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Security

by Spencer Tiberi

Introduction (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=0m1s)

- Our data is under constant threat, but how can we defend ourselves?

Privacy (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=0m22s)

- Keeping people away from things you don’t want them to see
- Computers are among the lease secure devices you own
  - Data or files are stored on them as 0s and 1s
    - Can be financial info, photos, etc.

Deleting Files (https://video.cs50.net/cscie1a/2017/fall/lectures/security?

(https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=1m13s)

- What does it mean to delete a file off of a hard drive?
    - Visually, it disappears from a desktop or folder
- Files are stored on a computer as 0s and 1s
- Some space needs to be allocated for the file
- The operating system has a file that keeps track of files an their location on disk
- Graphically, when a file is deleted, it moves to the trash (or recycle bin)
    - It can still be easily revived from here, until you empty the trash
- However, an operating system doesn't actually delete it from the hard drive
    - It simply forgets the location and existence of the file!
    - One can theoretically recover data by looking for familiar patterns of bits
- So how do we delete more securely?
    - Re-saving a file with overridden information actually could not override the old bits but rather create more 0s and 1s stored on a hard drive!
    - Special software can wipe data off of a hard drive
- Who do computers have this obvious flaw with deleting?
    - What if we accidentally delete a file?
        - This structure allows for recovery
    - Wiping data also takes a lot of time, so it's much faster to just forget locations of data

Cookies (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=7m30s)

- A feature supported by HTTP
- Little values a web server puts on a user's browser
- Used to remember if a user has visited a website before
    - Allows you to not have to log in every time you visit or refresh a page
        - When you log into a web server, a cookie is planted on your browser
    - Stored in a database
    - Browser will send value to web server to remind of previous login
- When we make a request we send:

```
GET / HTTP/1.1
Host: example.com
```

- We receive:

- We receive:

  ```
  HTTP/1.1 200 OK
  Set-Cookie: session=29823bf3-075a-433a-8754-707d05c418ab
  ```

  - The server gives us a cookie.
- A cookie is like an ink-based hand stamp for an amusement park or club
- Wireless information can be intercepted
  - What if a hacker could obtain the cookie
    - Session hijacking attack
    - If you have already logged in, hacker can pretend to be you
- Encryption scrambles this value so hackers cannot easily use it
- Browser history remembers everywhere you've been and everything you've done there
  - Convenient if you want to recall a website you've visited
    - But, so can anyone else with access to your browser
- Can clear browser history and cookies
  - History likely not securely scrubbed

  - Will protect you from nosey friends
  - Websites will forget you visited as the cookies will be deleted as well!

Incognito Mode (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=17m12s)

- Can open up a typically different colored browser window
- Use if you want history automatically removed
- Useful when building a website as sometimes you want a browser to forget old iterations of your website build

Authentication (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=18m41s)

- All of this assumes you log in
- If you don't use a passcode to protect your device, anyone can pretend to be you
  - What if you lose your phone or device?

Passwords (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=20m6s)

t=20m6s)

- On a phone could only be a few digits
  - Not super secure
  - _ _ _ _
    - With numbers, each space has 10 options
    - 10 x 10 x 10 x 10 = 10,000 possibilities
    - 0000-9999
- On many smartphones, you will have to wait for an amount of time if you have entered a bad passcode
  - Slows down the process of someone guessing
- Add more digits or letters of the alphabet
- Using a-z, A-Z, 0-9
- _ _ _ _
- Each space now has 62 options (26 + 26 + 10)
- 62 x 62 x 62 x 62 = 14,776,336 possibilities

- Maybe you're super secure and you have a 20-char password
  - You could forget it
  - Annoying to type in repetitively
- No one fits all
  - Short = bad, longer = good
  - Don't use popular words and phrases
    - Hackers will look for words or common phrases
- Most common Passwords
  1. 123456
  2. 123456789
  3. qwerty
  4. 12345678
  5. 111111
  6. 1234567890
  7. 1234567
  8. password
  9. 123123
  10. 987654321
- Hackers have dictionaries of bad passwords that they can search through and try
- Random passwords
  - Usually have to confirm so it can be hard to replicate
- Using numbers to represent letter is common

    - 1 for l
    - 4 for A
- It’s suggested you mix uppercase, lowercase, and and throw in numbers
    - Good to use misspellengs
- Don’t put your post-it with your password on your monitor!
- Constant password changes can be a net negative
    - Can encourage easier passwords to help with memorization

Password Resetting (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=30m49s)

- What if you forget your password?
    - Often can click on a link to reset your password
        - Asks you to type email address or username

    - Typically, you get an email with a link
        - Hopefully this goes back to the same website!
        - It likely has a random value in the URL
    - Once back at the website, you update your password
- The website has a database
    - It generated a random number and stored it with a note indicating password recovery
    - The website assumes that anyone who has access to this value and to the user’s email is you
- Typically, tech staff can’t tell you what your password is
    - Odds are your password is encrypted (scrambled) or, more technically, hashed in their database
- Getting a password in email means that the password are not hashed or encrypted!
    - Also, sending a password over email opens that email to interception
    - This is a red flag if a website does this

Using The Same Password (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=35m52s)

- You may have a favorite password that you reuse
    - Upside is that it’s convenient

- However, what if one of the websites are hacked?
    - A hacker may try to use the password on other websites to see what she or he can get into!

Password Managers (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=37m15s)

- Difficult to remember all these passwords
- Software called password managers exist that store on your phone or hard drive all usernames and passwords in an encrypted way
    - You have a master password that logs you into everywhere!
        - Store it physically in somewhere like a safety deposit box
- Password managers create long random passwords and will log in for you
    - All websites have different passwords!
- However, if you lose the master password, you cannot get the accounts back!

Two Factor Authentication (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=39m22s)

- First factor is a password
    - Historically, something "only" the user knows
    - Can be guessed
- Second factor should be fundamentally different
    - Should be something you have
        - An RSA device displays a unique value that is synced with a server

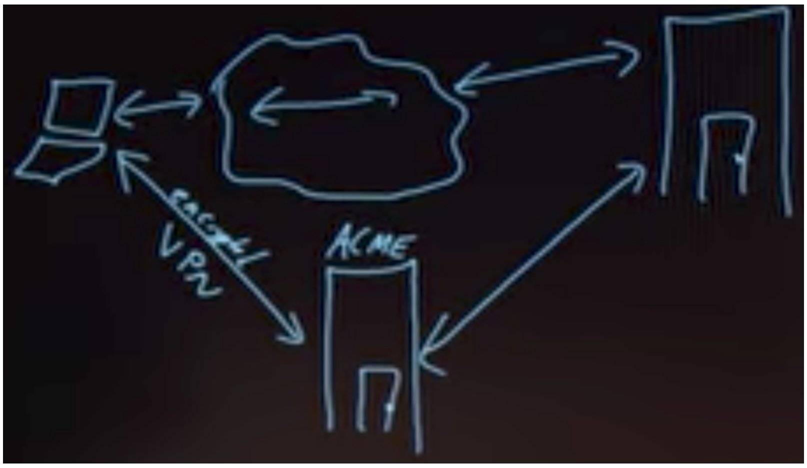
            - This number needs to be typed in too!
            - As long as this device isn't stolen by someone with your password, they can't get in as easily
        - Phones now run software that allows you to get a code and type them in

        - Phones now run software that allows you to get a code and type them in
- Should think about what websites you care about the most and enable two factor authentication
    - Some companies can use sms (text messages)

Network security (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=43m31s)

- So many of our current networks are wireless
    - You probably been conditioned to look for free wifi
        - Sometimes still might not connect for various reasons
- If the wireless connection has not padlock (no password to log in) the connection is not secure
    - You may still visit https or secure websites
    - However, everything you do on http sites can be seen

- What to do?
    - Don't use that network
    - Use a VPN (Virtual Private Network)
        - Connection to internet is encrypted



            - With an unsecured connection, anyone can access your data

VPN (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=46m57s)

- First establish encrypted connection to a server and let this server communicate for you
    - The connection between the VPN server and website can still be insecure!
- Because we are encrypting data through an algorithm, using a VPN can slow down speed

Firewall

Firewall (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=49m19s)

- A physical firewall is a wall between connected buildings that prevents the spread of fire
- In the world of computer science, a firewall is software that looks at IP addresses and helps keep bad guys out and user data inside
- Helps prevent people from accessing your computer

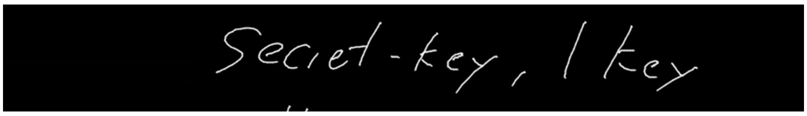
Encryption (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=51m4s)

- Suppose I want to send a secret message for “HI”
    - HI ➟ IJ
    - Change each letter by 1

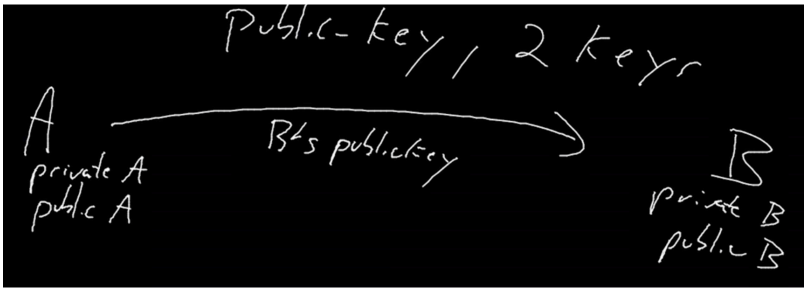
    - The recipient needs to know how it changed to revert
- Plaintext ➟ Cyphertext ➟ Plaintext
    - HI ➟ IJ ➟ HI
- This is called a caesar cypher
    - Rotational cyphers are not that secure
        - Can be guessed easily
        - Not used for internet encryption
    - For this to work, recipient needs the key
        - To know the key, we need to agree in advance
            - Can’t send it encrypted as well as they need the key!

Public Key Cryptography (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=54m44s)

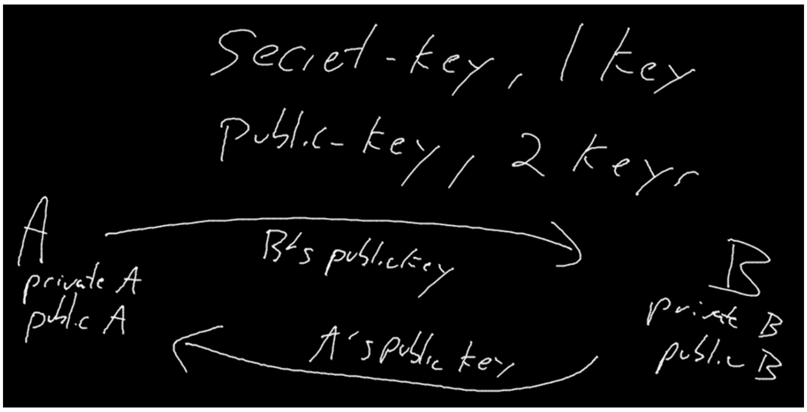
- The last example with a caesar cypher is secret-key cryptography
    - Only one key
- In public key cryptography there are two keys, one public and one private
    - Mathematical relationship between them
    - Use public key to encrypt, private key to decrypt



Secret-key, 1 key



  - Bob's private key can undo the effects of his public key
  - When Bob responds...



  - Bob sends a message using Alice's public key
- Your browser has its own public and private keys
  - So does websites like Google and Amazon
    - This allows them to communicate securely with you
- Often this processes is used to exchange a secret key

Phishing (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=58m28s)

- These kind of attacks have become so prevent that the following has been posted around Harvard's campus

Deleting helps you, reporting helps everyone.

phishing@harvard.edu

Learn to click wisely at security.harvard.edu.

HARVARD UNIVERSITY
Small Actions. Big Difference.
You help keep Harvard secure.

- Phishing attacks are when an adversary sends a somewhat official-looking email
    - May contain a link asking for a password or account info
    - The email may contain an elaborate backstory “justifying” the request
    - The malicious email is trying to obtain information from you
- Odds are that the link provided doesn’t go to the website being claimed
    - Can go to a website that looks legit
        - People can just copy HTML
- Results in giving up private information
- It’s healthy to distrust most email you get

    - Don’t follow links, type in the address for the company yourself
    - Sketchy emails may have typographical errors

Malware (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=1h2m10s)

- Malicious software can also be sent via email
- Windows is particularly vulnerable
- Software can be injected into your browser and your computer to erase your hard drive, make your computer send spam, or hold your data hostage
- Some malware encrypts your data and asks for large sums of money to get the key to decrypt it
    - Key could not even work!
    - This is called ransomware
- Malware can ultimately do anything on your computer

Trust (https://video.cs50.net/cscie1a/2017/fall/lectures/security?t=1h3m53s)

- At the end of the day, all of security and privacy boils down to trust
    - People around you
    - Algorithms/software

    - Algorithms/software
    - Manufacturers
- We’ve downloaded software with trust that it will only do what it claims
    - Word could log your key strokes
    - Chrome could monitor you even when not on Google’s website
    - Snapchat could not delete posts after being seen
- There have been cases where software was written to cover tracks of being monitored!
- Who’s to say the software we’re using is actually doing what we say?
- It’s east to curl up into a ball and worry, but we need to decide who to trust
- Security measures make it more difficult for someone to be malicious, but ultimately they can’t guarantee privacy
- You have to decide what data you’re comfortable with storing, what you view on the internet, who to trust, and how much to trust them