Module 1

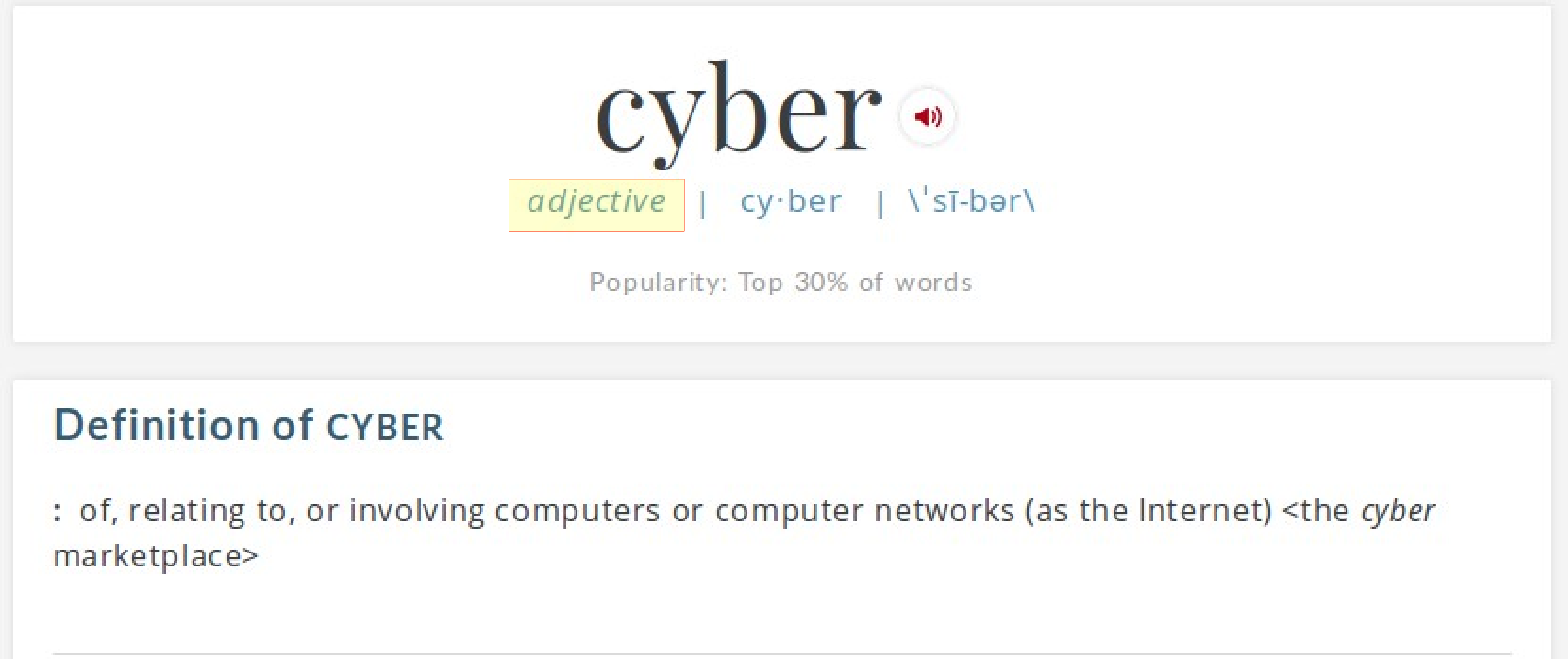
Principles of Cybersecurity

What is “Cybersecurity”?

“I have a son. He's 10 years old. He has computers. He is so good with these computers, it's unbelievable. The <u>security</u> aspect of <u>cyber</u> is very, very tough. And maybe it's hardly doable... We have so many things that we have to do better, and certainly <u>cyber</u> is one of them.”

-- Former U.S. President, Donald Trump

What is “Cybersecurity”?



cyber

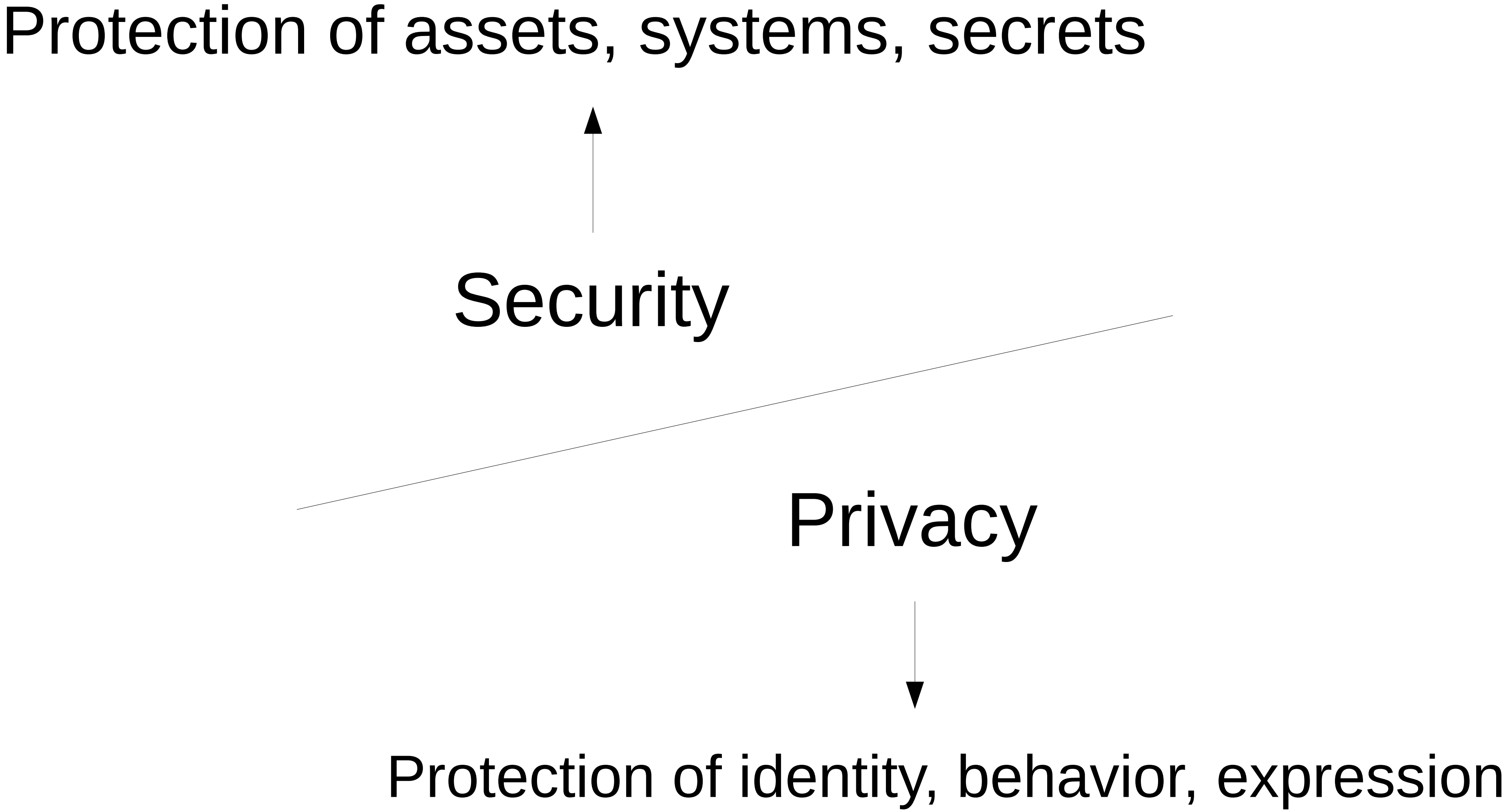
adjective | cy·ber | \ˈsī-bər\

Popularity: Top 30% of words

Definition of CYBER

: of, relating to, or involving computers or computer networks (as the Internet) <the *cyber* marketplace>

What is “Cybersecurity”?



Protection of assets, systems, secrets

Security

Privacy

Protection of identity, behavior, expression

CMPT 479

Class times:	M/W/F 9:30-10:20 am
TA:	Alireza Amirhossein
Place:	WMC3260

Grading

45%	3x Assignments (15%)
5%	Online Self-Assessment
20%	Mid-term Exam
30%	Final Exam

Online Self-Assessment

- One assessment for each module
- Due one week after module, midnight
- Posted on Canvas

Assignments

Each Assignment has a:

- Written Component

- Programming Component

There is a grace period (no penalty) of **exactly 48 hours** after the Assignment due date, at midnight.

If you need an extension of more than 48 hours, you must tell me with a valid reason before the Assignment due date.

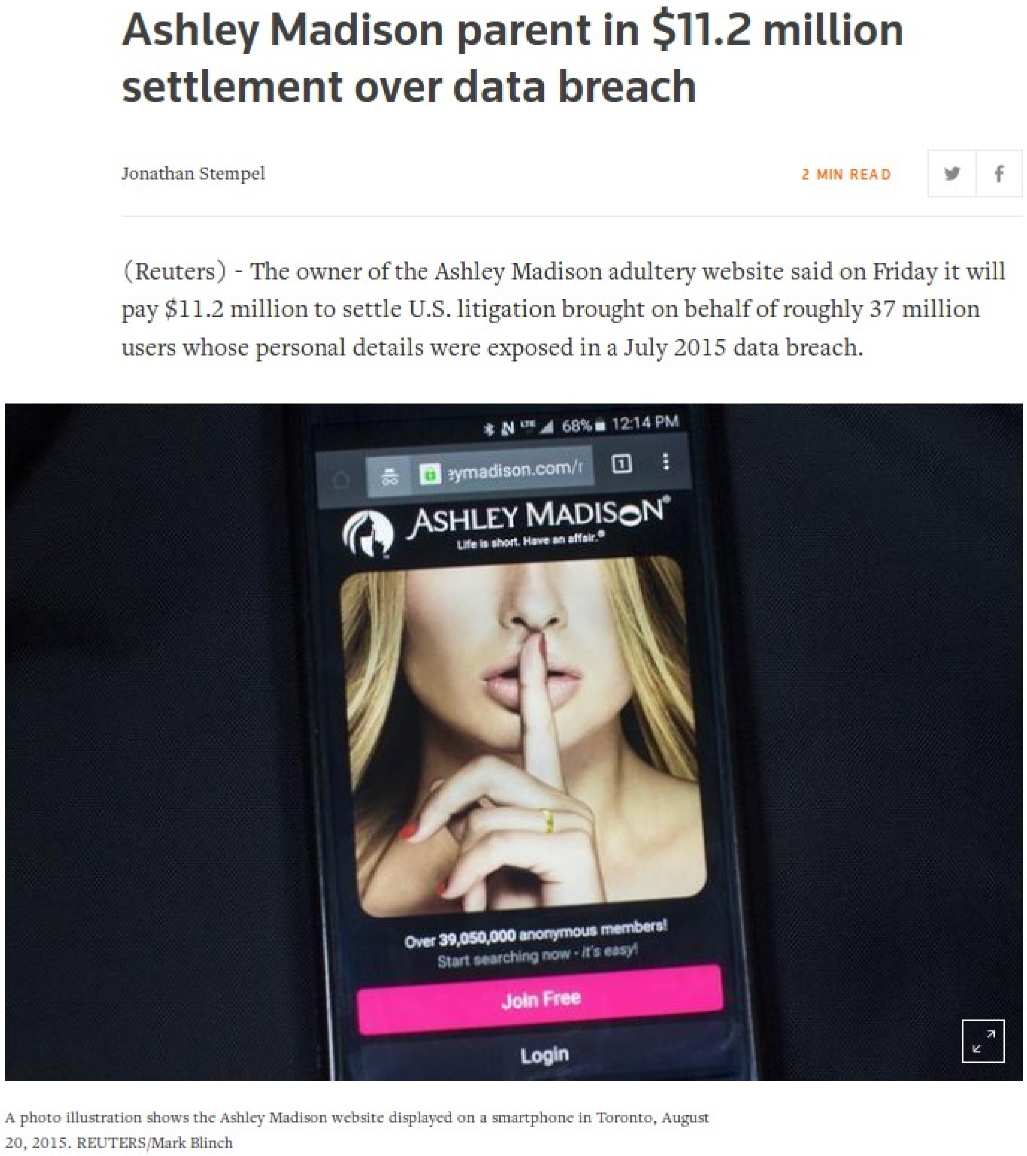
Contact

E-mail: taowang@sfu.ca

Please preface your e-mail title with “CMPT479”.

Any questions are welcome!

What is the price of security?



Ashley Madison parent in $11.2 million settlement over data breach

Jonathan Stempel

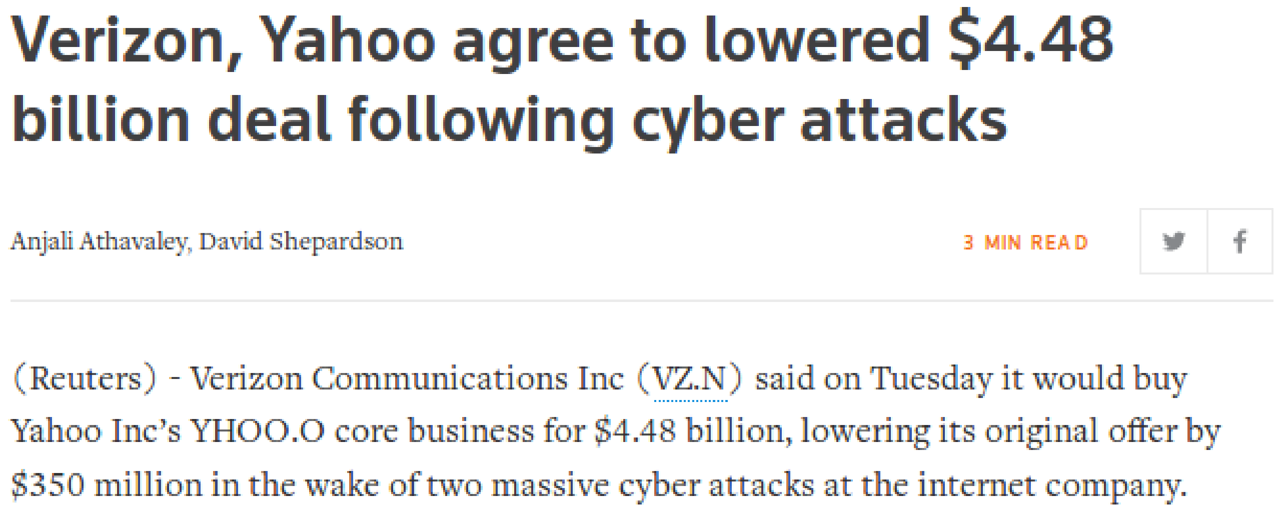
2 MIN READ

(Reuters) - The owner of the Ashley Madison adultery website said on Friday it will pay $11.2 million to settle U.S. litigation brought on behalf of roughly 37 million users whose personal details were exposed in a July 2015 data breach.

68% 12:14 PM
eymadison.com/r
ASHLEY MADISON®
Life is short. Have an affair.®
Over 39,050,000 anonymous members!
Start searching now - it's easy!
Join Free
Login

A photo illustration shows the Ashley Madison website displayed on a smartphone in Toronto, August 20, 2015. REUTERS/Mark Blinch

What is the price of security?



Verizon, Yahoo agree to lowered $4.48 billion deal following cyber attacks

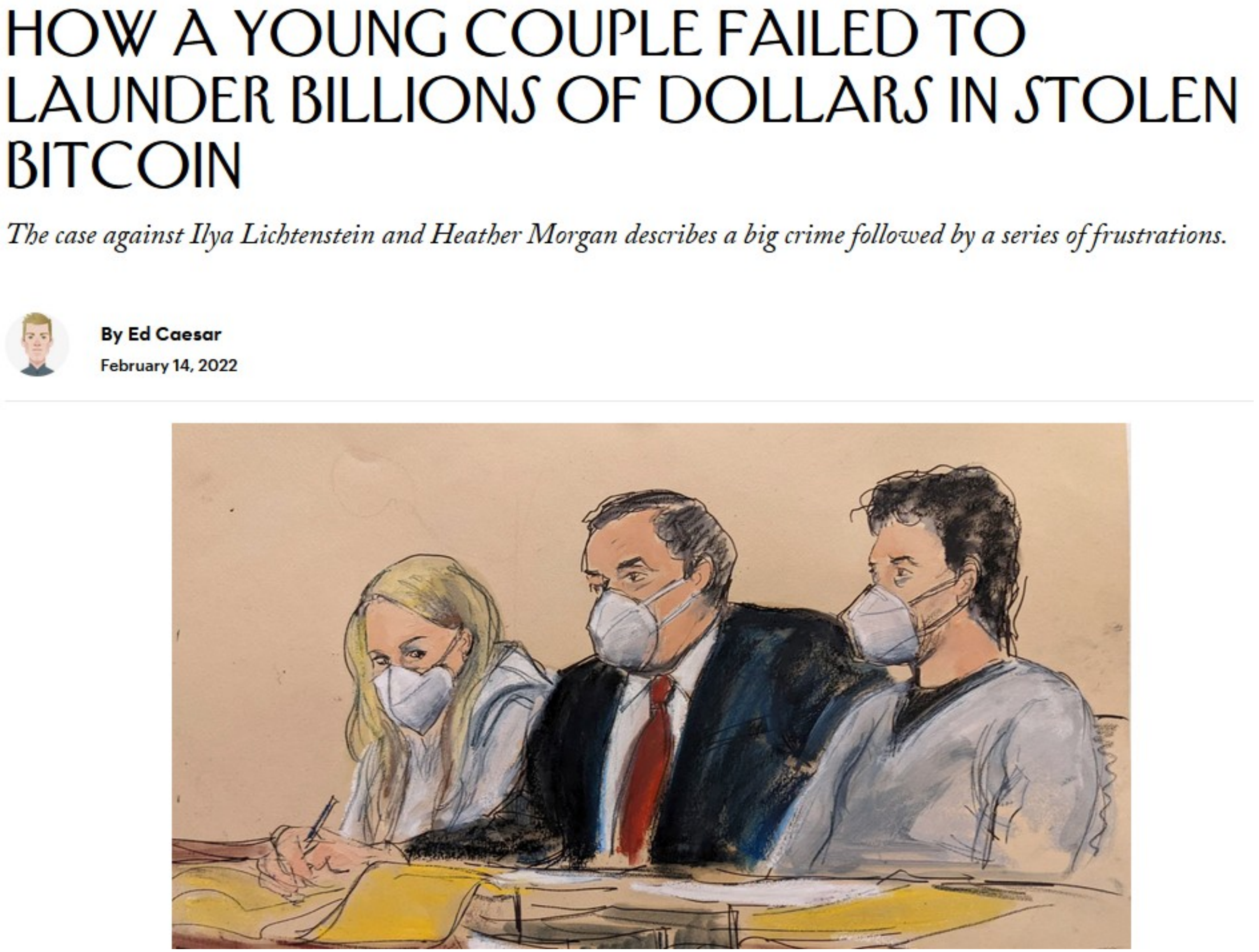
Anjali Athavaley, David Shepardson

3 MIN READ

(Reuters) - Verizon Communications Inc (VZ.N) said on Tuesday it would buy Yahoo Inc's YHOO.O core business for $4.48 billion, lowering its original offer by $350 million in the wake of two massive cyber attacks at the internet company.

At least 1 billion accounts compromised

What is the price of security?



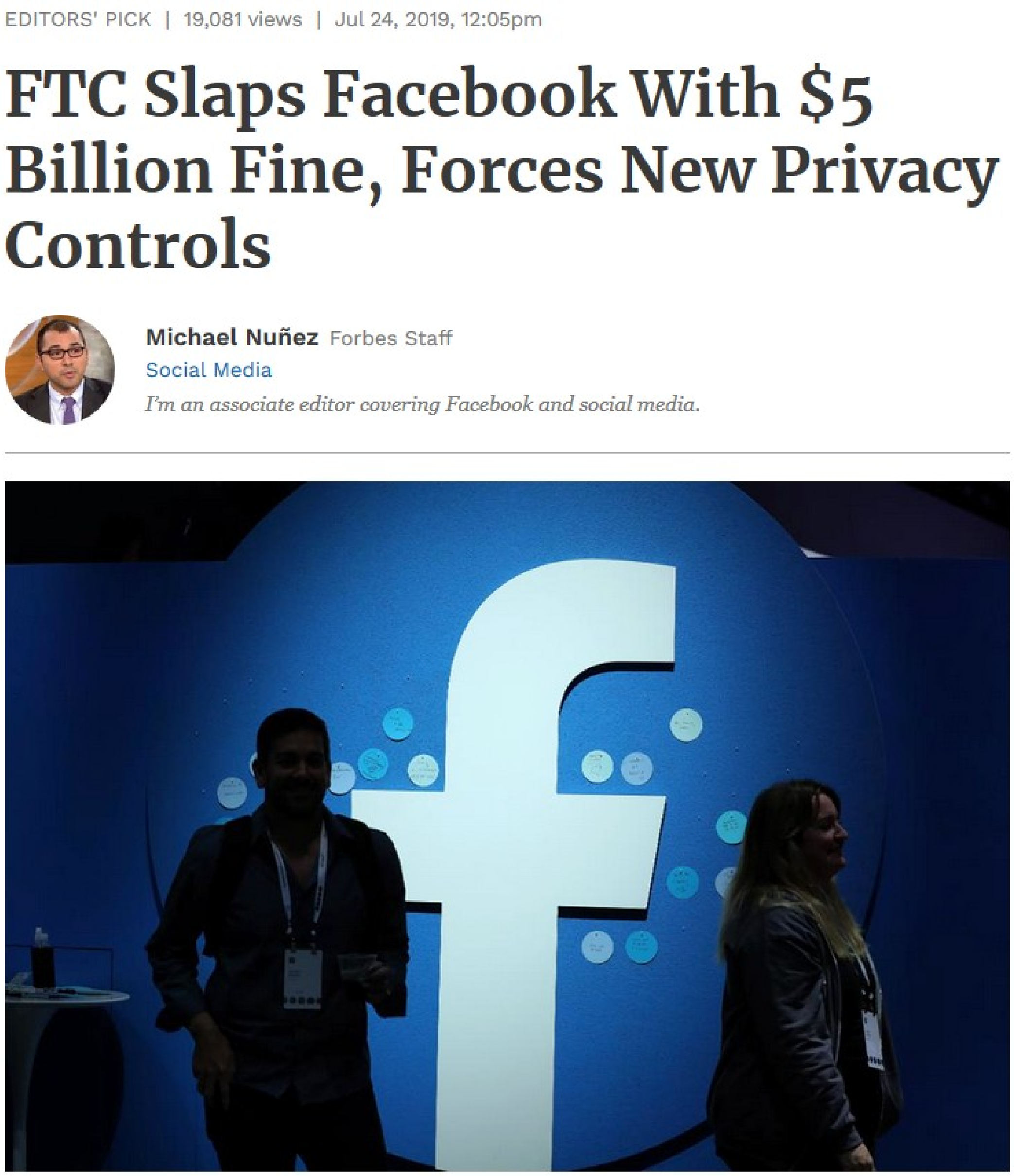
HOW A YOUNG COUPLE FAILED TO LAUNDER BILLIONS OF DOLLARS IN STOLEN BITCOIN

The case against Ilya Lichtenstein and Heather Morgan describes a big crime followed by a series of frustrations.

By Ed Caesar

February 14, 2022

What is the price of privacy?



EDITORS' PICK | 19,081 views | Jul 24, 2019, 12:05pm

FTC Slaps Facebook With $5 Billion Fine, Forces New Privacy Controls

Michael Nuñez Forbes Staff
Social Media
I'm an associate editor covering Facebook and social media.

Principles of CIA

Confidentiality

Information is secret

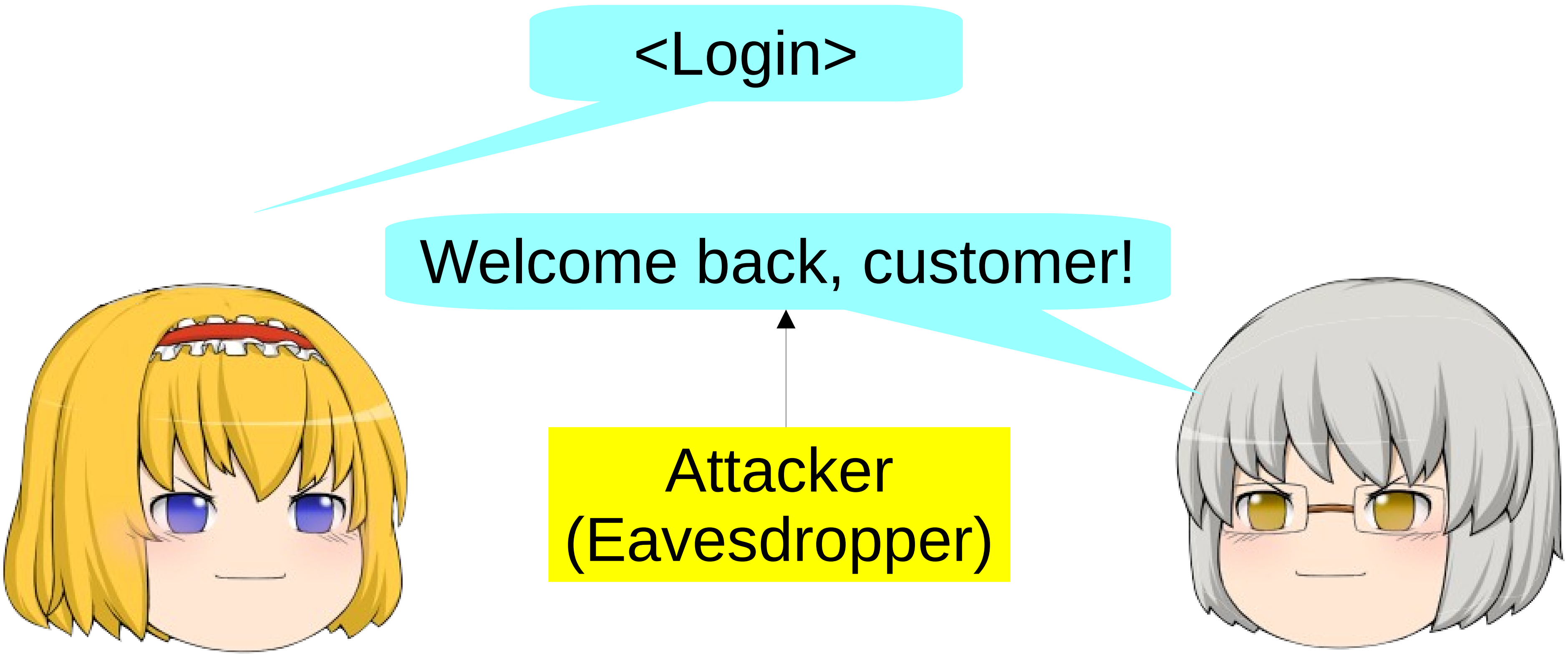
Integrity

Information/System is correct

Availability

System is usable

Principles of CIA



<Login>

Welcome back, customer!

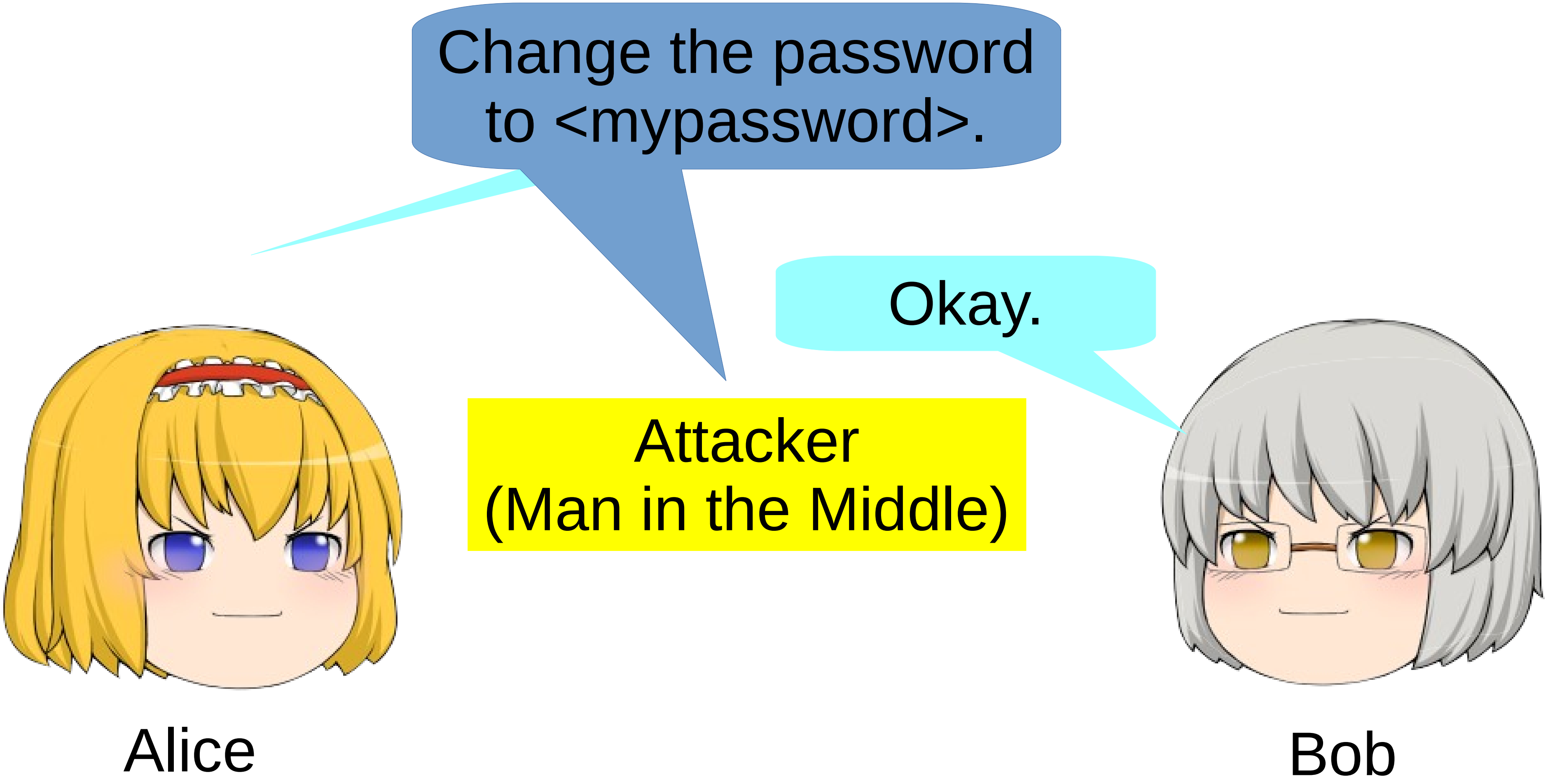
Attacker
(Eavesdropper)

Alice

Bob

Which principle is violated?
(Confidentiality, Integrity, Availability)

Principles of CIA



Change the password to <mypassword>.

Okay.

Attacker (Man in the Middle)

Alice

Bob

Which principle is violated?
(Confidentiality, Integrity, Availability)

Principles of CIA

- Distributed Denial of Service (DDoS)

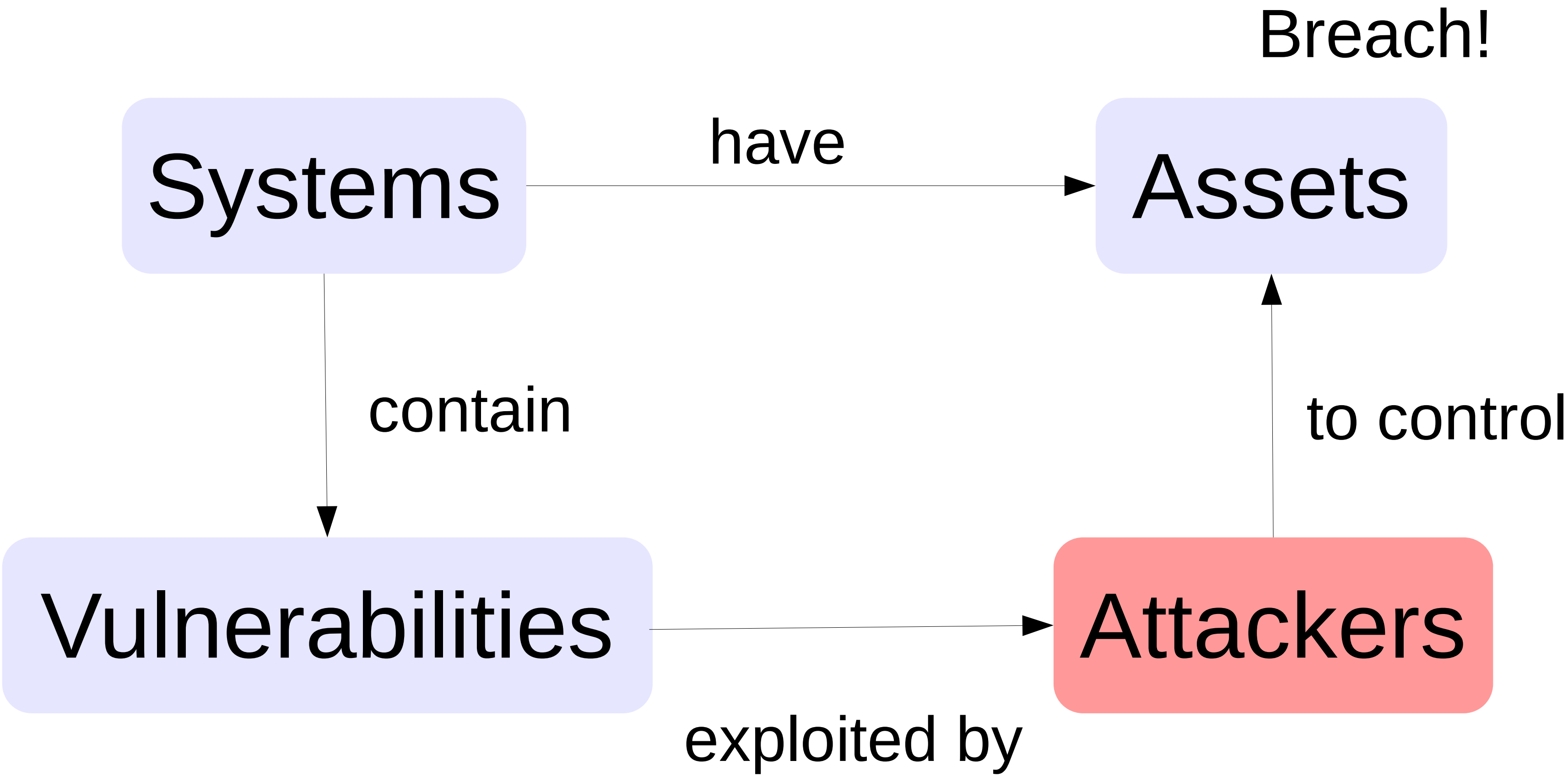
- Money was stolen from an online exchange

Which principle is violated?
(Confidentiality, Integrity, Availability)

Principles of CIA

- Distributed Denial of Service (DDoS)
  - ➔ The attacker used a botnet that was created by guessing trivial remote access passwords
- Money was stolen from an online exchange
  - ➔ The owners are forced to shut down the service
  - ➔ It turns out the attack was successful because an administrator opened a malicious file

Which principle is violated?
(Confidentiality, Integrity, Availability)


Breach!

Systems

have

Assets

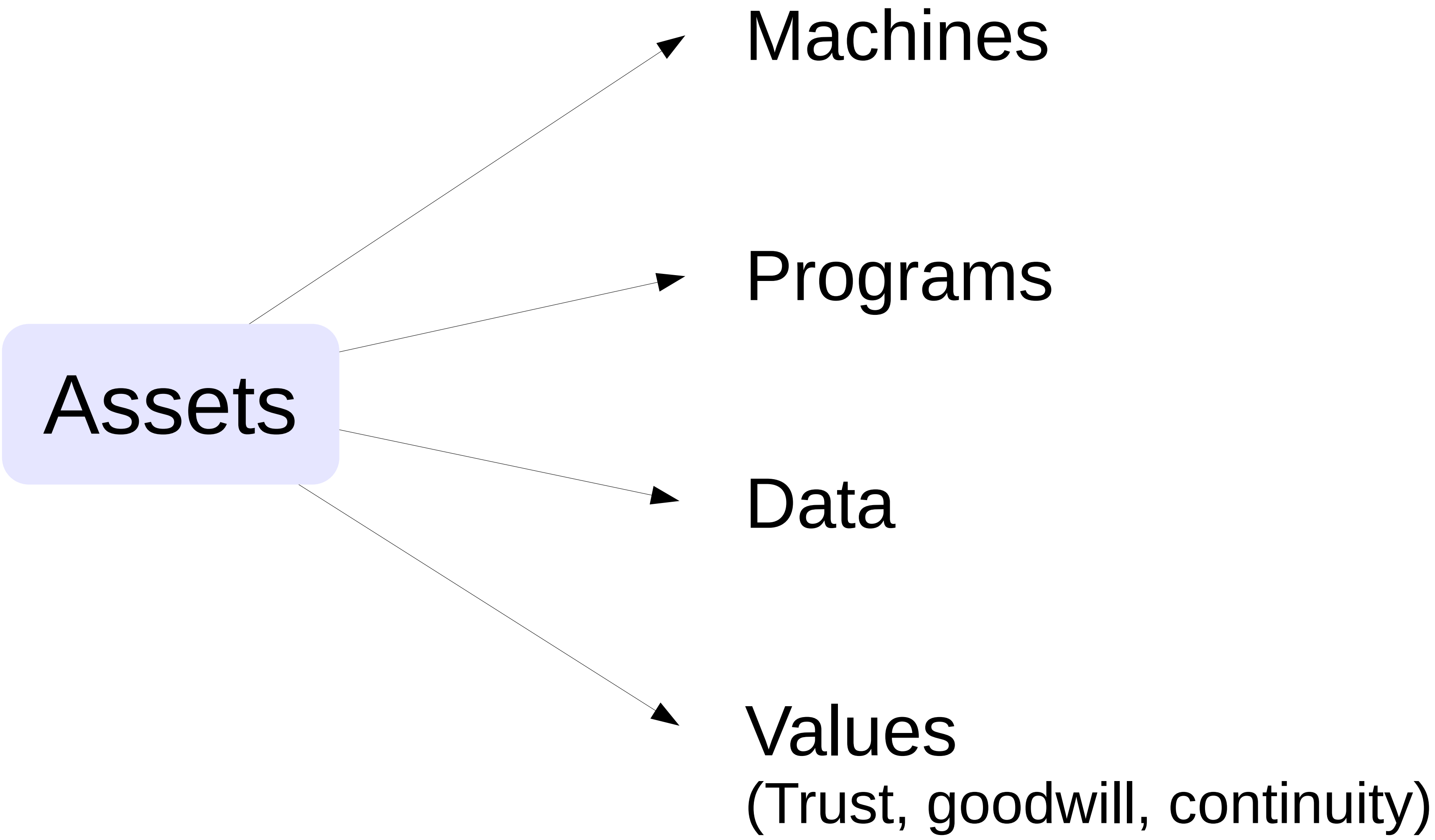
contain

to control

Vulnerabilities

Attackers

exploited by



Assets

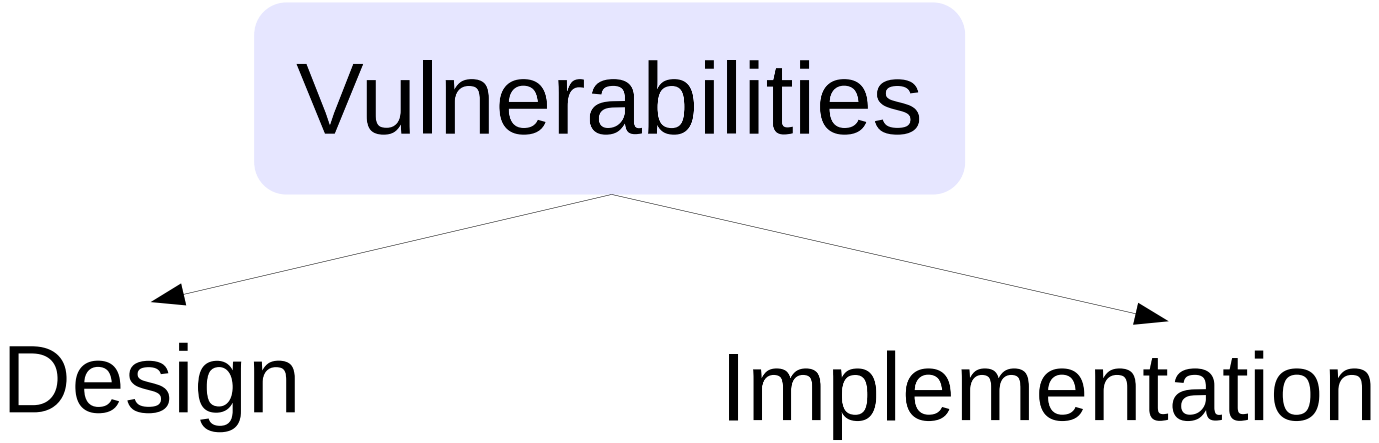
Machines

Programs

Data

Values
(Trust, goodwill, continuity)

Where do vulnerabilities come from?



Vulnerabilities

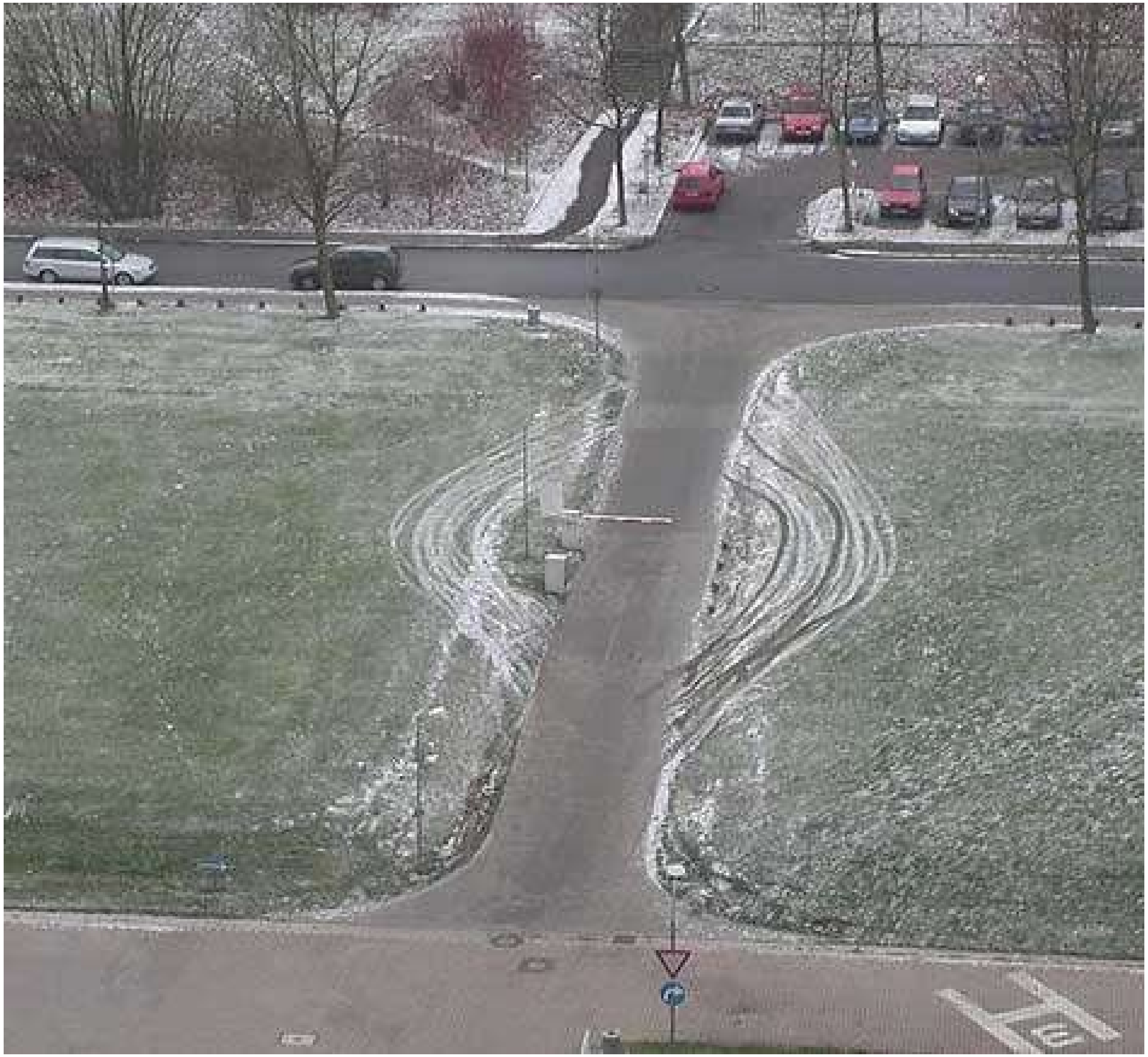
Design

Implementation

Wrong threat model/user model, didn’t design for security, etc.

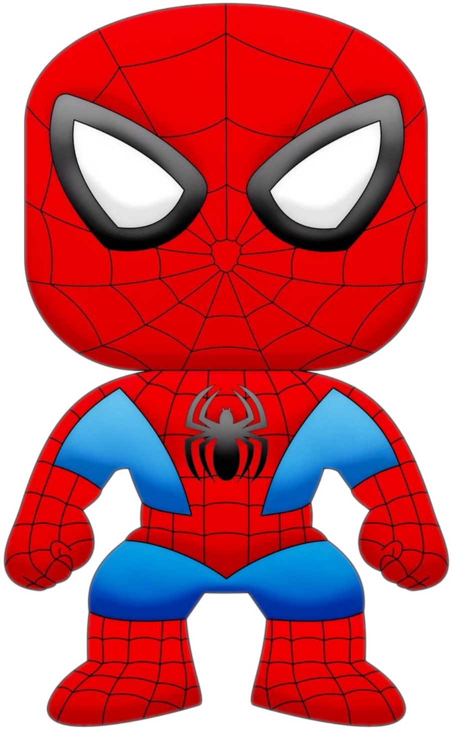
Errors in coding, hardware;
Intentional errors, etc.

Vulnerability by design



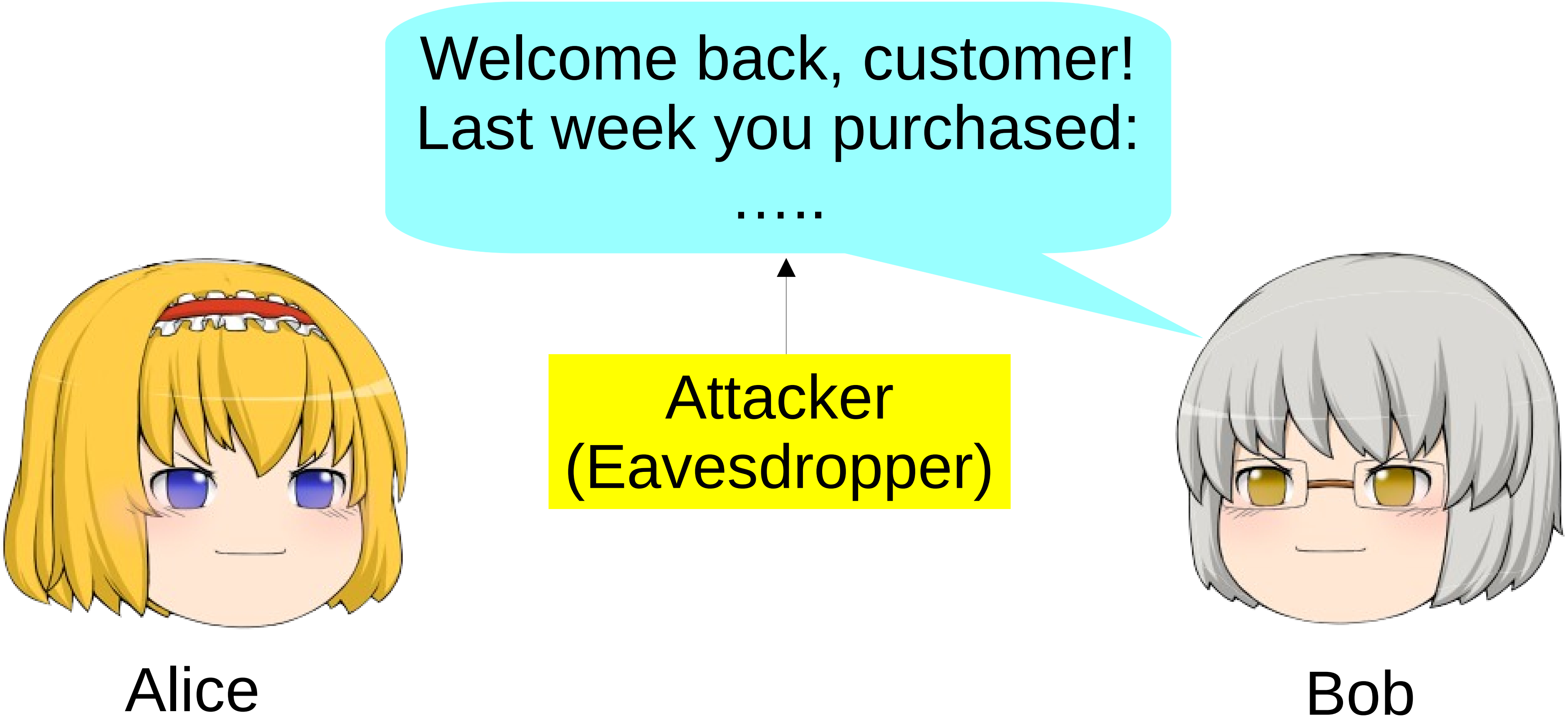
Spiderman Rule

With great power
comes great responsibility!



Privacy

Is privacy the same as confidentiality?



Welcome back, customer!
Last week you purchased:
.....

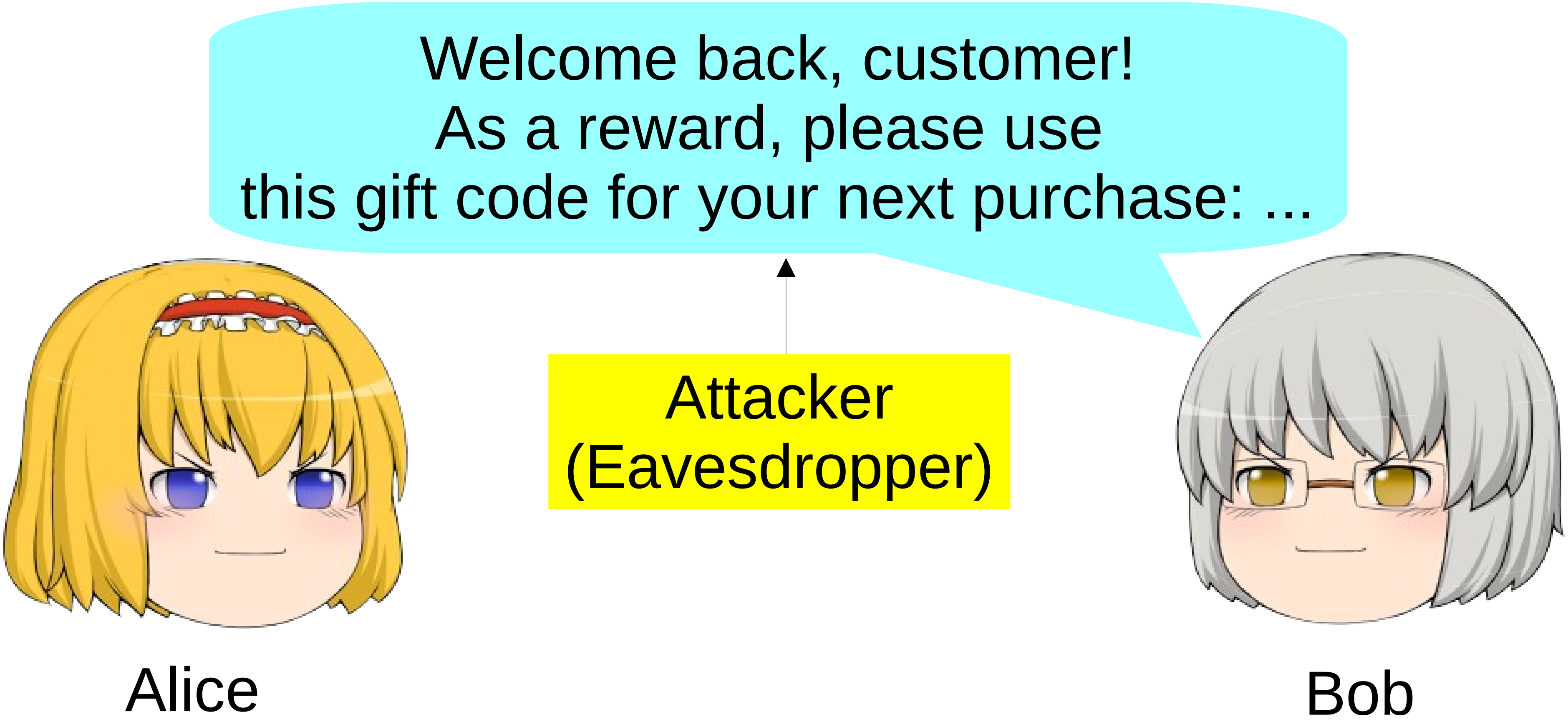
Attacker
(Eavesdropper)

Alice

Bob

Privacy

Is privacy the same as confidentiality?



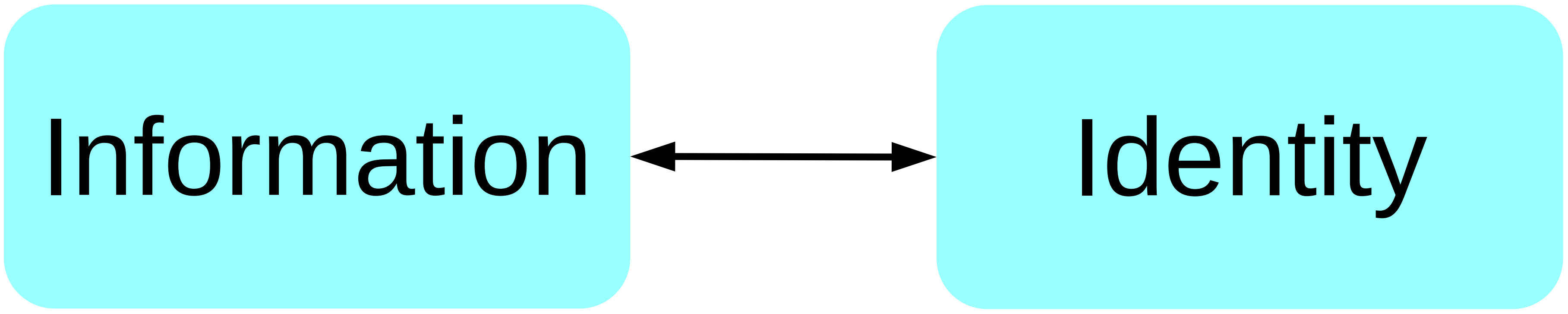
Welcome back, customer!
As a reward, please use
this gift code for your next purchase: ...

Attacker
(Eavesdropper)

Alice

Bob

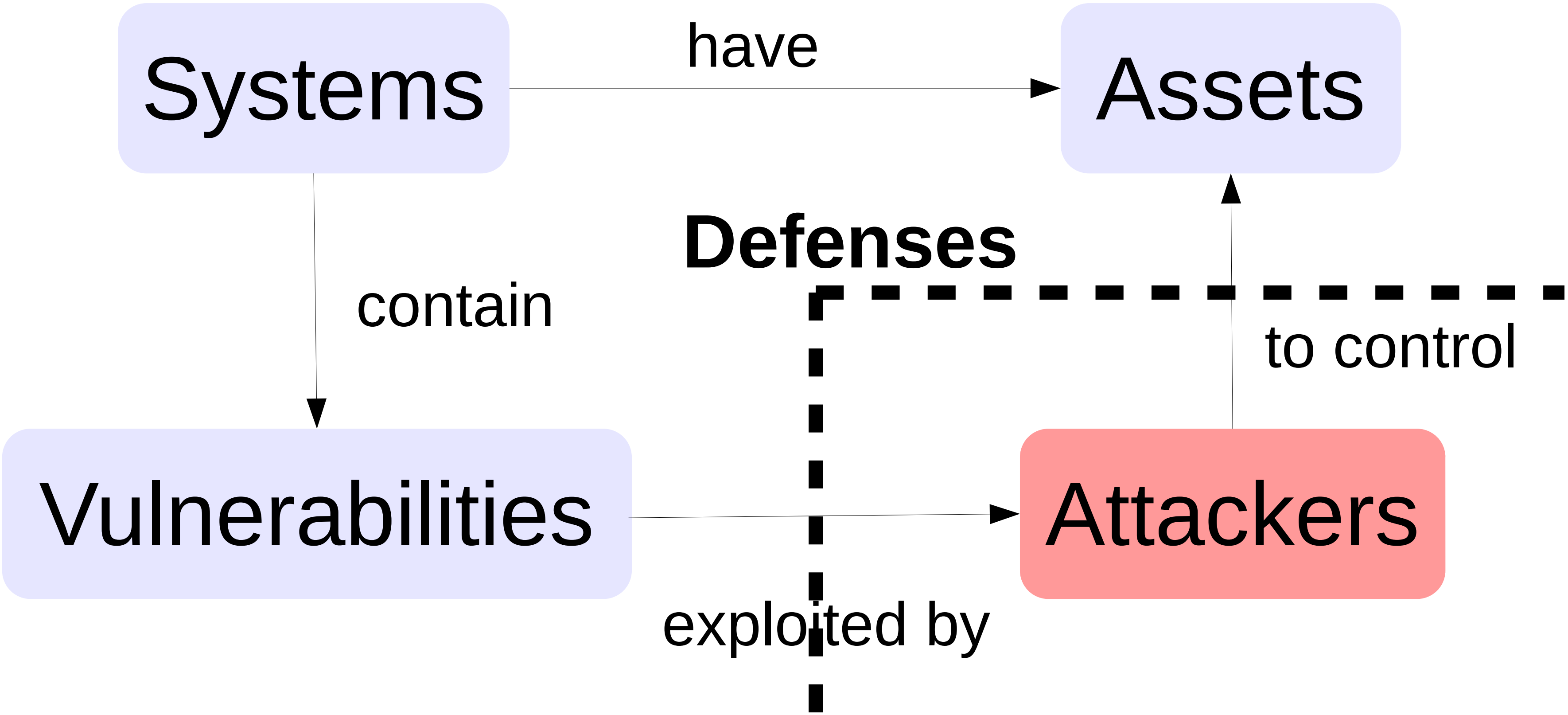
Privacy


Information

Identity

Issues: Expression, social vulnerability, behavioral analysis, discrimination

Protections: Anonymization, disassociation, security



have
Systems
Assets
contain
Defenses
to control
Vulnerabilities
Attackers
exploited by

Defensive Strategy

Risk Management:

A risk is something that could damage, destroy, or disclose data

Essential for convincing upper management to adopt security countermeasures!

- Quantitative Risk Analysis
- Qualitative Risk Analysis

Quantitative Risk Analysis

For any given risk, calculate single loss expectancy (SLE):

SLE = Asset Value * Exposure Factor

% of assets exposed to the risk

Then calculate the company’s annual loss expectancy (ALE):

ALE = SLE * annualized rate of occurrence

If your proposed countermeasure can reduce ALE more than the cost of the countermeasure, it’s good!

Principles of Secure Design

Security by Design:

Security should be considered starting from the design phase

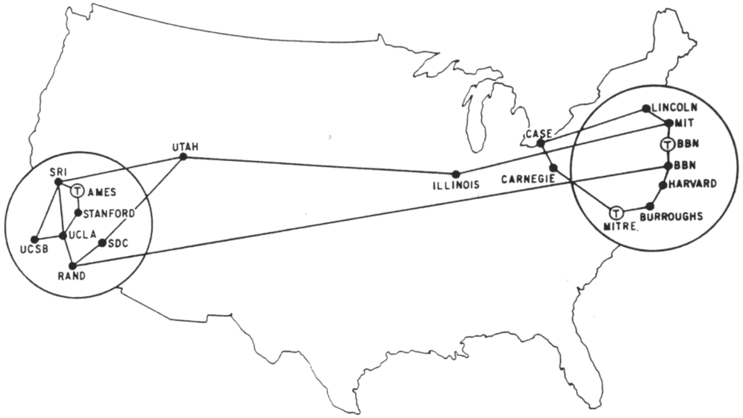
(Vulnerabilities should be considered starting from the design phase)

Principles of Secure Design

Is the Internet secure by design?

The goal [of ARPANET] was to exploit new computer technologies to meet the needs of military command and control against nuclear threats, achieve survivable control of US nuclear forces...

-- Stephen J. Lukasik, Director of DARPA (1967-1974)



MAP 4 September 1971

Saltzer and Schroeder’s Principles of Secure Design

1) Open Design

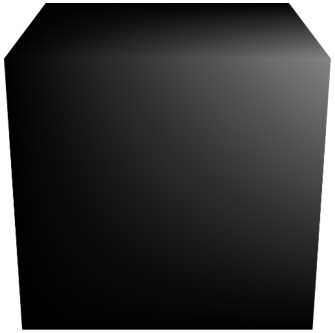
The system’s design should be openly available to everyone.

Saltzer and Schroeder’s Principles of Secure Design

1) Open Design

Opposite of Security through Obscurity:

Hide details of the implementation to prevent compromising analysis



Saltzer and Schroeder’s Principles of Secure Design

1) Open Design

Examples of Security through Obscurity:

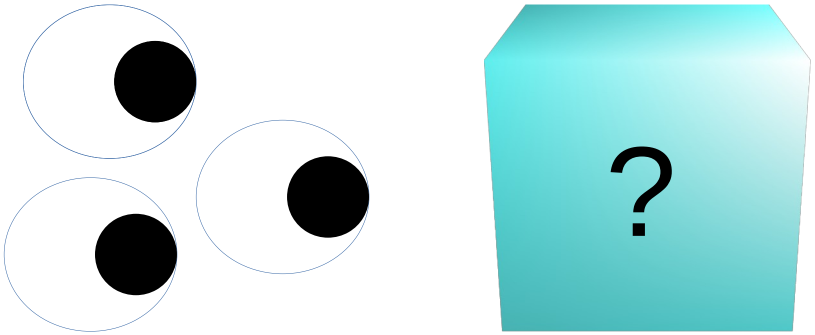
- Terms of Service + lawsuits barring reverse engineering
- Cryptosystems where the algorithms are secret

Saltzer and Schroeder's Principles of Secure Design

1) Open Design

"Given enough eyeballs, all bugs are shallow"

-- Linus Torvalds



Saltzer and Schroeder's Principles of Secure Design

1) Open Design

Heartbleed (2014):
Serious open-source software bug

"The eyeballs weren't looking"

Saltzer and Schroeder’s Principles of Secure Design

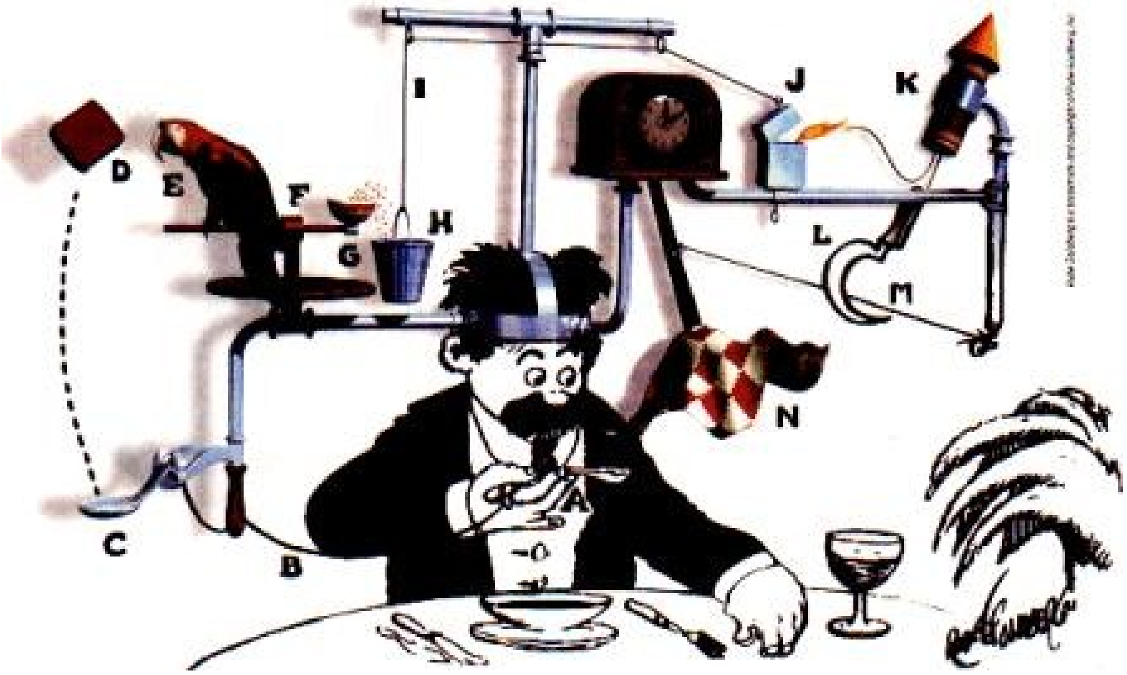
2) Economy of Mechanism

The system should be simple enough to understand and analyze.

Saltzer and Schroeder’s Principles of Secure Design

2) Economy of Mechanism

KISS Principle: Keep it simple/stupid



Saltzer and Schroeder’s Principles of Secure Design

2) Economy of Mechanism

- Helpful for security analysis
- Encourages good design
- Complicated solutions are bypassed by simple workarounds

Juicero (2016-2017)
Complicated solution, simple workaround

Saltzer and Schroeder’s Principles of Secure Design

3) Least Common Mechanism

The amount of shared mechanisms that all users depend on should be minimized.

Saltzer and Schroeder’s Principles of Secure Design

3) Least Common Mechanism

Examples for web hosting:

- Use multiple data centers
- Backup your database
- Localize computations

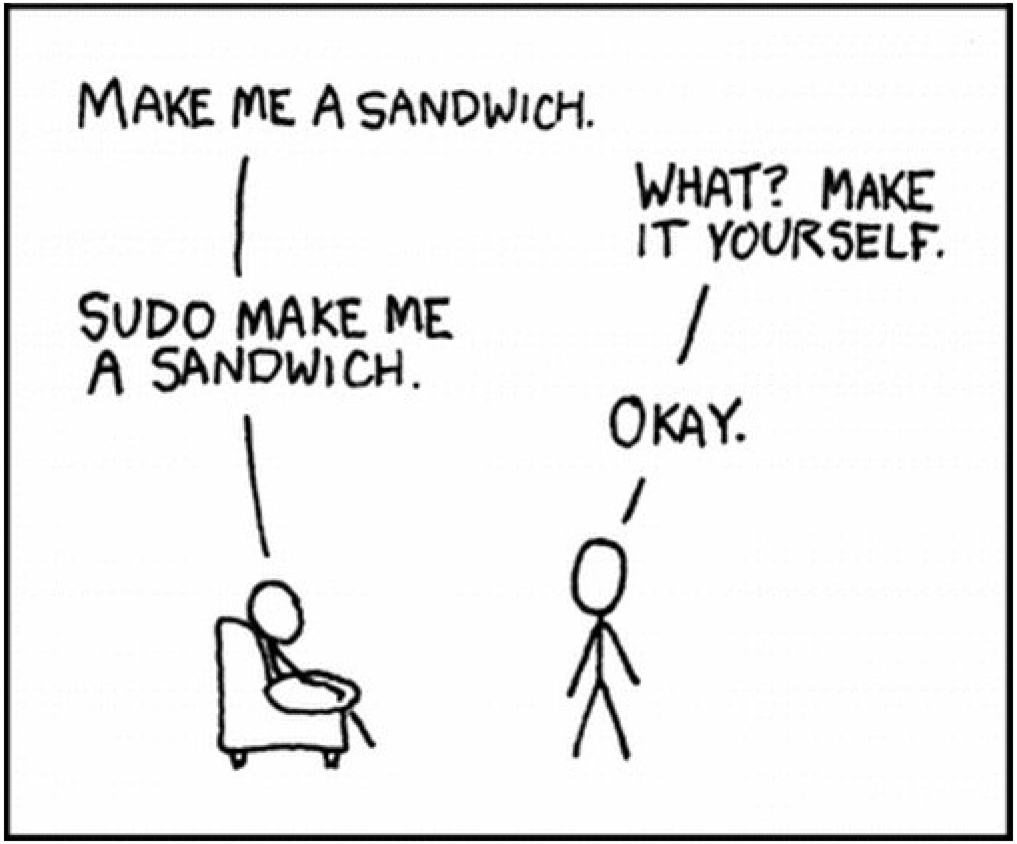
Saltzer and Schroeder's Principles of Secure Design

4) Least Privilege

A subject should only be given the minimum necessary privileges for completing its task.

Saltzer and Schroeder's Principles of Secure Design

4) Least Privilege



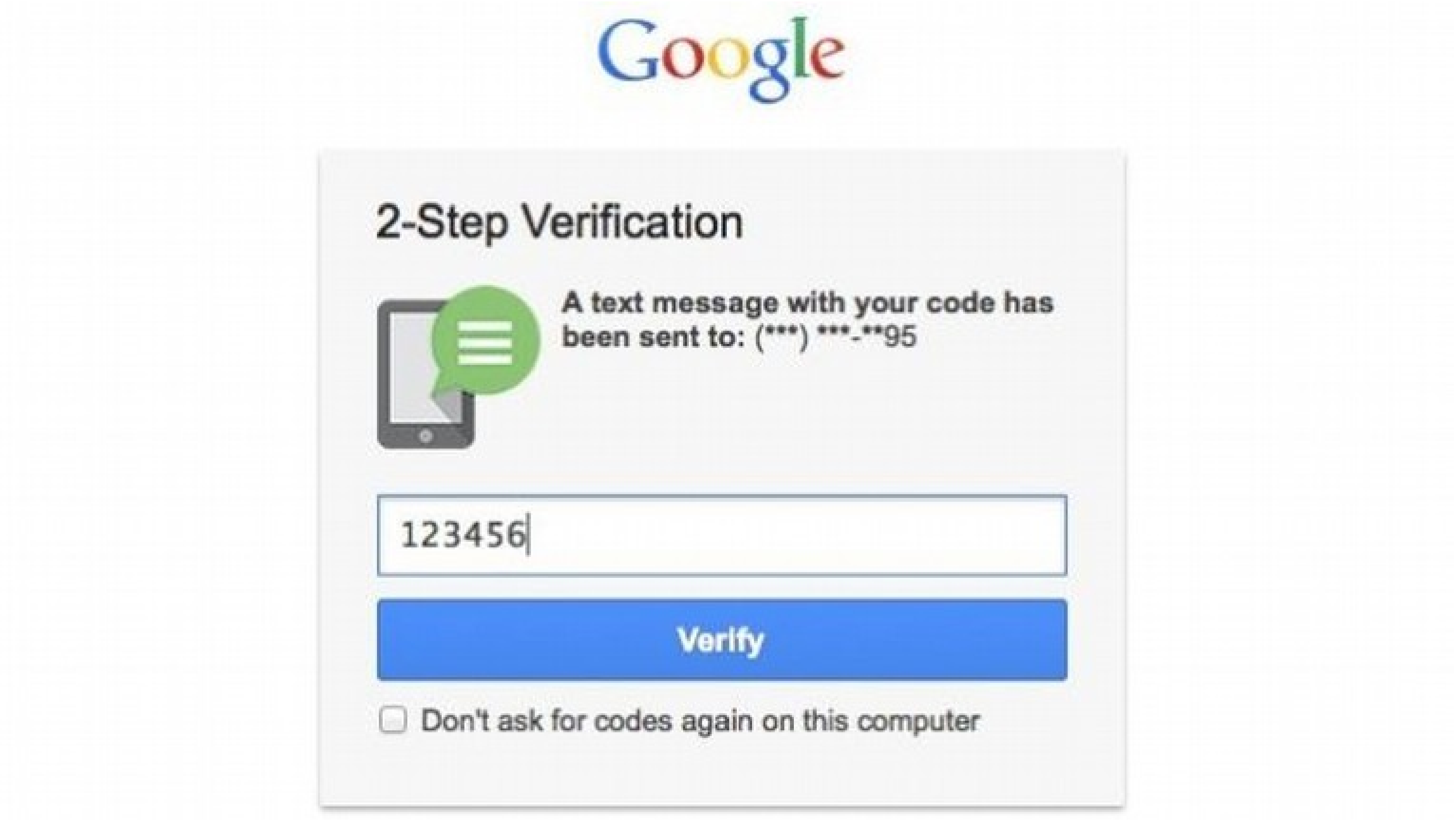
Saltzer and Schroeder’s Principles of Secure Design

5) Separation of Privileges

The system should grant permission based on multiple conditions.

Saltzer and Schroeder's Principles of Secure Design

5) Separation of Privileges



2-Step Verification

A text message with your code has been sent to: (***) ***-**95

123456

□ Don't ask for codes again on this computer

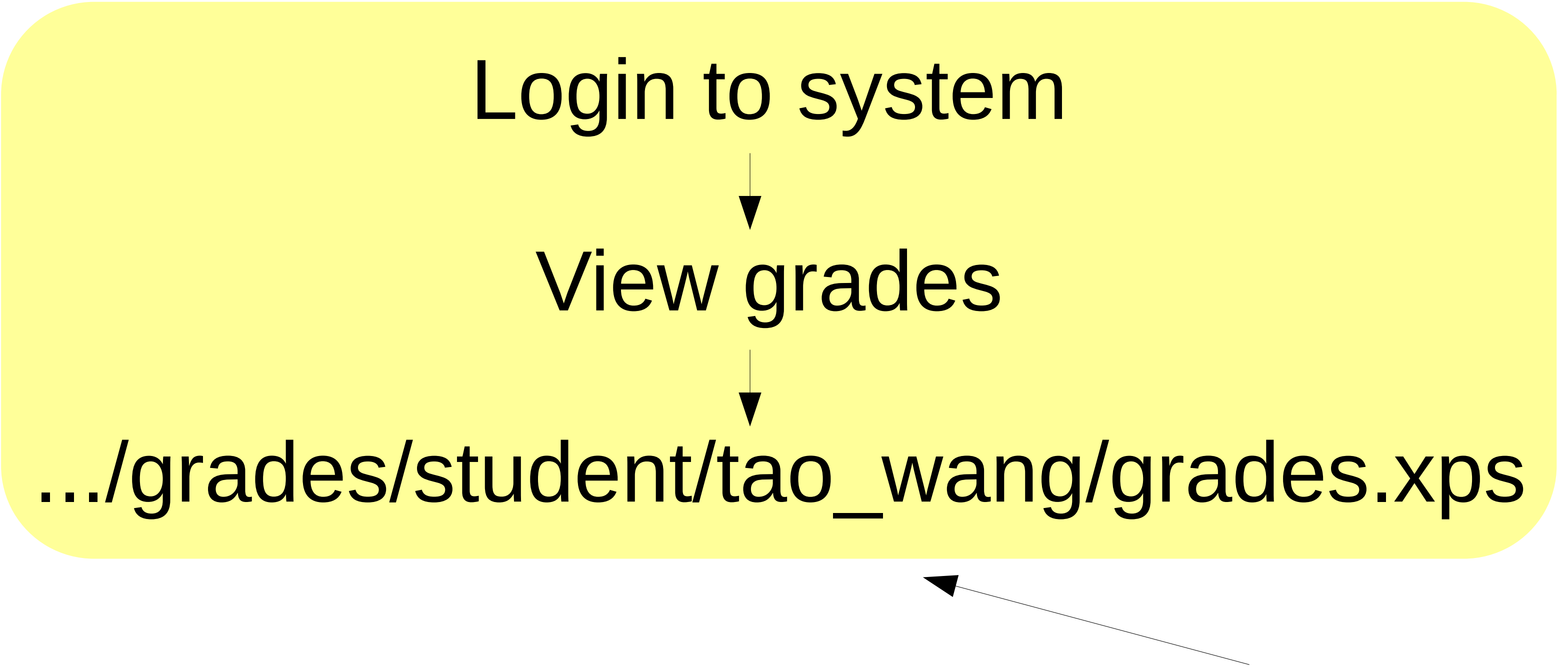
Saltzer and Schroeder's Principles of Secure Design

6) Complete mediation

All accesses should be checked.

Saltzer and Schroeder's Principles of Secure Design

6) Complete mediation



Login to system

View grades

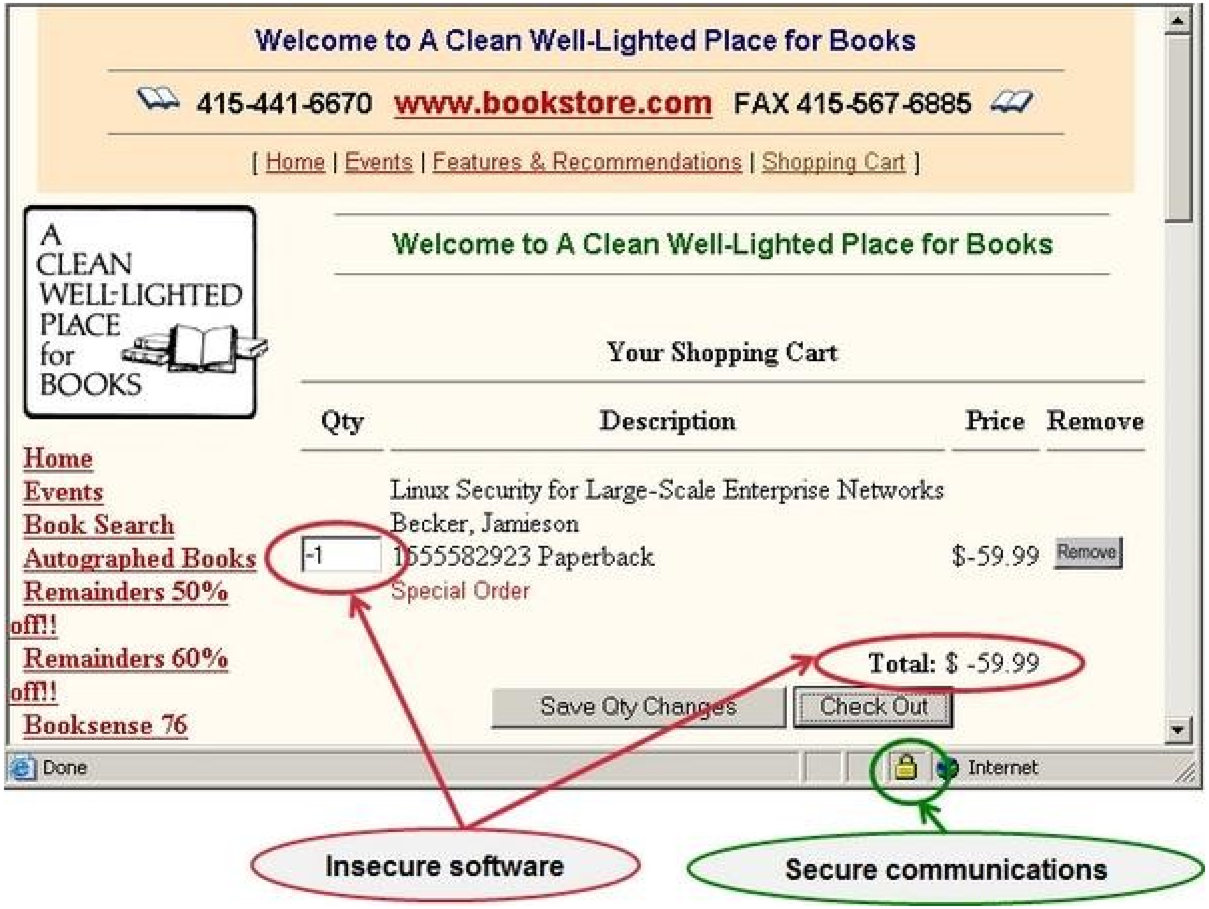
.../grades/student/tao_wang/grades.xps

What if we change this?

Related: TOCTTOU, cookie manipulation

Saltzer and Schroeder's Principles of Secure Design

6) Complete mediation



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Insecure software

Secure communications

Saltzer and Schroeder’s Principles of Secure Design

7) Fail-safe defaults

Upon failure, the system should revert to a secure default.

Saltzer and Schroeder's Principles of Secure Design

7) Fail-safe defaults

POODLE (Padding Oracle on Downgraded Legacy Encryption):

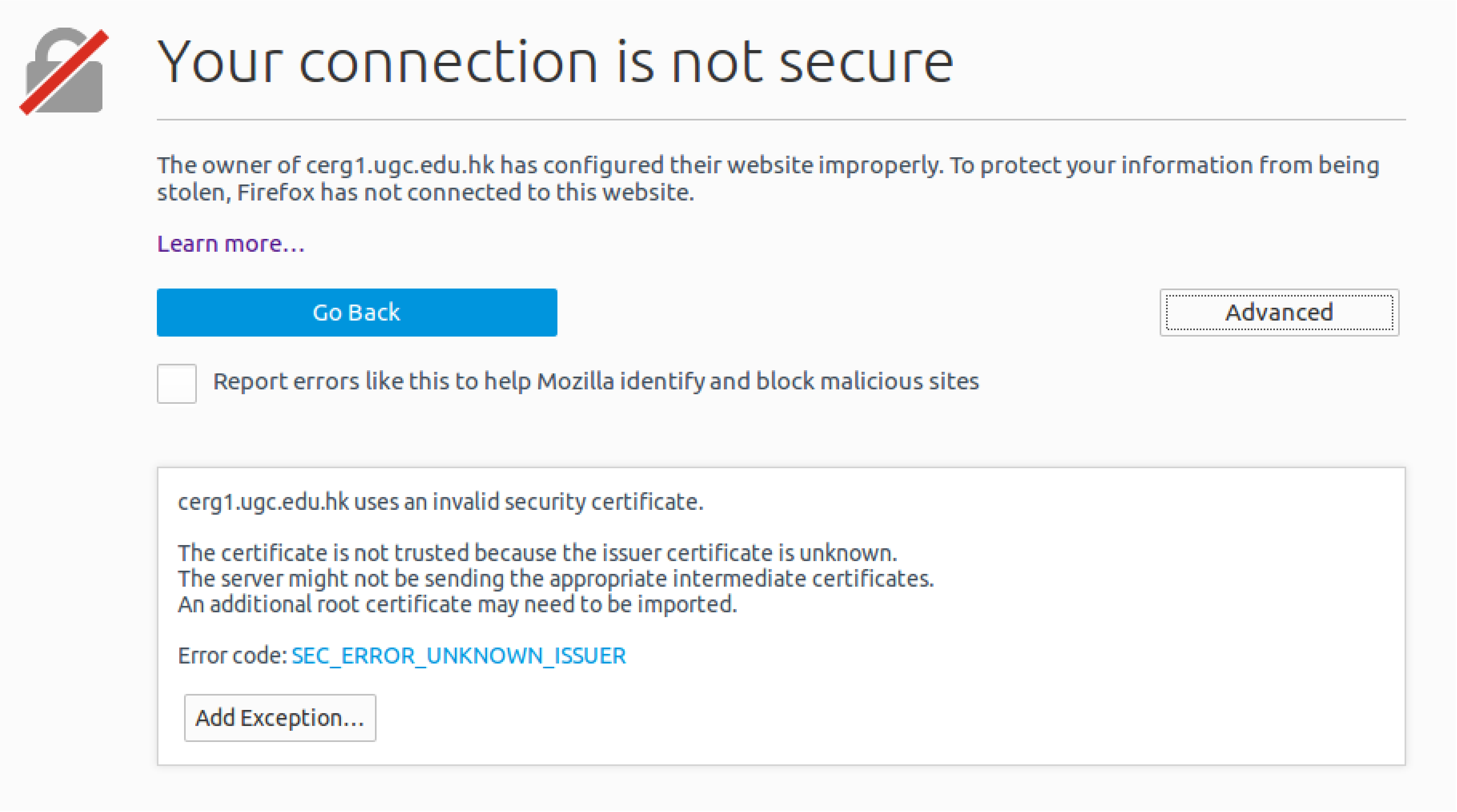
- SSL was updated to TLS to remove a padding oracle vulnerability
- Clients could force servers to downgrade to SSL again
- Hard to fix because some clients genuinely hadn't updated to TLS (2014)

Saltzer and Schroeder's Principles of Secure Design

8) Psychological Acceptability

Security should be intuitive to the human psyche.

Saltzer and Schroeder's Principles of Secure Design



Your connection is not secure

The owner of cerg1.ugc.edu.hk has configured their website improperly. To protect your information from being stolen, Firefox has not connected to this website.

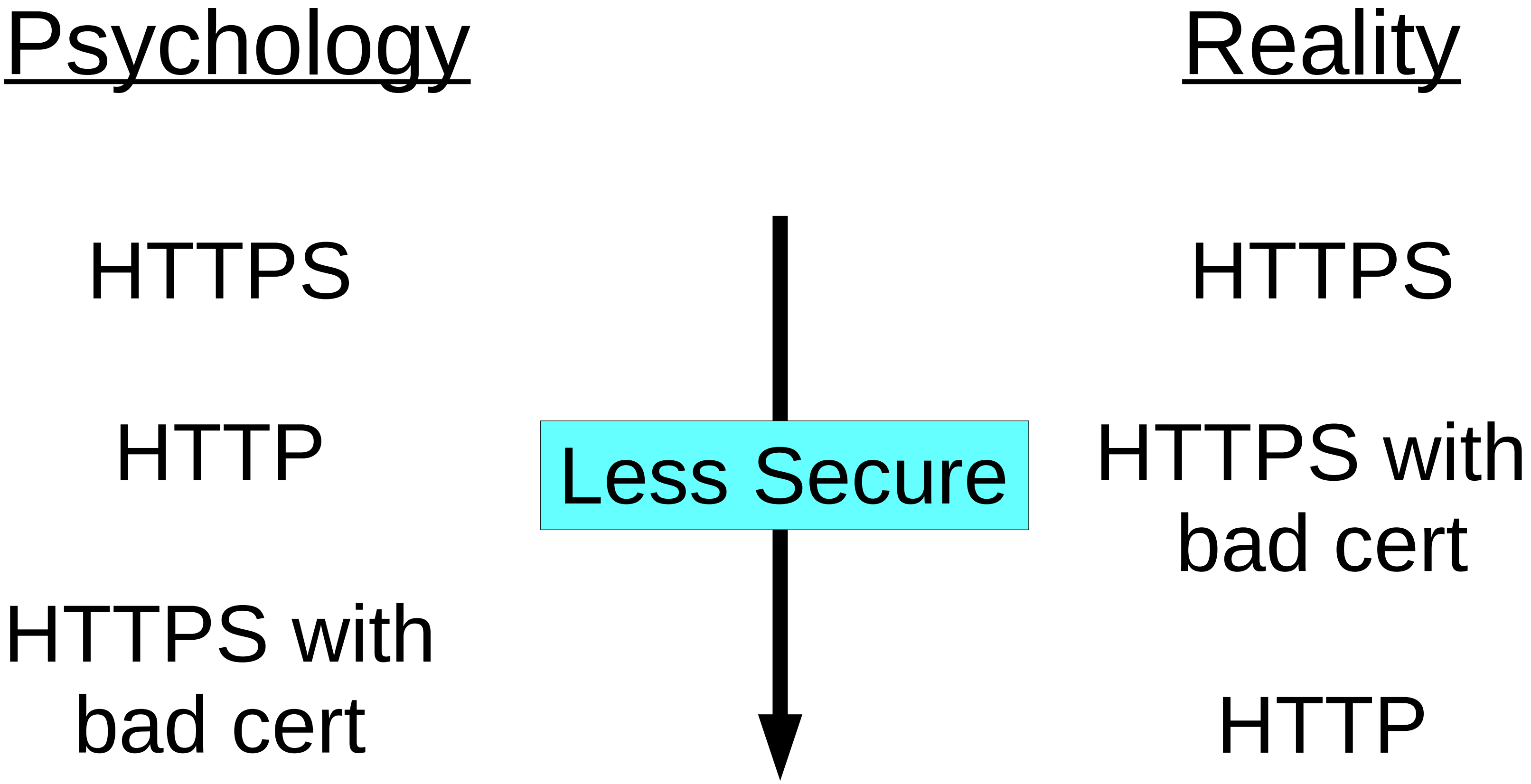
□ Report errors like this to help Mozilla identify and block malicious sites

cerg1.ugc.edu.hk uses an invalid security certificate.

The certificate is not trusted because the issuer certificate is unknown.
The server might not be sending the appropriate intermediate certificates.
An additional root certificate may need to be imported.

Error code: SEC_ERROR_UNKNOWN_ISSUER

Saltzer and Schroeder's Principles of Secure Design



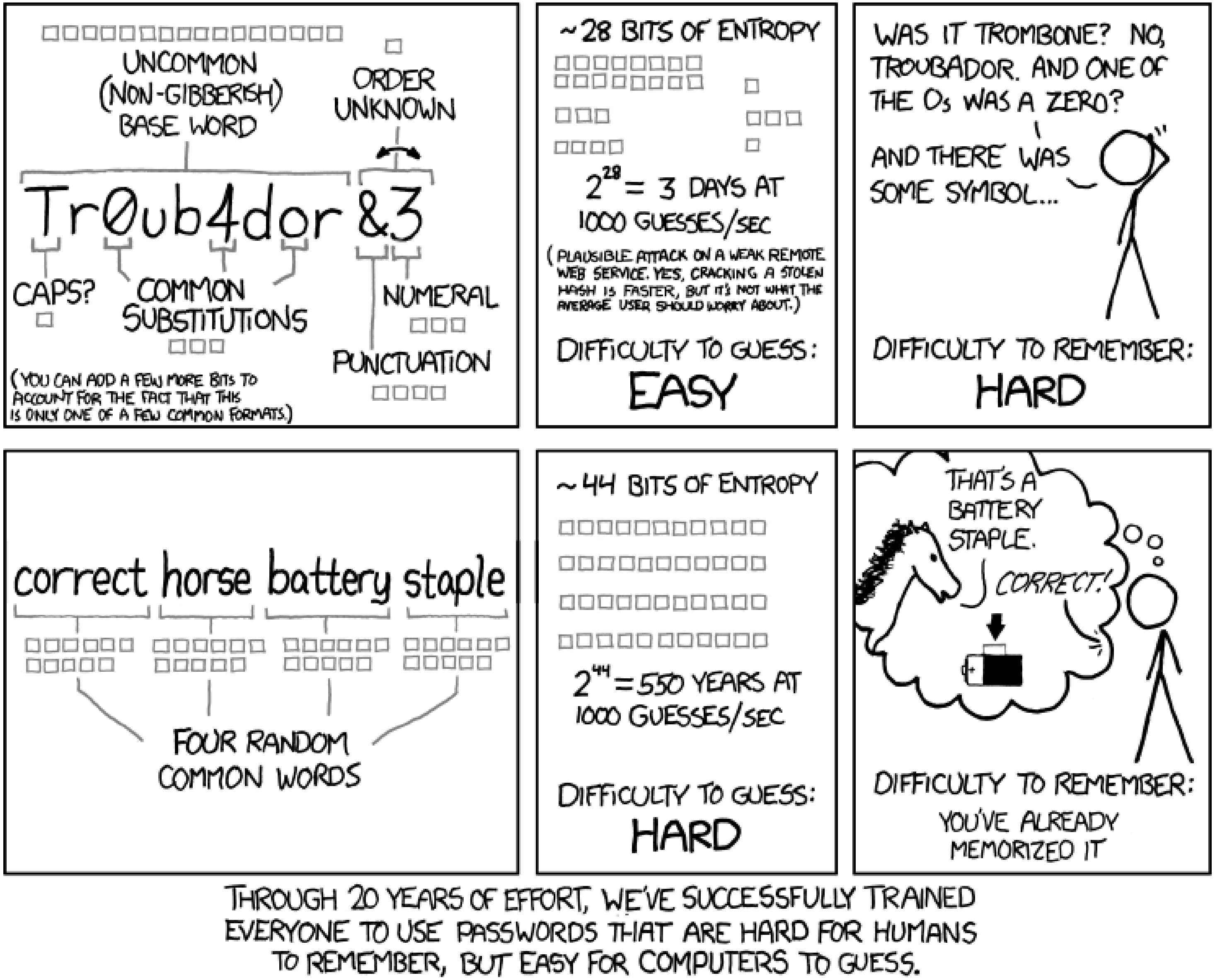
Psychology	Reality
HTTPS	HTTPS
HTTP	HTTPS with bad cert
HTTPS with bad cert	HTTP

Saltzer and Schroeder's Principles of Secure Design

9) Work factor

Consider how much effort an attacker needs to expend to attack the system.

Saltzer and Schroeder's Principles of Secure Design


UNCOMMON (NON-GIBBERISH) BASE WORD
ORDER UNKNOWN
Tr0ub4dor &3
CAPS?
COMMON SUBSTITUTIONS
NUMERAL
PUNCTUATION
(YOU CAN ADD A FEW MORE BITS TO ACCOUNT FOR THE FACT THAT THIS IS ONLY ONE OF A FEW COMMON FORMATS.)
~28 BITS OF ENTROPY
2^28 = 3 DAYS AT 1000 GUESSES/SEC
(PLAUSIBLE ATTACK ON A WEAK REMOTE WEB SERVICE. YES, CRACKING A STOLEN HASH IS FASTER, BUT IT'S NOT WHAT THE AVERAGE USER SHOULD WORRY ABOUT.)
DIFFICULTY TO GUESS: EASY
WAS IT TROMBONE? NO, TROUBADOR. AND ONE OF THE Os WAS A ZERO?
AND THERE WAS SOME SYMBOL...
DIFFICULTY TO REMEMBER: HARD
correct horse battery staple
FOUR RANDOM COMMON WORDS
~44 BITS OF ENTROPY
2^44 = 550 YEARS AT 1000 GUESSES/SEC
DIFFICULTY TO GUESS: HARD
THAT'S A BATTERY STAPLE.
CORRECT!
DIFFICULTY TO REMEMBER: YOU'VE ALREADY MEMORIZED IT
THROUGH 20 YEARS OF EFFORT, WE'VE SUCCESSFULLY TRAINED EVERYONE TO USE PASSWORDS THAT ARE HARD FOR HUMANS TO REMEMBER, BUT EASY FOR COMPUTERS TO GUESS.

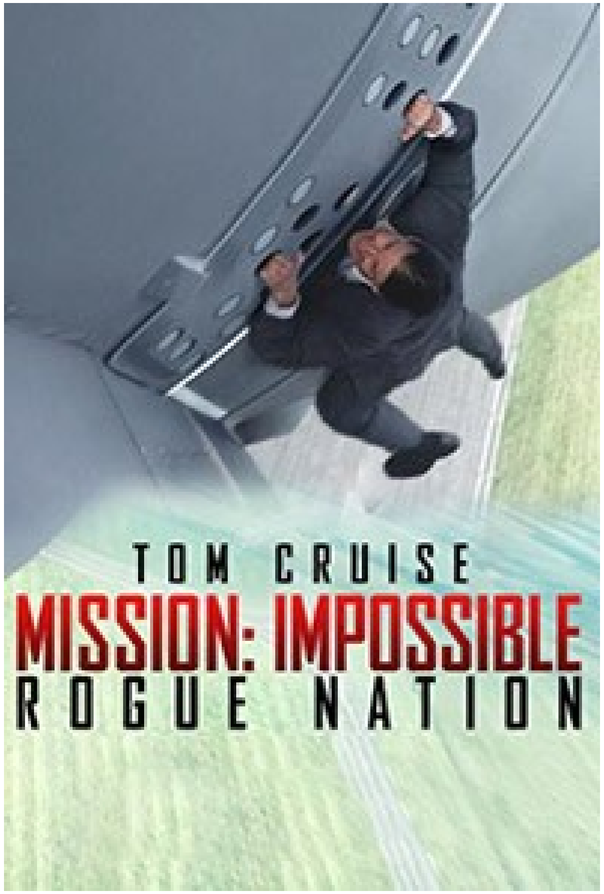
Saltzer and Schroeder's Principles of Secure Design

10) Compromise recording

Always record compromise events.

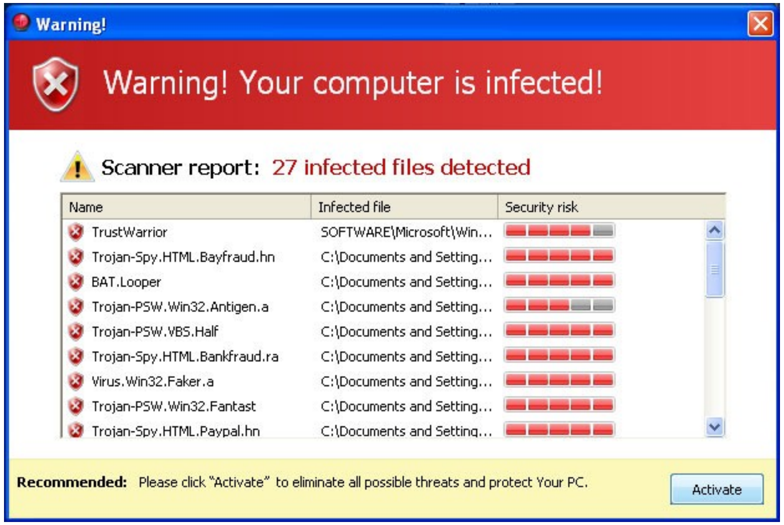
Which Principles are Used/Violated?

- Tom Cruise’s partner needs to enter a secure facility, which has three combination locks and biometric analysis (fingerprint, gait analysis)
- To put his profile on the system so he can bypass the biometric tests, Tom Cruise dives into a water control system, tears out the old profile drive, and inserts a new profile drive
- Once inside, his partner steals information about 2.4 billion pounds in various bank accounts of the PM



Which Principles are Used/Violated?

- I am scared, so I install the recommended anti-virus. A window pops up asking for admin privileges, I grant it.
- The anti-virus code is not available, so I don't know what it's really doing; I can only trust it
- The anti-virus is actually a virus, and it exploits a buffer overflow in glibc
- glibc is used by all programs written in C; many programs can trigger the virus



Warning! Your computer is infected!

Scanner report: 27 infected files detected

Name	Infected file	Security risk
TrustWarrior	SOFTWARE\Microsoft\Win...	■■■■□
Trojan-Spy.HTML.Bayfraud.hn	C:\Documents and Setting...	■■■■■
BAT.Looper	C:\Documents and Setting...	■■■■■
Trojan-PSW.Win32.Antigen.a	C:\Documents and Setting...	■■■□□
Trojan-PSW.VBS.Half	C:\Documents and Setting...	■■■■■
Trojan-Spy.HTML.Bankfraud.ra	C:\Documents and Setting...	■■■■■
Virus.Win32.Faker.a	C:\Documents and Setting...	■■■■■
Trojan-PSW.Win32.Fantast	C:\Documents and Setting...	■■■■■
Trojan-Spy.HTML.Paypal.hn	C:\Documents and Setting...	■■■■■

Recommended: Please click "Activate" to eliminate all possible threats and protect Your PC.