# Network Security Essentials Chapter 1

Wei Chen
chenwei@njupt.edu.cn
189-5189-6489

(Based on Lecture slides by Lawrie Brown)

故用兵之法，无恃其不来，恃吾有以待之；

无恃其不攻，恃吾有所不可攻也。

*The art of war teaches us to rely not on the likelihood of the enemy's not coming, but on our own readiness to receive him; not on the chance of his not attacking, but rather on the fact that we have made our position unassailable.*

***—The Art of War,* Sun Tzu**

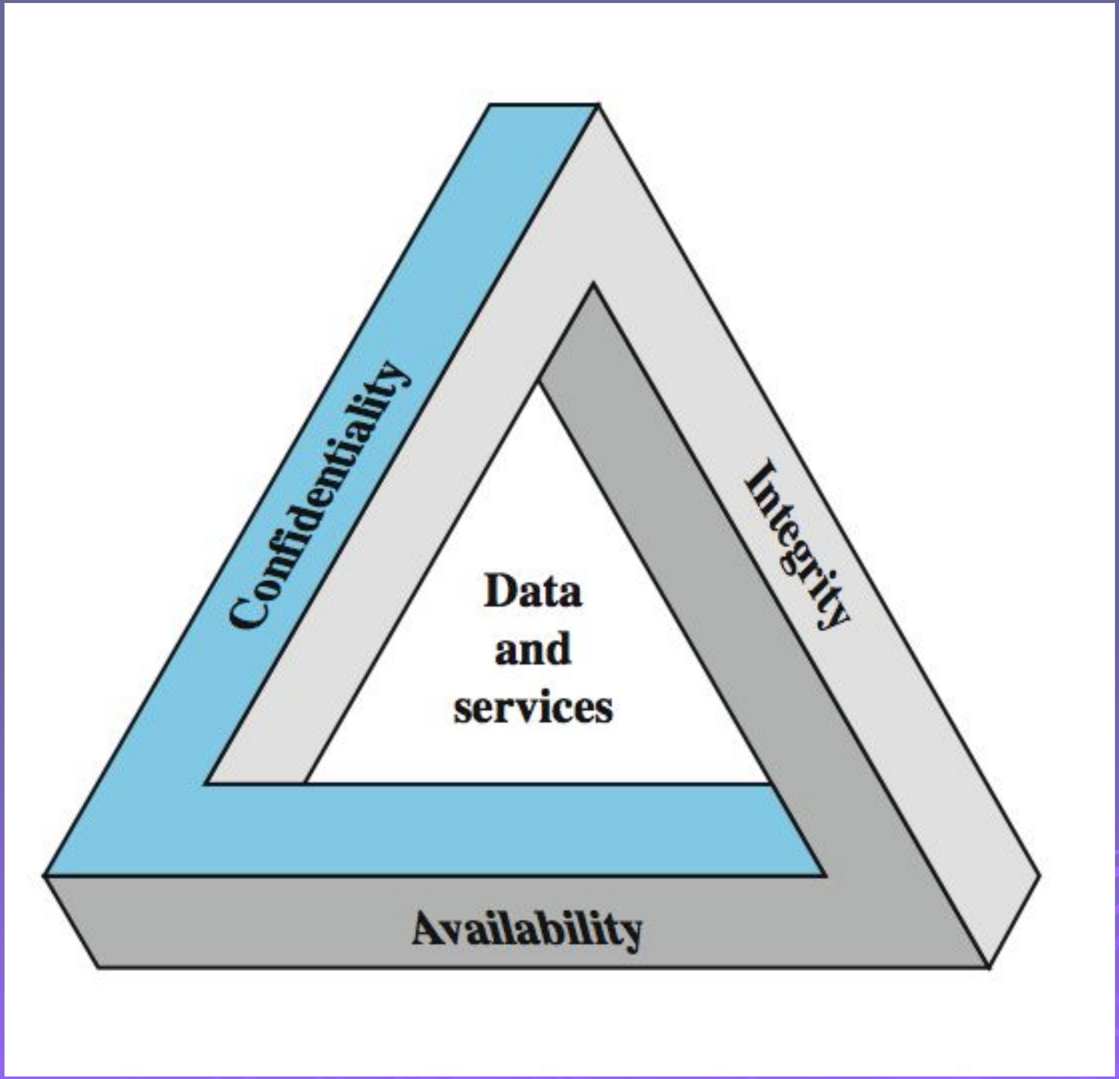
East German stamp honoring Clausewitz (1980)

- *The combination of space, time, and strength that must be considered as the basic elements of this theory of defense makes this a fairly complicated matter. Consequently, it is not easy to find a fixed point of departure.*
  ***— On War, Carl Von Clausewitz***

# Computer Security

- 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) [NIST 1995]

# Key Security Concepts



# Three Key Objectives

- Confidentiality
  - Data confidentiality
  - Privacy
- Integrity
  - Data integrity
  - System integrity
- Availability
- Additional concepts
  - Authenticity
  - Accountability

# Examples of Security Requirements

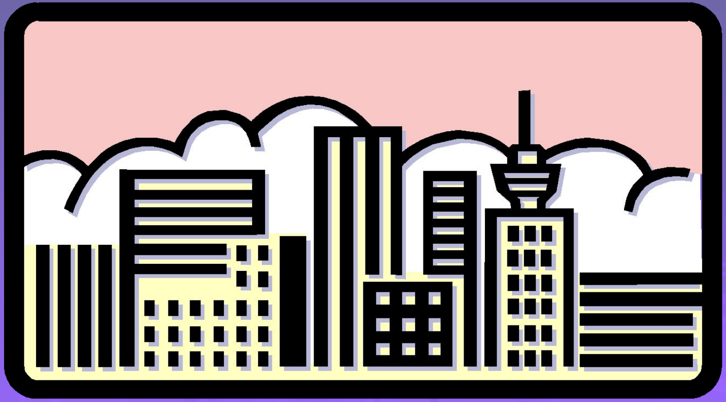
- confidentiality – student grades
- integrity – patient information
- availability – authentication service

# Computer Security Challenges

1. not simple
2. must consider potential attacks
3. procedures used counter-intuitive
4. involve algorithms and secret info
5. must decide where to deploy mechanisms
6. battle of wits between attacker / admin
7. not perceived on benefit until fails
8. requires regular monitoring
9. too often an after-thought
10. regarded as impediment to using system

# OSI Security Architecture

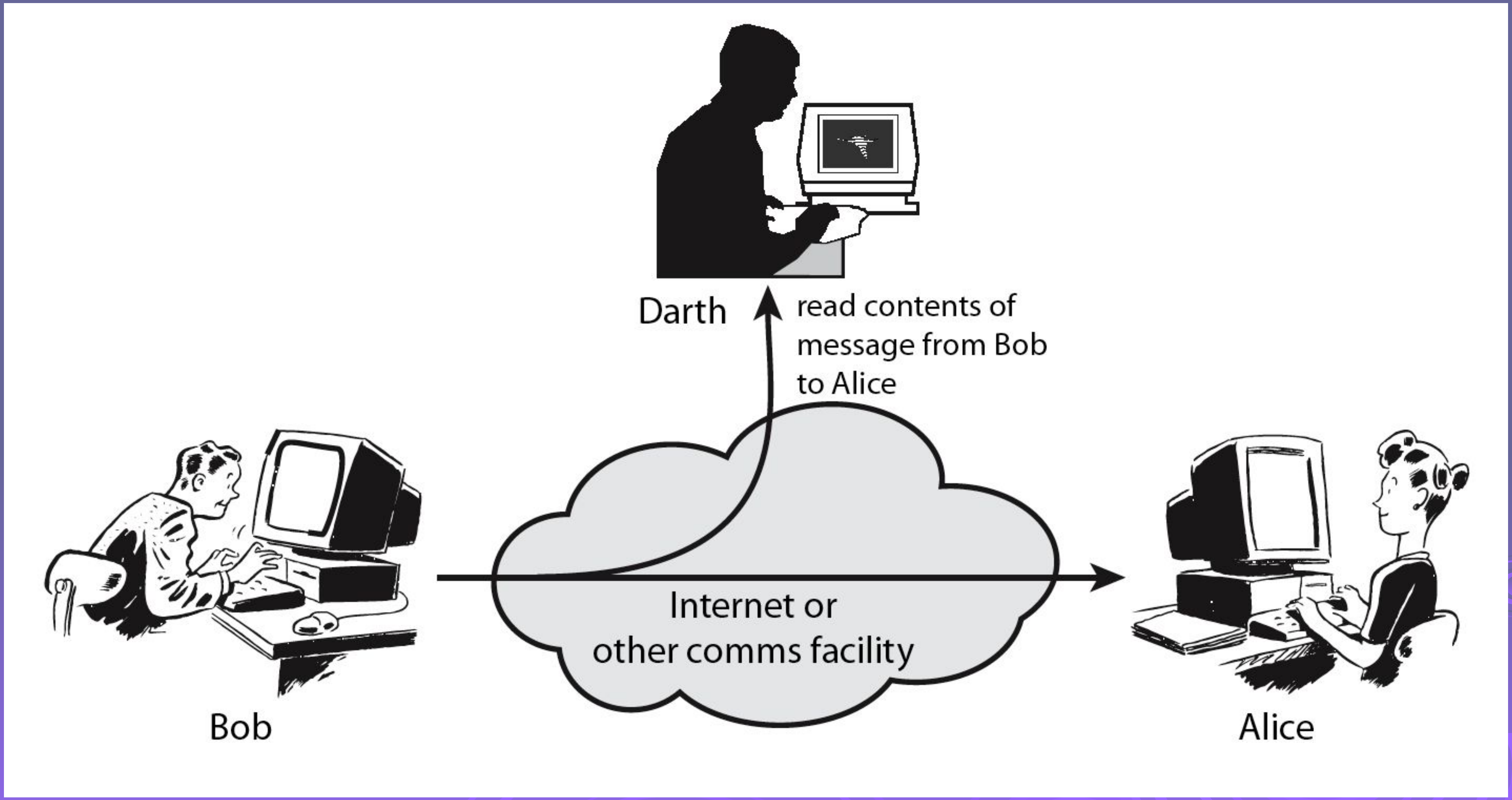
- ITU-T X.800 “Security Architecture for OSI”
- defines a systematic way of defining and providing security requirements
- for us it provides a useful, if abstract, overview of concepts we will study



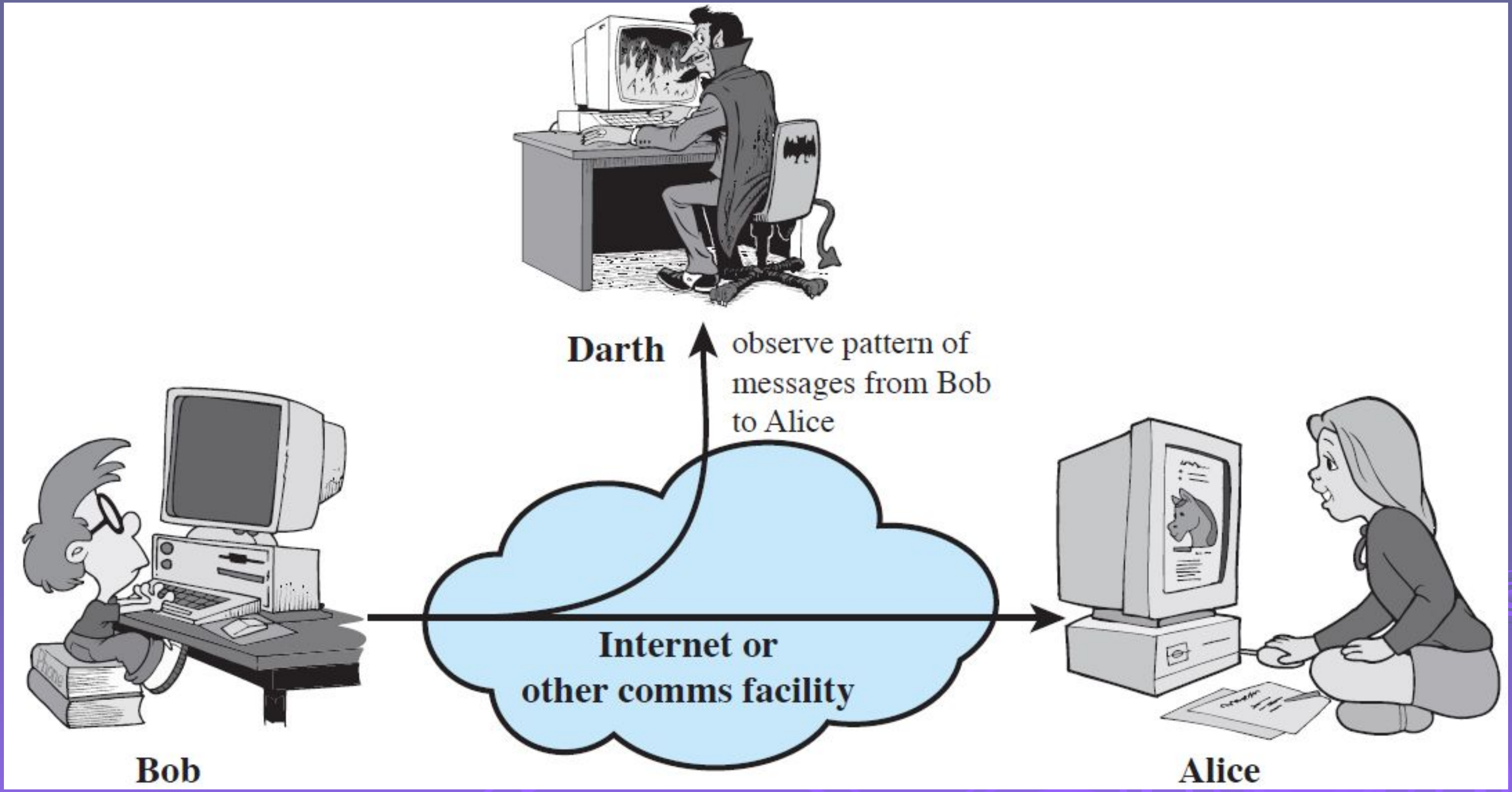
# Aspects of Security

- 3 aspects of information security:
  - **security attack**
  - **security mechanism: detect, prevent, recover**
  - **security service**
- terms
  - *threat* – a potential for violation of security
  - *attack* – an assault on system security, a deliberate attempt to evade security services

# Passive Attacks (1)
# Release of Message Contents

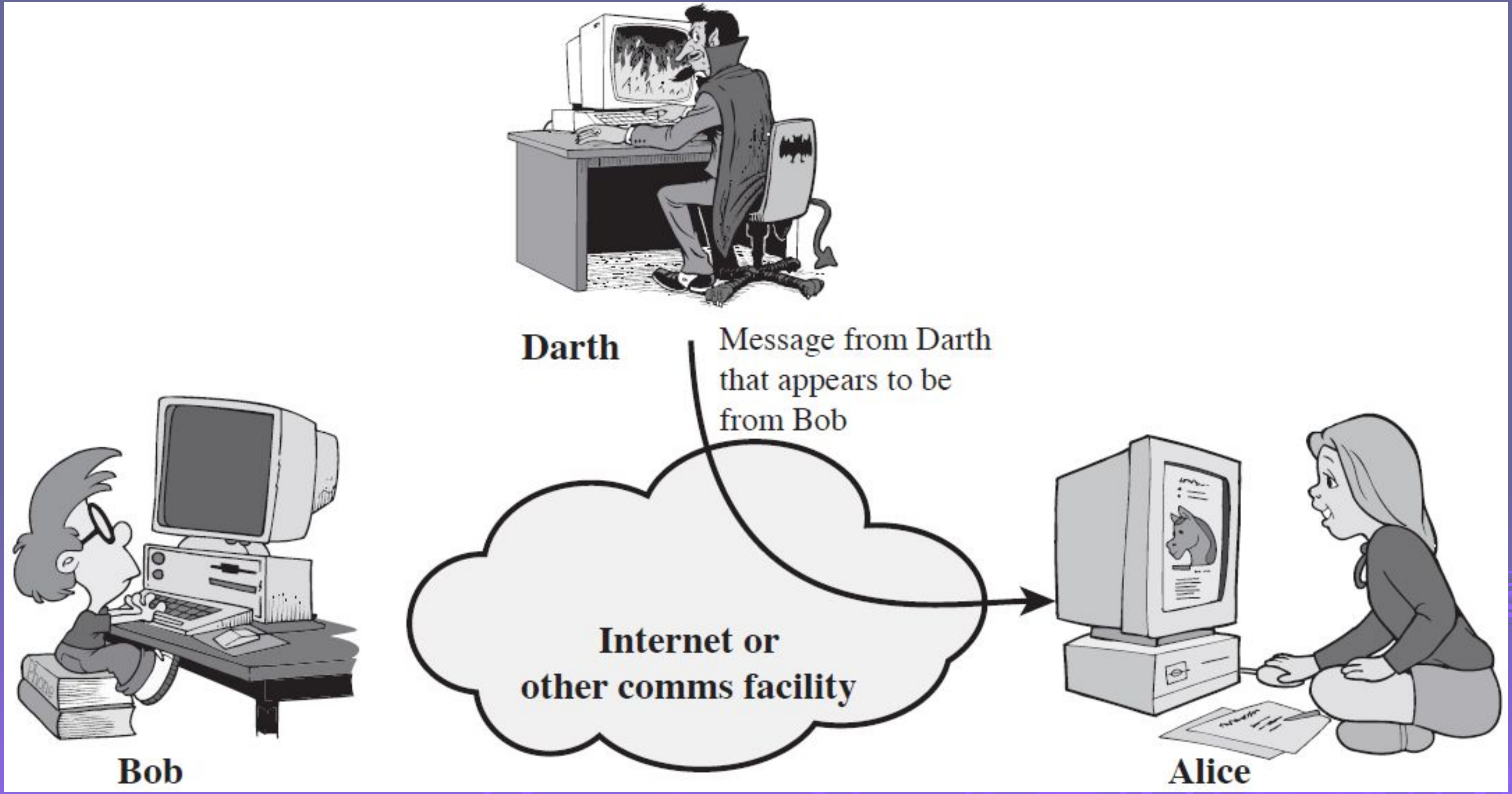


# Passive Attacks (2)
# Traffic Analysis

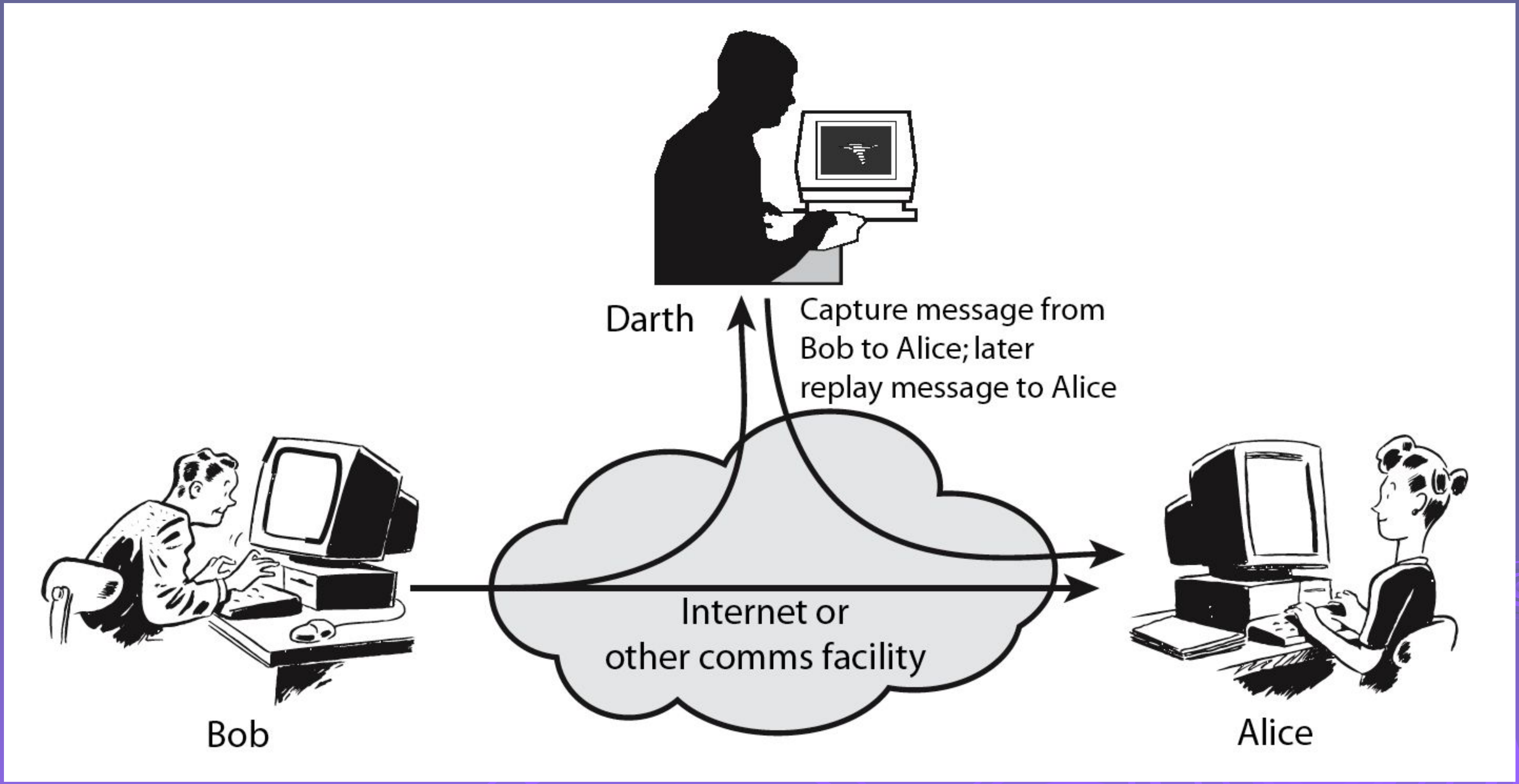

Darth
observe pattern of messages from Bob to Alice
Internet or other comms facility
Bob
Alice

- Passive attacks do not affect system resources
  - Eavesdropping, monitoring
- Two types of passive attacks
  - Release of message contents
  - Traffic analysis
- Passive attacks are very difficult to detect
  - Message transmission apparently normal
    - No alteration of the data
  - Emphasis on prevention rather than detection
    - By means of encryption

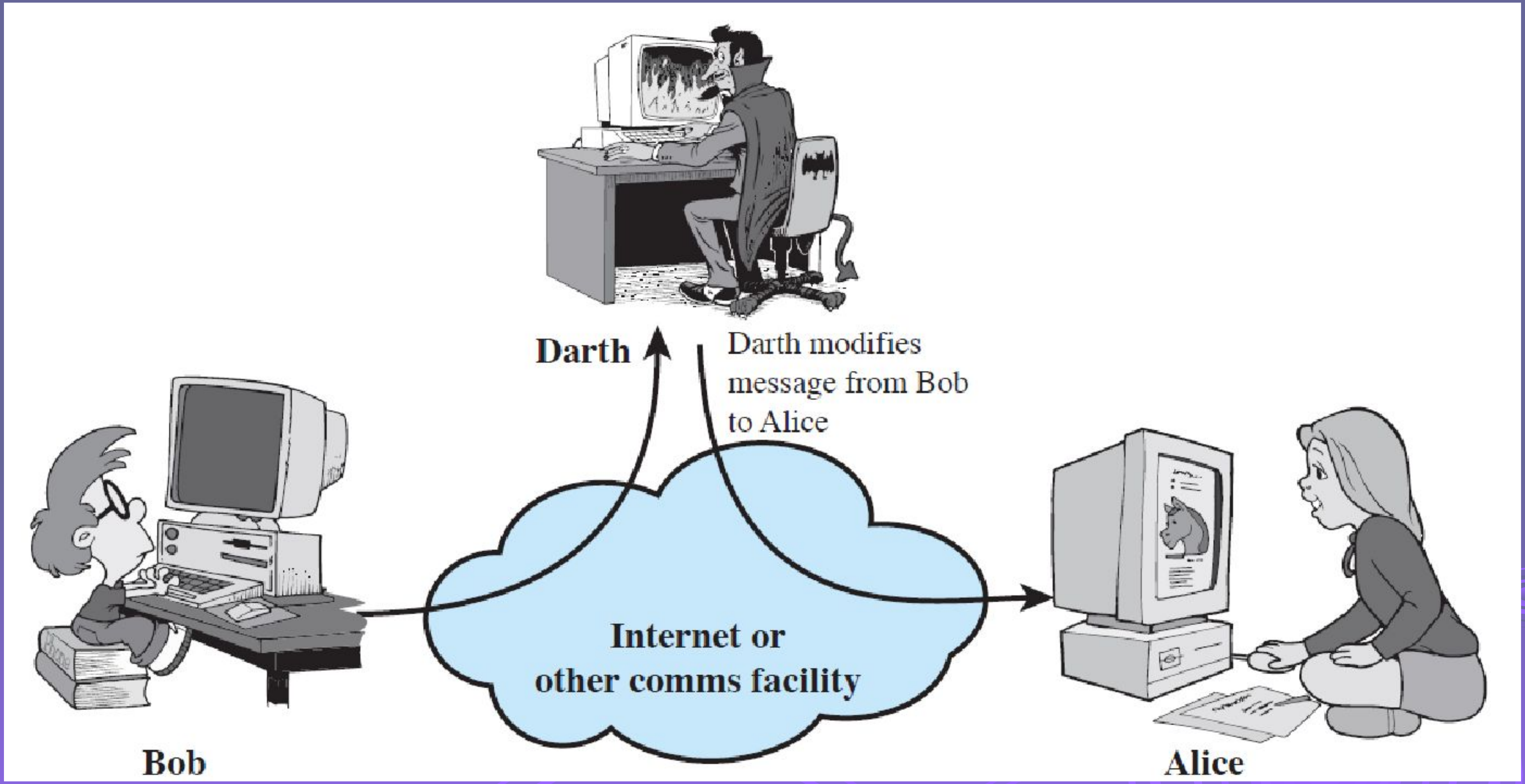
# Active Attacks (1) Masquerade


Darth
Message from Darth that appears to be from Bob
Bob
Internet or other comms facility
Alice

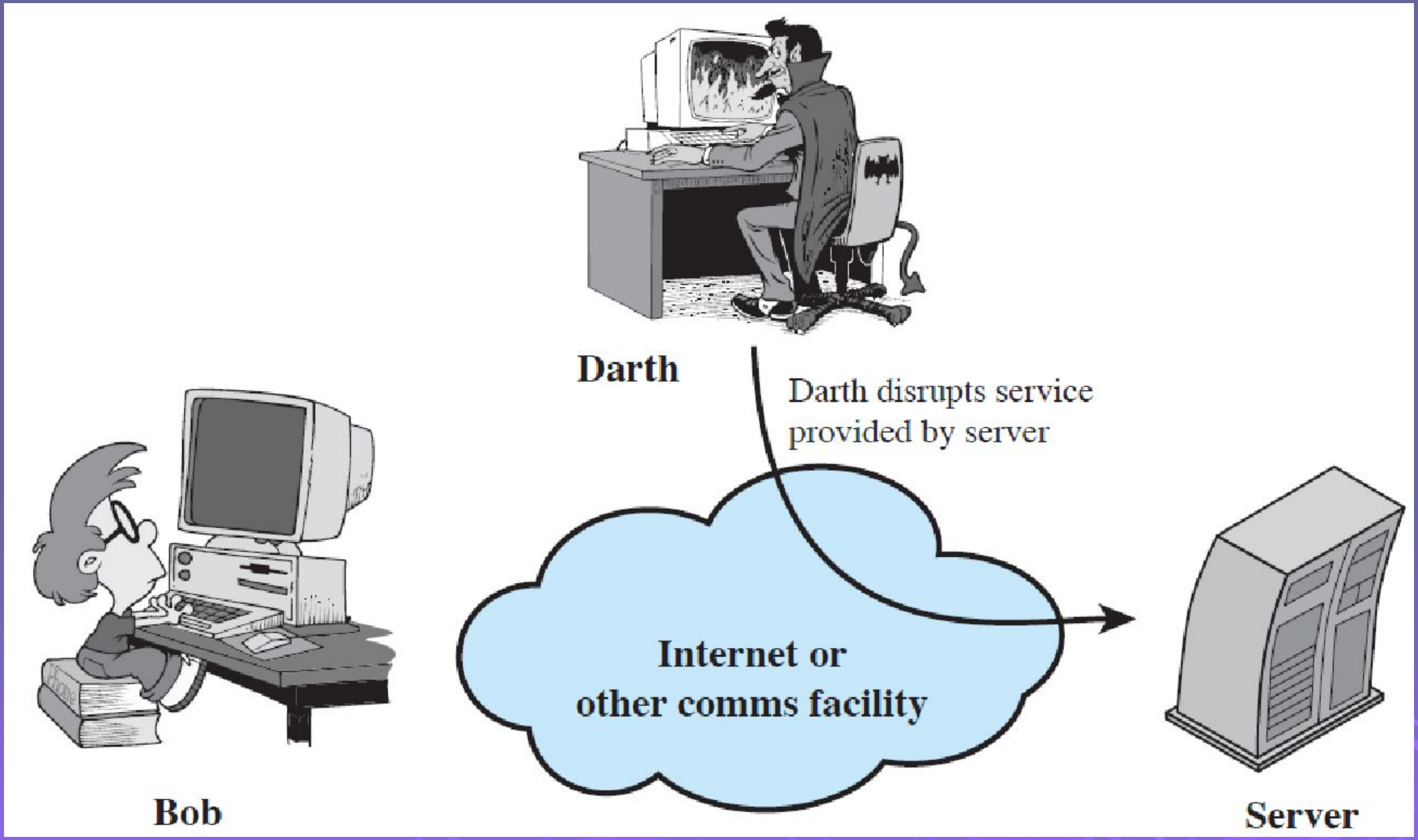
# Active Attacks (2) Replay


Darth
Capture message from Bob to Alice; later replay message to Alice
Internet or other comms facility
Bob
Alice

# Active Attacks (3)
# Modification of Messages


Darth
Darth modifies message from Bob to Alice
Internet or other comms facility
Bob
Alice

# Active Attacks (4)
# Denial of Service


Darth
Darth disrupts service provided by server
Internet or other comms facility
Bob
Server

- Active attacks try to alter system resources or affect their operation
  - Modification of data, or creation of false data
- Four categories
  - Masquerade
  - Replay
  - Modification of messages
  - Denial of service: preventing normal use
    - A specific target or entire network
- Difficult to prevent
  - The goal is to detect and recover

# Security Service

- enhance security of data processing systems and information transfers of an organization
- intended to counter security attacks
- using one or more security mechanisms
- often replicates functions normally associated with physical documents
  - which, for example, have signatures, dates; need protection from disclosure, tampering, or destruction; be notarized or witnessed; be recorded or licensed

# Security Services

- X.800:

  “a service provided by a protocol layer of communicating open systems, which ensures adequate security of the systems or of data transfers”

- 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

# Security Mechanism

- 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**
- hence our focus on this topic

# Security Mechanisms (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

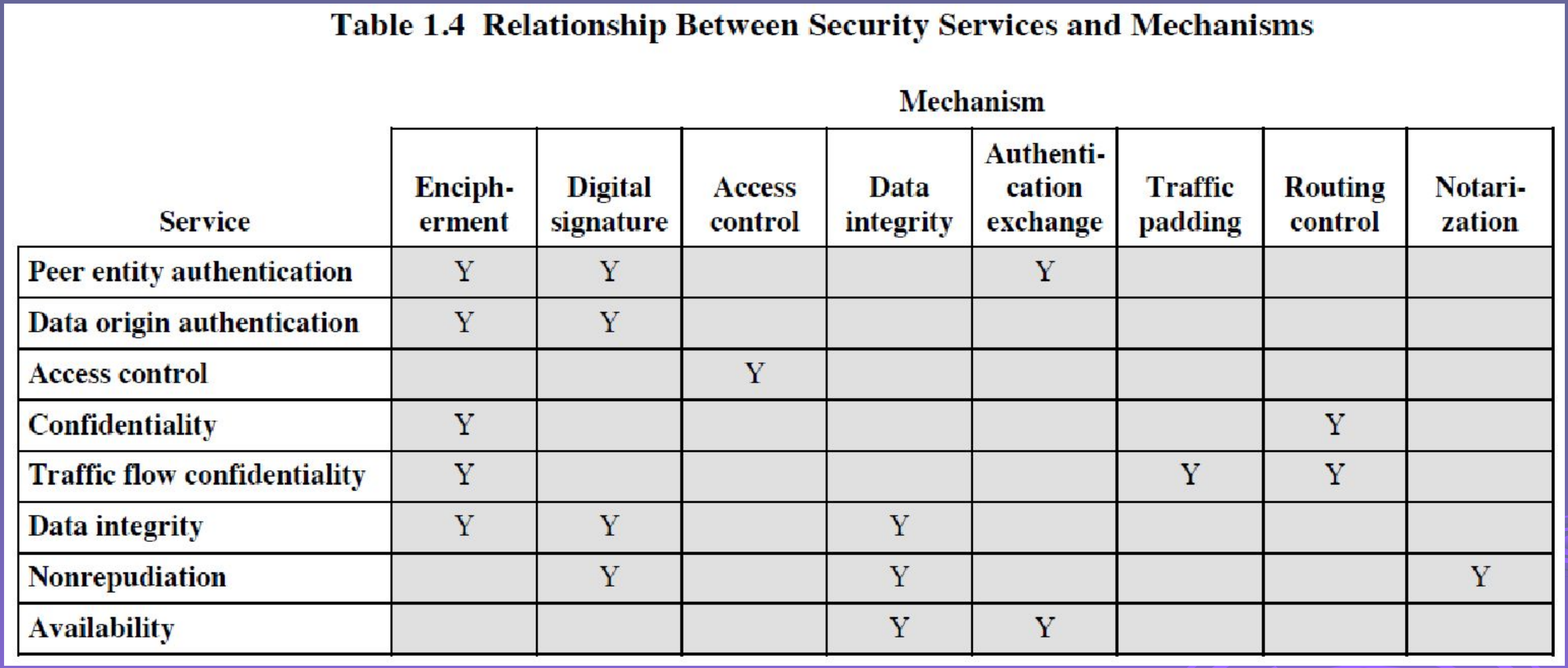
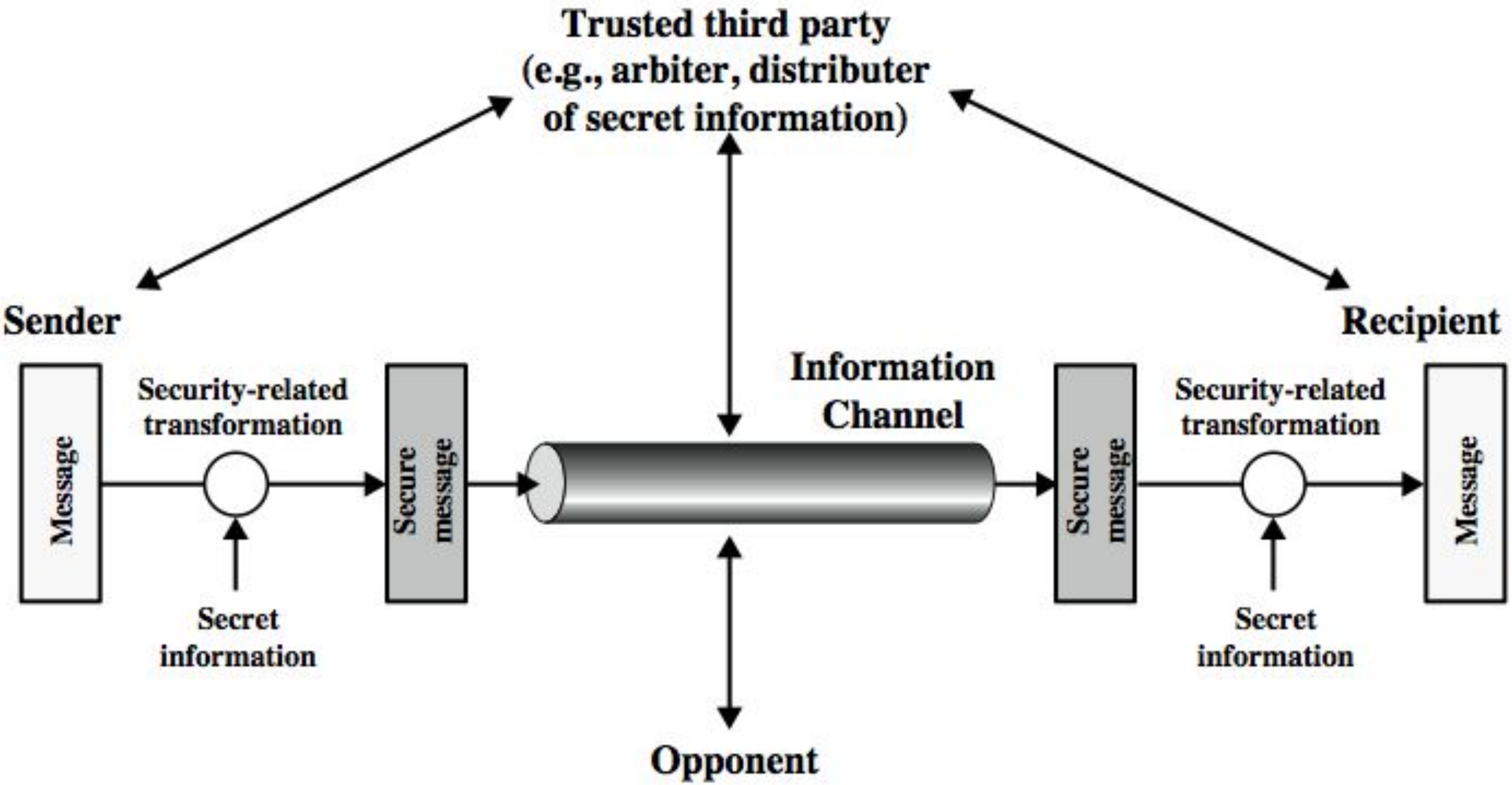


**Table 1.4 Relationship Between Security Services and Mechanisms**

| | Mechanism | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Service** | **Encipherment** | **Digital signature** | **Access control** | **Data integrity** | **Authentication exchange** | **Traffic padding** | **Routing control** | **Notarization** |
| **Peer entity authentication** | Y | Y | | | Y | | | |
| **Data origin authentication** | Y | Y | | | | | | |
| **Access control** | | | Y | | | | | |
| **Confidentiality** | Y | | | | | | Y | |
| **Traffic flow confidentiality** | Y | | | | | Y | Y | |
| **Data integrity** | Y | Y | | Y | | | | |
| **Nonrepudiation** | | Y | | Y | | | | Y |
| **Availability** | | | | Y | Y | | | |

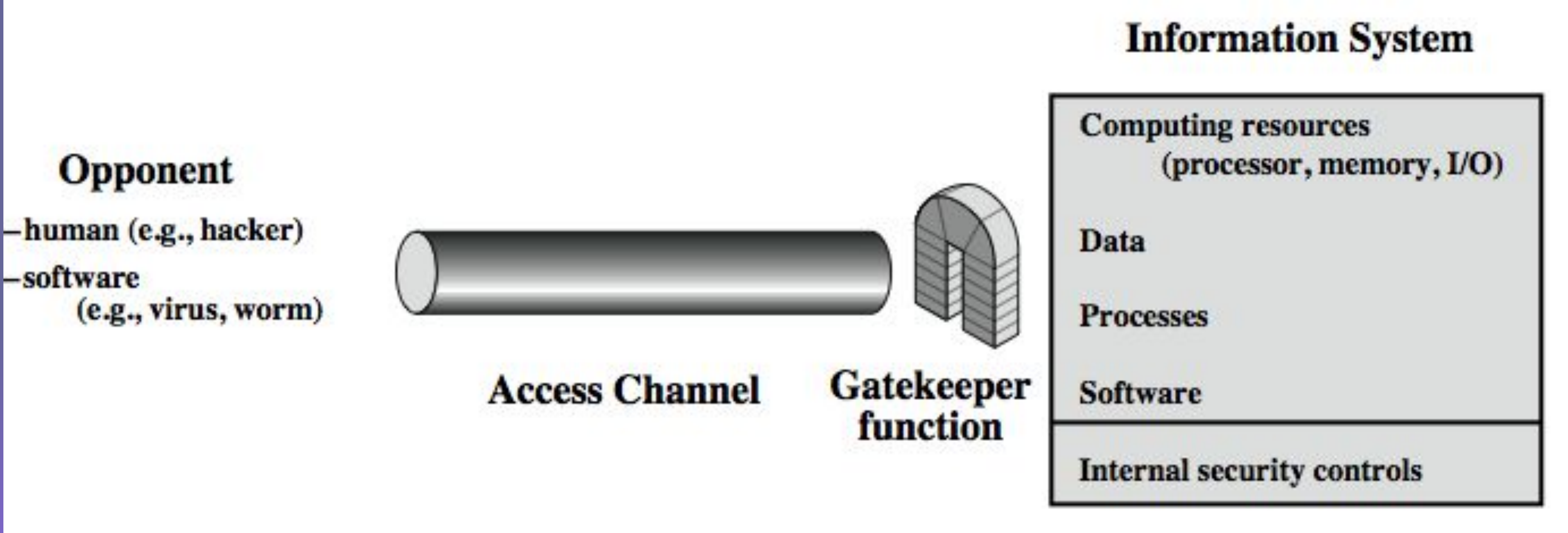
# Model for Network Security



# 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

# Model for Network Access Security



Information System

Computing resources
(processor, memory, I/O)

Data

Processes

Software

Internal security controls

Opponent

–human (e.g., hacker)

–software
(e.g., virus, worm)

# 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

# Standards

- NIST: National Institute of Standards and Technology
  - FIPS: Federal Information Processing Standards
  - SP: Special Publications
- ISOC: Internet Society
  - Home for IETF (Internet Engineering Task Force) and IAB (Internet Architecture Board)
  - RFCs: Requests for Comments

# Summary

- topic roadmap & standards organizations
- security concepts:
  - confidentiality, integrity, availability
- X.800 security architecture
- security attacks, services, mechanisms
- models for network (access) security