Chapter 1: Introduction

- Components of computer security
- Threats
- Policies and mechanisms
- The role of trust
- Assurance
- Operational Issues
- Human Issues

Basic Components

- Confidentiality
  - Keeping data and resources hidden
- Integrity
  - Data integrity (integrity)
  - Origin integrity (authentication)
  - Mechanisms: Prevention and Detection
- Availability
  - Enabling access to data and resources

Classes of Threats

- Threat
  - Potential violation of security through attacks
- Disclosure
  - Unauthorized access to information
  - Snooping (passive wiretapping)
- Deception
  - Acceptance of false data
  - Modification, spoofing, repudiation of origin, denial of receipt

Classes of Threats

- Disruption
  - Interruption or prevention of correct operation
  - Modification
- Usurpation
  - Unauthorized control of some part of a system
  - Modification, spoofing, delay, denial of service

Policies and Mechanisms

- Policy says what is, and is not, allowed
  - This defines "security" for the site/system/*etc*.
- Mechanisms enforce policies
- Composition of policies
  - If policies conflict, discrepancies may create security vulnerabilities

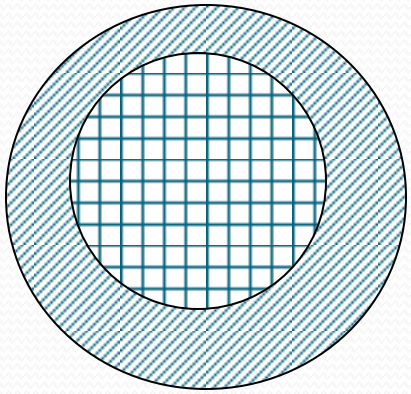
Goals of Security

- A policy defines “secure” and “non-secure” actions and mechanisms aim for the following:
- Prevention
  - Prevent attackers from violating security policy
  - Cumbersome, reduce flexibility
- Detection
  - Detect attackers’ violation of security policy
- Recovery
  - Stop attack, assess and repair damage
  - Continue to function correctly even if attack succeeds

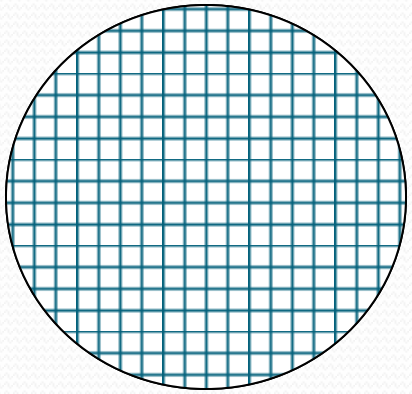
Trust and Assumptions

- Underlie *all* aspects of security
- Policies
  - Unambiguously partition system states (secure, not secure)
  - Correctly capture security requirements
- Mechanisms
  - Assumed to enforce policy
  - Support mechanisms work correctly

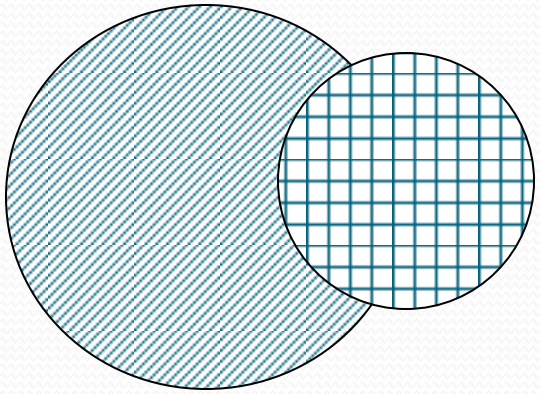
Types of Mechanisms



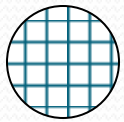
secure



precise



broad



set of reachable states

set of secure states

Assurance

- Measure of how well the system meets its requirements; i.e. how much you can trust the system to do what it is supposed to do.
- NIST Computer Security Handbook definition

  "degree of confidence one has that the security measures, both technical and operational, work as intended to protect the system and the information it processes"

  - "Does the security system design meet its requirements?"
  - "Does the security system implementation meet its specifications"

Assurance

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

Operational Issues

- Cost-Benefit Analysis
  - Is it cheaper to prevent or recover?
    - Overlap of mechanism's effects
    - Will it be possible to enforce
    - Ease of use
- Risk Analysis
  - Should we protect something?
  - How much should we protect this thing?
    - What would happen if the data/resource is compromised?
    - What is the likelihood that the threats will materialize?
  - The level of protection is a function of the likelihood and the effect of the attack.

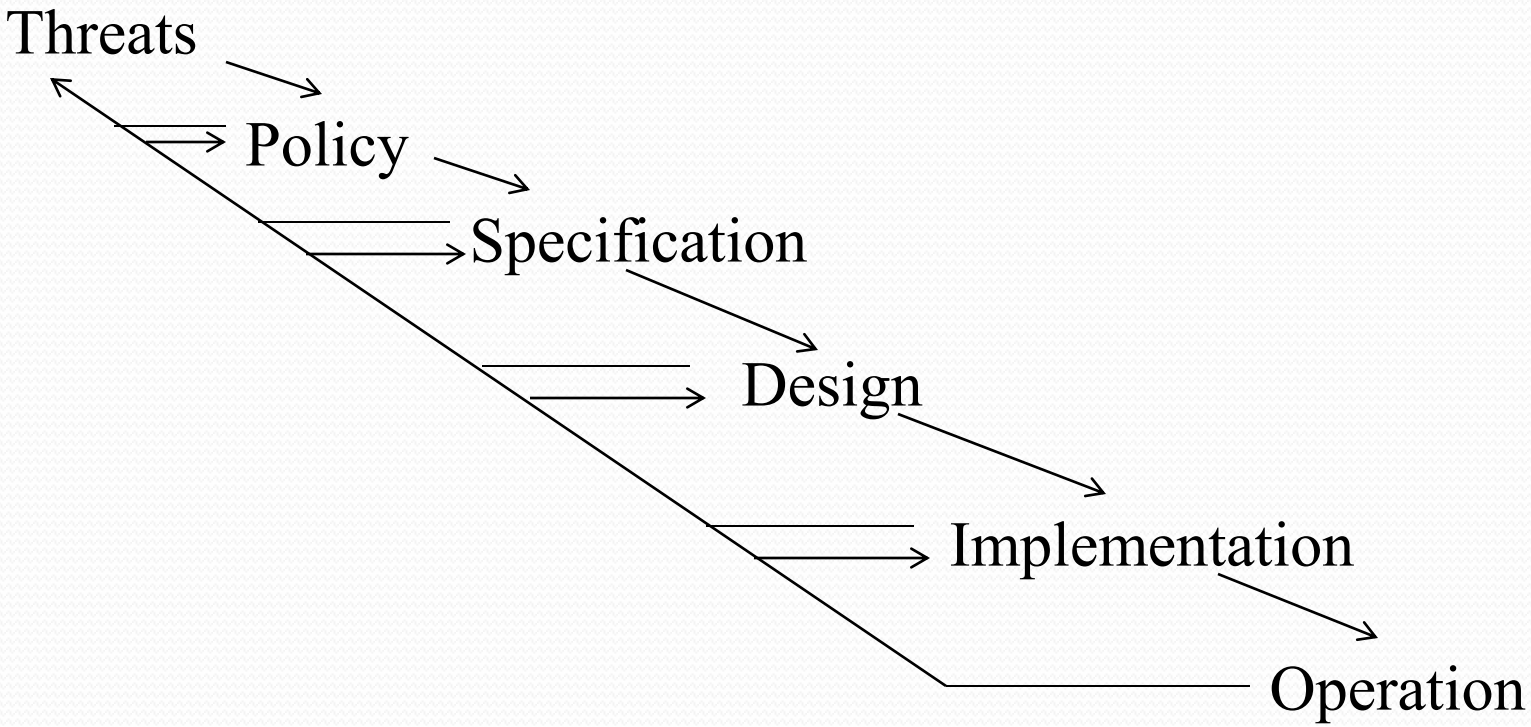
Operational Issues

- Risk Analysis
  - The amount of risk is a function of the environment
  - Risks change with time
  - Many risks are remote but exist
  - Problem of “analysis paralysis”
- Laws and Customs
  - Are desired security measures illegal?
  - Will people do them?

Human Issues

- Organizational Problems
  - No direct financial benefit
  - Requires financial support, resources, manpower
  - Power and responsibility
  - Trained dedicated personnel
- People problems
  - Outsiders and insiders
  - Social engineering

Tying Together



Key Points

- Policy defines security, and mechanisms enforce security
  - Confidentiality
  - Integrity
  - Availability
- Trust and knowing assumptions
- Importance of assurance
- The human factor

Security Policy

- Policy partitions system states into:
  - Authorized (secure)
    - These are states the system can enter
  - Unauthorized (nonsecure)
    - If the system enters any of these states, it's a security violation
- Secure system
  - Starts in authorized state
  - Never enters unauthorized state
- Breach of security
  - Occurs when a system enters an unauthorized state

Confidentiality

- *X* set of entities, *I* information
- *I* has *confidentiality* property with respect to *X* if no $x \in X$ can obtain information from *I*
- *I* can be disclosed to others
- Example:
  - *X* set of students
  - *I* final exam answer key
  - *I* is confidential with respect to *X* if students cannot obtain final exam answer key

Integrity

- *X* set of entities, *I* information
- *I* has *integrity* property with respect to *X* if all $x \in X$ trust information in *I*
- Types of integrity:
  - trust *I*, its conveyance and protection (data integrity)
  - *I* information about origin of something or an identity (origin integrity, authentication)
  - *I* resource: means resource functions as it should (assurance)

Availability

- *X* set of entities, *I* resource
- *I* has *availability* property with respect to *X* if all $x \in X$ can access *I*
- Types of availability:
  - traditional: *x* gets access or not
  - quality of service: promised a level of access (for example, a specific level of bandwidth) and not meet it, even though some access is achieved

Policy versus mechanism

- A security mechanism is an entity or procedure that enforces some part of the security policy.
- e.g. a corporation's policy indicates that all transactions related to a specific product must be completely confidential.
  - Only Alice and Jenny are allowed to perform the transactions on behalf of the clients
  - The data is tape backed-up everyday and the tapes are kept secure in an off-site location.

Policy Models

- Abstract description of a policy or class of policies
- Represents a particular policy or set of policies

Types of Security Policies

- Military (governmental) security policy
  - Policy primarily protecting confidentiality
- Commercial security policy
  - Policy primarily protecting integrity
- Confidentiality policy
  - Policy protecting only confidentiality
- Integrity policy
  - Policy protecting only integrity

Integrity and Transactions

- Begin in consistent state
  - "Consistent" defined by specification
- Perform series of actions (*transaction*)
  - Actions cannot be interrupted
  - If actions complete, system in consistent state
  - If actions do not complete, system reverts to beginning (consistent) state

Role of “trust”

- Confidentiality policies
  - No trust in the object itself (can the object be believed?)
  - Policy dictates whether or not the object can be disclosed
- Integrity policies
  - Indicate how much an object can be trusted.
  - How is the level of trust assigned?
    - e.g.: new version of software is obtained
      - High integrity (trust the vendor)
      - Low integrity (not tested on local system)
      - Medium integrity (trust the vendor, but also test on local system)
  - Integrity policies more dependent on the “trust” factor.

Trust

- When one understands the assumptions the security policies, mechanisms, and procedures rest on, then one gets a good understanding how effective those policies, mechanisms, and procedures are.

Trust in Formal Verification

- Gives formal mathematical proof that given input *i*, program *P* produces output *o* as specified
- Suppose a security-related program *S* formally verified to work with operating system *O*
- What are the assumptions?

Types of Access Control

- Discretionary Access Control (DAC)
  - individual user sets access control mechanism to allow or deny access to an object
    - Identity-based access control (IBAC)
- Mandatory Access Control (MAC)
  - system mechanism controls access to object, and individual cannot alter that access
    - Rule-based access control
- Originator Controlled Access Control (ORCON)
  - originator (creator) of information controls who can access information