Characterizing and Modeling User Activity on Smartphones

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Overview

Smartphones exist largely to serve the user. They provide services as demanded, such as communication and media playback/browsing, and act as a personal gateway to the internet. From a designer's perspective, the importance of a single component, or a single application, may be difficult to determine, since the actual workload is defined by end users.

To better understand how people use these new devices, we developed and distributed a logging application called NU JamLogger.

- Android G1 Smartphone users downloaded app
- Logs collected anonymously over 6 months
- Data from 25 most-logged users considered
- Represents over 1300 days of logged phone usage

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1242164916892 : Logger_Version v1.0-9 -21600000
1242164916895 : Logger_Version v1.0-9 -21600000
1242164916967 : CPU_Freq 383
1242164916974 : CPU_Utilization 51.36 37.16 14.20
1242164917018 : Battery 3882 2
1242164917058 : Load_Avg 2.31 2.81 2.63 2 192 453
1242164918084 : Cell_Traffic 0 89
1242164918091 : CPU_Freq 383
1242164918098 : CPU_Utilization 49.11 45.54 3.57
1242164918140 : Battery 3867 2
1242164918145 : Load_Avg 2.29 2.80 2.63 1 192 453
1242164918581 : Phone_Data_Activity_Out
1242164918582 : Phone_Data_Activity_None
1242164919270 : Cell_Traffic 202 74
1242164919289 : CPU_Freq 383
1242164919295 : CPU_Utilization 18.33 12.50 5.83
1242164919331 : Battery 3832 2
1242164919336 : Load_Avg 2.29 2.80 2.63 1 192 453
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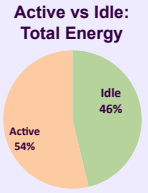
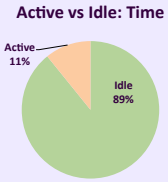
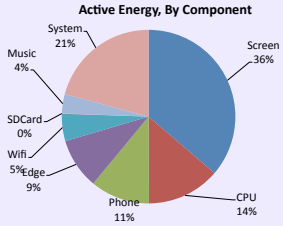
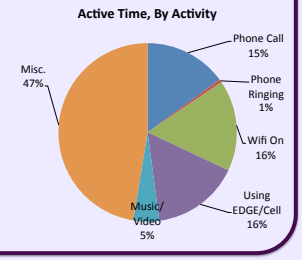
The Importance of Activity





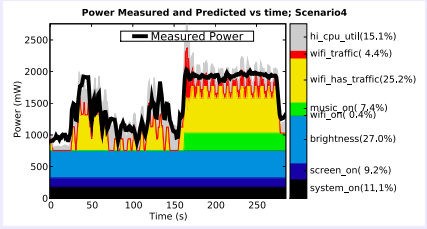
- A small amount of active time (11%) represents a large amount of energy consumed (54%)
- The display and CPU account for half of the active energy
  - The consumer OS does not support frequency scaling, and does not include display power management tools
  - Most users studied do not use downloadable power management tools and rarely adjust screen brightness manually



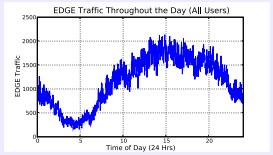


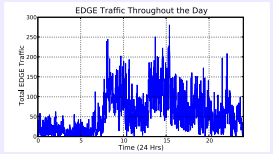
Power Measurement

- Power approximated from logs
  - Model built using Linear Regression on power measurements of the G1
  - Details described in previous work [1]



Traffic Patterns

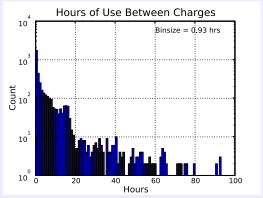


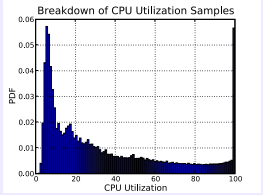


- There is a strong relationship between network traffic and time of day
- This holds for the aggregation of users (top), as well as individual users (bottom)
- Useful for network resource provisioning

Other Observations

- Users in the study tended to charge their battery every day
  - Top chart on right shows count of sessions (log scale) versus hours between charge (linear scale)
  - Most sessions between charges were less than 20 hours
  - In 20% of the sessions longer than 4 hours, the phones were used until the "low power" indicator was raised
- The CPU tended to be either very lowly utilized (< 10%) or completely utilized (100%)
  - Bottom chart shows PDF of CPU utilization samples





References:
[1] Alex Shye, Ben Scholbrock, Gokhan Memik. *Into the Wild: Studying Real User Activity Patterns to Guide Power Optimizations for Mobile Architectures*. In proceedings of the 42nd IEEE/ACM International Symposium on Microarchitecture (**MICRO**). New York, NY. December 12-16, 2009.