



Embedded

FA2026 • 2026-08-31

Intro to Embedded Team

Nikhil, Swetha, Krishnan, Ryan

Nikhil Date

- Admin
- Computer Science
- Fact: I play the piano



Swetha Karthikeyan

- Admin & embedded lead in SIGPwny
- Senior in Computer Engineering
- Fun fact: I play the violin and used to be in the university orchestra



Krishnan Shankar

- SIGPwny Admin
- Computer Engineering '27
- Fun fact: I built my own bike



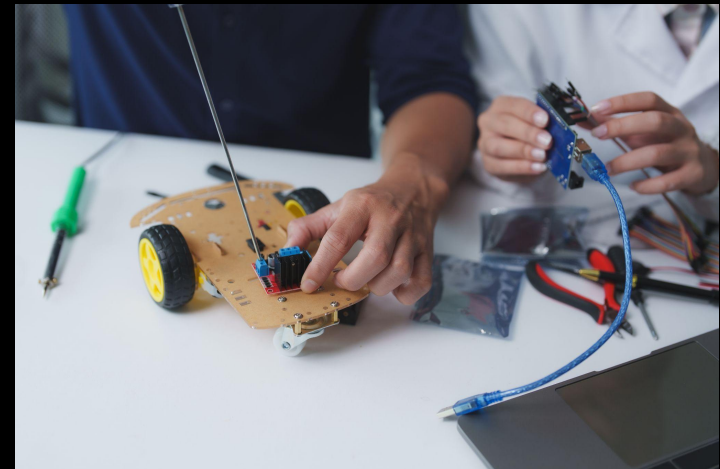
Ryan Yin

- SIGPwny Admin
- Computer Science '29
- Fun fact: I played mixed doubles badminton in high school



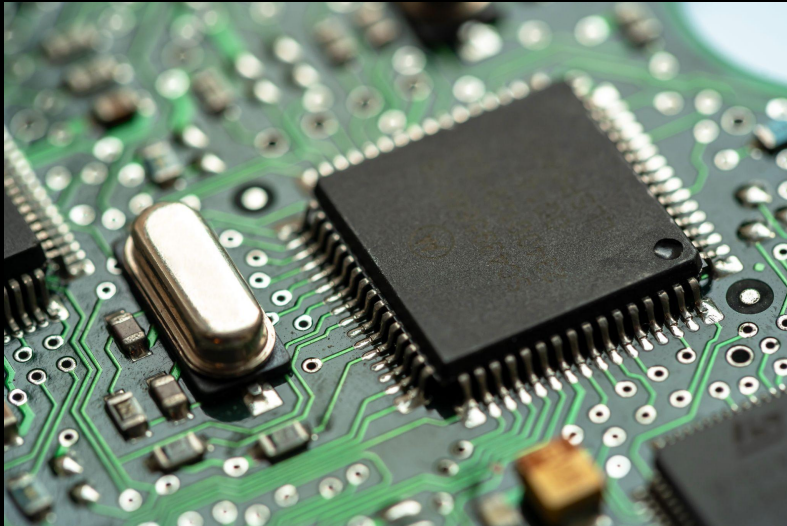
What is an Embedded System?

- Wikipedia: An **embedded system** is a specialized computer system—a combination of a computer processor, computer memory, and input/output peripheral devices—that has a dedicated function within a larger mechanical or electronic system.
- Examples:
 - Voting machines
 - Cars (entertainment system, vehicle controls)
 - Traffic lights
 - Security cameras
 - Insulin pump
 - Missiles
 - Any more?



What is an Embedded System?

- Common characteristics:
 - Part of a larger device
 - Interfaces with sensors
 - Actuates mechanisms
 - Often low-power, resource constrained (microcontrollers)



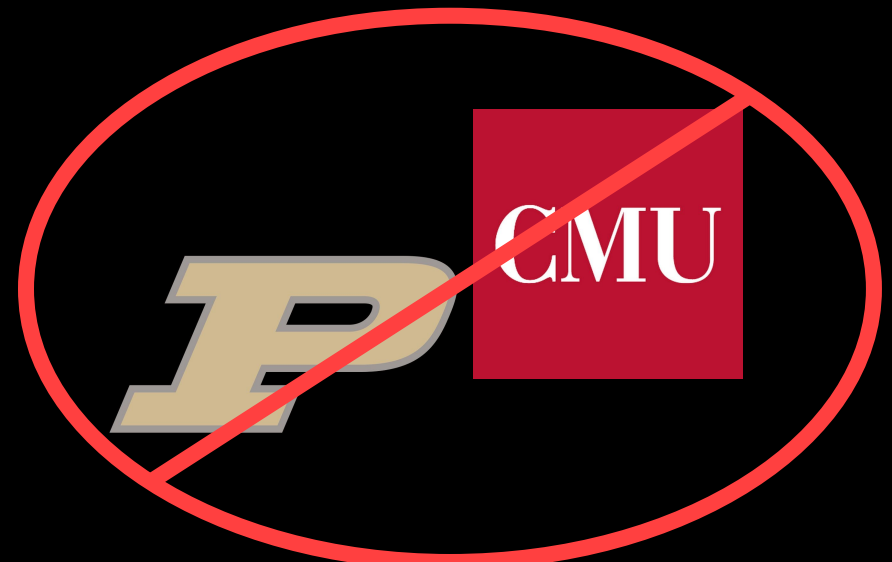
What is Embedded Team?

- We focus on security of embedded systems and IoT devices
- We are especially interested in the intersection of **hardware** and **software**
- We play competitions related to embedded security
- Sometimes, we do research or work on large development projects



Why join Embedded Team?

1. It's one of the best ways to learn about programming low level systems.
 - a. Embedded systems are tinier and usually much less complex than general computing systems, making it easier to build something from scratch
2. Learn how to apply the “adversarial mindset” in a completely new domain/field
3. Help us beat **Purdue** and **CMU**



Our Lab (Before)



Our Lab (After)



Planned Meetings

- Embedded 101: Fundamentals
- Embedded 102: Microcontroller Programming
- Embedded 103: Breadboarding and Hardware

- Secure Protocol Design
- Software Security
- Attacking “Secure” Protocols

- Side-Channel Attacks
- Firmware Security
- Fault Injection and Voltage Glitching
- Embedded Rust



CSAW Embedded Security Challenge

- Hosted by NYU
- Let us know if you're interested!
- [Home | CSAW](#)



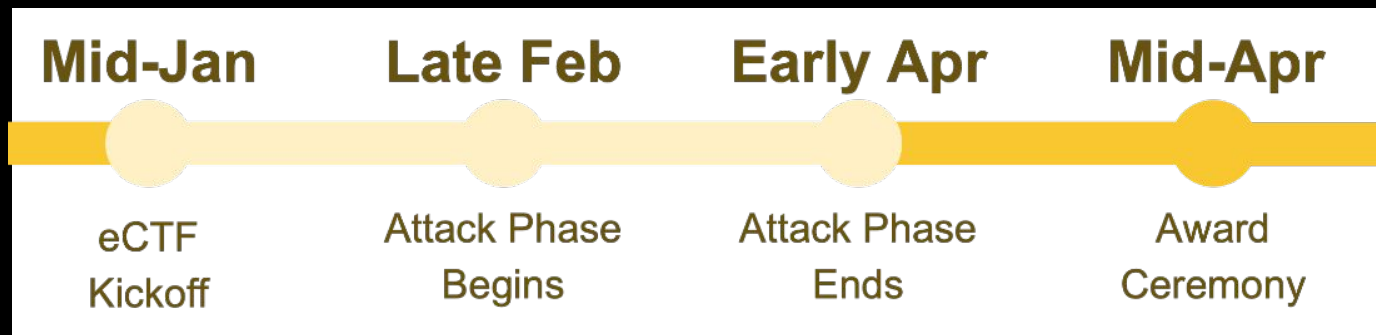
MITRE eCTF 2027

Starts in January 2027



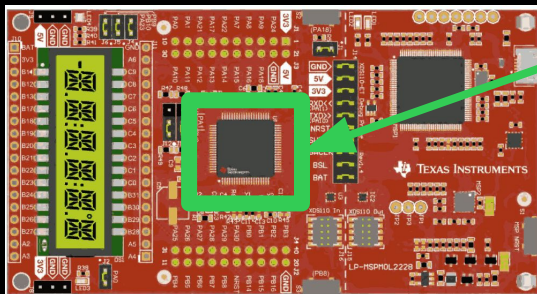
What is eCTF?

- **100+** high school and university teams participating
- Build a secure embedded device fitting the organizer's (MITRE) **functional** and **security** requirements
- Organizers verify **functional** requirements
- Teams earn points by breaking **security** requirements of competitors

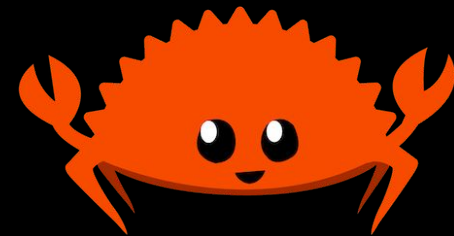


eCTF Design Phase

- **Goal:** convert organizer's requirements into a secure design
- First, specify protocol and cryptographic methods
 - Defense in depth: redundant security measures hedge against vulnerabilities
 - Carefully audit abstract design against requirements
- Next, implement the design
 - Many teams use **C**, we choose **Rust** for its safety
 - The concrete design must be secure in **software** and **hardware**
 - Other teams will attack your design and have **hardware** access

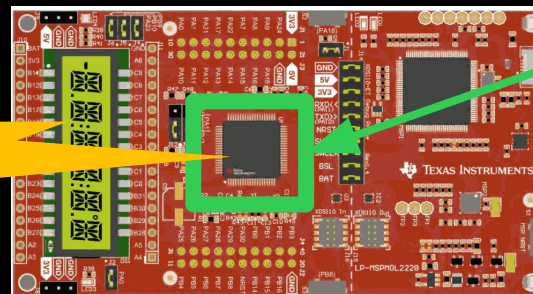
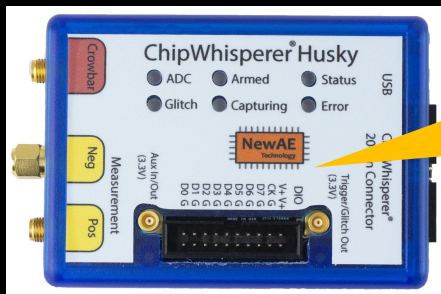


Your code runs here



eCTF Attack Phase

- **Goal:** break the **security** requirements
 - Points are awarded roughly per each requirement compromised
 - A single vulnerability may compromise many or all requirements
- Some creativity is required: a lot is in scope
- Typical C unsafety (buffer overflow, integer overflow)
- Bad crypto (padding oracle, ECB use, CBC manipulation)
- Timing side-channel (**memcmp**)
- Hardware attacks (fault injection, power analysis)



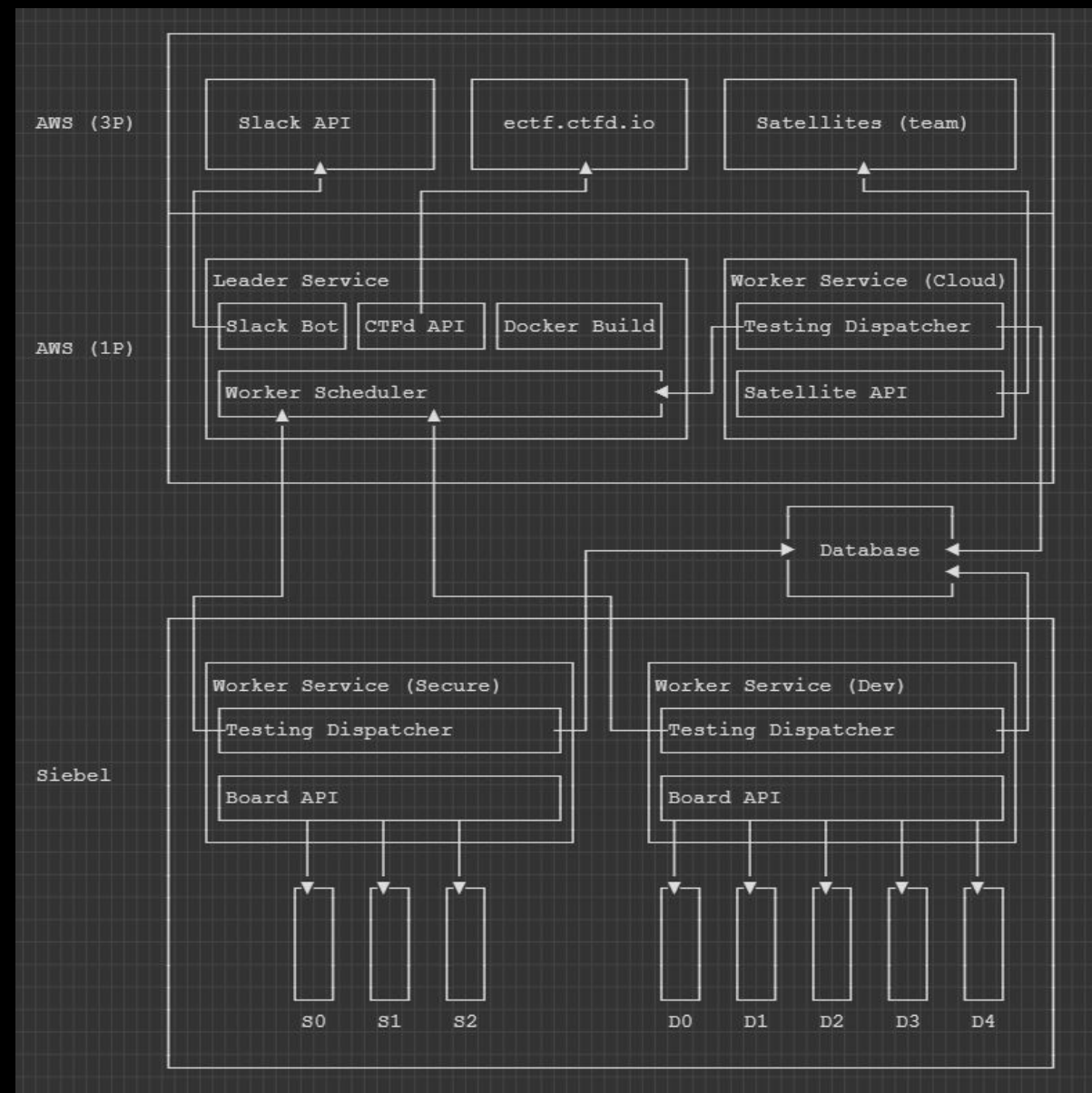
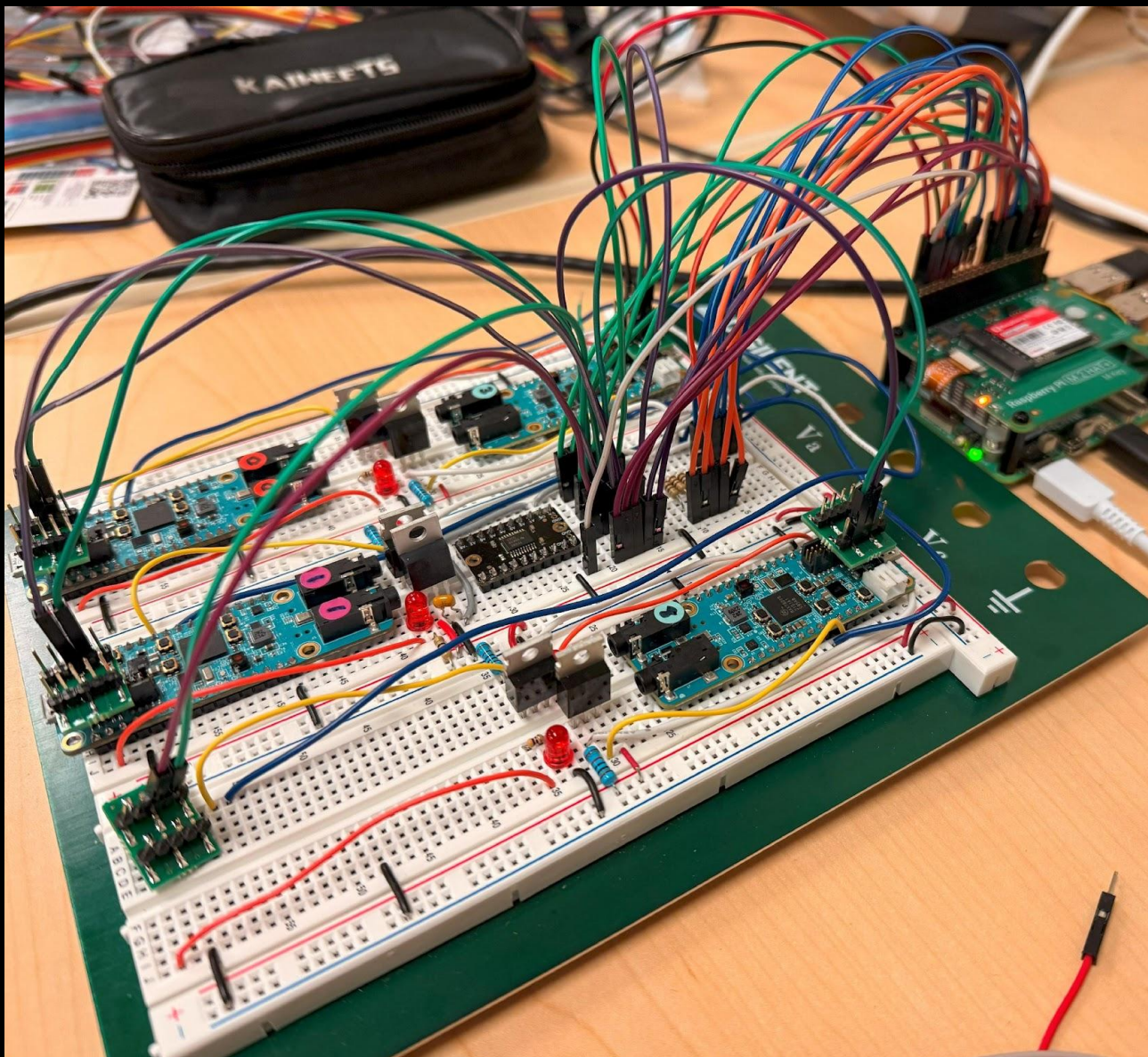
Other teams' code runs here too



Previous Competitions

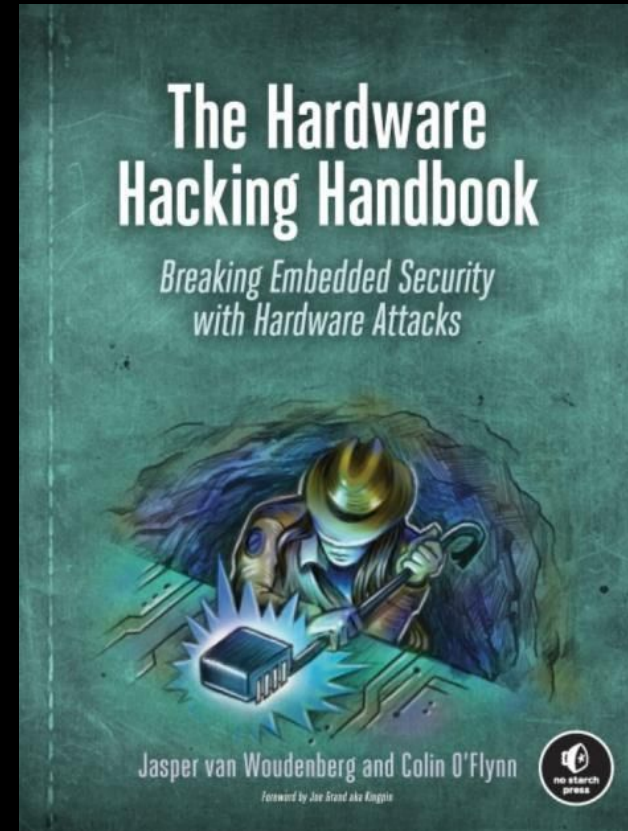
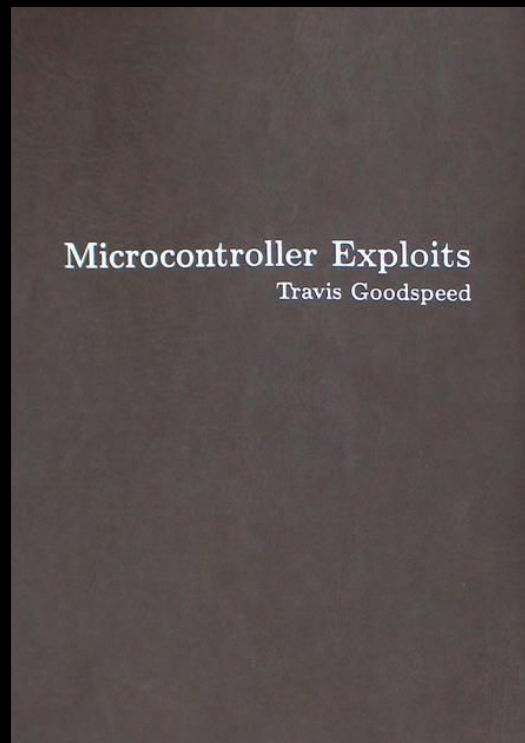
- **2023:** Car lock system
 - Key fob securely unlocks the car
 - Car DLC: upgrades enabled by manufacturer-provided package
- **2024:** Medical device
 - Modular system that authenticates components
 - Supports component replacement
 - Secure communication between parts
- **2025:** Satellite TV
 - Several channels which broadcast frames publicly
 - Boxes may decode frames only for a channel and time which is encoded in a subscription package
- **2026:** Secure HSM
 - Save files to them and ensure they can't be stolen





Cool Readings

- “Microcontroller Exploits” by Travis Goodspeed
- “The Hardware Hacking Handbook” by Jasper van Woudenberg and Colin O'Flynn



Other Resources

- MITRE EMB3D framework: <https://emb3d.mitre.org/>
 - Threat modeling framework for embedded systems
 - Think of it as a “checklist” to see what areas you need to consider for security



ECE OpenLab & Rep Role

- We have a lot of equipment we use for our labs & eCTF → using storage space in OpenLab: [ECE Openlab | Home](#)
- Interested in OpenLab and being our rep? Come talk to Swetha or DM on Discord



Next Meetings

2026-09-14 • Monday (skipping next week bc Labor Day)

- Embedded 101: Fundamentals
- Learn about the components of an embedded system and why security matters!



Meeting content can be found at
sigpwny.com/meetings.

