Lecture 1:
The Security Mindset

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ECE 422/CS 461 – Fall 2017

Security News

- Black Hat and DEFCON about 1 month ago
- Xerub releases decryption key for iOS secure enclave
- MalwareTech (Marcus Hutchins) pleads not guilty, faces 40 years in jail
- Chrome extensions hijacking on the rise
- Maersk Shipping reports $300M loss from ransomare attack

COURSE POLICIES

WARNING!

- This class is hard.
- Requires comfort with:

1. Assembly code
2. Architecture
3. Operating systems
4. Networking
5. Scripting
6. Web programming

Course Websites

- Course website: wiki.illinois.edu/wiki/display/CS461ECE422fall2017/
- Piazza: piazza.com/illinois/fall2017/cs461ece422
- Subversion: subversion.engr.illinois.edu/svn/fa17-cs461
- Append your netid to get to your personal svn directory

Grading

- 50% Programming Projects (MPs)
- 20% Midterm Exam (October 13th)
- 30% Final Exam (tentatively December 15th)

TO DO

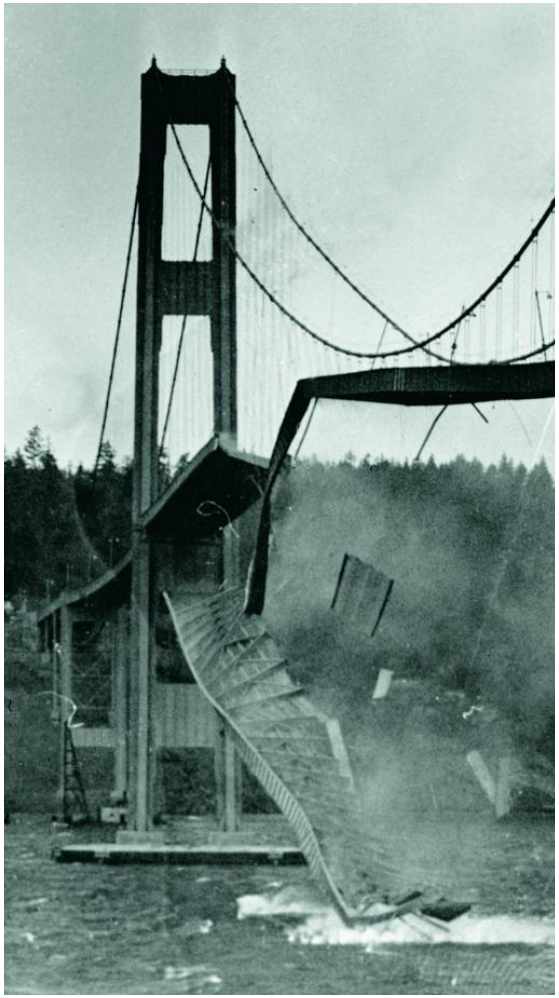
- Register on Piazza
- Find an MP partner

SECURITY MINDSET

What is Computer Security?

- Security is a property (or more accurately a collection of properties) that hold in a given system under a given set of constraints
- Can also mean the measures and controls that ensure these properties
- Security is weird, as we don’t *explicitly* study other properties

What’s the Difference?

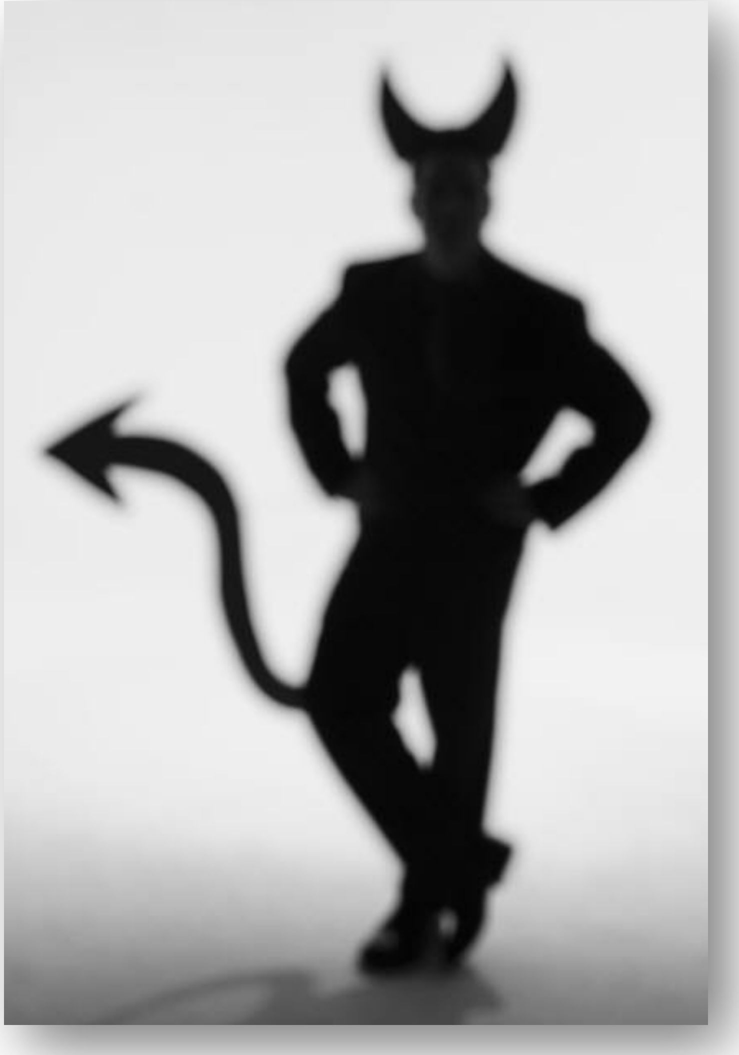


Meet the Adversary

“Computer security studies how systems behave in the presence of an adversary.”

- The adversary
  - a.k.a. the attacker
  - a.k.a. the bad guy

*   An intelligence that actively tries to cause the system to misbehave.



Assets

Things we want to protect:

- Hardware
- Software
- Data
- Communication facilities

http://www.dailysuperhero.com/2014/08/infinity-stones-guardians-of-galaxy-orb.html

Adversary

Someone who attacks or threatens our assets

http://www.liveforfilms.com/wp-content/uploads/2014/07/star-lord-guardians-of-the-galaxy-movie-1920x1080.jpg

Vulnerabilities

- **A flaw or weakness in a system. Can cause system to become**
  - Corrupt
  - Leaky
  - Unavailable

http://star-lordfc.deviantart.com

Threats/attacks

- **threat - the potential to exploit a vulnerability**
- **attack - exploiting a vulnerability to violate security of an asset**

http://www.mtv.com/movies/photos/g/Guardians_Clip/Guardians_Ball.gif

Countermeasures

Things we do to reduce threats, vulnerabilities, or attacks by preventing, minimizing, or taking corrective action

http://tvtropes.org/pmwiki/pmwiki.php/Film/GuardiansoftheGalaxy

Risk

An expectation of loss, expressed as the probability that an adversary will exploit a vulnerability with a harmful result

http://www.pinoyexchange.com/forums/showthread.php?t=577743&page=25

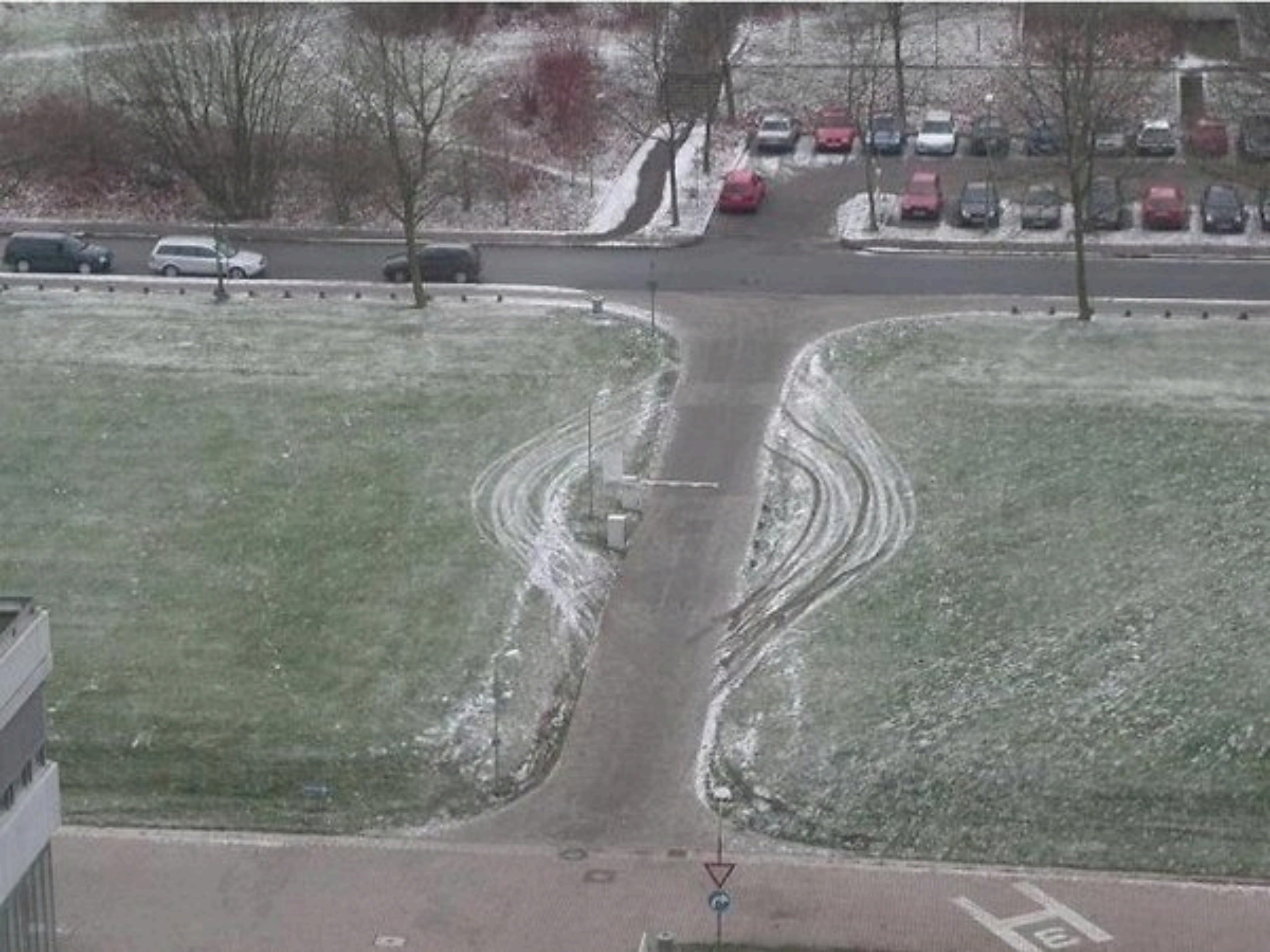
Why Study Attacks?

- Identify vulnerabilities so they can be fixed.
- Create incentives for vendors to be careful.
- Learn about new classes of threats.
  - Determine what we need to defend against.
  - Help designers build stronger systems.
  - Help users more accurately evaluate risk.

Thinking Like an Attacker

- Look for weakest links – easiest to attack.
- Identify assumptions that security depends on. Are they false?
- Think outside the box: Not constrained by system designer's worldview.

Practice thinking like an attacker: *For every system you interact with, think about what it means for it to be secure, and image how it could be exploited by an attacker.*



Exercise

- How might we break into Siebel Center?

Thinking as a Defender

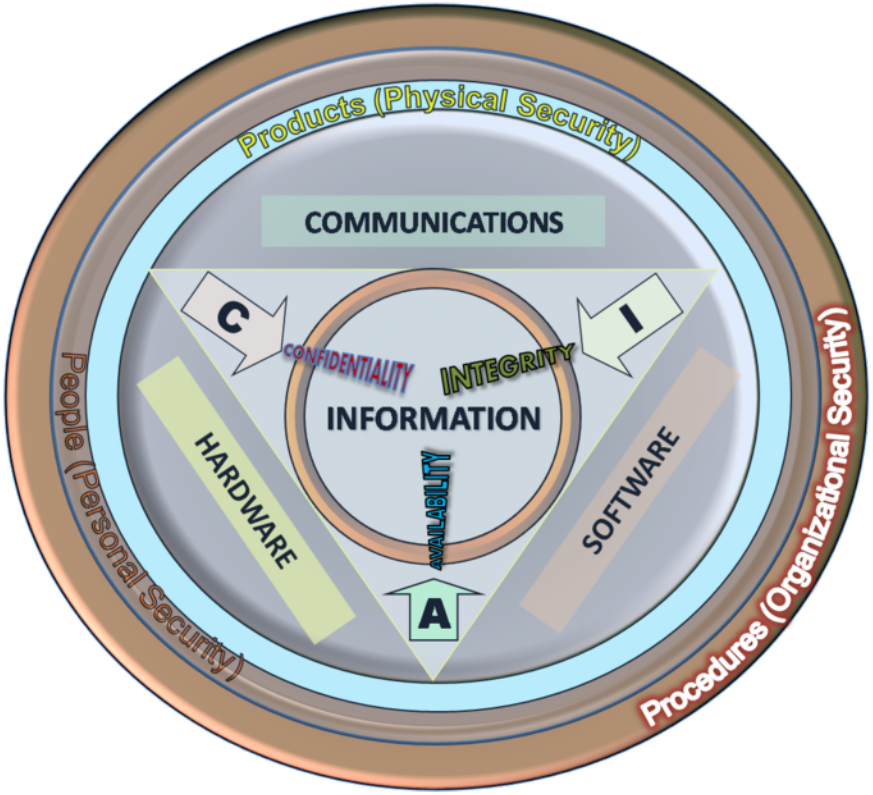
- Security policy
  - What are we trying to protect?
  - What properties are we trying to enforce?
- Threat model
  - Who are the attackers?
  - What are their Capabilities? Motivations?
- Risk assessment
  - What are the weaknesses of the system?
  - How likely?
- Countermeasures
  - Technical vs. nontechnical?
  - How much do they cost?

Challenge is to think rationally and rigorously about risk. *Rational paranoia.*

CIA Triad

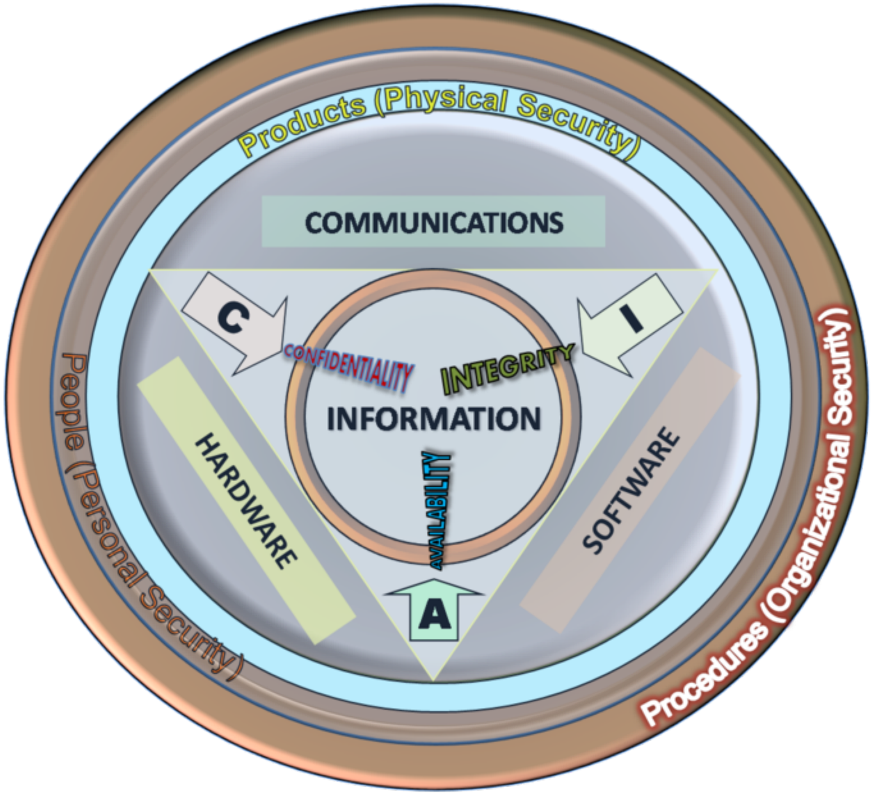
1. Confidentially
2. Integrity
3. Availability

- Additional objectives
  - – Authenticity
  - – Accountability


Products (Physical Security)
COMMUNICATIONS
C
I
CONFIDENTIALITY
INTEGRITY
INFORMATION
AVAILABILITY
HARDWARE
SOFTWARE
A
People (Personal Security)
Procedures (Organizational Security)

Security Policies

- What assets are we trying to protect?
- What properties are we trying to enforce?
- The CIA Triad:
  - Confidentiality
  - Integrity
  - Availability
- Additional properties:
  - Authenticity
  - Accountability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Threat Models

- Who are our adversaries?
  - Motives?
  - Capabilities?
- What kinds of attacks do we need to prevent?
  (Think like the attacker!)

- Limits: Kinds of attacks we should ignore?

Assessing Risk

- What would security breaches cost us?
  - Direct costs: Money, property, safety, ...
  - Indirect costs: Reputation, future business, well being, …
- How likely are these costs?
  - Probability of attacks?
  - Probability of success?
- Remember: ***rational*** paranoia

Countermeasures

- Technical countermeasures
- Nontechnical countermeasures
  - Law, policy (government, institutional), procedures, training, auditing, incentives, etc.

Security Costs

- No security mechanism is free
  - Direct costs: Design, implementation, enforcement, false positives
  - Indirect costs: Lost productivity, added complexity
- Challenge is rationally weigh costs vs. risk
  - Human psychology makes reasoning about high cost/low probability events hard

Design principles

- Economy of mechanism
- Fail-safe defaults
- Complete mediation
- Open design
- Separation of privilege
- Least privilege
- Least common mechanism
- Psychological acceptability
- Isolation
- Encapsulation
- Modularity
- Defense in depth
- Minimize ***attack surface***
- Least astonishment

Exercise

- How should you secure your bike?
  - Assets?
  - Adversaries?
  - Risk assessment?
  - Countermeasures?
  - Costs/benefits?

Exercise

- How should you secure your home/apartment/dorm room?
  - Assets?
  - Adversaries?
  - Risk assessment?
  - Countermeasures?
  - Costs/benefits?

The Security Mindset

- Thinking like an attacker
  - Understand techniques for circumventing security.
  - Look for ways security can break,
    not reasons why it won’t.
- Thinking like a defender
  - Know what you’re defending, and against whom.
  - Weigh benefits vs. costs:
    No system is ever completely secure.
  - “Rational paranoia!”

To Learn More …

- The Security Mindset. https://www.schneier.com/blog/archives/2008/03/the_security_mi_1.html
- https://freedom-to-tinker.com/blog/felten/security-mindset-and-harmless-failures/
- https://cubist.cs.washington.edu/Security/2007/11/22/why-a-computer-security-course-blog/

Questions?