HEALTH CARE FOR THE ELDERLY USING IOT

ORACLE

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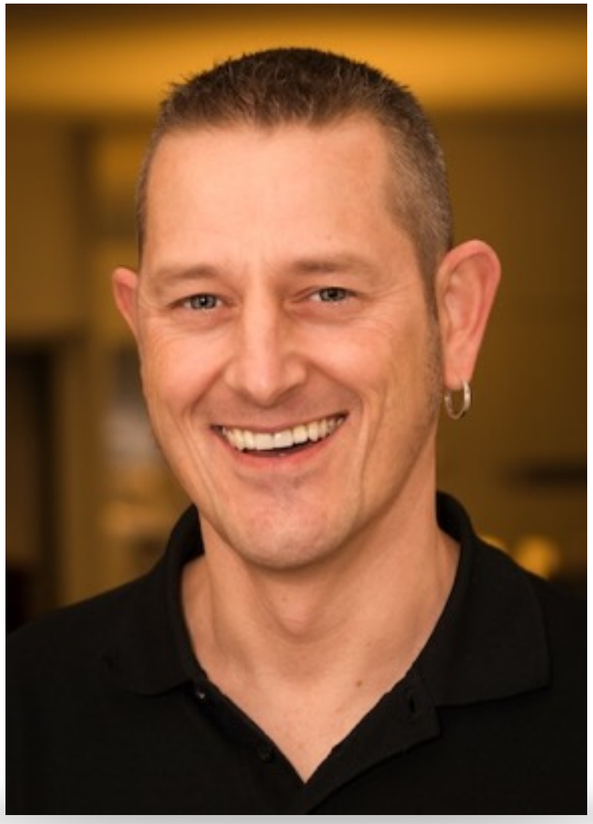

Gerrit Grunwald
Developer Evangelist
Oracle
@hansolo_

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IT'S

BEAUTIFUL

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BUT...

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THERE ARE PROBLEMS

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DEPOPULATION

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DEPOPULATION

- Countryside less popular to people
- Young people moving to the cities
- People in general getting older

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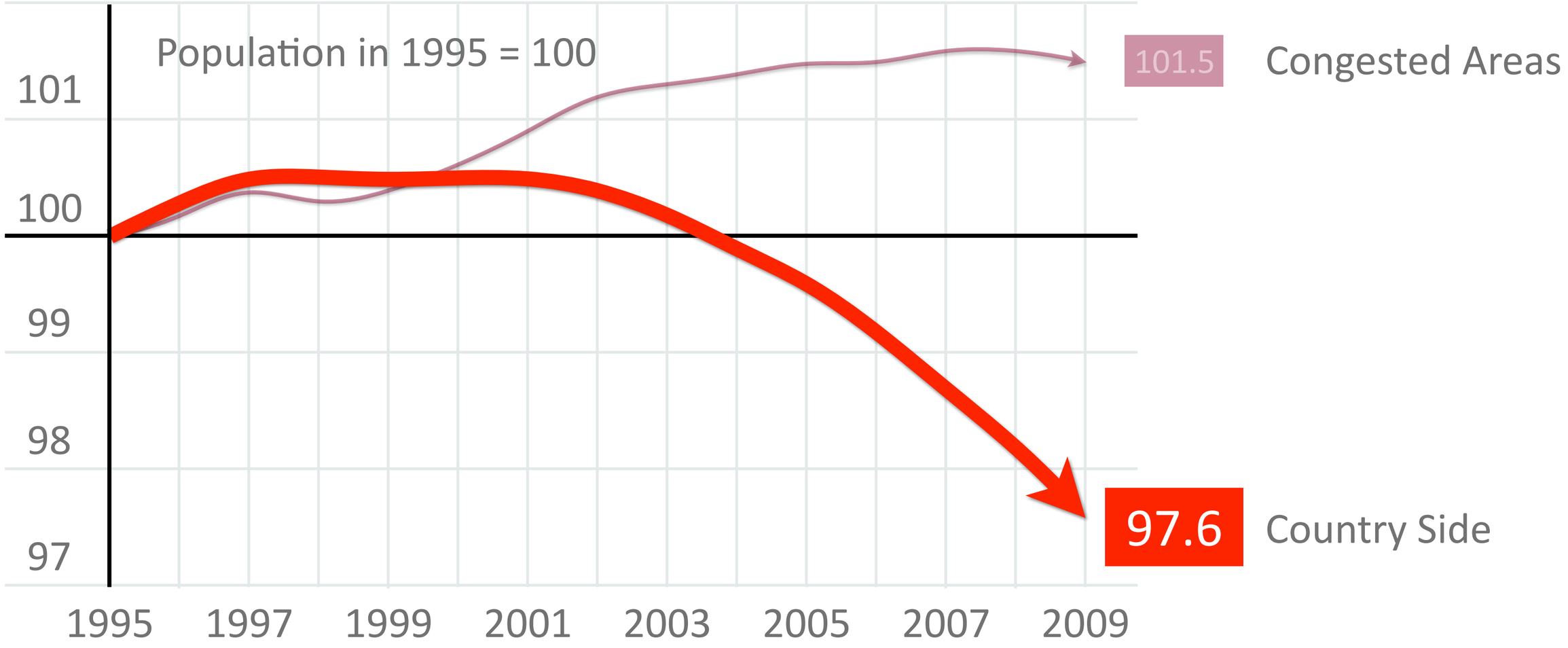
DEPOPULATION (e.g. GERMANY)



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LESS

ACCESS

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LESS ACCESS TO DOCTORS

- In rural areas half as many doctors
- Up to 5 times the distance to access health care services
- Fewer specialized health care services

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AGING

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DREAMS

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OFTEN THE REALITY

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PEOPLE ARE ALONE

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IN CASE OF NEED ?

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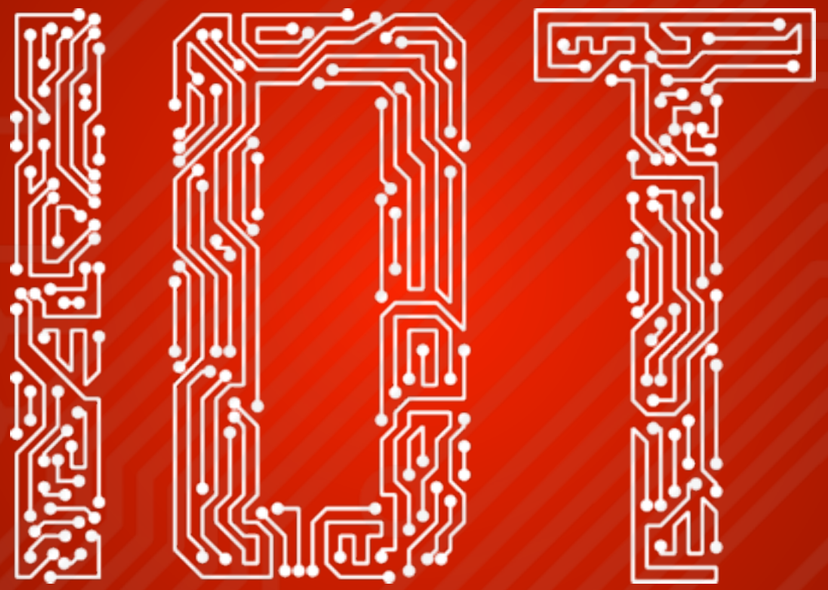

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HEALTH

INDICATORS

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HEALTH INDICATORS

- Steps walked a day
- Rooms changed a day
- Locations visited outside
- Time the TV set was running
- …

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HEALTH

ALERTS

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HEALTH ALERTS

- Dramatic decrease of steps for a longer period
- Room doesn't change anymore and person is at home

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HEALTH ALERTS

- TV is not used at all and person is at home
- Alarm button was triggered by Person

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HEALTH ALERTS

- Location outside doesn't change for long and it is night
- Location outside and bad weather (e.g. very cold etc.)

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HEALTH ALERTS

- and many many more…

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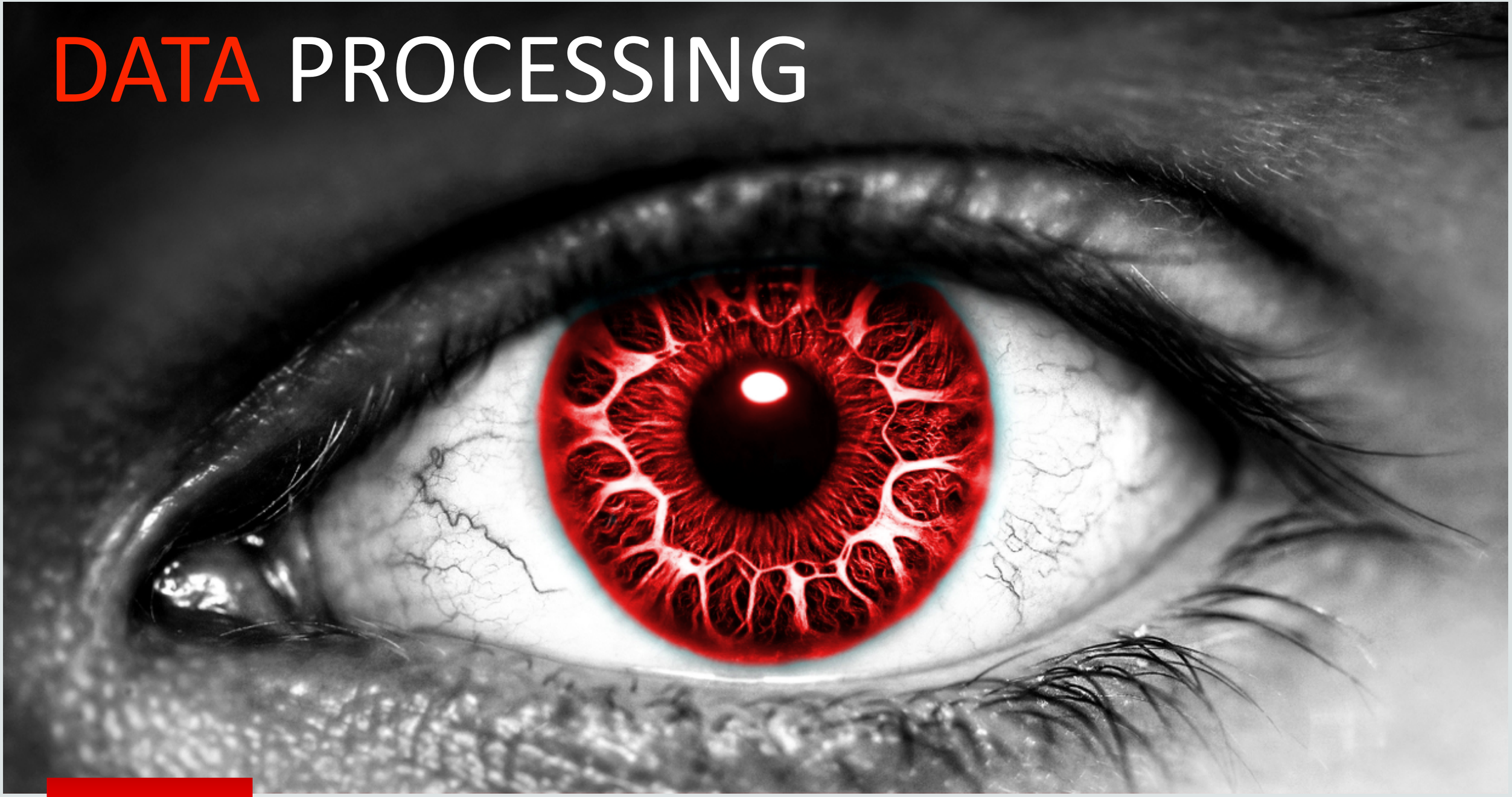
DATA PROCESSING



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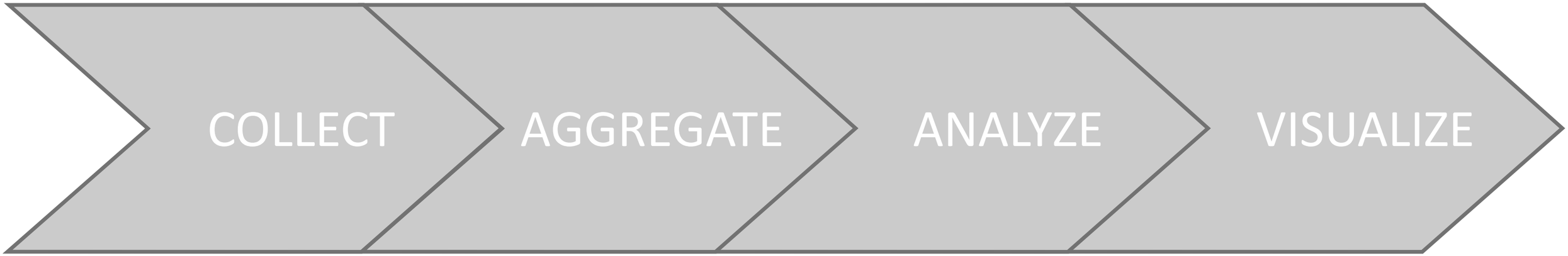
DATA PROCESSING



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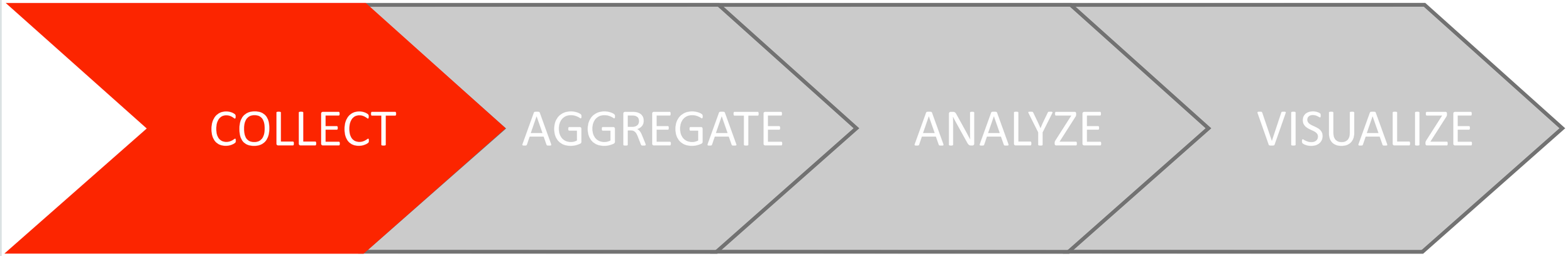
DATA PROCESSING



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COLLECTING

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HARDWARE REQUIREMENTS

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HARDWARE REQUIREMENTS

- Internet connection is crucial
- iBeacons to locate current room
- Accelerometer to count steps
- GPS to locate person outside
- Powermeter to detect TV usage

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IBEACONS

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IBEACONS

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IBEACONS

- Bluetooth Low Energy
- Broadcast unique ID
- Interval 0.1 - 10s
- Trigger location based action
- Useful for indoor navigation

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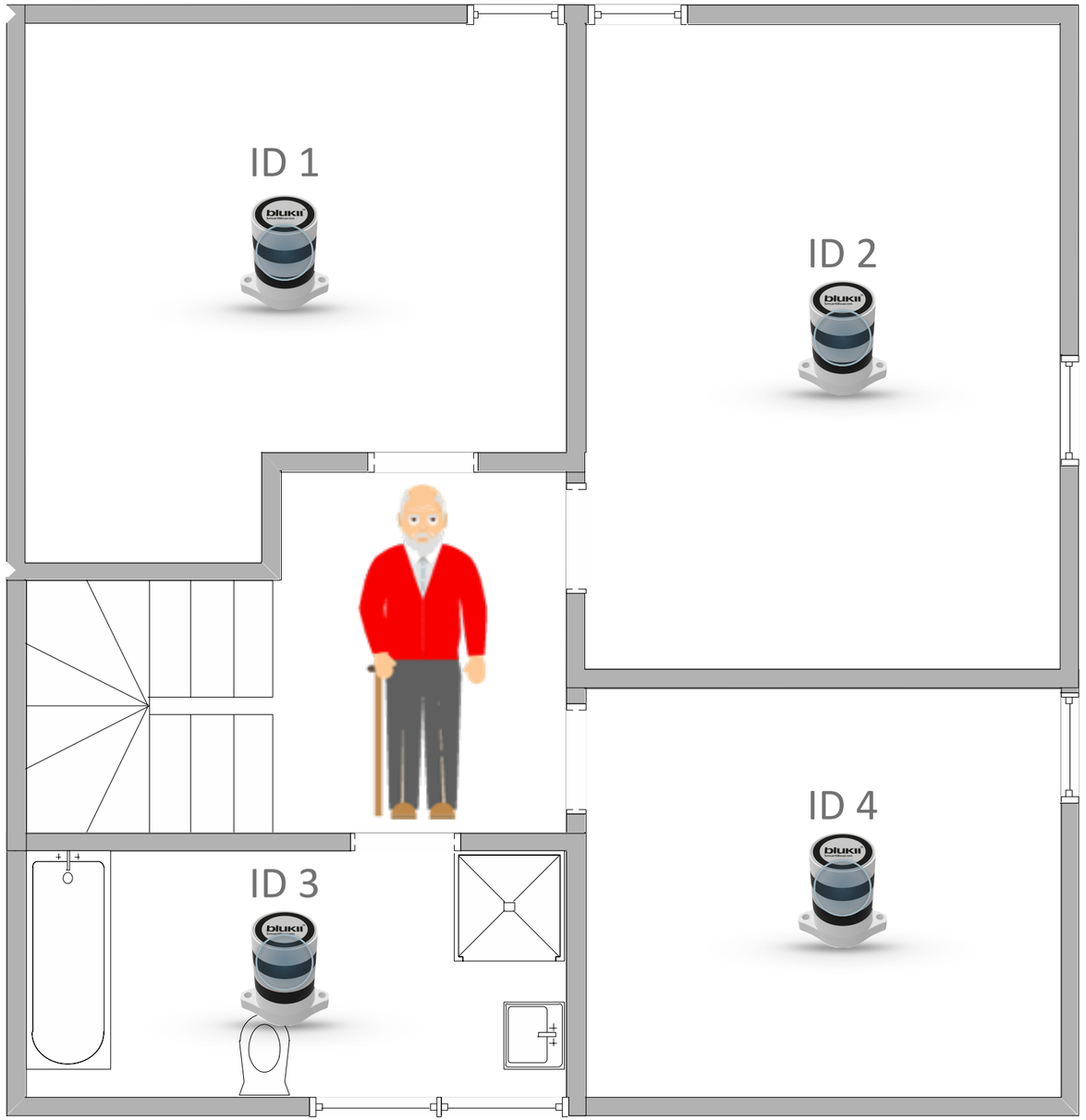
BEACONS

Beacon detection



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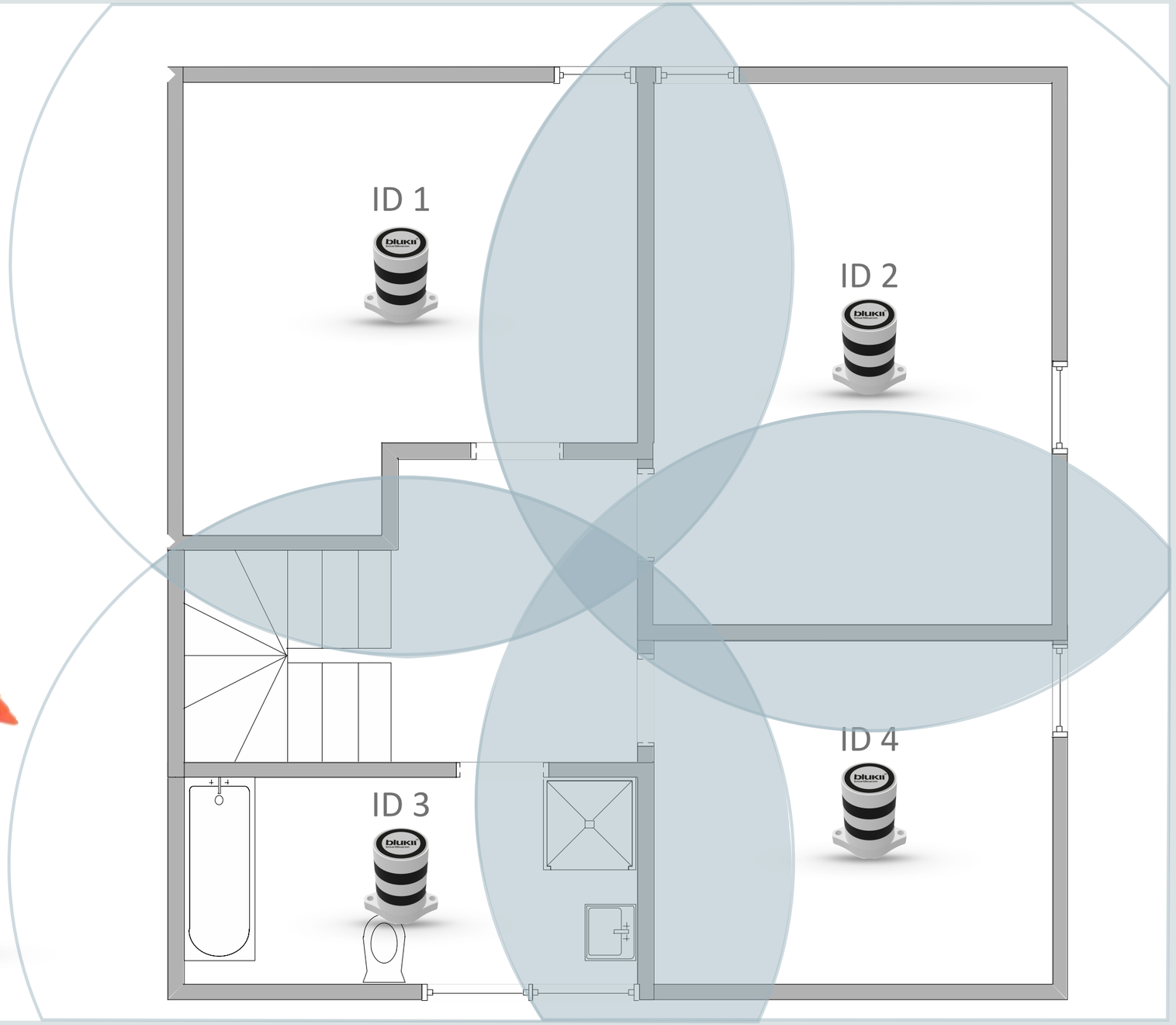
IBEACONS

TX Power to strong



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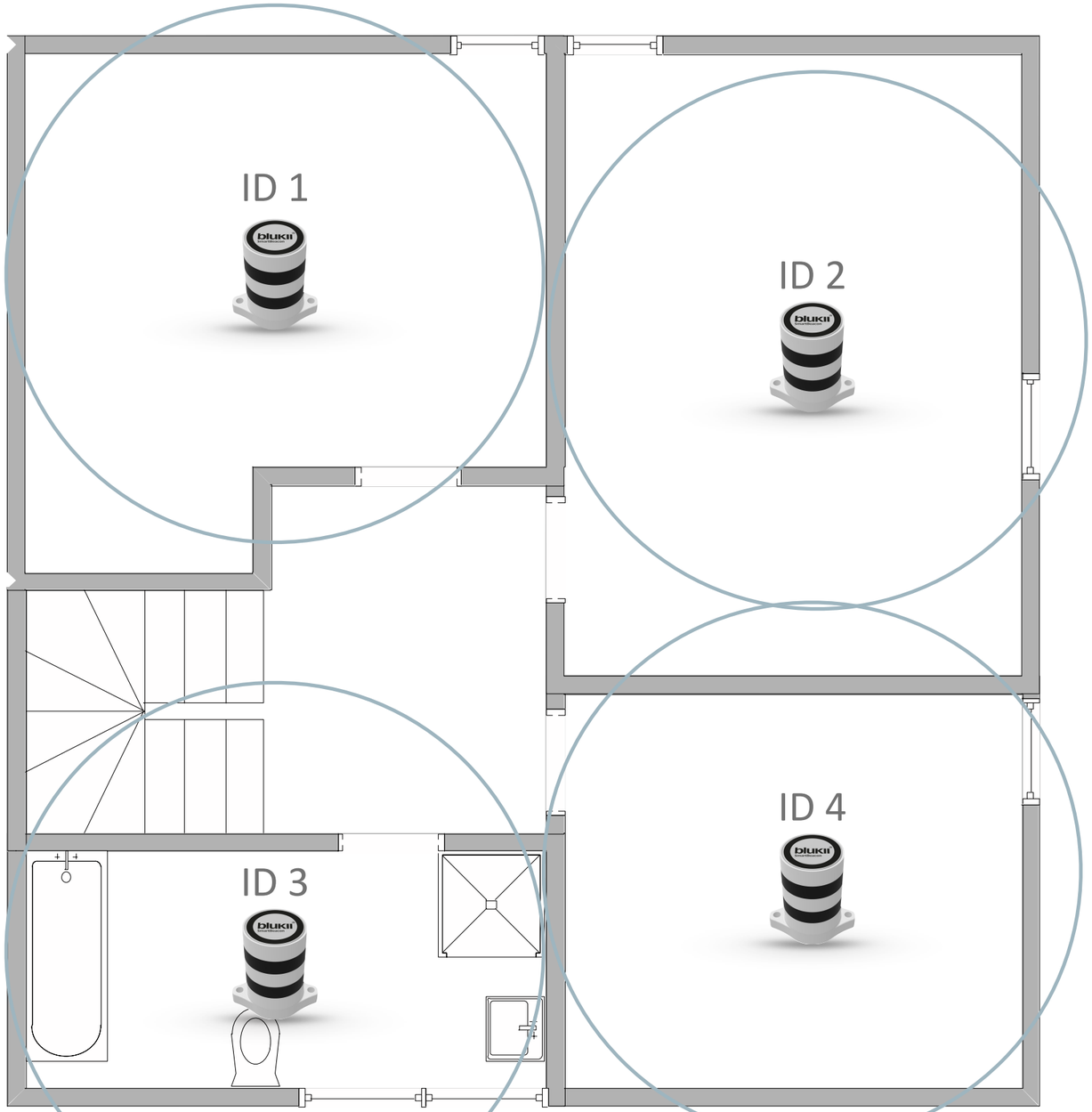
IBEACONS

TX Power less strong



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1ST ATTEMPT

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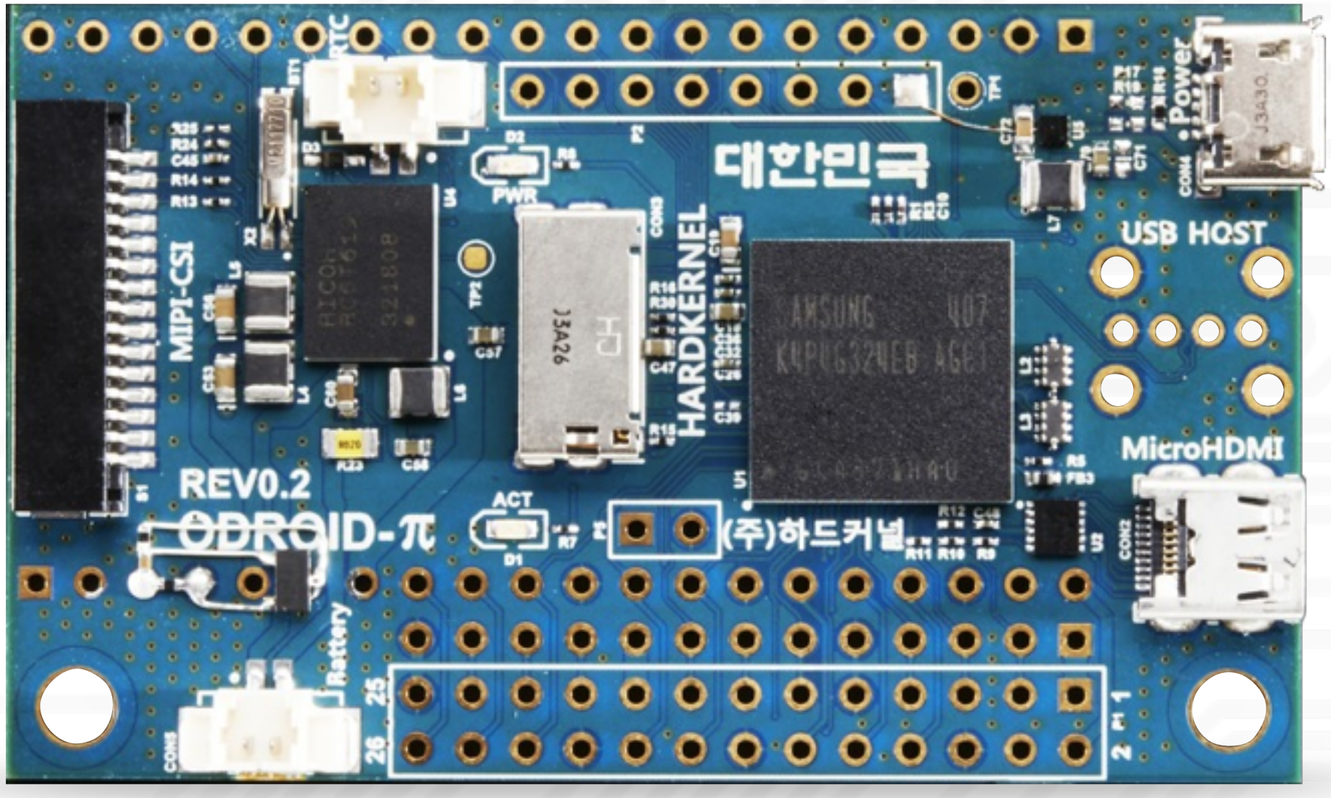
1ST ATTEMPT



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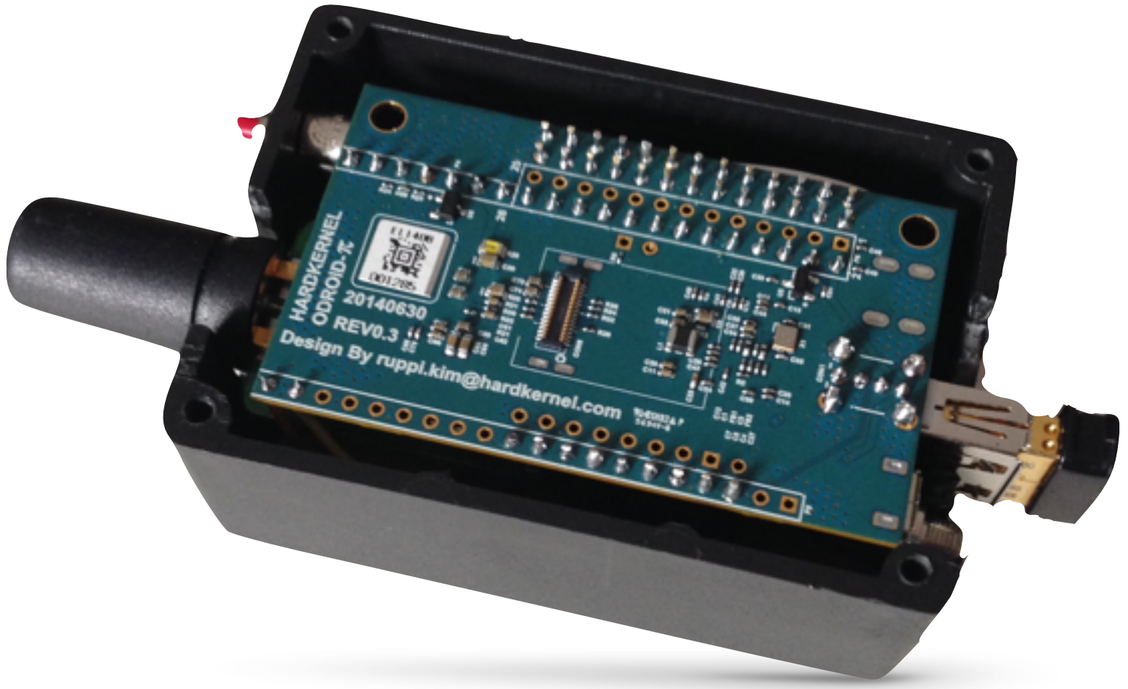
1ST ATTEMPT

- Odroid-W board
- GPS sensor
- BLE adapter
- Accelerometer
- Java SE 8 embedded



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1ST ATTEMPT

- To clunky
- Obtrusive
- Hard to handle
- No interactivity
- Battery life

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2ND ATTEMPT

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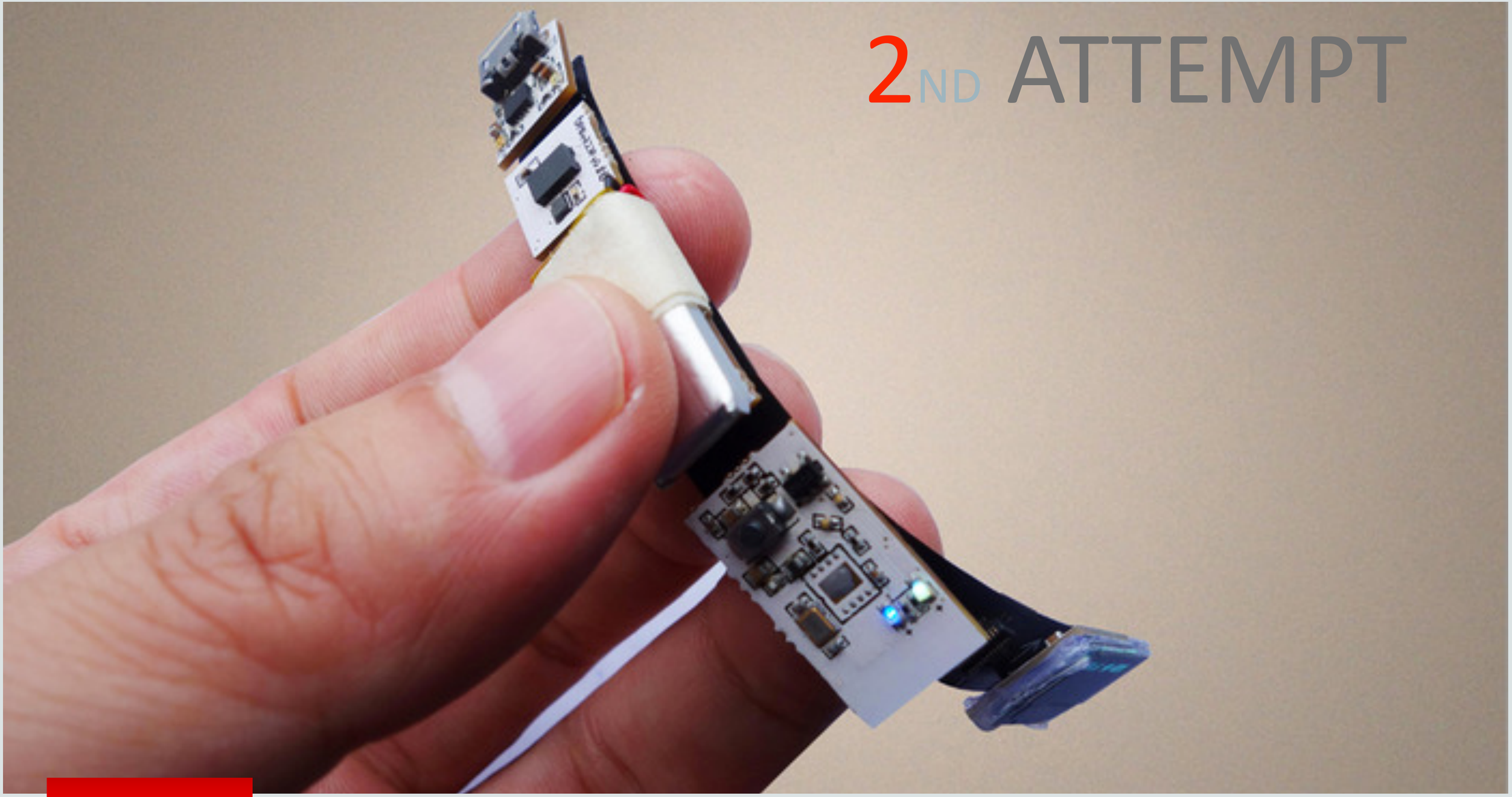
2ND ATTEMPT



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2ND ATTEMPT

- AtomWear
- Accelerometer
- BLE
- Tiny display
- C

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2ND ATTEMPT

- No GPS
- Hard to handle
- No interactivity
- Battery life

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3RD ATTEMPT

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3RD ATTEMPT

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3RD ATTEMPT

- 3G/4G connection
- WiFi + BLE
- Long battery runtime
- Can count steps
- Water resistant

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3RD ATTEMPT

- WiFi + BLE
- Long battery runtime
- Can count steps
- Interacts with phone
- Water resistant

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3RD ATTEMPT

- Flic button(s)
- BLE
- Long battery runtime
- Can trigger alerts
- Multiple buttons possible

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3RD ATTEMPT

- Easy to handle
- BLE and GPS
- Battery life
- Connectivity
- Interactivity

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SOFTWARE REQUIREMENTS

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SOFTWARE REQUIREMENTS

- Detect GPS location and Beacons
- Interact with Flic button
- Aggregate steps
- Call a contact person
- Publish data

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MOBILE APPLICATION

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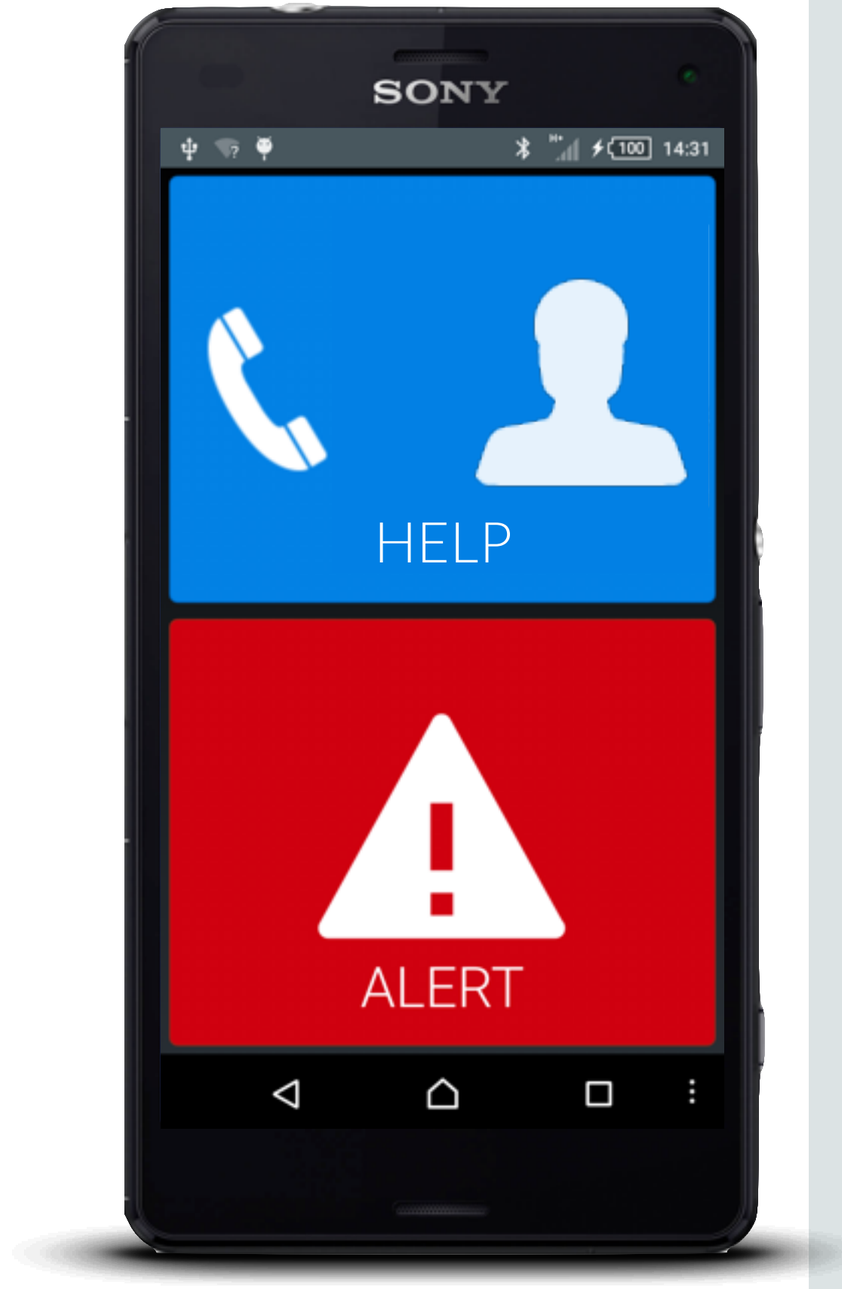
MOBILE APPLICATION SETUP



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MOBILE APPLICATION

- Can call contact person
- Can send Alert message
- Collects steps
- Detect beacons/location
- Has fall detection

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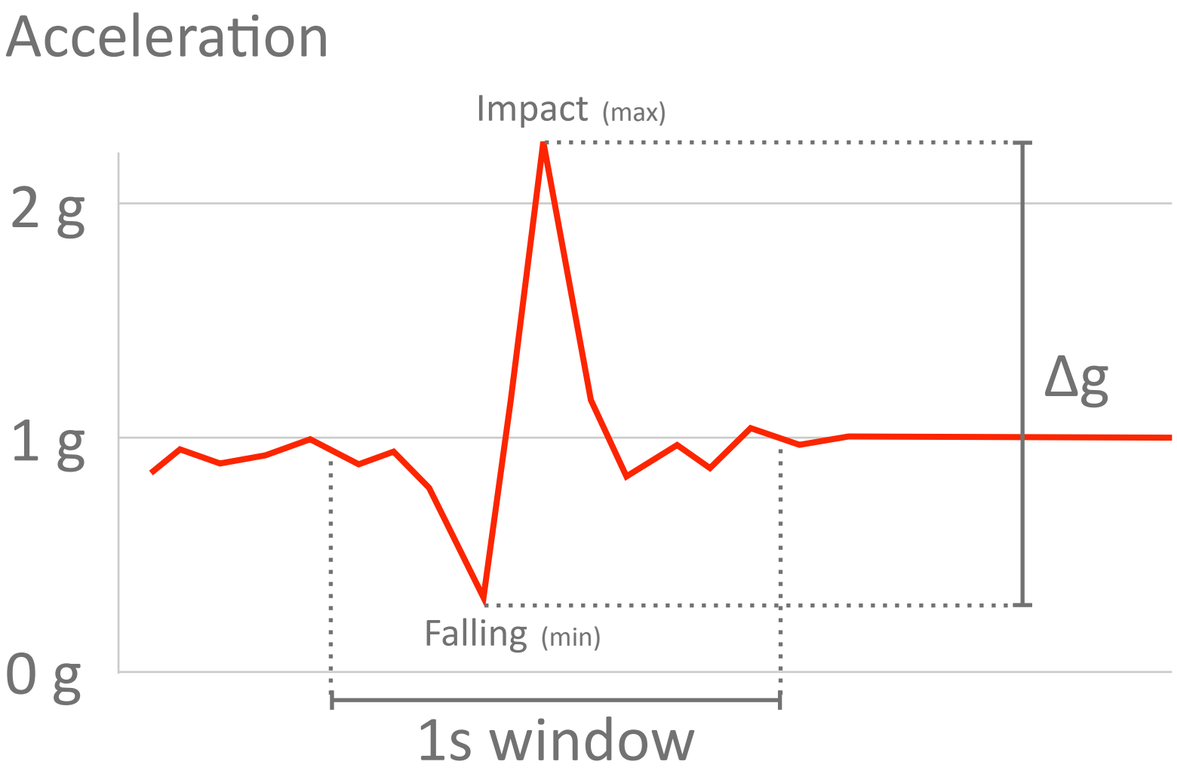
FALL DETECTION



- Fall detection
- Posture recognition
- Hit rate 85%

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WEAR

APPLICATION

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WEAR APPLICATION

- Call contact person
- Send Alert message
- Collects steps
- Interact with phone via BLE and WiFi

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WEAR APPLICATION

- Can be triggered by Watchface

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FLIC
BUTTON

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FLIC BUTTON

- Can trigger an Alert
- Interact with phone via BLE

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YOCTO WATT

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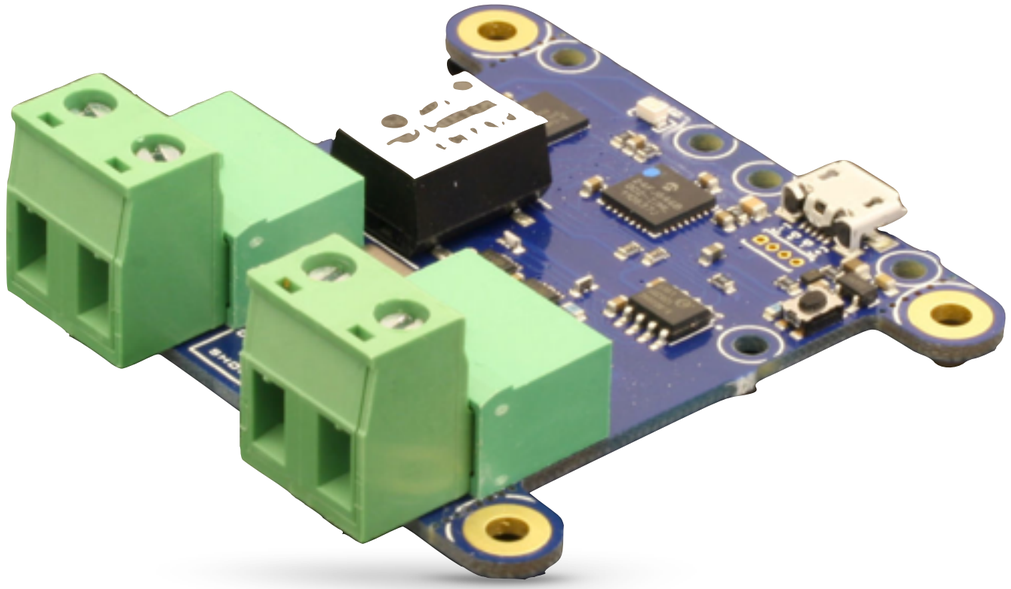
YOCTOWATT

- Measures power consumption
- Interact with phone/ gateway via WiFi



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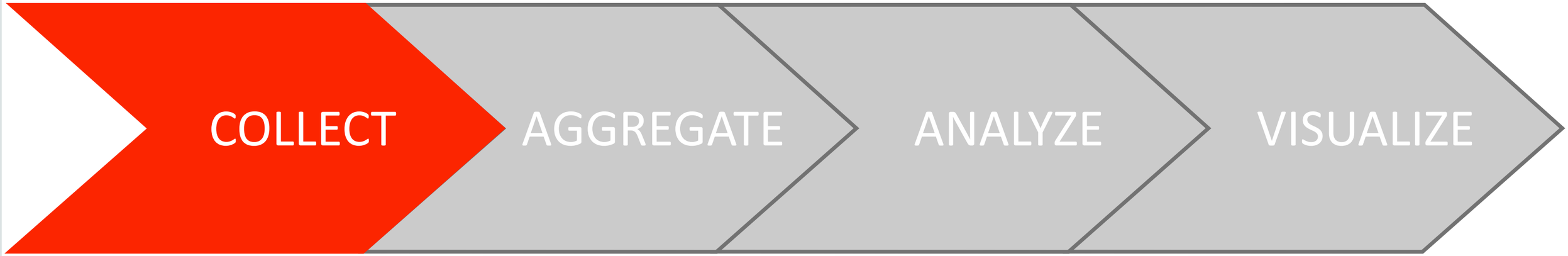
DATA PROCESSING



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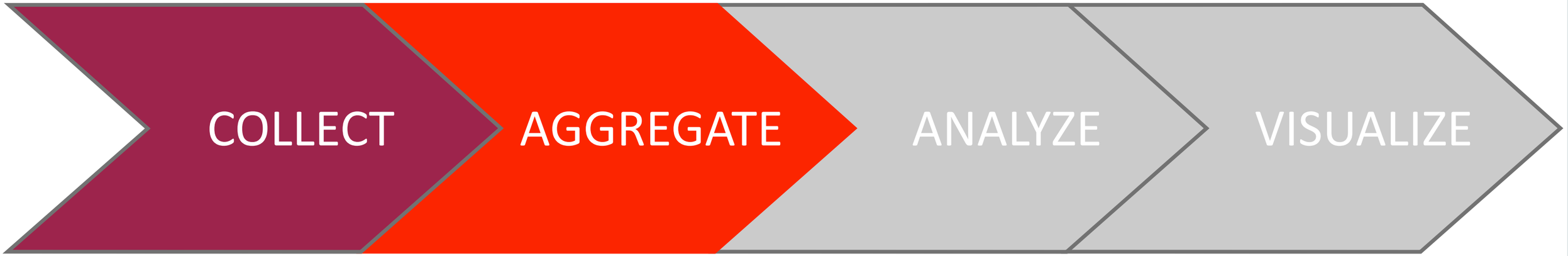
DATA PROCESSING



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AGGREGATING

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IOT

GATEWAY

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IOT GATEWAY

- ARM based Single Board Computer
- i.MX6 Quad 1GHz
- 4 GB RAM
- Java SE 8 emb.

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IOT GATEWAY

- GeoFence Server
- Aggregates data (direct, mqtt)
- Filters data
- Forwards data

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GEO FENCING

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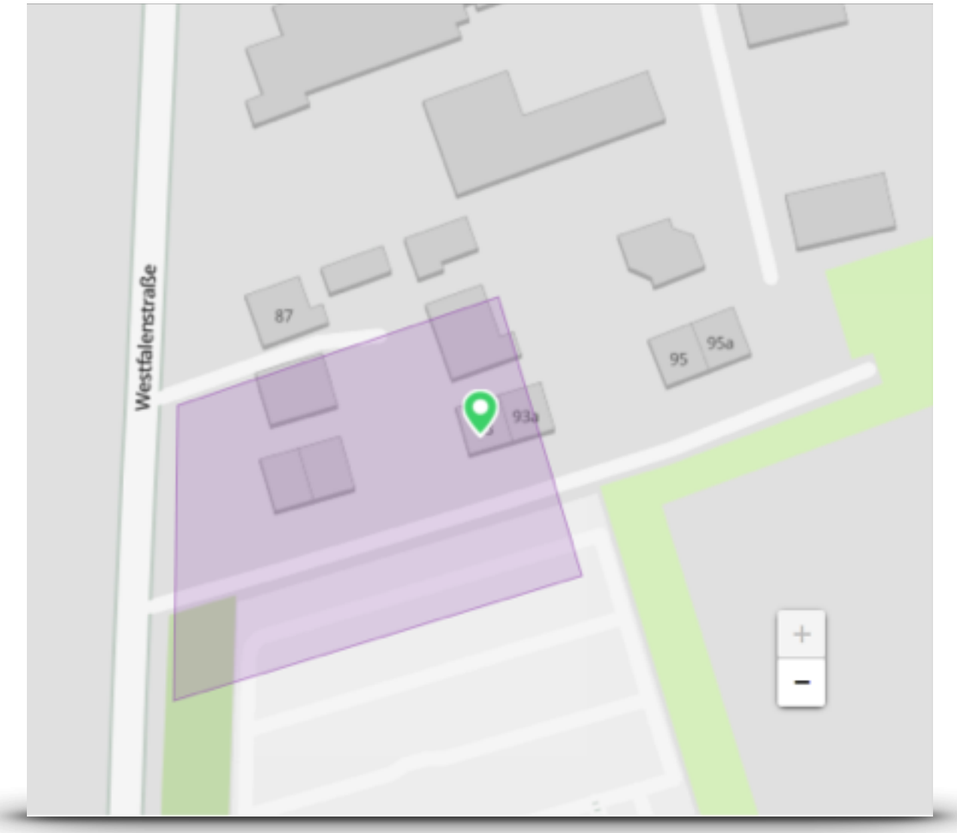
GEO FENCING

- Receives location
- Check against fences
- React on entering or leaving a fence



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AGGREGATING

DATA

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AGGREGATING DATA

- From directly connected sensors (TV set)
- From mobile phone via MQTT
- From GeoFence server via MQTT

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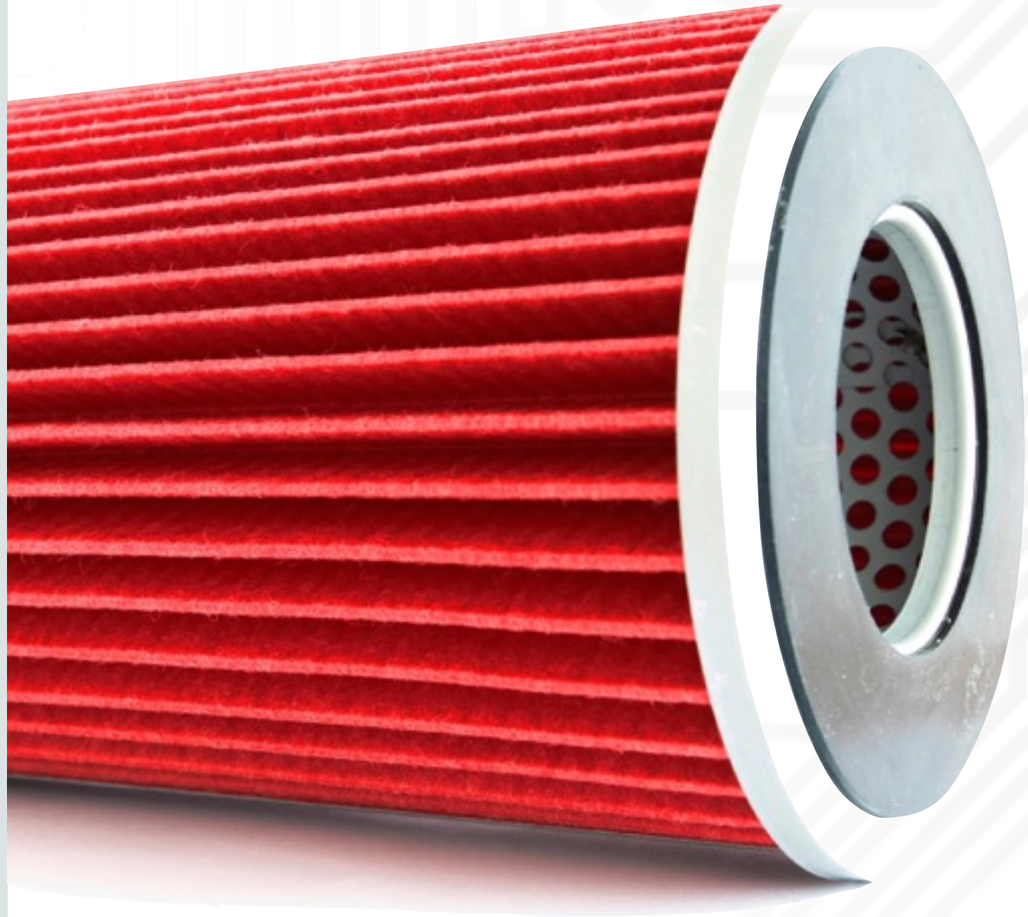

FILTERING DATA

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FILTERING DATA

- Filter faulty sensor data
  (wrong TV power consumption readings)
- Filter wrong location data
  (jumping location due to bad gps signal)
- Filter geo fence data
  (toggle between inside/outside fence due to bad gps)

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DATA FORWARDING

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DATA FORWARDING

- Forwards filtered person data via REST
  (used in visualization app)
- Forwards filtered data to a database
  (aggregated steps are stored once a day)

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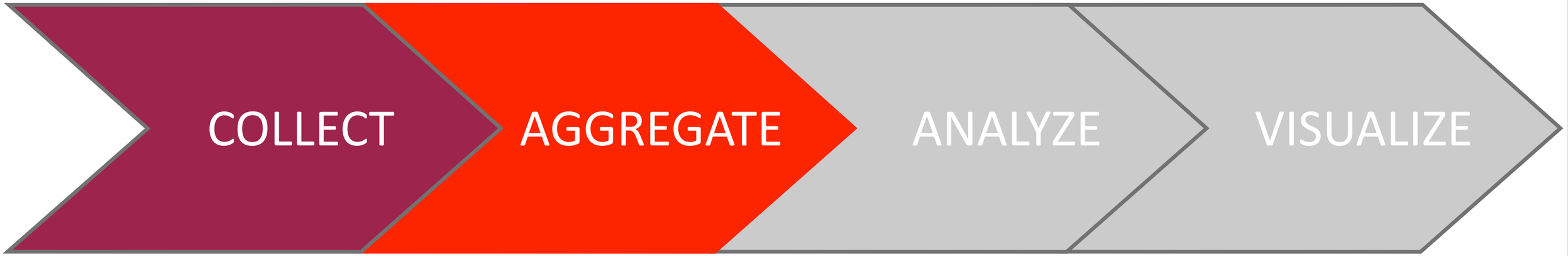
DATA PROCESSING



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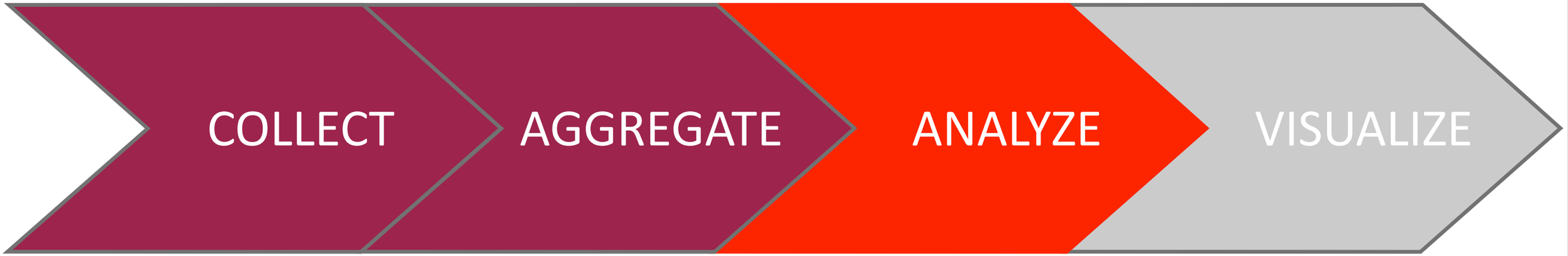
DATA PROCESSING



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ANALYZING

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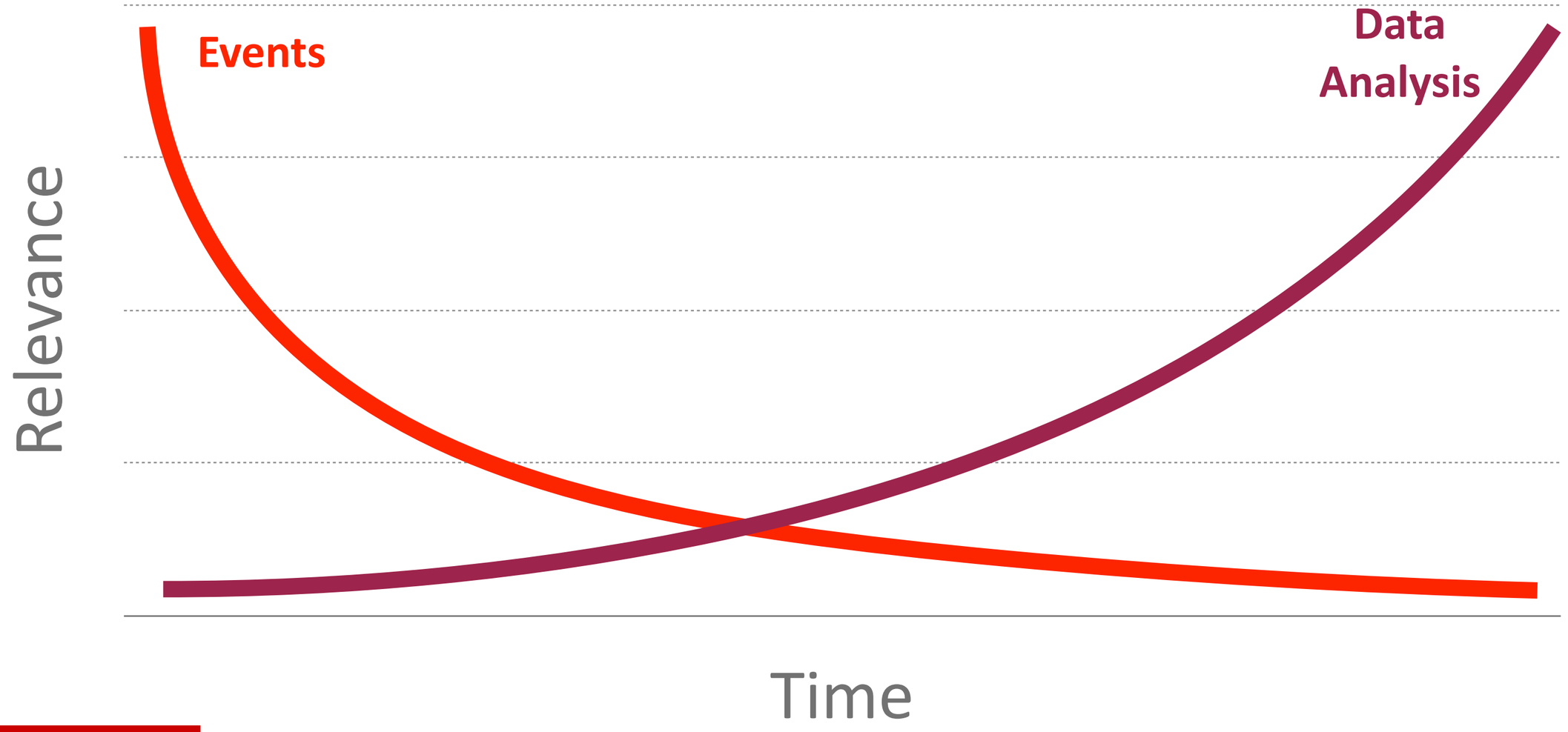
ANALYZING



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ANALYZING

- Simulation Dataset
- 5,000 people x 3 months history x 5 minute event interval
- 129 Million Events

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(spark.apache.org)

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- General purpose cluster computing system
- Started in AMPLab at University of California, Berkeley in 2008
- Open sourced in 2009

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- Engine written in Scala with API support for Scala, Java, Python and R (as of version 1.5)
- Core engine with modules

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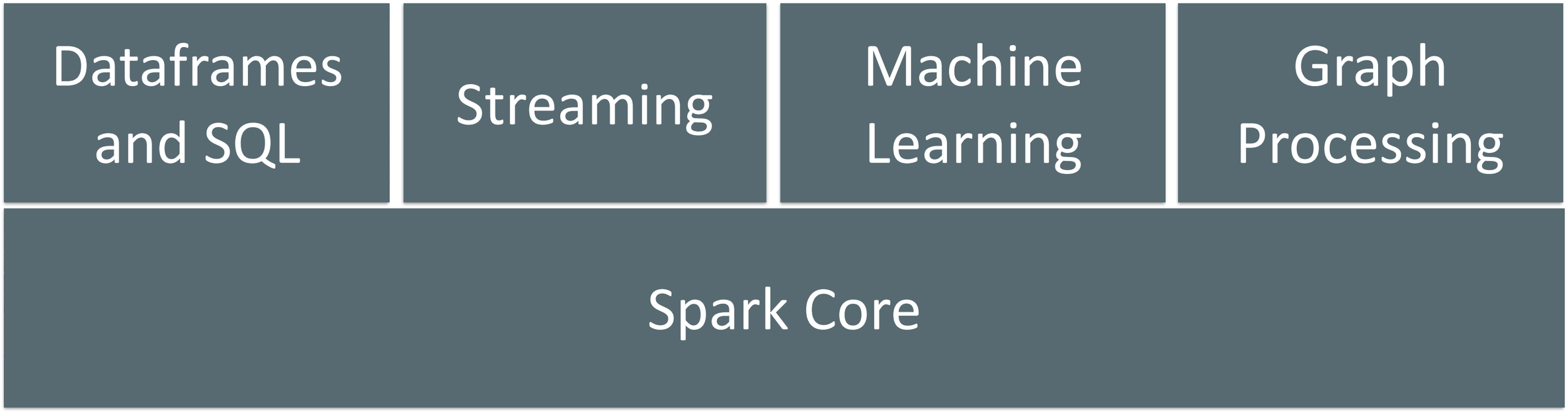
Architecture



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- Supports >80 data analysis algorithms
- map-reduce, groupBy, fold, join, count, union, sum,…
- Data from HDFS, Cassandra, SQL, Streams and many others

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RESILIENT DISTRIBUTED DATASETS

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Resilient Distributed Datasets

- Fault tolerant collection of elements
- Can be operated on in parallel
- Immutable once constructed
- Lazily Evaluated

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TRANSFORMATIONS & ACTIONS

- Transformations
  (construct new RDDs)
- Actions
  (Compute a Result)

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TRANSFORMATION EXAMPLE

- filter (func)

  (return a new dataset formed by selecting those elements of the source on which func returns true)

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ACTION EXAMPLE

- collect()

  (returns all elements as a collection)

- count()

  (returns the number of elements)

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```
// Java 8 with lambda
JavaRDD<String> lines = sc.textFile("hdfs://log.txt")
                          .filter(s -> s.contains("error"));
long numErrors = lines.count();
```

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BRINGING IT TOGETHER

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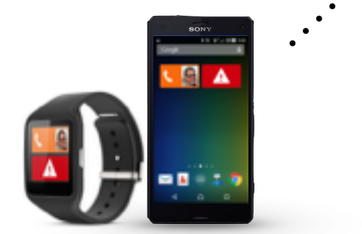
DEVICE

DEVICE



DEVICE

MQTT.ORG

BROKER

Spark Stream Processing

Historical Baseline Dataframe

Anomaly Detection Algorithm

"Suspicious Events"

REST

"Normal Events"

Historical Data

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RULES

- Usually person walks 4500 steps a day
- Usually person is going to the supermarket every Tuesday
- Person uses TV for 5h a day

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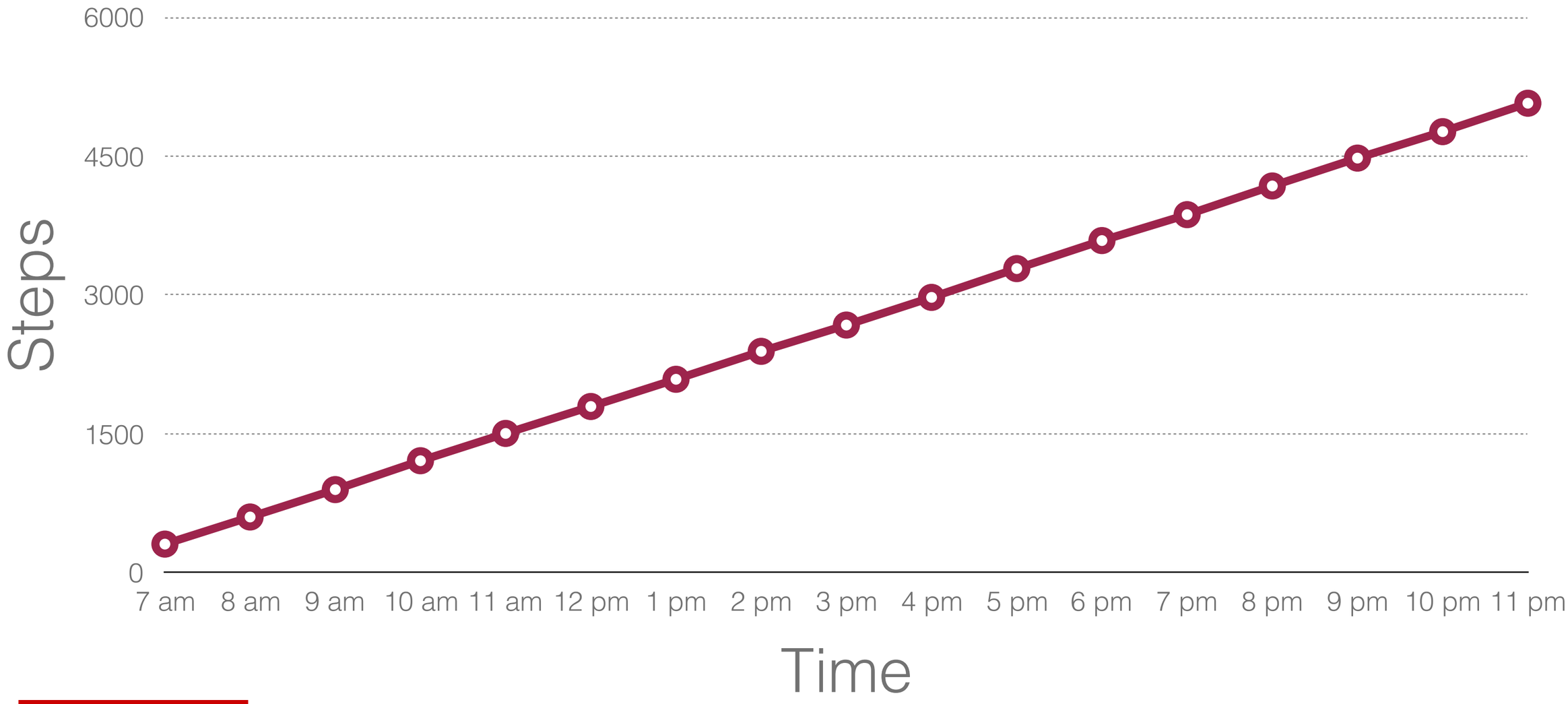
Individual Base Line



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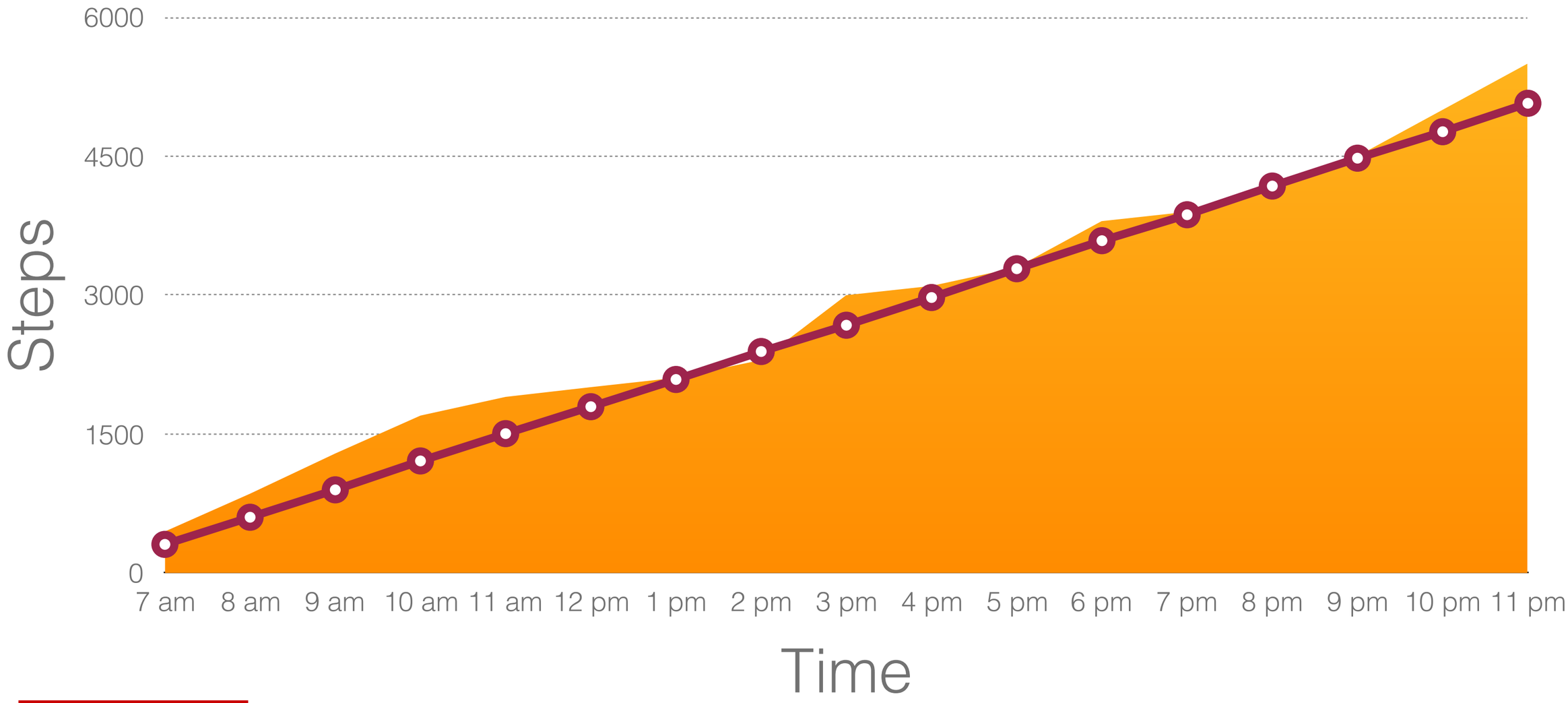
Daily Steps Within Typical Range



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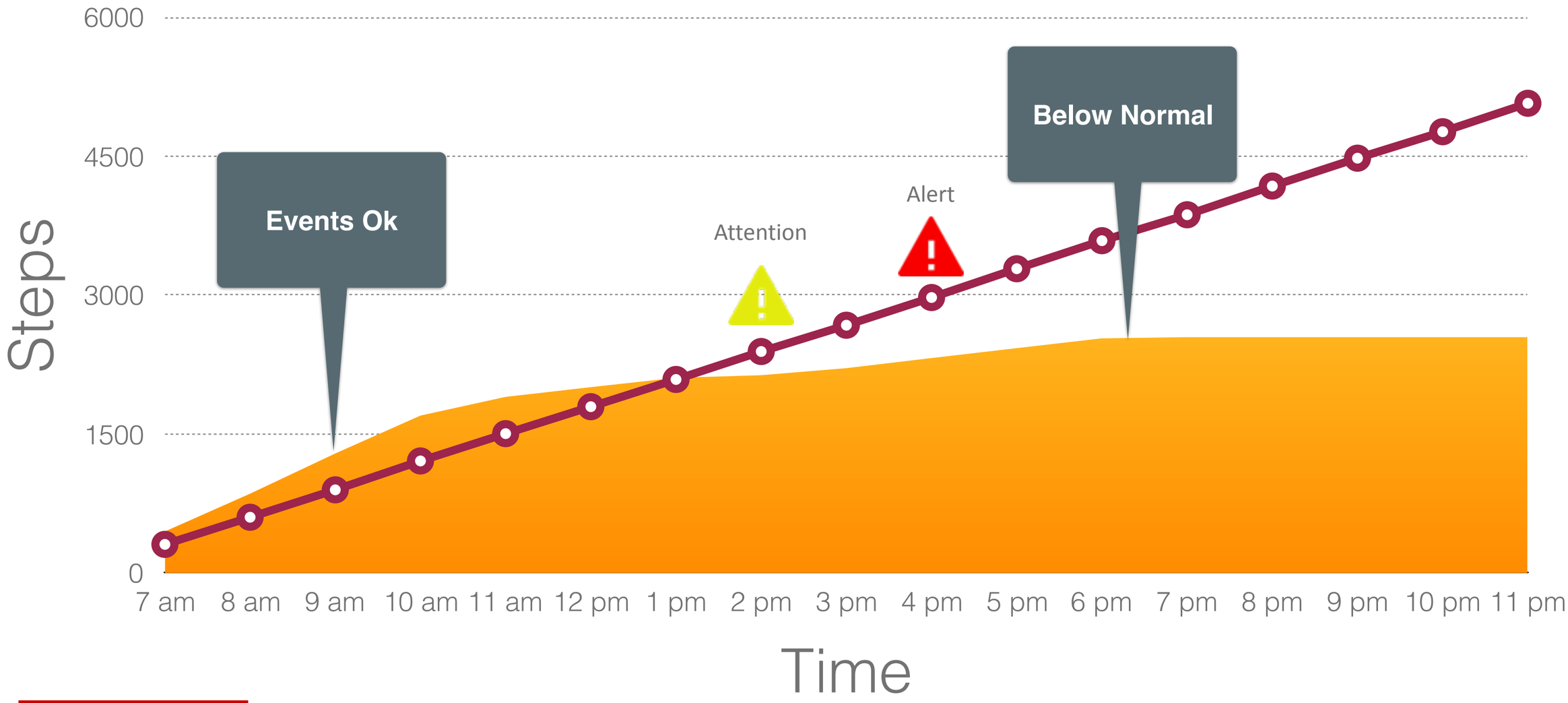
Daily Steps With Potential Anomaly



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DATA PROCESSING

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VISUALIZING

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JavaFx CLIENT

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JavaFx CLIENT

- Cross platform desktop client
- Show last known location
- Show information of person
- Show information of contact person
- Data via SSE from Application Server

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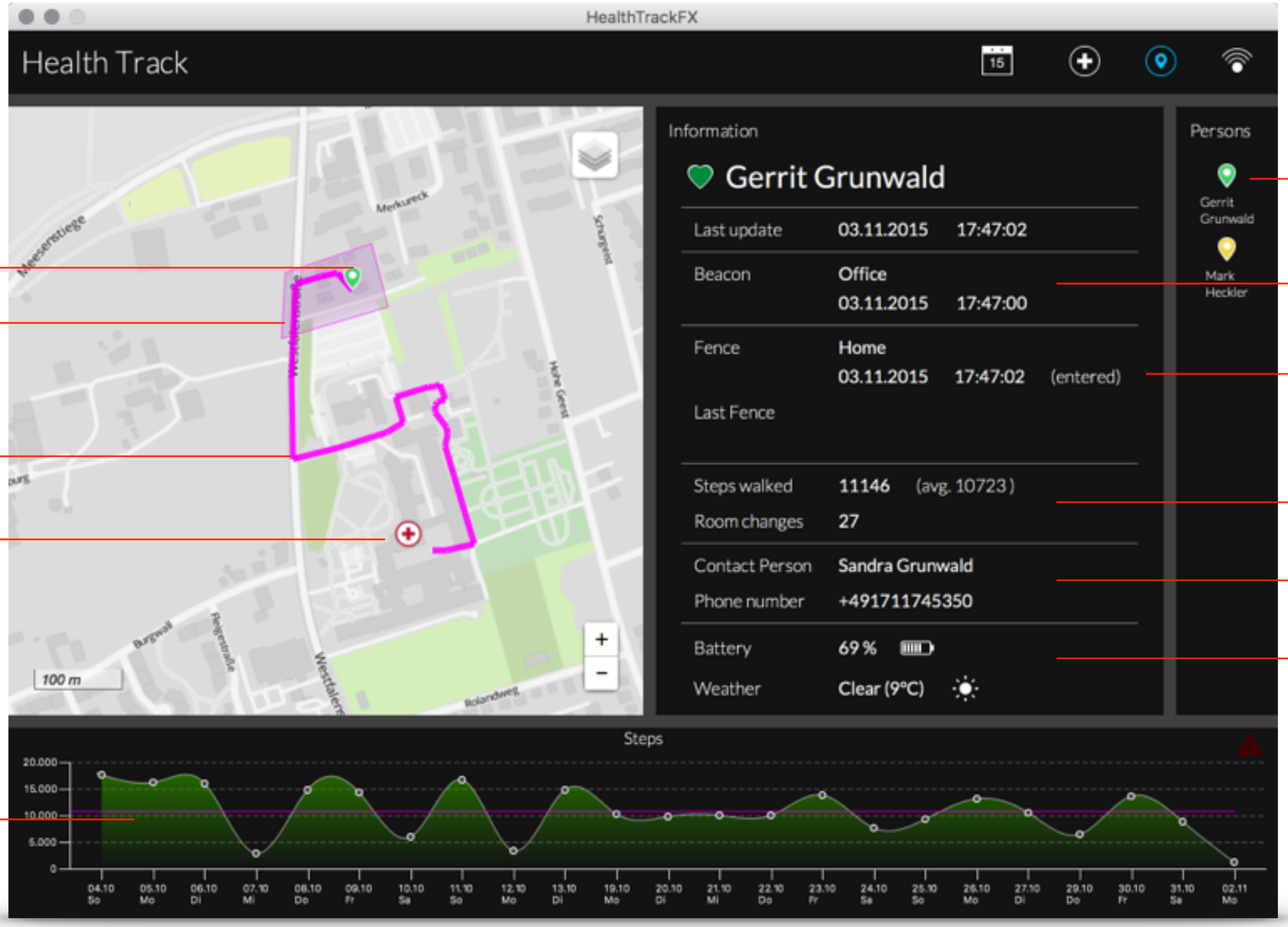
JavaFX CLIENT



Location
GeoFence

Routing

Nearest hospital

Steps walked

Persons

Current Room

Current Fence

Steps today

Contact Person

Battery, Weather, Day/Night

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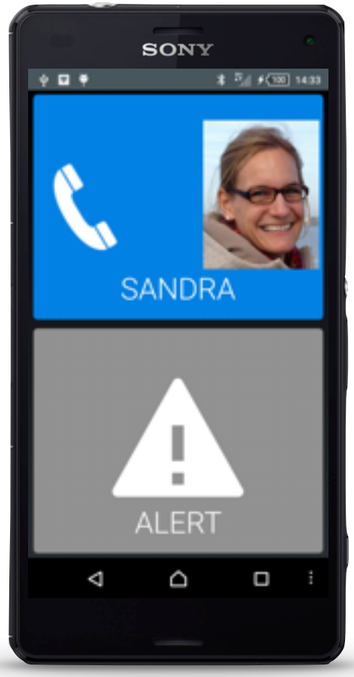
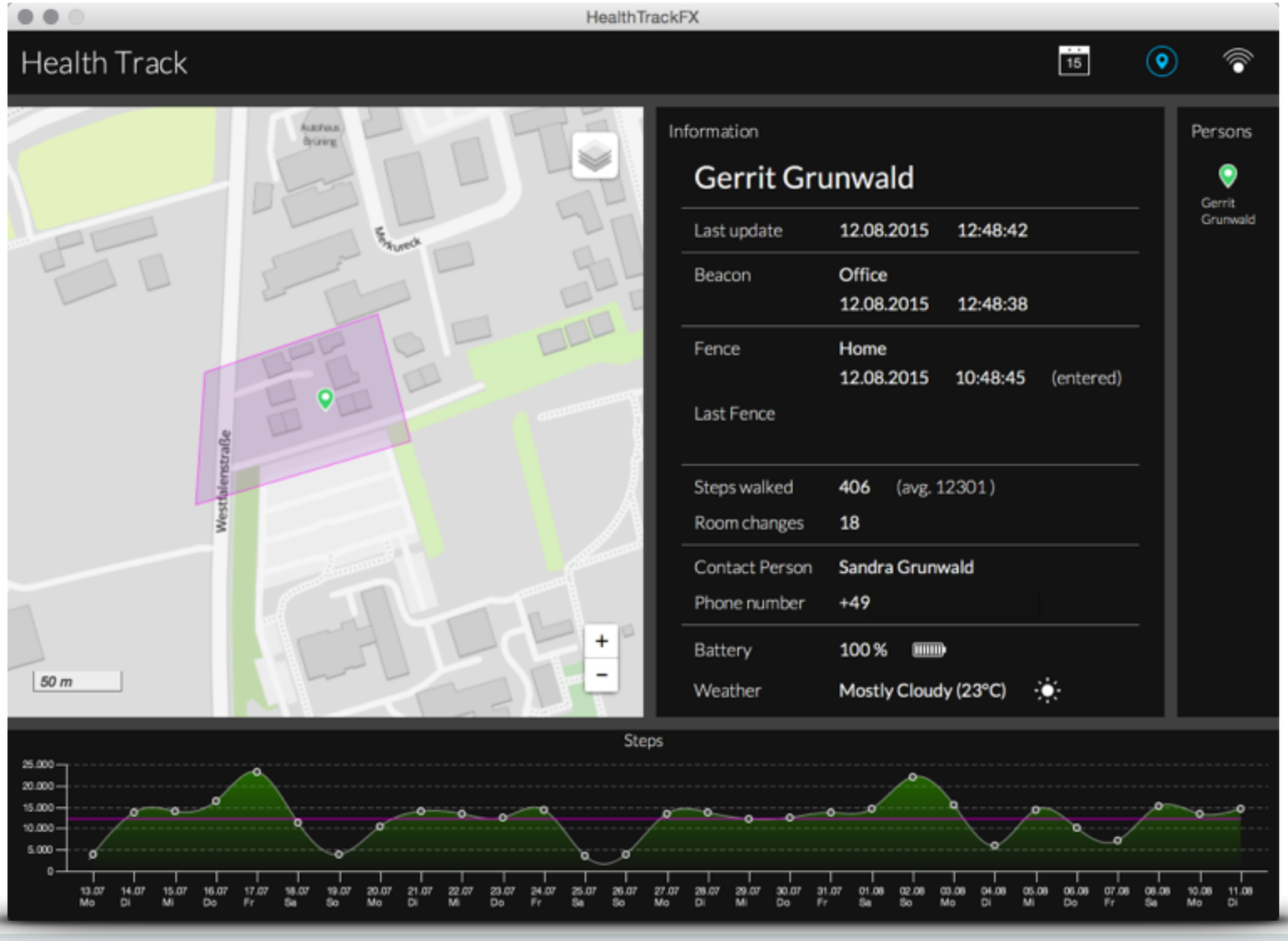
JavaFX CLIENT





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SETUP

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GATEWAY APPROACH

BLE

COLLECT

MQTT

MQTT.ORG

BROKER

MQTT

Spark

ANALYZE

VISUALIZE

MQTT

REST

REST

SSE

WiFi

AGGREGATE

REST

SERVER

REST

3rd PARTY

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MQTT

VISUALIZE

SSE

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IoT
Cloud Service

ANALYZE

REST

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REST

IoT
Cloud Service

ANALYZE

REST

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IoT
Cloud Service

ANALYZE

AGGREGATE

SSE

VISUALIZE

REST

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WiFi

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IOT CAN BE HELPFUL BUT…

- Devices have to be more unobtrusive
- Technology must be more easy
- Problematic to convince people
- Data Privacy and Security are critical
- Rural internet access is crucial

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