# CS165 – Computer Security

Introduction

September 27, 2024

# Outline

- Welcome!
- Goals of this course
  - Get to know computer security
  - Master a subset of critical skills in security
- Grading
- Introduction to the class

# Self intro

- Trent Jaeger, CSE Prof.
- Email: trentj@ucr.edu
- eLearn used for announcements, slides, assignments, forum
- Course webpage: https://www.cs.ucr.edu/~trentj/cs165-f24/
  - Link to the course schedule
- Office: WCH 442
- Office Hours: 4-5pm M and 3-4pm W or by appointment
- TA: Xin’an Zhou <xinan.zhou@email.ucr.edu>

# Problem – Compromise the Internet

***2000s – One vulnerability can take over the Internet***

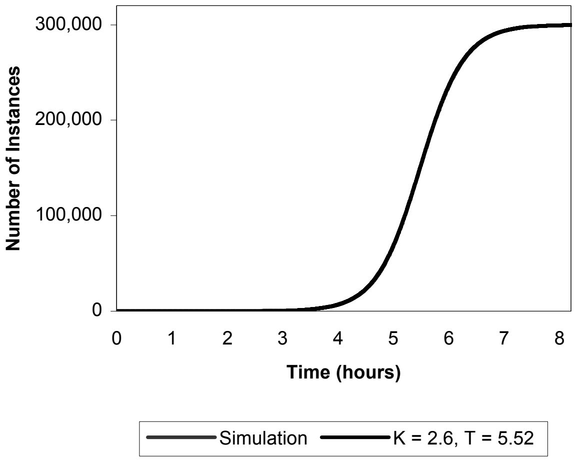
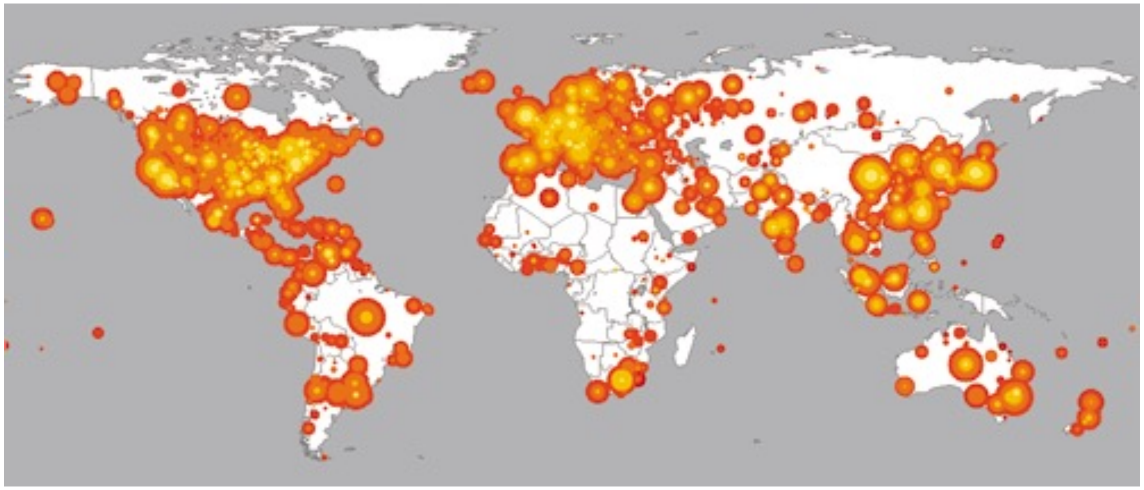


Figure 6: The spread of a simulated worm capable of 10 scans/second in a population of 300,000 vulnerable machines and its comparison to the model developed in Section 2. The simulation and theoretical results overlap completely.

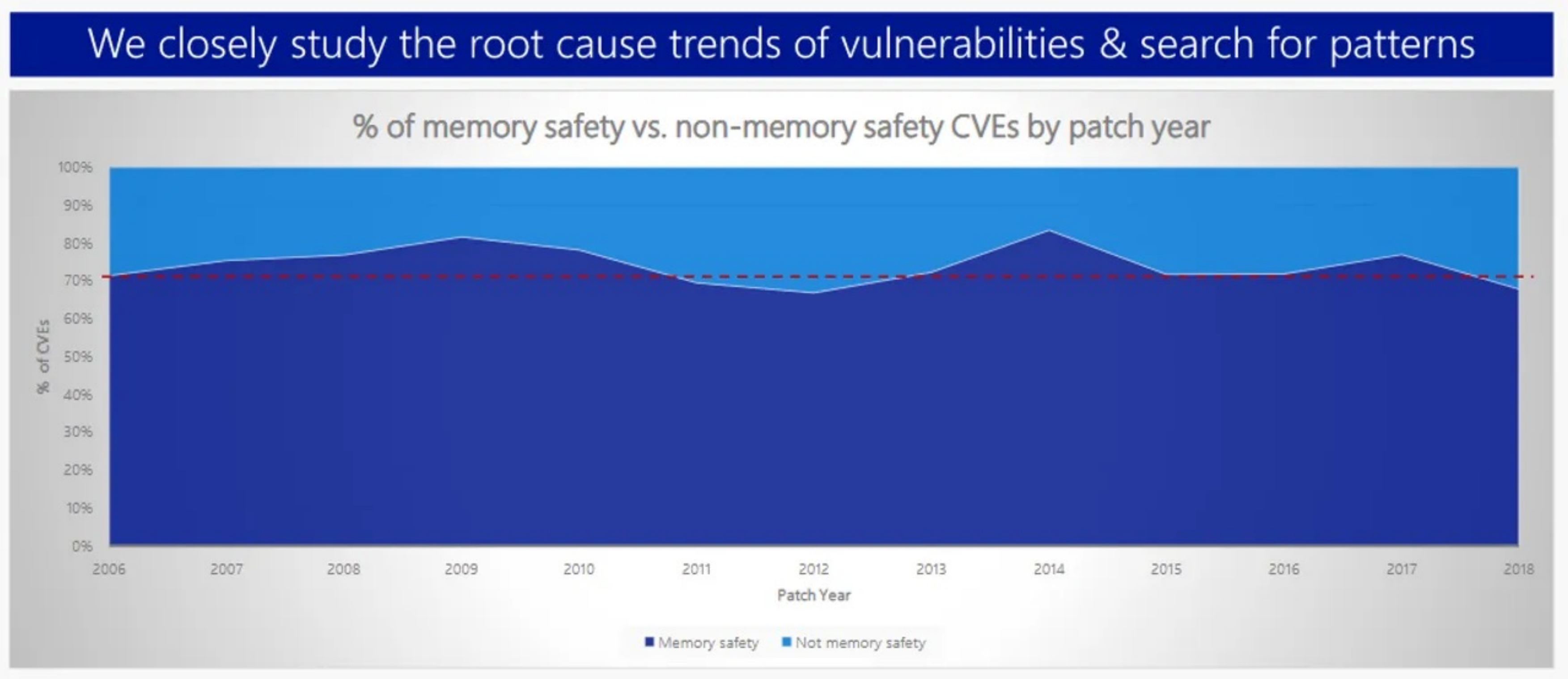


# Reaction – Confine Network Programs

***2000s – Sandbox "network-facing daemons" to prevent host compromise***

# Limitation – Buggy Software

***Lots of vulnerabilities in software – lots of “memory errors”***



We closely study the root cause trends of vulnerabilities & search for patterns

# Goals of this course

- Learn the principles of computer security
  - Diverse and domain-specific
- Gain hands-on experience (not just theory)
  - Learn to break things
    - $2M bounty for remote jailbreak!
  - And secure systems
    - Write secure code, configure systems securely
    - Analyze a system critically for weaknesses

# Goals of this course

- From this class, you'll learn to:
  - Perform attacks to exploit programs
  - Prevent attacks and their exploitation
  - Learn mechanisms to limit impact of exploits
- Become aware of security as a key dimension of software and system design and implementation

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# Course Info and Readings

- Course Management via Elearn (Canvas)
- Textbook
  - Tools and Jewels.  Paul van Oorschot. Online.
- Readings for each class determined by the class schedule
  - https://www.cs.ucr.edu/~trentj/cs165-w24/schedule.html
    - Linked from syllabus in elearn and …
    - https://www.cs.ucr.edu/~trentj/cs165-w24/
- Optional Textbook
  - Hacking: The Art of Exploitation (2nd Edition), by Jon Erickson
    - *Useful for understanding attacks.*

# Grading

- 1 Midterm: 25%
- 1 Final: 30%
- 3 Projects : 24%
- 4 quizzes: 16%
- Participation: 5%
  - Questions, answering others’ questions, forum activities, intellectual contribution

# Late policy

- 4 slack days for homework or project (combined)

- 2% bonus points if you do not use any
  - All or nothing

- When you exhaust your slack days, there is a 20% per day per assignment score deduction
  - If: (1) all the slack days have been exhausted and (2) that assignment is late.

# Academic Integrity

- UCR Academic Integrity Polices & Procedures
  - Linked to syllabus
  - Do not share your work outside of class!

# Ethics

- This course considers topics involving software exploitation techniques. As part of this investigation, we will cover technologies whose abuse may infringe on the rights of others. As an instructor, I rely on the ethical use of these technologies. Unethical use may include circumvention of existing security or privacy measurements for any purpose, or the dissemination, promotion, or exploitation of vulnerabilities of these services. Exceptions to these guidelines may occur in the process of reporting vulnerabilities through public and authoritative channels. Any activity outside the letter or spirit of these guidelines will be reported to the proper authorities and may result in dismissal from the class.

- When in doubt, please contact the instructor for advice. Do not undertake any action that could be perceived as technology misuse anywhere and/or under any circumstances unless you have received explicit permission from Professor Jaeger.

# Laws and Policies

- University of California Electronic Communications Policy
  - You can be expelled
- Federal and state laws criminalize computer intrusion and wiretapping
  - e.g., Computer Fraud and Abuse Act (CFAA), Electronic Communications Privacy Act (ECPA)

# Getting an A

- This class requires knowledge of computer organization, operating systems, networking
  - CS61, CS161, CS153, CS164 (a little bit)
- And a mature understanding of software and systems in general

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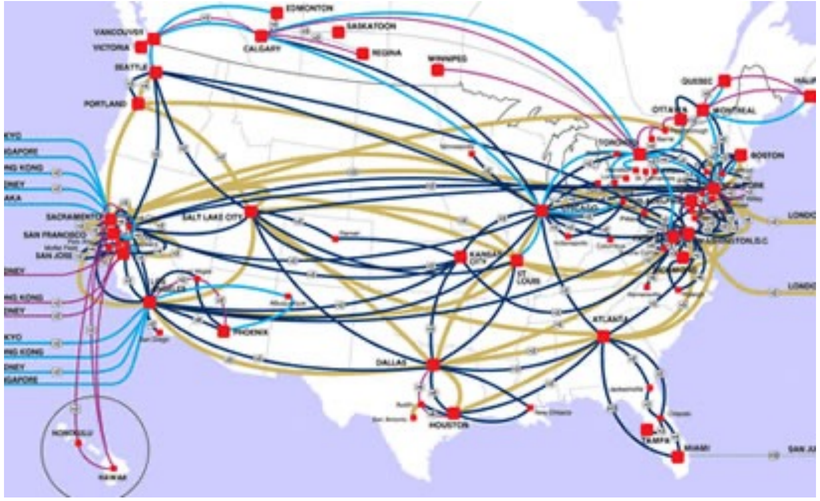
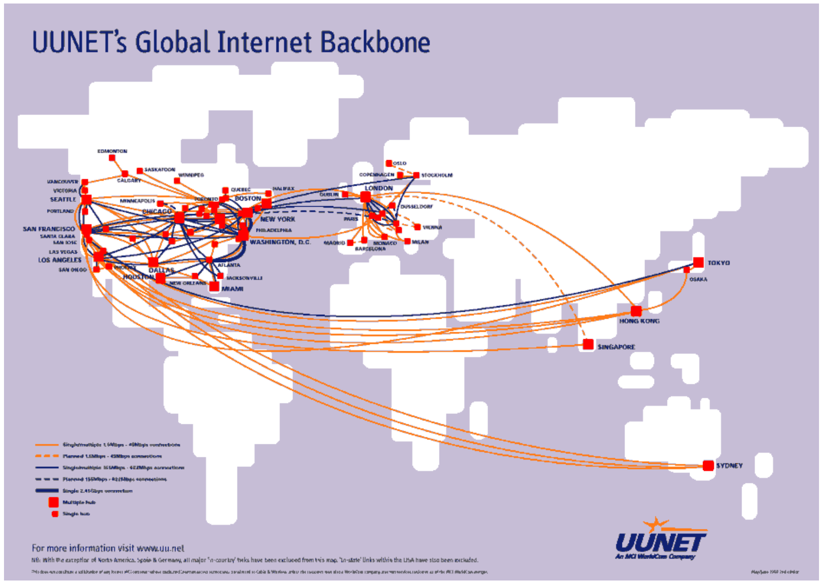
# Computer

# Network

OC192
OC48
OC12
DS3
AT&T


EDMONTON
SASKATOON
VANCOUVER
VICTORIA
CALGARY
REGINA
WINNIPEG
SEATTLE
PORTLAND
QUEBEC
OTTAWA
MONTREAL
BOSTON
SACRAMENTO
SAN FRANCISCO
SAN JOSE
SALT LAKE CITY
WASHINGTON D.C.
PHOENIX
DALLAS
ATLANTA
HOUSTON
TAMPA
MIAMI
HONOLULU
HAWAII


UUNET's Global Internet Backbone
EDMONTON
SASKATOON
CALGARY
WINNIPEG
VANCOUVER
VICTORIA
SEATTLE
PORTLAND
MINNEAPOLIS
TORONTO
QUEBEC
HALIFAX
BOSTON
CHICAGO
NEW YORK
PHILADELPHIA
WASHINGTON, D.C.
SAN FRANCISCO
SANTA CLARA
SAN JOSE
LAS VEGAS
LOS ANGELES
SAN DIEGO
DALLAS
HOUSTON
ATLANTA
NEW ORLEANS
JACKSONVILLE
MIAMI
OSLO
COPENHAGEN
STOCKHOLM
DUBLIN
LONDON
DUSSELDORF
PARIS
VIENNA
MADRID
MONACO
BARCELONA
MILAN
TOKYO
OSAKA
HONG KONG
SINGAPORE
SYDNEY
Single/multiple 1.5Mbps - 45Mbps connections
Planned 1.5Mbps - 45Mbps connections
Single/multiple 155Mbps - 622Mbps connections
Planned 155Mbps - 622Mbps connections
Single 2.4Gbps connection
Multiple hub
Single hub
For more information visit www.uu.net
NB: With the exception of North America, Spain & Germany, all major 'in-country' links have been excluded from this map. 'In-state' links within the USA have also been excluded.
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SECURITY RISK
HOW SAFE IS YOUR COMPUTER?

IS IT SAFE?

# Recent news

Data breach in March 2023

Facebook 50M accounts

Dyn DDoS attack

Insider threats

# What is security about?

# Security and security mindset

- “The study of how a system behaves under adversarial actions”
  - Intelligent attackers actively trying to lead the system to misbehave or do unexpected things

- Security vs. System

||     ||

- Corner cases vs. Common case

# Play Games vs. Security Games

# Play Games vs. Security Games

- Both deal with a set of man-made rules!
- Man-made rules have bugs (which can be exploited)!
  - Think about tax systems…
  - Warren Buffett’s tax rate is lower than his secretary’s
    - 17.3% on $39.8 million taxable income
    - Heck, it’s lower than my tax rate
  - The more complex, the more dangerous

# Thinking like an attacker

- Analyze game rules with goals to circumvent
  - Break into a locked door? Fake an identity?
  - Thought experiment: How to get into offices after hours?
- Think outside the box
  - Make program run differently than expected
  - Exploit unexpected effects
- Challenge security assumptions
  - All available points of attack: Threat Model
- One successful attack that exploits a vulnerability is good enough!

# Thinking like a defender

- Discover loopholes in game rules and fix them
  - With respect to a Threat Model
  - Need to cover all corner cases (is currently HARD!)
  - Always catch-up
- Design favorable rules for defense
  - Prevention of bad consequences (also HARD!)
  - Need to allow legitimate functionalities (which may lead to bad consequences)

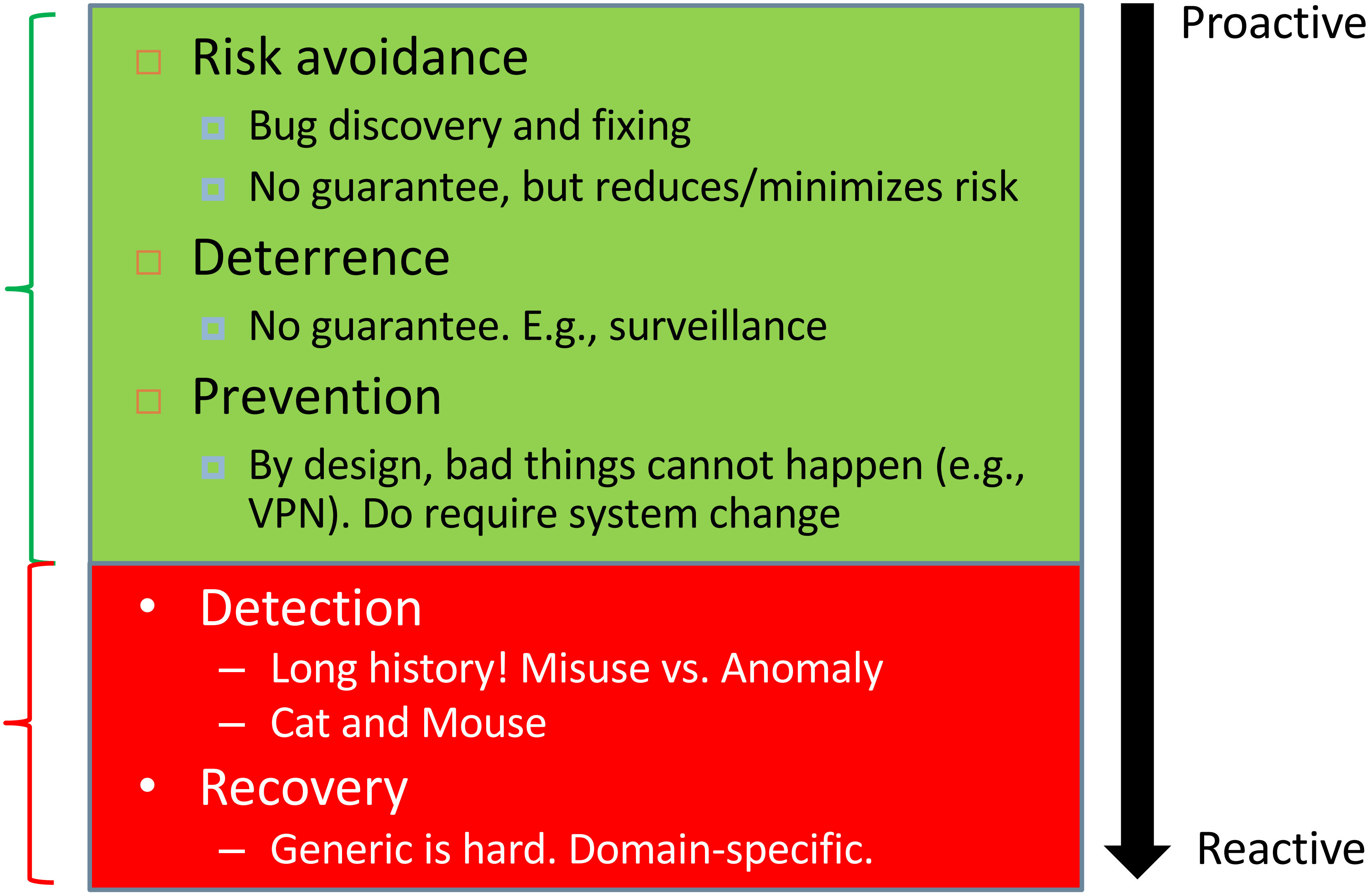
# Topics

- Software security
  - Attacks
  - Causes
  - Defenses
- Systems security
  - File security
  - Web security
  - Network security

Not a theory or crypto class

# Questions

# Goals of defenders



Before attacks happen

- Risk avoidance
  - Bug discovery and fixing
  - No guarantee, but reduces/minimizes risk
- Deterrence
  - No guarantee. E.g., surveillance
- Prevention
  - By design, bad things cannot happen (e.g., VPN). Do require system change

After attacks happen

- Detection
  - Long history! Misuse vs. Anomaly
  - Cat and Mouse
- Recovery
  - Generic is hard. Domain-specific.

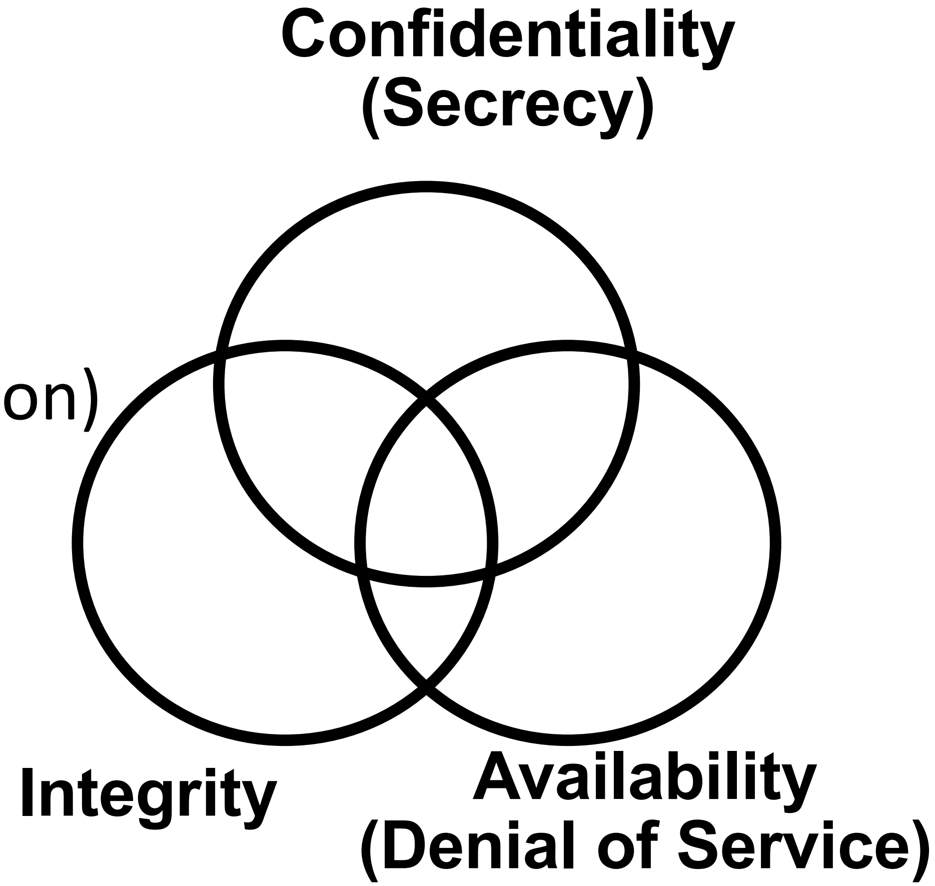
# Case study (detection): how people ensure physical security

Allow "non-malicious/dangerous" people in →

# Case study (detection): how people ensure cyber security

# Basic Goals in Security (CIA)

- Confidentiality
  - Keeping data and resources hidden
- Integrity
  - Data integrity (integrity)
  - Origin integrity (authentication)
- Availability
  - Enabling access to data and resources



# Threat model

- □ What resources/ capabilities / motivations the attacker has? What defenses are in place?

VS

Weakness < Vulnerability < Exploit < Attack