Advanced Network Security
Lecture 1 - Introduction

Dr Rob Hegarty

Attack Map

- https://threatmap.checkpoint.com/ThreatPortal/livemap.html

Introductions

- Dr Rob Hegarty
- Senior Lecturer in Computer Security & Digital Forensics
  - Consulting / Training / Research for GMP
  - Training for Military Intelligence
- Research Interest; Digital forensics, Computer Network Security, Cloud Computing, Social Network Analysis, Signature Detection
- Previous experience
  - Guest lecturer University of Salford
  - Postdoctoral Researcher Liverpool John Moores University
  - Police Trainer (Merseyside, Abu Dhabi, Kuwait)
  - Software Developer (Merseyside Police, Cheshire Police / EU Funded project)
  - PhD Digital Investigations (Cloud Forensics)
  - System Administrator
  - Secondary School Teacher
  - MSc Computer Network Security
  - BSc Software Engineering

Introductions

- Who are you?
- What is your background? (Employment, studies, etc)
- Why did you choose this MSc?
- What do you hope to do on completion of your MSc?
- Give one memorable fact about yourself? (e.g. a hobby, interest, or anecdote)

Aims & Objectives

- Upon completion of this lecture you will be able to:

- Comprehend the unit structure and assessment strategy
- Describe the need for security
- Describe the goals of network security
- Recognise the size of the problem security poses
- Identify who is responsible for security

Overview

- Unit overview
- Unit contents
- Part 1 topics
- Introduction to network security

Unit Overview

- Advanced Network Security
- Lecturers
  - Dr Rob Hegarty – Part 1
  - Dr Thomas Martin– Part 2
- Assessment
  - 50% Coursework (**Presentation 4th April, Report 12th April**)
  - 50% Exam
- Coursework
  - Practical & Report – Deployment of virtual network and demonstration of ethical hacking techniques (Group Based)
- Exam
  - Two sections each containing 3 questions
  - Answer two questions from each section

Suggested Reading

- Pfleeger and Pfleeger, Security in Computing
- Violent Python – T.J O'Connor
- http://www.diveintopython.net/
- The Art of Deception – Kevin Mitnick
- No Place to Hide: Edward Snowdon, the NSA and the Surveillance State – Glenn Greenwald

Unit Contents

- Topics
  - Introduction to network security
  - Network protocol header related security
  - IP Security, IDS and Firewalls
  - Web security & ethical hacking
  - Wireless security
  - Cloud security & recent developments
- Practical / Research Focus

Part 1 Topics

- Introduction to security
- Web security
- Ethical hacking
- Wireless security
- Cloud security
- Recent developments

Lecture & Lab Format (Weeks 1 – 6)

- 2 Hour lecture, with a tea/coffee break after the first hour followed by an in class task (seminar activity)
- 4 Hour lab session, with a tea/coffee/dinner break after the first two hours. This break provides the opportunity to discuss potential project ideas, employability, research, and emerging security issues with the lecturer.

What the course does

- Provides practical and academic experience of assessing the security of a system
- Gives an appreciation of the issues involved in the area
- Suggests tools and techniques that may be used
- Provides an understating of the analytical process
- Presents some emerging research areas in the field
- Focuses on the technical aspects, rather than the legal aspects

What the course doesn’t do

- Qualify you as a penetration tester
- Provide a single methodology that can be followed
- Teach you to analyse information, however it does provides a number of techniques that you may use
- Provide you with all the experience required to conduct a penetration test

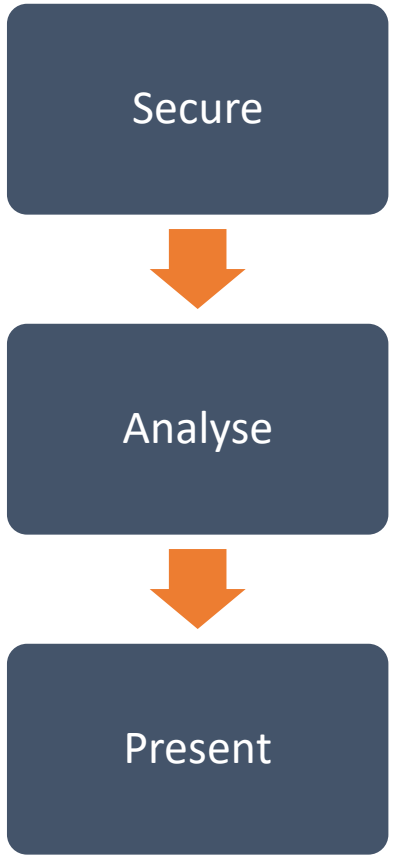
Computer Security vs. Digital Forensics

- Computer security aims to preserve the system state
- Digital forensics aims to identify how a system was compromised and attribute responsibility
- Two areas can be viewed as complementary, however the processes are distinct
- Conflict can arise between security practices and digital forensics (e.g. Encryption)

Digital Forensics Goals

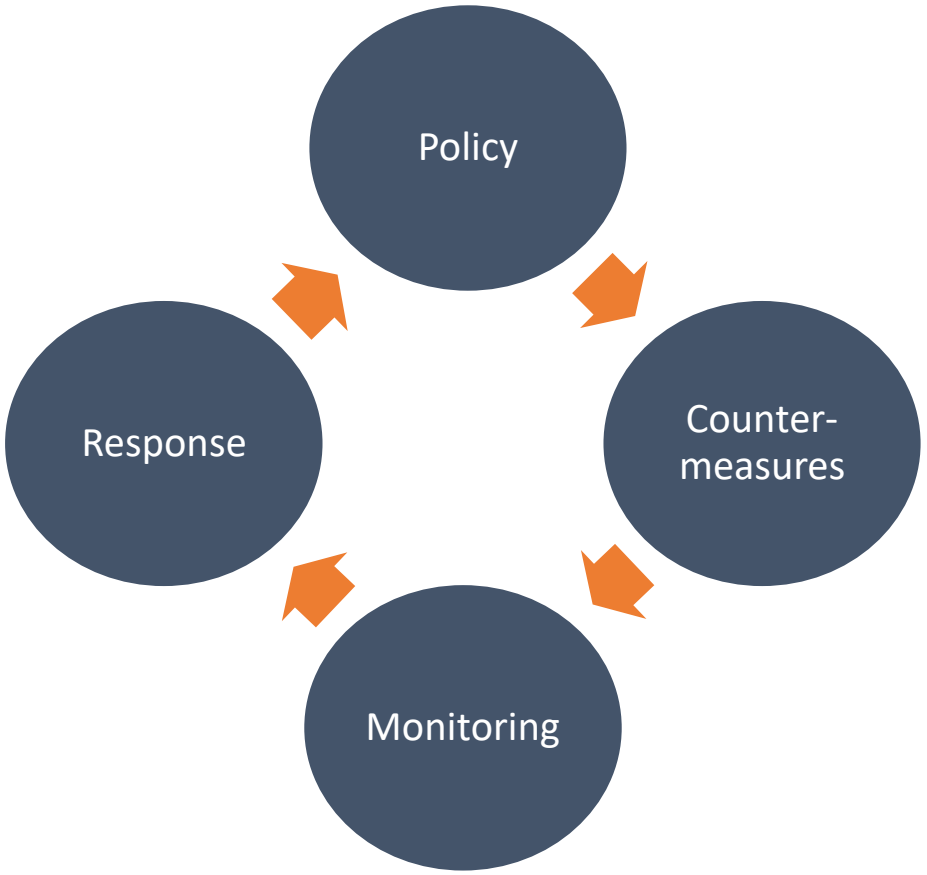
- Identify responsible entity & assign accountability for:
  - Breach of policy
  - Criminal act
- Preserve evidence integrity
- Linear process
  - Secure
  - Analyse
  - Present
- Emphasis on reproducibility

- Intelligence gathering



Computer Security Goals

- Preserve the state of the system
  - Confidentiality
  - Integrity
  - Availability
- Cyclic process
  - Policy
  - Countermeasures
  - Monitoring
  - Response



What is Security?

- Oxford English Dictionary
  - “The state or condition of being or feeling secure”
  - “Freedom from care, anxiety or apprehension; absence of worry or anxiety; confidence in one's safety or well-being.”

What is Security? [2]

- Security is multifaceted
  - Physical –Protection of physical items from unauthorised access or misuse
  - Personal – Protection of the users (employees & users) authorised to access the organisation
  - Operational – Protecting the details of an operation of activity
  - Communication – Protection of communications media (content)
  - Network – Protection of network components (infrastructure)
  - Information – Protection of information

Why do we Need Security?

- Consider vehicle security
  - Central locking
  - Remote locking
  - Alarm
  - Immobilisers
  - Trackers
  - Laser cut keys
- Goals
  - Vehicle theft prevention (Availability)
  - Content protection (Confidentiality, Integrity, Availability)
  - Occupant protection/Car jacking prevention (Integrity)
  - Vandalism deterrent (Integrity)
  - Vehicle recovery (Availability)
- Nothing can provide 100% security, however opportunists can be deterred by countermeasures.

Security for Organisations

- Information is the key to any successful organisation, it provides:
  - A means of efficiently and effectively running an organisation
  - A competitive edge
  - The ability to become/remain profitable
  - A mechanism to deliver products and services to customers
- Organisations, Governments & individuals all have data/information that requires protection
- Due to the importance of information it must be:
  - Available when required
  - Accurate & complete
  - Safe from unauthorised access

Information Characteristics

- The value of information is derived from the following characteristics
  - Availability – Information is available as and when required by authorised users.
  - Accuracy – Information is free from errors or mistakes, has not been intentionally or unintentionally modified to introduce inaccuracies
  - Authenticity – Information genuine, the provenance of the information can be validated
  - Confidentiality – Information is only disclosed to those authorised to view it
  - Integrity – The accuracy and completeness of the information is preserved
  - Utility – Information has inherent value for a specific purpose
  - Possession – Control or ownership of information

In Class Task

- Document your experience of computer security to date.
- Describe what motivated you to undertake this course.
- Research the various aspects of computer security online, describe which area of security is of particular interest to you e.g. Ethical Hacking, Cryptography, Information Assurance, etc
- Review the news story at the link below, and consider:
  - What are the main points?
  - What are the implication?
  - How would you explain the issue to a layperson?
  - https://arstechnica.com/gadgets/2018/01/meltdown-and-spectre-every-modern-processor-has-unfixable-security-flaws/

Security Concerns

- Network monitoring (Sniffing traffic to steal credentials/sensitive information)
- Exploitation of vulnerabilities
- Unauthorised access (leading to disclosure, modification, destruction of resources)
- Masquerading by users or systems
- Malicious code
- Message forgery
- Flooding attacks to prevent access to resources
- Use of compromised system to attack other systems

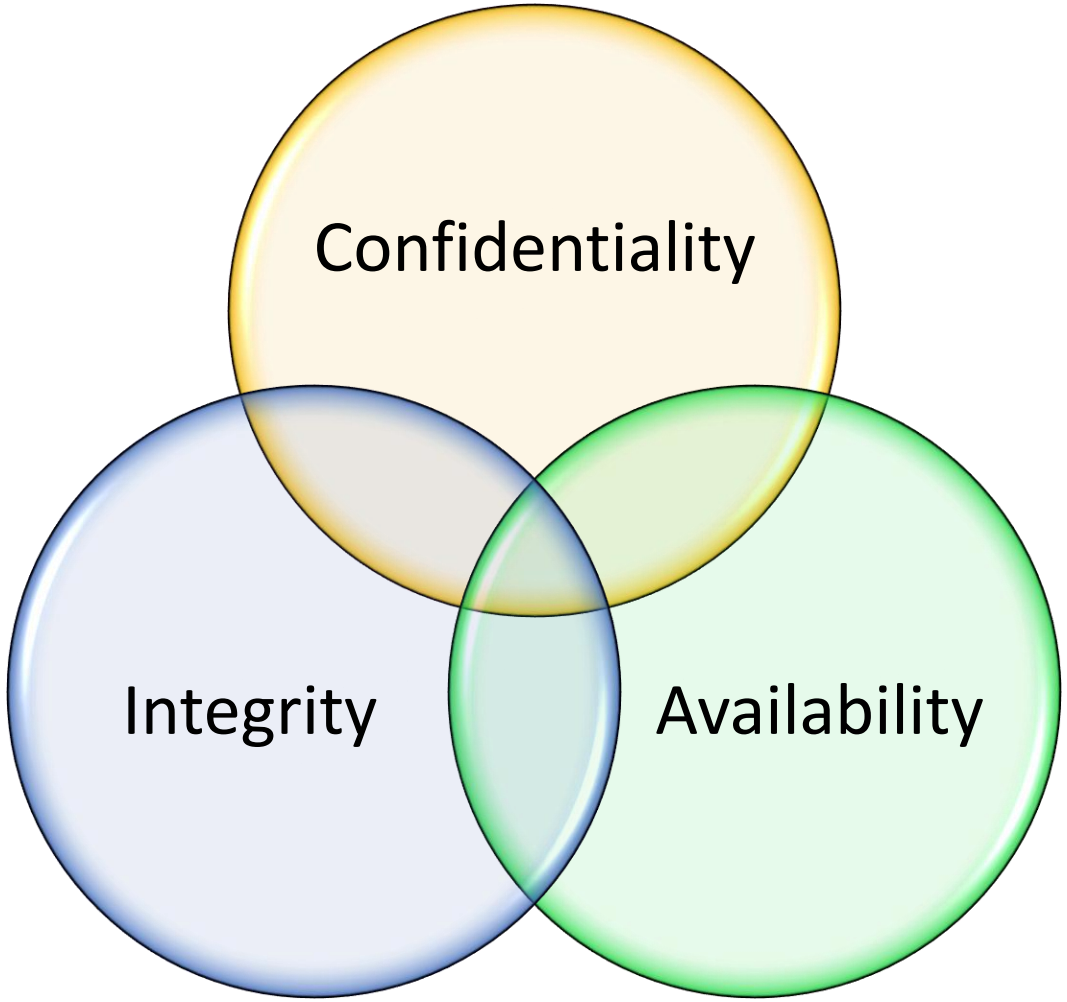
Need for Security - Timeline

- 100 B.C (Approx.) Julius Caesar (Roman Emperor)
  - Used Caesar cipher to encrypt communications (displacement cipher)
- 1920's Enigma machine
  - Used from 1920 and most notably by the Germans in WW2
- 1960's APRANET
  - Advanced Research Projects Agency Network, Early Packet Switched Network, First TCP/IP Network
- 1970's APRANET grows in popularity
  - Potential for misuse increased
  - Fundamental security problems identified
    - End points not secure from unauthorised access
    - Password structure vulnerable
    - No user identification of authentication

Need for Security

- 1980's UNIX OS Security (Bell Labs Grampp & Morris, 1984) (http://tinyurl.com/pegnfy8) (**Computer Security as we Know it**)
- 1990's WWW and Internet, millions of users online
- 2000's Mobile Internet and wireless
- 2005+ Cloud Computing, Internet of Things

CIA - Security Goals



CIA - Descriptions

- Confidentiality
  - Restricting Access
    - To those authorised to access a resource
    - Preventing access by unauthorised users
- Integrity
  - Preserving
    - The accuracy and completeness of data
    - Preventing authorised modification
- Availability
  - Ensuring a resource is available when required

Confidentiality

“EPIC” fail—how OPM hackers tapped the mother lode of espionage data

Two separate "penetrations" exposed 14 million people's personal info.

by Sean Gallagher - Jun 22, 2015 3:30am BST

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Ashley Madison hack is not only real, it’s worse than we thought

Intimate data for more than 30 million accounts, keys to Windows domain published.

by Dan Goodin (US) - Aug 19, 2015 9:02am BST

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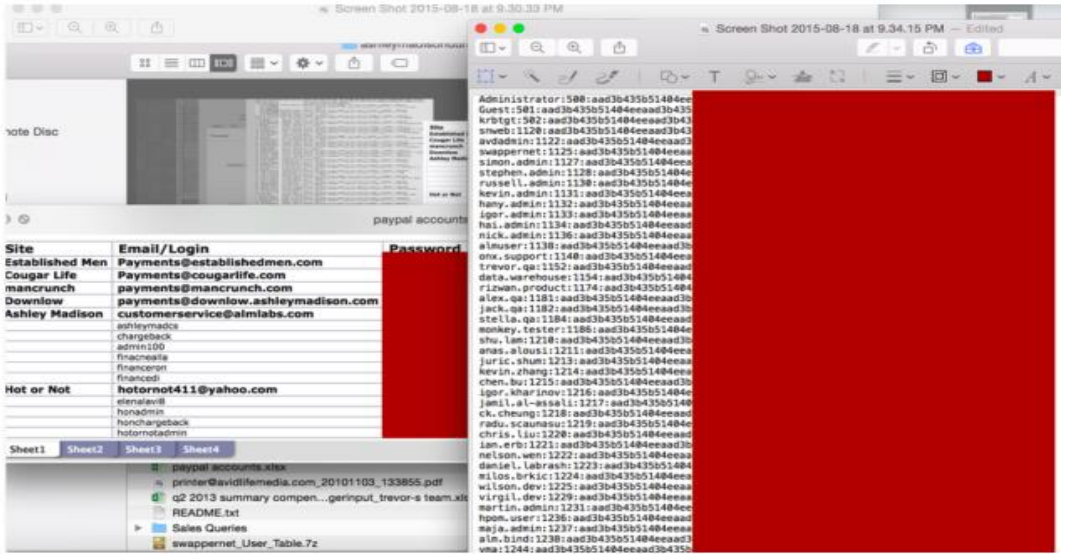

Source: www.arstechnica.com

Integrity

Active malware campaign uses thousands of WordPress sites to infect visitors

15-day-old campaign has spiked in past 48 hours, with >5,000 new infections daily.

by Dan Goodin - Sep 18, 2015 5:03am BST

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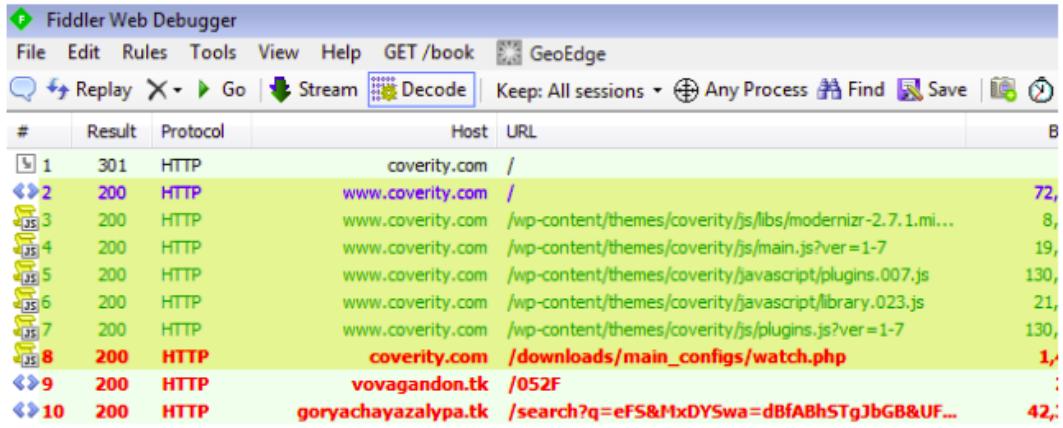


Malware infecting jailbroken iPhones stole 225,000 Apple account logins

Some targeted phones also held for ransom, researchers say.

by Dan Goodin (US) - Aug 31, 2015 7:40pm BST

Share Tweet 174

Source: www.arstechnica.com

Availability

Grinches steal Christmas for Xbox Live, PlayStation Network users

Hacker group knocks gaming networks offline with DDoS attack.

by Eric Bangeman - Dec 26, 2014 1:05am GMT

Share Tweet 178

UK's National Crime Agency hit by Lizard Squad DDoS

NCA slammed by DDoS for 2 hours in fit of pique—or possibly as ad for new service.

by Sean Gallagher (US) - Sep 1, 2015 3:51pm BST

Share Tweet 45

Source: www.arstechnica.com

Concepts & Terminology

- Threats, Vulnerabilities, Risks
  - Threats: Possible attack vectors
  - Vulnerabilities: Weaknesses that could be exploited
  - Risks: Possibility of a security breach, and severity of resultant damage
- Trade-offs
  - Security = Constraints on functionality/operational properties
  - Which in turn impacts system usability/ease of use
- Non-Repudiation (of origin)
  - Proving a message was sent by the person claiming to send the message
  - Digital signature used

Security is a Significant Problem

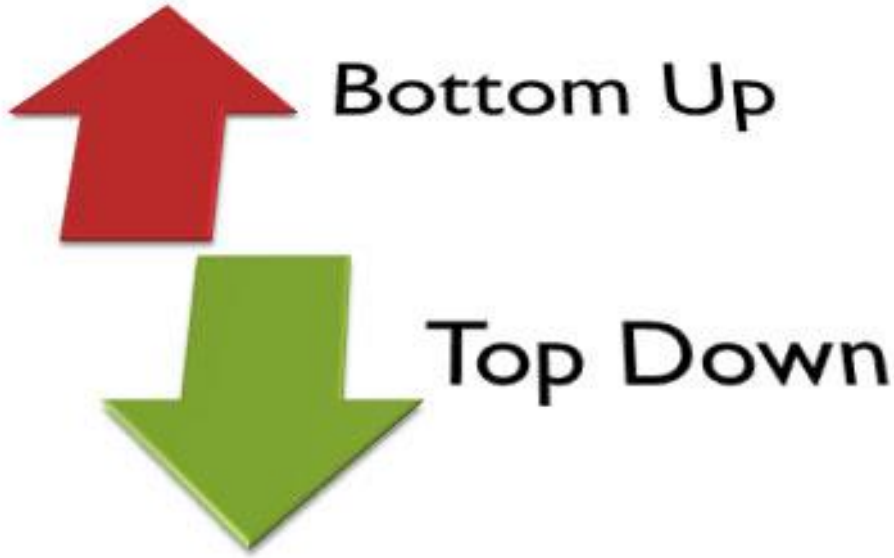
- Even large well resourced organisations fail at security
  - http://tinyurl.com/lgyx9lc
- The number and scale of data breaches reported is growing annually

Types of Attacker

- Diverse set of goals and approaches
- Amateur/Layperson
  - Most frequent offenders
  - Determine there is a weakness in a system they observer or are part of
- Hacker (Cracker not coder)
  - Students / Computing enthusiasts
  - Attempting to gain access without permission
  - Enjoy the challenge
- Career Criminal
  - A computing professional, using their skill set to engage in criminal activity
- State Sponsored
  - Well resourced
  - Aiming to improve situational awareness
  - Used for offense/defence

Security Responsibility

- EVERYONE should be responsible for security
- Security responsibility ideally falls into three main groups
  - Senior management
  - Project teams
  - Users
- BYOD makes this well established approach even more relevant



Security Approaches – Bottom-Up

- Driven by people at the coal face (e.g. system administrators*)
- Goals – Maintain system, Secure system
- Advantages – Understanding of the technical challenges, implications, and potential solutions.
- Disadvantages – Participant support, influence over management, inability to directly set and enact policy, ad-hoc reactive approach

- * Full disclosure, this was my role in the past

Security Approaches – Top-Down

- Driven by upper management
- Goals – Usability, Ability to determine accountability, Cost reduction, System security
- Advantages – Ability to directly prescribe policy, procedures and processes, formal development strategy.
- Disadvantages – Little understanding of technical issues, conflicting goals

Security Functions

- Four main functions of security in the organisation
  - Protect the organisations ability to function
  - Enables safe operation of applications and services hosted by the organisation
  - Protects data collected and used by the organisation
  - Safeguards technology and media assets the organisation uses

Security Countermeasures

- Various controls can be used to provide security
- A multi-pronged approach is best
- Countermeasures will be discussed throughout the course
- Countermeasures
  - Encryption
  - Software controls
  - Hardware controls
  - Policies and procedures
  - Physical controls

Summary

- Security is long standing problem
- Weak security is detrimental to the organisation or individual
- There are a number of countermeasures that can be used to provide security
- There is no such thing as a 100% secure system

Next Lecture

- Introduction to ethical hacking
- Ethical hacking procurement