Information Security

Chapter 1: Overview

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Chapter 1: Overview

- Computer Security Concepts and Terminology
- Fundamental Security Design Principles
- Attack Surfaces and Attack Trees
- Computer Security Strategy

Learning objectives

- Describe the key security requirements of confidentiality, integrity and availability
- Discuss the types security threats and attacks
- Explain the fundamental security design principles
- Discuss the use of attack surfaces and attack trees
- Understand the principle aspects of a comprehensive security strategy

A Definition of 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

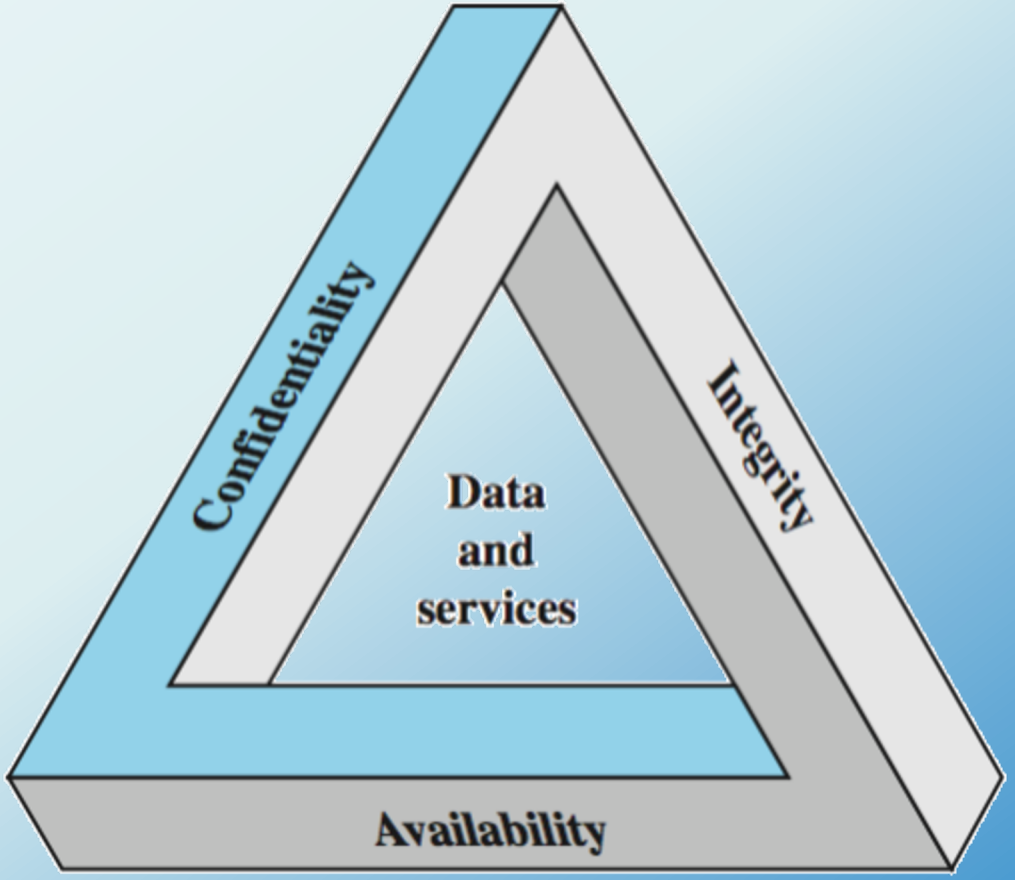
Three Key Objectives (the CIA triad)

1. **Confidentiality**
   - **Data confidentiality**: Assures that confidential information is not disclosed to unauthorized individuals
   - **Privacy**: Assures that individual control or influence what information may be collected and stored

Three Key Objectives (the CIA triad)

2. **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 operations in unimpaired manner
3. **Availability**: assure that systems works promptly, and service is not denied to authorized users

Key Security Concepts



A complete security picture

- **Authenticity**: the property of being genuine and being able to be verified and trusted; confident in the validity of a transmission, or a message, or its originator
- **Accountability**: generates the requirement for actions of an entity to be traced uniquely to that individual to support nonrepudiation, deference, fault isolation, etc.

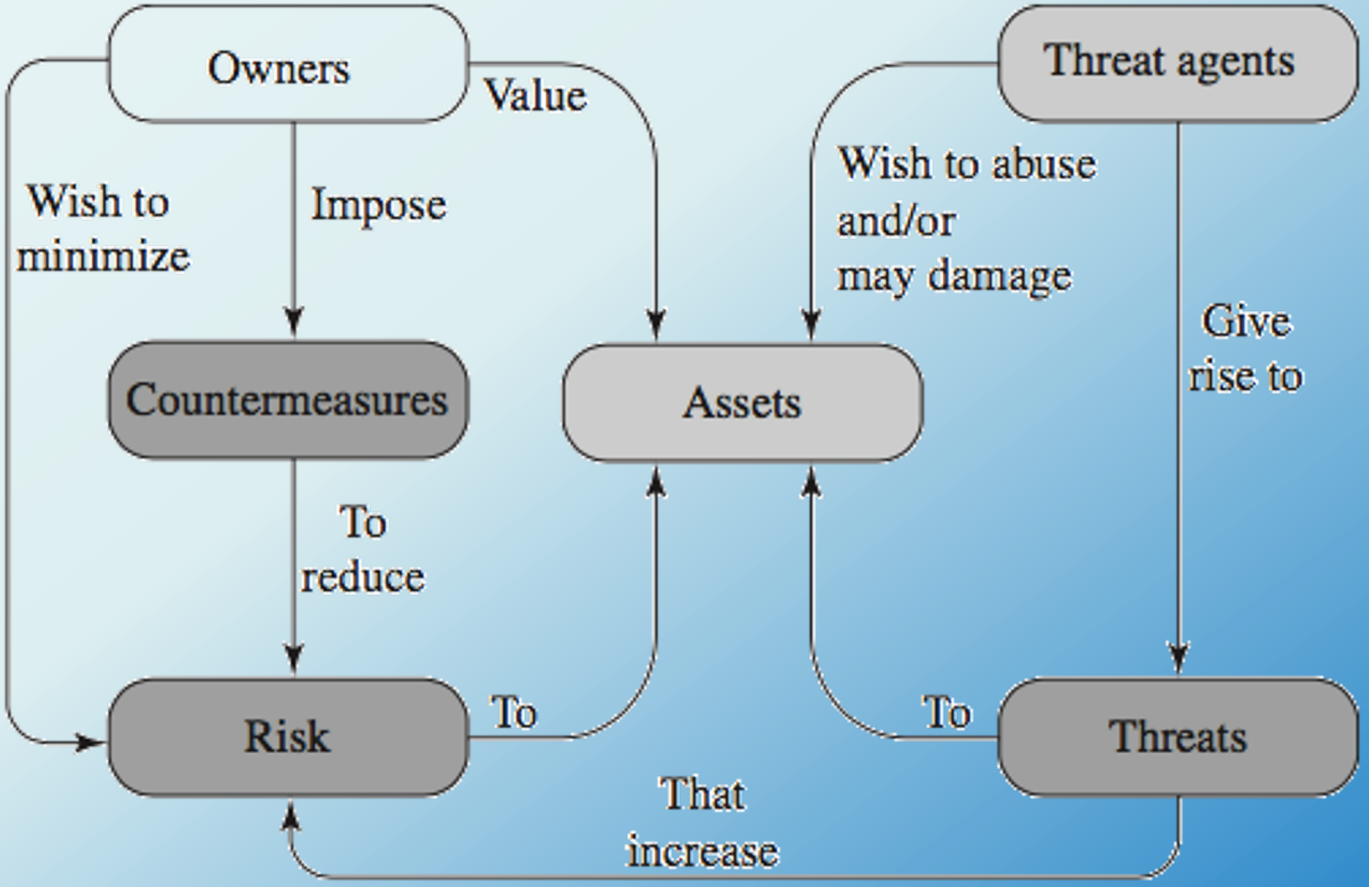
Challenges of Computer Security

1. Computer security is not simple
2. One must consider potential (unexpected) attacks
3. Procedures used are often counter-intuitive
4. Must decide where to deploy mechanisms
5. Involve algorithms and secret info (keys)
6. A battle of wits between attacker / admin
7. It is not perceived on benefit until fails
8. Requires constant monitoring
9. Too often an after-thought (not integral)
10. Regarded as impediment to using system

Computer Security Terminology

- Vulnerability
- Threat
- Adversary (Threat Agent or Threat Actor)
- Attack
- Asset
- Countermeasure
- Risk
- Security Policy

Security Concepts and Relationships



Fundamental Security Design Principles

- Despite years of research, it is still difficult to design systems that comprehensively prevent security flaws
- But good practices for good design have been documented (analogous to software engineering)
- Simplicity, Fail-Safe defaults, Complete Mediation, Open Design, No single point-of-failure, Minimum Exposure, Separation of Privileges, Least Privilege, Maximize the Entropy of Secrets, Traceability, Usability.

Fundamental Security Design Principles

1. **Economy of mechanism** (Simplicity)
2. **Fail-safe default**
3. **Complete mediation**: every access should be checked against an access control system
4. **Open design**: the design should be open rather than secret (e.g., encryption algorithms)
5. **No single-point-of-failure** (separation of privilege)

Fundamental Security Design Principles

6. **Compartmentalization (Layering)**: use of multiple, overlapping protection approaches
7. **Minimum exposure**
8. **Separation of privilege**: multiple privileges should be needed to do achieve access (or complete a task)
9. **Least privilege**: every user (process) should have the least privilege to perform a task
10. Maximize the entropy of secrets

Fundamental Security Design Principles

11. **Traceability**: Log security-relevant system events
12. **Usability**: Design usable security mechanisms

Attack surfaces

- Attack surface: the reachable and exploitable vulnerabilities in a system
  - Open ports
  - Services outside a firewall
  - An employee with access to sensitive info

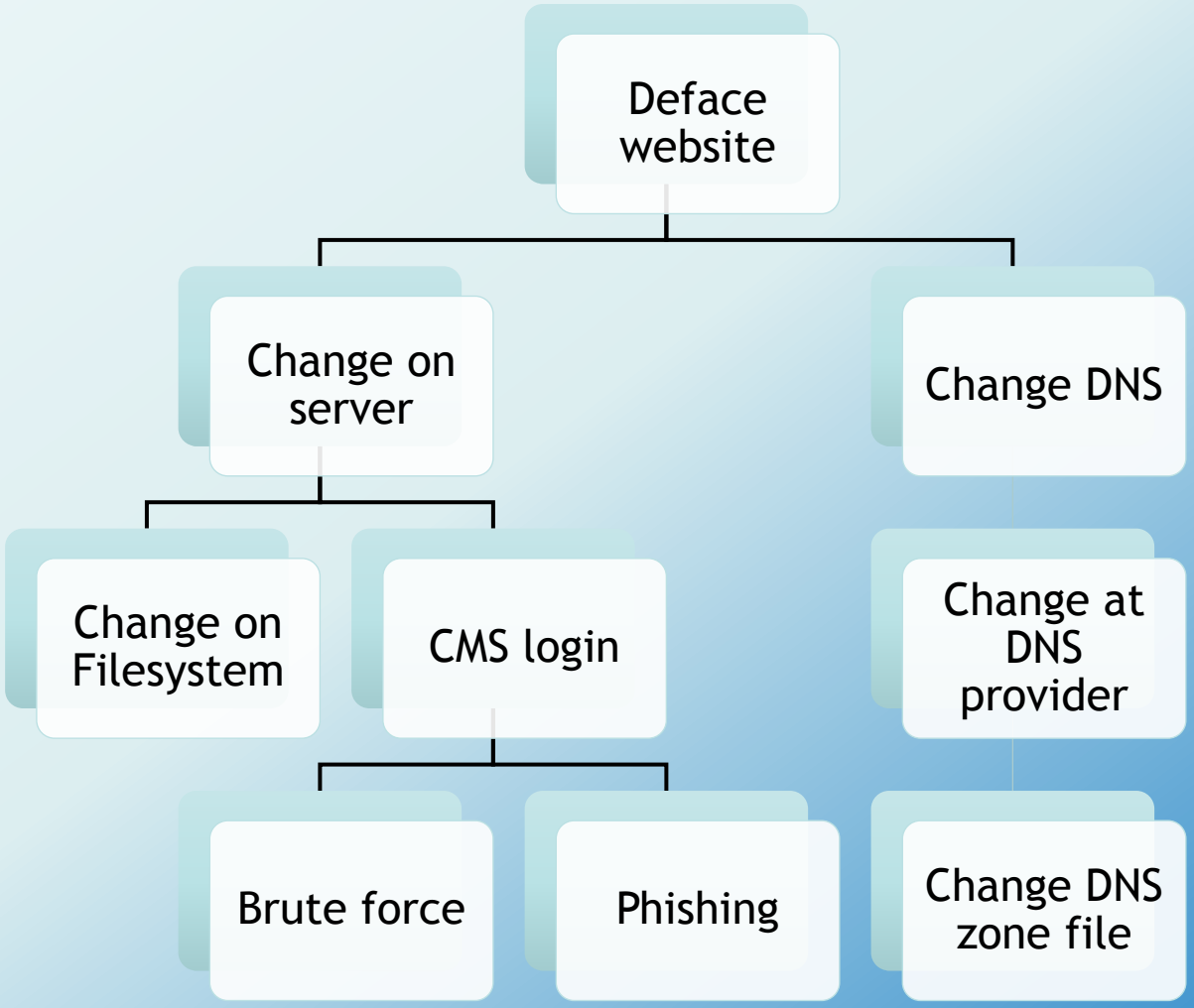
Attack surfaces

- Categories
  - **Network attack surface** (i.e., network vulnerability)
  - **Software attack surface** (i.e., software vulnerabilities)
  - **Human attack surface** (e.g., social engineering)
- Attack analysis: assessing the scale and severity of threats

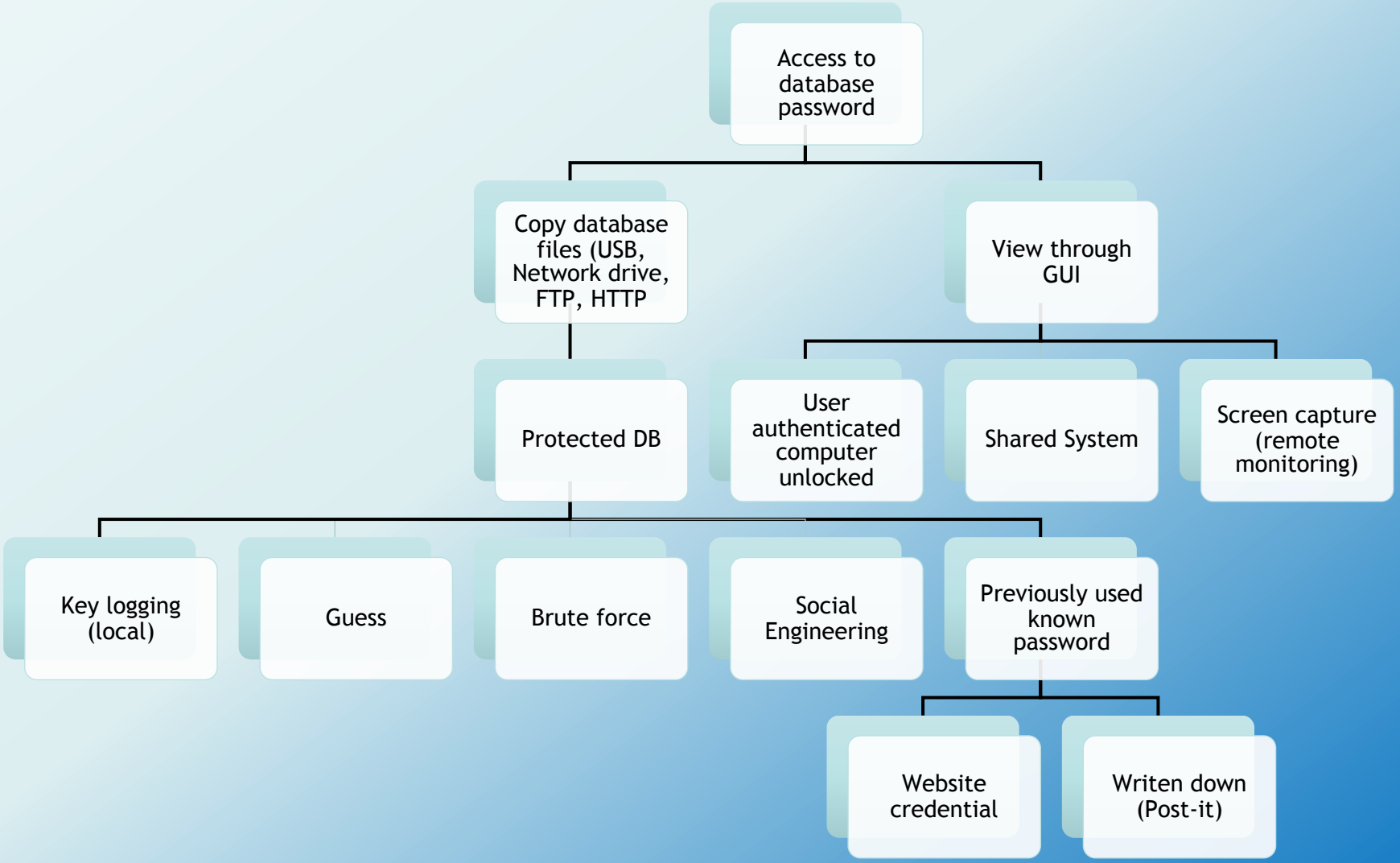
Attack trees

- A branching, hierarchical data structure that represents a set of potential vulnerabilities
- Objective: to effectively exploit the info available on attack patterns
  - Security analysts can use the tree to guide design and strengthen countermeasures

Attack Tree


Deface website
Change on server
Change DNS
Change on Filesystem
CMS login
Change at DNS provider
Brute force
Phishing
Change DNS zone file

Attack Tree

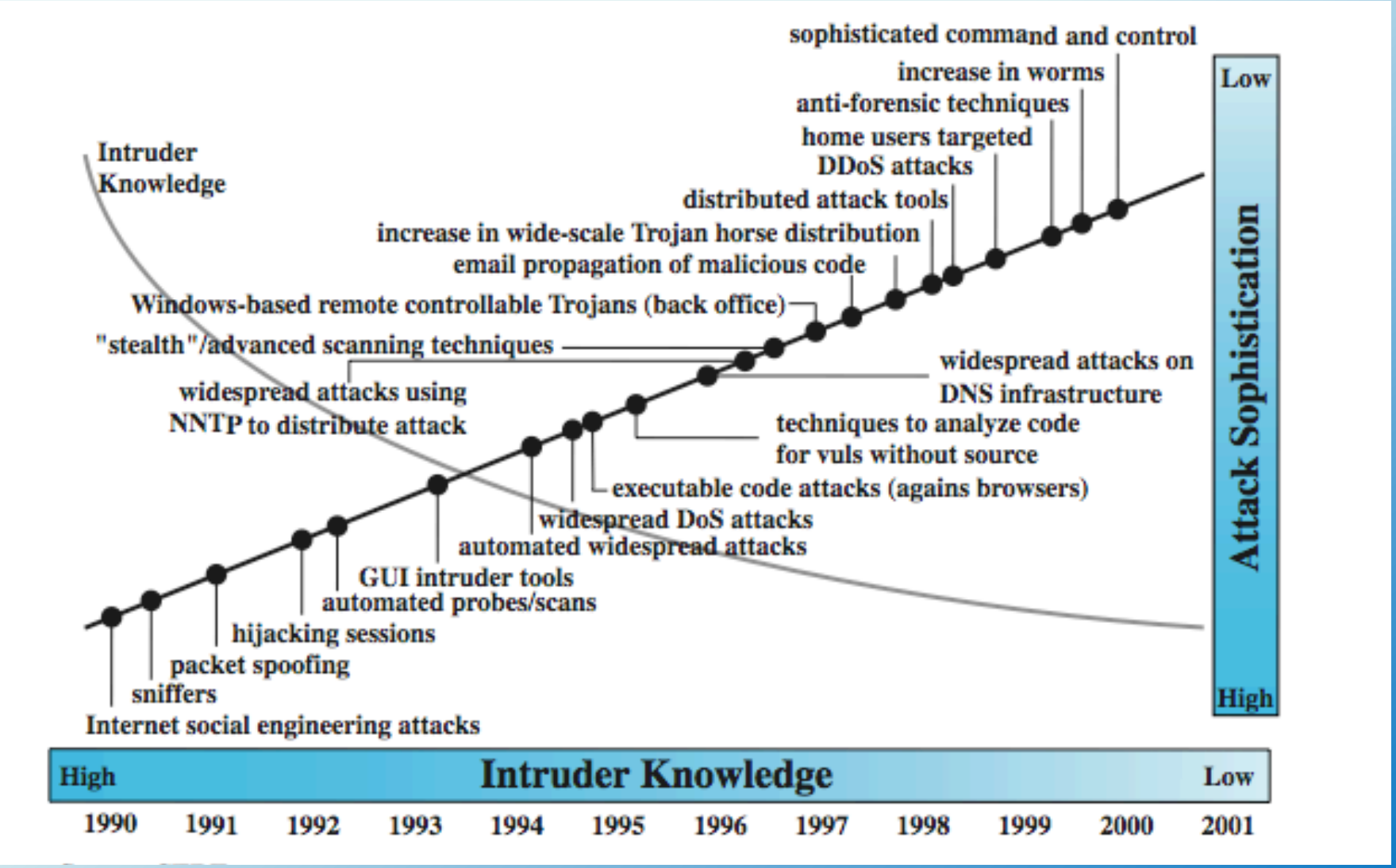

Access to database password
Copy database files (USB, Network drive, FTP, HTTP
View through GUI
Protected DB
User authenticated computer unlocked
Shared System
Screen capture (remote monitoring)
Key logging (local)
Guess
Brute force
Social Engineering
Previously used known password
Website credential
Writen down (Post-it)

Information Security Strategy

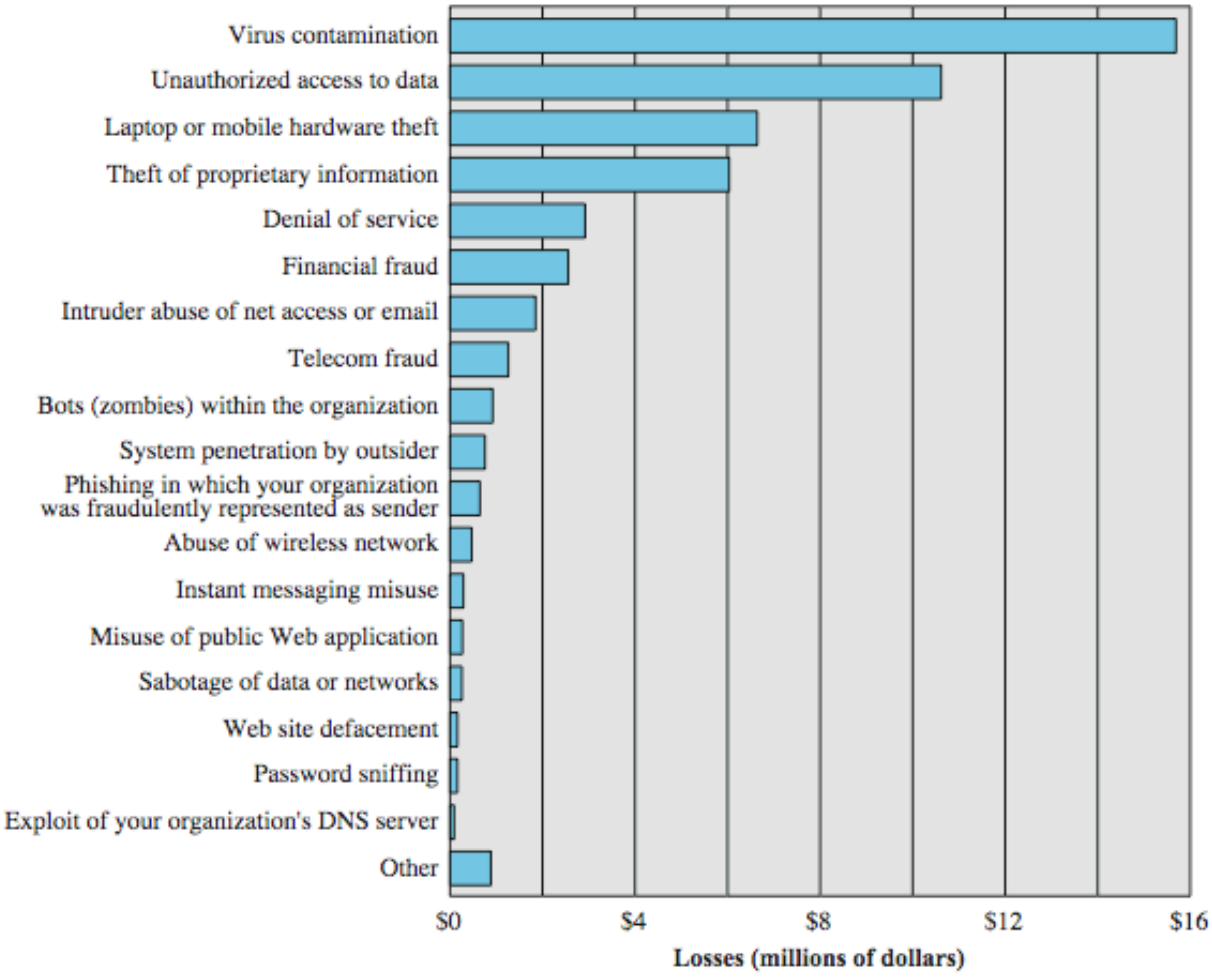
An overall strategy for providing security

- **Policy** (specs): what security schemes are supposed to do
  - Assets and their values
  - Potential threats
  - Ease of use vs security
  - Cost of security vs cost of failure/recovery
- **Implementation/mechanism**: how to enforce
  - Prevention
  - Detection
  - Response
  - Recovery
- **Correctness/assurance**: does it really work (validation/review)

Security Trends

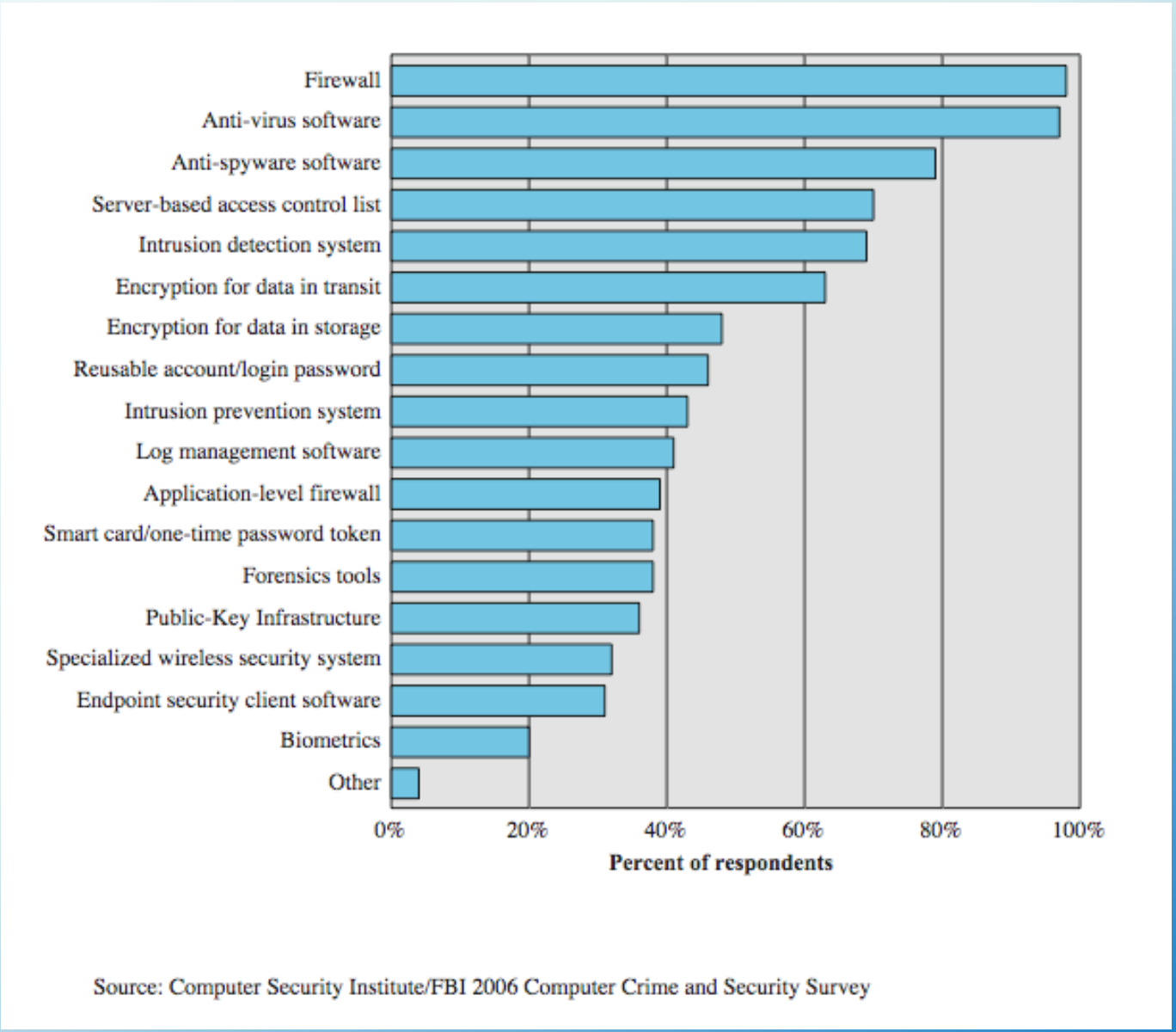


Computer Security Losses



Source: Computer Security Institute/FBI 2006 Computer Crime and Security Survey

Security Technologies Used



Source: Computer Security Institute/FBI 2006 Computer Crime and Security Survey

Summary

- Security concepts
- Terminology
- Security design principles
- Attack surface & Attack Tree
- Security strategy