Computer Security and Privacy

CS 489 / 698 Section 1

Fall 2007

Course mechanics

- Instructor: Ian Goldberg
  http://www.cs.uwaterloo.ca/~iang/

- Classes: Tuesdays and Thursdays
  10:00–11:30 MC 4042
  - Come to class! Not every bit of material will be on the slides or in the text.

- You will need an account on the student.cs environment
  - If you don't have a student.cs account for some reason, get one set up in MC 3017.

Course mechanics

- This course will use UW-ACE (aka UWANGEL) extensively.
  - Syllabus, calendar, lecture notes, additional materials, assignments, discussion, communication, important announcements, etc.
- It is your responsibility to keep up with the information on that site.
  - Check your UW email as well; we may need to send messages there.
  - Only use UW-ACE to send messages to course personnel.
- Feedback is encouraged!
  - Suggestion box on UW-ACE

Grading scheme

- Midterm (20%)
  - Around the end of October
- Final (30%)
- Assignments and self-tests (50%)
  - Work alone
  - Require CS student computing environment
  - Possibly additional tasks for CS 698 students
- Additional research survey paper for CS 698
  - Details on UW-ACE
- See UW-ACE for late and reappraisal policies, academic integrity policy, and other details.

Self-tests

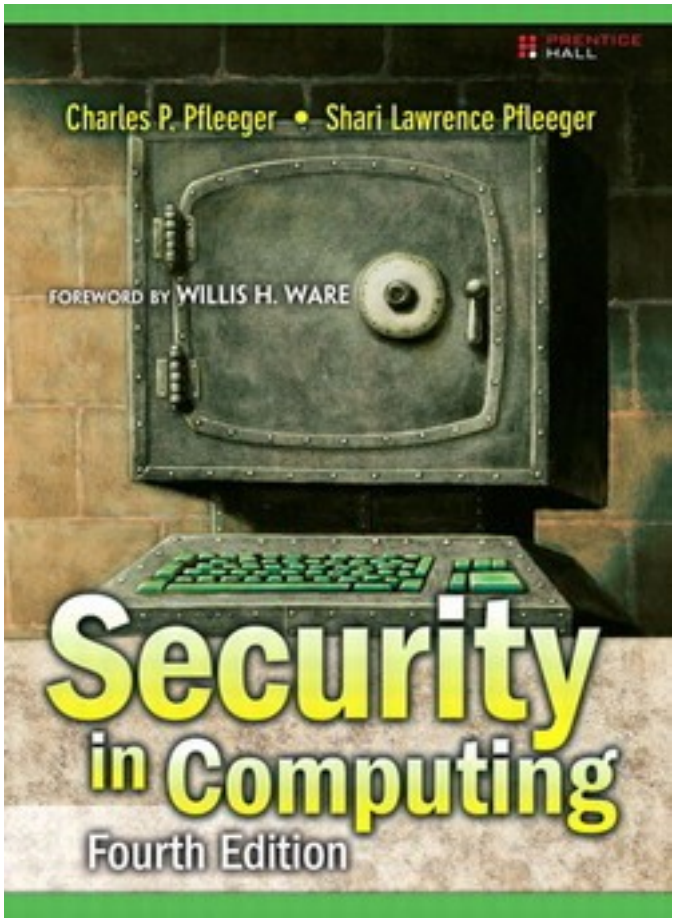
- The self-tests are worth 5% of your grade
- They're meant to help you keep up with the material, and gauge your grasp of it on an ongoing basis
- Check UW-ACE for the availability and deadline information for each self-test
  - First test: available tomorrow, deadline one week
  - No late self-tests will be accepted!
  - You can attempt each self-test as often as you like during its availability period; your last grade on each self-test will be the one recorded
- Format: online (on UW-ACE), usually multiple-choice or short answer questions

A note on security

- In this course, you will be exposed to information about security problems and vulnerabilities with computing systems and networks.
- To be clear, you are not to use this or any other similar information to test the security of, break into, compromise, or otherwise attack, any system or network without the express consent of the owner.
- In particular, you will comply with all applicable laws and UW policies.
- See UW-ACE for more details.

Required textbook

Security in Computing, 4th edition
Charles P. Pfleeger and Shari Lawrence Pfleeger
Prentice-Hall, 2007.



Other readings

- From time to time, there will be other readings assigned as well.
- They will usually be avaiable online, linked to from the UW-ACE lectures page.
- You should usually try to do the readings before the class in which we will discuss them.
  - Sometimes, this will be vital. You will be notified of such cases on the lectures web page.
  - There is such a reading for the next lecture.

This time

- What is our goal in this course?
- What is security?
- What is privacy?
- Who are the adversaries?
- Assets, vulnerabilities, threats, attacks and controls
- Methods of defence

What is our goal in this course?

- Our primary goal is to be able to identify security and privacy issues in various aspects of computing, including:
  - Programs
  - Operating systems
  - Networks
  - Internet applications
  - Databases
- Secondarily, to be able to use this ability to design systems that are more protective of security and privacy.

What is security?

- In the context of computers, security generally means three things:
  - Confidentiality
    - Access to systems or data is limited to authorized parties
  - Integrity
    - When you ask for data, you get the “right” data
  - Availability
    - The system or data is there when you want it
- A computing system is said to be **secure** if it has all three properties
  - Well, usually

Security and reliability

- Security has a lot to do with reliability
- A secure system is one you can rely on to (for example):
  - Keep your personal data confidential
  - Allow only authorized access or modifications to resources
  - Give you correct and meaningful results
  - Give you correct and meaningful results when you want them

What is privacy?

- There are many definitions of privacy
- A useful one: "informational self-determination"
  - This means that you get to control information about you
  - "Control" means many things:
    - Who gets to see it
    - Who gets to use it
    - What they can use it for
    - Who they can give it to
    - etc.

Example: PIPEDA

- PIPEDA (Personal Information Protection and Electronic Documents Act) is Canada's private-sector privacy legislation
- It lists ten Fair Information Principles companies have to abide by:
  - Be accountable
  - Identify the purpose of data collection
  - Obtain consent
  - Limit collection
  - Limit use, disclosure and retention
  - Be accurate
  - Use appropriate safeguards
  - Be open
  - Give individuals access
  - Provide recourse

Security vs. privacy

- Sometimes people place security and privacy as if they're opposing forces.

- Are they really? Do we have to give up one to get the other?

Who are the adversaries?

- Who's trying to mess with us?
- Various groups:
  - Murphy
  - Amateurs
  - “Script kiddies”
  - Crackers
  - Organised crime
  - Terrorists
- Which of these is the most serious threat today?

How secure should we make it?

- Principle of Easiest Penetration
  - "A system is only as strong as its weakest link"
  - The attacker will go after whatever part of the system is easiest for *him*, not most convenient for *you*.
  - In order to build secure systems, we need to learn how to think like an attacker!
  - How would you get private information from the US Social Security Administration database?
- Principle of Adequate Protection
  - "Security is economics"
  - Don't spend $100,000 to protect a system that can only cause $1000 in damage

Some terminology

- Assets
  - Things we might want to protect, such as:
    - Hardware
    - Software
    - Data
- Vulnerabilities
  - Weaknesses in a system that may be able to be exploited in order to cause loss or harm
  - e.g., a file server that doesn't authenticate its users

Some terminology

- Threats
  - A loss or harm that might befall a system
  - e.g., users' personal files may be revealed to the public
  - There are four major categories of threats:
    - Interception
    - Interruption
    - Modification
    - Fabrication
  - When we design a system, we need to state a threat model
    - This is the set of threats we are undertaking to defend against
    - Whom do we want to stop from doing what?

Some terminology

- Attack
  - An action which exploits a vulnerability
  - e.g., telling the file server you are a different user in an attempt to read or modify their files
- Control
  - Removing or reducing a vulnerability
  - You control a vulnerability to prevent an attack and block a threat.
  - How would you control the file server vulnerability?
  - Our goal: control vulnerabilities

Methods of defence

- How can we defend against a threat?
  - Prevent it: block the attack
  - Deter it: make the attack harder or more expensive
  - Deflect it: make yourself less attractive to attacker
  - Detect it: notice that attack is occurring (or has occurred)
  - Recover from it: mitigate the effects of the attack
- Often, we'll want to do many things to defend against the same threat
  - “Defence in depth”

Example of defence

- Threat: your car may get stolen
- How to defend?
  - Prevent: is it possible to absolutely prevent?
  - Deter: Store your car in a secure parking facility
  - Deflect: Use “The Club”
  - Detect: Car alarms, LoJack
  - Recover: Insurance

Defence of computer systems

- Remember we may want to protect any of our assets
  - Hardware, software, data
- Many ways to do this; for example:
- Cryptography
  - Protecting data by making it unreadable to an attacker
  - Authenticating users with digital signatures
  - Authenticating transactions with cryptographic protocols
  - Ensuring the integrity of stored data
  - Aid customers' privacy by having their personal information automatically become unreadable after a certain length of time

Defence of computer systems

- Software controls
  - Passwords and other forms of access control
  - Operating systems separate users' actions from each other
  - Virus scanners watch for some kinds of malware
  - Development controls enforce quality measures on the original source code
  - Personal firewalls that run on your desktop

Defence of computer systems

- Hardware controls
  - (Not usually protection of the hardware itself, but rather using separate hardware to protect the system as a whole.)
  - Fingerprint readers
  - Smart tokens
  - Firewalls
  - Intrusion detection systems

Defence of computer systems

- Physical controls
  - Protection of the hardware itself, as well as physical access to the console, storage media, etc.
  - Locks
  - Guards
  - Off-site backups
  - Don't put your data centre on a fault line in California

Defence of computer systems

- Policies and procedures
  - Non-technical means can be used to protect against some classes of attack
  - If an employee connects his own Wi-fi access point to the internal company network, that can accidentally open the network to outside attack.
    - So don't allow the employee to do that!
  - Rules about changing passwords
  - Training in best security practices

Recap

- What is our goal in this course?
  - Identify security and privacy issues
  - Design systems that are more protective of security and privacy
- What is security?
  - Confidentiality, Integrity, Availability
- What is privacy?
  - Informational self-determination

Recap

- Who are the adversaries?
  - Learn to think like an attacker
- Assets, vulnerabilities, threats, attacks and controls
  - You control a vulnerability to prevent an attack and block a threat.
- Methods of defence
  - Cryptography, software controls, hardware controls, physical controls, policies and procedures

Next time

- Program security
- Flaws, faults, and failures
- Types of security flaws
- Unintentional security flaws
  - Buffer overflows
  - Incomplete mediation
  - TOCTTOU errors

- Before next class:
  - Read “Smashing The Stack For Fun And Profit” (available on the lectures page in UW-ACE)