

Building Community LTE Networks with CoLTE

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This Talk

- Background: Community Networking
- Current Work: Community LTE package
- Upcoming Deployments
- Future Research

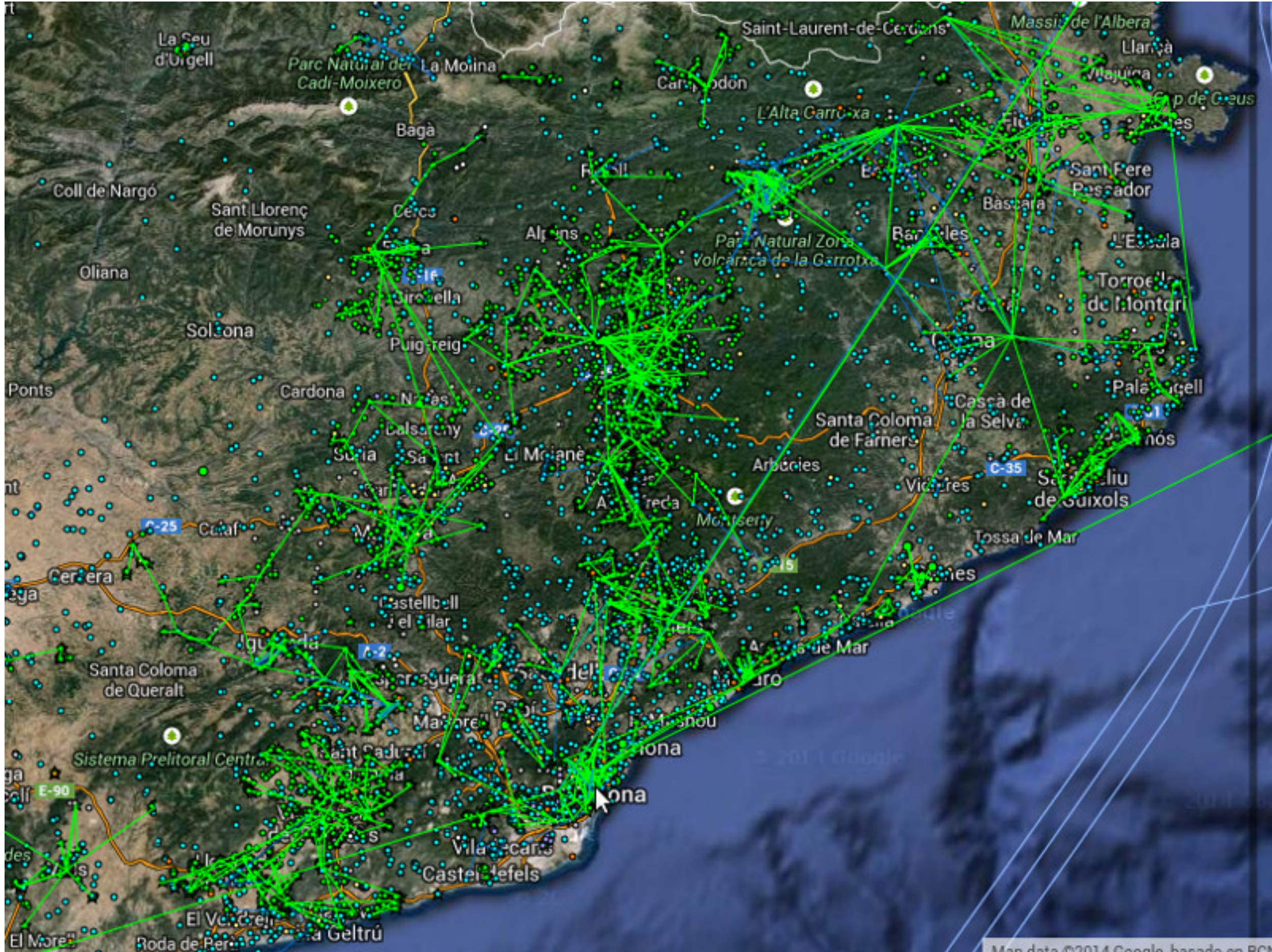
Community Networks

- Varies from small (dozens of members) to large (up to 40k)
- Can be in urban or rural areas
- Variety of wireless backhaul, usually WiFi for access
- Typically a distributed/decentralized mesh
- **Provisioned, owned, and managed by the community**

Community Networks



Community Networks



Community Cell Networks

- Typically smaller-scale (100s of users, one to three towers)
- Access technology is cellular (usually 2G)
- Network architecture more centralized
- Low backhaul requirements (one phone call = 10kbps)
- **Still community owned and managed!**

Community Cell Networks

- Lab's prior and current work in 2G networks
- Voice and text, Twilio for PLMN interconnect
- **Problem 1:** Osmocom/2G is complicated and often breaks
- **Problem 2:** Phone numbers are expensive
- **Problem 3: Doesn't provide Internet access**

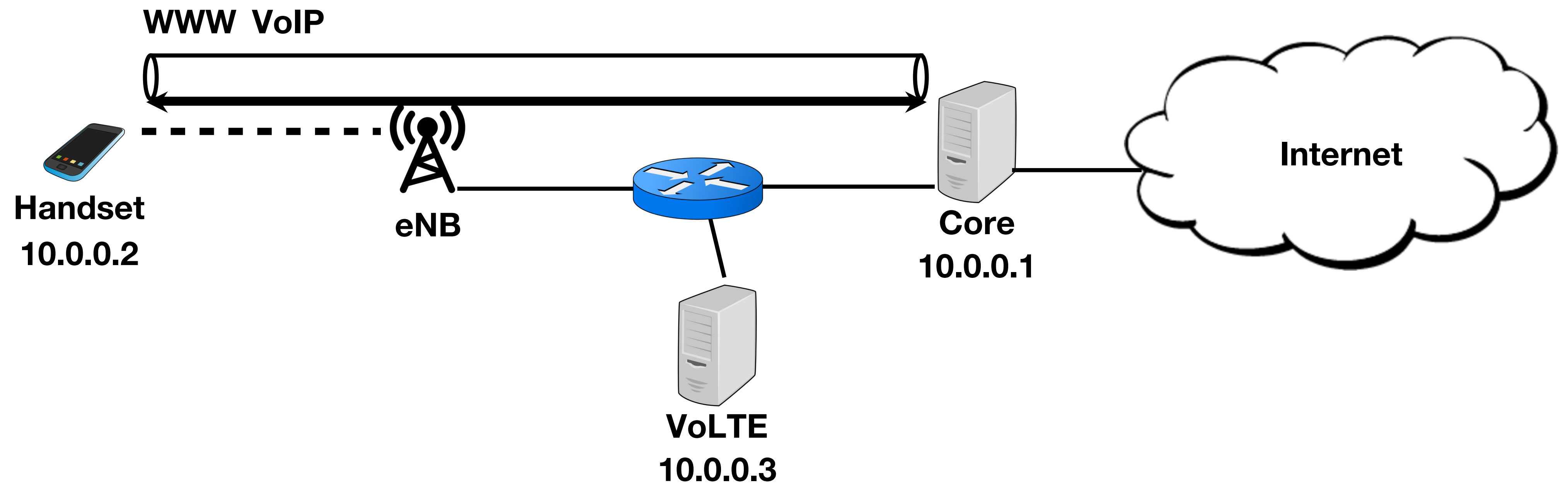
Why Not LTE?

- LTE network architecture *much* simpler than 2G
(10 network elements down to 3)
- Commodity hardware is coming down in price
(\$8k base stations down to \$2k)
- Handsets becoming widely available worldwide
(30% of handsets support LTE even in rural Indonesia)
- Open-source LTE stacks now available
(EPC used to be \$40k; now OAI and SRS are free)

LTE Is Based On IP

- LTE network substrate is *100% IP*
- This includes voice and text! (VoLTE is really just VoIP)
- Can run an LTE network with or without these functions
- *It's actually much easier to build a data-only LTE network!*

LTE Is Based On IP



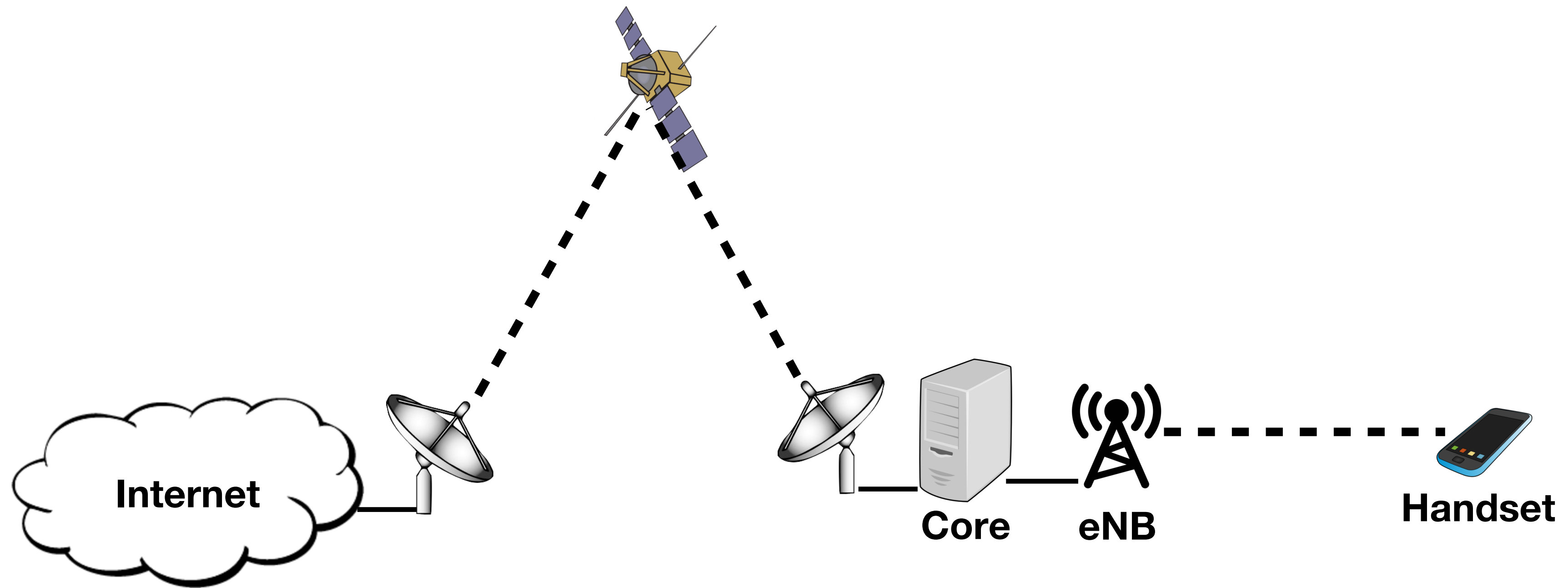
LTE As Access Tech

- High-speed Internet access (up to 150mbps)
- Long range of coverage (kilometers) for a single tower
- Small number of tower(s) eases routing and failure points
- All these make it a great candidate for rural access!

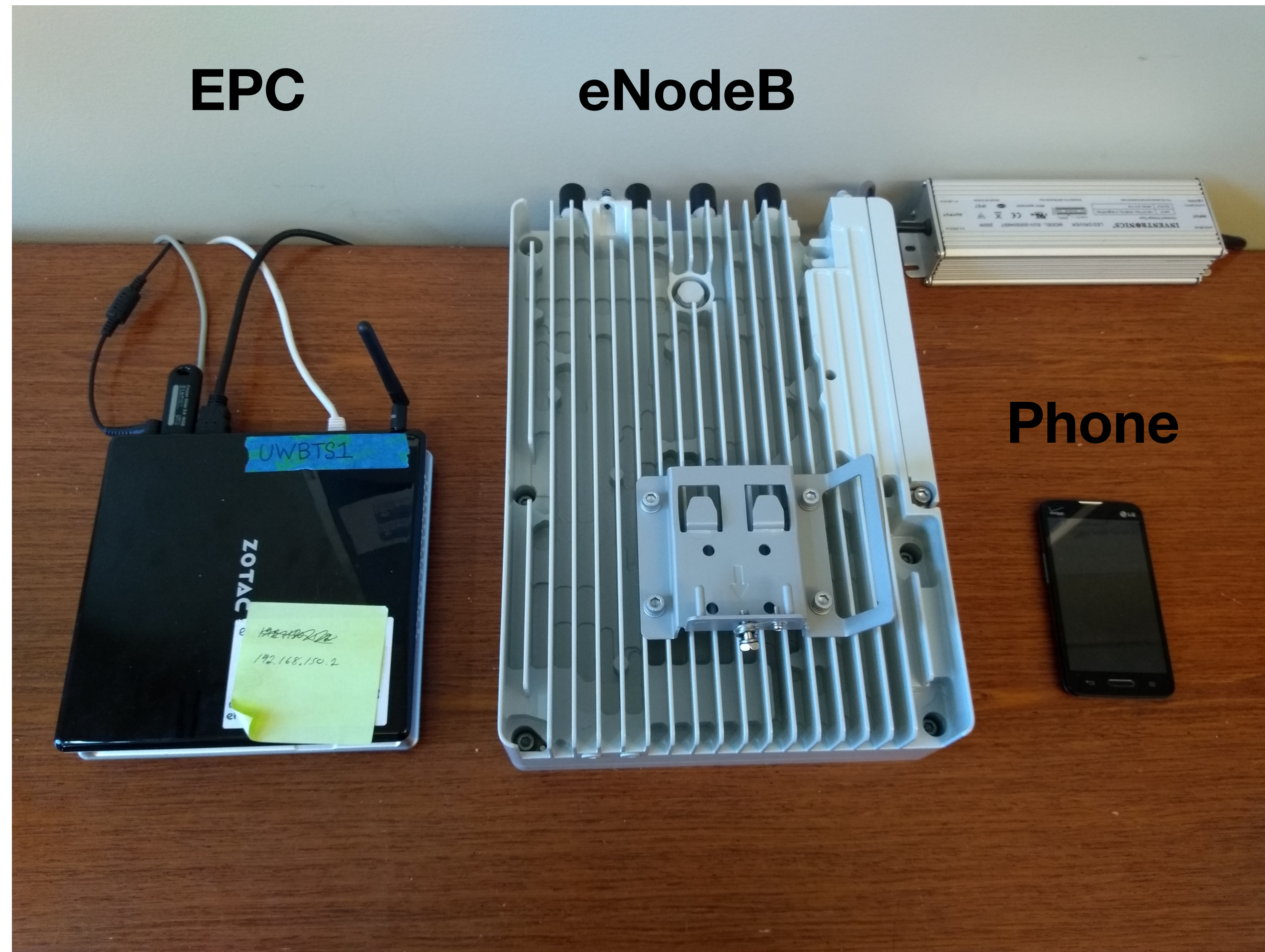
CoLTE: Community LTE

- Community LTE project, basically a network-in-a-box
- **Goal:** Open-source software system, everything you need to setup and run a commercial (or free) LTE network
- **Goal:** Easy and straightforward to install, even for regular people. Target is to be as simple as a WiFi router
- **Goal:** Provide step-guides and documentation for the parts of the project that we can't automate (SIMs, antennas, etc.)

CoLTE: Basic Architecture



CoLTE: Hardware Stack



CoLTE: Hardware Stack

- Standardized s6a interface means eNodeBs should be relatively plug-and-play with respect to the core
- Against all odds... this is actually our experience!
- Core network runs on a Zotac box (150 USD)
- Commercial eNodeBs coming down in price (2200 USD)

CoLTE: Core Software

- Based off Eurecom's OpenAirInterface project
- Most of our work was for stability: broken build scripts, dependency hell, consistent/sane variables and configs
- Hoping to release binaries and/or .deb packages soon
- Summer project: a web-based configuration/status tool

Billing Services

- **Big Decision #1:** We decided there's no reason to bill voice or text separately from data - it's all just IP packets anyways!
- **Big Decision #2:** We don't currently support voice/text - our target community already uses WhatsApp and Skype.
- Wrote our own web-based portal that lets users top up, transfer credit, check balance, and buy data packages

Billing Services

network.bokondini/status	network.bokondini/transfer	network.bokondini/purchase
Community Cellular Network	Community Cellular Network	Community Cellular Network
Account	Transfer	Purchase
Account Information	Transfer	Account
Phone Number: 0000006	Current Balance: \$500	Current Balance: \$500
Current Balance: \$500	Recipient Phone Number	Current Data: 10.0 MB
Data Balance: 10.0 MB	phone number	
	Amount To Send	Packages
	\$	Purchase 10MB for \$5
	Submit	Purchase 100MB for \$15
More Information		Purchase 1GB for \$25
Total Downloaded: 0.1 kB		
Total Uploaded: 0.1 kB		
IP Address?		
IMSI? (probably not)		

Local Services

- Our target deployment is *very* backhaul constrained (1Mbps)
- Locally hosting some webservices: Wikipedia, media server, OpenStreetMaps
- Everything hosted at “http://servicename.bokondini”
- Landing page at “<http://home.bokondini>” links to these services

Upcoming Deployments

- First Deployment: Bokondini, Indonesia
 - Previously a 2G community cell network
 - Backhaul: a 1 Mbps VSAT link
 - Data only, not voice or text
 - **Heading out straight from IETF**

Upcoming Deployments

- Second/Third Deployments: Indonesian Coast
 - Currently no coverage at all
 - Backhaul: We can connect to nearby fiber
- **Future Deployments: We're looking for partners!**

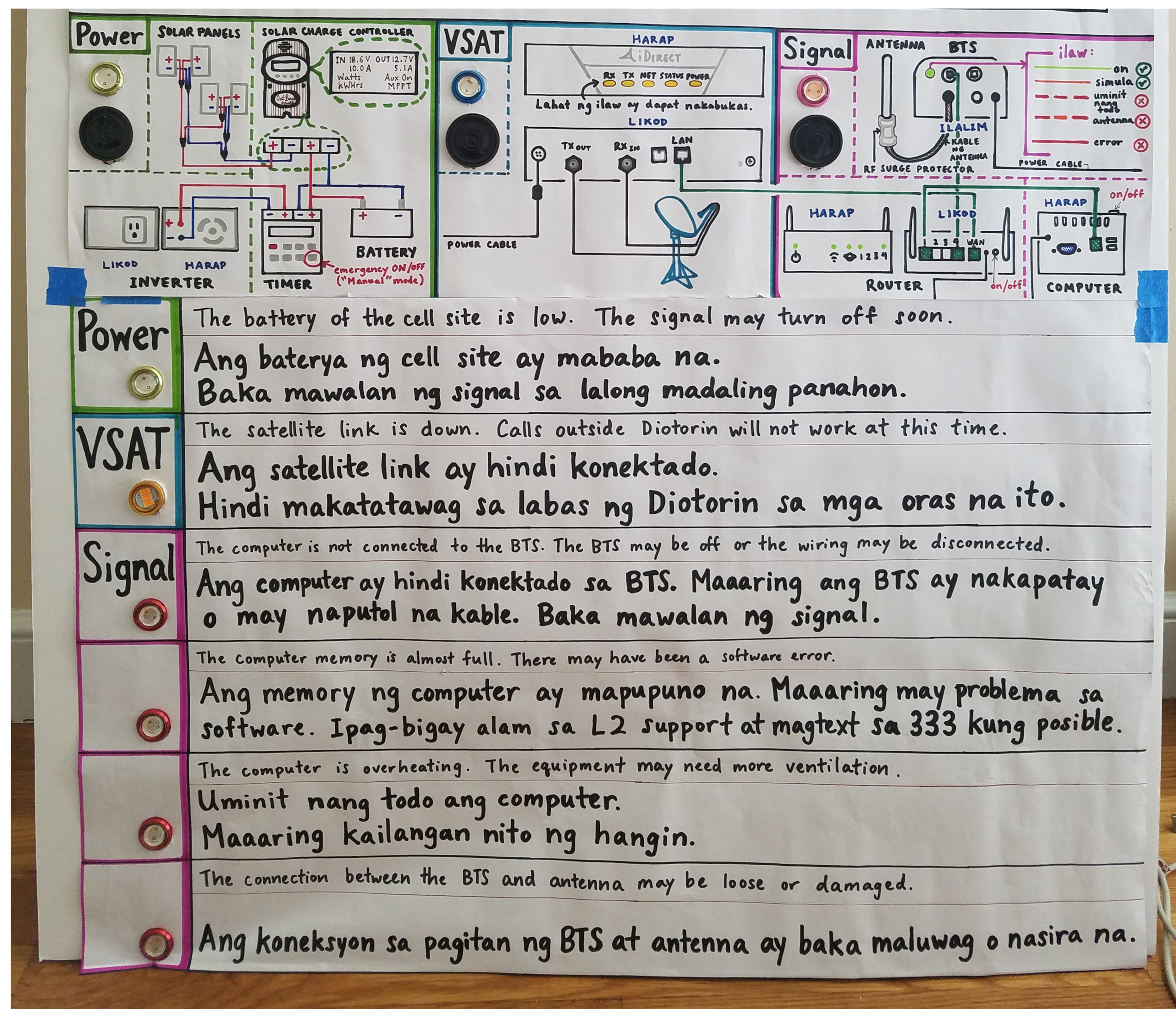
Future Research

- Thrust 1: Community-based repair and maintenance
- Thrust 2: In-network services and billing
- Thrust 3: Internet architecture

Community Repair

- Prior work (Jang 2018): Crowd-sourced repair of simple tasks, such as cleaning solar panels
- Current work: Sensors to automatically detect network problems (e.g. ping) and alert the community
- Goal: Much more robust/repairable network infrastructure!

Community Repair



Services and Billing

- Currently hosting local webservises (media, maps, etc.)
- Idea #1: Free or discounted data rate for local services?
- Idea #2: Free or discounted calling/texting? (WhatsApp)
- Idea #3: Web content caching (Youtube)

Internet Architecture

- Are we more of a telecom or an ISP? What does this mean?
- What's the difference between VoLTE and Skype/WhatsApp?
- What are the implications for services such as 2FA?
- Roaming in a world with loads of community LTE networks?
- How will LTE and WiFi relate, or merge, or complement?

Thanks!

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<http://communitylte.wordpress.com>