Mobile Apps: It’s Time to Move Up to ConDOS

ConDOS: the Context Dataflow OS

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How *Might* New Apps Use New Sensors?
OfficeFit app

› contextual fitness reminders in the office
  › “Don’t slouch while sitting.”
  › “You’ve been at your desk for too long.”
  › “Take the stairs instead of the elevator.”

› how it works
  › motion from IMU + sound from mic → various fitness activities
  › do this continuously
context data from sensors

› key pieces are ready
  › sensor hardware
  › application scenarios
  › algorithms (high accuracy inference, signal processing, db, etc.)

› where is the context?

› who is responsible for context?
  › individual apps
    › … but mobile OSs limit apps to foreground
    › … or apps can run anything in the background(!)
  › the cloud
    › … but energy cost of TX/RX is high
  › the mobile OS
ConDOS design proposal

› export *Context Data Units (CDUs)* rather than raw sensor data
  › higher-level abstraction than bytes
  › apps query or subscribe to CDUs

› each CDU is defined by a CDU Generator: a graph of processing components
  › combine Generators into composite context dataflow (like packet dataflow [kohler ’00])
  › provide a base CDU vocabulary (that is extensible)
benefits of OS-managed context

1. System services can use context
system services can use context

- memory management
  - preload calendar, email when in the office

<table>
<thead>
<tr>
<th>Context</th>
<th>Preload Action</th>
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<tbody>
<tr>
<td>in the office</td>
<td>Email, Calendar</td>
</tr>
<tr>
<td>at a party</td>
<td>Twitter, Facebook</td>
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- I/O
  - ring volume adjusted based on conversation
  - networking params dictated by movement [Balakrishnan ’10]
system services can use context

› security
  › auto password unlock when at home
  › lend your phone to others easily [liu ’09]

› energy management
  › predict time-to-recharge based on context
benefits of OS-managed context

2. Privacy enforced by OS protection

Kernel Services

- Scheduling
- Memory Management
- I/O
- Security
- Energy Management

Contextual Data Units

Hardware Abstraction Layer

Kernel Boundary

Apps
better sensor privacy

› mobile privacy is under attack
  › protecting raw sensor data is “trust the EULA”
  › 2/3 of popular apps use your data suspiciously
  › no idea what your raw data might be used for

› OS-managed context lets us do
  › app install time: per CDU type access control
    › … vs. per sensor type access control
  › app run time: visual inspection of CDUs shared
    › … vs. no comprehension of what is being shared
  › enforcement is low overhead
Motion Features

Motion State
sitting, walking, running

Audio
Interruptible
yes, no

CDU1
Logical Location
home, office, mall

Location DB

Geolocation
GPS, Cell, WiFi

CDU2
Motion State
sitting, walking, running

Motion Features

IMU
accel, gyro, mag

CDU3
Interruptible
yes, no

Audio Features

Silence Filter

User space
Kernel space

other OS services
Scheduling I/O Memory
Security
Management

Context Data
Generators

Context
dataflow
eexample

toward a design

app A

app G

... app Z

app A

app G

... app Z

app A

app G

... app Z

app A

app G

... app Z
› mobile OSs that don’t make sense make no sense

› ConDOS offers context as a primary app-OS interface

› apps, OS services and User Privacy may all benefit
thank you! questions?

backup slides follow
context
dataflow
as library

traditional OS services

Scheduling  I/O  Memory Management  Security  Energy Management

user space

Kernel space

control iface

app A

app G

... app Z

strong isolation

context

dataflow

as library

app A

app G

... app Z

strong isolation

traditional OS services

Scheduling  I/O  Memory Management  Security  Energy Management

resource multiplex function [engler '95]

context

dataflow

as library

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resource multiplex function [engler '95]
potential dataflow benefits

1. predictable execution [lee ’87]
2. shared flow processing
3. principled flow degradation
4. flow-to-hardware mapping