Sprint 4

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Edge Computing and the Internet of Things

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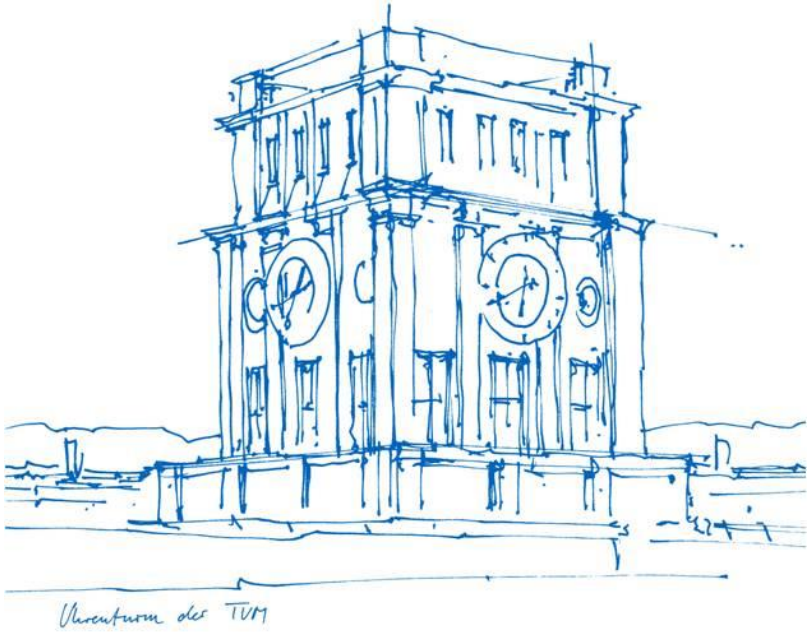
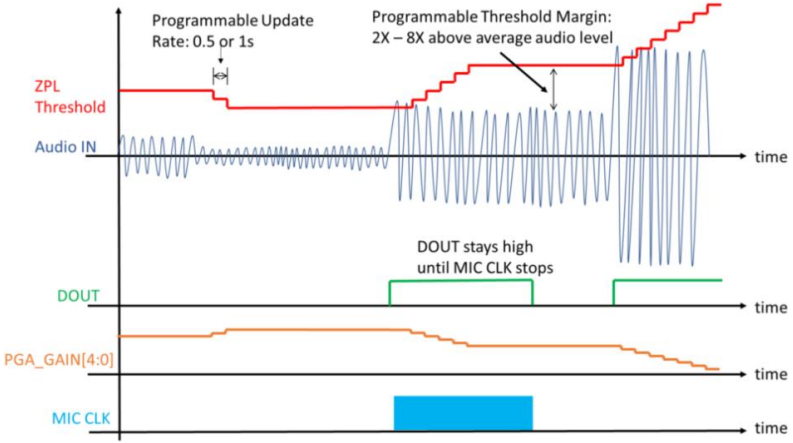


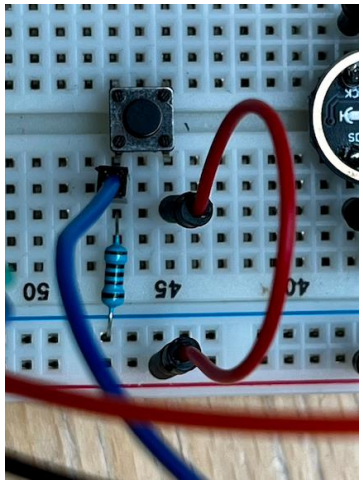
Deep sleep

Reality



[https://vespermems.com/products/vm3011/]

Solution

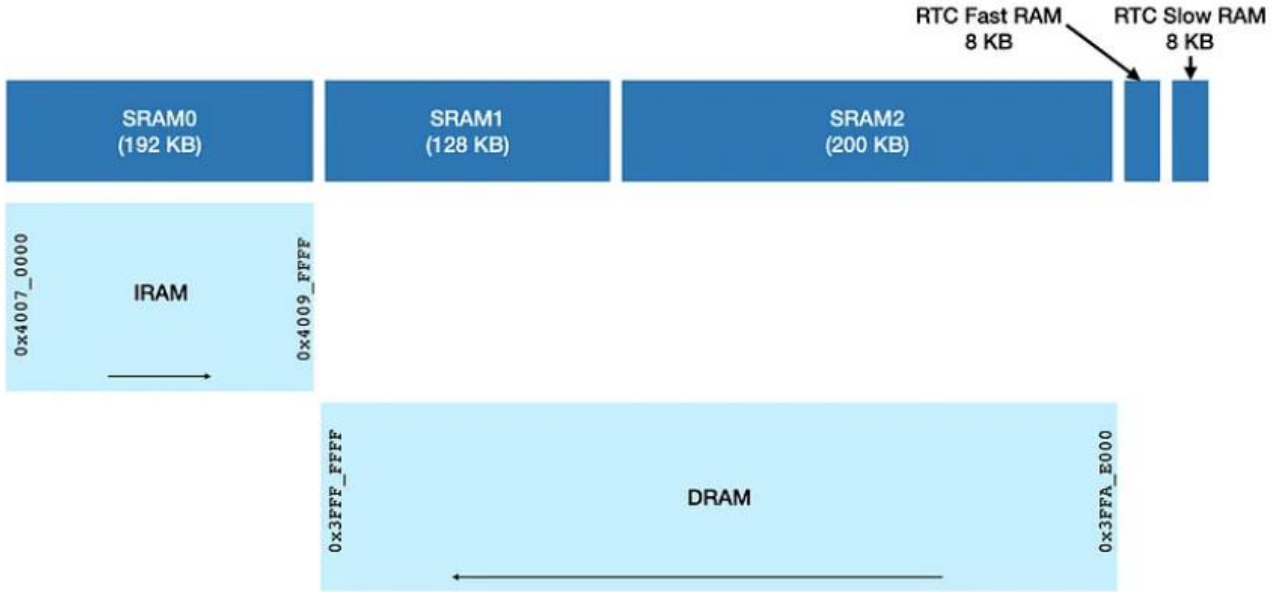


Post-training quantization

int16	floating-point	fixed-point
Training	≈ 88%	≈ 85%
Testing	≈ 88%	≈ 80%

int8	floating-point	fixed-point
Training	≈ 88%	≈ 88%
Testing	≈ 88%	≈ 88%

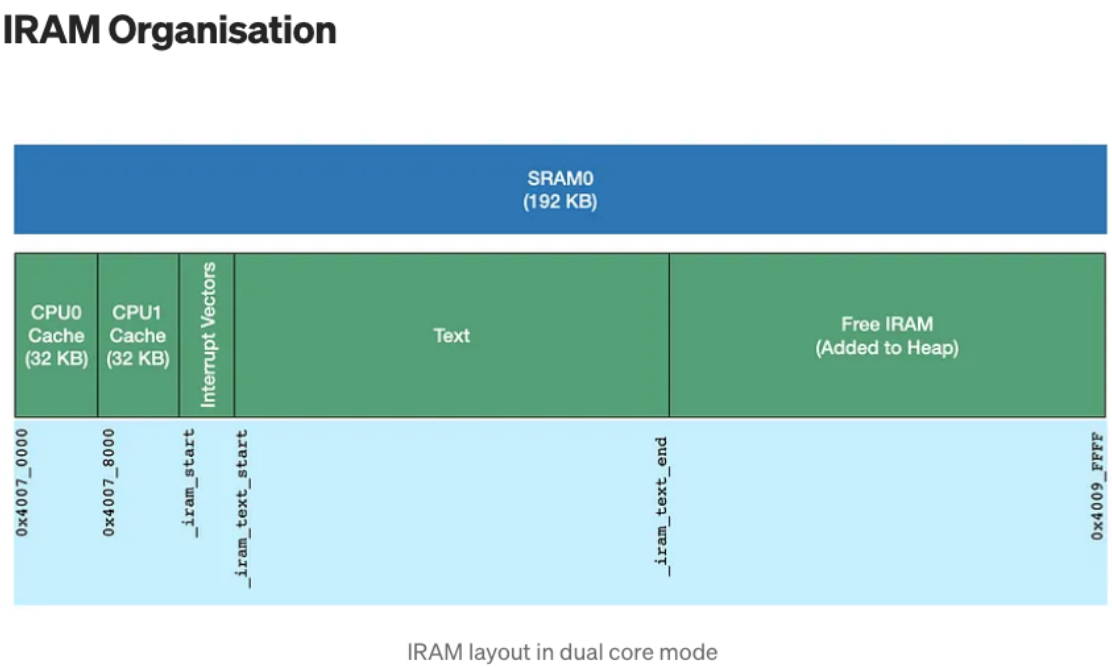
[ESP32] 512 kB SRAM ↯ heap



Programmers' Memory Map

[https://blog.espressif.com/esp32-programmers-memory-model-259444d89387]

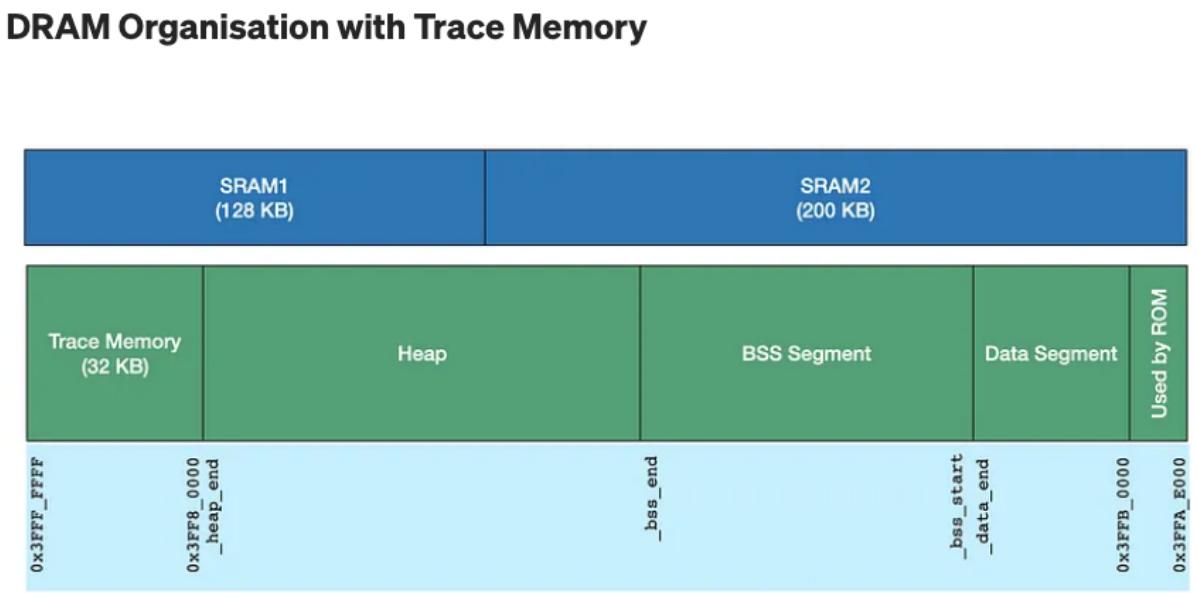
[ESP32] 512 kB SRAM ↯ heap



IRAM layout in dual core mode

[https://blog.espressif.com/esp32-programmers-memory-model-259444d89387]

[ESP32] 512 kB SRAM ↯ heap



DRAM Layout with Tracing Enabled

[https://blog.espressif.com/esp32-programmers-memory-model-259444d89387]

Memory inference

Example: 5s, 16kHz, MFCC: 308x32, quantization int8

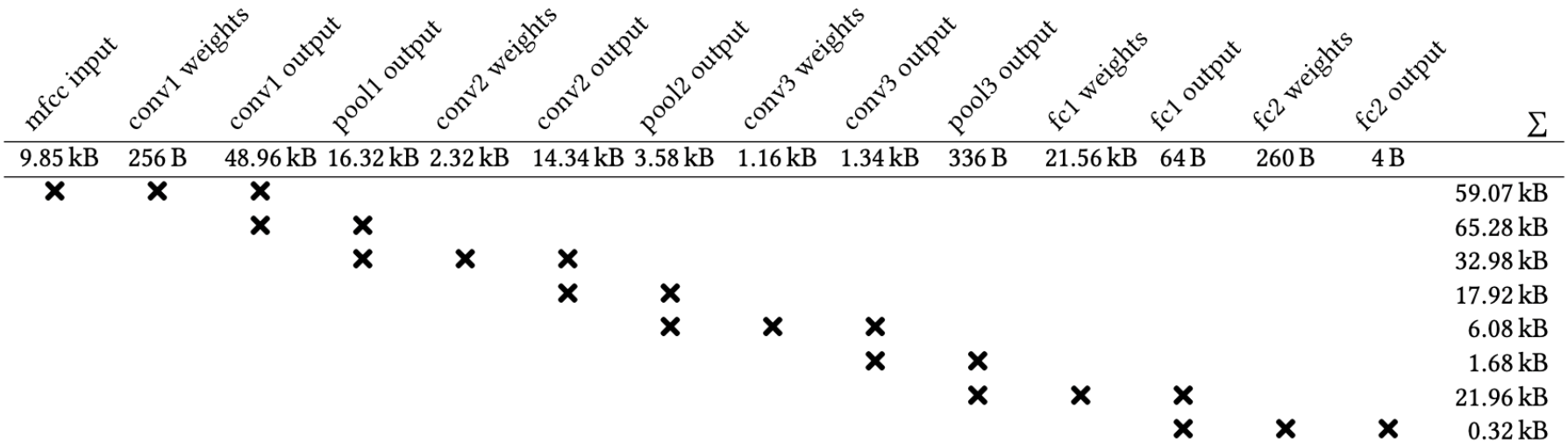
Free ≈350kB

Memory inference

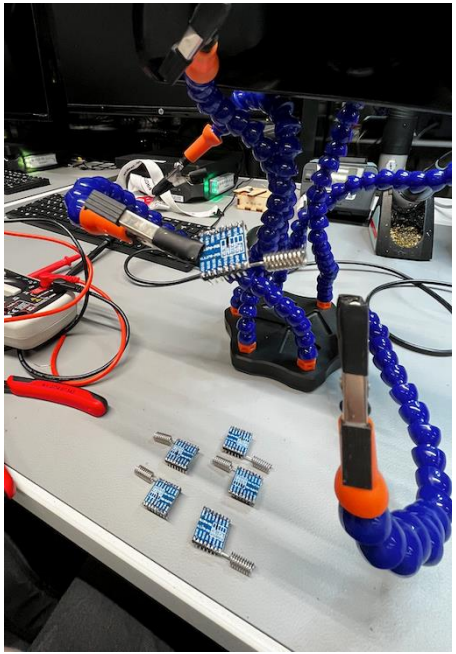
Example: 5s, 16kHz, MFCC: 308x32, quantization int8

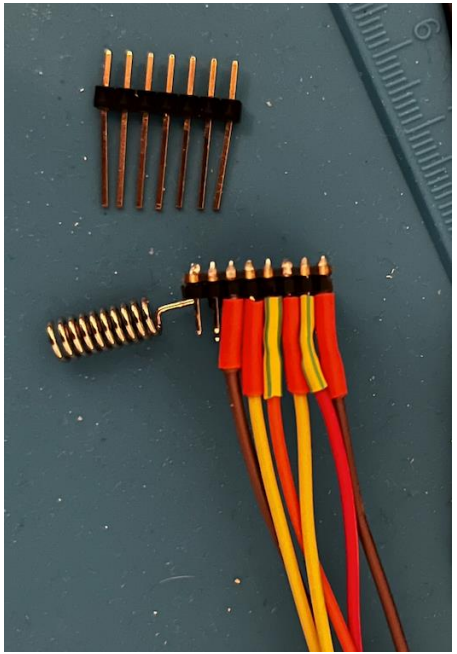
Free ≈350kB

Used ≈65kB



LoRa pitch





LoRa logic

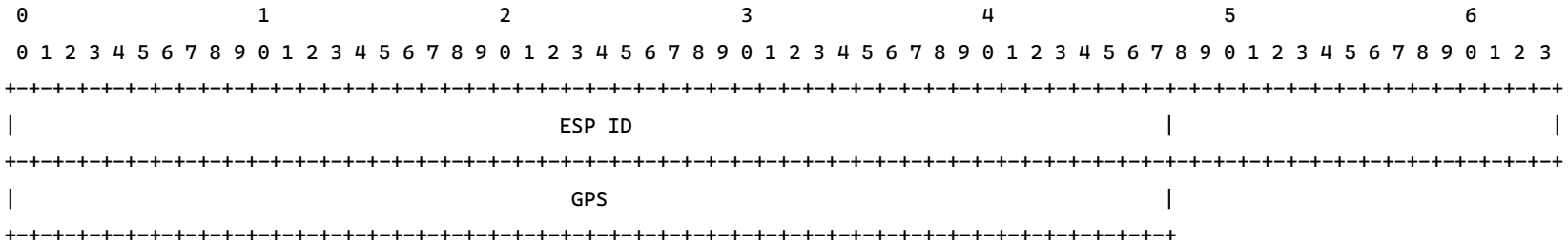
- **Initialization protocol:**
  - ESP -> RPi. MAC Address and GPS info
  - RPi -> ESP. ACK and local_id information (8 bits)

- **Classification protocol:**
  - ESP -> RPi. Local id and classification status of each bird.
  - RPi -> ESP. ACK.

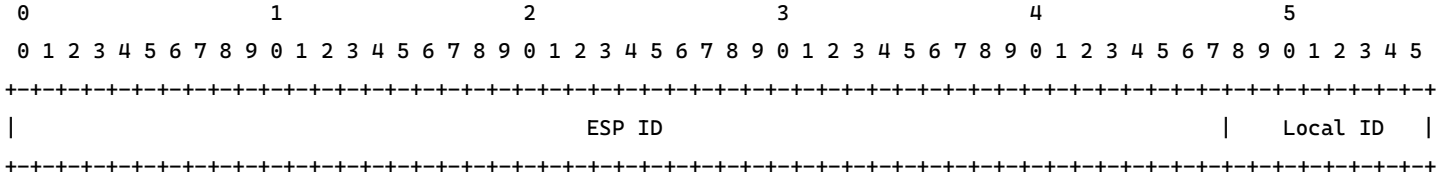
- The initialization protocol is established every 24 hours. (max. 3 retries per cycle)
- The classification protocol is established every 15 min. (max. 3 retries per cycle)

LoRa initialization payload packages

1. LoRa initialization package:

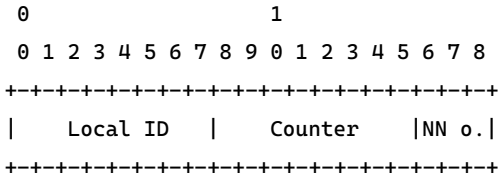


2. LoRa initialization package ACK:



LoRa information payload packages

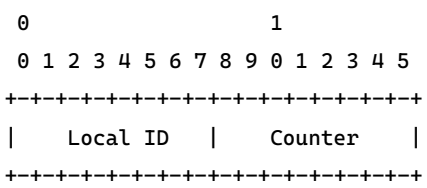
3. LoRa NN output package:



Example: 00000000 00000100 110 means:

- ID: 0.
- Counter: 4.
- NN classification: true for class 1, true for class 2, false for class 3.

4. LoRa NN output package ACK:



LoRa duty cycle

- Time on Air:
  - LoRa initialization package (112 bits) -> 105.1 ms / package
  - LoRa initialization ACK package (56 bits) -> 64.1 ms / package
  - LoRa information package (19 bits) -> 36 ms / package
  - LoRa information ACK package (16 bits) -> 33.4 ms / package

- In the worst case (every connection fails), the Time on Air is 7.17 s / 24 h.
- Time on Air is less than the fair use limit (30 s / 24 h).
- Time on Air is far less than legal limitations for LoRa (864 s / 24 h).

GPS Module

- Using the GY-GPS6MV2
- Using UART to send data to the ESP
- Cold start in ideal conditions is ~2 mins
- Cold start in non-ideal conditions is ~10-20 mins
- Timeout is set to 30 mins
- 2.5m accuracy in ideal conditions

DEMO