CS 45, Lecture 13
Security

Spring 2023

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Lecture Overview

The world is a scary place, and everyone is out to get you.

I hope you leave this lecture a *little* bit paranoid and a **lotta** bit interested in the field of security.

Lecture Overview

In today's lecture, we will cover:

- What computer security is
- Goals of computer security: authentication, confidentiality, integrity, and availability
- Social engineering attacks and general advice

What is Computer Security?

Computer security is the protection of computer systems and information from harm, theft, and unauthorized use.

> You'll find many different types and definitions of computer security (e.g. information security, network security, application security, etc.). These exact definitions are less important to us.

What is Computer Security?

The Computer Security Problem:

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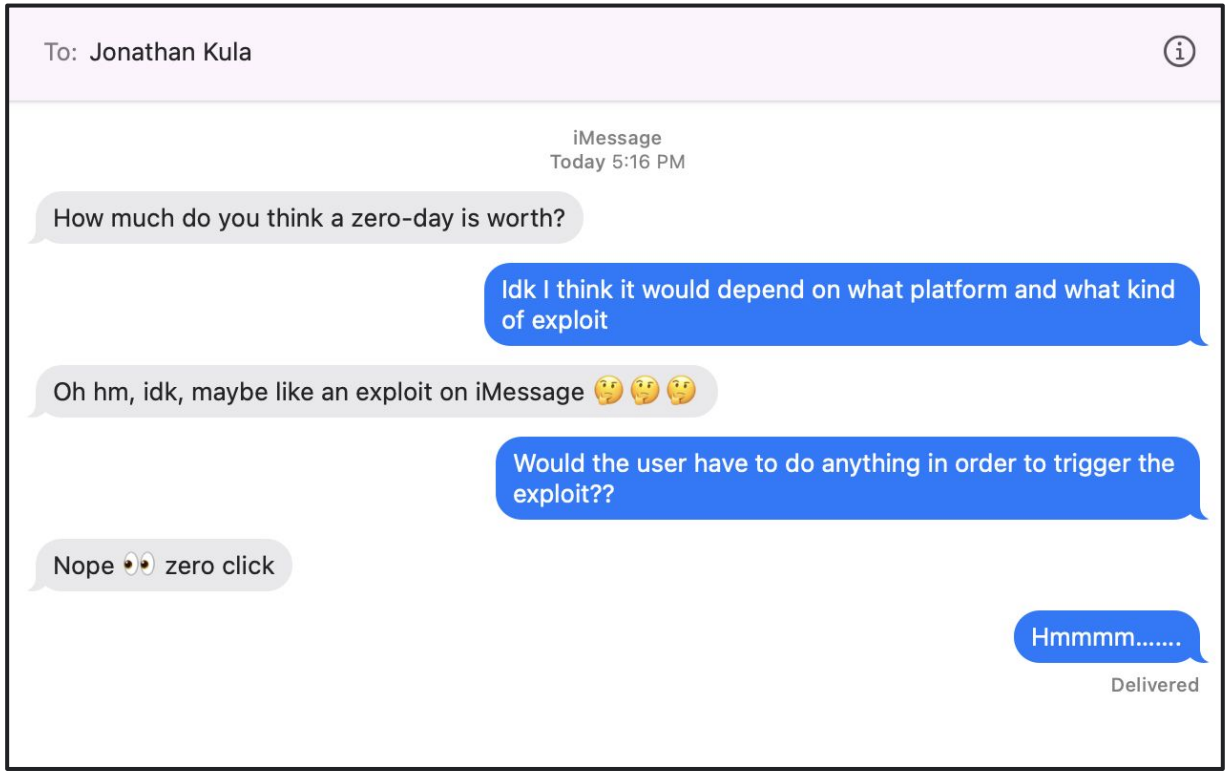
1) There is lots of buggy software out there.
2) A lot of money can be made from finding and exploiting these vulnerabilities.

What is Computer Security?



What is Computer Security?

The Computer Security Problem:

1) There is lots of buggy software out there.
2) A lot of money can be made from finding and exploiting these vulnerabilities.

A single zero-day exploit is estimated to be worth anywhere between $60,000 (Adobe Reader) to $2,500,000 (Apple iOS).

What is Computer Security?

A ***threat model*** is structured way to evaluate threats and risks to a system.

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To develop a threat model, we ask: **“what is our bad guy trying to do”**

It's important to think about who our adversary might be and what our adversary has access to.

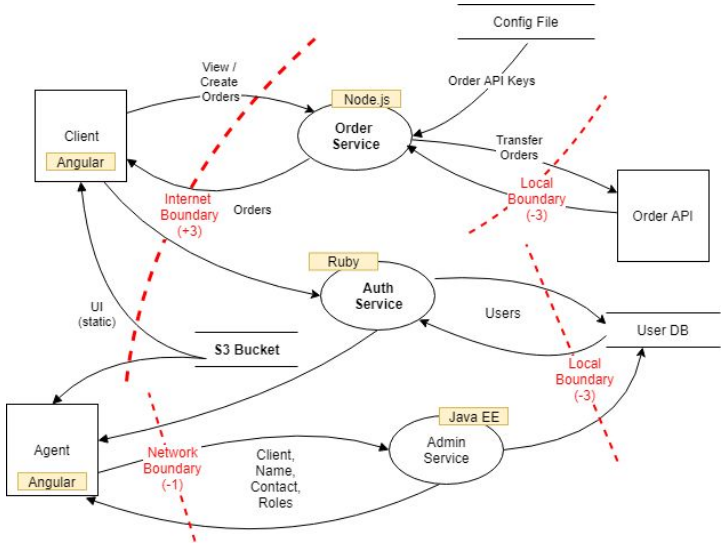


Diagram of complex threat modeling

What is Computer Security?

Threat models are context dependent.

Goals of Computer Security

We can consider a general case where we have some user, who wants to be able to:

- [ ] Visit the Bank of America website
- [ ] Log into their bank account
- [ ] View information about their bank statement
- [ ] Wire money to another user

Let's consider how we can guarantee security throughout this entire process.

Goals of Computer Security

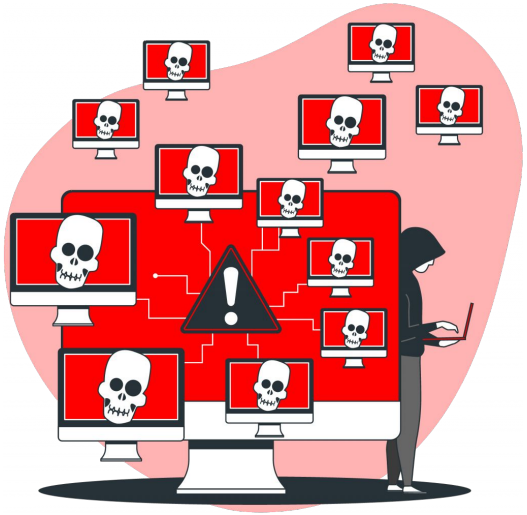
We can divide computer security into different goals:

1. Availability
2. Authentication
3. Confidentiality
4. Integrity

Availability

Availability: authorized users should always have access to their systems and data.

Problem: we want to prevent unauthorized users from preventing authorized users from using resources.



Availability

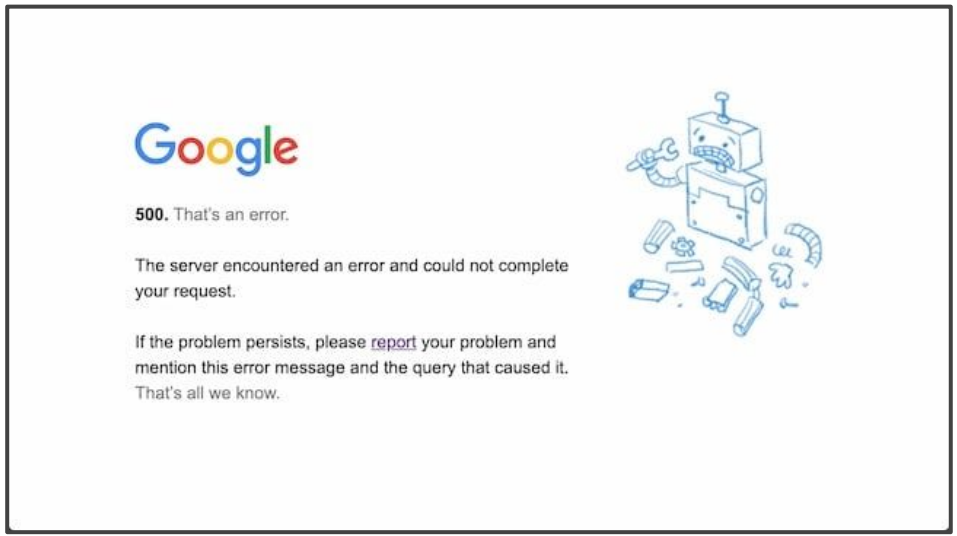
Let's experience something!

1. Open an alternate browser (that you **don't** normally use)
2. Visit **TheAnnoyingSite.com** and don't press any buttons
3. On the count of three... hold down the space bar!

Source: Feross Aboukhadijeh
https://github.com/feross/theannoyingsite.com

Availability

DoS Attack: Using up all of the resources is a way that an attacker can prevent other users from using the service.



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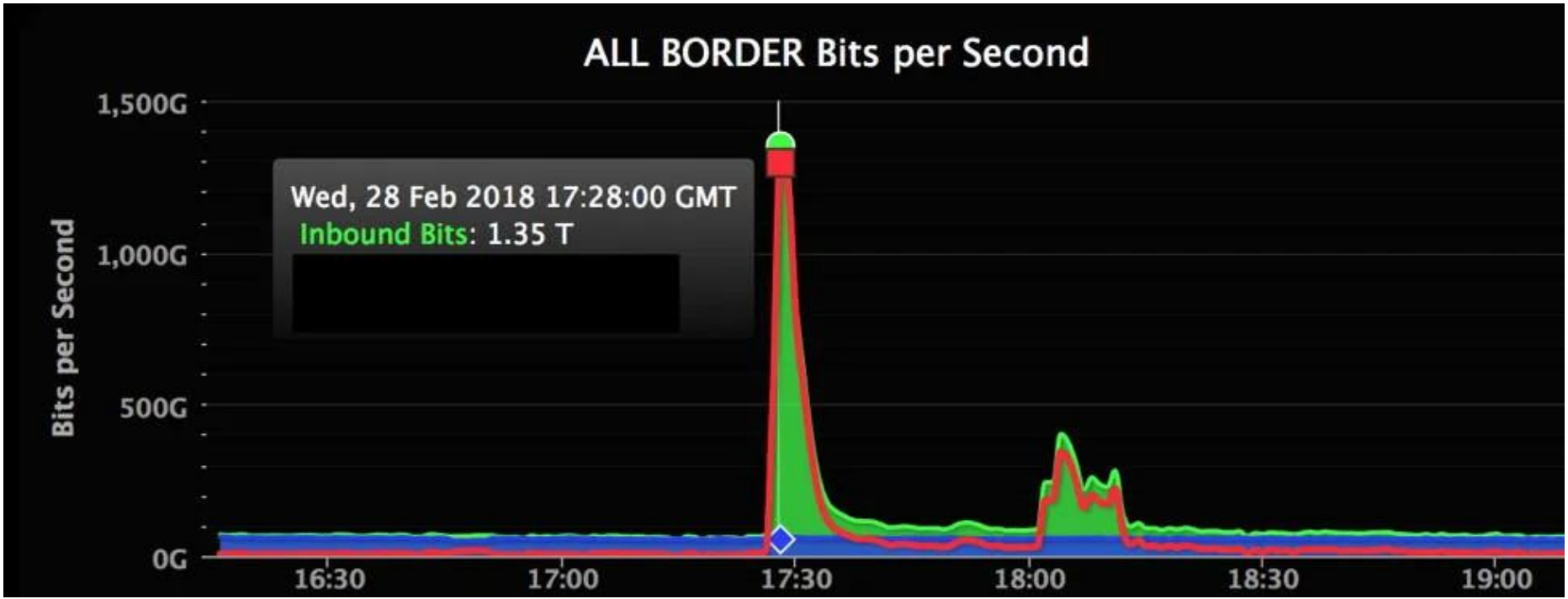

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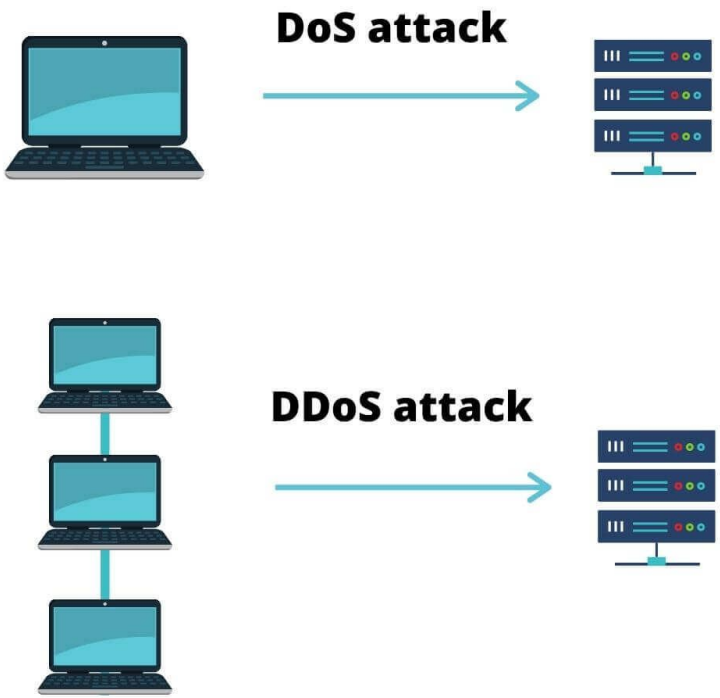


Source: UpGuard

Availability

DoS attacks are extremely prevalent!

DDoS cyberattacks temporarily
foreign ministry website

NYT, REDDIT, KICKSTARTER ARE ALL SUFFERING A DDOS ATTACK RIGHT NOW

e blocks record-breaking 71 million RPS DDoS attack

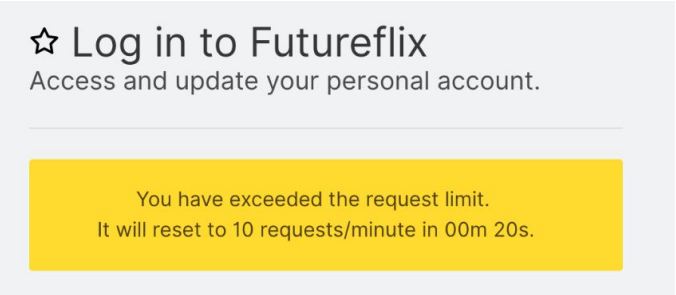
German airports hit with DDoS attack

The websites of seven German airports were taken down by hackers

Availability

Sites prevent DoS/DDoS attacks by:

- Limiting how many times you can make a request
- Distributing servers across multiple access points



Goals of Computer Security

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Authentication

Authentication is used to verify that a user is who they say they are.

Problem: we want to prevent unauthorized users from gaining access to our systems

Authentication

Most users choose weak passwords

Authentication

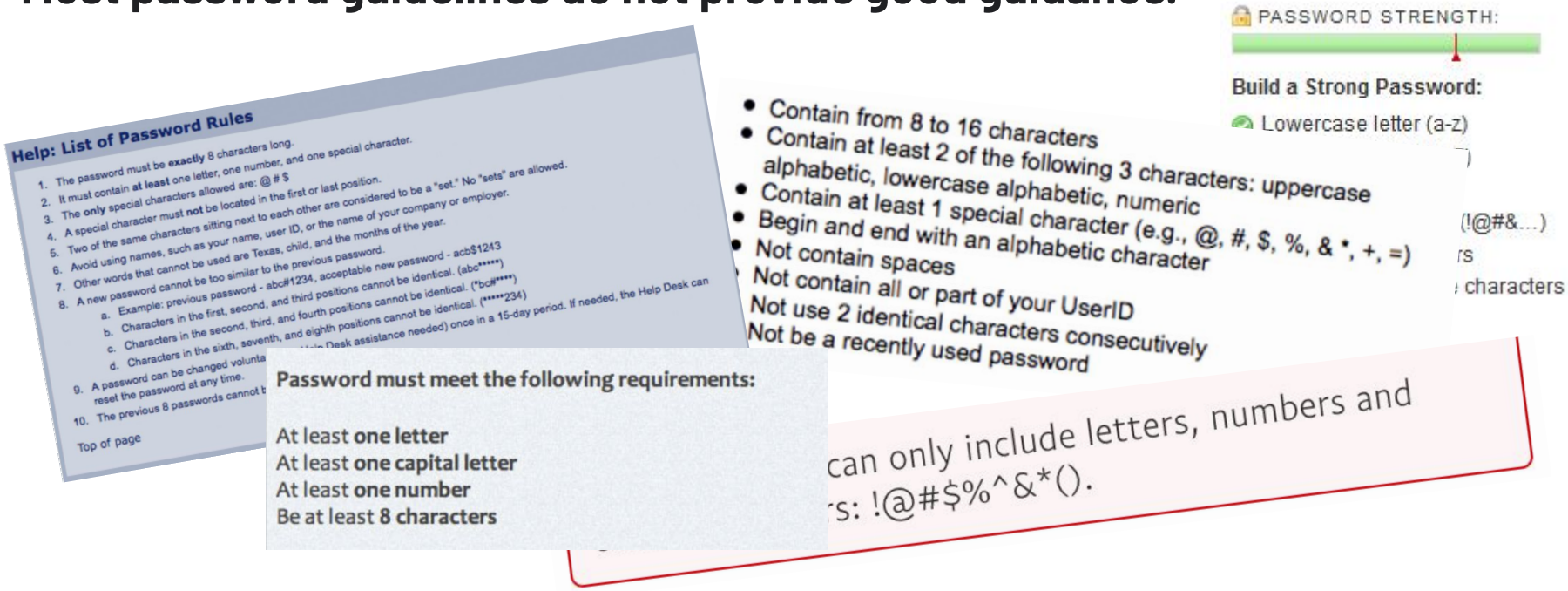
Most users choose weak passwords

2017	2018	2019	2020	2021	2022
123456	123456	123456	123456	123456	123456
password	password	123456789	123456789	123456789	123456789
12345678	123456789	qwerty	qwerty	12345	qwerty
qwerty	12345678	password	password	qwerty	password
12345	12345	1234567	1234567	password	1234567
123456789	111111	12345678	12345678	12345678	12345678
letmein	sunshine	12345	111111	111111	12345
12345678	1234567	iloveyou	123123	123123	iloveyou
football	qwerty	111111	iloveyou	1234567890	111111
iloveyou	iloveyou	123123	123abc	1234567	123123

Source: 2017-2020 and 2022 data from SplashData, 2021 data from NordPass

Authentication

Most password guidelines do not provide good guidance.



Source: Attorney General of Texas Child Support, Telnet, PayPal, and many other sites.

Authentication

Help: List of Password Rules

1. The password must be **exactly** 8 characters long.
2. It must contain **at least** one letter, one number, and one special character.
3. The **only** special characters allowed are: @ # $
4. A special character must **not** be located in the first or last position.
5. Two of the same characters sitting next to each other are considered to be a "set." No "sets" are allowed.
6. Avoid using names, such as your name, user ID, or the name of your company or employer.
7. Other words that cannot be used are Texas, child, and the months of the year.
8. A new password cannot be too similar to the previous password.
    a. Example: previous password - abc#1234, acceptable new password - acb$1243
    b. Characters in the first, second, and third positions cannot be identical. (abc*****)
    c. Characters in the second, third, and fourth positions cannot be identical. (*bc#****)
    d. Characters in the sixth, seventh, and eighth positions cannot be identical. (*****234)
9. A password can be changed voluntarily (no Help Desk assistance needed) once in a 15-day period. If needed, the Help Desk can reset the password at any time.
10. The previous 8 passwords cannot be reused.

Top of page

Authentication

Authentication

Choose the password!

`secretword` -or- `s$cretw0rd`
58 minutes — 1 month

`CoolWater` -or- `CfghWrylk`
17 hours — 19 hours

`HorseHouseLake` -or- `s$cretw0rd`
8 hundred thousand years — 1 month

`HorseHouseLake` -or- `HcdfyHatsrLpiq`
8 hundred thousand years — 23 trillion years

Source: https://www.security.org/how-secure-is-my-pasword/

Authentication

Password Best Practices

- Complex is not necessarily strong (e.g. `P@ssw0rd!`)
- Choosing multiple multiple random words may result in a stronger password, even if all words appear in a dictionary (e.g. `horsestaplebattery`)
- Check passwords against leaked breach data
- Don’t use the same passwords for all of your accounts!
- Length is the most important factor

Authentication

Password Manager

Authentication

Password Manager

Use one. 😁

Authentication

New Methods of Authentication

Something the user *knows*

Authentication

New Methods of Authentication

Something the user *knows* → a password

Authentication

New Methods of Authentication

Something the user *knows* → a password

Something the user has

Authentication

New Methods of Authentication

Something the user *knows* → a password

Something the user has → a phone, a badge, a cryptographic key

Authentication

New Methods of Authentication

Something the user *knows* → a password

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Something the user is

Authentication

New Methods of Authentication

Something the user *knows* → a password

Something the user has → a phone, a badge, a cryptographic key

Something the user is → a fingerprint, face ID, biometric data

Authentication

Goals of Computer Security

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Confidentiality

When we communicate with one another over the Internet, we expose ourselves to **privacy** concerns.

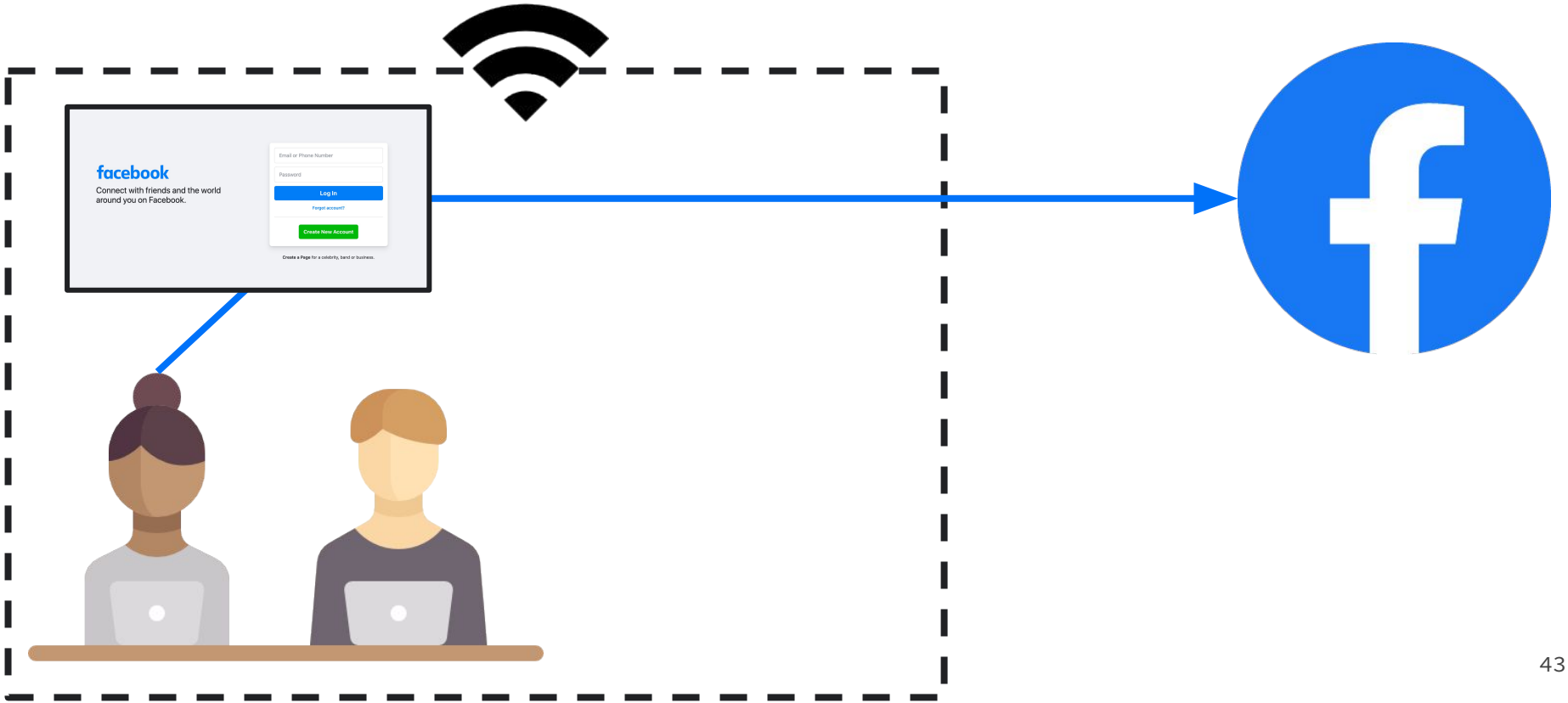
Unless our data is somehow obfuscated (usually through encryption), we risk other people seeing what we are sending.

Confidentiality

Confidentiality: only intended users should be able to read our data or information.

Problem: we want to prevent unintended users from reading information we send or that is stored on our systems

Confidentiality



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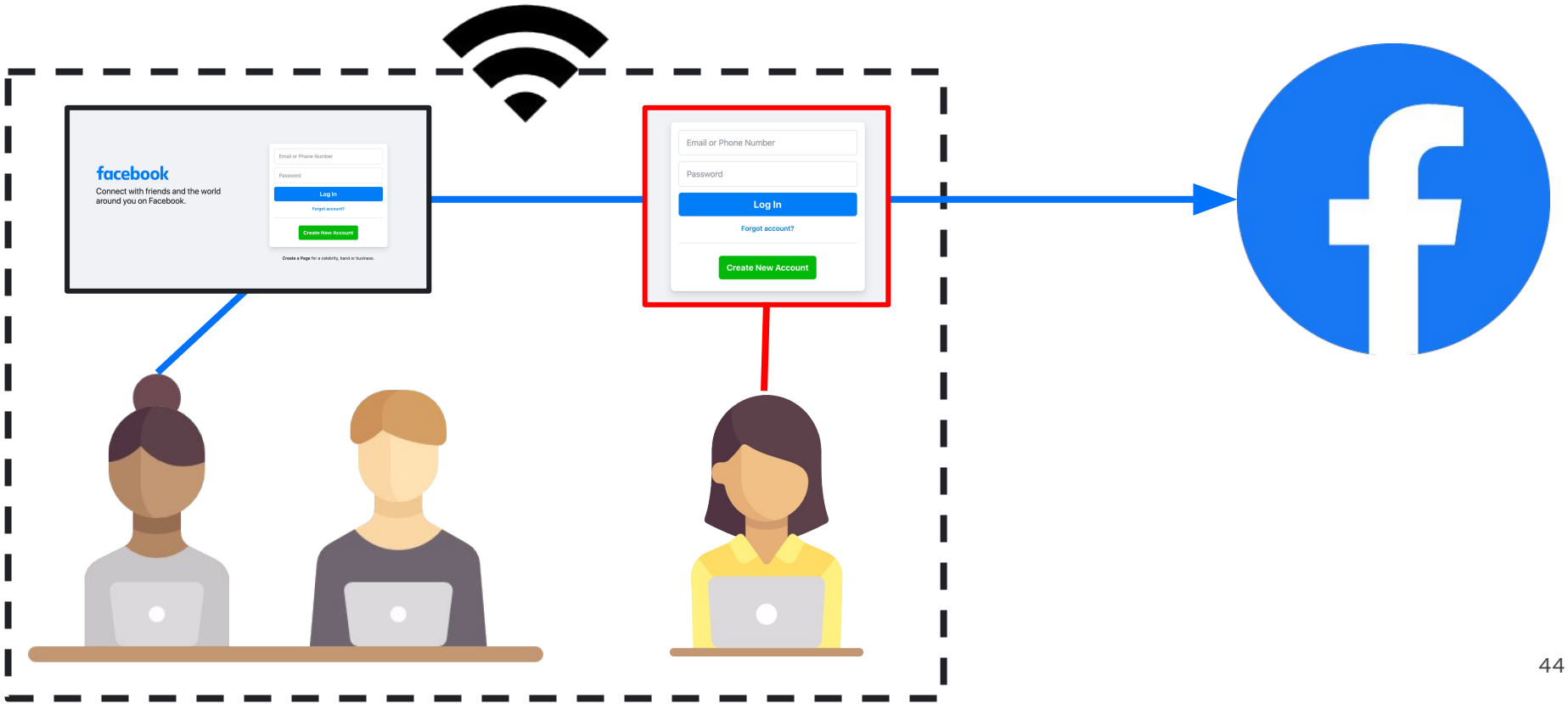

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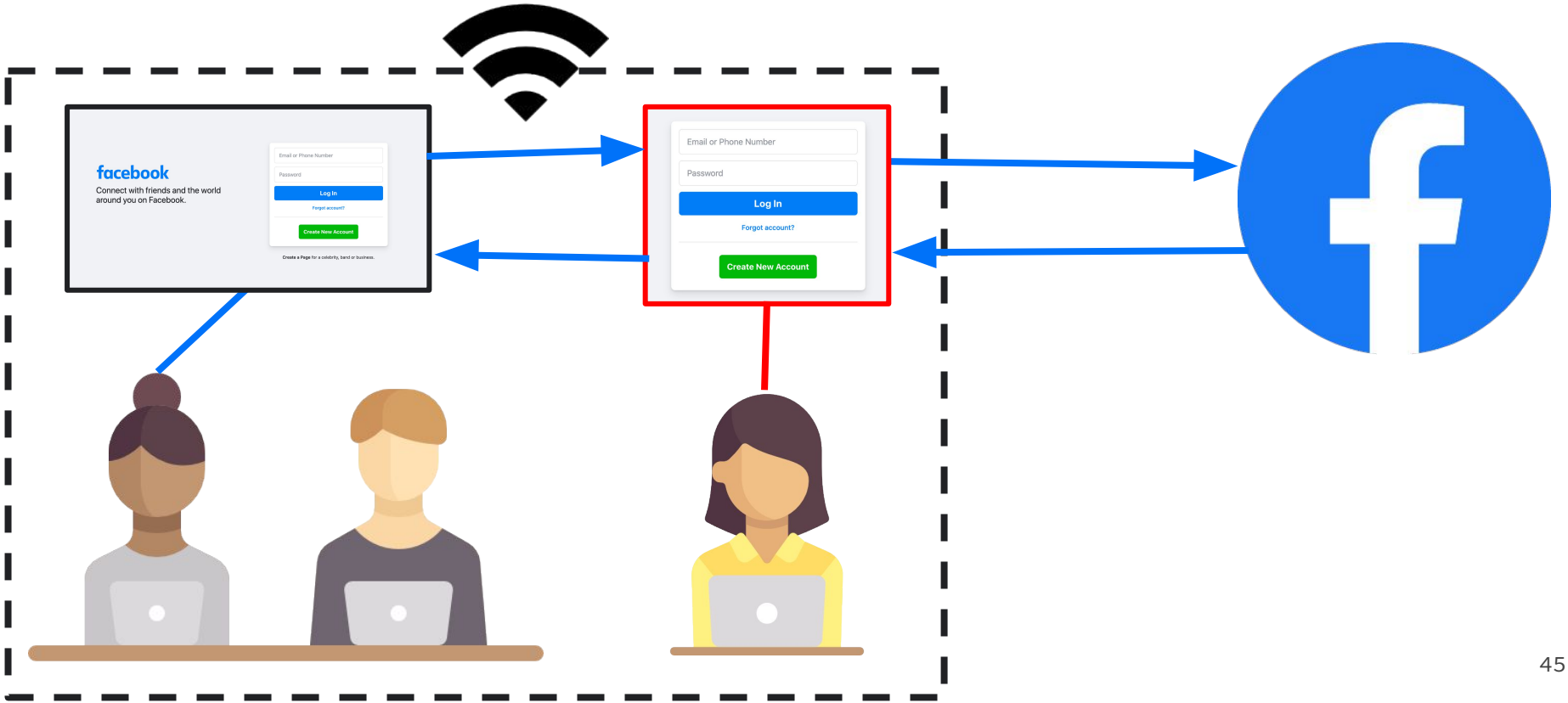

Confidentiality

HTTPS and TLS

HTTPS (Hyper Text Transer Protocol *Secure*) is used to send data between a web browser (e.g. Chrome running on your computer) and a website (e.g. Facebook).

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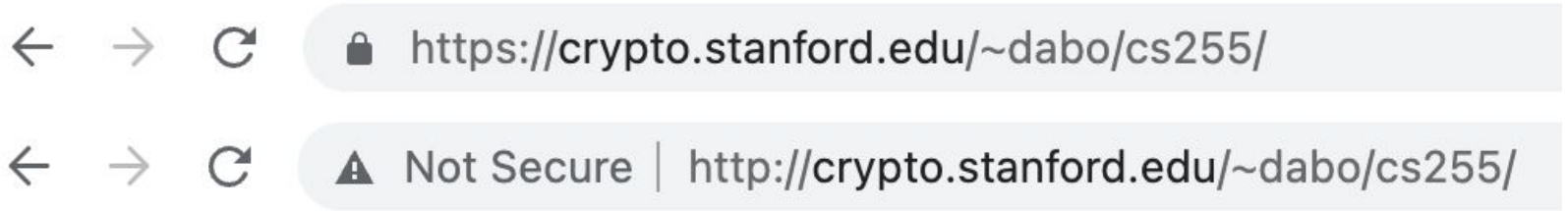

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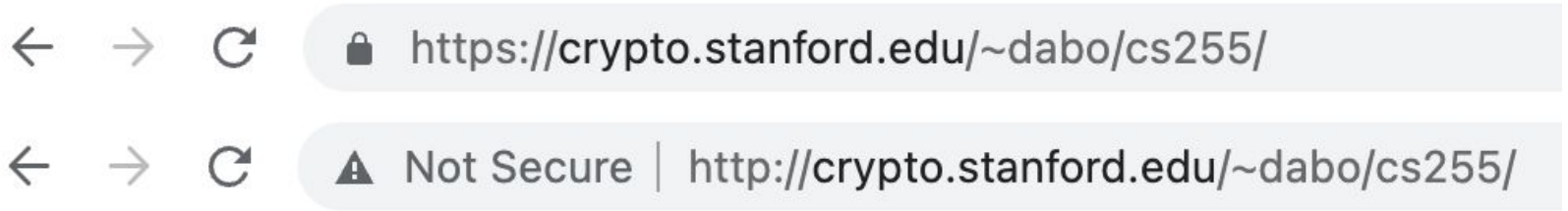


All of the data is encrypted using an encryption protocol called ***TLS*** (Transport Layer Security).

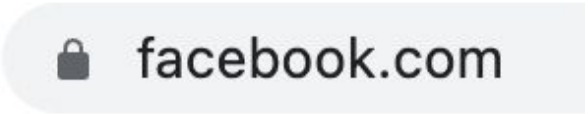
Confidentiality

[WIRESHARK DEMO]

Confidentiality

Confidentiality Best Practices

Always (we mean, *always*) use HTTPS.



Use private messaging: Signal is the best, WhatsApp is okay, Telegram is bad.

iMessage is secure... unless you have iCloud enabled.

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Integrity

Integrity: only authorized users should be able to modify data or information.

Problem: we want to prevent unauthorized users from modifying information that we send or that is stored on our systems

Integrity

On its way to 

"Jonathan sends $1000 to account Akshay."

`fg4s6yq8`	`7ll2ta0`	`95bh08qw`	`ab459k1q`	`5rtws2lp`

Integrity

On its way to BANK OF AMERICA

"Jonathan sends $1000 to account Akshay."

fg4s6yq8	7ll2ta0	95bh08qw	ab459k1q	5rtws2lp

"Jonathan sends $1000 to account Ayelet."

fg4s6yq8	7ll2ta0	95bh08qw	ab459k1q	p38ws5rd

Integrity

[XSS DEMO]

Integrity

We've already seen this!

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```
chgrp staff ./secrets
chmod g+r ./secrets
```

Integrity

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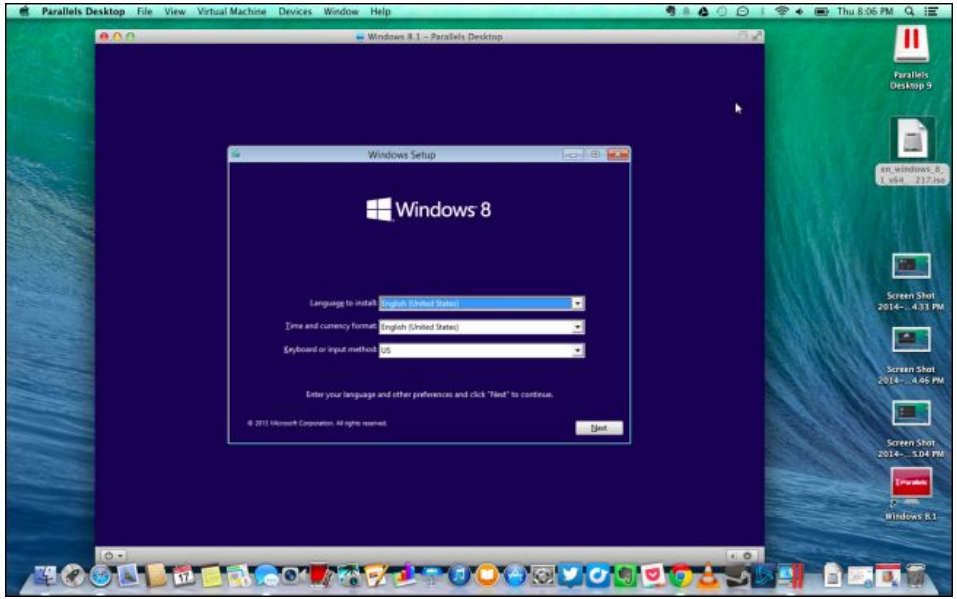
```

Access Control Lists (ACLs) describe what access each user has for every file, folder, or program.

ACLs maintain integrity by ensuring unauthorized users can't modify files.

Integrity

Virtual Machines are another way to preserve integrity is by ensuring that programs run within a confined ("sandboxed") environment.



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Social Engineering

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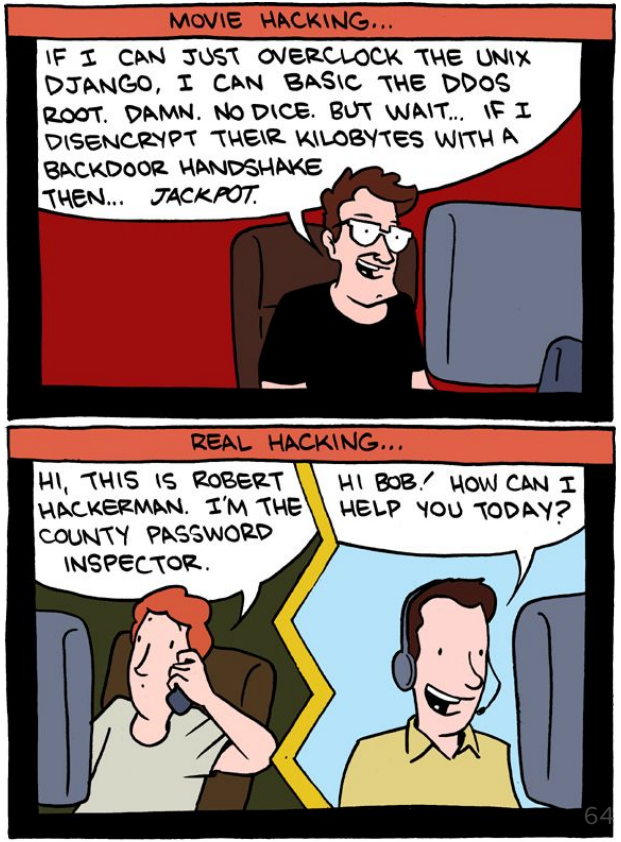

Social Engineering

Phishing Attacks

A ***phishing attack*** occurs when an attacker masquerades as a trusted entity and tricks the user into giving away sensitive information such as credit card information or login credentials.

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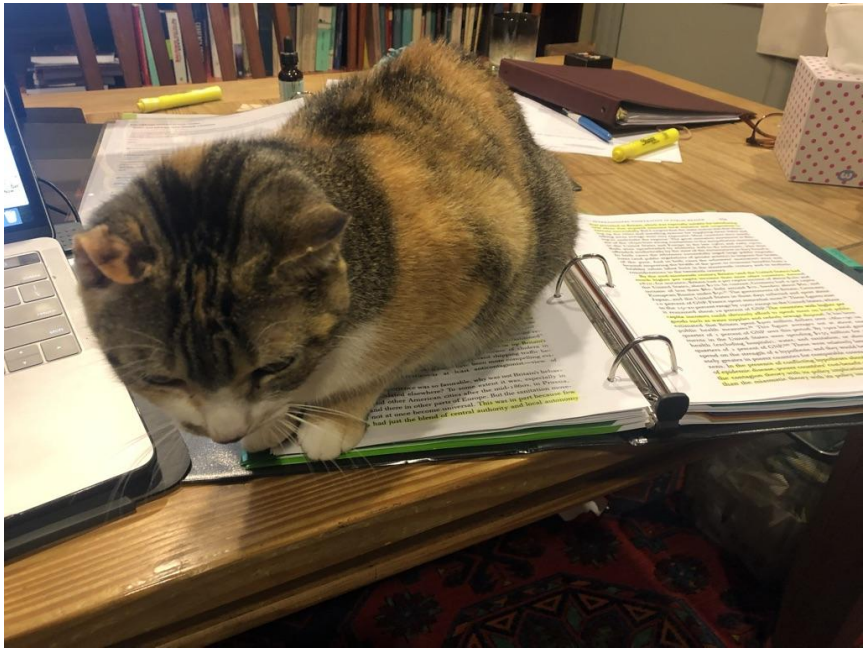
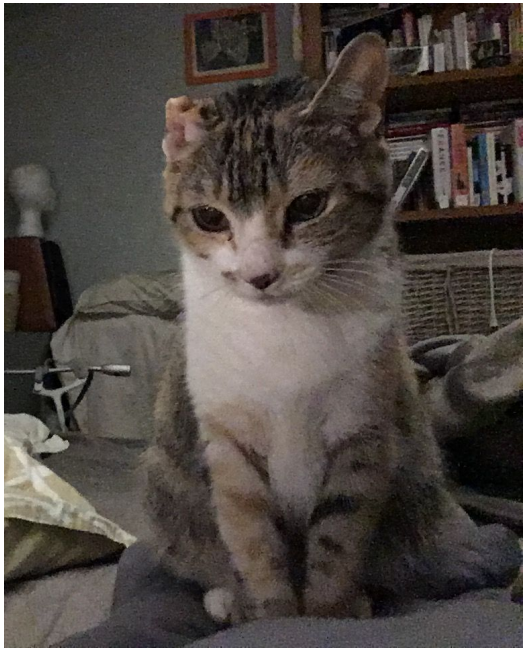
Example: a spoofed email from `it.stanford.edu`. The email claims that the user's password is about to expire and that the user needs to renew the password within 24 hours at a provided link.

Social Engineering

True Story Time



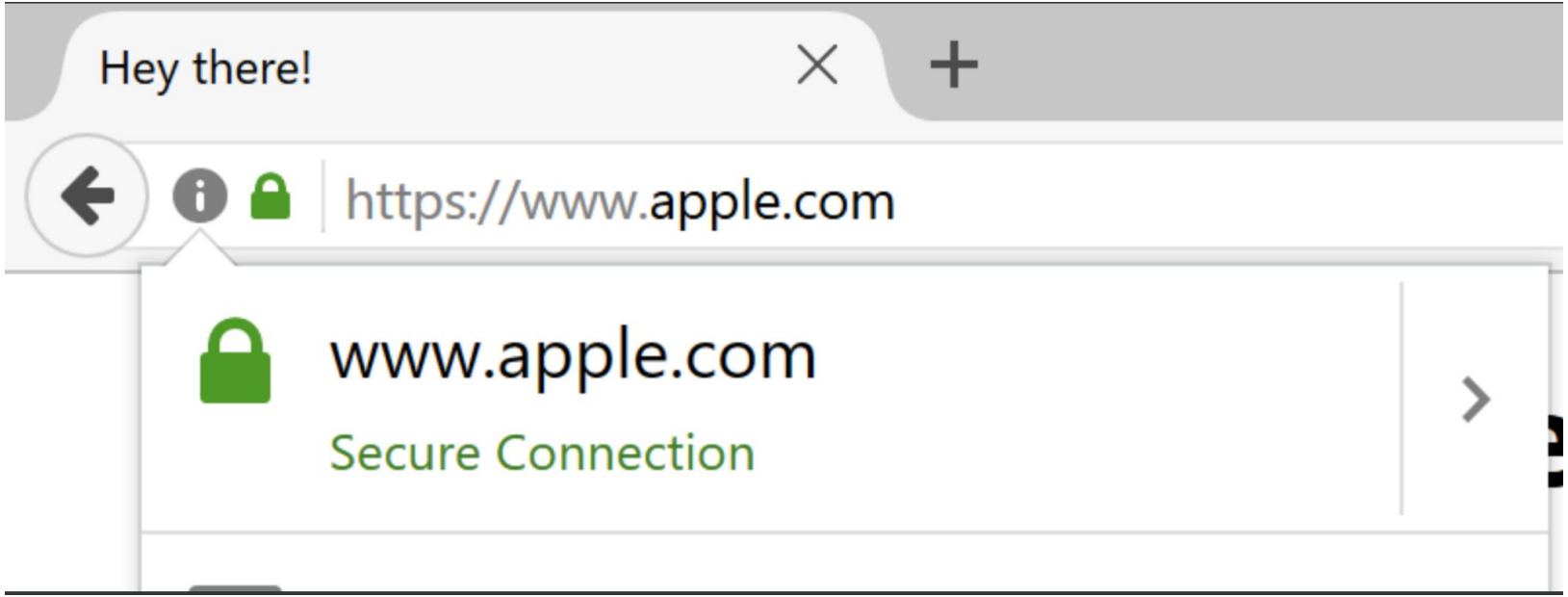


Social Engineering

True Story Time

Social Engineering

Notice anything wrong?



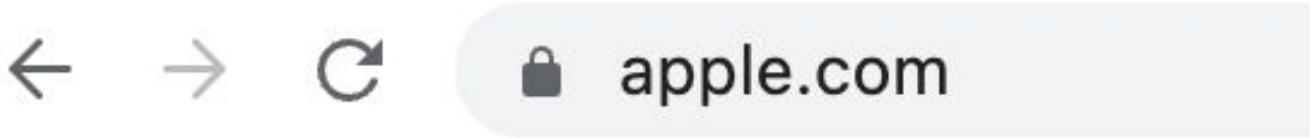
Social Engineering

Real:

Cyrillic:

Social Engineering

Real:



Cyrillic:

The Cyrillic representation uses punycode, which does break legitimate use cases.

Social Engineering

Best Practices Against Phishing

- Always ~~double~~ triple check that you aren't clicking on links from suspicious or unknown emails.
- Check the URL bar and sender address to make sure they appear as you expect them to.
- Use two factor authentication. Even if an attacker has your username and password, they won't have your smartphone...

Social Engineering

Ransomware Attack

A ***ransomware attack*** occurs when an attacker encrypts a user's files and data, and then demands a payment (a "ransom") in order to unlock the user's files and data.

Social Engineering

Best Practices Against Ransomware

- Backups, backups, backups.
- Turn on a file encryption system. (Encrypted File System for Windows, FileVault for macOS, or `dm-crypt` for Linux)
- Get your devices up to date. Updates are important because they often contain patches, which are fixes to remedy discovered vulnerabilities.

Other Advice

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- VPNs don't necessarily increase security; they change point of trust.
    - VPNs that are advertised on YouTube are almost completely useless; the VPN company can still see everything you do

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- Embedded devices (e.g. phones) are generally more secure.
- Again, use a password manager!