# Hardware Hacking for the Masses (and you!)

BusesCanFly

Image: https://cyberpunk.fandom.com/wiki/Aquadynamics_Laboratory

# buses@slides:~$ cat ./boring_disclaimer.txt

- I am not a lawyer
- This presentation is just my view/experiences and those of friends around me
- I have no clue what i’m doing 98% of the time
- Be responsible and hack your own stuff
- Links for where to find the images used are in the slide notes

- I am not a lawyer

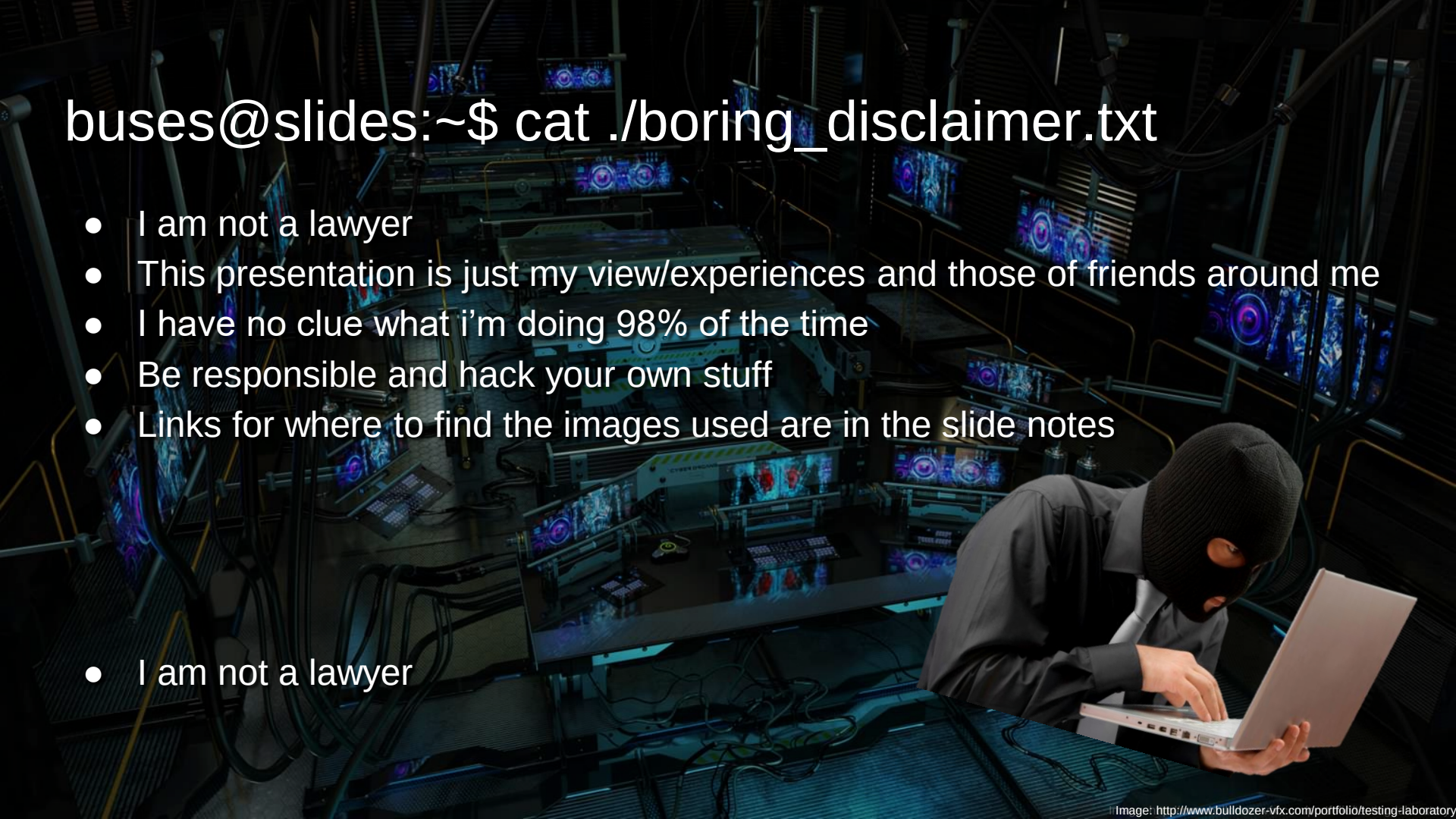


Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ whoami

- Just a noob exploring what I find fun
- {Embedded, Automotive} hardware hacker
  - Mostly a hobby
- Student
- Love rock climbing, quadcopter flying, and messing with electronics

Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ cat ./overview.txt

- What is hardware hacking?
  - What is hacking?
    - Making stuff do what it's not supposed too!
    - Dumping and learning all the secrets!
    - ~~General and absolute chaos~~
  - Very general idea with different areas
    - Some common ideas/concepts

In short, whatever you want it to be! If you can touch it, hack it, and have fun it’s hardware hacking.

Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ head -n 12 ./questions.*

- Isn’t hardware hacking hard?
  - No! ...yes?
  - (As with everything, it depends on what you do)
  - There is something for everyone
- Can I hack hardware?
  - ***YES!***
- What do I need to get started?
  - Stay right where you are and you’ll find out :)
- Is hardware hacking expensive?
  - A lot is possible for very little money

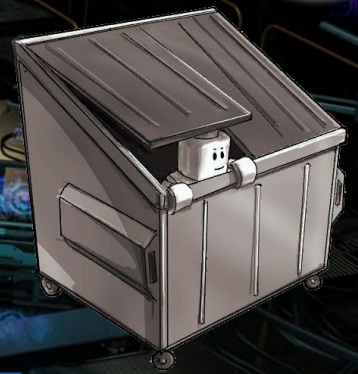
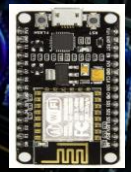
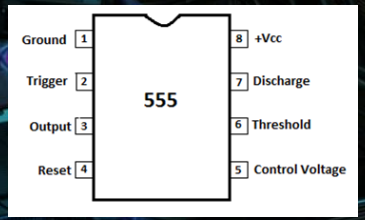


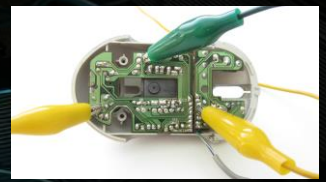
Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ tail -n 10 ./how2learn

- Projects!
  - Arduino’s
  - Raspberry pi’s + similar SBC’s
  - General electronics
    - Soldering
- Books
- Web resources
  - Youtube (GreatScott!, Electroboom)
  - Forums (Adafruit, Sparkfun)





https://makezine.com/projects/diy-hacks-how-tos-rapid-fire-mouse-button/

Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ more ./RTFM.txt

- Incredible amount of information online
  - Datasheets (IC's, processors, etc.)
  - Schematics
  - FCC documents (!)
    - http://fcc.io/
    - RF information, internal pictures, specifications, etc.
  - Firmware (can also be dumped off hardware)

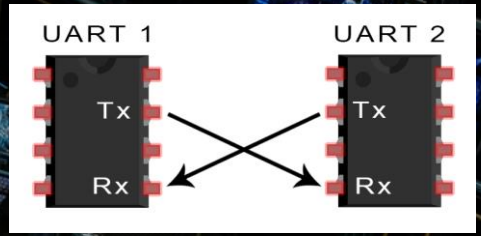



- Inspecting the hardware...

Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ tac ./things2know.txt | tac

- Baud rate
  - “The baud rate is the rate at which information is transferred in a communication channel.”
    - https://www.setra.com/blog/what-is-baud-rate-and-what-cable-length-is-required-1
  - 4800, 9600, 19200, 38400, 57600, 115200 (bits/sec)




- Common electronics terms
- Vcc: “voltage at the common collector." (AKA power, (+), voltage)
- GND: Ground, (-)
- Rx: Receive
- Tx: Transmit

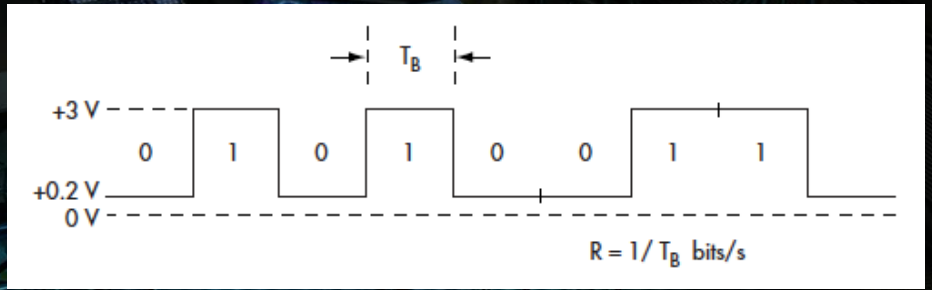
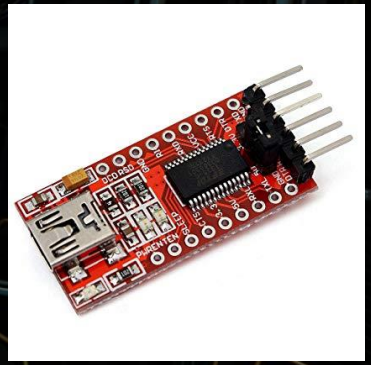
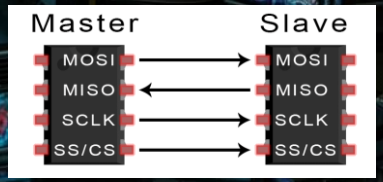



Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ #What do I look for?

- “Debug interfaces”
  - Code has to be loaded somehow!
  - Devs need a way to see information or interact with the devices
  - Busybox? Limited shell? Custom sh? Root shell? ...Arch?
- How can we get the information?
  - UART, JTAG (pin layouts/hardware)
  - SPI, I2C/I$^2$C, … (communication protocols)
  - “Common” interfaces:
    - USB
    - Ethernet
  - Screen, Minicom, Miniterm, PuTTY
    - Need to know Baud Rate





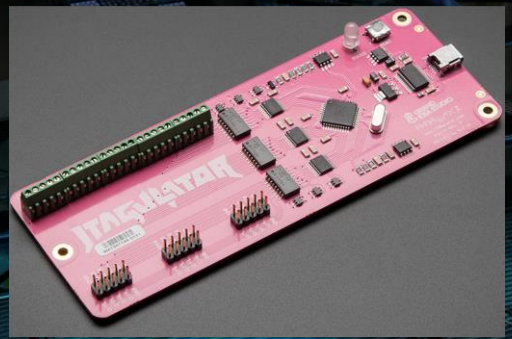
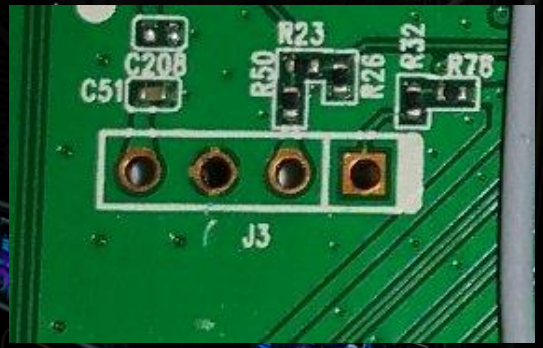
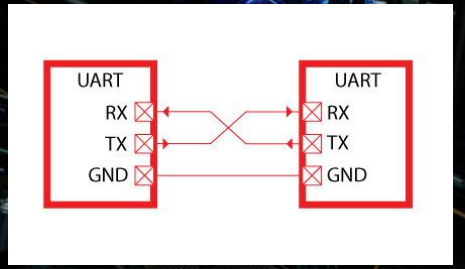



Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ more ./UART.txt

- “Universal Asynchronous Receiver/Transmitter”
- Very common, and easy to use!
- Generally 4 pins
  - ...but generally* don’t connect Vcc
- How do we identify them?
  - Trial and error
    - Small tricks
      - Ground is usually square (shared across board)
      - Vcc trace slightly thicker
      - Rx/Tx just guess
  - Oscilloscope
  - Logic analyzer



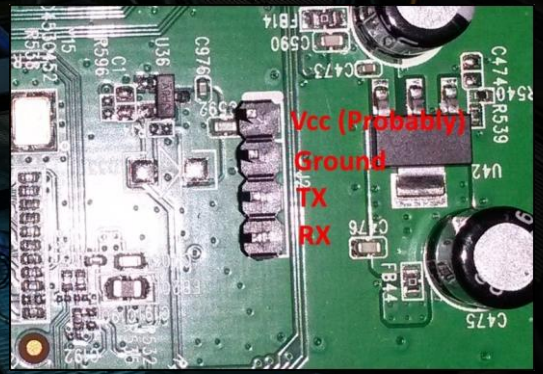
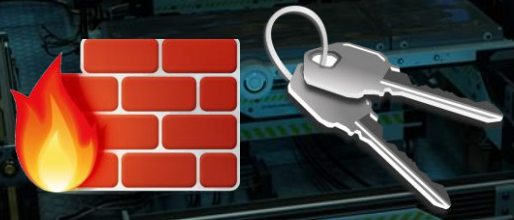




Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

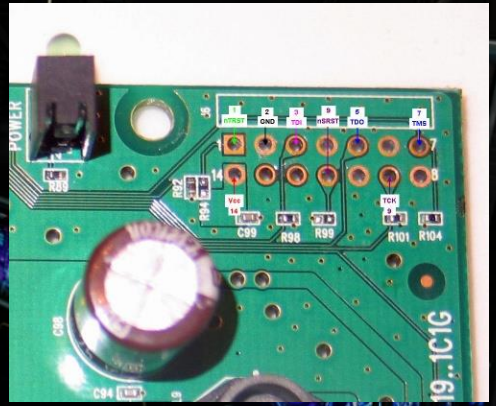

```
----------------------------------------------------------------
Welcome To Use TP-LINK COMMAND-LINE Interface Model.
----------------------------------------------------------------
TP-LINK(conf)#help
normal mode commands:
        clear           ---     clear screen
        exit            ---     leave to the privious mode
        help            ---     help info
        history         ---     show histroy commands
        logout          ---     logout cli model
config mode commands:
        config          ---     enter config mode
        igmp            ---     igmp config
        wan             ---     wan config
        wlctl           ---     wireless config
        lan             ---     lan config
        dev             ---     device control

TP-LINK(conf)#
```

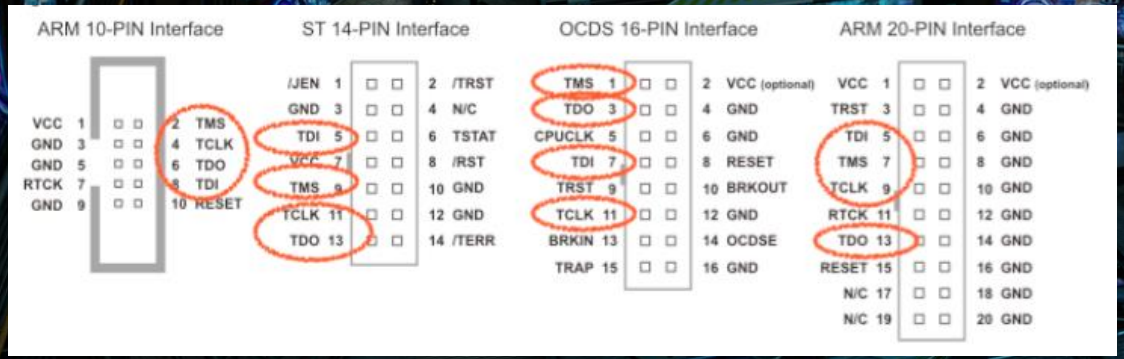
```
root@ubuntu:/home/oit/tools# python baudrate.py

Starting baudrate detection on /dev/ttyUSB0, turn on your serial device now.
Press Ctl+C to quit.



cccccccccccccccccccc Baudrate: 115200 cccccccccccccccccccc

dm major = 253
spiflash_ioctl_read, Read from 0x007df100 length 0x6, ret 0, retlen 0x6
Read MAC from flash(  7df100) 7c-ffffff8b-ffffffca-48-60-ffffffba
GMAC1_MAC_ADRH -- : 0x00007c8b
GMAC1_MAC_ADRL -- : 0xca4860ba
Ralink APSoC Ethernet Driver Initilization. v3.1  256 rx/tx descriptors allocated, mtu = 1500!
NAPI enable, Tx Ring = 256, Rx Ring = 256
spifd from 0x007df100 length 0x6, ret 0, retlen 0x6
Read MAC from flash(  7df100) 7c-ffffff8b-ffffffca-48-60-ffffffba
GMAC1_MAC_ADRH -- : 0x00007c8b
GMAC1_MAC_ADRL -- : 0xca4860ba
PROC INIT OK!
add domain:tplinkwifi.net
add domain:tplinkap.net
add domain:tplinkrepeater.net
add domain:tplinklogin.net
tp_domain init ok
L2TP core driver, V2.0
PPPoL2TP kernel driver, V2.0
Set: phy[0].reg[0] = 3900
```

Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ less ./JTAG.txt

- “Joint Test Action Group”
- Pin count can vary but core ones stay the same
- Can be secured* with a key/password
- Hit or miss



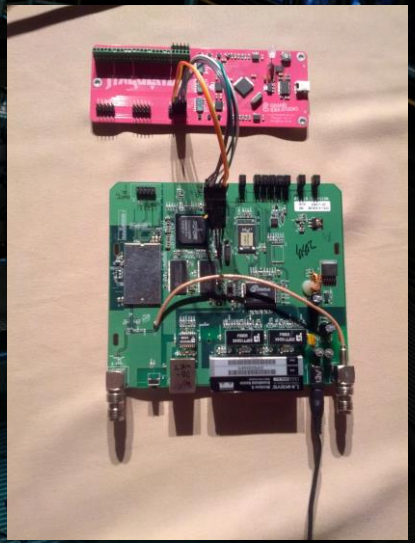



Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

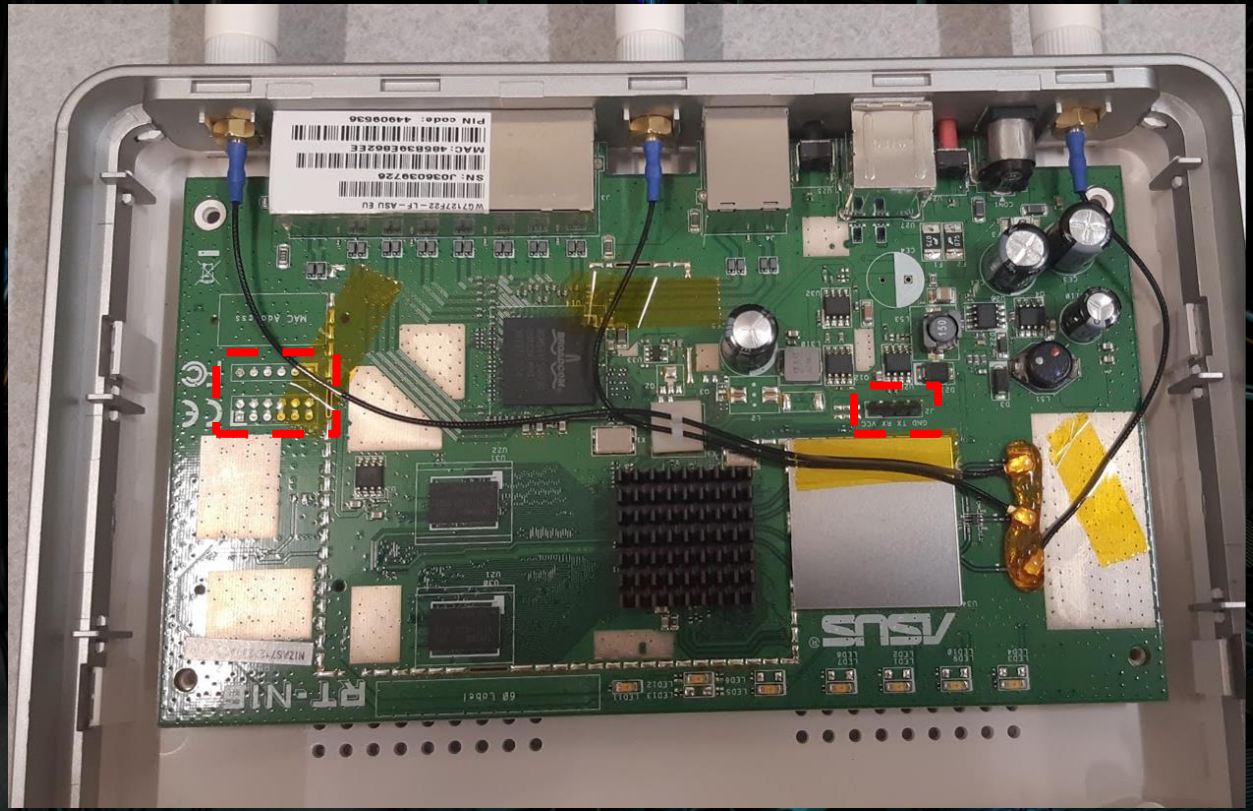



Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

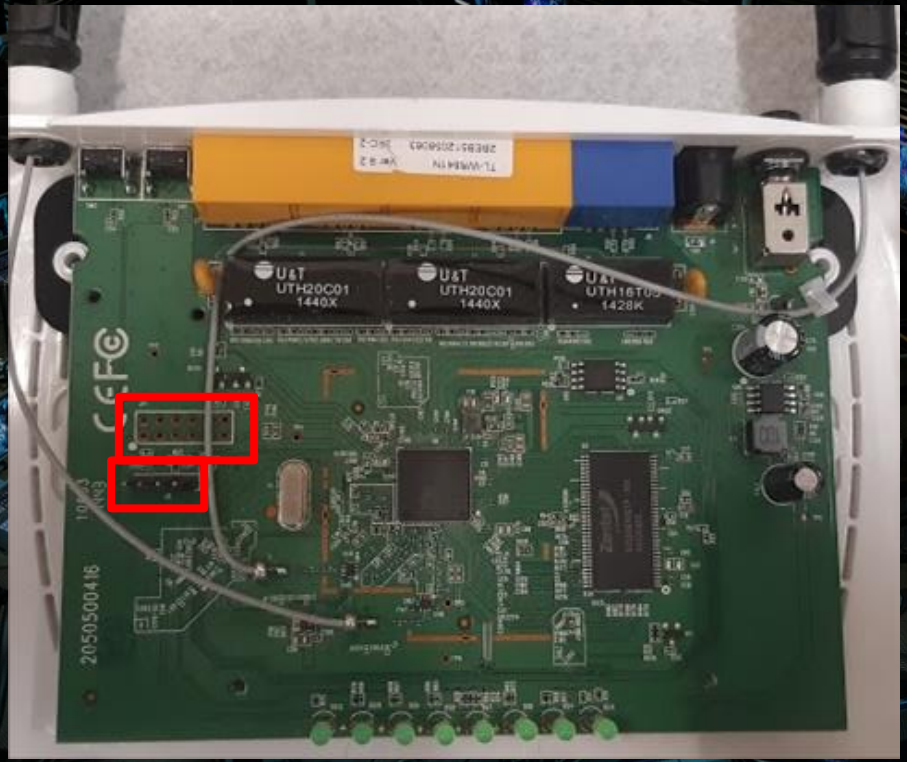



Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

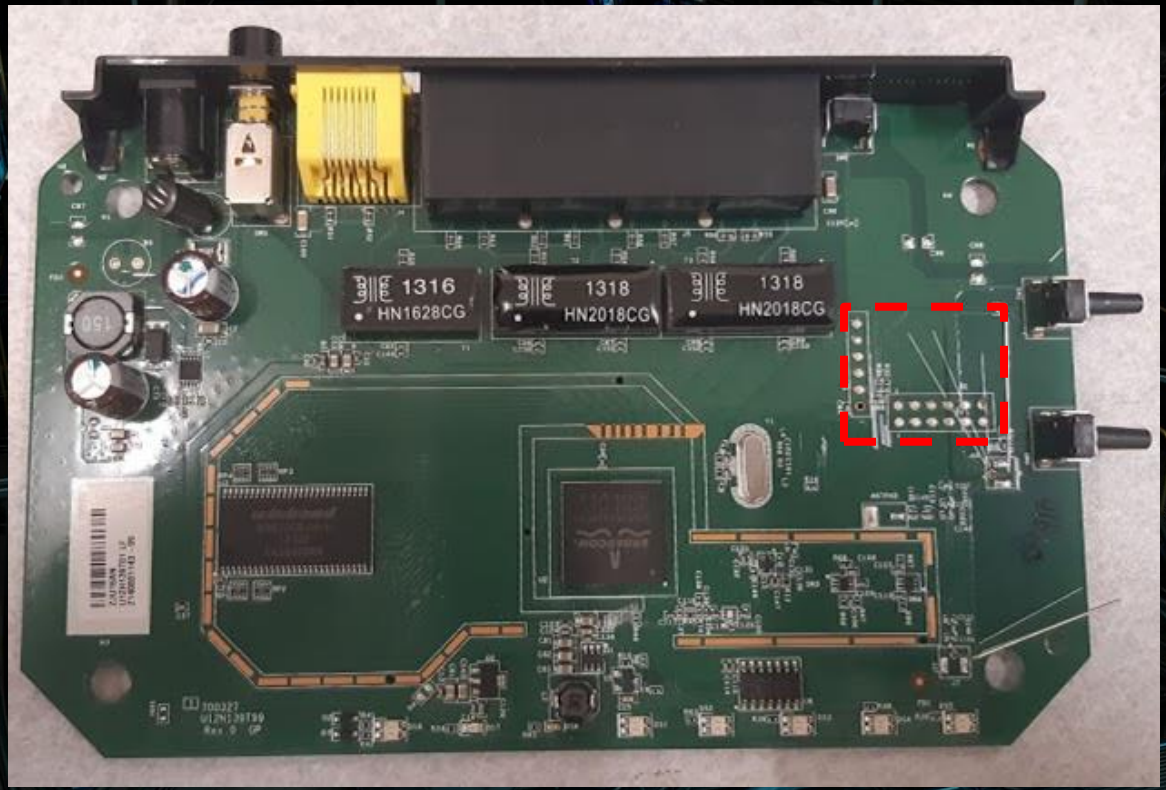
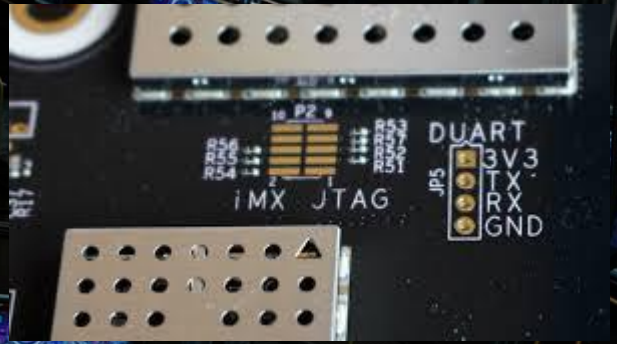
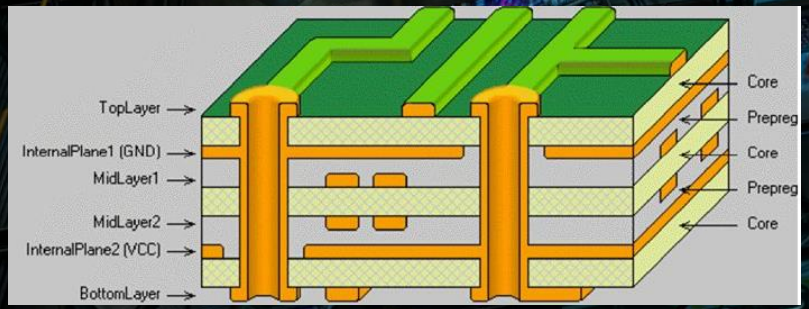



Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ xdg-open ./weird/

- Lots of PCB standards/techniques
- Different formats and standards for interfaces
- Learn through experience!



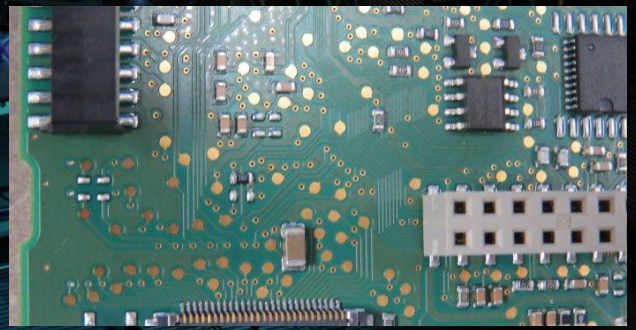
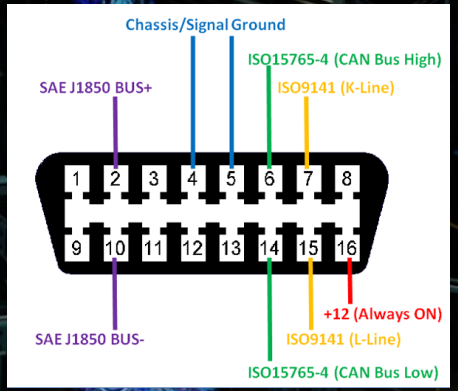



Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ cat ./explore.txt

- Automotive/Car hacking
- IoT devices
- ICS equipment
- Planes? Trains? Predator Drones?
- Car chargers
- Voting machines
- Cell phones



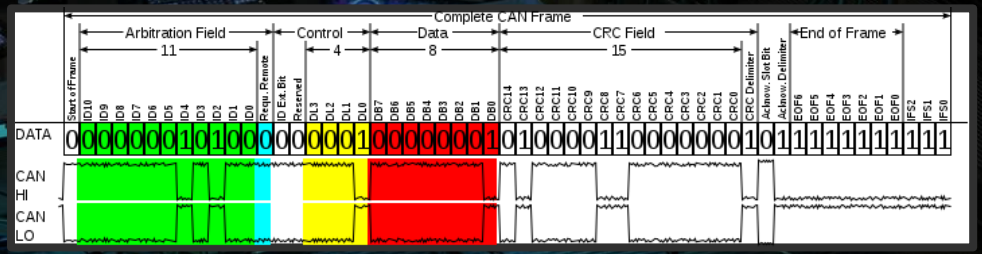
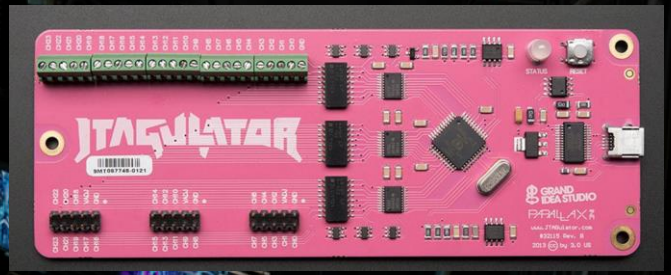
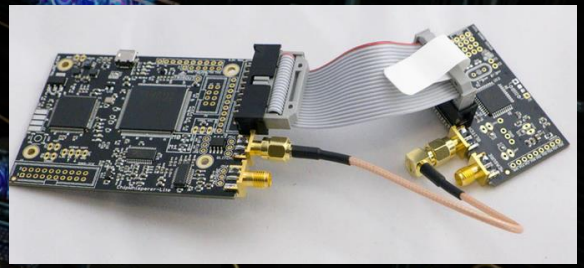



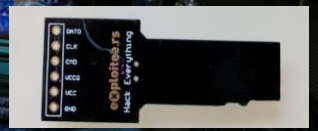

Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ open -t Tools.txt

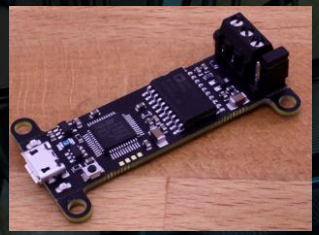
- Connecting to all the things...
  - Black Magic Probe (JTAG/SWD adapter)
  - JTAGulator (Best friend for JTAG)
  - Bus Pirate (Hardware connection multi-tool)
  - The Shikra (Similar to bus pirate)
  - UART cable(s) (Cheap but trusty, very useful)
  - Chip Whisperer (For glitching and side channel attacks)
  - greatFET (Great video here)
  - Logic analyzer [Salea is the god tier]
    - bitmagic
  - CANable [or CANtact] (Need an adapter cable to connect to OBDII ports)









# buses@slides:~$ perl ./resource1.sh

- Getting started:
  - https://learn.adafruit.com
  - https://learn.sparkfun.com/tutorials/where-do-i-start/all
  - http://konukoii.com/blog/2018/02/16/5-min-tutorial-root-via-uart/
  - https://blog.senr.io/blog/jtag-explained
  - http://www.nicolascollins.com/texts/originalhackingmanual.pdf
  - http://security.cs.rpi.edu/courses/hwre-spring2014/
- Books:
  - https://nostarch.com/catalog/hardware-and-diy
  - https://hackaday.com/2016/12/16/books-you-should-read-the-hardware-hacker/
  - https://nostarch.com/hardwarehackerpaperback
  - https://books.google.com/books/about/Hardware_Hacking_Handbook.html?id=DEqatAEACAAJ

Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ perl ./resource2.py

- Presentation/Talks/Slides…
  - Getting started with car hacking:
    - https://www.youtube.com/watch?v=56LB7pTyax4
  - Hardware hacking Defcon talks
    - Exploiteers DC talks (!)
      - https://youtu.be/S9MxbC0PO10
      - https://www.youtube.com/watch?v=h5PRvBpLuJs
    - https://www.defcon.org/images/defcon-12/dc-12-presentations/Fullam/dc-12-fullam.pdf
    - https://www.youtube.com/watch?v=I8yVaYpWDxE
    - https://www.youtube.com/watch?v=B8DjTcANBx0
  - Samy Kamkar's hardware hacking talk:
    - https://www.youtube.com/watch?v=tlwXmNnXeSY

Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ perl ./resource3

- IfNotPike's collection of SDR/radio/RF resources
  - https://github.com/notpike/SDR-Notes
- Samy Kamkar's array of projects
  - https://samy.pl
  - https://www.youtube.com/user/s4myk
- BLE ctf:
  - https://github.com/hackgnar/ble_ctf
- MG's amazing work:
  - https://github.com/O-MG/DemonSeed
- UART examples:
  - https://www.davidsopas.com/using-uart-to-connect-to-a-chinese-ip-cam/
  - https://www.blackhillsinfosec.com/how-to-hack-hardware-using-uart/

Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# buses@slides:~$ Shout-outs

- My amazing friends, family, teachers...
- The @thugcrowd crew
- The SAE Cyberauto event
- The car hacking village
- Bugcrowd
- Rqu, Specters, Soups, Deker, Eiais, DocProfSky, Butterfli

- You know who you are

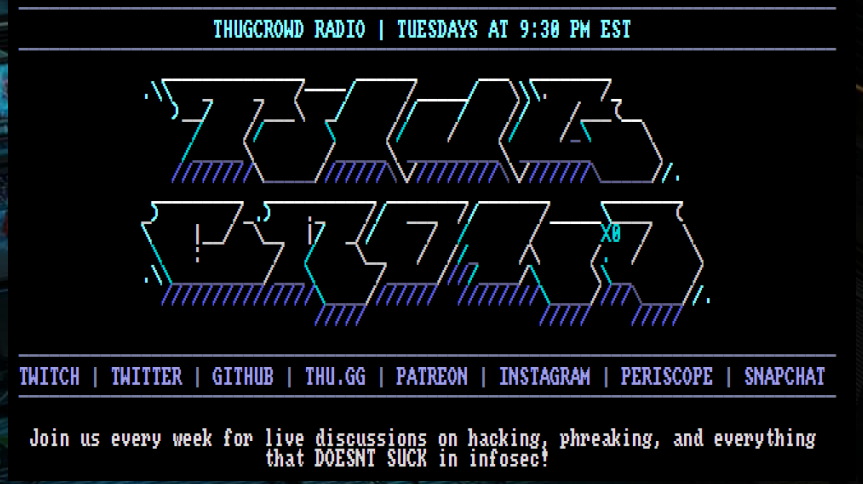




Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory

# Images

- https://commons.wikimedia.org/wiki/File:Arduino-uno-perspective-transparent.png
- http://pluspng.com/raspberry-pi-png-4298.html
- https://www.tp-link.com/us/support/faq/46/
- http://www.repeater-builder.com/motorola/gp68/gp68-overview.html
- https://fccid.io/M9MRDR6X8X/Label/FCC-ID-Label-1281984
- https://www.adafruit.com/product/954?gclid=EAIaIQobChMIzMfKnMiE5QIVTuDICh2RUg-jEAQYAiABEgKvyPD_BwE
- http://www.flupzor.nl/2015/04/30/root_on_ac750.html
- http://konukoii.com/blog/2018/02/16/5-min-tutorial-root-via-uart/
- https://www.pond5.com/stock-footage/10749013/zapping-exploding-electronic-circuit-board.html
- https://hackaday.com/2013/08/04/def-con-tamper-evidence-contests-and-embedded-talks/img_20130803_183741/
- https://blog.senr.io/blog/jtag-explained
- https://www.mattcarrier.com/post/hacking-the-winkhub-part-1/
- https://electronics.stackexchange.com/questions/79224/what-parts-would-one-typically-use-for-automated-pcb-testing
- https://www.allaboutcircuits.com/technical-articles/which-via-should-i-choose-a-guide-to-vias-in-pcb-design/
- https://components101.com/connectors/obd2
- https://www.polygon.com/2018/12/10/18134302/sigil-doom-sequel-john-romero-release-date-price
- https://www.agcnetworks.com/in/a-guide-to-choosing-the-right-firewall-2/

Image: http://www.bulldozer-vfx.com/portfolio/testing-laboratory