BOEIend!

Mobile Communications – Lab [JLIZN8]

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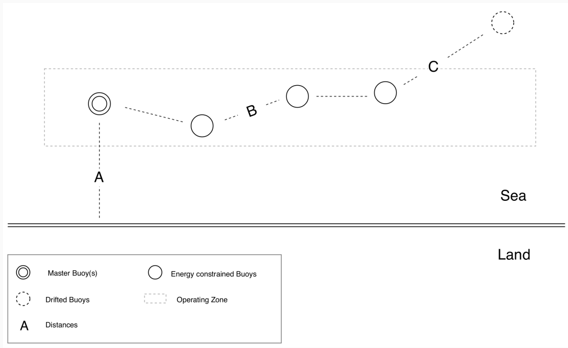

Figure 1: The problem scenario.

2. Assumptions

Table 1: Possible feasible communication technologies with their most important characteristics.

Communication technology	Range	Bitrate	Power usage
Bluetooth	100 m	1-3 Mbit/s	1 W
Bluetooth Low Energy	50-150 m	1 Mbit/s	10-100 mW
ZigBee	10-100 m	250 kbit/s	10-100 mW
Wifi	30-100 m	150-1024 bit/s	/
Cellular	35 km	35-170 kbit/s	/
LoRaWAN	2-5 km	0.3-50 kbit/s	Low
Ultra Wide Band [13], [14]	290 m	850 kbit/s	90 mA - 1 μA

2. Assumptions

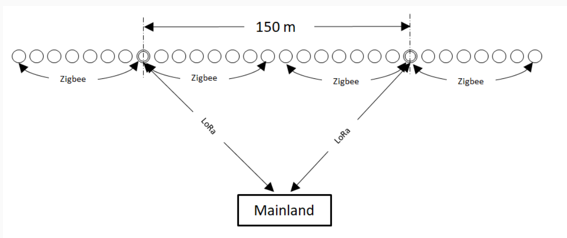

Figure 2: The overview of the proposed implementation.

3. Implementation

Communication between the buoys

Zigbee

- IEEE 802.15.4-standard
- Power efficient
- Low cost
- Range between 10 and 100 meters
- Bitrate of 0.12 Mbit/s

Zigbee Communication

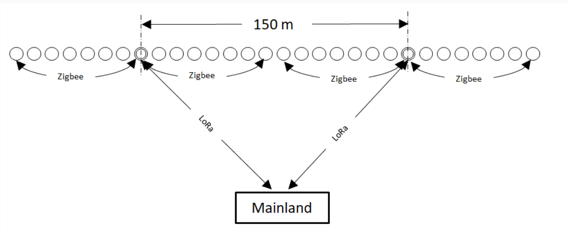

Figure 3: Zigbee Communication.

Components used on every buoy

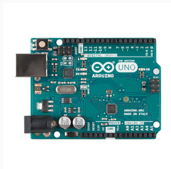

Figure 4: Arduino UNO.

Figure 5: DRAMCO XBee Shield.

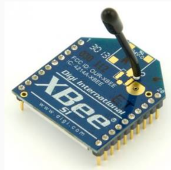

Figure 6: XBee Module.

Practical implementation

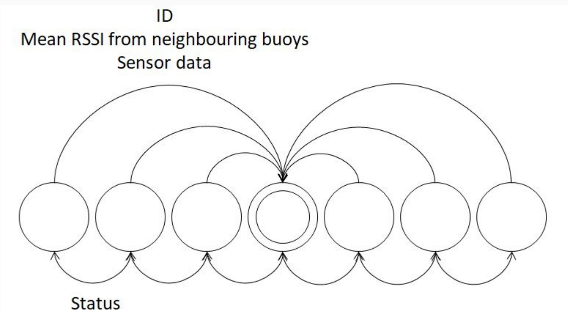

Figure 7: Practical implementation.

Master buoy

$$\left\{ \begin{array}{c} \text{Arduino UNO + DRAMCO XBeeShield + XBee module} \\ \text{Happy Gecko + DRAMCO LoRaWAN RN2483 modem} \end{array} \right\}$$

Arduino UNO (5V) $\Rightarrow$ **UART** $\Rightarrow$ Happy Gecko (3,3V)

Level shifter necessary!

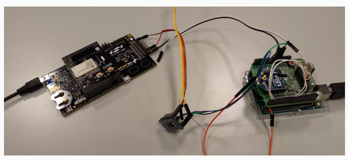

Figure 8: The master buoy.

Master buoy (cont.)

1. Receive message using interrupts on UART.
2. Parse message to values.
   $\underbrace{009}_{\text{Bouy ID}}\underbrace{64}_{\text{RSSI}}\underbrace{335}_{\text{VBAT}}$
3. Add values to Low Power Payload (LPP).
4. Send payload to Cayenne (≈ 'The Cloud') using LoRaWAN.

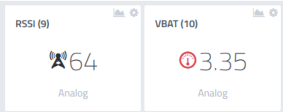

Figure 9: Cayenne cloud interface.

LoRaWAN

Why?

- Range between 2 to 5 kilometers
- Low power usage
- (low) bitrate of 0.3-50 kbit/s
  - ⇒ This is an important downside, see further!

4. Technical issues

RSSI vs. distance

RSSI: **R**eceived **S**ignal **S**trength **I**ndicator

- Good unit to predict distance?
- **Problem:** Negative logarithmic characteristic (Figure 11)
- Still possible, but more inaccurate

$$RSSI\ [dBm] \approx -10 \cdot n \cdot log(d)$$

d: distance in metres
n: the propagation constant or path-loss exponent
Free space has n= 2-4 (depends on environment)

Testing this method

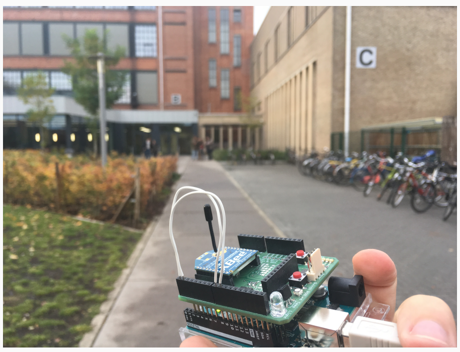

Figure 10: Measuring RSSI.

RSSI vs. distance

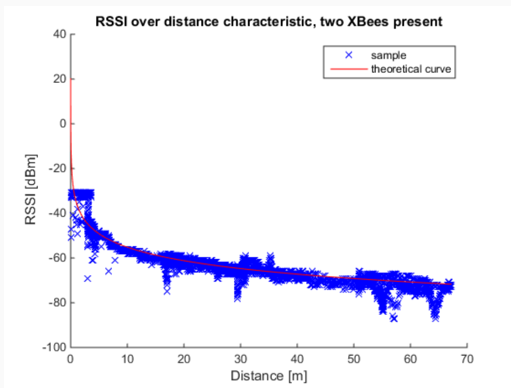

Figure 11: RSSI over distance [12].

RSSI vs. temperature

RSSI not always a constant value at the same distance.

Reasons

- Multipath fading
- Temperature and humidity?
- ...

RSSI vs. temperature

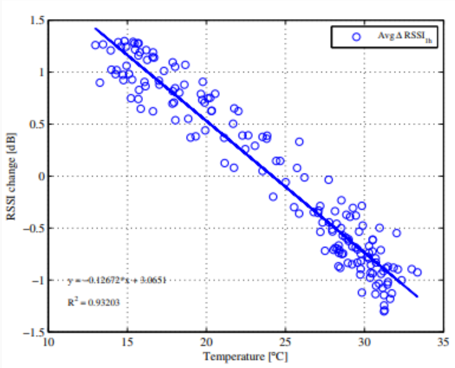

Figure 12: RSSI vs. temperature [15].

RSSI detecting method

RSSI good method for detecting a drifting buoy?

- Good for small distances
- Depends on the temperature
- Multipath fading (less in the ocean)

LoRaWAN dutycycle

We can't send LoRaWAN packets continuously.

- Duty-cycle of 0,1% or 1% of the time you can send
- 99(,9)% of the time we have to wait
- Europe: ETSI EN300.220 standard

5. Energy Efficiency

Arduino + Zigbee

ZigBee: energy efficient
Arduino: energy intensive

Solutions

- Deep-sleep mode
- Reducing amount of transmissions
- Energy efficient alternatives modules

Happy Gecko

Five Energy Modes

- More energy efficient
- Less functionality

6. Conclusion

6. Conclusion

Communication modules

- ZigBee Shield
- EMF32 Happy Gecko
- DRAMCO LoRaWAN RN2483

Difficulties

- LoRaWAN limited amount of data
- Legative logarithmic trend of the RSSI
- Ambient temperature with RSSI

Thanks for listening!
Questions?

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