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Universiteit Antwerpen

I-IOT low power

Smart Dumbbell

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Goals and requirements

A low power IOT device capable of:

- Indoor localization
- Outdoor localization
- Configuration via Bluetooth
- Communication via DASH7
- Communciation via LoRaWAN
- Visualisation via ThingsBoard

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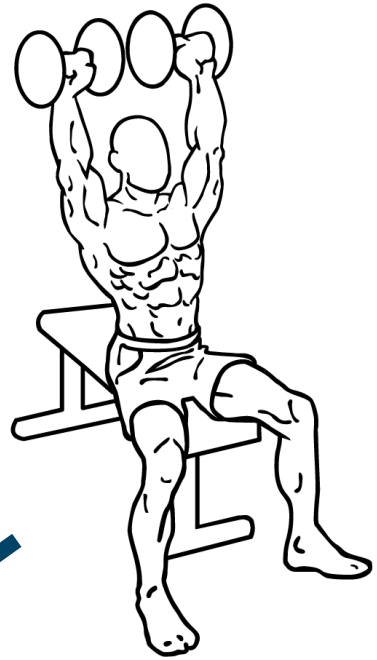
Overview

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

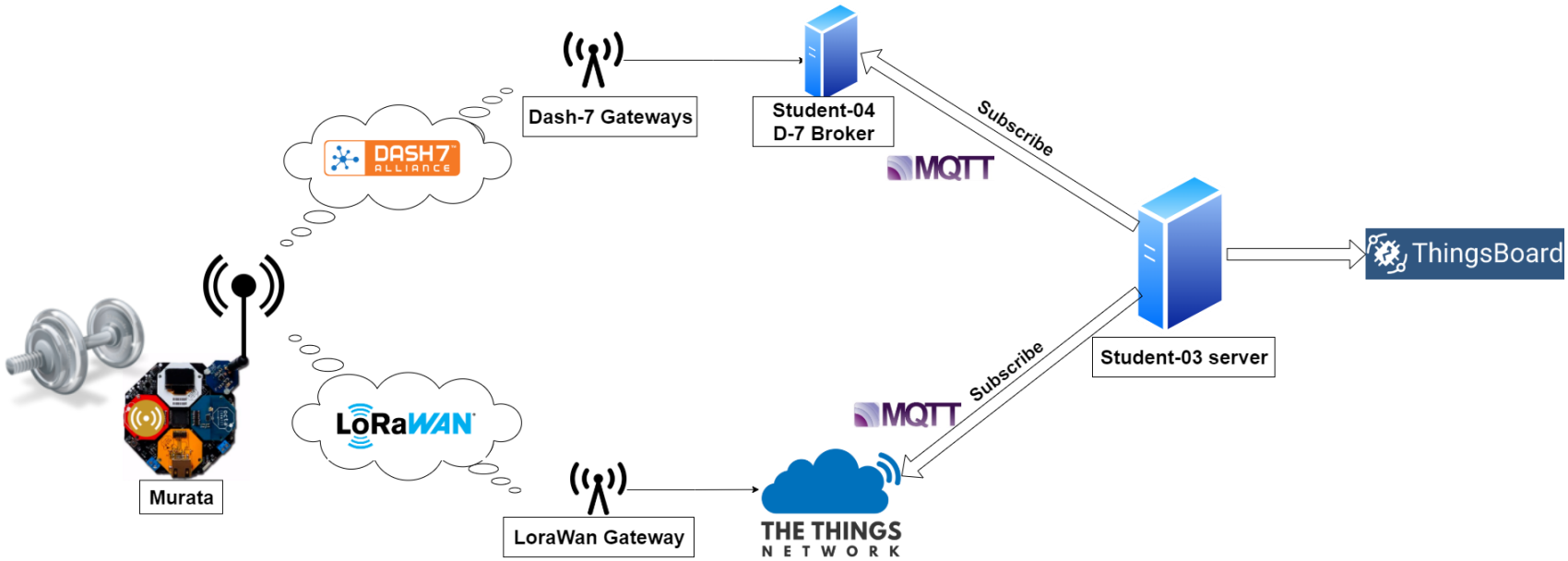
Concept



DASH7™

- Localization of dumbbell

Overview



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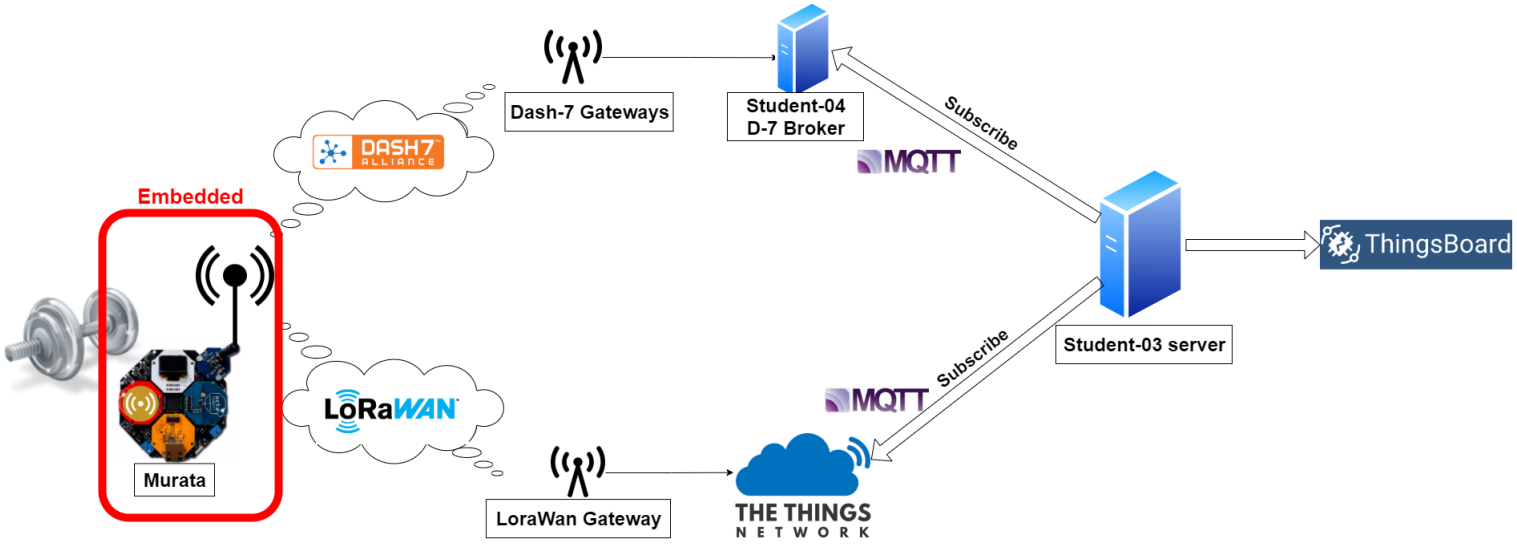


Reps

- Reps to accelerometer?
- Rep movement in two directions

  → 1 Interrupt
- Double click mode!

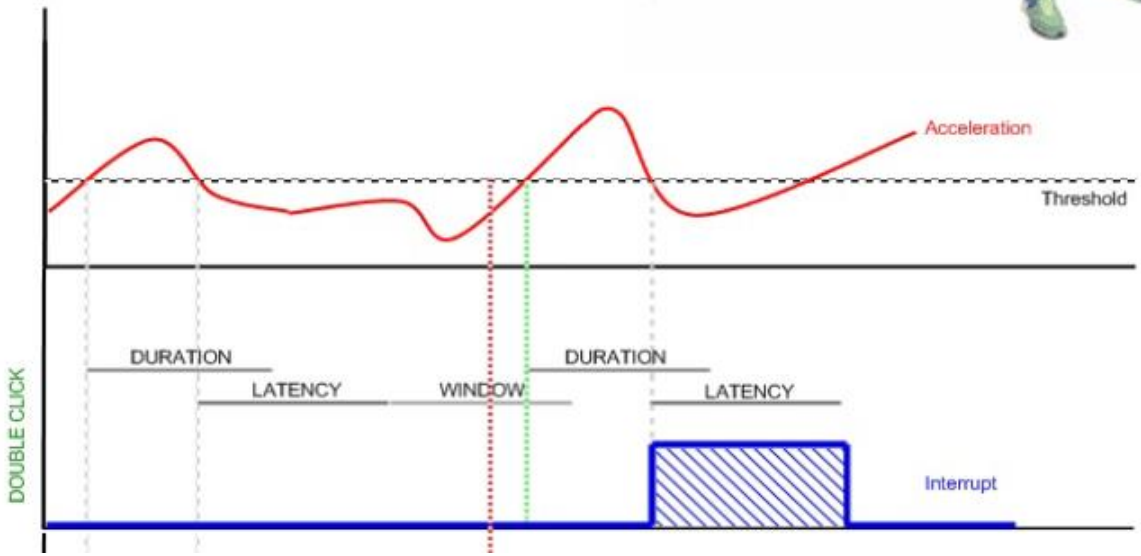


Figure: Double-Click (LSM303AGR Manual)

Sleep

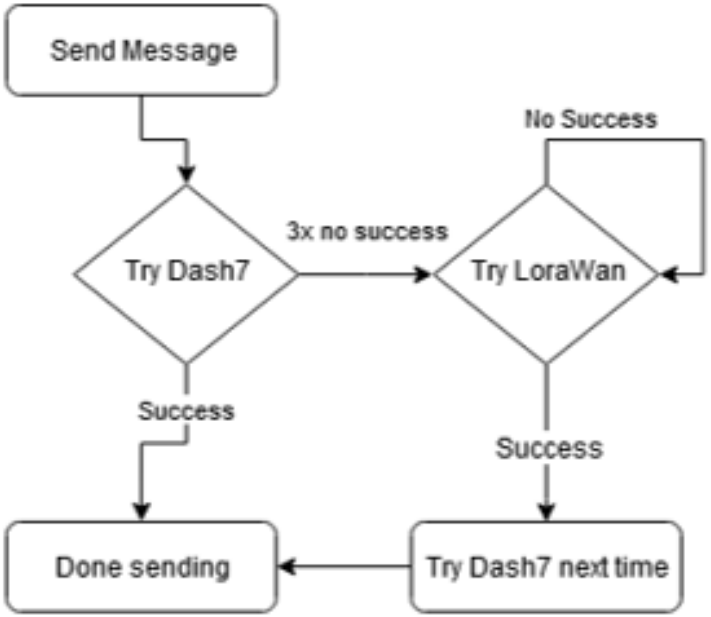
- HAL_Stopmode0
- Vcore clocks stopped
- HSI & HSE oscillators disabled
- WFI: Wait for Interrupt

Payload

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

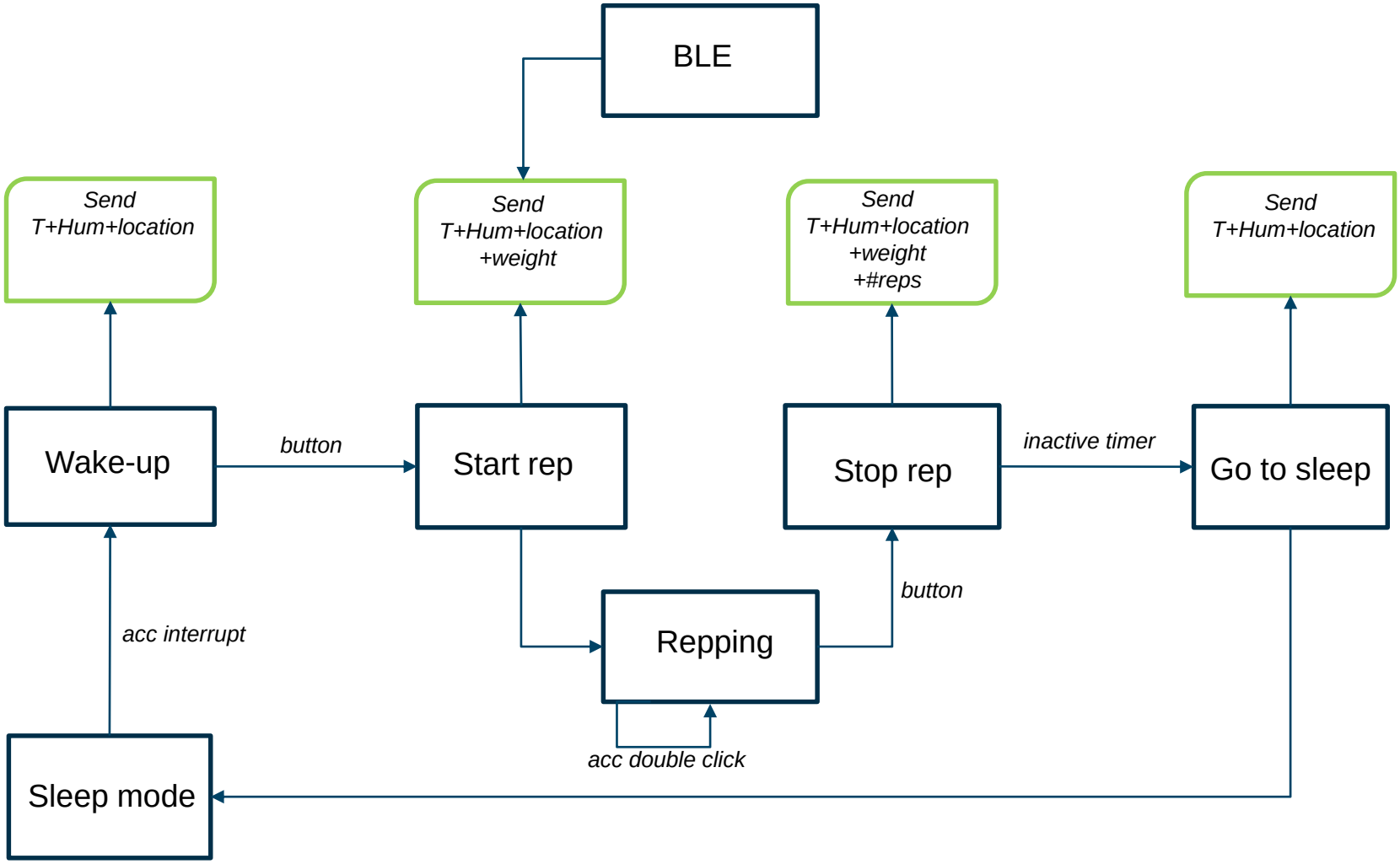
- For LoRa/Dash7
- MessageCounter: Differentiate

Dash7→LoRa




```
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



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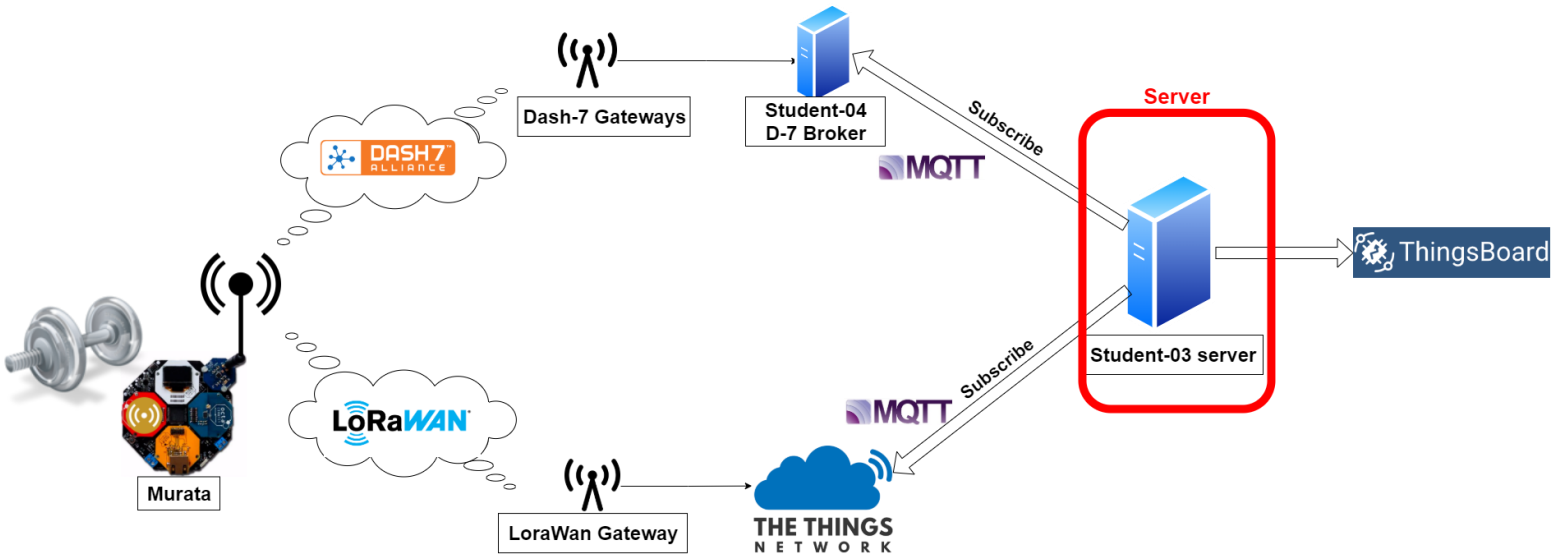


Program flow

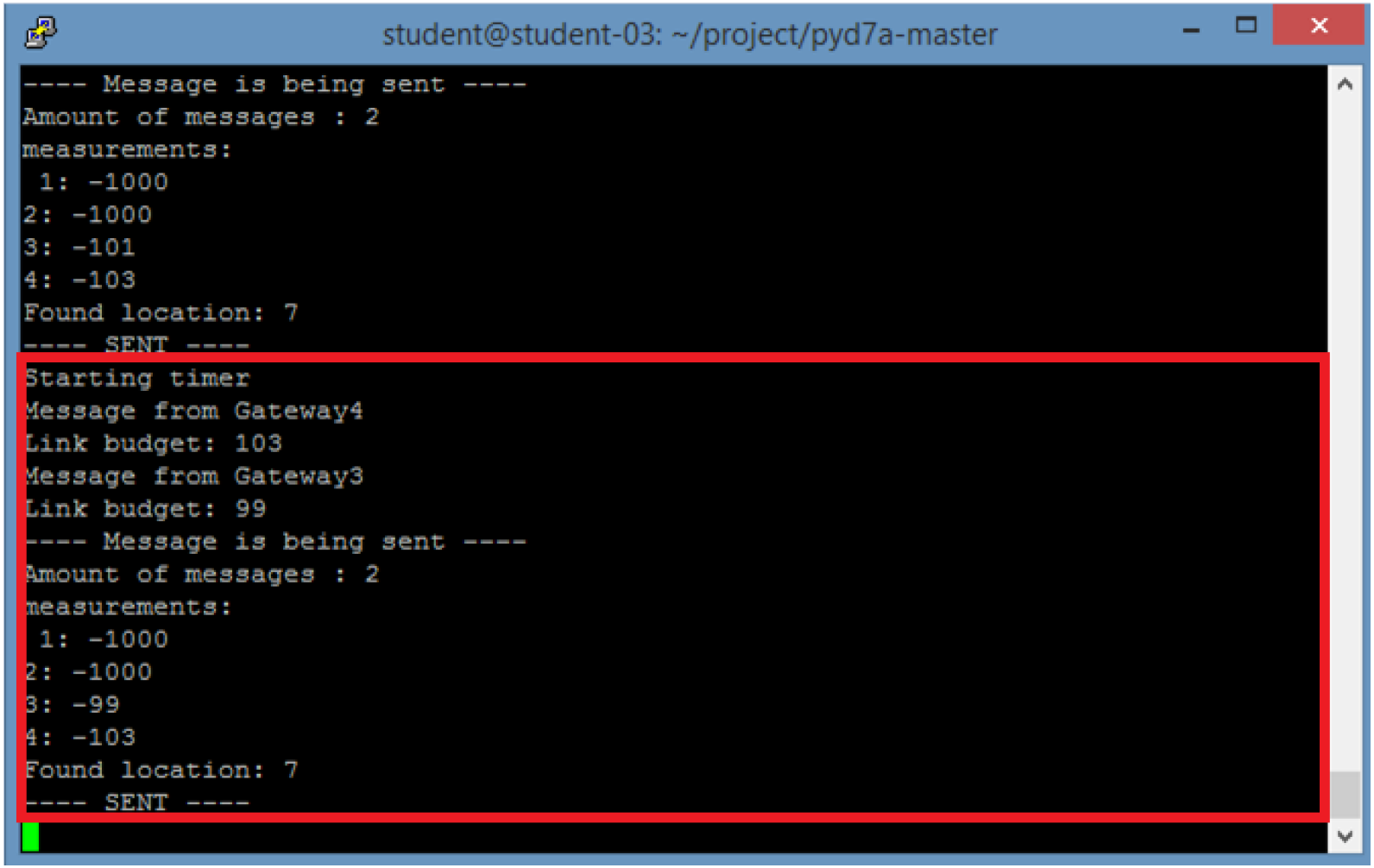
Subscribe to D7

- 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

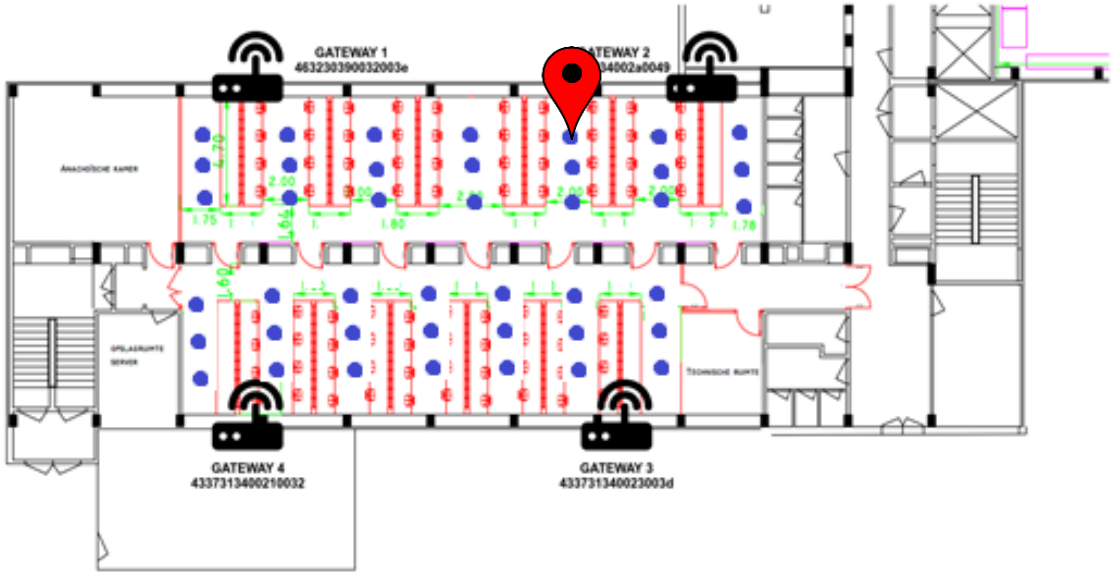
- Send isStolen to thingsboard

Data processing



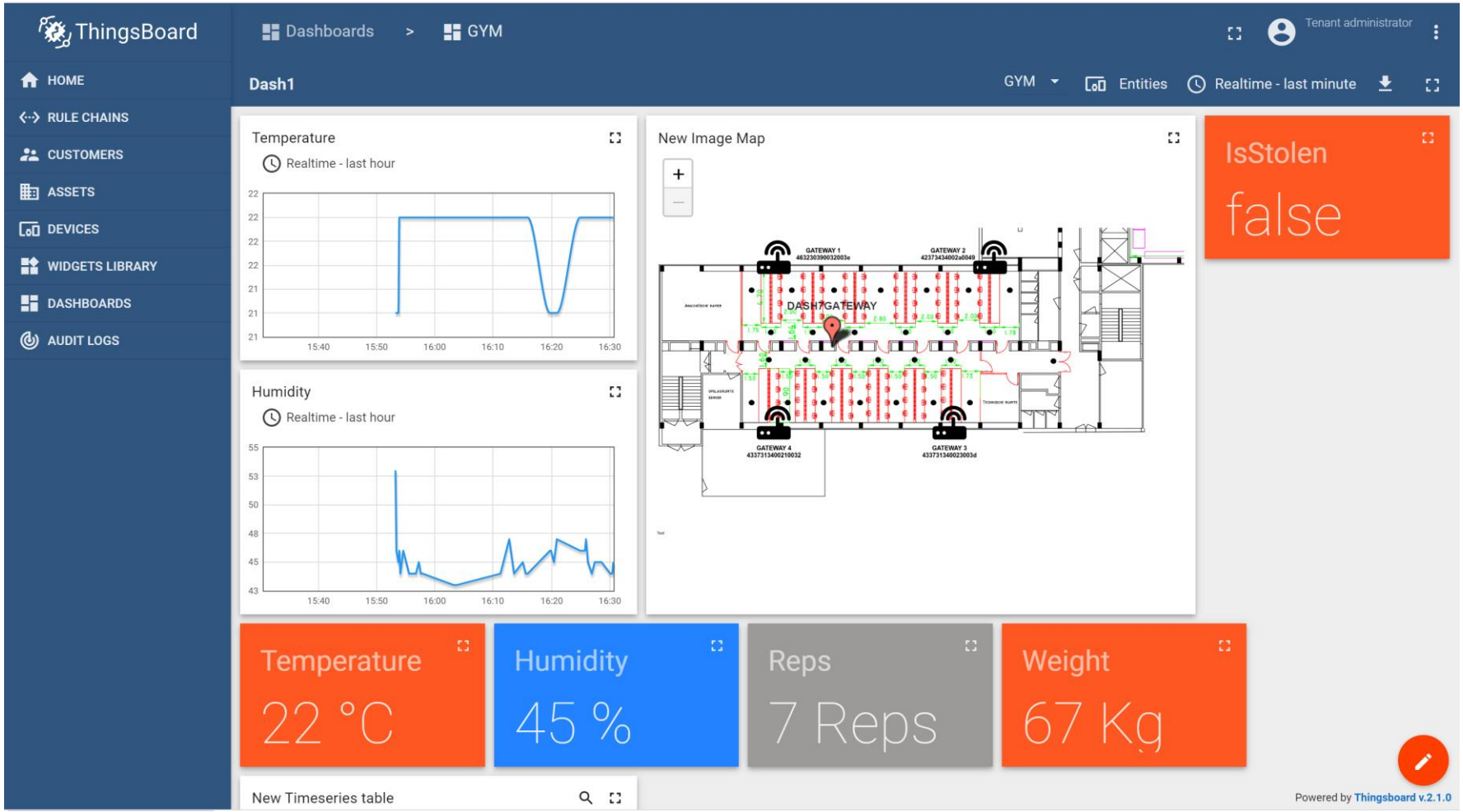
Localisation

- Training phase
- K Nearest Neighbours
- Classification



mongoDB

Thingsboard



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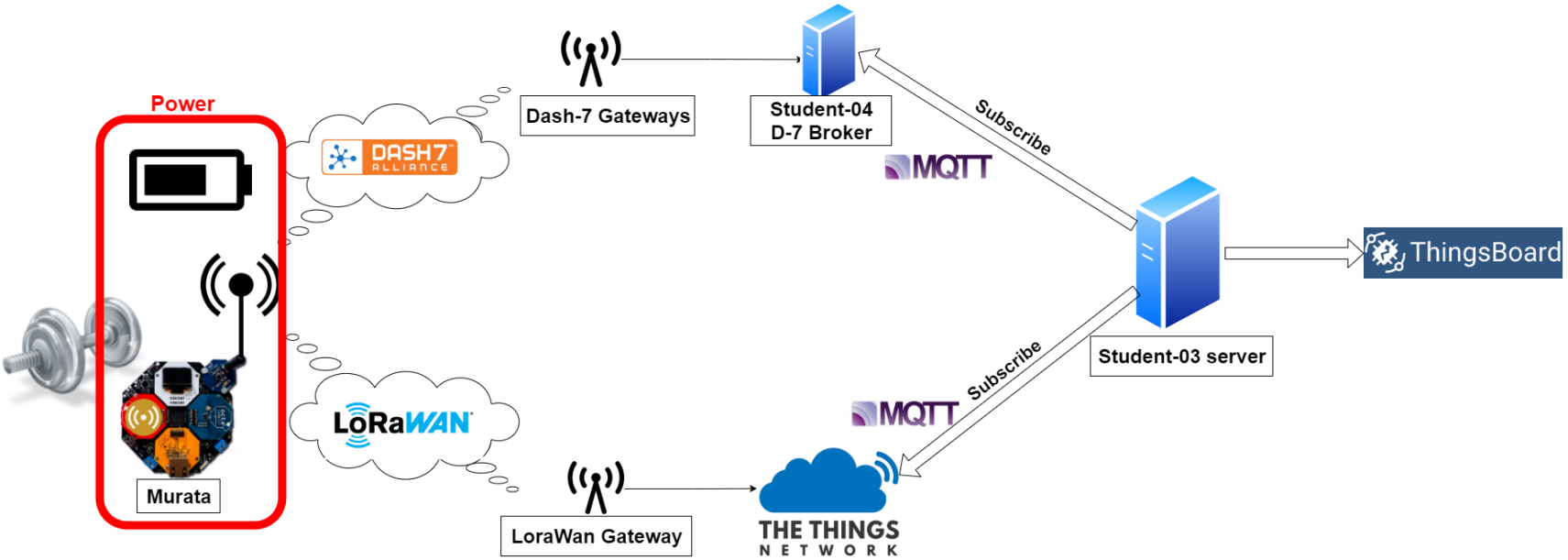
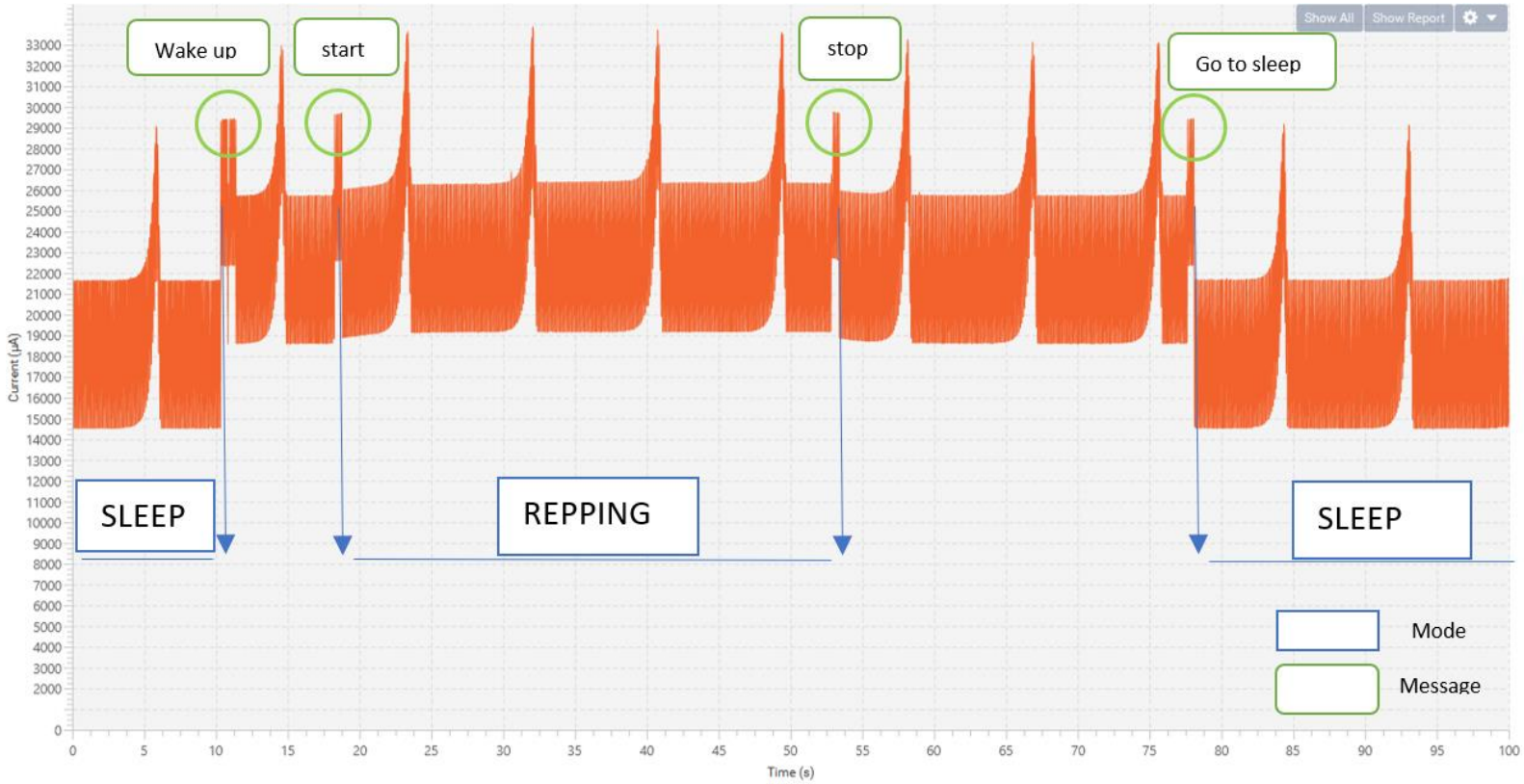
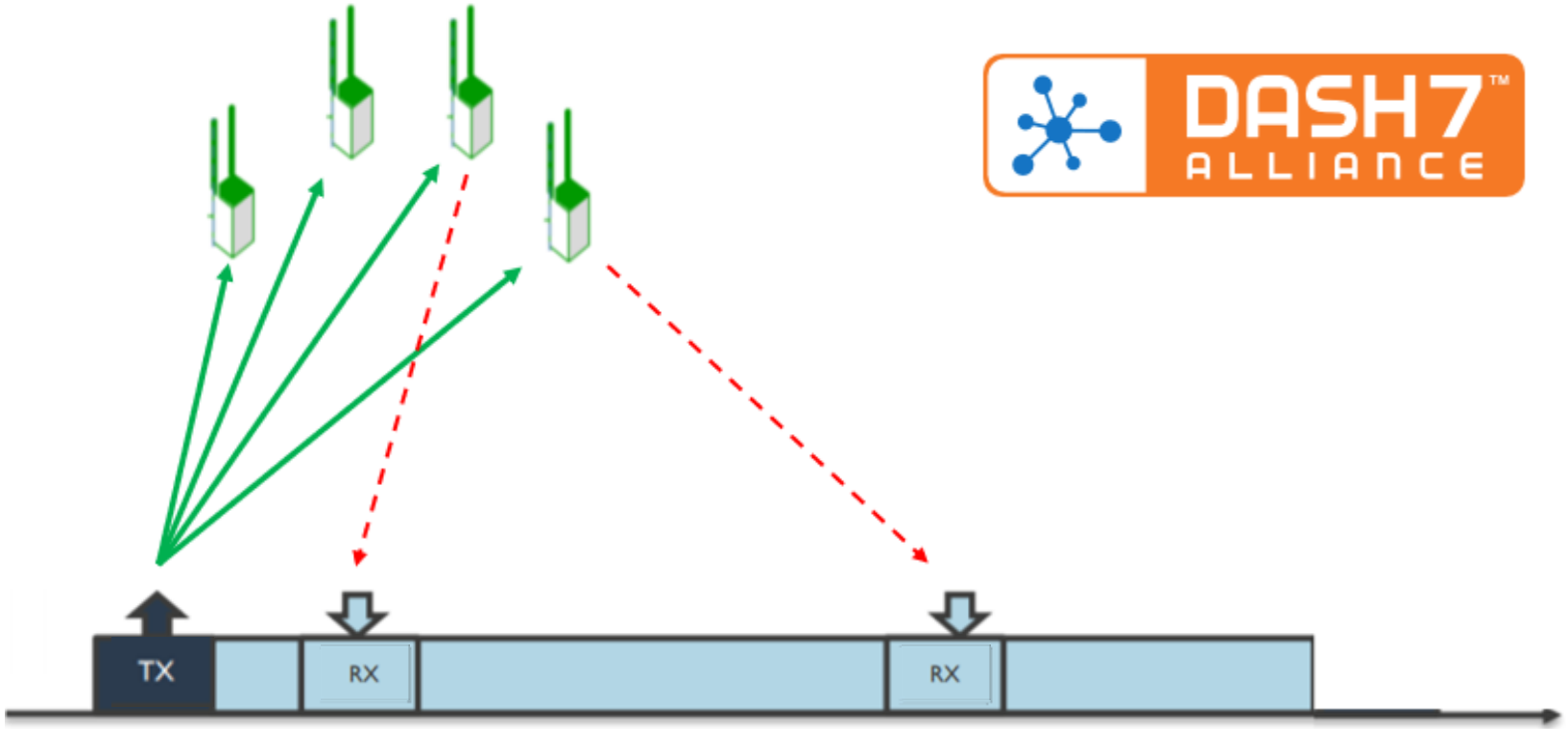
X-NUCLEO-LPM01A



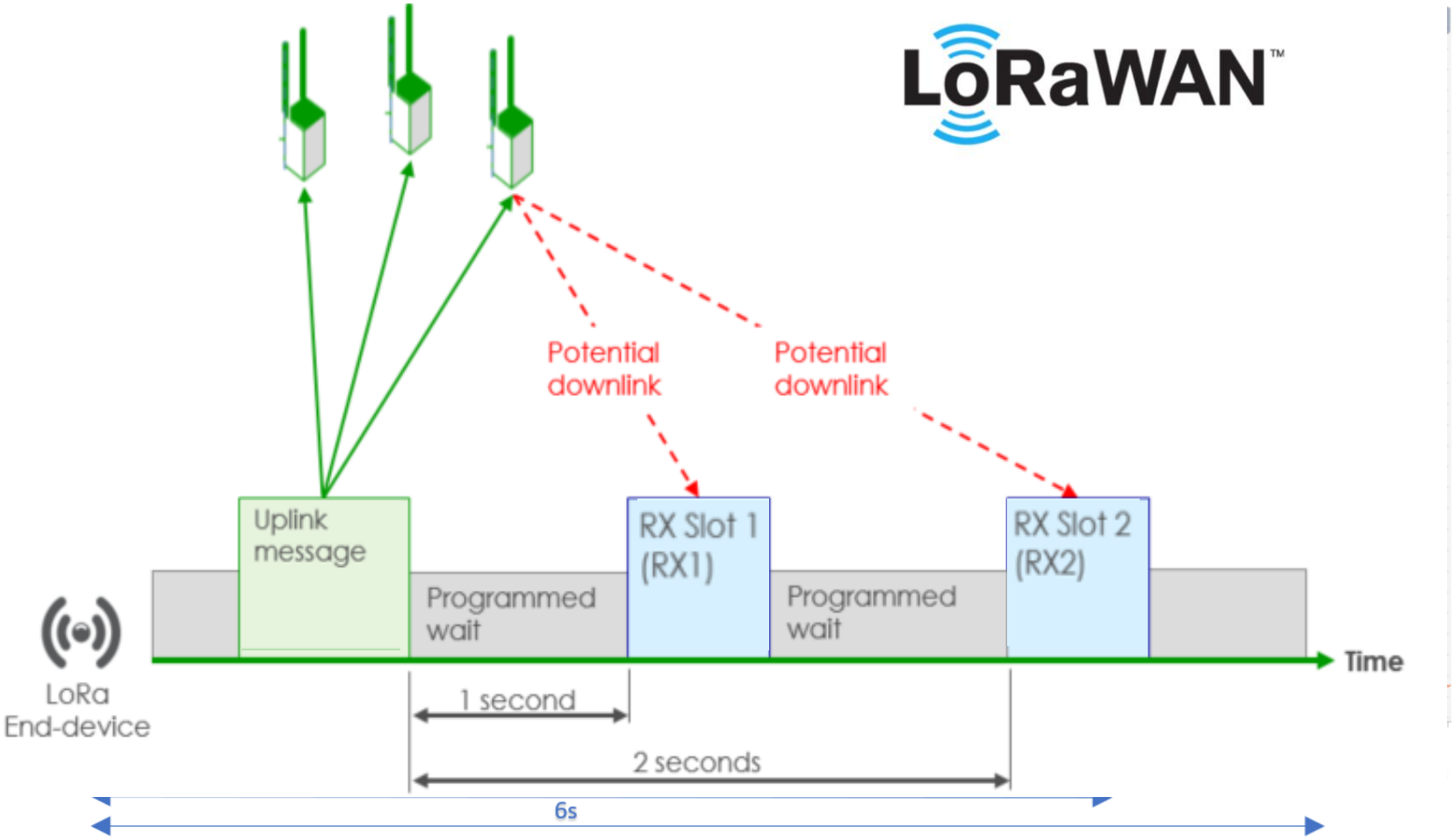
General flow



Dash7-tx-rx



LoRaWAN-tx-rx



Battery life

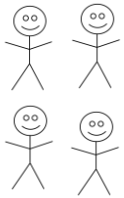
- Current measurements

Sleep mode	**18,10 mA**	DASH7 ALLIANCE	TX	**38,75 mA**
			RX	**20,50 mA**
Active mode	**21,25 mA**	LoRaWAN™	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

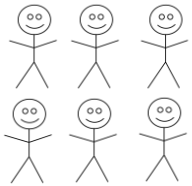
Battery life: use cases

Case 1



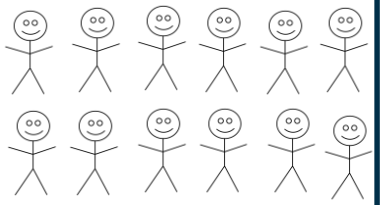
202 h

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
Only the sleep current matters

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

STOPMODE

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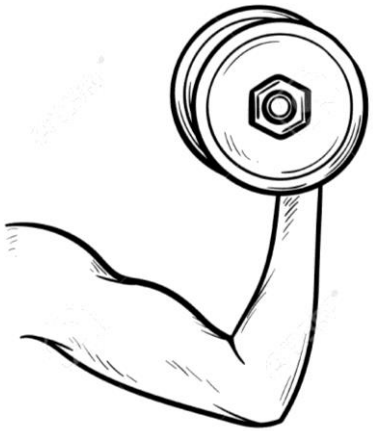
Conclusion and reflection



- Indoor Dumbbell localization ✓
- Outdoor Dumbbell localization ✗
- Configuration via Bluetooth ✓
- Communication via DASH7 ✓
- Communication via LoRaWAN ✓
- Live Visualisation ThingsBoard ✓
- Low power ★

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