Computer Security: Introduction

January 5, 2022

Course Page and Evaluation

Course page will be on google classroom.
Class code: ndjc3h6
Course Evaluation:
Assignments: 10%
Quizzes: 20% (Two quizzes: both will be considered)
Mid-sem: 30%
End-Sem: 40%

What is Computer Security?

What is Computer Security?

Computer security deals with computer-related assets that are subject to a variety of threats and for which various measures are taken to protect those assets.

Our Focus

1. What assets do we need to protect?
2. How are those assets threatened?
3. What can we do to counter those threats?

Computer Security

The NIST Computer Security Handbook [NIST95] defines the term computer security as follows:

Definition:

The protection afforded to an automated information system in order to attain the applicable objectives of preserving the integrity, availability, and confidentiality of information system resources (includes hardware, software, firmware, information/data, and telecommunications).

Key-objectives of Computer Security

- **Confidentiality:** The term covers two related concepts:
  - **Data confidentiality:** Assures that private or confidential information is not made available or disclosed to unauthorized individuals.
  - **Privacy:** Assures that individuals control or influence what information related to them may be collected and stored and by whom and to whom that information may be disclosed.

Key-objectives of Computer Security

- **Integrity:** The term covers two related concepts:
  - **Data integrity:** Assures that information and programs are changed only in a specified and authorized manner.
  - **System integrity:** Assures that a system performs its intended function in an unimpaired manner, free from deliberate or inadvertent unauthorized manipulation of the system.

Key-objectives of Computer Security

- **Availability:** Assures that systems work promptly and service is not denied to authorized users.

What does these objectives mean?

- **Confidentiality:** Authorized restrictions on information access and disclosure are preserved. It includes means for protecting personal privacy and proprietary information. A **loss of confidentiality** is the unauthorized disclosure of information.
- **Integrity:** Guarding against improper information modification or destruction. Also, ensuring information non-repudiation and authenticity. A **loss of integrity** is the unauthorized modification or destruction of information.
- **Availability:** Ensuring timely and reliable access to and use of information. A **loss of availability** is the disruption of access to or use of information or an information system.

Additional Security Objectives

- **Authenticity:** The property of being genuine and being able to be verified and trusted; confidence in the validity of a transmission, a message, or message originator.

  This means verifying that users are who they say they are and that each input arriving at the system came from a trusted source.

- **Accountability:** The security goal that generates the requirement for actions of an entity to be traced uniquely to that entity.

  This supports non-repudiation, deterrence, fault isolation, intrusion detection and prevention, and after-action recovery and legal action

Challenges of Computer Security

1. The requirements seem to be straightforward but the mechanisms used to meet those requirements can be quite **complex**, and understanding them may involve rather subtle reasoning.

2. In developing a particular security mechanism or algorithm, one must always **consider potential attacks** on those security features.

   In many cases, successful attacks are designed by looking at the problem in a completely different way, therefore exploiting an unexpected weakness in the mechanism.

Challenges of Computer Security

3. Because of point 2, the procedures used to provide particular services are often counterintuitive.
4. Having designed various security mechanisms, it is necessary to decide where to use them.
5. Security mechanisms require that participants be in possession of some secret information (e.g., an encryption key), which raises questions about the creation, distribution, and protection of that secret information.

Challenges of Computer Security

6. The great advantage that the attacker has is that he or she need only find a single weakness while the designer must find and eliminate all weaknesses to achieve perfect security.
7. Tendency to consider security as having little benefit, requires constant involvement, needs to be part of design, and consider security effects efficiency.

A Model for Computer Security

Adversary (threat agent)
An entity that attacks, or is a threat to, a system.

Attack
An assault on system security that derives from an intelligent threat; that is, an intelligent act that is a deliberate attempt (especially in the sense of a method or technique) to evade security services and violate the security policy of a system.

Countermeasure
An action, device, procedure, or technique that reduces a threat, a vulnerability, or an attack by eliminating or preventing it, by minimizing the harm it can cause, or by discovering and reporting it so that corrective action can be taken.

Risk
An expectation of loss expressed as the probability that a particular threat will exploit a particular vulnerability with a particular harmful result.

Security Policy
A set of rules and practices that specify or regulate how a system or organization provides security services to protect sensitive and critical system resources.

A Model for Computer Security

System Resource (Asset)
Data contained in an information system; or a service provided by a system; or a system capability, such as processing power or communication bandwidth; or an item of system equipment (i.e., a system component—hardware, firmware, software, or documentation); or a facility that houses system operations and equipment.

Threat
A potential for violation of security, which exists when there is a circumstance, capability, action, or event, that could breach security and cause harm. That is, a threat is a possible danger that might exploit a vulnerability.

Vulnerability
A flaw or weakness in a system's design, implementation, or operation and management that could be exploited to violate the system's security policy.

Assets of a Computer System

The assets of a computer system can be categorized as follows:

- **Hardware:** Including computer systems and other data processing, data storage, and data communications devices
- **Software:** Including the operating system, system utilities, and applications.
- **Data:** Including files and databases, as well as security-related data, such as password files.
- **Communication facilities and networks:** Local and wide area network communication links, bridges, routers, and so on.

Vulnerabilities of a Computer System

The following are general categories of vulnerabilities of a computer system or network asset:

- It can be **corrupted**, so that it does the wrong thing or gives wrong answers.
- It can become **leaky**. For example, someone who should not have access to some or all of the information available through the network obtains such access.
- It can become **unavailable** or very slow. That is, using the system or network becomes impossible or impractical.

These three general types of vulnerability correspond to the concepts of integrity, confidentiality, and availability.

Threats

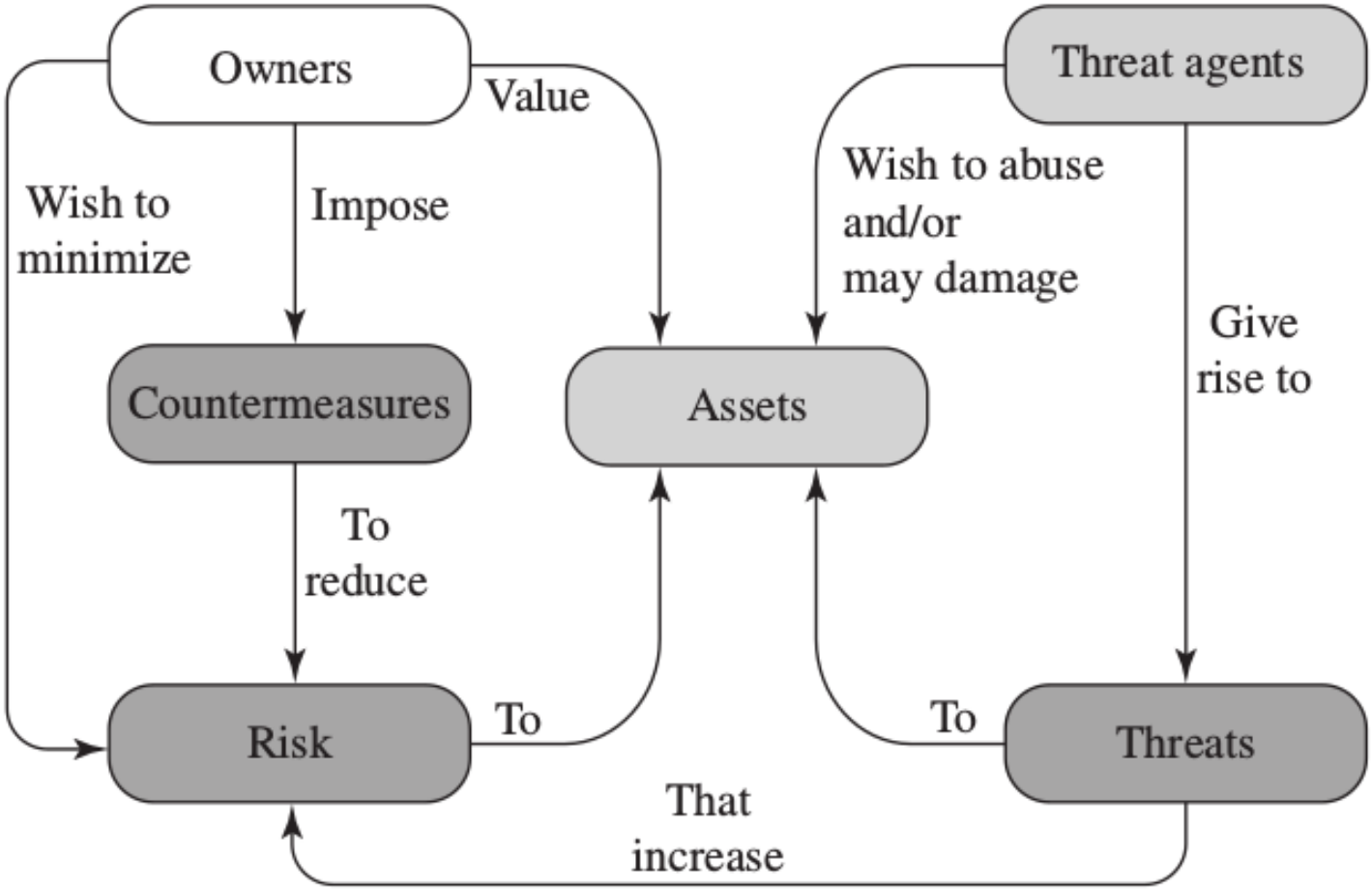
Corresponding to the various types of vulnerabilities to a system resource are threats that are capable of exploiting those vulnerabilities.

- We can distinguish two types of attacks:
- **Active attack:** An attempt to alter system resources or affect their operation.
- **Passive attack:** An attempt to learn or make use of information from the system that does not affect system resources.

We can also classify attacks based on the origin of the attack:

- **Inside attack:** Initiated by an entity inside the security perimeter (an "insider"). The insider is authorized to access system resources but uses them in a way not approved by those who granted the authorization.
- **Outside attack:** Initiated from outside the perimeter, by an unauthorized or illegitimate user of the system (an "outsider").

Security concepts and their relationship



Threat Consequences, and the Types of Threat Actions that Cause Each Consequence

Threat Consequence	Threat Action (Attack)
Unauthorized Disclosure A circumstance or event whereby an entity gains access to data for which the entity is not authorized.	**Exposure:** Sensitive data are directly released to an unauthorized entity. **Interception:** An unauthorized entity directly accesses sensitive data traveling between authorized sources and destinations. **Inference:** A threat action whereby an unauthorized entity indirectly accesses sensitive data (but not necessarily the data contained in the communication) by reasoning from characteristics or by-products of communications. **Intrusion:** An unauthorized entity gains access to sensitive data by circumventing a system's security protections.

Threat Consequences, and the Types of Threat Actions that Cause Each Consequence

Deception A circumstance or event that may result in an authorized entity receiving false data and believing it to be true.	**Masquerade:** An unauthorized entity gains access to a system or performs a malicious act by posing as an authorized entity. **Falsification:** False data deceive an authorized entity. **Repudiation:** An entity deceives another by falsely denying responsibility for an act.
Disruption A circumstance or event that interrupts or prevents the correct operation of system services and functions.	**Incapacitation:** Prevents or interrupts system operation by disabling a system component. **Corruption:** Undesirably alters system operation by adversely modifying system functions or data. **Obstruction:** A threat action that interrupts delivery of system services by hindering system operation.
Usurpation A circumstance or event that results in control of system services or functions by an unauthorized entity.	**Misappropriation:** An entity assumes unauthorized logical or physical control of a system resource. **Misuse:** Causes a system component to perform a function or service that is detrimental to system security.

Computer and Network Assets, with Examples of Threats

	Availability	Confidentiality	Integrity
Hardware	Equipment is stolen or disabled, thus denying service.	An unencrypted CD-ROM or DVD is stolen.	
Software	Programs are deleted, denying access to users.	An unauthorized copy of software is made.	A working program is modified, either to cause it to fail during execution or to cause it to do some unintended task.
Data	Files are deleted, denying access to users.	An unauthorized read of data is performed. An analysis of statistical data reveals underlying data.	Existing files are modified or new files are fabricated.
Communication Lines and Networks	Messages are destroyed or deleted. Communication lines or networks are rendered unavailable.	Messages are read. The traffic pattern of messages is observed.	Messages are modified, delayed, reordered, or duplicated. False messages are fabricated.

Attack Surfaces

An attack surface consists of the reachable and exploitable vulnerabilities in a system. Examples of attack surfaces are the following:

- Open ports on outward facing Web and other servers, and code listening on those ports
- Services available on the inside of a firewall
- Code that processes incoming data, email, XML, office documents, and industry-specific custom data exchange formats
- Interfaces, SQL, and Web forms
- An employee with access to sensitive information vulnerable to a social engineering attack

The End