

Building Community LTE Networks with CoLTE

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This Talk

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

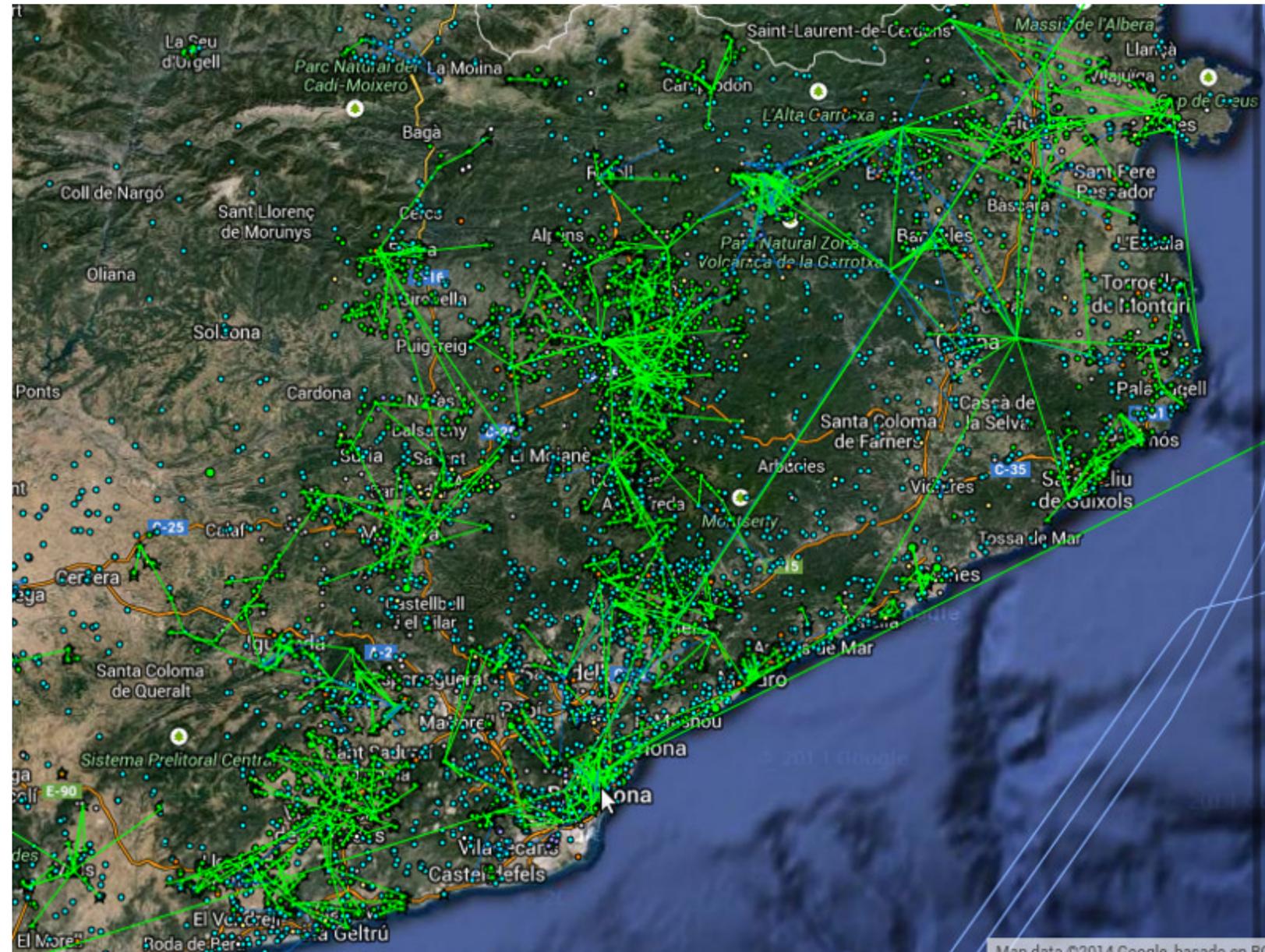
Community Networks

- 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**

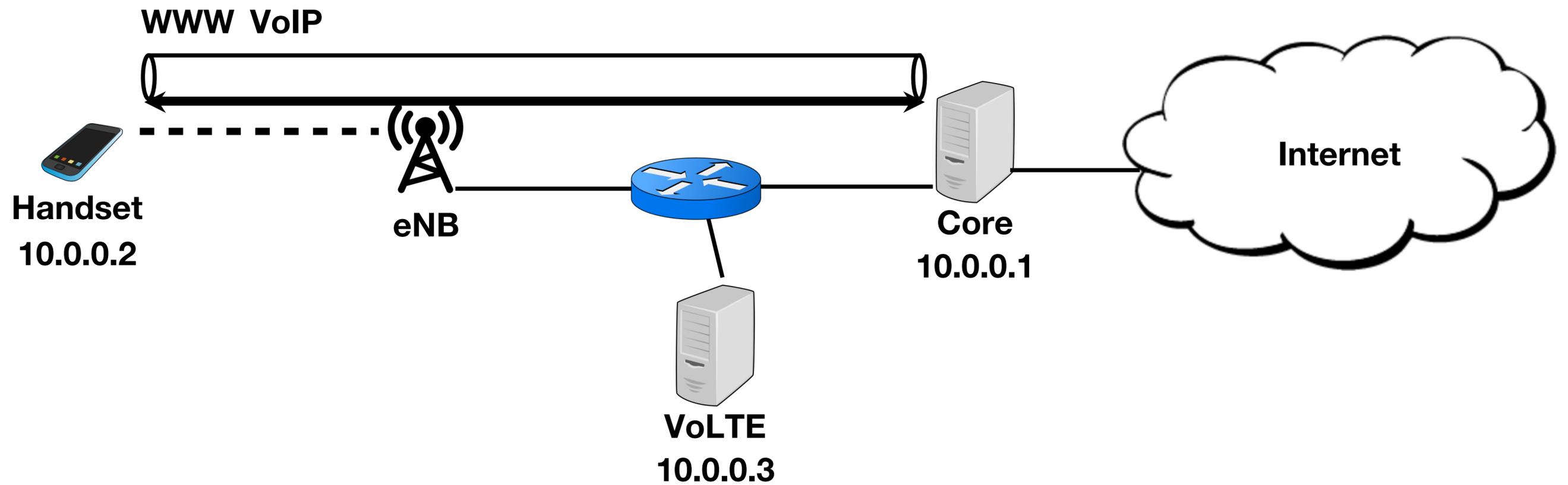
Why Not LTE?

- 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



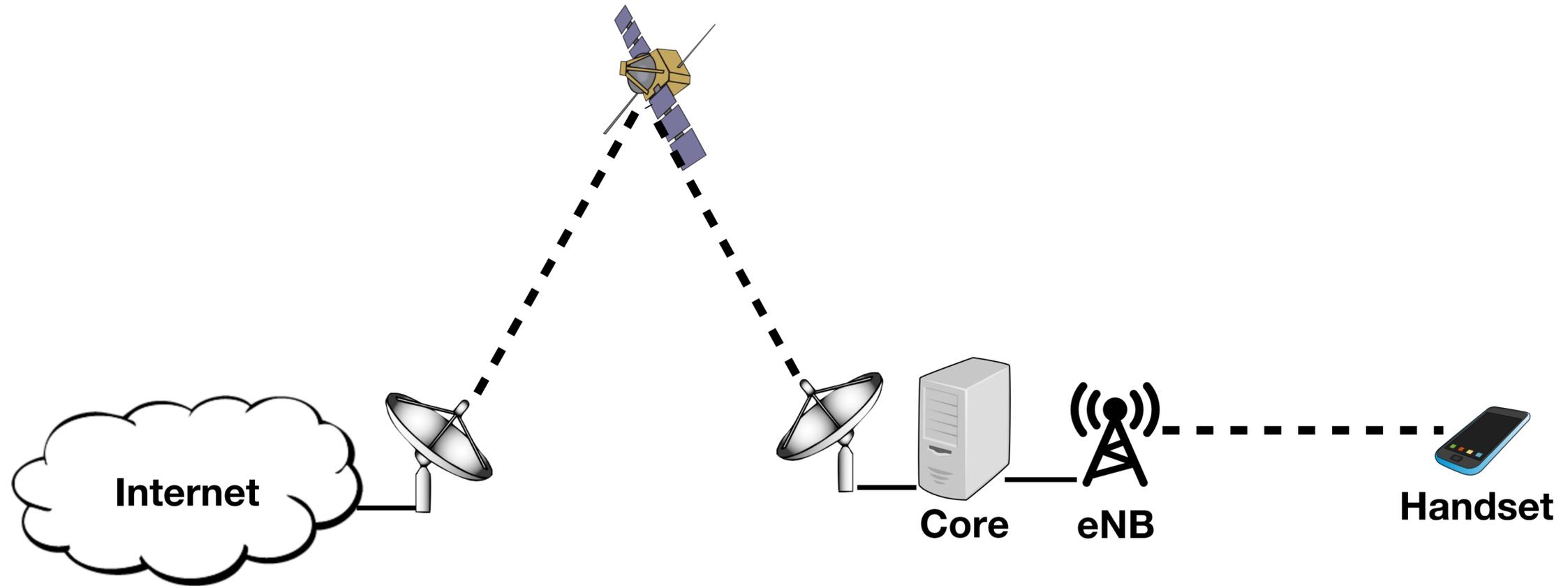
LTE As Access Tech

- 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!

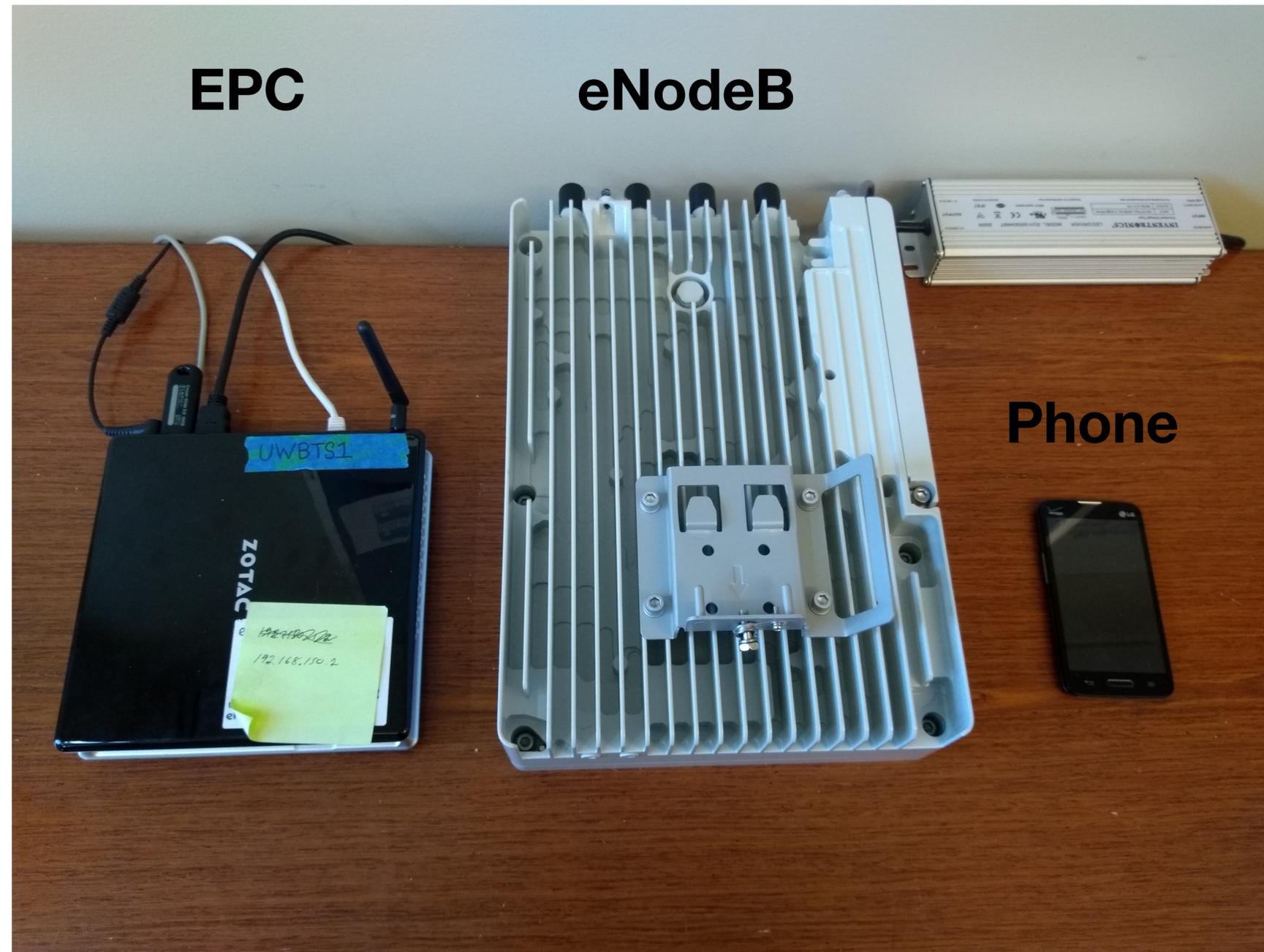
CoLTE: Community LTE

- 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

The image displays three sequential screenshots of a mobile web application for 'Community Cellular Network'. Each screenshot shows a browser address bar with a URL, a status bar at the top, and a navigation menu with 'Account', 'Transfer', 'Purchase', and 'Media' options.

Screenshot 1 (17:23): URL: `network.bokondini/status`. The 'Account' menu item is selected. The page content includes:

- Account Information:** Phone Number: 0000006, Current Balance: \$500, Data Balance: 10.0 MB.
- More Information:** Total Downloaded: 0.1 kB, Total Uploaded: 0.1 kB, IP Address?, IMSI? (probably not).

Screenshot 2 (17:24): URL: `network.bokondini/transfer`. The 'Transfer' menu item is selected. The page content includes:

- Transfer:** Current Balance: \$500, Recipient Phone Number (input field with placeholder 'phone number'), Amount To Send (input field with placeholder '\$'), and a blue 'Submit' button.

Screenshot 3 (17:24): URL: `network.bokondini/purchase`. The 'Purchase' menu item is selected. The page content includes:

- Account:** Current Balance: \$500, Current Data: 10.0 MB.
- Packages:** Three purchase options, each with a blue 'Purchase' button:
 - 10MB for \$5
 - 100MB for \$15
 - 1GB for \$25

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!**

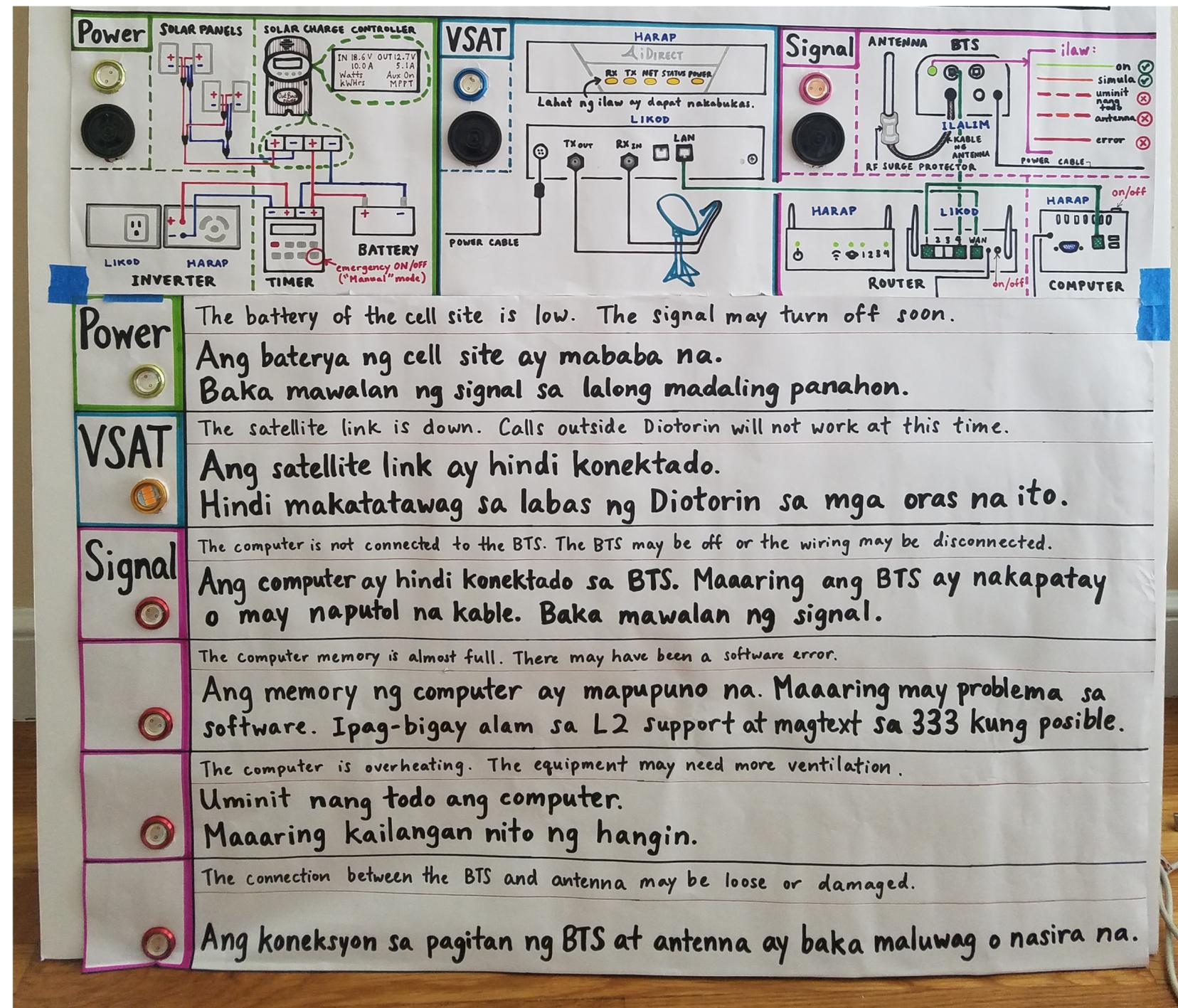
Future Research

- 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



Power

The battery of the cell site is low. The signal may turn off soon.

Ang baterya ng cell site ay mababa na.
Baka mawalan ng signal sa lalong madaling panahon.

VSAT

The satellite link is down. Calls outside Diutorin will not work at this time.

Ang satellite link ay hindi konektado.
Hindi makatatawag sa labas ng Diutorin sa mga oras na ito.

Signal

The computer is not connected to the BTS. The BTS may be off or the wiring may be disconnected.

Ang computer ay hindi konektado sa BTS. Maaaring ang BTS ay nakapatay o may naputol na kable. Baka mawalan ng signal.

The computer memory is almost full. There may have been a software error.

Ang memory ng computer ay mapupuno na. Maaaring may problema sa software. Ipag-bigay alam sa L2 support at magtext sa 333 kung posible.

The computer is overheating. The equipment may need more ventilation.

Umunit nang todo ang computer.
Maaaring kailangan nito ng hangin.

The connection between the BTS and antenna may be loose or damaged.

Ang koneksyon sa pagitan ng BTS at antenna ay baka maluwag o nasira na.

Services and Billing

- Currently hosting local webservices (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>