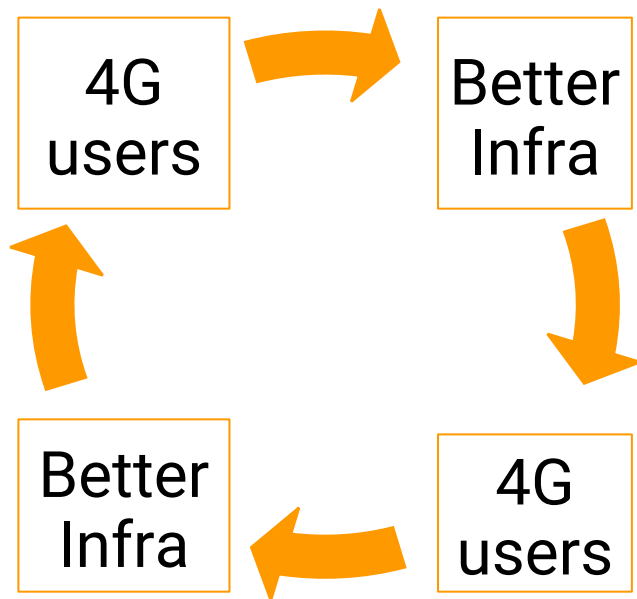# An Investigation of Phone Upgrades in Remote Community Cellular Networks

Kushal Shah, Philip Martinez, Emre Tepedelioglu, Shaddi Hassan, Cedric Festin, Joshua Blumenstock, Jo Dioniso, Kurtis Heimerl

Motivation:

4G users → Better Infra → 4G users → Better Infra → (cycle)

There's incentive in urban areas to upgrade devices. But, why are users in rural areas upgrading their phones without necessary infrastructure?

Motiviation: Need for upgrades

Important services such as E-governance and Mobile Money services

4G
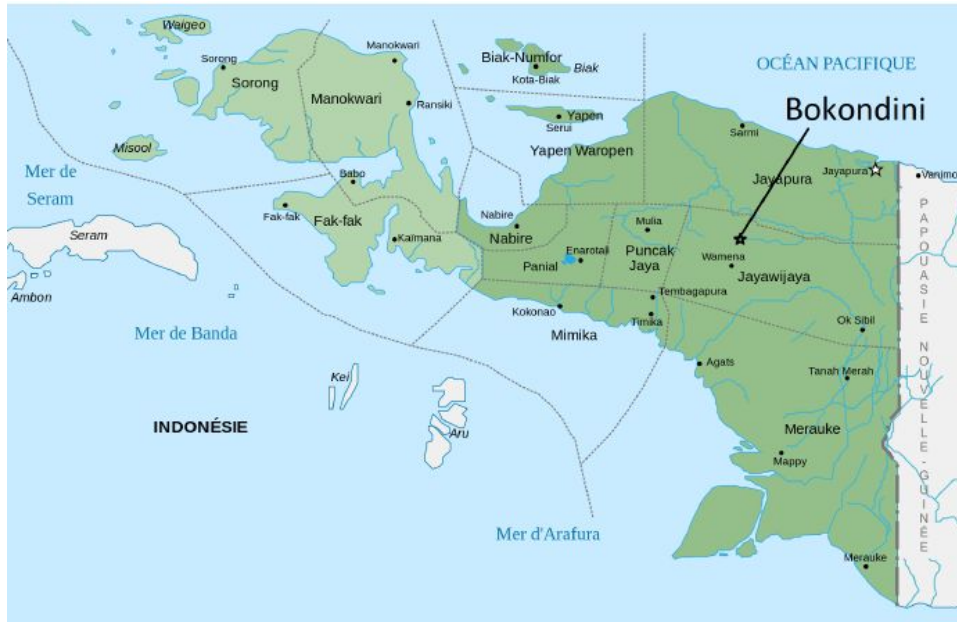Refarming
1800 MHz
900, 2100MHz

The end of 2G: Drive towards a future smartphone-only world
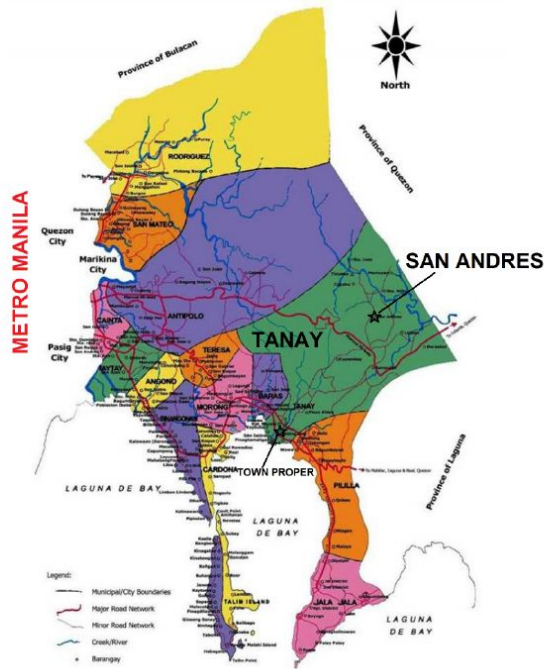
Community Cellular Networks

Community owned, community operated cellular networks

Bokondini, Papua (Indonesia)

- 4 hours drive from Wamena

- 1500 community members

- Subsistence Agriculture is the primary economic activity

San Andres (Philippines)

- Within accessible distance from a highly urban center

- Total population of 2,145 community members

- Agriculture and tourism are primary sources of income

- Installation of CCN has improved economic activity in the region

Data

TIMESTAMP	IMEI (International Mobile Equipment Identity)	IMSI (International Mobile Subscriber Identity)

Data
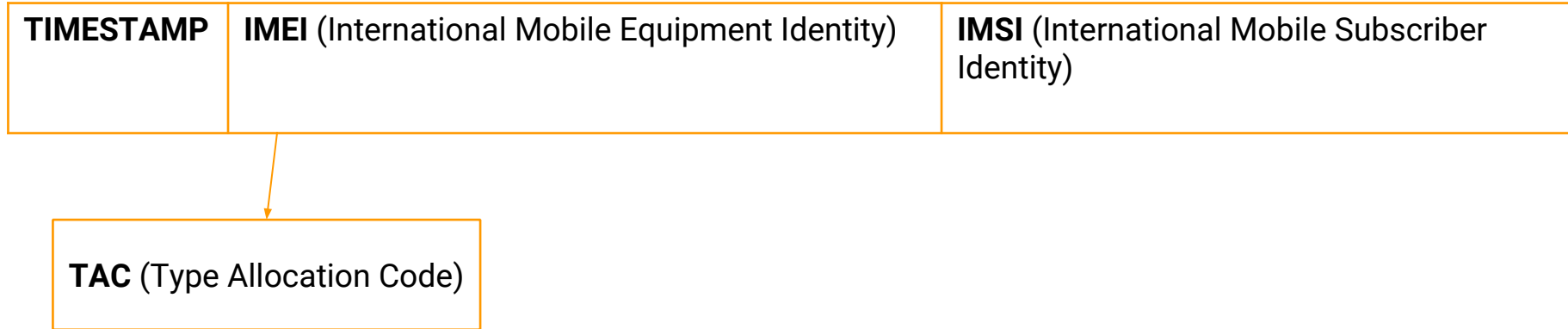
TIMESTAMP	IMEI (International Mobile Equipment Identity)	IMSI (International Mobile Subscriber Identity)

TAC (Type Allocation Code)

Data

| TIMESTAMP	IMEI (International Mobile Equipment Identity)	IMSI (International Mobile Subscriber Identity)

TAC (Type Allocation Code)

01124500

Field	Example
Marketing Name	iPhone A1203
Radios	GSM
Operating System	iOS
Radio Additions	Bluetooth 2.0
Manufactured	June 2007

Data

- 116, 988 records in Bokondini (ID) from August 2014 to March 2017
- 298, 292 records in San Andres (PH) from April 2016 to March 2017
- Logs **ALL** users who enter into the community network area:
  - Even those who are not part of the local network.
  - Registrations in Papua (ID) were logged daily.
  - Registrations in San Andres (PH) were logged hourly.

Operational Definitions

- **Local User**
- Primary Phone
- Phone Sharing
- Phone Upgrade
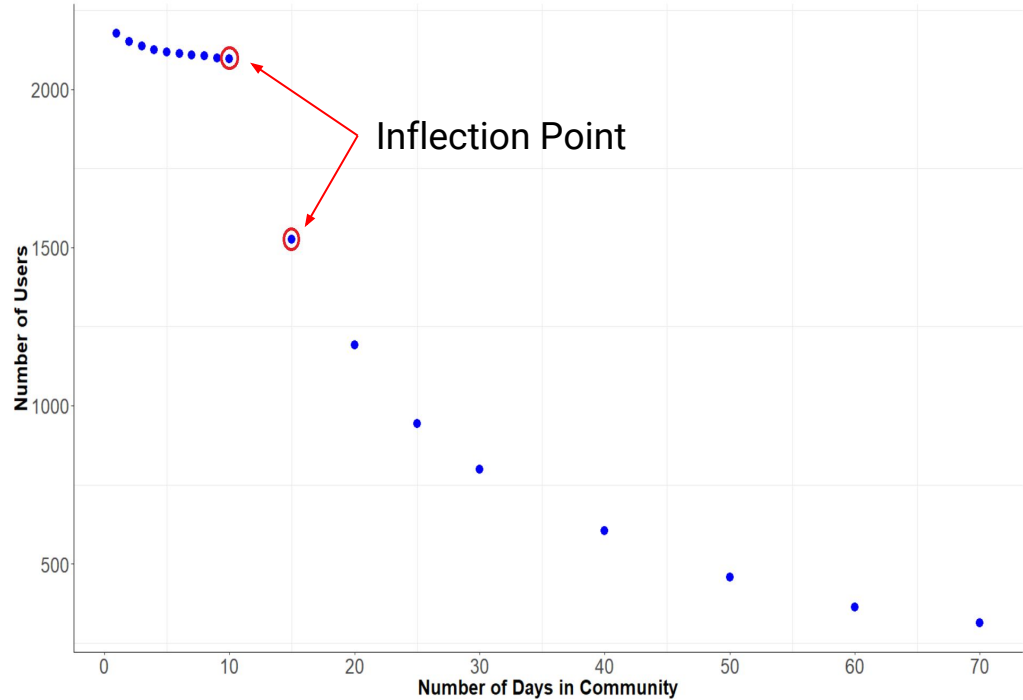
Operational Definitions

- Local User
- Primary Phone
- Phone Sharing
- Phone Upgrade

A user is a **local user**, if they have a SIM registered with the local telecom or have been in the community for at least ten days.

Operational Definitions

- Local User
- Primary Phone
- Phone Sharing
- Phone Upgrade

A user's **primary phone** is the one, in which the sim connects to a network most often during the day

Operational Definitions

- Local User
- Primary Phone
- **Phone Sharing**
- Phone Upgrade

A phone is **shared** if it changes users
with operation returning to earlier users.

Operational Definitions

- Local User
- Primary Phone
- Phone Sharing
- Phone Upgrade

A user has **upgraded or downgraded their phone** if they change their primary phone and do not switch back
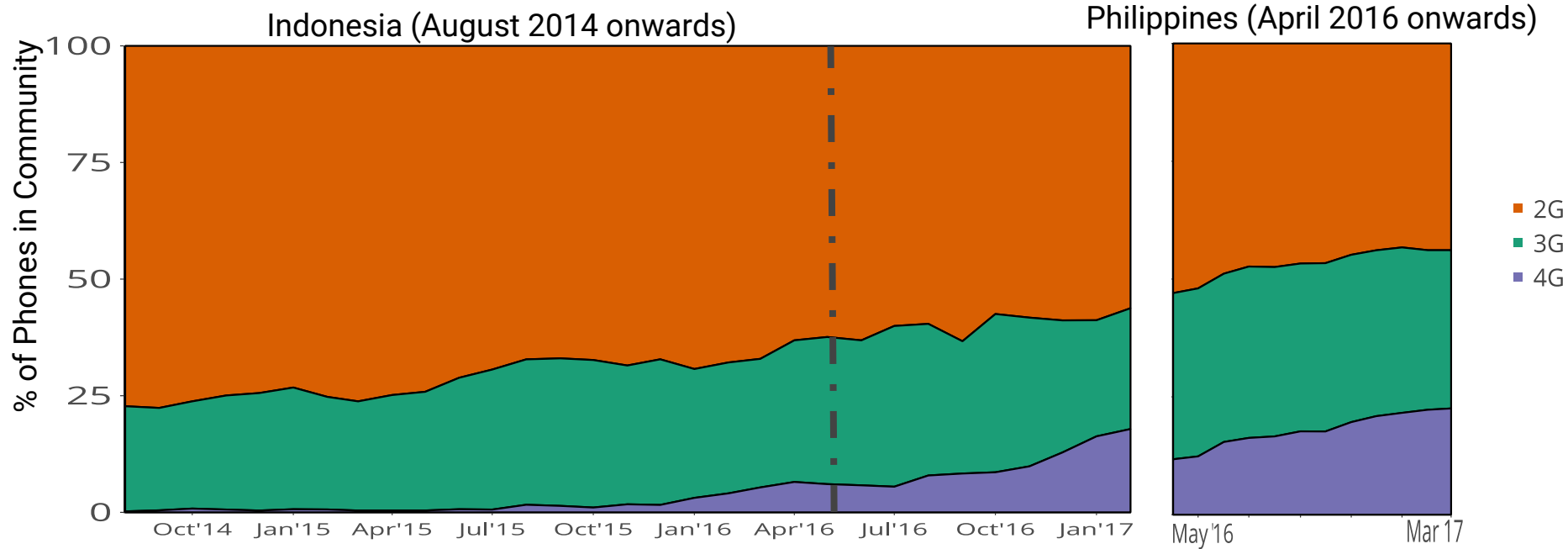
Call Logs: Local vs Non-local

Indonesia (August 2014 onwards)

Philippines (April 2016 onwards)
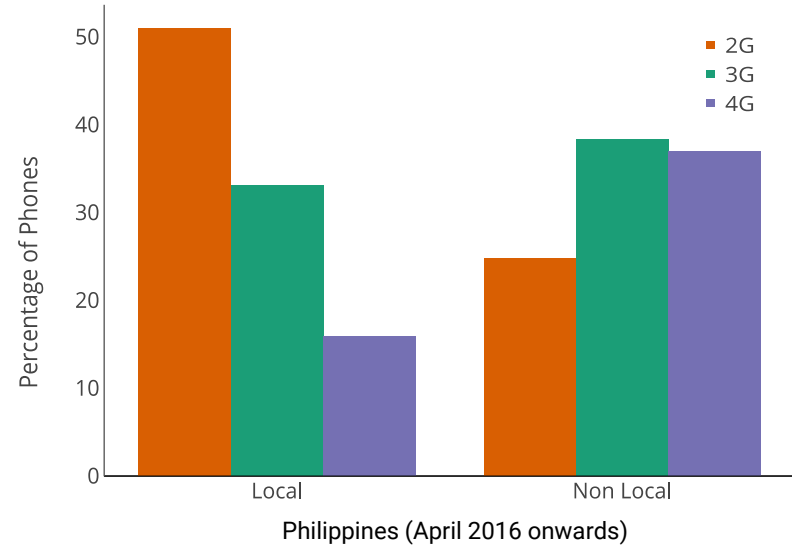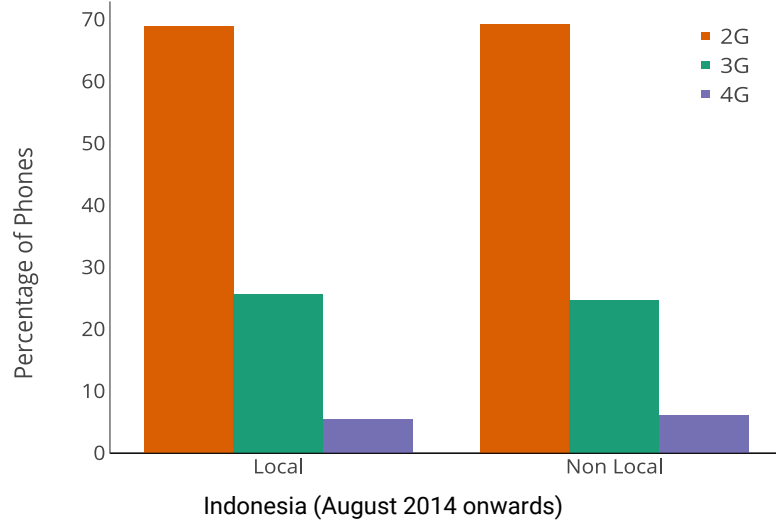
Using a nonparametric t-test, we observe that Non-local users (33%) in Philippines use significantly more 4G devices than local users (15%).

Call Logs: Phone Adoption

Proportion of 4G capable devices is increasing rapidly in both countries.

In last year:
Indonesia:
 6.5% -> 17.9%
Philippines:
 11.8% -> 22.5%

3G adoption has stalled, starting to shrink.

In last year:
Indonesia:
 30.4% -> 25.9%
Philippines:
 35.3% -> 33.6%

2G decreasing, being replaced by smartphones.

In last year:
Indonesia:
 63.1% -> 56.3%
Philippines:
 53% -> 43.9%

Call Logs: Phone Upgrades

From:	To: 2G	To: 3G	To: 4G
Philippines			
2G	39.75%	3.56%	13.79%
3G	4.70%	3.58%	3.18%
4G	12.38%	3.66%	15.51%
Indonesia			
2G	55.38%	1.32%	13.26%
3G	1.60%	1.65%	0.85%
4G	14.73%	0.94%	10.25%

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Plurality of users remaining with 2G phones.

Call Logs: Phone Upgrades

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3G	**1.60%**	**1.65%**	**0.85%**
4G	14.73%	**0.94%**	10.25%

Very few users transitioning to or from 3G phones

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Significant upgrading

Call Logs: Phone Upgrades

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Significant downgrading back to feature phones

Phone Logs: Age of Upgrades

	Mean	Median	Std. Dev
2G to 3G	2.73 years	2 years	1.67 years
2G to 4G	0.66 years	1 year	0.49 years
3G to 4G	0.85 years	1 year	0.39 years
4G to 4G	0.75 years	1 year	0.58 years

Indonesia (August 2014 onwards)

	Mean	Median	Std. Dev
2G to 3G	2.53 years	2 years	2.11 years
2G to 4G	1.89 years	2 years	1.16 years
3G to 4G	1.65 years	2 years	1.19 years
4G to 4G	1.38 years	1 year	1.05 years

Philippines (April 2016 onwards)
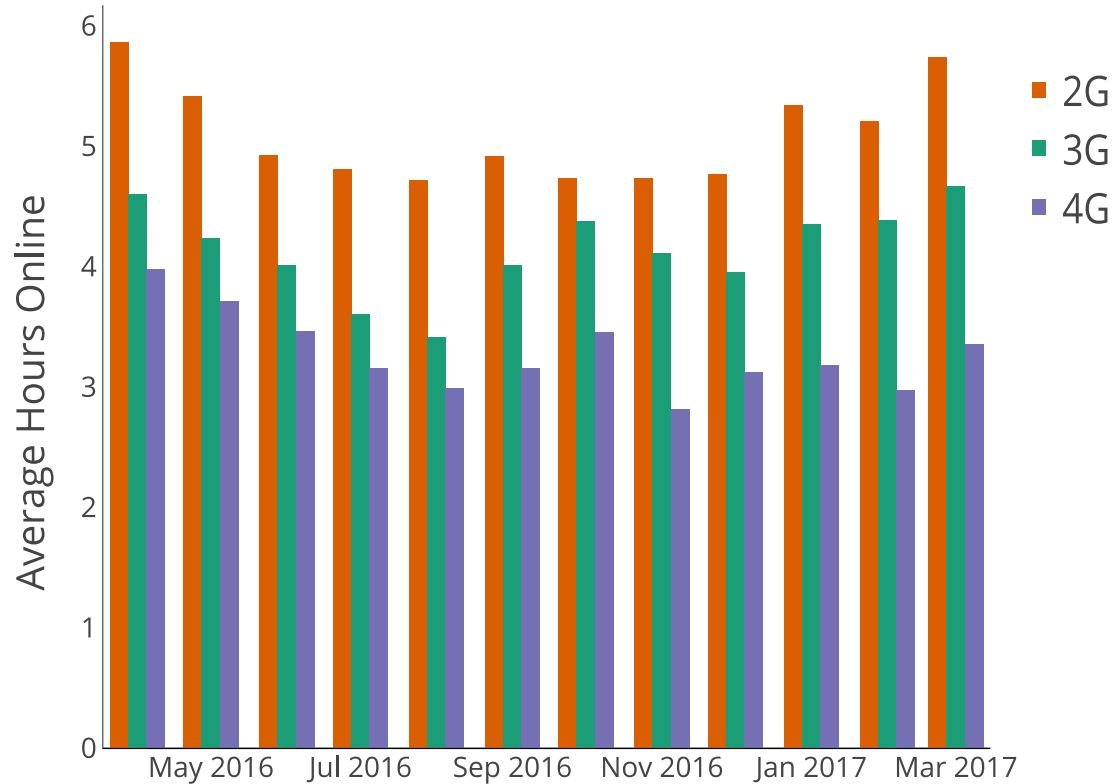
Community members upgrade to relatively newer devices in
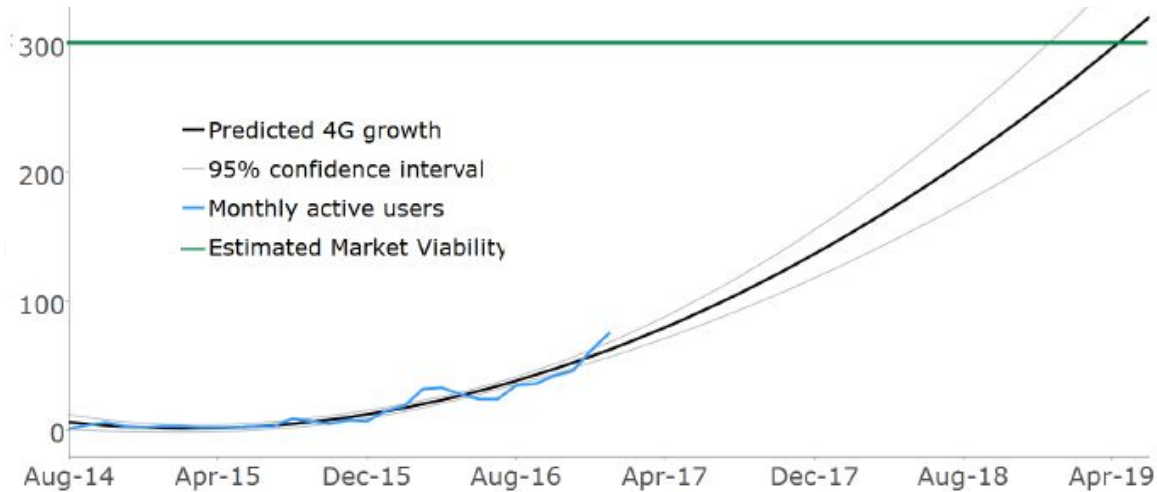Bokondini, since it's not easy to travel to nearby areas
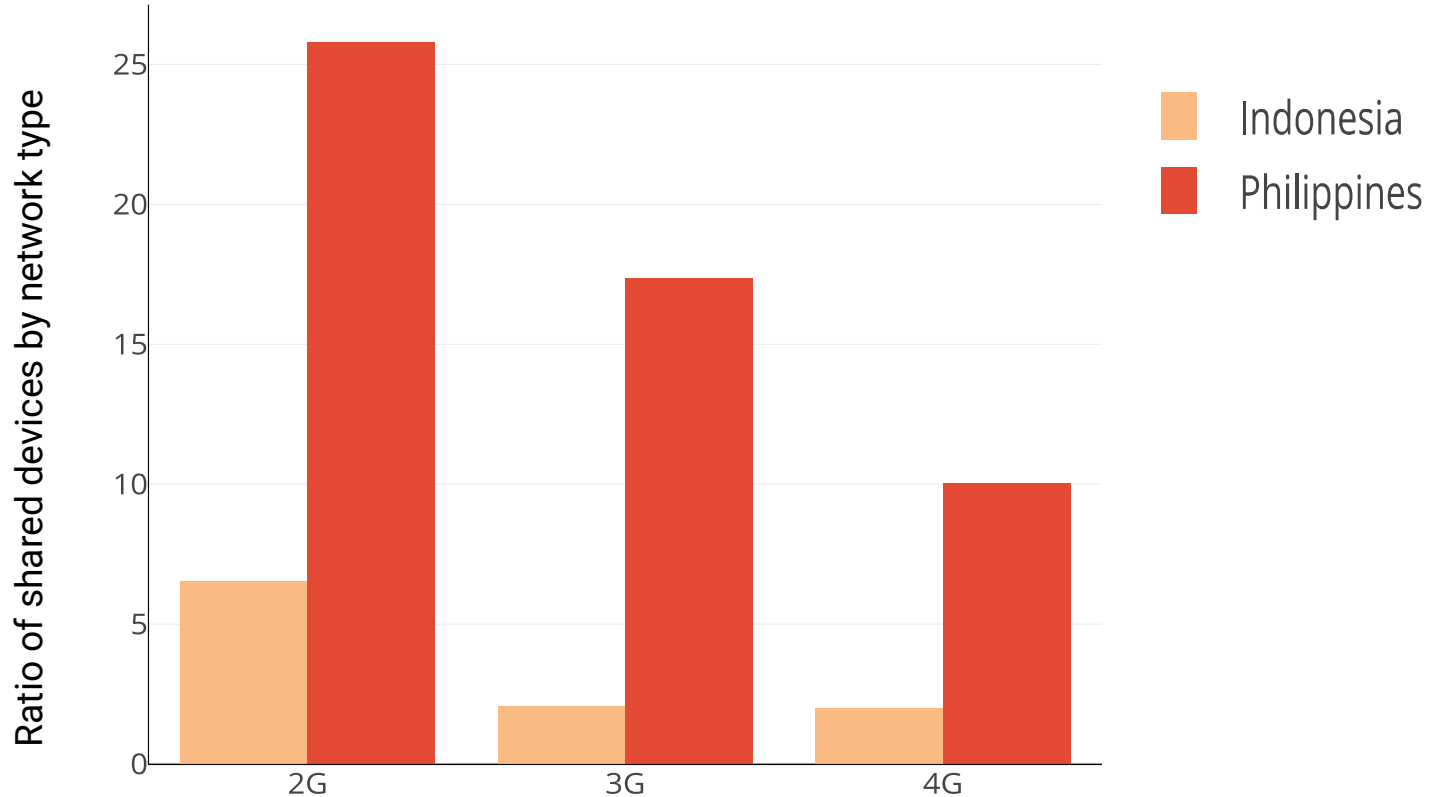
Phone Logs: Hourly Online Activity (PH)

2G phones are used more in the community than 4G phones

Results: Projecting Viability (ID)

$$Y_t = α + β_1 t + β_2 t^2 + ε_t$$

A 4G only base-station would be sustainably installed in Indonesia in April 2019

Quantitative Conclusions

- Local vs Nonlocal is an important distinction
- 4G growing rapidly, 3G dying, 2G also dying but with long runway
- Significant upgrade **and** downgrade behavior
- 2G phones more active: used more, shared more
- 4G Access points viable in mid 2019

Qualitative Data

- Interviewed cell phone owners and credit sellers in San Andres (Philippines) to better understand upgrade behavior

- Snowball sampling after interviewing credit sellers

- Total 15 semi-structured interviews

Why do people change phones?

If phones are lost, damaged or stolen

Usability/Features

Phones gifted to family members

Interviews - Theft or Loss

22 Year Old Construction Worker: Upgraded from feature phone to Cherry Mobile smartphone, then **dropped in water** and replaced with newer one.

28 Year Old Homemaker: Downgraded to Cherry Mobile when Samsung Galaxy was **loaned** to a friend of their child and then **not returned.**

Interviews - Usability: Entertainment

25 Year Old Male Tricycle Driver: "*This cellphone belongs to my wife, but my* ***child uses it****. My child is seven years old. We use it just for* ***games, music, Facebook****. (Facebook) is the only (app) that we know (how to use) here. I let him* ***download*** *as many* ***games*** *as possible, then I will borrow the phone from him.*"

Interviews - Usability: Features

22 Year Old Woman: "*If you have a **touchscreen** phone, you can do many things with it. You can **access the internet**. Unlike before, you can only do **calls and text**. But now, (with a touchscreen phone), you can call, text, (connect to the) internet, and other things.*"

Discussion: How to promote upgrades

Better power and network infrastructure required

- Curated media content
- Affordable and resilient smartphones

Conclusions

- Many benefits to feature phones
  - Power efficient
  - Less risk of loss
- Many benefits to smartphones
  - Media players
- If we want people to have and use smartphones, we need to make a compelling case for these areas
  - Local media servers
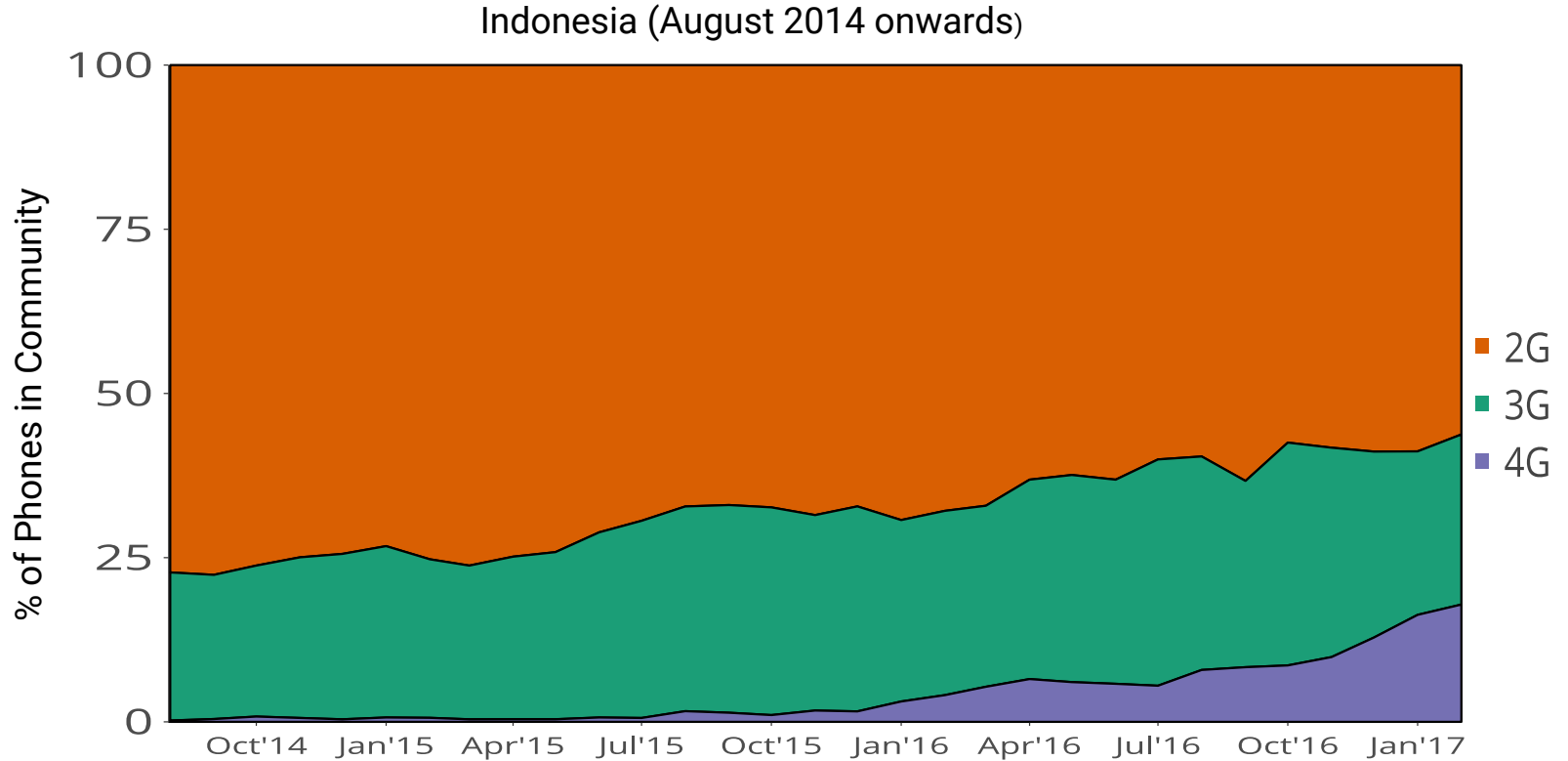 - Hardened devices

Acknowledgements

Thank you!

Call Logs: Phone Adoption
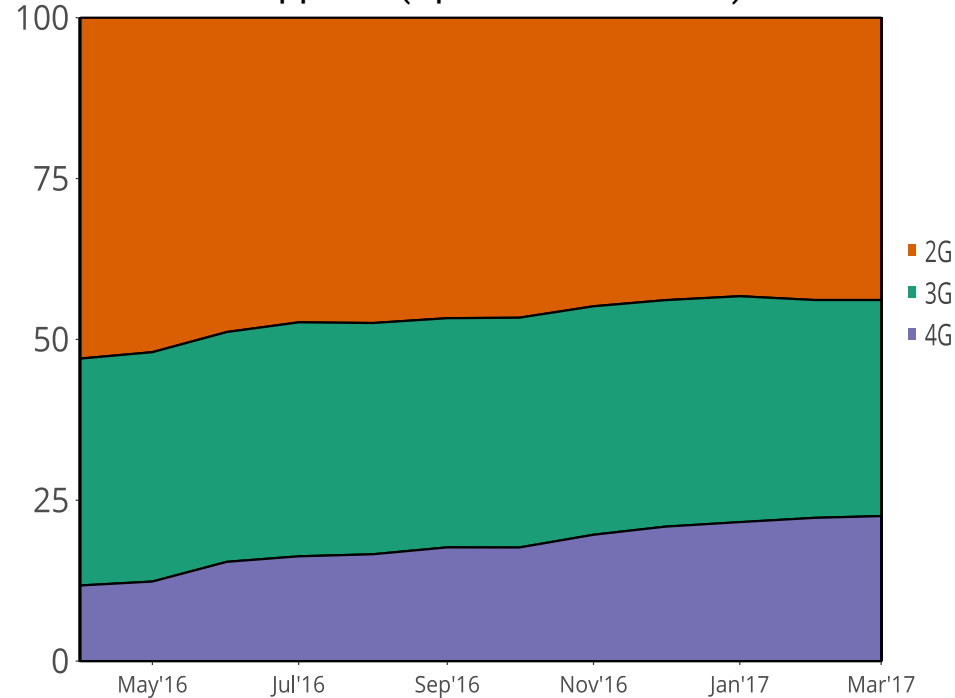
Indonesia (August 2014 onwards)

% of Phones in Community

2G
3G
4G

Oct'14 Jan'15 Apr'15 Jul'15 Oct'15 Jan'16 Apr'16 Jul'16 Oct'16 Jan'17

Call Logs: Phone Adoption

Philippines (April 2016 onwards)

Legend:
- 2G (orange)
- 3G (green)
- 4G (purple)

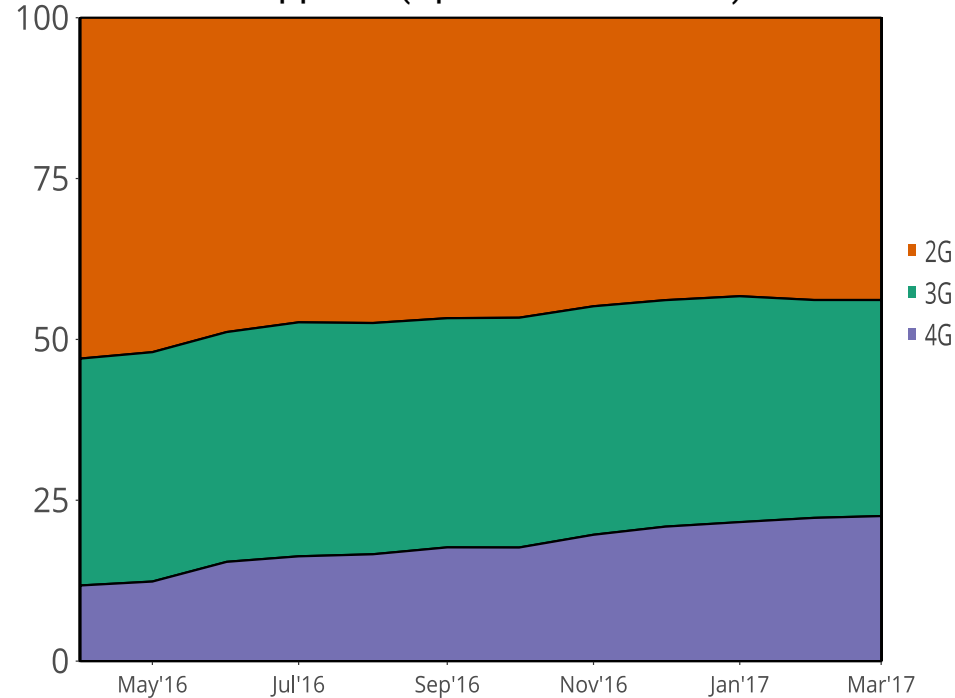Proportion of 4G capable devices is increasing rapidly in both countries.

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Call Logs: Phone Adoption

Philippines (April 2016 onwards)

3G adoption has stalled

In last year:
Indonesia: 22.5% -> 25.9%
Philippines: 35.3% -> 33.6%

Interviews - Instant Gratification

Respondent 4: "*We don't send text messages anymore. We send PMs through Facebook Lite, Viber, WhatsApp...*"

Respondent 3: "*Now, you can see if they are online. You know immediately if they are replying. Unlike before when you need to wait…*"

High-level Findings

Travel to nearby town to avail free WiFI
- Routinely change sim-cards

Tourists visiting nearby waterfall and hiking site