Smart e-ink information badge

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2025

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Motivation

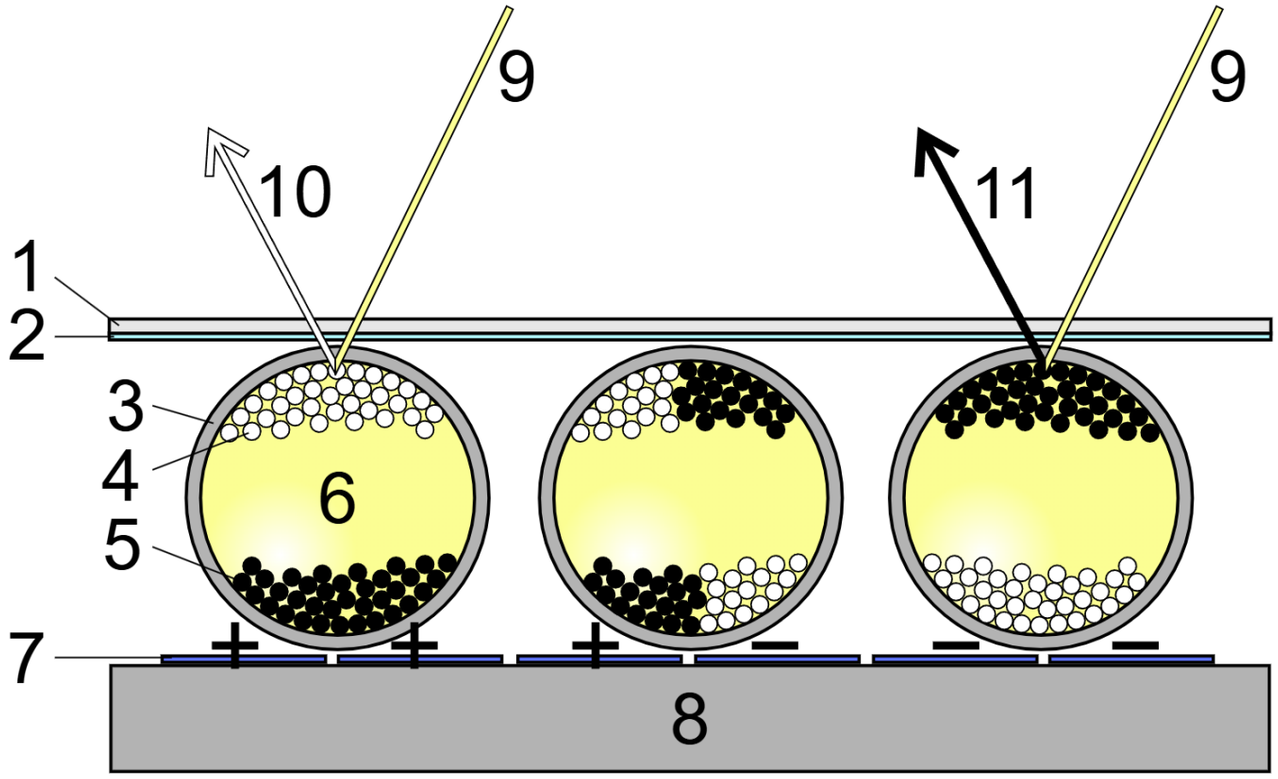
- Design an open solution for a medical congress where people in the committee change during the day
- Familiarize with ESP-IDF framework
- Familiarize with electronic paper technology
- Build a working prototype from start to finish

Thesis goals

1. Make a market research
2. Propose a concept of remotely controlled badges
3. Develop firmware for nodes and server
4. Build a working prototype of the system
5. Test the functionality and evaluate results
6. Compare achieved results with few commercial solutions

Electronic paper technology - EPD

- Consumes power only when redrawing and retains image
- Microcapsules with charged white and black particles suspended in oil
- When voltage is applied, pigments move within capsules



[1] Schematic side view of EPD display

Market analysis

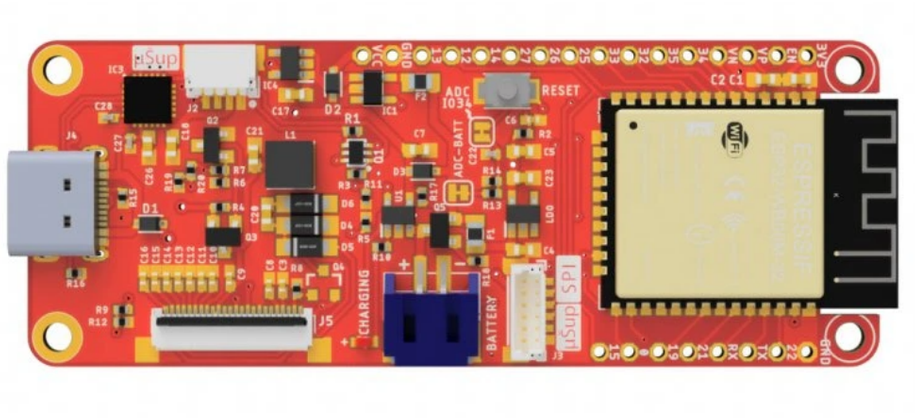
- 5 solutions ranging from meeting room signs to conference nameplates were analysed
- Generally proprietary solutions with closed eco-system
- Android or iOS app needed to control the devices
- Prices not listed for all products
- Not suitable for dynamic rewrites, only checks for updates in some interval

[2] DSPPA D7642 conference nameplate

[3] Taiden HCS-1085 conference nameplate

Hardware platform

- ESP32 - all peripherals needed (SPI, wireless communication, energy efficient)
- 7.5 inch B/W EPD panel from Good Display (reasonable refresh time and price)
- 4000 mAh LiPo battery

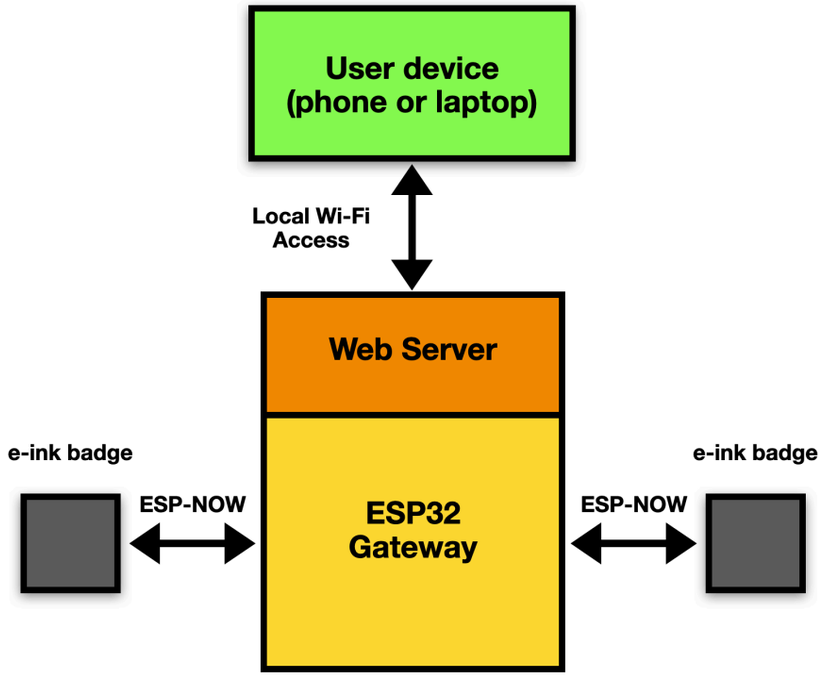


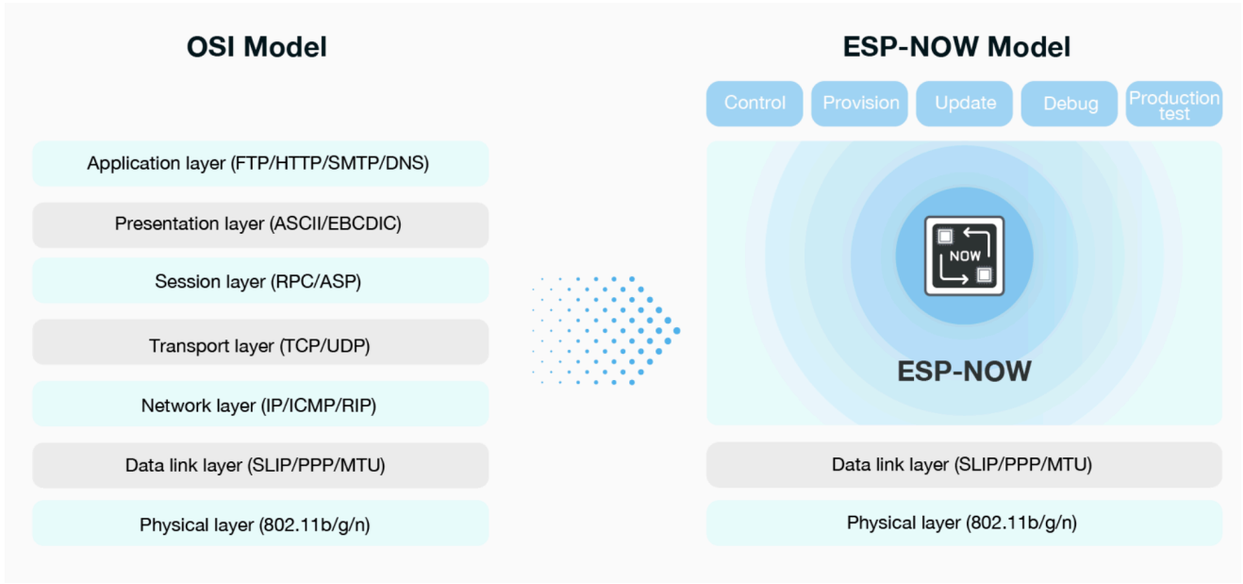
[4] ESPink dev board

[5] GD 7.5 inch EPD panel

Software architecture

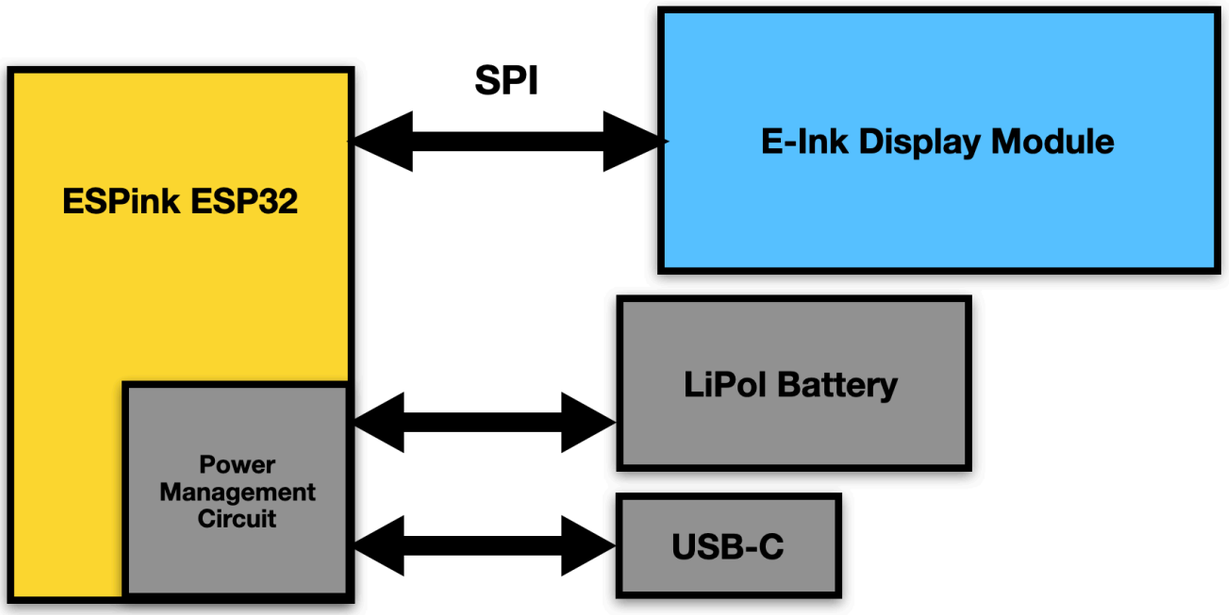
- ESP32 as a gateway running Wi-Fi AP and hosting a HTTP server
- ESP-NOW for gateway-badge communication, almost no overhead
- ESP-NOW operates on the data link layer (max 250 bytes)



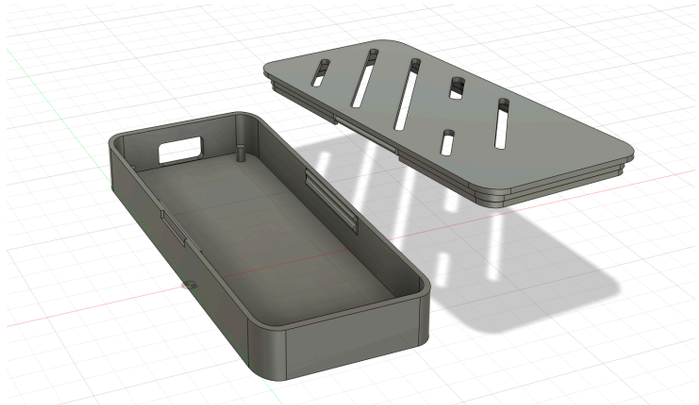


[6] ESP-NOW vs OSI model

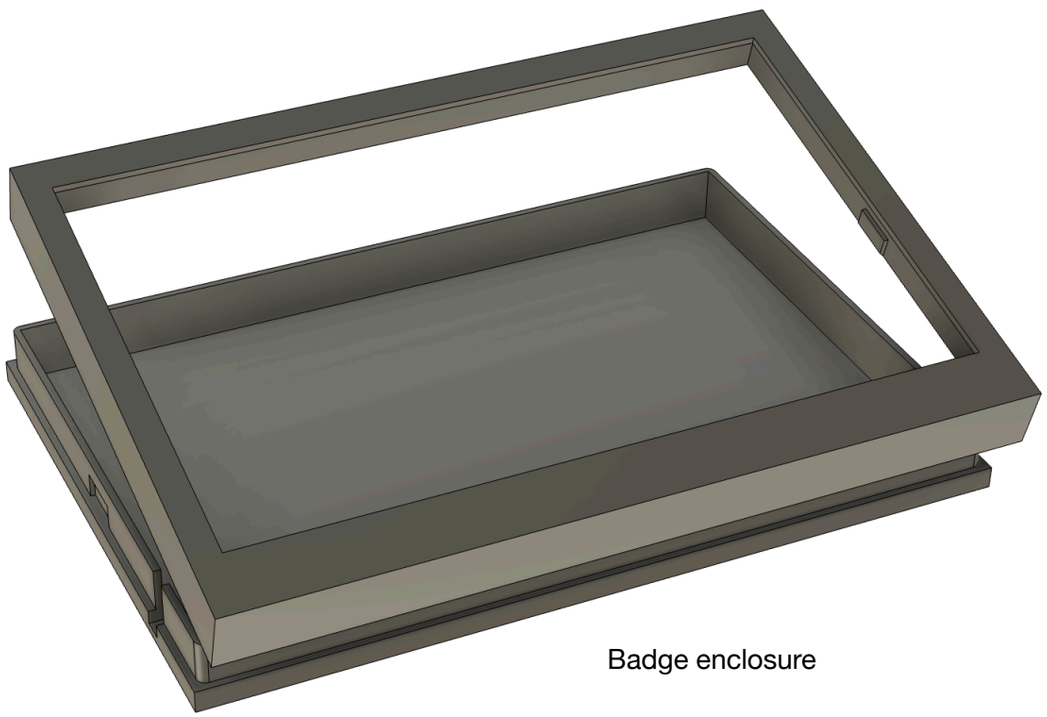
Prototype realization



Simplified badge schematic



Gateway enclosure



Badge enclosure

Prototype realization

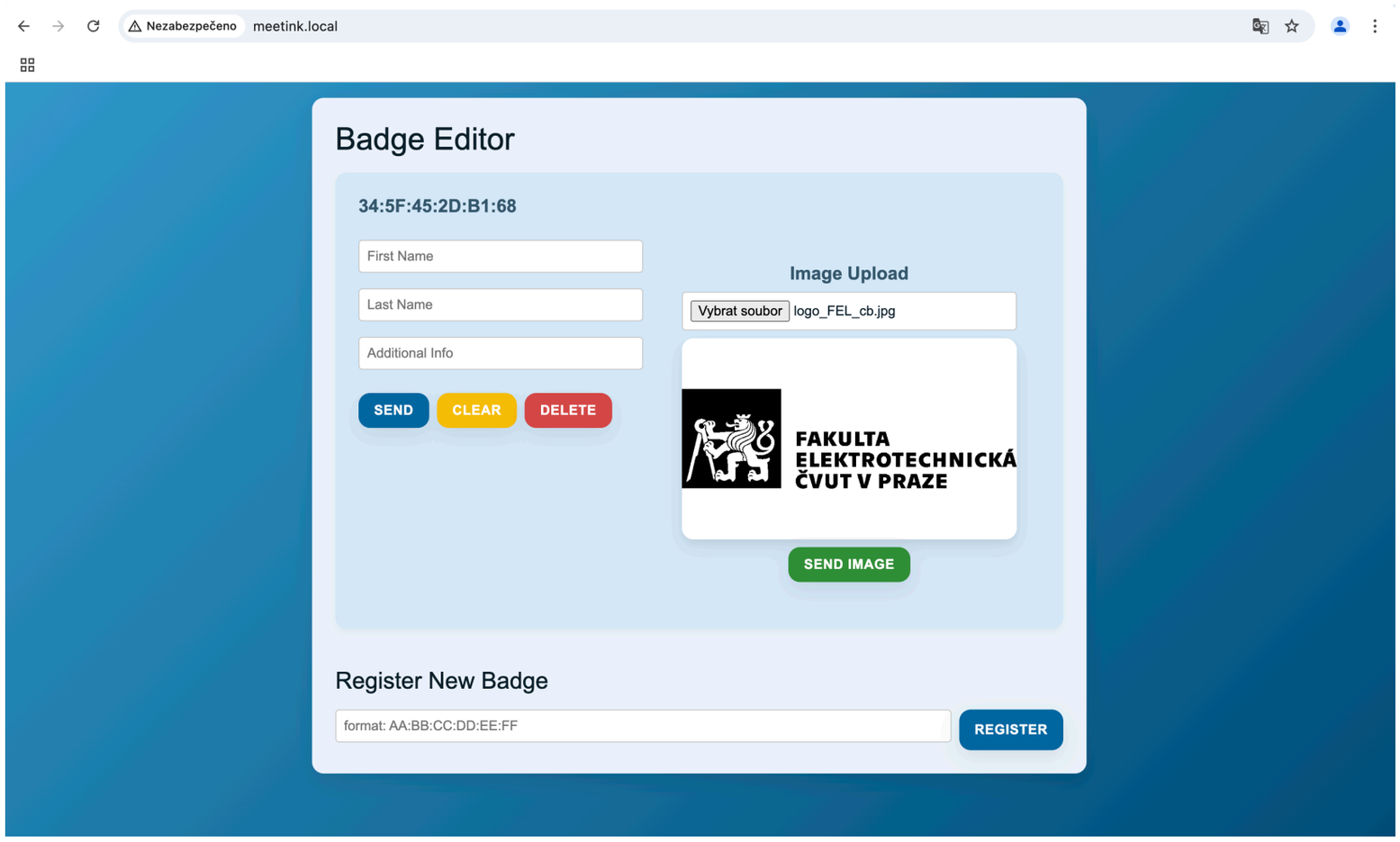
Webserver

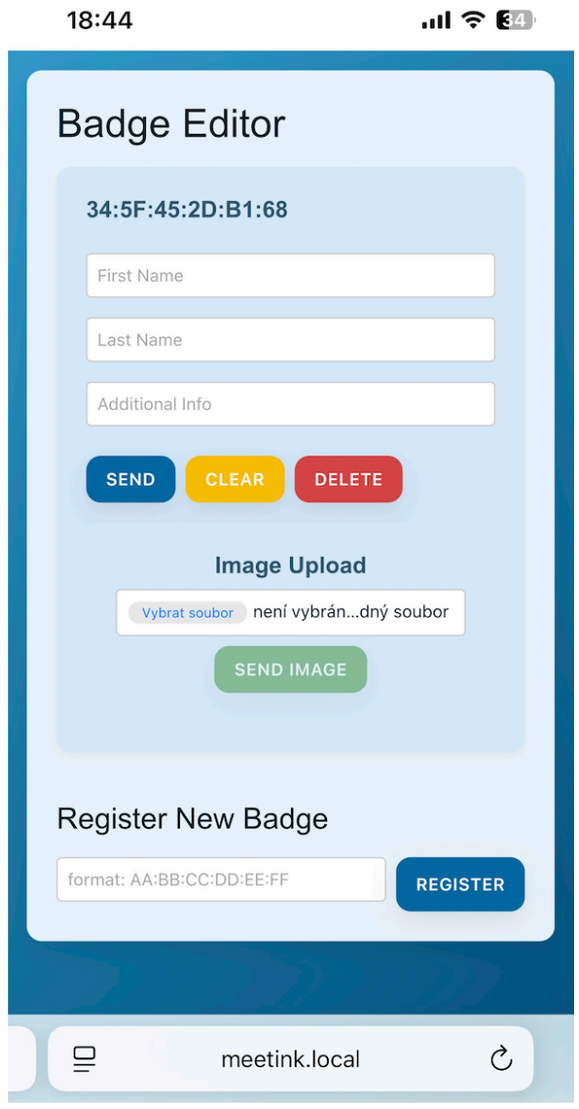
- Register new badges to the system (and remove)
- Send text data to badges
- Send image to badges (JavaScript does conversion on-device)
- Clear badges

Any resolution or colours

Badge resolution, B/W image

Webserver


Nezabezpečeno
meetink.local
Badge Editor
34:5F:45:2D:B1:68
First Name
Last Name
Additional Info
SEND
CLEAR
DELETE
Image Upload
Vybrat soubor
logo_FEL_cb.jpg
FAKULTA ELEKTROTECHNICKÁ ČVUT V PRAZE
SEND IMAGE
Register New Badge
format: AA:BB:CC:DD:EE:FF
REGISTER


18:44
Badge Editor
34:5F:45:2D:B1:68
First Name
Last Name
Additional Info
SEND
CLEAR
DELETE
Image Upload
Vybrat soubor
není vybrán...dný soubor
SEND IMAGE
Register New Badge
format: AA:BB:CC:DD:EE:FF
REGISTER
meetink.local

Prototype testing

- Indoor with other 2.4 GHz signals present
- Distance ranging from 5 to 70 m
- Various client devices
- Battery life over 30 hours

Evaluation of achieved results

- All goals achieved: autonomous operation, no proprietary infrastructure, remote rewriting
- Cost of the badge around $67 and $17 for the gateway
- Future work:
  - dynamic layout
  - improved battery life
  - periodic changes of the screen
  - voting button

ČVUT
ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

Thank you for your attention

Any questions? Feel free to ask.

Resources

- [1] upload.wikimedia.org/wikipedia/commons/3/3a/Electronic_paper_%28Side_view_of_Electrophoretic_display%29_in_svg.svg
- [2] https://www.dsppacs.com/uploads/image/20221214/11/paperless-board_1670990283.jpg
- [3] https://www.taiden.com/upload/goodsgallery/2024-07/6690dadf0a3fc.png
- [4] https://github.com/LaskaKit/ESPink
- [5] https://www.good-display.com/product/396.html
- [6] https://www.espressif.com/sites/all/themes/espressif/images/esp-now/model-en.png