Bring Back the Bison!!!

IU’s longest-running mascot was the bison. Chosen in 1965, it was inspired by the bison on the state seal of Indiana.

The last time IU Football was in the Rose Bowl they were the IU Bison! (1968)

English Professor Paul Gutjar launched a campaign in 2021 to “Bring Back the Bison”, developing lots of merch for the student body in the process.

IU Student Government recently passing a bill called "Bring Back the Bison Act of 2024" to reinstate the bison as the official mascot.

Rumor has it…. There is a big mascot announcement coming.


THE BISON
ABIDES

Exam Metrics

Everyone did well.

Should the test be curved? 4 Yes, 2 No.

If you scored <90% see me after class.

Agenda/Announcements

Welcome back from Spring Break!!

Project 3 Releasing soon?

Easy day today - quick lecture on JTAG.

Next time, Physical Attacks.

Exam Scores posted. Exam review, maybe next week?

JTAG Security and Trust

JTAG

- Introduction to JTAG
- High-Level JTAG Exploits
- Popular JTAG Exploits
- Security Options

JTAG Introduction

- JTAG refers to IEEE Std. 1149.1, Standard Test Access Port and Boundary Scan Architecture

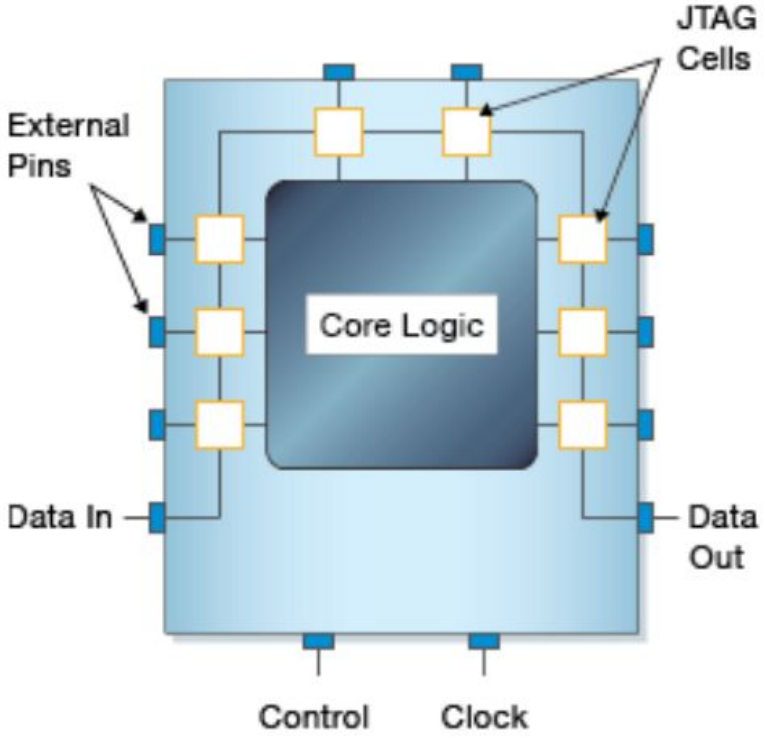
- Created in 1985 as a standard way to test and access hardware.

- IEEE Std. 1532, Boundary-Scan-Based System Configuration of Programmable Devices

- Initially adopted for testing hardware & peripherals. Eventually expanded to do so much more.

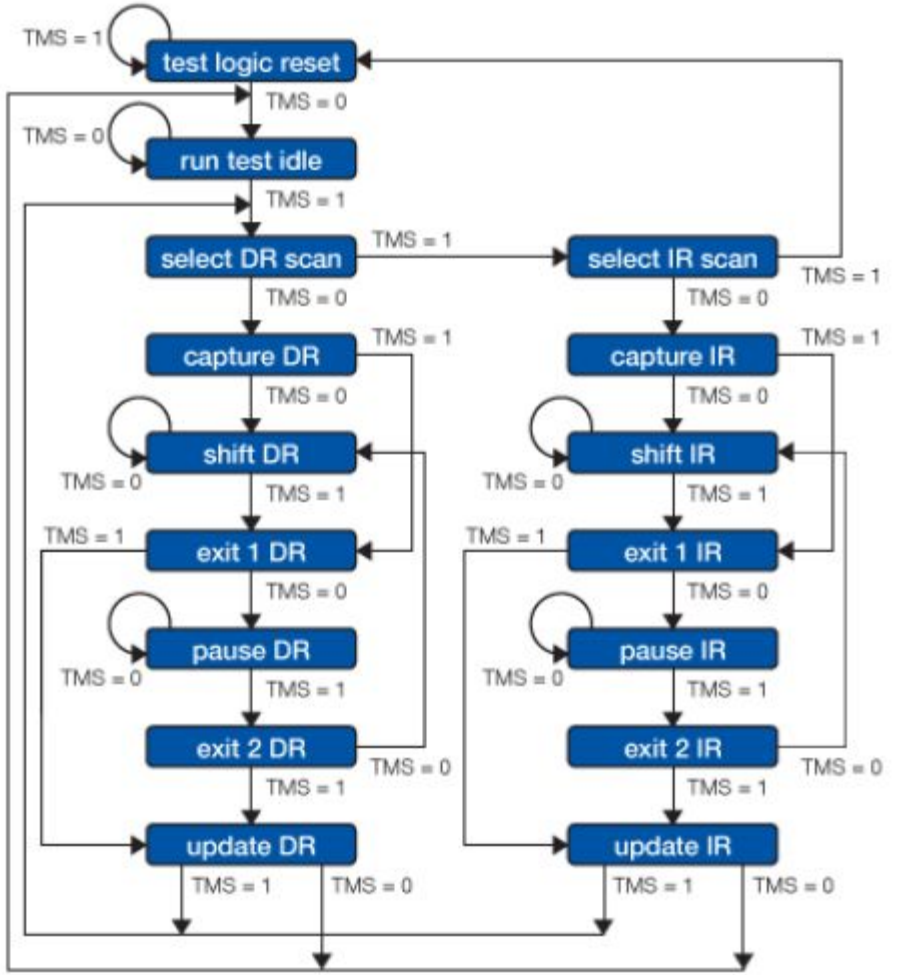
Goals / Benefits of JTAG

- Low Cost
- Inter-circuit testing without
- Increased fault detection cove
- Lower test time



Physical Components

- TAP
    - Test Access Port
    - Interprets JTAG protocol
    - Controlled by TMS signal
- BSR
    - Boundary Scan Registers
    - Between module and TAP



JTAG Control (Pins)

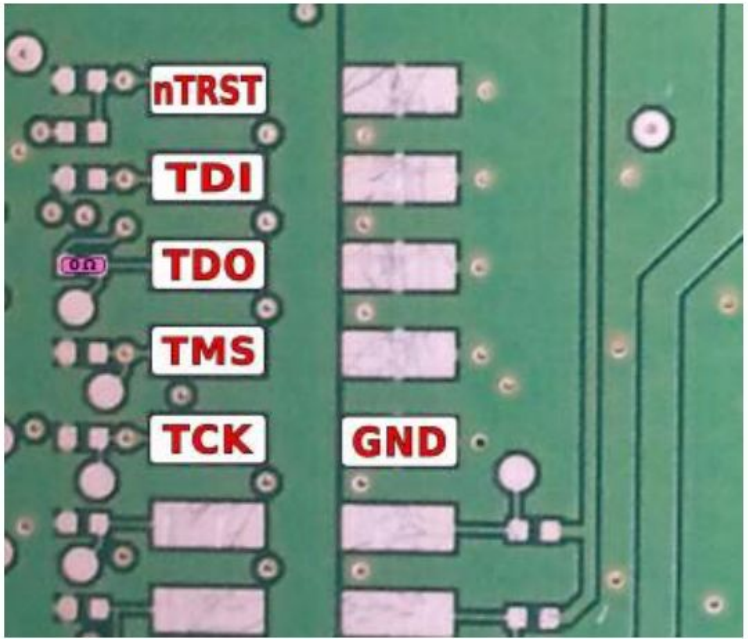
TDO: Test Data Output

TDI: Test Data Input

TMS: Test Mode Select

TCK: Test Clock

TRST: Resets TAP Controller



JTAG Modes

Bypass: Connects TDI to TDO

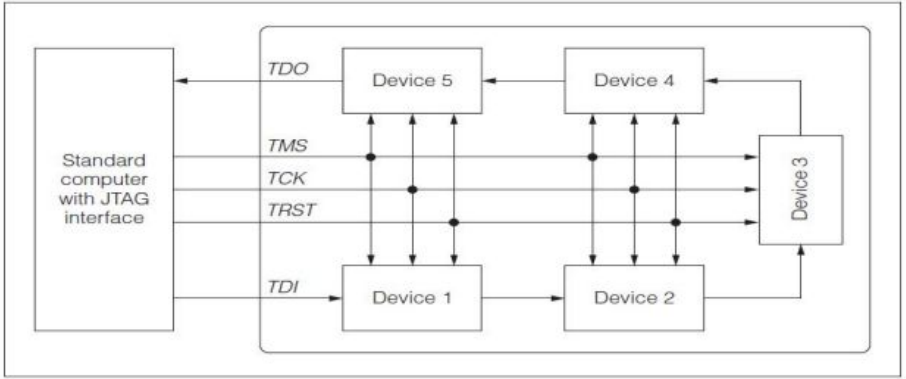
- One cycle delay

ExTest: Asserts data on output pins

- Reads data from input pins

InTest: Asserts data on input pins

- Reads data from output pins



JTAG Overview

JTAG Benefits

- Low Cost
- Ease of testing

Physical Components

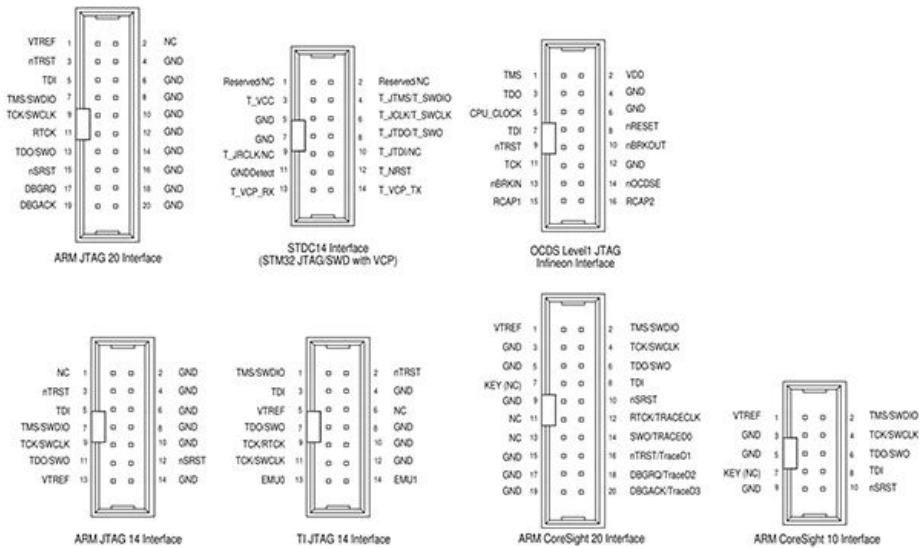
- TAP, BSR

JTAG Pins

- TDI, TDO, TMS, TCK, TRST

JTAG Modes

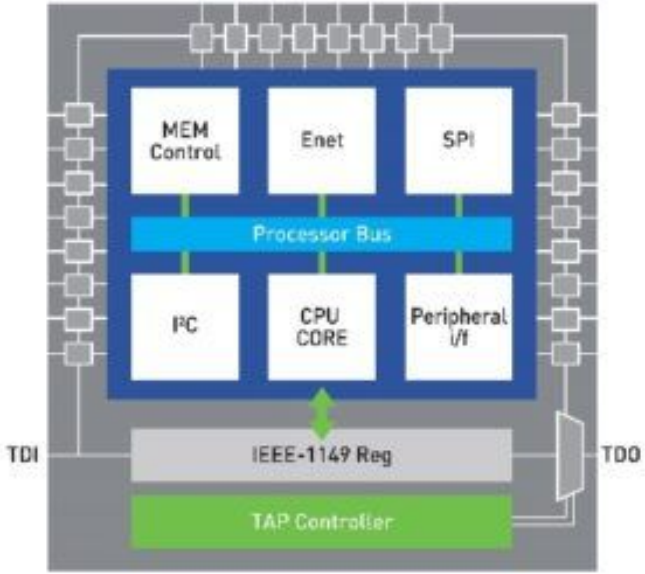
- Bypass, ExTest, InTest



Common Footprints.

What can you do with JTAG in today's world?

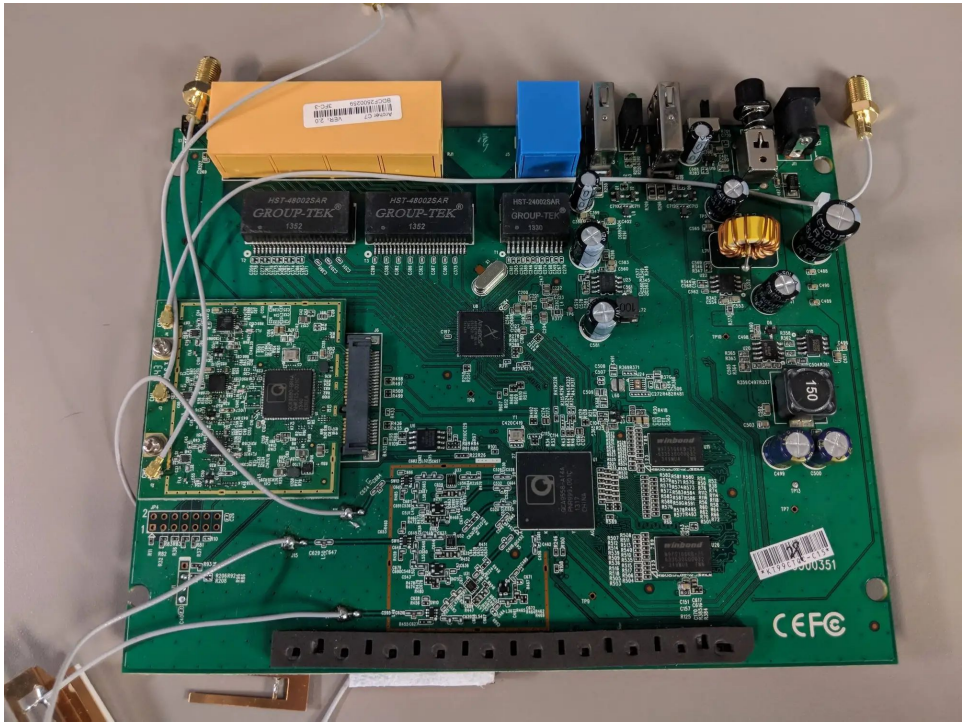
- Test Hardware
- Program Firmware
- Read Volatile and Non-Volatile Memory
- Debug?!
  - Set breakpoints
  - Access CPU/uControllers
- Set or program security sensitive material
  - Keys
  - EFuses
- Anything the designer implemented!



High Level JTAG Exploits

- Sniff TDI/TDO signals.
- Modify TDI/TDO signals.
- Control TMS and TCK signals.

Just gain control of the JTAG!!

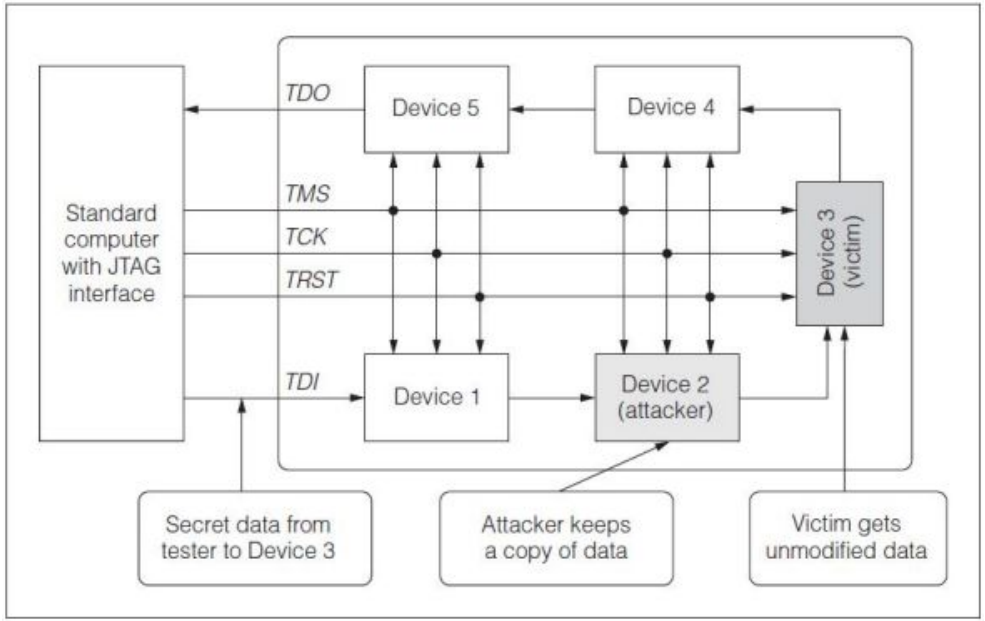


https://www.keysight.com/blogs/en/tech/nwvs/2022/02/24/hardware-reverse-engineering-hack-tp-link-ac1750-router-root-password-using-jtag

Sniff TDI/TDO Signals

Used to intercept secrets being sent to or from a chip.

Preceding or chip after victim chip behaves differently during bypass to intercept message.

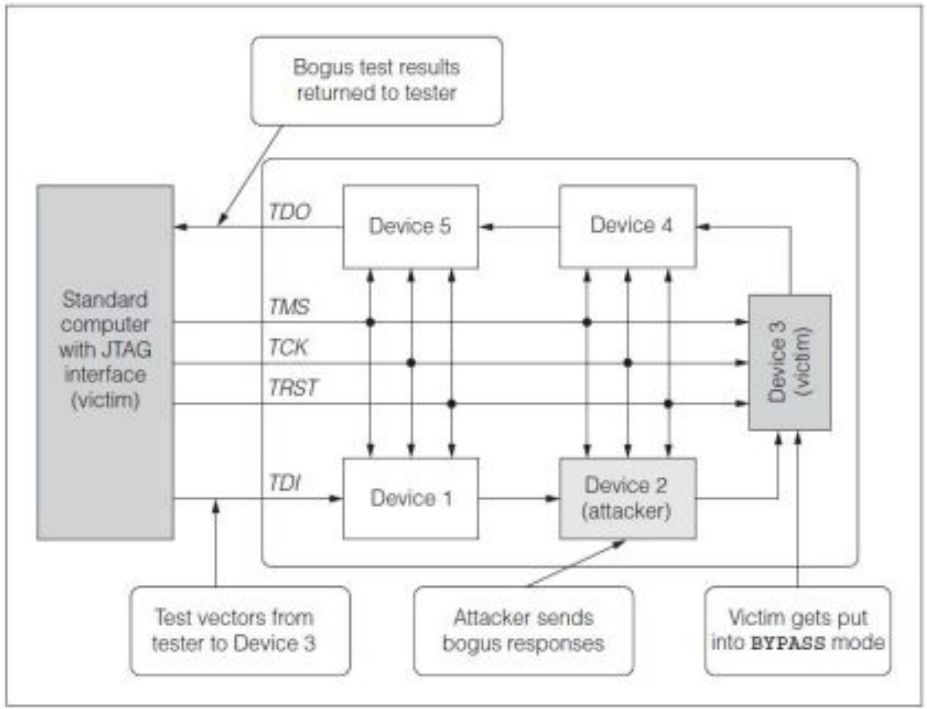


Modify TDI/TDO Signals

Can modify Test Vectors and Test Responses.

Can be used to fake correct or false tests.

Attacker can either be upstream or downstream of victim based on attack.



Control TMS and TCK Signals

For many exploits, TMS and TCK signals need to be controlled.

Attacker needs to be able to overpower.

The signal sent by TAP.

Attacking device needs to be able to force TMS and TCK above or below logic threshold voltage.

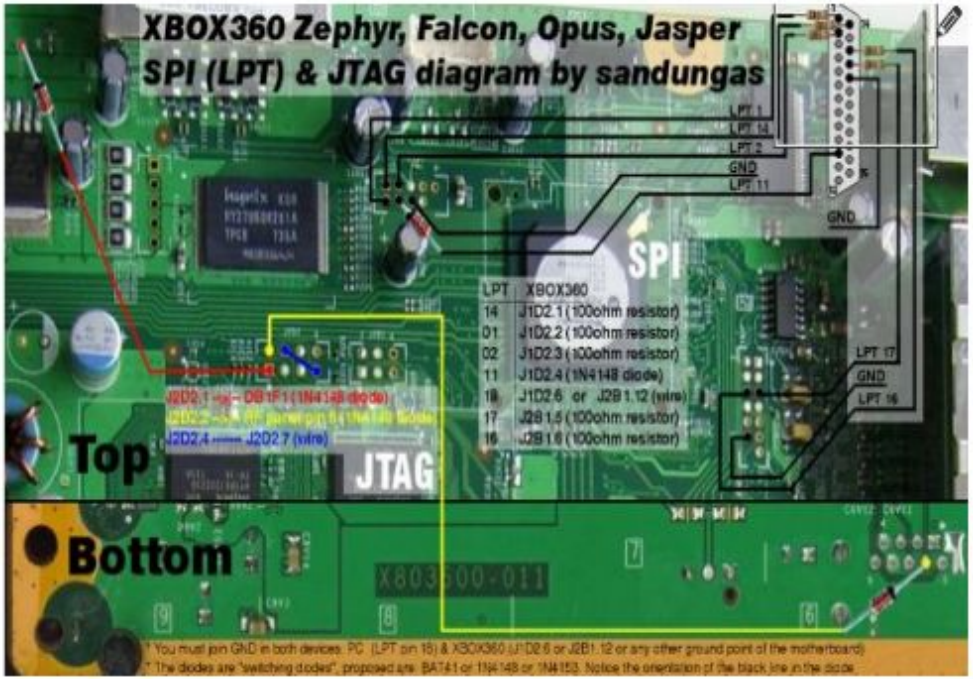
Can be done by combining lines to make a more powerful driver or using multiple attackers to overcome TMS and TCK signals

Xbox 360 JTAG Exploit

Used to override Microsoft security features

Allows homebrew code to be run, installation of HD, game modification, ripping of games.

JTAG is used to extract secret keys needed to perform exploits and to change programming



https://consolemods.org/wiki/Xbox_360:JTAG

Security Options

Buffers in the JTAG Chain n JTAG system connected in Star pattern instead of being chained(Separate TMS and TCK).

Encryption/Authentication for JTAG use

- Most of the research in JTAG security would be classified under this.
- Although it would provide much better protection, like all security hardware, increases cost and space.

Challenge / Response

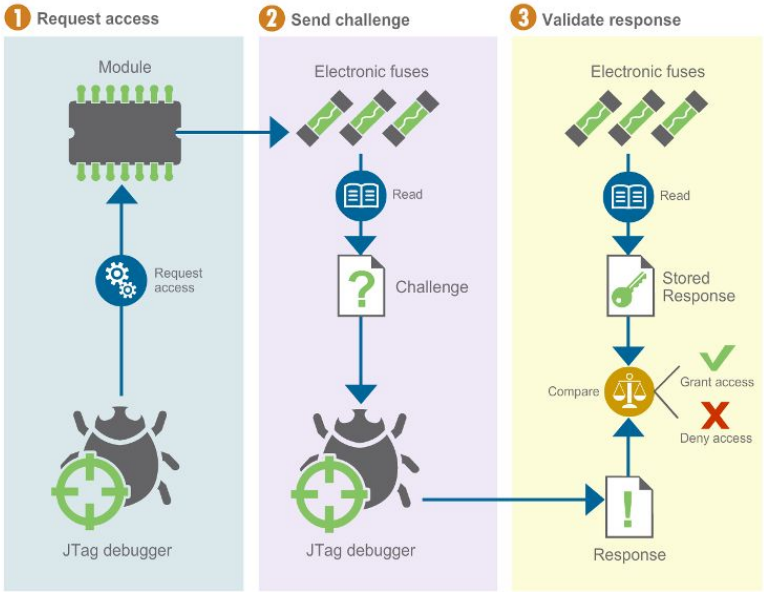
Requires PUF or randomly burned fuses.

Requires Set_Challenge and Get_Response instructions in JTAG implementation

A Challenge input is given to the JTAG module, and the module will hash this with the value of its fuses to create the response.

Only a known, trusted module will give a correct response.

So, can be determined if modules are trusted or not.



Public/Private Key Authentication

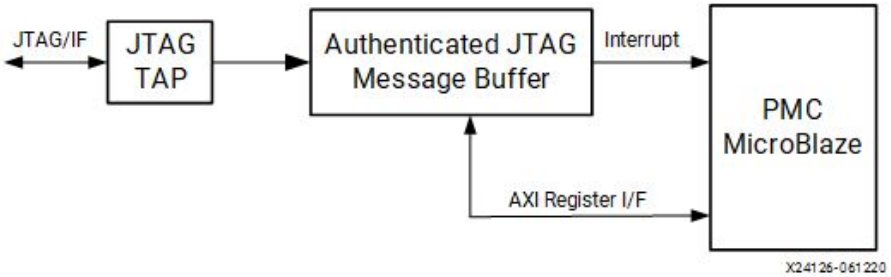
Tester/Updater is required to have a certificate of authentication signed by a designated third party.

Authenticators public key is known to JTAG system.

Using the known public key, the JTAG system can decrypt the certificate and determine whether the tester/updater is trusted.

Trusted testers/updaters are allowed access to JTAG system, un-trusted are blocked

Figure: Secure Enablement of JTAG Interface



User Permissions

A user permission level, N, allows them access to instructions with a level less than N.

Requires extra hardware to authenticate user and set permission level, and to save settings for what each permission level can and cannot do.

Ex. In memory, a permission level is saved for each module in the JTAG system. When that module is trying to be accessed, the saved level is compared to the current permission level

Removal / Destruction of JTAG

To completely defend against JTAG attacks, one thought is to remove the JTAG hardware all together.

- Does not leave a way to in-field test
- Can use BIST for testing.

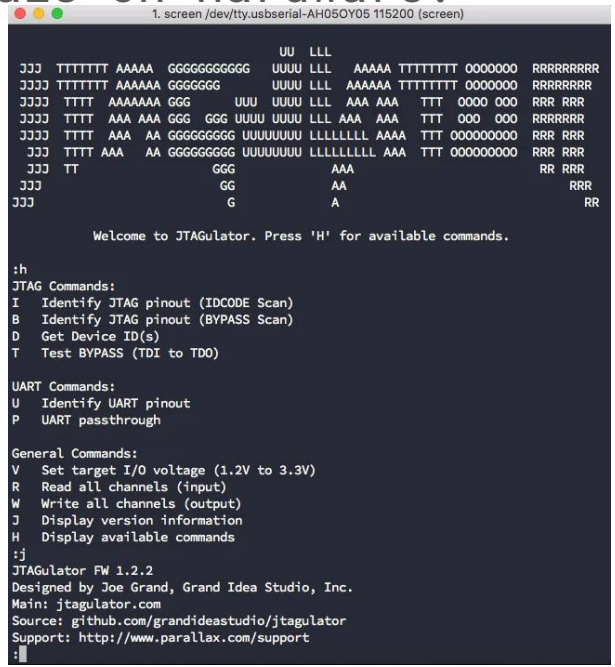
Similarly to removal of JTAG, some companies use security fuses to disable JTAG before the hardware leaves the factory.

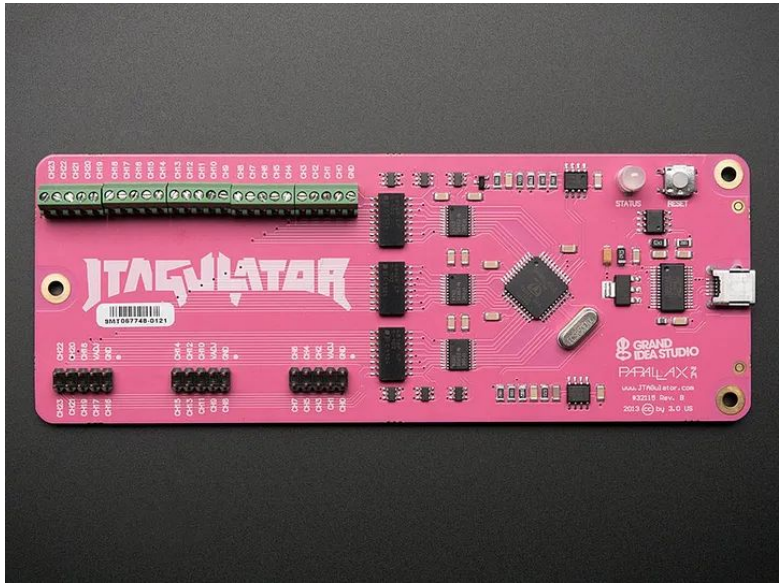
- Can implement different levels of disabled JTAG use

Any problems with this??

Modern Tools

JTAGulator: Embedded device to help you narrow down and find JTAG signals on hardware.





Modern Tools

OpenOCD: Open source software for interacting with JTAG. Can also be used to instrument a JTAG debugger.