



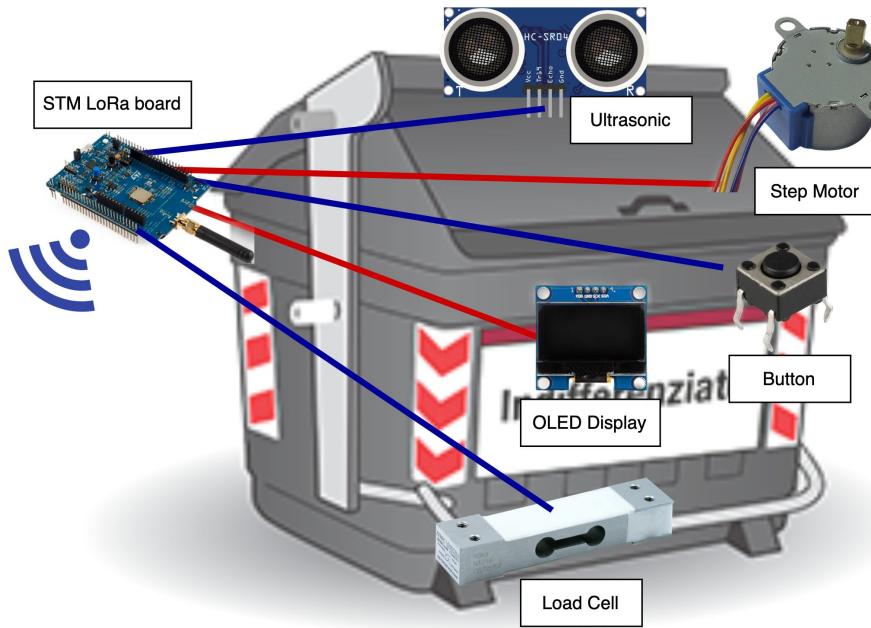
checkBin

Brief recap

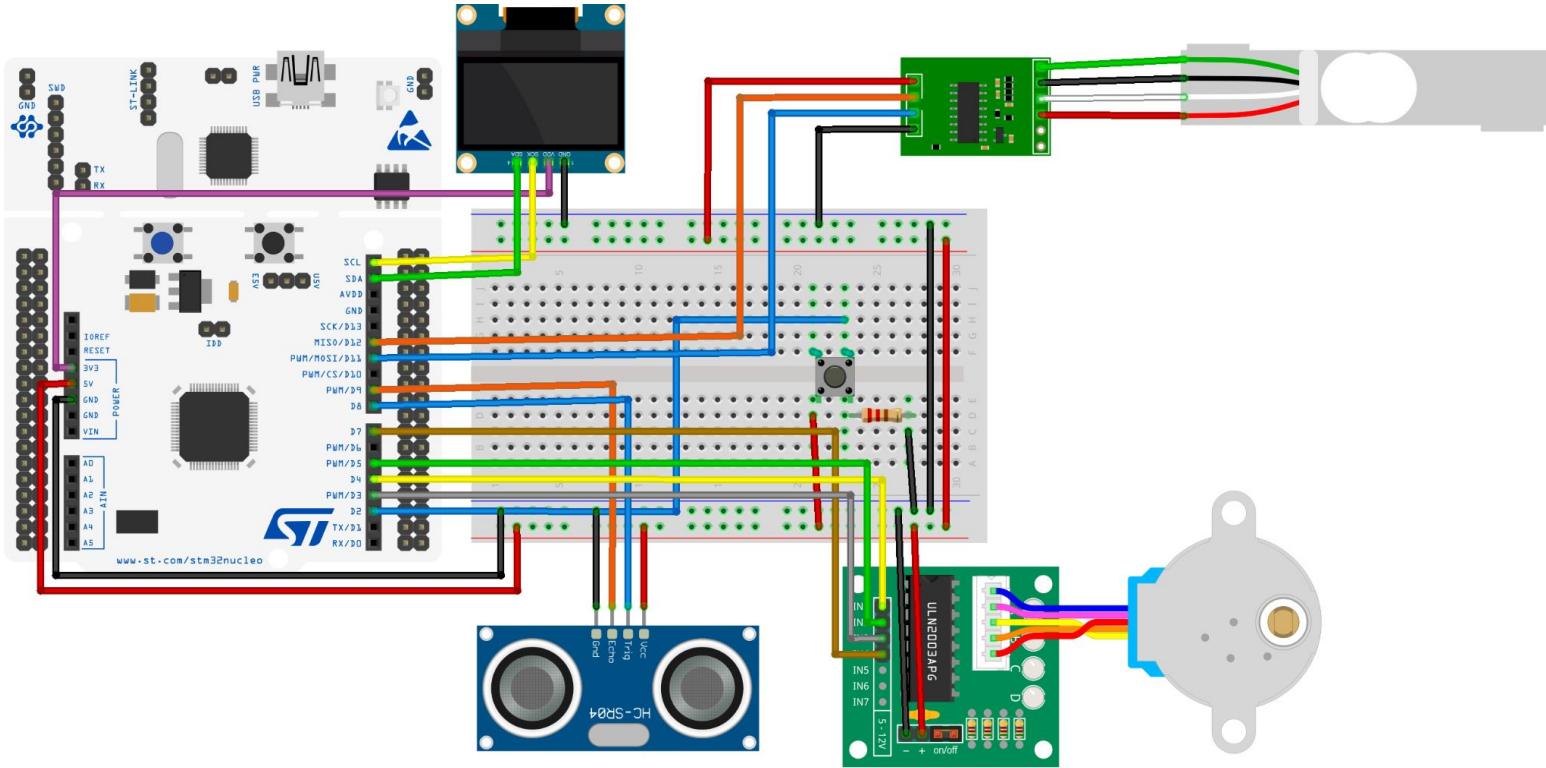


Hardware

Main hardware components



Wiring diagram

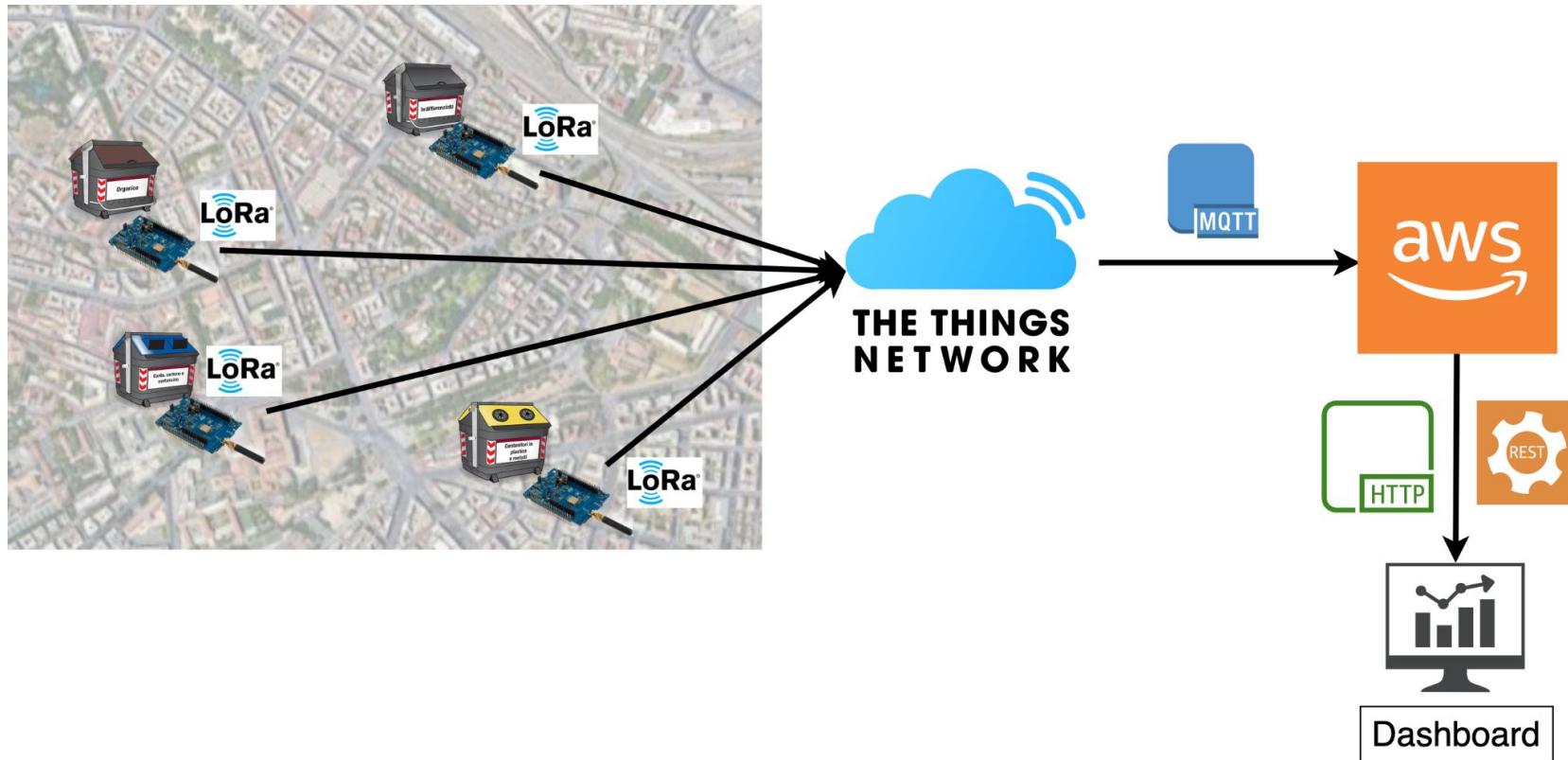


Prototype

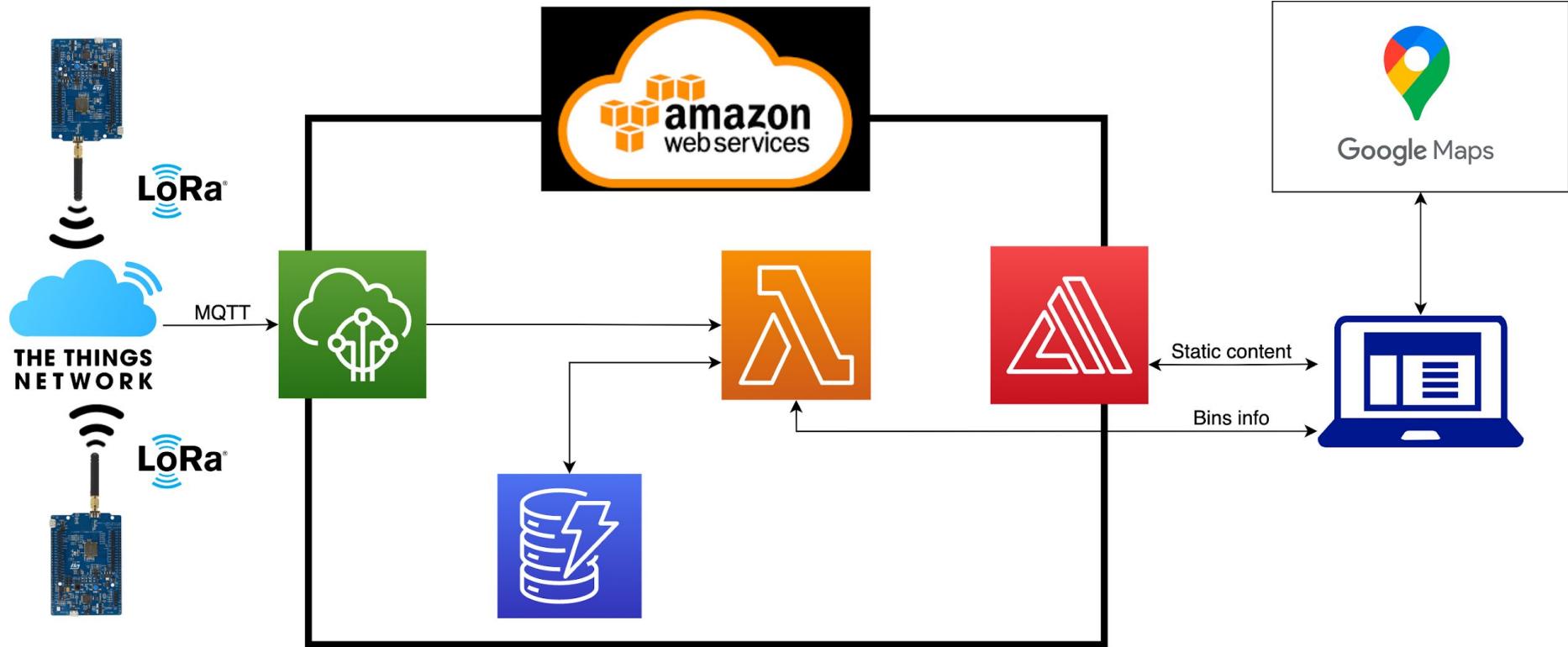


Network and Cloud

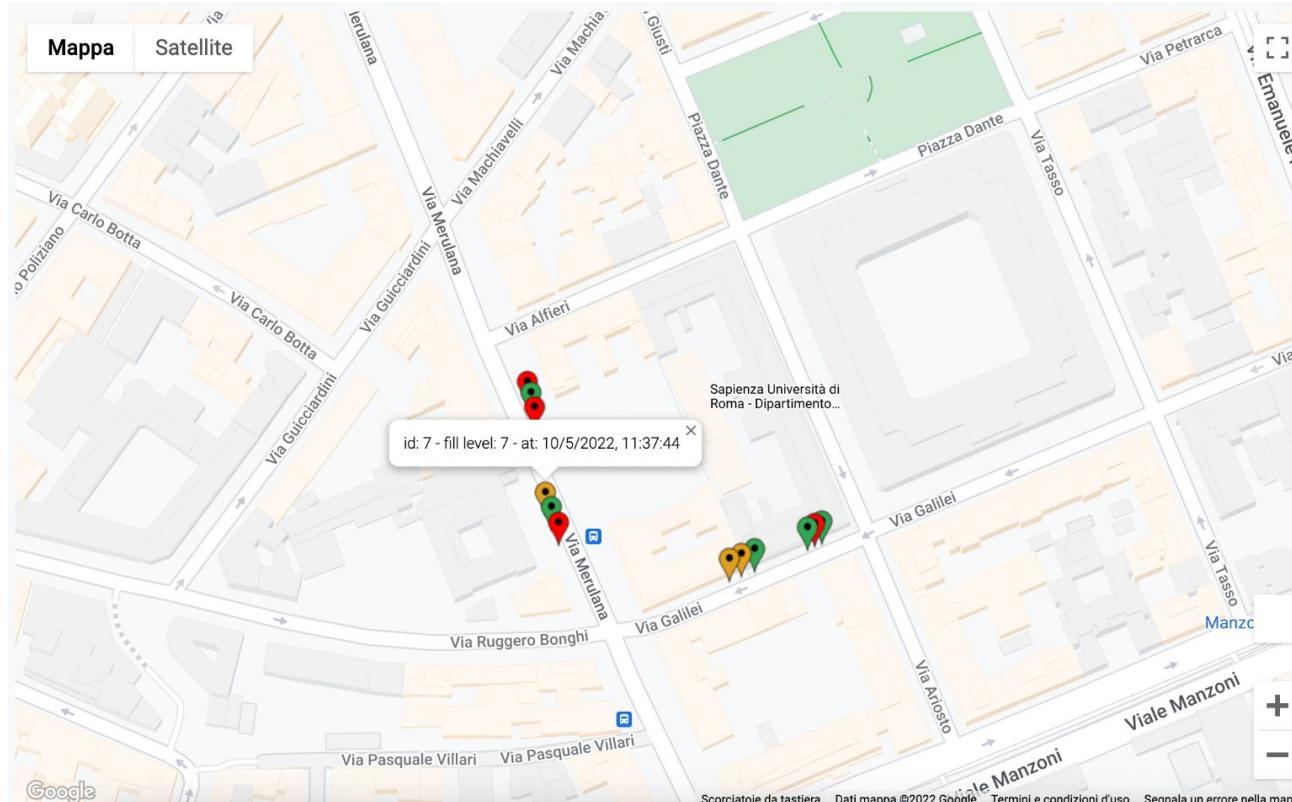
Network diagram



Cloud diagram



Web Dashboard



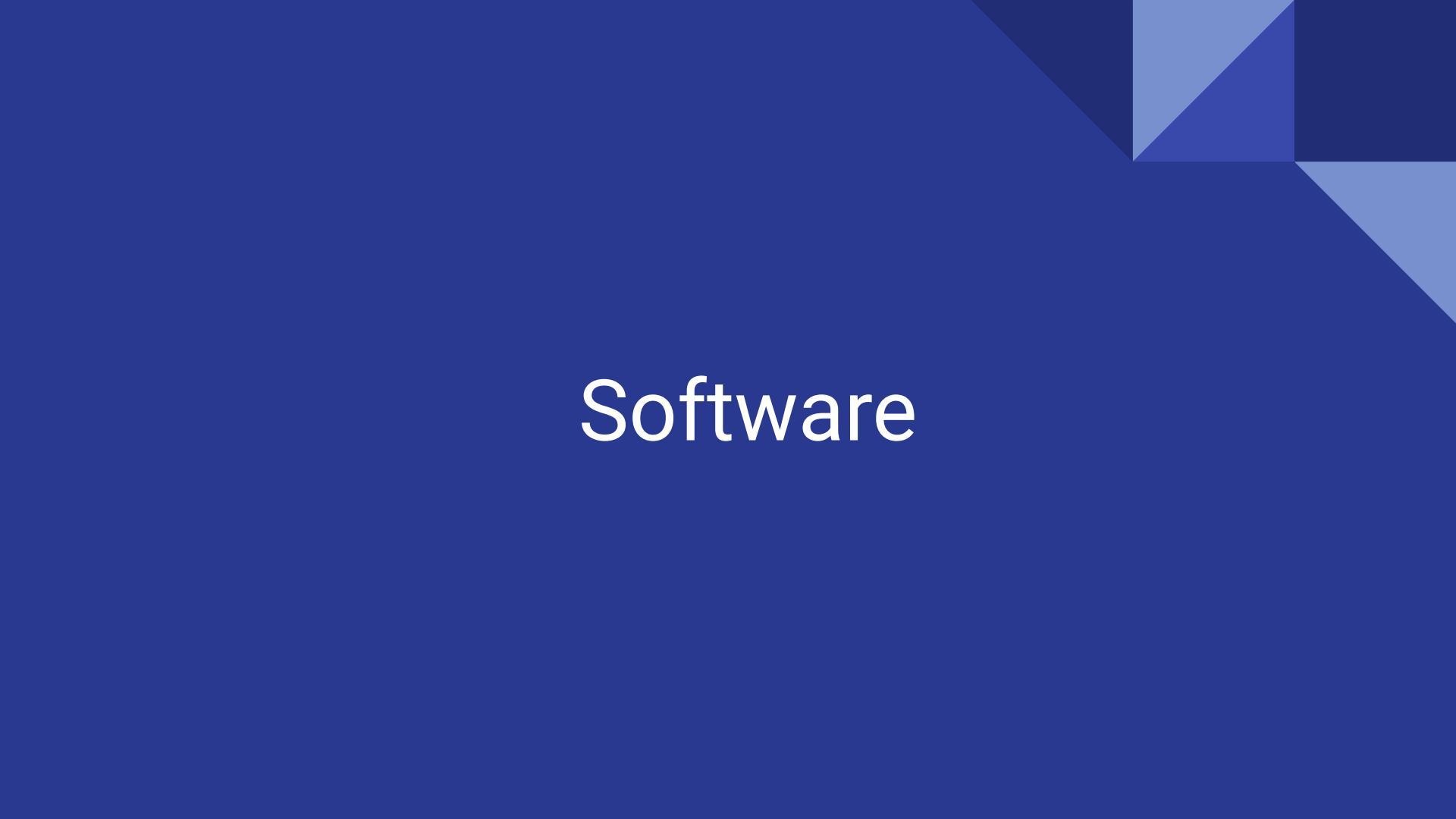
checkBin

Legend

- Fill level between 8 and 10
- Fill level between 5 and 7
- Fill level between 0 and 4

To add a new bin, fill the form with the coordinates and click on "Add Bin". After a while will appear the new bin's ID

GitHub Repository: [checkBin](#)

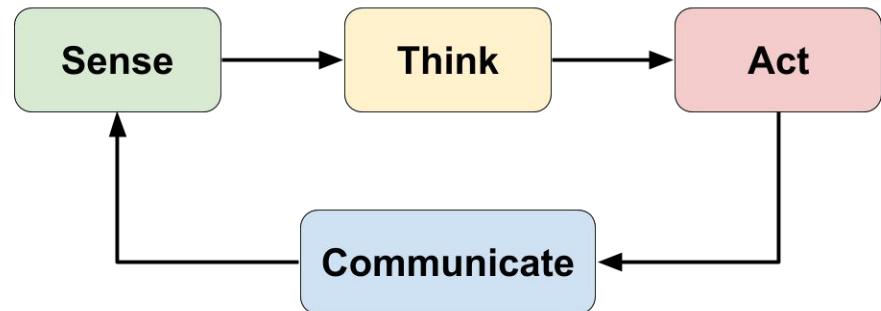
The background of the slide features a dark blue gradient. Overlaid on this are several light blue triangles of varying sizes and orientations, creating a sense of depth and movement.

Software

Additions to the Code

Functions necessary to:

- Listen for button presses
- Show a progress bar



Evaluation

Requirements and metrics

- The accuracy error of the fill level must be at most 10%;
- The update of the fill levels must be shown in the dashboard within 2 hours from the actual changes;
- The system must be energy independent for at least a year;

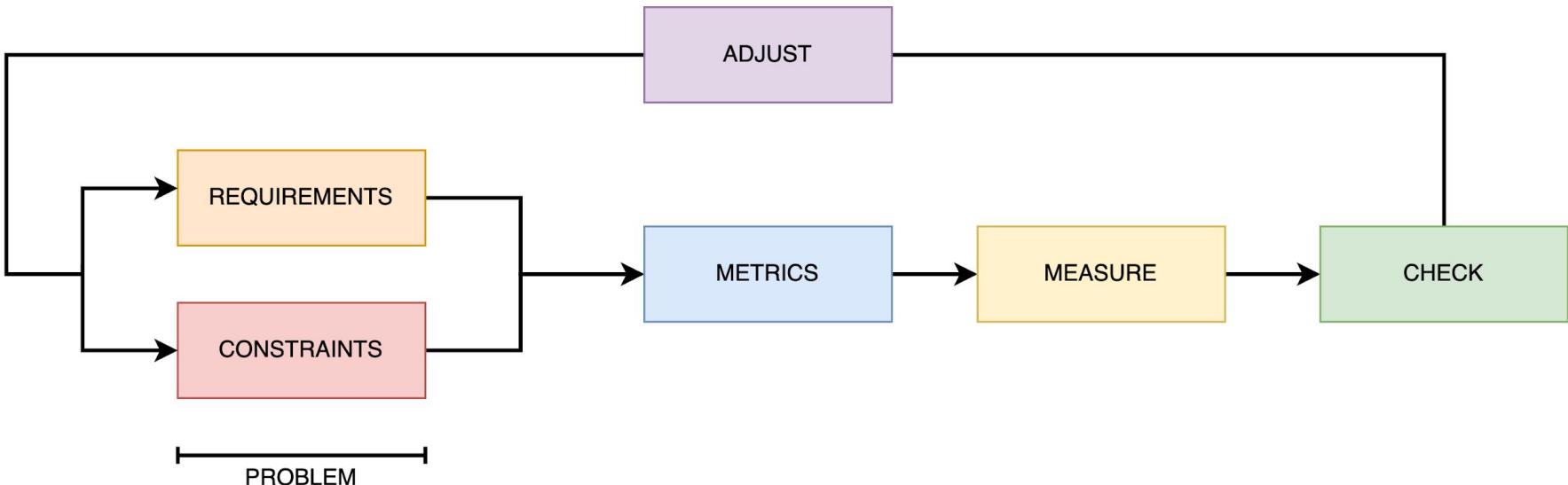
* These requirements were set making reasonable assumptions on the observed real world.

Requirements and metrics

- The capacity of the bin must not be reduced by more than 5% (both in weight and volume);
- The system must be compliant with the LoRa duty cycle restrictions;
- The ratio of wrong fill level measurements over total fill level measurements must be < 5%;
- The system must be able to scale up.

* These requirements were set making reasonable assumptions on the observed real world.

Requirements

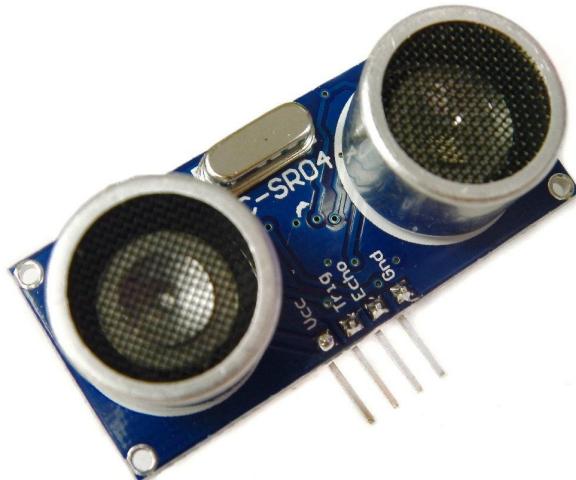


Fill level accuracy

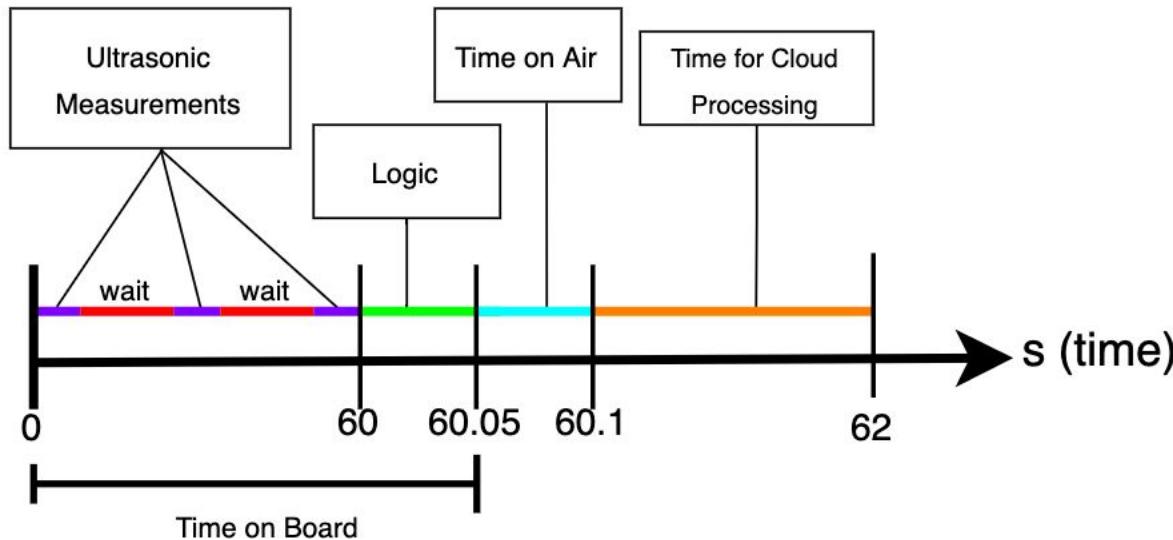
Fill level → value between 0 and 9

Fill level step represents a range of size $\text{bin_height}/10$

Error percentage of the fill level:
max 10% of the total height



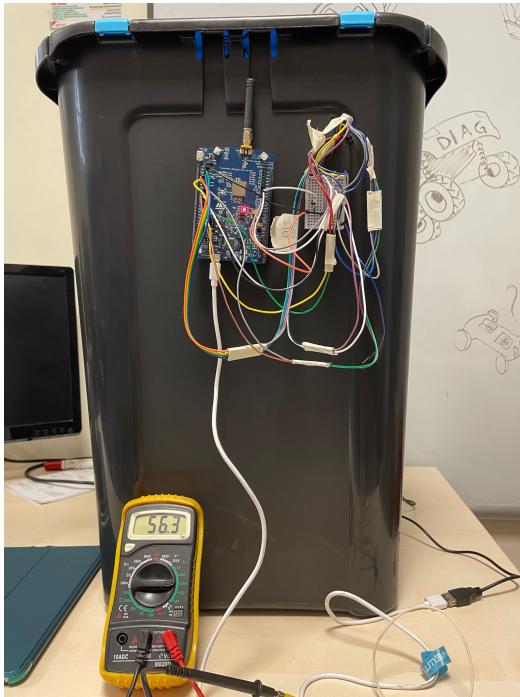
Latency on the web dashboard update



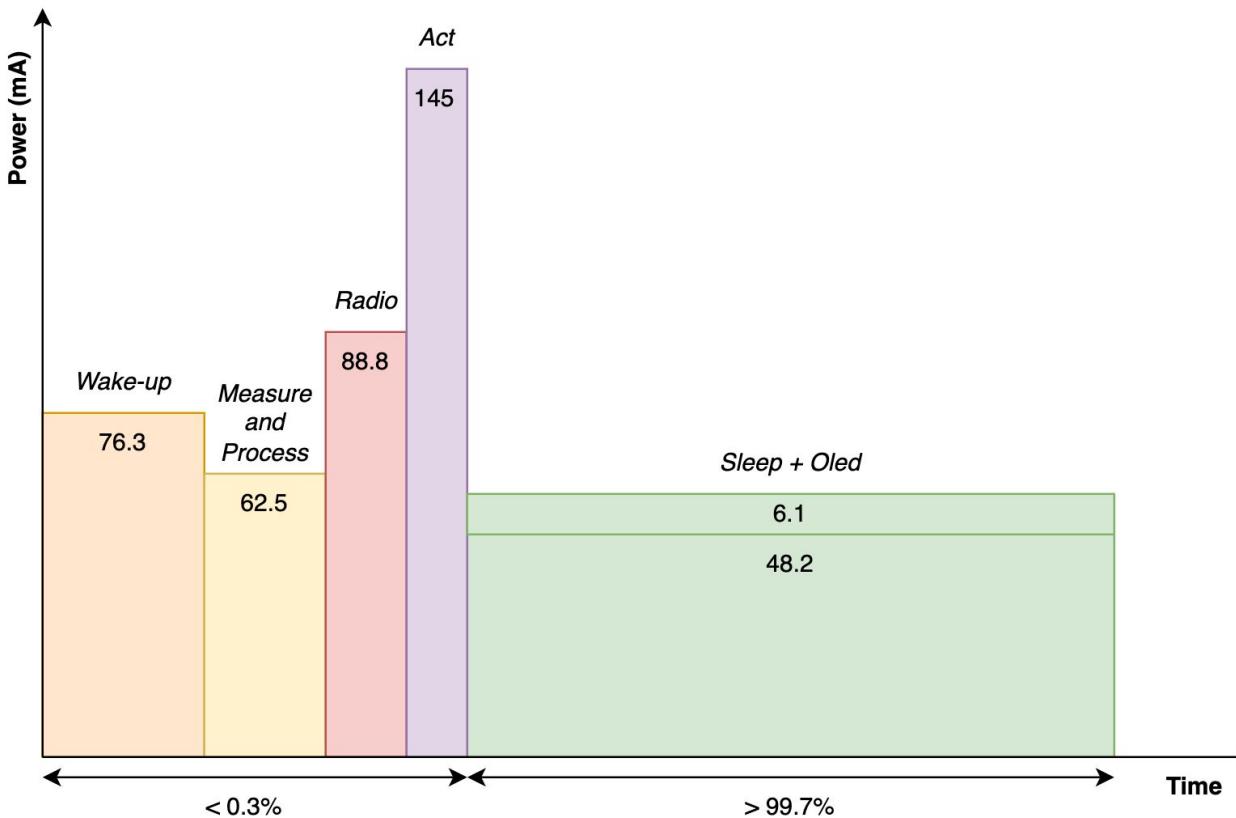
*the image is NOT in scale

$$\begin{aligned}\text{Latency} &= T_{\text{Board}} + T_{\text{Air}} + T_{\text{Cloud}} = T_{\text{Ultrasonic}} + T_{\text{Logic}} + T_{\text{Air}} + T_{\text{Cloud}} \\ &= 60 + 0.05 + 0.05 + 2 = 62.1s \approx 62s\end{aligned}$$

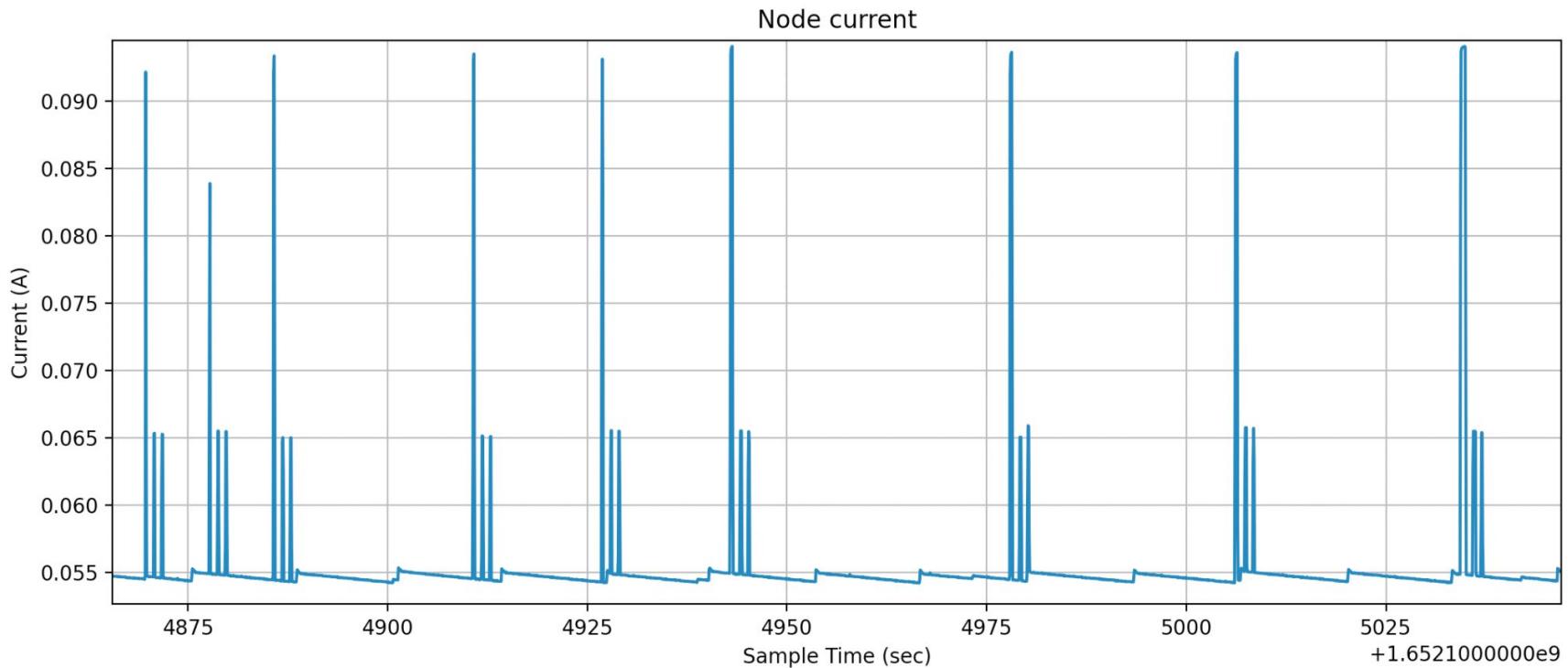
Energy consumption/1



Energy consumption/2



Energy consumption/3



Battery

500A battery reduces bin capacity
by at least 8% in standard bins



Must implement charging method



Charging methods

5W solar panel



1400 - 3400 mAh per day



Accuracy of the system

Fill level from ultrasonic sensor	Total measurements	Detected anomalies	Undetected anomalies
0	2	0	0
1	3	0	0
2	5	0	0
3	4	0	0
4	7	0	0
5	6	1	0
6	3	0	0
7	3	1	0
8	4	0	1
9	3	0	0
-----	-----	-----	-----
Total	40	2	1



Scalability

Experiment system_simulation #315591

User mazzitel

Submitted 2022-05-10 14:33:39

Started 2022-05-10 14:33:40

Duration 10 minutes (17%) of 1 hour

Nodes 12

State Running

● Stop ⬇️ Download

🔗 Actions on selected nodes ▾

Nodes	UID	Firmware	Monitoring	Deployment	Actions	⋮
st-Irwan1-14.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□
st-Irwan1-15.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□
st-Irwan1-16.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□
st-Irwan1-17.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□
st-Irwan1-18.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□
st-Irwan1-19.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□
st-Irwan1-20.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□
st-Irwan1-21.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□
st-Irwan1-22.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□
st-Irwan1-23.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□
st-Irwan1-24.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□
st-Irwan1-25.saclay.iot-lab.info				Success	▶ ⌚ ⟳ ☰ 🔗 ✖	□

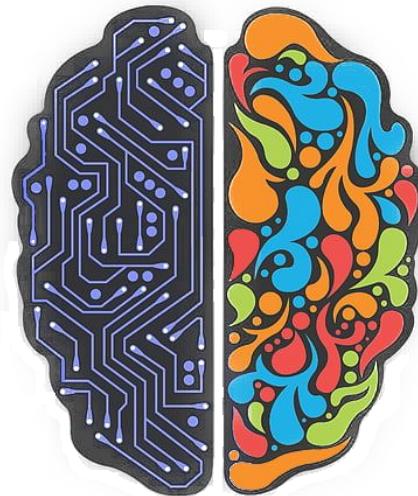
Simulation

Time	Entity ID	Type	Data preview	Verbose stream
↑ 14:39:51	test-device	Forward uplink data message	MAC payload: 39 <> FPort: 2 Data rate: SF11BW125 SNR: 11.2 RSSI: -77	<input checked="" type="checkbox"/>
↑ 14:39:45	eui-70b3d57ed0050665	Forward uplink data message	MAC payload: 34 <> FPort: 2 Data rate: SF8BW125 SNR: 10.5 RSSI: -75	<input type="checkbox"/>
↑ 14:39:41	eui-70b3d57ed005066f	Forward uplink data message	MAC payload: 30 <> FPort: 2 Data rate: SF8BW125 SNR: 11.2 RSSI: -88	<input type="checkbox"/>
↑ 14:39:40	eui-70b3d57ed0050664	Forward uplink data message	MAC payload: 39 <> FPort: 2 Data rate: SF8BW125 SNR: 11.25 RSSI: -79	<input type="checkbox"/>
↑ 14:39:29	test-node-2	Forward uplink data message	MAC payload: 38 <> FPort: 2 Data rate: SF9BW125 SNR: 12.5 RSSI: -77	<input type="checkbox"/>
↑ 14:39:29	eui-70b3d57ed0050660	Forward uplink data message	MAC payload: 34 <> FPort: 2 Data rate: SF8BW125 SNR: 11.25 RSSI: -81	<input type="checkbox"/>
↑ 14:39:28	eui-70b3d57ed0050662	Forward uplink data message	MAC payload: 39 <> FPort: 2 Data rate: SF8BW125 SNR: 8.2 RSSI: -77	<input type="checkbox"/>
↑ 14:39:23	eui-70b3d57ed005065c	Forward uplink data message	MAC payload: 30 <> FPort: 2 Data rate: SF10BW125 SNR: 9.8 RSSI: -89	<input type="checkbox"/>
↑ 14:39:22	eui-70b3d57ed005065e	Forward uplink data message	MAC payload: 39 <> FPort: 2 Data rate: SF10BW125 SNR: 11 RSSI: -82	<input type="checkbox"/>
↑ 14:39:19	eui-70b3d57ed0050665	Forward uplink data message	MAC payload: 33 <> FPort: 2 Data rate: SF8BW125 SNR: 9 RSSI: -71	<input type="checkbox"/>
↑ 14:39:16	eui-70b3d57ed005065f	Forward uplink data message	MAC payload: 39 <> FPort: 2 Data rate: SF8BW125 SNR: 10.75 RSSI: -91	<input type="checkbox"/>
↑ 14:39:14	eui-70b3d57ed0050664	Forward uplink data message	MAC payload: 34 <> FPort: 2 Data rate: SF8BW125 SNR: 8.25 RSSI: -78	<input type="checkbox"/>
↑ 14:39:13	eui-70b3d57ed0050661	Forward uplink data message	MAC payload: 39 <> FPort: 2 Data rate: SF9BW125 SNR: 13.5 RSSI: -87	<input type="checkbox"/>
↑ 14:39:10	eui-70b3d57ed005065d	Forward uplink data message	MAC payload: 39 <> FPort: 2 Data rate: SF9BW125 SNR: 9.5 RSSI: -87	<input type="checkbox"/>

```
1652186383.366101;st-lrwan1-20;AFTER--  
1652186384.912023;st-lrwan1-24;Message Sent  
1652186384.912297;st-lrwan1-24;SEND: 9  
1652186384.912419;st-lrwan1-24;Sent: 9  
1652186384.912509;st-lrwan1-24;AFTER--  
1652186384.971985;st-lrwan1-25;BEFORE  
1652186384.972234;st-lrwan1-25;RANDOM NUMBER: 1  
1652186386.432435;st-lrwan1-19;Message Sent  
1652186386.433761;st-lrwan1-19;SEND: 0  
1652186386.435270;st-lrwan1-19;Sent: 0  
1652186386.435312;st-lrwan1-19;AFTER--  
1652186390.162332;st-lrwan1-25;Message Sent  
1652186390.163737;st-lrwan1-25;SEND: 4  
1652186390.164674;st-lrwan1-25;Sent: 4  
1652186390.164995;st-lrwan1-25;AFTER--  
1652186390.658987;st-lrwan1-14;BEFORE  
1652186390.661526;st-lrwan1-14;RANDOM NUMBER: 9  
1652186393.34021;st-lrwan1-22;Fail to send: no ACK received  
1652186393.340272;st-lrwan1-22;SEND: 9  
1652186393.341022;st-lrwan1-22;Sent: 9  
1652186393.342377;st-lrwan1-22;AFTER--
```

Future plans

Machine learning



Interval between
measurements

Specific weight for
each waste type

e-ink Display

0.005mA in standby

8mA during update phase

e-ink :0.16mAh per day

vs

oled: 54mAh per day



Charging methods

Mechanical energy



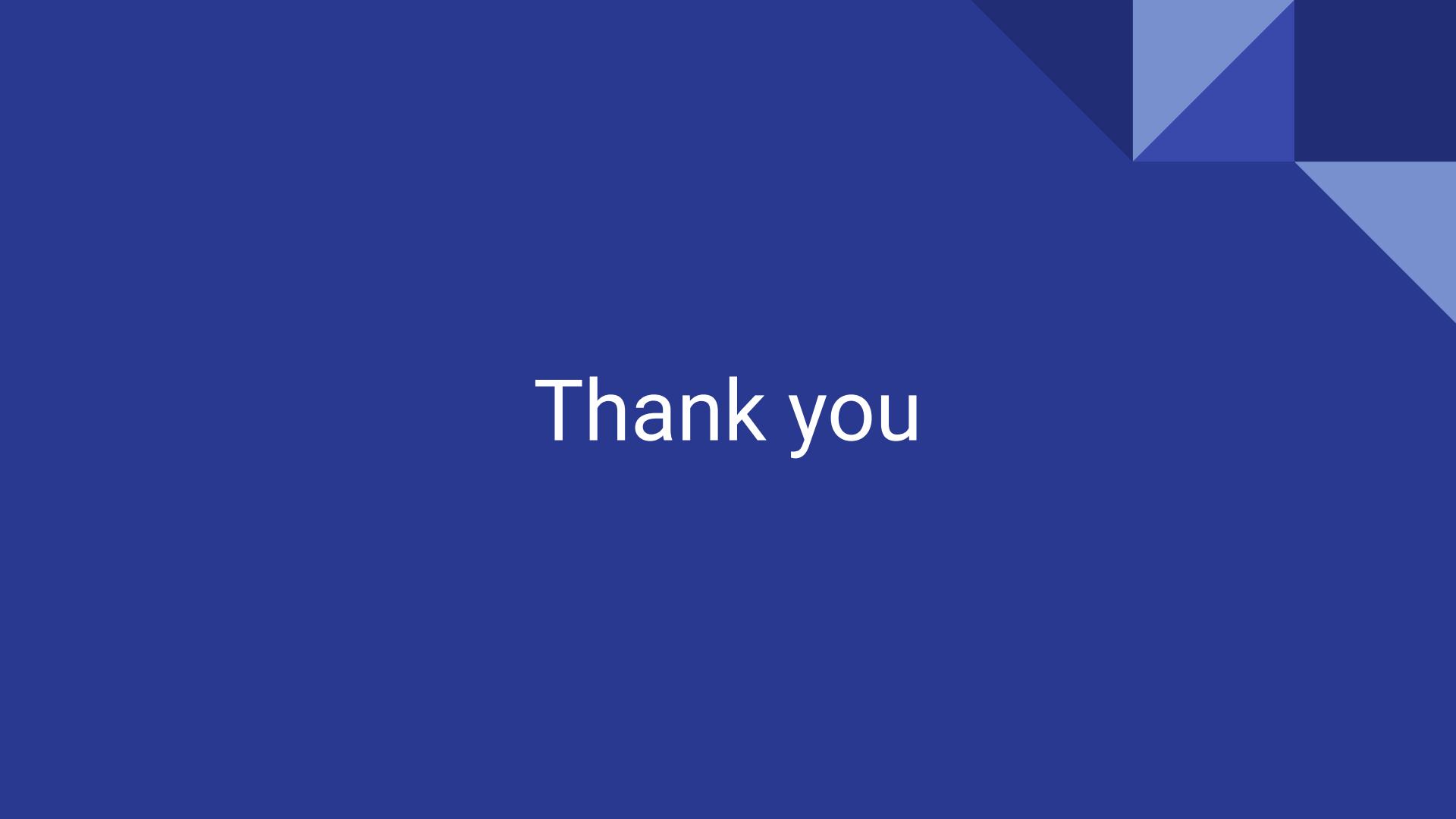
Sunlight



Electric power

Demo

<https://dev7723.d2wnn0xh1kb5op.amplifyapp.com/>



A dark blue background featuring a geometric pattern of overlapping triangles in various shades of blue, creating a sense of depth and movement.

Thank you