Analyzing Firmware With Binwalk

Author: https://github.com/small-goblin

Firmware is the collection of code, images, data, etc that's packaged and "flashed" (programmed onto) small devices. Stuff like renta-scooters, your home internet router, digital cameras, jet engines…. Etc.

If you're researching a device, there's a lot of ways to get firmware. Either off the device itself, or maybe downloaded from the manufacturer. Once you have the firmware how do you get out all the bundled data? Usually it isn't in a human readable format.

Binwalk is a program that "file slices" or uses heuristics to determine not only what kind of files exist in the binary, but roughly where those files begin and end. It isn't always perfect, but it's usually one of the first steps to reverse engineering firmware to find vulnerabilities.

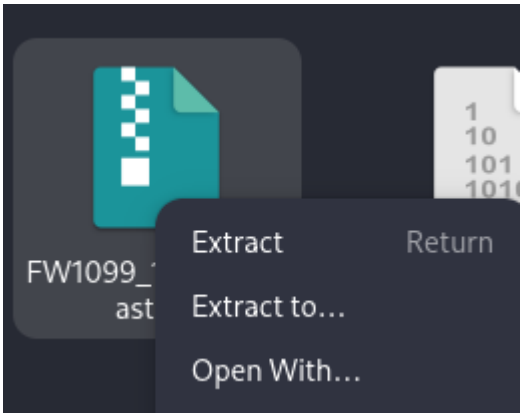
1. Download the firmware

https://github.com/navaismo/Ender-3V3-SE/releases/tag/v1.0.9.9

Download: FW1099_115Kbps_Fast.zip

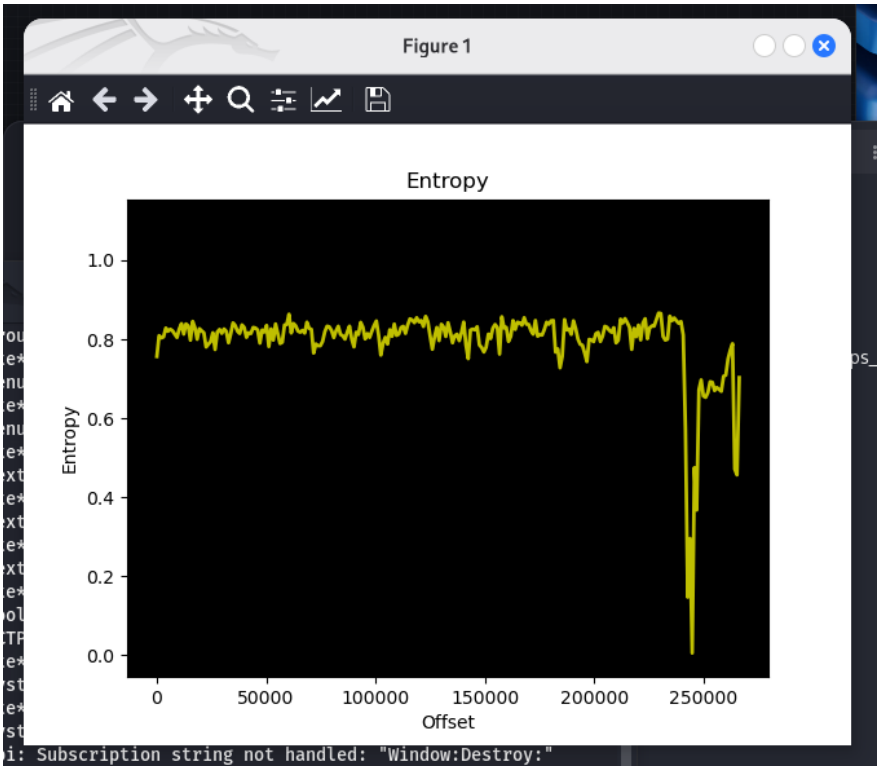
This is a modified firmware for the ender3, a common hobbyist 3d printer.

Right Click, Extract the ZIP



2. Check the entropy of the file.

Terminal: binwalk FW1099_115Kbps_Fast.bin -E

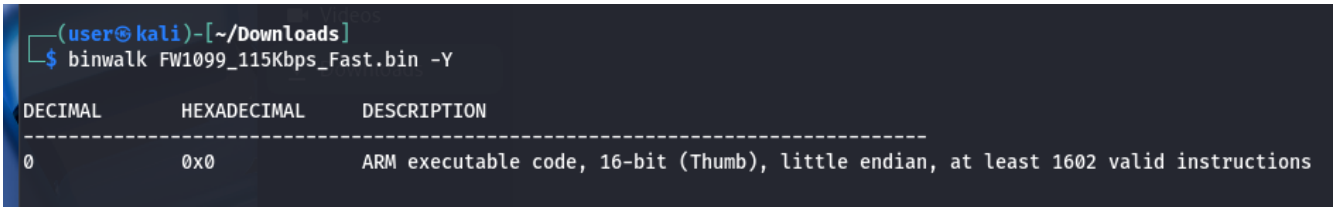


Our firmware shows low entropy.

This means: the firmware is either plain text, binary data, or structured coherently in some other unknown format. Not encrypted! Not compressed! If it was, it would have a much higher entropy, because the bytes would be more or less random.

3. So what kind of firmware is this? We can check

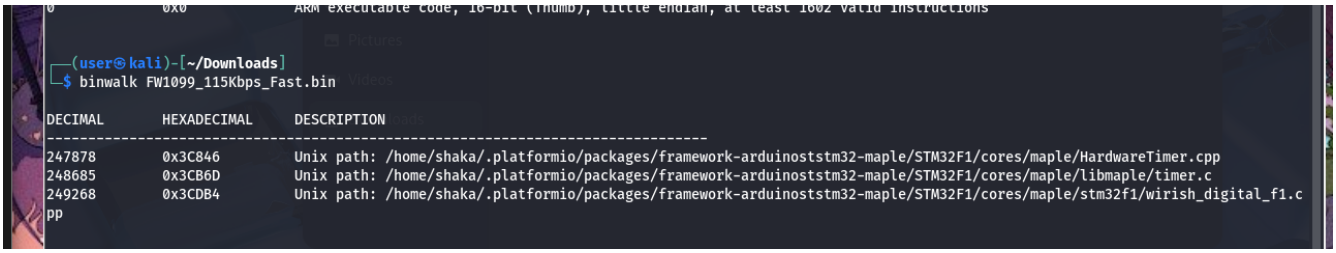
terminal: binwalk FW1099_115Kbps_Fast.bin -Y



Seems like this firmware was compiled for an ender3 that uses an ARM processor.

4. Can we recover any embedded files?

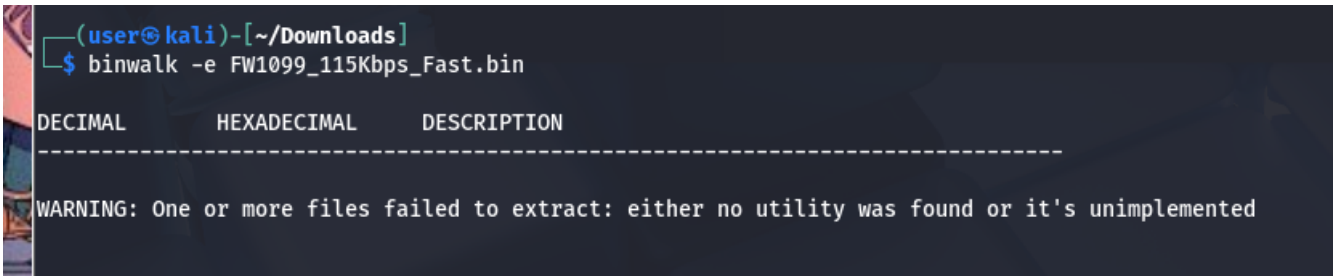
terminal: binwalk FW1099_115Kbps_Fast.bin



It looks like binwalk was able to locate at least three files.

Lets extract the files into a folder for additional analysis.

terminal: binwalk -e FW1099_115Kbps_Fast.bin



This fails, which isn’t uncommon for difficult to extract files or unrecognized formats.

We can try a different command, to tell binwalk to extract everything it can.

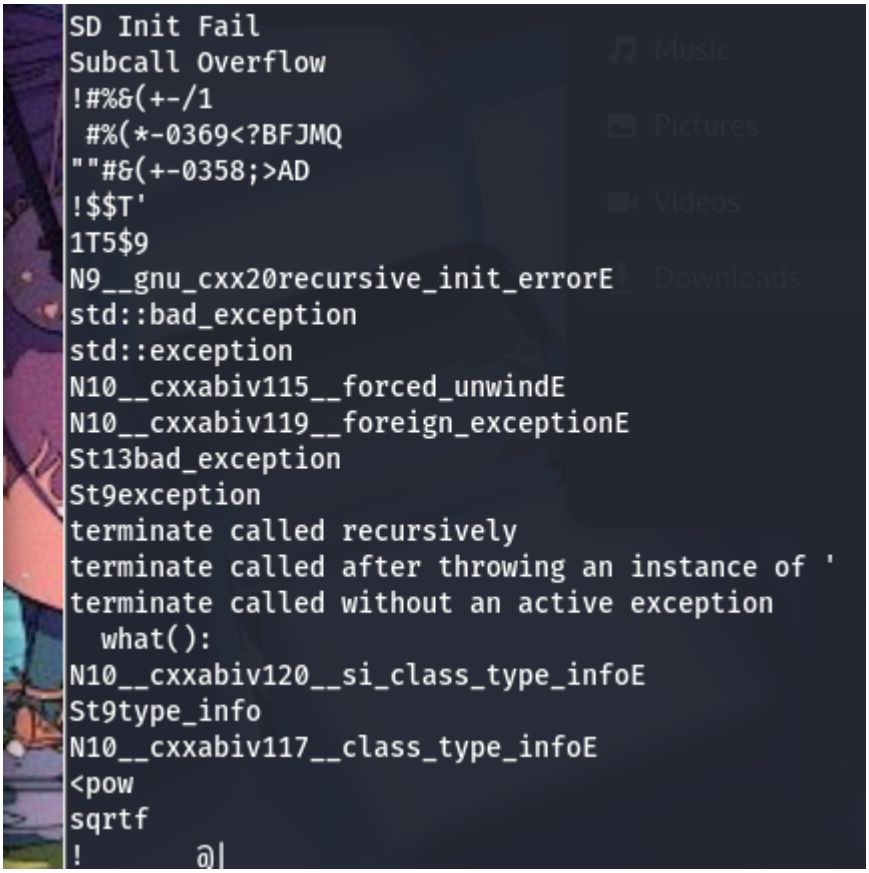
terminal: binwalk --dd=".*" FW1099_115Kbps_Fast.bin

These files are named after their hex value. You can either rename them, or use the output table as a reference.

5. Lets see if there’s any printable strings in these files

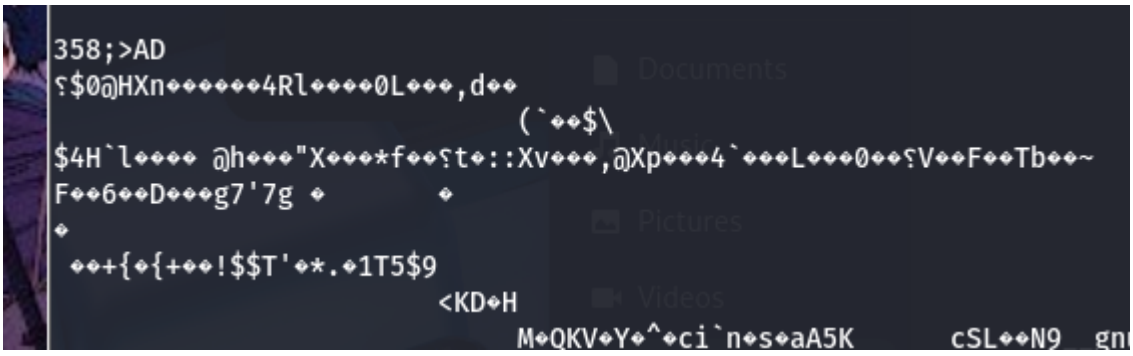
terminal: strings ./_FW1099_115Kbps_Fast.bin.extracted/*

We can see a lot of what looks like output for exception handling.



Inside of these files is also a lot of nonsense strings, which could likely be code being interpreted as text.

terminal: cat _FW1099_115Kbps_Fast.bin.extracted/3C846



From here, we’d want to review these files further using a dissembler tool, and hex editor.

Read more

- https://github.com/ReFirmLabs/binwalk
- https://en.wikipedia.org/wiki/Entropy_(information_theory)
- https://en.wikipedia.org/wiki/Firmware
- https://owasp.org/owasp-istg/index.html