# Cyber Security Introduction, history and terminology

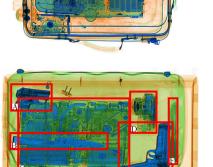
Chris G. Willcocks Durham University

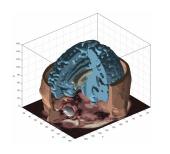
# Introduction about me



- DL & Cyber: Mostly industry projects
- Security projects with regional police
- Medical projects with sensitive data
- Anti-counterfeiting
- 1. NHS
- 2. Unilever
- 3. P&G, Dyson
- 4. AstraZenica
- 5. NERSOU

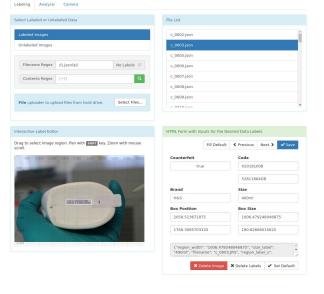








**P&G** Deep Learning, Analysis & Training Interface





### Introduction submodule outline



- This course is not like the others
  - Cyber security is not really a science.
- Course with 10 lectures
- Specialist lab with NERSOU
  - This is excellent security experience
- <u>3x</u> primary 2-hour labs
  - 1. Building a secure system
  - 2. Hacking the system
  - 3. Securing the system from the vulnerability
  - 4. Hacking the system again with a smarter method
  - 5. Repeating
- Summative coursework assignment
  - Given **early on** teaching week 13
- 100% assessed by the coursework



## Introduction teaching approach



- Prioritising breadth >> depth
  - Introductory coverage of all main areas
  - Awareness is important in your future careers
- Prioritised by popularity
  - There are lots of "interesting" small hacks in limited domains, we cover main stuff that you will most likely encounter
- Offensive & defensive
  - Learning where to look
  - How to spend our money/time wisely?

#### Pentester mindset



image from https://mile2.com

- $\circ$  "Surely they won't do that"  $\rightarrow$  "Surely they will!"
- Think like a hacker, "where are the easy assets?" Think blue to assess the threat and risk.

## **Introduction** ethics and legal disclaimer



# WARNING: Not everything you can technically do is legal!

You will learn things in this module that are technically possible. **But!** 

Nothing here is intended as an incitement to crack.

Breaking into systems to "demonstrate" security problems best causes a headache to overworked sysadmins, and at worst compromises the system for many users and could lead to **prosecution**.

If you spot a security hole, **don't exploit it**, instead report it to the relevant administrators confidentially.

## Introduction pathway to becoming a Cyber Security professional

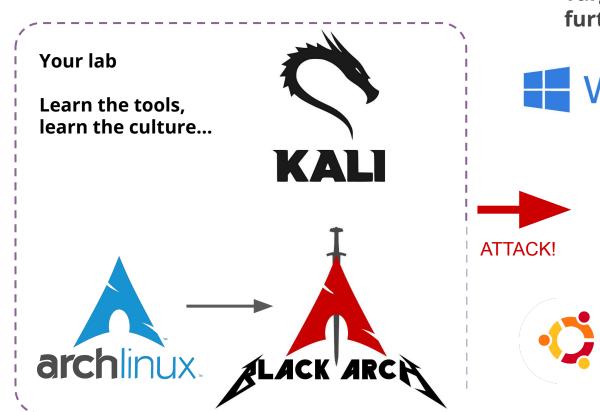


Create your own mini cyber security lab

Install VirtualBox on your PC







Target on LAN or further...







# **Definition** what is computer security?



"Computer security is the protection of computer systems against adversarial environments"

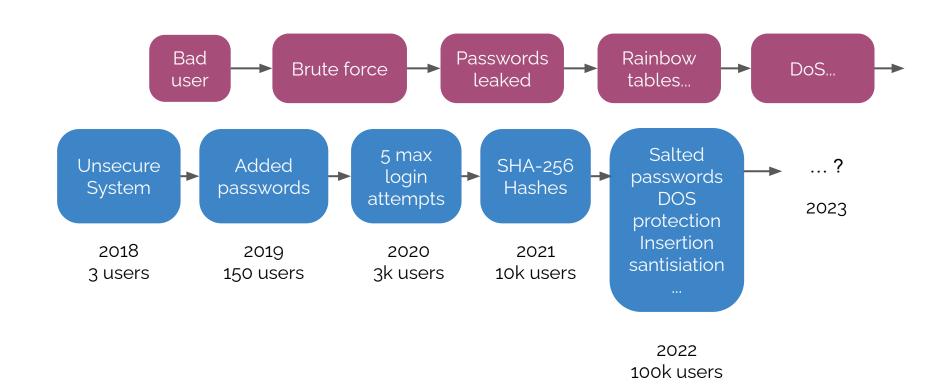
conflicting/competing/attacking

- 1. Allow intended use
- 2. Prevent unintended use

## **Definition** what is computer security?



#### ...it's an arms race



## **Definition** what is computer security?

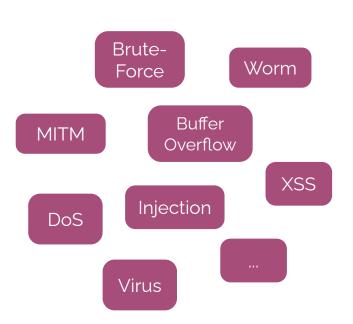


#### ...however

The same patterns tend to crop up again and again with new and evolving variations.

In this short course you will:

- 1. Learn these **patterns**
- 2. Learn how **easy** they are to exploit
- 3. Learn how to **protect** against them
- 4. Raise **awareness** of issues



# Why is this compulsory?



#### Undergraduate jobs:

#### 1. Software developer

Client logins at Tesla, billing systems at Ebay, User data at Facebook, Gmail, databases at AWS, ...

- 2. **Manager** with tight deadlines hope you'll remember this sub-module
- 3. **Research** job with sensitive data
- 4. **Systems administrator** with user data
- 5. **Game developer** with user data
- 6. **Data analyst** with sensitive patient information on your local machine ...

# **History** a brief history of cyber security



#### **Major historical events:**

**1971:** Creeper- first worm. On teletype! Reaper was made to delete Creeper.

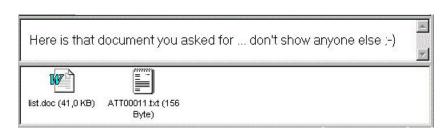
1988: The Morris worm, created by Robert Morris to assess the size of the internet. First to be convicted under misuse act. Now a professor at MIT.

```
BBN-TENEX 1.25, BBN EXEC 1.30
@FULL
@LOGIN RT
         TTY12 08-APR-72
YOU HAVE A MESSAGE
@SYSTAT
UP 85:33:19
              3 JOBS
LOAD AV
          3.87 2.95
                        2.14
JOB TTY
        USER
                   SUBSYS
    DET
         SYSTEM
                   NETSER
    DET
                   TIPSER
         SYSTEM
3
    12
                   EXEC
         RT
I'M THE CREEPER : CATCH ME IF YOU CAN
```

# History a selection of historical hacks



**2000:** The **Melissa** and **ILOVEYOU** virus. LOVE-LETTER-FOR-YOU.txt.**vbs** Windows hid extensions by default.



**2005-2007:** TJX was hacked (TK Maxx) 45 million credit card details stolen. Cost the company \$256 million.

**2013:** Yahoo breach. Worse than initially reported; all 3 billion Yahoo users details stolen (news since 3 October 2018).

**2017:** WannaCry ransomware. Encrypted hard drive demanding BitCoins. Not much money retrieved by estimated damage \$4 billion. Also the Net neutrality debate. Age of botnets 80% bots on FCC.

**2022**: Apache Log4j vulnerability. 18,378 vulnerabilities reported in 2021.

# How big is cyber security today?



- 1. As of 2004 the cybersecurity market was **\$3.5 billion**
- 2. As of 2017 the cybersecurity market is £120 billion
- Spending predicted to exceed \$1 trillion from 2017 to 2021 (report)

Link to real-time map

Link to visualisation of security breaches

National cyber security centre, part of GCHQ.









# Most of it is unreported



Big stories hit the news every so often, but actually every day:

- 1. Privilege escalation
- 2. Arbitrary code execution

Туре	Issues	Local	Remote	Open	Fixed
Unknown	0	0	0	0	0
Critical	390	0	390	32	358
High	545	122	423	24	521
Medium	806	154	652	29	777
Low	253	92	161	21	232
Total	1994	368	1626	106	1888

ssues								
vulnerable	all							
Group	Issue	Package	Affected	Fixed	SeverIty	Status	Ticket	Advisory
AVG-369	CVE-2017-12133 CVE-2017-12132	lib32-glibc	2.25-7		Critical	Vulnerable		
AVG-368	CVE-2017-12133 CVE-2017	glibc	2.25-7		Critical	Vulnerable		
AVG-417	CVE-2017-12154	linux	4.13.3-1		High	Vulnerable		
AVG-390	CVE-2017-12858	libzip	1.2.0-1		High	Vulnerable		
AVG-359	CVE-2017-11608 CVE-2017-11605 CVE-2017-11555 CVE-2017-11554	libsass	3.4.5-1		High	Vulnerable		
AVG-355	CVE-2017-13066 CVE-2017-13065 CVE-2017-13064 CVE-2017-13063 CVE-2017-12937 CVE-2017-12936 CVE-2017-12935 CVE-2017-11403	graphicsmagick	1.3.26-1		High	Vulnerable		
AVG-331	CVE-2017-9986 CVE-2017-9985 CVE-2017-9984	linux	4.11.7-1		High	Vulnerable		
AVG-328	CVE-2017-9984 CVE-2017-9257 CVE-2017-9256 CVE-2017-9255 CVE-2017-9254 CVE-2017-9253 CVE-2017-9223	faad2	2.7-4		High	Vulnerable	FS#54613	

## ...so much to choose from!



Туре	Issues	Local	Remote	Open	Fixed	Advisories
multiple issues	-	-	-	-	-	211
unknown	0	0	0	0	0	0
access restriction bypass	103	23	80	9	94	14
arbitrary code execution	676	4	616	36	640	118
arbitrary command execution	30	8	22	1	29	16
arbitrary file overwrite	6	5	1	1	5	3
arbitrary filesystem access	11	3	8	0	11	1
arbitrary file upload	0	0	0	0	0	0
authentication bypass	10	0	10	0	10	2
certificate verification bypass	3	0	3	0	3	3
content spoofing	83	1	82	2	81	2
cross-site request forgery	8	0	8	0	8	2
cross-site scripting	61	2	59	2	59	8
denial of service	645	1,56	473	38	607	85
directory traversal	8	0	8	0	8	2
incorrect calculation	8	0	8	0	8	0
information disclosure	185	38	147	12	173	28
insufficient validation	34	5	29	1	33	6
man-in-the-middle	11	0	11	0	11	3
open redirect	5	0	5	0	5	2
private key recovery	12	5	7	0	12	6
privilege escalation	66 -	0	16	1	65	35
proxy injection	1	0	1	U	-	3
same-origin policy bypass	17	1	16	3	14	0
sandbox escape	4	1	3	0	4	0
session hijacking	2	0	2	0	2	1
signature forgery	0	0	0	0	0	0
silent downgrade	1	0	1	0	1	0
sql injection	1	0	1	0	1	0
time alteration	0	0	0	0	0	0
url request injection	1	0	1	0	1	0
xml external entity injection	2	0	2	0	2	1
Total	1994	368	1626	106	1888	552

Execute whatever you like...

Get whatever you like from others...

...and do whatever you like...

# Topics in this sub-module



- 1. History, cybersecurity today and basic terminology (this week)
- 2. Applied cryptography
- 3. Identification, authentication, authorization
- 4. Operating system security (recommended for coursework)
- 5. Network & web security
- 6. Database security
- 7. Exploits and malware
- 8. Human factors
- 9. Software security (a double lecture as needs some training in assembly)
- 10. Calculating risk and ML security

# Terminology 1/2



#### 1. Assets

Something of value to a person or organisation.

#### 2. Vulnerability

 Weakness of a system that could be accidentally or intentionally exploited to damage assets.

#### 3. Threat

Potential danger of an adversary exploiting a vulnerability.

#### 4. Risk

Asset value × probability of threat occurrence × severity.

#### 5. Adversaries

 An agent (person, government, press, ...) that circumvents the security of a system.

#### 6. Attack

An assault on system security

# Terminology 2/2



#### 7. Countermeasure

Actions/processes that an owner may take to minimize risk of a vulnerability.

#### 8. <u>C</u>onfidentiality

Ensuring assets are only available to those who should be allowed.

#### 9. <u>Integrity</u>

Ensuring consistency, accuracy and trustworthiness of data...

#### 10. <u>A</u>vailability

Ensuring that assets are always available (e.g. in the event of an attack)...

#### 11. Accountability

Recording actions so that users can be held accountable for their actions.

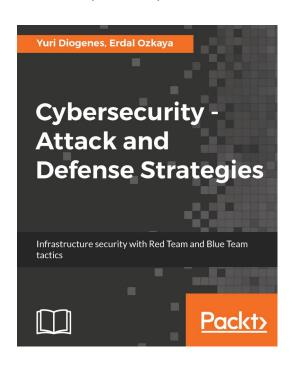
#### 12. Reliability

Ensuring that a system can progress despite errors.

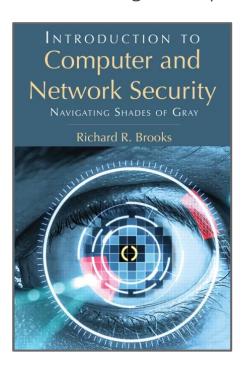
# Not compulsory reading/watching



Good, recent, "mindset"



Good book, good scope



Very good TV series!

