CSE 490K Lecture 9

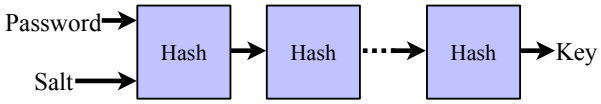
Authentication and Human Aspects to Computer Security

Tadayoshi Kohno

Some slides derived from Vitaly Shmatikov's and Dan Simon's

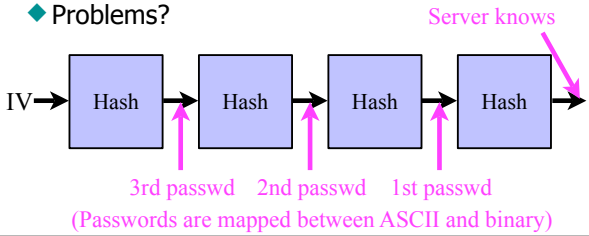
PBKDF

- Problem:
  - Wish to encrypt file on local system using a password
  - User remembers password (e.g, a 16 character passphrase)
  - File encrypted with a symmetric cryptographic key (e.g., a 128 bit random key)
- Solution: Password-based key derivation

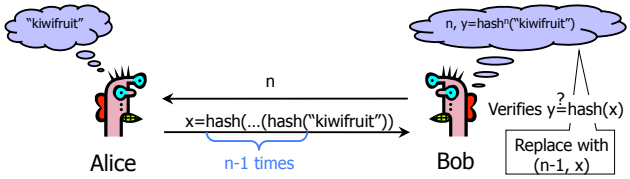


SKeys

- One time "passwords"
  - Easy for server to check
  - Hard for adversary who captures token to figure out the next one
  - User keeps list of passwords
- Problems?

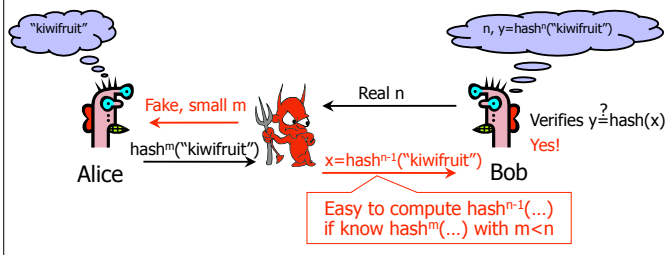


Lamport's Hash



- Main idea: "hash stalk"
  - Moving up the stalk (computing the next hash) is easy, moving down the stalk (inverting the hash) is hard
  - n should be large (can only use it for n authentications)
- For verification, only need the tip of the stalk

"Small n" Attack



- First message from Bob is not authenticated!
- Alice should remember current value of n

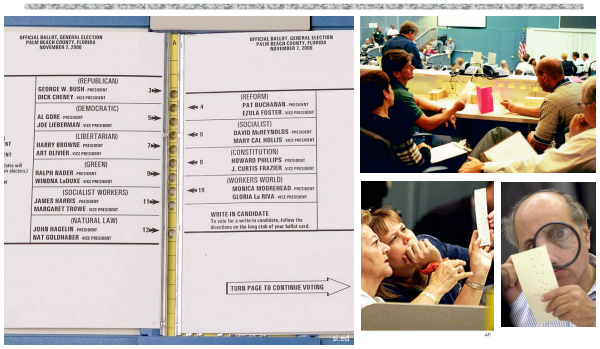
Two-factor authentication

- Authentication
  - What you know
  - Who you are
  - What you are
- Idea: More is better
  - Authenticate with two factors
  - ATM cards
    - Physical card - something you have
    - PIN - something you know

Authentication Adversaries

- Eavesdropper
- Pretend to be Bob and accept connections from Alice
- Initiate conversation pretending to be Alice
- Read Alice's database
- Read Bob's database
- Modify messages in transit between Alice and Bob
- Any combination of the above

Poor Usability Causes Problems



Importance

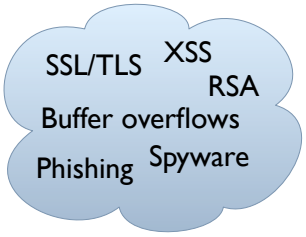
- Why is usability important?
  - People are the critical element of any computer system
    - People are the real reason computers exist in the first place
  - Even if it is **possible** for a system to protect against an adversary, people may use the system in other, **less secure** ways
- Today
  - Challenges with security and usability
  - Key design principles
  - New trends and directions

Issue #1: Complexities, Lack of Intuition

Real World

We can see, understand, relate to.

Electronic World



Too complex, hidden, no intuition.

Issue #1: Complexities, Lack of Intuition

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Issue #1: Complexities, Lack of Intuition

- Mismatch between perception of technology and what really happens
  - Public keys?
  - Signatures?
  - Encryption?
  - Message integrity?
  - Chosen-plaintext attacks?
  - Chosen-ciphertext attacks?
  - Password management?
  - …

Issue #2: Who's in Charge?

Real World	Electronic World
	
Complex, hidden, but *doctors manage*	Complex, hidden, and *users manage*

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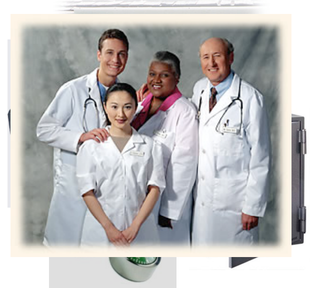	
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	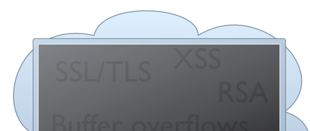
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Users want to feel like they're in control.

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Issue #2: Who's in Charge?

- Systems developers should help protect users
  - Usable authentication systems
  - Red/green lights
- Software applications help users manage their applications
  - P3P for privacy control
  - PwdHash, Keychain for password management
  - Some say: Can we trust software for these tasks?

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"I remembered hearing about it and thinking that people that click on those links are stupid," she says. "Then it happened to me." Ms. Miller says she now changes her password regularly and avoids clicking on strange links. (Open Doors, by V. Vara, The Wall Street Journal, Jan 29, 2007)

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Social Network Users Have Ruined Their Privacy

Posted by Zonk on Tuesday December 26, @08:28AM
from the putting-it-all-out-there dept.

Steve Kerrison writes

"There's little point in worrying about ID cards, RFID tags and spyware when more and more people are throwing away their privacy anyway. And the potential consequences are dire.' I've written an article on the dangers of social networks and how many users seem to forget just how public the information they post can be. This follows a warning sent out by the CS department of Bristol University, advising students that they risk lost job opportunities, getting in trouble with their parents and more, if they don't take care. The warning, however, really applies to all social network users, be they college students or over-zealous blog posters."

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Schneier on Security
A weblog covering security and security technology.

« The Emergence of a Global Infrastructure for Mass Registration and Surveillance | Main | PDF Redacting Failure »

May 02, 2005

Users Disabling Security
It's an old story: users disable a security measure because it's annoying, allowing an attacker to bypass the measure.

> A rape defendant accused in a deadly courthouse rampage was able to enter the chambers of the judge slain in the attack and hold the occupants hostage because the door was unlocked and a buzzer entry system was not activated, a sheriff's report says.

Security doesn't work unless the users want it to work. This is true on the personal and national scale, with or without technology.

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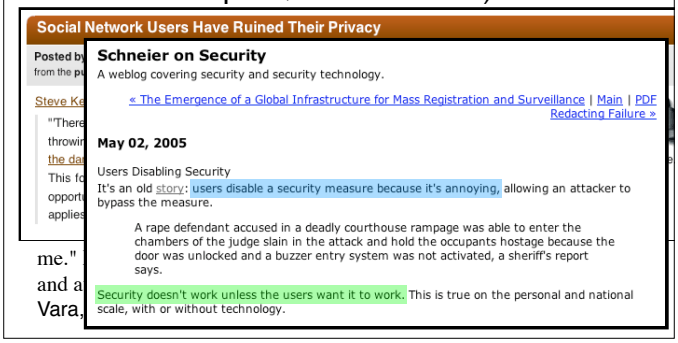
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Issue #4: No Accountability

- Issue #3 is amplified when users are not held accountable for their actions
  - E.g., from employers, service providers, etc.
  - (Not all parties will perceive risks the same way)

Issue #5: Awkward, Annoying, or Difficult

- Difficult
  - Remembering 50 different, "random" passwords
- Awkward
  - Lock computer screen every time leave the room
- Annoying
  - Browser warnings, virus alerts, forgotten passwords, firewalls
- Consequence:
  - Changing user's knowledge may **not** affect their behavior

Issue #6: Social Issues

- Public opinion, self-image
  - Only "nerds" or the "super paranoid" follow security guidelines
- Unfriendly
  - Locking computers suggests distrust of co-workers
- Annoying
  - Sending encrypted emails that say, "what would you like for lunch?"

Issue #7: Usability Promotes Trust

- Well known by con artists, medicine men
- Phishing
  - More likely to trust professional-looking websites than non-professional-looking ones

Response #1: Education and Training

- Education:
  - Teaching technical concepts, risks
- Training
  - Change behavior through
    - Drill
    - Monitoring
    - Feedback
    - Reinforcement
    - Punishment
- May be part of the solution - but not the solution

Response #2: Security Should Be Invisible

- Security should happen
  - Naturally
  - By Default
  - Without user input or understanding
- Recognize and stop bad actions
- Starting to see some invisibility
  - SSL/TLS
  - VPNs
  - Automatic Security Updates

See Dan Simon's slides: http://research.microsoft.com/projects/SWSecInstitute/slides/simon.ppt

Response #2: Security Should Be Invisible

- "Easy" at extremes, or for simple examples
  - Don't give everyone access to everything
- But hard to generalize
- Leads to things not working for reasons user doesn't understand
- Users will then try to get the system to work, possibly further reducing security

See Dan Simon's slides: http://research.microsoft.com/projects/SWSecInstitute/slides/simon.ppt

Response #3: "Three-word UI:" "Are You Sure?"

- Security should be transparent
  - Except when the user tries something dangerous
  - In which case a warning is given
- But how do users evaluate the warning? Two realistic cases:
  - Always heed warning. But see problems / commonality with Response #2
  - Always ignore the warning. If so, what's the point?

See Dan Simon's slides: http://research.microsoft.com/projects/SWSecInstitute/slides/simon.ppt

Response #4: Use Metaphors, Focus on Users

- Clear, understandable metaphors:
  - Physical analogs; e.g., red-green lights
- User-centered design: Start with user model
- Unified security model across applications
  - User doesn't need to learn many models, one for each application
- Meaningful, intuitive user input
  - Don't assume things on user's behalf
  - Figure out how to ask so that user can answer intelligently

See Dan Simon's slides: http://research.microsoft.com/projects/SWSecInstitute/slides/simon.ppt

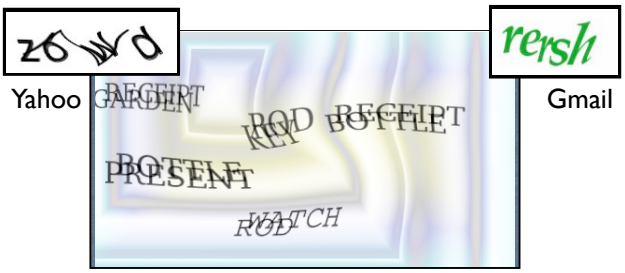
Response #5: Least Resistance

- "Match the most comfortable way to do tasks with the least granting of authority"
  - Ka-Ping Yee, Security and Usability
- Should be "easy" to comply with security policy
- "Users value and want security and privacy, but they regard them only as secondary to completing the primary tasks"
  - Karat et al, Security and Usability

Human Verification

- Problem:
  - Want to make it hard for spammers to automatically create many free email accounts
  - Want to make it difficult for computers to automatically crawl some data repository
- Need a method for servers to distinguish between
  - Human users
  - Machine users
- Approach: CAPTCHA
  - Completely Automated Public Turing Test to Tell Computers and Humans Apart

CAPTCHAs



captcha.net

Idea: "easy" for humans to read words in this picture, but "hard" for computers

Caveats

- Usability challenges with visual impairments
- Researchers studying how to break CAPTCHAs
- Some attackers don't break CAPTCHAs; they hire or trick others

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> The following article describes an attack against the web images (so-called "CAPTCHAS") that are used to prevent robots from using certain web applications such as the creation of free e-mail accounts. The images are a form of "Turing Test", easy for a human user of normal ability to process, but difficult for a piece of software. The attack involves routing the CAPTCHA image to a page that advertises free porn. Users have to decode the CAPTCHA to get the advertised images and in doing so, unwitting assist spammers in creating bogus e-mail addresses.
>
> "But at least one potential spammer managed to crack the CAPTCHA test. Someone designed a software robot that would fill out a registration form and, when confronted with a CAPTCHA test, would post it on a free porn site. Visitors to the porn site would be asked to complete the test before they could view more pornography, and the software robot would use their answer to complete the e-mail registration."

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Will Solve Captcha for Money?

Posted by CmdrTaco on Wed Sep 06, '06 08:37 AM
from the i've-done-worse-for-less dept.

alx_lo writes

"Captchas are a nice idea to protect your blog or guestbook from being spammed by robots. But what good is this protection when you can hire "data entry specialists" to solve captchas for $0.60 per hour for 50 hours a week? Anyone here who can think up a solution that does not include drastically changing the global economy? How about captchas that require cultural background knowledge to solve?"

Phishing: A Few Headlines

- "11.9 million Americans clicked on a phishing e-mail in 2005"
- "Gartner estimates that the total financial losses attributable to phishing will total $2.8 bln in 2006"
- "Phishing and key-logging Trojans cost UK banks £12m"
- "Swedish bank hit by 'biggest ever' online heist"

  "Swedish Bank loses $1 Million through Russian hacker"

MillerSmiles.co.uk

home

Tuesday 24th April 2007

172098 scams in our archive

24 recent phishing scams

Welcome to MillerSmiles.co.uk! We are one of the internet's leading anti-phishing sites, maintaining a massive archive of phishing and identity theft email scams.

We are currently storing all scam reports with our HoneyTrap database which is now available for commercial license. This database currently holds 172098 reports.

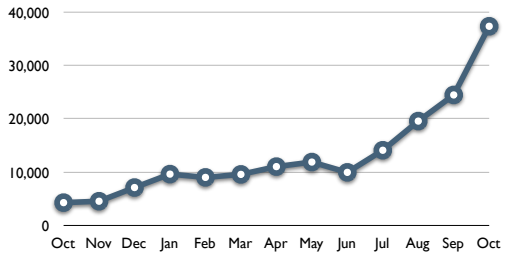
We also run a news service (headlines below) which brings you all the latest headlines from the world of fraudulent emails and phishing.

Latest Phishing News Headlines:

- Anti-Phishing Browsers Not Working
- Keylogging Website Trend
- Facebook Phishing
- Phishing Trend Continues
- Tax Phishing Scams
- Christmas phishing threats loom
- Phishing - A Tougher Art
- Google fixes security flaw
- Phishing Protection in Office SP2

eBay	24th April 2007	eBay Limited Account Access Details
Flagstar Bank	24th April 2007	Flagstar Banking - Security Notification #27107
HSBC Bank	24th April 2007	Online Security -(HSBC Bank Ownership Verification Alert)
PayPal	24th April 2007	Receipt of your last transaction
Fifth Third Bank	24th April 2007	The 53rd Bank USA Commercial Banking: Please Update Your Banking Data
PayPal	24th April 2007	New email address added to your account!
PayPal	23rd April 2007	Verify Your Account!

New Phishing Sites by Month (Oct 2005 to Oct 2006)

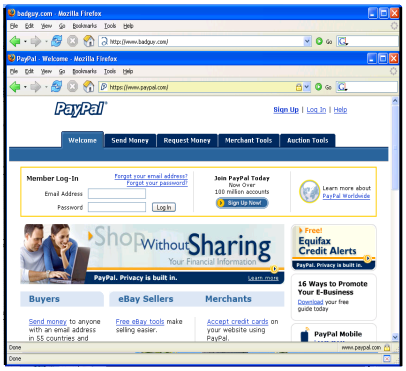


Source: http://www.antiphishing.org/reports/apwg_report_september_october_2006.pdf

Typical Phishing Page

Typical Phishing Page

Or Even Like This



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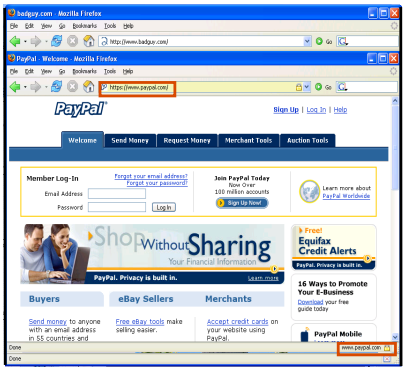

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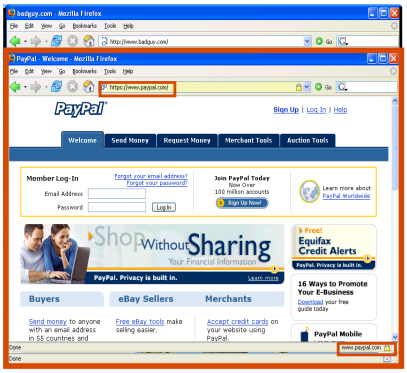

A Closer Look

A Closer Look

A Closer Look

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And You End Up Here

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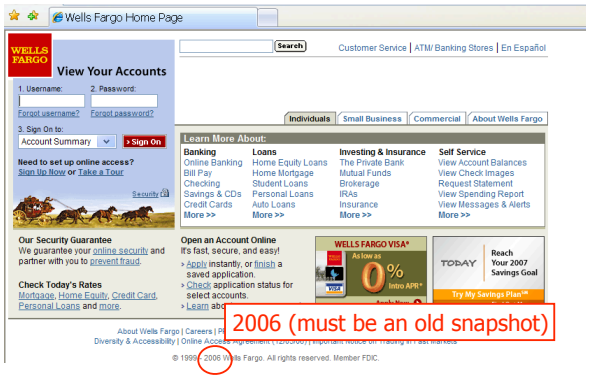

Phishing Techniques

- Use confusing URLs
  - http://gadula.net/.Wells.Fargo.com/signin.html
- Use URL with multiple redirection
  - http://www.chase.com/url.php?url="http://phish.com"
- Host phishing sites on botnet zombies
  - Move from bot to bot using dynamic DNS
- Pharming
  - Poison DNS tables so that victim's address (e.g., www.paypal.com) points to the phishing site
  - URL checking doesn't help!

Why Phishing Works

[Dhamija et al, CHI 2006]

- Experiment
  - 22 participants
  - 20 websites
  - Asked to determine whether fraudulent
- Results
  - Successful phishing sites fooled 90% of participants
  - 23% of participants did not look at address bar, status bar, or other security indicators
  - 15 of 22 participants ignored popup warnings

Social Engineering Tricks

- Create a bank page advertising an interest rate slightly higher than any real bank; ask users for their credentials to initiate money transfer
  - Some victims provided their bank account numbers to "Flintstone National Bank" of "Bedrock, Colorado"
- Exploit social network
  - Spoof an email from a Facebook or MySpace friend
    - Jan 29 WSJ article about MySpace hack
  - In a West Point experiment, 80% of cadets were deceived into following an embedded link regarding their grade report from a fictitious colonel

Experiments at Indiana University

[Jagatic et al.]

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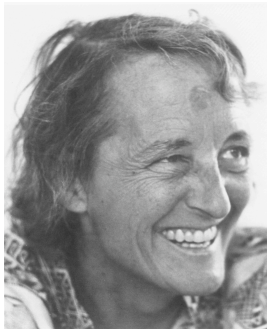
- Email redirected to a spoofed site inviting the user to enter his/her secure university credentials
  - Domain name clearly distinct from indiana.edu
- 72% of students entered their real credentials into the spoofed site
  - Males more likely to do this if email is from a female

Seven Stages of Grief



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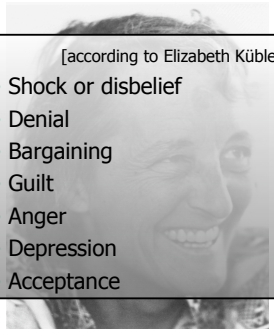

[according to Elizabeth Kübler-Ross]

- Shock or disbelief
- Denial
- Bargaining
- Guilt
- Anger
- Depression
- Acceptance

Victims' Reactions (1)

[Jagatic et al.]

- Anger
  - Subjects called the experiment unethical, inappropriate, illegal, unprofessional, fraudulent, self-serving, useless
  - They called for the researchers conducting the study to be fired, prosecuted, expelled, or reprimanded
- Denial
  - No posted comments included an admission that the writer had fallen victim to the attack
  - Many posts stated that the poster did not and would never fall for such an attack, and they were speaking on behalf of friends who had been phished

Victims' Reactions (2)

[Jagatic et al.]

- Misunderstanding
  - Many subjects were convinced that the experimenters hacked into their email accounts. They believed it was the only possible explanation for the spoofed messages.
- Underestimation of privacy risks
  - Many subjects didn't understand how the researchers obtained information about their friends, and assumed that the researchers accessed their address books
  - Others, understanding that the information was mined from social network sites, objected that their privacy had been violated by the researchers who accessed the information that they had posted online

More Details

- Control group: 15 of 94 (16%) entered personal information
- Social group: 349 of 487 (72%) entered personal information

- 70% of responses within first 12 hours
- Adversary wins by gaining users' trust

More Details

	To Male	To Female	To Any
From Male	53%	78%	68%
From Female	68%	76%	73%
From Any	65%	77%	72%

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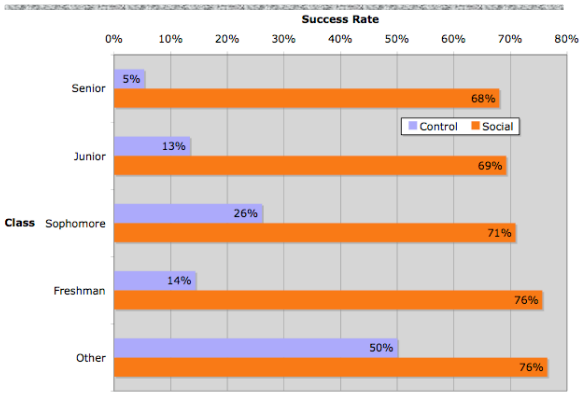

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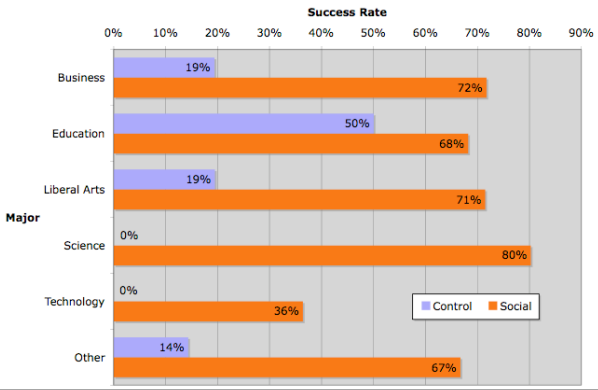

Comments on Previous Homeworks

- Confidentiality and Integrity are related
  - But different!
  - Confidentiality problems can lead to integrity problems, and vise versa
- Bank example

Assets

- Need to know what you are protecting!
  - Hardware: Laptops, servers, routers, PDAs, phones, ...
  - Software: Applications, operating systems, database systems, source code, object code, ...
  - Data and information: Data for running and planning your business, design documents, data about your customers, data about your identity
  - Reputation, brand name
  - Responsiveness
- Assets should have an associated value (e.g., cost to replace hardware, cost to reputation, how important to business operation)

Adversaries

- National governments
- Terrorists
- Thieves
- Business competitors
- Your supplier
- Your consumer
- New York Times
- Your family members (parents, children)
- Your friends
- Your ex-friends
- ...

Threats

- Threats are actions by adversaries who try to exploit vulnerabilities to damage assets
  - Spoofing identities: Attacker pretends to be someone else
  - Tampering with data: Change outcome of election
  - Denial of service: Attacker makes voting machines unavailable on election day
  - Elevation of privilege: Regular voter becomes admin
- Specific threats depend on environmental conditions, enforcement mechanisms, etc
  - You must have a clear, simple, accurate understanding of how the system works!

Threats

- Several ways to identify threats
  - By damage done to the assets
  - By the source of attacks
    - (Type of) insider
    - (Type of) outsider
    - Local attacker
    - Remote attacker
    - Attacker resources

Vulnerabilities

- Weaknesses of a system that could be exploited to cause damage
  - Accounts with system privileges where the default password has not been changed (Diebold: 1111)
  - Programs with unnecessary privileges
  - Programs with known flaws
  - Known problems with cryptography
  - Weak firewall configurations that allow access to vulnerable services
  - ...
- Sources for vulnerability updates: CERT, SANS, Bugtraq, the news(?)

Risks

- Quantitative risk management
  - Example: Risk = Asset × Threat × Vulnerability
  - Monetary value to assets
  - Threats and vulnerabilities are probabilities
  - (Yes: Difficult to assign these costs and probabilities)
- Qualitative risk management
  - Assets: Critical, very important, important, not important
  - Vulnerabilities: Has to be fixed soon, should be fixed, fix if convenient
  - Threats: Very likely, likely, unlikely, very unlikely

CTR and CBC homework problems