

Situating Network Infrastructure with People, Practices, and Beyond: A Community Building Workshop

Esther Han Beol Jang
Paul G. Allen School for Computer
Science and Engineering
Seattle, Washington, USA
infrared@cs.washington.edu

Phoebe Sengers
Cornell University Information
Science and Science & Technology
Studies
Ithaca, New York, USA
sengers@infosci.cornell.edu

Melissa Densmore
University of Cape Town
Cape Town, South Africa
melissa.densmore@uct.ac.za

Nicola J. Bidwell
International University of
Management
Windhoek, Namibia
nic.bidwell@gmail.com

Naveen Bagalkot
Srishti Manipal Institute of Art,
Design and Technology
Bengaluru, Karnataka, India
naveen.bagalkot@manipal.edu

Morgan Vigil-Hayes
Northern Arizona University School
of Informatics, Computing, and Cyber
Systems
Flagstaff, Arizona, USA
Morgan.Vigil-Hayes@nau.edu

Jen Liu
Cornell University Information
Science
Ithaca, New York, USA
jl3835@cornell.edu

Nervo Verdezoto
Cardiff University School of
Computer Science and Informatics
Cardiff, UK
verdezotodiasn@cardiff.ac.uk

Shaddi Hasan
Virginia Tech Department of
Computer Science
Blacksburg, Virginia, USA
shaddi@vt.edu

ABSTRACT

Abstract: Our world is now connected and even *entangled* in unprecedented ways through networked technologies. Yet pockets of unequal connectivity persist, and technical infrastructures for connectivity remain difficult to design and build even for experts. In this workshop we aim to bring together a global community of multi- and inter-disciplinary researchers and implementers working on infrastructure development and connectivity to explore the existing design challenges and opportunities for bringing technical dimensions of networked infrastructures in conversation with human-computer interaction (HCI) and the social science of infrastructure. We will share, assess and define research problems and resources for rethinking networked infrastructures from human-, community-, and society-centered perspectives, understanding them to be embedded with human values and biases. We particularly intend our collaborative work to support real-world connectivity initiatives, which have grown in critical importance over the pandemic years—especially projects in support of Global South communities. Concrete deliverables from the workshop will include: (1) an initial shared bibliography to help formalize the state of knowledge in our area, (2) an agenda of shared goals, challenges, and intentions in our field, (3) a compilation of resources to support future work, and (4) social and organizing infrastructures for continued communication and academic collaboration.

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

CSCW'22 Companion, November 8–22, 2022, Virtual Event, Taiwan

© 2022 Copyright held by the owner/author(s).

ACM ISBN 978-1-4503-9190-0/22/11.

<https://doi.org/10.1145/3500868.3560716>

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; • **Networks**; • **Applied computing** → **Telecommunications**; • **Social and professional topics** → **Computing / technology policy**; • **General and reference** → **Design**;

KEYWORDS

infrastructure studies, networking technology, participatory design, network policy and governance, community networks, merging theory and practice, community building

ACM Reference Format:

Esther Han Beol Jang, Nicola J. Bidwell, Jen Liu, Phoebe Sengers, Naveen Bagalkot, Nervo Verdezoto, Melissa Densmore, Morgan Vigil-Hayes, and Shaddi Hasan. 2022. Situating Network Infrastructure with People, Practices, and Beyond: A Community Building Workshop. In *Computer Supported Cooperative Work and Social Computing (CSCW'22 Companion)*, November 8–22, 2022, Virtual Event, Taiwan. ACM, New York, NY, USA, 6 pages. <https://doi.org/10.1145/3500868.3560716>

1 INTRODUCTION AND GOALS

Our workshop builds on the potential for social-scientific and technology-oriented studies of computer networks to inform each other. New socio-technical theories have emerged from the design, development, use, and regulation of computer networking technologies in diverse contexts around the world and, simultaneously, social-scientific analyses are shaping an array of computer networking infrastructures. Expertise in “network connectivity” is distributed across academic fields, such as Human Computer Interaction (HCI), Information and Communication Technologies

for Development (ICT4D), Computer Communications, Social Sciences of Technology (STS), Information Sciences, and Participatory Design (PD), Public Policy, Law, and Geography, and across non-academic sectors and civil society groups, such as Free/Libre Open Source Software (FLOSS) projects, hackerspaces, community radio activism, and policy advocates. Meanwhile travel restrictions during the global pandemic have both fractured localised academic-practitioner links and prompted new virtual connections. Our workshop aims to foster links to enrich thinking, share resources and build community. It extends discussion over the past six years in special interest workshops/panels on topics ranging from community-based telecoms (e.g.[10]) to socio-ecological implications of escalating 5G and deep-sea cables (e.g.[3]), aiming to integrate other perspectives and agendas such as networked sensing systems (e.g. [2]) and policy advocacy. The enthusiastic response of CSCW 2021 attendees to Josephine Miliza's opening keynote suggests our workshop may also engage researchers who did not previously consider computer networking to be a focus of their work.

2 RELATED WORK

The vast scope of entanglements between social science and computer networking technologies can make it difficult for researchers or practitioners to find the many others with whom there is so much to share. This workshop will provide a framework for making important links between theoretical perspectives and practical experiences by building on relevant clusters of academic work, e.g.:

Community Networks (CNs) and radio. A robust body of research examines how communities collaborate to build and maintain their own *community networks* for Internet and digital services [21, 23–25, 28, 54], especially in places where they were formerly inaccessible [31, 33]. Many studies of CNs [22, 29, 37, 40, 42] and community radio projects [41, 43, 45, 52, 57] integrate technical development with community engagement, putting social science in direct conversation with system design and implementation.

Human-centered design of networking technologies. In other network design contexts, researchers have folded social science insights and methods into design processes to explore human-centered issues in network infrastructure [13–16, 26, 27, 30, 32, 35, 49, 50, 56], for example using participant observation within a network architecture design team to uncover embedded values [55]. Social science insights have also informed network technology design supporting community healthcare [18] [4, 17, 59], agricultural data integration [53], optimised environmental sensing [62], and the movement of money and goods [36]. Some studies have served as precursors to design, such as investigations of network traffic characteristics or repair in remote rural communities that reveal their particular needs [38, 39, 60].

Policy and governance of networked technologies. Other work explores relationships between technical development [53, 58] and governance [6–9, 61] of networking technologies. Research on the material and technical realities of the internet [19, 20] finds structural inequalities are produced through differential modes of access [11, 12, 46–48] and various analyses have prompted recommendations for telecommunications policy change, such as more inclusive FM-radio licensing [9] and wireless spectrum regulation

[51]. Earlier discussions (e.g. [10]) reflected on the complex challenges of diverse communities operating their own telecommunications, and how they reconcile local practices with funding and legislation regimes that were not designed to support them. These conversations are especially timely given intensified efforts around the world, due to the pandemic, to bridge gaps in connectivity, and the factors that preclude equitable communications access.

Socio-technical theories of networked technologies. Theoretical insights have also been produced by socio-technical analyses of relations between networking technologies and decolonizing and feminist concerns [5, 7], critical pedagogies [44], and plural and beyond-human onto-epistemologies [22, 34]. For instance, in discussions, about "networking rurality" at 4S [1], STS studies of internet and energy infrastructures illuminated insights about relational onto-epistemologies in remote indigenous communities and prompted conversations about the effect of light emittance of LEO satellite internet infrastructures, such as SpaceX's Starlink, on ways of being, knowing and doing in the Kalahari.

3 WORKSHOP THEMES

We organize our interests into the following provisional interrelated themes, to which workshop attendees may contribute:

- (1) **Social scientific analyses in technology design and implementation:** This theme will consider how to apply social science insights/theories in developing network technologies. For example:
 - Integrating local knowledge into environmental sensor networks, e.g. monitoring air quality
 - Local languages and interfaces in networked applications
 - Designing decentralized/mesh vs. more centralized network architectures
 - How problem framings in networking research produce and prevent systems of oppression
- (2) **Intersections of networking practices with political and economic conditions, and governance:** This theme will analyze organizational, institutional, disciplinary, policy and governance factors that shape infrastructures, exploring how networks are produced at the confluence of technical possibility, cultural/historical context, and political/economic realities. For example:
 - How North American tribal networks are produced to reflect tribal sovereignty
 - How CNs are impacted by radio spectrum and regulatory frameworks
 - Funding policies/programs, financial models, and case studies for Global South networks
 - Other challenges and responses (advocacy, direct action) related to regulations/policies
- (3) **Alternative perspectives on networking:** This theme will draw connections between participants' interests in networks in different domains, for different purposes and diverse critical and onto-epistemic perspectives. For example:
 - How to embed critical lenses,(e.g. gender/feminist/decolonial) in different areas of inquiry and research methodologies

- CNs as mutual aid, and their intersection with activist and organizing spaces
- Imagining networks from beyond-human/pluriversal/re-worlding/multi-species perspectives

4 LOGISTICS

4.1 Virtual Tools

We will host our workshop on a widely accessible video-conference platform that can support live captioning, chat, and breakout rooms to facilitate synchronous group activities (e.g. Zoom). Before and after the workshop, we will provide different digital channels to promote and support inclusive conversations, including: an email list; a platform for one-on-one chats and parallel discussions (e.g. Discord); and, a Google Drive folder for asynchronous collaboration on shared documents.

The workshop's website will be an information hub, including agenda, goals, tentative schedule, submission instructions, and links to other communications channels. Workshop facilitators will use collaborative editing tools for group activities and shared note-taking (e.g. Miro boards), with designated note-takers and automated captioning throughout group activities supporting accessibility.

4.2 Recruiting Participants

We will recruit ~30 participants interested in network infrastructures and connectivity, publicizing via online channels such as social media and e-mail lists. We will prioritise both relevant research communities (e.g. GAIA, LIMITS, ICTD, COMPASS, and SIGCOMM), practitioners in civic and advocacy groups (e.g. the Association for Progressive Communications, FLOSS communities, community radio and network builders/maintainers around the world), and regional professional groups (e.g. IEEE ComSoc).

Interested attendees will submit a Google form including: name, affiliation(s), short bio (100 words), time zone, accessibility needs, and the workshop themes that their work/interests relate to including new ones they would like to explore. Prospective participants will also submit an image that represents their interest in networks (with captions for accessibility), and a visualisation (poster/slide/other) around which they will briefly present their interests at the workshop.

5 WORKSHOP STRUCTURE

5.1 Pre-workshop

We will make our digital channels available at least 2-3 weeks before the workshop, so that participants may socialize and begin online conversations.

5.2 Format and Program

We propose a program that enables participation in different time zones, and will work with the CSCW conference organizers to achieve a format that can allow participants to attend other workshops. We suggest two 3-hour sessions, with different content, repeated twice with different groups based on time zone. We will schedule sessions to accommodate participants' preferred times.

5.3 Tentative Schedule

5.3.1 Session A.

- 00:00 - 00:15: Icebreakers A
- 00:15 - 00:45: Lightning talks A
- 00:45 - 01:00: Social Break
- 01:00 - 02:00: Discussion A
- 02:00 - 02:15: Social Break
- 02:15 - 02:45: Exercise A
- 02:45 - 03:00: Wrap up and reflection

5.3.2 Session B.

- 00:00 - 00:15: Icebreakers B
- 00:15 - 00:45: Lightning talks B
- 00:45 - 01:00: Social Break
- 01:00 - 02:00: Discussion B
- 02:00 - 02:15: Social Break
- 02:15 - 02:45: Exercise B
- 02:45 - 03:00: Wrap up and reflection

5.4 Activity Descriptions

5.4.1 Icebreakers. In breakout rooms participants will show-and-tell around their submitted visuals 4.2. This activity will be repeated in both sessions with different mixes of participants.

5.4.2 Lightning Talks. Participants will present their interests (during either Session A or B) for 2 minutes, including a core concept from their research or practice and themes they wish to discuss.

5.4.3 Discussions. During Session A, we will discuss all 3 (or more) workshop themes (3) in breakout rooms from the direction of "how social science can inform networking research." We will distribute participants initially according to their interests and re-shuffle breakout rooms part-way through to enable participants to engage with different topics and people. In Session B, we will encourage participants to reflect on their discussions in new groups from the direction of "how networking technology research and designs can inform social science analyses and theory." We will then return to the whole group to share highlights and takeaways.

5.4.4 Exercises. The exercises aim to collaboratively compile shared resources. In Session A, we will discuss making our research and practice area explicit. We will first identify problem spaces and research questions and their real-world relevance, foundational related works, venues and sub-disciplines, and contribute to a shared repository of scholarly and practitioner resources. Then we will seed a bibliography in interest groups. In Session B, we will start to consolidate resources and indicate next steps. This includes identifying resources that people may have or need to pursue their networking interests, such as funding, connections to advocacy or developer groups, *etc.* For each exercise, we will have small group discussions in breakout rooms.

6 CALL FOR PARTICIPATION

This workshop, spread across two days in time-zone convenient sessions, aims to foster a global community of researchers and practitioners with technical and social science expertise in computer networks. We aim to expand upon and build links between different conversations, and support these with relevant resources .

The workshop will discuss: applying social scientific analyses to technology and implementation; social-scientific analysis of the production and governance of networking infrastructure; alternative perspectives on networking; and, intersections of networking practices with political and economic conditions.

The workshop will produce: (1) a shared, extensible bibliography to make the state of the art explicit and inclusive, (2) a compilation of resources to support future work, (3) an agenda of shared goals, challenges, and intentions, and (4) social and organizing infrastructures for continued communication and collaboration.

We especially intend for workshop outputs and collaborations to engage with real-world connectivity initiatives, particularly in support of marginalized groups and Global South communities.

To participate, please fill in the Google form on our website (<https://cscwnetworks.wordpress.com>) by September 1, 2022. Along with your name and short biography we would like you to upload an image that represents your interest in networks, and a visualisation (poster/slide/other) around which you can talk about your interests for 2 minutes. Please send any questions to cscwnetworks@gmail.com.

7 ORGANIZERS

Esther Jang is a PhD student in Computer Science at the University of Washington. Her research on CNs in rural and urban contexts focuses on how communities of practice can build and sustain technical infrastructures. She helped install CNs in the Philippines, Mexico, Tanzania, and the US; is a lead organizer and installer for the Seattle Community Network; and a Director at the Local Connectivity Lab, a nonprofit that supports CNs through technology research, deployment, and teaching.

Nic Bidwell is associate professor at Aalborg University and adjunct professor at the International University of Management, Namibia. Her research, on contexts marginalized by technogeopolitics, includes rural Australia, Namibia, South Africa, Mozambique, Kenya, Uganda, Indonesia, Argentina, Mexico and India. Nic's ethnographically informed co-design set the stage for South Africa's first community owned ISP. Her analyses of relations between regulation and participation in CNs and radio have informed advocacy for policy change. She has been active in the African CN movement since its launch, co-founded AfriCHI, is a member of Digital-Environment System Coalition and Chairs SIGCHI EC's Sustainability Committee.

Jen Liu is a PhD student in Information Science at Cornell University. Her research investigates the ecological, social, and political implications of computing technologies and infrastructures. Jen has worked on topics including land politics in digital agriculture and knowledge production in environmental sensing. Her dissertation is on the impact of climate change on networked infrastructures in the American South.

Phoebe Sengers is a professor in Information Science and STS at Cornell. Her work integrates ethnographic and historical analysis of the social implications of technology with design methods to suggest alternative future possibilities, with a focus on the effects of rural infrastructure. She currently leads the NSF project, "Understanding and Improving the Social Impact of High-Bandwidth Farm Networking Infrastructure" which integrates networking research,

sociology of agriculture, and research through design to develop design and policy recommendations for new on-farm networking infrastructure. At Cornell, she is a member of the Graduate Field of Computer Science, associate faculty with the Department of Art, and a member of the Cornell Initiative for Digital Agriculture.

Naveen Bagalkot is a design researcher, educator and facilitator at the intersections of HCI, PD and community-based care. As a co-founder of Design Beku collective, he facilitates collaborative design and critical making for and with grassroots community organizations (e.g. MAYA Health, Enable India). As teaching faculty at Srishti Manipal Institute of Art, Design and Technology, he teaches across undergraduate and graduate programs in HCI.

Nervo Verdezoto is a senior lecturer at Cardiff University, with expertise in ethnographically informed, user-centred and participatory design, physical computing and evaluating socio-technical systems with particular focus on Digital Health and Sustainability. He has investigated invisible work and infrastructures across multiple care settings with recent work explores how care infrastructures and socio-technical and cultural practices influence maternal and child health in the Global South.

Melissa Densmore is associate professor at the University of Cape Town, where she leads the HCI Lab and the Hasso Plattner Institute Research School at UCT in ICT4D. Her research looks at community-based digital innovation for maternal and child health and CNs. The award-winning iNethi project is an open-source platform for enabling community-based wireless hosting of local content and services.

Morgan Vigil-Hayes is an assistant professor at Northern Arizona University. Her research examines the nexus of last-mile network connectivity and uses of networks for community good, most recently on how new architectures and services can enhance the goals of tribal communities in the American Southwest to promote Nation-building. Morgan's 2022 NSF CAREER award will characterize how communities collaborate around measuring the Internet and co-design a platform to facilitate Internet activism.

Shaddi Hasan is an assistant professor of computer science at Virginia Tech, where his research addresses scale and flexibility challenges faced by service provider networks, especially in rural and developing regions, such as architectures that can support diverse network operators. Shaddi has worked with CNs in Indonesia, Mexico, the Philippines and the USA, was previously with Facebook Connectivity and was a co-founder at Endaga, a startup that built tools for community-run cellular networks.

REFERENCES

- [1] 2021. 4S Annual Meeting 2021. https://convention2.allacademic.com/one/ssss/ssss21/index.php?PHPSESSID=tms8aondgaq2s435hbi0fkfu8e&cmd=Online+Program+Search&program_focus=fulltext_search&search_mode=content&offset=0&search_text=networking+rurality
- [2] 2022. ACM SIGCOMM 2022 - ACM SIGCOMM 2022. <https://conferences.sigcomm.org/>
- [3] 2022. World Summit on the Information Society Forum 2022. <https://www.itu.int/net4/wsis/forum/2022/en>
- [4] Naveen Bagalkot, Nervo Verdezoto, Michelle Lewis, Paula Griffiths, Deirdre Harrington, Nicola Mackintosh, and Judith Angelitta Noronha. 2018. Towards Enhancing Everyday Pregnancy Care: Reflections from Community Stakeholders in South India. In *Proceedings of the 9th Indian Conference on Human Computer Interaction (Bangalore, India) (IndiaHCI'18)*. Association for Computing Machinery, New York, NY, USA, 71–74. <https://doi.org/10.1145/3297121.3297130>
- [5] Nicola Bidwell. 2021. Decolonising in the Gaps: Community Networks and the Identity of African Innovation. 97–115. <https://doi.org/10.1007/978-3-030-54169-9>

- 9_6
- [6] Nicola J Bidwell. 2019. Women and the Spatial Politics of Community Networks: Invisible in the Sociotechnical Imaginary of Wireless Connectivity. In *Proceedings of the 31st Australian Conference on Human-Computer-Interaction (OZCHI '19)*. Association for Computing Machinery, New York, NY, USA, 197–208. <https://doi.org/10.1145/3369457.3369474>
 - [7] Nicola J. Bidwell. 2020. Women and the Sustainability of Rural Community Networks in the Global South. In *Proceedings of the 2020 International Conference on Information and Communication Technologies and Development (ICTD2020)*. Association for Computing Machinery, New York, NY, USA, Article 21. <https://doi.org/10.1145/3392561.3394649>
 - [8] Nicola J. Bidwell. 2021. Rural Uncommoning: Women, Community Networks and the Enclosure of Life. *ACM Transactions on Computer-Human Interaction* 28, 3, Article 19 (July 2021). <https://doi.org/10.1145/3445793>
 - [9] Nicola J. Bidwell, Roberto Cibin, Conor Linehan, Laura Maye, and Sarah Robinson. 2021. Being Regulated: Licence to Imagine New Technology for Community Radio. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW1 (April 2021), 154:1–154:27. <https://doi.org/10.1145/3449228>
 - [10] Nicola J Bidwell, Melissa Densmore, André Van Zyl, Sarbani Banerjee Belur, and Nicolas Pace. 2019. Artful integrations of infrastructures by community-based telecoms. In *Proceedings of the 9th International Conference on Communities & Technologies-Transforming Communities*. 331–335.
 - [11] Mehrab Bin Morshed, Michaelanne Dye, Syed Ishtiaque Ahmed, and Neha Kumar. 2017. When the Internet Goes down in {Bangladesh}. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '17)*. Association for Computing Machinery, New York, NY, USA, 1591–1604. <https://doi.org/10.1145/2998181.2998237>
 - [12] Jenna Burrell. 2018. Thinking Relationally about Digital Inequality in Rural Regions of the US. *First Monday* 23, 6 (2018).
 - [13] Marshini Chetty, Richard Banks, AJ. Brush, Jonathan Donner, and Rebecca Grinter. 2012. You're Capped: Understanding the Effects of Bandwidth Caps on Broadband Use in the Home. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12)*. Association for Computing Machinery, New York, NY, USA, 3021–3030. <https://doi.org/10.1145/2207676.2208714>
 - [14] Marshini Chetty, Richard Banks, Richard Harper, Tim Regan, Abigail Sellen, Christos Gkantsidis, Thomas Karagiannis, and Peter Key. 2010. Who's Hogging the Bandwidth: The Consequences of Revealing the Invisible in the Home. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10)*. Association for Computing Machinery, New York, NY, USA, 659–668. <https://doi.org/10.1145/1753326.1753423>
 - [15] Marshini Chetty, David Haslem, Andrew Baird, Ugochi Ofoha, Bethany Sumner, and Rebecca Grinter. 2011. Why Is My Internet Slow? Making Network Speeds Visible. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11)*. Association for Computing Machinery, New York, NY, USA, 1889–1898. <https://doi.org/10.1145/1978942.1979217>
 - [16] Marshini Chetty, Hyojoon Kim, Srikanth Sundaresan, Sam Burnett, Nick Feamster, and W. Keith Edwards. 2015. UCap: An Internet Data Management Tool for the Home. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. Association for Computing Machinery, New York, NY, USA, 3093–3102. <https://doi.org/10.1145/2702123.2702218>
 - [17] Melissa Densmore, Ben Bellows, John Chuang, and Eric Brewer. 2013. The Evolving Braid: How an Organization in Uganda Achieved Reliable Communications. In *Proceedings of the Sixth International Conference on Information and Communication Technologies and Development: Full Papers - Volume 1 (Cape Town, South Africa) (ICTD '13)*. Association for Computing Machinery, New York, NY, USA, 257–266. <https://doi.org/10.1145/2516604.2516620>
 - [18] Melissa Densmore and Nervo Verdezoto. 2022. Home, Comach Network. <https://comach.melissadensmore.com>
 - [19] Paul Dourish. 2015. Not the Internet, but This Internet: How Othernets Illuminate Our Feudal Internet. In *Proceedings of the Fifth Decennial Aarhus Conference on Critical Alternatives (CA '15)*. Aarhus University Press, Aarhus N, 157–168. <https://doi.org/10.7146/aahec.v1i1.21200>
 - [20] Paul Dourish. 2017. *The Stuff of Bits: An Essay on the Materialities of Information*. MIT Press.
 - [21] Marisa Elena Duarte. 2017. *Network Sovereignty: Building the Internet across Indian Country*. University of Washington Press, USA.
 - [22] Marisa Elena Duarte, Morgan Vigil-Hayes, Ellen Zegura, Elizabeth Belding, Ivone Masara, and Jennifer Case Nevarez. 2021. As a Squash Plant Grows: Social Textures of Sparse Internet Connectivity in Rural and Tribal Communities. *ACM Transactions on Computer-Human Interaction* 28, 3 (July 2021), 16:1–16:16. <https://doi.org/10.1145/3453862>
 - [23] Michaelanne Dye, David Nemer, Neha Kumar, and Amy S. Bruckman. 2019. If It Rains, Ask Grandma to Disconnect the Nano: Maintenance & Care in Havana's StreetNet. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (Nov. 2019), 187:1–187:27. <https://doi.org/10.1145/3359289>
 - [24] Michaelanne Dye, David Nemer, Josiah Mangiameli, Amy S. Bruckman, and Neha Kumar. 2018. El Paquete Semanal: The Week's Internet in Havana. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. Association for Computing Machinery, New York, NY, USA, 1–12. <https://doi.org/10.1145/3173574.3174213>
 - [25] Michaelanne Dye, David Nemer, Laura R. Pina, Nithya Sambasivan, Amy S. Bruckman, and Neha Kumar. 2017. Locating the Internet in the Parks of Havana. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. Association for Computing Machinery, New York, NY, USA, 3867–3878. <https://doi.org/10.1145/3025453.3025728>
 - [26] W. Keith Edwards, Rebecca E. Grinter, Ratul Mahajan, and David Wetherall. 2011. Advancing the State of Home Networking. *Communications of The Acm* 54, 6 (June 2011), 62–71. <https://doi.org/10.1145/1953122.1953143>
 - [27] W. Keith Edwards, Mark W. Newman, and Erika Shehan Poole. 2010. The Infrastructure Problem in HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10)*. Association for Computing Machinery, New York, NY, USA, 423–432. <https://doi.org/10.1145/1753326.1753390>
 - [28] Jaydon Faraó, Monet Burse, Hafeni Mthoko, and Melissa Densmore. 2020. Stakeholder Relations and Ownership of a Community Wireless Network: The Case of iNethi. In *Innovations and Interdisciplinary Solutions for Underserved Areas*, Jessica P. R. Thorn, Assane Gueye, and Adam P. Hejnowicz (Eds.). Springer International Publishing, Cham, 176–191.
 - [29] Philip Garrison, Esther Han Beol Jang, Michael A. Lithgow, and Nicolás Andrés Pace. 2021. "The Network Is an Excuse": Hardware Maintenance Supporting Community. *Proc. ACM Hum.-Comput. Interact.* 5, CSCW2, Article 464 (Oct. 2021). <https://doi.org/10.1145/3479608>
 - [30] Rebecca E. Grinter, W. Keith Edwards, Marshini Chetty, Erika S. Poole, Ja-Young Sung, Jeonghwa Yang, Andy Crabtree, Peter Tolmie, Tom Rodden, Chris Greenhalgh, and Steve Benford. 2009. The Ins and Outs of Home Networking: The Case for Useful and Usable Domestic Networking. *ACM Transactions on Computer-Human Interaction* 16, 2, Article 8 (June 2009). <https://doi.org/10.1145/1534903.1534905>
 - [31] Shaddi Hasan, Mary Claire Barela, Matthew Johnson, Eric Brewer, and Kurtis Heimerl. 2019. Scaling Community Cellular Networks with CommunityCellular-Manager. In *USENIX Symposium on Networked Systems Design and Implementation*. 735–750.
 - [32] Shaddi Hasan, Yahel Ben-David, Max Bittman, and Barath Raghavan. 2015. The challenges of scaling WISPs. In *Annual Symposium on Computing for Development*. 3–11.
 - [33] Kurtis Heimerl, Shaddi Hasan, Kashif Ali, Eric Brewer, and Tapan Parikh. 2013. Local, Sustainable, Small-Scale Cellular Networks. In *International Conference on Information and Communication Technologies and Development (ICTD '13)*. ACM, Cape Town, South Africa, 2–12.
 - [34] Sara Heitlinger, Lara Houston, Alex Taylor, and Ruth Catlow. 2021. Algorithmic food justice: Co-designing more-than-human blockchain futures for the food commons. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–17.
 - [35] Chaya Hiruncharoenvate, Wesley Smith, W. Keith Edwards, and Eric Gilbert. 2016. Popup Networks: Creating Decentralized Social Media on Top of Commodity Wireless Routers. In *Proceedings of the 19th International Conference on Supporting Group Work (GROUP '16)*. Association for Computing Machinery, New York, NY, USA, 149–158. <https://doi.org/10.1145/2957276.2957285>
 - [36] Kenneth Holstein, Jennifer Wortman Vaughan, Hal Daumé III, Miro Dudik, and Hanna Wallach. 2019. Improving fairness in machine learning systems: What do industry practitioners need?. In *Proceedings of the 2019 CHI conference on human factors in computing systems*. 1–16.
 - [37] Esther Jang, Mary Claire Barela, Matt Johnson, Philip Martinez, Cedric Festin, Margaret Lynn, Josephine Dionisio, and Kurtis Heimerl. 2018. Crowdsourcing Rural Network Maintenance and Repair via Network Messaging. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 67, 67:1–67:12 pages. <https://doi.org/10.1145/3173574.3173641>
 - [38] Esther Han Beol Jang, Philip Garrison, Ronel Vincent Vistal, Maria Theresa D. Cunanan, Maria Theresa Perez, Philip Martinez, Matthew William Johnson, John Andrew Evangelista, Syed Ishtiaque Ahmed, Josephine Dionisio, Mary Claire Aguilar Barela, and Kurtis Heimerl. 2019. Trust and Technology Repair Infrastructures in the Remote Rural Philippines: Navigating Urban-Rural Seams. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (Nov. 2019), 1–25. <https://doi.org/10.1145/3359201>
 - [39] D. L. Johnson, Elizabeth M. Belding, and Gertjan van Stam. 2012. Network Traffic Locality in a Rural African Village. In *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development (ICTD '12)*. Association for Computing Machinery, New York, NY, USA, 268–277. <https://doi.org/10.1145/2160673.2160707>
 - [40] Matthew William Johnson, Esther Han Beol Jang, Frankie O'Rourke, Rachel Ye, and Kurtis Heimerl. 2021. Network Capacity as Common Pool Resource: Community-Based Congestion Management in a Community Network. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW1 (April 2021), 61:1–61:25. <https://doi.org/10.1145/3449135>
 - [41] Konstantinos Kazakos, Siddhartha Asthana, Madeline Balaam, Mona Duggal, Amej Holden, Limelemla Jamir, Nanda Kishore Kannuri, Saurabh Kumar,

- Amarendar Reddy Manindla, Subhashini Arcot Manikam, GVS Murthy, Papreen Nahar, Peter Phillimore, Shreyaswi Sathyanath, Pushpendra Singh, Meenu Singh, Pete Wright, Deepika Yadav, and Patrick Olivier. 2016. A Real-Time IVR Platform for Community Radio. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. Association for Computing Machinery, New York, NY, USA, 343–354. <https://doi.org/10.1145/2858036.2858585>
- [42] Maria Rosa Lorini, Melissa Densmore, David Johnson, Senka Hadzic, Hafeni Mthoko, Ganief Manuel, Marius Waries, and André van Zyl. 2019. Localize-It: Co-designing a Community-Owned Platform. In *Locally Relevant ICT Research*, Kirstin Krauss, Marita Turpin, and Filistea Naude (Eds.). Springer International Publishing, Cham, 243–257.
- [43] Maria Rosa Lorini, Amalia Sabiescu, and Nemanja Memarovic. 2017. Collective digital storytelling in community-based co-design projects. An emergent approach. *The Journal of Community Informatics* 13, 1 (2017). <https://doi.org/10.15353/joci.v13i1.3296>
- [44] Kgotso Ditshego Magoro and Nicola J. Bidwell. 2022. Land, Letsema and Leola: Digital Transformation on a Rural Community's Own Terms.
- [45] Laura Maye, Sarah Robinson, Nadia Pantidi, Liana Ganea, Oana Ganea, Conor Linehan, and John McCarthy. 2020. Considerations for Implementing Technology to Support Community Radio in Rural Communities. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20)*. Association for Computing Machinery, Honolulu, HI, USA, 1–13. <https://doi.org/10.1145/3313831.3376580>
- [46] Roberta M. Melvin and Andrea Bunt. 2012. Designed for Work, but Not from Here: Rural and Remote Perspectives on Networked Technology. In *Proceedings of the Designing Interactive Systems Conference (DIS '12)*. ACM, New York, NY, USA, 176–185. <https://doi.org/10.1145/2317956.2317984>
- [47] Roberta M. Melvin, Andrea Bunt, Erick Oduor, and Carman Neustaedter. 2015. The Effect of Signal Expense and Dependability on Family Communication in Rural and Northern Canada. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 717–726. <https://doi.org/10.1145/2702123.2702301>
- [48] Preeti Mudliar. 2018. Public WiFi is for men and mobile internet is for women: Interrogating politics of space and gender around WiFi hotspots. *Proceedings of the ACM on Human-Computer Interaction* 2, CSCW (2018), 1–24.
- [49] Erika Shehan Poole, Marshini Chetty, Rebecca E. Grinter, and W. Keith Edwards. 2008. More than Meets the Eye: Transforming the User Experience of Home Network Management. In *Proceedings of the 7th ACM Conference on Designing Interactive Systems (DIS '08)*. Association for Computing Machinery, New York, NY, USA, 455–464. <https://doi.org/10.1145/1394445.1394494>
- [50] Thomas Pötsch, Salman Yousaf, Barath Raghavan, and Jay Chen. 2018. Zyxt: A network planning tool for rural wireless ISPs. In *Proceedings of the 1st ACM SIGCAS Conference on Computing and Sustainable Societies*. 1–11.
- [51] Carlos Rey-Moreno and Shaun Pather. 2020. Advancing Rural Connectivity in South Africa through Policy and Regulation: A Case for Community Networks. In *2020 IST-Africa Conference (IST-Africa)*. IEEE, 1–10.
- [52] Sarah Robinson, Nicola J. Bidwell, Roberto Cibin, Conor Linehan, Laura Maye, John McCarthy, Nadia Pantidi, and Maurizio Teli. 2021. Rural Islandness as a Lens for (Rural) HCI. *ACM Transactions on Computer-Human Interaction* 28, 3 (May 2021), 20:1–20:32. <https://doi.org/10.1145/3443704>
- [53] Gloire Rubambiza, Phoebe Sengers, and Hakim Weatherspoon. 2022. Seamless Visions, Seamless Realities: Anticipating Rural Infrastructural Fragility in Early Design of Digital Agriculture. In *CHI Conference on Human Factors in Computing Systems (CHI '22)*. Association for Computing Machinery, New York, NY, USA, Article 451. <https://doi.org/10.1145/3491102.3517579>
- [54] Christian Sandvig. 2013. Connection at Ewiiapaayp Mountain: Indigenous Internet Infrastructure. In *Race after the Internet*. Routledge, 174–206.
- [55] Katie Shilton. 2018. Engaging Values despite Neutrality: Challenges and Approaches to Values Reflection during the Design of Internet Infrastructure. *Science, Technology, & Human Values* 43, 2 (2018), 247–269.
- [56] Sonesh Surana, Rabin K Patra, Sergiu Nedevschi, Manuel Ramos, Lakshminarayanan Subramanian, Yahel Ben-David, and Eric A Brewer. 2008. Beyond Pilots: Keeping Rural Wireless Networks Alive. In *NSDI*, Vol. 8. 119–132.
- [57] R. Talhouk, T. Bartindale, K. Montague, S. Mesmar, C. Akik, A. Ghassani, M. Najem, H. Ghattas, P. Olivier, and M. Balaam. 2017. Implications of Synchronous IVR Radio on Syrian Refugee Health and Community Dynamics. In *Proceedings of the 8th International Conference on Communities and Technologies*. ACM, Troyes France, 193–202. <https://doi.org/10.1145/3083671.3083690>
- [58] Lucy Van Kleunen, Brian Muller, and Stephen Voida. 2021. "Wiring a City": A Sociotechnical Perspective on Deploying Urban Sensor Networks. *ACM Hum.-Comput. Interact.* 5, CSCW1, Article 178 (April 2021). <https://doi.org/10.1145/3449252>
- [59] Nervo Verdezoto, Naveen Bagalkot, Syeda Zainab Akbar, Swati Sharma, Nicola Mackintosh, Deirdre Harrington, and Paula Griffiths. 2021. The Invisible Work of Maintenance in Community Health: Challenges and Opportunities for Digital Health to Support Frontline Health Workers in Karnataka, South India. *Proc. ACM Hum.-Comput. Interact.* 5, CSCW1, Article 91 (apr 2021), 31 pages. <https://doi.org/10.1145/3449165>
- [60] Morgan Vigil, Matthew Rantanen, and Elizabeth Belding. 2015. A First Look at Tribal Web Traffic. In *Proceedings of the 24th International Conference on World Wide Web (WWW '15)*. International World Wide Web Conferences Steering Committee, Republic and Canton of Geneva, Switzerland, 1155–1165. <https://doi.org/10.1145/2736277.2741645>
- [61] Richmond Y. Wong and Steven J. Jackson. 2015. Wireless Visions: Infrastructure, Imagination, and US Spectrum Policy. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW '15)*. Association for Computing Machinery, Vancouver, BC, Canada, 105–115. <https://doi.org/10.1145/2675133.2675229>
- [62] Matt Ziegler, Michael Quinlan, Zage Strassberg-Phillips, Manasi Shah, Lauren Vreeken, Chris Jones, Karen Goodfellow, Jes Lefcort, Richard Anderson, and Kurtis Heimerl. 2021. "How's Shelby the Turtle today?" Strengths and Weaknesses of Interactive Animal-Tracking Maps for Environmental Communication. In *ACM SIGCAS Conference on Computing and Sustainable Societies (COMPASS)*. ACM, Virtual Event Australia, 349–363. <https://doi.org/10.1145/3460112.3471967>