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Teaching Offensive and Defensive Cyber Security in Schools using a Raspberry Pi Cyber Range

UWEcyber Gold Award

in association with
National Cyber Security Centre

Department for Digital, Culture, Media & Sport

Academic Centre of Excellence in **Cyber Security Education**

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Overview

1. Problem statement

2. Proposed Pi Lab environment

3. Use case for teaching

4. Discussion and Conclusion

Problem Statement

- We hosted a set of teacher workshops to best understand the challenges they face, and to co-create practical teaching materials.

- Teachers remark on lack of time, lack of resources, and in some cases, lack of confidence.

- Constrained by curriculum demands that do not allow time to explore topics in sufficient detail with clear practical examples.
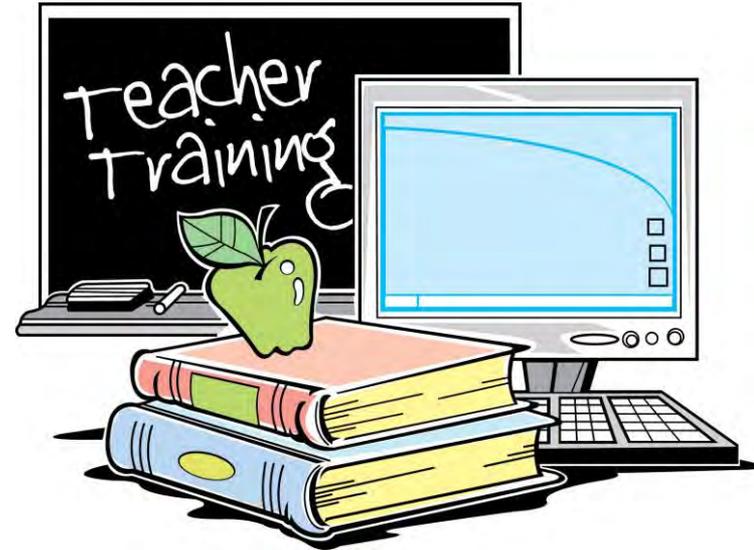
Problem Statement

- **Can we provide a "starting block" for** teachers to build from, to develop their own practical teaching resources?

- Can we support this at multiple levels of teacher confidence?
  - A low confident teacher may just **want the prepared "starting block".**
 - A high confidence teacher could extend this much further.
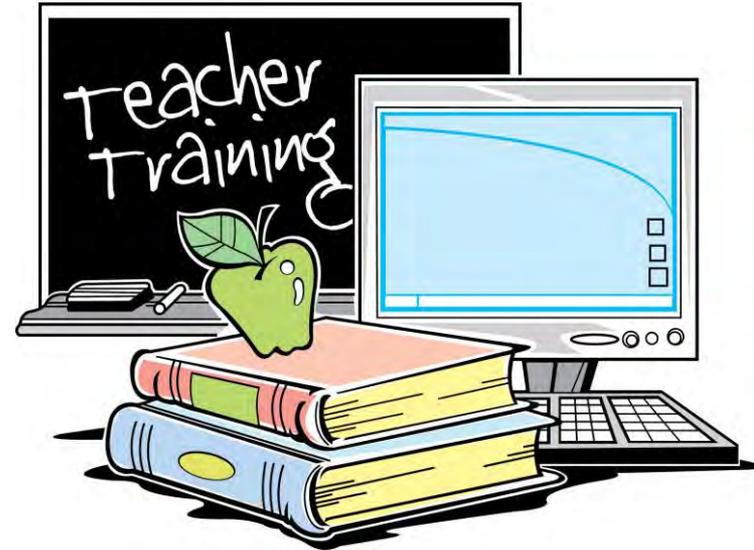
UWEcyber Pi Lab

- Portable solution - not reliant on any school infrastructure

- Single and multiple machine setup **–** can be used for individual and group learning

- Easy to rebuild **–** a safe environment to tinker without fear

- Cost-effective **–** RPi4 starts approx. $35

- Networked **–** pre-configured for RPi access point for offensive/defensive exercise.

Wireless Access Point PiLab Image
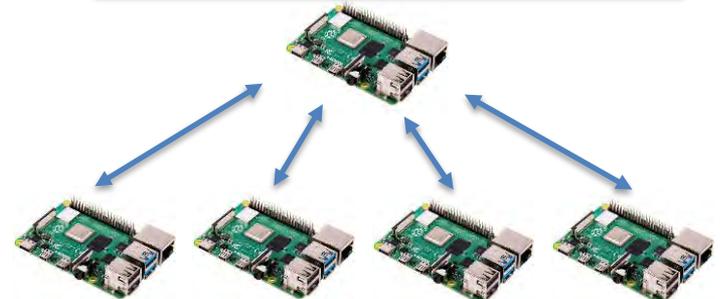
Multiple Student PiLab Images

UWEcyber Pi Lab – Pre-install

- We pre-configure the PiLab with existing tools:
  - Kali Linux is the base OS for UWEcyber PiLab image
  - Docker container deployment
  - **"OWASP Juice Shop" container**
    - Suitable for demonstrating Injection and Brute Force attacks
  - **"CTFd" container**
    - Enable student competitions on Juice Shop
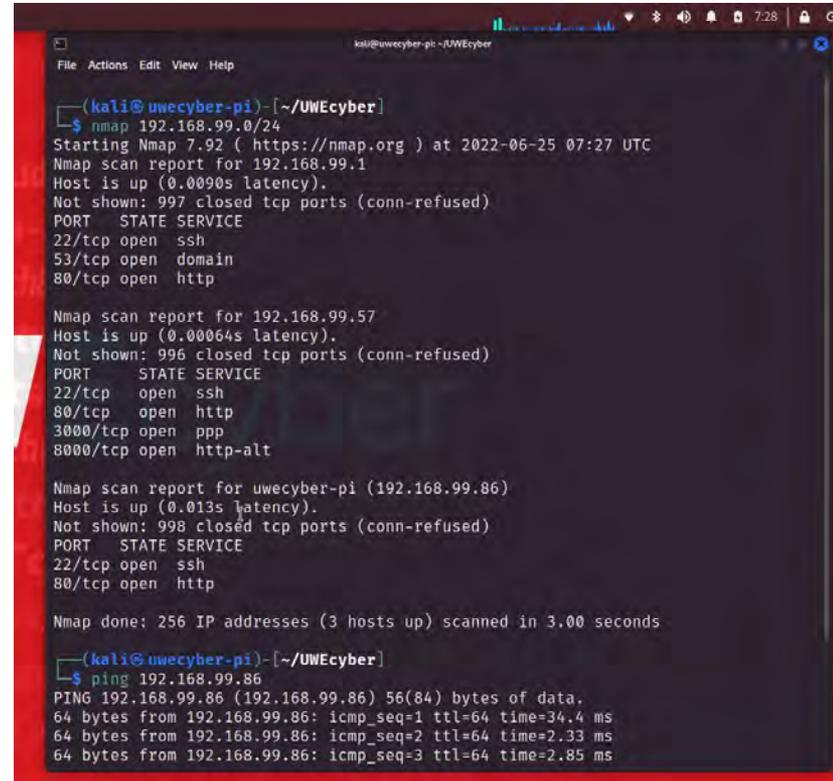 - Burp Suite and other additional tools
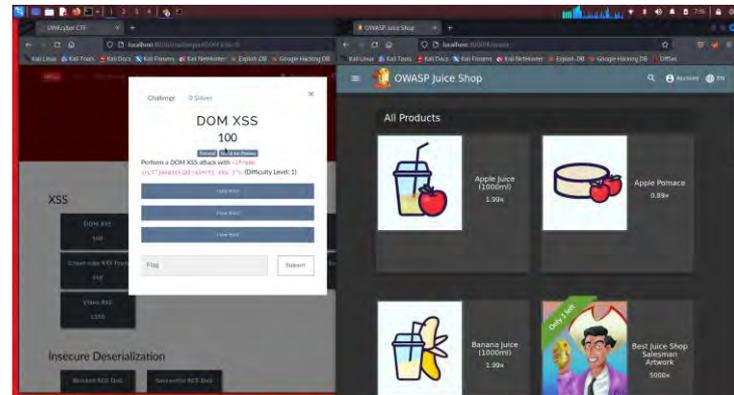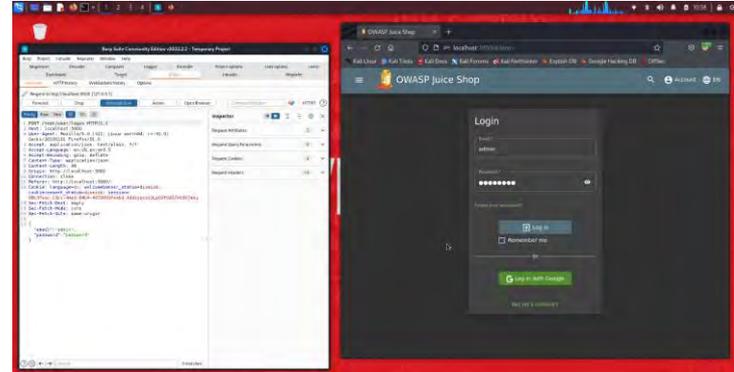
Multi-machine case study

- What about a multi-machine use case?

- We provide a simple case study that teachers can follow as part of a structure lesson on offensive and defensive security

Wireless Access Point PiLab Image

Multiple Student PiLab Images
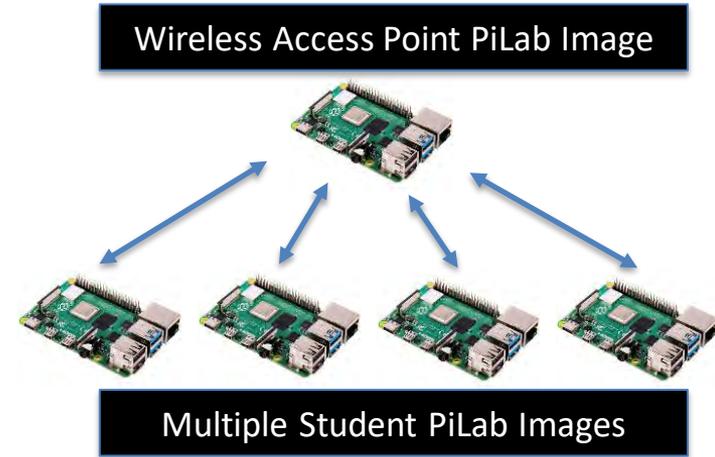
Multi-machine case study

- Nmap (Network Mapper)
  - Students can scan the network to identify other connected devices, and to uncover what service ports are available on these devices.

  - Teacher may have allocated an **attacking "red" team, and a defensive "blue" team for the purpose of the** directed activity.
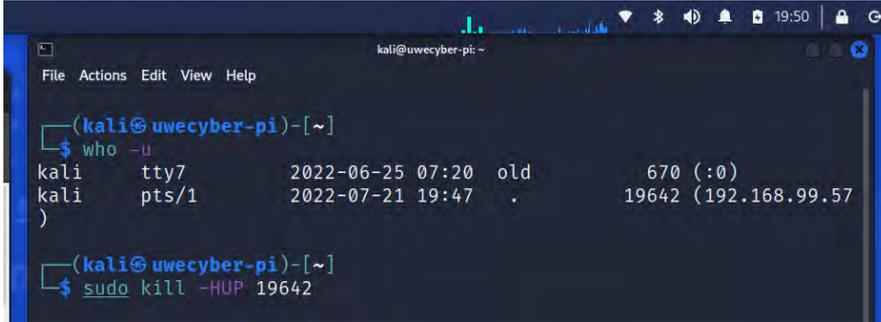
Multi-machine case study

- Remote Access and Defacement Attack
  - All devices begin with the default kali:kali credentials.

  - Initial reconnaissance scan can be used to identify the web server running on each PiLab device.

  - Attacking team can try to **"deface"** the website of the defensive blue team by gaining access via SSH, and modifying the index.html page being served.
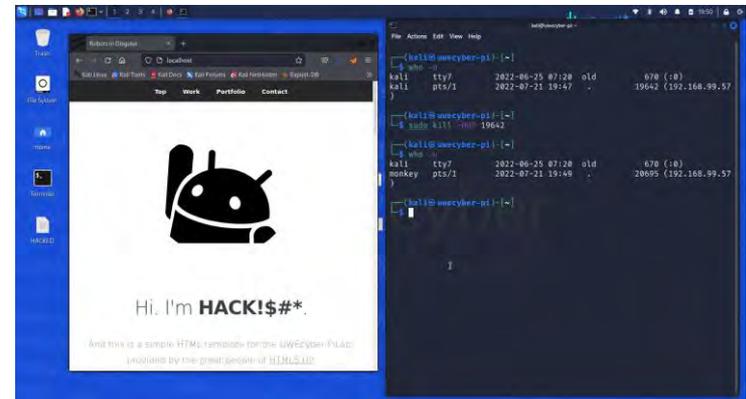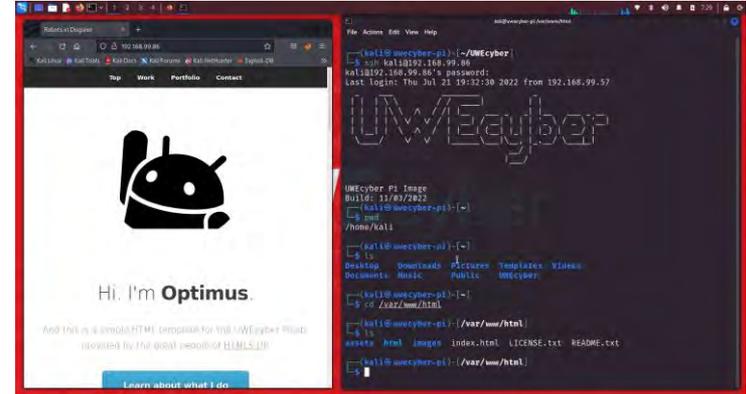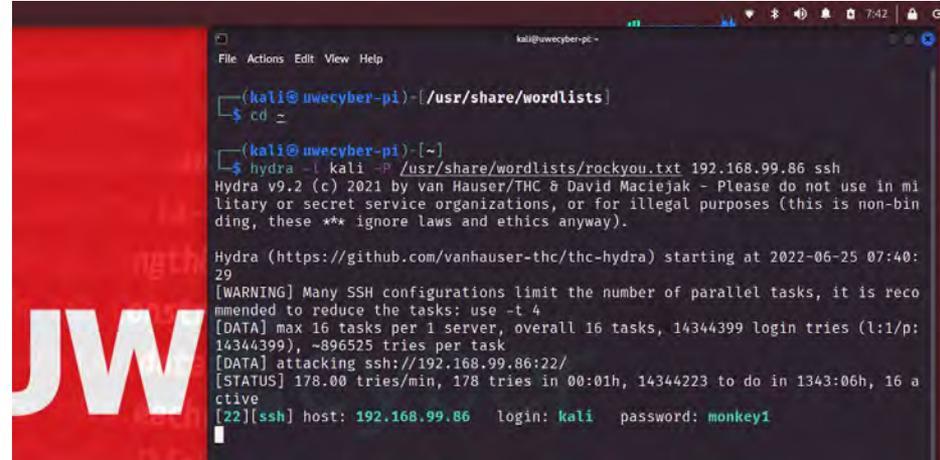
Multi-machine case study

- Defensive strategy
  - Blue team may be able to find **"who" is connected by SSH.**
  - They can **then also "kill"** their network connection.
  - They may want to change their password with **"passwd".**
  - For the purpose of the structured activity, *we would encourage the teacher to issue a known password* – e.g., this could be randomly drawn from a hat or similar.

Multi-machine case study

- Brute Force Password Attack
  - **The red team can use "Hydra" to** brute force the new password for the blue team SSH.
  - Since the password appears in a known breach list, we can uncover this.

Multi-machine case study

- Additional Tasks
  - Red team could also create a new user on the target machine for the blue team to identify.

  - Blue team **could "kick"** the attackers off the system again, and could hide the SSH server on a different port.

  - Blue team may use ufw (uncomplicated firewall) to block the malicious IP address completely

Discussion

- Teachers liked the platform and the extensibility offered, whilst also having some pre-prepared activity to get started with.

- Use case is intended to be a relatively simple attack-defend scenario whilst also giving scope to teachers to tailor it for specific age range in their class.

- Use case covers a wide variety of *fundamentals* including IP addresses, networking basics, and linux command line tools.

- Group-based tasks as well as single user tasks (e.g., Juice Shop) appeal to teachers as extension activities for students to explore.

Resources

- All Pi Lab SD card images, and associated workshop materials available online at:

    http://www.cems.uwe.ac.uk/~pa-legg/resources/teachers/

- We would be keen for the community to make use of this material, and to provide comments and feedback on how it can be improved further.

Thank you for listening

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