CS 458 / 658
Computer Security and Privacy

Module 1
Introduction to Computer Security and Privacy

Spring 2014

Instructor

Urs Hengartner

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- https://cs.uwaterloo.ca/~uhengart/
- Office hours: T 10:00 – 11:00 am in DC 3526 (or by appointment)

Course website

- This course will use LEARN
  - Syllabus, calendar, lecture notes, additional materials, assignments, announcements, policies, etc.
  - Site will be updated regularly
  - It is your responsibility to ensure that you are authorized to access the site and to keep up with the information on that site.
- Feedback is encouraged!

Piazza

- Discussion related to the course will take place on Piazza (piazza.com)
  - General course questions, announcements
  - Assignment-related questions
  - Like LEARN, you are expected to keep up with the information on Piazza

Additional communication

- Use discussion forums in Piazza for all communication
  - Use a private question for questions not of general interest
- Use email only as a last resort and then it must be from your uwaterloo.ca email address
- Some communication might be sent to your uWaterloo email address
  - Check your uWaterloo email account regularly or have email forwarded to your regular account

Course syllabus

- You are expected to be familiar with the contents of the course syllabus
- Available on the course home page and LEARN
- If you haven't read it, read it after this lecture

Plagiarism and academic offenses

- We take academic offenses very seriously
  - Even (especially?) in fourth year
- Nice explanation of plagiarism online
  - `https://uwaterloo.ca/arts/current-undergraduates/student-support/ethical-behavior`
- Read this and understand it
  - Ignorance is no excuse!
  - Questions should be brought to instructor
- Plagiarism applies to both text and code
- You are free (even encouraged) to exchange ideas, but no sharing code or text

Plagiarism (2)

- Common mistakes
  - Excess collaboration with other students
    - Share ideas, but no design or code!
  - Using solutions from other sources (like for previous offerings of this course, maybe written by yourself)
- Possible penalties
  - First offense (for assignments; exams are harsher)
    - 0% for that assignment, -5% on final grade
  - Second offense
    - More severe penalties, including suspension
- Penalties for graduate students are more severe
- More information linked to from course syllabus

Grading scheme for CS 458

- Midterm (15%)
  - Tue, Jun 10, 2014, 7:00–8:20 pm in DC 1351
  - There is no alternate midterm.
- Final (30%)
  - You must pass the weighted exam mark in order to pass the course!
- Assignments ($3 \times 15\% = 45\%$)
  - Work alone
- Self-tests (5%)
- Blog task (5%)
- Additional research survey paper for CS 658
  - See syllabus for more details
- See syllabus for late and reappraisal policies, academic integrity policy, and other details

Assignments

- Assignments will be due at 3:00 PM
- Late submissions will be accepted up to 48 hours after due date
- There will be no penalty for accepted late submissions
- Multiple assignments can be submitted late, including the last one
- No assistance will be given after the due date
- You must notify your instructor before the due date of any severe, long-lasting problems that prevent you from completing an assignment on time

Self-tests

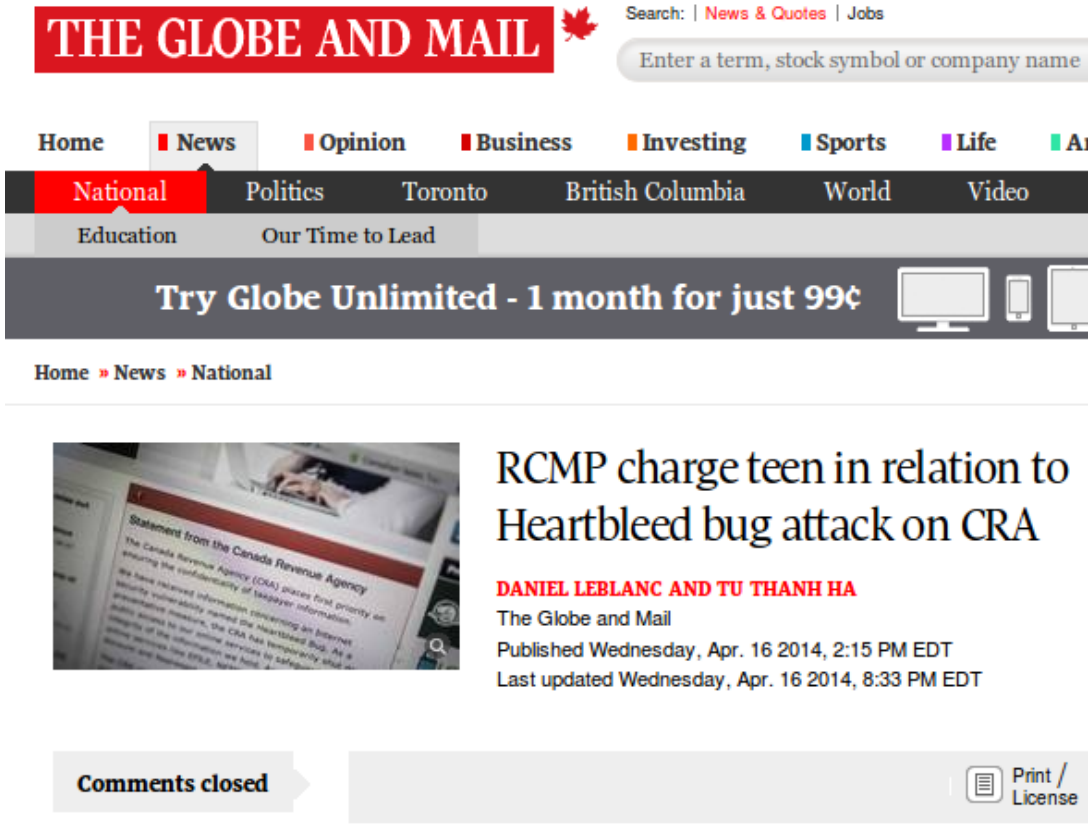
- The self-tests are worth 5% of your grade
- They're meant to help you keep up with the material, and gauge your grasp of it on an ongoing basis
- Check calendar in LEARN for the availability and deadline information for each self-test
  - First test: available tomorrow, deadline one week
  - No late 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 LEARN), usually multiple-choice questions

Blog task

- Many of the security and privacy problems that we will discuss in this course will (unfortunately) occur in the real world during the next four months
- The blog task forces you to keep up with these developments
- Each student has to write one blog post during an assigned timeslot
- You must also participate in the discussion of other students' blog posts throughout the term
- Blog task is part of material covered in exams
- See LEARN for sign-up and other instructions

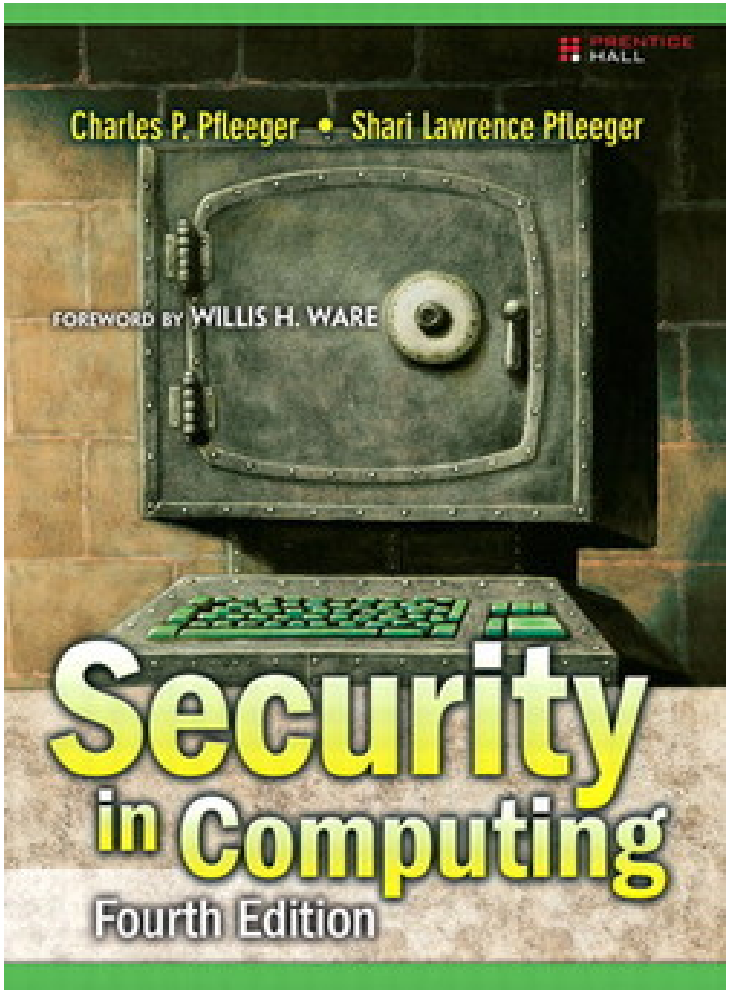
A note on security

- 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 uWaterloo policies
- See syllabus for more details



http://www.theglobeandmail.com/news/national/rcmp-charge-teen-in-relation-to-alleged-heartbleed-bug-theft/article18041007

Required textbook



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

- You are expected to know
  - entire textbook sections, as listed on course website
  - all the material presented in class

`http://proquest.safaribooksonline.com/9780132390774`

Other readings

- From time to time, there will be additional assigned readings
- They will be linked to from the modules page in LEARN
- There will be both mandatory and optional readings
- You must read the mandatory ones before the class in which we will discuss them
    - There is such a reading for the next lecture

Course mechanics

- Teaching assistants: Aaron Atwater, Tariq Elahi, Hassan Khan, Yihang (Frank) Song, Jalaj Upadhyay

- Come to class! Not every bit of material will be on the slides or in the text

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

Module outline

1. What is our goal in this course?
2. What is security?
3. What is privacy?
4. Who are the adversaries?
5. Assets, vulnerabilities, threats, attacks, and controls
6. 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:
  - **C**onfidentiality
    - Access to systems or data is limited to authorized parties
  - **I**ntegrity
    - When you ask for data, you get the "right" data
  - **A**vailability
    - 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):
  1. Keep your personal data confidential
  2. Allow only authorized access or modifications to resources
  3. Give you correct and meaningful results
  4. 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
- Lists ten Fair Information Principles companies need to abide by:
  1. Be accountable
  2. Identify the purpose of data collection
  3. Obtain consent
  4. Limit collection
  5. Limit use, disclosure and retention
  6. Be accurate
  7. Use appropriate safeguards
  8. Be open
  9. Give individuals access
  10. Provide recourse

(Read more: `https://www.priv.gc.ca/leg_c/p_principle_e.asp`)

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
  - Government "cyberwarriors"
  - 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 $1,000 in damage

Weakest link

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:
    1. Interception
    2. Interruption
    3. Modification
    4. Fabrication
  - When designing a system, we need to state the threat model
    - Set of threats we are undertaking to defend against
    - Whom do we want to prevent from doing what?

Some terminology

- Attack
  - An action which exploits a vulnerability to execute a threat
  - 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: prevent 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: Immobilizer? Is it possible to absolutely prevent?
  - Deter: Store your car in a secure parking facility
  - Deflect: Use "The Club", have sticker mentioning car alarm, keep valuables out of sight
  - Detect: Car alarms, OnStar
  - 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
  - Don't put your nuclear power plant in a tsunami zone

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