UWE Bristol | University of the West of England

CISSE

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

UWE cyber Gold Award

in association with National Cyber Security Centre

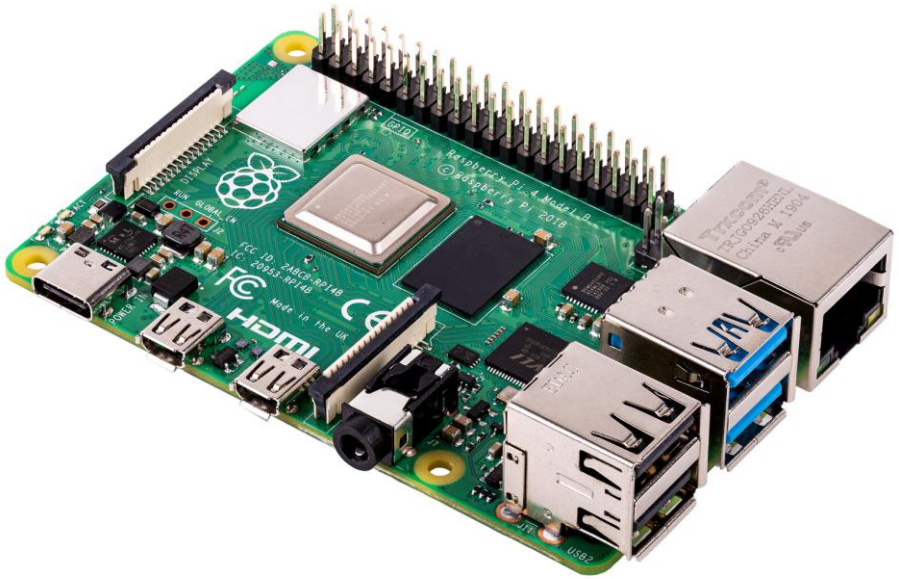
Department for Digital, Culture, Media & Sport

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

14th November 2022

Overview

1. Problem statement
2. Proposed Pi Lab environment
3. Use case for teaching
4. Discussion and Conclusion



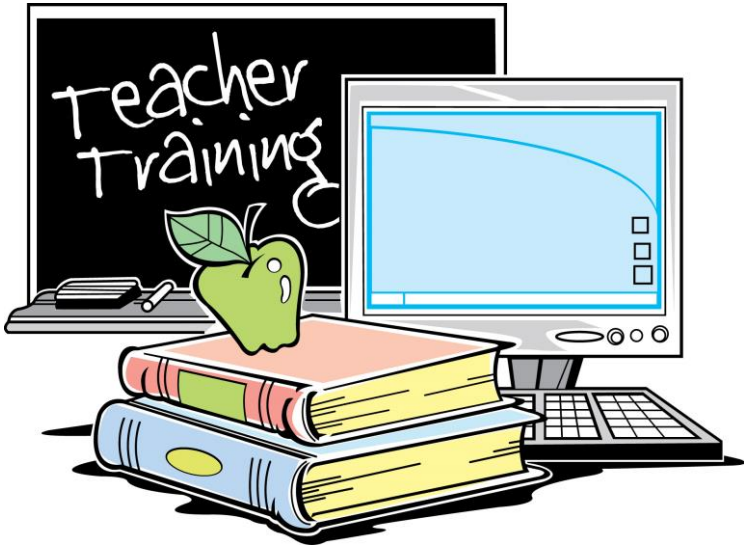
Problem Statement

- 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?**

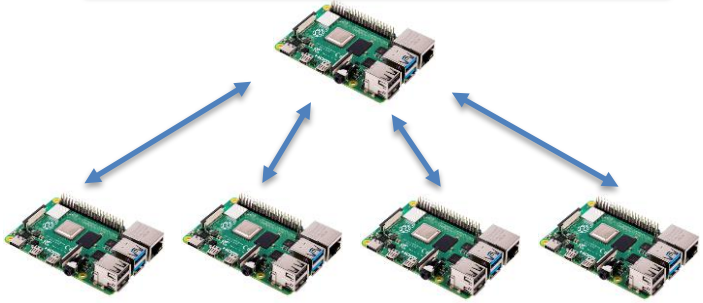
- **Can we support this at multiple levels of teacher confidence?**
  - **A low confident teacher may just want the prepared "starting block".**
  - **A high confidence teacher could extend this much further.**



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.

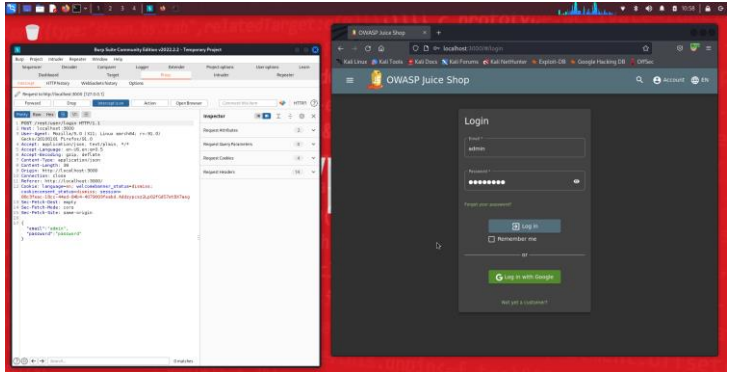
Wireless Access Point PiLab Image

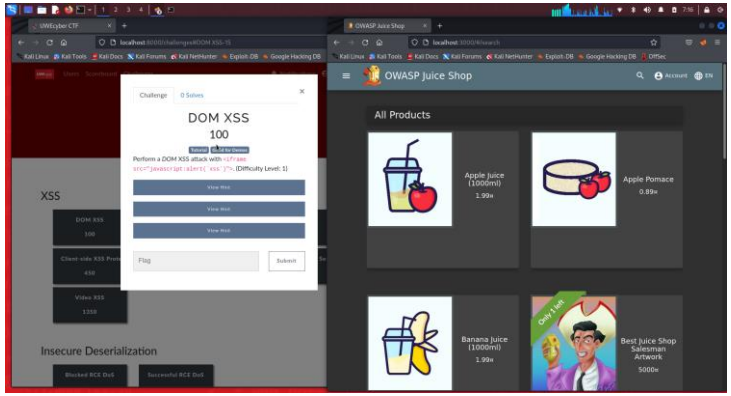


Multiple Student PiLab Images

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

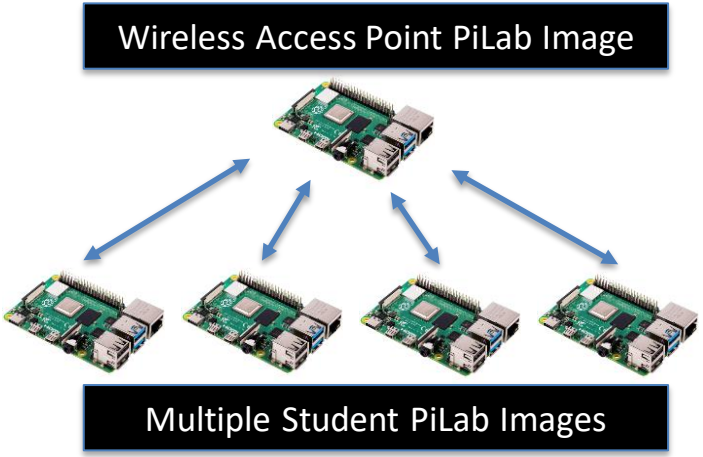




Multi-machine case study

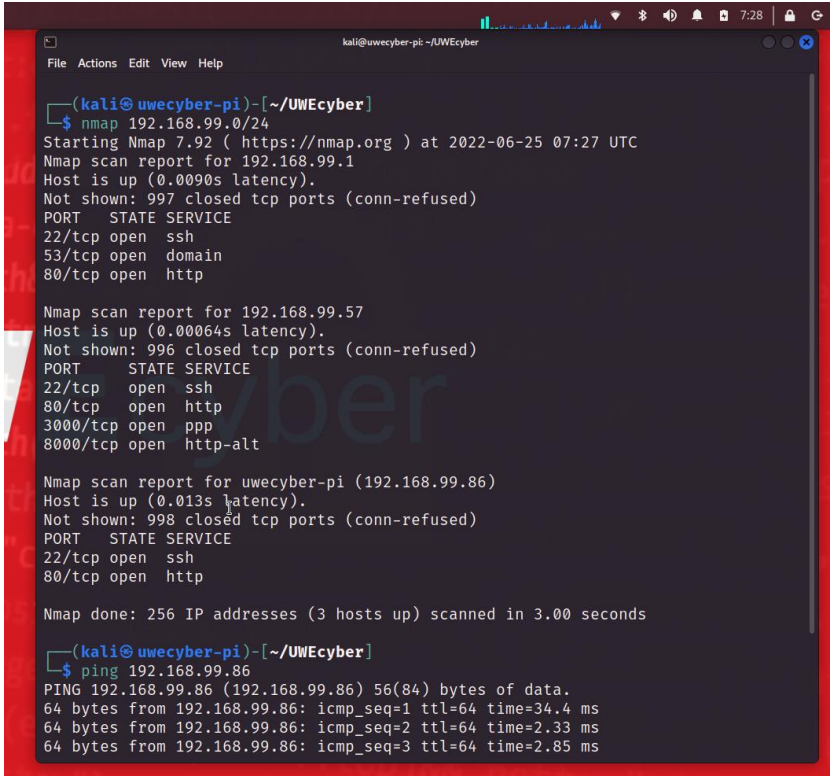
- **What about a multi-machine use case?**

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



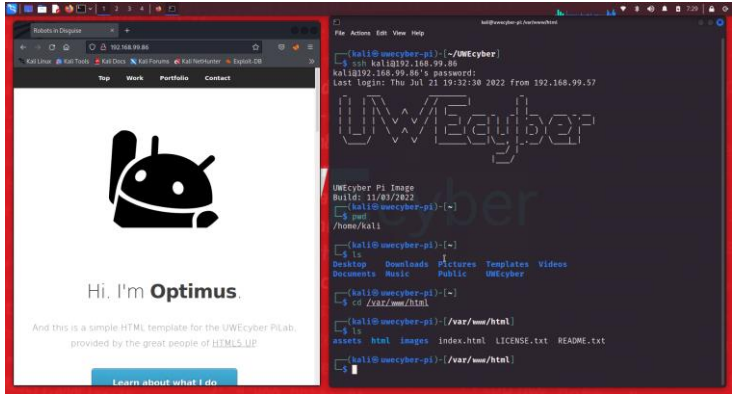
Multi-machine case study

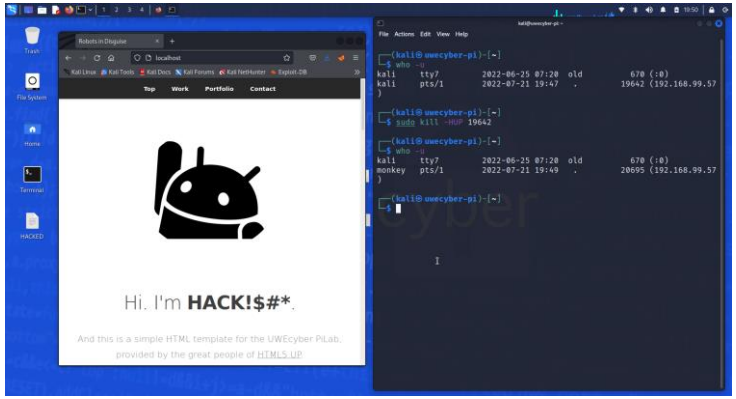
- **Nmap (Network Mapper)**
  - Students can scan the network to identify other connected devices, and to uncover what service ports are available on these devices.
  - Teacher may have allocated an attacking "red" team, and a defensive "blue" team for the purpose of the directed activity.



Multi-machine case study

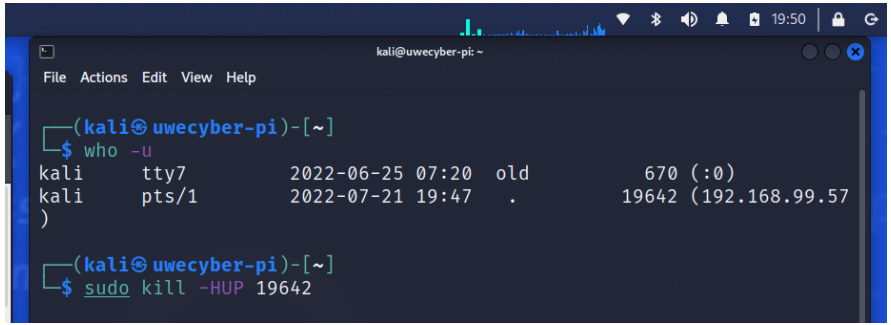
- **Remote Access and Defacement Attack**
  - All devices begin with the default kali:kali credentials.
  - Initial reconnaissance scan can be used to identify the web server running on each PiLab device.
  - Attacking team can try to "deface" the website of the defensive blue team by gaining access via SSH, and modifying the index.html page being served.





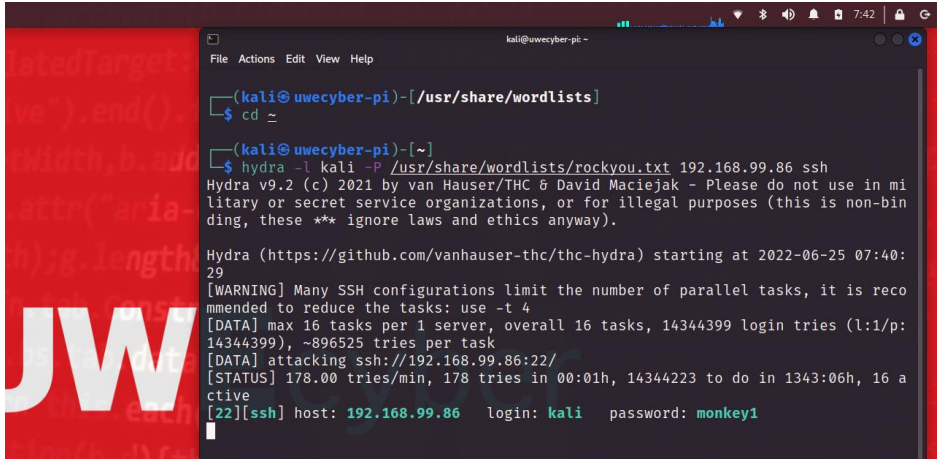
Multi-machine case study

- **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.



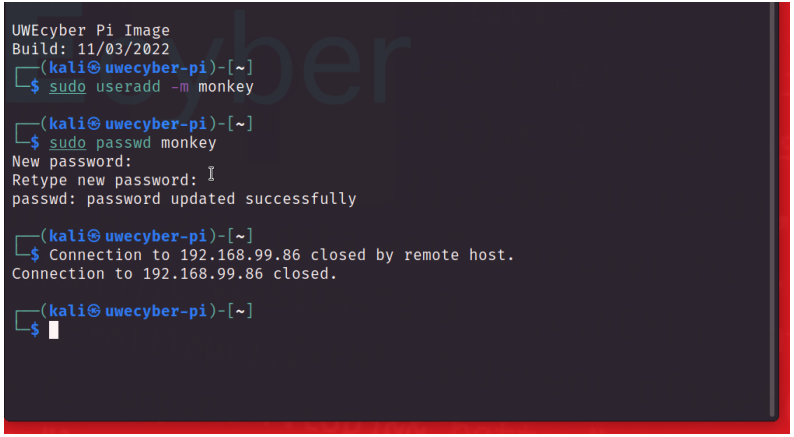
Multi-machine case study

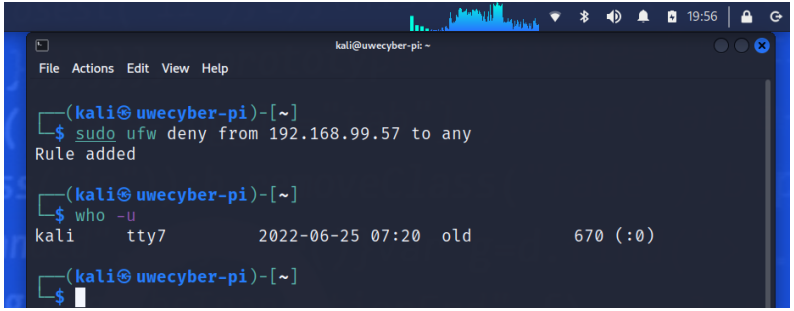
- **Brute Force Password Attack**
  - The red team can use “Hydra” to brute force the new password for the blue team SSH.
  - Since the password appears in a known breach list, we can uncover this.



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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