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Fall Detection on the Road

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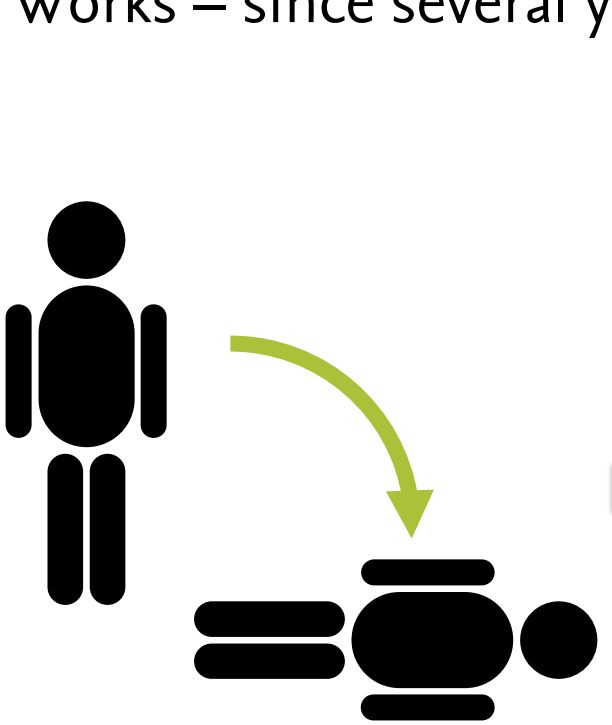
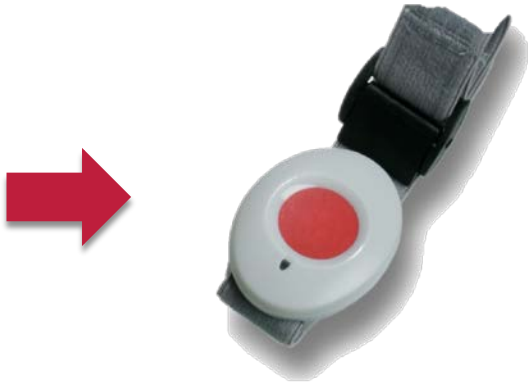
Observed behavior 1: Normal usage

- Works – since several years





Fall occurs

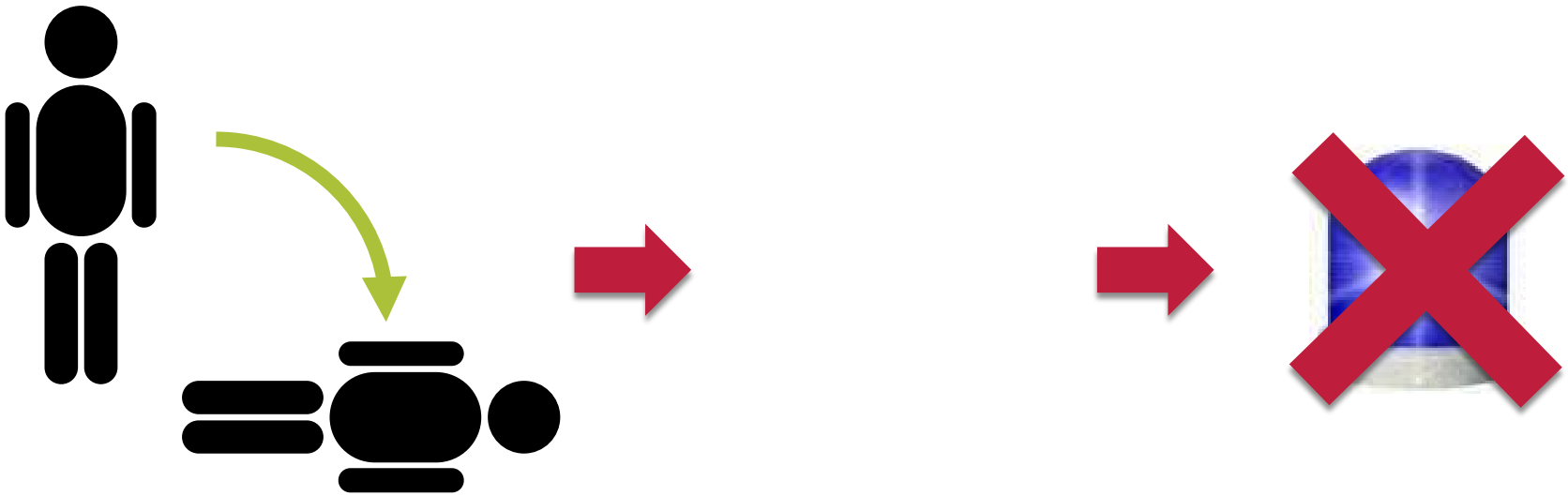
Button pressed

Alarm initiated

Personal Emergency Response System (PERS) – Non-Usage

Observed behavior 2: Non-usage

- Forgets to wear sender
- Doesn't even know where it is



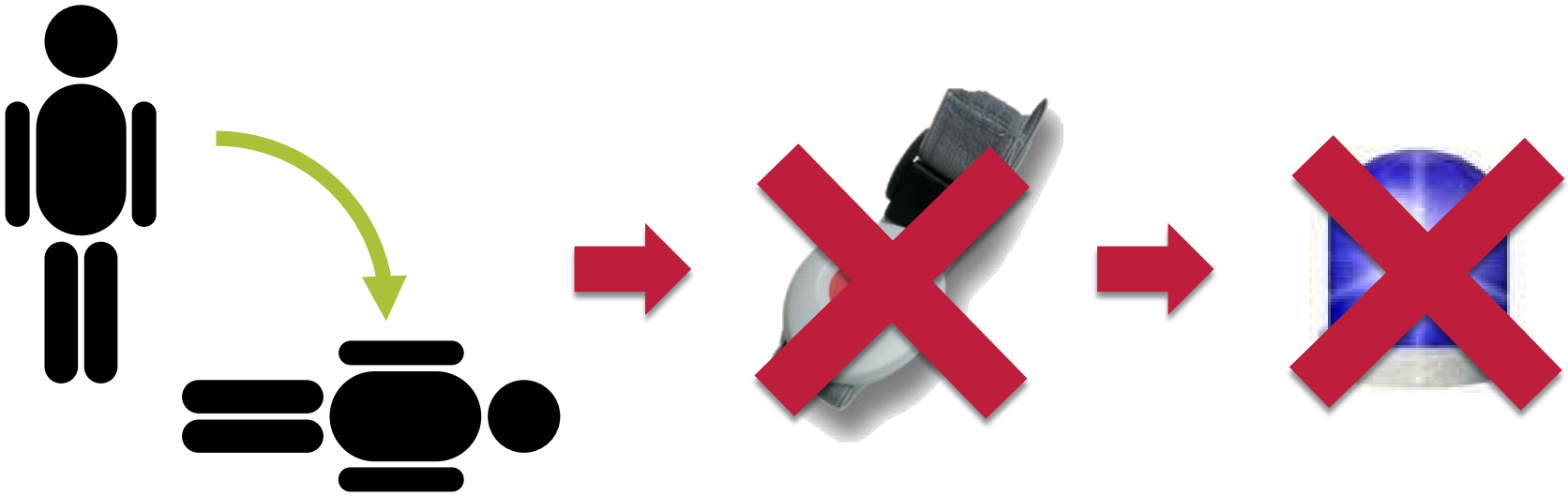
Fall occurs

No button to press

No alarm

Observed behavior 3: Refused usage

- "The mobile nursing service will come anyway – in 2-4 hours"
- "I'll wait here on the floor – don't want to bother anyone"



Fall occurs

Button not pressed

No alarm

Personal Emergency Response System (PERS) – Anxious Usage

Observed behavior 4: Anxious usage

- "I feel safe – I better wear that thing 24/7"
- Many false alarms during nighttime

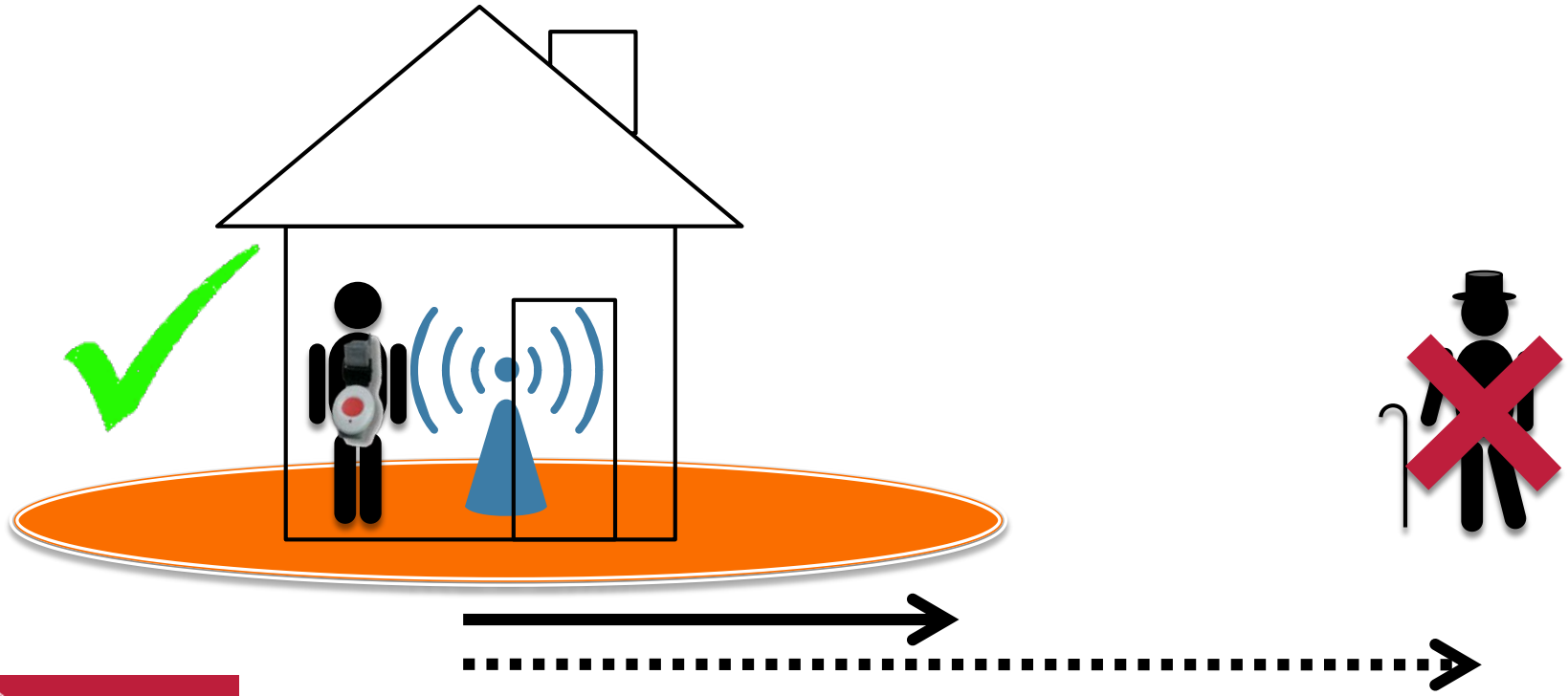
Bad dream occurs

Button accidentally pressed

False Alarm

Observed behavior 5: Avoidance behavior

- "System works good at home."
- "So, why leave it and enter the unsafe outside?!"



Summary: Personal Emergency Response System (PERS)

1. Normal usage
   - OK, this is boring… ✓
2. Non-usage
   - Indoors: Fixed Sensors (Cameras, Laser Scanners, etc.)
3. Refused usage
   - Additional autonomous fall detection and automatic alarm notification
4. Anxious usage
   - Only autonomous fall detection and automatic alarm notification
5. Avoidance behavior
   - System that also works “on the road”

→ Mobile PERS with autonomous fall detection needed… here we go!

Some Related Work

PerFallID [1], iFall [2]

- Systems/Applications for Android Smartphones
- Detect falls with built in sensors
- Report falls via 2/3/4G connection
- Additional location information via GPS

Everybody owns a smartphone!

- Enough processing capabilities for fall detection
- Communication interfaces for alarm messages

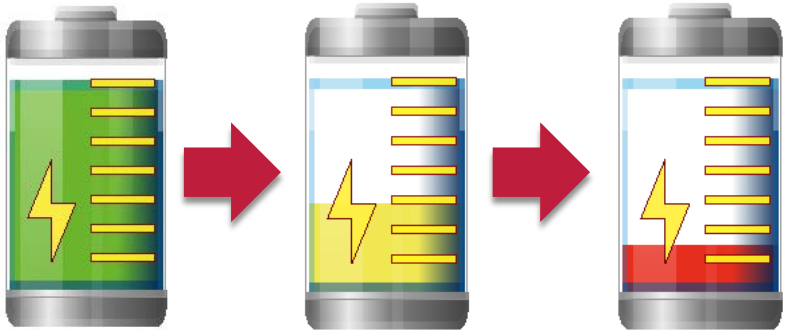
Problem solved?!

[1] J. Dai, X. Bai, Z. Yang, Z. Shen, and D. Xuan, “Mobile phone-based pervasive fall detection,” Personal and Ubiquitous Computing, vol. 14, no. 7, pp. 633–643, 2010.
[2] F. Sposaro and G. Tyson, “ifall: An android application for fall monitoring and response,” in Engineering in Medicine and Biology Society,2009. EMBC 2009. Annual International Conference of the IEEE, 2009.

Limitations of Smartphones

Position on the body

- Pocket
- Jacket
- Handbag



Battery Lifetime – HTC Dream

- PerFallID: 33.5 hours
- Idle time: 402 hours (according to HTC)
- → less than 10% of nominal time
- → in reality: depends on usage
- ➔ never enough!

One Single Device for Indoor and Outdoor Usage?!

Smartphone?!

- Charging when returning home
  - Not able to detect falls @home
- PSTN better suited for alarm messages
  - 2/3/4G networks are not that stable

→ Smartphone cannot be the single PERS device!

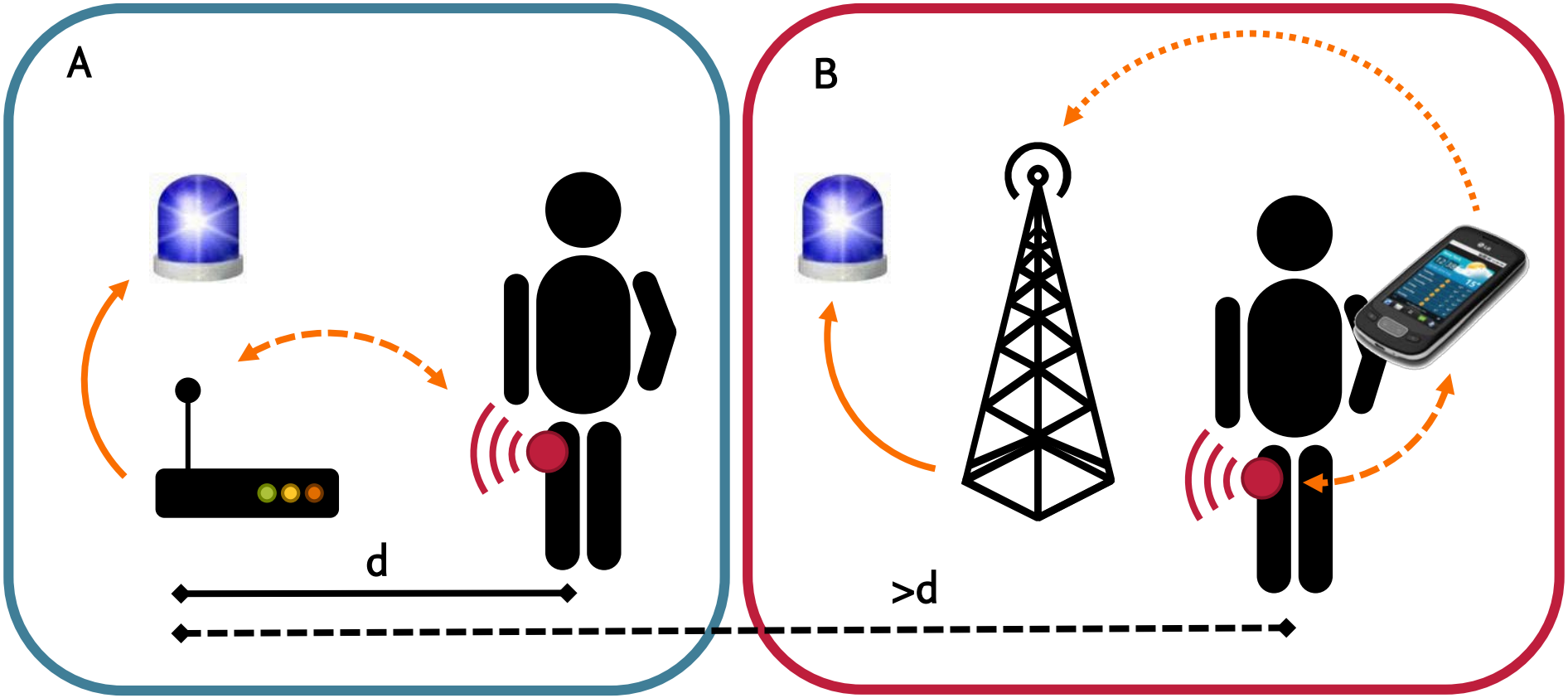
"Pimped" wearable sensor?!

- Adding 2/3/4G communication interfaces
  - Lifetime decreased
  - Cost added

➔ No single device possible

Proposed System: 3 Parts

- One and the same senor for fall detection
- Two systems for emergency calls: Home station & Smartphone



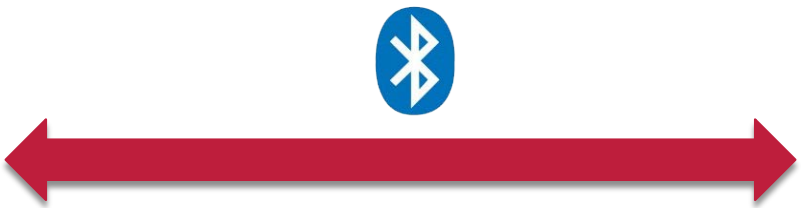
System for Mobile Fall Detection

Android Smartphone: e.g. Motorola Milestone

- ARM Cortex A8 550 MHz, 256 MB RAM, 512 MB ROM
- Accelerometer, Compass, Light-Sensor
- 3G, Bluetooth

INGA Wireless Sensor Node

- 8-bit Microcontroller @ 8 MHz, 16 kB RAM, 128 kB Flash, SD
- Accelerometer, Gyroscope, Barometric Pressure Sensor
- IEEE 802.15.4 radio, additional Bluetooth radio



On the Road…

Emergency Messages

- Sent by Smartphone
- Via 2/3/4G network

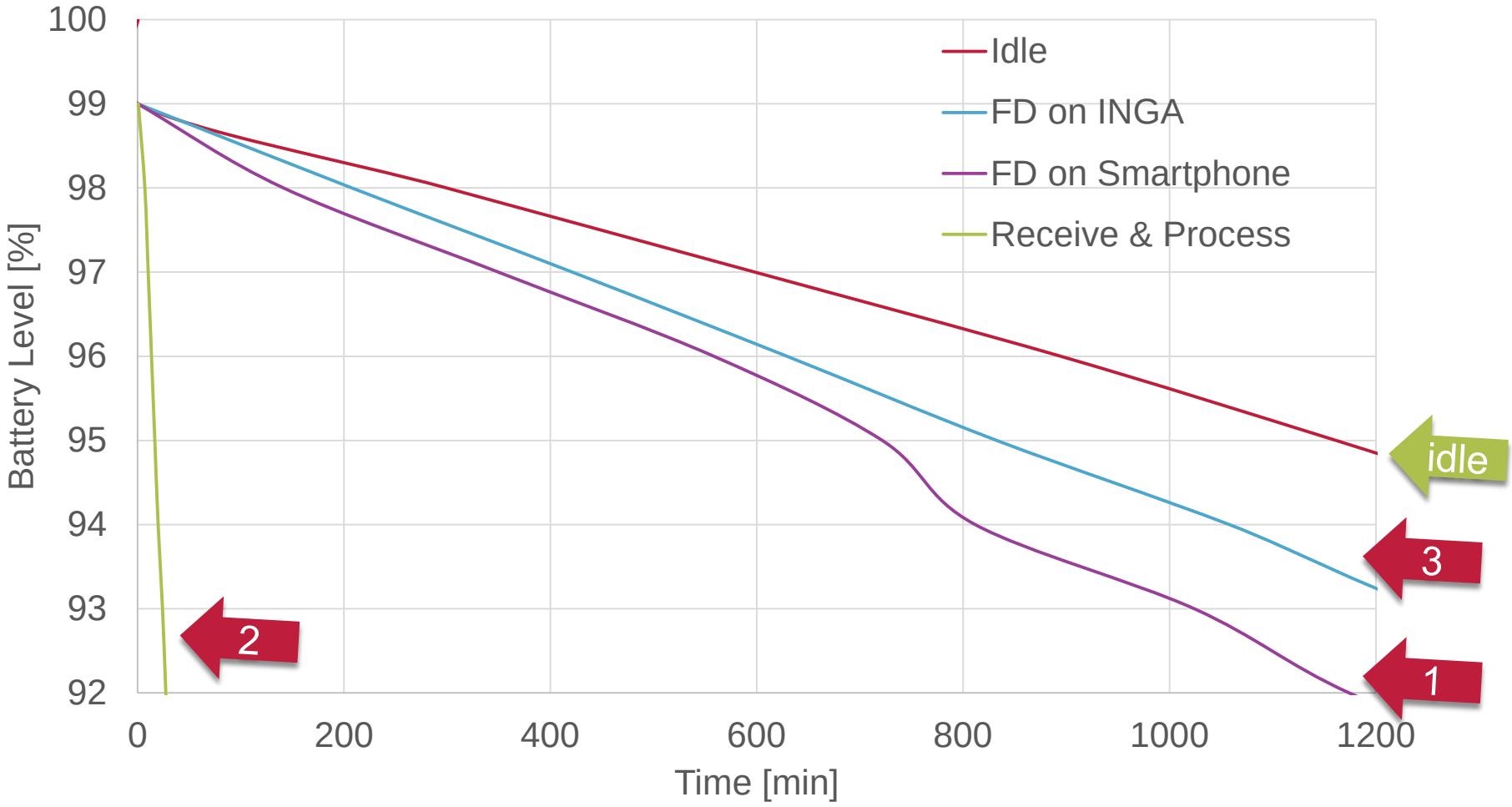
Where to Implement the Mobile Fall Detection?

- Obviously not in the Home Station

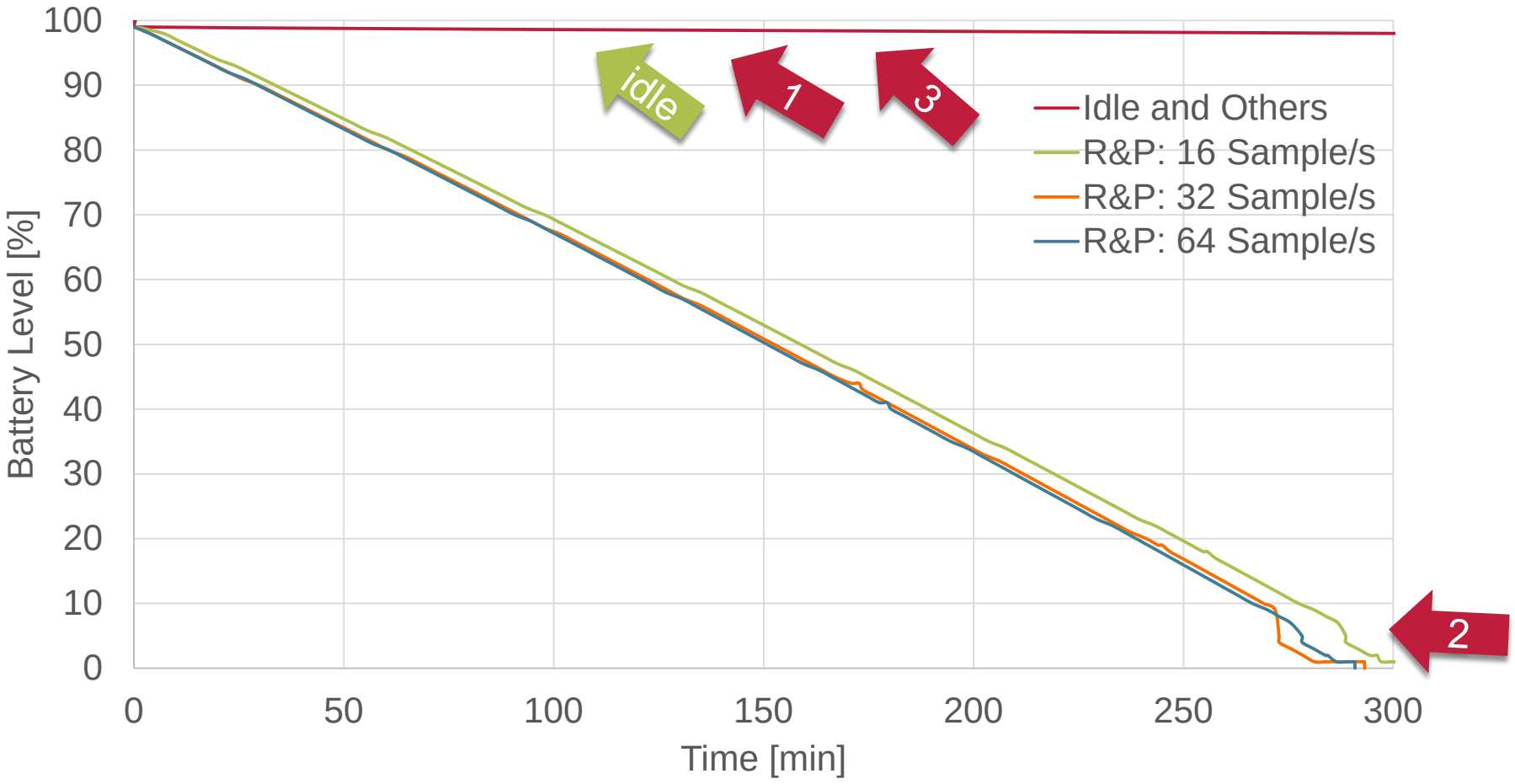
Possible solutions

1. Sensor sampling and fall detection on smartphone
2. Sensor sampling on node, fall detection on smartphone
3. Sensor sampling and fall detection performed by node

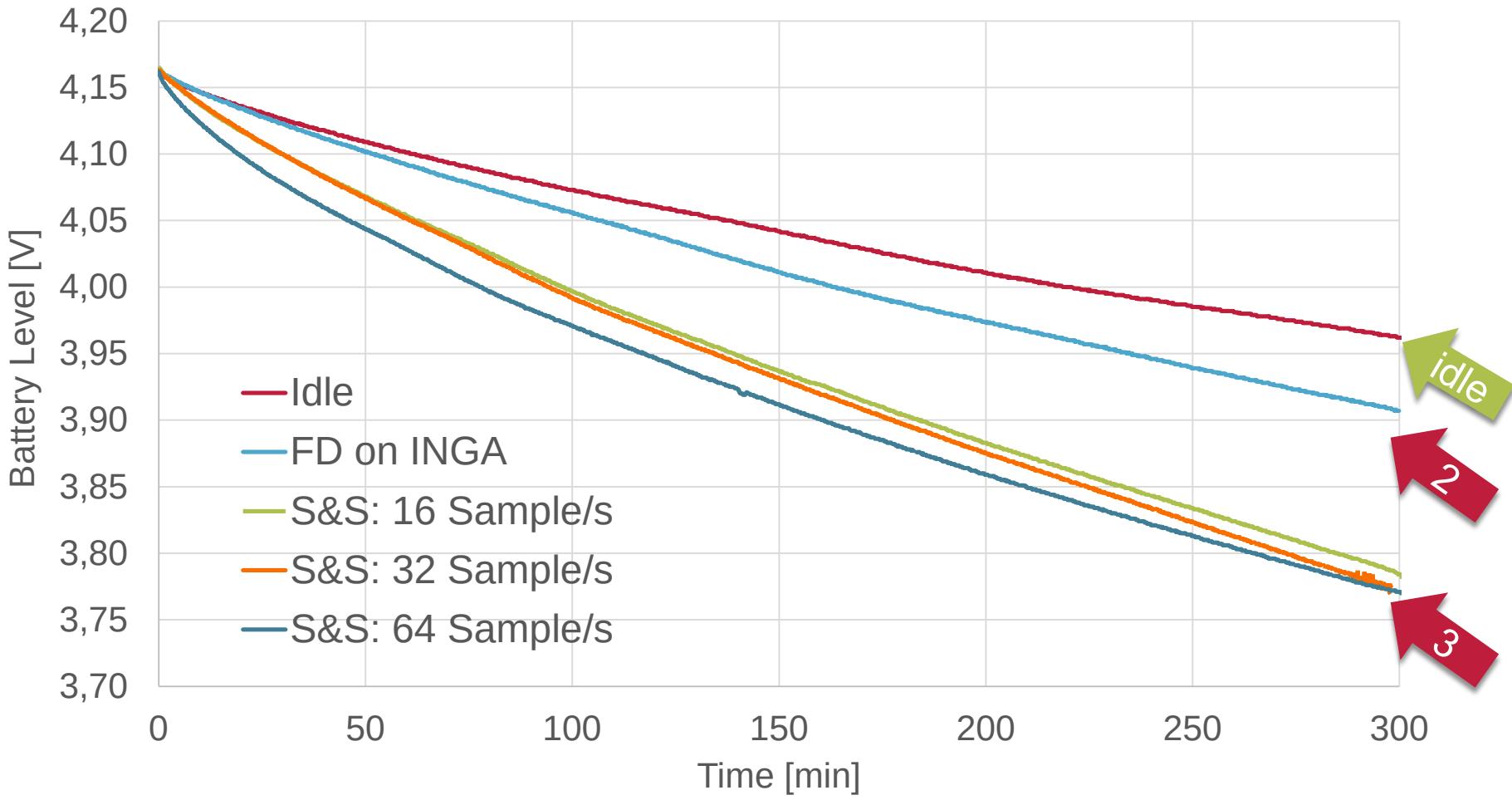
Evaluation: Energy Consumption of Smartphone



Evaluation: Energy Consumption of Smartphone – R&P Detailed



Evaluation: Energy Consumption of INGA Node



Conclusion

Mobile PERS with Fall Detection is needed to …

- Cope with “avoidance behavior”
- Handle “refused” and “anxious usage”

Sensor Node for Data Sampling

- Determined position at body
- One and the same device

Sensor Node for Fall Detection Algorithms

- Takes advantage of interrupt routines
- No continuous transmission -> low energy

Thanks for the attention!

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