

About me

Oresti Banos, PhD, Asst. Prof.

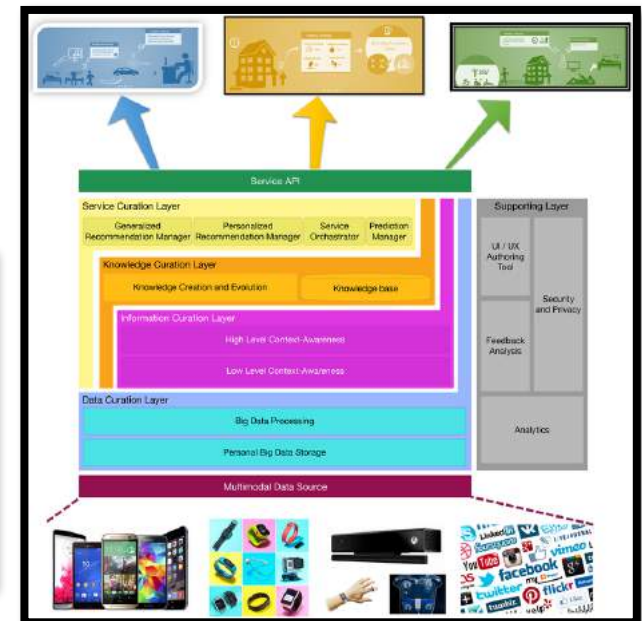
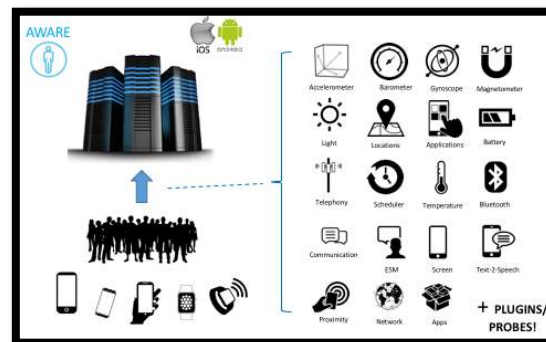
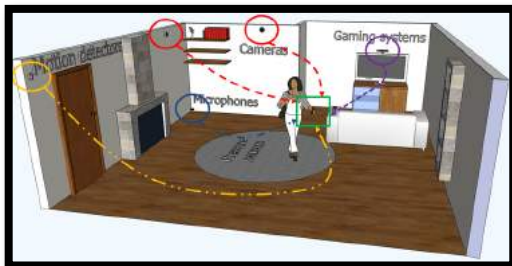
Web: <http://orestibanos.com/>

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Research:

- smart mobile sensing
- holistic behaviour modelling
- virtual coaching systems



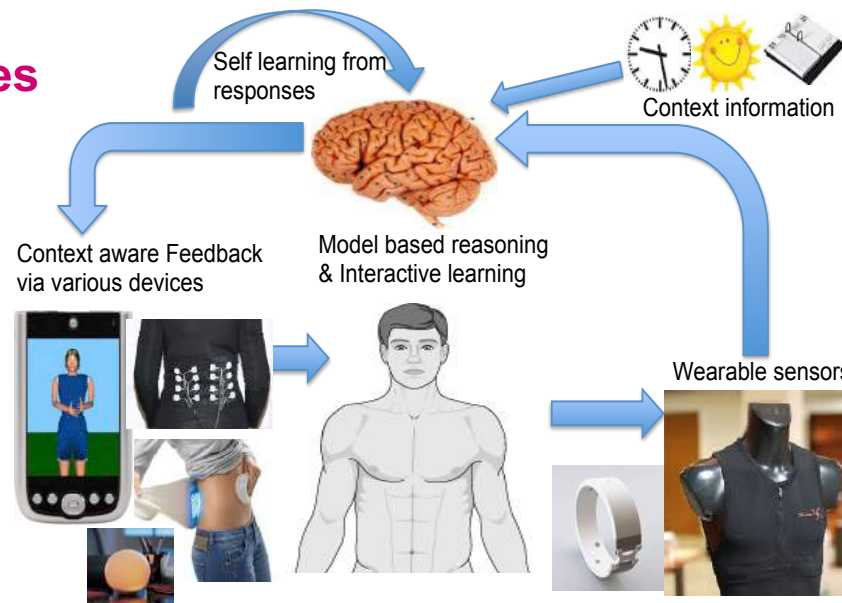
Center for Monitoring and Coaching: “High Tech Care with a Human Touch”

<https://www.utwente.nl/ctit/cmc/>

Human Behaviour Modeling

- Artificial intelligence
- Machine learning
- Behavior change frameworks
- Persuasive tech
- Coaching strategies

Application domains:
Frailty, Stroke, Diabetes, Pain
Parkinson's, Alzheimer's, Autism

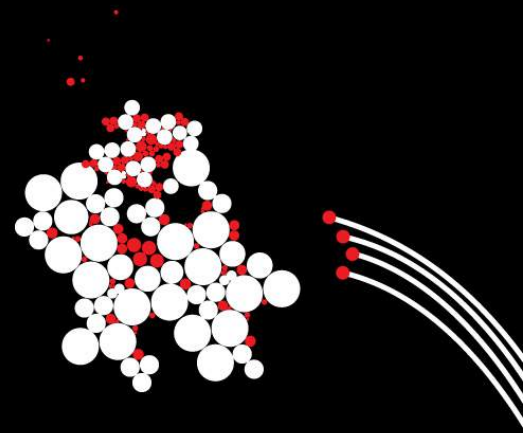


Human-Computer Interaction

- Haptic interfaces
- (Embodied) Virtual agents
- Natural language processing

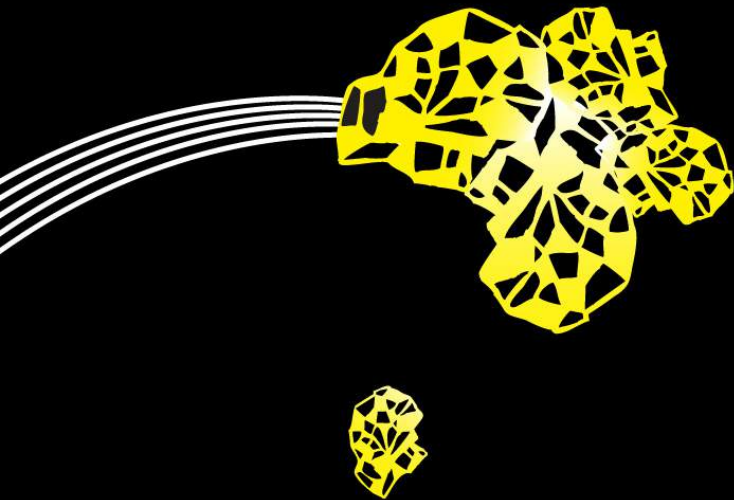
Multimodal Sensing

- Wearables
- Textiles
- Ambient sensors
- SNS
- ESM



What your smartphone tells about your behavior

Challenges and Opportunities



Oresti Banos

4TU Symposium: Wearables in Practice

September 22, 2017

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<http://orestibanos.com/>



Smartphones vs Wearables

**Will the smartwatch destroy
the smartphone?** **ANDROID AUTHORITY** (2013)

**WILL SMARTWATCHES KILL
SMARTPHONES?** **WIRED** (2014)

**Will Wearables Wipe Out the
Smartphone?** **AdvertisingAge** (2015)

Will Smartphones Ever Be Obsolete?
TIME (2017)

Smartphones vs Wearables

Will the smartwatch destroy the smartphone? ANDROID AUTHORITY (2013)

WI
SN

.L
(2014)

Will W
Smart



Will Smartphones Ever Be Obsolete?
TIME (2017)

Smartphones & Wearables



Foldable Smartphones



Wearable Smartphones

Projected Smartphones



Implantable Smartphones

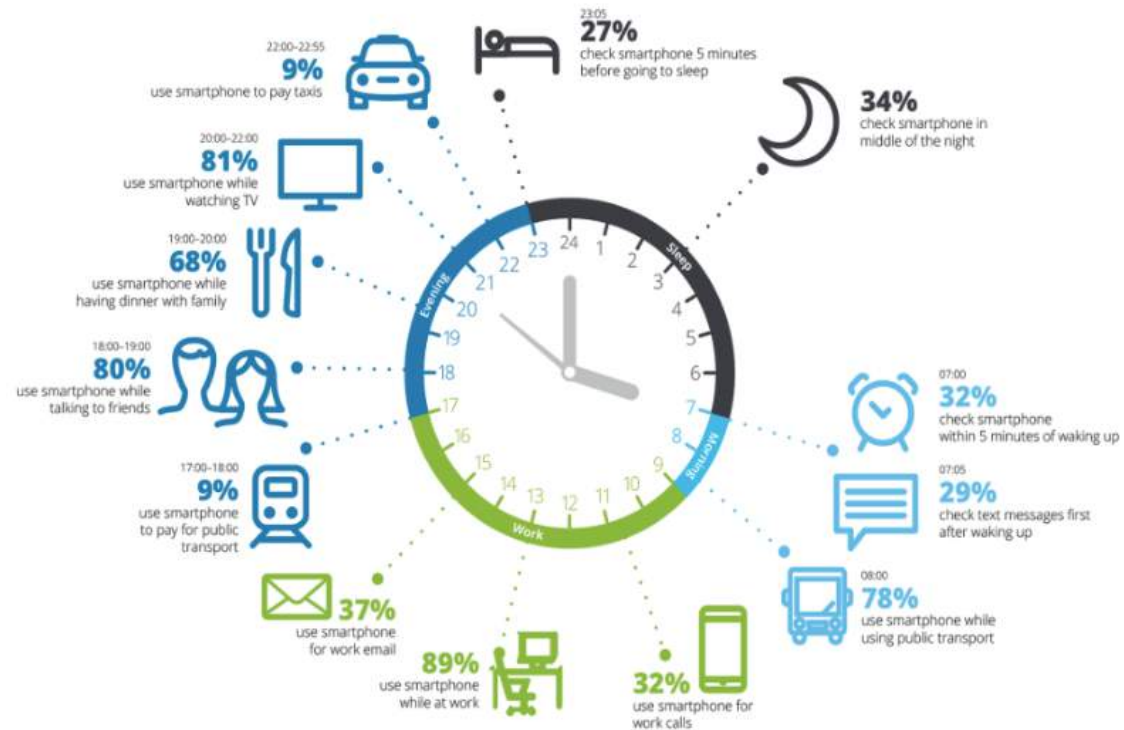


What's so special about smartphones (to consider them in social/behavioral/health sciences)?

- Mature technology
- Huge variety of built-in (and pluggable) sensors: accelerometer, gyro, proximity, compass, barometer, heart rate, SpO2, humidity, fingerprint, NFC, GPS, mic, iris scanner
- Everyday “omnipresent” companions/observers



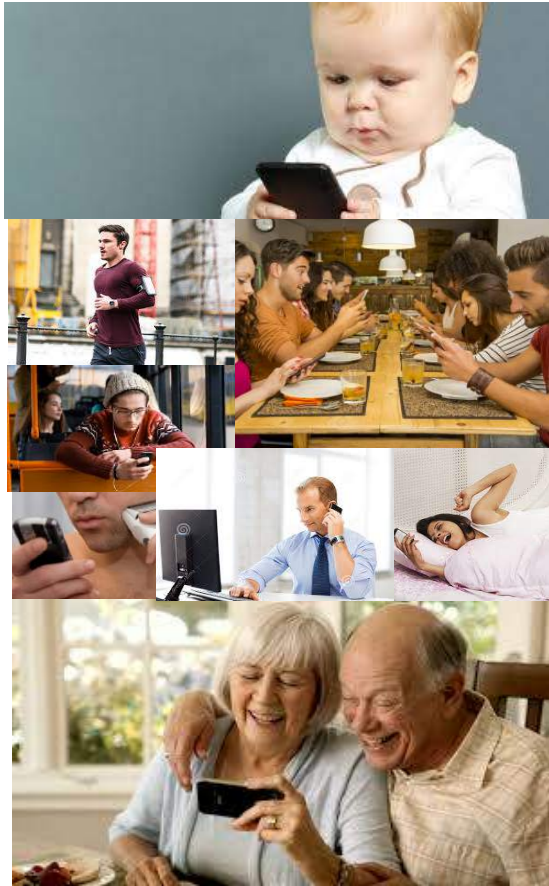
The “silent” observers



(Deloitte, Global Mobile Survey 2016)

The “silent” observers

Explicit interactions



Implicit interactions



Observing and measuring behavior



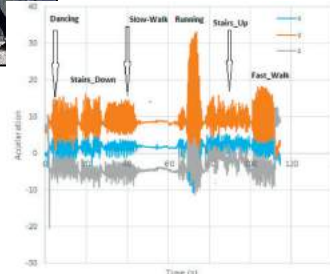
Observe & Measure Human Behavior

In the wild – Naturalistic Sensing

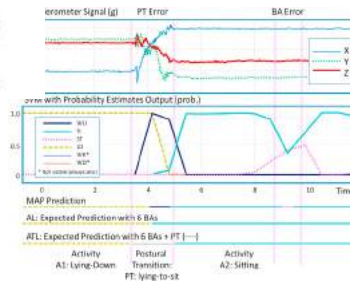
Large groups – Crowd Sensing

Multiple dimensions – Holistic Sensing

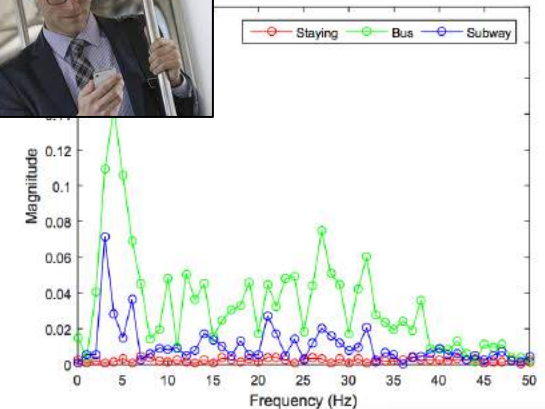
Physical behavior



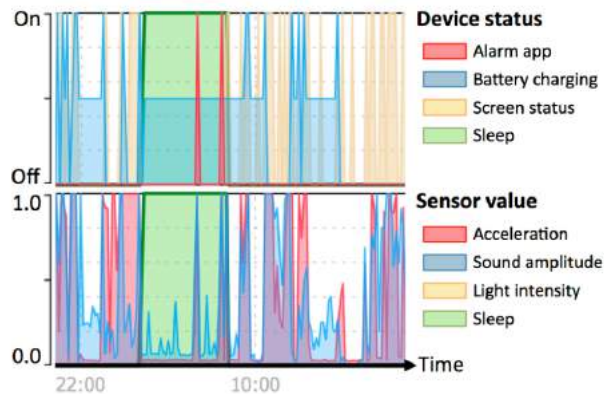
(Procedia Comp. Sci., Bayat et al. 2014)



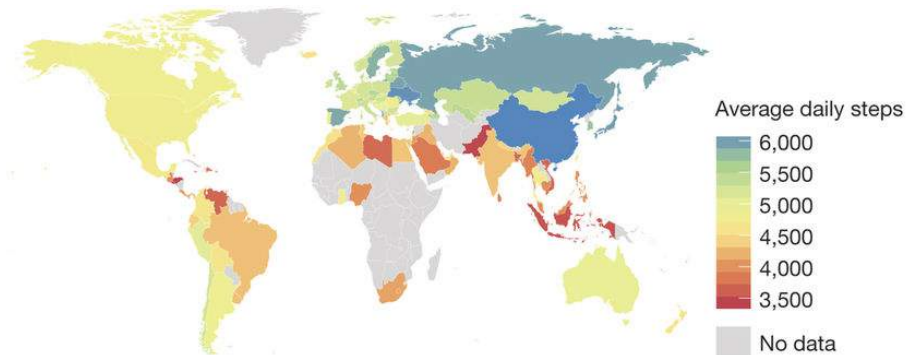
(Neurocomp., Reyes et al. 2016)



(Sensors, Hur et al. 2017)



(CHI, Min et al. 2014)



(Nature, Althoff et al. 2017)

Social behavior

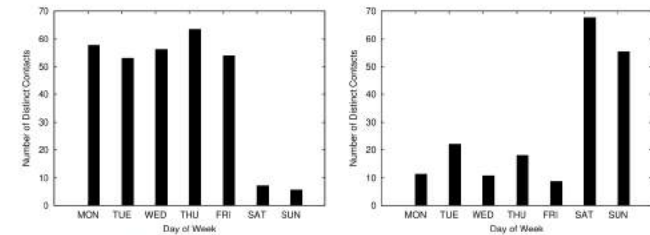
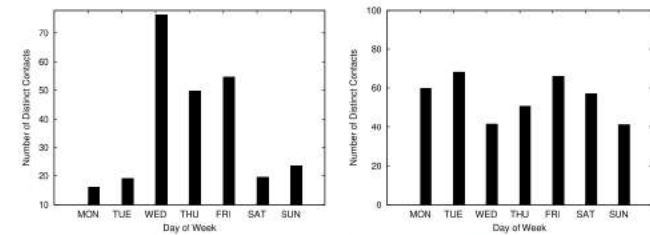
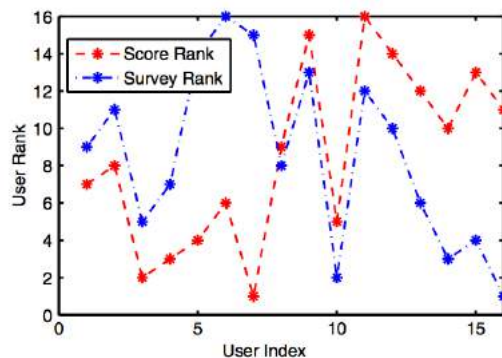


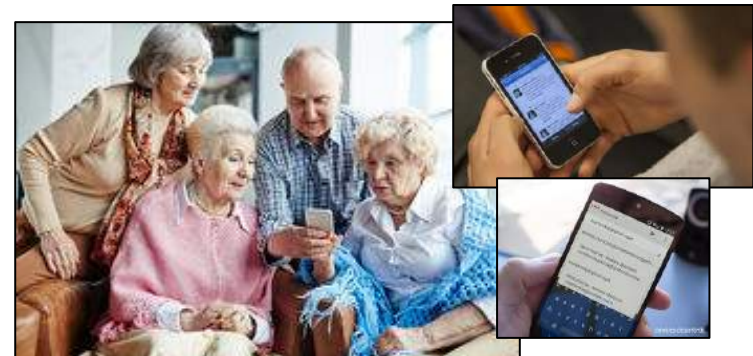
Fig. 7. The number of contacts decreases/increases at weekend.



(Perv. & Mob. Comp., Vu et al. 2015)



(Mobile Netw. Appl., Lane et al. 2014)

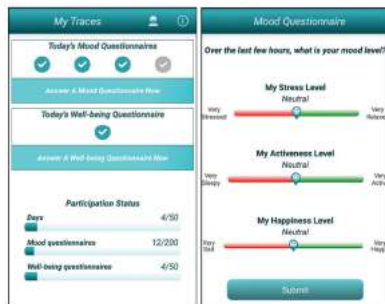


Emotional behavior

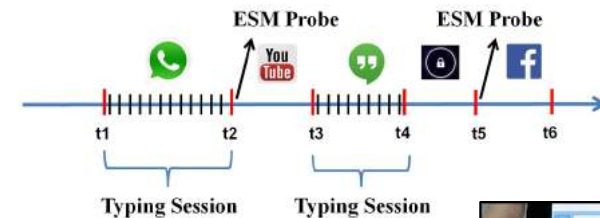


Feature	Import	Correlation	The more bored, the ..
time_last_outgoing_call	0.0607	-0.143	less time passed
time_last_incoming_call	0.0580	0.088	more time passed
time_last_notif	0.0564	0.091	more time passed
time_last_SMS_received	0.0483	0.053	more time passed
time_last_SMS_sent	0.0405	-0.090	less time passed
time_last_SMS_read	0.0388	-0.013	less time passed
light	0.0537	-0.010	darker
hour_of_day	0.0411	0.038	later
proximity	0.0153	-0.186	less covered
gender (0=f, 1=m)	0.0128	0.099	more male (1)
age	0.0093	n.a.	+20s/40s, -30s
num_notifs	0.0123	0.061	more notifications
time_last_notif_cntr_acc	0.0486	-0.015	less time passed
time_last_unlock	0.0400	-0.007	less time passed
apps_per_min	0.0199	0.024	more apps per minute
num_apps	0.0124	0.049	more apps
bytes_received	0.0546	-0.012	less bytes received
bytes_transmitted	0.0500	0.039	more bytes sent
battery_level	0.0268	0.012	the higher
battery_drain	0.0249	-0.014	the lower

(Ubicomp, Pielot et al. 2015)

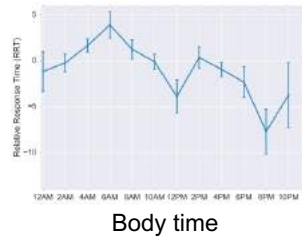
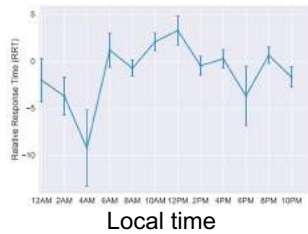


(Ubicomp, Mehrotra et al. 2017)



(MobileHCI, Gosh et al. 2017)

Cognitive behavior



(Ubicomp, Abdullah et al. 2016)



MINI MENTAL STATE EXAMINATION (MMSE)

MINI MENTAL STATE EXAM
use name the:

Point?
Clock?
Day of Week?
Month?

Orientation to time /5

Where are we?
State?
City?
Country?
Hospital?
Floor/Ward?

Orientation to place /5

"I am now going to test your memory"
Name 3 objects. Ask them to repeat all 3.
1 point for each object remembered. Repeat
until learnt all 3 so that recall can be tested.

Serial 7s
"Please count backwards from 100 in steps of 7"
100, 93, 86, 79, 72, 65

alternatively:
Spell WORLD backwards
D L R O W

Attention and Calculation /5

"Please repeat the 3 objects I asked you to remember" Recall /3

"Please name these objects"
Point to a wristwatch and a pencil Naming /2

"Please repeat the following phrase"
"No ifs, ands or buts" Repetition /1

"Please follow this command"
"Take this paper in your right hand, fold it in half and place it in your lap" Complex command /5

Please read and obey the following command
CLOSE YOUR EYES

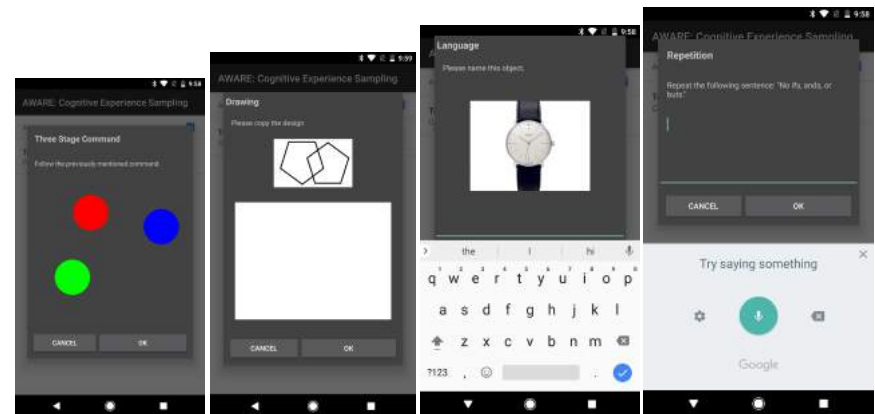
"Please write a sentence"
Must have a noun, verb and make sense

"Please copy the following drawing"

20 pts correct answer
10 pts correct copy
5 pts correct
0 pts incorrect

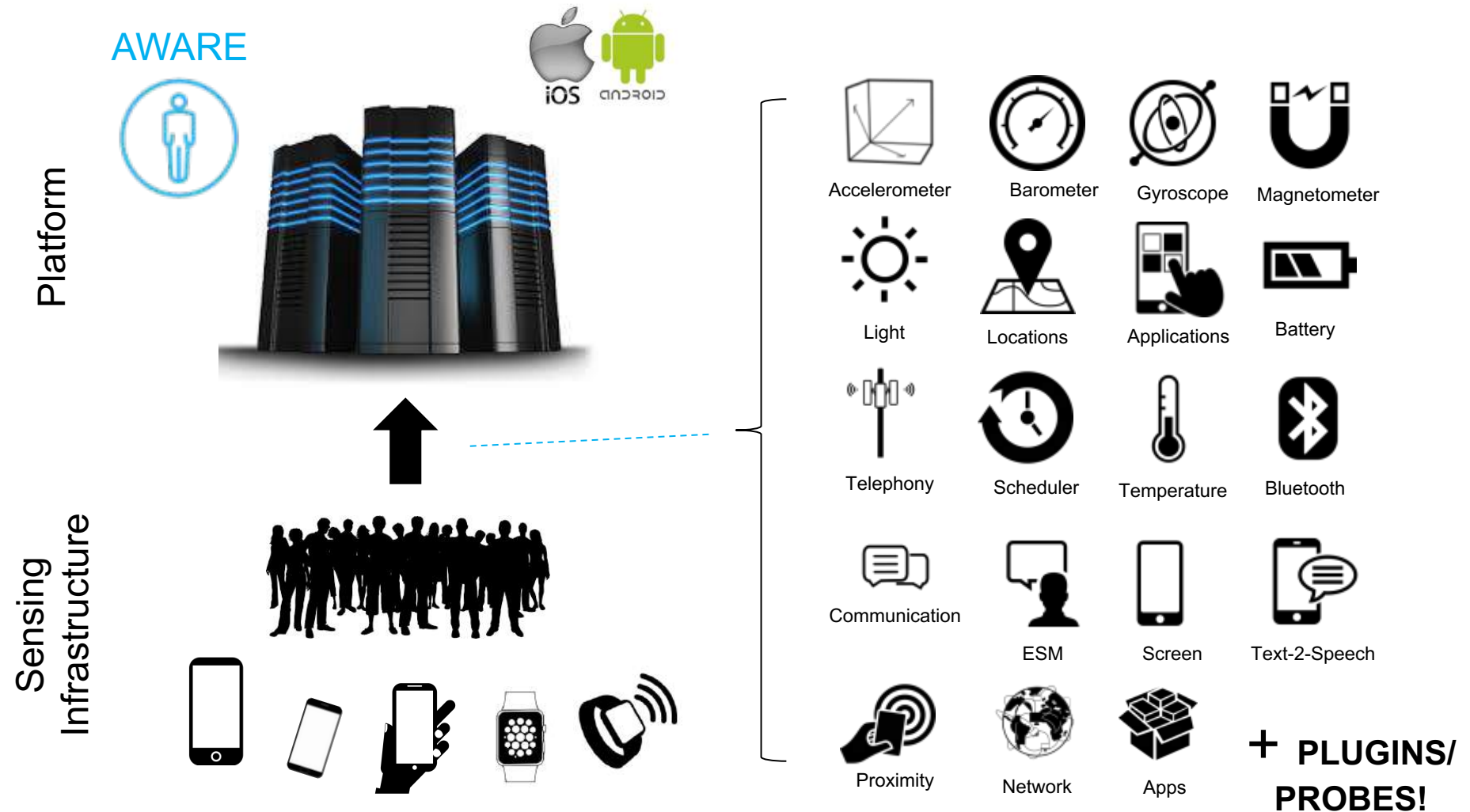
1 point each for the last 3 commands /3

TOTAL /30



(-, Wohlfahrt-Laymann et al. 2017)

HoliBehave: Holistic Monitoring and Analysis of Human Behavior



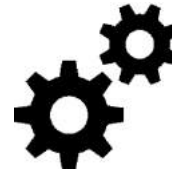
HoliBehave: Holistic Monitoring and Analysis of Human Behavior

AWARE



Platform

(1) Create new sensing campaign

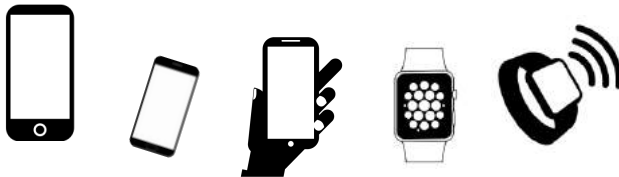
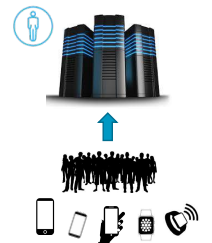


(2) Select sensors of interest (and/or plugins)



(3) Users join the campaign (informed consent)

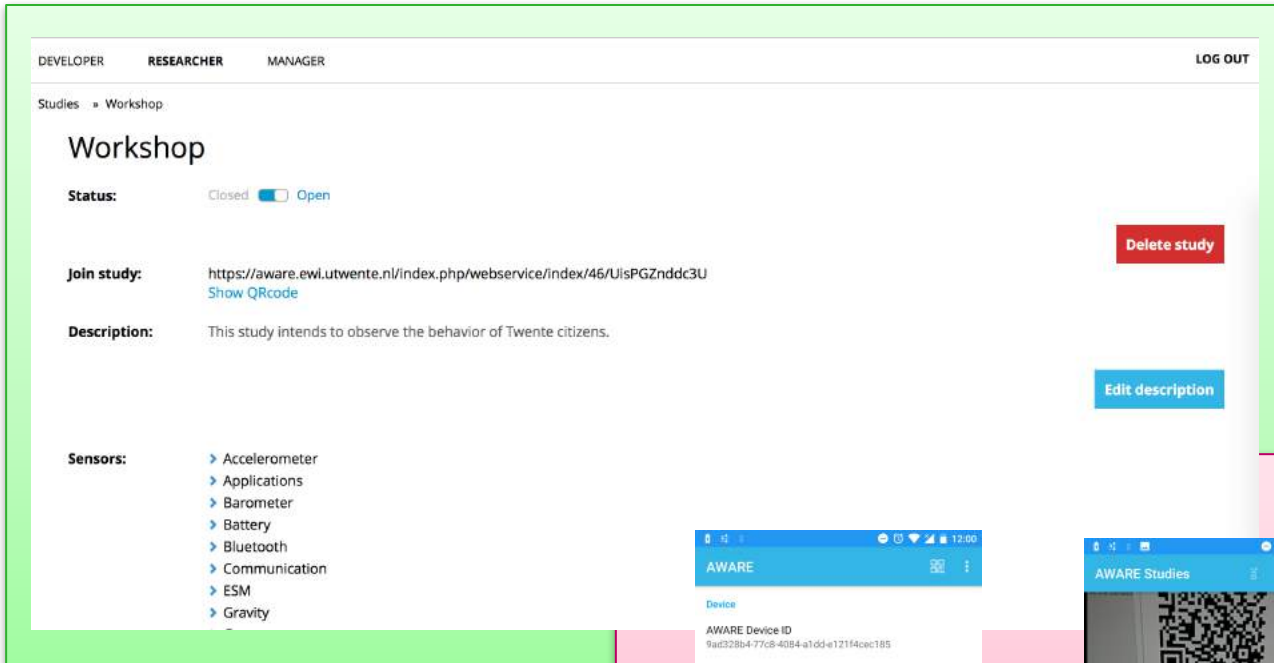
(4) Digital data is collected, uploaded and persisted into the platform



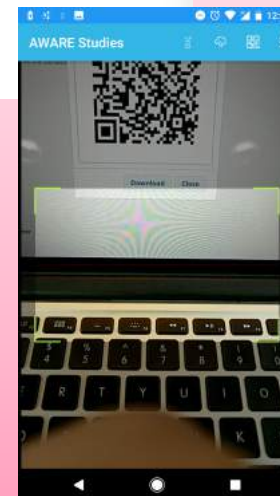
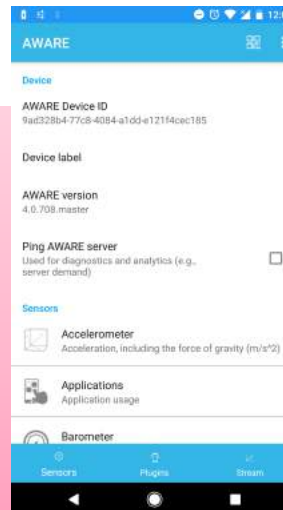
Sensing Infrastructure

HoliBehave: Holistic Monitoring and Analysis of Human Behavior

Server



Client



Challenges

- Battery
- Data plans
- Availability
- Privacy



Take home messages

- Smartphones provide an enormous set of opportunities to observe and measure behavior unobtrusively, in the wild, at large-scale and in a holistic fashion
- Smartphones should not be replaced by wearables but combined into super-sensing platforms
- Stronger efforts needed to cope with the challenges constraining user willingness

Thank you!

MAY THE
SMARTPHONE
BE WITH YOU

