CS 45, Lecture 13
Security

Winter 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.

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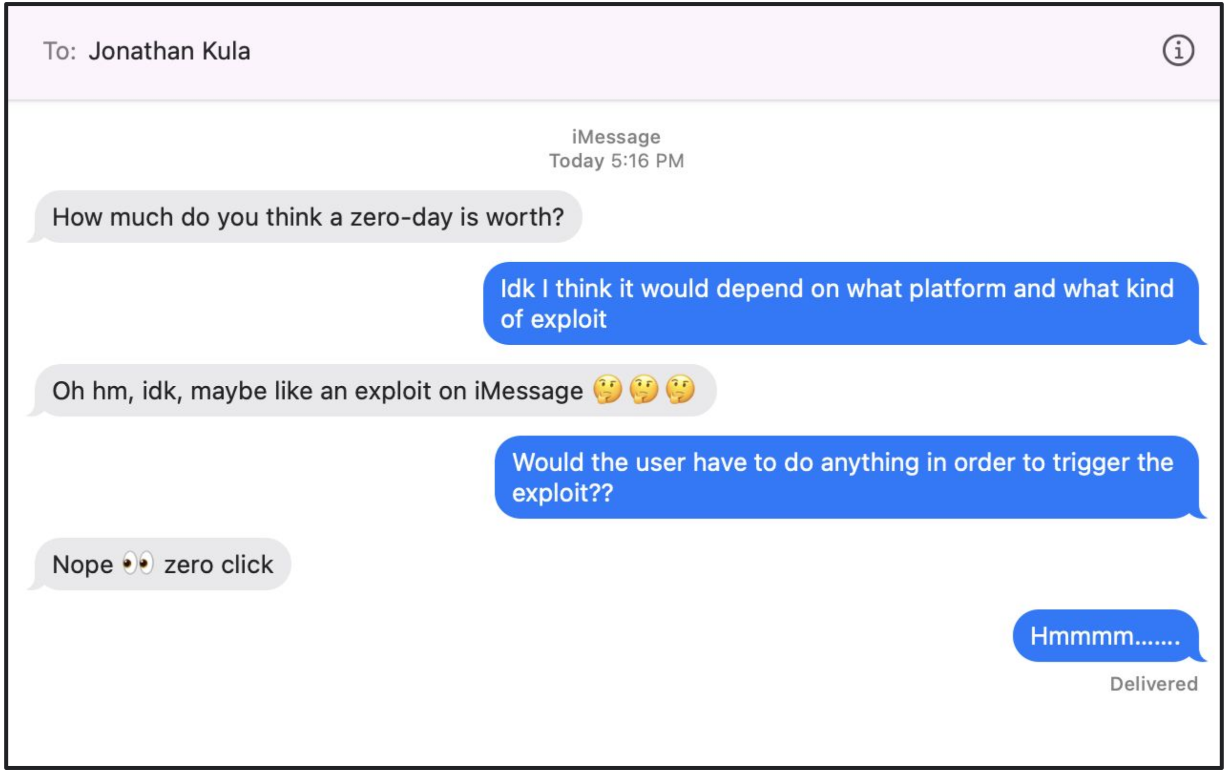
1) There is lots of buggy software out there.

2) A lot of money can be made from finding and exploiting these vulnerabilities.

What is Computer Security?



To: Jonathan Kula

iMessage
Today 5:16 PM

How much do you think a zero-day is worth?

Idk I think it would depend on what platform and what kind of exploit

Oh hm, idk, maybe like an exploit on iMessage 🤔🤔🤔

Would the user have to do anything in order to trigger the exploit??

Nope 👀 zero click

Hmmmm.......

Delivered

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

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.

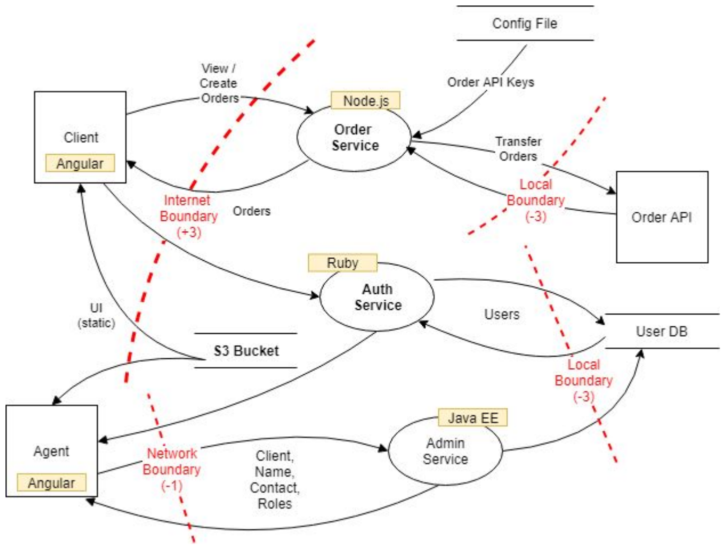
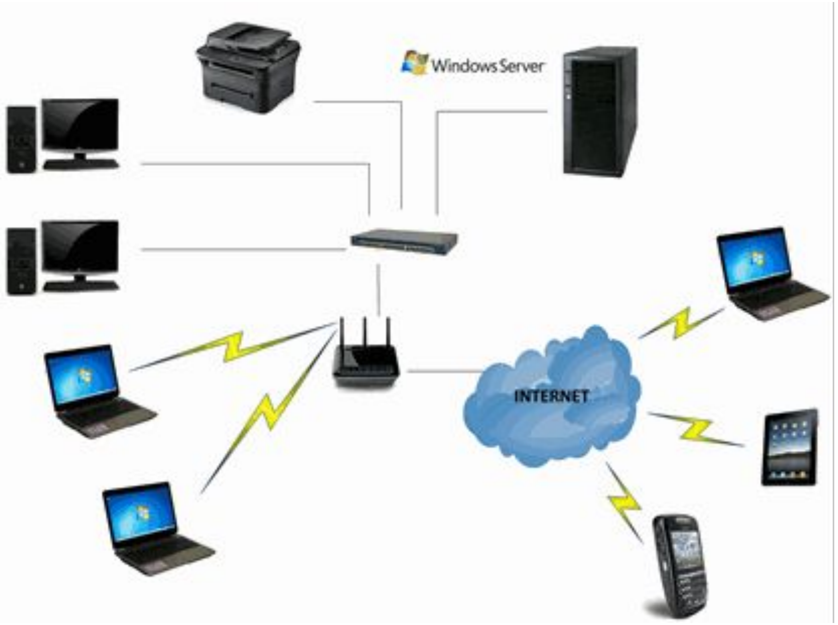


Diagram of complex threat modeling

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

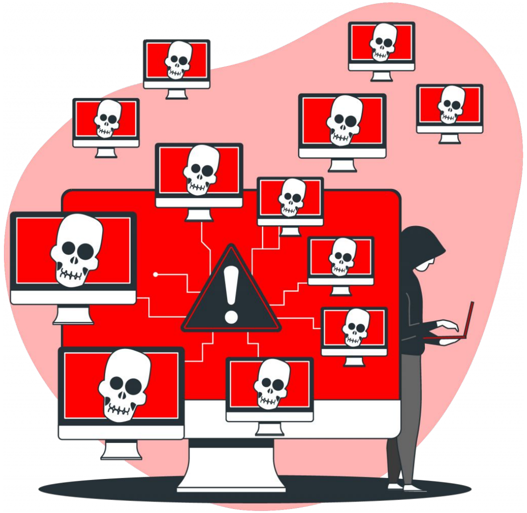
We can divide computer security into different goals:

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

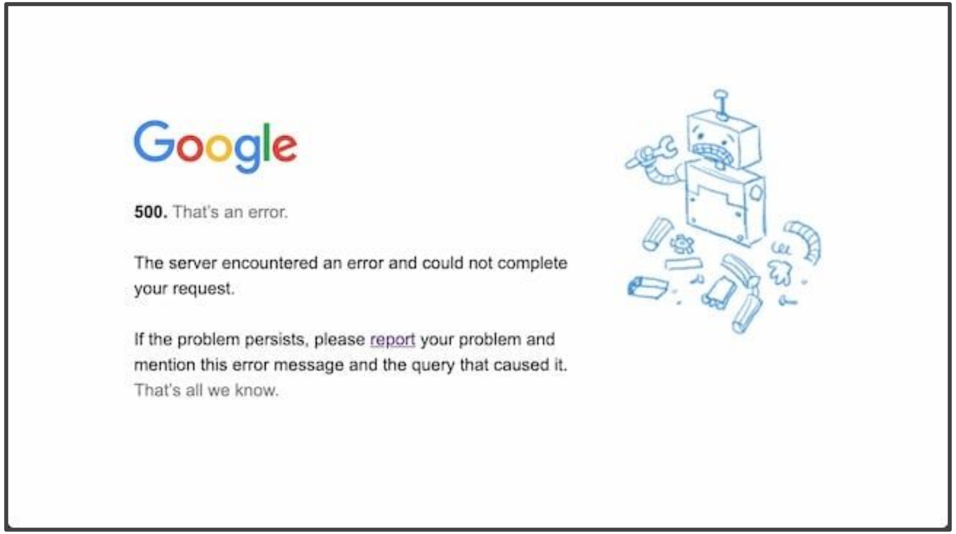
Let's experience something!

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.



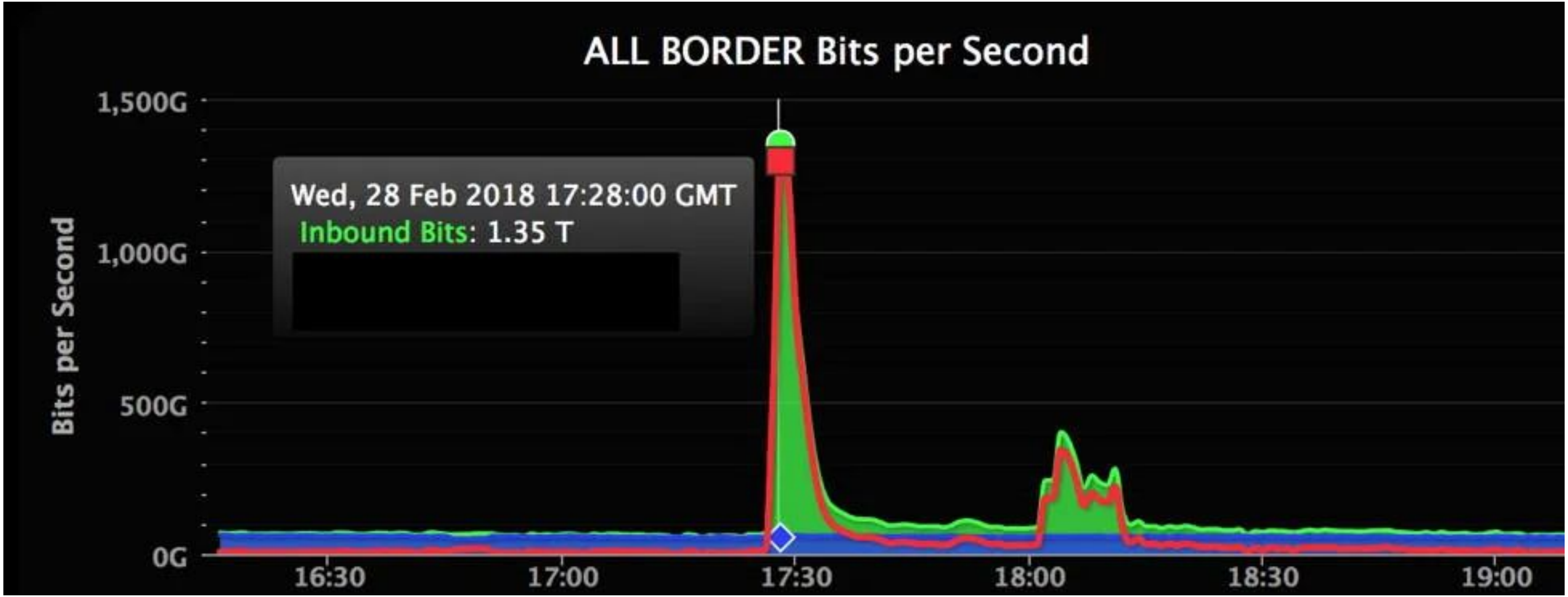
Google

500. That's an error.

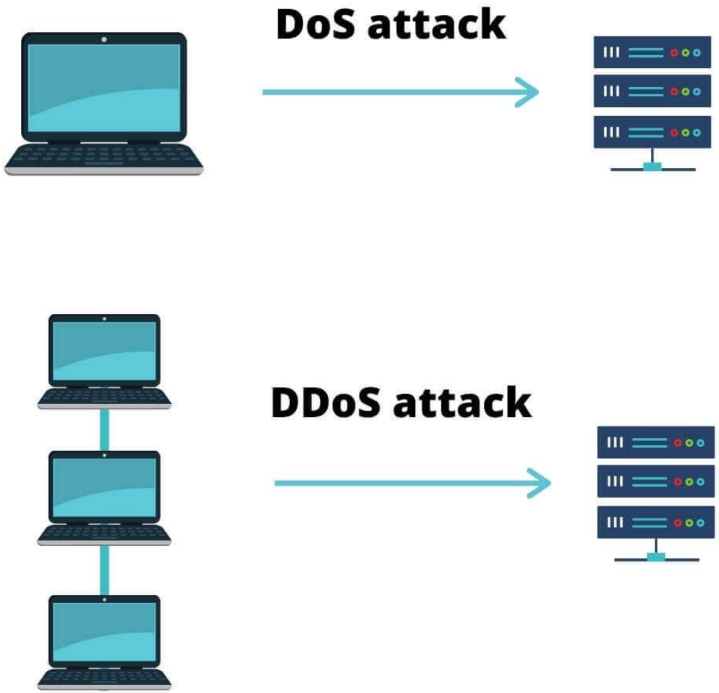
The server encountered an error and could not complete your request.

If the problem persists, please report your problem and mention this error message and the query that caused it. That's all we know.

Availability



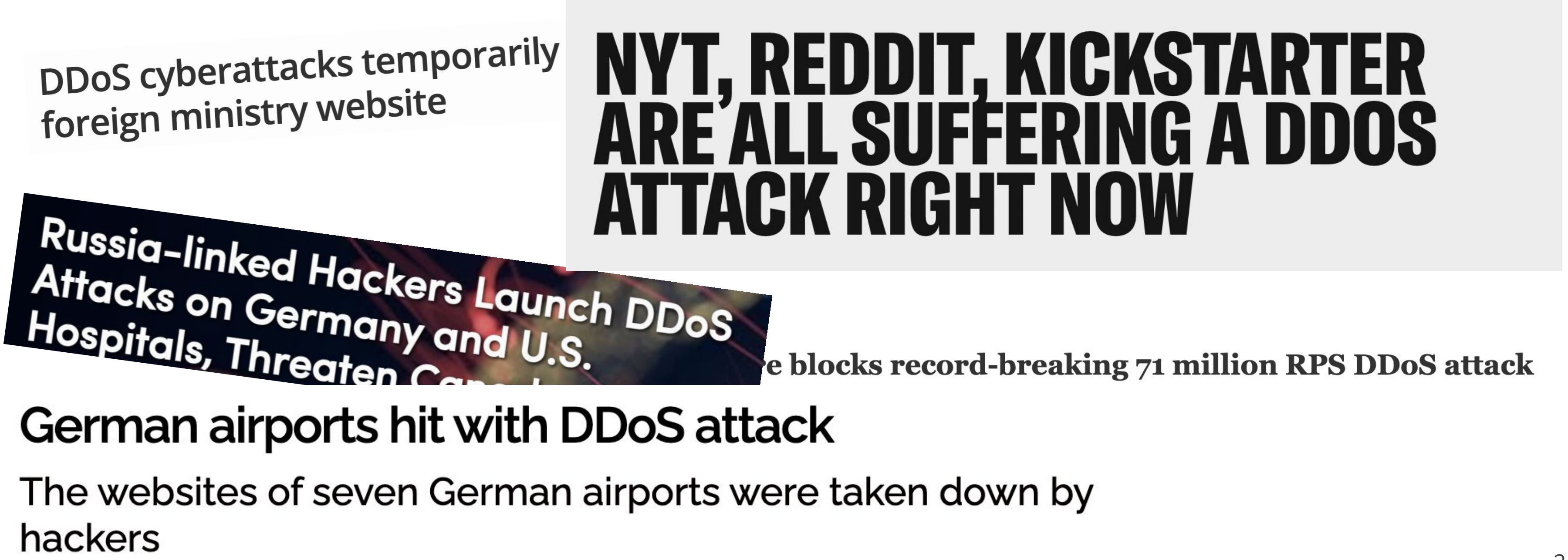
Availability



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

Russia-linked Hackers Launch DDoS Attacks on Germany and U.S. Hospitals, Threaten Ca

e blocks record-breaking 71 million RPS DDoS attack

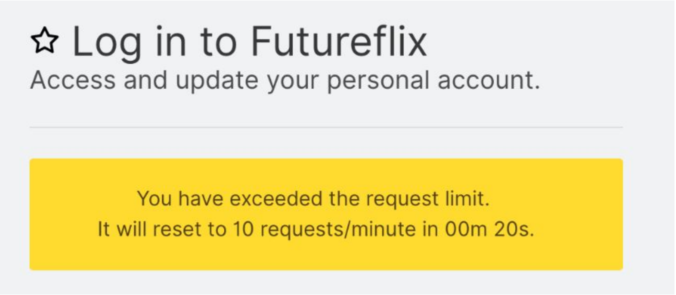
German airports hit with DDoS attack

The websites of seven German airports were taken down by hackers

Availability

Sites prevent DoS/DDoS attacks by:

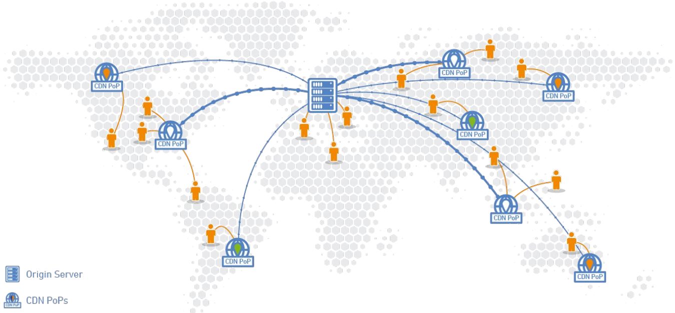
- Limiting how many times you can make a request
- Distributing servers across multiple access points



☆ Log in to Futureflix

Access and update your personal account.

You have exceeded the request limit.
It will reset to 10 requests/minute in 00m 20s.



Goals of Computer Security

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

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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

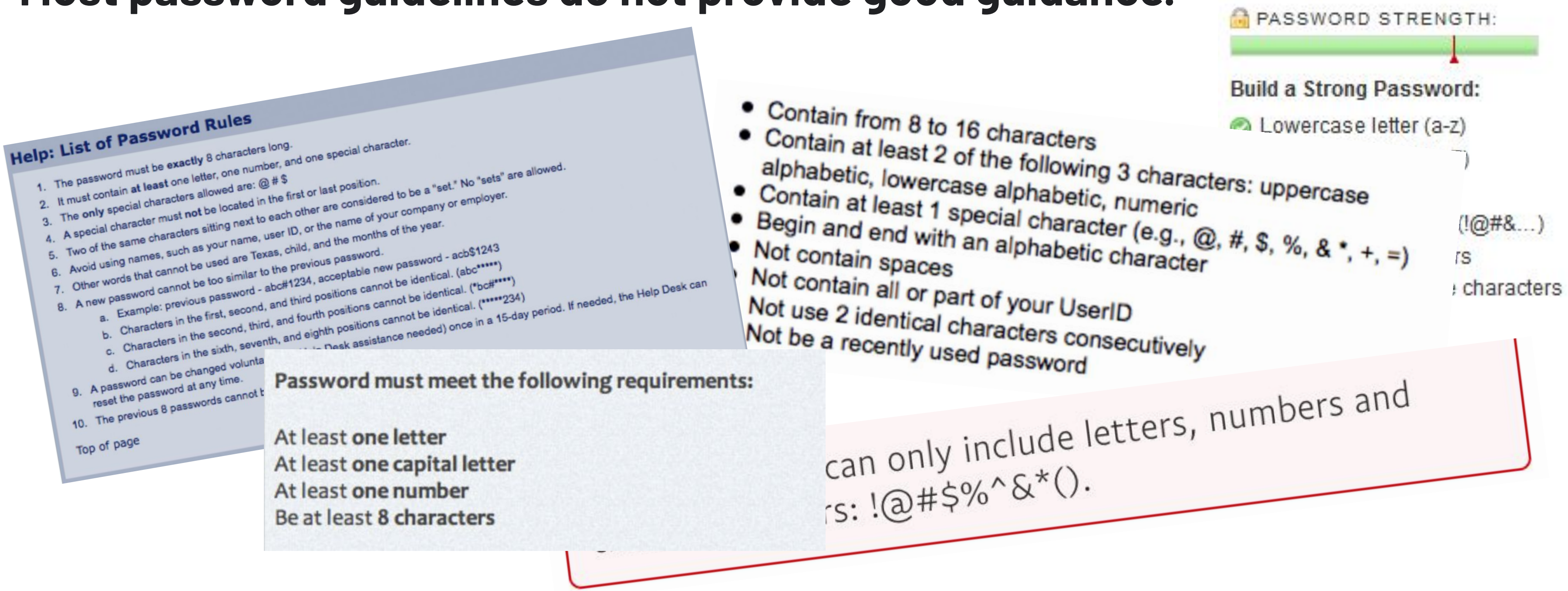
Most users choose weak passwords

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.



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 volunta 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 b

Top of page

Password must meet the following requirements:

At least **one letter**
At least **one capital letter**
At least **one number**
Be at least **8 characters**

- Contain from 8 to 16 characters
- Contain at least 2 of the following 3 characters: uppercase alphabetic, lowercase alphabetic, numeric
- Contain at least 1 special character (e.g., @, #, $, %, & *, +, =)
- Begin and end with an alphabetic character
- Not contain spaces
- Not contain all or part of your UserID
- Not use 2 identical characters consecutively
- Not be a recently used password

PASSWORD STRENGTH:

Build a Strong Password:

Lowercase letter (a-z)

)

(!@#&...)

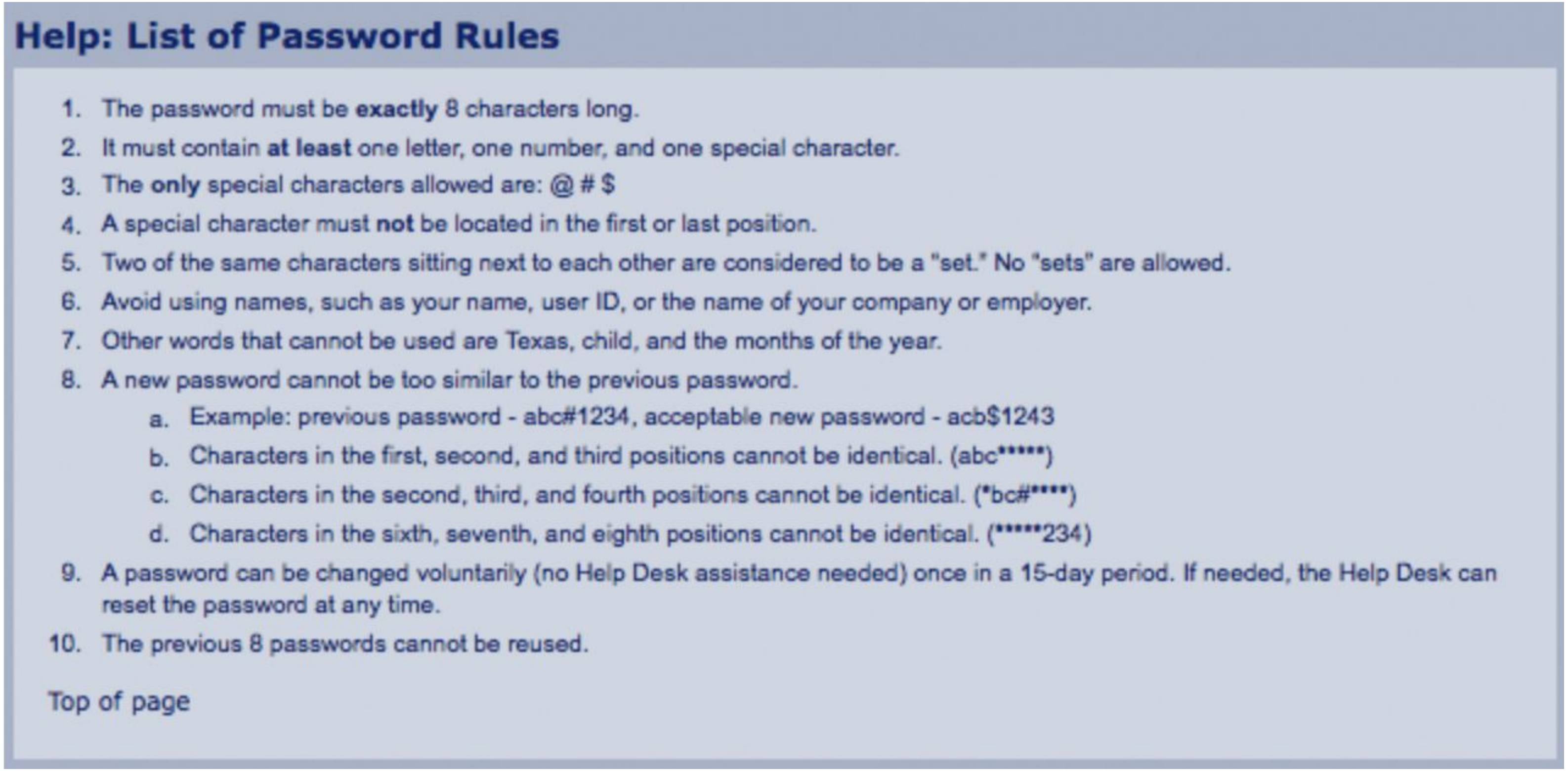
rs

characters

can only include letters, numbers and
rs: !@#$%^&*().

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

Authentication



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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

" WELL, THEY BANNED PASSWORD RE-USE.
WHAT DO YOU EXPECT ME TO DO?"

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

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

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

That was MUCH easier than I expected! Why did I pull an ALL-NIGHTER studying?
Which final was it?
Not a final. He just signed up for TWO FACTOR AUTHENTICATION.
MIT
PJ
©MIT

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

Confidentiality

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

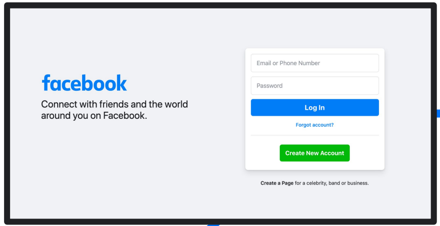
Unless our data is somehow obfuscated (usually through encryption), we risk other people seeing what we are sending.

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



facebook

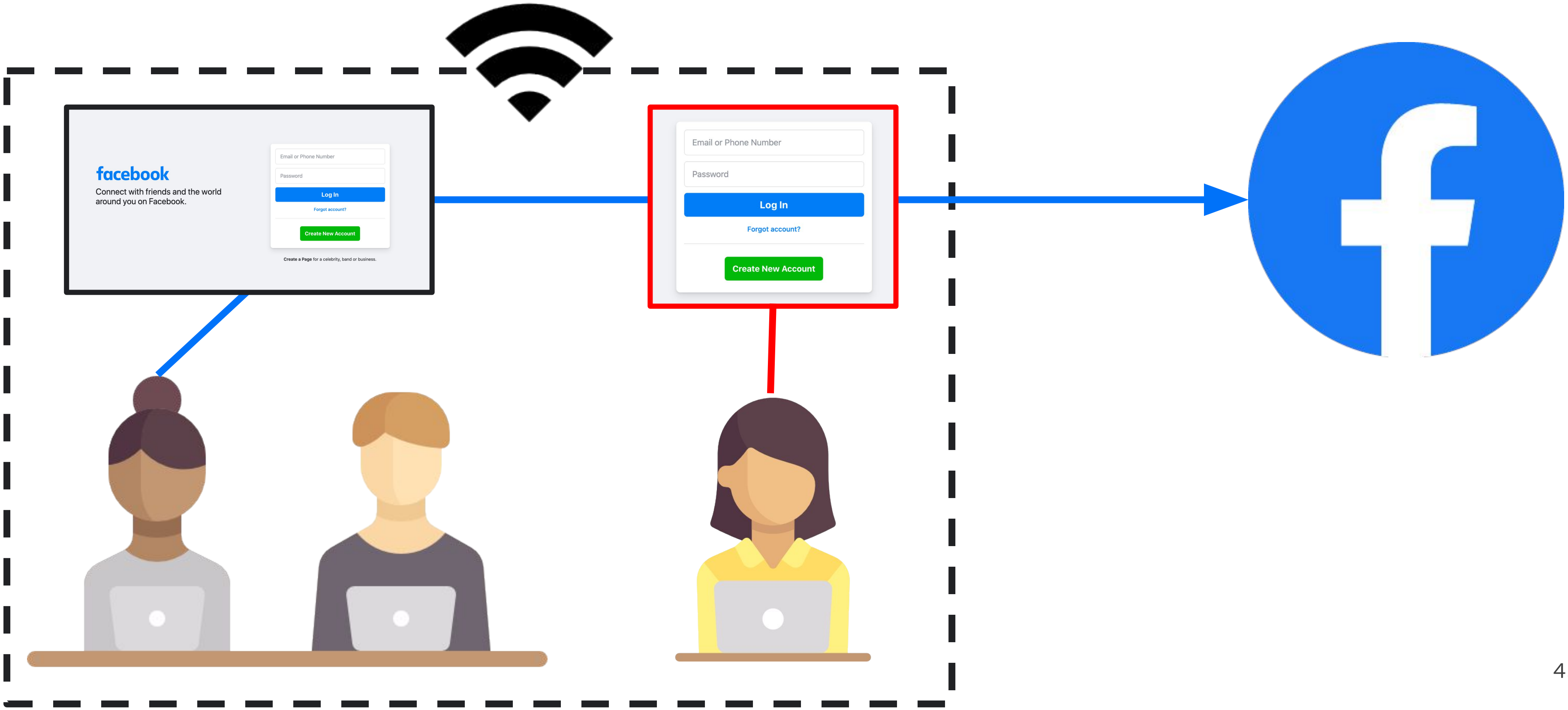
Connect with friends and the world around you on Facebook.

Email or Phone Number

Password

Create a Page for a celebrity, band or business.

Confidentiality



facebook

Connect with friends and the world around you on Facebook.

Email or Phone Number

Password

Log In

Forgot account?

Create New Account

Create a Page for a celebrity, band or business.

Email or Phone Number

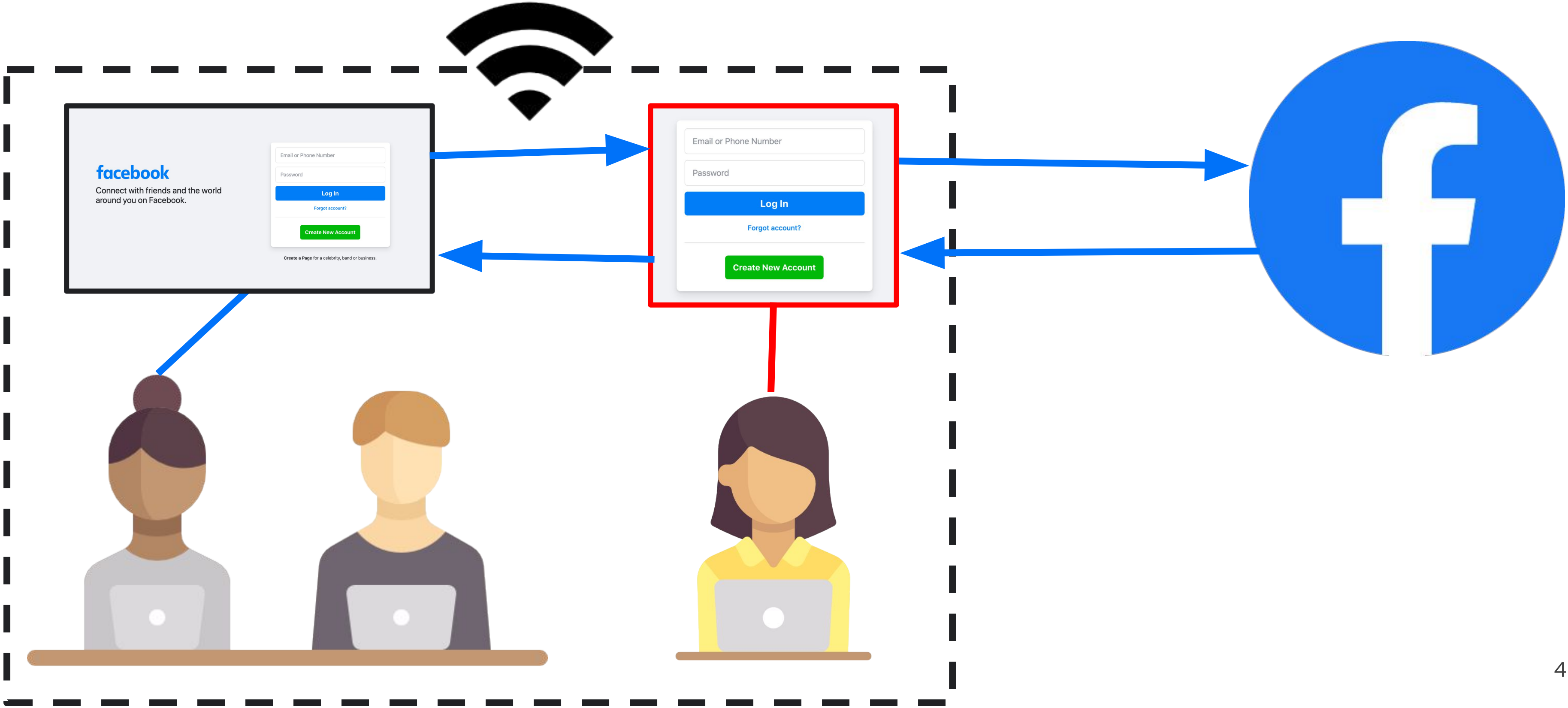
Password

Log In

Forgot account?

Create New Account

Confidentiality



facebook

Connect with friends and the world around you on Facebook.

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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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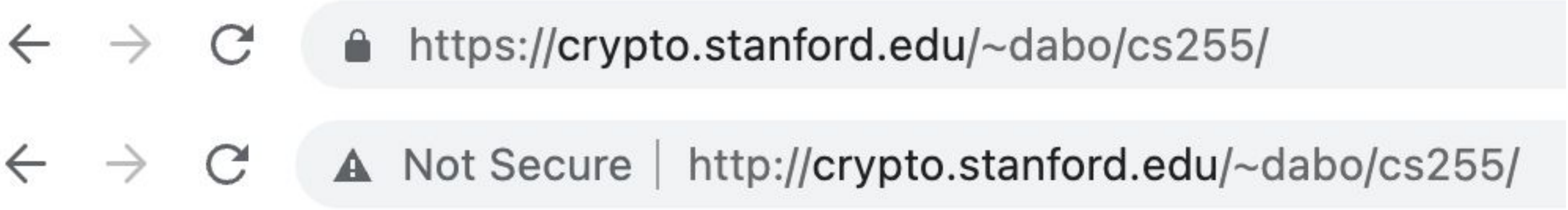


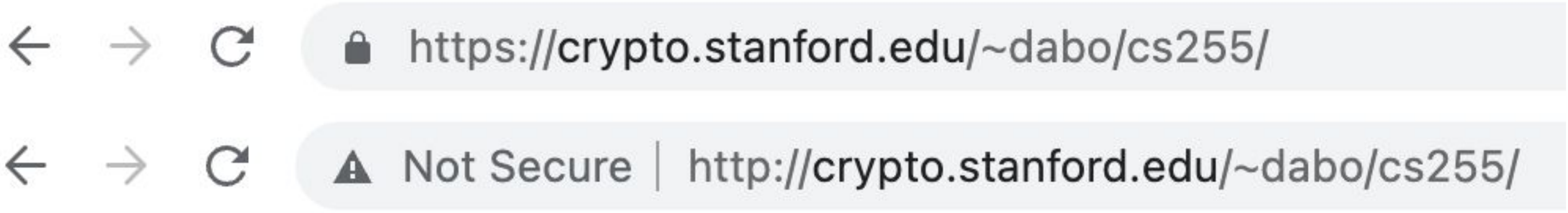
https://crypto.stanford.edu/~dabo/cs255/

Not Secure | http://crypto.stanford.edu/~dabo/cs255/

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).



https://crypto.stanford.edu/~dabo/cs255/

Not Secure | http://crypto.stanford.edu/~dabo/cs255/

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

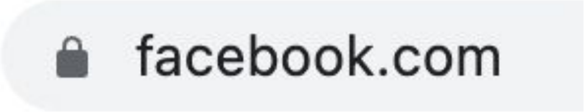
Confidentiality

[WIRESHARK DEMO]

Confidentiality

Confidentiality Best Practices

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



facebook.com

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

iMessage is secure… unless you have iCloud enabled.

Goals of Computer Security

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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 BANK OF AMERICA

"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!

Integrity

We've already seen this!

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

Integrity

We've already seen this!

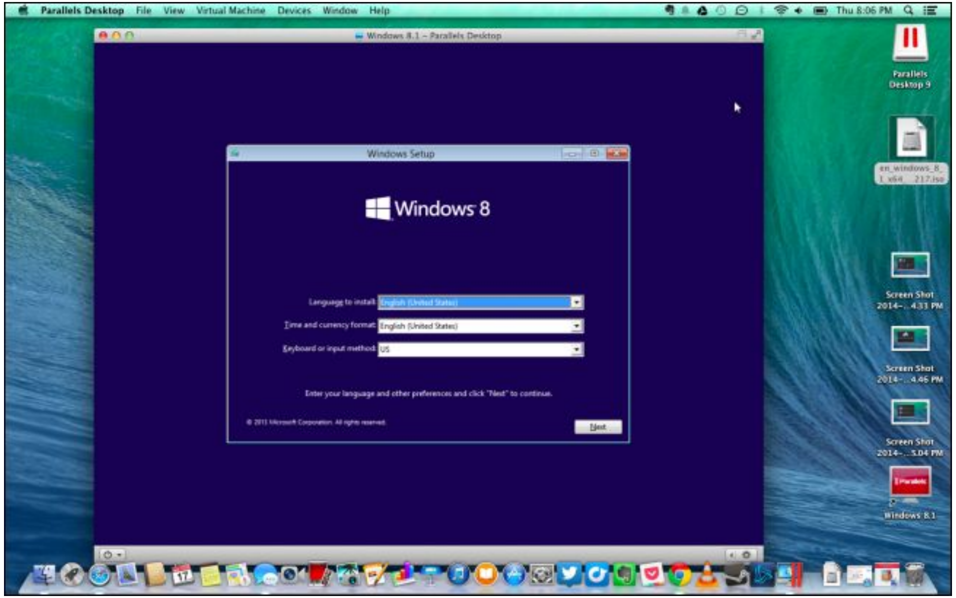
```
chgrp staff ./secrets
chmod g+r ./secrets
```

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.


Parallels Desktop
File
View
Virtual Machine
Devices
Window
Help
Thu 8:06 PM
Windows 8.1 – Parallels Desktop
Windows Setup
Windows 8
Next
Parallels Desktop 9
en_windows_8_1_x64_...217.iso
Screen Shot 2014-... 4.33 PM
Screen Shot 2014-... 4.46 PM
Screen Shot 2014-... 5.04 PM
Windows 8.1

Language to install: English (United States)

Time and currency format: English (United States)

Keyboard or input method: US

Enter your language and other preferences and click "Next" to continue.

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Goals of Computer Security

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Social Engineering

Social Engineering

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Social engineering uses psychological manipulation to trick users into making security mistakes or giving away sensitive information.

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Social engineering uses psychological manipulation to trick users into making security mistakes or giving away sensitive information.

MOVIE HACKING...
IF I CAN JUST OVERCLOCK THE UNIX DJANGO, I CAN BASIC THE DDOS ROOT. DAMN. NO DICE. BUT WAIT... IF I DISENCRYPT THEIR KILOBYTES WITH A BACKDOOR HANDSHAKE THEN... JACKPOT.
REAL HACKING...
HI, THIS IS ROBERT HACKERMAN. I'M THE COUNTY PASSWORD INSPECTOR.
HI BOB! HOW CAN I HELP YOU TODAY?

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.

Social Engineering

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This is often done using a duped email, text message, or having a user open a link.

Social Engineering

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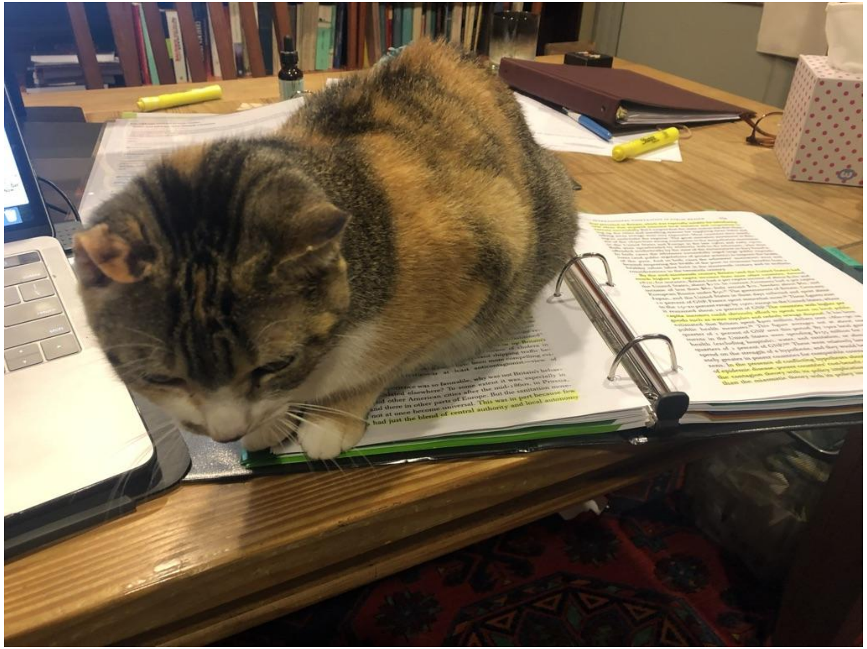
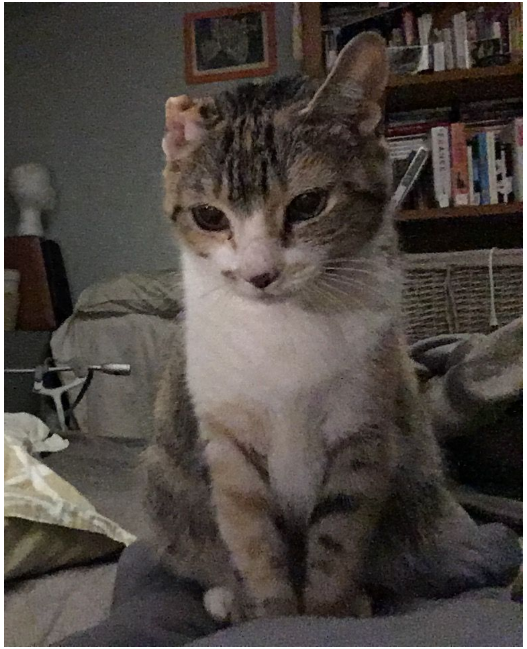
This is often done using a duped email, text message, or having a user open a link.

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

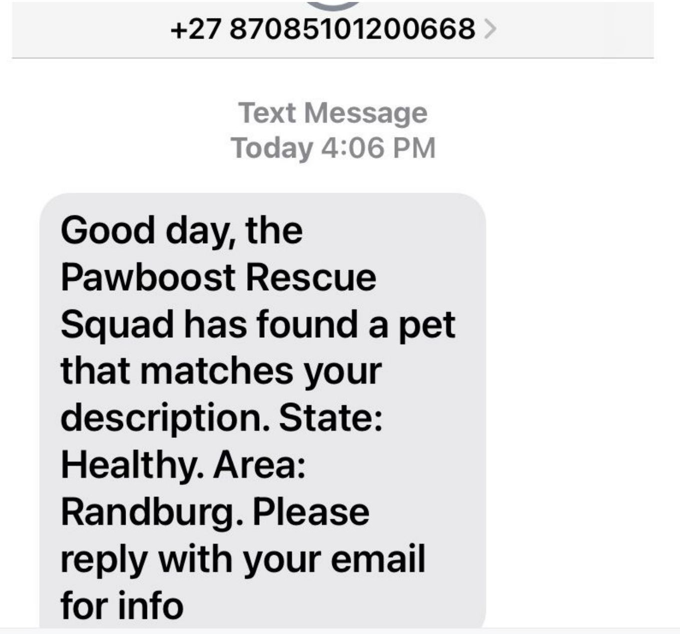
True Story Time





Social Engineering

True Story Time



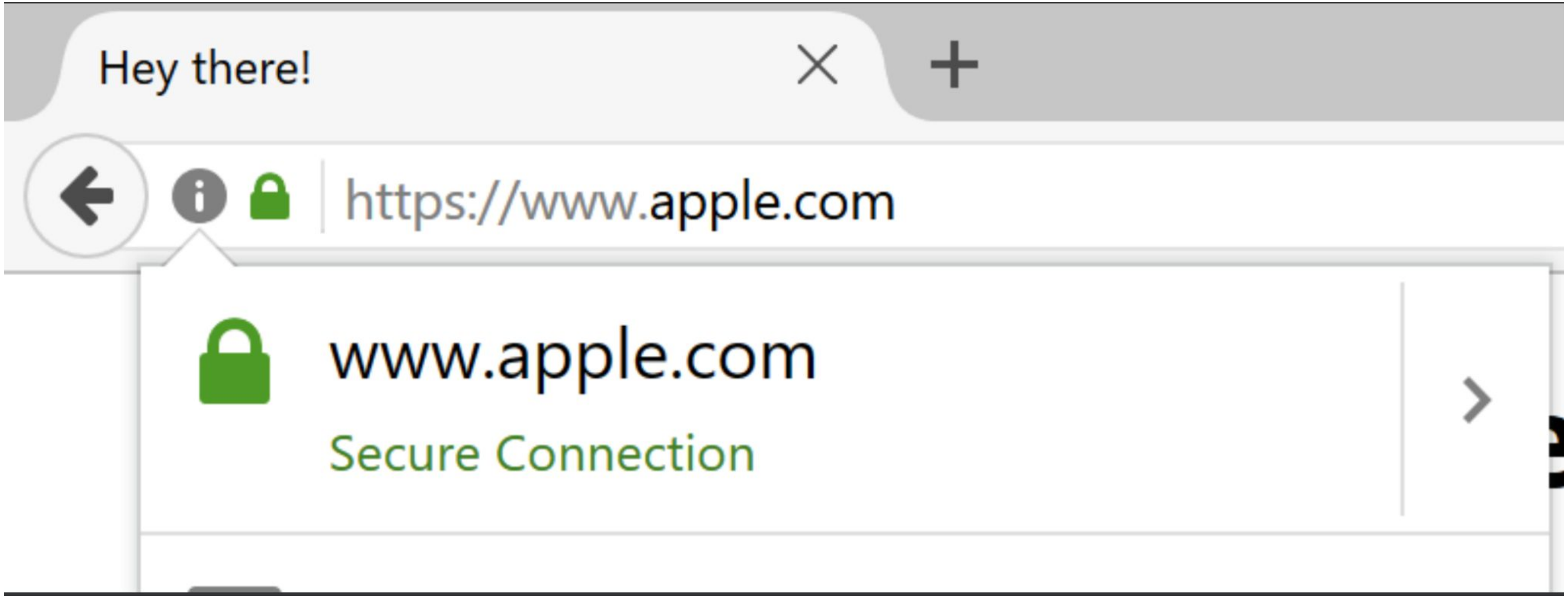
+27 87085101200668

Text Message
Today 4:06 PM

Good day, the Pawboost Rescue Squad has found a pet that matches your description. State: Healthy. Area: Randburg. Please reply with your email for info

Social Engineering

Notice anything wrong?



Hey there!

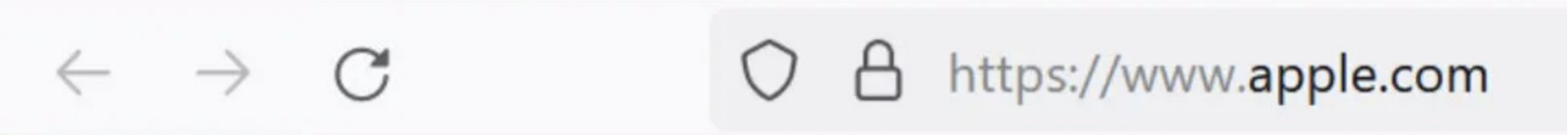
https://www.apple.com

www.apple.com

Secure Connection

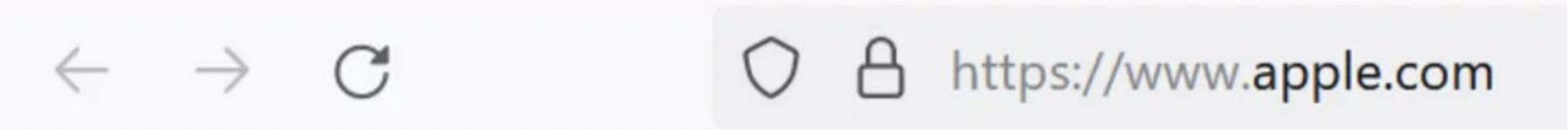
Social Engineering

Real:



https://www.apple.com

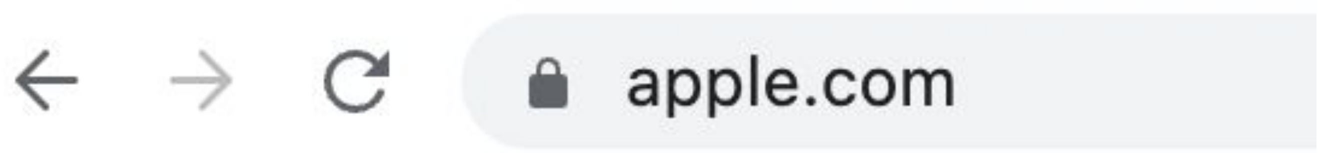
Cyrillic:



https://www.apple.com

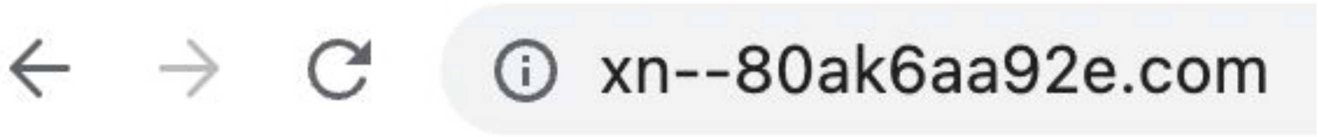
Social Engineering

Real:



apple.com

Cyrillic:



xn--80ak6aa92e.com

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.

PARENTING in 1989
Dad, I need $1 to pay the late fee on this video I rented.
AGAIN?!
NEWS
PARENTING in 2014
Dad, I need $100 to pay the ransomware on my phone.
AGAIN?!
PJ
www.ITworld.com

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

Other Advice

- VPNs don't necessarily increase security; they change point of trust.
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- Again, use a password manager!