CORE SECURITY

Adventures in Embedded Device Exploration and Exploitation

Bobby Kuzma, CISSP
Systems Engineer

October 21, 2016

About this talk

This talk is:

- An introduction to embedded device hacking
- An inventory of useful tools, and how to Macguyver around them.
- A tale of some of the things I've learn, and screwed up

This talk is not:

- A case study or deep dive. Come back this afternoon for "**Oh Dear... vulnerability hunting in access controls**"

CORE SECURITY

Hi! I’m Bobby.

I show people how to use things. Like Pentesting Software.

I get to pentest things.

I break stuff and call it research.

And I love my job.

What’s the Problem?

Ethernet and 802.11 chips are stupid cheap:

- Thousands^WMillions of new “network enabled” devices
- Embedded systems programming is very different…
- “Experience” is a problem

Basically…

Internet of Things

=

Internet of [redacted]

Code

What kind of “things”

- Industrial Control
- Access control and physical security
- Cameras
- Power management
- Environmental Controls
- Appliances
- Printers
- MRI Machines
- IV Drug Pumps

Who owns the Embedded Devices?

A subject for Meditation…

Security Practices for Embedded Devices are stuck in the 90s…

And not the good part of the 90s.

Common Problems to hunt

- Default passwords
- Hardcoded, undocumented passwords
- Command injection
- SQL Injection
- No update path
- Crappy or non-existent crypto
- Key Management? Say What?

Show me the… Hardware

Hospira Lifecare PCA pump

- Unauthenticated Telnet as root
- Hardcoded Passwords
- Plain text wireless creds
- Directly editable drug database
- Common keying

CORE SECURITY

HID Edge/VertX Card readers

- Unauthenticated Command Injection allows doors to be unlocked
- Vulnerable base OS

Cisco ASA Firewalls

- Memory Corruption
- And other goodies

Sounds fun.
How can I play?

Step 0

Find something to hack on!

Look at what's new, or interesting, or cheap.

Check out recent research and conference presentations

Protip: Get at least 3 of them, especially if it's from China

Step 1

Identify the Attack Surface

Where does data enter or exit?

Management software or web services…

Examine the firmware

Step 2

Examine the hardware

Take it apart…

Look for interesting chips…

Look for interesting breakouts, vias, or pads

Useful Tools – Part 1

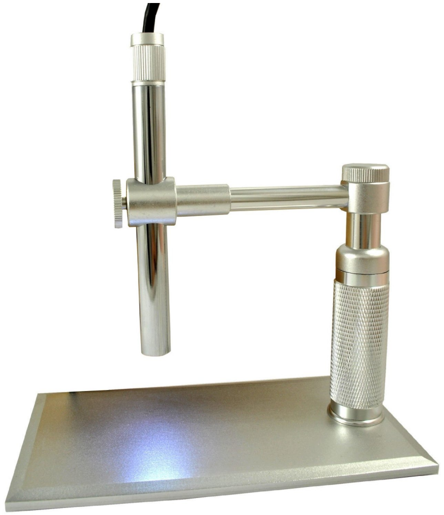
Good screwdrivers and tips, including security bits

Figure out what’s what

- Lots of pins: Interesting
- Big chips: Interesting
- Google everything printed on the chip
- Datasheets are your friend

Useful Tools – Part 2

Protip: Magnification is good. So is getting your eyes checked.



Useful Tools – Part 3

Multimeters

<- $5.99 at Harbor Freight

$300 at many, many places ->

Useful Tools – Part 3

Protip:

Keep several cheap DMMs on hand to test “iffy” circuits. You will cry less when they blow up ☹

Step 3

Get the firmware

The easy way: Firmware is downloadable from the website

The middle way: Reverse Engineer management software to get URL

The hard way: Hardware hacking: UART, JTAG, SPI, Chip Off, Glitching

Step 3 – The Hard Way

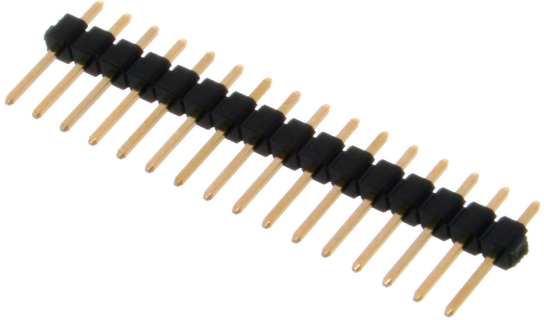
Start with the easy, and less invasive methods first.

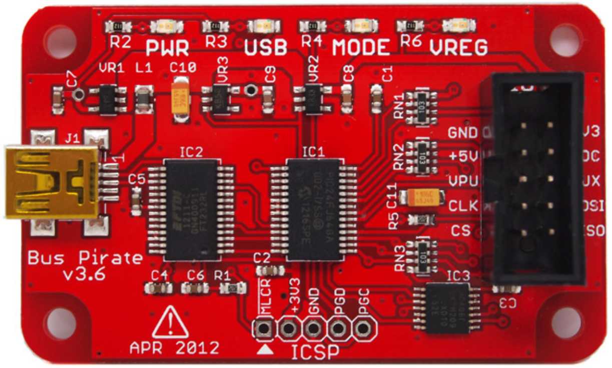
How Dangerous?	Method
Mostly Harmless*	UART
	JTAG
Watch your ground!	Probing flash chip leads
Magic Smoke Release Probable	Chip-off flash reading
	Microcontroller glitching attacks

*I may or may not have accidentally destroyed several hundred dollars worth of targets

Useful Tools – Part 4

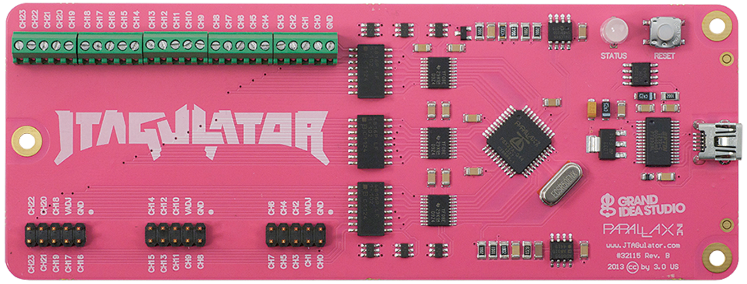
Protip: Learn to solder. Please.





The BusPirate

$30



The JTAGULATOR

$150

Decent temperature controlled soldering rig ->

$90-ish

Protip: MacGuyvering

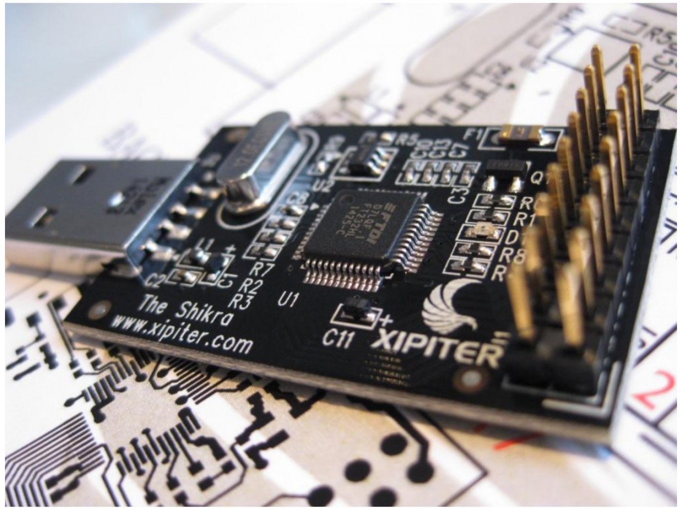
No JTAGulator, no problem.

Turn device OFF

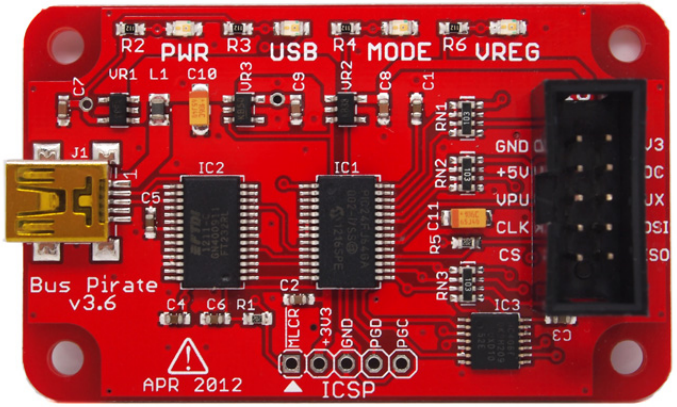
Use multimeter in continuity mode, datasheet, and magnifier to trace pins to confirm JTAG pinout

Useful Tools – Part 5

DSLogic Pro
$100



The Shikra
$45



BusPirate
$27

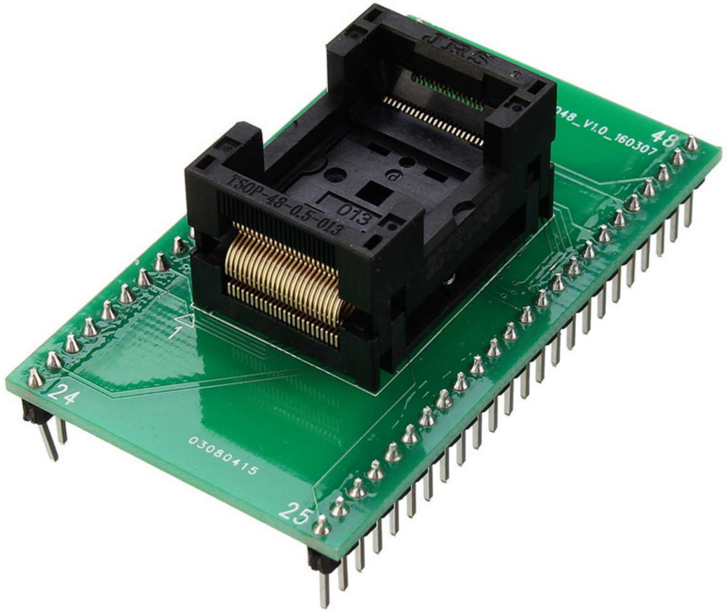
Protip: MacGuyvering

The BusPirate can be turned into a low fidelity logic analyzer with the right firmware.

Useful Tools – Part 6

ChipQuik Alloy
$17ish

TMN-5000
EEPROM/Flash
Programmer
$300

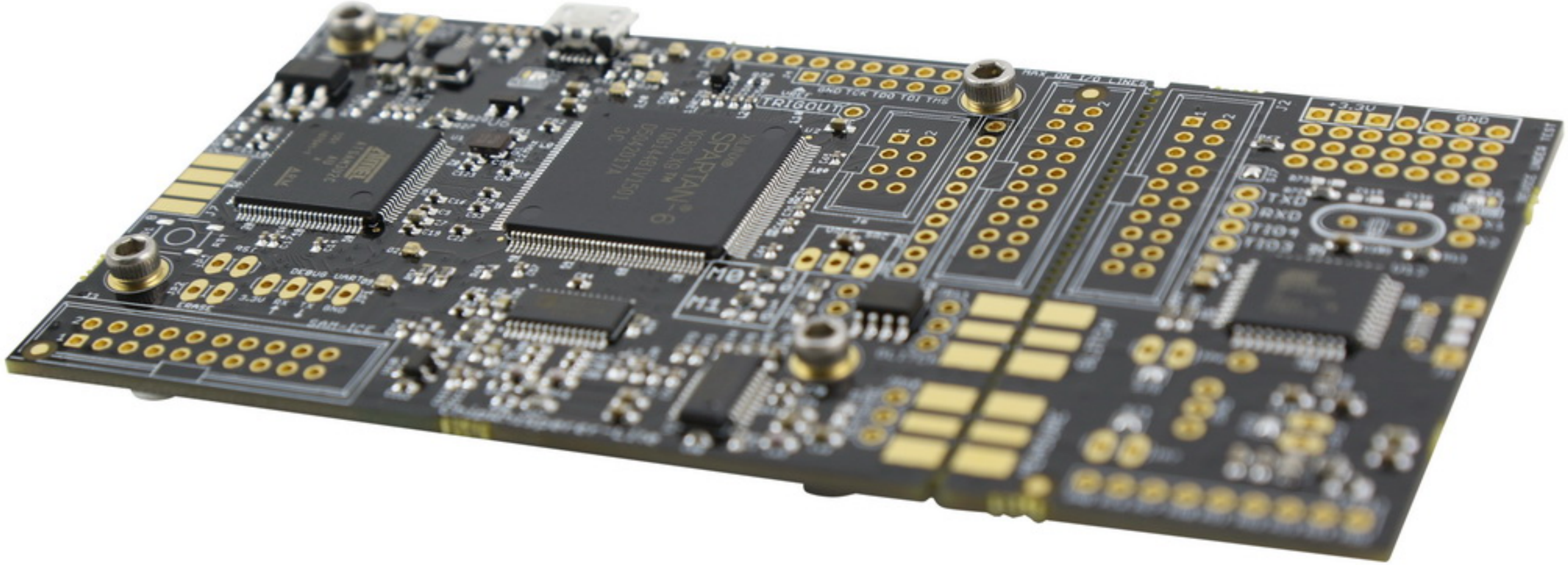


Chip adapter
$40-70

Protip: MacGuyvering

You can use a BusPirate or Shikra and an adapter to dump flash memory.

Useful Tools – Last Ditch

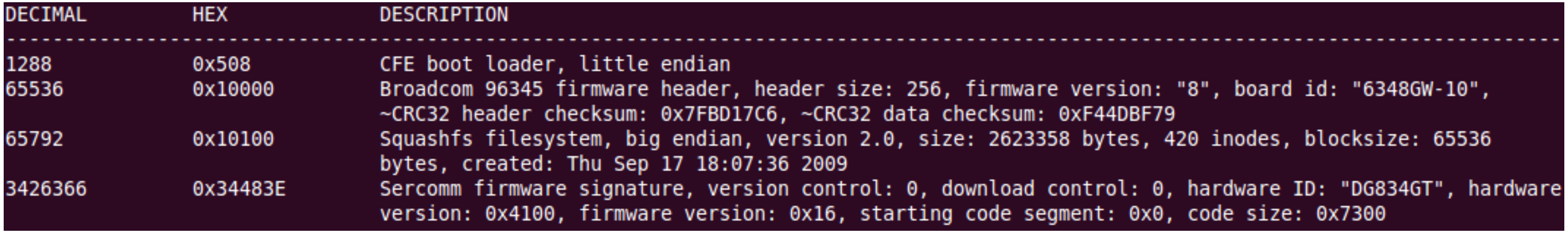


ChipWhisperer
$300

Step 4

Extract the firmware

Binwalk is awesome and free.



```
DECIMAL       HEX           DESCRIPTION
--------------------------------------------------------------------------------------------------------------------------------
1288          0x508         CFE boot loader, little endian
65536         0x10000       Broadcom 96345 firmware header, header size: 256, firmware version: "8", board id: "6348GW-10",
                            ~CRC32 header checksum: 0x7FBD17C6, ~CRC32 data checksum: 0xF44DBF79
65792         0x10100       Squashfs filesystem, big endian, version 2.0, size: 2623358 bytes, 420 inodes, blocksize: 65536
                            bytes, created: Thu Sep 17 18:07:36 2009
3426366       0x34483E      Sercomm firmware signature, version control: 0, download control: 0, hardware ID: "DG834GT", hardware
                            version: 0x4100, firmware version: 0x16, starting code segment: 0x0, code size: 0x7300
```

Get Binwalk at http://www.binwalk.org

Step 5

Audit and Reverse Engineer

If you’re lucky, it’s a Linux or unix-like RTOS

Look for weird services

Hardcoded passwords

Certificates or keys

Step 5

Audit and Reverse Engineer

Disassembly tools are needed to dive deeper:

- ILSpy for .NET assemblies
- IDA Pro – Supports almost every CPU architecture. Expensive
- BinaryNinja – New, supports x86,x64, and ARM. Extensible.
- Radare2 – Open Source, robust. Free, but learning curve.

Step 5

You found something, now what?

Hardware manufacture can be… squirrelly.

Coordinated disclosure should be your first option…

Full disclosure is a very big hammer. Use it sparingly.

Have fun!

Step Fin

And now…

Continue the discussion

bkuzma@coresecurity.com

@BobbyAtCore

http://www.coresecurity.com

CORE SECURITY