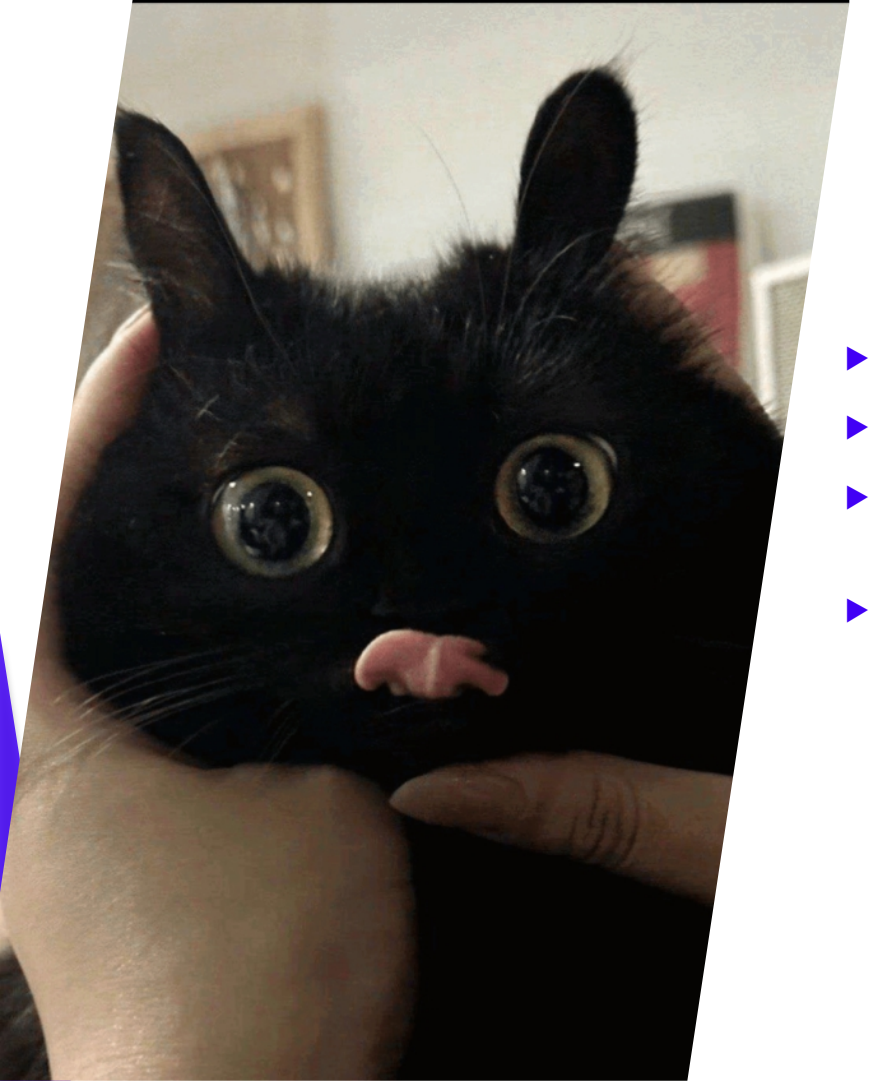
OzSec 2025

Isaiah Davis-Stober

Super cool guy



What I’m going to cover

- What is firmware?
- The IoT epidemic
- How to acquire firmware samples
- Dynamic and static analysis

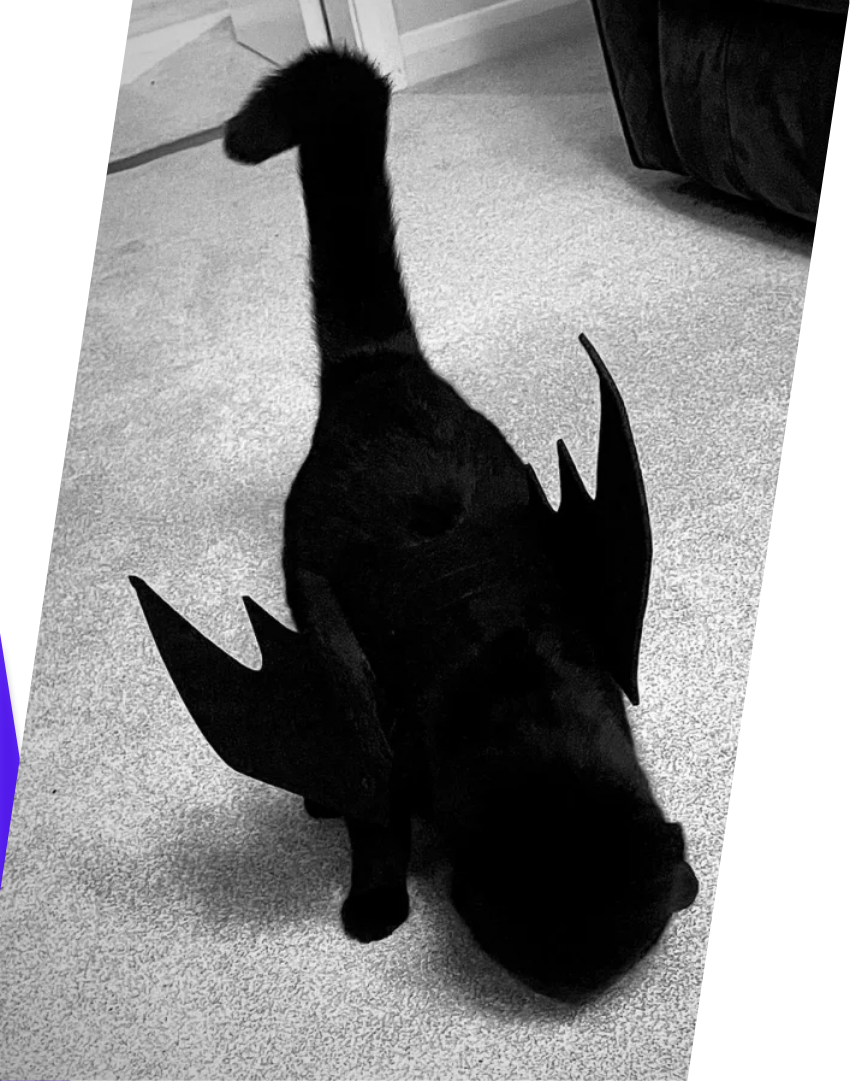
Who am I?

Experience:

I’ve been tearing apart (and sometimes putting back together) electronics since I was born, and tearing apart IoT devices for the last couple of years

Things I like:

- Misusing computers
- Cats
- Lock picking/bypassing
- Tearing apart whitelabel IoT devices



What is “IoT”?

It’s the Internet of Things babyyyyy

IoT Examples

What is Firmware?

- Lowest level of software
- Interacts directly with the hardware

Familiar operating systems

Key differences between embedded Linux and other operating systems you are probably familiar with

Why embedded is so different

- Different chip architecture
- Less compute power
- Super low level
- Interacting directly with hardware

Why firmware so interesting

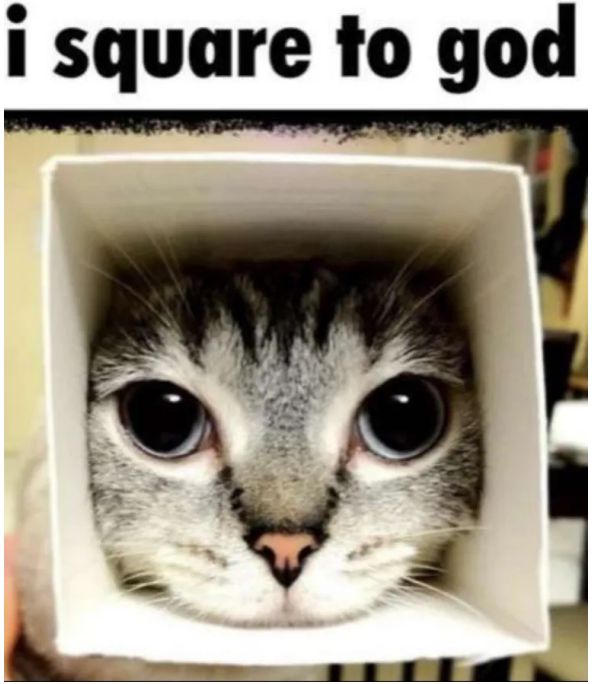
- Lowest level means if you control it you are god
- It is often neglected/ignored

Why is it a fun target?

- Low level is fun
- I don’t have to fight an AV
- No one configures things correctly

IoT epidemic and why it’s stupid

- Every product is the minimum viable product
- Toasters were not meant to have an internet connection



Quick rant about “smart” devices

Privacy concerns

I just want it to work, why does it need an account?

Firmware acquisition

- Download
- Extraction

Downloading firmware

- Manufacture website
- Open S3 buckets
- Some very nice person who is distributing a copy in a legally questionable way
- FTP servers
- OTA update servers that only do useragent checks

http://fw.ajcloud.net/01.10711/gQdotgSHpnXq4JXEap4Nuw_ota_firmware_01.10711.11.01.pkg

For example: ftp://ftp2.dlink.com/PRODUCTS/DIR-882/REVA/

Bootloader

Common bootloaders

U-Boot

- U-Boot
- Barebox
- RedBoot
- RT-Thread

Extracting firmware

- UART
- JTAG
- Flash extraction (chip on and chip off)

UART (Universal Asynchronous Receiver/Transmitter)

RX -> TX

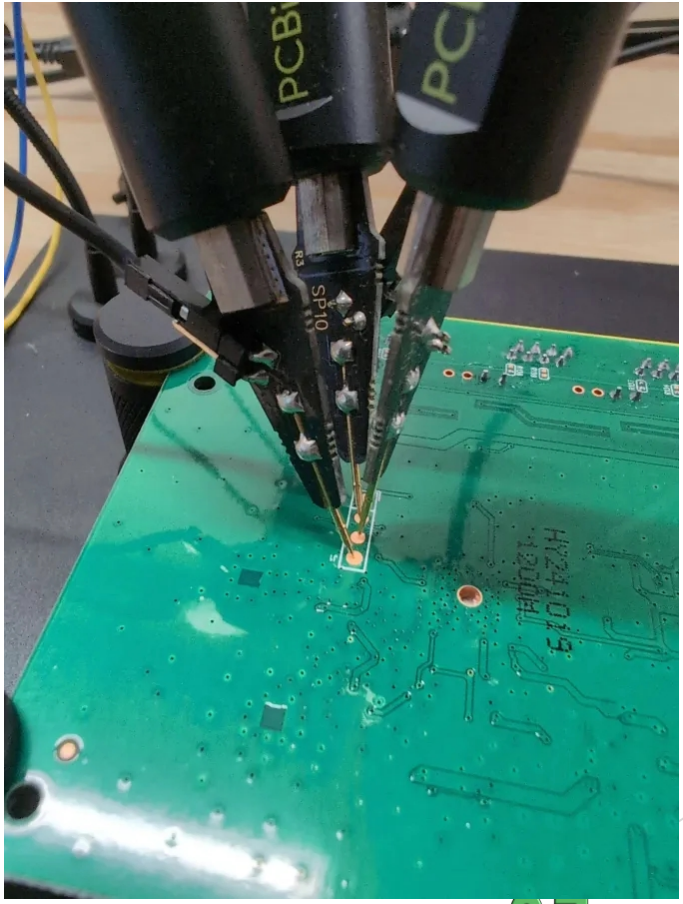
TX - > RX

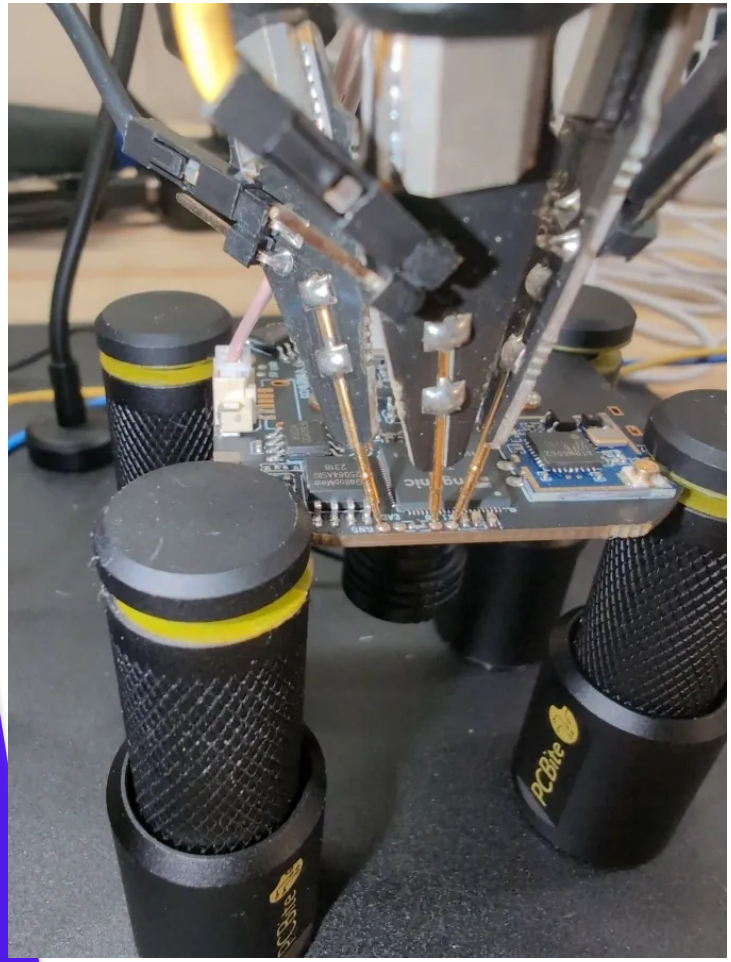
GND -> GND

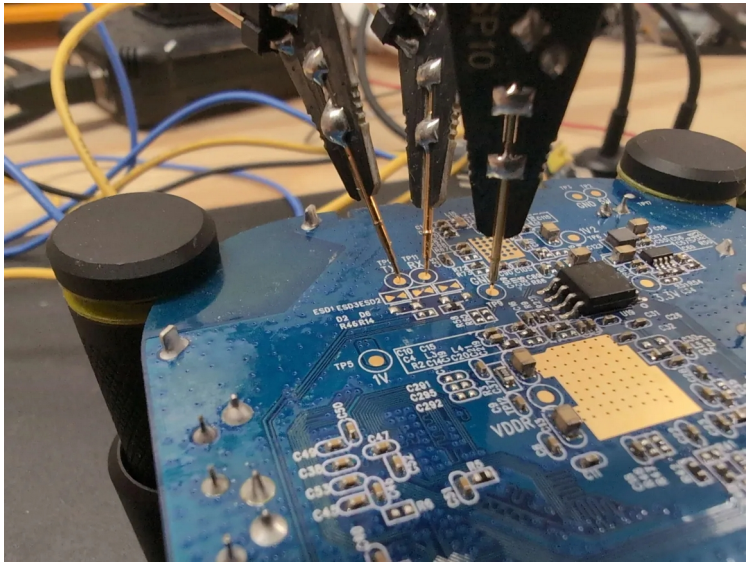
Common baud rates:

- 115200
- 57600
- 38400
- 9600


J1


SP10


PCBite


TP5
1V
VDDA

JTAG (Joint Test Action Group)

- Debugging interface similar to UART
- More pins
- More in depth
- Not just a serial terminal

```
BusyBox v1.27.2 () built-in shell (ash)

------run profile file-----

[0000000779][W] IOT TEST:my_really_cool_wifi_password, IOT TEST:my_really_cool_wifi_password

[0000000802] firmware version: 1.7.3
[0000000802] not update firmware
[0000000813] fua_video_capture_jpg start
mount: mounting none on /sys/kernel/debug failed: No such file or directory
root@(none):/# [0000000823] get_wifi_data waitting..., register_flag 0
[0000000831][W] WAKEUP_TYPE_POWERON

[0000000882] fua_video_capture_jpg to /tmp/snap.jpg
[0000000897][I] common_i_pcm8kto16k /tmp/sound8k.pcm /tmp/sound.pcm OK, len 28800
[0000000897] play_audio_amr_2 /tmp/sound.pcm 100.
[0000000942] fua_set_day_night_mod day_night_mod 0
[0000000942][I] device_test_video_routine
[0000000942][I] device_test_routine wait usb connect
[0000000998] fua_audio_play_set_volume 100
[0000001042] change to day mode
[56]SUNXI_SPI_DEFAULT_CLK = 70000000[54]readcmd 11
[56]SUNXI_SPI_DEFAULT_CLK = 70000000[377]#
ciapp start...
mount jffs2
mount jffs2 over
[0000000492][W] ciapp(v:241) run build_2023/4/14:Apr  1 2024 06:00:08
```

Checking boot log for information

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```
---RealTek(RTL8196E)at 2015.01.06-18:13-0800 v1.6 [16bit](400MHz)
bootbank is 1, bankmark FFFFFFF0
check_image_header  return_addr:05010000 bank_offset:00000000
no sys signature at 00010000!
no sys signature at 00020000!
no rootfs signature at 000E0000!
no rootfs signature at 000F0000!
Jump to image start=0x80500000...
return_addr = 05030000 ,boot bank=1, bank_mark=0xfffffff0...
decompressing kernel:
Uncompressing Linux... done, booting the kernel.
done decompressing kernel.
start address: 0x80003480
CPU revision is: 0000cd01
Determined physical RAM map:
 memory: 02000000 @ 00000000 (usable)
Zone PFN ranges:
  Normal   0x00000000 -> 0x00002000
Movable zone start PFN for each node
early_node_map[1] active PFN ranges
    0: 0x00000000 -> 0x00002000
Built 1 zonelists in Zone order, mobility grouping on.  Total pages: 8128
Kernel command line: console=ttyS0,38400 root=/dev/mtdblock1
icache: 16kB/16B, dcache: 8kB/16B, scache: 0kB/0B
NR_IRQS:48
PID hash table entries: 128 (order: 7, 512 bytes)
console handover: boot [early0] -> real [ttyS0]
Dentry cache hash table entries: 4096 (order: 2, 16384 bytes)
Inode-cache hash table entries: 2048 (order: 1, 8192 bytes)
Memory: 26420k/32768k available (2566k kernel code, 6348k reserved, 459k data, 108k init, 0k highmem)
Calibrating delay loop... 398.95 BogoMIPS (lpj=1994752)
Mount-cache hash table entries: 512
net_namespace: 524 bytes
NET: Registered protocol family 16
bio: create slab <bio-0> at 0
```

Flash dumping

- Types of flash
- Tools
- Methods

Types of flash interfaces

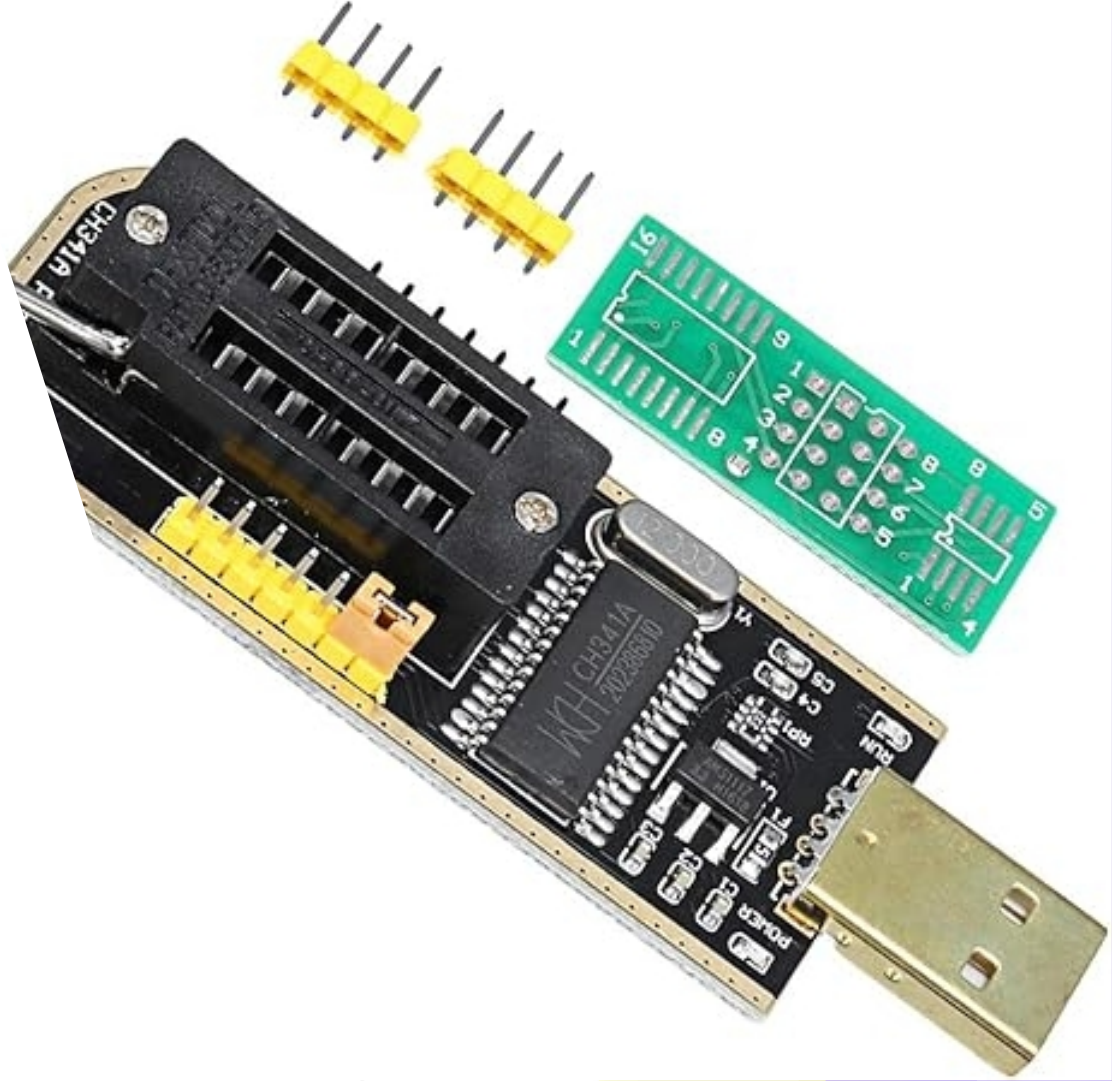
- SPI (Serial Peripheral Interface)
- QSPI (Quad Serial Peripheral Interface)
- I2C (Inter-Integrated Circuit)

Tools for dumping flash

- Hardware
  - Xgecu
  - CH341a
- Software
  - Flashrom
  - minipro

CH341a

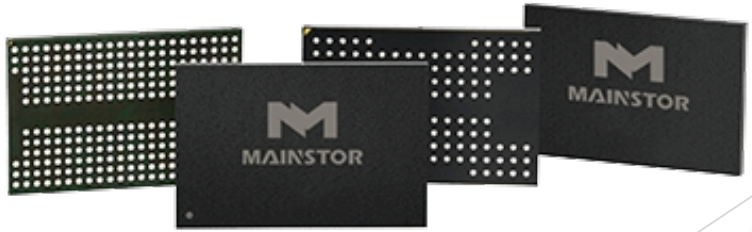
- Easiest tool for using the CH341a programmer which is $14 on Amazon
- Works on just about every chip I’ve tried*
- *dumping, it cannot always write them



Methods

- Chip on
  - Easy
  - No Soldering
  - Difficult with larger chips
  - Can only do packages with exposed pins

- Chip off
  - Some soldering
  - Extremely consistent
  - Can do much larger chips
  - Can do BGA packages

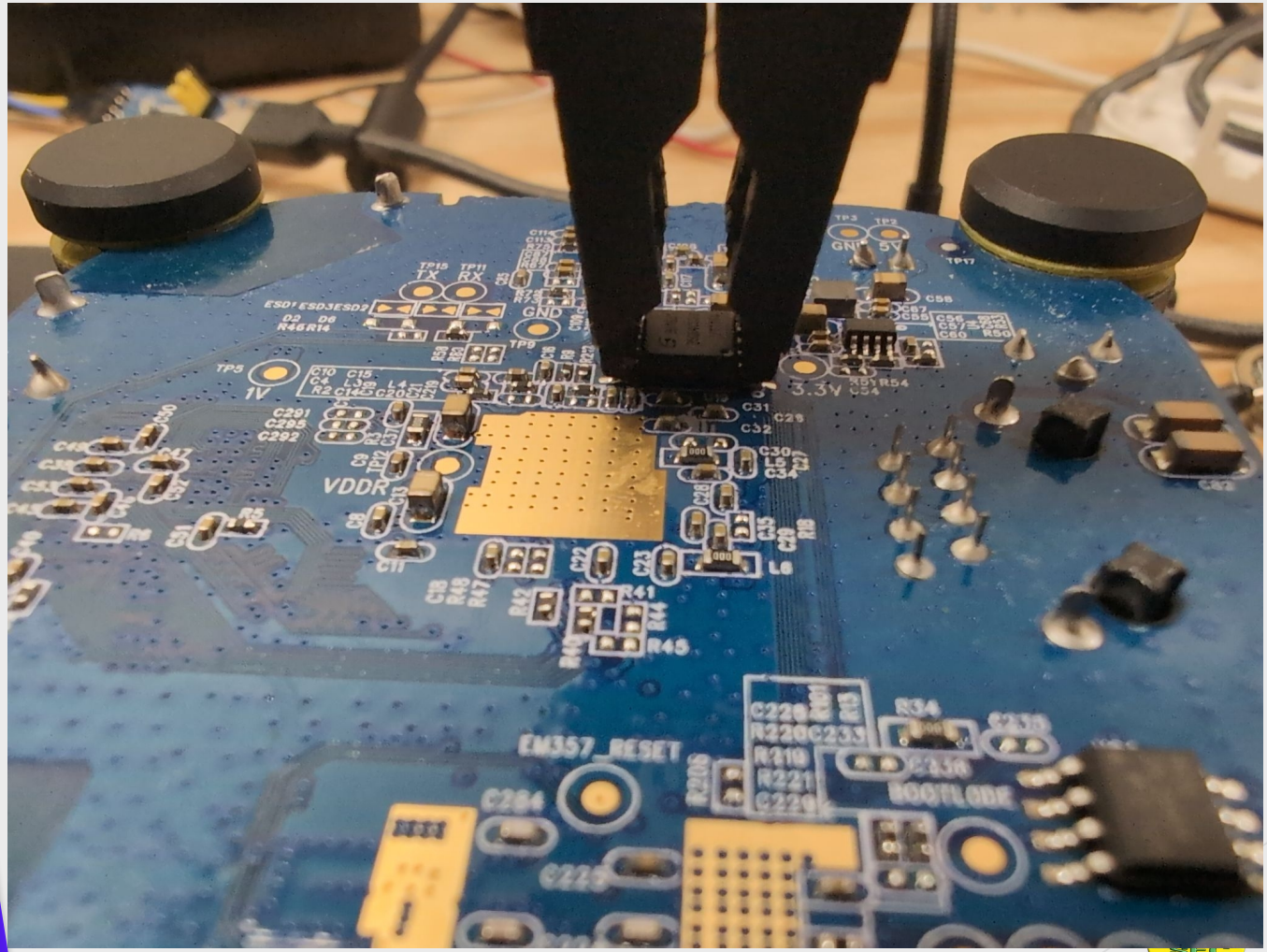


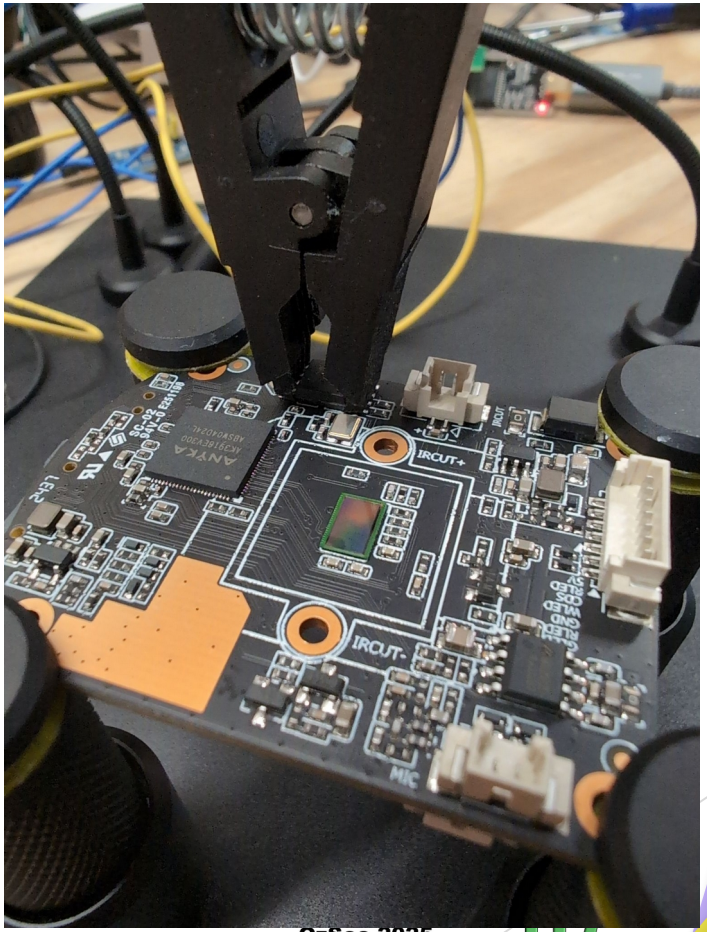
(This is a BGA package)

Chip on flash dumping

Dumping the firmware straight off of the flash module, without taking it off the board

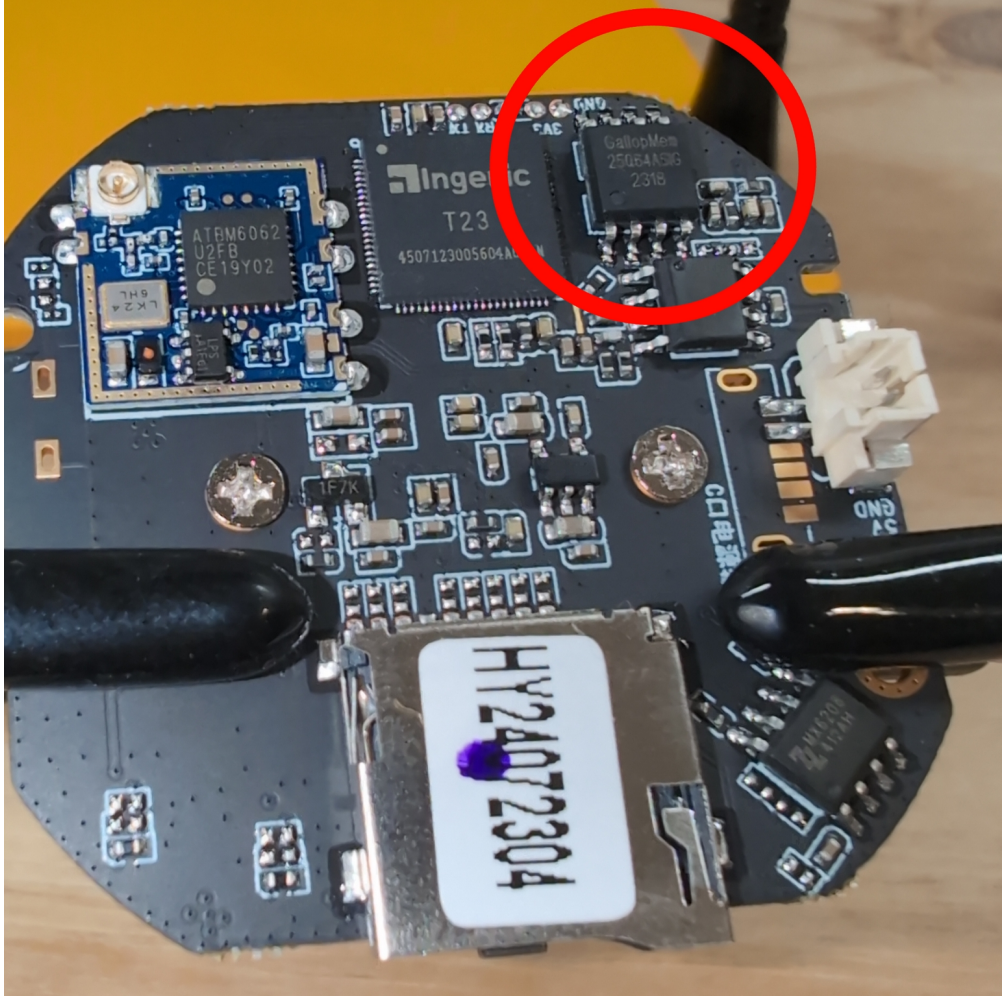
- SOP8 clip
- CH341a and flashrom


TP15
TX
TP11
RX
GND
TP9
TP5
1V
VDDR
CTF
TP3
GND
TP2
5V
TP17
3.3V
EM357_RESET
BOOTLODE


IRCUT+
IRCUT-
MIC

Chip off flash dumping

- Adapter for whatever package you are dumping
- Minor soldering skills


GallopMem
25Q64ASIG
2318
T23
ATBM6062
U2FB
CE19Y02
HY2407230A

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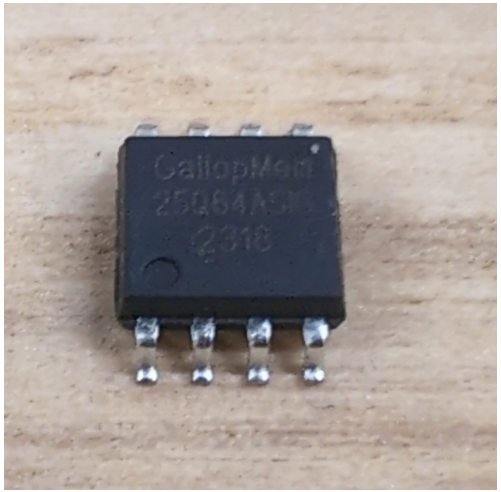
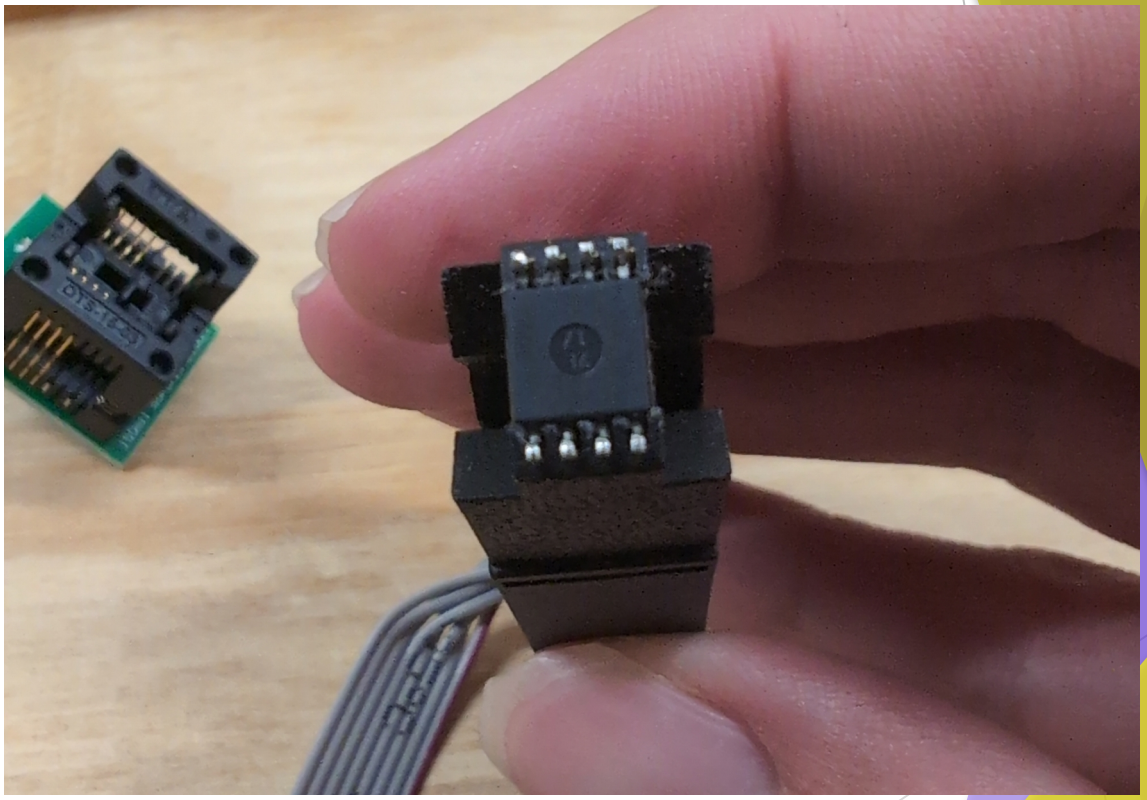

CallopMed
25Q64A
2318

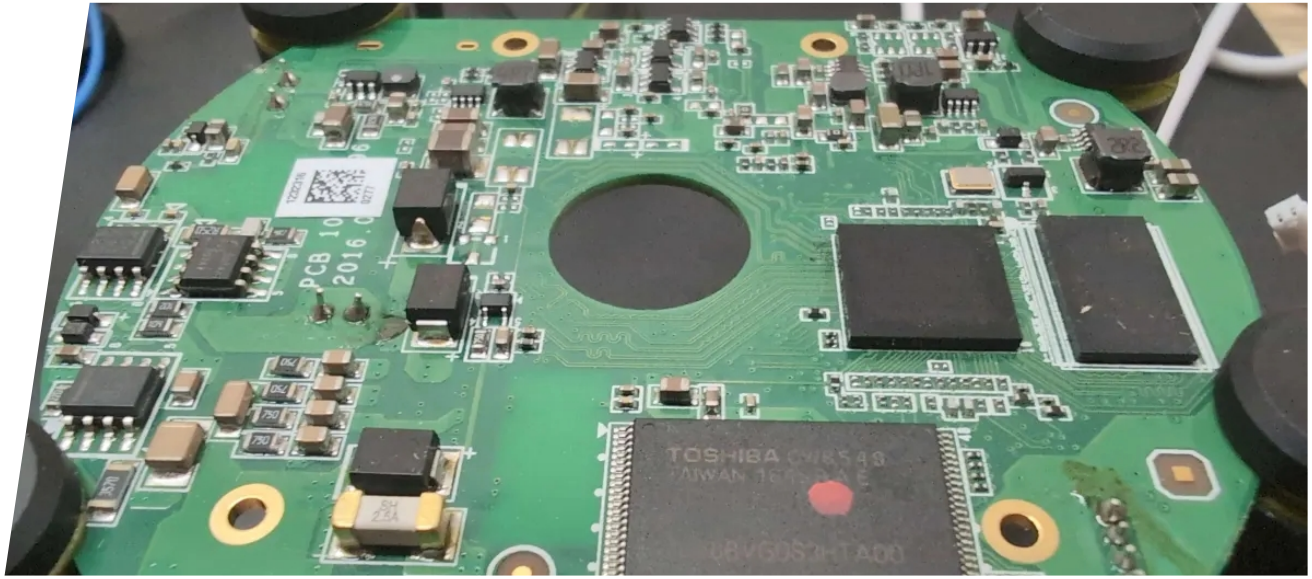


Using Flashrom

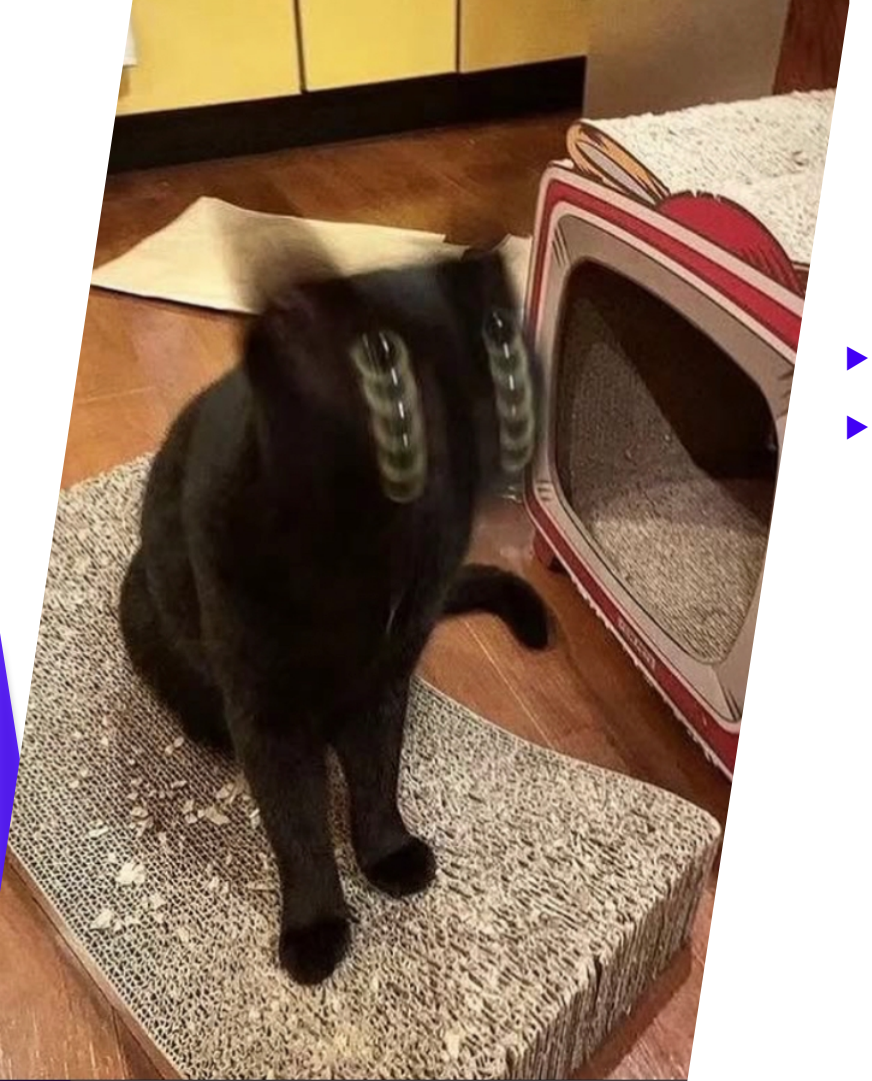
- Amazing for SPI flash

XGecu

- Amazing for everything else



Main use



Analyzing firmware

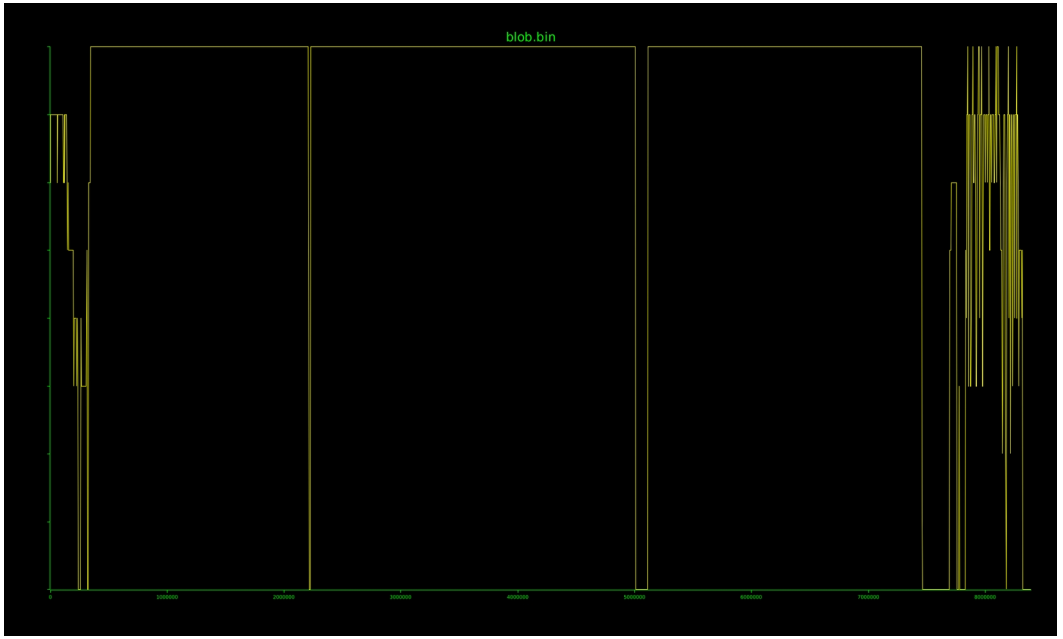
- Static vs dynamic analysis
- Common embedded systems filesystems

Checking if the dump is encrypted

- Check entropy with binwalk
- Checking what different parts of the file look like with binvis.io

Binwalk -E

Probably not encrypted



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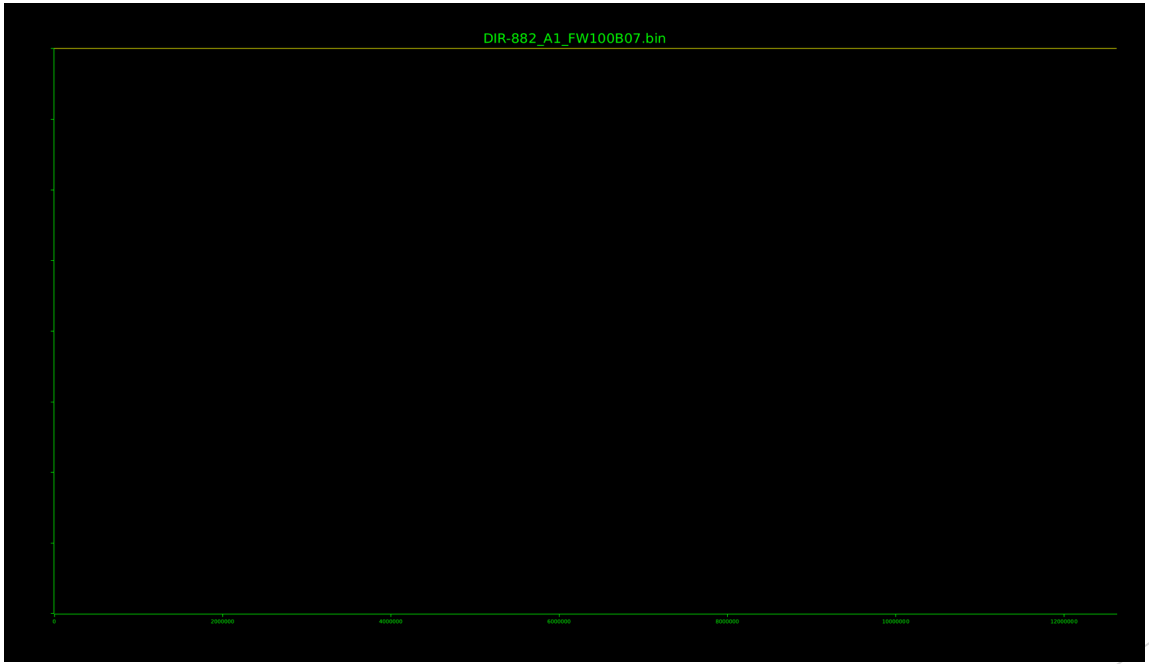
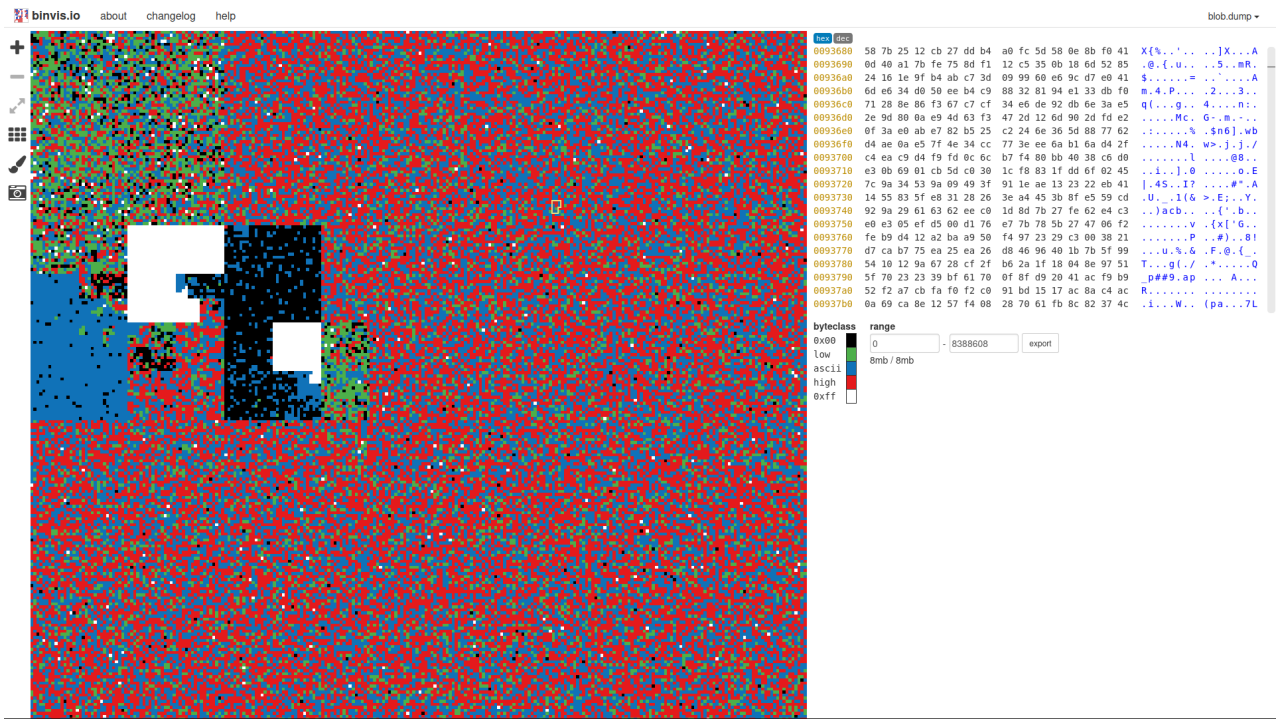
Binwalk -E

Almost certainly encrypted





binvis.io

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Static analysis

- Binwalk
- Strings
- Ghidra
- xxd

- FACT (Firmware Analysis and Comparison Toolkit)

Determining the type of system you're working with

- CPU architecture
  - MIPS
  - ARM
- What the firmware might be based on
  - Linux
  - FreeRTOS
  - Something else

Extracting the filesystems and directory structure

```
└─(09:50:54 on main ✖ ✭)──> binwalk -e blob.bin                                  ──(Fri,Apr25)─┘

                              /home/neko/firmware/sengled/extractions/blob.bin
----------------------------------------------------------------------------------------------------
DECIMAL                       HEXADECIMAL                     DESCRIPTION
----------------------------------------------------------------------------------------------------
4896                          0x1320                          LZMA compressed data, properties: 0x5D,
                                                              dictionary size: 8388608 bytes, compressed
                                                              size: 18576 bytes, uncompressed size: 60912
                                                              bytes
65552                         0x10010                         bzip2 compressed data, total size: 129090 bytes
206872                        0x32818                         LZMA compressed data, properties: 0x5D,
                                                              dictionary size: 8388608 bytes, compressed
                                                              size: 920470 bytes, uncompressed size: 3207476
                                                              bytes
1245184                       0x130000                        SquashFS file system, little endian, version:
                                                              4.0, compression: lzma, inode count: 518, block
                                                              size: 131072, image size: 1770878 bytes,
                                                              created: 2038-01-29 01:48:48
4259856                       0x410010                        bzip2 compressed data, total size: 129090 bytes
4401176                       0x432818                        LZMA compressed data, properties: 0x5D,
                                                              dictionary size: 8388608 bytes, compressed
                                                              size: 920470 bytes, uncompressed size: 3207476
                                                              bytes
5439488                       0x530000                        SquashFS file system, little endian, version:
                                                              4.0, compression: lzma, inode count: 518, block
                                                              size: 131072, image size: 1770878 bytes,
                                                              created: 2038-01-29 01:48:48
----------------------------------------------------------------------------------------------------
[+] Extraction of lzma data at offset 0x1320 completed successfully
[+] Extraction of bzip2 data at offset 0x10010 completed successfully
[+] Extraction of lzma data at offset 0x32818 completed successfully
[+] Extraction of squashfs data at offset 0x130000 completed successfully
[+] Extraction of bzip2 data at offset 0x410010 completed successfully
[+] Extraction of lzma data at offset 0x432818 completed successfully
[+] Extraction of squashfs data at offset 0x530000 completed successfully
----------------------------------------------------------------------------------------------------

Analyzed 1 file for 101 file signatures (226 magic patterns) in 449.0 milliseconds
```

Common File systems

Read only

- SquashFS

Writeable

- JFFS2 (Journaling Flash File System v2)

Combining them

- OverlayFS

Extracting those common filesystems

SquashFS

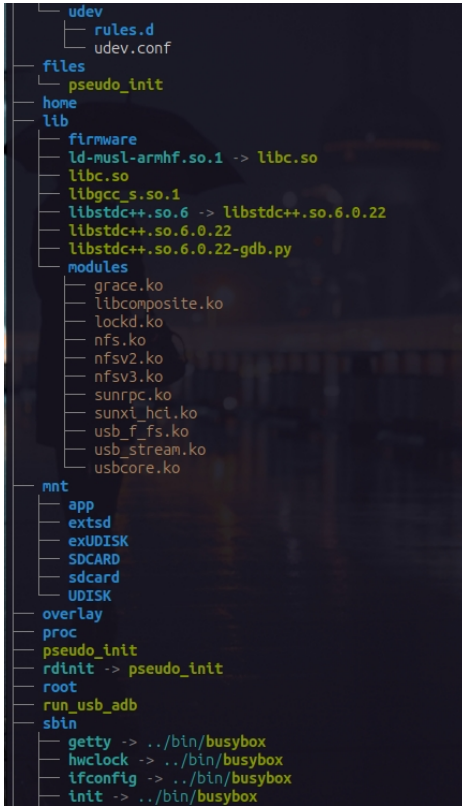
- UnsquashFS
- Sasquatch (patch for unsquashfs)

JFFS2

- Jefferson

Directory layout

- exa -T
- ls -R



Determining how the filesystems are mounted

- fstab
- inittab
- Whatever other init script they are using

File: **inittab.sh**

```
16  # Startup the system
17  ::sysinit:/sbin/swapoff -a
18  # ::sysinit:/bin/mount -t tmpfs tmpfs /dev
19  ::sysinit:/bin/mkdir -p /dev/pts
20  ::sysinit:/bin/mkdir -p /dev/shm
21  ::sysinit:/bin/mount -a
22  ::sysinit:/bin/hostname -F /etc/hostname
23
24  # now run any rc scripts
25  ::sysinit:/etc/init.d/rcS
26
27  # Put a getty on the serial port
28  #console::respawn:-/bin/sh
29  console::respawn:/sbin/getty -L console 115200 vt100 # GENERIC_SERIAL
30
31  # Stuff to do for the 3-finger salute
32  #::ctrlaltdel:/sbin/reboot
33
34  # Stuff to do before rebooting
35  ::shutdown:/bin/umount -a -r
```

Locating files

- grep
- find
- rg (ripgrep)
- exa -T
- Guessing

Getting the BusyBox Version

strings -n 10 busybox | grep "BusyBox"

Looking for configuration files

- .conf
- .ini

```
└─(11:17:12 on main ✖ ✹ ★)──> find . -type f -name "*.conf"
./etc/lld2d.conf
./etc/host.conf
./etc/ushare.conf
./etc/wscd.conf
./etc/boa/boa.conf
./etc/vsftpd.conf
./etc/samba/smb.conf
```

Finding misconfigurations in said conf files

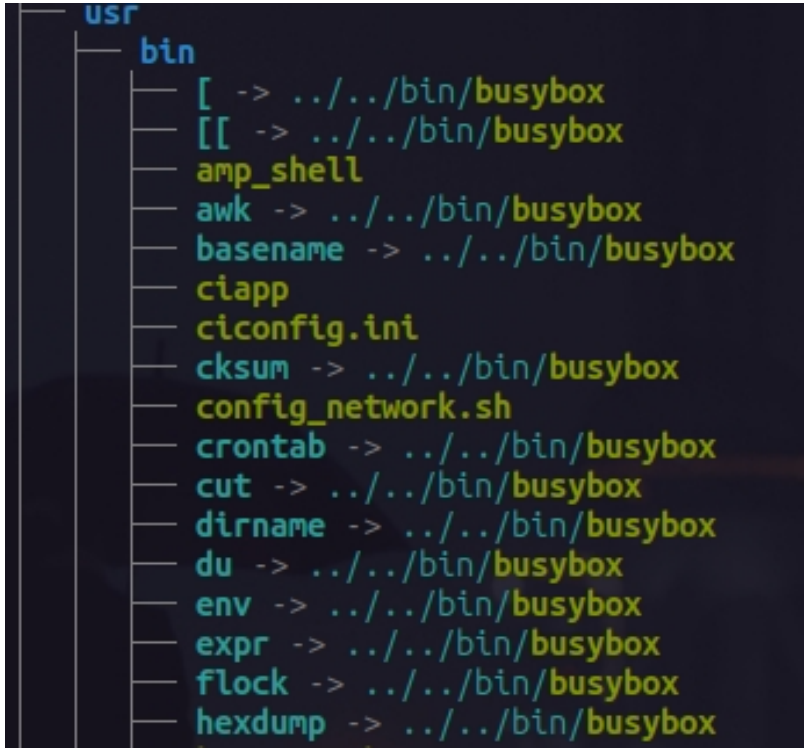
- It helps to be somewhat familiar with the default configuration file for the service (if possible)
- Just read it
- Not every misconfiguration is actually exploitable or useful

Locating custom utilities and scripts

- A basic understand of Linux and common utilities goes a long way here in not wasting your time

First, BusyBox

- A useful utility for small embedded Linux machines
- Single utility
- Does all of the things
- Swiss Army Knife of Embedded Linux
- No one updates it



Just symlink

- It’s that easy
- To find custom utilities just look for executables that aren’t symlinks

File: **pseudo_init**

```
#!/bin/sh

MOUNT_ETC=1
MOUNT_OVERLAY=0

################################ functions ################################

#mkfs_jffs2() <device in /dev/by-name>
mkfs_jffs2() {
    ! [ -x /usr/sbin/mkfs.jffs2 ] \
        && ! [ -x /sbin/mkfs.jffs2 ] \
        && echo "Not Found /usr/sbin/mkfs.jffs2 or /sbin/mkfs.jffs2" \
        && return 1

    # format to jffs2
    local erase_block=$(/bin/cat /proc/mtd \
        | /bin/grep "$(basename $1)" \
        | /usr/bin/awk '{print $3}')
    /bin/mkdir -p /tmp/jffs2.dir/tmp
    mkfs.jffs2 -p -e 0x${erase_block} -d /tmp/jffs2.dir \
        -o /tmp/jffs2.img >/dev/null || return 1
    /bin/dd if=/tmp/jffs2.img of=$1 || return 1
    /bin/rm -rf /tmp/jffs2.img /tmp/jffs2.dir
    return 0
}

mkfs_ubifs() {
    mkfs.ubifs -x lzo -y "$1"
}

mount_etc() {
    local etc_update=0
    # if enable ota, do update
    [ -f /etc/init.d/rc.ota-upgrade ] \
        && source /etc/init.d/ota-upgrade

    #local root_dev="$(readlink /dev/by-name/rootfs)"
    local root_dev="$(readlink /dev/by-name/rootfs_data)"

    # if mount failed, format.
    case "${root_dev}" in
        /dev/mtdblock*)
            # /bin/echo "mount jffs2"
            /bin/mount -t jffs2  -o rw,sync /dev/by-name/rootfs_data /etc
            # /bin/echo "mount jffs2 over"

            [ -e /etc/etc_complete -a ! -e /etc/etc_need_update ] \
                && return
            # /etc/etc_complete and /etc/etc_need_update both exist, that means we just need to update
            [ -e /etc/etc_complete -a -e /etc/etc_need_update ] && /bin/echo "do etc update" && etc_update=1

            cp -arf /etc/ciconfig.ini /tmp/
            cp -arf /etc/config_data.dat /tmp/
            cp -arf /etc/other_data.dat /tmp/
            /bin/umount /etc
```

Checking out custom scripts

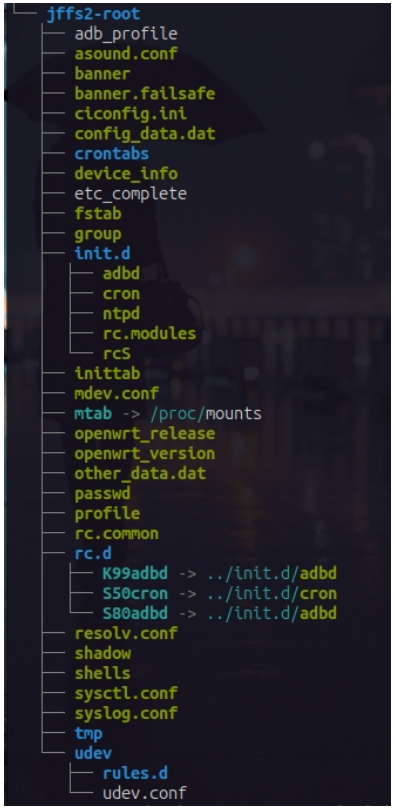
- Usually as simple as reading them

Common things you might find in custom scripts

- Embedded credentials
- Possible endpoints
- OTA (Over The Air) update process
- telnetd initialization
- DropBear initialization
- Poor error handling
- Understanding of how the filesystems are setup/used
- True enlightenment

Finding hard coded credentials

- Passwd file
- Shadow file
- Keys
- Configuration files
- Custom application/script strings



Once you’ve found them

- Often hashed (but not always)
- Google the hash

File: shadow

```
1 root:91rMiZzGliXHM:1:0:99999:7:::
2 daemon:*:0:0:99999:7:::
3 ftp:*:0:0:99999:7:::
4 network:*:0:0:99999:7:::
5 nobody:*:0:0:99999:7:::
```

File: passwd

```
1 root:$1$0WlvKUDR$.yqcW5hBKyVJKCHQ4njdB/:0:0:root:/root:/bin/ash
2 daemon:*:1:1:daemon:/var:/bin/false
3 ftp:*:55:55:ftp:/home/ftp:/bin/false
4 network:*:101:101:network:/var:/bin/false
5 nobody:*:65534:65534:nobody:/var:/bin/false
```

For instance, Samba

```
File: smbpasswd
1  samba:500:E37D9D1B60CE6031F4EE5CAB3C10B45B:246D949F60611CFA928A476B3FF28B25:[U          ]:LCT-43D6003C:
```

This one is “Shirley/”

Over The Air updates

A possible attack vector if there is no signing or security efforts put into the update process

```
31  mount_etc() {
32      local etc_update=0
33      # if enable ota, do update
34      [ -f /etc/init.d/rc.ota-upgrade ] \
35          && source /etc/init.d/ota-upgrade
36
```

telnetd

- It’s telnet, what more do you want?
- Even if it is configured it might not actually be in started automatically

```
426  #/usr/sbin/telnetd &
427  /sbin/syslogd &
428  #hardcode but fast
429  #mount_etc_hardcode
430  #set_parts_by_name_hardcode
431  #mount_usr
432
433  exec /sbin/init
```

```
426  /usr/sbin/telnetd &
427  /sbin/syslogd &
428  #hardcode but fast
429  #mount_etc_hardcode
430  #set_parts_by_name_hardcode
431  #mount_usr
432
433  exec /sbin/init
```

SSH

- Often Dropbear
- Often super out of date

File: **dropbear**

```
1  config dropbear
2       option PasswordAuth 'on'
3       option RootPasswordAuth 'on'
4       option Port         '22'
5  #    option BannerFile   '/etc/banner'
```

Appalling script error handling

- It’s always bash
- No one ever does proper error handling in bash

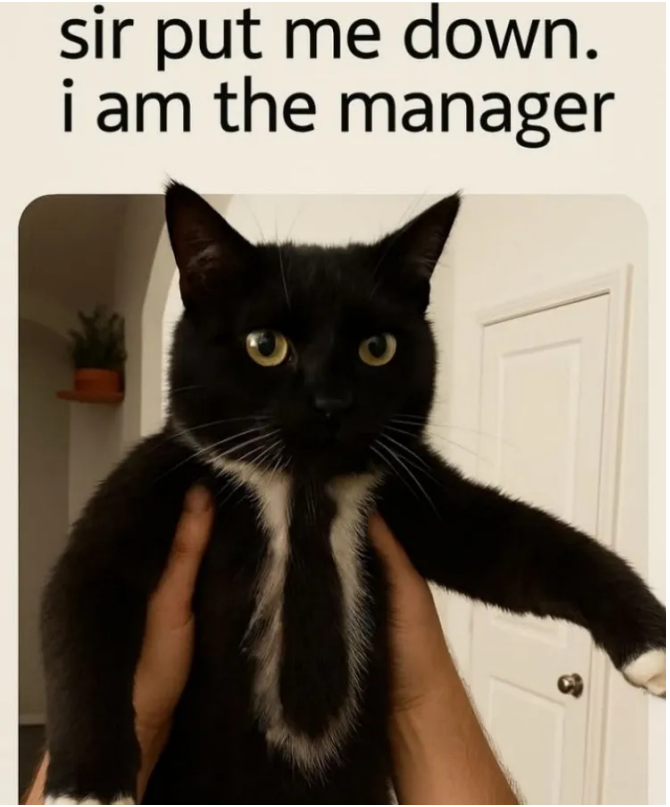
Weird and wacky filesystem setups

JFFS2 and SquashFS can be layered and can be used to do some funky stuff

Usually this is just OverlayFS, but sometimes something interesting will be done to handle OTA updates or factory resets

Checking out custom utilities

- Strings
- Ghidra (or IDA if you have money like that)
- xxd



File: **base_conf.ini**

```
1  [auth]
2  key=1111111111111111
3  [USERINFO]
4  #压力测试使用/正常填写Off即可
5  PressureTest=Off
6  #新产测
7  NewfactoryTest=On
8  #定时重启
```

```
└─(11:24:11)──> bat ciconfig.ini
```

File: **ciconfig.ini**

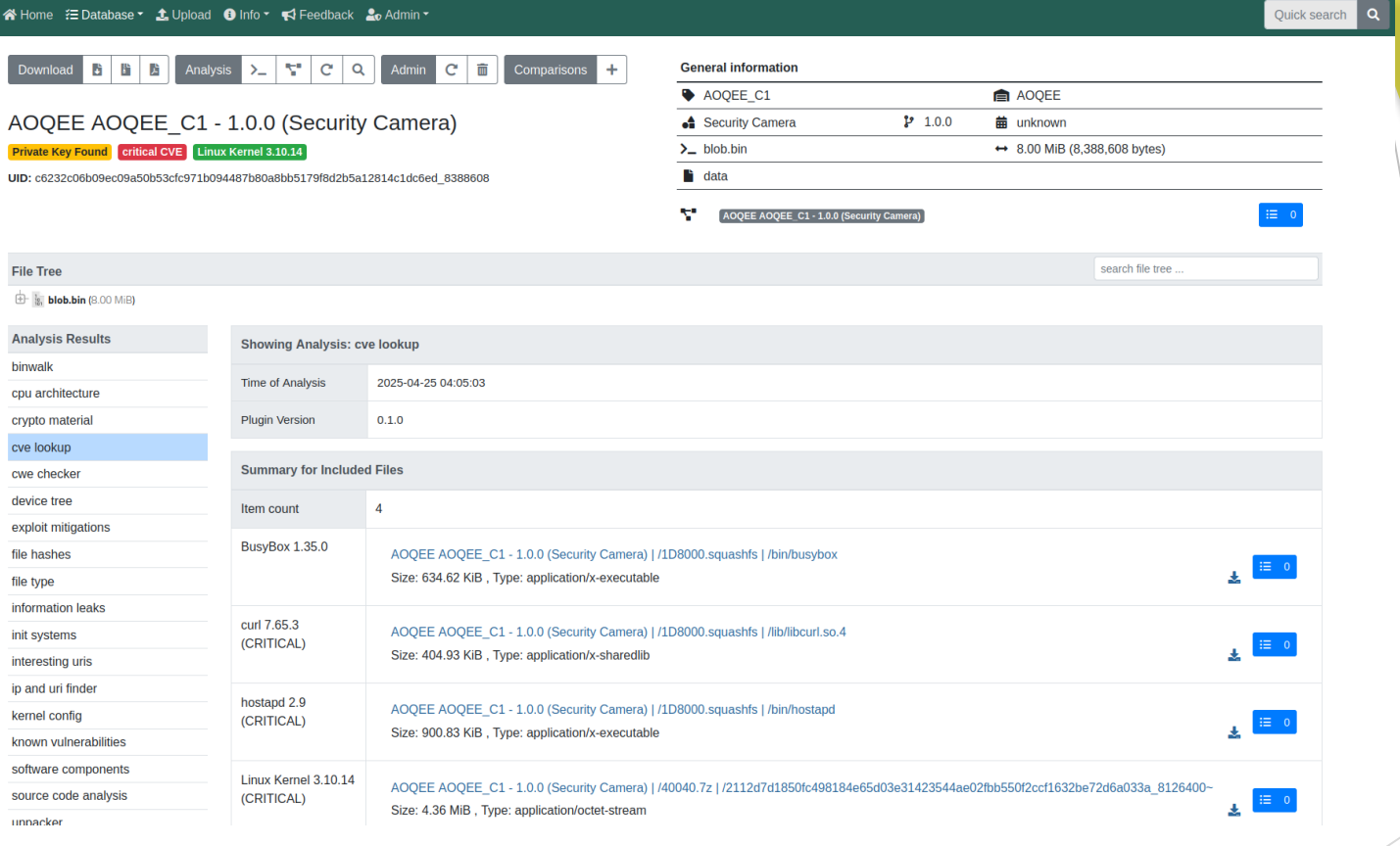
```
1  [wlan]
2  keepalive_interval=15
3  dtim_interval=6
4  suspend_pm=2
5  ap_ssid=
6  ap_pwd=
7
8  [server]
9  web_server_url=https://api.v2.gdxp.com;
10 cmd_server_ip=120.24.87.105;
11 cmd_server_port=8888;
12 udp_server_ip=120.24.87.105;
13 udp_server_port=25050;
14 stun_server_ip=8.218.91.142;
15 stun_server_port=17051;
16 p2p_server_ip=47.242.63.121;
17 p2p_server_port=17051;
18 push_server_url=http://120.24.87.105:58720;
19 oss_from_id=9;
20 oss_endpoint=http://oss-cn-shenzhen.aliyuncs.com;
21 oss_bucket=sz-aiwit;
```

Common things to find in custom utilities

- Embedded credentials
- URLs/URIs
- IPs and ports
- API keys

F.A.C.T (Firmware Analysis and Comparison Toolkit)

- Great for basic static analysis of firmware samples
- You will still have to explore custom utilities and scripts yourself
- Really helpful to compare a new sample to see if you can expect something you've seen before
- https://fkie-cad.github.io/FACT_core/



F.A.C.T.

OzSec 2025

Dynamic analysis

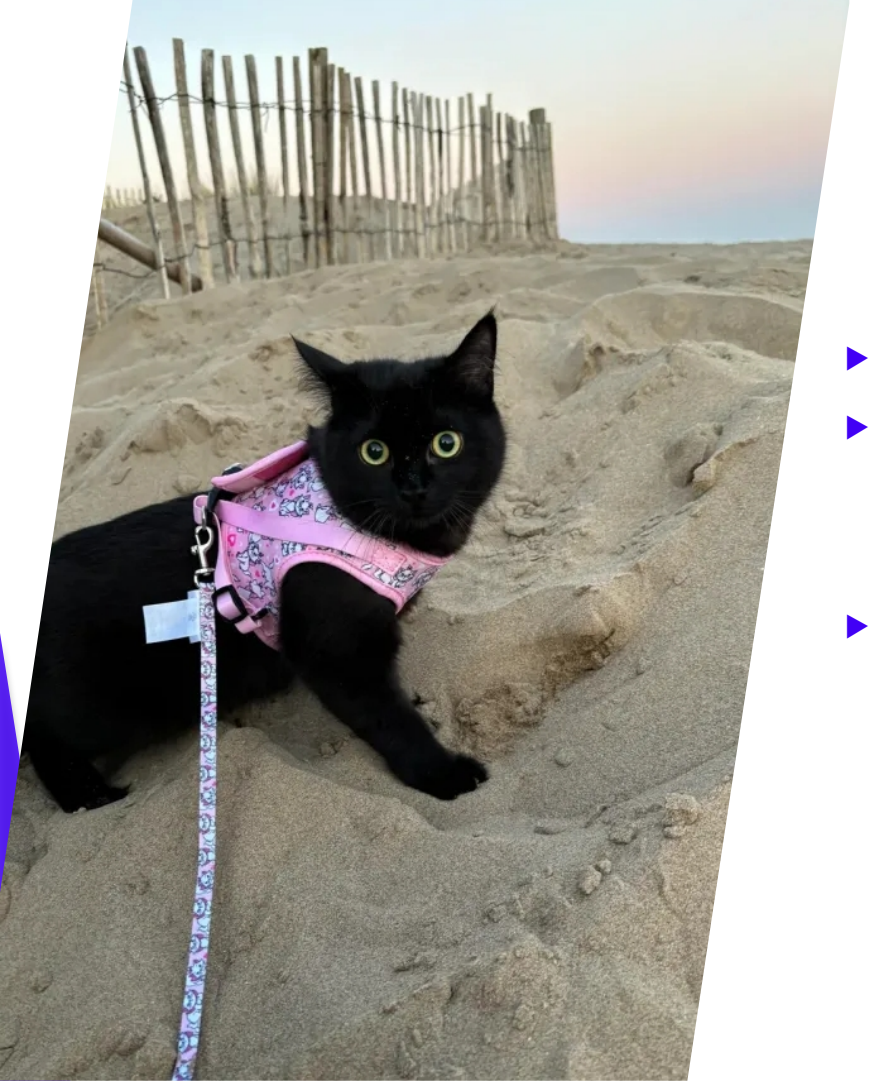
- Emulators
- Watching what the device is doing over UART/JTAG/Network

Emulators

- Emulators are great if you don’t have physically access to the hardware
- They are a huge pain to setup for most IoT devices so I don’t bother for most of these

Getting onto a device and seeing what’s going on

- Exploring the filesystem on a live device
- Testing applications to see what they do
- Watching/modifying network traffic



UART shell

- Setup is the same as before
- Use the credentials that you found in the copy of the firmware you already extracted
- Done

UART Shell

```
msh >dmesg

|commitid: 507a5f56d
|halgitid: 507a5f56d
|timever : Tue, 07 May 2024 16:11:56 +0800

[WRN]: [do_initcall_level:0096]:                    initcall: 0x43c3f9cc.
[WRN]: [do_initcall_level:0096]:                    initcall: 0x43c4159c.
[WRN]: [do_initcall_level:0096]:                    initcall: 0x43c417c8.
[WRN]: [do_initcall_level:0096]:                    initcall: 0x43c419c8.
[WRN]: [do_initcall_level:0096]:                    initcall: 0x43c422c4.
[WRN]: [do_initcall_level:0096]:                    initcall: 0x43c477b0.
[WRN]: [do_initcall_level:0096]:                    initcall: 0x43c497cc.
[INF]: [rv_to_a7_rproc_init:0080]:                  [AMP_INFO]Init proc ok.

[INF]: [rv_to_a7_rproc_mmap:0186]:                  [AMP_INFO]map pa(0x43d23c78) to va(0x43d23c78)

[INF]: [openamp_sunxi_create_rproc:0174]:           [AMP_INFO]Wait master update resource_table

[WRN]: [do_initcall_level:0096]:                    initcall: 0x43c47338.
[WRN]: [do_initcall_level:0096]:                    initcall: 0x43c48ca0.
[WRN]: [do_initcall_level:0096]:                    initcall: 0x43c48a24.
[WRN]: [do_initcall_level:0096]:                    initcall: 0x43c48d84.
msh >[VIN_ERR]used1 is 0
[VIN]set clk end
[ERR]: [hal_twi_sys_pinctrl_init:1751]:             [twi0] not support in sys_config
msh >
```

Other shell options

- JTAG has some ways of getting a shell
- SSH
- Telnet

Network traffic

- How do we get it?
- What’s in it?

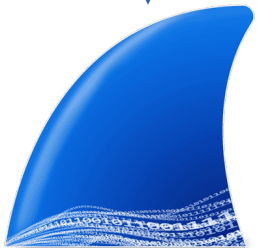
Network setup

- Ralink WiFi adapter
- MitMProxy and hostapd
- Some fun routing rules and dnsmasq

Network setup

Victim

My Laptop with a Transparent Proxy

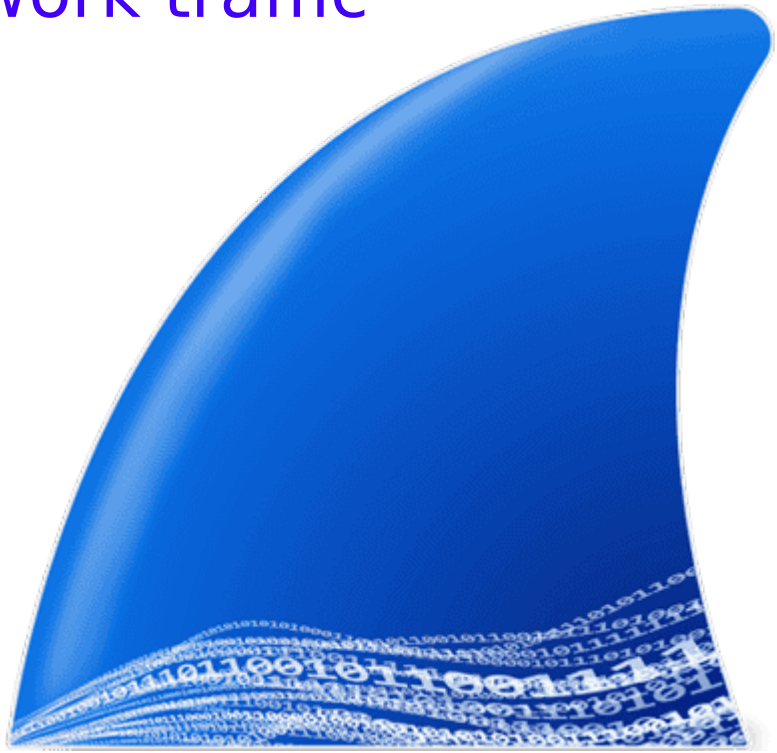


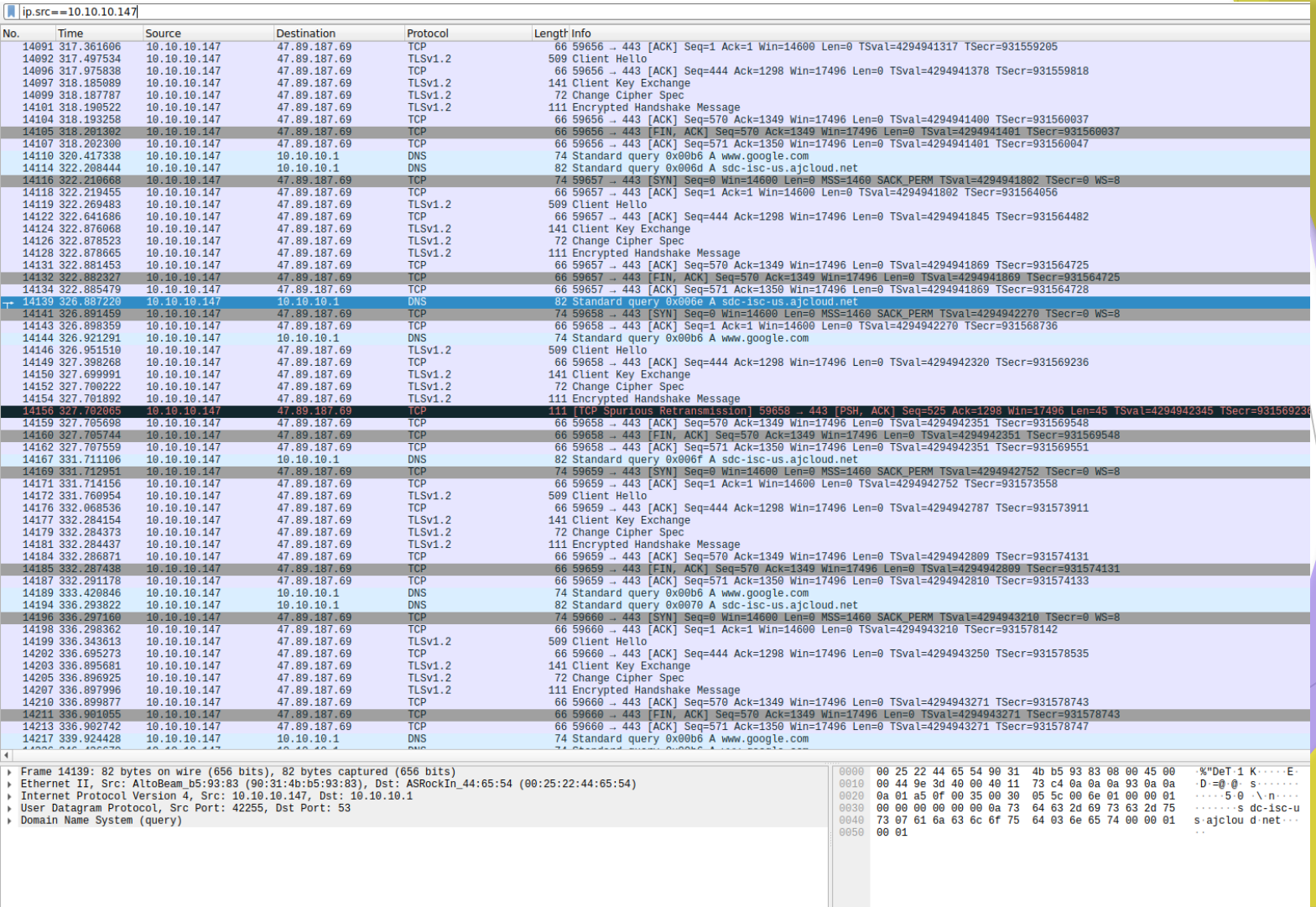
Wireshark/Tshark

Alibaba Cloud

Analyzing network traffic

- Wireshark/Tshark





ip.src==10.10.10.147

No.	Time	Source	Destination	Protocol	Length	Info
14091	317.361606	10.10.10.147	47.89.187.69	TCP	66	59656 → 443 [ACK] Seq=1 Ack=1 Win=14600 Len=0 TSval=4294941317 TSecr=931559205
14092	317.497534	10.10.10.147	47.89.187.69	TLSv1.2	509	Client Hello
14096	317.975838	10.10.10.147	47.89.187.69	TCP	66	59656 → 443 [ACK] Seq=444 Ack=1298 Win=17496 Len=0 TSval=4294941378 TSecr=931559818
14097	318.185089	10.10.10.147	47.89.187.69	TLSv1.2	141	Client Key Exchange
14099	318.187787	10.10.10.147	47.89.187.69	TLSv1.2	72	Change Cipher Spec
14101	318.190522	10.10.10.147	47.89.187.69	TLSv1.2	111	Encrypted Handshake Message
14104	318.193258	10.10.10.147	47.89.187.69	TCP	66	59656 → 443 [ACK] Seq=570 Ack=1349 Win=17496 Len=0 TSval=4294941400 TSecr=931560037
14105	318.201302	10.10.10.147	47.89.187.69	TCP	66	59656 → 443 [FIN, ACK] Seq=570 Ack=1349 Win=17496 Len=0 TSval=4294941401 TSecr=931560037
14107	318.202300	10.10.10.147	47.89.187.69	TCP	66	59656 → 443 [ACK] Seq=571 Ack=1350 Win=17496 Len=0 TSval=4294941401 TSecr=931560047
14110	320.417338	10.10.10.147	10.10.10.1	DNS	74	Standard query 0x00b6 A www.google.com
14114	322.208444	10.10.10.147	10.10.10.1	DNS	82	Standard query 0x006d A sdc-isc-us.ajcloud.net
14116	322.210668	10.10.10.147	47.89.187.69	TCP	74	59657 → 443 [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM TSval=4294941802 TSecr=0 WS=8
14118	322.219455	10.10.10.147	47.89.187.69	TCP	66	59657 → 443 [ACK] Seq=1 Ack=1 Win=14600 Len=0 TSval=4294941802 TSecr=931564056
14119	322.269483	10.10.10.147	47.89.187.69	TLSv1.2	509	Client Hello
14122	322.641686	10.10.10.147	47.89.187.69	TCP	66	59657 → 443 [ACK] Seq=444 Ack=1298 Win=17496 Len=0 TSval=4294941845 TSecr=931564482
14124	322.876068	10.10.10.147	47.89.187.69	TLSv1.2	141	Client Key Exchange
14126	322.878523	10.10.10.147	47.89.187.69	TLSv1.2	72	Change Cipher Spec
14128	322.878665	10.10.10.147	47.89.187.69	TLSv1.2	111	Encrypted Handshake Message
14131	322.881453	10.10.10.147	47.89.187.69	TCP	66	59657 → 443 [ACK] Seq=570 Ack=1349 Win=17496 Len=0 TSval=4294941869 TSecr=931564725
14132	322.882327	10.10.10.147	47.89.187.69	TCP	66	59657 → 443 [FIN, ACK] Seq=570 Ack=1349 Win=17496 Len=0 TSval=4294941869 TSecr=931564725
14134	322.885479	10.10.10.147	47.89.187.69	TCP	66	59657 → 443 [ACK] Seq=571 Ack=1350 Win=17496 Len=0 TSval=4294941869 TSecr=931564728
14139	326.887220	10.10.10.147	10.10.10.1	DNS	82	Standard query 0x006e A sdc-isc-us.ajcloud.net
14141	326.891459	10.10.10.147	47.89.187.69	TCP	74	59658 → 443 [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM TSval=4294942270 TSecr=0 WS=8
14143	326.898359	10.10.10.147	47.89.187.69	TCP	66	59658 → 443 [ACK] Seq=1 Ack=1 Win=14600 Len=0 TSval=4294942270 TSecr=931568736
14144	326.921291	10.10.10.147	10.10.10.1	DNS	74	Standard query 0x00b6 A www.google.com
14146	326.951510	10.10.10.147	47.89.187.69	TLSv1.2	509	Client Hello
14149	327.398268	10.10.10.147	47.89.187.69	TCP	66	59658 → 443 [ACK] Seq=444 Ack=1298 Win=17496 Len=0 TSval=4294942320 TSecr=931569236
14150	327.699991	10.10.10.147	47.89.187.69	TLSv1.2	141	Client Key Exchange
14152	327.700222	10.10.10.147	47.89.187.69	TLSv1.2	72	Change Cipher Spec
14154	327.701892	10.10.10.147	47.89.187.69	TLSv1.2	111	Encrypted Handshake Message
14156	327.702065	10.10.10.147	47.89.187.69	TCP	111	[TCP Spurious Retransmission] 59658 → 443 [PSH, ACK] Seq=525 Ack=1298 Win=17496 Len=45 TSval=4294942345 TSecr=9315692
14159	327.705698	10.10.10.147	47.89.187.69	TCP	66	59658 → 443 [ACK] Seq=570 Ack=1349 Win=17496 Len=0 TSval=4294942351 TSecr=931569548
14160	327.705744	10.10.10.147	47.89.187.69	TCP	66	59658 → 443 [FIN, ACK] Seq=570 Ack=1349 Win=17496 Len=0 TSval=4294942351 TSecr=931569548
14162	327.707559	10.10.10.147	47.89.187.69	TCP	66	59658 → 443 [ACK] Seq=571 Ack=1350 Win=17496 Len=0 TSval=4294942351 TSecr=931569551
14167	331.711106	10.10.10.147	10.10.10.1	DNS	82	Standard query 0x006f A sdc-isc-us.ajcloud.net
14169	331.712951	10.10.10.147	47.89.187.69	TCP	74	59659 → 443 [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM TSval=4294942752 TSecr=0 WS=8
14171	331.714156	10.10.10.147	47.89.187.69	TCP	66	59659 → 443 [ACK] Seq=1 Ack=1 Win=14600 Len=0 TSval=4294942752 TSecr=931573558
14172	331.760954	10.10.10.147	47.89.187.69	TLSv1.2	509	Client Hello
14176	332.068536	10.10.10.147	47.89.187.69	TCP	66	59659 → 443 [ACK] Seq=444 Ack=1298 Win=17496 Len=0 TSval=4294942787 TSecr=931573911
14177	332.284154	10.10.10.147	47.89.187.69	TLSv1.2	141	Client Key Exchange
14179	332.284373	10.10.10.147	47.89.187.69	TLSv1.2	72	Change Cipher Spec
14181	332.284437	10.10.10.147	47.89.187.69	TLSv1.2	111	Encrypted Handshake Message
14184	332.286871	10.10.10.147	47.89.187.69	TCP	66	59659 → 443 [ACK] Seq=570 Ack=1349 Win=17496 Len=0 TSval=4294942809 TSecr=931574131
14185	332.287438	10.10.10.147	47.89.187.69	TCP	66	59659 → 443 [FIN, ACK] Seq=570 Ack=1349 Win=17496 Len=0 TSval=4294942809 TSecr=931574131
14187	332.291178	10.10.10.147	47.89.187.69	TCP	66	59659 → 443 [ACK] Seq=571 Ack=1350 Win=17496 Len=0 TSval=4294942810 TSecr=931574133
14189	333.420846	10.10.10.147	10.10.10.1	DNS	74	Standard query 0x00b6 A www.google.com
14194	336.293822	10.10.10.147	10.10.10.1	DNS	82	Standard query 0x0070 A sdc-isc-us.ajcloud.net
14196	336.297160	10.10.10.147	47.89.187.69	TCP	74	59660 → 443 [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM TSval=4294943210 TSecr=0 WS=8
14198	336.298362	10.10.10.147	47.89.187.69	TCP	66	59660 → 443 [ACK] Seq=1 Ack=1 Win=14600 Len=0 TSval=4294943210 TSecr=931578142
14199	336.343613	10.10.10.147	47.89.187.69	TLSv1.2	509	Client Hello
14202	336.695273	10.10.10.147	47.89.187.69	TCP	66	59660 → 443 [ACK] Seq=444 Ack=1298 Win=17496 Len=0 TSval=4294943250 TSecr=931578535
14203	336.895681	10.10.10.147	47.89.187.69	TLSv1.2	141	Client Key Exchange
14205	336.896925	10.10.10.147	47.89.187.69	TLSv1.2	72	Change Cipher Spec
14207	336.897996	10.10.10.147	47.89.187.69	TLSv1.2	111	Encrypted Handshake Message
14210	336.899877	10.10.10.147	47.89.187.69	TCP	66	59660 → 443 [ACK] Seq=570 Ack=1349 Win=17496 Len=0 TSval=4294943271 TSecr=931578743
14211	336.901055	10.10.10.147	47.89.187.69	TCP	66	59660 → 443 [FIN, ACK] Seq=570 Ack=1349 Win=17496 Len=0 TSval=4294943271 TSecr=931578743
14213	336.902742	10.10.10.147	47.89.187.69	TCP	66	59660 → 443 [ACK] Seq=571 Ack=1350 Win=17496 Len=0 TSval=4294943271 TSecr=931578747
14217	339.924428	10.10.10.147	10.10.10.1	DNS	74	Standard query 0x00b6 A www.google.com

```
▸ Frame 14139: 82 bytes on wire (656 bits), 82 bytes captured (656 bits)
▸ Ethernet II, Src: AltoBeam_b5:93:83 (90:31:4b:b5:93:83), Dst: ASRockIn_44:65:54 (00:25:22:44:65:54)
▸ Internet Protocol Version 4, Src: 10.10.10.147, Dst: 10.10.10.1
▸ User Datagram Protocol, Src Port: 42255, Dst Port: 53
▸ Domain Name System (query)
```

```
0000  00 25 22 44 65 54 90 31  4b b5 93 83 08 00 45 00   ·%"DeT·1 K·····E·
0010  00 44 9e 3d 40 00 40 11  73 c4 0a 0a 0a 93 0a 0a   ·D·=@·@· s·······
0020  0a 01 a5 0f 00 35 00 30  05 5c 00 6e 01 00 00 01   ·····5·0 ·\·n····
0030  00 00 00 00 00 00 0a 73  64 63 2d 69 73 63 2d 75   ·······s dc-isc-u
0040  73 07 61 6a 63 6c 6f 75  64 03 6e 65 74 00 00 01   s·ajclou d·net···
0050  00 01                                             ··
```

SSL certificate abuse

Lack of certificate pinning

- Many devices don’t have certificate pinning
- This allows you to MitM TLS connections, not just unencrypted connections

Ways IoT devices can be better secured

- Locking down the bootloader
- Stop shipping things in debug mode
- Encrypted flash
- Not shipping a MVP
- Not using really dumb password
- Verifying OTA updates
- Pinning SSL certificates

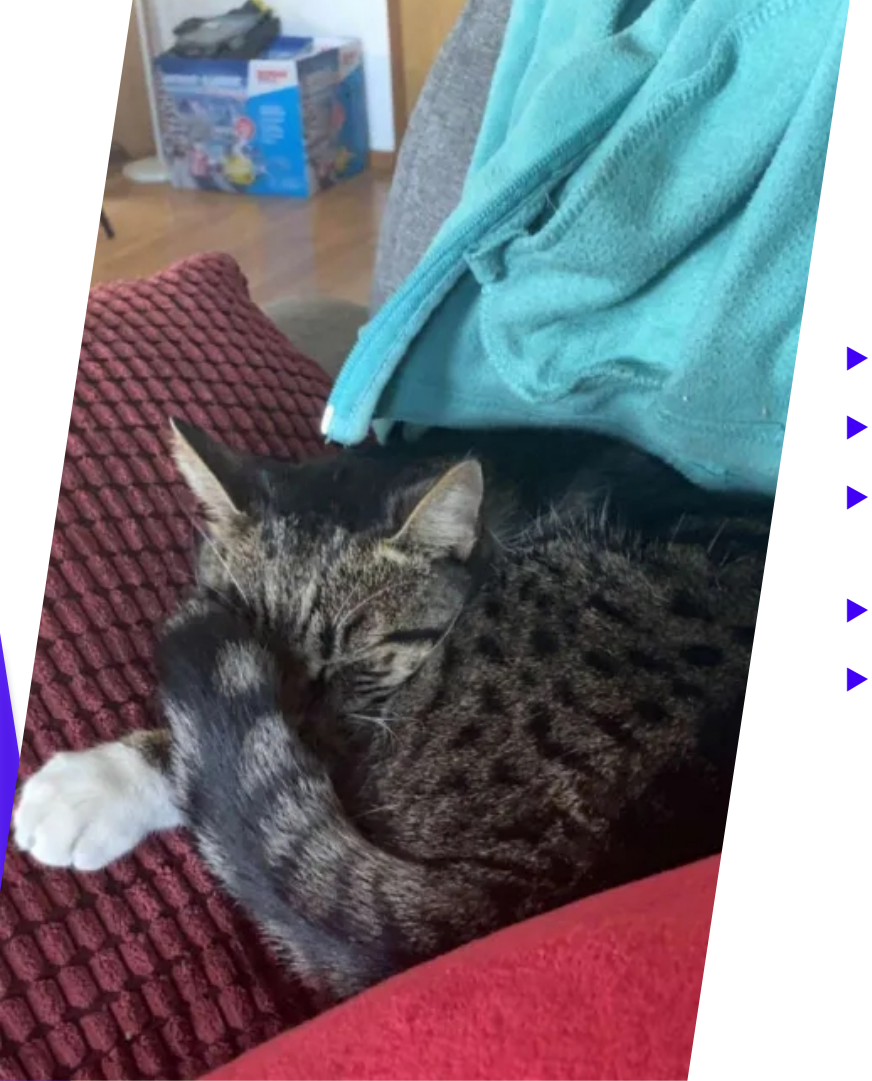
Those all cost money

Possible impacts

Initial foothold

- Routers
- IP cameras

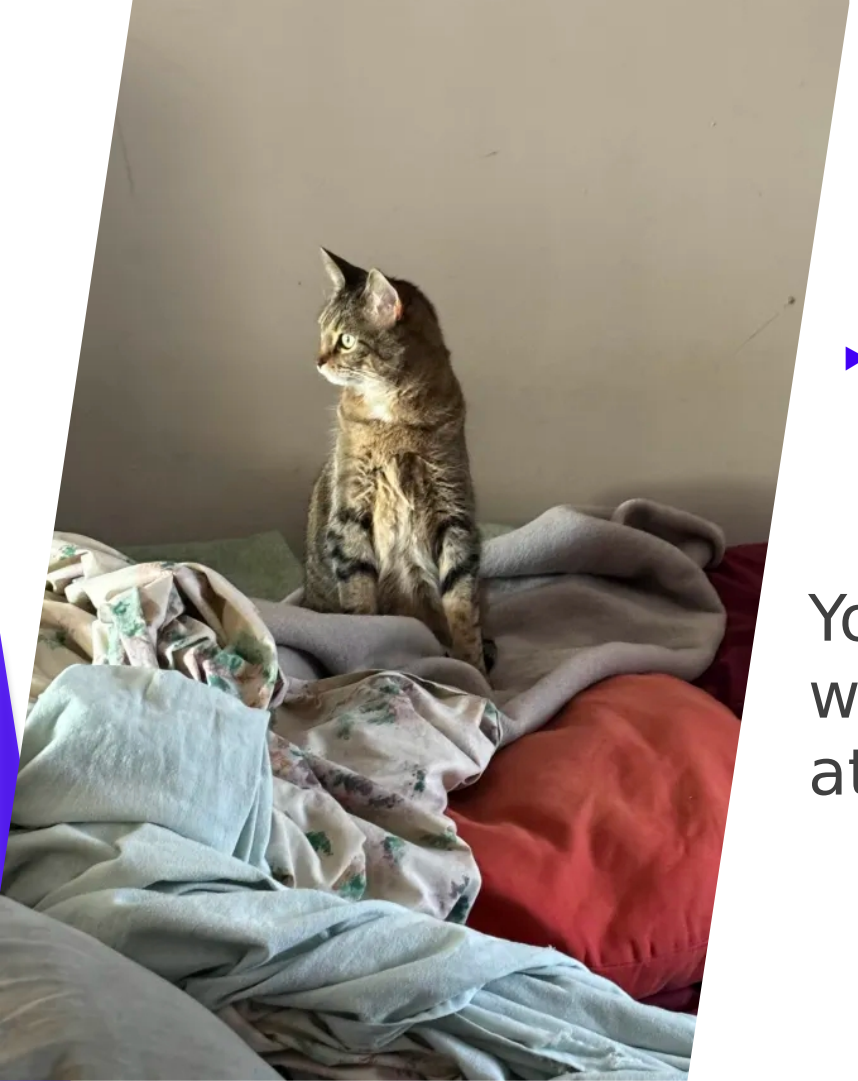
PUT IoT DEVICES ON THEIR OWN VLAN



Botnets

- Mirai
- Bashlite
- Aisuru (apparently behind the attacks this week)
- Qbot
- Reaper

Questions?



Thanks for listening

- Thank you for listening to me talk about this stuff, I hope you all enjoyed.

You can find me at www.powershell.zip or at SecKC every month

OzSec 2026

- Thank you for Attending!!
- Looking forward to next year already
- Pre-Register for OzSec2026
  - https://ozsecurity.org/