Towards Building a Community Cellular Network in the Philippines: Initial Site Survey Observations

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ABSTRACT

In this paper, we present preliminary site survey findings for a community cellular network project in the Philippines. We document our observations from our visits to unserved communities, notably on how they deal and adapt to the lack of cellular access. We also identify challenges in deploying the technology in the Philippine setting.

CCS Concepts

•**Human-centered computing** → **Empirical studies in HCI;**

General Terms

Information and Communications Technology and Development

1. INTRODUCTION

Mobile phone usage has ballooned in rural areas of the world. ITU estimates that 5 billion of the world's population have cellular access [1]. However, a significant portion is still unserved, especially in developing countries such as the Philippines. The main reason for this "digital divide" in cellular access is economic. The traditional model of telecom access requires equipment appropriate for urban-population scale, high reliability, high quality of service, and needing remote employees (non-locals). Companies are unwilling to invest large capital in areas where populations are too small to generate enough revenues to cover these operating costs and expenses, and so these areas remain unserved.

To address this problem, Heimerl et. al. designed a new model, referred to as a community cellular network (CCN), that could provide access to these unserved regions [2]. CCNs are small-scale, community-centric, bottom-up cellular networks. With this model, local owners and operators have the freedom to make decisions regarding the network - such as design, operation, service offerings, pricing and billing policies. As such, the network can be customized according to the needs and resources of the target community. This concept has been piloted in Papua, Indonesia and that network has been operational since February 2013.

To further evaluate this model, we aim to deploy the CCN concept in the Philippines, where community-operated cellular networks are completely novel. By providing cellular coverage in remote rural communities, we will promote access to fundamental communication services that can not be sustainably covered using traditional cellular network architectures. On top of this, our group will also design hardware improvements to the base station and develop custom services for the communities.

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2. BACKGROUND

2.1 Cellular Infrastructure in the Philippines

There are two main players in the Philippine cellular communications industry, with each having 65 million and 52.9 million subscribers as of 2015 [3, 4]. These two telcos follow a top-down model wherein they decide when and where cellular networks will be deployed. One of their main considerations in selecting where to install the base station is its profitability in the area. Hence, they deploy mostly to populated places where profit is guaranteed and substantial.

As a consequence, many villages, especially the remote ones with low population, are still left unserved and unconnected. Installing a base transceiver station (BTS) in the said areas is challenging because of the required profit margin to cover the large capital outlay. For instance, setting up and sustaining the operation of a small-capacity BTS requires the community to have enough traffic that would generate a monthly revenue of approximately $8900, which is difficult to achieve considering the number of subscribers and a rural average revenue per user (ARPU) of less than $2. Also, rather than spending capital on expanding coverage to these areas, we observe that telcos prefer to invest in the next generation of cellular technology or advanced mobile data services in profitable urban areas with existing cellular coverage.

The current process for communities wishing to have cellular coverage in their area is to have their local government unit endorse a 'service application request' to a telco. If a telco entertains the request, it will conduct an inspection of the area and look into the feasibility of putting up the service, with their business model and projections in mind. The decision to roll out services falls solely on the telco – the community has little influence over it.

2.2 Policy and Regulation

On a policy standpoint, the government recognizes the importance of public telecommunications services. There is a provision in the Philippine Telecommunication Act (Republic Act 7925) that mandates telcos to give high priority in extending basic services to unserved areas [5]. Moreover, it stipulates that "government shall promote a fair, efficient and responsive market to stimulate the growth and development of the telecommunications facilities and services at affordable rates." However, there are no existing guidelines to implement the said provision of the law. A universal service fund was established by virtue of the said law, but the government agency tasked to manage it was abolished in 2011, rendering the fund inactive [6].

2.3 Site Survey Context

From March 2015 to August 2015, the team visited several remote locations in the Philippines as shown in Figure 1. We targeted municipalities that were reported to have no cellular coverage from any telco. The sites were either rural areas or seaside communities that had no immediate road access to the nearest town proper. Also, the population for each site was small, not exceeding 3000 people.

Figure 1: Map of the Philippines, showing the visited sites

The goal of these preliminary visits was to gather relevant information that would help in deciding where to deploy the CCNs. Activities included the following: (a) performing spectrum analysis to verify cellular coverage in the area; (b) obtaining secondary socio-demographic data on population, livelihood and other statistics from the communities reported to have no cellular coverage; (c) noting geographical features of the area that could present challenges in the implementation of a village base station; and (d) engaging in face-to-face key informant interviews (KIIs) to learn about the community and how they manage without cellular coverage and limited network access.

Particularly for the KIIs, the interviews were conducted with community leaders, health workers, government employees, teachers, and residents as respondents. The interviews included topics on livelihood, government services, existing infrastructure (sources of electricity, television, and other technologies), educational system, disaster response and communication. On the communication part, the discussions focused on their current ways of communicating with nearby communities, getting in touch with their family and relatives living in other towns or abroad, contacting the government's regional and central headquarters, and connecting with traders and merchants outside the villages. These interviews allowed us to learn how people in the selected communities go about their practical tasks and activities without immediate cellular access. We summarized our observations into themes in the succeeding section.

3. OBSERVATIONS

We categorized our field observations relating to mobile phone and cellular network usage into the four main themes below.

3.1 Phone Ownership Despite Lack of Coverage

Despite the lack of coverage, the people in the visited communities own mobile phones. Phone adoption is greatly boosted by the lowering prices of mobile phones in the market. As of January 2016, a feature phone that has a built-in MP3 player, FM radio and camera can be bought for as low as $8.50. Carrier-subsidized basic smartphones can be bought for as low as $17, while unlocked models go for at least $21.

With the current features of mobile phones, they are not seen or used primarily as communication devices but instead as entertainment gadgets. Phones are used for playing games, music and videos. This distinctive use of cellphones creates unique income opportunities such as "download centers" for media and game applications. Villagers usually get their content from these download centers in the town proper, where Internet connectivity is available. This is their alternative since they do not have internet access in their own communities to do the downloads themselves.

3.2 Extra Effort to Get Access

We have observed that people in the visited communities are willing to go through extra effort just to get cellular access. For example, they may travel for more than an hour just to be able to call or send text messages. They either trek to some elevated areas or ride a boat offshore or to a nearby town where cellular signal is available.

We also lightly touched upon the subject of pricing during the informal interviews. Some interviewees mentioned that they are willing to pay a higher rate for calls and short message sending (SMS) as long as the prices are reasonable. By reasonable, they usually mean commensurate with the significant amount of time or cost that they would save by avoiding traveling to an area with coverage.

3.3 Coverage-Awareness

We have recognized that people living in these areas have adapted to the lack or intermittent cellular coverage in several ways. First, they have a sense of coverage-awareness. They have identified and memorized places where there is guaranteed signal. One community we visited has identified such area and erected a hut where they could do their calls in comfort (see Figure 2). In places with intermittent coverage, the subscribers have a notion that placing their phones in areas with no obstructions would help them get a better signal. Thus they usually place their phones near windows.

Second, they do scheduled calls and batch processing of SMS. Whenever they travel to the town proper to sell their produce, they also take advantage of this opportunity to call or send SMS to their immediate family and relatives outside of their village.

3.4 Managing resource scarcity

Most of the villages we have visited are not connected to electric power grids. However, many have solar panels, which were donated by private non-government organizations. There are other

sites that rely on micro hydropower plants set up for their community by some cooperatives. And a few, especially those affluent ones, have bought diesel generators for themselves.

Figure 2: A 'Hut Spot' where people could place calls and SMS

Figure 3: Battery of a villager being charged by the community-owned solar panel

Regardless of their power set up, the people in these communities are aware that they have limited electricity resources and acknowledge that they must manage them well. They make up for this by using electricity only when needed. For instance, they only operate their power equipment at some given schedules or mostly at night. Nevertheless, they have enough to power some of their devices such as light bulbs, television, radio and of course their phones. In times when these solar panels and power plants fail, the villagers can still charge their phones for minimal fees through phone charging stations set up by some entrepreneurs.

The subscribers in these communities are prepaid users and typically they only top-up their pre-pay account balance when needed. Moreover, they usually avail of promos offered by the network providers that would maximize their already limited budget. An example of a popular promo allows unlimited calls and texts to any subscriber of the same network for a day and can be availed for less than $1. Hence, the subscribers exploit their promo by keeping in touch with their family, friends and business partners during the limited duration that they are in the town proper. In general, people usually choose SMS over voice calls because it is cheaper.

4. CHALLENGES TO SETTING UP A CCN

From the findings enumerated in the previous section, we can say that communication is highly valued in these areas; people are willing to go the extra lengths required to gain access. As such, CCNs are promising interventions to solve the lack of connectivity. However, our initial findings also revealed challenges that we are about to encounter during the next phase of this project. We enumerate some of the identified ones below.

4.1 Spectrum Regulation

The most apparent challenge in deploying CCNs is obtaining a spectrum license. The current model of frequency licensing in the Philippines requires a congressional mandate to license a particular telecom for nationwide service. As such, even in areas where these telcos have no presence, small-scale cellular networks cannot broadcast without coordinating with the regulatory agency and the assigned frequency owner. This is in contrast to other countries, such as the Netherlands, wherein a portion of the DCS1800 band is set aside for unlicensed, low-power GSM networks [7]. Moreover, only 26% of the available spectrum in the Philippines is below 1GHz, the bands ideal for operators to expand services to rural areas at lower costs [8]. The national regulator has yet to decide on releasing more bands to operators to accelerate rollout and lowering prices per user.

Our team is currently in talks with the national regulator and a major telco network to obtain permission to transmit using their frequency. However, in the long run, we hope to get legislative support to provide a swath of frequencies for development and research efforts.

4.2 System Robustness

The system must be hardened against equipment failures and unforeseen natural disasters. One site that we visited was recently hit by a strong typhoon which caused infrastructural damages. Their grid electricity was cut off and was still unrestored one month after the typhoon. Typhoons are common events in the area as well, with many hitting the area in the last decade. In general, the remoteness of our target sites means that access and repairs may take a longer time than usual. As such the equipment must be sturdy and reliable enough to withstand unforeseen events.

In addition to the recommendations made by Brewer et. al. [9], we also have several design considerations that would help make our system more robust. First, we are considering a collapsible tower design such that in times of strong typhoons, the tower can be mounted down. In terms of power, we are designing enhancements on the BTS power amplifier (PA) that would turn it on only when the BTS needs to communicate. This scheme would help reduce the power consumption, especially during off-peak hours.

4.3 Indigenous people and the technology

For some of the sites we visited, a portion of the population are members of indigenous groups. From our interviews, indigenous people welcome the technology with enthusiasm. Some of them even own cellphones which they use for entertainment and communication. However, there were also concerns voiced by fellow community members who are non-indigenous people regarding the impact of the roll-out of technology on the community. They think that without proper counter-measures, the technology will disrupt and threaten the existing indigenous culture which they wish to preserve. We believe their concern is valid and must be handled carefully. Thus, we aim to consider propositions and conditions, and ensure that the indigenous people's culture and identity are preserved. In this context, we could develop applications that would digitally preserve, promote, and propagate the local culture and identity.

4.4 Network Sustainability

Another important concern is how to make the network sustainable. It should be able to earn profit to cover the operating expenses and maintenance cost of the equipment. To accomplish this goal, we believe that it is key to involve the right partners and to foster a sense of ownership in the community. Otherwise, the system would just be left in disrepair once broken, as commonly happens to "turned-over" projects.

Determining the suitable operator of the village base station is a crucial task. We may choose the village chieftain as operator because he/she has administrative authority over the village, or we may opt to form a cooperative to encourage a sense of ownership to all members of the community. Also, we may take advantage of sari-sari stores (small neighborhood retail stores) as prepaid reload-

ing and SIM reselling partners - mimicking the strategy of commercial telcos. As much as possible, we would like to see that income from the network will not be retained solely by the operator but also be distributed to the community members as well.

4.5 Designing custom services for the communities

We are currently developing mobile services that we plan to customize for every community. Examples of the services are as follows: local announcements and messages, updates on news, market prices and other information, call and texts promos, localized and community-inspired games, and custom or local language interactive voice response apps.

It is essential that we design these services such that they are accessible to all the subscribers. They should run on most of the widely used mobile phone models in the community. As much as possible, they should be even accessible to feature phones. Moreover, the services should be easily used and operated by even the non-tech-savvy users.

5. ONGOING AND FUTURE WORK

5.1 Engineering improvements

We are currently in the design and prototyping phase of improving the CCN's hardware and software components. On the hardware front, an improved PA design with a target efficiency of 70% is in progress. Studies on GSM slot and burst detection schemes to facilitate PA duty-cycling are also underway. Beam-steering using phased and variable array antenna are currently in the simulation stage.

For the software side, we are currently building the base software modules, from which services and applications can be built upon. From these blocks, we also created prototypes of the possible services that would run locally on the BTS. Examples include a simple survey service, and SMS-based query services. In addition, a web-based management interface for the network operator is currently being developed. Features of this interface include subscriber and services management.

5.2 In-depth quantitative and qualitative studies

The next phase in this project is to conduct a formal qualitative study using randomized control trials. We will start with a baseline survey to scope out and assess each community's characteristics before the CCN is introduced. The baseline is targeted to start in April 2016. Following this, the team will introduce a series of experiments to study how the CCN affects the community's or the individual's social networks, information access, and economic opportunities.

We will also supplement this with qualitative studies, primarily using participatory observation to start and then later on, with in-depth interviews and focus group discussions. This will help us to flesh out the details and provide a richer and deeper understanding of the community's perception towards the CCN intervention.

5.3 Pilot deployment

After the baseline survey is conducted and the treatment sites have been identified, we will move forward with deploying a pilot site in San Luis, Aurora, Philippines. The initial CCN trial will provide basic voice and SMS service. The installation will be monitored for technical issues and concerns while at the same time the qualitative and quantitative studies are ongoing. We will also conduct training at the community level and organize a cooperative which would eventually handle the operation of the CCN.

6. CONCLUSION

In this work, we have presented our preliminary observations on how people in unserved communities deal and adapt to the lack of cellular access. We have found out the following: (1) people still own phones despite the lack of coverage; (2) they are will go the extra mile just to be able place calls and texts; (3) people in these areas are very aware where coverage is present; and lastly, (4) they have schemes to manage their resource scarcity issues. As we also conduct these site surveys, we have also identified several challenges that we should carefully consider and resolve in order to have a successful CCN deployment.

Currently, the team is undertaking work both on the engineering and social science fronts to improve the system and evaluate the CCN model. Ultimately, we hope that this project would serve as a model in providing cellular access and connectivity to the isolated and remote areas of the Philippines and other parts of the world.

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