Fall 2008: CS442
Introduction to Computer Security

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Lecture 1

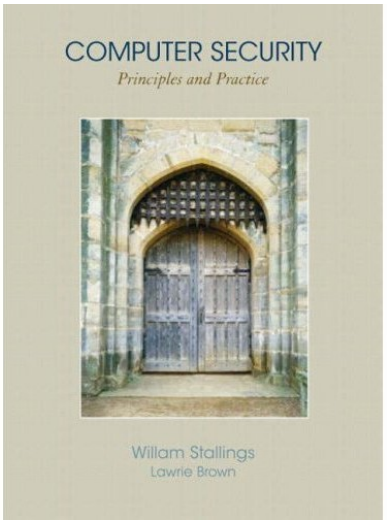
Administrivia

- Class webpage:
- **http://www.cs.rutgers.edu/~vinodg/teaching/442/**

- Office hours: Mon, 6:30pm-7:30pm.
- TA: Chih-Cheng Chang

Required Textbook

- Computer Security: Stallings and Brown.



Topics to be covered

- Cryptography basics:
  - Symmetric and Public key crypto.
- Network security
  - Key exchange protocols, IPSec, SSL.
- System security
  - Memory errors and exploits, authentication, authorization, virtual machines.

Topics to be covered

- Web security
  - Threat landscape: XSS, SQL Injection, XSRF, Javascript security. Browser security.
- Software security
  - Techniques to find vulnerabilities, secure coding practices
- Other topics
  - Anonymity, Information flow.

Grading

- Homeworks (3) – 30%
  - One requires coding in **C** and **x86** assembly
- Midterm – 20%
- Project – 20%
  - Groups of size 3 or 4.
  - Details to be announced late September.
- Final exam (cumulative) – 30%

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)
- Availability
  - Enabling access to data and resources

Classes of Threats

- Disclosure
  - Snooping
- Deception
  - Modification, spoofing, repudiation of origin, denial of receipt
- Disruption
  - Modification
- Usurpation
  - 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

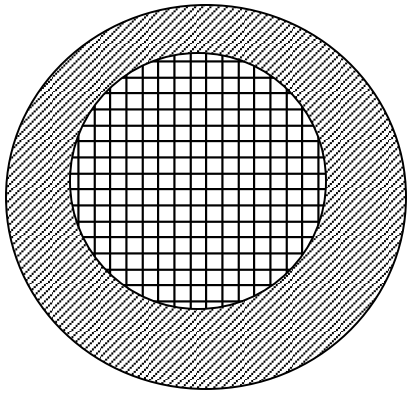
Goals of Security

- 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

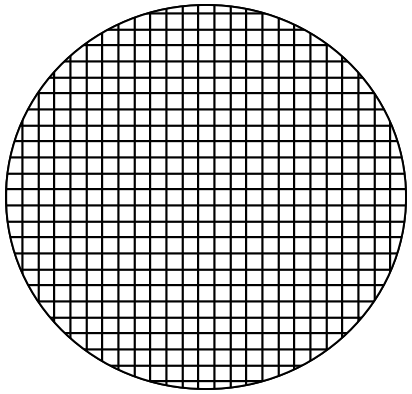
Trust and Assumptions

- Underlie *all* aspects of security
- Policies
  - Unambiguously partition system states
  - Correctly capture security requirements
- Mechanisms
  - Assumed to enforce policy
  - Support mechanisms work correctly

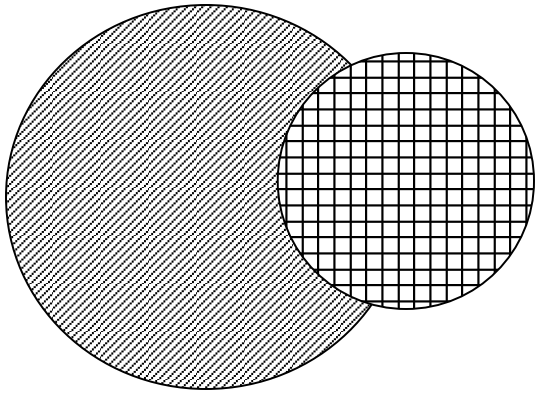
Types of Mechanisms



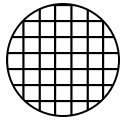
secure



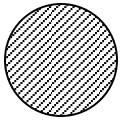
precise



broad



set of reachable states



set of secure states

Assurance

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

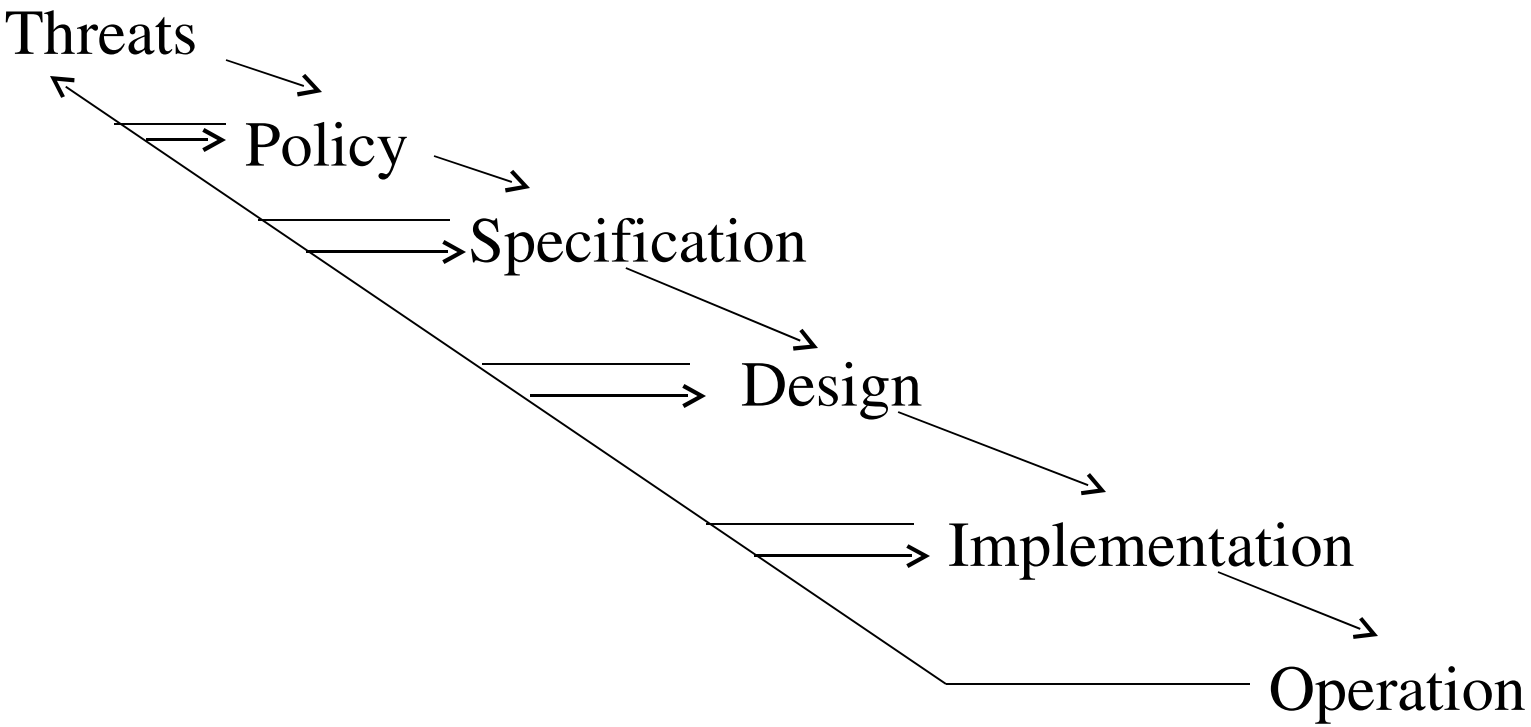
Operational Issues

- Cost-Benefit Analysis
  - Is it cheaper to prevent or recover?
- Risk Analysis
  - Should we protect something?
  - How much should we protect this thing?
- Laws and Customs
  - Are desired security measures illegal?
  - Will people do them?

Human Issues

- Organizational Problems
  - Power and responsibility
  - Financial benefits
- 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 Design Principles

- See Lecture 1 Handout.
- Principles
  - Least Privilege
  - Fail-Safe Defaults
  - Economy of Mechanism
  - Complete Mediation
  - Open Design
  - Separation of Privilege
  - Least Common Mechanism
  - Psychological Acceptability

Overview

- Simplicity
  - Less to go wrong
  - Fewer possible inconsistencies
  - Easy to understand
- Restriction
  - Minimize access
  - Inhibit communication

Least Privilege

- A subject should be given only those privileges necessary to complete its task
  - Function, not identity, controls
  - Rights added as needed, discarded after use
  - Minimal protection domain

Fail-Safe Defaults

- Default action is to deny access
- If action fails, system as secure as when action began

Economy of Mechanism

- Keep it as simple as possible
  - KISS Principle
- Simpler means less can go wrong
  - And when errors occur, they are easier to understand and fix
- Interfaces and interactions

Complete Mediation

- Check every access
- Usually done once, on first action
  - UNIX: access checked on open, not checked thereafter
- If permissions change after, may get unauthorized access

Open Design

- Security should not depend on secrecy of design or implementation
  - Popularly misunderstood to mean that source code should be public
  - "Security through obscurity"
  - Does not apply to information such as passwords or cryptographic keys

Separation of Privilege

- Require multiple conditions to grant privilege
  - Separation of duty
  - Defense in depth

Least Common Mechanism

- Mechanisms should not be shared
  - Information can flow along shared channels
  - Covert channels
- Isolation
  - Virtual machines
  - Sandboxes

Psychological Acceptability

- Security mechanisms should not add to difficulty of accessing resource
  - Hide complexity introduced by security mechanisms
  - Ease of installation, configuration, use
  - Human factors critical here

Key Points

- Principles of secure design underlie all security-related mechanisms
- Require:
  - Good understanding of goal of mechanism and environment in which it is to be used
  - Careful analysis and design
  - Careful implementation