Introduction to Computer Security Lecture Slides

Introduction to cybersecurity

Associate Prof. Mihai Chiroiu

Honor Code

"My job is to talk to you, and your job is to listen. If you finish first, please let me know."

Harry Hershfield

Selected topics

1.Introduction. Cybersecurity properties.

2.Cryptography fundamentals. Root of trust.

3.Access Control. Social engineering.

4.Authentication mechanisms.

5.Network Security I (Local services: ARP, DHCP, ICMP, Firewalls)

6.Network Security II (Remote services: VPN, Email, DNS, Cloud)

7. Digital certificates. HTTPS.

8.Web Applications Security (DB security, XSS)

9.OS Security (ASLR, DEP).

10.Anti-X security solutions (XDR, Antivirus, etc.)

11.Application Security (Buffer overflow)

12.Forensics (Sandboxing)

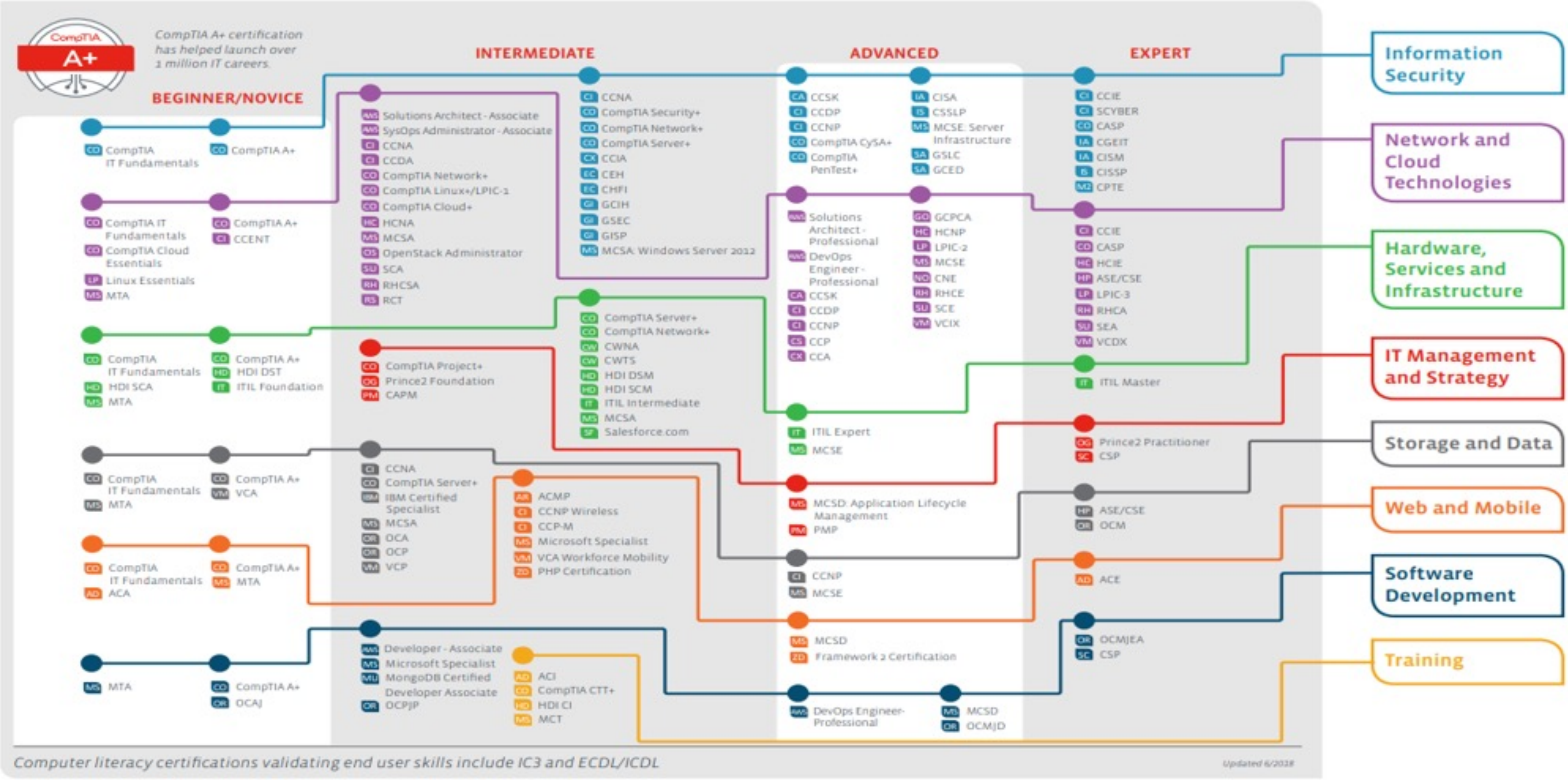
13.Privacy preserving technologies (TOR)

IT Certification Roadmap

Explore the possibilities with the CompTIA Interactive IT Roadmap at: CompTIA.org/CertsRoadmap

CompTIA

Certifications validate expertise in your chosen career.



CompTIA A+

CompTIA A+ certification has helped launch over 1 million IT careers.

	BEGINNER/NOVICE	INTERMEDIATE	ADVANCED	EXPERT
Information Security	CompTIA IT Fundamentals CompTIA A+	CCNA CompTIA Security+ CompTIA Network+ CompTIA Server+ CCIA CEH CHFI GCIH GSEC GISP MCSA: Windows Server 2012	CCSK CCDP CCNP CompTIA CySA+ CompTIA PenTest+ CISA CSSLP MCSE: Server Infrastructure GSLC GCED	CCIE SCYBER CASP CGEIT CISM CISSP CPTE
Network and Cloud Technologies	CompTIA IT Fundamentals CompTIA Cloud Essentials Linux Essentials MTA CompTIA A+ CCENT	Solutions Architect - Associate SysOps Administrator - Associate CCNA CCDA CompTIA Network+ CompTIA Linux+/LPIC-1 CompTIA Cloud+ HCNA MCSA OpenStack Administrator SCA RHCSA RCT	Solutions Architect - Professional DevOps Engineer - Professional CCSK CCDP CCNP CCP CCA GCPCA HCNP LPIC-2 MCSE CNE RHCE SCE VCIX	CCIE CASP HCIE ASE/CSE LPIC-3 RHCA SEA VCDX
Hardware, Services and Infrastructure	CompTIA IT Fundamentals HDI SCA MTA CompTIA A+ HDI DST ITIL Foundation	CompTIA Server+ CompTIA Network+ CWNA CWTS HDI DSM HDI SCM ITIL Intermediate MCSA Salesforce.com	ITIL Expert MCSE	ITIL Master
IT Management and Strategy		CompTIA Project+ Prince2 Foundation CAPM	MCSD: Application Lifecycle Management PMP	Prince2 Practitioner CSP
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Web and Mobile	CompTIA IT Fundamentals ACA CompTIA A+ MTA	ACMP CCNP Wireless CCP-M Microsoft Specialist VCA Workforce Mobility PHP Certification	MCSD Framework 2 Certification	ACE
Software Development	MTA CompTIA A+ OCAJ	Developer - Associate Microsoft Specialist MongoDB Certified Developer Associate OCPJP	DevOps Engineer-Professional MCSD OCMJD	OCMJEA CSP
Training		ACI CompTIA CTT+ HDI CI MCT		

Computer literacy certifications validating end user skills include IC3 and ECDL/ICDL

Updated 6/2018

Logistics

- https://ocw.cs.pub.ro/courses/isc

Grading

- **4p** - Written exam (TBD)
- **1.5p** - Homework 2
- **1.5p** - Homework 1
- **1p -** Lecture attendance (minim 3; 10 x 0.1)
- **2p** - Lab (10 x 0.2)
- **Total = 10p**
- **Minim 5p to pass the course.**

Cybersecurity Properties

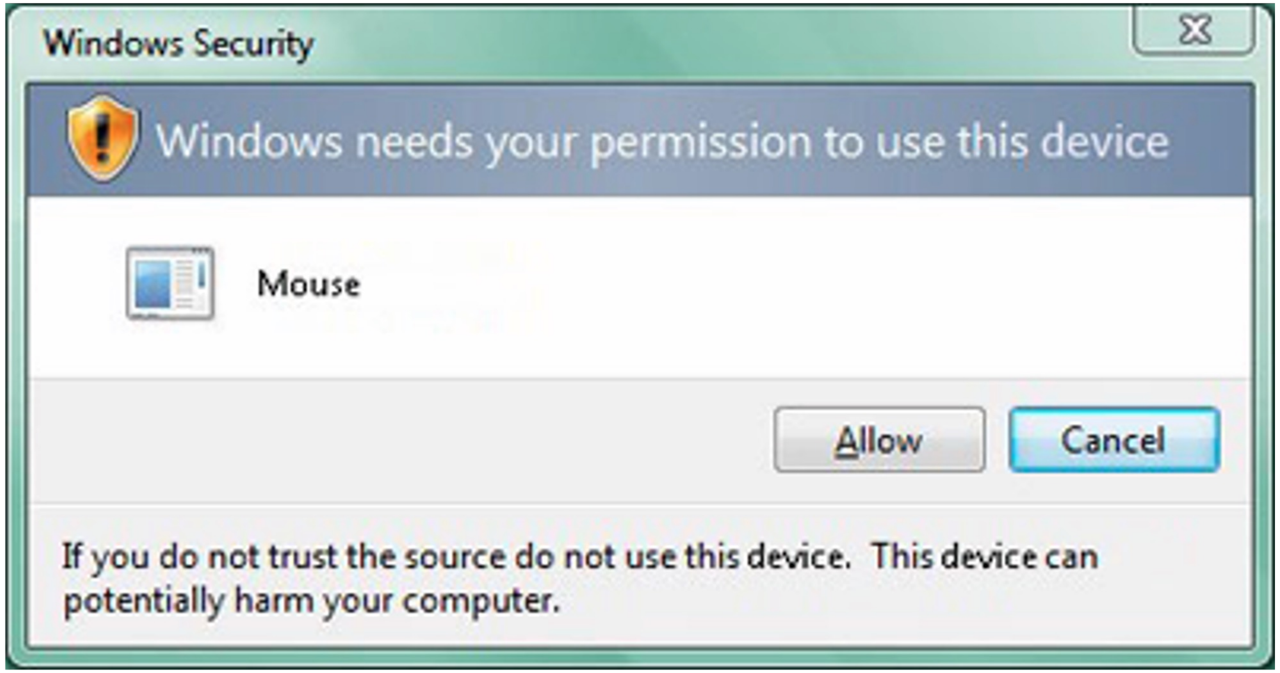
Associate Prof. Mihai Chiroiu

What is security? (theory)

- Cybersecurity is, given an **attacker’s model** and a specific **context**, the technique to control **who** may **use** or **modify** the **data**.

What is security? (reality)

- “Measures designed to produce a feeling of security rather than the reality.” Bruce Schneier



Windows Security

Windows needs your permission to use this device

Mouse

If you do not trust the source do not use this device. This device can potentially harm your computer.

https://desciclopedia.org/wiki/Arquivo:Bloqmouse.png

Theory vs. Reality

- Don’t protect $1B with encryption that can be broken for $1M.
- Don’t spend $10M to protect $1M.

Romanian Legislation (not translated)

- Introducerea, modificarea sau ştergerea de date informatice, restricţionarea accesului la aceste date ori împiedicarea în orice mod a funcţionării unui sistem informatics […] se pedepseşte cu închisoarea de la 2 la 7 ani.
- Lege 286/2009 – Art. 360
  - (1) Accesul, fără drept, la un sistem informatic se pedepseşte cu închisoare de la 3 luni la 3 ani sau cu amendă.
  - (2) Fapta prevăzută în alin. (1), săvârşită în scopul obţinerii de date informatice, se pedepseşte cu închisoarea de la 6 luni la 5 ani.
  - (3) Dacă fapta prevăzută în alin. (1) a fost săvârşită cu privire la un sistem informatic la care […] accesul este restricţionat sau interzis pentru anumite categorii de utilizatori, pedeapsa este închisoarea de la 2 la 7 ani.

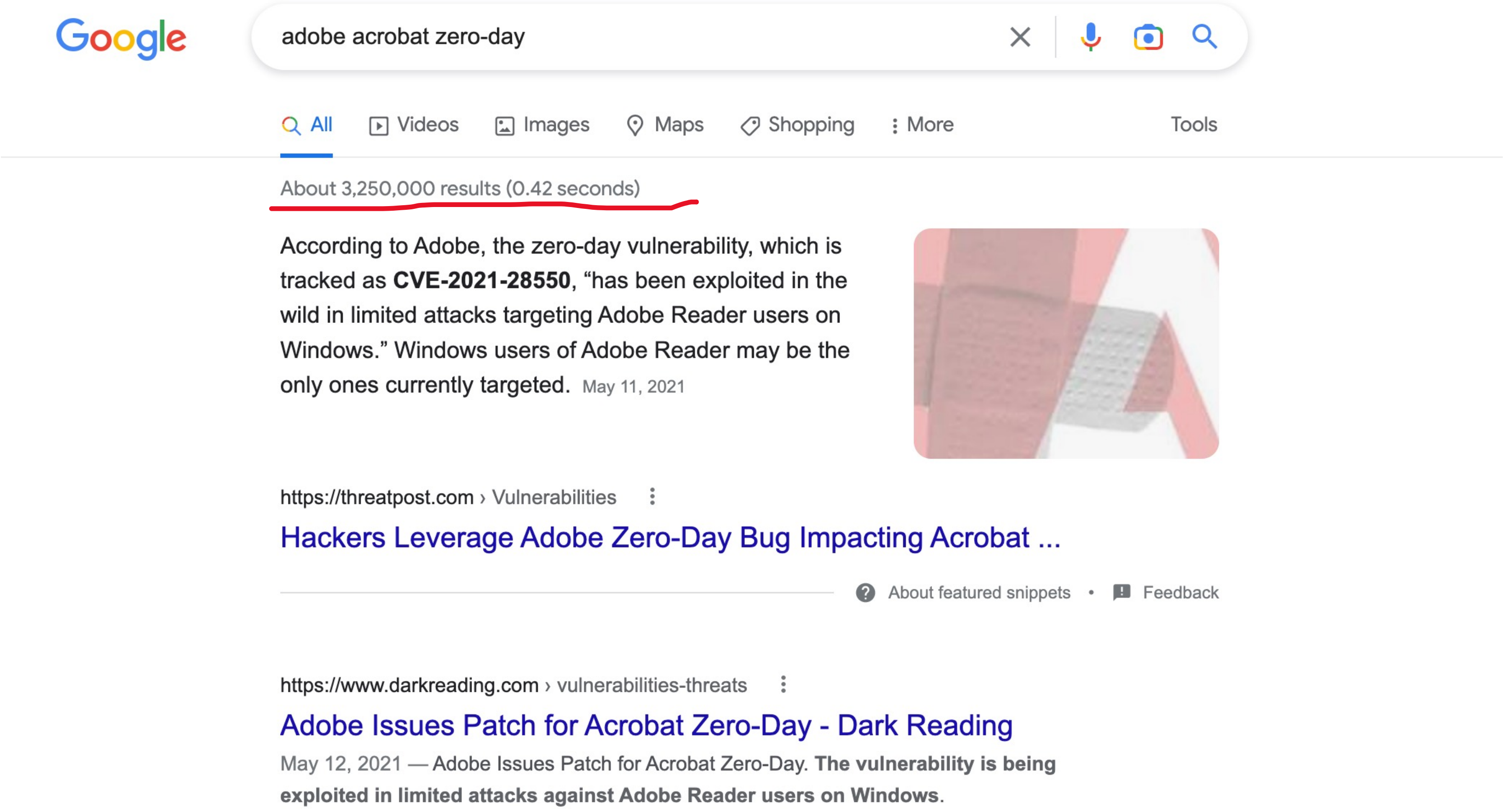
Security Theatre

Assets

- What is interesting and why in the cyber world?

- Typically not accounted for very good, therefore hackable
  - E.g. because everyone wants fast business increases

Exploitability of assests



adobe acrobat zero-day

About 3,250,000 results (0.42 seconds)

According to Adobe, the zero-day vulnerability, which is tracked as **CVE-2021-28550**, “has been exploited in the wild in limited attacks targeting Adobe Reader users on Windows.” Windows users of Adobe Reader may be the only ones currently targeted. May 11, 2021

https://threatpost.com › Vulnerabilities

Hackers Leverage Adobe Zero-Day Bug Impacting Acrobat ...

https://www.darkreading.com › vulnerabilities-threats

Adobe Issues Patch for Acrobat Zero-Day - Dark Reading

May 12, 2021 — Adobe Issues Patch for Acrobat Zero-Day. **The vulnerability is being exploited in limited attacks against Adobe Reader users on Windows**.

Attack surface

- External
- Internal
  - Malicious
  - Mistake

Attackers - headlines

- World’s Biggest Data Breaches & Hacks
  - http://www.informationisbeautiful.net/visualizations/worlds-biggest-data-breaches-hacks/

Attackers

- From pranksters to professionals.
  - Script Kiddies
  - Vulnerability Brokers vs Cybercriminals
    - Bug bounty programs
  - Hacktivists
  - National State Adversaries
  - Advanced persistent threat (APT)

Hacker’s tools

- Password crackers
  - John the Ripper, Ophcrack, L0phtCrack, THC Hydra, RainbowCrack, and Medusa.
- Wireless hacking tools
  - Aircrack-ng, Kismet, InSSIDer, KisMAC, Firesheep, and NetStumbler.

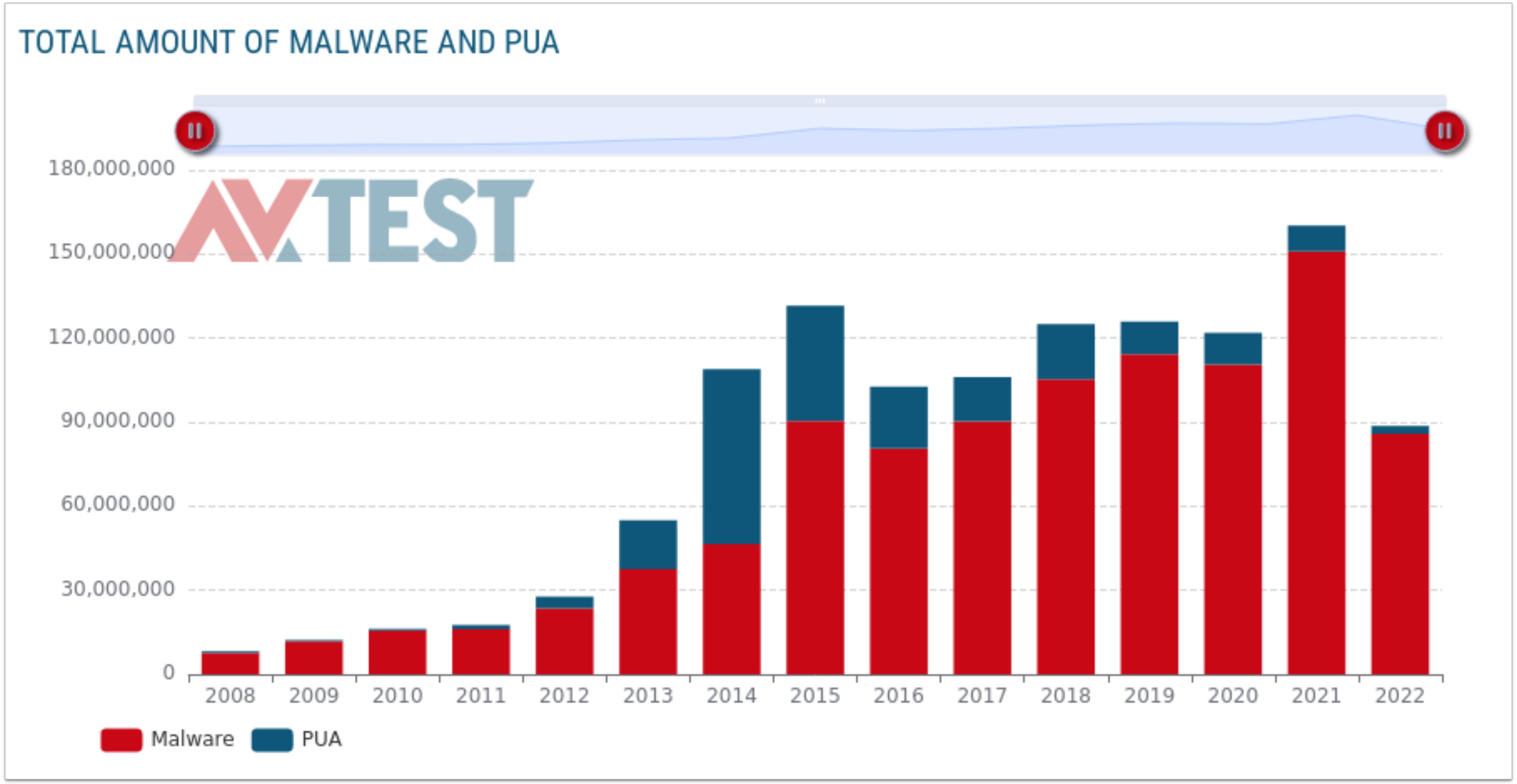
Hacker’s tools

- Network scanning and hacking tools
  - Nmap, SuperScan, Angry IP Scanner, and NetScanTools.
- Packet crafting tools
  - Hping, Scapy, Socat, Yersinia, Netcat, Nping, and Nemesis.
- Packet sniffers
  - Wireshark, Tcpdump, Ettercap, Dsniff, EtherApe, Paros, Fiddler, Ratproxy, and SSLstrip.
- Rootkit detectors
  - AIDE, Netfilter, and PF: OpenBSD Packet Filter.
- Fuzzers to search vulnerabilities
  - Skipfish, Wapiti, and W3af.
- Forensic tools
  - Sleuth Kit, Helix, Maltego, and Encase.

Hacker’s tools

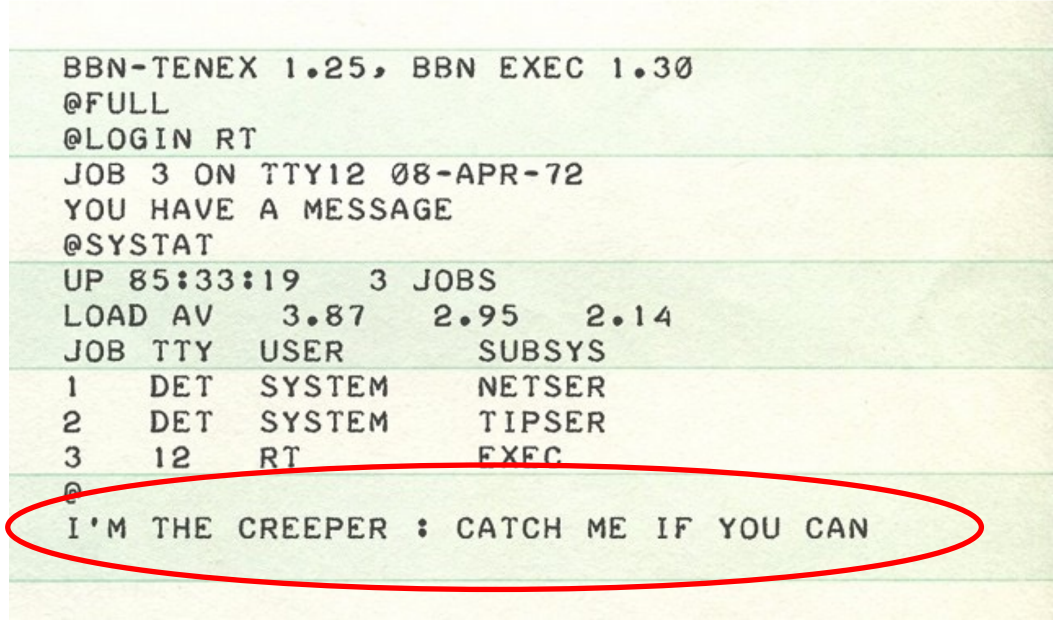
- Debuggers
  - GDB, WinDbg, IDA Pro, and Immunity Debugger.
- Hacking operating systems
  - Kali Linux, SELinux, Knoppix, Parrot OS, and BackBox Linux.
- Encryption tools
  - VeraCrypt, CipherShed, Open SSH, OpenSSL, OpenVPN, and Stunnel.
- Vulnerability exploitation tools
  - Metasploit, Core Impact, Sqlmap, Social Engineer Tool Kit, and Netsparker.
- Vulnerability scanners
  - Nipper, Securia PSI, Core Impact, Nessus, SAINT, and Open VAS.

New malware and potentially unwanted applications (PUA)



https://www.av-test.org/en/statistics/malware/

Original war: Creeper & Reaper

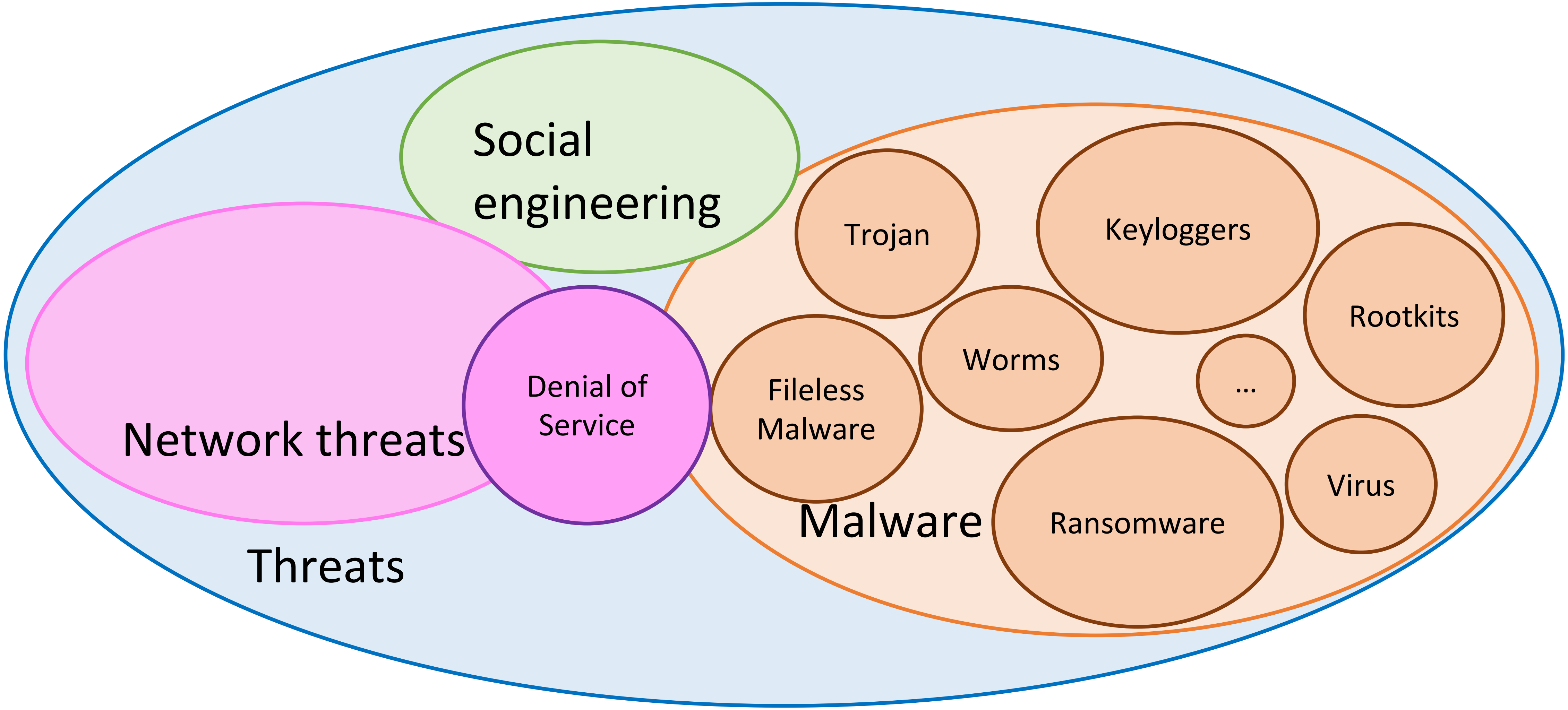


```
BBN-TENEX 1.25, BBN EXEC 1.30
@FULL
@LOGIN RT
JOB 3 ON TTY12 08-APR-72
YOU HAVE A MESSAGE
@SYSTAT
UP 85:33:19    3 JOBS
LOAD AV    3.87    2.95    2.14
JOB TTY   USER       SUBSYS
1   DET   SYSTEM     NETSER
2   DET   SYSTEM     TIPSER
3   12    RT         EXEC
@
I'M THE CREEPER : CATCH ME IF YOU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

https://corewar.co.uk/creeper.htm

- Bob Thomas created “Creeper”, a software that moved between computers with a TENEX operating system in 1971.
- Ray Tomlinson (email creator) added self-copying, instead of moving.
- Ray Tomlinson created Reaper, to chase and delete “Creeper”.

Types of threats



Types of malware

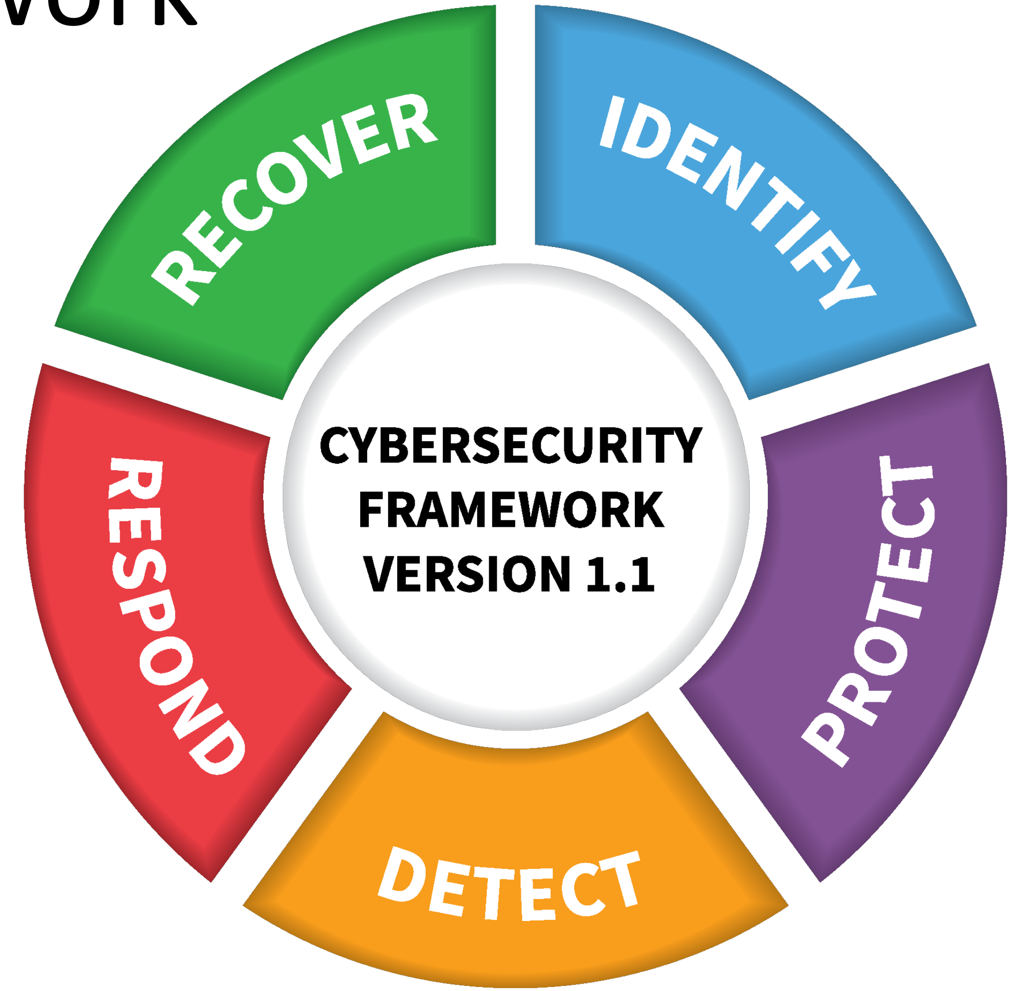
- Virus
- Worm
  - Logic bomb
- Trojan horse
  - Remote Access Trojan
- Ransomware
- Spyware
- Adware

Attackers vs defenders

- In general, it’s easier to destroy than to create
  - “rm –rf /”

- Evasion Method
  - Encryption and tunneling
  - Resource exhaustion
  - Traffic fragmentation
  - Protocol-level misinterpretation
  - Traffic substitution

NIST framework



Defenders

- Interesting maps
  - https://cybermap.kaspersky.com/
  - https://www.talosintelligence.com/
  - https://threatmap.fortiguard.com/
  - https://threatmap.checkpoint.com/

Defender’s tasks

- Use a trustworthy IT vendor
- Keep security software up-to-date
- Perform regular penetration tests
- Back up to cloud and hard disk
- Periodically change WIFI password
- Keep security policy up-to-date
- Enforce use of strong passwords
- Use two factor authentication

Defender’s tools

- Penetration testing
  - Black box (unknown environment)
  - White box (known environment)
  - Gray box (partially known environment—to model insider threat agents, for instance)
- Tactics, Techniques, and Procedures (TTPs)
  - Generalized statement of adversary behavior
  - Campaign strategy and approach (tactics)
  - Generalized attack vectors (techniques)
  - Specific intrusion tools and methods (procedures)
- Indicator of compromise (IoC)
  - Specific evidence of intrusion
  - Individual data points
  - Correlation of system and threat data
  - AI-backed analysis
  - Indicator of attack (IoA)

Threat hunting

- Use log and threat data to search for indicators of compromise IoCs
- Plan threat hunting project in response to newly discovered threat
- Use security information and event management (SIEM)
- Consider possibility of alerting adversary to the search

Security properties - Basics

- Confidentiality
  - Prevent disclosure of sensitive information to unauthorized parties.
- Integrity
  - Protection/Detection of data from intentional or accidental modification.
- Availability
  - Assurance that systems and data are accessible by authorized users when needed.

Security properties - Basics

- Non-repudiation – origin and/or reception of message cannot be denied in front of third party

Security properties

- Data protection/personal data privacy
  - fair collection and use of personal data, in Europe a set of legal requirements
- Anonymity/untraceability
  - ability to use a resource without disclosing identity/location
- Pseudonymity
  - anonymity with accountability for actions.

Security properties

- Unlinkability
  - ability to use a resource multiple times without others being able to link these uses together
  - Bad examples: HTTP “cookies”
- Unobservability
  - ability to use a resource without revealing this activity to third parties

Security properties

- Rollback
  - ability to return to a well-defined valid earlier state (backup, revision control, undo)
- Audit – monitoring and recording of user-initiated events to detect and deter security violations
- Copy protection, information flow control
  - ability to control the use and flow of information
  - Digital Rights Management

What is there to secure?

- Data at rest
- Data in transit
- Data in use

Security Administration

Security Administration

- Policies
- Standards
- Guidelines
- Procedures
- Baselines

Security Policy

- A **contract** that states how to protect information assets
  - It needs to be “s.m.a.r.t.” (specific measurable achievable timely)
  - Management instructions indicating a course of action, a guiding principle, or appropriate procedure
  - High-level statements that provide guidance to workers who must make present and future decisions
  - Must be communicated to others

- It defines what “security” means for an organization

Security Policy - example

- Authentication policy
  - Specifies authorized persons that can have access to network resources and identity verification procedures.
- Password policies
  - Ensures passwords meet minimum requirements and are changed regularly.
- Acceptable Use Policy (AUP)
  - Identifies network applications and uses that are acceptable to the organization. It may also identify ramifications if this policy is violated.
- Remote access policy
  - Identifies how remote users can access a network and what is accessible via remote connectivity.
- Maintenance policy
  - Specifies operating systems and end user application update procedures.
- Incident handling procedures
  - Describes how security incidents are handled.

Documents Supporting Policies

- Standards – dictate specific minimum requirements in our policies
- Guidelines – suggest the best way to accomplish certain tasks
- Procedures – provide a method by which a policy is accomplished (the instructions)

Thought Experiment #1

- Your personal (protected) health information is stored in a personal electronic folder. (https://ehr.des-cnas.ro/cnasportalext/index.html)
- Design a security policy to protect them.
  - What is there to protect?
  - From whom?
  - How long should data be saved?
  - What about CIA?
- Enter **HIPAA Rules and Regulations.**

Security and complexity

- Downside: Complexity brings vulnerability
    - How secure is a 1000-computer network with >1000 users and 200 different applications?
    - How secure is a simple button?

- Still, we DO need complexity to accomplish our tasks

Least privilege

- Complex systems are more difficult to secure.
- The more applications deployed, the more possible vulnerabilities.

Weakest link

- An infrastructure is as strong as its weakest link.

References

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2. https://www.owasp.org/images/2/25/OWASP_angela_sasse_appsec_eu_aug2013.pdf (on 31.10.2022)
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