



ORSETO MELETO

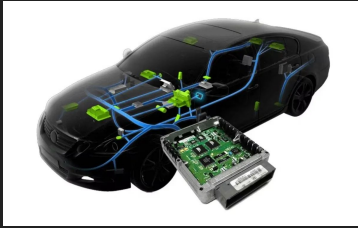
# MITRE embedded Capture the Flag (eCTF)

embedded cybersecurity competition



# What are Embedded Systems?

An embedded system is a **purpose-built** combination of hardware and software designed to **perform a dedicated function**.



Car ECU



Thermostat



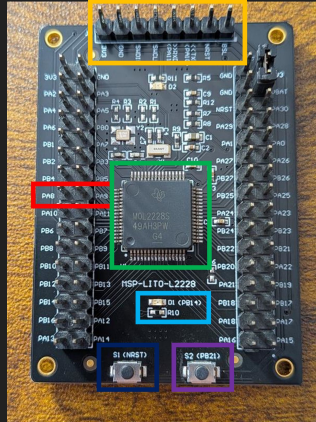
Router

- May run **bare-metal** (no Operating System) or with a lightweight RTOS
- Firmware is tailored to a specific task
- Must meet strict requirements (like performance, memory usage, etc.)

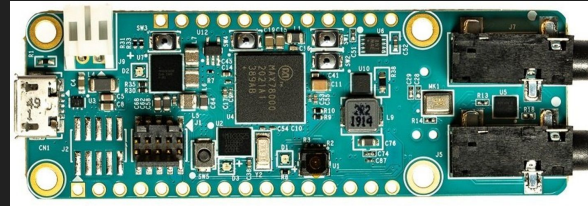
# What is MITRE eCTF?



- A semester-long embedded cybersecurity competition (~3 months)
- Students design and attack real embedded systems
- Focuses on hardware + firmware security



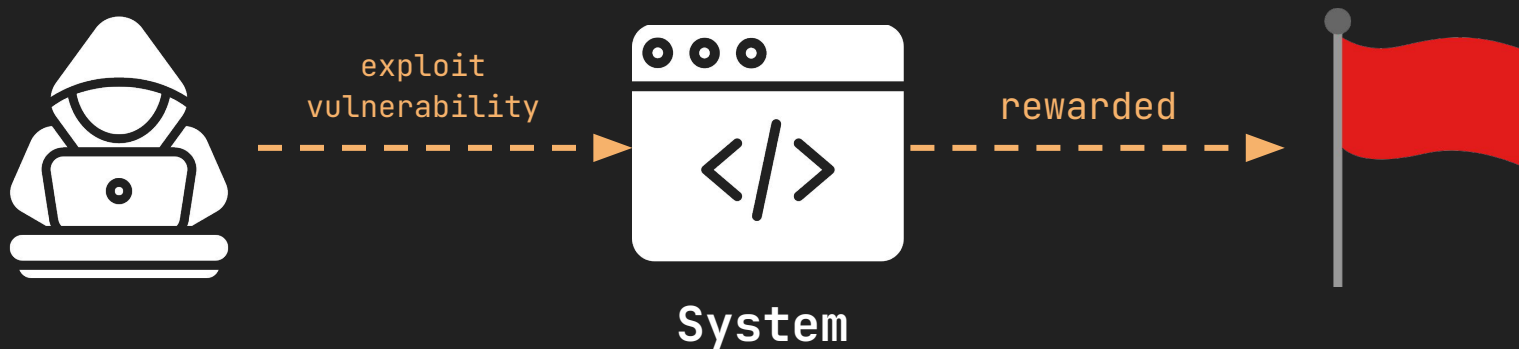
2026 Hardware



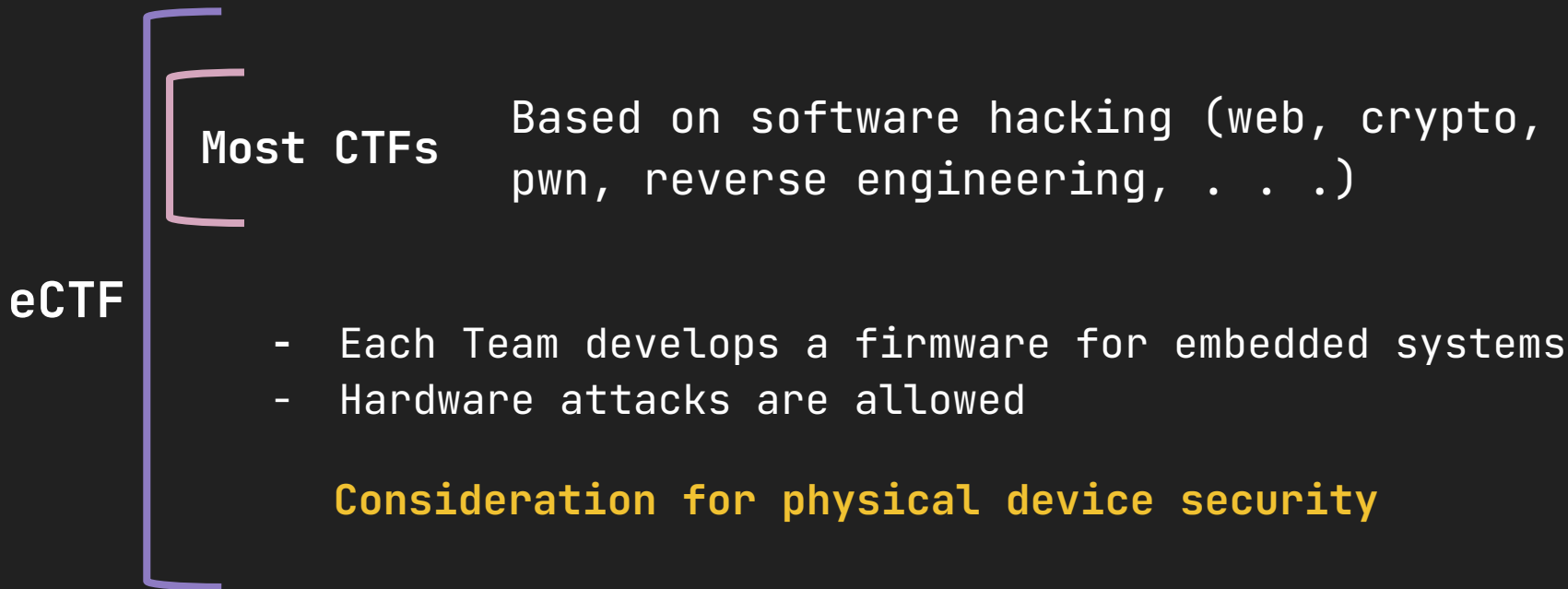
2025 Hardware

# What is a "CTF"?

A Capture The Flag (CTF) is a cybersecurity competition where participants solve security challenges to find hidden strings called **flags**.



# What makes eCTF different from CTFs



# How the competition works

2 Main Phases (~1.5 months each)

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From ~Mid January to ~Mid April



## **Design Phase**

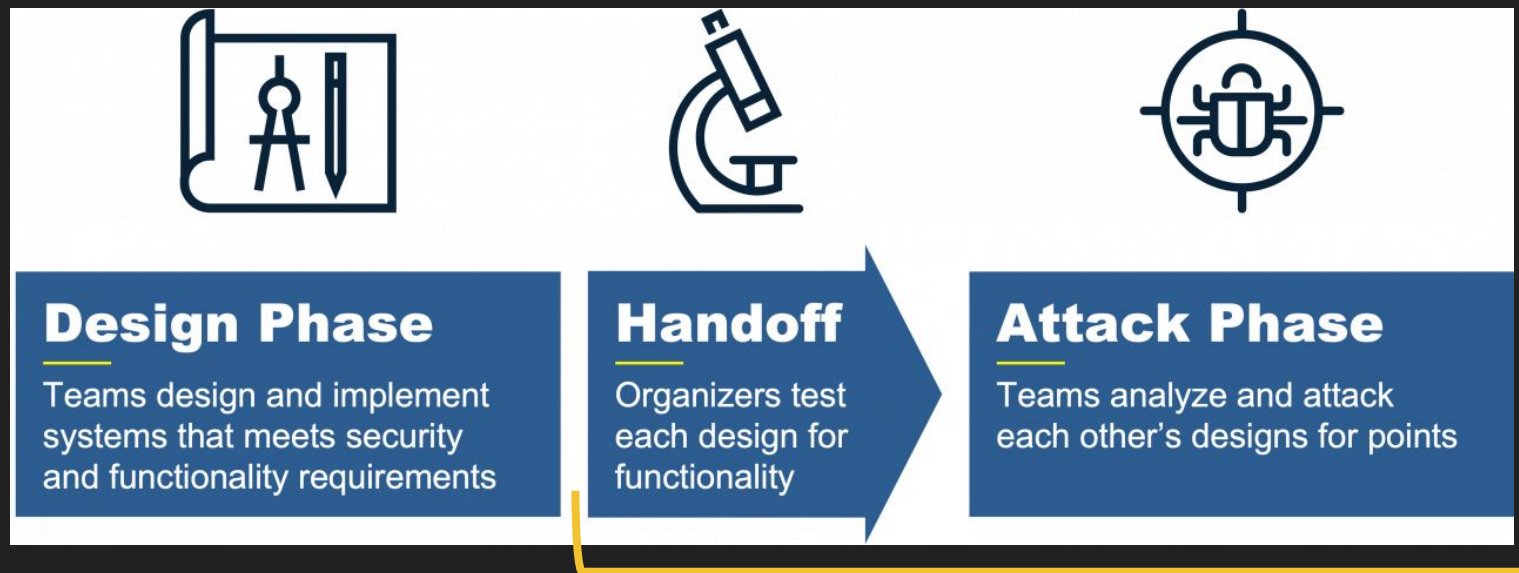
Teams design and implement systems that meets security and functionality requirements

Flag scenarios are provided, each describing how it can be captured

# How the competition works

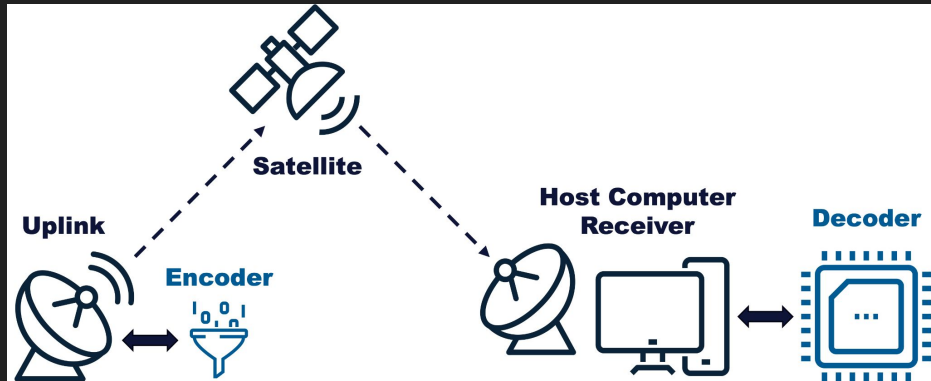
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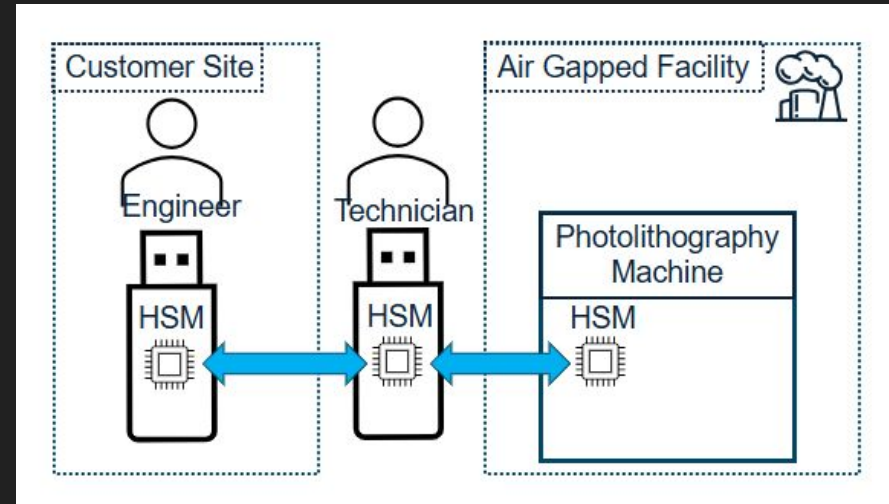


# Previous years systems overview

## 2025 – Satellite TV System

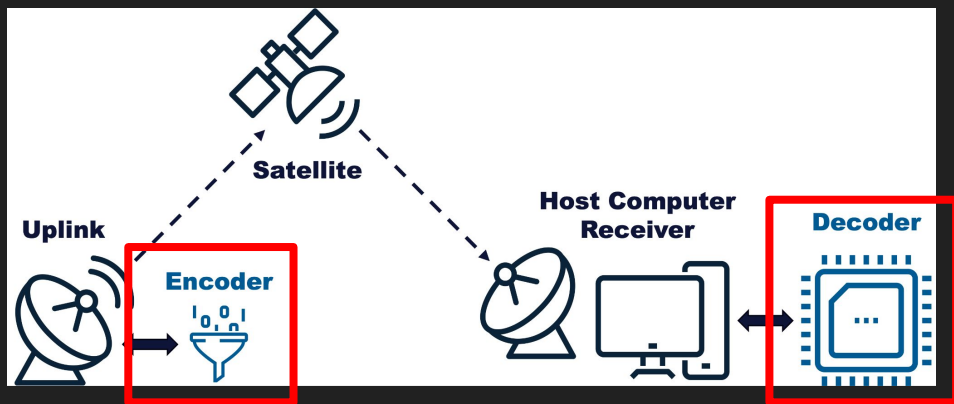


## 2026 – Secure Chip Foundry Storage

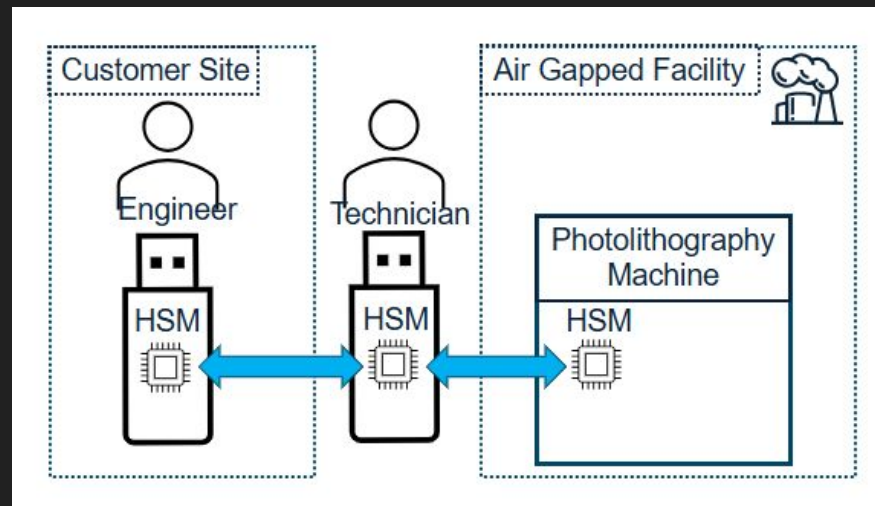


# Previous years systems overview

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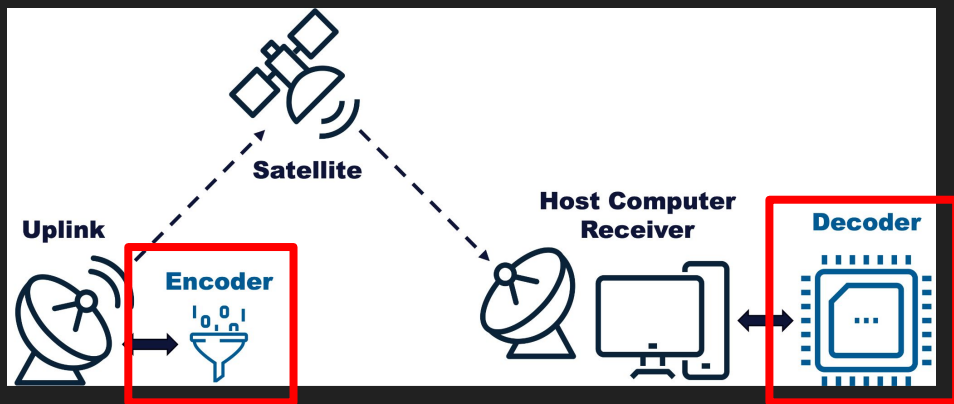


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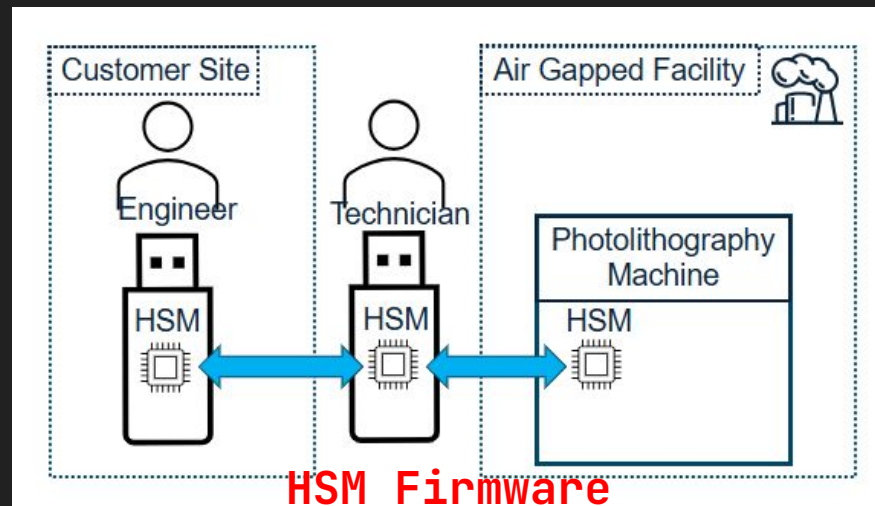


# Previous years systems overview

## 2025 – Satellite TV System



## 2026 – Secure Chip Foundry Storage



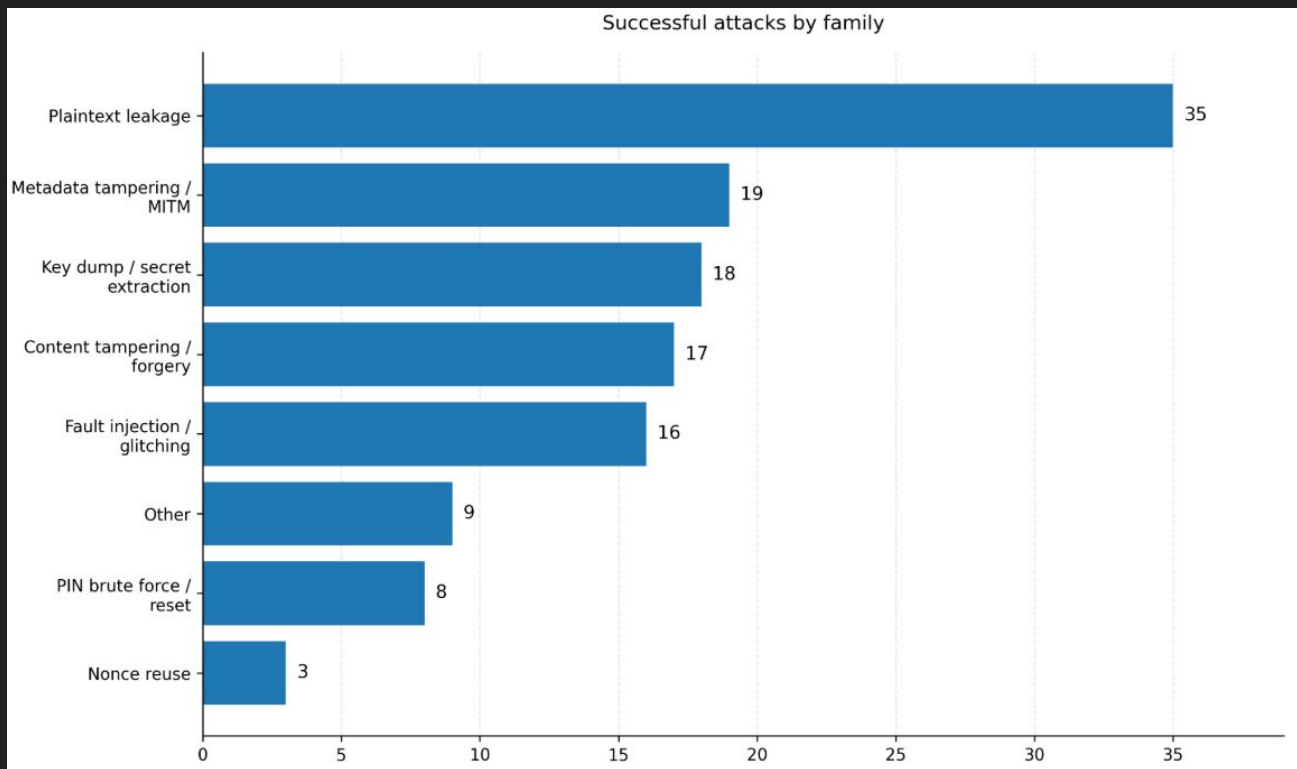
# Attack phase overview

Chance to perform both

Software attacks

Hardware attacks

# Attack phase overview



2026 successful attacks by category

# Attack phase overview



Looks scary, doesn't it?

You'll figure it out.

Probably...

# Infrastructure



In 2026, we built a remote server  
to develop and run attacks

**It may not be pretty, but it  
works.**

Automation is possible, depending on  
challenge rules and constraints

# Why should you join?

- Learning (I know... it's university)
- Hands-on experience with real hardware
- Build and break real systems
- See how others solve the same problems (sometimes... questionably)
- Make fun of Americans
- You get to compete with people all around the globe
- Did I mention making fun of Americans?
- I'm serious, you can't imagine the code we've read.

# Who Can Join & How?

- University students (you can get CFUs)
- Basic knowledge in at least one of the following:
  - Embedded systems
  - Cyber security (preferably CTFs)
  - Hands-on electronics / hardware work

Contact prof. Bruno Crispo ([bruno.crispo@unitn.it](mailto:bruno.crispo@unitn.it))

- Include in CC Luigi Dell'Eva ([luigi.delleva@unitn.it](mailto:luigi.delleva@unitn.it))

# eCTF Results: 2025-2026

## 2025 Scoreboard

| Rank | School                                  | Score  | Position Change |
|------|-----------------------------------------|--------|-----------------|
| 1    | Carnegie Mellon University              | 58,030 | 0               |
| 2    | Purdue University                       | 19,420 | 0               |
| 3    | University of Michigan                  | 19,112 | 1               |
| 4    | City College of San Francisco           | 18,970 | -1              |
| 5    | University of Illinois Urbana-Champaign | 17,710 | 0               |
| 6    | The Ohio State University               | 16,611 | 2               |
| 7    | Indian Institute of Technology Madras   | 16,394 | -1              |
| 8    | University of California, Los Angeles   | 16,332 | -1              |
| 9    | Mountain View High School               | 14,302 | 1               |
| 10   | United States Air Force Academy         | 13,755 | 2               |
| 11   | Massachusetts Institute of Technology   | 13,657 | 0               |
| 12   | University of South Alabama             | 13,642 | -3              |
| 13   | University of Trento                    | 13,428 | 0               |
| 14   | Brigham Young University                | 12,173 | 0               |
| 15   | University of California, Santa Cruz    | 10,350 | 1               |
| 16   | University of Connecticut               | 10,215 | 1               |
| 17   | Baldwin Wallace University              | 10,068 | -2              |
| 18   | Northeastern University                 | 8,715  | 2               |
| 19   | University of Washington                | 8,544  | 0               |
| 20   | Georgia Institute of Technology         | 8,377  | -2              |
| 21   | Michigan State University               | 8,175  | 0               |
| 22   | Johns Hopkins University                | 7,471  | 0               |
| 23   | Purdue University                       | 7,087  | 0               |
| 24   | Parkway Spark!                          | 6,677  | 0               |
| 25   | New York institute of Technology        | 5,753  | 0               |
| 26   | Ecole Royale de l'Air                   | 5,635  | 1               |

## 2026 Scoreboard

| Rank | School                                  | Score  | Change |
|------|-----------------------------------------|--------|--------|
| 1    | Carnegie Mellon University              | 55,004 | 0      |
| 2    | University of California, Santa Cruz    | 46,664 | 0      |
| 3    | Indian Institute of Technology Madras   | 45,130 | 0      |
| 4    | University of Illinois Urbana-Champaign | 40,282 | 0      |
| 5    | City College of San Francisco           | 29,424 | 0      |
| 6    | University of Michigan                  | 25,128 | 0      |
| 7    | University of Trento                    | 22,969 | 0      |
| 8    | Ecole Royale de l'Air                   | 19,777 | 0      |
| 9    | Purdue University                       | 16,606 | 0      |
| 10   | Brigham Young University                | 14,186 | 0      |
| 11   | People's Education Society University   | 13,864 | 0      |
| 12   | East Tennessee State University         | 13,811 | 0      |
| 13   | Binghamton University                   | 12,375 | 1      |
| 14   | University of Luebeck                   | 12,290 | -1     |
| 15   | University of Denver                    | 10,941 | 0      |
| 16   | Dakota State University                 | 9,981  | 1      |
| 17   | The Ohio State University               | 9,890  | -1     |
| 18   | Tufts University                        | 8,853  | 1      |
| 19   | Tennessee Tech University               | 8,204  | -1     |
| 20   | Case Western Reserve University         | 8,052  | 0      |
| 21   | The Pennsylvania State University       | 7,258  | 1      |
| 22   | University of Dayton                    | 7,144  | 1      |
| 23   | People's Education Society University   | 6,725  | -2     |
| 24   | Gdańsk University of Technology         | 6,561  | 0      |
| 25   | Colombe academy of Technology           | 6,483  | 1      |
| 26   | Oklahoma Christian University           | 6,266  | -1     |

# Questions?

# References

- About the eCTF - <https://rules.ectf.mitre.org/about/index.html>
- What is an Embedded System? - <https://reboundeu.com/insights/blog/what-is-an-embedded-system/>