



28/01/2020

I-IOT low power

Smart Dumbbell

Yves De Boeck

Mohammad Amir

Gauthier de Borrekens

Wouter Jacobin

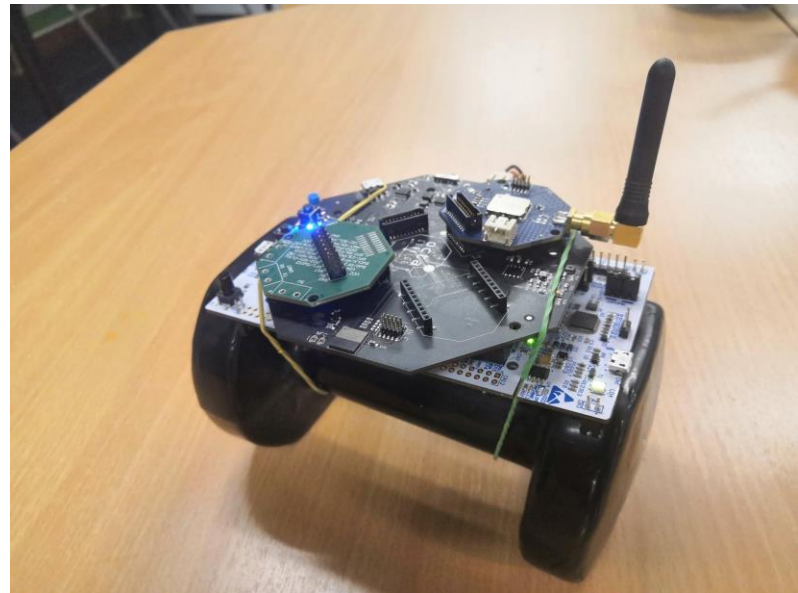
Goals and requirements

A low power IOT device capable of:

- Indoor localization 
- Outdoor localization  GPS 
- Configuration via 
- Communication via 
- Communication via 
- Visualisation via 

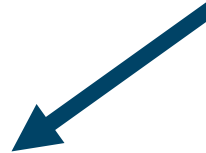
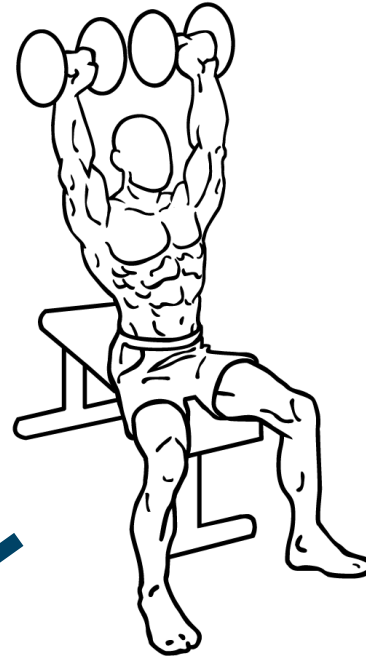
Overview

- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion



Concept

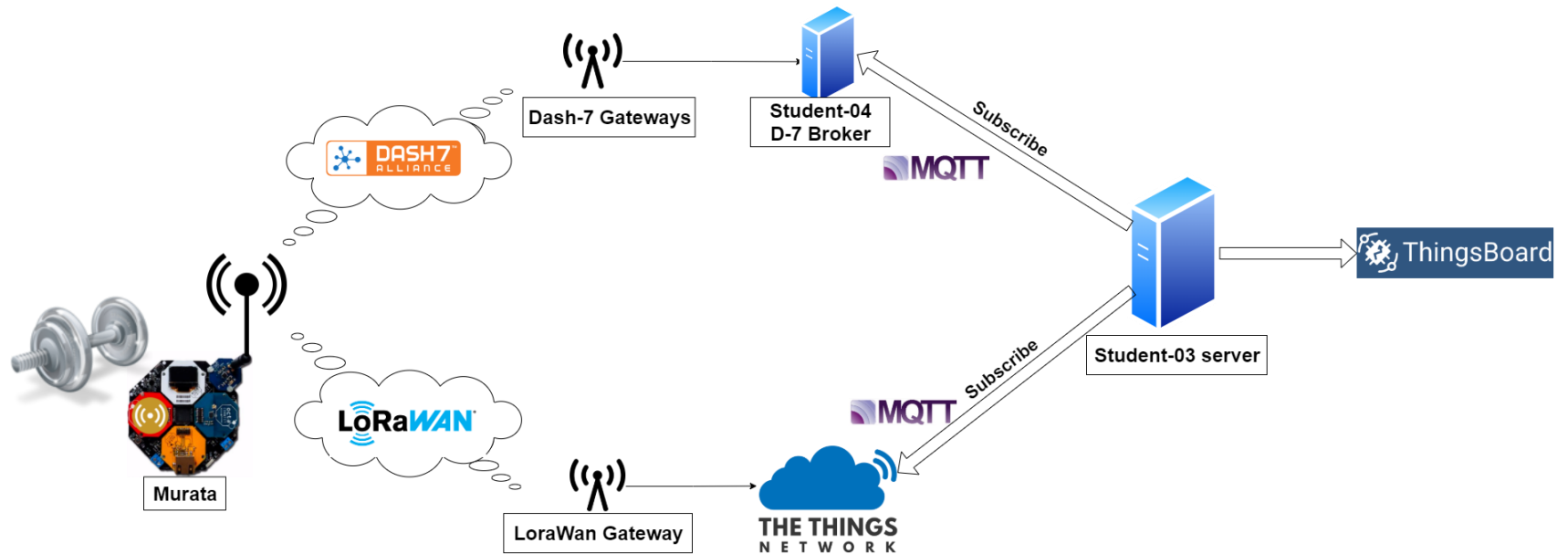
- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion



- Localization of dumbbell

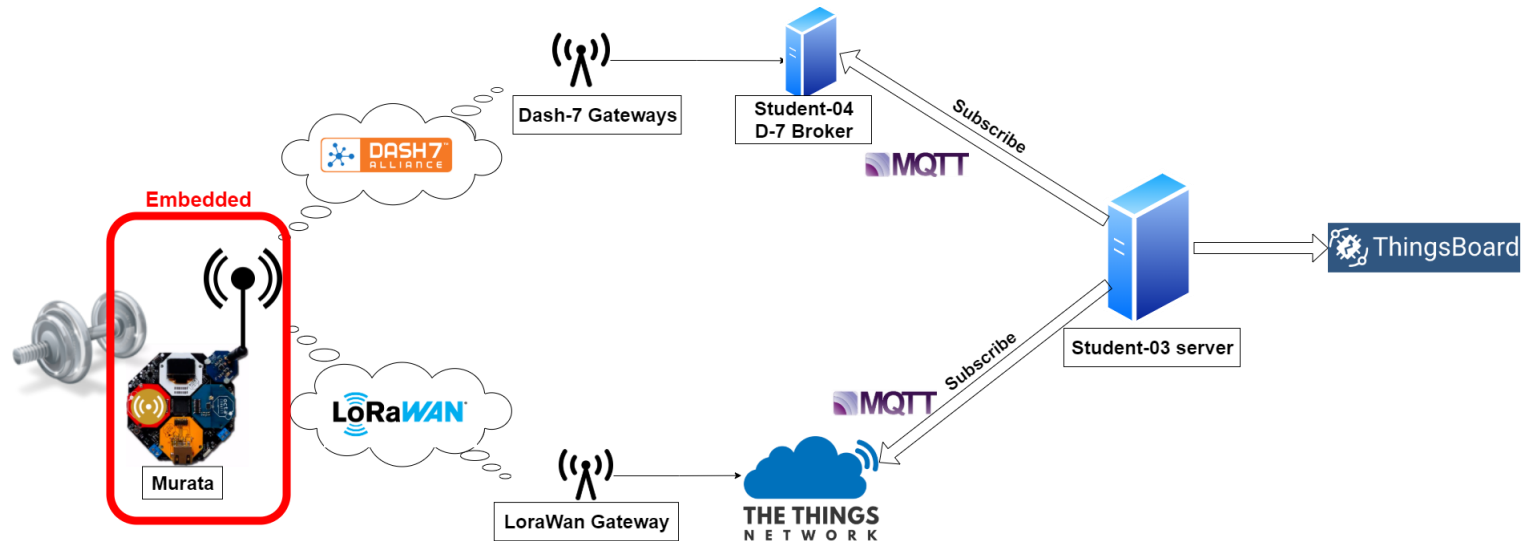
Overview

- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion



Overview

- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion



Reps

- Reps to accelerometer?
- Rep movement in two directions
→ 1 Interrupt
- Double click mode!

○ Concept
○ Embedded side
○ Server side
○ Power consumption
○ Conclusion

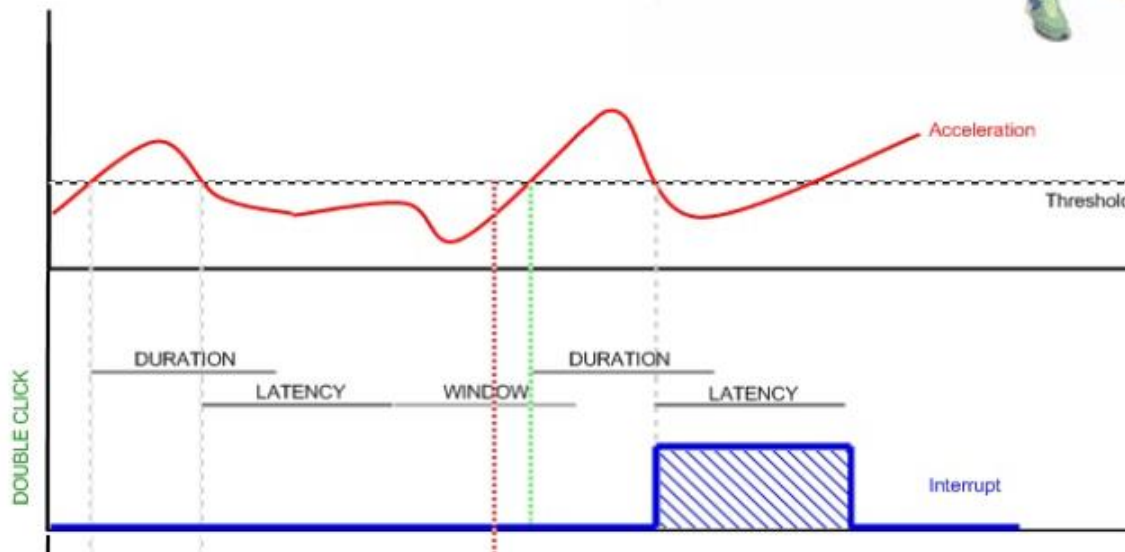


Figure: Double-Click (LSM303AGR Manual)

Sleep



- HAL_Stopmode0
- Vcore clocks stopped
- HSI & HSE oscillators disabled
- WFI: Wait for Interrupt

Payload

0	1	2	3	4	5
Temp	Hum	Reps	MessageCounter	Weight	Reserved

- For LoRa/Dash7
- MessageCounter: Differentiate

Dash7→LoRa

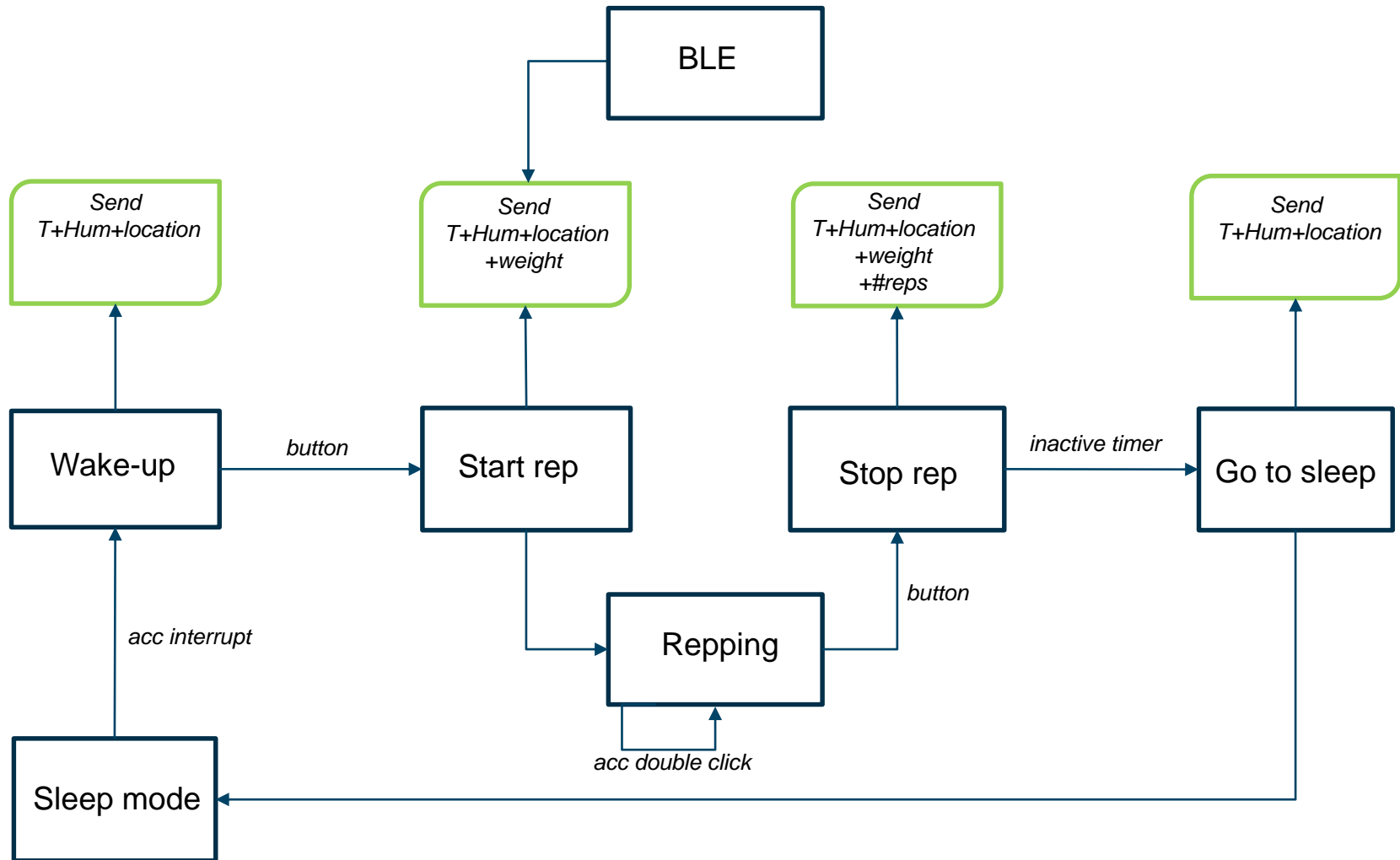
- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion



```
Sending Dash7 message with payload size 6
Murata modem command with tag 2 completed (success = 0)
Failure counter = 3
Going to LoRaWAN mode
```

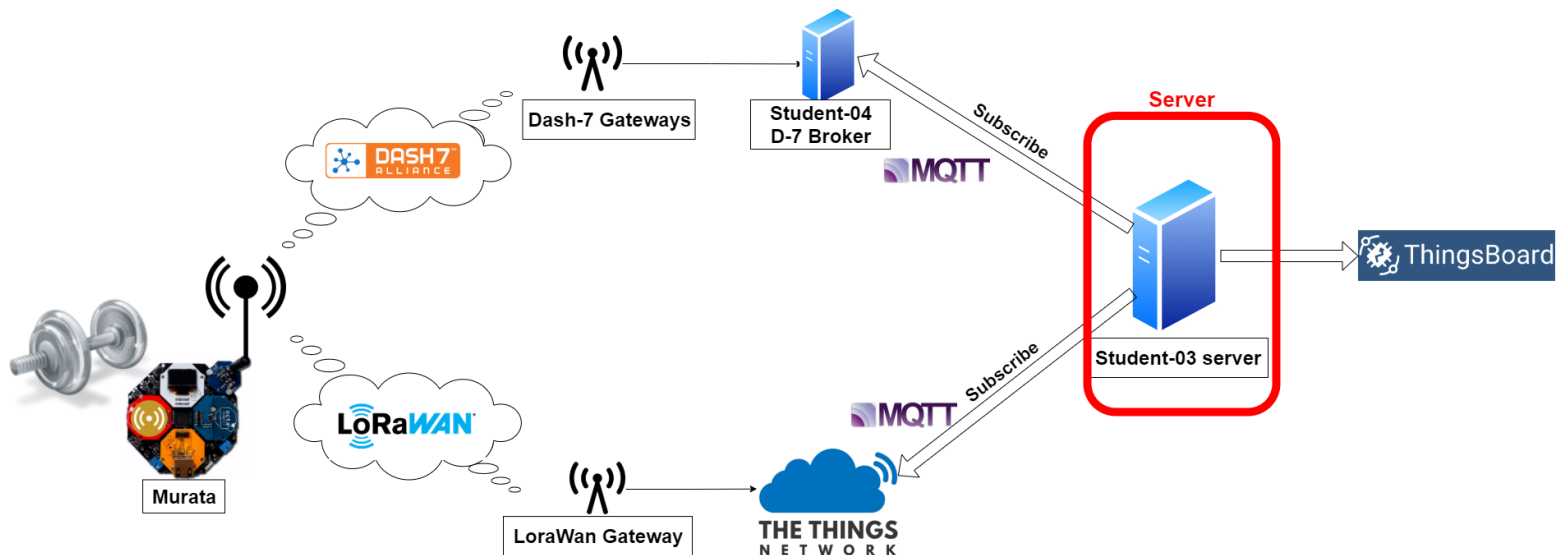
Program Flow

- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion



Overview

- Concept
- Embedded side
- **Server side**
- Power consumption
- Conclusion



Program flow

Subscribe to D7

- Start localization if
 - received from all gateways
 - 5 seconds have passed
 - New message has arrived
- Do localization using kNN
- Send data to thingsboard

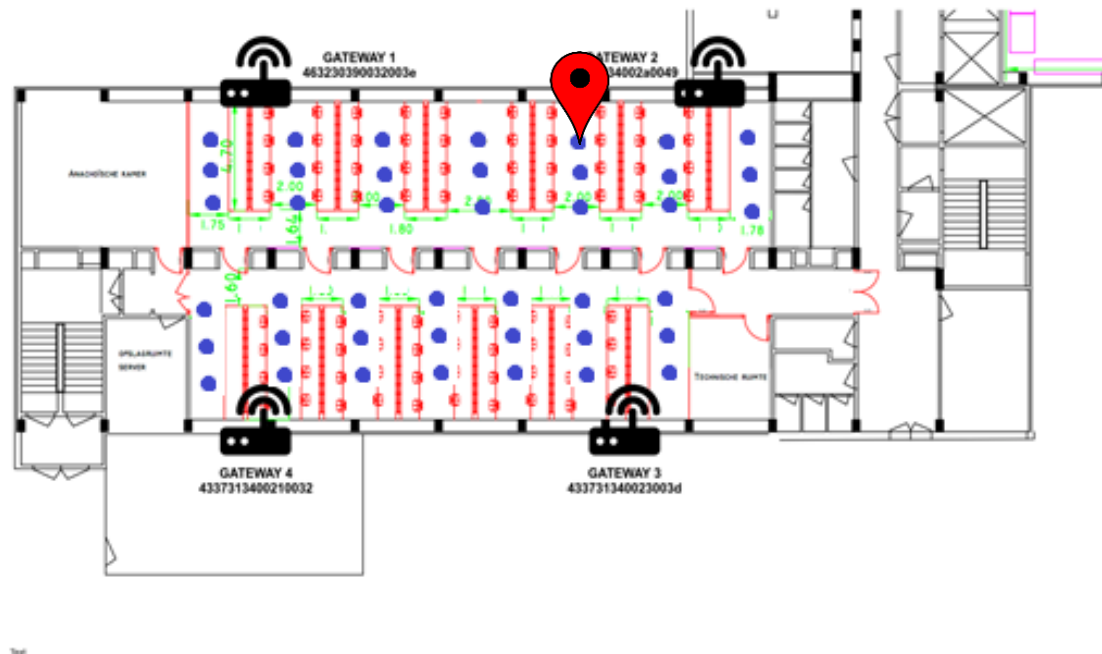
Subscribe to LoRaWAN

- Send isStolen to thingsboard

Localisation

- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion

- Training phase
- K Nearest Neighbours
- Classification



Thingsboard

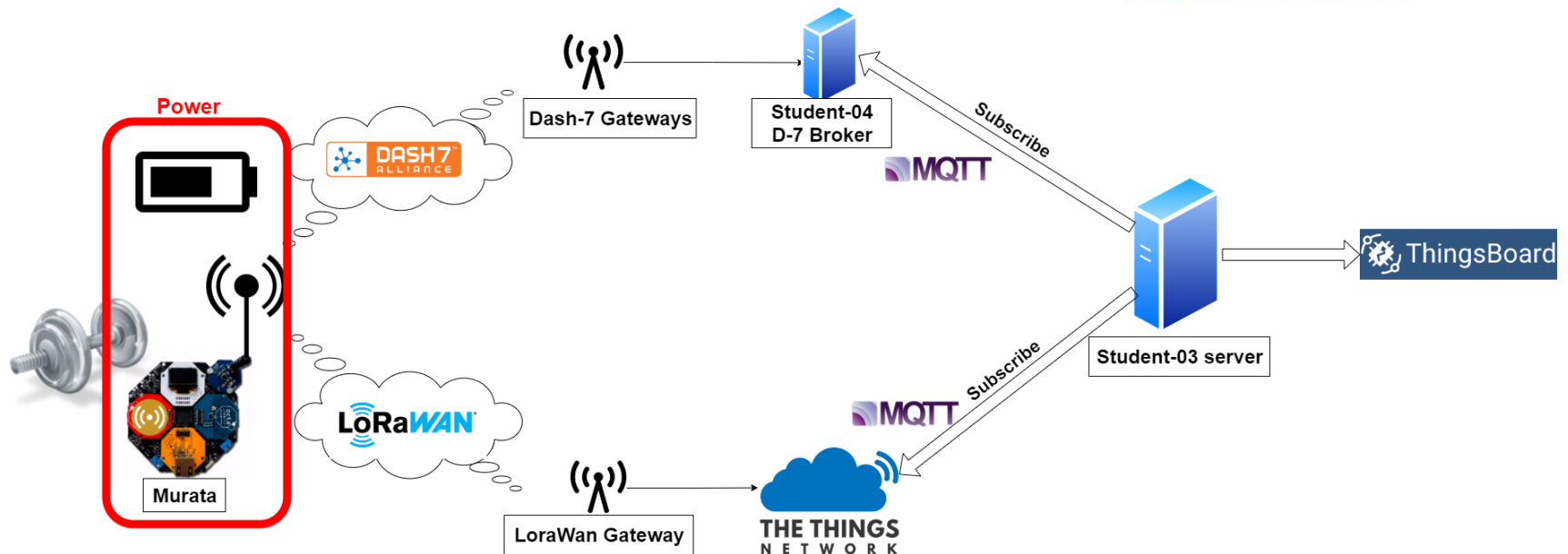
- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion



Overview

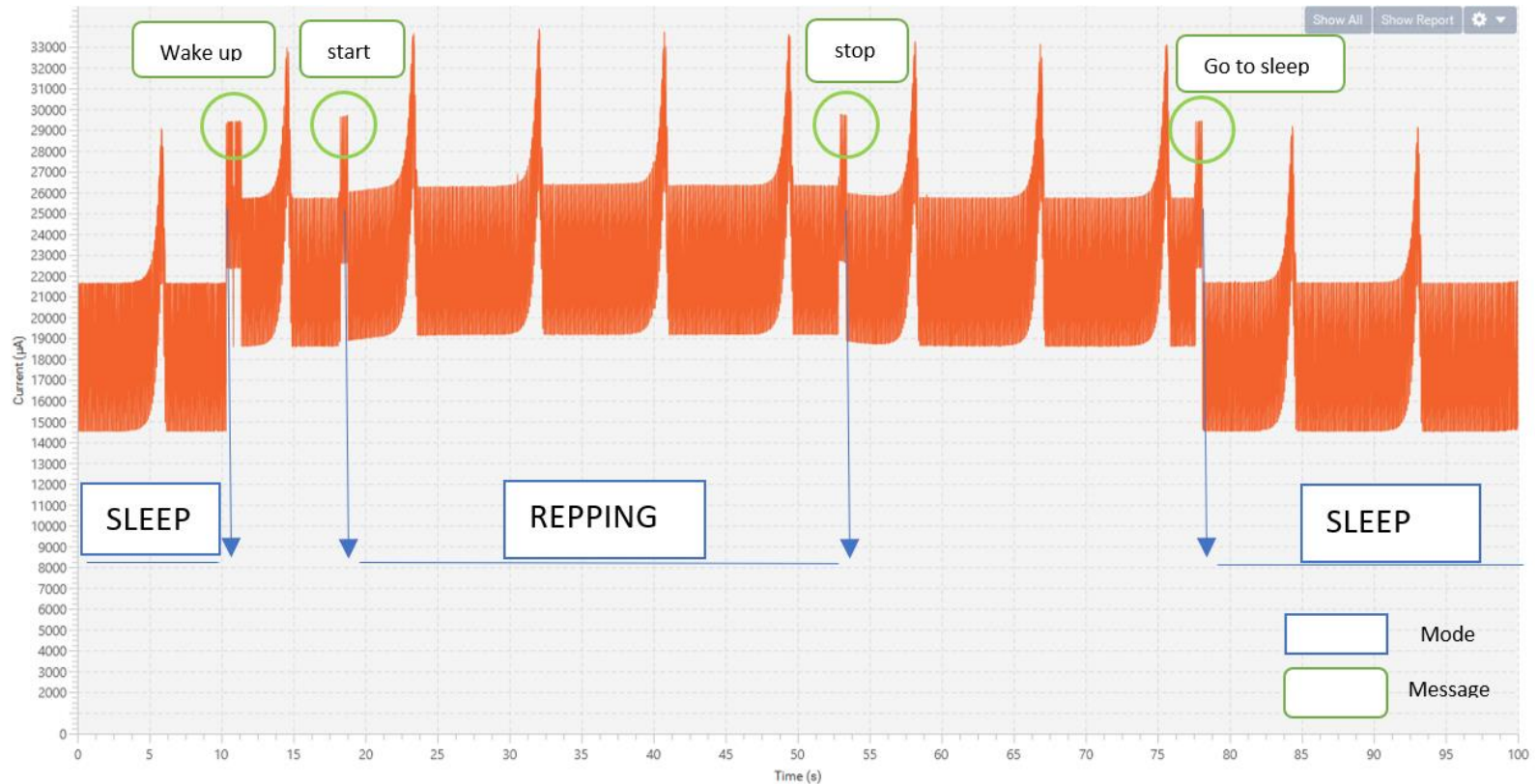
X-NUCLEO-LPM01A

- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion



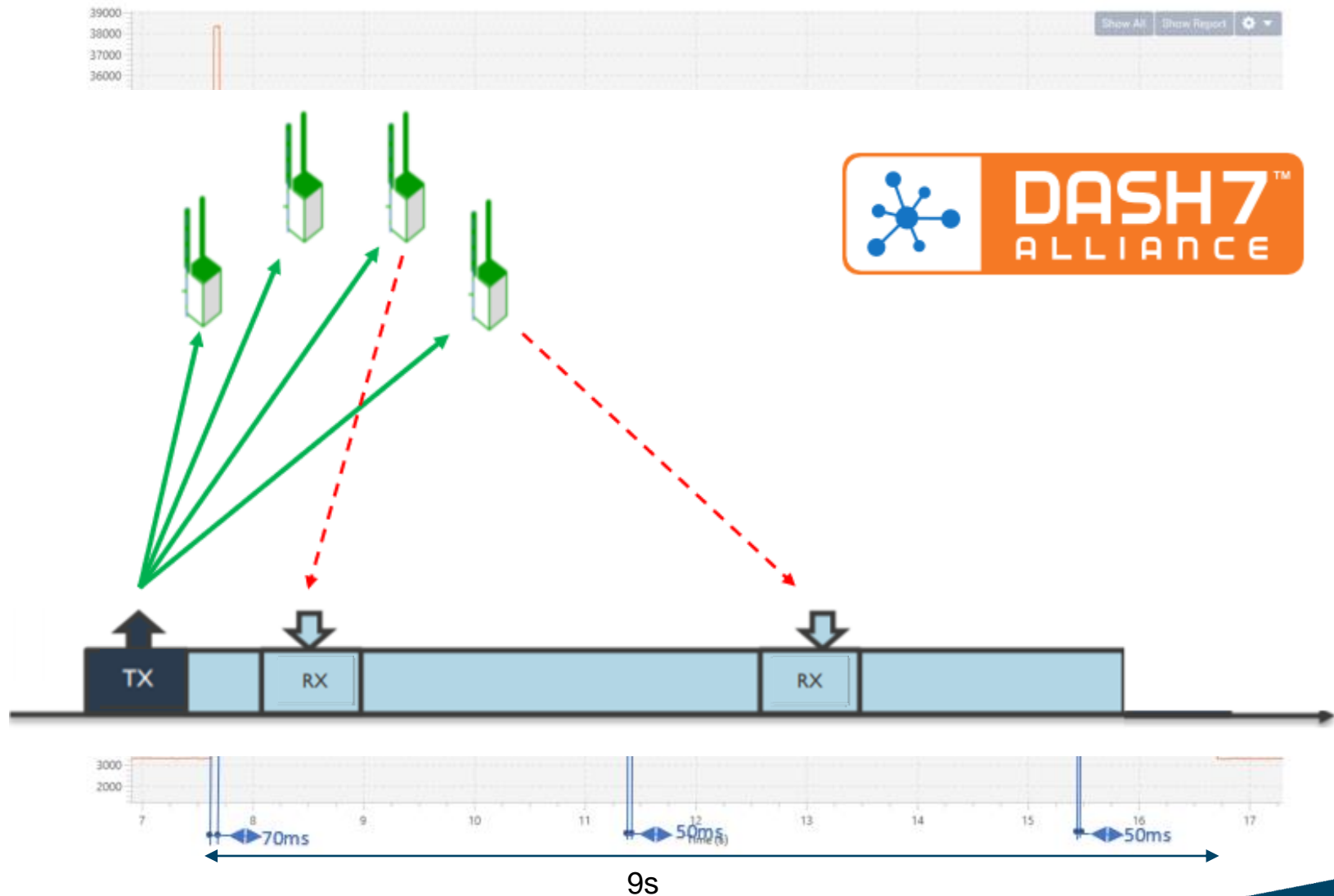
General flow

- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion



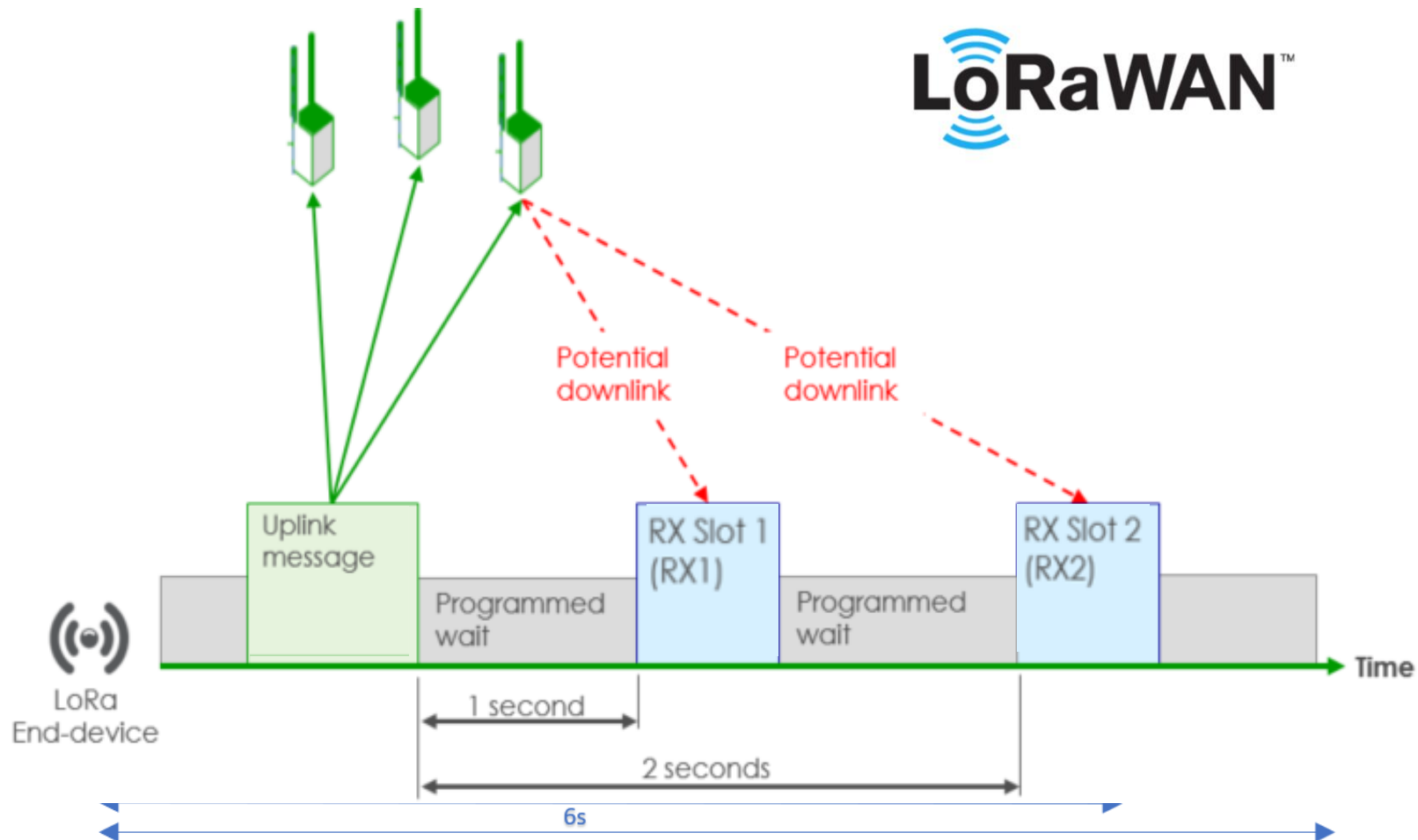
Dash7-tx-rx

- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion



LoRaWAN-tx-rx

- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion



Battery life

- Current measurements

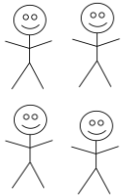
Sleep mode	18,10 mA		TX 38,75 mA RX 20,50 mA
Active mode	21,25 mA		TX 35,50 mA RX 16,00 mA

- Assumptions

- Open 12 hours / day
- Used 2 times per hour
- Used for 1 minute at a time
- Capacity of 3700 mAh

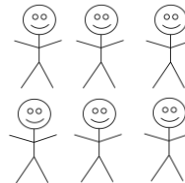
Battery life: use cases

Case 1



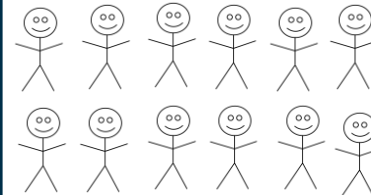
202 h

Case 2



200 h

Case 3



195 h

Case 1



202 h

Case 2



201 h

Case 3



198 h

Case 1

OPEN x12

202 h

Case 2

OPEN x10

203 h

Case 3

OPEN x6

204 h

Battery life: sleep current

Case 1

Sleepcurrent
18 mA

202 h

Case 2

Sleepcurrent
15 mA

240 h

+19%

Case 3

Sleepcurrent
10 mA

347 h

+71%

Conclusion

Sleep current matters most





- Turn off unused modules and peripherals
- Disable clocks for unused modules and peripherals
- Reduce the clock frequency

STOPMODE

Overview

- Concept
- Embedded side
- Server side
- Power consumption
- Conclusion

Conclusion and reflection

- Indoor Dumbbell localization ✓
- Outdoor Dumbbell localization ✗
- Configuration via  **Bluetooth** ✓
- Communication via  ✓
- Communication via  **LoRaWAN** ✓
- Live Visualisation  **ThingsBoard** ✓
- Low power ★





28/01/2020