CSE 127: Introduction to Security

Threat modeling continued

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Some slides from Kirill Levchenko, Stefan Savage, and Deian Stefan

Continued from last time: Threat modeling

Exercise

How would you steal my email password?

Exercise

How would you steal an election?

Exercise

What security systems do you interact with?

Thinking like a Defender

- Security policy
  - What are we trying to protect?
  - What properties are we trying to enforce?
- Threat model
  - Who are the attackers? Capabilities? Motivation?
  - What kind of attack are we trying to prevent?
- Risk assessment
  - What are the weaknesses of the system?
  - What will successful attacks cost us?
  - How likely?
- Countermeasures
  - Costs vs. benefits?
  - Technical vs. nontechnical?

Security Policies

- What *assets* are we trying to protect?
  - Password (hashes)
  - Emails
  - Browsing history
- What properties are we trying to enforce?
  - Confidentiality
  - Integrity
  - Availability
  - Privacy
  - Authenticity

Threat Models

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

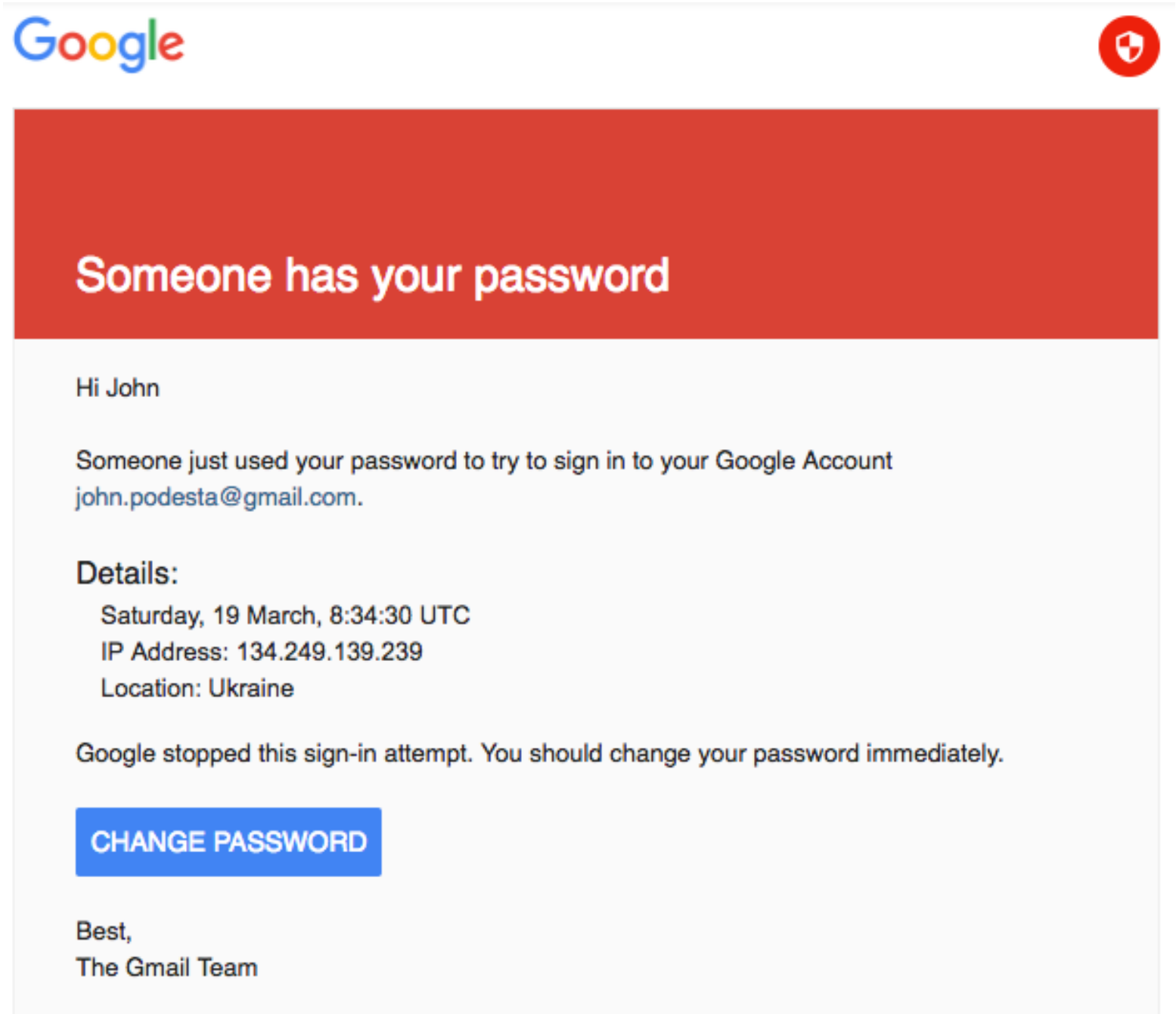
Example of Threat Modeling

Threat	Ex-girlfriend/boyfriend breaking into your email account and publicly releasing your correspondence with the My Little Pony fan club	Organized criminals breaking into your email account and sending spam using your identity	The Mossad doing Mossad things with your email account
Solution	Strong passwords	Strong passwords + common sense (don't click on unsolicited herbal Viagra ads that result in keyloggers and sorrow)	Magical amulets? Fake your own death, move into a submarine? YOU'RE STILL GONNA BE MOSSAD'ED UPON

Figure 1: Threat models

James Mickens "This World of Ours"

Example of Threat Modeling



Who is John Podesta?

Assessing Risk

Remember: *Controlled paranoia*

- 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?

Countermeasures

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

Ho


Damaged propellant
burner trailer
Damaged Safir
mobile-erector-launcher

Security Costs

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

Exercise

Should you lock your door?

- Assets?
- Adversaries?
- Risk assessment?
- Countermeasures?
- Costs/benefits?

Exercise

Should you use automatic software updates?

- Assets?
- Adversaries?
- Risk assessment?
- Countermeasures?
- Costs/benefits?

Exercise

Should we protect the CSE bear?

- Assets?
- Adversaries?
- Risk assessment?
- Countermeasures?
- Costs/benefits?

Secure Design

- Common mistake:
  Convince yourself that the system is secure

- Better approach:
  Identify *weaknesses* of design, focus on correcting them
  Formally prove that design is secure (soon)

- Secure design is a **process**
  Must be practiced continuously
  Retrofitting security is super hard

Where to focus defenses

- *Trusted components*
  Parts that must function correctly for the system to be secure.

- *Attack surface*
  Parts of the system exposed to the attacker

Security Principles

- Simplicity, open design, and maintainability
- Privilege separation and least privilege
- Defense-in-depth and diversity
- Complete mediation and fail-safe

Exercise

Preventing cheating on an online exam?

Exercise

Preventing you from stealing my password?

Stack Buffer Overflows

When is a program secure?

- Formal approach: When it does exactly what it should
  - Not more
  - Not less

- But how do we know what it is supposed to do?

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- Formal approach: When it does exactly what it should
  - Not more
  - Not less

- But how do we know what it is supposed to do?
  - Somebody tells us? (Do we trust them?)
  - We write the code ourselves? (What fraction of the software you use have you written?)

When is a program secure?

- Pragmatic approach: When it doesn't do bad things
- Often easier to specify a list of "bad" things:
  - Delete or corrupt important files
  - Crash my system
  - Send my password over the internet
  - Send threatening email to the professor

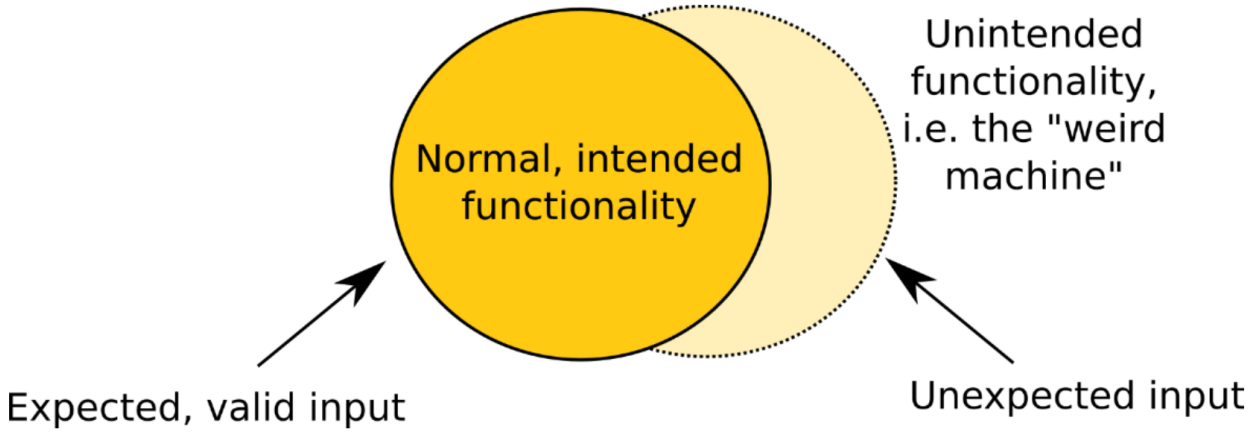
When is a program secure?

What if the program doesn’t do bad things, but could?

Is it secure?

Weird machines

- Complex systems contain unintended functionality



- Attackers can trigger this unintended functionality
  - i.e. they are exploiting vulnerabilities

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  - Why? This lets an attacker run code on your computer!

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  - Why? This lets an attacker run code on your computer!
- Typically these involve violating *assumptions* of the programming language or its runtime

Exploiting vulnerabilities (the start)

- Dive into low-level details of how exploits work
    - How can a remote attacker get a victim program to execute their code?
- Threat model: Victim code is handling input that comes from across a security boundary
    - What are some examples of this?
- Security policy: Want to protect integrity of execution and confidentiality of data from being compromised by malicious and highly skilled users of our system.