



UNIVERSITY OF
CAMBRIDGE

ErdOS

Enabling opportunistic resources sharing in
mobile Operating Systems

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Motivation

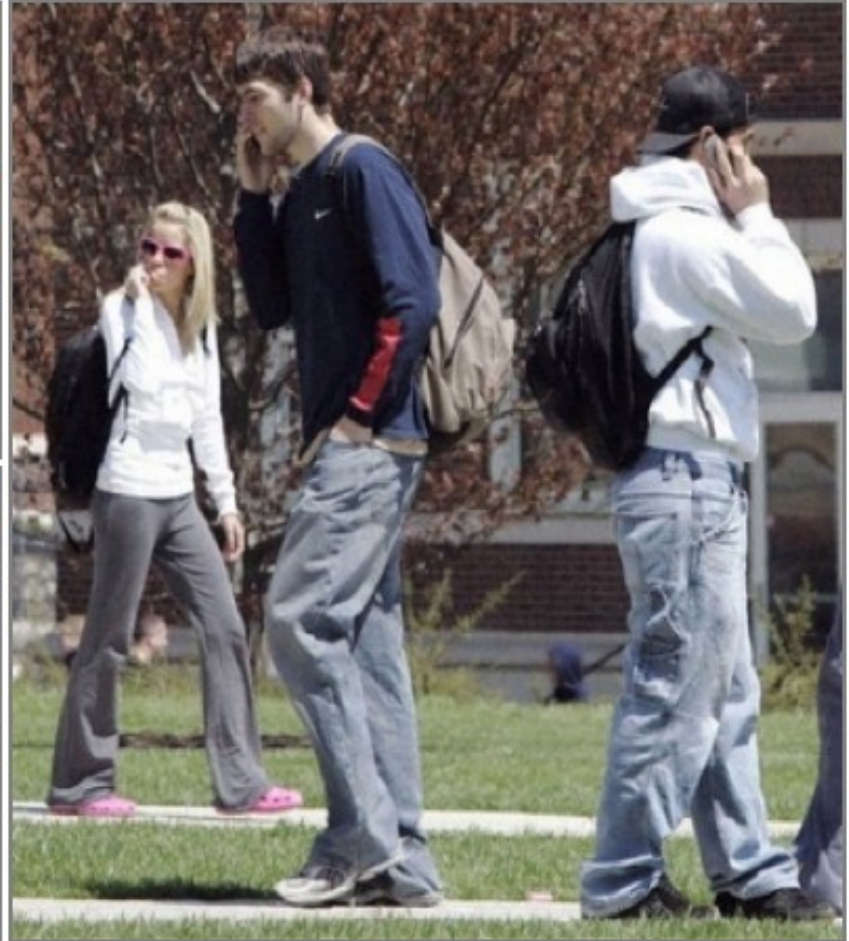


Motivation

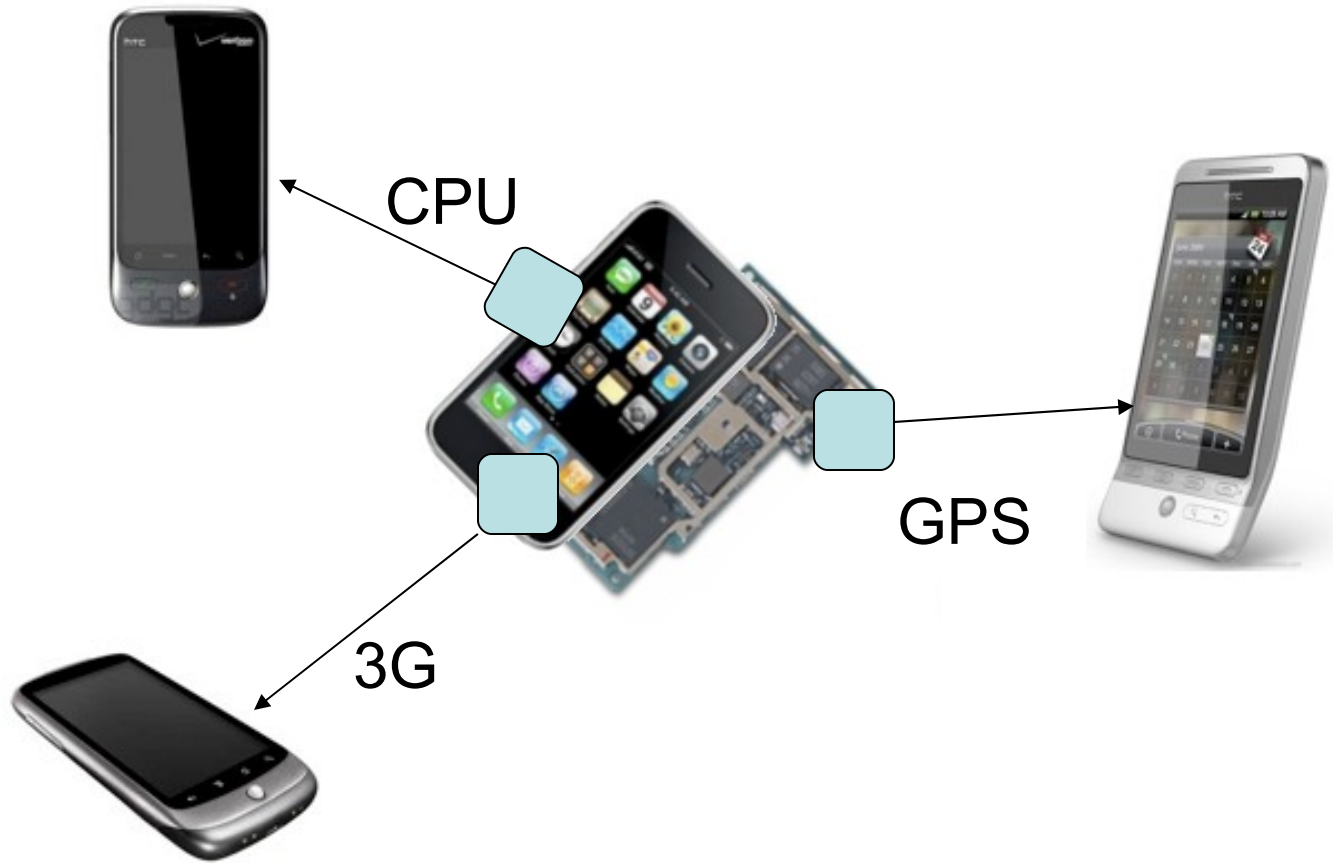


“Energy is still the main limitation in mobile systems”

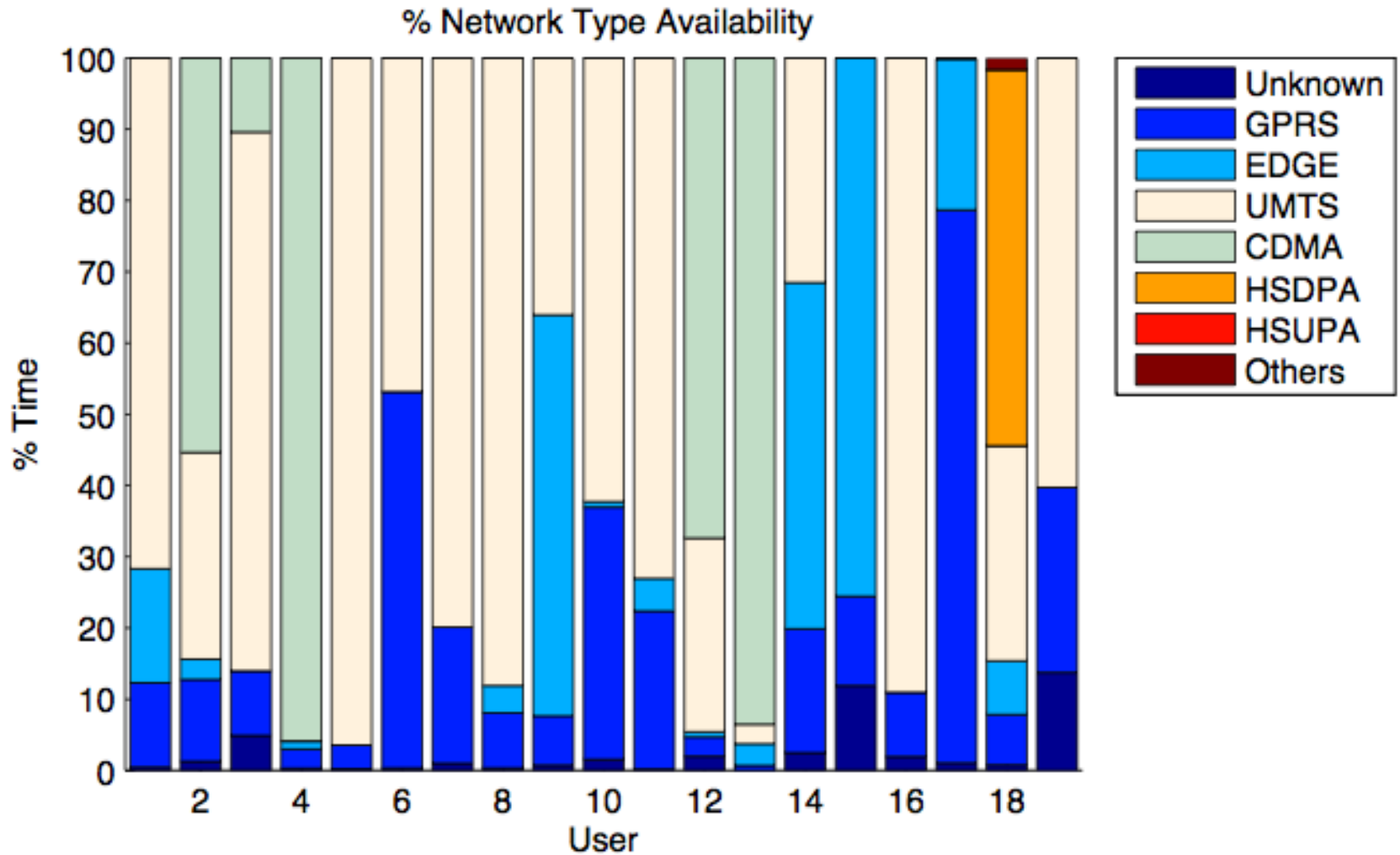
Motivation



Motivation



Motivation



Motivation

Network Type



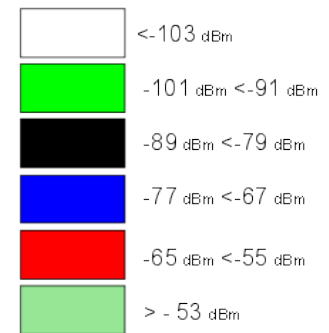
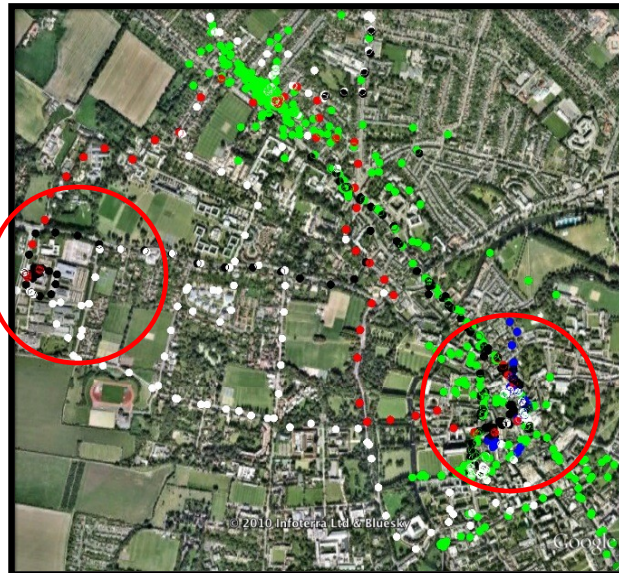
Operator 1



Operator 2



Signal Strength



Motivation

Why not sharing mobile resources opportunistically with other users?



ErdOS

ErdOS

Social energy-aware OS

Access co-located resources opportunistically

Customised proactive resources management

Social connections provide access control

Dataset Description

- 18 Android OS users
- 1-2 weeks
- Resources Tracker



“Exhausting battery statistics”. Mobiheld 2010

Dataset Description

Battery Statistics

Current
Voltage
Remaining Capacity
Temperature
Charging Status

O.S. Info

CPU
Process
Memory

Time
Location (Cell ID)
Roaming
Screen State

Contextual

Airplane Mode
Telephony State
Cellular Network Type
Cellular Network State
WiFi State
Bluetooth State
GPS State
Traffic

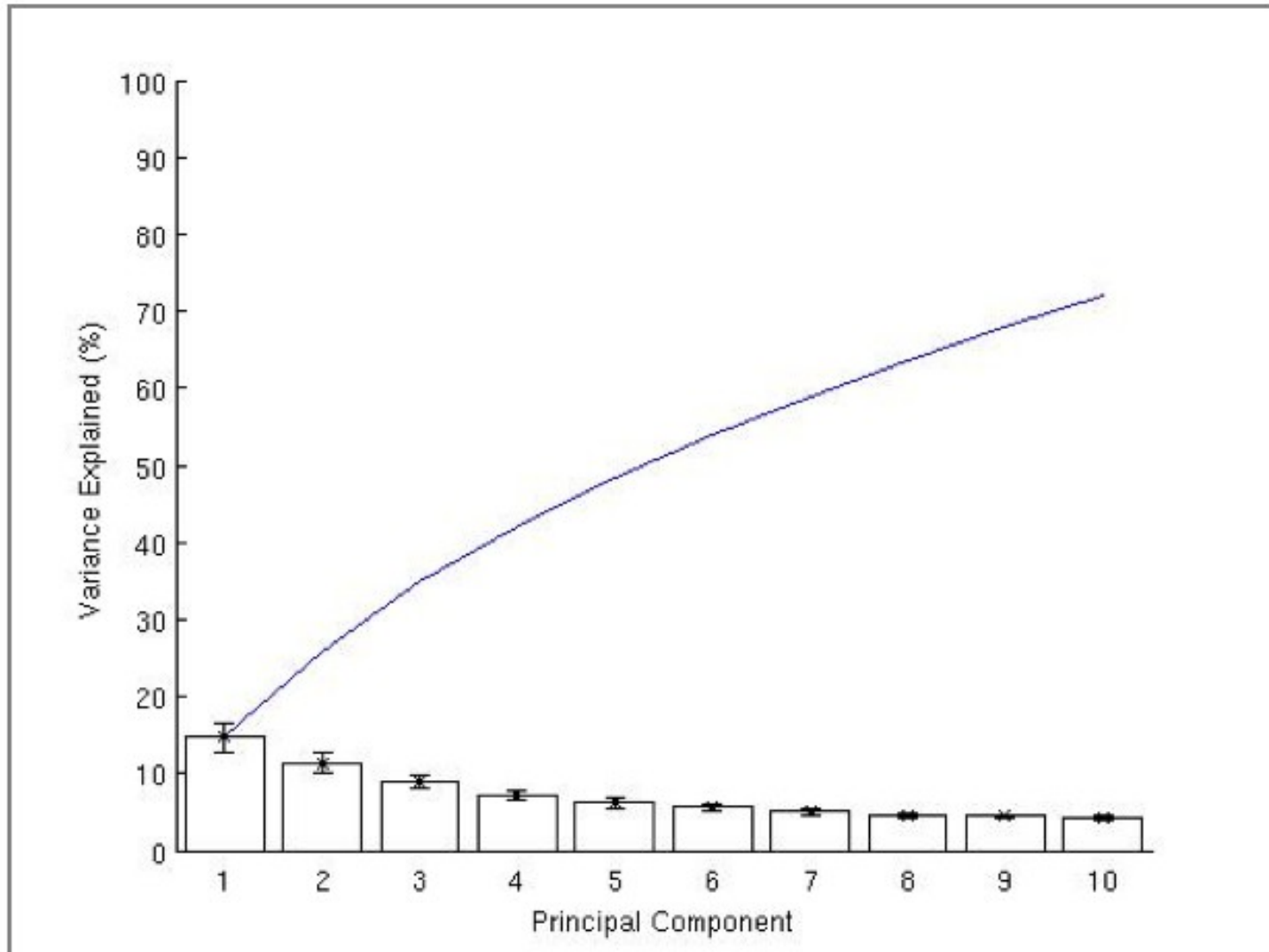
Network & Telephony

Usage Analysis Tools

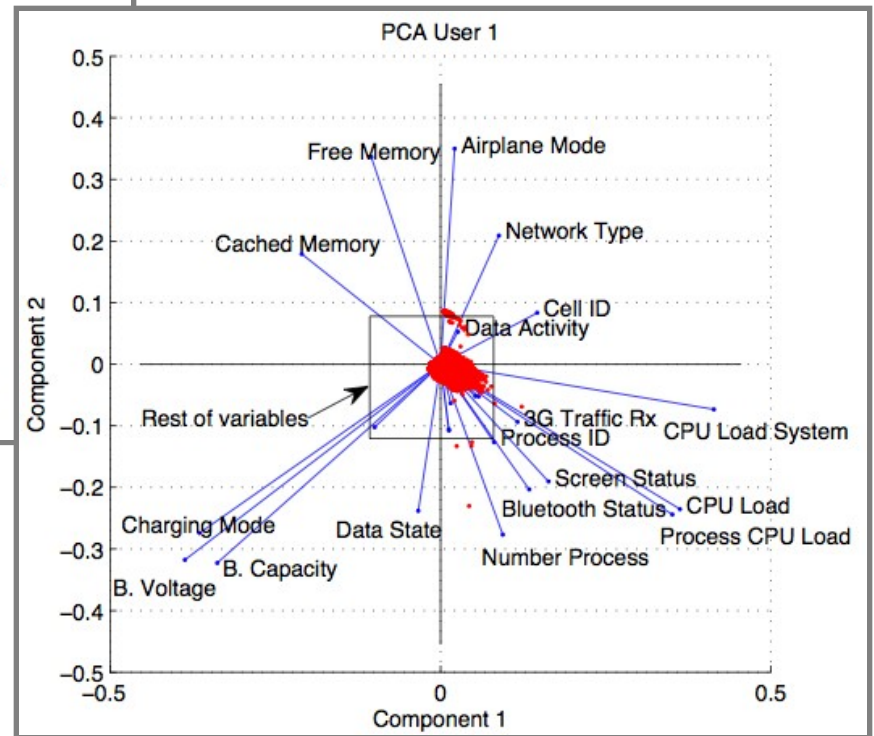
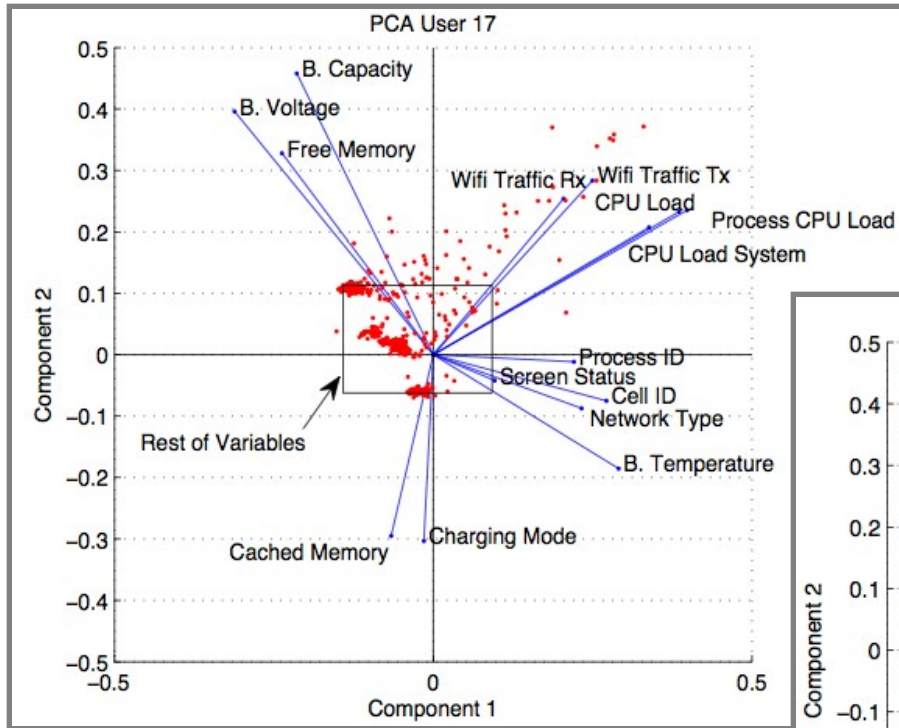
Principal Component Analysis (PCA):

Transforms a number of possibly correlated variables into a smaller number of uncorrelated ones called Principal Components

Principal Component Analysis

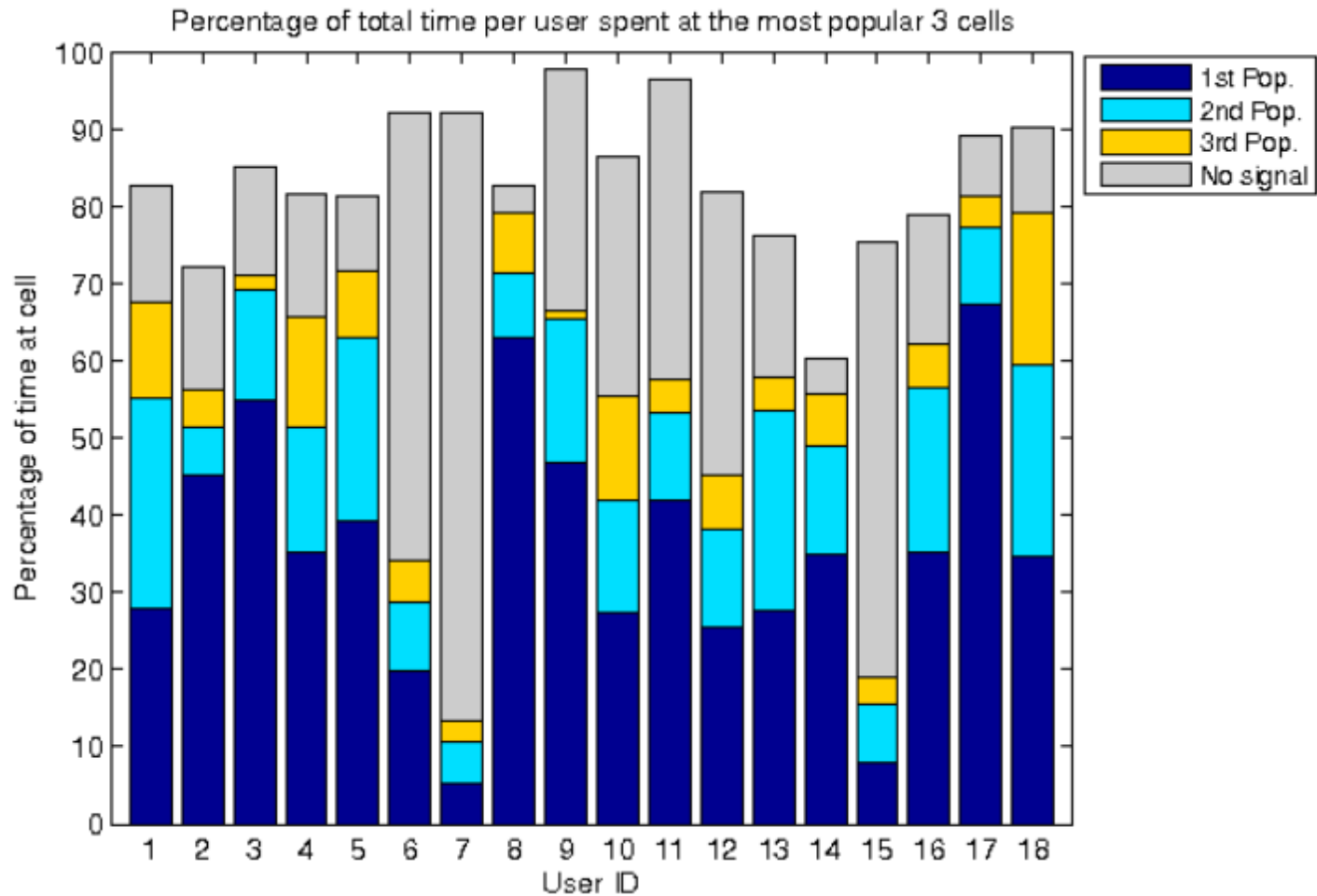


Principal Component Analysis

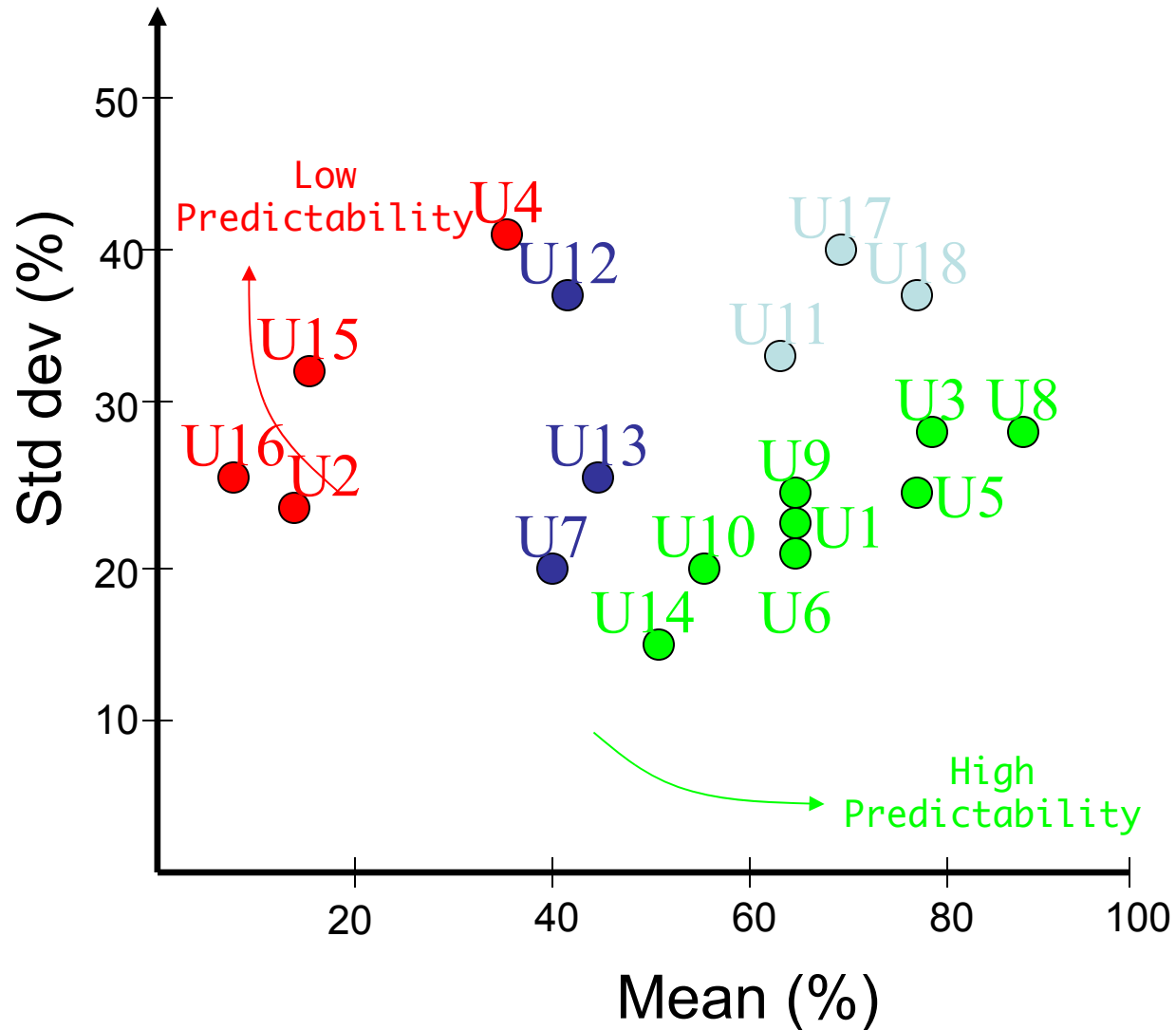




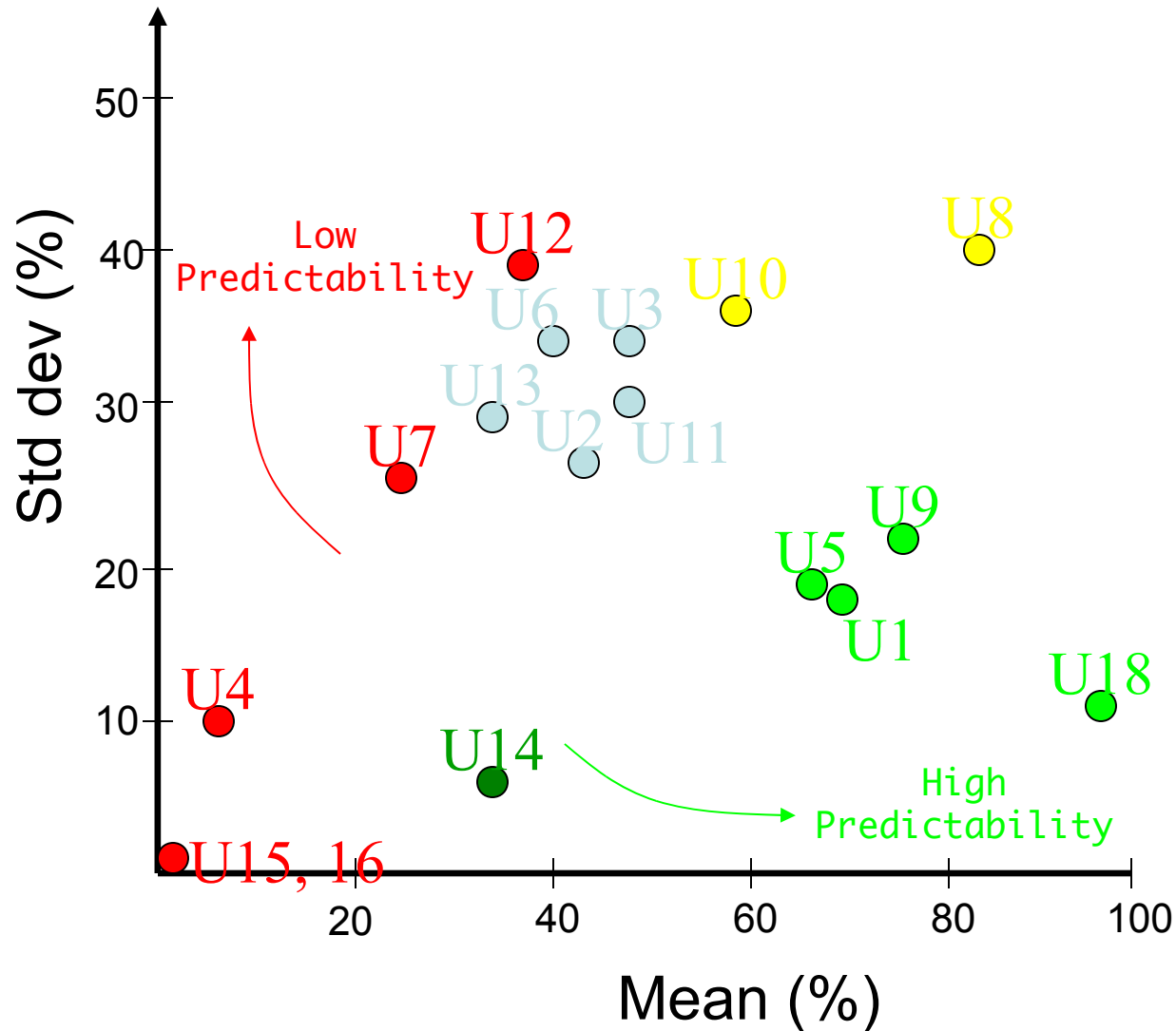
Context importance



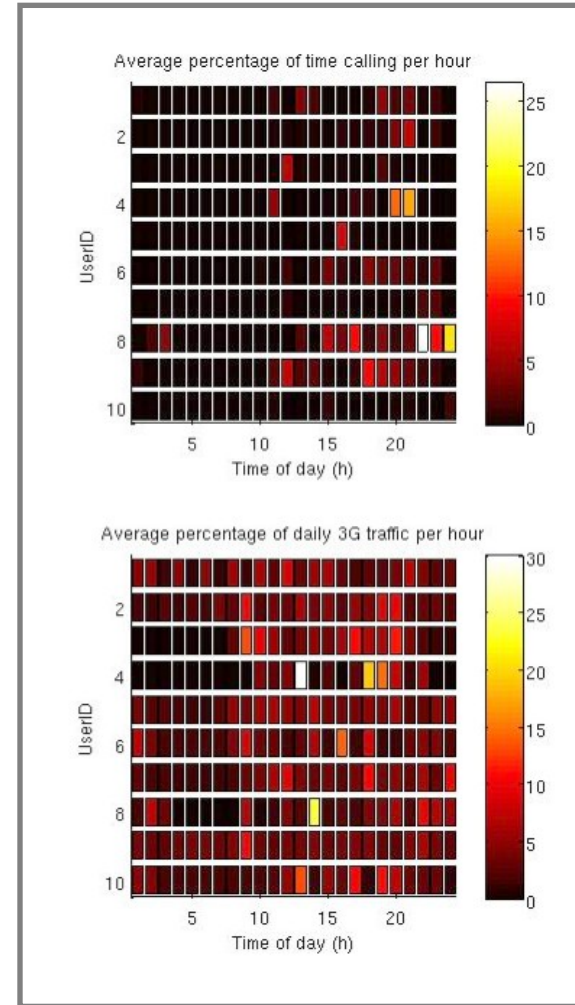
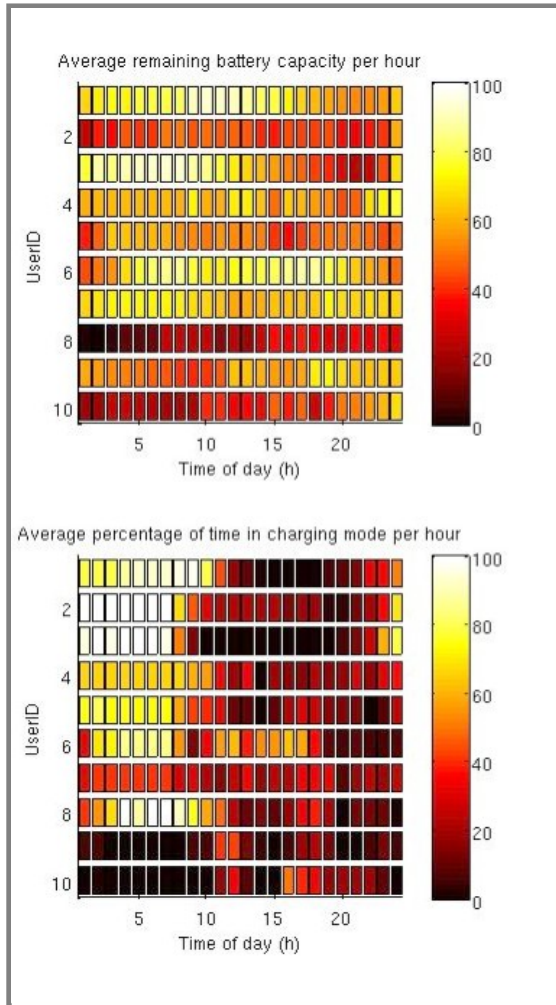
Spatial context: Screen usage



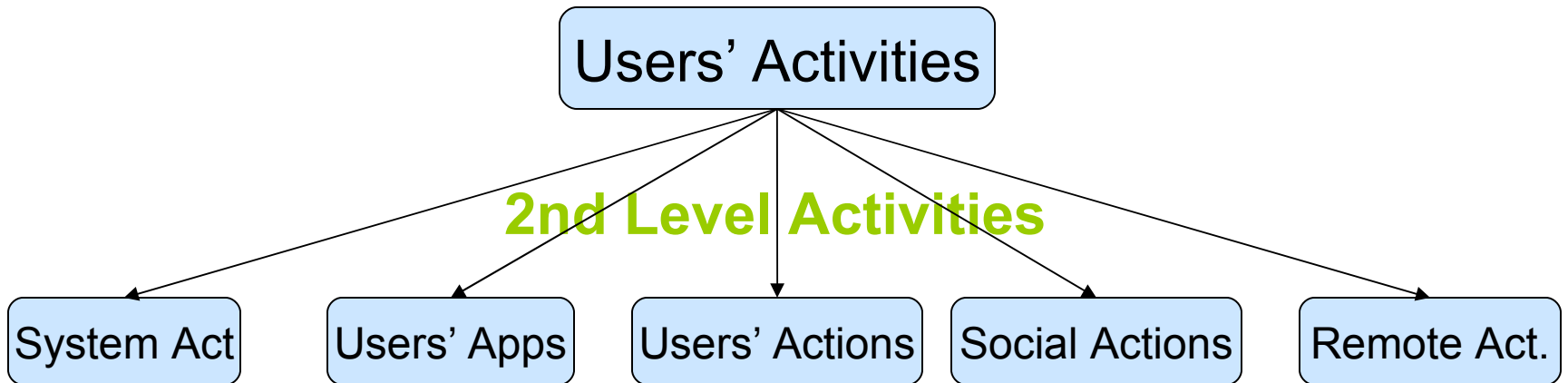
Spatial context: Cellular traffic



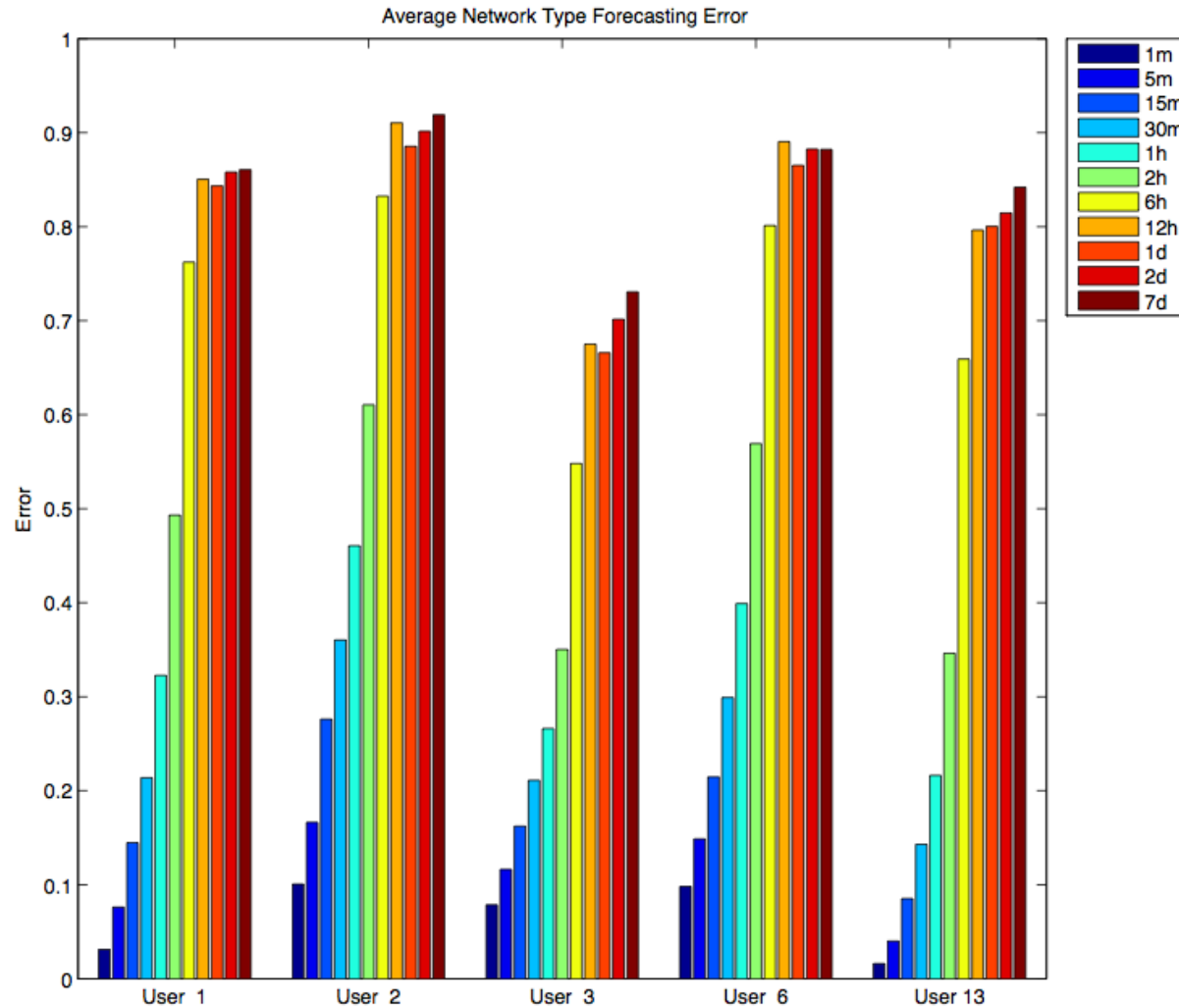
Temporal context: Daily usage



Resources Allocations: Activities



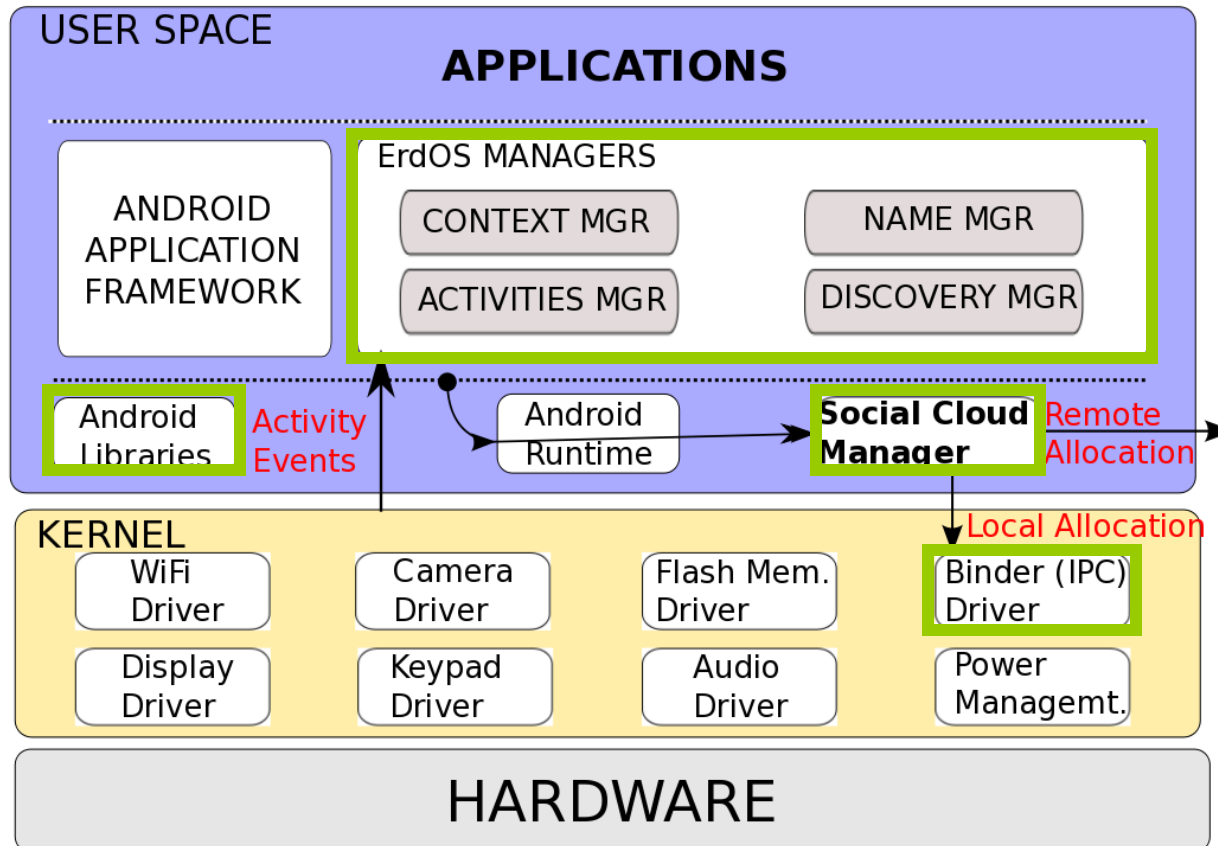
Forecasting Resources State



Access Control

- Social links facilitate access control and security
 - Unix-like permissions are made automatically based on users' social networks
 - Proximity reduces privacy and security issues
 - OSNs can help to exchange public keys

Architecture



Related work

- Resource allocation and energy-aware OS
 - **ECOSystem**. Zeng et al. [ACM ASPLOS](#), 2002
 - **Quanto**. Stoica et al. [USENIX](#) 2008
 - **CinderOS**. Rumble et al. [MOBIHELD](#) 2009

- Mobile usage and energy demand
 - Falaki et al. [ACM Mobisys](#) 2010
 - Oliver, [ACM HotPlanet](#) 2010
 - Balasubramanian et al. [ACM IMC](#) 2010
 - Rice et al. [ACM PerCOM](#) 2010

Conclusions

- Energy is a primary target for optimization in mobile handsets
 - Benefits in QoS and energy savings by accessing resources opportunistically
 - Social links can be used for access control policies
- Applications and users' behavior generate complex dynamics and interdependencies among resources
 - Energy allocation and resources control must be customized to each user and handset
 - Pro-active resources management aided by contextual information

Future Work

- Finishing implementation as an Android OS extension
 - Performance/Scalability evaluation
- Demonstrate benefits of sharing different resources (Cellular Nets, GPS, CPU)
- Resources Discovery Protocols
- Research on lighter forecasting techniques
 - Cloud Computing?
- Security evaluation
- Incentive schemes?



That's all Folks!

Questions?

Thanks!

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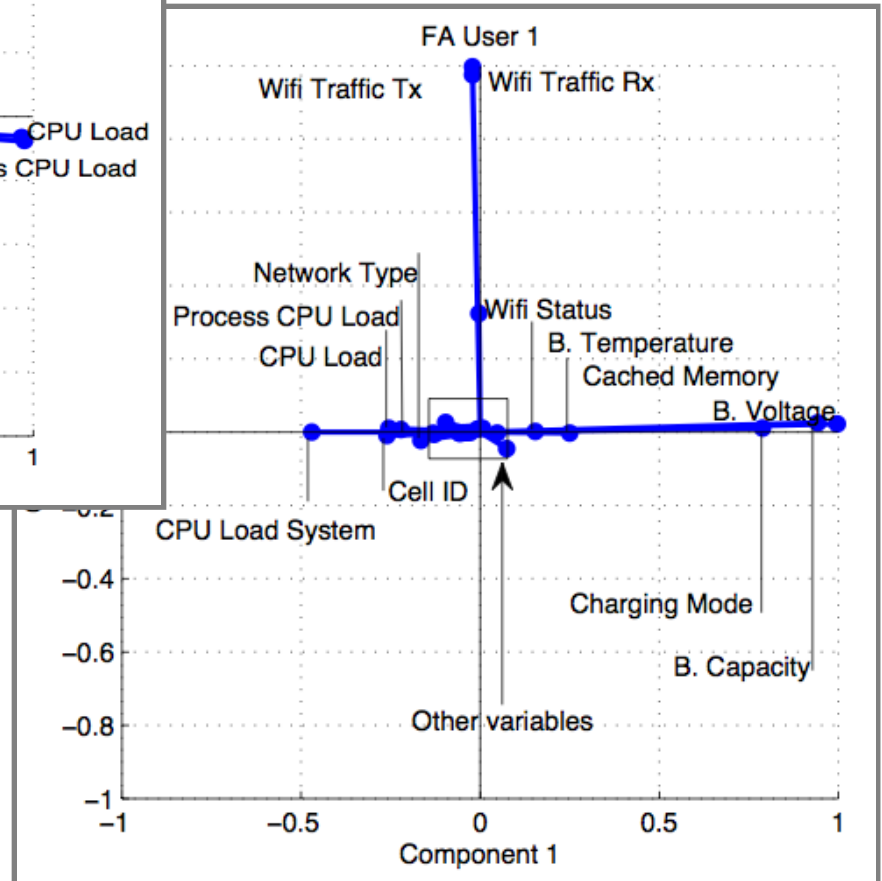
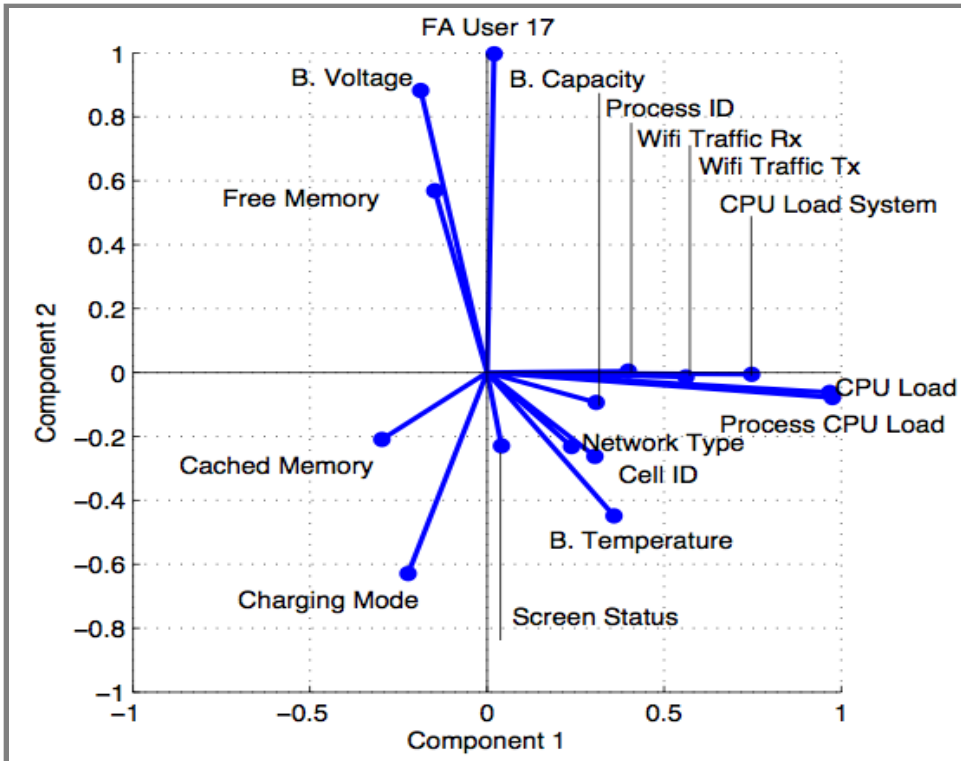
<http://www.cl.cam.ac.uk/~nv240/erdos.html>

Usage Analysis - Tools

Factor Analysis:

Describes variability among observed variables in terms of fewer unobserved variables called factors

Factor Analysis



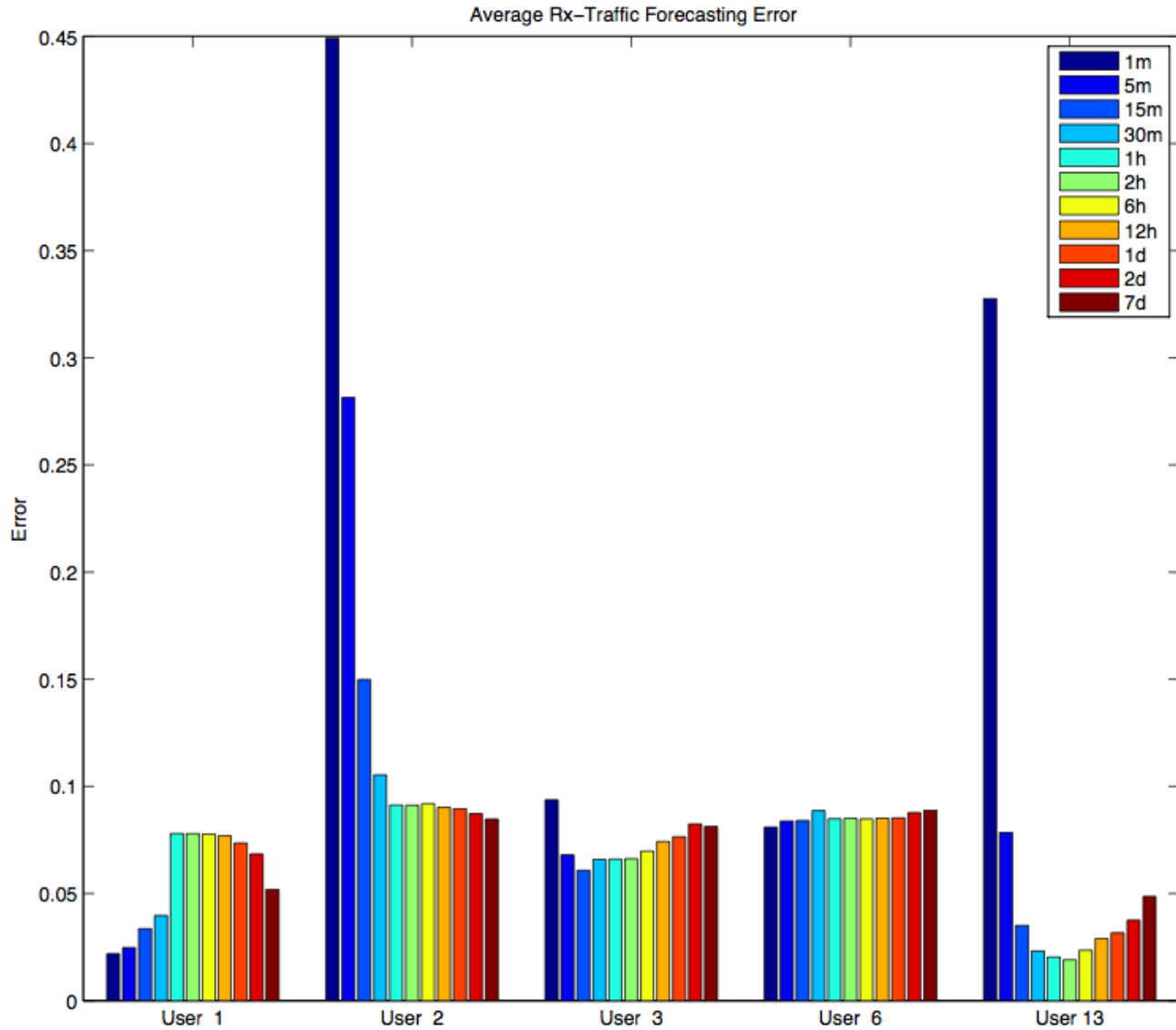
Previous energy-aware OS

- **ECOSystem** General Purpose, 2002
- **Quanto** Sensors, 2008
- **Cinder** Mobile phones, 2009

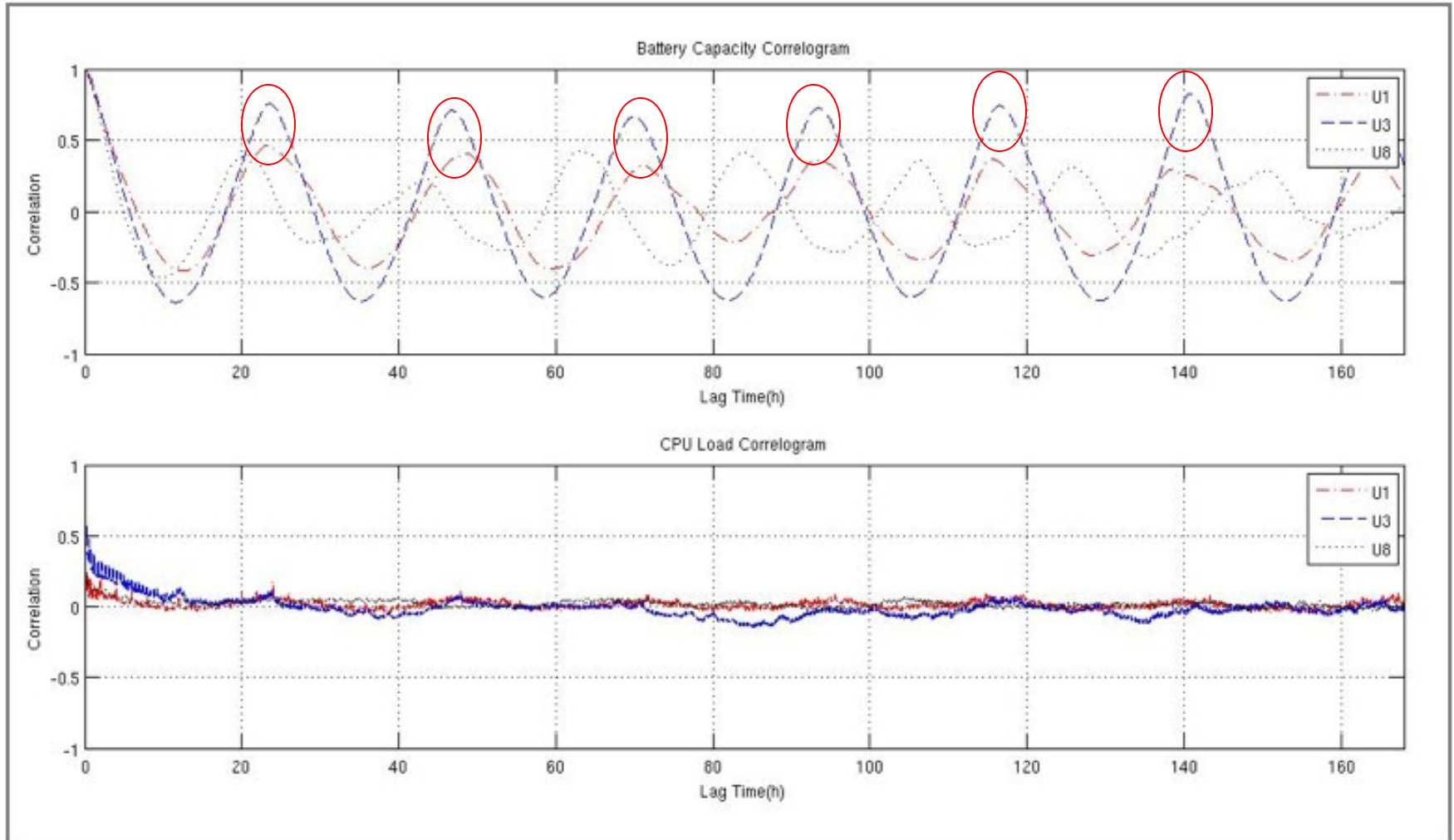
Main problems:

- Sampling technique
- Energy allocation based on battery capacity/discharging rate or offline measurements
 - Inaccurate indicator
- Mobile resources demand require a totally different approach:
 - Context matters (i.e. Signal strength)
 - Proactive resources management

Forecasting Downlink Traffic



Temporal context. Periodicity



Name Manager

