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CO331 – Network and Web Security

6. Pentesting

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Course web page: http://www.doc.ic.ac.uk/~maffeis/331

Security touchpoints

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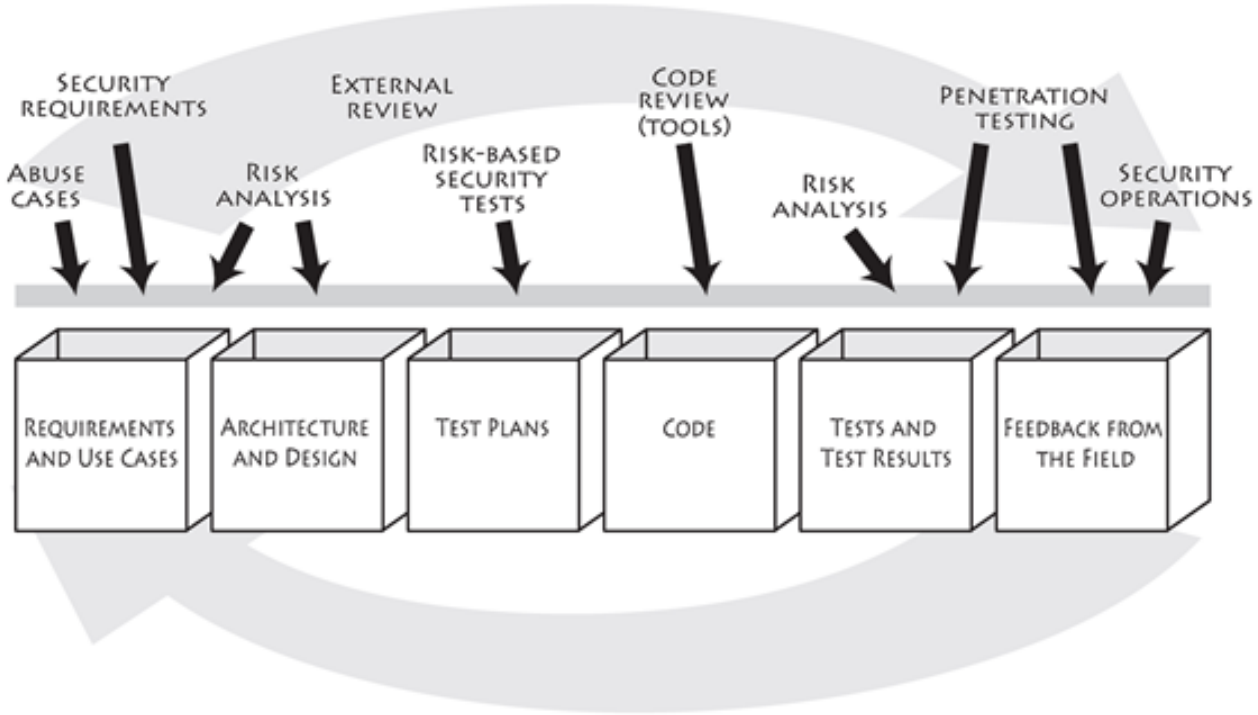
- Abuse cases
- Security requirements
- Risk analysis
- ✓ – Threat modelling + quantitative risk assessment
- Risk-based security tests
- Code review ✓
- **Penetration testing** ⟵
- Security operations



Pentesting

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- ***Pen****etration* ***testing***: pay someone to break into your system/organisation and report weaknesses
  - Network security, physical access, social engineering…
- Important to scope the pentesting exercise and avoid operational damage
  - Restrictions on targets to attack, tools and techniques to use, admissible side effects
- Access to information
  - Black box: no information
  - Gray box: selected information to help focus the exercise
  - White box: access to source code, system architecture, protocols, valid accounts
- Hard to ensure that pentester "tried hard enough"
  - Sometimes pentesting teams are played against each other
  - Pentester certifications (such as CISSP, https://www.isc2.org/cissp/) commend higher fees
  - Penetration Testing Execution Standard (PTES): fundamental principles and technical guidelines for penetration testing: http://www.pentest-standard.org/index.php

PTES

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- Key steps
  1. Pre-engagement interactions
     - Sign contract, define scope, agree on rules of engagement
  2. **Intelligence gathering**
  3. **Threat modelling**
  4. **Vulnerability analysis**
  5. **Exploitation**
  6. **Post-exploitation**
  7. Reporting
     - Provide actionable intelligence to the customer: executive summary, technical report, etc

- We use penetration testing as a way to
  - Find weaknesses in our web applications
  - Gain insight into attacker's approach

Attackers compared

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	Black hat	Gray hat	White hat
Definition	*Penetrates a system without permission*	*Penetrates a system without permission but with good intentions*	*A pentester doing her job*
Is it legal?			
Avoid detection			
Constraints			
Tools			
Disclosure			

2. Intelligence gathering

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- **Passive** information gathering
  - Aim to build a DFD, a network map, an architectural diagram, an organization chart, a sociogram of the target
  - Avoid any interaction with the target to avoid suspicion
    - To be sure, you can block your access to target using a proxy or firewall
  - Look for publicly available information about the target
    - Search online presence of company and/or employees (social networks, blogs), for comments, emails, company roles/data
    - Locate the target Web presence (services, webpages)
      - Use search engines cache, archive.org, alexa.org
      - Look at the source code of webpages for comments, hidden form fields, links
      - Find out what protocols are used: HTTP(S), FTP, SMTP
      - Look for any uptime statistics sites
      - Query the domain registrar, look for reverse DNS information
    - Look for comments in open source code used by the target
      - Are there open bugs?
      - Hardcoded credentials in older versions of the code
  - Caution: even publicly accessible data may be protected by law

Google Hacking

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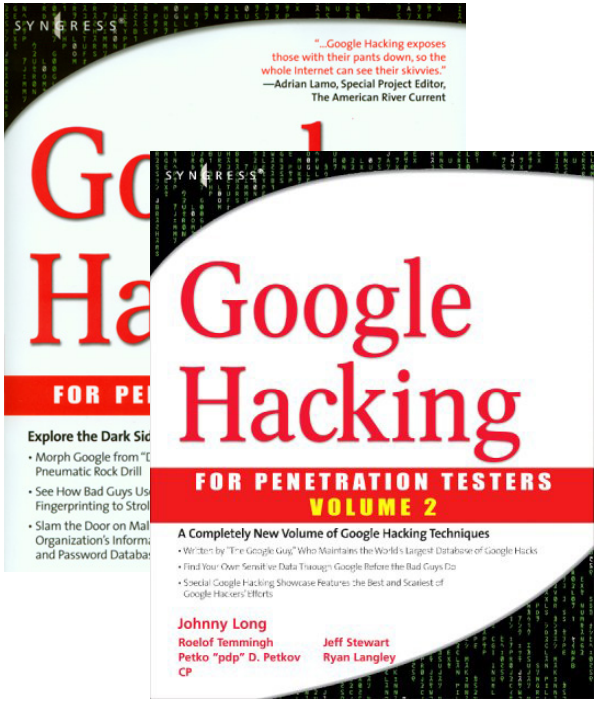
- 1,084 pages on passive information gathering (and more) with Google
- Some advanced operators
  - Search for files with specific extensions
    `ext:pdf`
  - Search within a given website only
    `site:example.com`
  - Search inside url or title or body of a page
    `"index.html" inurl: -html`
- Identifying potential targets using operators
  - Locate (unintentional) exposed directory listings
    `intitle:index.of "parent directory"`
  - Locate sites running software known to be vulnerable
    `allintext:"Powered by phpbb"`
    `inurl:index.asp`
- Cache search
  - The code of cached webpages can be seen without accessing the target
  - Use proxy to prevent loading uncached elements (images)
- Google slows down some “interesting” queries using CAPTCHAs



2. Intelligence gathering

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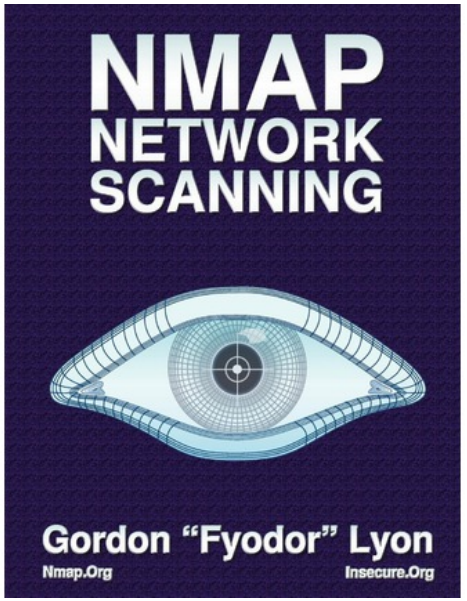
- **Active** information gathering
  - Other useful information can be obtained by contacting target services
    - These activities may be detected as suspicious
    - Better to do it from IP addresses that you will not use for exploitation
  - What version is the DNS server running?
    - `dig` query to target DNS server
  - Verify potential email addresses, user names
    - Send an email, see if it bounces
  - Determine network perimeter
    - Are you accessing the target directly, or via a firewall?
    - Use `traceroute`, reverse DNS to identify intermediate hosts
  - Probe the network
    - Host discovery: identify what subnet addresses are active
    - Port scanning: identify what ports accept communications
    - OS fingerprinting: identify target OS
    - Identify services
      - *Banner grabbing:* some services send identifying information by default
      - By reverse-engineering the protocol
      - Sometimes it's enough to send a random string and observe the error msg
  - We'll see some of these in the network lab next week



4. Vulnerability analysis

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- Unpatched systems
  - Search in the CVE database for vulnerabilities affecting any identified component
  - Scan for known vulnerabilities using tools
    - Nessus, Nikto, W3AF, Metasploit scanner, Nmap scripts
    - Beware that vulnerability scanners typically send a lot of probes, so are easy to detect
  - Same as above for exposures (misconfigurations)
- Patched systems
  - If source code is available, perform code review
    - By hand: we'll do that for JavaScript and PHP
    - Using static analysis tools
    - This activity can be very time consuming
  - Try to trigger unknown vulnerabilities
    - Using educated guesses: often used for SQLi, XSS
    - Fuzzing input parameters: automated tools help with this task
- Obtain credentials
  - Investigate password policies, identify default passwords
  - Look for password hashes published by hackers (offline dictionary attack)

5. Exploitation

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- Gain access to the target system by exploiting the identified vulnerabilities
- Use valid credentials, or try brute-force (online dictionary attack)
- Run publicly available exploits
  - From databases: https://www.**exploit-db**.com/
  - Using automated tools: we'll try Metasploit
    - Use exploits tailored to verified vulnerabilities, don't just throw anything the tool has at the target (easy to detect)
- Build your own exploits
  - We'll do that for PHP, JavaScript, SQLi, XSS …

6. Post-exploitation

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- Well done, you're in! What now?
- If the exploited account is not `admin`, try privilege escalation
  - *pass-the-hash* technique in Windows
    - send the admin's hashed password to an internal authentication server
    - the server verifies the hash and grants you admin access
  - Confused deputy: exploit application that runs as *root* or *system*
- Steal data
  - Explore local and network disks for interesting files
  - Install keylogger
  - Capture screenshots, access webcam
- Send data back to hacker
  - Password hashes off-line
  - Other valuable data
  - Use information-hiding techniques to avoid detection
- Pivot: use compromised host to exploit other targets on LAN
- Maintain access
  - Open backdoors, reverse shells
  - Create new user accounts to login later
- Cover your tracks
  - Manipulate logs
  - Install rootkits to hide backdoors
- We'll practice some of these in the lab