Power

Power Measurement

Mode	Description	Current Consumption (mA)
Wifi active	Transmitting	256
	Receiving	103
CPU active, wifi idle	Frequency 240 MHz	72.2
	Frequency 160 MHz	43.9
	Frequency 80 MHz	33.4
	Frequency 40 MHz	21.8
	Frequency 10 MHz	9.76
Light sleep	Frequency 160 MHz	2.02
Deep sleep		1.19

How long is the lifetime of a 600 mAh battery? Assume that every 2 hours between 8:00 and 18:00 there will be a batch of enter/exit events. Assume a clock frequency of 160Mhz and that the automatic light sleep mode is switched on.

According to the assumptions above, below is a schedule of enter and exit events on a workday:
- Entry sequence at around 8:00,
- Exit and then entry sequences at around 10:00,
- Exit and then entry sequences at around 12:00,
- Exit and then entry sequences at around 14:00,
- Exit and then entry sequences at around 16:00,
- Exit sequence at around 18:00,
- Thus, there are 10 batches each day

Below are the additional **assumptions** made:
- 5V potential difference (for a board attached battery this might be lower)
- The exit/entry events only happen on weekdays (5),
- The board is always active throughout an enter/exit event,
- An enter/exit event lasts for 2 seconds,
- On average 30 students exit or enter a room,
- The transmission of the updated count value consumes around 7.5μWh energy,
- Once every 5 beacon frames is received and processed,
- Each beacon frame is advertised with a period of 100 milliseconds,
- The time range of the beacon listening peak is around 4ms,
- Every message published consumes about 5~10μWh, let's say 7μWh.

Then the expected energy consumption of the board per week could be categorized as follows:
- **Beacon frame processing with 2 beacons per second**

$$7 \cdot 24 \cdot 60 \cdot 60 \cdot 2 \cdot \left(\frac{4}{1000} \cdot 5 \cdot 0.103\right) = 2491.776\, Ws$$

- **On workdays:**

- **Idle activity during enter/exit events**

$$5 \cdot 10 \cdot 30 \cdot (2 \cdot 5 \cdot 0.0439) = 658.5\, Ws$$

- **Transmission of updated count**

$$5 \cdot 10 \cdot 30 \cdot \left(7 \cdot 3600 \cdot 10^{-6}\right) = 37.8\, Ws$$

- **Light sleeping all the time**

$$(7 \cdot 24 \cdot 60 \cdot 60 \cdot 5 \cdot 0.00202) = 6108.48\, Ws$$

To sum it all up, total expected energy consumption per week is 9296.556 Watt-seconds which is around **2582.377 mWh**. This means that a lithium-ion battery with a capacity of 600 mAh and 3.7 Volts, which has an energy capacity of **2220 mWh**, would last for almost a week. The exact ratio of the energy capacity to the weekly energy consumption turns out to be **0.85967308413**.

The ratio above indicates that the battery would last for around 6 days which is a quite respectable lifetime for such a small lithium-ion battery, thanks to the energy efficiency of ESP32 Wrover-B as well as of the code. For the power analysis we referred to our latest code version. This version has an improved event-driven design in which we were able to omit the main infinite while loop. Moreover, we apply delays on the tasks for updating the OLED each minute and to restart the board at midnight. In our previous version we continuously polled the current time to observe time changes. An approach that unnecessarily consumes much energy, what was mentioned in the first milestone evaluation.