibid.

102. Ibid.

103. Ibid.

104. Ibid.

105. Ibid.

example of how these community lessons are organized.”¹⁰⁶ These events “through a community tech science fair atmosphere” gather stewards and community members together with other members of the community to “share their know-how on everything from wireless mesh set-up to how to build a mobile app.”¹⁰⁷ These free and accessible “neighborhood specific” fairs bring “technology to the community, by the community members who will benefit the most from them.”¹⁰⁸ By the end of 2018, DCTP hopes that “every neighborhood district in Detroit will have organized at least one Data DiscoTech.” One DCTP leadership team member described this as a “significant grassroots, ground up display of the talent that resides in the heart of Detroit neighborhoods.”¹⁰⁹

Apply the “Concept of the Commons” to tech and communications infrastructure and airwaves.

DCTP staff members as well as those in the community noted that “digital environments support life as crucially as food and water do.”¹¹⁰ DCTP want policymaker’s to “expand thinking about environmental awareness from solely about clean air, clean water, and land use and into, and including, airwaves and an open internet” which “directly affects health and environments.”¹¹¹ Staff members stated that “the digital age has shown us the flexibility of the ‘commons’.”¹¹² They explained that the concept of “the commons” is the “cultural and natural resources accessible to all members of a society, including natural materials such as air, water, and a habitable earth.”¹¹³ These resources are “held in common, not owned privately.”¹¹⁴ DCTP wants the concept of the commons to “include the infrastructure that contains the immense collective pool of information the internet holds” because “the ways in which we communicate to each other directly affect our environment.”¹¹⁵

Understand that lives are at stake when it comes to policies around data and communications and plan accordingly.

106. Ibid.

107. Ibid.

108. Ibid.

109. Ibid.

110. Community member: Document analysis.

111. DCTP staff member: Study interview.

112. Ibid.

113. Ibid.

114. Ibid.

115. Ibid.

A DCTP leadership team member stated that, "In a city that is over 80 percent black, with high concentrations of poverty, including more than 39 percent of the black population living below the poverty line as well as the largest population of foreign-born residents in the country, our staff members and Digital Stewards have come to believe that surveillance and profiling is a very real threat."¹¹⁶ They elaborated that, "Considering that 40% of households in Detroit lack a persistent connection to the Internet" this has left many community members "without the ability to interface with essential government services."¹¹⁷ In "marginalized and vulnerable communities," DCTP staff members and Digital Stewards have "witnessed an increase in lighting and cameras around businesses within those communities while street lights have been extinguished in many underserved neighborhoods."¹¹⁸ They stated that impact of this "coupled with water shutoffs" and "school closings on those who are already disenfranchised" may lead to "communities finding themselves in dire situations, leading to crime, violence, and ultimately the destruction of their own neighborhoods."¹¹⁹ Community members noted that these conditions "much like those in many urban areas" may lead to "profiling, surveillance and precrime." DCTP staff members cited examples in Chicago where data "has been used to profile and target marginalized and immigrant communities"¹²⁰ and were "aware of the need to create community based infrastructure that protects privacy."¹²¹

Further aims of DCTP staff members, Digital Stewards, and community members

- "Tech must be considered in urban planning."¹²²
- "Tech isn't always the solution."¹²³
- "Communities are capable of ownership and governance of tech."¹²⁴
- "Communities still need public infrastructure and human involvement."¹²⁵

¹¹⁶. Ibid.

¹¹⁷. Ibid.

¹¹⁸. Ibid.

¹¹⁹. Ibid.

¹²⁰. Ibid.

¹²¹. Ibid.

¹²². DCTP staff: Document Analysis.

¹²³. Ibid.

¹²⁴. Ibid.

¹²⁵. Ibid.

- “Algorithms/data sets aren’t enough to solve the complex problems faced by marginalized or underserved communities.”¹²⁶
- “Tech language needs to be de-mystified.”¹²⁷
- “Create stories that offer humanizing, relatable scenarios so that people can understand these narratives.”¹²⁸

Discussion and Analysis of Research Questions

RQ1: Looking to the future, how might other evolving technologies or interfaces or platforms associated with broadband networks enhance or hinder certain population groups’ effective use and access to information resources?

From analysis of the interviews with DCTP staff members as well as documents including Digital Steward and community member testimonies, it became apparent that a consistent belief among those involved with DCTP’s projects is that the integration of wireless mesh technology as a community-based infrastructure solution can create and foster community engagement through infrastructure deployment, maintenance, and use.

Susan Morse Moomaw argued in 2016 that community member involvement, specifically promoting public involvement in local decision-making, not only improves the results of community development but also lets community members know that their knowledge and experience is valued and will be listened to.¹²⁹ Moomaw cites Clay Spinuzzi’s methodology of participatory design¹³⁰ as an example of the positive results of integrating community member knowledge into the community design process. She also refers to Randolph T. Hester’s study on a neighborhood playground where he noted that community design often fails when the product is given more emphasis than the process of fostering community development.¹³¹

In terms of broadband’s specific role in community engagement and development, Dorothy Kidd’s analysis of grassroots organization’s campaign for digital access in the San Francisco Bay area concludes that digital

126. Ibid.

127. Ibid.

128. Ibid.

129. Moomaw.

130. Spinuzzi.

131. Hester.

democratization, or the move away from a corporately controlled digital infrastructure and toward community participation, requires community members to take ownership over infrastructure deployment and use.¹³² Hintz and Milan argue, when analyzing community-based technology organizations, that community member engagement and involvement is an important factor in democratizing broadband policy development and increases community member participation in technology implementation and expansion.¹³³

Through their interaction with people that have been “marginalized” in Detroit through poverty, age, social status, or gender, DCTP staff members have witnessed community member’s willingness to not only access but also have some form of control over information resources in the form of wireless mesh networks.

For this organization, mesh technology, in this capacity, serves both a functional and an organic purpose. It is both a tool and a service. In terms of its use as a tool, it can provide small-scale networked communication to those cutoff from larger networks through lack of access as a result of financial resources. Thus impoverished communities are given the ability to have some form of digital networking capability. In terms of an “organic service,” we see from analysis of DCTP that they aim to use it as a method of community engagement. A theme emerged that depicted marginalized populations, who may feel disenfranchised from day-to-day community governance and infrastructure decision-making, as being engaged through DCTP’s initiatives in the creation and maintenance of mesh networks thus bypassing the regular power gap and placing decision-making in the hands of the community members themselves. For DCTP engaging with community members in this way also fosters community interaction on technology-based issues. For DCTP’s technology trainers and Digital Stewards, their educational methods introduce technology at a community-centered level, taking into account distinctions in age-based and other demographically focused learning needs, thus transforming it from an expert topic to one that is understandable and usable for those at whom the technology is aimed.

RQ2: How can we foster public hybrid broadband, focusing not only on the technological infrastructure of the network but also situating broadband

132. Kidd.

133. Milan, “At the Margins of Internet Governance.”

networks within existing communities as a means to promote digital self-determination for indigenous and other disadvantaged groups?

Wireless mesh networks, while functioning independently, are ultimately integrated into the wider digital ecosystem. These wireless networks have arisen in response to specific needs and operate as highly specialized solutions to localized issues. They are also, according to DCTP, a means of community ownership that promotes digital self-determination. The themes identified by this study show that a primary focus of both DCTP staff and community members is that of taking ownership not only of technology but of the narratives surrounding that technology and marginalized populations. DCTP hopes that a system of community owned and operated systems existing within the larger public and private Internet ecosystem can not only drive community ownership of technology but also will act as a means to create new narratives regarding these communities and technology. Indeed, a large part of the work of DCTP staff, Digital Stewards, and community members involves dispelling myths they believe describe underserved or marginalized communities as lacking the capacity to take on the challenge of technological adoption. One of the challenges of “digital self-determination,” from a policy perspective, is allowing communities to determine for themselves the best practices for technological deployment and adoption. An overarching theme associated with the work of DCTP is the view that it should be the community members who are not only listened to but also involved in the implementation process instead of being dictated to in terms of “what is best for them.” DCTP has developed a model that combines community engagement, training, as well as access to funding mechanisms that they believe can effectively inspire community members to adopt ownership of community-based communication technology solutions. This method places emphasis on community-based digital self-determination and moves decision-making from an external source and into the community itself.

Conclusion, Limitations of Study, and Recommendations

First, it must be stated that this study focused on one organization operating in one location in the United States. As such, even though the organization’s practices and principles have been deployed in multiple locations throughout the world, this study is limited in terms of generalizability. Where it may be possible to infer results of this study onto similar

organizations, or to propose public policy, in response to these findings, further research in this area, focusing on other organizations working in similar areas, is necessary to further expand this area of research. Second, given the nature of qualitative research and analysis, it is accepted that the results of this study are affected by research subjectivity. The choices made during research construction and analysis will have affected the outcomes of this study. Other researchers with differing philosophical reasoning or operating under different research criteria may have discovered alternative outcomes. Despite these limitations, however, the findings of this study do have implications for organizations working in this sector, policymakers, as well as future research.

Implications for Organizations

One of the primary findings from this study was DCTP's understanding and use of community members' skills and knowledge. DCTP's aim, through its Digital Stewards program, is to train community members to be the point-of-contact for technology education. In this way, the organization at some point will no longer be needed by a community technology project as they will have their own community members trained and ready to provide support and further training. DCTP leadership emphasized that it is important to identify within communities those members who are willing to serve as Stewards and to utilize existing knowledge within a community to build projects around.

When referring to the Digital Ecosystem, DCTP staff emphasized the need to work with all institutions of a community when developing technology projects. This involves taking a holistic approach to community technology research prior to project design. DCTP staff and community members aim to understand how multiple areas of a community may be both impacted by a technology project but also may be utilized to improve implementation. For example, DCTP has worked with schools and community anchor institutions to host events and with local businesses and residencies to construct or host infrastructure. In this way, it is necessary for organizations to have "project buy-in" from multiple community partners in order to effectively implement a community technology project.

For organizations planning tech education, this study identified several techniques, or philosophies, that they believe are necessary when interacting with marginalized groups. First, DCTP technology trainers emphasized

that exploratory learning had been useful in not only engaging community members with unfamiliar technology but also allowing community members to self-identify their strengths and unique interests. DCTP's "Data Discos" and other workshops utilize an open-space interactive environment. In this environment, multiple stations are set up where community members can interact and learn about different technologies at their own pace and making their own choices regarding which stations to visit. DCTP trainers believe that this open and exploratory learning environment gives community members "agency" over their learning choices as well as allowing trainers to identify which skills community members are naturally drawn to. Second, in terms of more structured workshops, DCTP highlighted their attempts to create "intergenerational" and "disadvantaged demographic focused" classrooms. DCTP and their Digital Stewards have committed to having their learning environments be led by demographics that are traditionally not dominant in the tech sector, such as older individuals or female and nongender binary community members. This structure, they believe, will promote disadvantaged or marginalized groups as both leaders and educators in community wireless technology projects.

Implications for Policymakers

The very existence of community-based wireless networks can be viewed as a symptom of lack of adequate access to affordable, reliable high-speed Internet, specifically for individuals marginalized by poverty or other disadvantaged demographics. Even in urban areas, such as Detroit, there appears to be a need, based on the existence of five wireless networks established by DCTP, for community members to deploy their own networking solutions. A study of FCC form 477 data in 2017 by the Institute of Local Self-Reliance showed that even in areas covered by high-speed Internet more than 129 million US households are limited to only a single provider (based on the FCC's current benchmarks of 25 Mbps download and 2 Mbps upload).¹³⁴ This lack of options has inevitably led to some communities turning to community created and owned solutions.

134. See <https://ilsr.org/pealing-net-neutrality-puts-177-million-americans-at-risk/>. Accessed February 7, 2018.

As well as being a symptom of lack of access CWN's also act as a challenge to incumbent private providers. Sofia Milan¹³⁵ describes CWN's, and their associated activist organizations, as acting as social movement "beyonders." According to Milan, these organizations, instead of focusing on pressuring policymakers to implement change, build self-organized, decentralized, and citizen-owned networks as a means of displaying an alternative to the status quo. In this way, organizations such as DCTP hope to show, by example, new methods of infrastructure deployment in order to present an alternative to traditional institutions and methods.

Much can be taken by policymakers from this study's analysis of DCTP's mesh-network projects and community training initiatives; promoting underrepresented demographics in the tech sector, planning technology policy with a consideration for interconnected policy areas, utilizing community members in policy planning and implementation, considering digital technology as a part of environmental policy, and considering the effects of digital privacy policy on marginalized communities.

When considering diversity in the tech sector, demographic intersectionality is an important element to consider. While the tech sector has attempted to diversify, its workforce results have shown that tech companies when focusing on recruiting women, for example, has resulted in increased numbers of predominantly white women.¹³⁶ Research on tech sector recruitment shows that women of color, for example, usually only make up around 3 percent of the average workforce in Silicon Valley. In order to combat this, policymakers can use the example set by DCTP of providing avenues for underrepresented, particularly ethnic minority or older aged individuals, to not only have access to technology training initiatives but to be given leadership roles within these initiatives. This could come in the form of technology leadership programs specifically funded to identify underrepresented tech sector demographics.

DCTP staff member's spoke of the need to view all the policy areas in a community as an interconnected ecosystem. For DCTP staff members, this meant considering how education, health, social services, and other areas of policy, are not only affected by technology but could have an effect on technology. In the United States, communications

135. Milan, *Social Movements and Their Technologies*.

136. See <https://gizmodo.com/the-alarming-downsides-to-tech-industry-diversity-repor-1789797486>. Accessed February 9, 2018.

infrastructure deployment and adoption have mostly been left to private incumbent providers. A policy model that isolates one area of infrastructure in this way leaves little room for policymakers to connect telecommunications policy to other areas. DCTP staff and leadership emphasized the need to policymakers to view telecommunications policy as interconnected to other areas of public policy. When considering telecommunications, infrastructure deployment policymakers should build into their models multiple policy areas and identify where areas overlap and are interconnected. For example, health and education policy are affected by digital access, especially in remote areas, therefore, digital telecommunications policy needs to be guided not only by telecommunications decision-makers but through input and collaboration with these other policy institutions. In terms of environmental policy, DCTP staff and community members expressed their desire for policymakers to view digital infrastructure as part of a community's environment and thus take into account the environmental impact of digital infrastructure and also how that infrastructure could be used to improve environmental policy.

As previous studies have shown community design and the policy process can be improved by the integration and utilization of local knowledge and community members. All of DCTP's projects are founded on the basis that successful project completion will see community members adopt and take ownership of the final project. For policymakers, identifying and integrating community members into technology policy implementation would not only make use of local knowledge, thus saving time on external research, but also will provide communities with opportunities to interact with local policy in a positive way.

Privacy policy and the Internet will become ever more important as the Internet continues to be a vital part of our everyday lives. Research into Internet privacy and marginalized communities requires its own area of study and will not be advanced to any significant degree by this study. Through their interaction with marginalized, specifically immigrant, communities in Detroit DCTP staff expressed their desire that digital privacy policy be considered in light of these populations. This has led DCTP to adopt in their digital infrastructure projects processes that protect data for marginalized populations. DCTP hopes that in future any consideration of data gathering and storage policy will take into account the safety and privacy of groups, such as immigrant communities or other targeted groups, who may be put in danger by abuse of data privacy.

Future Research

As stated earlier, an area of future research that requires further exploration is that of data privacy and marginalized communities. Specifically, how can data privacy policy be improved in order to protect marginalized populations from data intrusion? In terms of CWNs and organizations such as DCTP, there are further research questions that need to be explored in the light of these findings:

- Are the Detroit Digital Justice Principles unique to Detroit and does US digital policy address the access needs of communities?
- What effect do CWN's have on promoting underrepresented demographics in the tech sector?
- How effectively do communities maintain CWN's once organizations, such as DCTP, have finalized passing project ownership over to communities?
- How sustainable are CWN's when faced with increased provider competition?
- What cost models do CWN's adopt?
- How have resilient networks been deployed in the wake of natural disasters and loss of communications through war or government intervention
- What funding mechanisms are available to organizations such as DCTP and how can similar organizations access these funds?
- How can technology training initiatives, such as the Digital Stewards program, be implemented on a larger scale?

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