Understanding Smartphone Usage

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Motivation: How do people use their smartphones?

Many basic facts on smartphone usage are unknown:

1. How often does a user interact with the phone? How long is each interaction?
2. How many applications does a user run and how is her attention spread across them?
3. How much network traffic is generated?
4. What limits network performance on smartphones?

Why do these questions matter?

1. Assessing effectiveness of existing mechanisms to save energy and improve performance
2. Proposing new resource management mechanisms based on better understanding of usage
3. Guiding future smartphone hardware/software design

Datasets: Measured on the phones

Dataset1:

- 33 Android users with unlimited voice, text, and data plans
- Recorded screen events, call events, application interaction times, application network traffic
- 7-21 weeks of data per user (9 weeks average)

Dataset2:

- 222 Windows Mobile users with voice and unlimited data
- Start and end time of application invocations were recorded
- 8-22 weeks of data per users (16 weeks average)

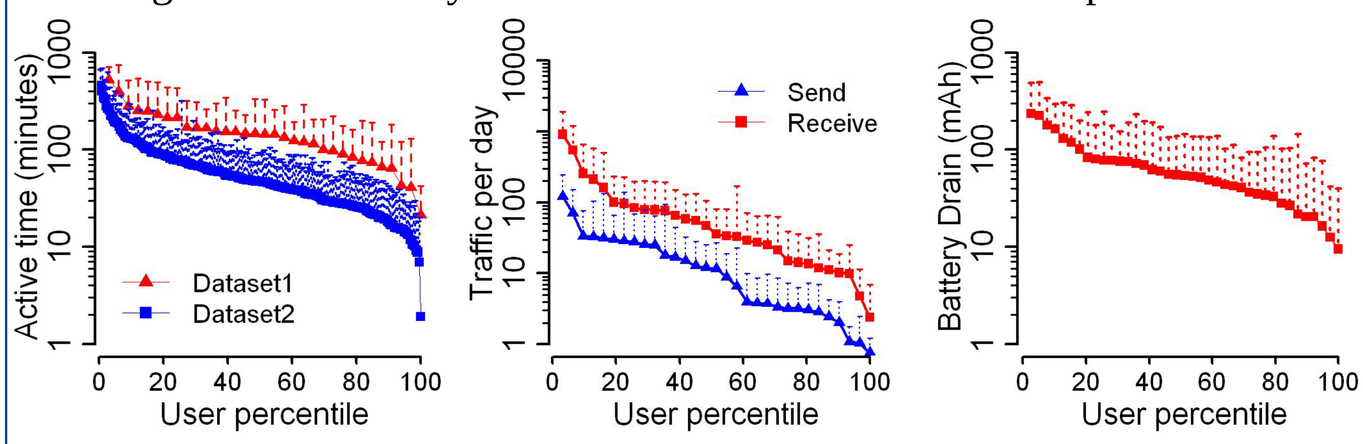
Dataset3:

- 8 Windows Mobile and 2 Android users with unlimited voice and data plans
- Packet level traces, including link layer headers were logged
- 4-12 weeks of data per user (7 weeks average)

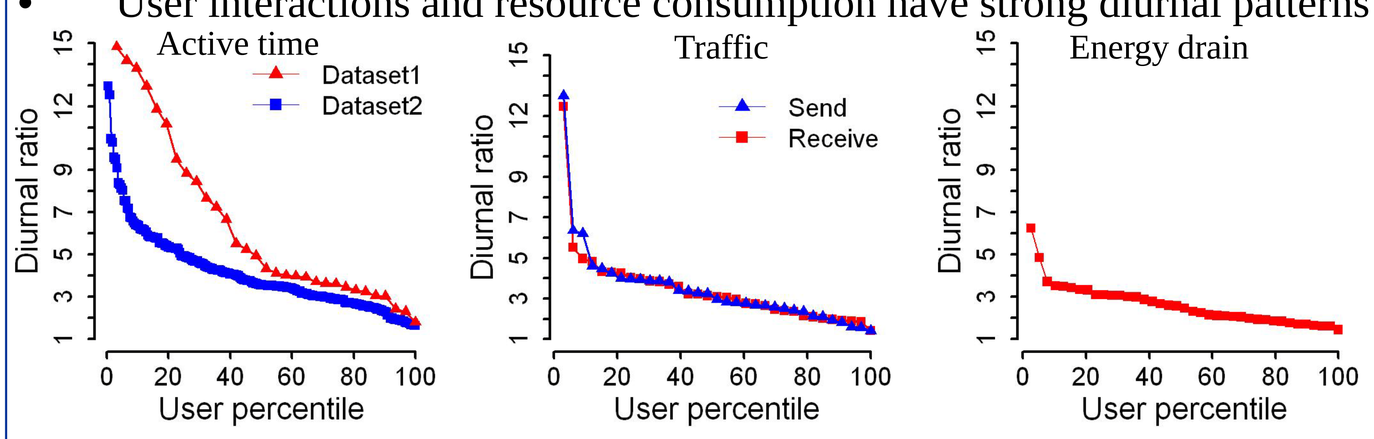
Diversity: Quantitative diversity among users

Interactions and resource consumption:

- Significant diversity in interaction and resource consumption

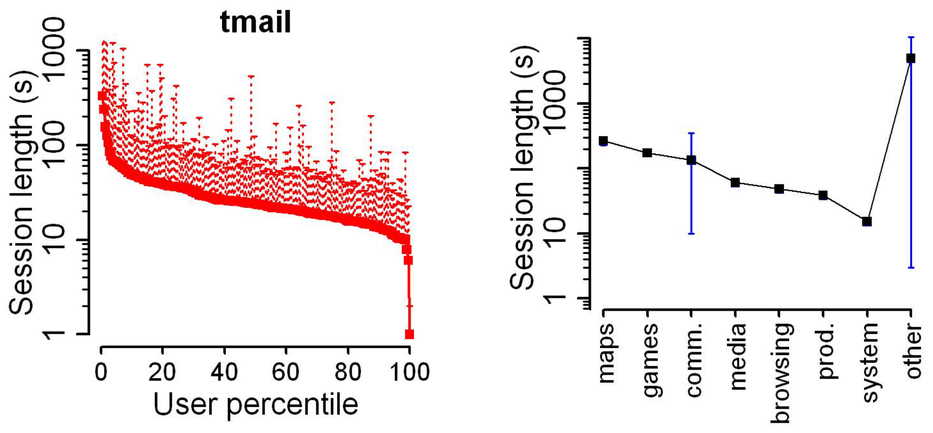


- User interactions and resource consumption have strong diurnal patterns

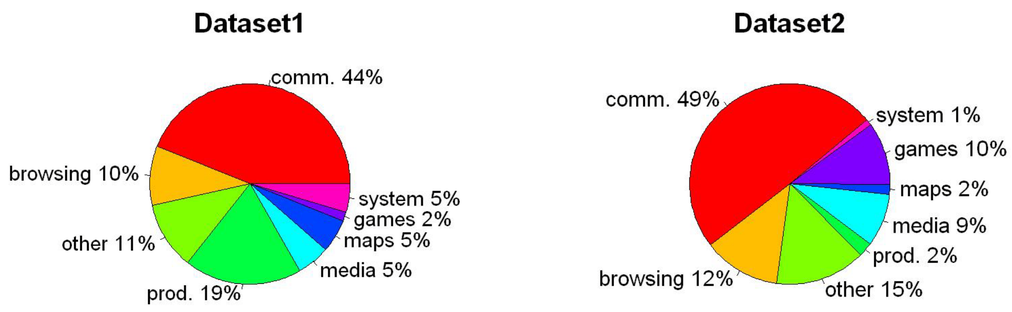


Applications:

- Close to 90% of sessions include only one application.

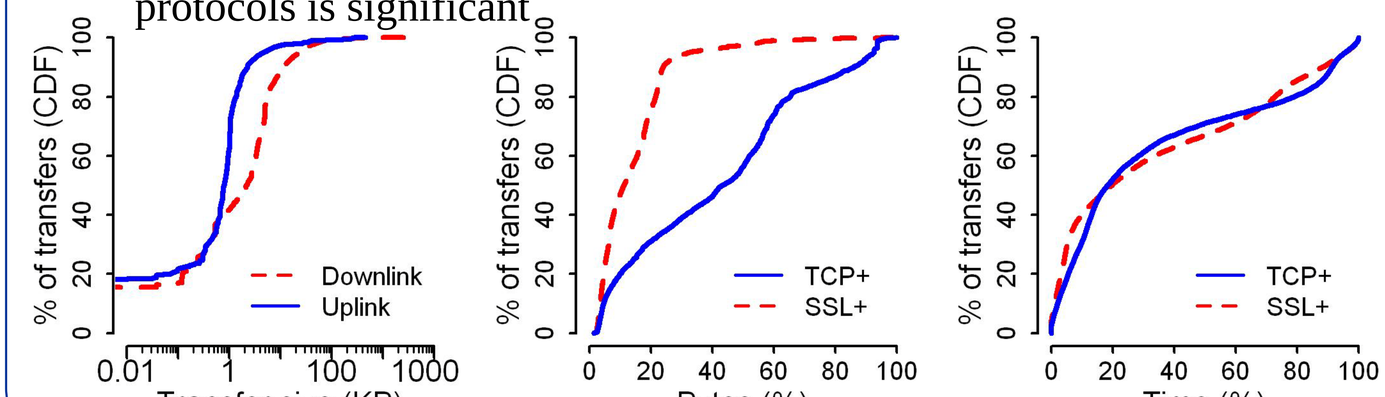


- Smartphones are primarily communication devices



Network performance

- Most of the transfers are small therefore overhead of lower layer protocols is significant

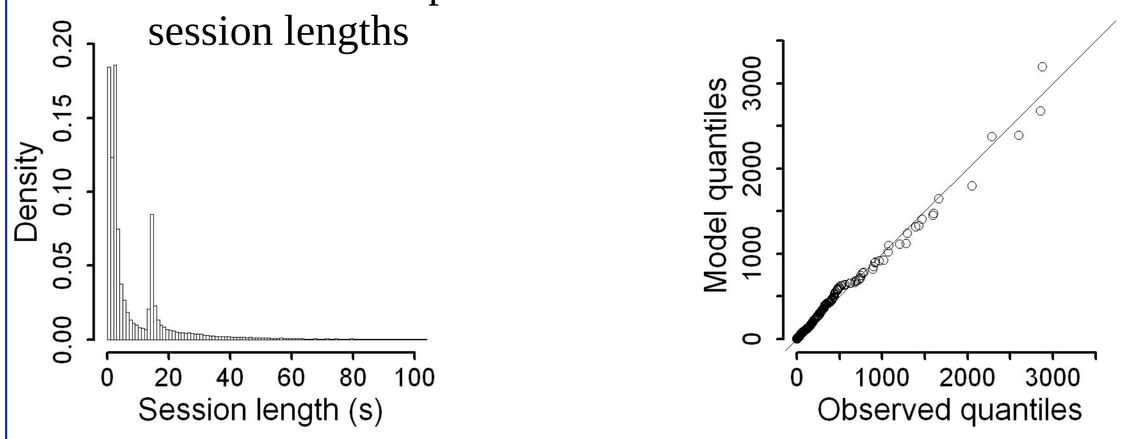


- Most TCP connections are limited by loss and server send windows

Limit	Uplink (%)	Downlink (%)
Packet loss	81.0	61.5
Sender window	4.1	27.4
Receiver window	6.8	3.4
Bandwidth	5.1	2.9
Transport	0.7	0.0
Unknown	2.4	4.8

Towards Modeling Usage: Qualitative similarities among users

- A mixture of Exponential and shifted Pareto distributions explains session lengths



$$r.Exp(\lambda) + (1-r).Pareto(x_m, \alpha)$$

- For each user application popularity drops exponentially