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(W1)

module-5 Penetration Testing, Incident Response and forensics 21/09/2022

⇒ Penetration testing is security testing in which assessors mimic real-world attacks to identify methods for circumventing the security features of an application, system or network. (overcome an obstacle)

- important to take vulnerability scans
- to ensure cyber controls are working

↳ Approaches

- Internal vs External (hackers)
- web and mobile app assessments
- Social Engineering
- Wireless Network, Embedded & IOT
- ICS penetration

↳ Industry control systems: outdated passwords, OS's, soc eng. etc (oil, gas, electric industries)

↳ General methodology

planning > Discovery > Attack > Report

↳ **Planning**

- set Objectives
- Establish boundaries
- Informing need-to-know employees

↳ **Discovery**

- Vulnerability Analysis (Identify OS & major software apps and match them with info or known vulnerabilities in vulnerability databases)

↳ **Dorks** : google dorks
- admin login pages
- usernames and passes
- vulnerable entities
- Sensitive documents
- Govt/military data
- Email list
- Bank account details and more

↳ passive vs active

- monitoring employees
- listening to network traffic

vs

- Network mapping
- port mapping
- password cracking

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## Scanning tools

- network mapper (ex: NMAP)
- network Analyzer & profiler (ex: Wireshark)
- password crackers (ex: John the Ripper)
- Hacking tools (ex: Metasploit)

## Passive - Online

- Wire Sniffing (data packet capture across network)
- Man in the middle (hijacking session)
- Replay Attack (data retransmission or delay)

## Active - Online

- password Guessing (Brute force Attack)
- Trojan/Spyware/Keyloggers (collects data from session)
- Hash Injection (Authenticate to a remote server or service by using underlying NTLM or LANMan hash of a user's password)
  - [getting password file from server and decode it]
  - older version of NTLM
  - (New Technology Lan Manager - suite of microsoft - provides authentication, integrity and confidentiality to users)
- phishing (malicious link)

↳ Offline Attacks

- pre-computed Hashes
- Distributed Network Attack (DNA)
- Rainbow Attack.

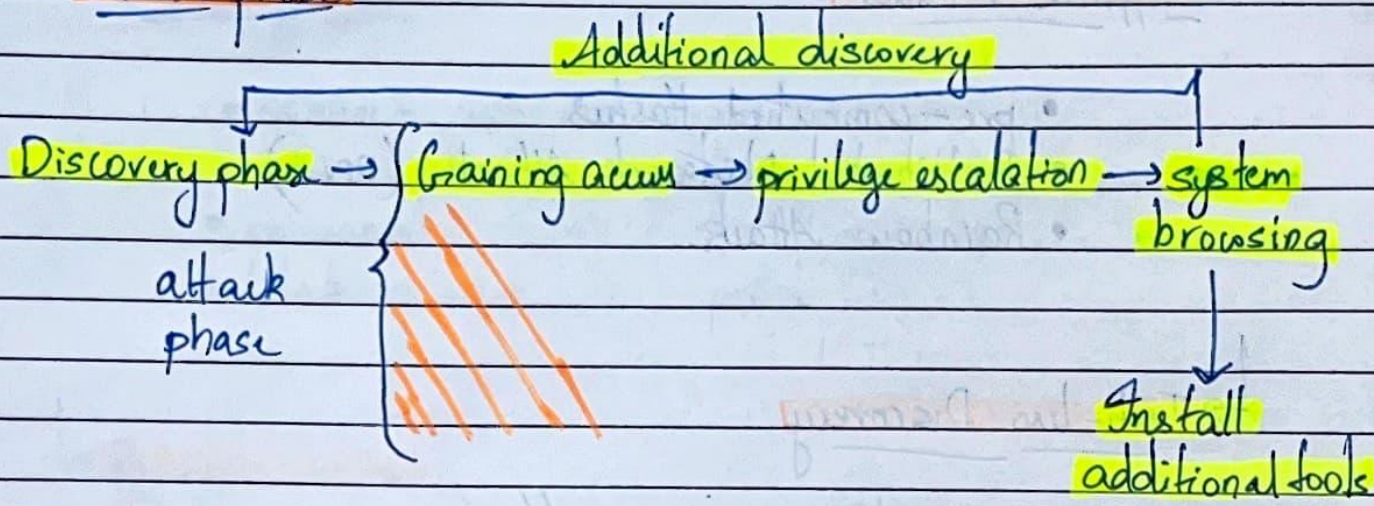
↳ Tech-less Discovery

- Social Engineering !!
- Shoulder surfing (use someone to physically see if the employee is inputting their password)
- Dumpster diving (not illegal to check trash of a company)

⇒ Notable website: securitytrails.com/blog/google-hacking-techniqu
-for google dorks and more

: subscription.packthub.com/search
-library

## Attack phase




### Exploited vulnerabilities

- misconfiguration
- Kernel flaws
- Insufficient Input Validations
- Symbolic links (file point to another file)
- file descriptor attacks (numbers used to keep track of file names)
- Race conditions
  ↓
  program or process entered privilege mode
- Buffer overflows (not chunking input for appropriate length)
- Incorrect file & directory permissions

## Resources

(penetration testing executing standard)

- ibm.biz/PTES-exploit
- ibm.biz/owasp-pentest

## Reporting

- Executive Summary (who, what, when, where of testing)
  - Background
  - Overall posture
  - Risk Ranking
  - General findings
  - Recommendations
  - Roadmap

high level detail

## Technical Review (why and how of testing)

- Introduction (person involved, contact info, assets involved, etc)
- Scope
- Vulnerability Assessment
- Vulnerability Confirmation
- Post Exploitation
- Risk/Exposure

## penetration Tools for pentesting

- Kali Linux
- ~~nmap~~ nmap.org !! (for CEH)
- JTRipper
- ~~gr~~ metasploit
- wireshark
- HTB (practice) - lame walkthrough

@ ibm.biz/<tool-name>

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## ⇒ Incident Response

**Event**: something not with respect to normal behaviour of system or change to normal behaviour

**Incident**: Event that has a negative impact on the IT system or organization

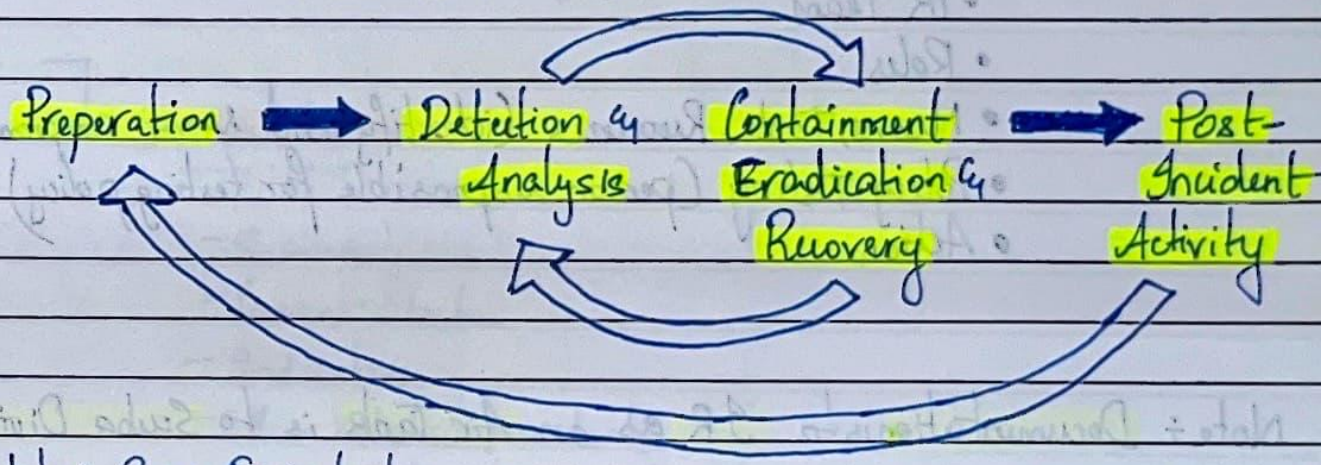
### ↳ IR Team models

- Central (Single response team)
- Distributed (per site or per office)
- Coordinating
  - ↳ relationship with other teams (areas to look for)
    - management
    - Information Assurance
    - IT Support
    - Legal
    - Public Affairs and media Relations
    - Human Resources
    - Business Continuity planning
    - Physical Security and facilities management.

## ↳ Common Attack Vectors

- External/Removable media
- Attrition (sustained or persistent attack to weaken defence)
- Web
- Email
- Impersonation
- Loss or theft of equipment

## ↳ Incident Response phases (NIST framework)




Note ÷ Sans Equivalent
- preperation
- identification
- Containment
- Eradication
- Recovery
- lessons learned.

↳ The best offence

- Risk Assessment
- Host Security
- Network Security
- Malware Prevention
- User awareness and training

} part of prep

↳ Preperation

- Incident Response Policy
  - IR Team
  - Roles
  - Means, Tools, Resources (identify and recover compromised data)
  - Policy Testing (person responsible for testing policy)
  - Action

Note: Documentation is to IR as an Air Tank is to Scuba Diving

↳ Detection and Analysis

- Precursor: sign that an incident may occur in the future. (web server log entries showing usage of vuln scanner)
- Indicator: sign that an incident may have occured or may be occurring now.

(Antivirus software alerts malware infection)

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## Monitoring systems

- IDS vs IPS
- DLP
  - Data loss prevention - ensures that sensitive data isn't lost, misused or accessed by unauthorized users
- SIEM
  - analysis of event and log data in real time with Security Information Management (SIM)

## Documentation

- Summary
- Current status
- Indicators
- Other related incidents
- Actions taken by incident handlers
- Chain of custody
- impact assessment
- contact info
- evidence gathered
- next steps to be taken

## Types of impact

### (functional)

- none - no effect to org's service to users
- low - minimal effect; lost efficiency
- Medium - lost ability to provide a critical service to subset of system users
- high - no longer able to provide critical service to users

### (Information)

- none - no info was exfiltrated, changed or deleted
- privacy Breach - sensitive PII of users accessed or exfiltrated
- proprietary Breach - unclassified proprietary information, such as protected critical infrastructure information (PCII) was accessed or exfiltrated.
- Integrity loss - Sensitive or proprietary info was changed or deleted.

### (Recoverability effort)

- Regular - Time to recovery is predictable with existing resource
- Supplemented - " with additional resources
- Extended - Time to recovery is unpredictable; additional resources and outside help are needed.
- Not Recoverable - Recovery from incident isn't possible.

(sensitive data enfiltrated and posted publicly); launch investigation.

↳ ① Containment, ② Eradication and ③ Recovery

↳ ① • potential damage to theft ~~of~~ resources
• Need for evidence preservation
• Service Availability
• Time and resources needed to implement strategy
• Duration of Solution

- forensics in IR
  - capture backup image of system as-is
  - gather evidence
  - follow chain of custody protocol

↳ ② • deleting malware
• disabling breached user account
• identifying and mitigating all vulnerabilities exploited

↳ ③ • Recovery using clean backups
• replacing compromised files with clean versions
• Installing patches
• changing passwords
• tightening network parameter (firewall rulesets, router ACLs)

- high lvel testing, monitoring deployed.

↳ Post incident

- lessons learned

- Utilizing data collected (reviewing response times, system impacted)
- Evidence Retention
- Documentation

⇒ Incident Response Demo

↳ Common threats

- Software Attacks
- Data enfil
- Information Sabotage
- Theft of equipment

↳ Attack Vectors

→ website ~~using~~ hosting malicious content.

Counter mechanism ←

- Qradar (collects system event info from devices or apps on our network including log info from os)
- McAfee epolicy Orchestrator
- Next generation firewall

↳ IR process

- preparation (contact shareholders, teams involved)
- Detection & analysis
- Containment, Eradication & Recovery
- Post-Incident Activity

↳ Using Qradar we see multiple information like

- Description
- log ID
- offense type
- offense Source
- Magnitude
- Source IPs
- Destination IPs
- Users
- Log Source
- Events
- flows

- Clicking on any of the offenses, brings us to the summary page giving us different details, including Top 5 Source IPs, dest IPs, log sources.

- Main thing to notice is top 5 Annotations.

- Going through the events to get more details (DNS queries, risk meter, threat, etc.)

- To check it out, go to events, click on Event/flow count.

- Then we note down our information to proceed to step 2 of Incident Response.

- In an Incident Response form, we have:
  - Type of ~~Template~~ Incident: DNS query to known botnet
  - Detection Source: QRadar
  - Environment: LAB
  - Hostname: LABPC2
  - IP address: 192.168.6.12 (affected one)
  - Webserver: No. (system is a workstation)
  - Public IP: 8.8.8.8 (google's DNS Server)

##########

- start recording what time we found the information

timestamps
- 1302 - weberdut.ro (malicious DNS query discovered)
- 1303 - workstation 192.168.4.6 LABPC02 (found out that DNS query came from our workstation)
- 1307 - Submit ticket to network team to disable switch port.
- 1309 - Kick off mcAfee ENS full scan
- 1313 - Reviewed McAfee ENS full scan results, 0 files were detected
- 1314 - Recommend system to be reimaged
- 1500 - Submit ticket to have system reimaged

- After doing all that, we can send the information up and allow them to process it and archive it.

- Now that the investigation is done, we close the incident.
- Reason for closing - closed: testing
- Note - copy paste the incident response form.

- If we see any false positives, ex: a local to local DDoS Attack, it might just be an user working with server to develop application using an API.
- So multiple 443 is expected (session open, closes) for that system from workstation
- So we close the offense, stating reason: Non-Issue.
- Note: The rule threshold has been increased.
- Lowers the amount of false positives.

↳ So to summarize IR process

- Step 1 was preparation
  - Know what to look for
  - Know what assets we're monitoring
  - Events to trigger on
  - people to contact in case of incident
- step 2 was Detection and Analysis
  - gather information
  - Research events that triggered alert
  - determine if event is real

- Step 3 was Containment, Eradication and recovery
  - disconnect from network
  - contact team for those network connections
  - look for other threats
  - look for areas that it might have spread to
  - get system back in state
  - give direction to reimage system

- step 4 was post incident Activity
  - after action report to be made
  - include mistakes committed
  - anything that could have been done better
  - anything to increase efficiency.

⇒ free and open source IR tools

- Cynet 360
- GRR Rapid Response
- Alien Vault
- Cyphon
- Volatility
- Sans Investigative forensics Toolkit (SIFT) Workstation
- TheHive Project

↳ SOAR → combining IR, automation and threat intelligence.

- Security Orchestration Automation and Response
- capabilities include:
  - Orchestration: ability to connect to and integrate various tools
  - Automation: ability to collect data automatically and enrich events.
  - Response: ability to allow analysts to manage, collaborate, and share data regarding incidents for better outcomes.

⇒ QRadar lab Using IBM QRadar SIEM (Check files for instruction manual)

→ Incident Response team:
- Incident Handler Communication and facilities
- Incident Analysis Resources (port list, Docs, Crypto hashes)
- Incident Analysis Hardware and Software

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## ⇒ Forensics

↳ Digital forensics is application of scienu to the collection & identification, enamination and analysis of data while preserving integrity of data and maintaining dicet chain of custody

↳ Types of data

- dusktop Computers (CDs, DVDs)
- Servers (Internal, enternal drives, application usag)
- Network Storage devices (network Activity)
- ~~devices~~ laptop (portable digital devices)

↳ need

- Incident handling
- log monitoring
- Data recovery
- Data acquisition
- operational troublshooting
- Regulatory Compliance / due diligence

## Forensic Process

- Collection ①
- Examination ②
- Analysis ③
- Reporting ④

### ①

- more Types of data
  - Externally owned property
  - Computer at home office
  - Alternate Sources of data
  - logs
  - Keystroke monitoring.

- Steps to collect data
  - Develop a plan to acquire the data
  - Acquire data
  - Verify integrity of data

- Observe Chain of Custody
  - Keep log of every person who handled evidence.
  - store evidence in secure location.

- copy of evidence to be made
- verify integrity of copy vs original.

↳ (2)

- Bypassing Controls (OS and apps may have data compression, encryption, Acc...)
- Sea of data
- Tools

- Basically examining data

↳ (3)

- include identifying people, places items and events
- Putting pieces of data
- coordinated between multiple sources of data is crucial

↳ (4)

- report needs to detail basis of your conclusions
- Detail every test conducted, methods and tools used and result

- Report Composition

- Overview/Case Summary
- Forensic Acquisition & Examination Preparation
- Findings & Report (Analysis)
- Conclusions

## - Sans Institute best practice (findings & Analysis)

- Take ss
- Bookmark evidence via forensic application of choice
- Use built in logging/reporting options within forensic tool
- highlight and exporting data items into .csv or .txt files
- Use digital audio recorder vs handwritten notes when necessary

↳ Data files

- Windows
  - FAT
  - 12
  - 16
  - 32
  - NTFS
  - ReFS
- Unix
  - EXT - 2, 3, 4
  - ReiserFS
  - XFS
  - JFS
  - Btrfs
- macOS
  - HFS+
  - APFS

- What not there

- Deleted files : not really deleted, info pointing to file location is deleted
- Slack Space : entire file allocation unit size reserved for file even if it doesn't need that much space
- Free space : media ie not allocated.

## - MAC Data

- Modification Time
- Accus Time
- Created Time

## - Colluting Backup

- Logical Backup : copies files and directories of logical volume ; doesn't capture other data present on media (deluted files or residual data)
  : Rasoura Intensive : can be used on live system
- Imaging : Generates bit-for-bit copy of original media (including free and slack space)
  : if evidence or analysis is needed, it should be worked on this duplicate.
  : can't be used on live system.

## - Tools for Techniques

- file viewers
- Uncompressing files
- GUI for Data Structures
- Identifying known files
- String Searches and pattern matches
- Metadata

↳ OS data exists in volatile and non-volatile state

volatile: data lost after system powered down. eg: network connections.
⇓
- slack space
- open files
- running processes
- login sessions
- OS Time
- memory contents
- network configurations
⇓
- collection and prioritization of volatile data (open files)

non-volatile: exists even after system is powered down
⇓
- Config files
- logs
- Application files
- Data files
- Swap files
- Dump file
- Hibernation files
- Temporary files
⇓
Collecting non volatile data
- consider power-down options

↳ Logs

- In case of network hack:
  - collect logs of all network devices lying in the route of hacked device and perimeter router (ISP Router)

- In case of an unauthorized access:
  - Save web server logs, application server logs, application logs, router or switch logs, firewall logs, database logs, IDS logs, etc.

- In case of a Trojan / Virus / Worm Attack
  - Save antivirus logs apart from event logs.

↳ Windows

- Analyzing locations like
  - Recycle bin
  - Registry
  - Thumbs.db (folder icons) representing thumbnails of
  - files
  - browser history
  - print spooling

↳ MacOS

- Unix based OS containing Mach 3 microkernel and freeBSD based subsystem.
- Put the Mac into target disk mode to create a forensic duplicate of hard disk with firewall cable between 2 pc's

↳ Linux

- Analyze location like:

- /etc [%SystemRoot%/System32/config]
  - contains system configs directory holding separate config files for each application
- /var/log
  - contains application and security logs.
  - kept for 4-5 weeks
- /home/$USER
  - user data and configuration info
- /etc/passwd
  - contains user account information.

## Application data

- config settings
- Authentication
- Logs
- data
- supporting files (Docs, links, graphics)
- App Architecture (local, client/server, peer-to peer)

## Types of applications

- Email
- Web Usage (host-cookies, history, fav websites; server-TS, IPs,
- Interactive Communications (group chat, etc) \ Type of request)
- Data Concealment tools
- Security Applications
- Document Usage
- file sharing.

protocol ÷ IRC → internet-Relay chat

## ↳ Network Data

### → TCP/IP

- **Application layer** : sends and receives data for particular apps, such as DNS, HTTP, SMTP

(packet)

- **Transport layer** : provides connection oriented or connection-less services for transporting application layer services between network.
  - TCP/UDP

(datagram)

- **Network layer (IP layer)** : Routes packets across networks.
  IP - fundamental network protocol for TCP/IP.
  other protocols - ICMP, IGMP.

(frame)

- **Hardware layer (Data link layer)** : handles communications on physical network components.
  ex : Ethernet protocol.

## ↳ Sources of network data

- firewalls and Routers (may log every packet)
- packet Sniffers & protocol Analyzers
- Intrusion detection system
- Remote Access

- Network forensic Analysis Tools
- Security events management Software

↳ **Data Value**

- IDS Software
- SEM Software
- NFAT Software (network forensic Analysis tool)
- firewalls, routers, proxy servers, & RAS
- DHCP Servers (log each IP address assignment to associated MAC address)
- packet sniffers !!
- Network Monitoring
- ISP Records

↳ **Attacker Identification**

- Contact IP address owner
- Send network traffic (ping IP) (not recommended for org)
- Application Content (Data packet could contain attacker identity info)
- seek ISP Assistance
- History of IP address (trends of suspicious activity)

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# ⇒ Introduction to Scripting

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↳ IBM's Job Control language (JCL) → first scripting language

↳ **Script Usage**

- automation
- Image rollovers
- Validation
- Backup
- Testing

↳ **Python**

- open Source
- portable
- high level

↳ **Data Structures**

- Tuple → immutable sequence of objects → (), (1,2,3), ('python', 3)
- List → mutable sequence of objects → [], [1,2,3], ['hell', 'wor']
- set → set/frozenset → unordered set of unique items
  → {1,2,3}, {"world", 'hello'}
  → frozenset → immutable ; set → mutable
- Dictionary → items composed of key value pair → {}, {'name': 'Ezio', 'surname': 'Melotti'}

## Digital forensics using python programming

- web server fingerprinting
- simulation of Attacks
- Port Scanning
- Website Cloning
- load generation and testing of website
- Creating IDS and IPS
- Wireless network Scanning
- Transmission of traffic in network
- Accessing mail Servers, etc.

- website : https://opensourceforu.com/2016/11/python-programming-digital-forensics-security-analysis/

## Graphic and Visualization functions in python

- Seaborn
- MatplotHib

## Scientific Computing functions

- Numpy
- Pandas