Note: Towards Community-Empowered Network Data Action

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ABSTRACT

The Federal Communications Commission (FCC) has recently released official technical requirements for its Broadband Data Collection (BDC) processes, with the purpose of improving the accuracy of broadband coverage data in the United States. A key process in the BDC establishes the opportunity for communities to crowdsource Internet measurements that may dispute coverage data maintained by Internet service providers. This process outlines complex requirements that may provide a substantial barrier to community participation. In this poster we share the design of a network measurement tool suite and the requirements for a community coordination tool to support community-led efforts to challenge official reports. Our design is based on “counter-data action” principles, which call unethical and authoritative uses of data into question.

CCS CONCEPTS

• **Human-centered computing → Open source software**; • **Networks → Network measurement**.

KEYWORDS

network measurements, citizen science, counter-data action, community cooperation and empowerment

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1 INTRODUCTION AND MOTIVATION

Rural regions and tribal lands are the last frontiers for Internet access in the United States, and they are places where reliance on mobile (rather than fixed) broadband is especially high. The Federal Communications Commission (FCC) acknowledges that broadband access on tribal lands today is insufficient and significantly lagging behind both urban and rural areas [5]. To add to the immediate problem of access, there is also a significant measurement problem in understanding the extent and quality of mobile access; the data provided to the FCC by providers has well known quality limitations [1, 8] and alternatives such as crowdsourcing mobile measurements exhibits biases of various types [12]. Further, the FCC stopped reporting entirely on high speed mobile cellular (LTE) deployment in tribal areas after 2018 due to insufficient or misrepresented data, systemically rendering the Native broadband experience as invisible. Accurate data matters for documenting the digital divide and for directing resources to locations of highest need.

Despite erasure from official data sets, tribes and other rural communities are resourceful and resilient. For example, in light of inaccurate and/or incomplete data by the FCC, communities have conducted their own measurement campaigns to challenge provider claims of coverage. In 2018, the state of Pennsylvania conducted state-wide measurements in collaboration with Pennsylvania State University (Penn State) to produce evidence of substantial inaccuracies in the FCC data especially in rural parts of the state [11]. This was an extensive effort, requiring a year and more than 11 million speed tests conducted by the Penn State research team and utilizing the open measurement platform M-Lab[1]. More recently, a small island community in Maine documented lack of coverage by their provider, Spectrum, with information provided by 100 citizens and coalesced by the town manager into a ground reality view of coverage [2]. As noted in the article, “[Town manager] Fisher's experiments in crowd-sourced coverage mapping show how much work underserved communities need to put in to even try to assert the realities of local internet access.” [2]

Community collection of network data that contradicts official reports, whether from government or Internet service providers, has the potential to be the basis for “counter-data actions”, a term originated by critical geographers Dalton and Thatcher, and expanded upon by Currie et al. as “acts of resistance to politically dominant datasets” [3, 4]. The term counter-data action is inspired by critical data studies, where data is “situated in socio-technical systems that surround its production, processing, storing, sharing, analysis, and reuse.” [3]. Currie et al. exemplify counter-data action in the form of a community-based event where researchers and citizens participated in a civic hackathon to identify limitations

[1] https://www.measurementlab.net/

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in datasets on police officer involved homicides in LA, and to develop a more just methodology for re-interpreting this data. Other counter-data action efforts include novel measurements, such as the activities described in Meng and DiSalvo [9] as a grassroots affordable housing organization collected their own data on property vacancies and blight to counter official county data that contained "gross inaccuracies".

Against the backdrop of known limitations in mobile broadband measurement data accuracy, the FCC has recently released official technical requirements for its Broadband Data Collection (BDC) processes in response to the Broadband Deployment Accuracy and Technological Availability (DATA) Act passed by the United States Congress in 2020 [7, 14]. The goal of this endeavor is to maintain publicly available datasets to accurately display mobile broadband coverage and availability on a digital, interactive map of the United States. Of particular interest to us, a key process in the BDC establishes the opportunity for individual consumers as well as local community and government entities to *challenge* existing coverage data maintained by Internet Service Providers (ISP's). The purpose of the challenge process is to enable communities to crowdsource internet measurements locally that may dispute ISP-provided data, "based on both a lack of service and poor service quality" [7]. Disputes will subsequently prompt a set of processes for ISP's to respond. In effect, the FCC is outlining requirements for counter-data action on the part of communities.

Although prima facie promising, a careful look at the BDC challenge process reveals complex requirements that may provide a substantial barrier to community participation, perhaps especially for sparse and less resourced communities such as in rural and tribal areas. For example, the process of creating and submitting what is termed a "cognizable challenge"[7] is not simple. In order to be accepted for a challenge, measurement speed test data must be collected within a particular set of parameters, including restrictions on the time of day and duration of the tests. A sufficient density of measurements must be collected, and a set of specific measurement metrics must be gathered. The FCC both acknowledges and then dismisses the burden on communities noting that "[w]hile the Commission acknowledged that consumers are likely to submit challenges in distinct, localized areas instead of expending the time and resources to test in a broader area or for extended periods, it also recognized that providers should not be subject to the undue cost of responding to a large number of challenges in very small areas. [6]"

We are currently examining the design and development of sociotechnical systems capable of bridging the techno-political requirements of the FCC challenge process and the on-the-ground realities of community data collection capacities. In this poster we share the design of a measurement ecosystem and the requirements for a community coordination tool. In keeping with best practices, the design of this tool will draw on community input, such as what we have learned so far through preliminary research. These efforts include a contextual inquiry and semi-structured interviews with community partners to design an interactive dashboard for visualizing network expansion efforts, as well as a user study on the implementation of an open source, network measurement application for smartphones. We have also observed workshops, one led by FCC officials and another one by tribal government leaders, to better understand the resources available in these communities of interest. Our work has the potential for real-world impact as communities seek to participate in the FCC-defined challenge process, as well as to inform the literature on counter-data action in a new space where both government and commercial providers exert power.

2 COMMUNITY COORDINATION TOOL

In ongoing work, we are developing a researcher- and citizen-friendly tool suite, called *CellWatch*, which comprises an app for measuring mobile broadband availability and quality, together with public-facing data access through a dashboard and interactive maps. Following the line of work on counter-data action, and the FCC's most recent efforts to allow consumers to contest existing coverage datasets, we wish to expand CellWatch with a complementary tool that allows for community coordination. The FCC's requirements for contesting or *challenging* data is intricate, and places an inordinate amount of responsibility on individual consumers and communities, as opposed to providers. The objective of incorporating a community coordination tool with CellWatch is to bridge the technical gap between the FCC requirements and community resources, and to support coordinated measurement activities.

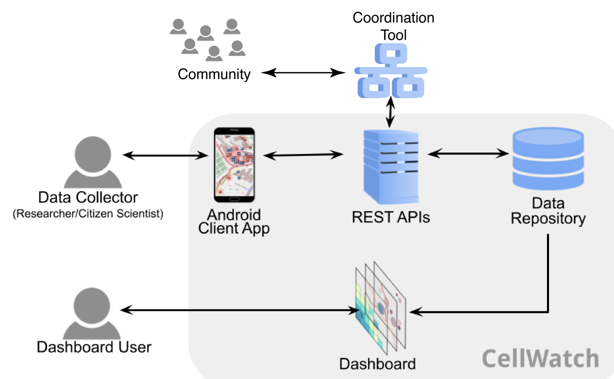

Figure 1: CellWatch ecosystem architecture.

The CellWatch ecosystem comprises three primary components, depicted in Figure 1: (i) a mobile broadband measurement application running on an Android client capable of making active and passive measurements of performance and signal quality; (ii) a backend Data Repository of measurement results with a set of APIs to support efficient retrieval and bulk data contributions; and (iii) a public-facing Dashboard. In addition, the Community Coordination Tool will aid with planning and documenting community efforts for network measurements. The system supports three types of users: Data Collectors, whether researchers or citizen scientists, who run the Android app to collect mobile broadband measurement data; Dashboard Users who are interested in exploring the current data, accessing maps of performance and coverage in particular geographies, or downloading specific datasets for offline analysis and use; and Communities who, by interfacing with the Coordination Tool, may contribute data from compatible collection efforts, or may be able to automatically pull data from CellWatch to inform future measurement efforts.

2.1 Requirements Overview

The following describes basic requirements for the Community Coordination Tool. We will first outline some key functionality, followed by a brief analysis on the structure and nature of the information being handled.

Through past engagement with rural and tribal communities, we understand that these groups do not have enough spare time and available expertise to undertake a large technological endeavor. Thus, the Community Coordination Tool will lighten the cognitive load by distilling the FCC documents and translating the requirements into actionable, digestible tasks or recommendations. One application of this would be to maintain a "completion meter" that shows how close the community is to achieving a cognizable challenge in a particular area. In other words, based on the existing measurements stored in CellWatch's data repository, the Community Coordination Tool should be able to compare these data points against FCC requirements to determine what is missing and suggest a process for collecting sufficient data. Similarly, the Coordination Tool should be able to handle queries such as "where is measurement most needed?" and display areas with the least amount of measurements available, in order to effectively funnel community resources. Finally, in accordance with these planning capabilities, the tool should support the ability to claim a measurement task. In other words, based on the information gleaned from the completion meter and the queries on areas with most need, users should be able to commit to conducting measurements on a particular day, time, and location.

Our preliminary contextual inquiry and semi-structured interviews with community partners gave us insights into a demand for flexible systems that incorporate informal, local knowledge. The Coordination Tool should be able to store and support user-generated notes or information snippets, and subsequently have the option to match these to measurements stored in the CellWatch Data Repository. For instance, given that the tool is able to maintain a completion meter, user annotations could describe or anticipate any possible difficulties in collecting the necessary data over a certain region, and even include a record of both human and non-human resources available to community members for overcoming these obstacles. Another application of user annotations would be for community members to highlight critical areas, such as schools or regions with highly variable coverage, in order to prioritize measurement efforts. This would complement the query "where is measurement most needed?" described above, which is based on simple numerical values, by providing a richer, and highly contextual metric for prioritizing the location of measurements based on lived experiences. This amalgamation of data sources produces a system that combines precise, quantitative measurements, as queried from the CellWatch data repository, with contextual, qualitative data collected by community collaborators. Such combination could further support counter-data action efforts by "making concrete what otherwise becomes a formal abstraction" [3]. Local knowledge would be particularly beneficial for addressing issues beyond coverage availability, and provide a more comprehensive examination into coverage *quality*.

3 FUTURE WORK AND INTRINSIC CHALLENGES

A unique challenge of this research, particularly in the context of underserved areas, is that it will require not just a one-time data contesting endeavor, but will entail repeated campaigns, especially to challenge quality of coverage. Likewise, we will have to take into account how spotty cellular coverage in such regions affects the design and usability of our tool. For example, our system should handle connectivity issues gracefully, as we are concerned with supporting individuals and communities that may lack technical expertise.

It is also important to consider the cultural and political implications of carrying out network measurements within underserved communities, such as in tribal lands. Currie et al. describe that, as researchers, we must "address [our] own positionality, [and] carefully consider the implications of the data [we] use" [3]. How can we respect and uphold the community's sovereignty over their land during these projects? Who will own the data collected on such areas? How can we ensure that these communities are treated and/or compensated fairly during these exchanges? This type of research falls into the human-centered networking category, requiring both expertise in Internet measurement and in human-centered design, which further speaks to the challenge of this work.

Fundamental to our goal is to empower both citizens and networking researchers. This merits consideration of what has been learned over decades of citizen science projects to ensure we are incorporating best practices. Of particular relevance to this work, sustainable citizen science projects provide APIs and open standards that enable interoperability wherever possible [10, 13]. Based on this literature, it is our intention to make the outputs of our work, including the CellWatch tools and source code, and collected mobile network measurements, publicly available, except where they contain proprietary data. Commercial entities such as SamKnows, which develops the proprietary network measurement app for the FCC [2], will likely rise to the opportunity to profit from community needs. An independent, open-source effort such as CellWatch and its accompanying Community Coordination Tool could provide a valuable alternative for underserved communities. (We note that Sovereign Tribal nations may not want measurements taken on Tribal land put into the public domain. We have a long established history of working in such communities and will respect all local laws and customs.)

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