Repair in Community Networks

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- http://ictd.cs.washington.edu
- Established research group focusing on technology and poverty (ICTD)
- Professor Richard Anderson
 - ~6 Students
 - Focus on health and financial services
- Professor Kurtis Heimerl (*https://kurti.sh*)
 - ~4 Students
 - Focused on Internet access and conservation





Community Networks

- Networks built, owned, and operated by citizens and users in a participatory and open manner
- Systems largely built on 802.11 "mesh"
 - Operates in unlicensed spectrum
 - Technology is understood by "professionals"
 - Inexpensive point-to-point wifi gear like Ubiquity
- Large focus on *sustainability:*
 - Often financial, infrastructural, social



Example: Guifi.net

- Located in Catalonia, Spain
 - Ostensibly "rural" Spain, for what that means
- 36000 nodes, 69000 km of links (p2p wifi and Fiber)
- Lots of cool research papers on architecture, economics, and intranet services
 guifi
- Lots of other examples:
 - NYC Mesh (USA)
 - Gram Marg (India)
 - Altermundi (Argentina)



Background on Community Cellular

- Built off of software implementations of cellular protocols - Osmocom, OAI, Open5Gs
 - Hardware is trickier: often SDR-based but commercial solutions are becoming common
- Reason: Better for *rural* connectivity than 802.11 Wifi
 - Wide-area (centralized failure and repair)
 - Supports basic feature phones (important circa 2010)



CoLTE

Technology: LTE
Partners: Ob Anggen / Airwaves Missions /

Rhizomatica

- Sites: 1 (Indonesia) & 1 (Mexico)
- Users: ~150
- Services: Generic IP/Local Media



CoLTE: Rhizomatica

- Major community cellular provider in Oaxaca, Mexico
- ~17 GSM based networks, exploring LTE
- We're partnering with Rhizo to explore community-based congestion control
 - E.g., How can we do congestion control in packet networks without price constraints?
 - Preliminary work in submission, deployment in progress



CoLTE: Airwave Missions

- Our original partner community in Bokondini, Papua, Indonesia
- Installed GSM in 2013, LTE in 2019
- Ongoing research:
 - Continued technology development
 - Measurement studies on network adoption, use, and incentives



Other networks: Inuvialuit Regional Corporation

- Ulukhaktok, Northwest Territories, Canada
- Partners: Inuvialuit Regional Corporation, Internet Society
- Goals:
 - Deploy an Inuvialuit community network
 - Develop local support systems
 - Measure impacts



Current Agenda: Is community cellular appropriate for wide-area networking in *cities* as well?

95% of Seattleites have access to the Internet

Internet Access by Demographic

		With Internet Access	Without Inf	ternet Access
	75%	Living in Poverty	11111	25%
85%		Household Member Living with a Disability	15%	
90%		Primary Language Other than English	10%	
91%		Older Adults (65 years +)	9%	
91%		Single Adult Households	9%	
92%		Race/Ethnic Minorities	8%	

Online Activity Levels: By Impacted Groups

	Low M	led Low	Medium 📕 Me	ed High	📕 High	
	Children in Ho	ousehold				
5%-	16%	22%	29%	28	28%	
No Children in Household						
	28%	27	7% 17%	14%	13%	

White							
20%	25%	20%	20%	16%			
Minorities							
21%	20%	18%	19 %	22%			

English as Primary Language Spoken

19% 24%		% 20%		20%	18%	
English is n	ot Primary	Langua	ge Spoke	en		
2/10/	0000	18%	1/1%	12%	24%	

Disability i	n HH				
4	3%	22%	11% 11%		13%
No Disabili	ity in HH			_	
18%	24%	20%	20%		18%

Under 65 years of age



Local Connectivity Lab: Affordable Internet

- Access is still hard for urban low-income people
 - Financial barriers: Monopoly pricing, device costs
 - Overly strict requirements for low-income plans
 - Housing insecure populations
- Solution: Partner with local digital equity organizations to provide broad mobile coverage
 - Tacoma Cooperative Network
 - Tacoma Public Libraries
 - Seattle Refugee Women's Alliance (ReWA)
 - City of Seattle "Internet For All" initiative







CBRS

- FCC opened frequencies in 3.5-3.7 GHz Citizen's Band Radio Service (CBRS) spectrum
 Dynamic spectrum
- Dynamic spectrum allocation via a Spectrum Allocation Service (SAS), run by wireless companies



14 dBi CPE: 60 Mbps down & 8 Mbps up, at 2.1 km away

Union Bay

Numbe



VBTS/CoCoMoNets

- Technology: GSM
- Partners: University of the Philippines/Globe Telecom/LGUs
- Sites: 7
- Users: ~3000
- Services: Voice/SMS



Remoteness: urban dependence, challenging transport



Goal: Infrastructure Sustainability

y libreng SIM Card ngayon dito!

BI

TRIPPLE]

Infrastructure and Repair

Infrastructure is both relational and ecological (...) and it is part of the balance of **action, tools, and the built environment**, inseparable from them.

-Susan Leigh Star, The Ethnography of Infrastructure

(some) Related Work

Learning to fix: knowledge, collaboration and mobile phone repair in Dhaka, Bangladesh - Ahmed et al.

Invisible users: Youth in the Internet cafés of urban Ghana - Burrell

"If god gives me the chance i will design my own phone" exploring mobile phone repair and postcolonial approaches to design in rural Kenya - Wyche et al.

Research Questions

What repair happens in these communities?

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By who?

Research Questions

What repair happens in these communities?

By who?

What is needed to support repair?

Findings



There is plenty of device breakage

- Typhoons and storms \rightarrow water entry
- Salt and humidity from the sea \rightarrow corrosion
- Living near water \rightarrow accidents
- Electrical "brown-outs" and voltage spikes → circuit damage
- Malware and computer viruses → non-functionality

Puzzle: No Local Repair Shops

Finding: Lack of electronics repair



Why not repair?

Lack of electronics repair

You can find [a broken phone] loitering around here, sometimes. There's one there.

-Community Cell Site Maintenance Officer, Dikapinisan

Why not repair? (1)

R2: I didn't have [the refrigerator] repaired, **don't have money to pay for it**.

R1: I had it checked by a repairman, and when he got here (...) I asked him how much I had to pay, he said 3500 for the labor. **With that price I would just buy an new one**.

-Chief Community Security Officer and Day Care Teacher, Dikapinisan

Why not repair? (1) Economics of repair don't work

Cheap appliances not designed for repair encounter harsher environments than they were designed for.

Why not repair? (1) Economics of repair don't work

Low income

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Physical, geographical, environmental conditions

Local Repair Expert

-2013

-20-

Why not repair? (2)

[People] seldom ask me for repair because I do not have a source for parts. I would have to source it outside [the community]. And when I do source it outside, they do not give me parts [in Baler]... They reserve the parts for their own repairs.

Why not repair? (2) Too Remote

Hard to get parts- scarce, far away

Excluded from part-sharing repairer networks in Baler

Why not repair? (3)

I don't let unskilled people fix stuff. My sibling, who is an electrician, comes here... If there's something broken.

I let him sit on [my] boat... [He comes] whenever I say. Last week, he was here twice. [. . .] I had him install our e-classroom.

-Elementary School Principal, Dibut

Why not repair? (3) No one trusted to do repairs

Lack of trust in local skills

She has a boat and can make her brother come over

-Elementary School Principal, Dibut

Success story: AURELCO

• 9 local electrical "linemen"

When [AURELCO personnel] come here to perform repair [then I am able to ask for some spare supplies for electrical installations].

I tag along and observe while AURELCO does maintenance.

Regular stocking of supplies

Informal teaching

Regular stocking of supplies

Informal teaching

[We have the 'shotgun stick'] made of fiberglass that we use to grab onto the power line. So we don't get electrocuted. [I also use the] safety belt. Plus the step belt, to use going up the post. Pliers, electrical tools. (...) They're going to pick us up somewhere in the other town. We're just going to walk to where the boat is waiting for us.

-Local government-employed electrician, Dikapinisan

What is needed for repair?

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(4) Locally accessible institutions for formal education and certification help with #1-3

Anecdotes on Repair

Lessons largely not taken up; scope too large and we had funding for university support to 'paper over'

Some success stories: tell bit about Typhooon

Concluding Thoughts

Rural Areas vary widely; in both resources and abilities

Much of the existing design in "sustainability" doesn't match their needs or experiences.

These problems are solvable but require a depth of engagement that is difficult without large-scale institutional support.



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1. Spectrum - Cellular uses licensed spectrum.

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- a. Yes but they've started creeping in on other unlicensed bands
 - i. LTE-U and LTE-LAA are both protocols for operating cellular in Wifi bands
- b. Citizen's Broadband Radio Service (CBRS) is a dual licensed regime

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- 2. Hardware Cellular hardware is super expensive and only telecoms can afford it at scale.

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 - a. Not since LTE. A reasonable LTE access point (eNB) costs ~\$2500USD, about half of a 2G radio.
 - b. This will continue to shrink as more manufacturers enter the NR space as they're "small cells"

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- 2. Hardware Cellular hardware is super expensive and only telecoms can afford it at scale.
- 3. Interconnect Telecoms don't play ball.
 - a. Still true, but as LTE is entirely IP-based, that's fine. We can peer at IXPs.
 - b. OTT services (e.g., WhatsApp, Messenger, etc) are dominant anyhow!

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 - a. Wireless ISPs (WISPs) use wide-area LTE solutions to provide Internet to millions of rural US households.
 - b. "Private LTE" is rapidly gaining traction.

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- 2. Hardware Cellular hardware is super expensive and only telecoms can afford it at scale.
- 3. Interconnect Telecoms don't play ball.
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There is a great opportunity for urban community cellular networks





Mobile phone: 20 Mbps down & 1 Mbps up at 0.43 km away