



# Cryptography and Network Security

## 1. Overview

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# Outline

- Security concepts
- X.800 security architecture
- Security attacks, services, mechanisms
- Models for network (access) security
- Network security terminologies . com

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# Computer Security Objectives

## Confidentiality

- 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

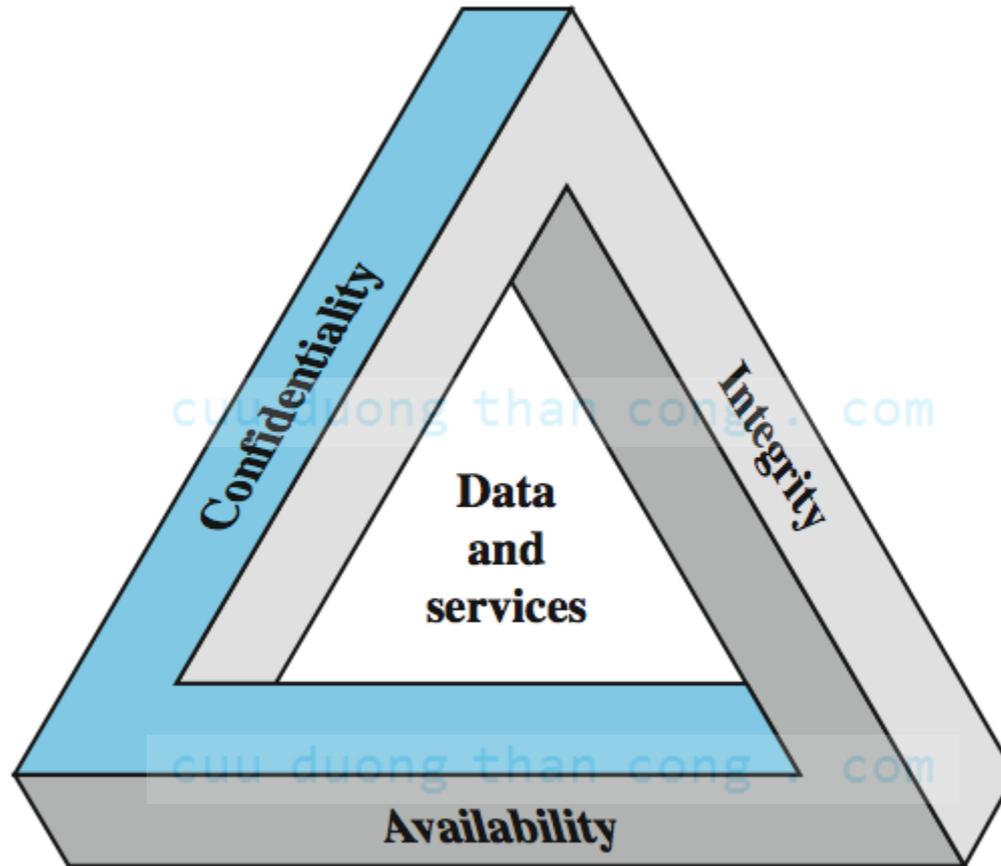
## Integrity

- 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

## Availability

- Assures that systems work promptly and service is not denied to authorized users

# CIA Triad



*The Security Requirements Triad*

# Possible Additional Concepts

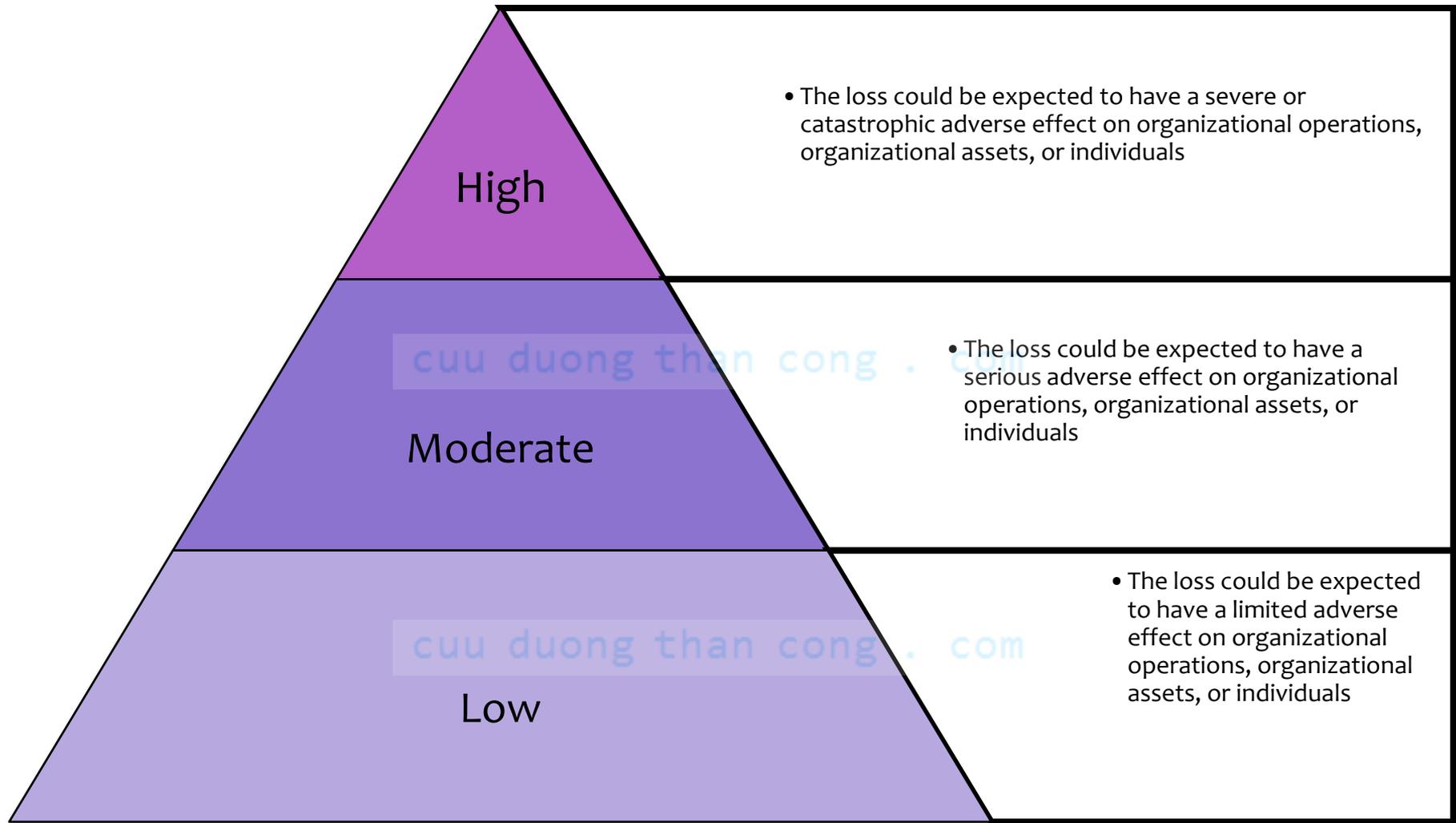
## Authenticity

- 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

# Levels of Impacts



# Low Impact

- The loss could be expected to have a *limited adverse* effect on organizational operations, organizational assets, or individuals.
- A *limited adverse* effect means that, for example, the loss of confidentiality, integrity, or availability might
  - i. cause a degradation in mission capability to an extent and duration that the organization is able to perform its primary functions, but the effectiveness of the functions is noticeably *reduced*;
  - ii. result in *minor damage* to organizational assets;
  - iii. result in *minor financial loss*; or
  - iv. result in *minor harm* to individuals.

# Moderate Impact

- The loss could be expected to have a *serious adverse effect* on organizational operations, organizational assets, or individuals.
- A *serious adverse effect* means that, for example, the loss might
  - i. cause a *significant degradation* in mission capability to an extent and duration that the organization is able to perform its primary functions, but the effectiveness of the functions is significantly reduced;
  - ii. result in *significant damage* to organizational assets;
  - iii. result in *significant financial loss*; or
  - iv. result in *significant harm* to individuals that does not involve loss of life or serious, life-threatening injuries.

# High Impact

- The loss could be expected to have a *severe* or *catastrophic adverse effect* on organizational operations, organizational assets, or individuals.
- A *severe* or *catastrophic adverse effect* means that, for example, the loss might
  - i. cause a *severe degradation* in or *loss of mission capability* to an extent and duration that the organization is not able to perform one or more of its primary functions;
  - ii. result in *major damage* to organizational assets;
  - iii. result in *major financial loss*; or
  - iv. result in *severe* or *catastrophic harm* to individual involving loss of life or serious, life-threatening

# OSI Security Architecture

## ■ Security attack:

- Any action that compromises the security of information owned by an organization.

## ■ Security mechanism:

- A process (or a device incorporating such a process) that is designed to detect, prevent, or recover from a security attack.

## ■ Security service:

- A processing or communication service that enhances the security of the data processing systems and the information transfers of an organization.
- The services are intended to counter security attacks, and they make use of one or more security mechanisms to provide the service

# Terms



## **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.

## **Attack**

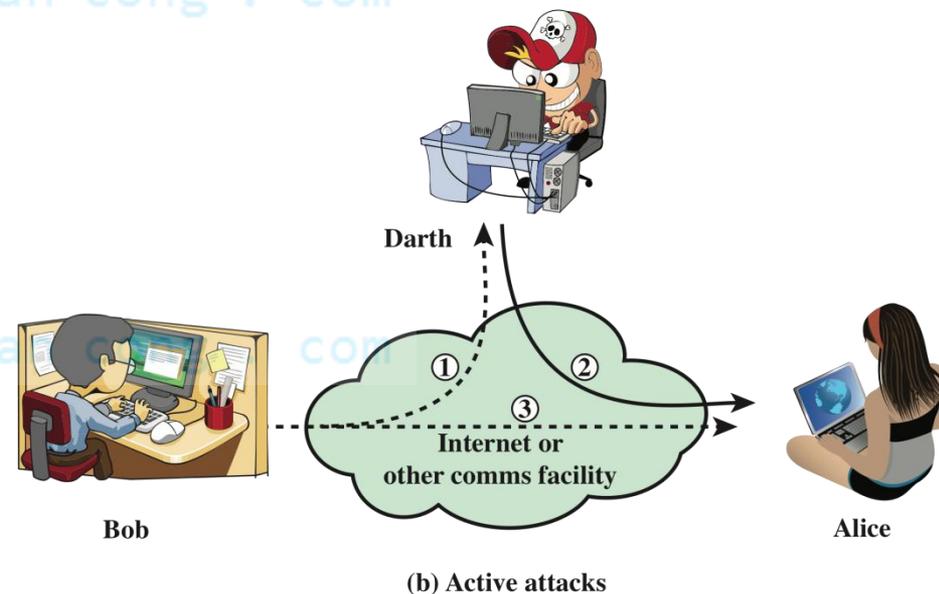
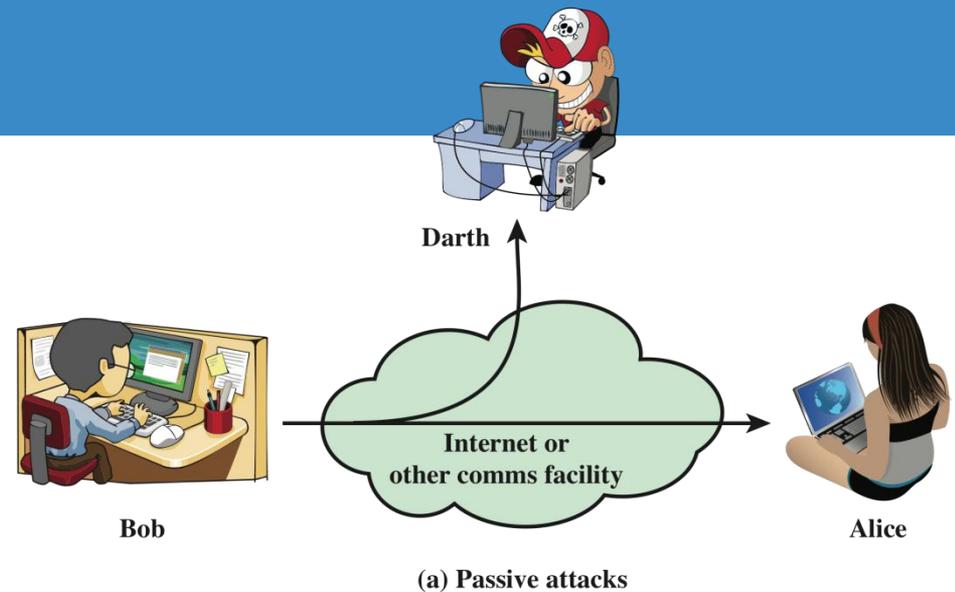
An assault on system security that derives from an intelligent threat; that is, an intelligent act that is a deliberate attempt (especially in the sense of a method or technique) to evade security services and violate the security policy of a system.

# Security Attacks

- A means of classifying security attacks, used both in X.800 and RFC 4949, is in terms of *passive attacks* and *active attacks*

- A **passive attack** attempts to learn or make use of information from the system but does not affect system resources

- An **active attack** attempts to alter system resources or affect their operation



# Passive Attacks

- Passive attacks are in the nature of eavesdropping on, or monitoring of, transmissions.
- The goal of the opponent is to *obtain information* that is being transmitted.
- Two types of passive attacks are
  - i. the release of message contents and
  - ii. traffic analysis.

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# Active Attacks

- Involve some modification of the data stream or the creation of a false stream
- Difficult to prevent because of the wide variety of potential physical, software, and network vulnerabilities
- Goal is to detect attacks and to recover from any disruption or delays caused by them



## Masquerade

- Takes place when one entity pretends to be a different entity
- Usually includes one of the other forms of active attack

## Replay

- Involves the passive capture of a data unit and its subsequent retransmission to produce an unauthorized effect

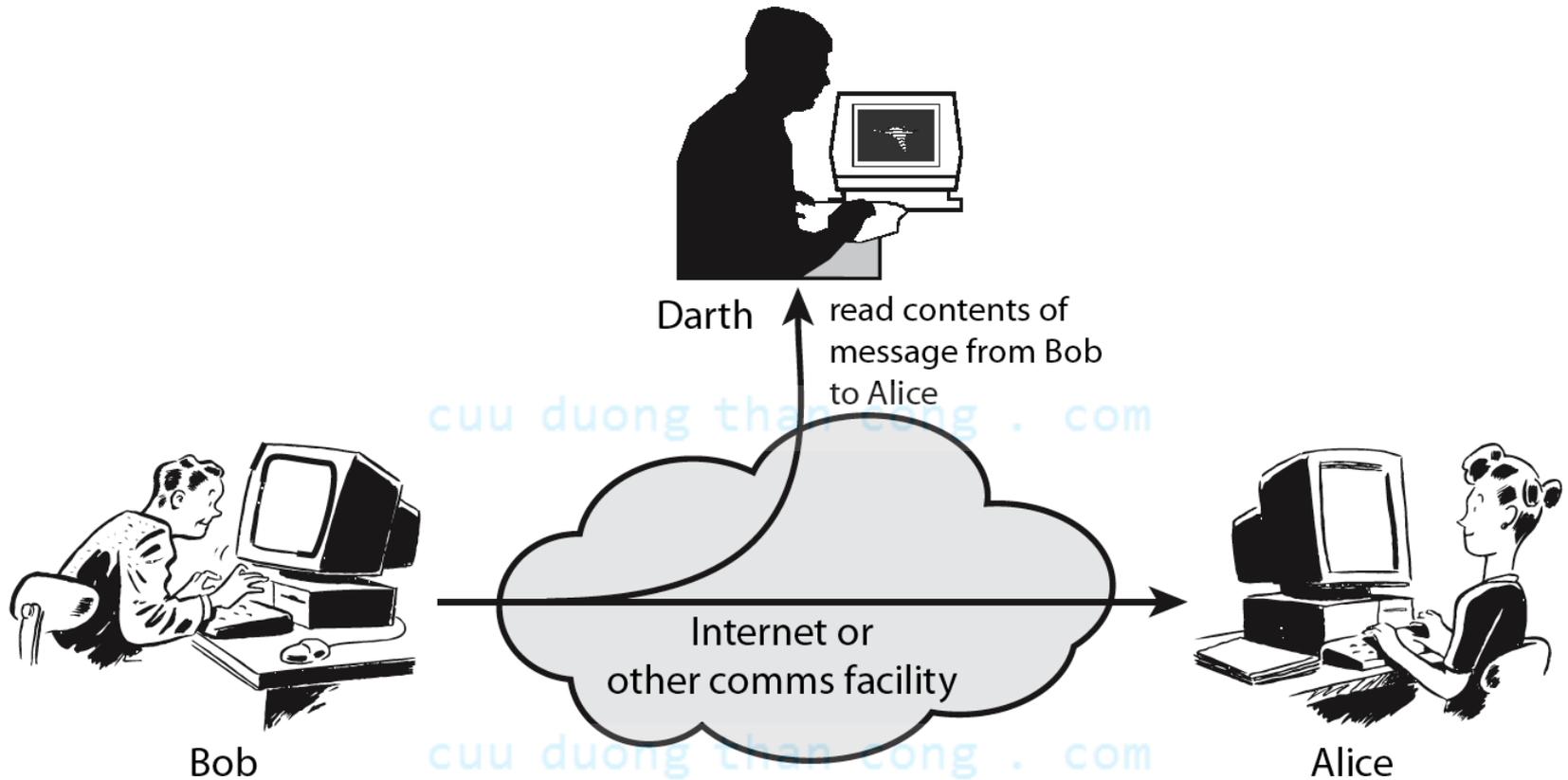
## Modification of messages

- Some portion of a legitimate message is altered, or messages are delayed or reordered to produce an unauthorized effect

## Denial of service

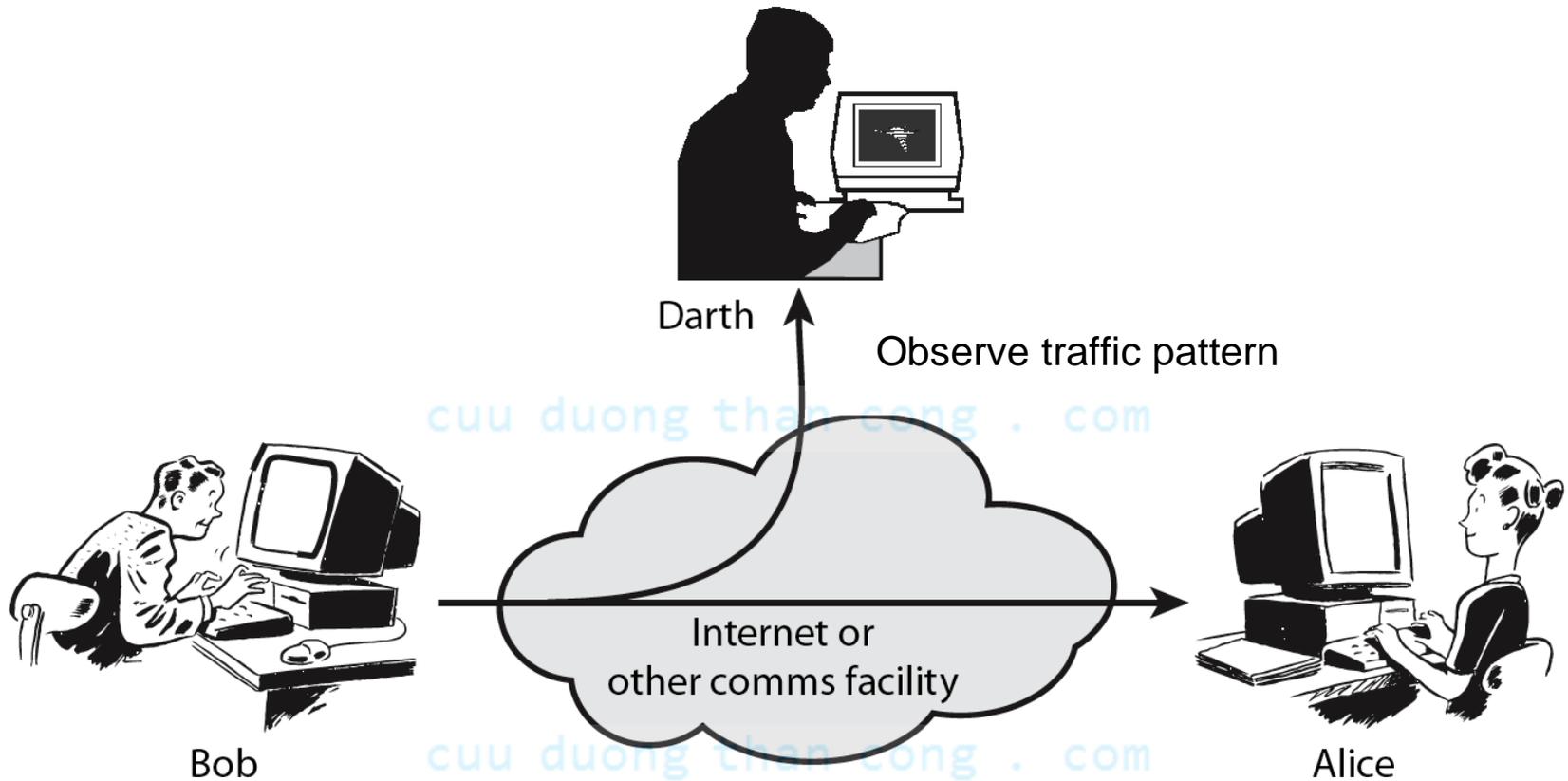
- Prevents or inhibits the normal use or management of communications facilities

# Passive Attacks - Interception



*Release of message contents*

# Passive Attacks – Traffic Analysis



*Traffic analysis*

# Handling Attacks

- **Passive attacks – focus on Prevention**
  - Easy to stop
  - Hard to detect
- **Active attacks – focus on Detection and Recovery**
  - Hard to stop
  - Easy to detect

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# Security Services

- X.800:

a **service** provided by a protocol layer of communicating open systems and that ensures adequate security of the systems or of data transfers

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- RFC 2828:

“a processing or communication service provided by a system to give a specific kind of protection to system resources”

# Security Services (X.800)

- **Authentication** - assurance that communicating entity is the one claimed
  - have both peer-entity & data origin authentication
- **Access Control** - prevention of the unauthorized use of a resource
- **Data Confidentiality** – protection of data from unauthorized disclosure
- **Data Integrity** - assurance that data received is as sent by an authorized entity
- **Non-Repudiation** - protection against denial by one of the parties in a communication
- **Availability** – resource accessible/usable

# Authentication

- Concerned with assuring that a communication is authentic
  - In the case of a single message, assures the recipient that the message is from the source that it claims to be from

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- In the case of ongoing interaction, assures the two entities are authentic and that the connection is not interfered with in such a way that a third party can masquerade as one of the two legitimate parties

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Two specific authentication services are defined in X.800:

- Peer entity authentication
- Data origin authentication

# Access Control

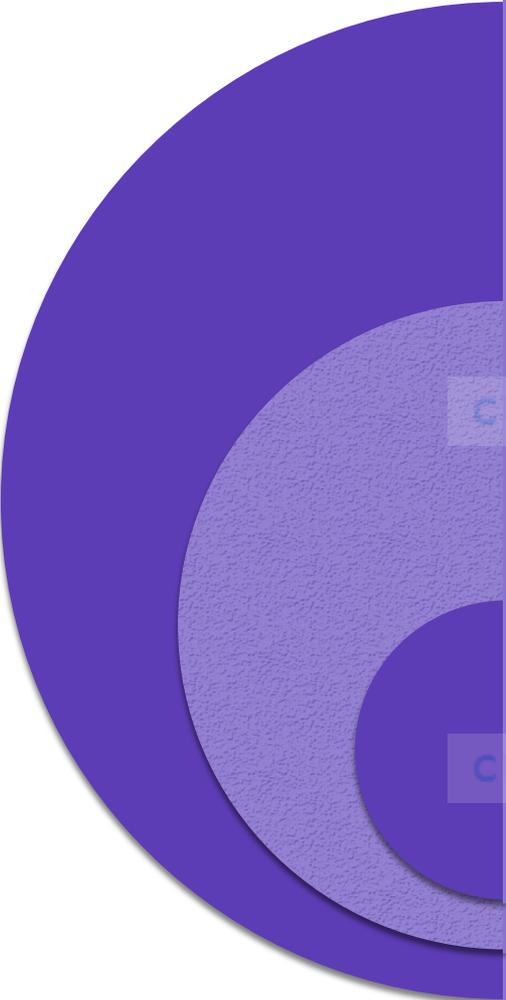
- The ability to limit and control the access to host systems and applications via communications links
- To achieve this, each entity trying to gain access must first be indentified, or authenticated, so that access rights can be tailored to the individual

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# Data Confidentiality

- The protection of transmitted data from passive attacks
  - Broadest service protects all user data transmitted between two users over a period of time
  - Narrower forms of service includes the protection of a single message or even specific fields within a message
- The protection of traffic flow from analysis
  - This requires that an attacker not be able to observe the source and destination, frequency, length, or other characteristics of the traffic on a communications facility

# Data Integrity



Can apply to a stream of messages, a single message, or selected fields within a message

Connection-oriented integrity service, one that deals with a stream of messages, assures that messages are received as sent with no duplication, insertion, modification, reordering, or replays

A connectionless integrity service, one that deals with individual messages without regard to any larger context, generally provides protection against message modification only

# Nonrepudiation

- Prevents either sender or receiver from denying a transmitted message
- When a message is sent, the receiver can prove that the alleged sender in fact sent the message
- When a message is received, the sender can prove that the alleged receiver in fact received the message

# Security Mechanism

- As known as **control**
- Feature designed to detect, prevent, or recover from a security attack
- No single mechanism that will support all services required
- However one particular element underlies many of the security mechanisms in use:
  - cryptographic techniques

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# Security Mechanism (X.800)

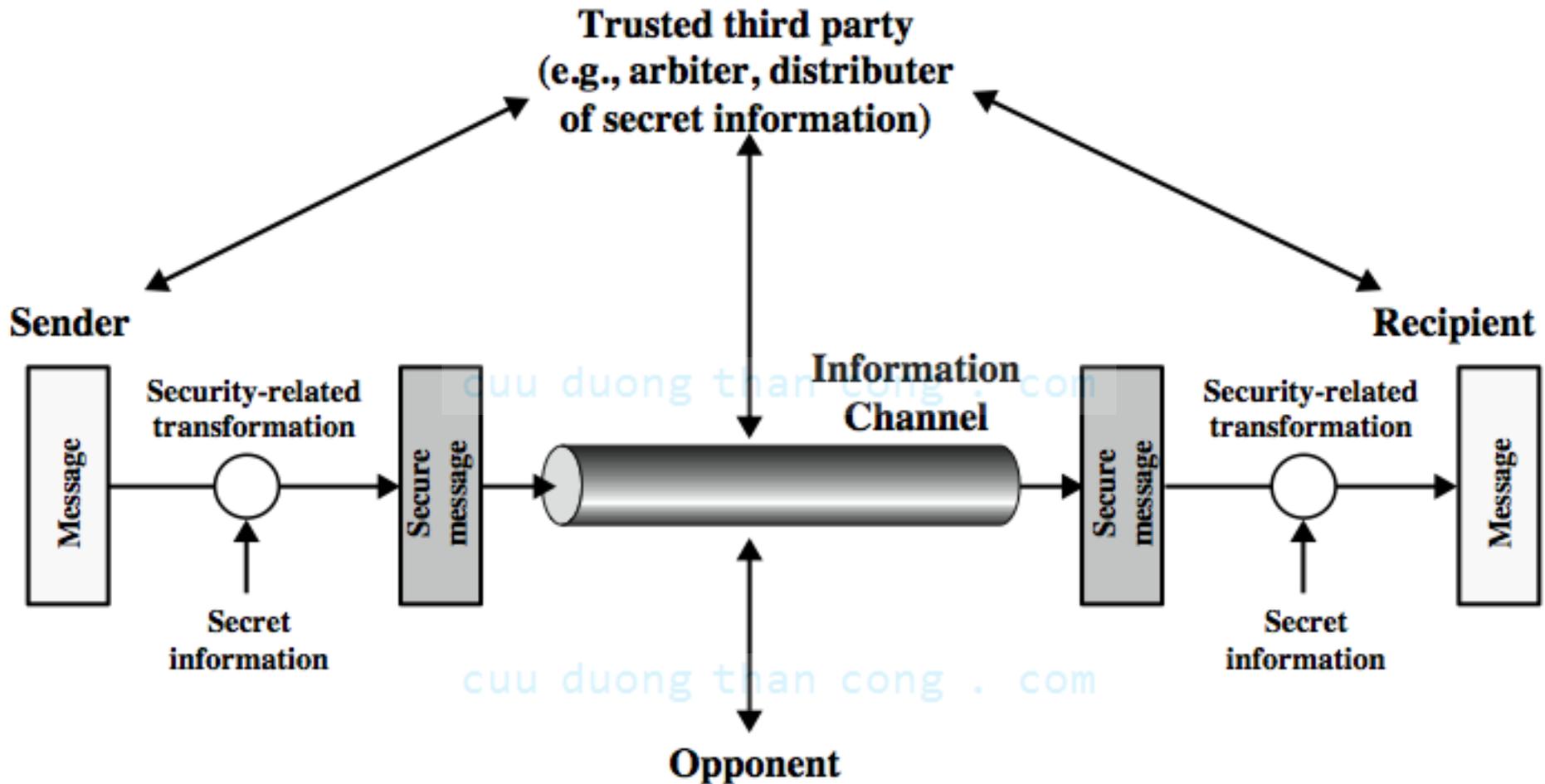
## Specific Security Mechanisms

- Encipherment
- Digital signatures
- Access controls
- Data integrity
- Authentication exchange
- Traffic padding
- Routing control
- Notarization

## Pervasive Security Mechanisms

- Trusted functionality
- Security labels
- Event detection
- Security audit trails
- Security recovery

# A Model for Network Security



# A Model for Network Security

- Using this model requires us to:
  1. design a suitable algorithm for the security transformation
  2. generate the secret information (keys) used by the algorithm
  3. develop methods to distribute and share the secret information
  4. specify a protocol enabling the principals to use the transformation and secret information for a security service

# A Model for Network Access Security

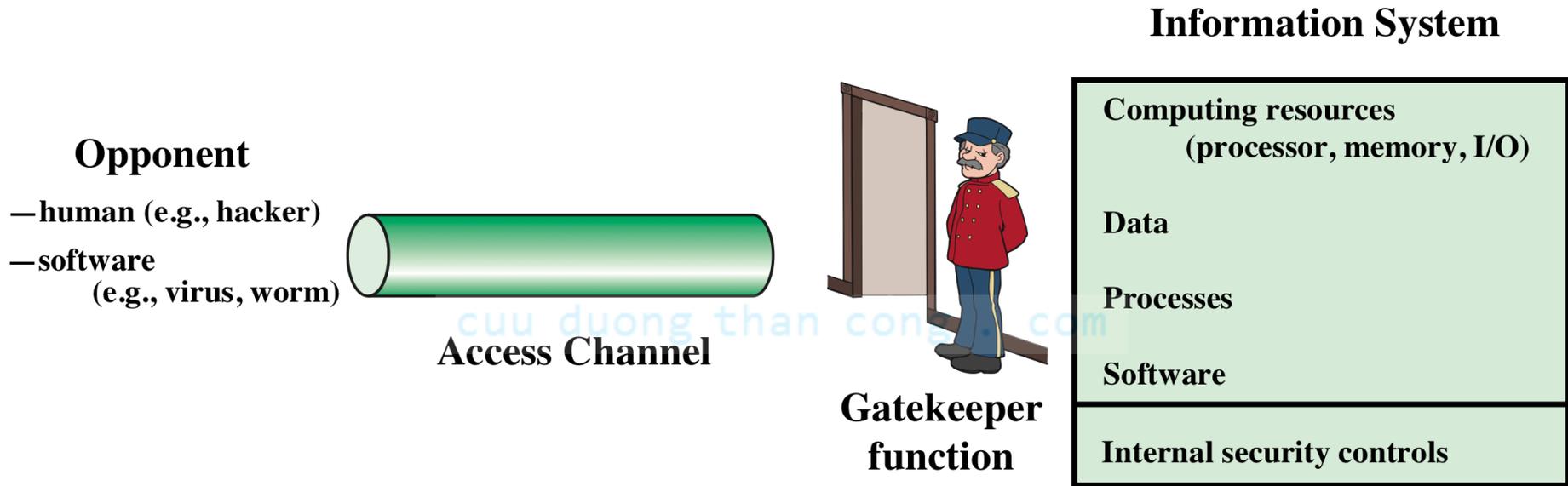


Figure 1.3 Network Access Security Model

# A Model for Network Access Security

- **Using this model requires us to:**
  1. Select appropriate gatekeeper functions to **identify users**
  2. Implement security controls to ensure only **authorised users access** designated information or resources
- **Note that model does not include:**
  1. monitoring of system for successful penetration
  2. monitoring of authorized users for misuse
  3. audit logging for forensic uses, etc.

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# Unwanted Access

- Placement in a computer system of logic that exploits vulnerabilities in the system and that can affect application programs as well as utility programs such as editors and compilers
- Programs can present two kinds of threats:
  - Information access threats
    - Intercept or modify data on behalf of users who should not have access to that data
  - Service threats
    - Exploit service flaws in computers to inhibit use by legitimate users

# Some Basic Terminologies

- **plaintext** - original message
- **ciphertext** - coded message
- **cipher** - algorithm for transforming plaintext to ciphertext
- **key** - info used in cipher known only to sender/receiver
- **encipher (encrypt)** - converting plaintext to ciphertext
- **decipher (decrypt)** - recovering plaintext from ciphertext
- **cryptography** - study of encryption principles/methods
- **cryptanalysis (codebreaking)** - study of principles/ methods of deciphering ciphertext without knowing key
- **cryptology** - field of both cryptography and cryptanalysis

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# Summary

- Security concepts
  - Confidentiality,
  - Integrity,
  - Availability
- X.800 security architecture
- Security attacks, services, mechanisms
- Models for network (access) security

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# References

- *Cryptography and Network Security, Principles and Practice*, William Stallings, Prentice Hall, Fifth Edition, 2011

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