

# Revisiting Network Energy Efficiency of Mobile Apps: Performance in the Wild

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# The Problem

- Over the past 15 years, CPU performance has increased 250x but battery life has only doubled!
- We know how to design apps that don't drain batteries (as much)...

The screenshot shows the Scientific American website. At the top, the logo "SCIENTIFIC AMERICAN™" is on the left, and "Sign In | Register" with a user icon is on the right. Below the logo is a search bar with the placeholder text "Search ScientificAmerican.com". A navigation bar contains links: "Subscribe" (in a red box), "News & Features", "Topics", "Blogs", "Videos & Podcasts", "Education", and "Citizen Science". Below this is a breadcrumb trail "Tech » Features" and links for "Email" and "Print". A blue banner states: "This article is from the In-Depth Report Consumer Electronics in 2015: Building the Internet of Things". The article title is "People Love Their Smartphones but Hate the Batteries [Survey Results]". The sub-headline reads: "Scientific American readers say smartphones have not replaced tablets or PCs, and still need better batteries, cameras and biometric security options". The byline is "By Larry Greenemeier | November 28, 2014". A green box icon indicates a video, with text: "More than 2,000 Scientific American readers responded to last month's online survey asking how they use their smartphone, which gadgets it". To the right of the text is a partial image of a smartphone.

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SCIENTIFIC AMERICAN™

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Home World U.S. Politics Economy Business Tech Markets Opinion Arts Life

Twitter Names Jack Dorsey as Its Permanent CEO

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TECH | KEYWORDS

## Our One Wish? Longer Battery Life

Making gadgets thinner and lighter is a trend that has outlived its usefulness

MARKET LOCKERS

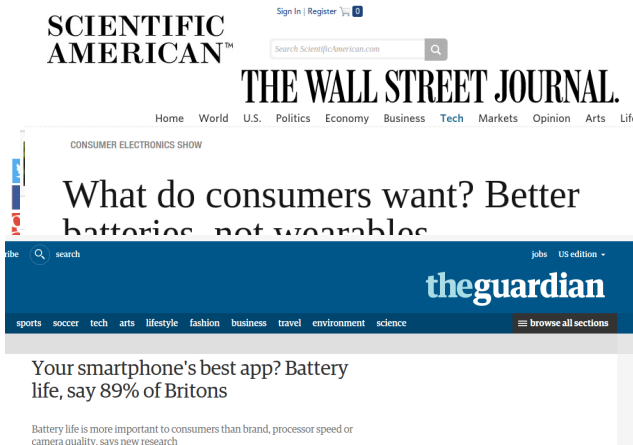
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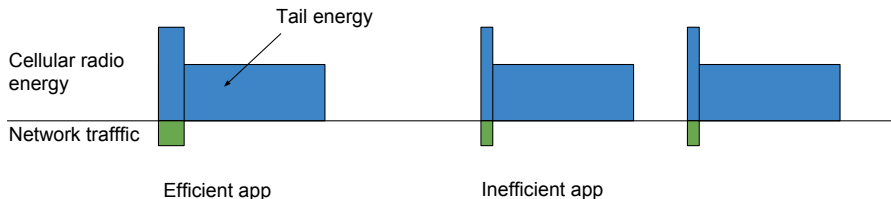
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## Prior work: App design is a problem

Application network patterns make a huge difference, generally

- Periodic transfers have a disproportionate impact<sup>1</sup>
- Understanding app behavior in the wild is essential<sup>2</sup>
- Continuous online presence has a high cost<sup>3</sup>



<sup>1</sup>Huang et al, MobiSys 2012; Qian et al, WWW 2012

<sup>2</sup>Xu et al, IMC 2011; Gember et al, IMC 2012

<sup>3</sup>Aucinas et al, CoNEXT 2013

# Research questions

- What are real users experiencing in the wild?
- Given all this interest, are apps getting better?
  - Some are, but many apps aren't.
  - Background updates are often too frequent for how much users use the app.
  - New problem: foreground traffic that keeps running after the app is closed.
- Are current measures sufficient?
  - Per-app ad-hoc performance improvements don't solve the problem entirely
  - We show minor OS-level suppression of background traffic from underused apps can make a big difference

# Overview

- Experimental setup
- Contribution 1: Foreground traffic not terminated
- Contribution 2: Background traffic continues to drain battery.
- Contribution 3: Excessive background traffic from unused or underused apps.
- Recommendations

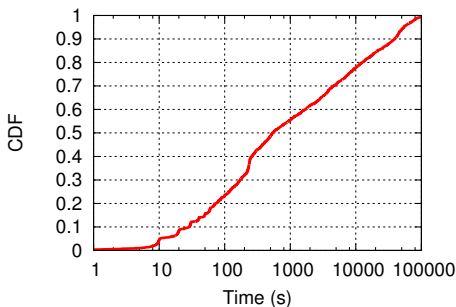


# Methodology

- 20 users, 342 apps total, over almost 2 years
- Collect unencrypted packet payloads, user input events, packet-process mappings, foreground/background process codes
- All data anonymized, study IRB-approved
- Highly diverse set of top apps among users, but some in common (e.g. facebook)

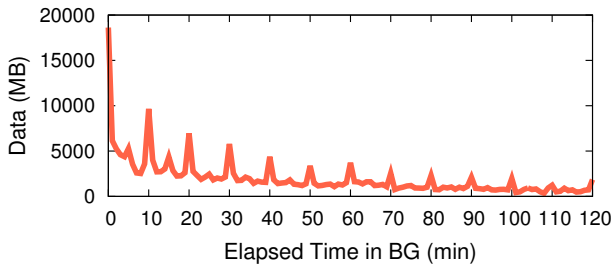
# Foreground requests not terminated

- Majority of Chrome's traffic occurs in the background!
- Root cause: requests started in the foreground keep running
- A popular local website sends network requests every 2 seconds
  - Can continue for hours, even after the app is minimized



Duration traffic sent/received after Chrome sent to background.

## Foreground requests not terminated



84% of apps send 80% of background traffic within 60s of minimizing the app

## Periodic background traffic

For many apps described in prior work, this has gotten a lot better. For example<sup>4</sup>:

App	Beginning	End
Pandora, Facebook	every 1 minute in 2012 <sup>5</sup>	1/ hour
Gmail	Every 30 minutes	Highly varying intervals, as needed?
Go Weather	5 minutes	40 minutes

Update frequencies

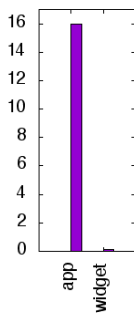
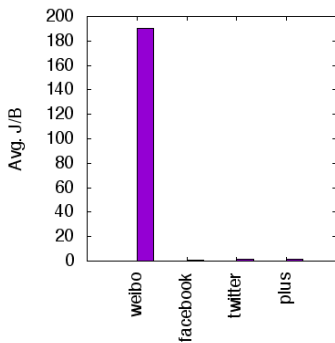
Is the problem solved?

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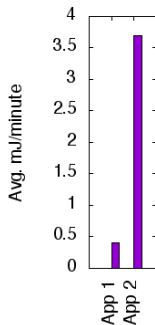
<sup>4</sup>See the paper for more details

<sup>5</sup>Qian et al, WWW '12

## Periodic background traffic



Weather app



Podcast apps

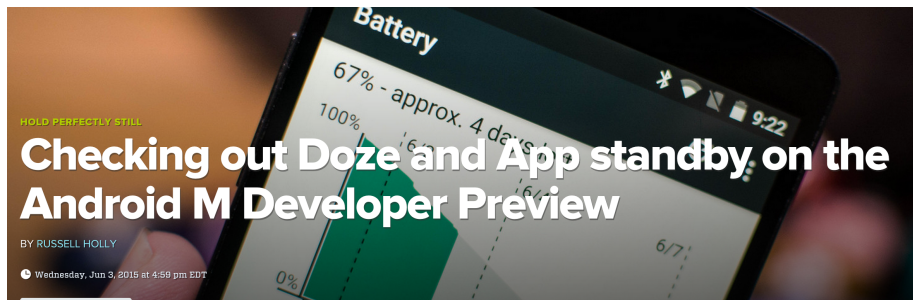
Getting it consistently right, every time, probably won't happen

## Unused background traffic

- We observed background traffic is sometimes present even for apps a user rarely uses
- What if we try something really simple like killing an app after its unused for 3 consecutive days?

	<i>Plus</i>	<i>Weibo</i>	<i>Maps</i>	<i>ESPN</i>	<i>Accuweather</i>	<i>Skype</i>
A: % days with only background traffic	42	83	70	13	43	62
B: Max consecutive background days	40	24	84	10	18	49
C: Disable after 3 days: avg.% energy reduction	14	54	39	6.2	22	45

## Unused background traffic



After our paper was submitted, Google announces OS support for managing background traffic and reducing power consumption...

## Conclusions and recommendations:

- Apps should be aware of their foreground/background state and be sure to manage network traffic appropriately
- Major apps reducing periodicity of network traffic + using improved push services has been helpful
  - Now to get everyone else on board!
- OS-level management of background traffic would be very valuable
  - There are millions of apps, we cant expect every developer to get it right



Thank you!

Any questions?