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Threats for computers and networks

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Agenda

- Web security
  - → Holism, attackers & attacks
- What is Malware?
  - → Viruses, Trojans, Worms, Rootkits, Backdoors etc
- Crime in the Internet
  - → Spam, Phishing, Espionage, Vandalism
- Securing computer
  - → Anti-Virus software
- CVSS

Web security

- "Web Security" = Security of the WWW
  - → Or even more general, the Internet
    - » We will cover this here briefly and only in this presentation!
- Three main areas:
  - → Client security: Especially web browsers
    - » But also: Breaking into the client somehow
  - → Server security: Web servers & their applications
    - » But also: Breaking into the server somehow
  - → Transport security: What happens between those two
- Here we will cover mainly the web server security (as related to the WWW, not generally) and the transport security
  - → Or breaking into the server/client through the WWW

Holistic security

- Although we will cover only some aspects here, a broader view is necessary:
  - → Is your server physically secure?
    - » Standing under the reception desk?
  - → Is your OS secure?
    - » Windows/Linux updates regularly installed?
  - → Is your network secure?
    - » Can anyone plug into a port/WLAN security?
  - → Is your organization secure?
    - » Resetting passwords by request on the telephone?
  - → Is your web server application secure?
    - » CGI scripts? XSS? …

Covered here (partly!)

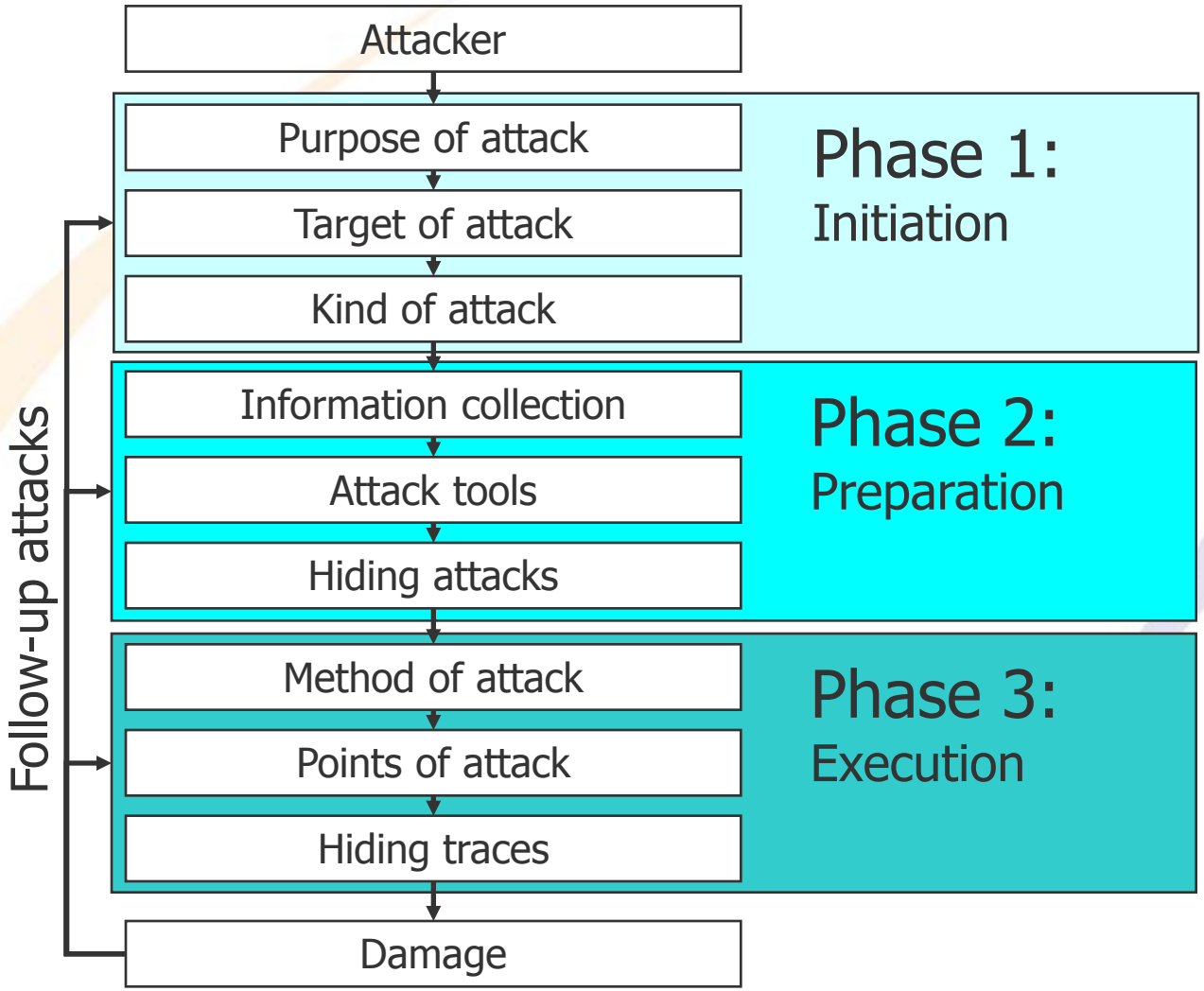
Who might attack whom?

- Clients: Uninteresting, because a lot of work for little gain
  - → If possible automatically → very interesting!
  - → Might be useful, because typically rather less secure and the information gained there can be interesting
    - » Computers of top management/developers/…
    - » Passwords which might be used for servers too!
    - » "Stepping stone" for getting into the network
- Servers: Very interesting!
  - → High computing power, bandwidth, …
    - » Using it as your own server (esp. for illegal material!)
  - → Inside a companies network (or at least the DMZ)
    - » First foothold for gaining access to more interesting data
  - → Multiplication effect: Trying to infect all users of this server
    - » Adding virus/trojan/… to downloads
    - » Inserting XSS/CSRF/… into the pages

Typical attacks

- Defacement: Vandalism
  - → Modify the homepage with some political/… message
- Infiltration: Unauthorized access
  - → Typically to steal information or resources
- Phishing: Spoofing a web site to fool end-users
  - → Getting users to do something they wouldn't do otherwise
- Pharming: DNS manipulation to impost a website
  - → Otherwise like phishing
- Click Fraud: Make money by visits/cause loss for others
  - → Typically Google Adwords and similar; but banners as well
- Denial of Service: Stop the server from working
  - → Political or as a tool for blackmailing
- Data theft: Stealing confidential information
  - → Like credit card numbers

Phases of a cyber attack



Network security overview

- What is it, that attackers might place on a webserver?
  - → Some kind of malware
  - → But what is “malware”?
    - » See next slides!
- What data might attackers download from our webserver?
  - → All kind of personal data, including credit cards etc.
  - → Information from private/paying-customers-only areas
- But why should we care?
  - → Unless it’s targeted at us, but normally only on our users!
  - → Legal liability/consequences, loss of reputation, lost revenue, costs incurred, resource usage, …
  - → Bad publicity

What is "Malware"?

- Malware = Malicious software
  - → Any software designed to cause "harm" to ICT equipment
  - → Requires this to be done without (informed) consent
    - » Some users really want spyware and install it deliberately …!
- Reasons for Malware:
  - → "Can do": Pranks, proving programming proficiency, …
    - » No actual damage (or only unintentionally)
    - » In old times, today very rare!
  - → Vandalizing: Destroy data, leave message
    - » To harm others and gain fame; rather rare today
  - → Profiteering: For (in-)direct financial gain
    - » Obtaining valuable information for selling or resources (computing power, bandwidth, non-blacklisted E-Mail sender, …)
- Very often: Attacks are a commercial venture (cost vs gain)

Malware functions

- Malware has typically three functions
  - → Not every has all three!
    - » E.g. spyware often lacks infection by being installed deliberately
    - » Vandalism malware has no concealment (or only for a short time)
- ❶ Infection: Get there without permission
  - → Usually requires some kind of user interaction, which is sometimes used as a legal pretext (“But he said ‘Install’!”)
    - » Often the information is insufficient!
  - → Typical examples: Virus, Worm, CSRF
- ❷ Concealment: Hide from the user and detection
  - → Or from detection/removal programs; to remain on the user’s computer for as long as possible
  - → Like: Trojan horse, Rootkit, Backdoor, hidden frames
- ❸ Profiting: Achieve your aim and making money (payload)
  - → Typical examples: Keystroke logger, Botnet, phishing pages

Malware: Virus

- A computer program designed to spread from computer to computer without the users permission
- Must be transferred to the new destination by a human
  - → Inserting an infected diskette, USB stick, forwarding an E-Mail
- Locations of viruses:
  - → Boot sectors: Diskettes/USB-Sticks; rare today
  - → Documents: Macros in office documents
  - → E-Mails: Some viruses send out copies of themselves
    - » Still require users to execute them, usually by tricking them
      - – E.g. pornographic photo, amusing program, important patch, …
  - → Cross-site-scripting: Embedding itself on community sites
    - » Add some code to be shown when visiting this profile/video/…
    - » May send out URLs to bring other users to visit this site
- Of little importance for web security (→ general IT security!)

Malware: Virus

- Methods to avoid detection:
  - → Do not infect everything: Small files make it difficult to hide
    - » Infect only sparsely; change techniques below (key, poly.)
  - → Hide from OS: Intercept OS calls to modify the result
    - » Reading the infected file returns the perfectly normal data
    - » Countermeasures require directly reading the disk
  - → Encryption: Encrypts itself with a random key
    - » Only the decryption part remains unchanged
    - » Dangerous for virus: Self-modifying code is rare and suspicious!
  - → Polymorphic code: Similar to encryption, but modifies itself
    - » This includes the decryption part!
      - – Replaces small pieces of machine code with different ones with an equivalent functionality
- Note: These are general approaches and are at least sometimes implemented by web attacks as well!
  - → JavaScript is often polymorphic and encrypted

Malware: Worm

- Similar to a virus, but requires no human interactions
  - → Replicates itself automatically; often used to create botnets
- Examples:
  - → Propagation by E-Mail: Sends an E-Mail, which contains an exploit so that mere viewing installs the worm
  - → Propagation by Internet: The worm connects to other computers and uses an exploit to install itself there
  - → Propagation by web server: Each user visiting the site is infected and spreads it again (MySpace worm!)
- Huge problem: Restriction!
  - → Worms can easily eat up the whole bandwidth/resources of a network and the computers on them!
  - → Difficult for a worm to decide, whether a system has already been infected and should therefore not be attempted again
    - » Some worms install patches for the vulnerability they exploited!

Malware: Trojan

- Software performing a normal function perfectly, but having an additional hidden function as well
  - → There is no self-replication, only installation by users!
    - » No hiding behind normal actions, like booting a computer
  - → Deliberate installation → Gets around security measures
    - » Administrator right? Security warning? → We're just doing a normal installation of a useful program!
  - → Web: Many “browser bars” could be considered as this
- Typical payload of a Trojan: Backdoor or keylogger
  - → Often also includes a downloading component
    - » So the Trojan remains small; additional code is downloaded over time from a web server or a P2P network and installed
- Extremely simple to program
  - → Ordinary software + small addition

Malware: Rootkits

- A kind of operating system which virtualizes your normal OS
  - → No hardware access → Needs an exploit (or Trojan)
  - → Usually not a goal in itself; just to hide from detection
- Hides itself even from the operating system
  - → Almost no possibility for scanning programs to detect them!
  - → Usually grants administrator privileges to the malicious user
- Typically hidden:
  - → Files: To keep the one code/data hidden
  - → Network connections: For downloading software, accepting commands, passing on the stolen data
  - → Registry entries: Which are required for it to run
  - → Memory: To avoid detection by inspecting the RAM
- May be purely memory-based to hide even better
  - → But will not survive a reboot then!
- "Positive" rootkits exist also: E.g. emulation of CD drives

Malware: Types of rootkits

- In order of difficulty and occurrence in the wild!
- Firmware: Rootkit stored in firmware (system BIOS!)
  - → Reprogramming the BIOS; sometimes jumper needed
  - → Can also be expansion card BIOSes!
- Virtualized: Modify the boot sequence; boot itself → Then OS
  - → Similar to a virtualization software
  - → Can intercept all calls to the hardware
    - » Not even reading the hard disk sector by sector can detect it!
- Kernel: Modifying the kernel, typically by a device driver (Win) or a loadable module (Linux)
  - → Can modify internal OS structures, e.g. process tables
- Library: Intercept system calls through intended interfaces
  - → Can usually be found be comparing the libraries to originals
- Application: Replace system programs by other executables
  - → Typically filtering the output from the "real" program

Malware: Rootkit detection

- Comparing the files to originals
  - → With numerous OS patches this becomes quite difficult!
  - → E.g. "Tripwire": Create hash code and compare against it later
  - → Will not work within the system if its file system is subverted!
- Comparing the memory of processes to the code on disk
  - → Detects dynamic modifications
  - → Compare the sector-wise read DLL to the memory version
- Look for signatures in files, memory, registry, …
  - → Works only for those which are "incomplete" in hiding
- Use statically linked binaries from a read-only memory
  - → These can still only detect, what the operating system provides; direct hardware access can still be intercepted
- Generally: Turn off the system & boot from a trusted source
  - → Not really usable as continuous precaution for servers!

Malware: The Sony Rootkit

- Sony distributed millions of music CDs containing a rootkit
  - → This was installed with the music player to prevent unauthorized copying of the content (DRM)
  - → This was not disclosed upon installation
    - » Rootkit was installed before the EULA was shown!
  - → There was no possibility to uninstall it
    - » The player could be removed, but not the rootkit part!
- Functionality: Hide any files, registry keys and processes that start with "sys"
  - → Easy to exploit by other malware, which actually did happen!
- After discovery, a removal software was provided
  - → This would phone home
  - → It would only unmask the files, but not remove them
  - → Only the second version did actually remove it
- Result: Recall, swap offer, class action (with settlement)

Malware: The Sony Rootkit

4.11.2005: Thomas Hesse
(Sony BMG president of Global Digital Business)

"Most people don't even know what a rootkit is, so why should they care about it?"

Malware: Backdoors

- A method to bypass normal authentication
  - → Typically a hidden user account or a software stealthily waiting for connections and spawning a root shell
  - → Usually an "open" or "symmetric" door: Anyone knowing about it can use it to gain access
    - » Theory: Using asymmetric encryption only the perpetrator could use it, even if it was publicly known!
      - – Such approaches exist for specially crafted RSA key generation
- Two main types:
  - → Local backdoor: Requires local access; used to become root
  - → Remote backdoor: Allows access from anywhere
- Typically an important part of any Malware: Granting the malicious user full control over the machine subverted
  - → Dangerous already as such, because of their symmetry!

See http://www.ussg.iu.edu/hypermail/linux/kernel/0311.0/0666.html for an example!

Malware: Keystroke loggers

- Recording every single key pressed by the user
  - → Related: Taking screenshots in regular intervals
- Used esp. for phishing and generally obtaining passwords
  - → Note: From the key log it is not necessarily trivial to isolate the password, but e.g. when the username is known, this becomes easier (example: "root\nsecret\n")
  - → Will not help with one-time-passwords and tokens!
    - » Except live monitoring + interception
- Available in hard- and software
  - → Especially hardware is also used in legal investigations
- Many countermeasures possible, but most of them are difficult to use or otherwise problematic
  - → Web-based keyboards, mouse gestures, Drag&Drop (→ malware tries to subvert this by movement capturing!), speech recognition, selecting with mouse and overwriting, …

Malware: Botnets

- Group of automatically working zombie computers
  - → A (large) number of home and office computers which have been hacked and are controlled by a single external person or group, i.e. “central management”
    - » Number can range up to several millions, but typically are a few hundred thousands!
- Requires a command & control infrastructure
  - → Previously: A hardcoded single server → Vulnerable!
    - » Can be taken down easily, can be used to identify all bots
  - → Now: P2P → No central server, updates between bots to recover from control servers being taken down
    - » Often hacked web server themselves!
  - → Or: Fast Flux DNS: The association Name⇔IP changes faster (60 sec!) than tracking by law-enforcement is possible
    - » Requires cooperation by the domain name registrar

Malware: Botnets

- Communications is typically over known protocols
  - → IRC, DNS (different content), P2P protocols, HTTP
  - → Reason: Someone might have a firewall somewhere
    - » Standard protocols may pass them, even if the actual content is different (“strange” binary HTTP up-/download)
- Botnets are usually rented to others for use
  - → Sending Spam, DoS attack, click fraud, phishing, …
  - → And, of course, spreading the bot software to other computers to obtain new ones!

Spyware, Adware: Malware?

- Spyware: Secretly monitoring the user and adapting the behaviour (of some software or the computer)
- Adware: Software with advertising functionality
  - → Pay for it by looking at ads/sharing relevant data
- These cannot be directly classified as Malware, as many very legitimate examples exist!
  - → Spyware: Personalization software
  - → Adware: Shareware, demos, freeware with "payment" by ads
- Decision based on:
  - → Full disclosure of what is collected and transferred
  - → Consent by the user
  - → Removability (some Adware removes their "parent" with them!)
- Attention: Many programs exist, which claim to remove spyware → Expensive, but are itself spyware or install more!

Top 6 currently important attack forms 2012

- Targeted hacking of web servers
  - → To place malware on them
  - → As preparation for information theft from connected closed networks or databases
- Drive-by-exploits on webservers to build botnets
- Targeted malware infiltration by E-Mail and through social engineering to take over a specific computer for espionage
- Distributed Denial-of-Service attacks through botnets to reduce the availability of webservers and the network connection of the institution under attack
- Untargeted distribution of malware through SPAM and drive-by-exploits with a focus on identity theft
- Multi-stage attacks, e.g. compromising central security infrastructure (like certification authorities), for later other attacking various other systems

Crime in the Internet

- Crime has found the Internet: Because it pays off!
  - → Internationality is important here: Committing crimes in foreign countries is an effective barrier to actual prosecution
    - » Little or no information is provided (police cooperation lacking)
    - » It might not even be a crime in these countries!
  - → Many "shady" products → Do you really want to tell the police your penis/breast enlargement pills didn't show up
    - » Or that they didn't work as advertised ☺ ?
- Several categories exist
  - → Normal crime with evidence in the Internet
    - » Murder with some E-Mails stating the intention
  - → Normal crime within the Internet
    - » Defamation, fraud (eBay), paedophilia

Internet crime

  - → "Real" Internet crime: Only possible there
    - » Click-fraud, phishing, DoS, viruses, data theft, illegal access

Prosecution is difficult → prevention is more important!

Crime in the Internet: Spam

- In many (but **not all!**) countries sending unrequested advertisement E-Mails is prohibited
- Business areas
  - → Obtaining E-Mail addresses (harvesting from websites, hacking computers, generating them, …)
  - → Sending Spam: Renting botnets, (ab-)using open relays
- Often coupled with fraud:
  - → Objects sold are not delivered/fake/not working
  - → Billing takes place anyway/in advance
- Pays off even for very low response rates
  - → 1.000.000 spam mails → ≈ US$ 100
    - » 0,002 percent response → 20 customers (1 in 50.000!)
- Tool for recruiting victims for other schemes
  - → Typical example: Money laundering after phishing

Crime in the Internet: Phishing

- Phishing: Representing as someone else to obtain personal information, which would otherwise have been withheld
  - → Usually employed for identity theft
  - → A very lucrative business!
    - » Online banking: Average of € 4.500 damage per victim!
- Typical target: Online banking or credit card data
  - → User IDs, passwords, PIN, TAN, card number, CVV …
  - → "Victims": Banks, eBay, PayPal (real victims: their users!)
- Phishing technique: Usually two steps
  - → Sending out Spam with forged links, requesting users to "confirm" their personal information (or else …) on the web
  - → Forging a website to look like the original
    - » Biggest problem: Making the URL look right
    - » Biggest danger: Cross Site Scripting (→ it **IS** the real website!)

Crime in the Internet: Phishing

- Exploiting the information gained:
  - → Accessing the account and transferring the money to a third person (usually not directly involved)
    - » Credit cards → Buy money, play online casino, buy on eBay, …
  - → Third person retrieves money, pockets 10%, and passes the remaining 90% on by Western Union
    - » Western Union → Practically untraceable!
  - → Fourth person picks up money from WU and transfers it on
    - » Requires photo ID; in some countries only number + password!
- Possible precautions:
  - → Full content inspection (E-Mails and webpages)
  - → Careful reading: Phishing usually misses personal data
    - » "Dear valued customer" instead of "Dear Mr. Sonntag"
  - → Browsers alerting (fake URLs, known phishing sites lists, …)
  - → Improved logins (SMS-TAN, recognizing image, iTAN etc.)

Crime in the Internet: Phishing

- Transaction authentication instead of user authentication
  - → Would be a very good help against phishing!
- Basic idea:
  - → Generate a password based on destination and amount of the transaction and use this to authenticate it
- Example:
  - → Enter destination and amount in a token, which produces a unique password based on this and the token ID
  - → Enter the token into the web form
  - → The bank verifies it
  - → Result: Without the token no transaction is possible, and an existing transaction cannot be "hijacked" and changed

Crime in the Internet: Espionage

- Typically done by secret services/countries/large companies
  - → Not much is know; victims usually don't talk or prosecute!
- This is "big business" → There is a lot of money at stake, so the effort is very high
  - → Experienced hackers deliberately target specific machines or networks and employ various techniques
    - » May include social engineering, e.g. of management executives
  - → Large effort and considerable knowledge
    - » May include bribing "insiders"
  - → The Internet is just one attack vector
- Protecting against this is very hard!
  - → For "normal" companies probably not an important issue
  - → Still, some precautions should be taken!

Crime in the Internet: Vandalism

- Typical example: Website defacement
  - → Changing the content of the website to show something different, like a political message
    - » Today of little importance any more, or only coupled with other activities (data stolen from website)
  - → Modify the content to exploit browser vulnerabilities
    - » Of high importance!
    - » Will target all persons visiting this page
- Prime targets: Large Web 2.0 sites which allow customer-supplied content (or any other site echoing user input)
  - → Doesn't require hacking, only lack of verification of input
- Today not only about changing static webpages, but rather changing the database producing the dynamic content
  - → SQL injection attacks are very prominent here!

Securing computers

- Every computer today should be secured
  - → Not securing it could lead to legal liability!
    - » At least for companies, where the standard is higher
    - » "Normal" measures must be taken, i.e. what everyone else does too and what is seen as the typical minimum investment
- Difficulty of distribution:
  - → Keeping scanning software up to date with signatures
  - → Making sure it runs everywhere and has not been disabled
  - → Ensure that reports are investigated, not just clicked away
  - → One possible solution: “Back to mainframes”!
    - » Not directly, but in the sense of thin-clients: Everything is computed on a central server, and only the UI is remote
      - – Remote computers can be secured tightly with read-only software, no interfaces, etc.
    - » Central system can be configured and controlled more easily

BUT: Web browsing is always allowed!

Securing computers: Antivirus

- Basic requirement for every computer
  - → Looks for viruses (and worms, trojans, etc. depending on manufacturer/product), includes web pages during download
- Typical method:
  - → Signature scanning: Searching for specific strings (bytes)
    - » The payload, the reproduction area, the decryption part, …
  - → Heuristics: Searching for characteristics in the code
    - » Intended to detect unknown viruses (no signature yet available)
    - » Problem of false positives!
    - » May involve:
      - – Executing suspicious code in a virtual machine → What does it do?
      - – Decompile and analyze source code
      - – Check for "strange" function calls
  - → Behavioural blocking: Stopping potentially dangerous behaviour and asking the user for permission
    - » Works very well, but depends largely on the user's attention!

Securing computers: Personal firewall

- Similar to network firewalls, but running only on a single computer and protecting only this one
  - → Controls network traffic to and from the computer
    - » Usually not address/port translation
  - → Added advantage: Can "inspect" the program also
    - » Which programs running for which user are allowed to connect to which computer/listen on which port
      - – E.g.: "explorer.exe" vs. "192.168.2.1" contacting a ssh server
  - → Can prompt users whether to allow/deny specific connections
    - » Adapts the protection profile accordingly
    - » Too many warnings → Users will shut it off or just click "yes"
- May itself be the target of an attack (when vulnerable)
  - → "Witty" worm: Targeted firewall with buffer overflow
- Typically running as administrator
  - → Else malware can shut them down/reconfigure them as well!
- Useless here: Web browsing/serving is always allowed

Securing computers: Content filtering

- Content filtering: Disallowing certain content
  - → Typically blocking pornography, advertisements, spam, …
    - » Companies: Everything unrelated to the work tasks
  - → Is only secondarily a security issue!
    - » Many such sites try to infect/harass users (aside from content!)
- Typically based on application gateways
  - → Web-proxies, E-Mail servers
- Base functionality:
  - → Black-/Whitelists: Explicit lists of what is forbidden/allowed
    - » E.g. attachments of certain types/extensions (.exe, .bat, …)
    - » May be centralised on a server (and continually updated) or local
  - → Content inspection: Looking at the content and deciding, whether this should be passed on or not
    - » Bayesian networks (require training), content anomalies, language, regular expressions, URLs, proximity, …

Securing networks

- Networks need to be secured as well as hosts
  - → Defence in depth: Don't allow the content in, but if it manages to pass, the individual clients try again
    - » Basic premise: Different strategies/programs at each node!
  - → If we can't prevent it, at least try to detect it
- Networks should be exactly defined and little connected
  - → Only few and clearly defined interfaces between them
    - » These interfaces then perform extensive security measures
  - → Inside is connected extensively → barriers are impossible
  - → Any wireless network is a huge problem here (But: 802.1x)!
- Thinks especially also of non-computer network components
  - → Infrastructure (switches, routers, …), others (printers)
- Networks are usually the domain of experts, so no "ignorant" user must be dealt with
  - → E.g. loosening security for easier working!

Securing networks: Firewalls

- Firewalls: Blocking in- and outgoing network connections
  - → Problem: They see only the network traffic; no other information is available → Connection tracking etc.

    Absolute requirement for each and every network!
- Contrary to personal firewalls usually at least some incoming connection must be allowed as well
  - → Every server application: Web, E-Mail, SSH, VNC, …
- It must be ensured, that the firewall is on the perimeter
  - → I.e., there are no alternative ways into the network
    - » Examples: WLAN, VPN connections
  - → Ideally, the internal network is separated into zones as well
    - » DMZ (servers), internal (different departments separately, …)
- Strictly speaking, the firewall would only inspect packets
  - → In most cases content inspection takes place as well

Securing networks: Firewalls

- Rules for firewall rules:
  - → Whitelist traffic: Only allow what must be allowed because of necessity; forbid everything else
    - » May require deep packet inspection
      - – E.g. FTP: Port number for data connection is passed within
  - → Hide information: Do not respond to the outside at all unless necessary (for routing to work; public services)
  - → Avoid stateless services: Replies cannot be distinguished from traffic originating from an attacker → Stateful filtering
  - → Block known exploits: Enforce passing of "valid" packets only
    - » If a sequence is know to be dangerous, deny it as well
  - → Use NAT and private addresses inside
    - » And check the source of all packets
      - – Inside address appearing from outside → Drop it!
  - → Rate limit dangerous connections if possible
    - » Example: Maximum of one SSH request/second from one IP

Securing networks: IDS

- Intrusion Detection Systems should detect unwanted manipulations of computer systems
  - → The illegal "being there"
  - → In difference to a firewall an IDS doesn't decide/block traffic, it just silently listens and tries to detect (network-based)
    - – Host-based IDS are similar to personal firewall + anti-virus SW
    - » Therefore it is located inside the network
      - – Special focus therefore on internal → internal attacks as well!
    - » Firewall = Prevention; IDS = Detection (after the fact)
- Can be signature (→ anti virus) or anomaly based
  - → Observes the traffic and builds a "baseline" after learning
  - → Any deviations from this "normal" behaviour are detected
    - » Usually only significant differences produce alerts, as this method is obviously prone to false positives
      - – Rare actions might not be in baseline; some users have a wide spectrum of "normal" behaviour; …

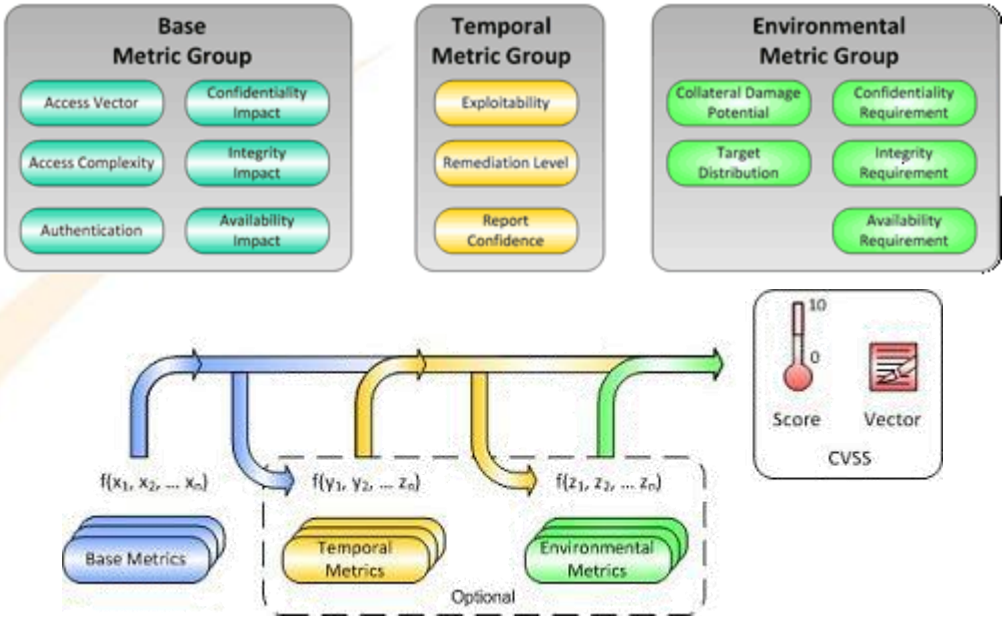
Securing networks: IDS

- Result of an alert can be passive or reactive
  - → Reactive: Logging of users, blocking switch ports, changing firewall rules, tightening permissions etc.
    - » "Intrusion Prevention System"
  - → Passive: Notification of the administrator
- Special IDS variant: Honeypots
  - → Systems set up to not be worked with, but attacked
    - » No "normal" change will occur there ever
    - » Contain "interesting" but incorrect/unusable information
    - » Should be "easier" or more attractive to attack
    - » Every modification is therefore a sign of an (successful) attack
  - → They are closely monitored and what "happens" to them will then be blocked for the "real" servers!
  - → Also used to collect evidence for later prosecution
  - → Attention: Should not be usable as stepping stone for further attacks to the network or as zombies!

CVSS
Common Vulnerability Scoring System

- To provide a common way to assess vulnerabilities
  - → I.e., how urgent is fixing the problem (ranking)?
- It provides
  - → Standardized vulnerability scores: Single score for all hard- & software systems, regardless of vendor (and their scores)
    - » Also immune from their interests/motivations!
  - → Open Framework: Clear definition how the score was calc.
    - » Allows comparison between vulnerabilities
  - → Prioritized risk: Individualization for each company
    - » Some part of the CVSS is world-applicable, though!
- Note: This is version 2!
- Response (generalized; from CVSSv1 typical responses):
  - → 0-3: Wait for service pack; 4-5: Next patch cycle; 6-7: Within 1 week; 7-10: NOW!

How CVSS works



- Three metric groups: Base, temporal and environmental
  - → Base: Intrinsic & fundamental characteristics of vulnerability
    - » Constant over time, independent of environment
  - → Temporal: What changes over time
    - » Independent of environment
  - → Environmental: Properties depending on the actual use of the vulnerable system at the end-users installation

CVSS overview

- Base and temporal metrics specified by security analysts
  - → Requires detailed knowledge of the product, the vulnerability and possible/existing exploits
  - → Environmental metrics → Calculated by everyone himself!
- Each vulnerability is scored separately
  - → Synergistic effects are ignored → Can be added through environmental metrics (security requirements)
- Vulnerabilities are scored according to a typical installation
  - → If you have special security precautions, your CVSS could be lower, if security is loosened, higher!
- Worst-case scoring: Better safe than sorry
  - → If several attack vectors exist → Easiest one
  - → Several products affected, but patch only for one → Unfixed
  - → Root level access → Complete loss of C, I, and A!
    - » Plus: Loss of integrity usually affects availability too

Base metrics

- Access Vector: How the vulnerability can be exploitet
  - → Local, adjacent network (broadcast/coll. domain), network
- Access Complexity: How difficult is the exploitation after achieving access to the system
  - → Low (little skill, manually possible), medium (limit sources, additional data needed, non-default config.), high (special conditions only; race condition, suspicious social eng.)
- Authentication: How often authentication is necessary
  - → None, single, multiple (>=2; even if same credentials)
- Confidentiality Impact: What data can be accessed
  - → None, partial (some tables in DB only), complete (everything)
- Integrity Impact: What the attacker could modify
  - → None, partial (no control which files), completely (everything)
- Availability Impact: What other users experience
  - → None, partial (delays), complete (shutdown, unusable)

Temporal metrics

- Exploitability: State of exploit technology available
  - → Unproven (theoretical), proof-of-concept (unpractical, needs substantial modifications by skilled attacker), functional (code available and works in most situations), high (exploitable by mobile autonomous code, works every time), not defined
- Remediation Level: What is available as a fix
  - → Official fix (patch by vendor), temporary fix (official but temporary patch), workaround (unofficial solution), unavailable (no solution, impossible), not defined
- Report Confidence: How sure it is the vulnerability exists
  - → Unconfirmed (single unconfirmed source, conflicting reports, rumour), uncorroborated (multiple non-official sources), confirmed (acknowledged by vendor, publication, exploit code, exploitation), not defined

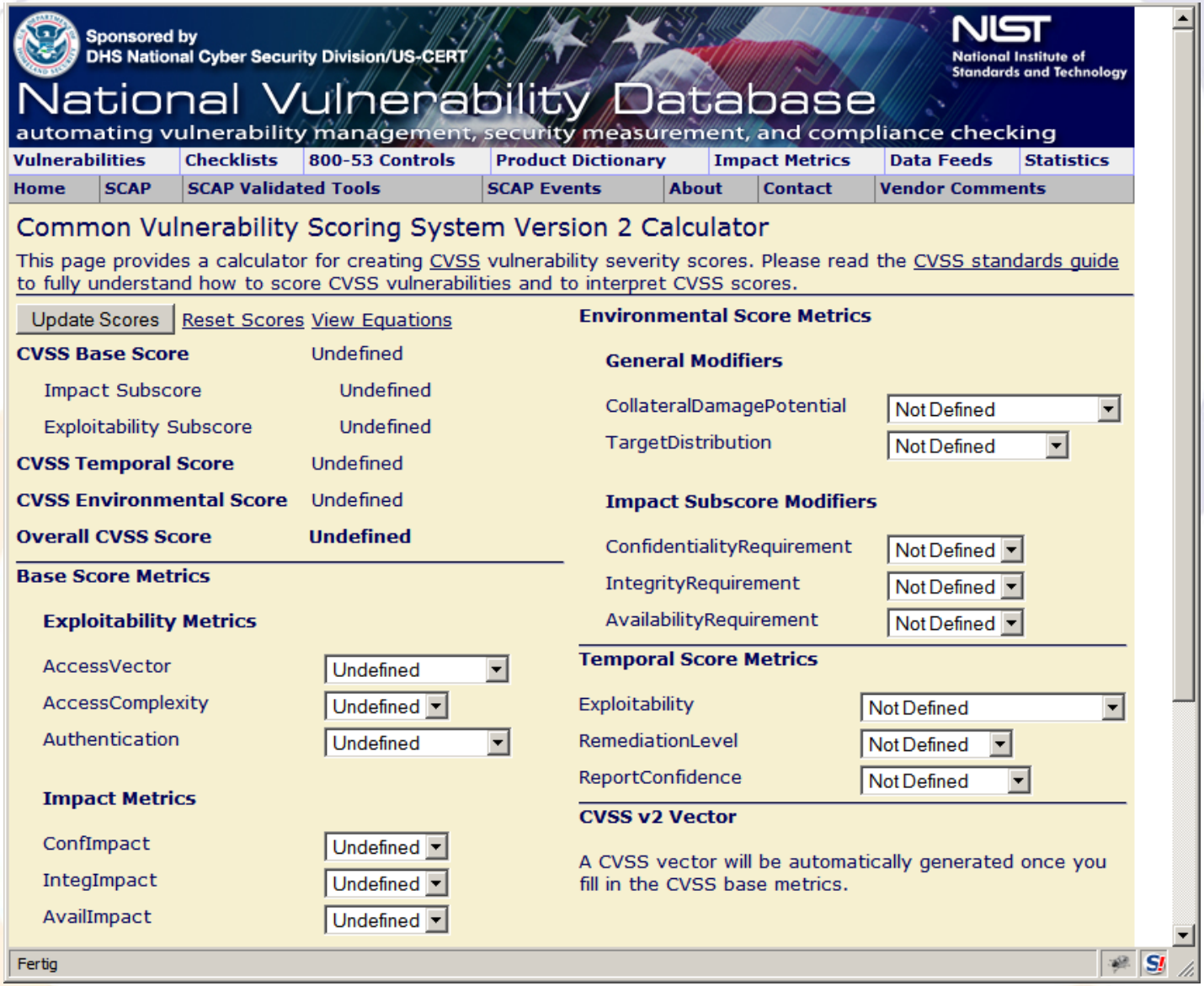
Environmental metrics

- Collateral Damage Potential: Potential for loss of life or physical assets; economic/productivity/revenue loss
  - → None, low (slight damage), low-medium (moderate loss), medium-high (significant loss), high (catastrophic damage), not defined
    - » Note: What is "slight" or "moderate" is company specific as well!
- Target Distribution: Percentage of systems potent. affected
  - → None, low (small scale; 1%-25%), medium (26%-75%), high (76%-100%), not defined
    - » Percentage as affecting the total environment
      - – One central single point of failure → 100%!
    - » Very high influence on final result!
- Security Requirements: Importance of the asset to the organization; 3 parts (availability, integrity, confidentiality)
  - → Low (limited adverse effects), medium (serious effects), high (catastrophic effects), not defined

Scoring

- Scoring is very complicated and consists of numerous equations and values for each possible value
  - → Base score = ((0.6*Impact)+(0.4*Exploitability)–1.5)*f(Impact))
    - » Impact = 10.41*(1-(1-ConfImpact)*(1-IntegImpact)*(1-AvailImpact)
    - » Exploitability = 20*AccessVector*AccessComplexity*Authentication
    - » f(impact)=0 if Impact=0, 1.176 otherwise
    - » AccessVector: local=0.395, adjacent=0.646, network=1
  - → TemporalScore = BaseScore*Exploitab.*Remed.Level*ReportConf.
  - → EnvironmentalScore = (AdjustedTemporal+(10-AdjustedTemporal)* CollateralDamagePotential)*TargetDistribution
    - » AdjustedTemporal = Temporal score recomputed with the base scores impact adjusted by the CAI-requirements
    - » AdjustedImpact = min(10,10.41*(1-(1-ConfImpact*ConfReq)* (1-IntegImpact*IntegReq) *(1-AvailImpact*AvailReq)))
- Complicated calculation! → Use software
  - → http://nvd.nist.gov/cvss.cfm?calculator&adv&version=2

Scoring


Sponsored by
DHS National Cyber Security Division/US-CERT
NIST
National Institute of Standards and Technology
National Vulnerability Database
automating vulnerability management, security measurement, and compliance checking
Vulnerabilities
Checklists
800-53 Controls
Product Dictionary
Impact Metrics
Data Feeds
Statistics
Home
SCAP
SCAP Validated Tools
SCAP Events
About
Contact
Vendor Comments
Common Vulnerability Scoring System Version 2 Calculator
This page provides a calculator for creating CVSS vulnerability severity scores. Please read the CVSS standards guide to fully understand how to score CVSS vulnerabilities and to interpret CVSS scores.
Update Scores
Reset Scores
View Equations
CVSS Base Score
Undefined
Impact Subscore
Undefined
Exploitability Subscore
Undefined
CVSS Temporal Score
Undefined
CVSS Environmental Score
Undefined
Overall CVSS Score
Undefined
Base Score Metrics
Exploitability Metrics
AccessVector
Undefined
AccessComplexity
Undefined
Authentication
Undefined
Impact Metrics
ConfImpact
Undefined
IntegImpact
Undefined
AvailImpact
Undefined
Environmental Score Metrics
General Modifiers
CollateralDamagePotential
Not Defined
TargetDistribution
Not Defined
Impact Subscore Modifiers
ConfidentialityRequirement
Not Defined
IntegrityRequirement
Not Defined
AvailabilityRequirement
Not Defined
Temporal Score Metrics
Exploitability
Not Defined
RemediationLevel
Not Defined
ReportConfidence
Not Defined
CVSS v2 Vector
A CVSS vector will be automatically generated once you fill in the CVSS base metrics.
Fertig

CVSS example:CVE-2002-0392

Apache Chunked-Encoding Memory Corruption Vulnerability

- Execution of arbitrary code (with webserver privileges) or DoS through incorrect handling of chunked encoding
- Base score = 9
  - → Access Vector: Network (possible from remote)
  - → Access Complexity: Low (nothing special required)
  - → Authentication: None (just send a request)
  - → Confidentiality, Integrity Impact = Partial (web content, local user/configuration information; arbitrary code)
  - → Availability Impact = Complete (DoS)
- Temporal score = 7.4
  - → Exploitability = Functional (exploit code exists)
  - → Remediation Level = Official fix (official patch available)
  - → Confidence = Confirmed (→ official patch!)
- Environmental: Depending on assessment → 0.0 – 9.2

Conclusions

- Many different threats exist → Ignoring them will not help!
- There is no single solution for security
  - → Against various attacks various countermeasures are available
- Vulnerabilities must be monitored closely
  - → Depending on size, just observer the lists or calculate your own CVSS for all new vulnerabilities yourself
- Minimum configuration for every computer:
  - → Anti virus + personal firewall
- Minimum configuration for every network:
  - → Firewall
  - → Optional: Proxies with content inspection for various protocols
    - » E-Mail: Anti virus, anti spam, WWW: Exploit/virus/URL-filtering
    - » Intrusion detection system for infrastructure hosts and network

Questions?

Thank you for your attention!

Literature

- Mell, Peter, Scarfone, Karen, Romanosky, Sasha: A Complete Guide to the Common Vulnerability Scoring System Version 2.0 http://www.first.org/cvss/cvss-guide.html
- BSI: Register aktueller Cyber-Gefährdungen und –Angriffsformen https://www.bsi.bund.de/SharedDocs/Downloads/DE/BSI/Cyber-Sicherheit/BSI-A-CS_001.pdf?__blob=publicationFile