CSci 4271W
Development of Secure Software Systems
Day 27: Authentication and usability
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Outline
- ROC curve exercise, cont’d
  - Web authentication
  - Names and identities
  - Announcements intermission
- Usability and security
  - Usable security example areas

Where are these in ROC space?
A if (iris()) return REJECT; else return ACCEPT;
B return REJECT;
C if (iris()) return ACCEPT; else return REJECT;
D if (iris() & pitch()) return ACCEPT; else return REJECT;
E return ACCEPT;
F if (rand() & 1) return ACCEPT; else return REJECT;
G if (pitch()) return ACCEPT; else return REJECT;
H if (iris() || pitch()) return ACCEPT; else return REJECT;

Per-website authentication
- Many web sites implement their own login systems
  - If users pick unique passwords, little systemic risk
  - Inconvenient, many will reuse passwords
  - Lots of functionality each site must implement correctly
  - Without enough framework support, many possible pitfalls

Building a session
- HTTP was originally stateless, but many sites want stateful login sessions
  - Built by tying requests together with a shared session ID
  - Must protect confidentiality and integrity

Session ID: what
- Must not be predictable
  - Not a sequential counter
- Should ensure freshness
  - E.g., limited validity window
- If encoding data in ID, must be unforgeable
  - E.g., data with properly used MAC
  - Negative example: crypt(username || server secret)

Session ID: where
- Session IDs in URLs are prone to leaking
  - Including via user cut-and-paste
  - Usual choice: non-persistent cookie
    - Against network attacker, must send only under HTTPS
    - Because of CSRF, should also have a non-cookie unique ID
### Session management
- Create new session ID on each login
- Invalidate session on logout
- Invalidate after timeout
  - Usability / security tradeoff
  - Needed to protect users who fail to log out from public browsers

### Account management
- Limitations on account creation
  - CAPTCHA? Outside email address?
- See previous discussion on hashed password storage
- Automated password recovery
  - Usually a weak spot
  - But, practically required for large system

### Client and server checks
- For usability, interface should show what’s possible
- But must not rely on client to perform checks
- Attackers can read/modify anything on the client side
- Easy example: item price in hidden field

### Direct object references
- Seems convenient: query parameter names resource directly
  - E.g., database key, filename (path traversal)
- Easy to forget to validate on each use
- Alternative: indirect reference like per-session table
  - Not fundamentally more secure, but harder to forget check

### Function-level access control
- E.g., pages accessed by URLs or interface buttons
- Must check each time that user is authorized
  - Attack: find URL when authorized, reuse when logged off
- Helped by consistent structure in code

### Accounts versus identities
- "Identity" is a broad term that can refer to a personal conception or an automated system
- "Name" is also ambiguous in this way
- "Account" and "authentication" refer unambiguously to institutional/computer abstractions
- Any account system is only an approximation of the real world

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### Real human names are messy
- Most assumptions your code might make will fail for someone
  - ASCII, length limit, uniqueness, unchanging, etc.
- So, don’t design in assumptions about real names
- Use something more computer-friendly as the core identifier
  - Make "real" names or nicknames a presentation aspect
Zooko’s triangle

Claims (2001) it is hard/impossible for a naming scheme to be simultaneously:
  - Human-meaningful
  - Secure
  - Decentralized
  - Too imprecise to be definitively proven/refuted
Blockchain-based name systems are highest-profile claimed counterexamples
A useful heuristic for seeing design tensions

Identity documents: mostly unhelpful

"Send us a scan of your driver’s license"
  - Sometimes called for by specific regulations
  - Unnecessary storage is a disclosure risk
  - Fake IDs are very common

Identity numbers: mostly unhelpful

Common US example: social security number
  - Variously used as an identifier or an authenticator
    - Dual use is itself a cause for concern
  - Known by many third parties (e.g., banks)
  - No checksum, guessing risks
  - Published soon after a person dies

"Identity theft"

The first-order crime is impersonation fraud between two other parties
  - E.g., criminal trying to get money from a bank under false pretenses
The impersonated “victim” is effectively victimized by follow-on false statements
  - E.g., by credit reporting agencies
  - These costs are arguably the result of poor regulatory choices
  - Be careful w/ negative info from 3rd parties

Users are not ‘ideal components’

Frustrates engineers: cannot give users instructions like a computer
  - Closest approximation: military
  - Unrealistic expectations are bad for security

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Note to early readers

This is the section of the slides most likely to change in the final version
If class has already happened, make sure you have the latest slides for announcements
Most users are benign and sensible

- On the other hand, you can't just treat users as adversaries
  - Some level of trust is inevitable
  - Your institution is not a prison
- Also need to take advantage of user common sense and expertise
  - A resource you can't afford to pass up

Don't blame users

- "User error" can be the end of a discussion
- This is a poor excuse
- Almost any "user error" could be avoidable with better systems and procedures

Users as rational

- Economic perspective: users have goals and pursue them
  - They're just not necessarily aligned with security
- Ignoring a security practice can be rational if the rewards is greater than the risk

Perspectives from psychology

- Users become habituated to experiences and processes
  - Learn "skill" of clicking OK in dialog boxes
- Heuristic factors affect perception of risk
  - Level of control, salience of examples
- Social pressures can override security rules
  - "Social engineering" attacks

User attention is a resource

- Users have limited attention to devote to security
  - Exaggeration: treat as fixed
- If you waste attention on unimportant things, it won't be available when you need it
- Fable of the boy who cried wolf

Research: ecological validity

- User behavior with respect to security is hard to study
- Experimental settings are not like real situations
- Subjects often:
  - Have little really at stake
  - Expect experimenters will protect them
  - Do what seems socially acceptable
  - Do what they think the experimenters want

Research: deception and ethics

- Have to be very careful about ethics of experiments with human subjects
  - Enforced by institutional review systems
- When is it acceptable to deceive subjects?
  - Many security problems naturally include deception

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Email encryption
- Technology became available with PGP in the early 90s
- Classic depressing study: "Why Johnny can't encrypt: a usability evaluation of PGP 5.0" (USENIX Security 1999)
- Still an open "challenge problem"
- Also some other non-UI difficulties: adoption, govt. policy

Phishing
- Attacker sends email appearing to come from an institution you trust
- Links to web site where you type your password, etc.
- Spear phishing: individually targeted, can be much more effective

Phishing defenses
- Educate users to pay attention to X:
  - Spelling → copy from real emails
  - URL → homograph attacks
  - SSL "lock" icon → fake lock icon, or SSL-hosted attack
- Extended validation (green bar) certificates
- Phishing URL blacklists

SSL warnings: prevalence
- Browsers will warn on SSL certificate problems
- In the wild, most are false positives
  - foo.com vs. www.foo.com
  - Recently expired
  - Technical problems with validation
  - Self-signed certificates (HA2)
- Classic warning-fatigue danger

SSL warnings: effectiveness
- Early warnings fared very poorly in lab settings
- Recent browsers have a new generation of designs:
  - Harder to click through mindlessly
  - Persistent storage of exceptions
- Recent telemetry study: they work pretty well

Older SSL warning

Modern Firefox warning

Modern Firefox warning (2)
Modern Firefox warning (3)

Spam-advertised purchases
- "Replica" Rolex watches, herbal V!@gr@, etc.
- This business is clearly unscrupulous; if I pay, will I get anything at all?
- Empirical answer: yes, almost always
  - Not a scam, a black market
  - Importance of credit-card bank relationships

Advance fee fraud
- "Why do Nigerian Scammers say they are from Nigeria?" (Herley, WEIS 2012)
- Short answer: false positives
  - Sending spam is cheap
  - But, luring victims is expensive
  - Scammer wants to minimize victims who respond but ultimately don't pay

Trusted UI
- Tricky to ask users to make trust decisions based on UI appearance
  - Lock icon in browser, etc.
- Attacking code can draw lookalike indicators
  - Lock favicon
  - Picture-in-picture attack

Smartphone app permissions
- Smartphone OSes have more fine-grained per-application permissions
  - Access to GPS, microphone
  - Access to address book
  - Make calls
  - Phone also has more tempting targets
  - Users install more apps from small providers

Permissions manifest
- Android approach: present listed of requested permissions at install time
- Can be hard question to answer hypothetically
  - Users may have hard time understanding implications
- User choices seem to put low value on privacy

Time-of-use checks
- iOS approach: for narrower set of permissions, ask on each use
  - Proper context makes decisions clearer
  - But, have to avoid asking about common things
  - iOS app store is also more closely curated

Trusted UI for privileged actions
- Trusted UI works better when asking permission (e.g., Oakland'12)
- Say, “take picture” button in phone app
  - Requested by app
  - Drawn and interpreted by OS
  - OS well positioned to be sure click is real
- Little value to attacker in drawing fake button