Authentication: Password & Biometrics

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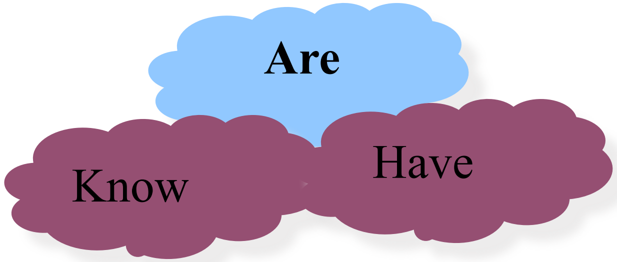
Some of the slides are from Mark Stamp.

Access Control

- Two parts to access control
- Authentication: are you who you say you are?
  - Determine whether access is allowed
  - Authenticate human to machine
  - Or authenticate machine to machine
- Authorization: are you allowed to do that?
  - Once you have access, what can you do?
  - Enforces limits on actions

Are You Who You Say You Are?

- Authenticate a human to a machine?
- Can be based on…
  - Something you **know**
    - For example, a password
  - Something you **have**
    - For example, a smartcard
  - Something you **are**
    - For example, your fingerprint



Something You Know

- Passwords
- Lots of things act as passwords!
    - PIN
    - Social security number
    - Mother’s maiden name
    - Date of birth
    - Your first boss’s name
    - Name of your pet, etc.

Why Passwords?

- Why is “something you know” more popular than “something you have” and “something you are”?
- **Cost**: passwords are free
- **Convenience**: easier for sysadmin to reset pwd than to issue a new thumb

“Passwords are one of the biggest practical problems facing security engineers today.”

Keys vs Passwords

- **Crypto keys**
- Spse key is 64 bits
- Then 2^{64} keys
- Choose key at random…
- …then attacker must try about 2^{63} keys

- **Passwords**
- Spse passwords are 8 characters, and 256 different options each character
- Then $256^8 = 2^{64}$ pwds?!
- But users do not select passwords at random
- Attacker has far less than 2^{63} pwds to try **(dictionary attack)**

dictionary attack: tries only those possibilities which are deemed most likely to succeed, typically derived from a list of words such as in a dictionary

Good and Bad Passwords

- Bad passwords
  - frank
  - Fido
  - Password
  - incorrect
  - Pikachu
  - 88195277
  - AustinStamp

- Good Passwords?
  - jflej,43j-EmmL+y
  - 09864376537263
  - 0nceuP0nAt1m8 ← Passphrase
  - P0kem0n

Passphrase:

- longer (10~30 letters) to make brute force attacks difficult
- if well chosen, they will not be found in any phrase or quote dictionary
- **Structured to be more easily memorable** than passwords

Password Experiment

- Three groups of users — each group advised to select passwords as follows
  - **Group A:** At least 6 chars, 1 non-letter
  - winner → **Group B:** Password based on passphrase
  - **Group C:** 8 random characters
- Results
  - **Group A:** About 30% of pwds easy to crack
  - **Group B:** About 10% cracked
    - Passwords easy to remember
  - **Group C:** About 10% cracked
    - Passwords hard to remember

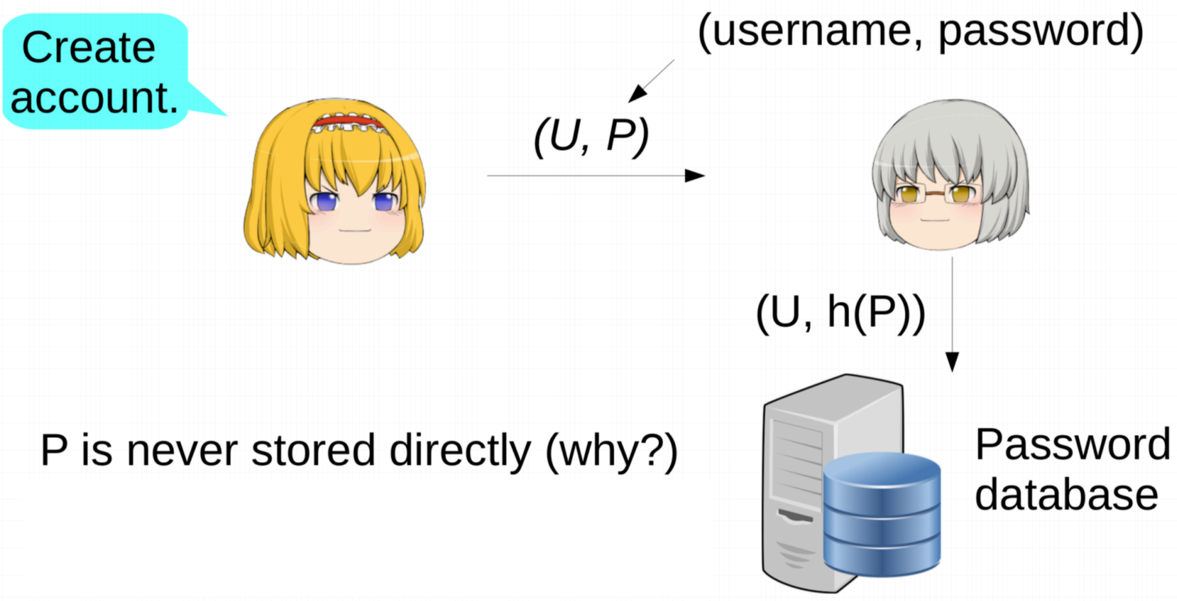
Attacks on Passwords

- Attacker could…
  - Target one particular account
  - Target any account on system
  - Target any account on any system
  - Attempt denial of service (DoS) attack
    - What’s the connection here?
    - Think about the ATM machine…

Password File?

- Bad idea to store passwords in a file
- But we need to verify passwords
- Solution?

How companies store your password?



Create account.

(username, password)

(U, P)

(U, h(P))

P is never stored directly (why?)

Password database

Dictionary Attack towards a File of hashed passwords

- Attacker pre-computes $h(x)$ for all x in a **dictionary** of common passwords
- Suppose the attacker gets access to password file containing hashed passwords
  - She only needs to compare hashes to her pre-computed dictionary
  - After one-time work of computing hashes in dictionary, actual attack is trivial
- Can we prevent this search-based attack?
  - Or at least make it more difficult?

Salt (Random Chosen Value)

- Hash password with **salt**
- Choose random salt s and compute

  $$y = h(\text{password}, s)$$

  and store (s,y) in the password file
- Note that the salt s is not secret
- Still easy to verify salted password
- But lots more work for the attacker
  - Why?
  - Must recompute hash for each user

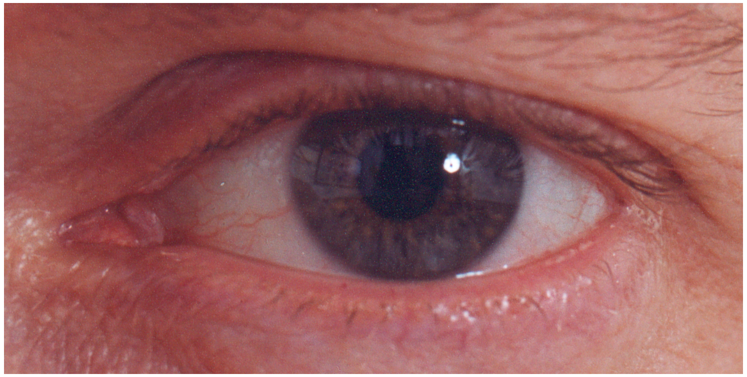
Other Password Issues

- Too many passwords to remember
  - Results in password reuse
  - Why is this a problem?
- Who suffers from bad password?
  - Login password vs ATM PIN
- Failure to change default passwords
- Social engineering…
- Error logs may contain “almost” passwords
- Bugs, keystroke logging, spyware, etc.

Passwords

- **Password attacks are too easy**
  - Often, one weak password will break security
  - Users choose bad passwords
  - Social engineering attacks, etc.
- Passwords are a **BIG** security problem
  - And will continue to be a problem
- Popular password cracking tools
  - Password Crackers
  - Password Portal
  - L0phtCrack and LC4 (Windows)
  - John the Ripper (Unix)
- Admin should use these tools to test weak password.

Biometrics

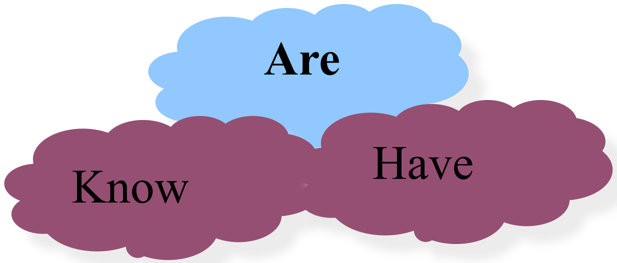


Something You Are

- Biometric
  - **"You are your key"**

❑ Examples

- Fingerprint
- Handwritten signature
- Facial recognition
- Speech recognition
- Walking (gait) recognition
- Many more!



Why Biometrics?

- May be better than passwords
- But, cheap and reliable biometrics needed
  - Today, an active area of research
- Biometrics **are** used in security today
  - Fingerprint to unlock car door
  - Palm print for secure entry

Ideal Biometric

- **Universal** — applies to (almost) everyone
  - In reality, no biometric applies to everyone
- **Distinguishing** — distinguish with certainty
  - In reality, cannot hope for 100% certainty
- **Permanent** — physical characteristic being measured never changes
  - In reality, OK if it to remains valid for long time
- **Collectable** — easy to collect required data
  - Depends on whether subjects are *cooperative*
- Also, safe, user-friendly

Enrollment vs Recognition

- Enrollment phase
  - Subject's biometric info put into database
  - Must carefully measure the required info
  - OK if slow and repeated measurement needed
  - Must be very precise
  - May be a weak point in real-world use

Root trust

- Recognition phase
  - Biometric detection, when used in practice
  - Must be quick and simple
  - But must be reasonably accurate

Biometric Errors

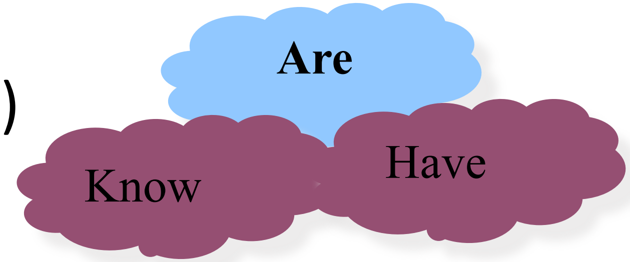
- **Fraud rate** versus **insult rate**
  - Fraud **(false negative)** — Attacker mis-authenticated as Alice
  - Insult **(false positive)** — Alice not authenticated as Alice
- For any biometric, generally speaking, can decrease fraud or insult, but other one will increase
- For example
  - 99% voiceprint match ⇒ low fraud, high insult
  - 30% voiceprint match ⇒ high fraud, low insult
- **Equal error rate:** rate where fraud == insult
  - A way to ***compare*** different biometrics

Biometrics: The Bottom Line

- Biometrics are hard to forge
- But attacker could
  - Steal Alice’s thumb
  - Photocopy Bob’s fingerprint, eye, etc.
  - Subvert software, database, “trusted base” …
- And how to revoke a “broken” biometric?
- **Biometrics are not foolproof**

Are You Who You Say You Are?

- Something in your possession
- Examples include following…
  - Car key
  - Laptop computer (or MAC address)
  - Password generator (next)
  - ATM card, smartcard, etc.



2-factor Authentication

- Requires any 2 out of 3 of
  - Something you **know**
  - Something you **have**
  - Something you **are**

Examples

- Credit card: Card and signature
- ATM: Card and PIN