SAVONIA

IoT Threats – Hardware and Software Vulnerabilities, DoS Attacks

Cybersecurity Fundamentals

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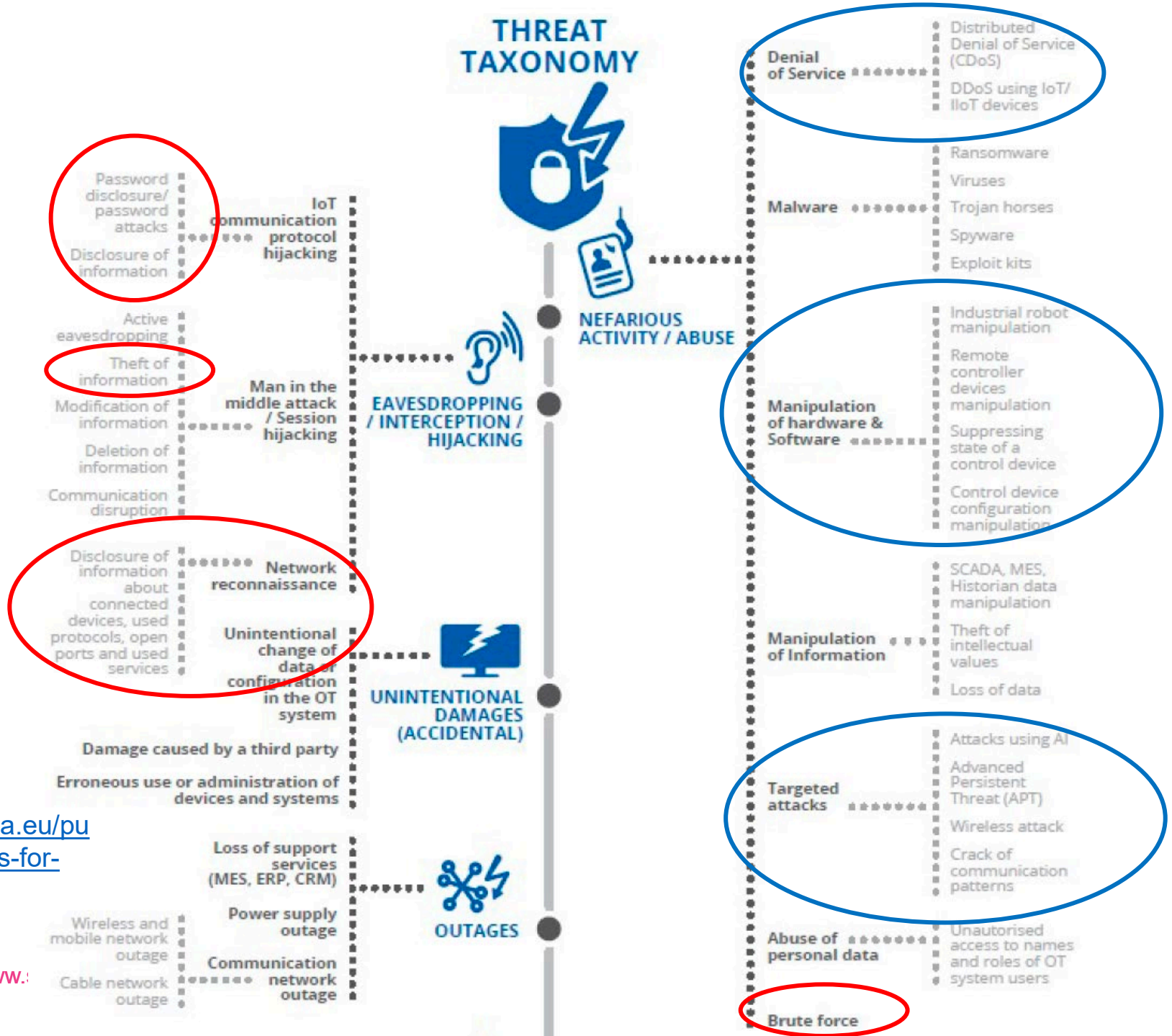
Threats we covered last week

Lab 2 exercises

Today's lecture



source: https://www.enisa.europa.eu/publications/good-practices-for-security-of-iot

STRIDE

- Each threat is a violation of a desirable property for a system
- Today we will target Confidentiality and Availability

Threat	Desired property	Threat Definition
Spoofing	Authenticity	Pretending to be something or someone other than yourself
Tampering	Integrity	Modifying something on disk, network, memory, or elsewhere
Repudiation	Non-repudiability	Claiming that you didn't do something or were not responsible; can be honest or false
Information disclosure	Confidentiality	Someone obtaining information they are not authorized to access
Denial of service	Availability	Exhausting resources needed to provide service
Elevation of privilege	Authorization	Allowing someone to do something they are not authorized to do

Source: https://en.wikipedia.org/wiki/STRIDE_model

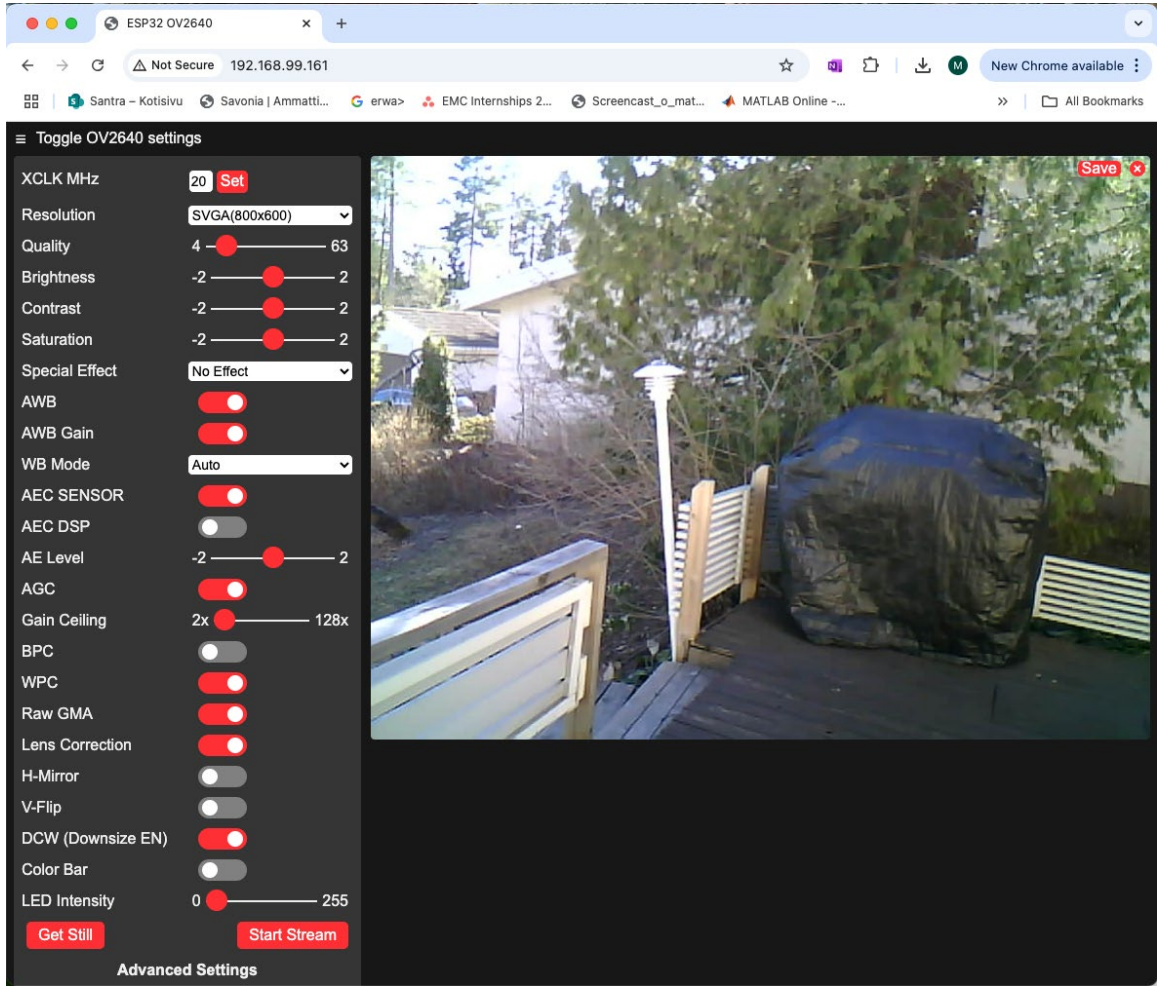
CIA triad

Case study for today

- We become aware that there is a video streaming service hosted on the property of Company X
- It has been leaked / some intelligence done that this service is available in the following IP address: 192.168.99.161
- Our case:
  - Try to figure out if the network in which the streaming service is hosted is seen in our classroom.
    - Record the SSID
  - Find more information about the network
- Plot twist: one camera in the same network is found in the dumpster
  - What can be figured out from the hardware?
  - Gather information from the firmware of the device and try to get access to the network based on it.
  - If you get access, try to case a DoS attack against the video streaming service.
- Reporting:
  - Document the steps
  - Discuss this case: attack vectors involved, mitigation actions (how to prevent)

Leak of available service

- We become aware that there is a video streaming service which runs in this IP address: 192.168.99.161
  - What can we learn about the security of this service from this photo?



CIA triad

Network reconnaissance

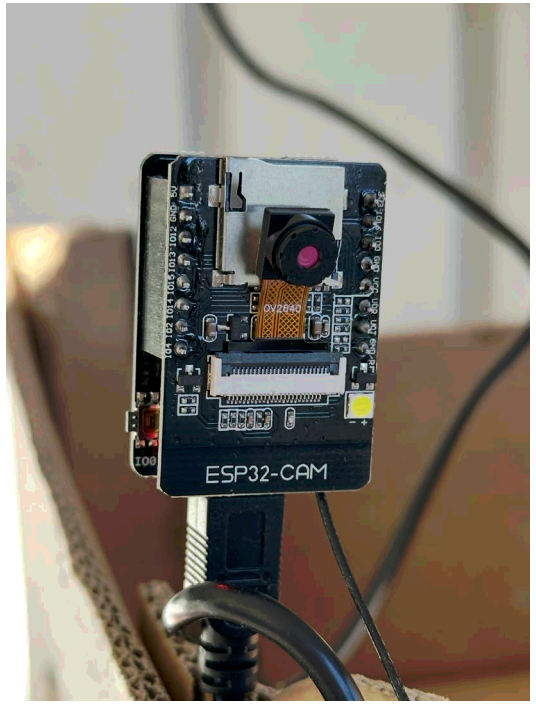
- Check which WiFi networks are available in the classroom.
  - Can you recognize names of organizations?
  - What do you know about their sizes? How many clients should they be able to serve?
- What can you tell about the service in question based on its IP address?
  - How many clients there can be in the yet unknown network?
  - What does this tell about the size of the organization?
- Does any SSID stand out?
- Check the signal strengths with some software or app.

Network reconnaissance

- Does any SSID name stand out? List the suspected ones.
- Check the classroom. Do you see any suspicious device brought inby the teacher which might give a clue about the network?
- Write down the SSID or SSIDs when you have your suspects

Plot twist: physical incident

- You realize someone takes a security camera to SER collection bin (electronic waste) or someone steals one of their security cameras. That camera ends up on your table.
- Opening up the camera reveals a microcontroller. Can you figure out what it is?



Do research on the microcontroller

- Does it have any easily accessible ports?
- Is there a way to connect your computer to it?
- Can you view or download the contents of the microcontroller?

Microcontroller flash memory contents

- It appears the microcontroller has USB port
  - Alternatively: UART pins are discovered and wires soldered
- Can the flash memory contents be read?
  - Search for methods for this particular microcontroller

Microcontroller type: ESP32 CAM

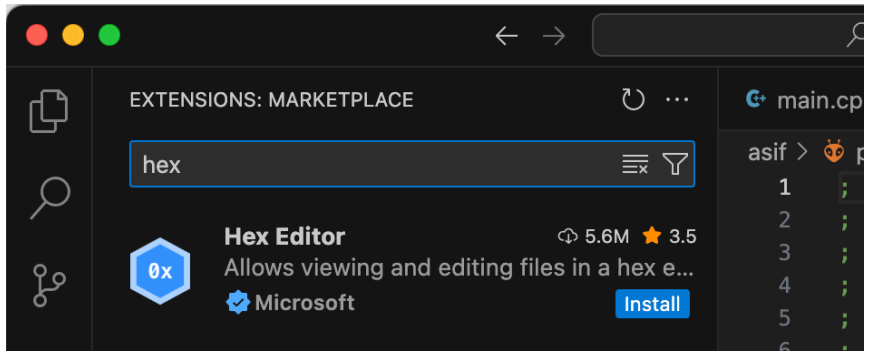
- Camera module documents: https://docs.ai-thinker.com/en/esp32-cam
- Microcontroller manufacturer: https://www.espressif.com/
- Software download tool for Windows: https://docs.espressif.com/projects/esp-test-tools/en/latest/esp32/production_stage/tools/flash_download_tool.html
- Arduino IDE includes a tool which can be used as well: **esptool**
- Mac OS terminal command to read entire flash memory:

```
/Users/markkukellomaki/Library/Arduino15/packages/esp32/tools/esptool_py/4.9.dev3/esptool --chip esp32 --port /dev/cu.usbserial-14210 --baud 460800  read_flash 0x00000 0x400000 camera_binary.bin
```

- The flash file camera_binary.bin is available in Moodle

Microcontroller flash memory contents

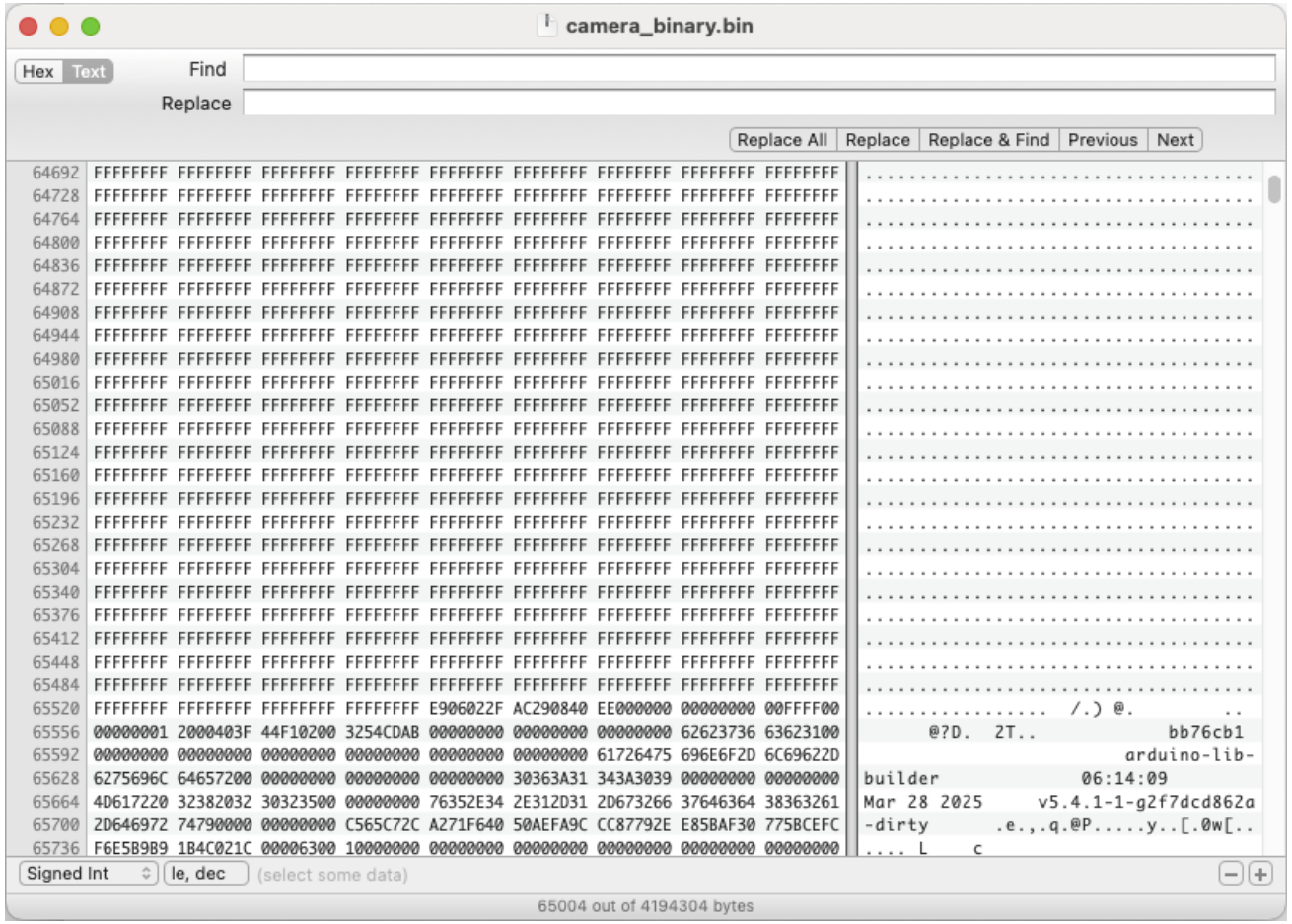
- Let us study the contents of the binary file using hex editor. Options:
  - Online: https://hexed.it/
  - Visual Studio Code: Hex Editor extension
  - Mac OS:



- Install one of the tools and start exploring

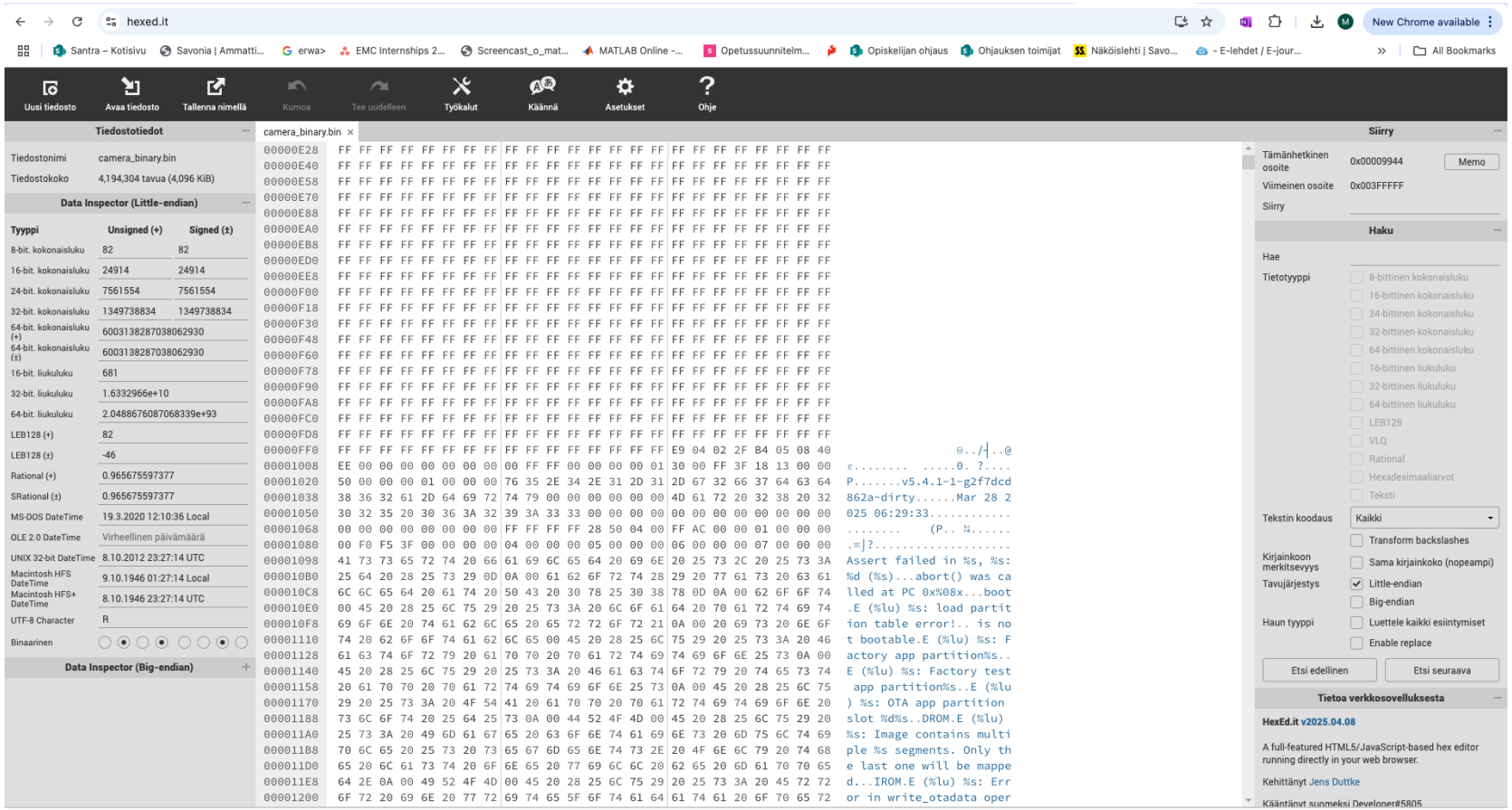
Hex editing

- This is how it looks like in Hex Fiend:



Hex editing

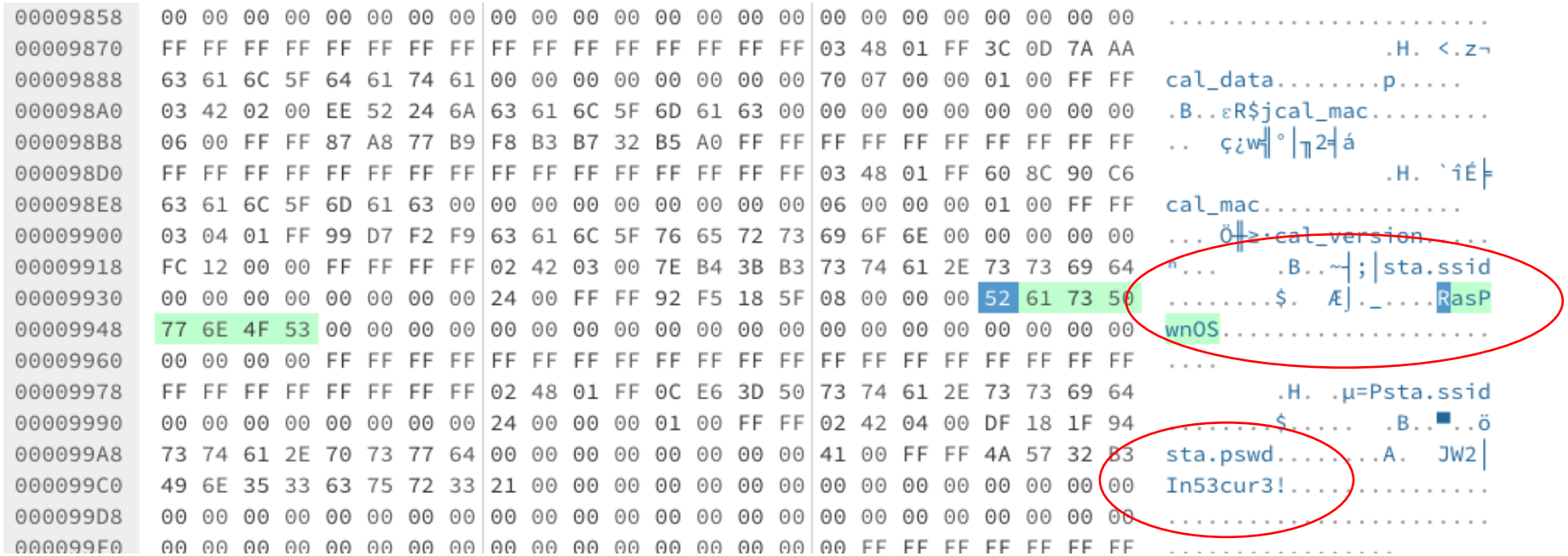
- This is how it looks like in HExEd.it website (remember to check encoding settings if you do not have Nordic language settings)



Hex editing

- Open the .bin file in hex editor
- Browse through and check which parts are human readable
  - General observations? What can you find?
- Search for the potential SSIDs you saw in Wifi listing
  - Use Find function of the tool
  - Which one do you find?
- Check all instances of the found SSID: is there any string that follows the SSID string at the same distance in memory? Does it look like a password?
  - Identify the string and try to connect to the Wifi router

Hex editing


00009858 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ....
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00009888 63 61 6C 5F 64 61 74 61 00 00 00 00 00 00 00 00 70 07 00 00 01 00 FF FF cal_data........p.....
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000098E8 63 61 6C 5F 6D 61 63 00 00 00 00 00 00 00 00 00 06 00 00 00 01 00 FF FF cal_mac.....
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00009960 00 00 00 00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF ....
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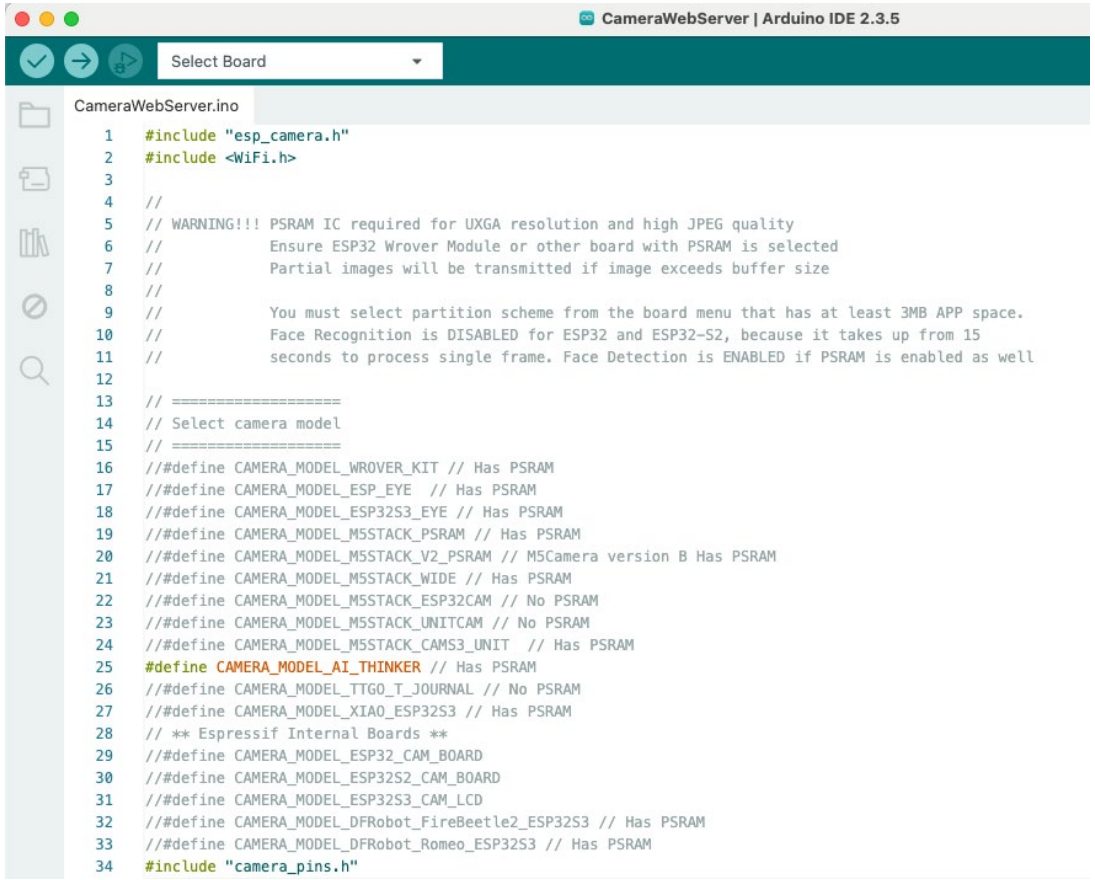
000099D8 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000099F0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 FF FF FF FF FF FF FF .....

Check the source code

- Download the source code file CameraWbServer.ino from Moodle
- Inspect the source code: how are the network credentials handled?



Try to access website in the network

- After connecting to the wifi, check your IP address
  - Windows: ipconfig
  - Mac OS: if config

```
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        options=6460<TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
        ether 4a:4f:05:89:6c:81
        inet6 fe80::849:cac4:554e:45a3%en0 prefixlen 64 secured scopeid 0xa
        inet 192.168.99.158 netmask 0xffffff00 broadcast 192.168.99.255
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect
        status: active
```

- Ping the hotspot: ping 192.168.99.1
- Try the website shown earlier for video streaming
- Try also this website: 192.192.99.13

Denial of Service attack

- Let us try to bring down the website in address: 192.168.99.13
- Study Kali linux tool slowhttpstest: https://www.kali.org/tools/slowhttptest/
- Try the tool and simultaneously try to access the website
- Did it work? How do you know?

- Repeat the DoS attack to the streaming service
  - Write down your observations

Summary

- Network reconnaissance
  - Wifi network SSID must be chose carefully
    - Sometimes it may reveal too much
- Embedded device stores suprising information
  - Design of the device should minimize amount of connectors and potential attack ports
  - Software design for embedded devices must ensure credentials are not stored unencrypted ⇔ hex editing tools
  - Confidentiality was not preserved in our example
- Network services need proper firewall for DoS attack prevention
  - Simple, automated tools can prevent availability of website
  - Availability was not preserved in our example

Assignment

- Make a report on the phases of today's exercise
- Report commands you used with screenshots of the different phases
- Write what you learned about embedded device security and DoS attacks