



SECURITY IN COMPUTING, FIFTH EDITION

Chapter 1: Introduction



Objectives for Chapter 1

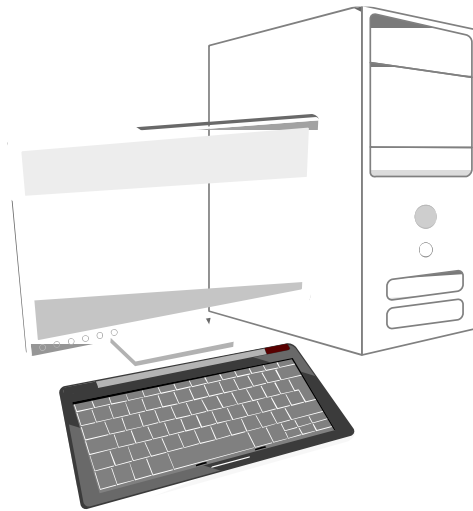
- Define *computer security* as well as basic computer security terms
- Introduce the C-I-A Triad
- Introduce basic access control terminology
- Explain basic threats, vulnerabilities, and attacks
- Show how controls map to threats



What Is Computer Security?

- The protection of the assets of a computer system
 - Hardware
 - Software
 - Data

Assets



Hardware:

- Computer
- Devices (disk drives, memory, printer)
- Network gear

Software:

- Operating system
- Utilities (antivirus)
- Commercial applications (word processing, photo editing)
- Individual applications

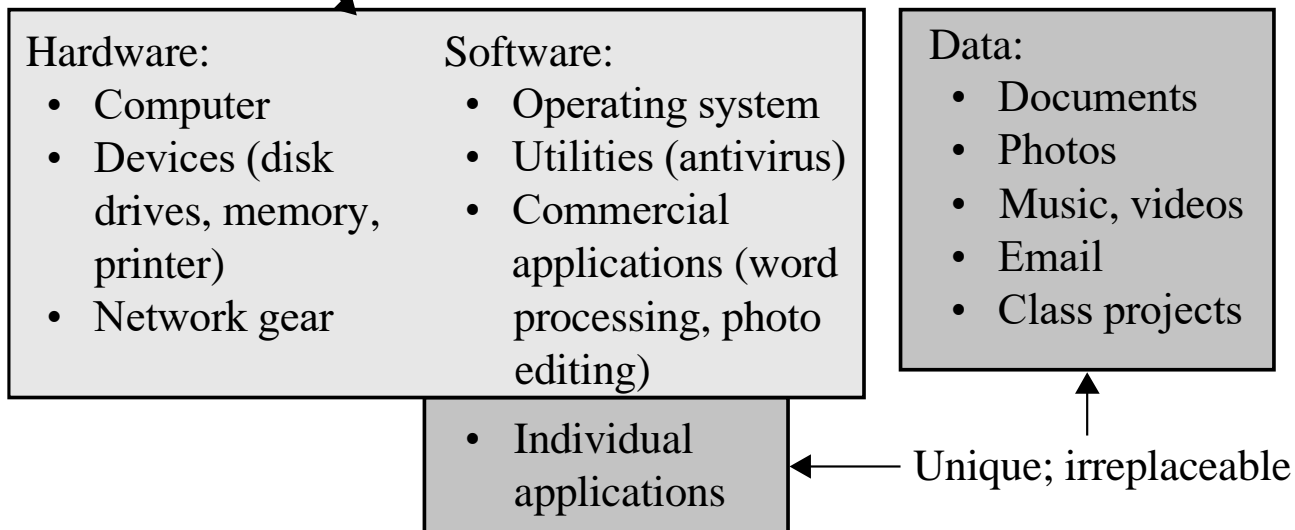
Data:

- Documents
- Photos
- Music, videos
- Email
- Class projects

Values of Assets



Off the shelf;
easily replaceable





Basic Terms

- Vulnerability
- Threat
- Attack
- Countermeasure or control



Vulnerabilities, Threats, Attacks,

Controls

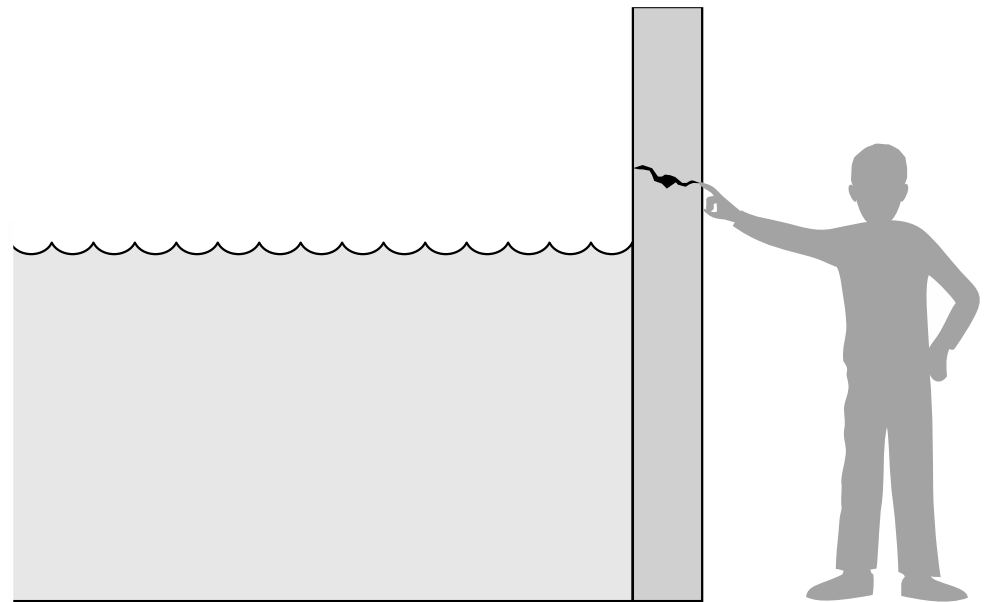
- **Vulnerability** is a weakness in the security system
 - (i.e., in procedures, design, or implementation), that might be exploited to *cause loss or harm*.
- **Threat** to a computing system is a set of circumstances that has the *potential to cause loss or harm*.
 - a potential violation of security
- A human (*criminal*) who exploits a vulnerability perpetrates an **attack** on the system.
- How do we address these problems?
 - We use a **control** as a protective measure.
 - That is, a control is an action, device, procedure, or technique that *removes or reduces a vulnerability*.

Threat and Vulnerability

Relationship among threats, controls, and vulnerabilities:

- A threat is blocked by control of a vulnerability.
- To devise controls, we must know as much about threats as possible.

The fact that the violation might occur means that the actions that might cause it should be guarded against.



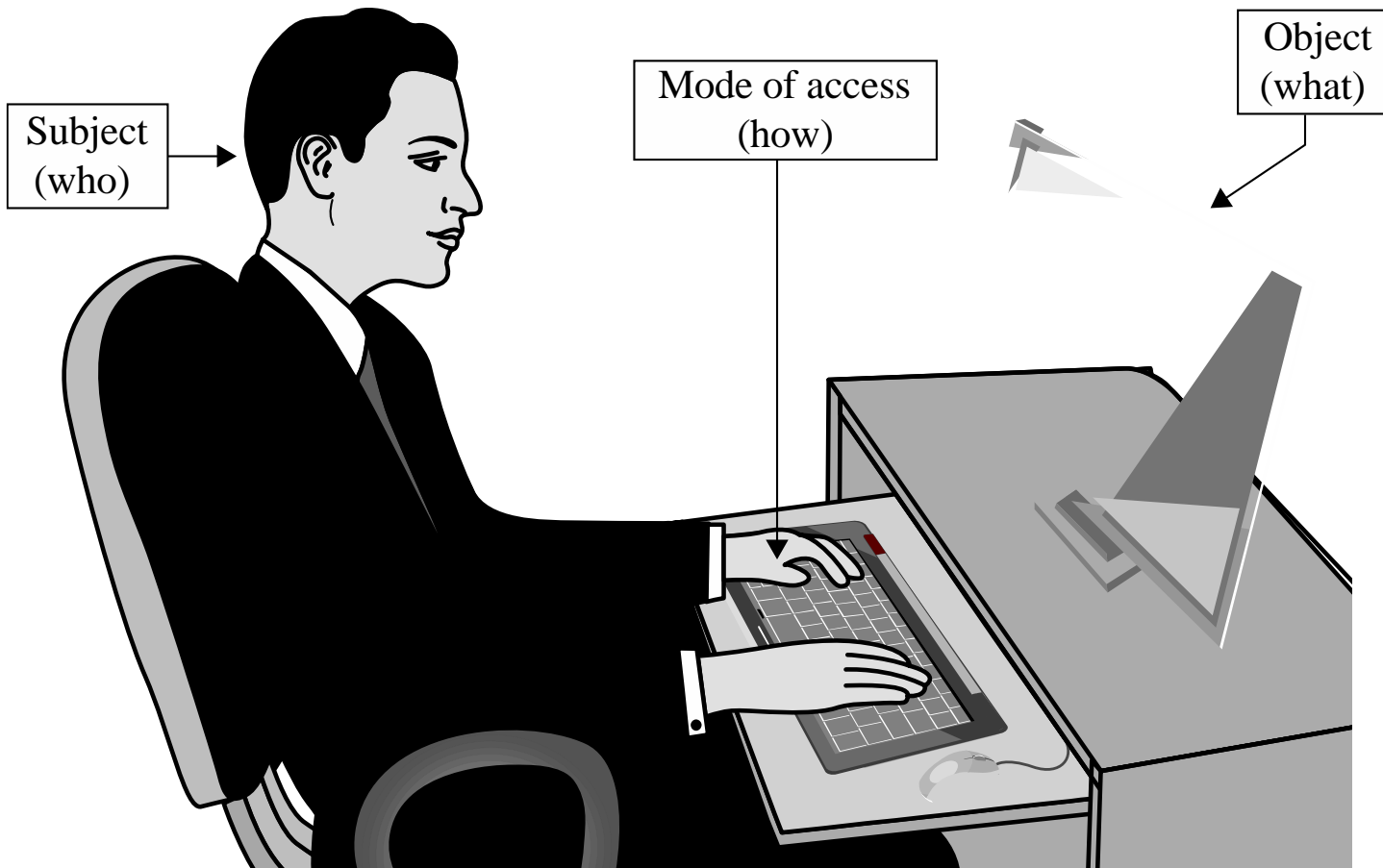


C-I-A Triad

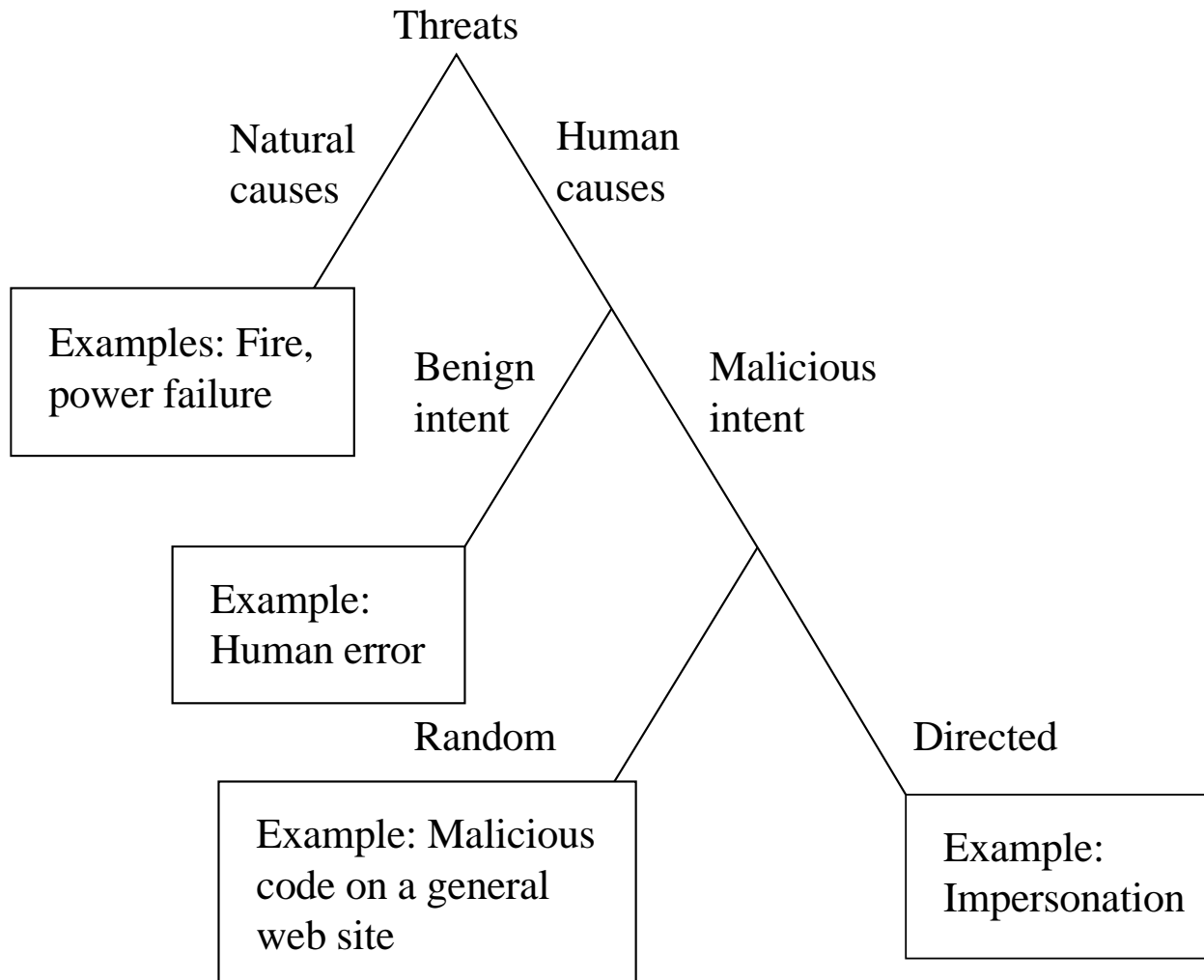
- Confidentiality
- Integrity
- Availability
- Sometimes two other desirable characteristics:
 - Authentication
 - the process or action of proving or showing **something to be true, genuine, or valid.**
 - Nonrepudiation
 - is the assurance that someone cannot deny something.
 - i.e. **nonrepudiation** refers to the ability to ensure that a party to a contract or a communication **cannot deny the authenticity of their signature** on a document or the sending of a message that they originated

Access Control

Policy:
Who + What + How = Yes/No



Types of Threats

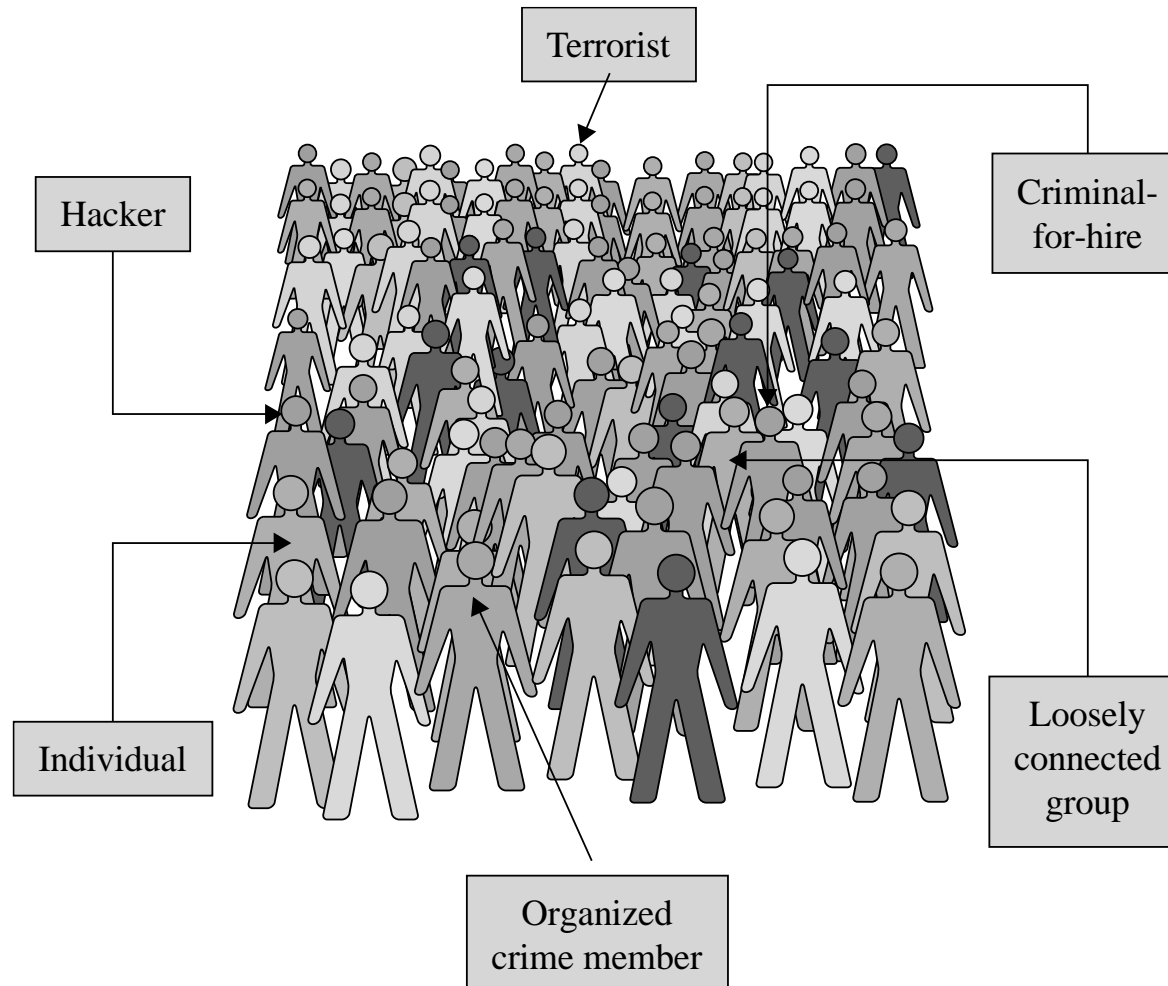




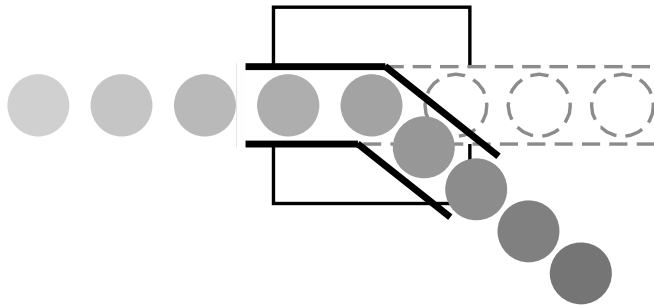
Advanced Persistent Threat (APT)

- Organized
- Directed
- Well financed
- Patient
- Silent

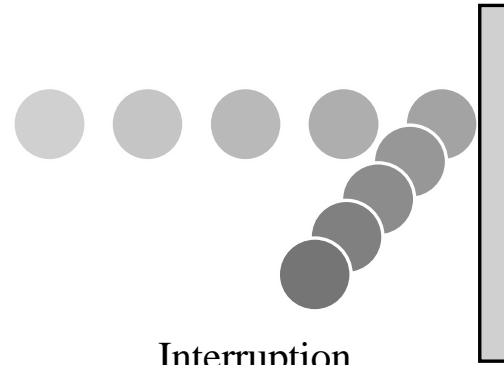
Types of Attackers



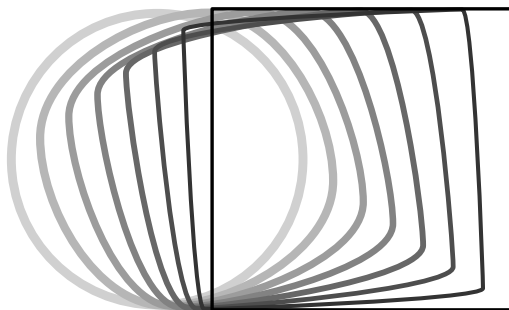
Types of Harm



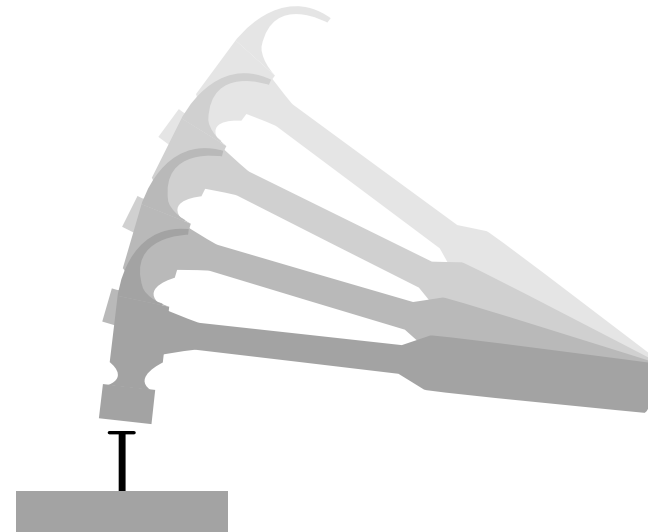
Interception



Interruption



Modification



Fabrication



Threats

- In an **interception** means that some unauthorized party has gained access to an asset.
- In an **interruption**, an asset of the system becomes lost, unavailable, or unusable.
- If an unauthorized party not only accesses but **tampers** (forges) with an asset, the threat is a **modification**.
- Finally, an unauthorized party might create a **fabrication** of **counterfeit** objects on a computing system.

Method—Opportunity—Motive (MOM)

Opportunity



Motive

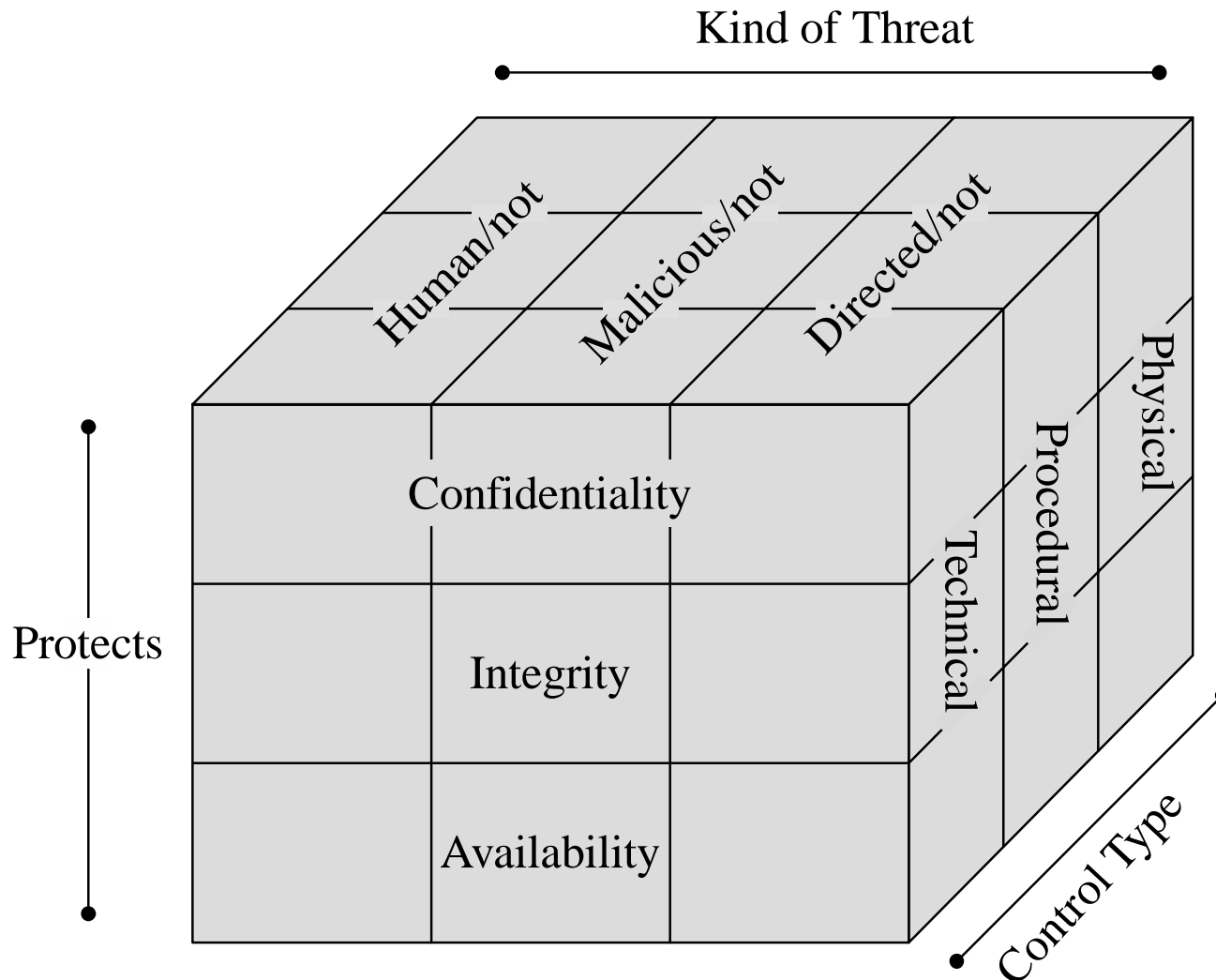
Method



Method, Opportunity, and Motive

- A malicious attacker must have **three things (MOM)**:
 - *method*: the skills, knowledge, tools, and other things with which to be able to pull off the attack
 - Knowledge of systems are widely available
 - *opportunity*: the time and access to accomplish the attack
 - Systems available to the public are accessible to them
 - *motive*: a reason to want to perform this attack against this system

Controls/Countermeasures





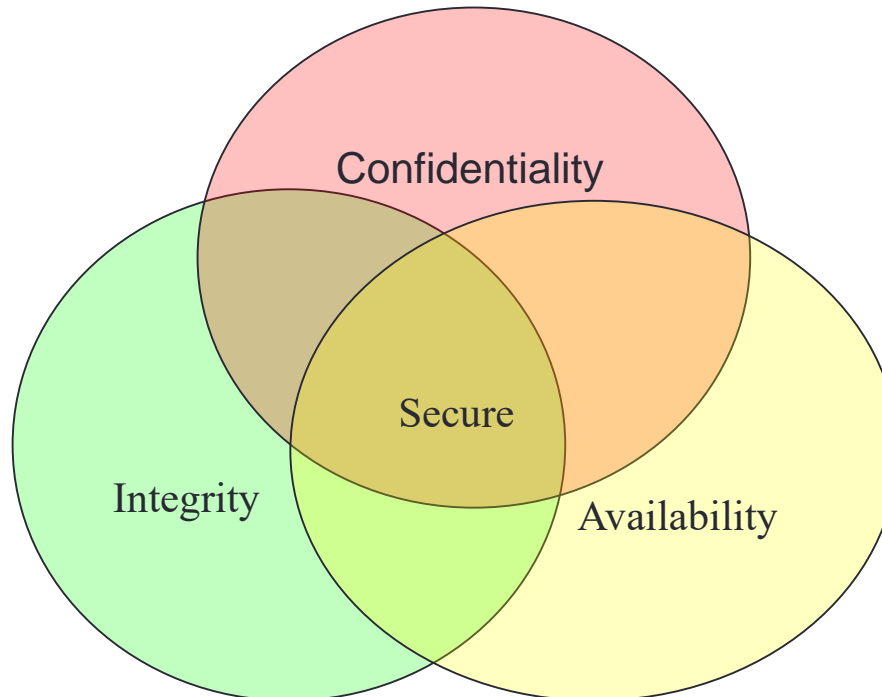
Security Goals



- When we talk about computer security, we mean that we are addressing three important aspects of any computer-related system: **confidentiality, integrity, & availability (CIA)**
 - **Confidentiality** ensures that computer-related assets are accessed only by authorized parties.
 - **i.e.** reading, viewing, printing, or even knowing their existence
 - Secrecy or privacy
 - **Integrity** means that assets can be modified only by authorized parties or only in authorized ways.
 - **i.e.** writing, changing, deleting, creating
 - **Availability** means that assets are accessible to authorized parties at appropriate times.
 - **i.e.** often, availability is known by its opposite, denial of service.

Relationship between Confidentiality Integrity and Availability

- In fact, these three **characteristics** can be **independent**, can **overlap**, and can even be **mutually exclusive**.





Goals of Security

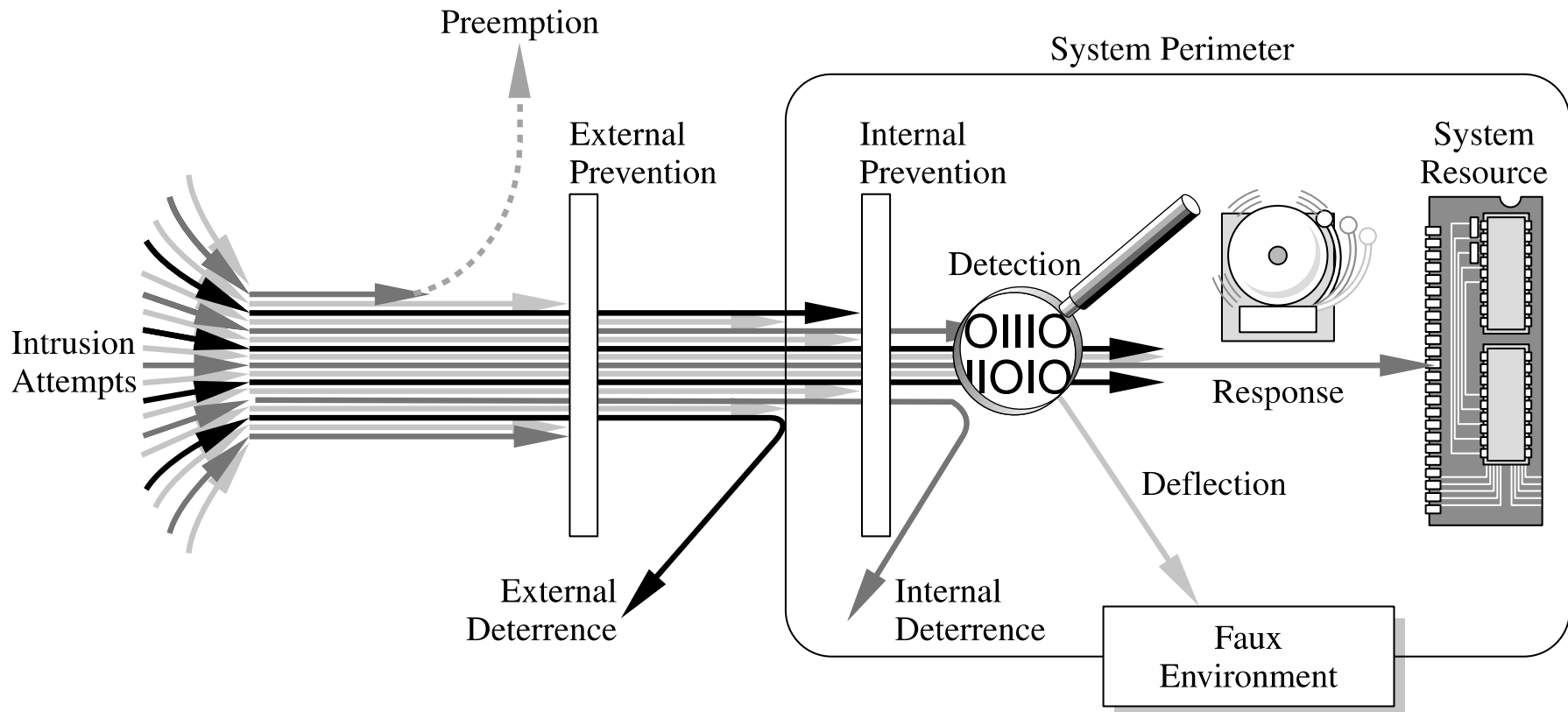
- Prevention
 - Prevent attackers from violating security policy
- Detection
 - Detect attackers' violation of security policy
- Recovery
 - Stop attack, assess and repair damage
 - Continue to function correctly even if attack succeeds



Trust and Assumptions

- **Trust** underlies *all* aspects of security
- Policies
 - Unambiguously partition system states
 - Correctly capture security requirements
- Mechanisms
 - Assumed to enforce policy
 - Support mechanisms work correctly

Different Types of Controls





Controls Available

- **Encryption**

- We take data in their normal, unscrambled state, called:
 - **cleartext** or **plaintext**, and **transform** them so that they are unintelligible to the outside observer; the transformed data are called **enciphered** text or **ciphertext**.
- **Encryption** clearly addresses the need for **confidentiality** of data.
- Additionally, it can be used to ensure **integrity**;
 - *data that cannot be read generally cannot easily be changed in a meaningful manner.*



Controls Available

- **Encryption does not solve all** computer security problems, and other tools must complement its use.
 - if encryption is not used properly, it may have no effect on security or could even degrade the performance of the entire system.
- **Weak encryption** can actually be **worse than no encryption** at all,
 - because it gives users an unwarranted sense of protection.
- *Therefore, we must understand those situations in which encryption is most useful as well as ways to use it effectively.*



Controls Available



- **Software/Program Controls**

- Programs must be secure enough to *prevent outside attack*
- They must also be developed and maintained so that we can be confident of the programs' dependability.

- **Program controls include the following:**

- **Internal program controls:** parts of the program that enforce security restrictions,
 - i.e. *access limitations in a database* management program
- **Operating system and network system controls:** *limitations enforced by the operating system* or network to protect each user from all other users
 - i.e. chmod on UNIX: (Read, Write, Execute) **vs.** (Owner, Group, Other)
- **Independent control programs:** application programs,
 - i.e. *password checkers*, intrusion detection utilities, or *virus scanners*, that protect against certain types of vulnerabilities



Controls Available

- **Development controls:**

- quality standards under which a program is **designed, coded (implementation), tested**, and maintained to prevent software faults from becoming exploitable vulnerabilities
 - i.e. **Penetration testing** (**pen testing or ethical hacking**), is the practice of testing a computer system, network or web application to *find security vulnerabilities that an attacker could exploit*.

- Software controls frequently affect users directly ?

- i.e. when the user is **interrupted and asked for a password** before being given access to a program or data.
- Because they influence the usability of the system, software controls must be carefully designed.
 - Ease of use and capabilities are often competing goals in the design of a collection of software controls.



Controls Available

- **Hardware Controls**

- Numerous hardware devices have been created to assist in providing computer security. These devices include a variety of means, such as
 - hardware or [smart card](#) implementations of encryption
 - locks or cables [limiting access](#) or deterring theft
 - devices to verify users' identities
 - firewalls
 - intrusion detection systems
 - circuit boards that control access to storage media



Controls Available

- **Policies and Procedures**

- Sometimes, we can rely on [agreed-on procedures or policies](#) among users rather than enforcing security through hardware or software means
 - i.e. [frequent changes of passwords](#)
- We must not forget the value of community standards and expectations when we consider how to enforce security.

- **Physical Controls**

- i.e. locks on doors,
- [guards at entry points](#),
- [backup copies](#) of important software and data, and
- physical site planning that reduces the risk of natural disasters.



Effectiveness of Controls

- **Awareness of Problem**

- People using controls must be convinced of the need for security. That is, people will willingly cooperate with security requirements only if they understand
 - why security is appropriate in a given situation.



Effectiveness of Controls

- **Likelihood of Use**

- Of course, no control is effective unless it is used

- **Principle of Effectiveness:**

- Controls must be used properly to be effective.
 - They must be efficient, easy to use, and appropriate.
- This principle implies that computer security controls
 - must be efficient enough, in terms of time, memory space, human activity, or other resources used,
 - using the control does not seriously affect the task being protected.
 - Controls should be selective so that they do not exclude legitimate accesses.



Effectiveness of Controls

- **Overlapping Controls**
 - Several different controls may apply to address a single vulnerability.
- **Periodic Review**
 - Just when the security specialist finds a way to secure assets against certain kinds of attacks, the opposition doubles its efforts in an attempt to defeat the security mechanisms. Thus, judging the effectiveness of a control is an ongoing task.



Principle of Weakest Link

- **Security can be no stronger than its weakest link !!!**
 - Whether it is the power supply that powers the firewall or the operating system under the security application or the human who plans, implements, and administers controls, a failure of any control can lead to a security failure.



Summary

- Vulnerabilities are weaknesses in a system;
 - threats exploit those weaknesses;
 - controls protect those weaknesses from exploitation
- Confidentiality, integrity, and availability are the three basic security primitives
- Different attackers pose different kinds of threats based on their capabilities and motivations
- Different controls address different threats; controls come in many flavors and can exist at various points in the system