Introduction

CMSC 414: Computer and Network Security

Spring 2016

What is computer & network security?

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  - Does the software achieve the desired behavior?

- Security is a form of correctness
  - Does the software prevent “undesired” behavior?

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The key difference:

Security involves an adversary who is active and malicious.

Attackers seek to circumvent protective measures.

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  - Variant: *fairness*

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This is a subset

Attacks are common

From just the past 9 months or so:

Why are attacks common?

Why are attacks common?

- Security is a property of the systems *we build*

- Many attacks begin by exploiting a vulnerability
  - Vulnerability = software defect that can be exploited to yield an undesired behavior
    - Software defect = the code doesn't "behave correctly"

- Software defects arise due to
  - flaws in the design and/or
  - bugs in the implementation

Why are attacks common?

- Because attacks derive from **design flaws** and/or **implementation bugs**

- But all software has bugs: so what?

- A *normal user* never sees most bugs
  - Post-deployment bugs are usually rare corner cases

- Too expensive to fix every bug
  - Only fix what's likely to affect normal users

Why are attacks common?

Attackers are not normal users

- Normal users avoid bugs/flaws
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This extends beyond software:

Attacks are possible even with perfect software

Why are attacks common?

Because it's **profitable**

And because a system is
*only as secure as its **weakest link***

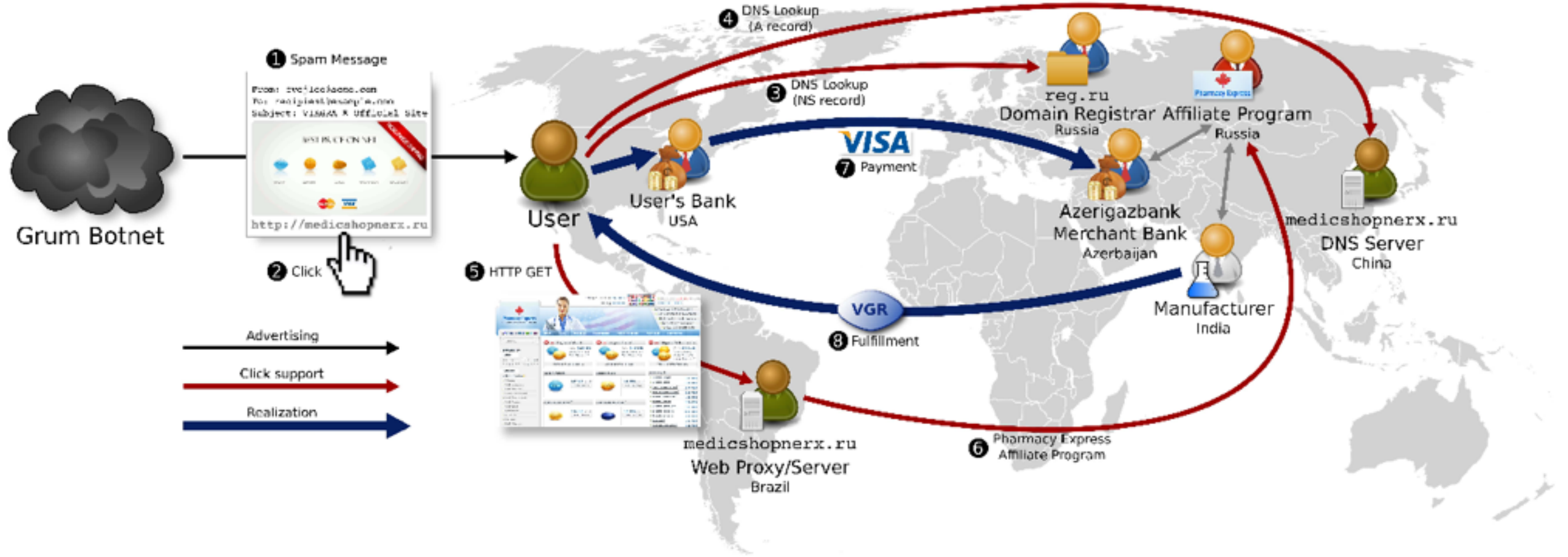

Figure 1: Infrastructure involved in a single URL's value chain, including advertisement, click support and realization steps.

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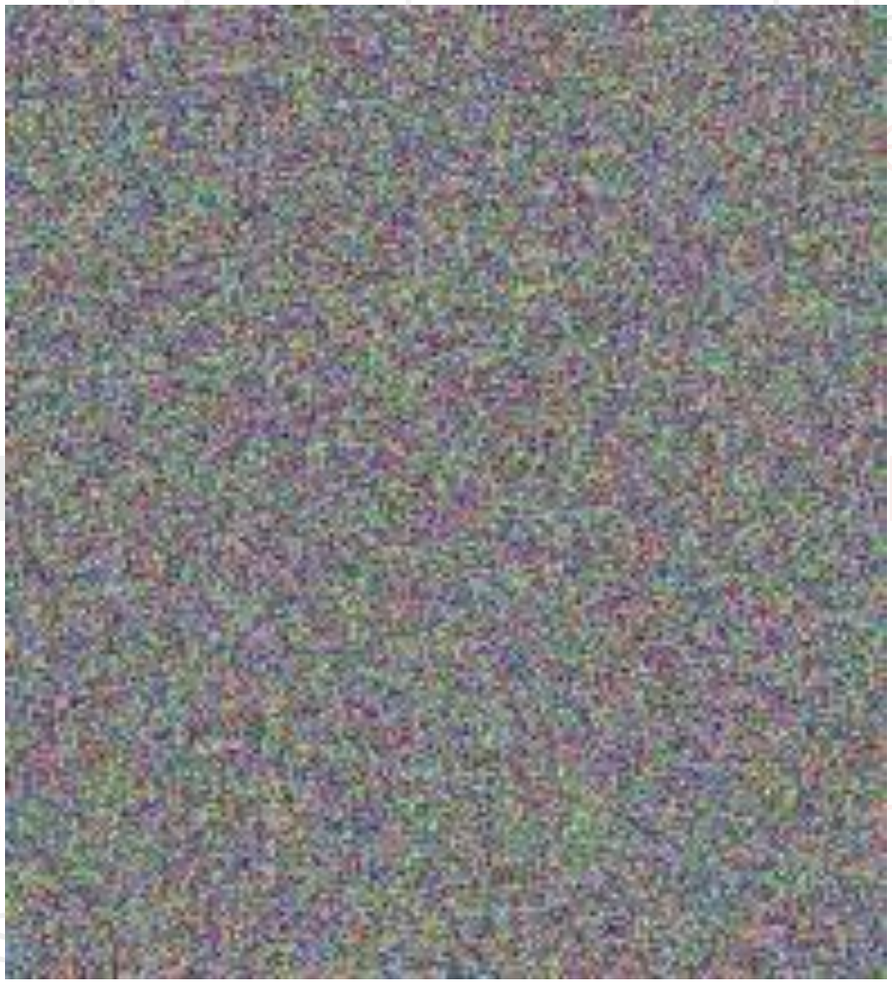
Develop a foundation for deeply understanding
the systems we use and build.

Widespread misuse of crypto



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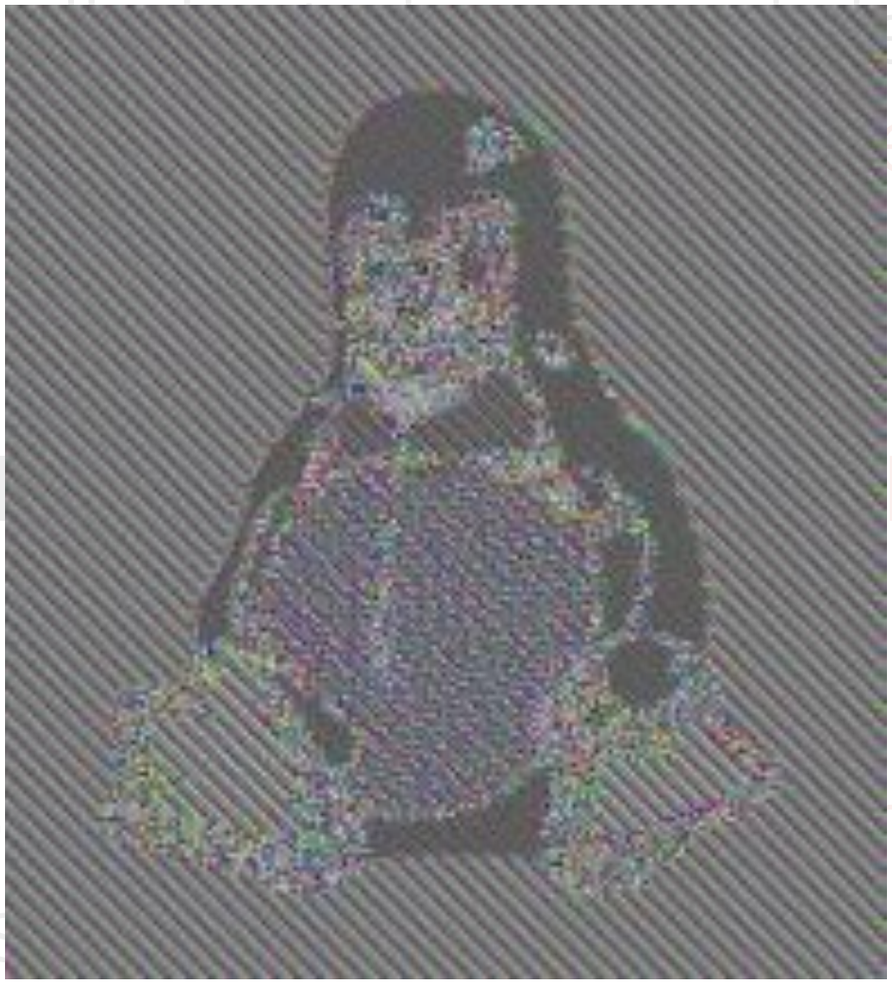

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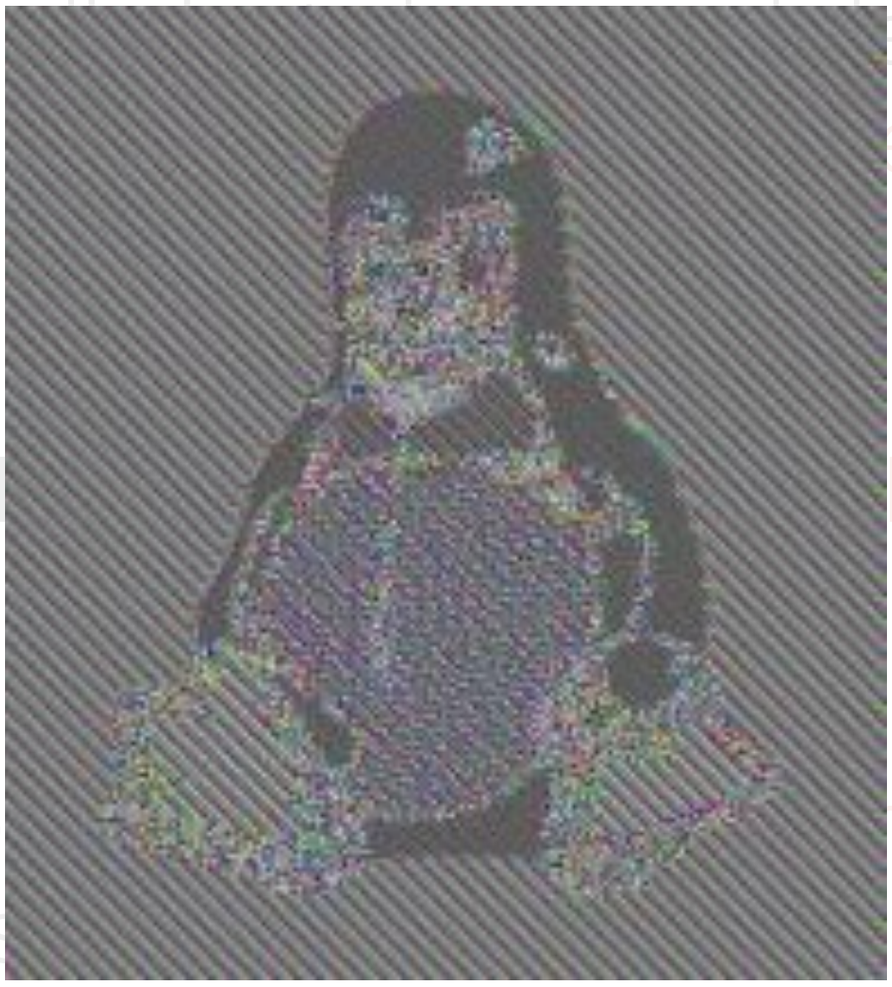

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50% of Android apps that use crypto encrypt in this manner

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Software **Hardware** **Protocols**

Users **Law** **Economics**

The Goals of CMSC 414

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and/or make them harder to exploit.

Be able to think like attackers.

Develop a foundation for deeply understanding
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This time

- What is security?
- Administrative
- Analyzing a system's security
  1. Summarize the system
  2. Identify the assets
  3. Identify the adversaries & threats
  4. Identify the vulnerabilities
- Trusting trust

Administrative

Communicating

- Resources and all this info will be on the class website
  - http://www.cs.umd.edu/class/spring2016/cmsc414

- Who
  - Me: Dave Levin (dml@cs.umd.edu)
  - TAs: Frank Cangialosi
    Jacob Hammontree
    Lee Williams
    Chengxi Ye
  - Office hours are on the website
  - If my office hours don't work for you, **email me** and set up a time

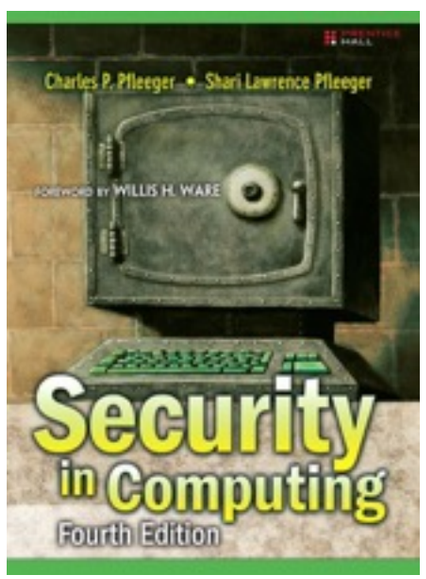
- We will be using Piazza
  - You should have been added; let me know if you haven't

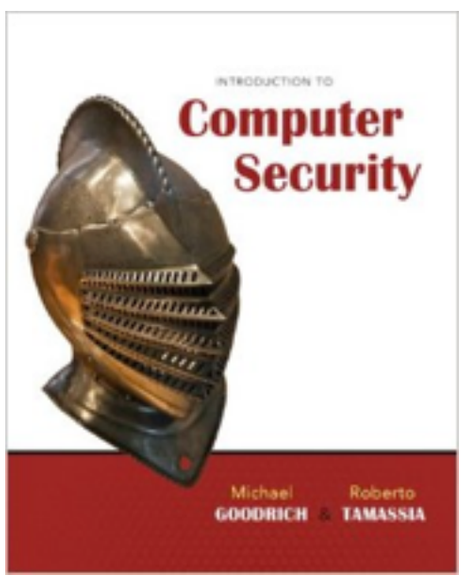
Administrative

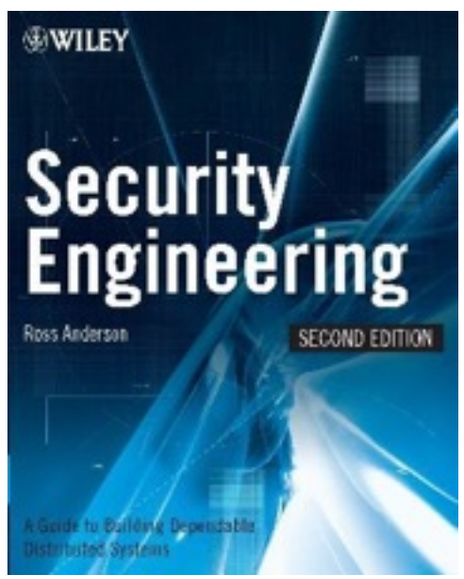
Textbooks

- None required
  - Mostly in-class and papers posted on website

- Recommended texts, if you are so inclined
  - "Security in Computing", Pfleeger & Pfleger
  - "Introduction to Computer Security", Goodrich & Tamassia
  - "Security Engineering", Ross Anderson
    - Free online: http://www.cl.cam.ac.uk/~rja14/book.html







Administrative

Outside reading

- The best way to learn is to reinforce
- *Lots* of security resources (something is always breaking).
  - Krebs on security
  - Bruce Schneier's blog
  - reddit.com/r/netsec
  - Any other favorites? Let us know on Piazza

What’s in this course?

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Software Security

How do we build software that is secure?

Memory safety

Malware

Web security

Static analysis

Design principles

What's in this course?

Software Security

Crypto

What it is, and how to use it responsibly

A black-box approach to crypto

Designing protocols that *use* crypto

Authentication: proving who you are

Anonymity: hiding who you are

What's in this course?

Software Security

Crypto

Network Security

Attacks on TCP & DNS

Botnets

Underground spam economies

How to build secure networked systems.

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Software Security

How do we build software that is secure?

Crypto

What it is, and how to use it responsibly.

Network Security

How to build secure networked systems.

Attacks and defenses across all of these

Brief Listing of the Top 25

This is a brief listing of the Top 25 items, using the general ranking.

NOTE: 16 other weaknesses were considered for inclusion in the Top 25, but their general scores were not high enough. They are listed in a separate "On the Cusp" page.

Rank	Score	ID	Name
[1]	93.8	CWE-89	Improper Neutralization of Special Elements used in an SQL Command ('SQL Injection')
[2]	83.3	CWE-78	Improper Neutralization of Special Elements used in an OS Command ('OS Command Injection')
[3]	79.0	CWE-120	Buffer Copy without Checking Size of Input ('Classic Buffer Overflow')
[4]	77.7	CWE-79	Improper Neutralization of Input During Web Page Generation ('Cross-site Scripting')
[5]	76.9	CWE-306	Missing Authentication for Critical Function
[6]	76.8	CWE-862	Missing Authorization
[7]	75.0	CWE-798	Use of Hard-coded Credentials
[8]	75.0	CWE-311	Missing Encryption of Sensitive Data
[9]	74.0	CWE-434	Unrestricted Upload of File with Dangerous Type
[10]	73.8	CWE-807	Reliance on Untrusted Inputs in a Security Decision
[11]	73.1	CWE-250	Execution with Unnecessary Privileges
[12]	70.1	CWE-352	Cross-Site Request Forgery (CSRF)

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Ethics and legality

- You will be learning about (and implementing and *launching*) attacks, many of which are in active use today.

- ***This is not an invitation to use them without the explicit written consent of all parties involved***

- If you want to try something out, then *let me know* and I will try to help create a safe environment

- This is not just a question of ethics; to do otherwise would risk violating UMD policies and MD/USA laws

Prerequisite knowledge

- You should be reasonably proficient in C and Unix
- You should also be creative and resourceful (those who try to attack your systems will be!)
- Otherwise, this course **won't** require any prior knowledge in networking or crypto

What’re grades based on?

- Grade breakdown
  - 50%: Projects (P1-P3: 10%, P4: 20%)
  - Midterms (2 x 12% each)
  - Final (25%)
  - Meet your instructor (1%)

Meet your instructor (that's me!)

- You come by my office at some point ***before the last day of classes*** and we chat

- Gives me a chance to get to know each of you, learn about your interests, chat plans/research…

- Again: if you are booked during my office hours, just email me to set up a time.

Midterms & Exams

Expected dates

Midterm #1:	Midterm #2:	Final exam:
Mar. 10	Apr. 21	May 18
12%	**12%**	**25%**

Please see the syllabus for information about excused absences

Trusting Trust

Is anything really “secure”?

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  - What is the ***threat model***? What can the attacker do?
  - What are the ***assets*** you seek to protect?
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  - That’s the spirit!
  - But how did you compile your code again?
  - Who built your OS? Your hardware?…

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Required reading

“Reflections on Trusting Trust”
Ken Thompson

What does a security vulnerability look like?

Brief look at the Heartbleed vulnerability

Next time

We will begin our 1st section:

Software Security

By investigating

Buffer overflows

and other memory safety vulnerabilities

To prepare: you may want to brush up on your C

Particularly if this seems foreign to you:

```
char buf[32];
unsigned *ptr = (unsigned*) (buf + 12);
*ptr += 0x1a;
```