



28/01/2020

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
- Communication via
- Communication via
- Visualisation via



Goals and requirements

A low power IOT device capable of:

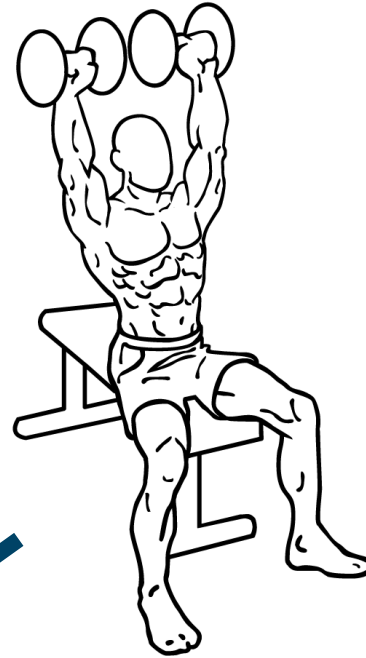
- Indoor localization
- Outdoor localization
- Configuration via  **Bluetooth®**
- Communication via 
- Communication via  **LoRaWAN™**
- Visualisation via 

Overview

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

Concept

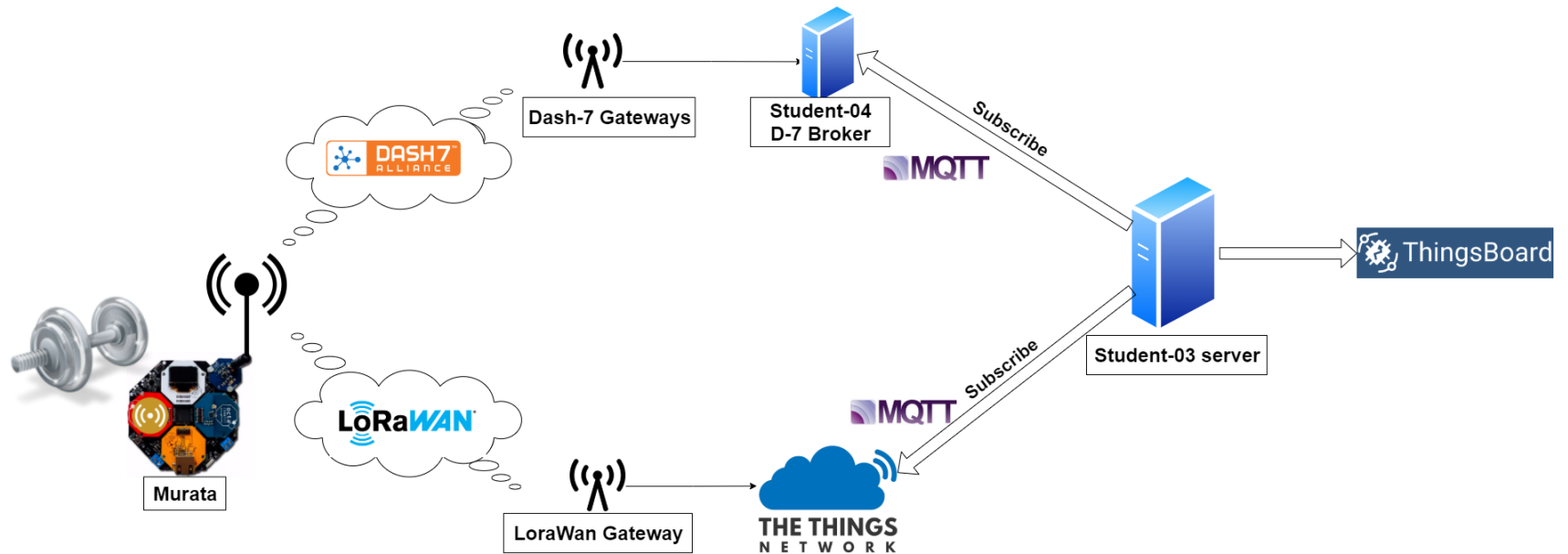
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- Localization of dumbbell

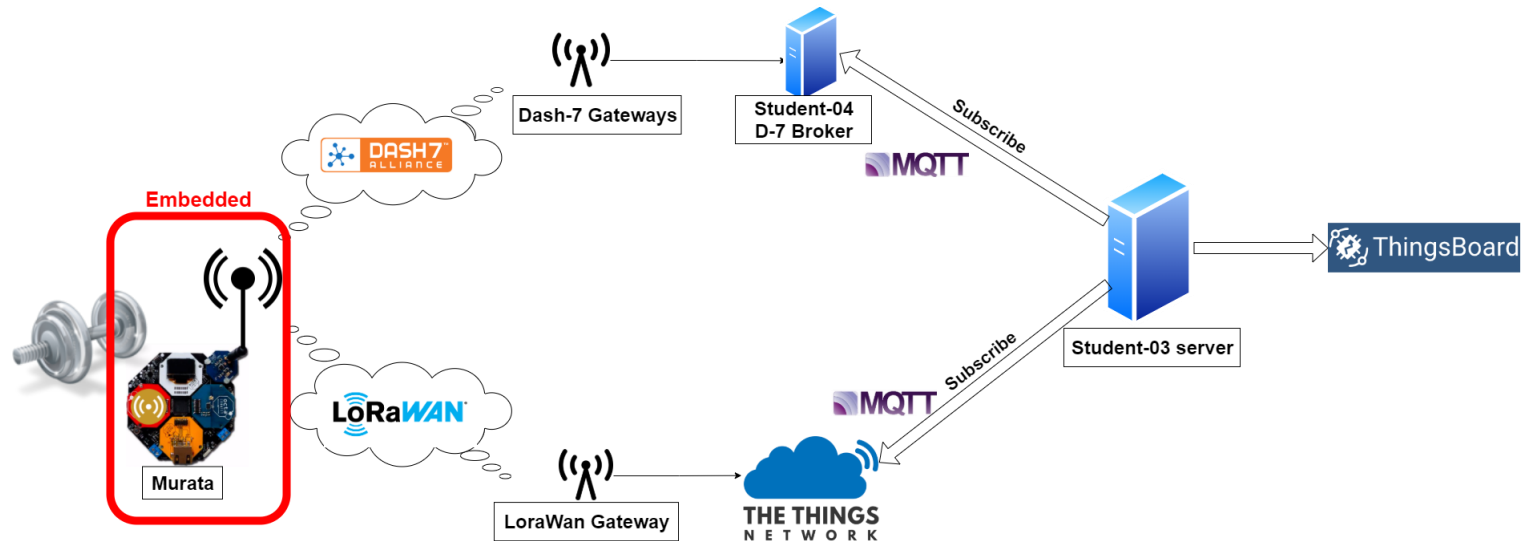
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Overview

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Reps

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

○ Concept
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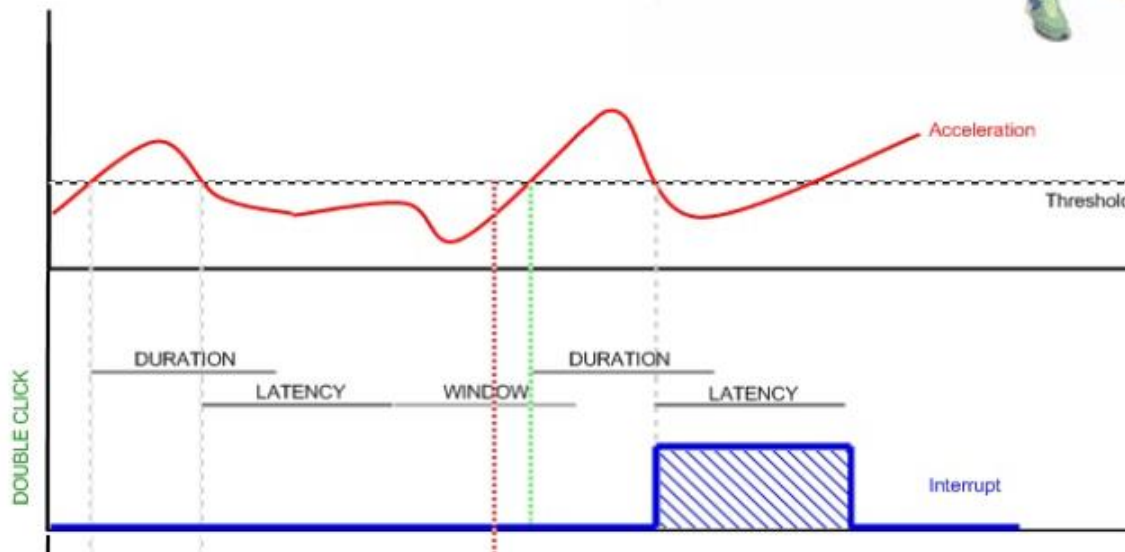


Figure: Double-Click (LSM303AGR Manual)

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

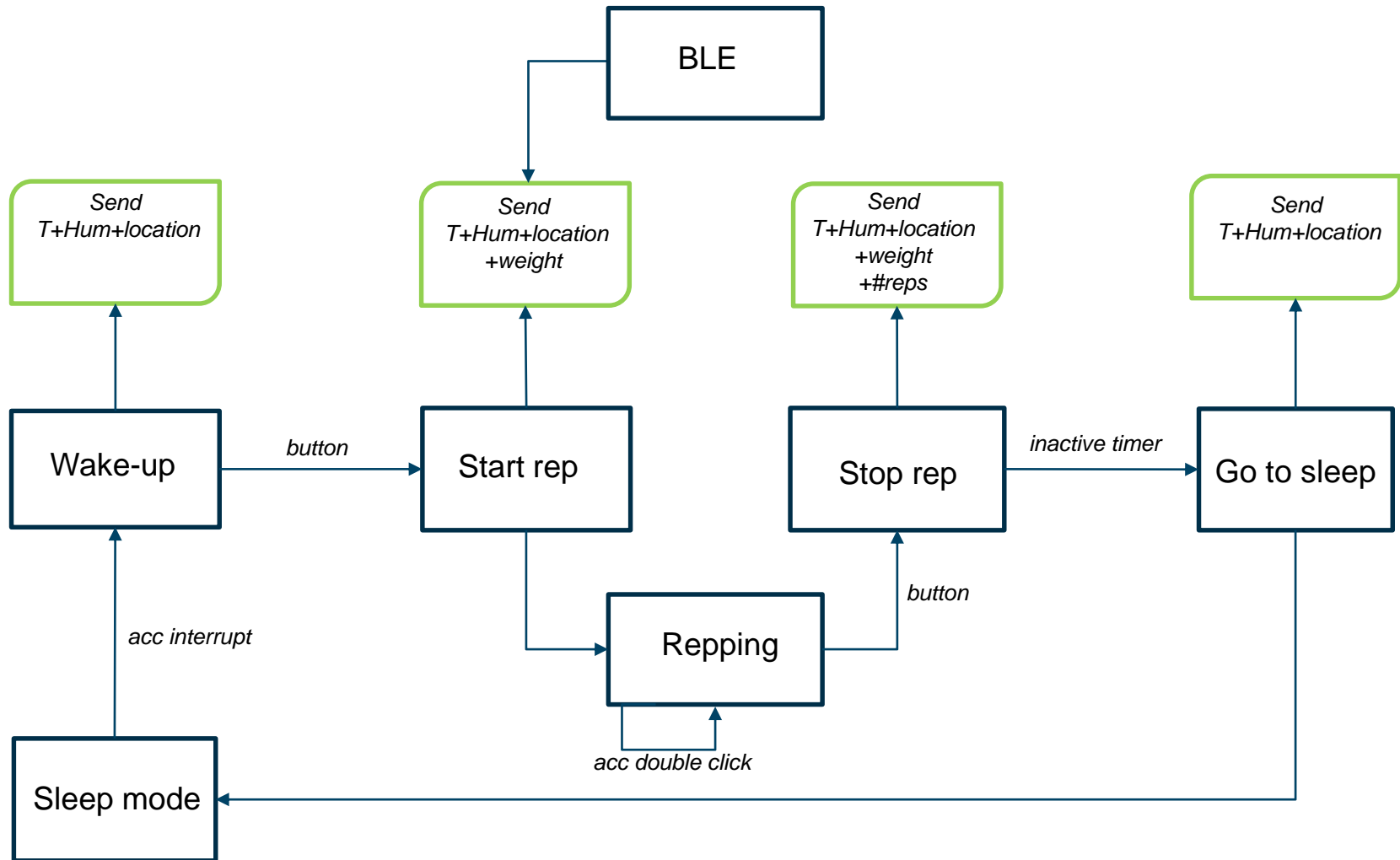
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```
Sending Dash7 message with payload size 6
Murata modem command with tag 2 completed (success = 0)
Failure counter = 3
Going to LoRaWAN mode
```

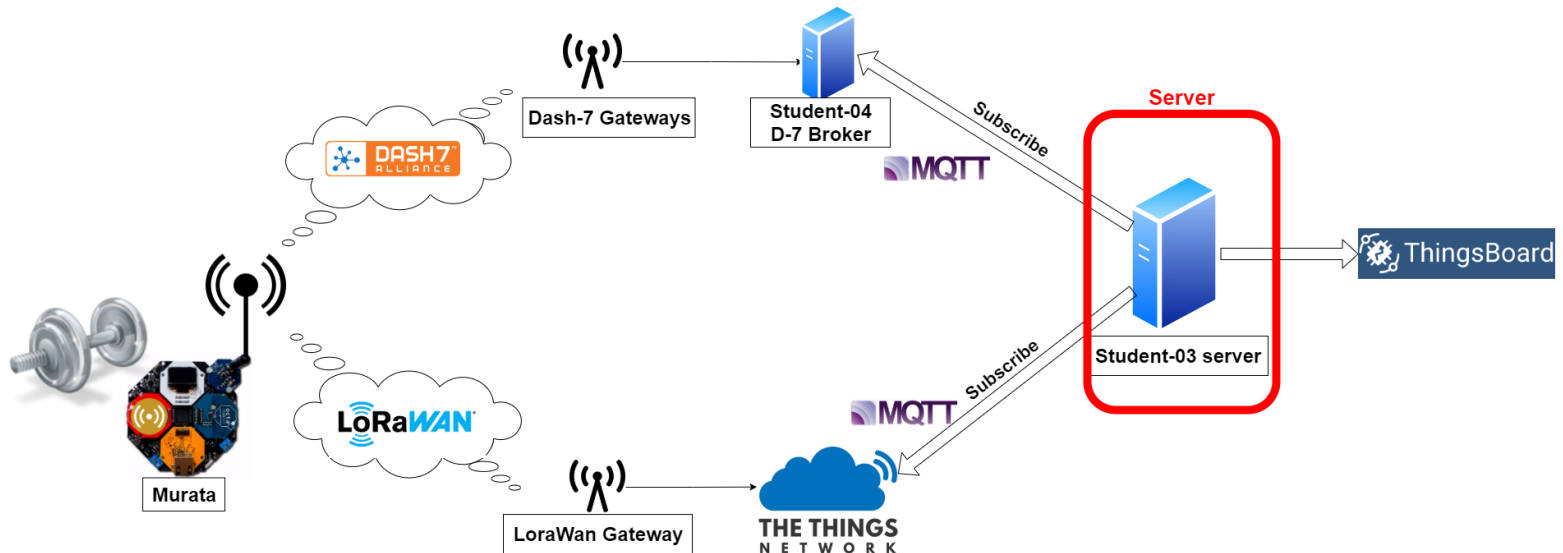
Program Flow

- Concept
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Overview

- Concept
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- **Server side**
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Program flow

Subscribe to D7

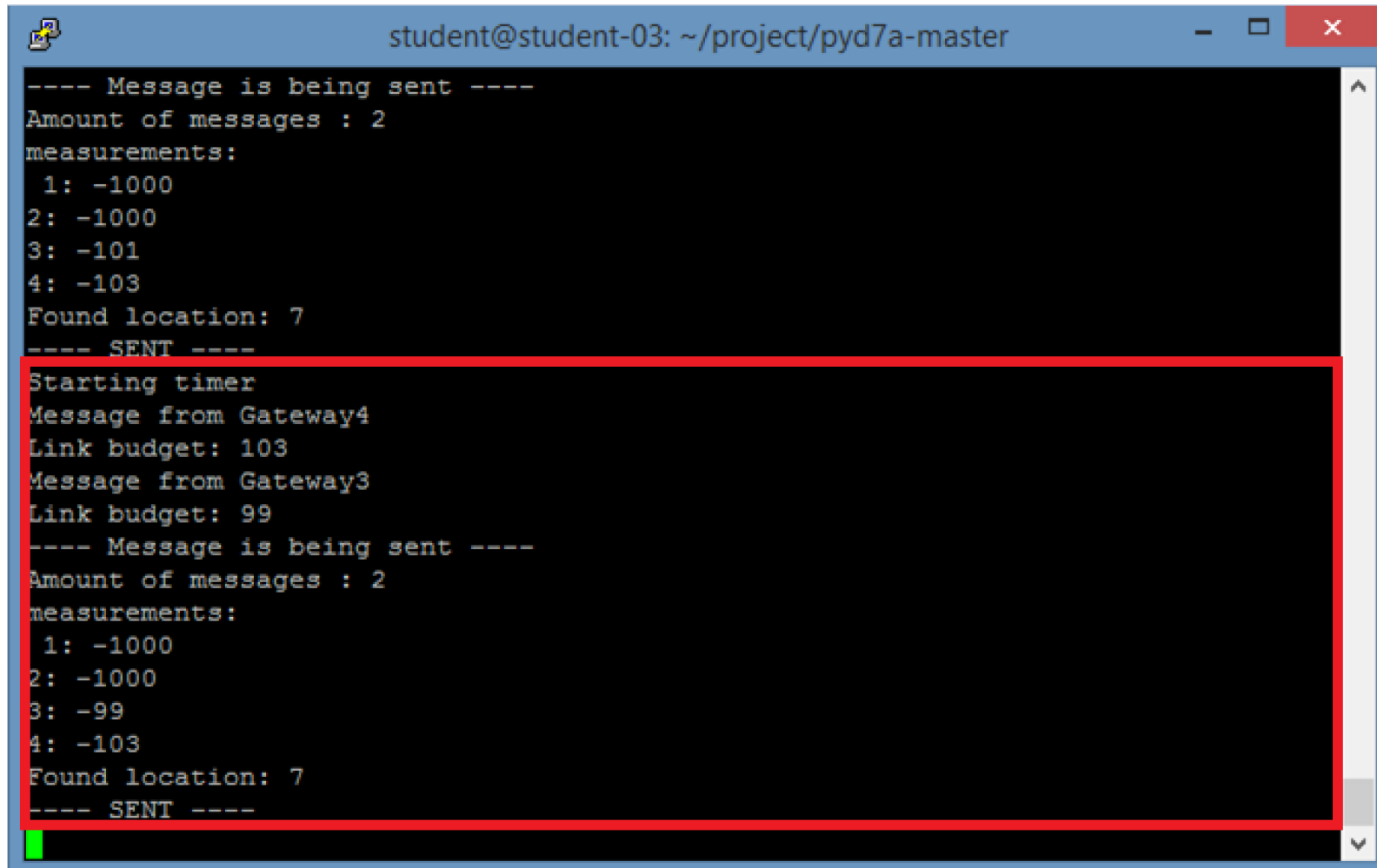
- Start localization if
 - received from all gateways
 - 5 seconds have passed
 - New message has arrived
- Do localization using kNN
- Send data to thingsboard

Subscribe to LoRaWAN

- Send isStolen to thingsboard

Data processing

- Concept
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A terminal window titled 'student@student-03: ~/project/pyd7a-master' displays a log of network message processing. The log is divided into two main sections, each preceded by '---- Message is being sent ----'. The first section shows 'Amount of messages : 2' and a list of measurements: 1: -1000, 2: -1000, 3: -101, 4: -103, followed by 'Found location: 7' and '---- SENT ----'. The second section, which is highlighted with a red rectangular border, shows 'Starting timer', 'Message from Gateway4', 'Link budget: 103', 'Message from Gateway3', 'Link budget: 99', followed by '---- Message is being sent ----', 'Amount of messages : 2', and a list of measurements: 1: -1000, 2: -1000, 3: -99, 4: -103, followed by 'Found location: 7' and '---- SENT ----'. The terminal has a blue title bar and standard window controls.

```
student@student-03: ~/project/pyd7a-master

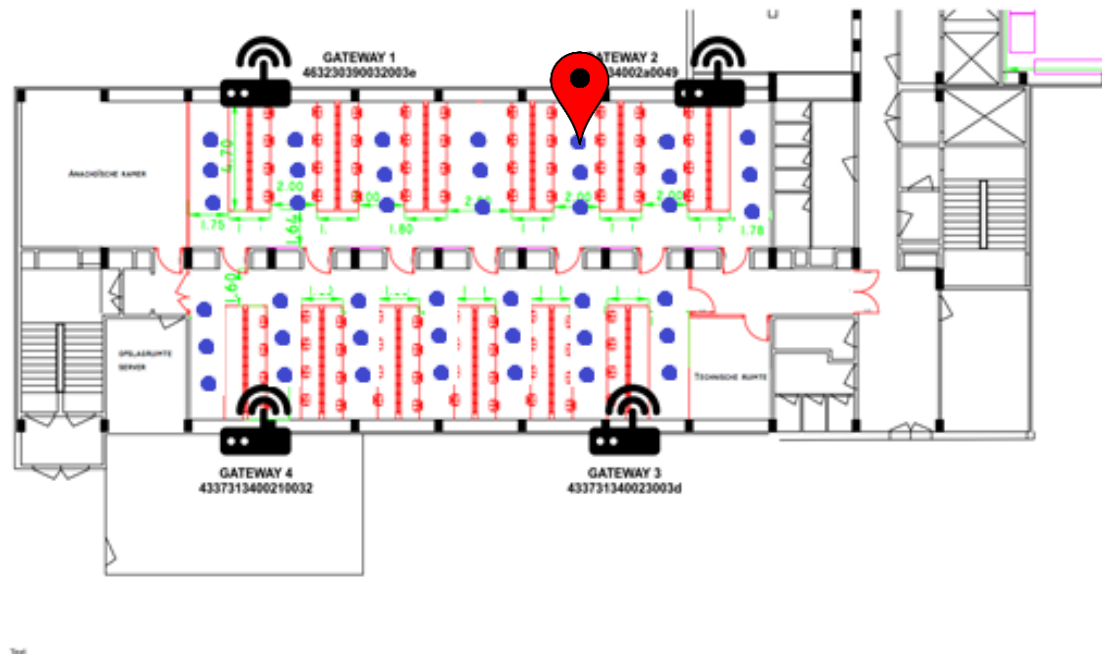
---- Message is being sent ----
Amount of messages : 2
measurements:
 1: -1000
 2: -1000
 3: -101
 4: -103
Found location: 7
---- SENT ----

Starting timer
Message from Gateway4
Link budget: 103
Message from Gateway3
Link budget: 99
---- Message is being sent ----
Amount of messages : 2
measurements:
 1: -1000
 2: -1000
 3: -99
 4: -103
Found location: 7
---- SENT ----
```


Localisation

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- Training phase
- K Nearest Neighbours
- Classification



Thingsboard

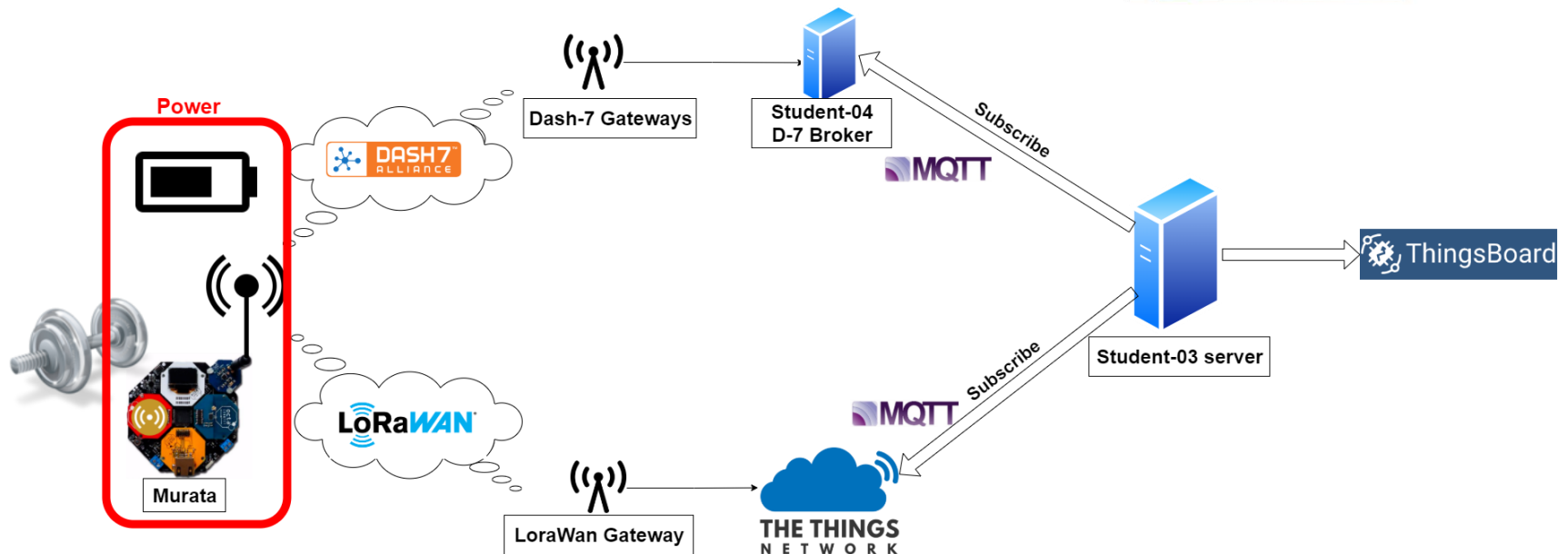
Concept
Embedded side
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Power consumption
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Overview

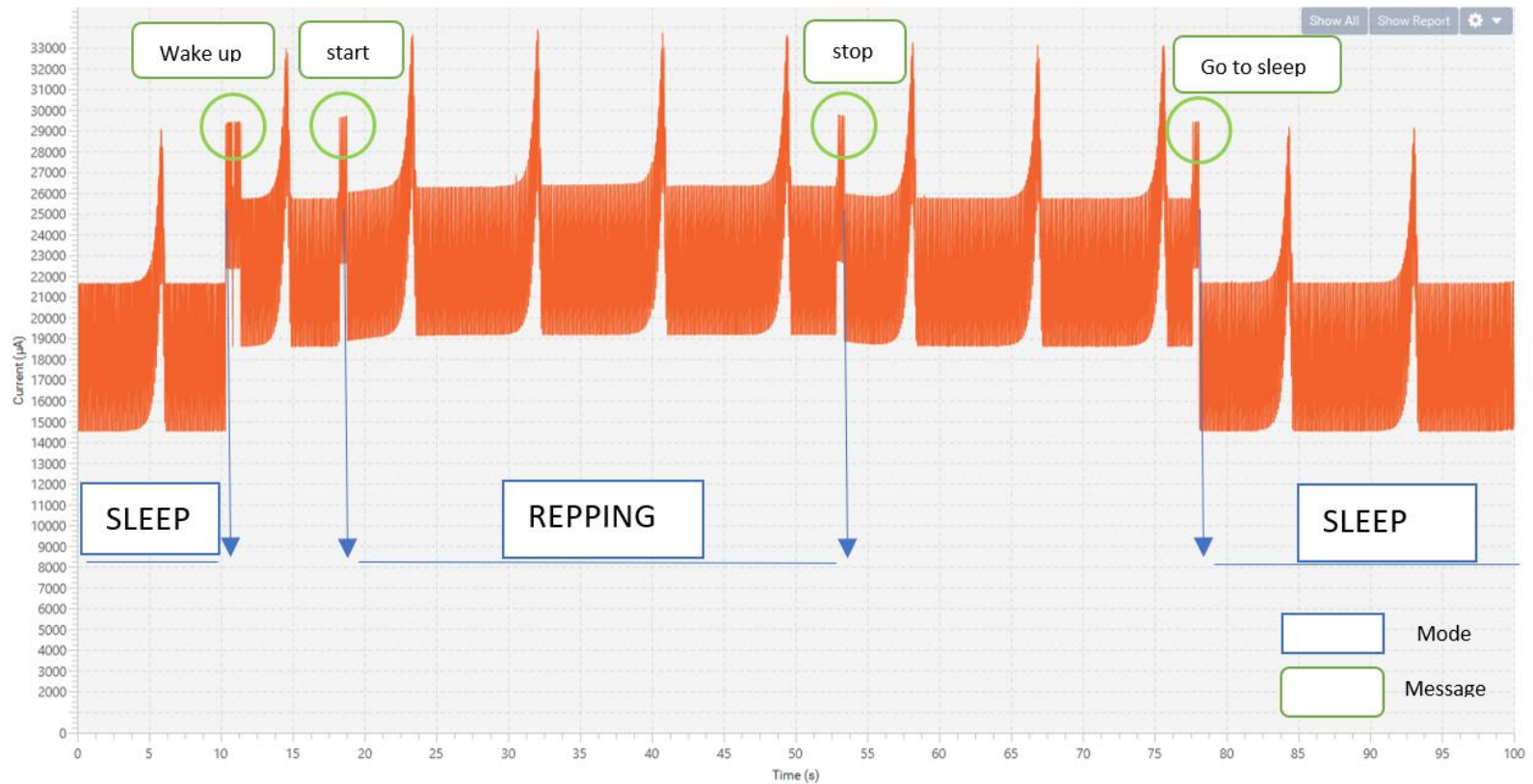
X-NUCLEO-LPM01A

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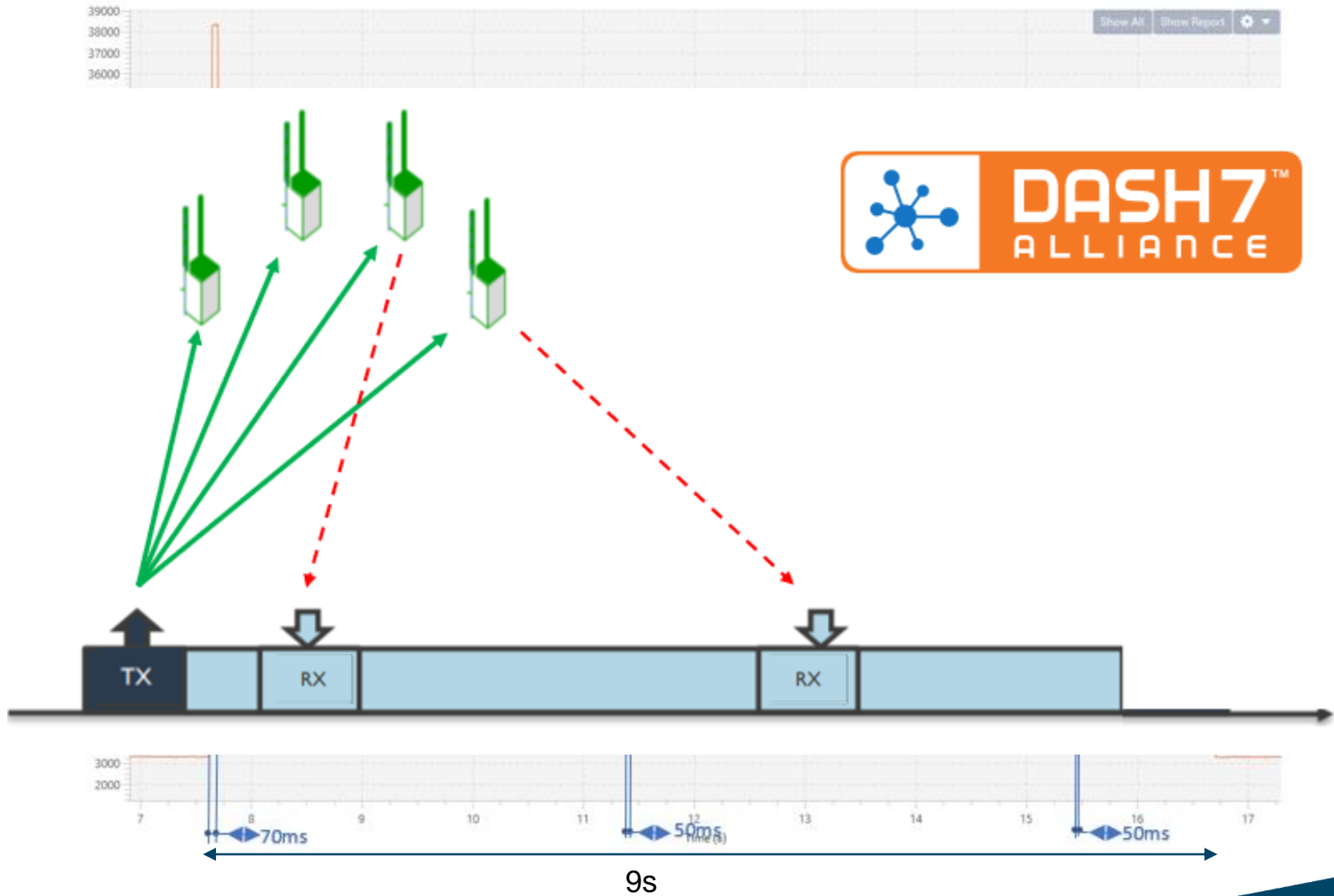
General flow

- Concept
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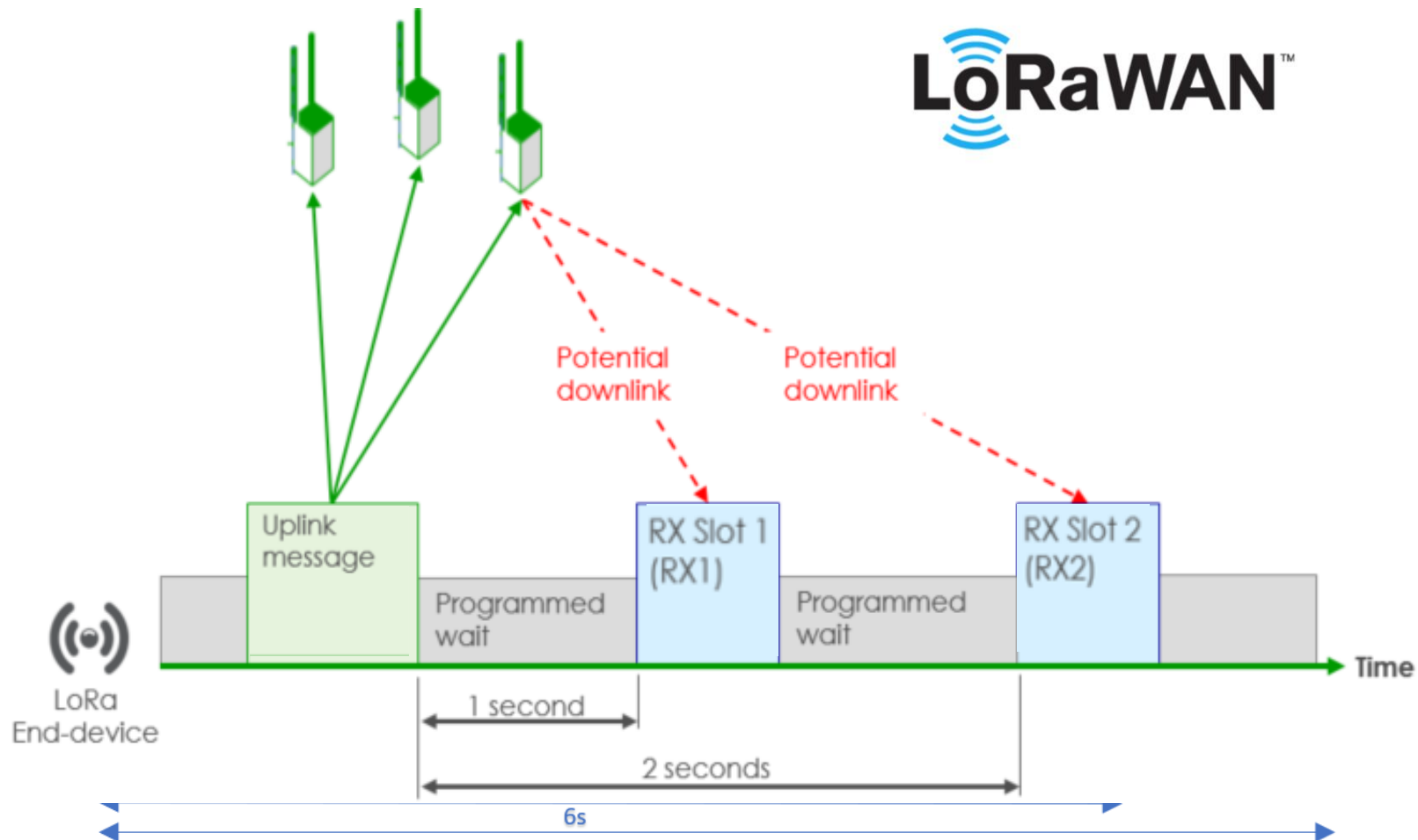
Dash7-tx-rx

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LoRaWAN-tx-rx

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Battery life

- Current measurements

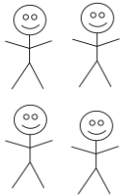
Sleep mode	18,10 mA		TX RX	38,75 mA 20,50 mA
Active mode	21,25 mA		TX RX	35,50 mA 16,00 mA

- Assumptions

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

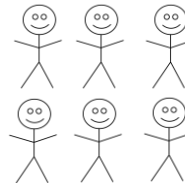
Battery life: use cases

Case 1



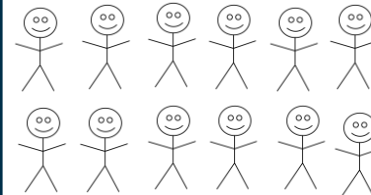
202 h

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  ✓
- Communication via  **LoRaWAN** ✓
- Live Visualisation  **ThingsBoard** ✓
- Low power ★





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