CSci 4271W
Development of Secure Software Systems
Day 27: Authentication and usability

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Outline

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;
```

Outline

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

Outline

Accounts versus identities

- "Identity" is a broad term that can refer to a personal conception or an automated sytem
- "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

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

Outline

ROC curve exercise, cont'd

Web authentication

Names and identities

Announcements intermission

Usability and security

Usable security example areas

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

Outline

ROC curve exercise, cont'd

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Usable security example areas

Users are not 'ideal components'

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

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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ROC curve exercise, cont'd

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Usable security example areas

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

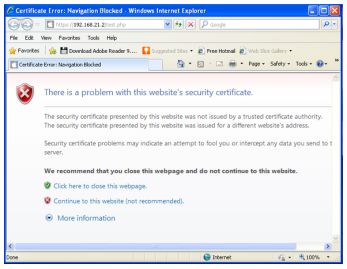
Phishing defenses

- 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

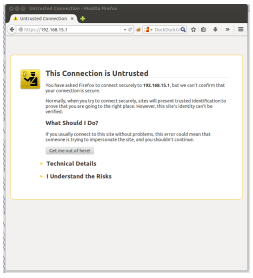
Older SSL warning



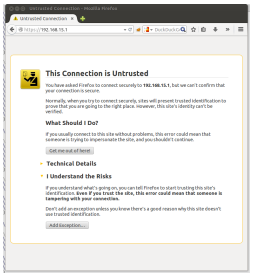
SSL warnings: effectiveness

- 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

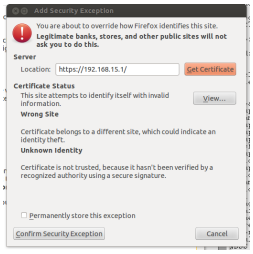
Modern Firefox warning



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