Overview of Information Security

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Outline

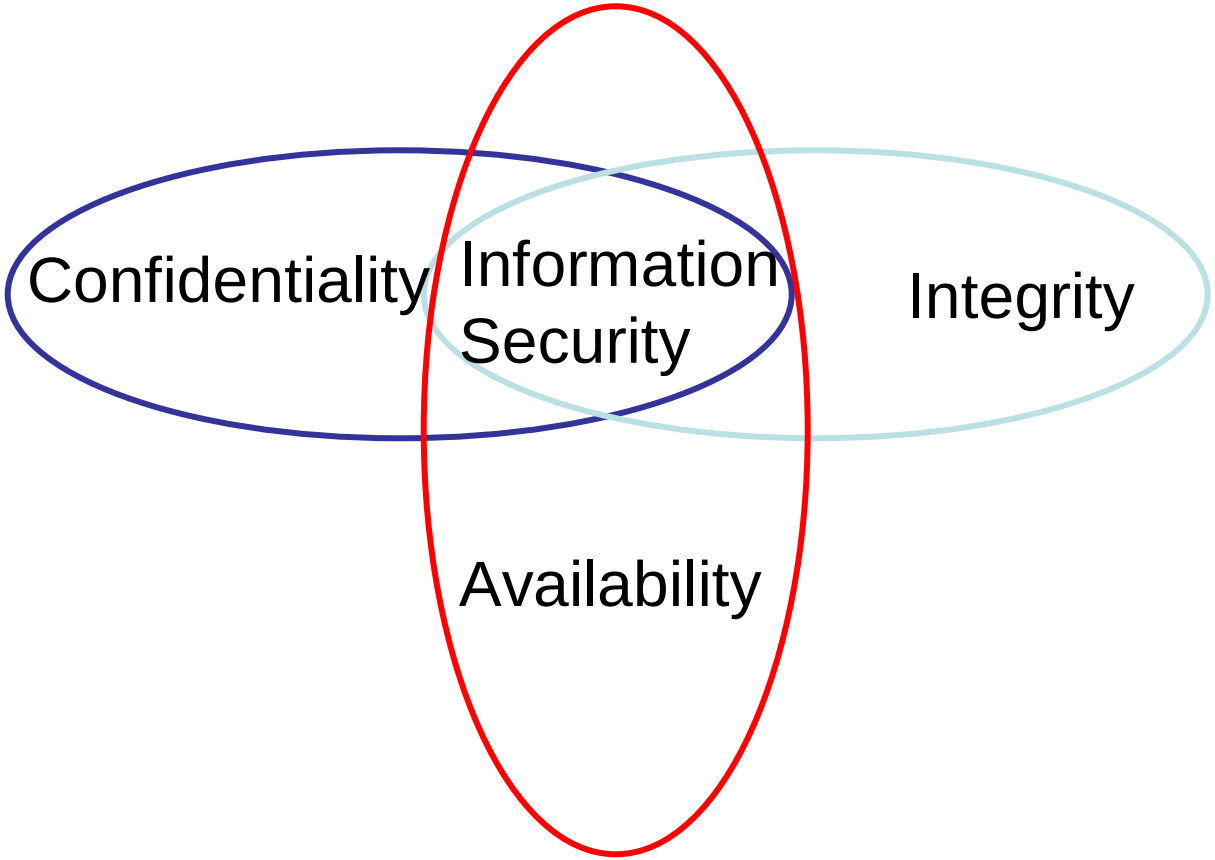
- Information Security: basic concepts
- Privacy: basic concepts and comparison with security
- Access control, security policies, and models
  - Access control policies
    - the matrix model and the safety problem
    - discretionary access control
    - mandatory access control
    - role-based and task-based access control
    - context-based access control
    - chinese wall access control
  - Administration policies

Information Security: Basic Concepts

Information Protection - Why?

- Information are an important strategic and operational asset for any organization
- Damages and misuses of information affect not only a single user or an application; they may have disastrous consequences on the entire organization
- Additionally, the advent of the Internet as well as networking capabilities has made the access to information much easier

Information Security: Main Requirements



Information Security: Examples

- Consider a payroll database in a corporation, it must be ensured that:
  - salaries of individual employees are not disclosed to arbitrary users of the database
  - salaries are modified by only those individuals that are properly authorized
  - paychecks are printed on time at the end of each pay period

Information Security: Examples

- In a military environment, it is important that:
  - the target of a missile is not given to an unauthorized user
  - the target is not arbitrarily modified
  - the missile is launched when it is fired

Information Security - main requirements

- *Confidentiality* - it refers to information protection from unauthorized read operations
  - the term *privacy* is often used when data to be protected refer to individuals
- *Integrity* - it refers to information protection from modifications; it involves several goals:
  - Assuring the integrity of information with respect to the original information (relevant especially in web environment) – often referred to as *authenticity*
  - Protecting information from unauthorized modifications
  - Protecting information from incorrect modifications – referred to as *semantic integrity*
- *Availability* - it ensures that access to information is not denied to authorized subjects

Information Security – additional requirements

- *Information Quality* – it is not considered traditionally as part of information security but it is very relevant

- *Completeness* – it refers to ensure that subjects receive all information they are entitled to access, according to the stated security policies

Classes of Threats

- Disclosure
  - Snooping, Trojan Horses
- Deception
  - Modification, spoofing, repudiation of origin, denial of receipt
- Disruption
  - Modification
- Usurpation
  - Modification, spoofing, delay, denial of service

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

Information Security – How?

- Information must be protected at various levels:
  - The operating system
  - The network
  - The data management system
  - Physical protection is also important

Information Security – Mechanisms

- Confidentiality is enforced by the access control mechanism
- Integrity is enforced by the access control mechanism and by the semantic integrity constraints
- Availability is enforced by the recovery mechanism and by detection techniques for DoS attacks – an example of which is query flood

Information Security – How?
Additional mechanisms

- *User authentication* - to verify the identity of subjects wishing to access the information
- *Information authentication* - to ensure information authenticity - it is supported by signature mechanisms
- *Encryption* - to protect information when being transmitted across systems and when being stored on secondary storage
- *Intrusion detection* – to protect against impersonation of legitimate users and also against insider threats

Data vs Information

- Computer security is about controlling access to information and resources
- Controlling access to information can sometimes be quite elusive and it is often replaced by the more straightforward goal of controlling access to data
- The distinction between data and information is subtle but it is also the root of some of the more difficult problems in computer security
- *Data* represents information. *Information* is the (subjective) interpretation of data

Data vs Information

Data Physical phenomena chosen by convention to represent certain aspects of our conceptual and real world. The meaning we assign to data are called information. Data is used to transmit and store information and to derive new information by manipulating the data according to formal rules.

from:

P.Brinch Hansen. *Operating Systems Principles*. Prentice-Hall, 1973.

Data vs Information

- Protecting information means to protect not only the data directly representing the information
- Information must be protected also against transmissions through:
  - Covert channels
  - Inference
    - It is typical of database systems
    - It refers to the derivation of sensitive information from non-sensitive data

Inference - Example

Name	Sex	Programme	Units	Grade Ave
Alma	F	MBA	8	63
Bill	M	CS	15	58
Carol	F	CS	16	70
Don	M	MIS	22	75
Errol	M	CS	8	66
Flora	F	MIS	16	81
Gala	F	MBA	23	68
Homer	M	CS	7	50
Igor	M	MIS	21	70

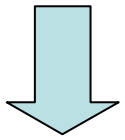
Inference - Example

- Assume that there is a policy stating that the average grade of a single student cannot be disclosed; however statistical summaries can be disclosed
- Suppose that an attacker knows that Carol is a female CS student
- By combining the results of the following legitimate queries:
  - Q1: SELECT Count (*) FROM Students WHERE Sex ='F' AND Programme = 'CS'
  - Q2: SELECT Avg (Grade Ave) FROM Students WHERE Sex ='F' AND Programme = 'CS'

    The attacker learns from Q1 that there is only one female student so the value 70 returned by Q2 is precisely her average grade

Information Security: A Complete Solution

- It consists of:
  - first defining a *security policy*
  - then choosing some *mechanism* to enforce the policy
  - finally providing *assurance* that both the mechanism and the policy are sound

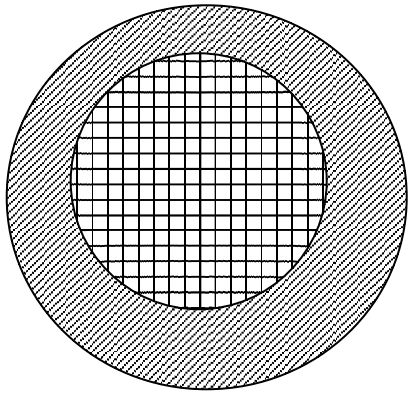


SECURITY LIFE-CYCLE

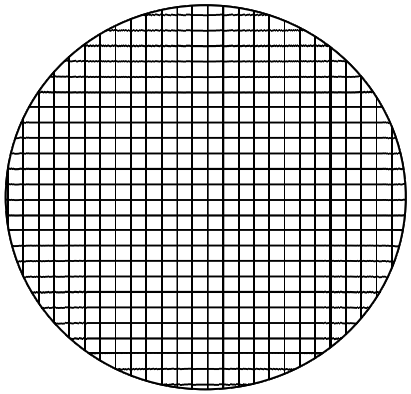
Policies and Mechanisms

- Policy says what is, and is not, allowed
  - This defines “security” for the information
- Mechanisms enforce policies
- Composition of policies
  - If policies conflict, discrepancies may create security vulnerabilities

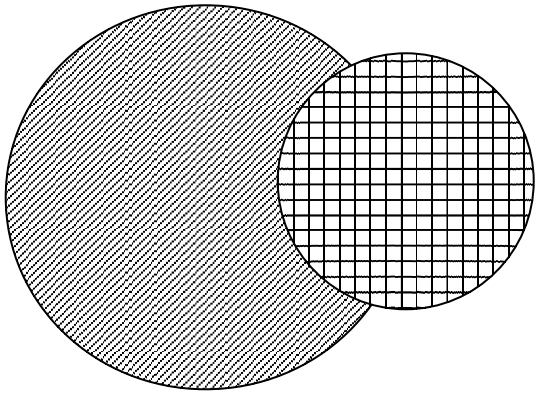
Types of Mechanisms



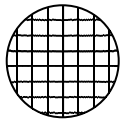
secure



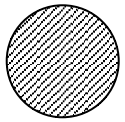
precise



broad



set of reachable states



set of secure states

Assurance

- Specification
  - Requirements analysis
  - Statement of desired functionality
- Design
  - How system will meet specification
- Implementation
  - Programs/systems that carry out design

Management and Legal Issues

- Cost-Benefit Analysis
  - Is it more cost-effective to prevent or recover?
- Risk Analysis
  - Should we protect some information?
  - How much should we protect this information?
- Laws and Customs
  - Are desired security measures illegal?
  - Will people adopt them?

Human Factor Issues

- Organizational Problems
  - Power and responsibility
  - Financial benefits
- People problems
  - Outsiders and insiders
  - Social engineering

Key Points

- Policies define security, and mechanisms enforce security
  - Confidentiality
  - Integrity
  - Availability
- Importance of assurance
- The human factor

Privacy

Motivations

- Privacy is an important issue today
  - Individuals feel
    - Uncomfortable: ownership of information
    - Unsafe: information can be misused
    - (e.g., identity thefts)
  - Enterprises need to
    - Keep their customers feel safe
    - Maintain good reputations
    - Protect themselves from any legal dispute
    - Obey legal regulations

Definition

- **Privacy** is the ability of a person to control the availability of information about and exposure of him- or herself. It is related to being able to function in society anonymously (including pseudonymous or blind credential identification).
- **Types of privacy** giving raise to special concerns:
  - Political privacy
  - Consumer privacy
  - Medical privacy
  - *Information technology end-user privacy; also called data privacy*
  - Private property

Data Privacy

- Data Privacy problems exist *wherever uniquely identifiable data relating to a person or persons are collected and stored, in digital form or otherwise*. Improper or non-existent disclosure control can be the root cause for privacy issues.

- The most common sources of data that are affected by data privacy issues are:
  - Health information
  - Criminal justice
  - Financial information
  - Genetic information

Data Privacy

- The challenge in data privacy is to share data while protecting the personally identifiable information.
  - Consider the example of health data which are collected from hospitals in a district; it is standard practice to share this only in aggregate form
  - The idea of sharing the data in aggregate form is to ensure that only non-identifiable data are shared.
- The legal protection of the right to privacy in general and of data privacy in particular varies greatly around the world.

Technologies with Privacy Concerns

- Biometrics (DNA, fingerprints, iris) and face recognition
- Video surveillance, ubiquitous networks and sensors
- Cellular phones
- Personal Robots
- DNA sequences, Genomic Data

Approaches in Privacy-Preserving Information Management

- Anonymization Techniques
  - Have been investigated in the areas of networks (see the Anonymity Terminology by Andreas Pfitzman) and databases (see the notion of k-anonymity by L. Sweeney)
- Privacy-Preserving Data Mining
- P3P policies
  - Are tailored to the specification of privacy practices by organizations and to the specification user privacy preferences
- Hippocratic Databases
  - Are tailored to support privacy policies
- Fine-Grained Access Control Techniques
- Private Information Retrieval Techniques

Privacy vs Security

- Privacy is not just confidentiality and integrity of user data
- Privacy includes other requirements:
  - Support for user preferences
  - Support for obligation execution
  - Usability
  - Proof of compliance