UNIVERSITY OF CAMBRIDGE

ErdOS

Enabling opportunistic resources sharing in mobile Operating Systems

Narseo Vallina-Rodríguez

Jon Crowcroft

University of Cambridge

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

http://nosql.mypopescu.com/post/1016320617/mongodb-is-web-scale

MongoDB.com, Feb 2011

Motivation

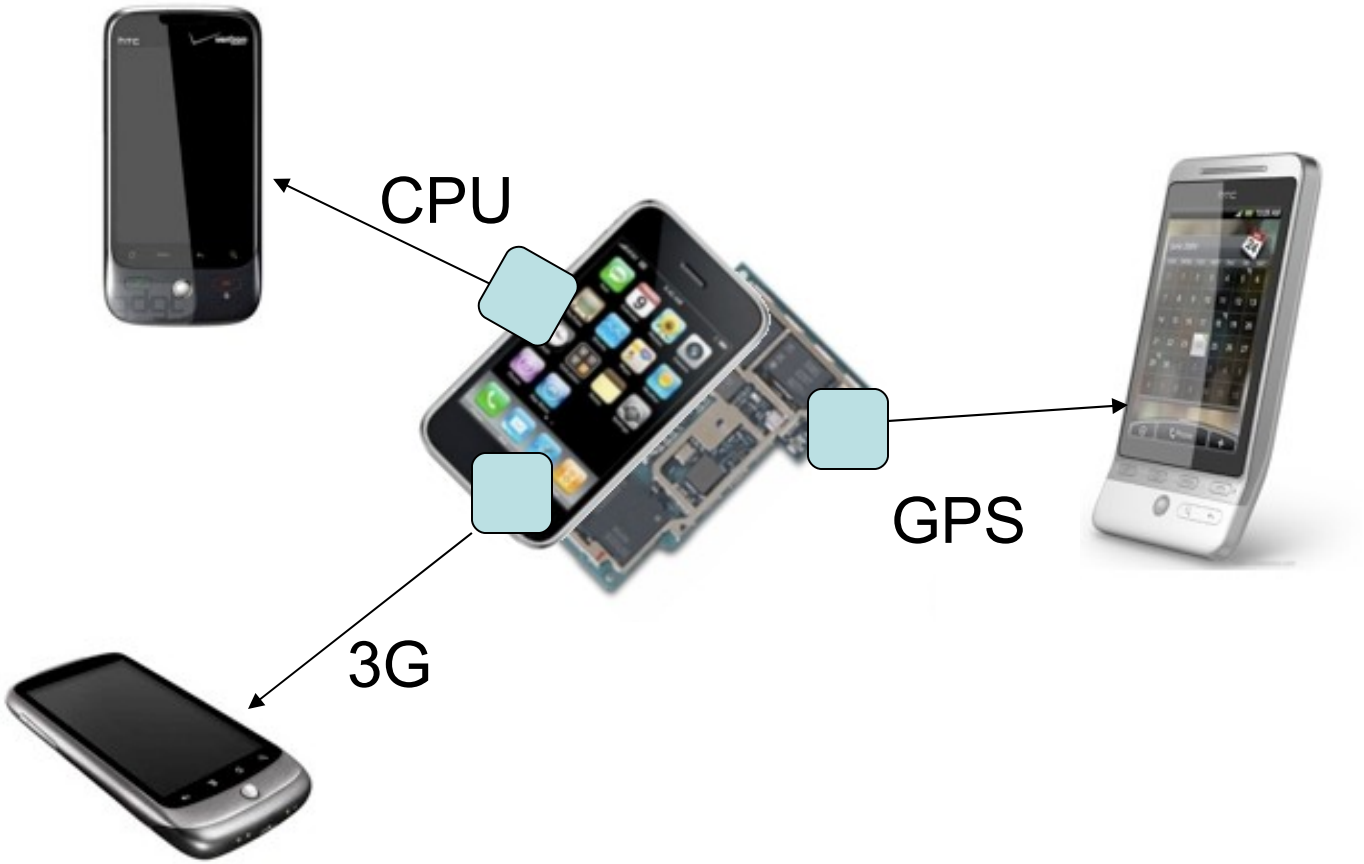

WiFi
Bluetooth
GSM/GPRS/3G
Camera
Accelerometer
GPS
CPU (1 GHz)
Storage (>2 GB)
11:03 PM
Google
Maps
Gallery
YouTube
Market
Phone
Gmail
Browser
Helping Grandpa Get His Tech On
New York Times
61°

Motivation

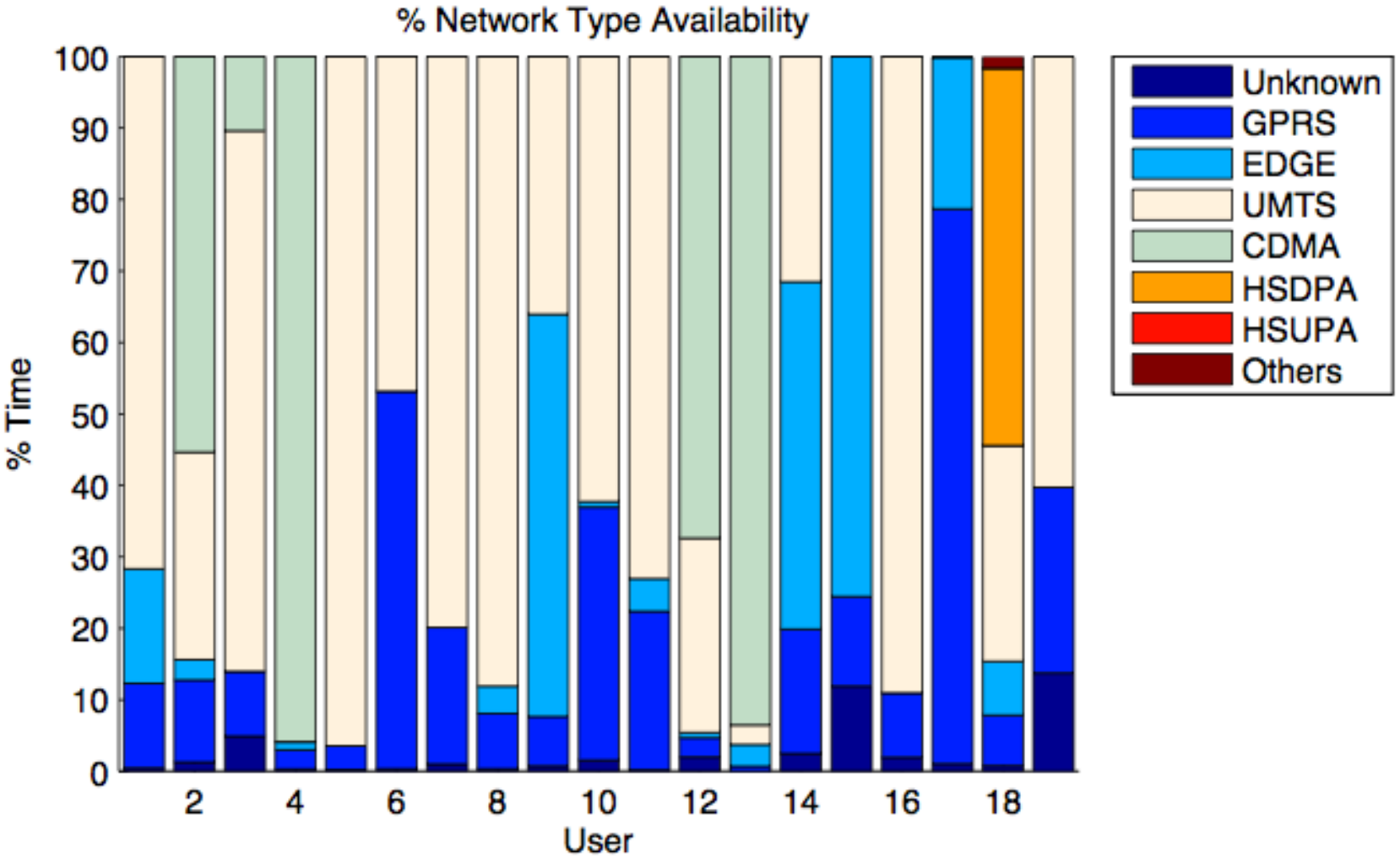
"Energy is still the main limitation in mobile systems"

Motivation

Motivation

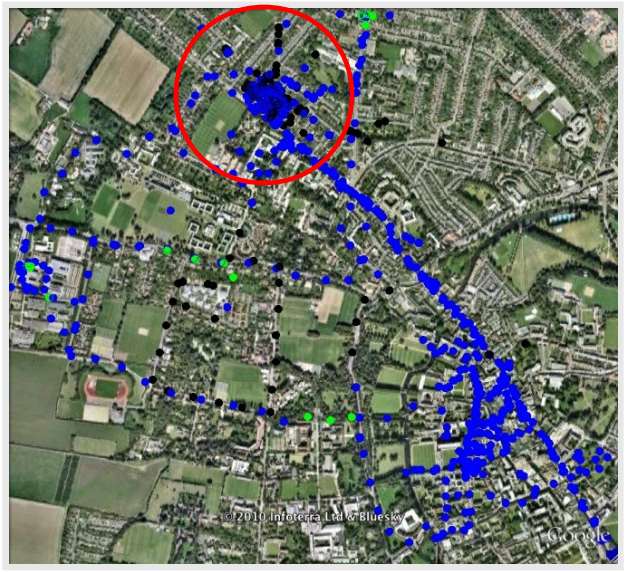


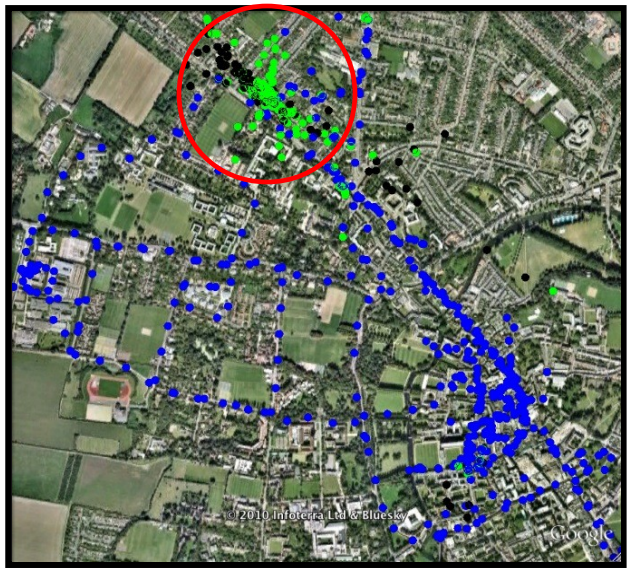
Motivation


% Network Type Availability
% Time
User
0
10
20
30
40
50
60
70
80
90
100
2
4
6
8
10
12
14
16
18
Unknown
GPRS
EDGE
UMTS
CDMA
HSDPA
HSUPA
Others

Motivation

Network Type





GPRS
EDGE
UMTS

Operator 1

Operator 2

Signal Strength

<-103 dBm
-101 dBm <-91 dBm
-89 dBm <-79 dBm
-77 dBm <-67 dBm
-65 dBm <-55 dBm
> - 53 dBm

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

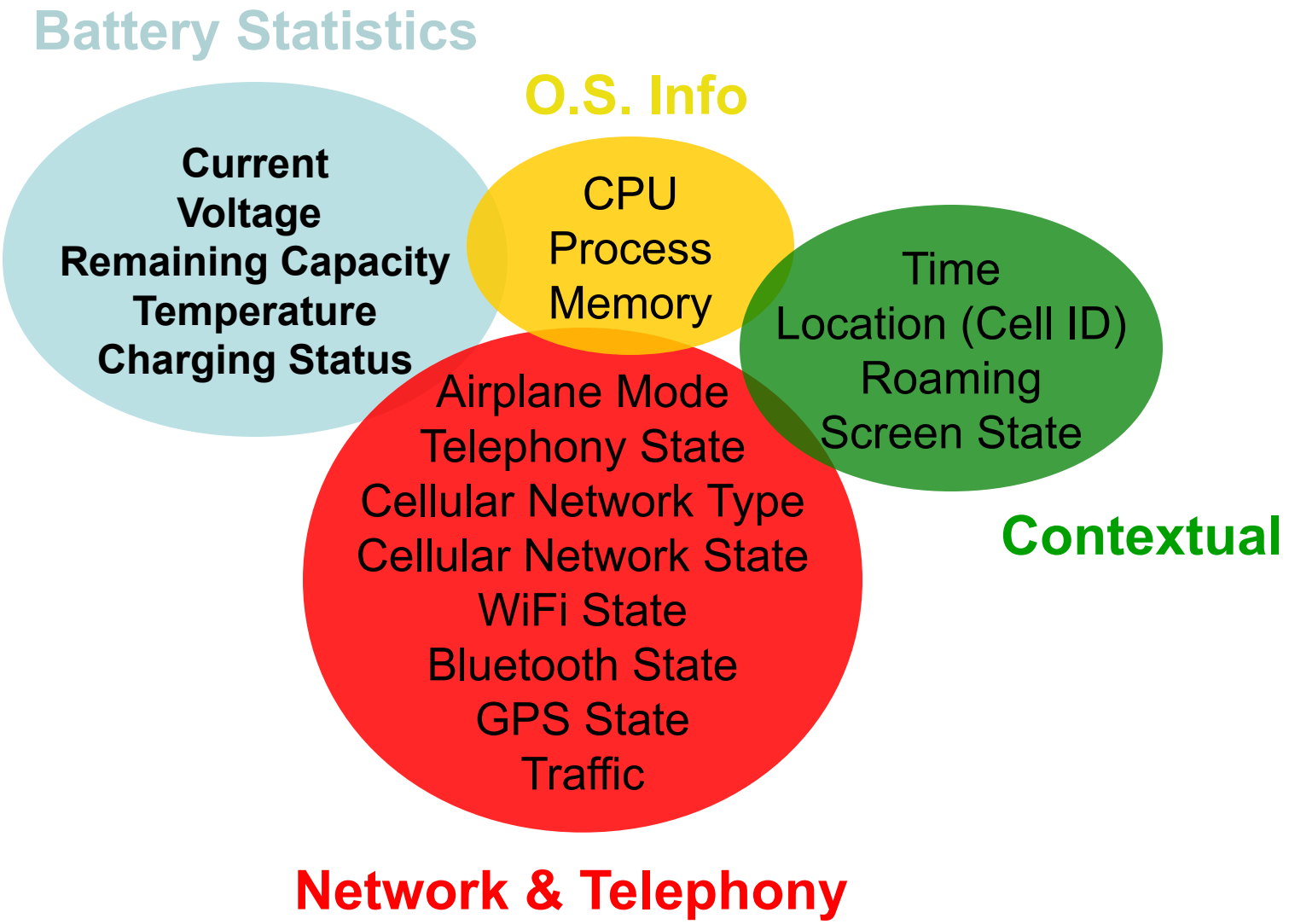
Social connections provide access control

Dataset Description

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

"Exhausting battery statistics". Mobiheld 2010

Dataset Description

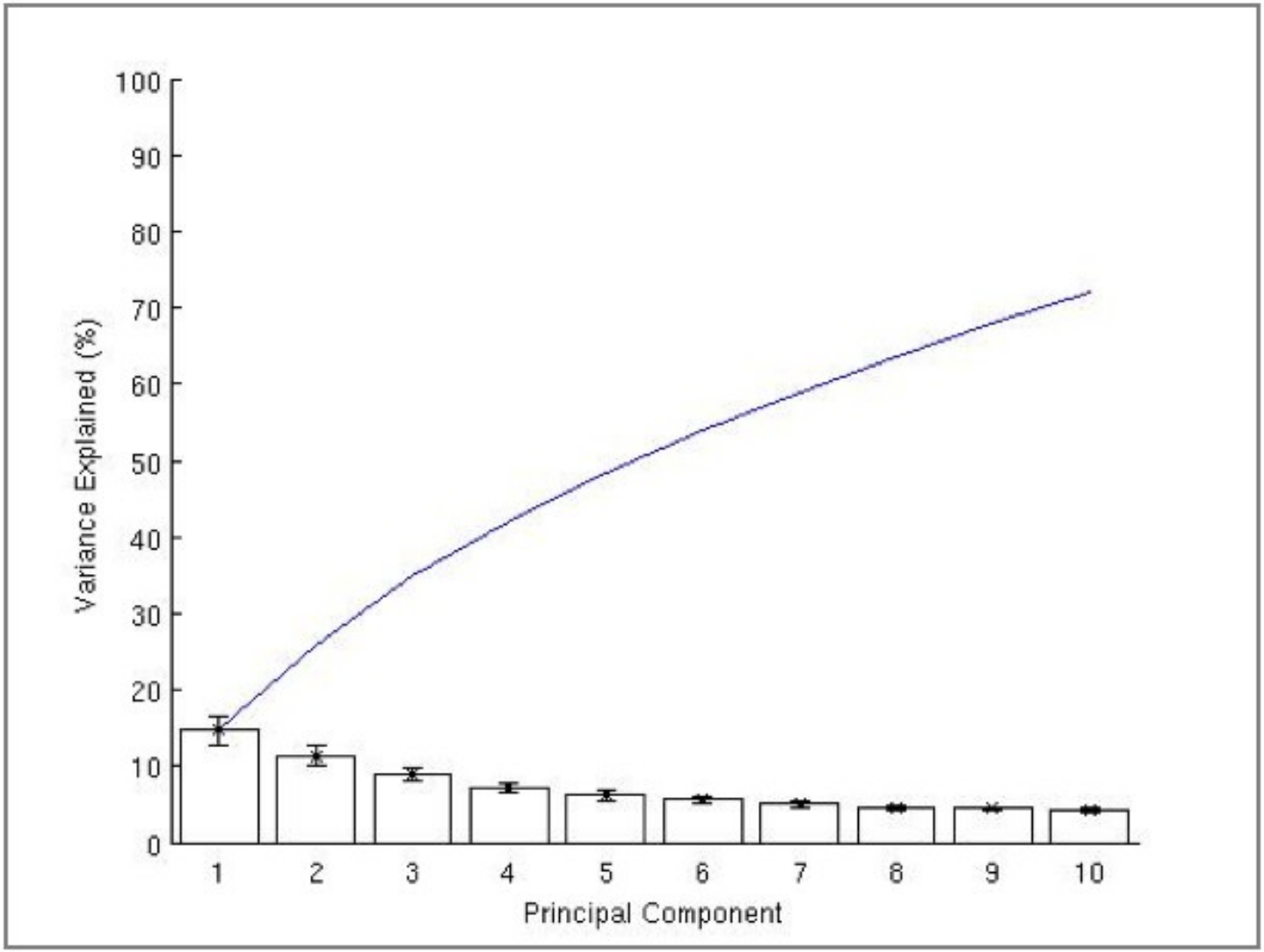


Usage Analysis Tools

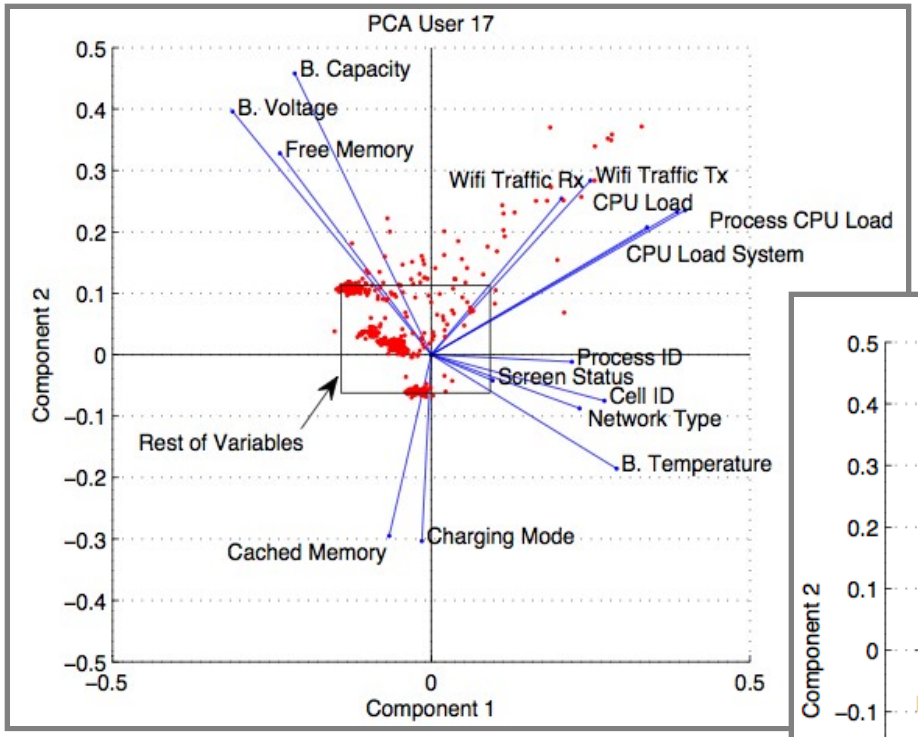
Principal Component Analisys (PCA):

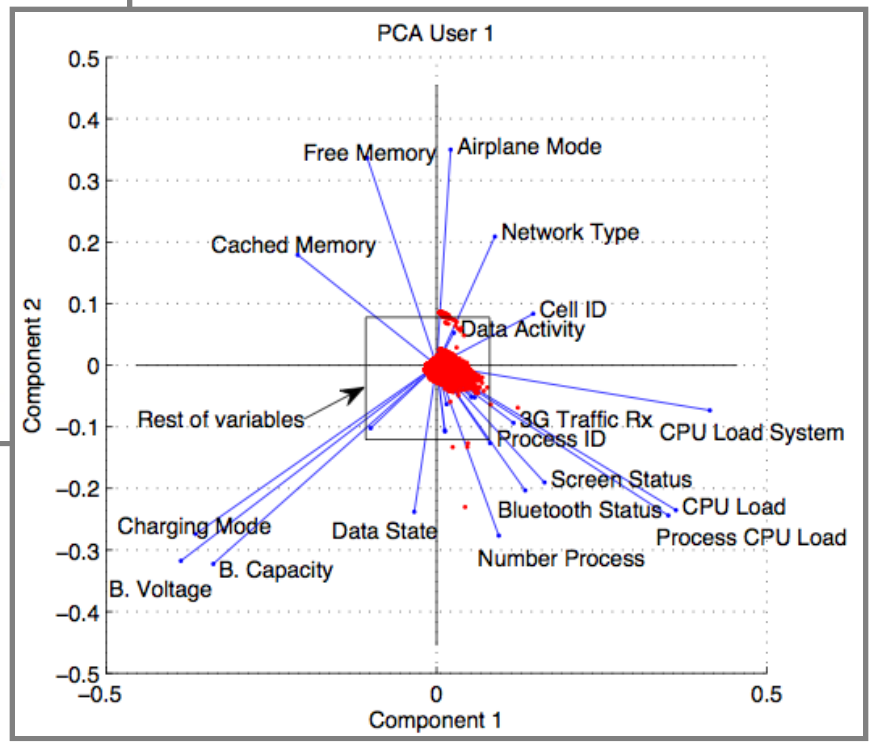
Transforms a number of possibly correlated variables into a smaller number of uncorrelated ones called Principal Components

Principal Component Analysis

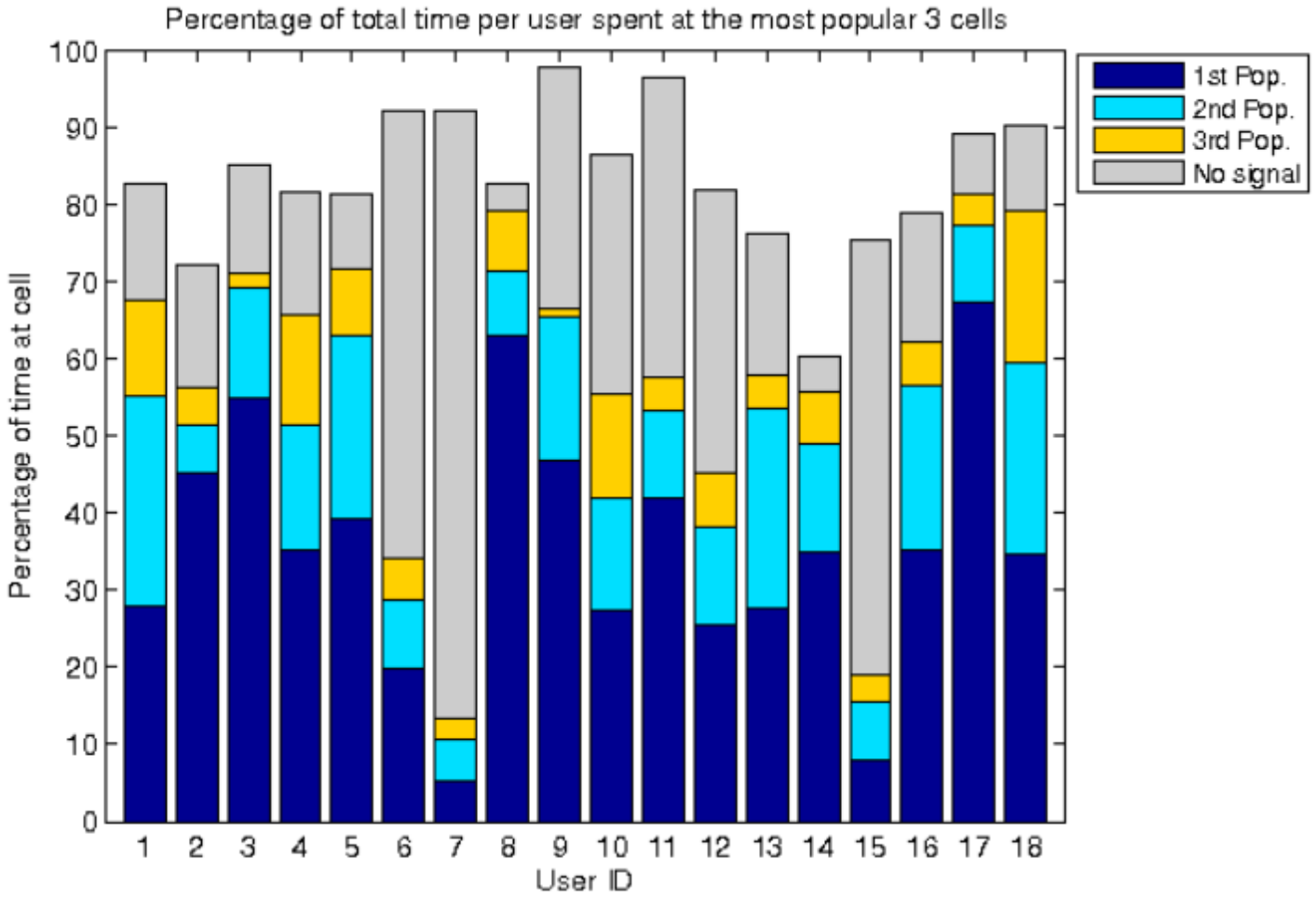


Principal Component Analysis

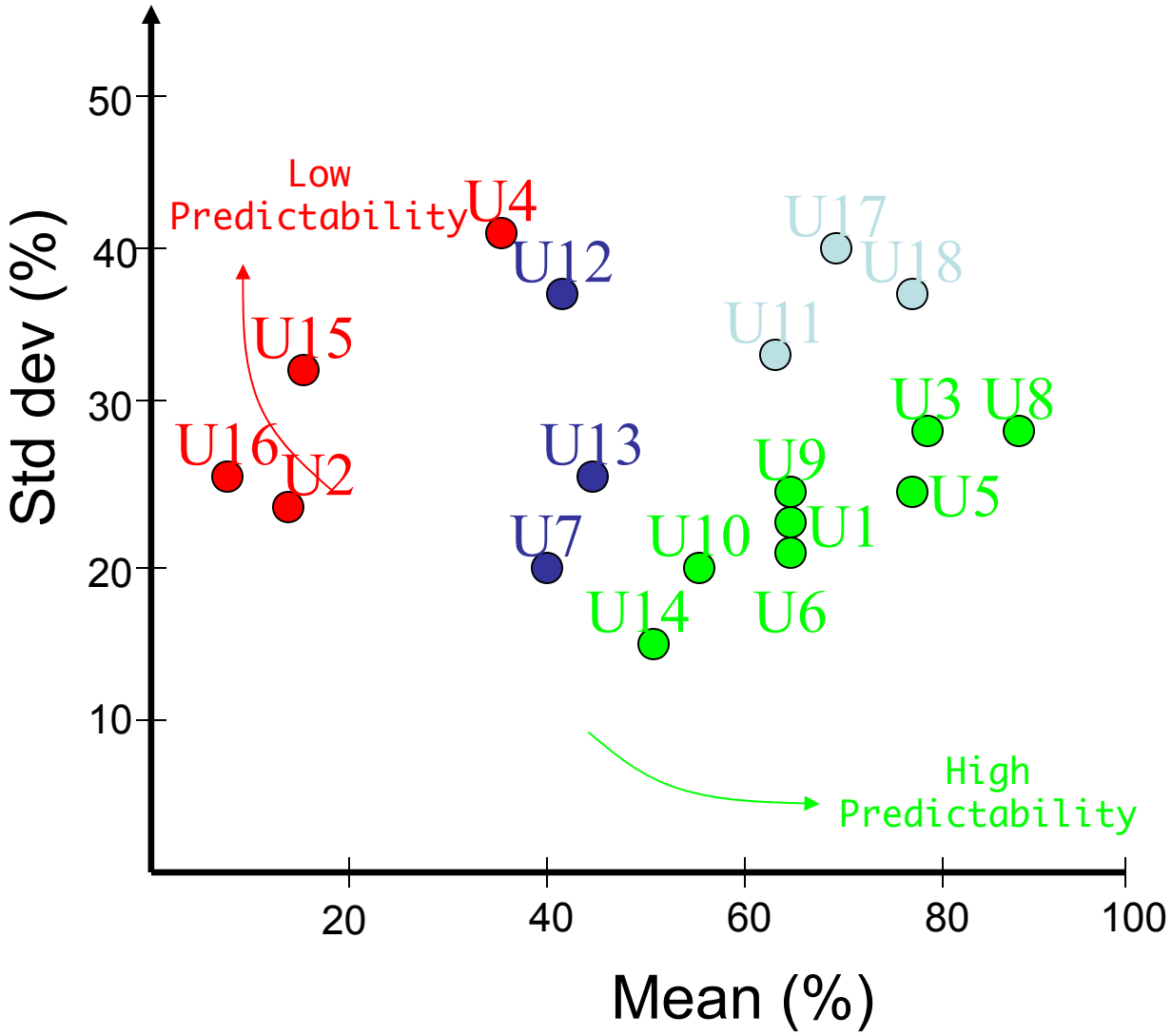




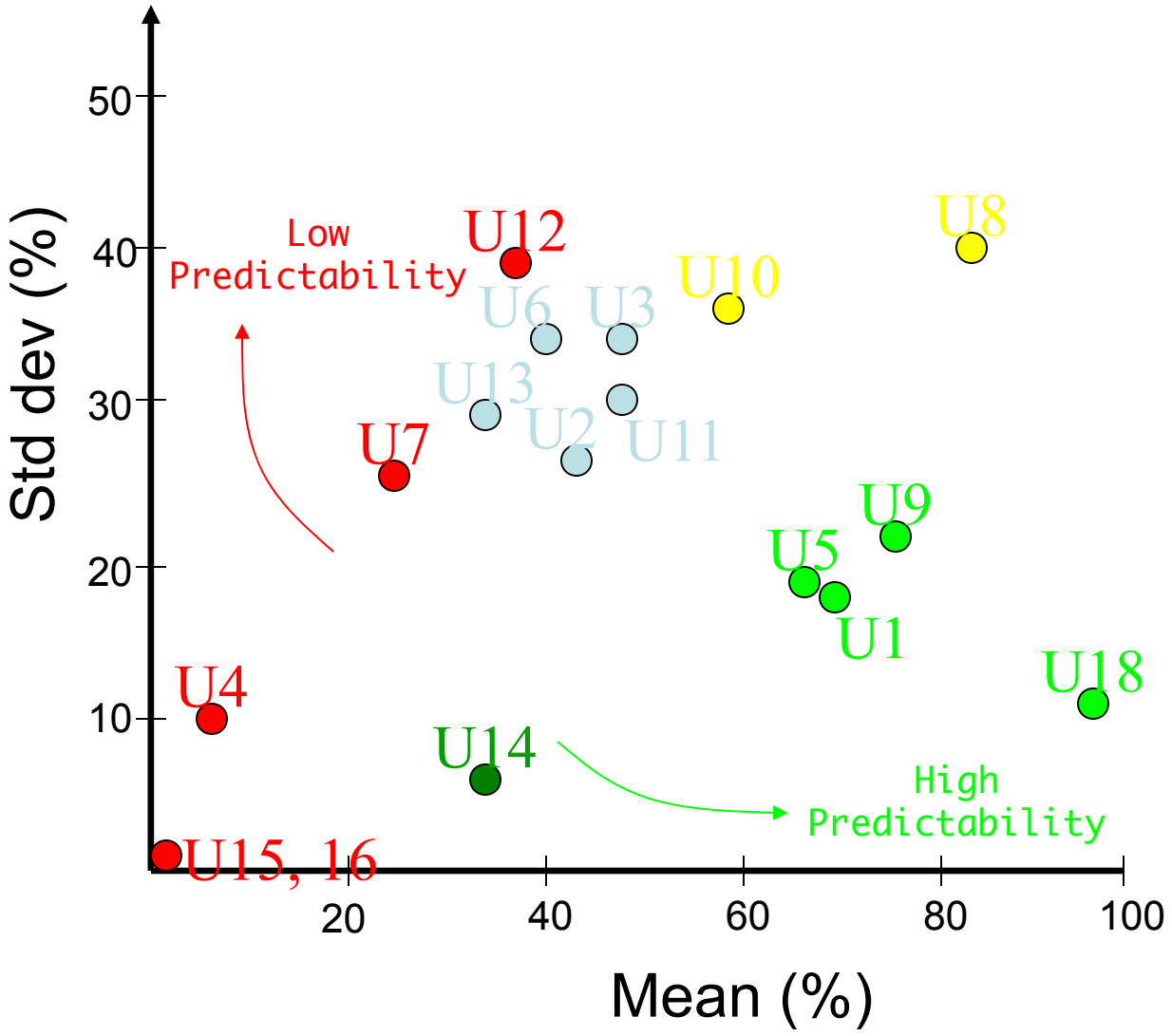
Context importance



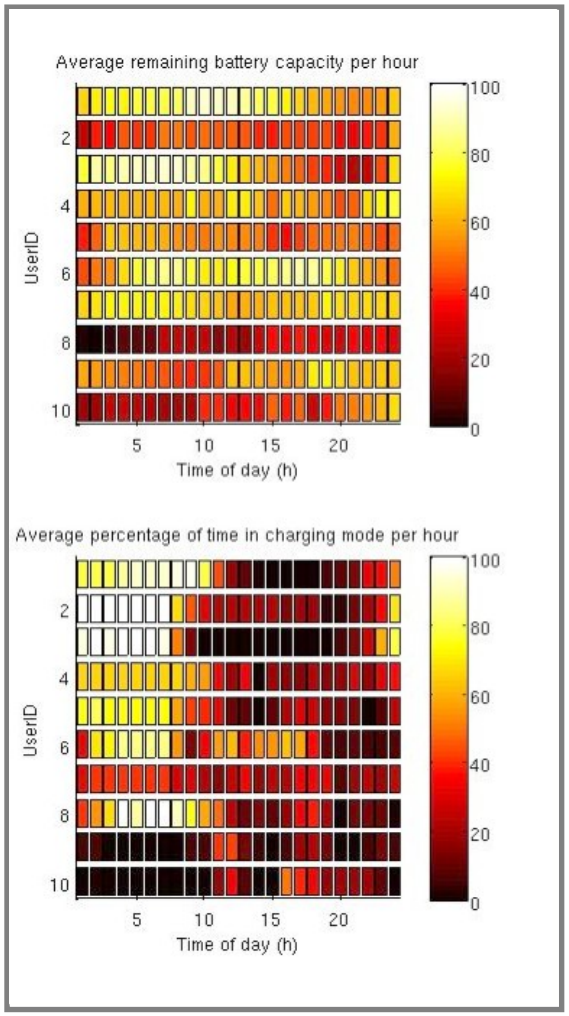
Spatial context: Screen usage

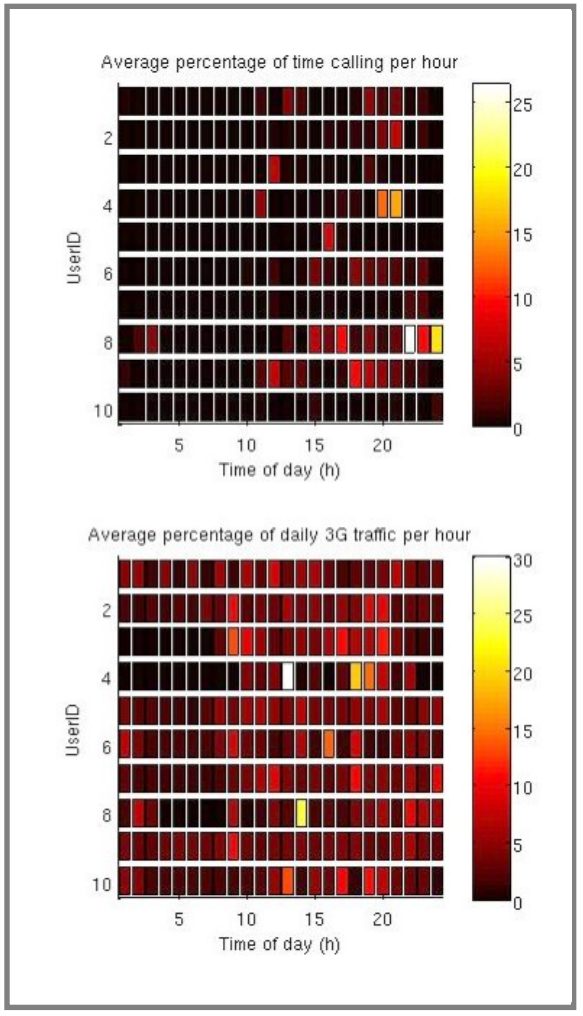


Spatial context: Cellular traffic

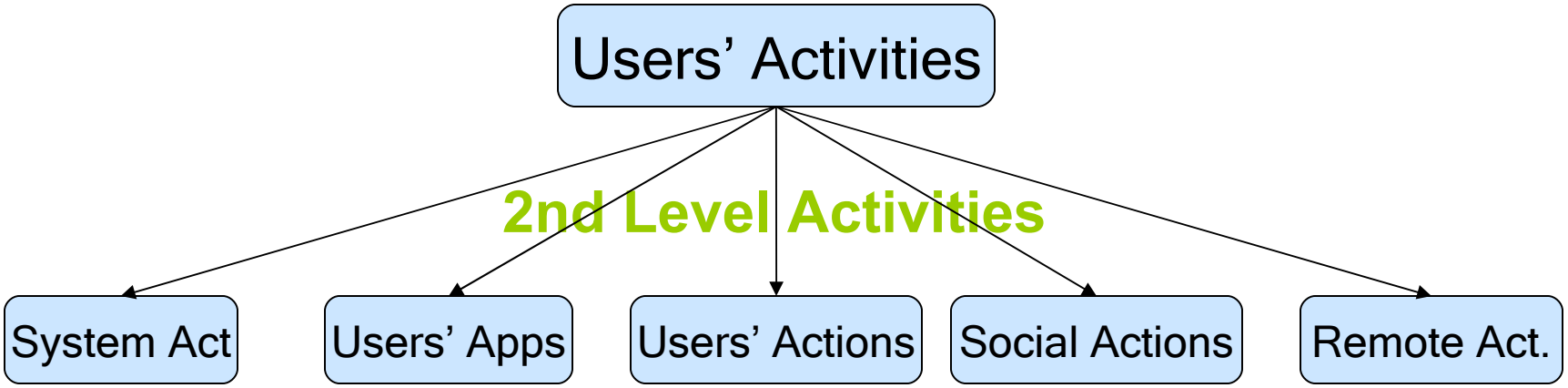


Temporal context: Daily usage

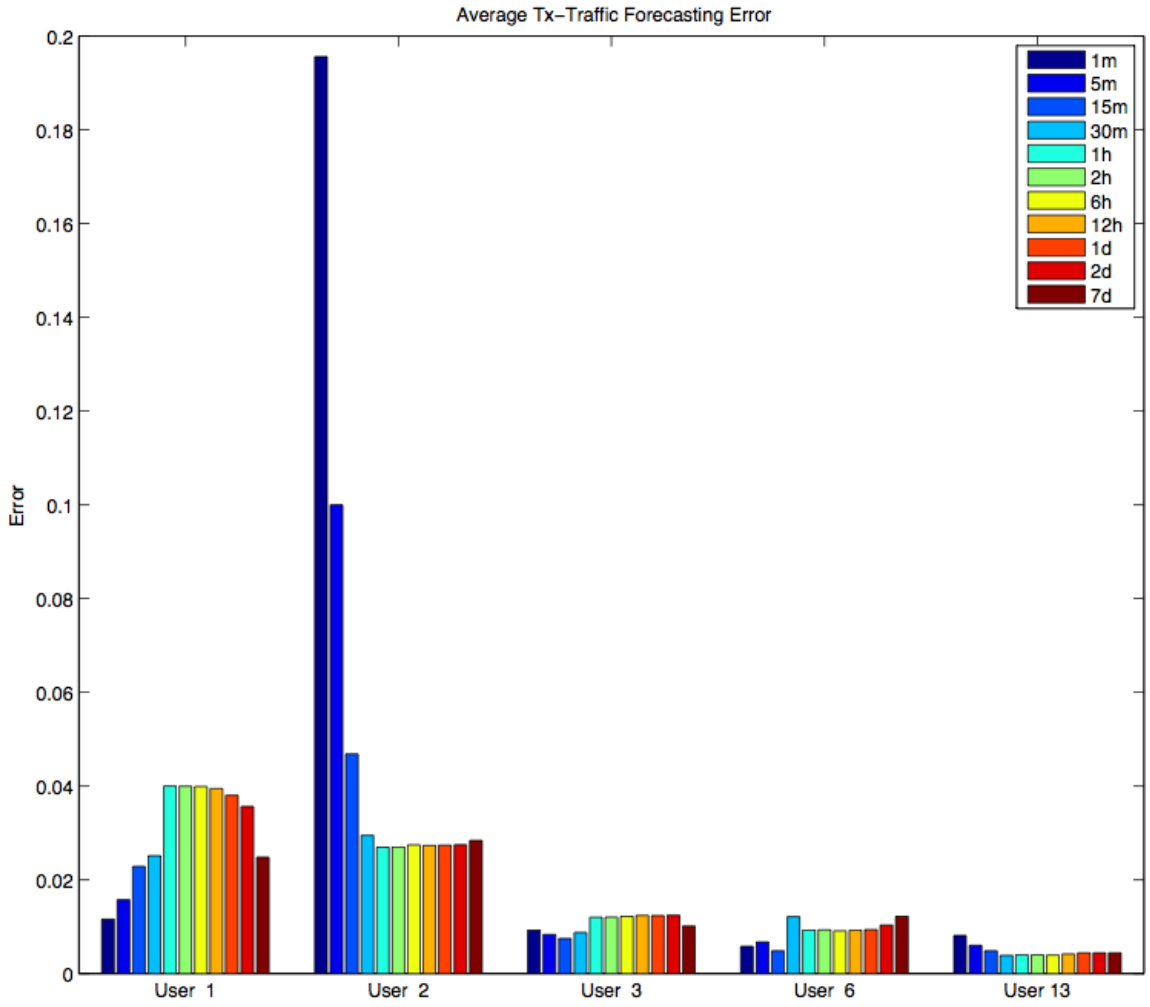




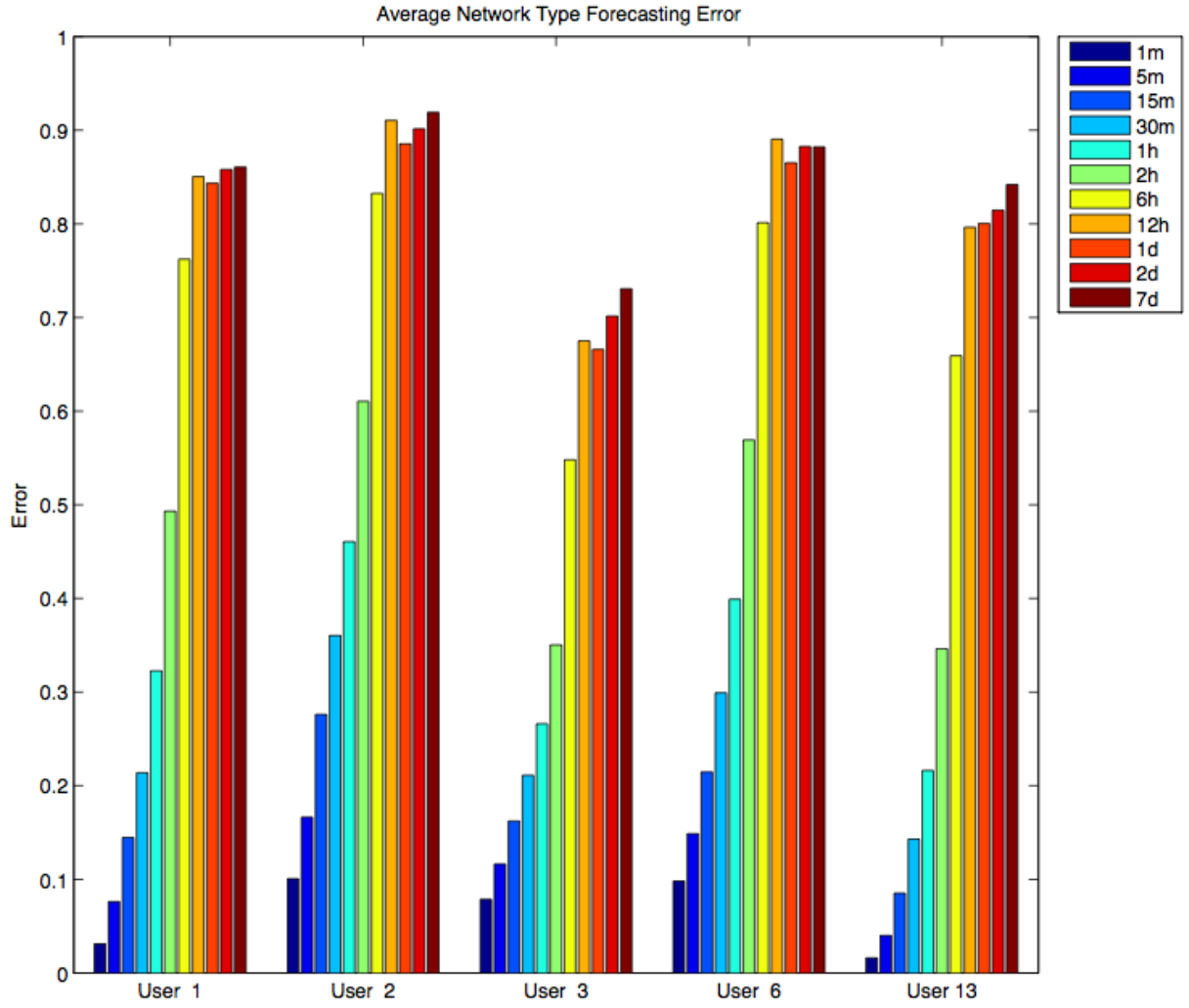
Resources Allocations: Activities



Forecasting Resources Demands



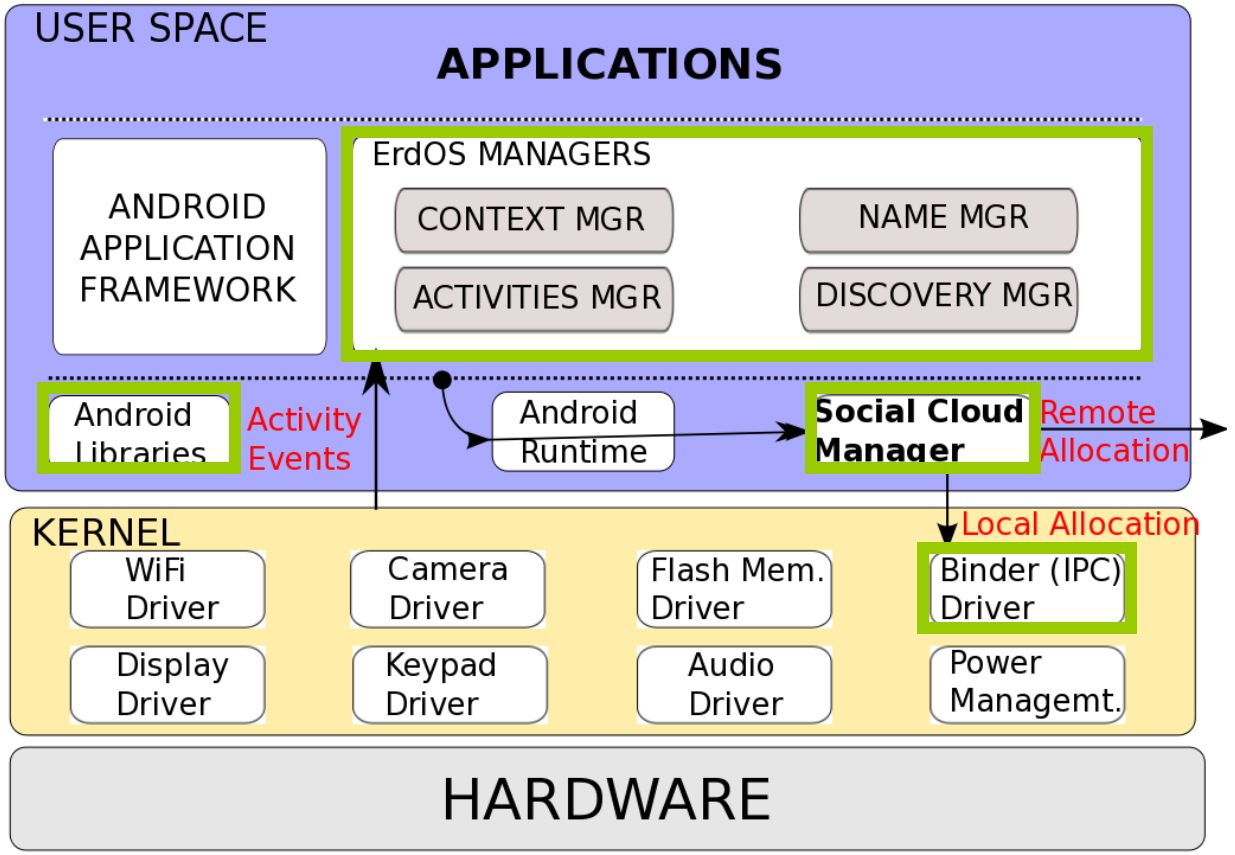
Forecasting Resources State



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?

Questions?
Thanks!

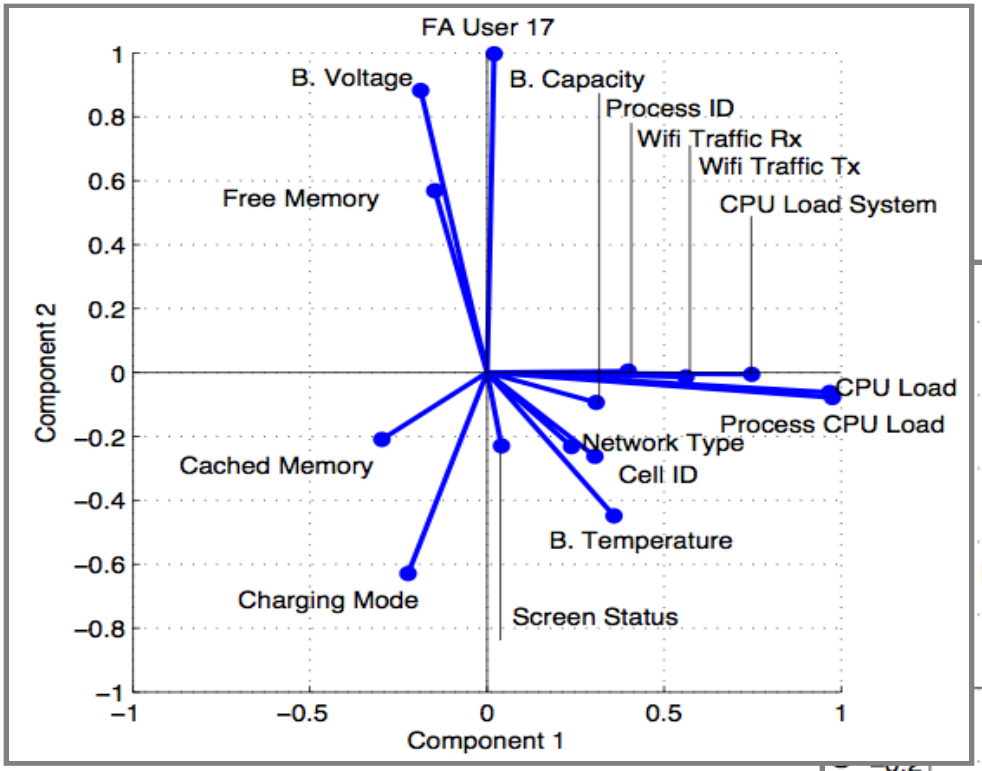
Email: nv240@cam.ac.uk
http://www.cl.cam.ac.uk/~nv240/erdos.html

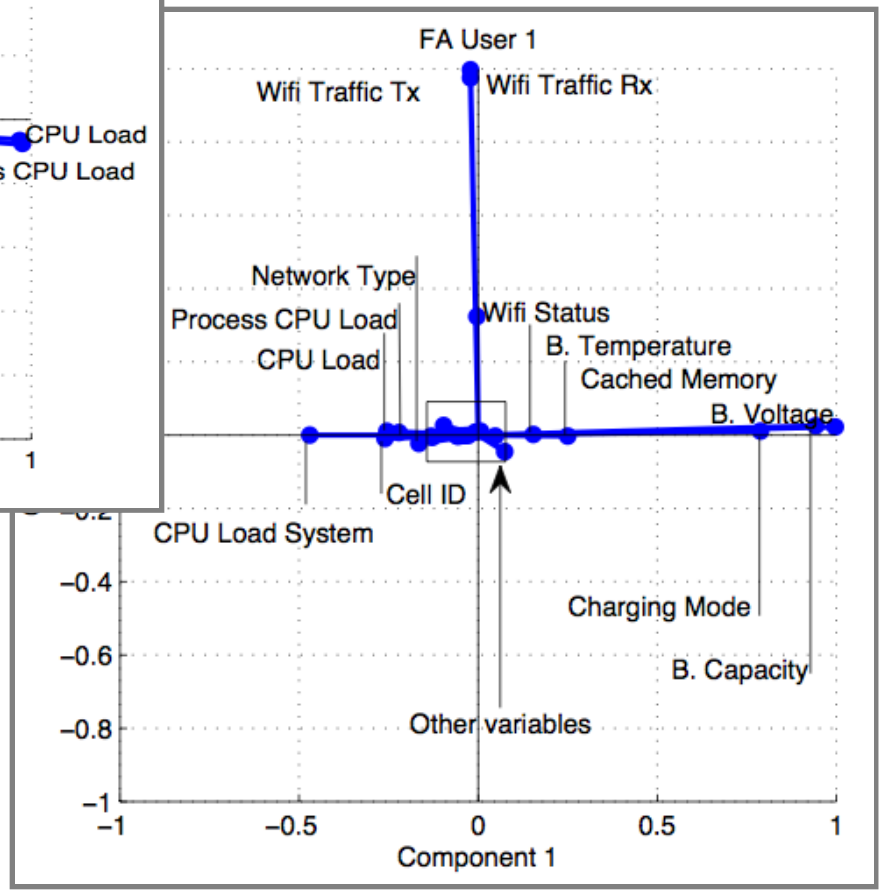
Usage Analysis - Tools

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

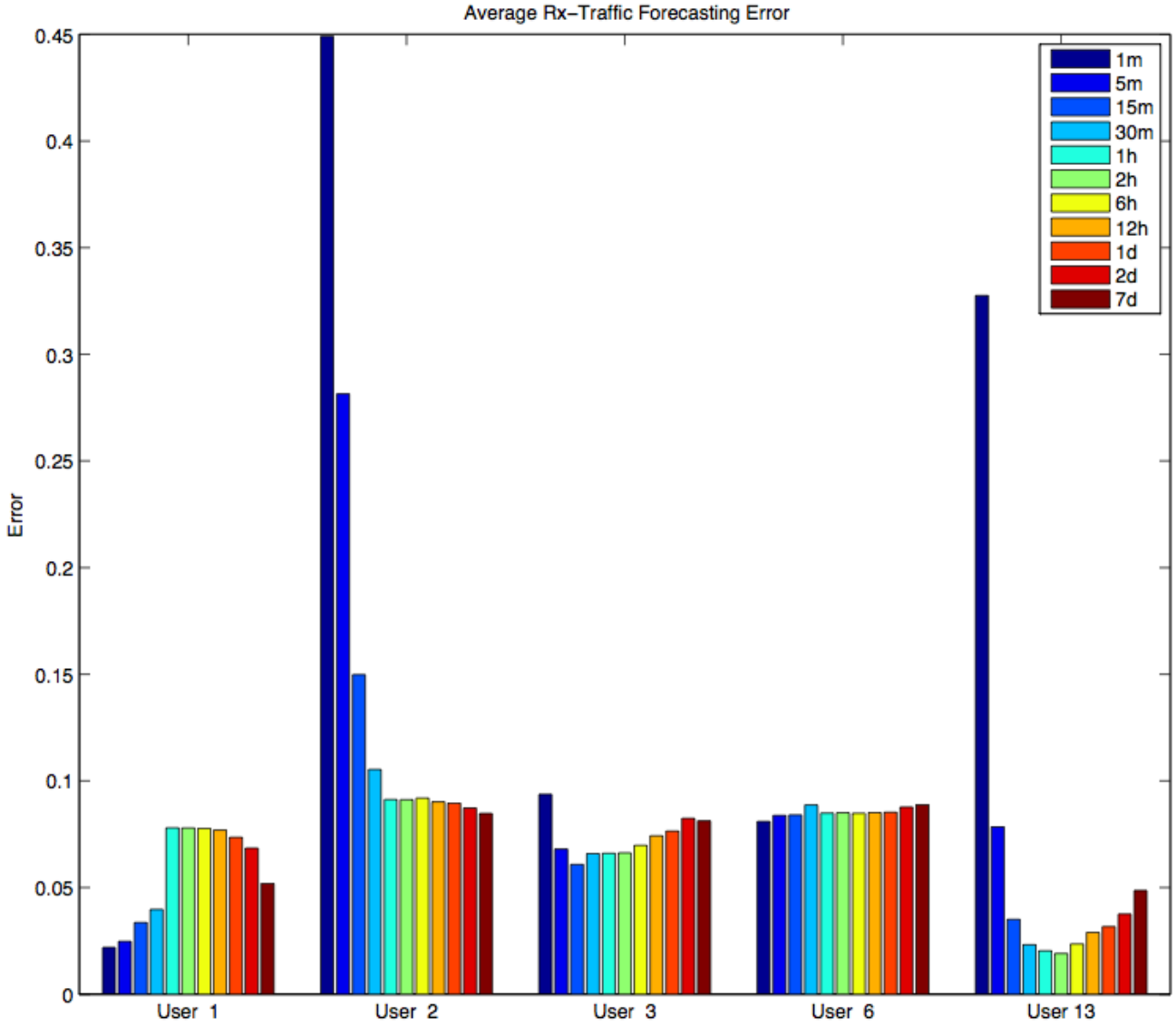
- Inaccurate indicator

-Mobile resources demand require a totally different approach:

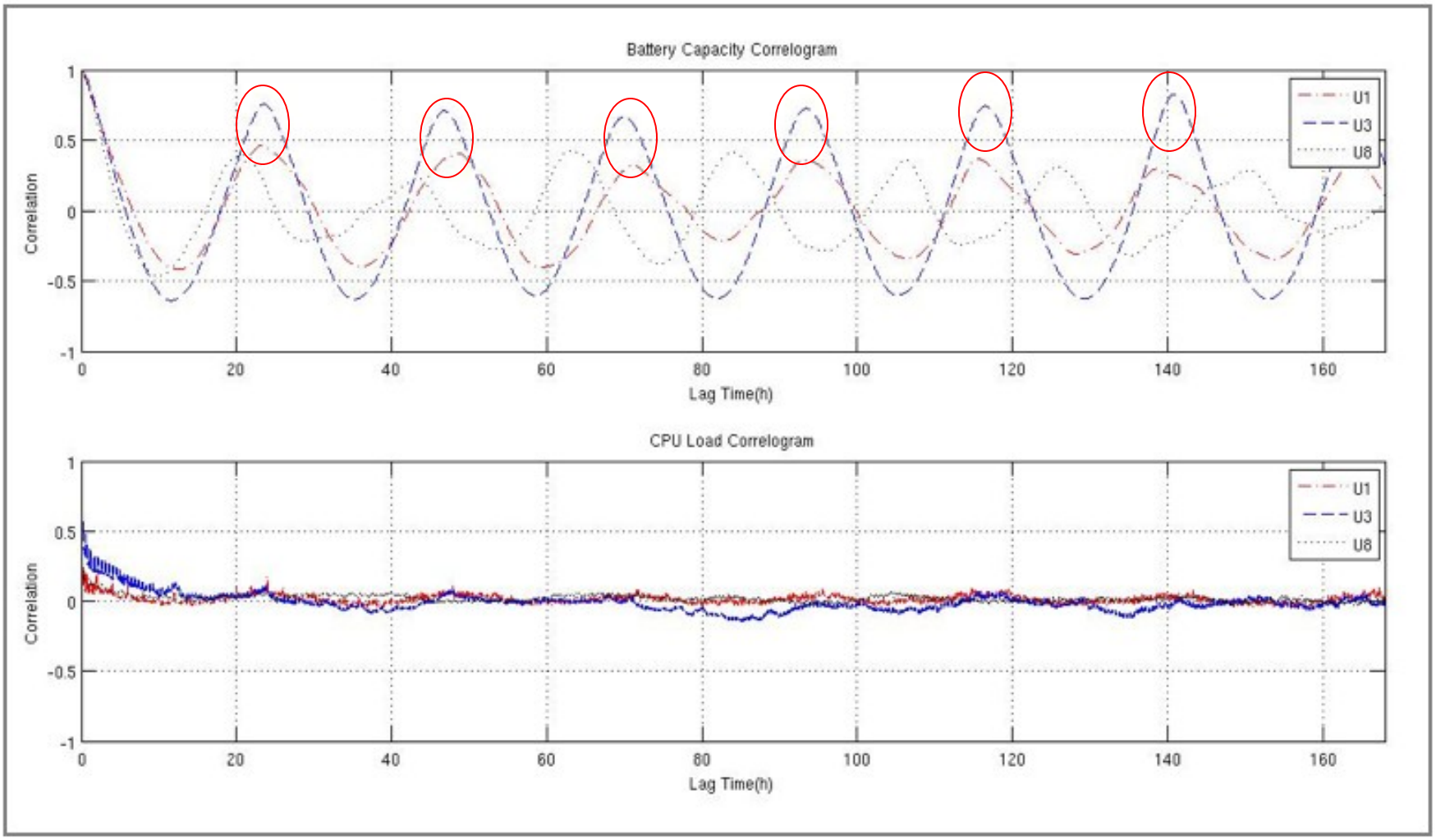
-Context matters (i.e. Signal strength)

-Proactive resources management

Forecasting Downlink Traffic



Temporal context. Periodicity



Name Manager