

# CSE 484 / CSE M 584: Authentication

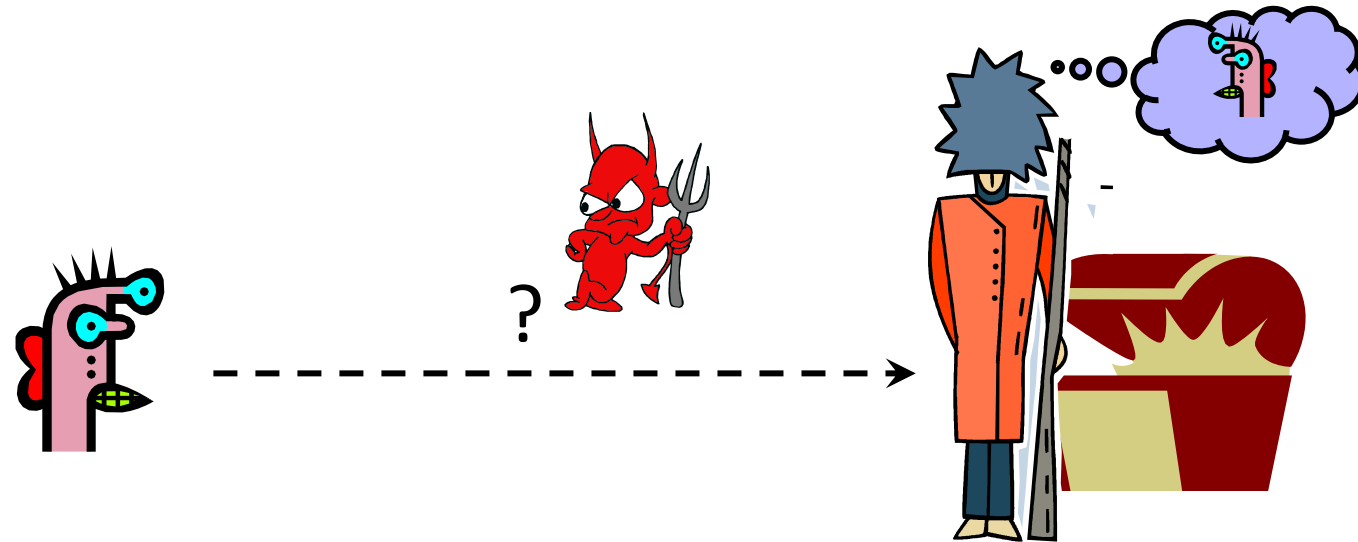
Fall 2024

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# Announcements

- **Lab 2:** Ongoing
- **Homework 3:** Out today
- **Today:** More on **authentication**
  - Check out optional (funny!) reading by James Mickens on course schedule
- **Upcoming**
  - Next few lectures: Usable Security, Mobile Platform Security
  - Next week: **No class Monday (Veteran's Day), Guest lecture Friday**

# Basic Problem



**Challenge:** How do you prove to someone that you are who you claim to be?

Any system with access control must solve this problem.

# Many Ways to Prove Who You Are

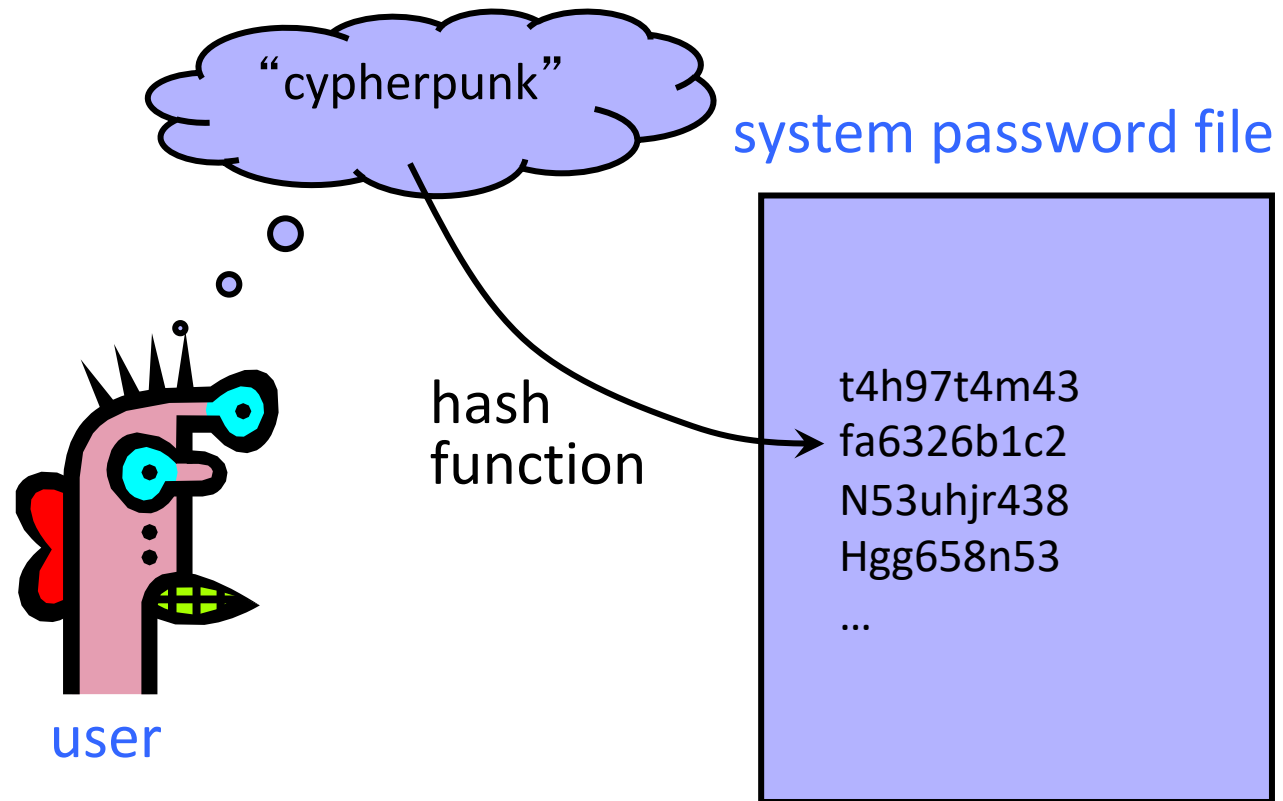
- What you know
  - Passwords
  - Answers to questions that only you know
- Where you are
  - IP address, geolocation
- What you are
  - Biometrics
- What you have
  - Secure tokens, mobile devices

# Passwords and Computer Security

- In 2012, 76% of network intrusions exploited weak or stolen credentials (username/password)
  - Source: Verizon Data Breach Investigations Report
- In Mitnick’s “Art of Intrusion” 8 out of 9 exploits involve password stealing and/or cracking
- First step after any successful intrusion: install sniffer or keylogger to steal more passwords
- Second step: run cracking tools on password files
  - Cracking needed because modern systems usually do not store passwords in the clear

# Password Storage

- How should we store passwords on a server?
  - In cleartext?
  - Encrypted?
  - Hashed?



# Password Hashing

- Instead of user password, store  $H(\text{password})$
- When user enters password, compute its hash and compare with entry in password file
  - System does not store actual passwords!
  - System itself can't easily go from hash to password
    - Which would be possible if the passwords were encrypted
- Hash function  $H$  must have some properties
  - **One-way**: given  $H(\text{password})$ , hard to find password
    - No known algorithm better than trial and error
  - “Slow” to compute

# UNIX Password System

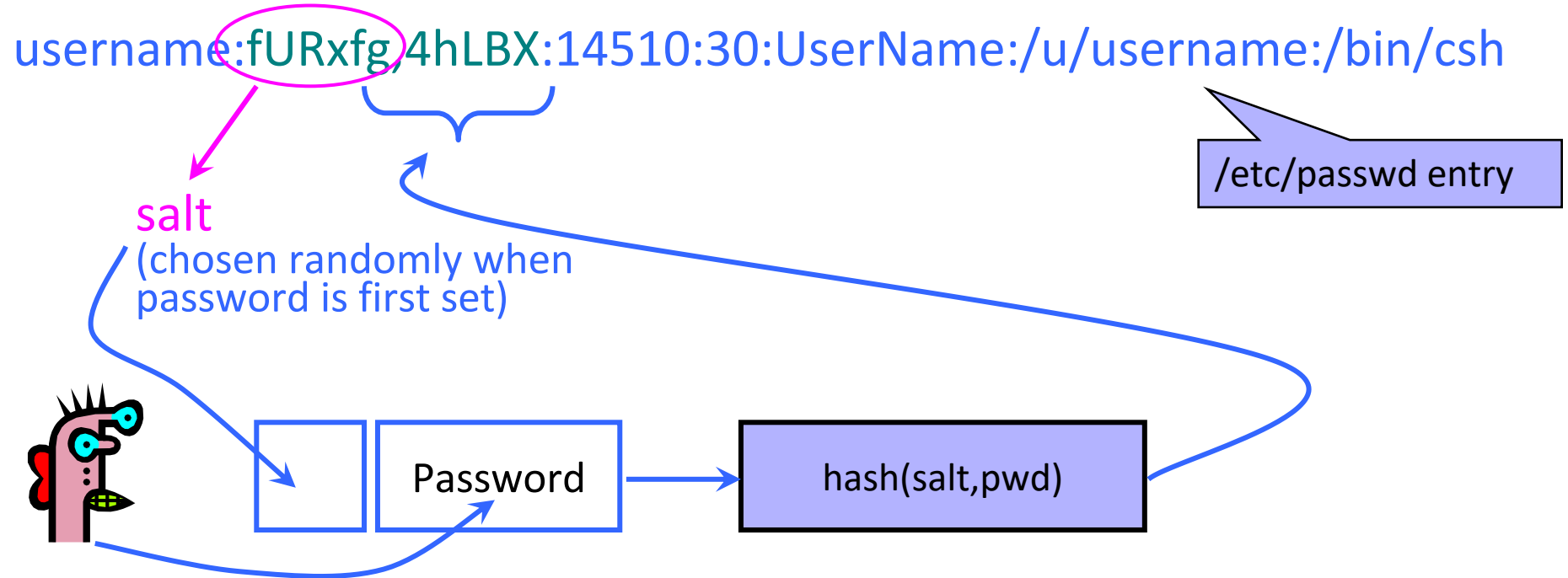
- Approach: Hash passwords
- Problem: passwords are not truly random
  - With 52 upper- and lower-case letters, 10 digits and 32 punctuation symbols, there are  $94^8$  == 6 quadrillion possible 8-character passwords ( $\sim 2^{52}$ )
  - **BUT:** Humans like to use dictionary words, human and pet names == 1 million common passwords



# Dictionary Attack

- **Dictionary attack** is possible because many passwords come from a small dictionary
  - Attacker can **pre-compute**  $H(\text{word})$  for every word in the dictionary. **This only needs to be done once!**
    - This is an offline attack
    - Once password file is obtained, cracking is instantaneous
  - Sophisticated password guessing tools are available
    - Take into account freq. of letters, password patterns, etc.

# Salt



- Users with the same password have different entries in the password file
- Offline dictionary attack becomes much harder

# Advantages of Salting

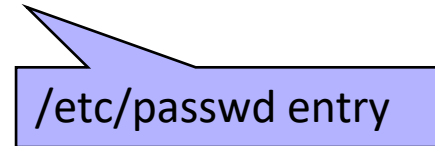
- Without salt, attacker can pre-compute hashes of all dictionary words once for all password entries
  - Same hash function on all UNIX machines
  - Identical passwords hash to identical values; one table of hash values can be used for all password files
- With salt, attacker must compute hashes of all dictionary words once for each password entry
  - With 12-bit random salt, same password can hash to  $2^{12}$  different hash values
  - Attacker must try all dictionary words **for each salt value** in the password file
- Pepper: Secret salt (not stored in password file)

# Shadow Password

username:x:14510:30:User Name:/u/username:/bin/csh



Hashed password is no longer stored in a world-readable file



Hashed passwords are stored in `/etc/shadow` file which is only readable by system administrator (root)

# Other Password Security Risks

- Keystroke loggers
  - Hardware
  - Software (spyware)
- Shoulder surfing
- Same password at multiple sites
- Broken implementations
  - Recall TENEX timing attack
- Social engineering



## AirDrive Forensic Keylogger

The **AirDrive Forensic Keylogger** is an innovative ultra-small USB hardware keylogger, only **0.4" (10 mm)** in length. It can be accessed with any Wi-Fi device such as a computer, laptop, tablet, or smartphone. It is the smallest hardware keylogger available on the market, making it a professional surveillance and security tool. The Pro version offers **time-stamping**, **E-mail reporting** and **data streaming**.

\$67<sup>99</sup> or €57<sup>99</sup>

[More info](#)

# Other Issues

- Usability
  - Hard-to-remember passwords?
  - Carry a physical object all the time?
- Denial of service
  - Attacker tries to authenticate as you, account locked after 3 failures

# Default Passwords

- Examples from Mitnick's "Art of Intrusion"
  - U.S. District Courthouse server: "public" / "public"
  - NY Times employee database: pwd = last 4 SSN digits
- Mirai IoT botnet
  - Weak and default passwords on routers and other devices

# Weak Passwords



- RockYou hack
  - “Social gaming” company
  - Database with 32 million user passwords from partner social networks
  - Passwords stored in the clear
  - December 2009: entire database hacked using an **SQL injection attack** and posted on the Internet
  - One of many such examples!



# Weak Passwords

## Password Popularity – Top 20

Rank	Password	Number of Users with Password (absolute)
1	123456	290731
2	12345	79078
3	123456789	76790
4	Password	61958
5	iloveyou	51622
6	princess	35231
7	rockyou	22588
8	1234567	21726
9	12345678	20553
10	abc123	17542

Rank	Password	Number of Users with Password (absolute)
11	Nicole	17168
12	Daniel	16409
13	babygirl	16094
14	monkey	15294
15	Jessica	15162
16	Lovely	14950
17	michael	14898
18	Ashley	14329
19	654321	13984
20	Qwerty	13856

# Password Policies

- Old recommendation:
  - 7 or 8 characters, at least 3 out of {digits, upper-case, lower-case, non-alphanumeric}, no dictionary words, change every 4 months, password may not be similar to previous 12 passwords...



Image from [http://www.interactivetools.com/staff/dave/damons\\_office/](http://www.interactivetools.com/staff/dave/damons_office/)

# Password Policies

- Old recommendation:
  - 7 or 8 characters, at least 3 out of {digits, upper-case, lower-case, non-alphanumeric}, no dictionary words, change every 4 months, password may not be similar to previous 12 passwords...
- **But ...** results in frustrated users and less security
  - Burdens of devising, learning, forgetting passwords
  - **Users construct passwords insecurely, write them down**
    - Can't use their favorite password construction techniques (small changes to old passwords, etc.)
  - Heavy password re-use across systems
  - **(Password managers can help)**

# “New” (2017) NIST Guidelines 😊

- *Remove requirement to periodically change passwords*
- *Screen for commonly used passwords*
- *Allow copy-paste into password fields*
  - *But concern: what apps have access to clipboard?*
- *Allow but don't require arbitrary special characters*
- *Etc.*

<https://pages.nist.gov/800-63-3/sp800-63b.html>

# Recovering Passwords: A Weak Link

## Palin E-Mail Hacker Says It Was Easy

By [Kim Zetter](#)  September 18, 2008 | 10:05 am | Categories: [Elections](#), [Hacks and Cracks](#)

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after the password recovery was reenabled, it took seriously 45 mins on wikipedia and google to find the info, Birthday? 15 seconds on wikipedia, zip code? well she had always been from wasilla, and it only has 2 zip codes (thanks online postal service!)

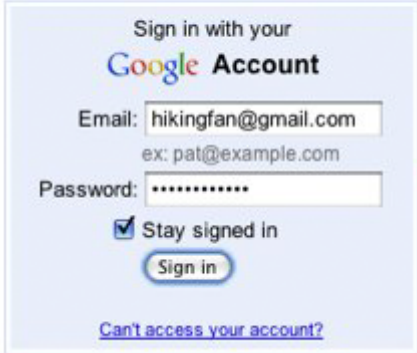
the second was somewhat harder, the question was "where did you meet your spouse?" did some research, and apparently she had eloped with mister palin after college, if youll look on some of the screenshits that I took and other fellow anon have so graciously put on photobucket you will see the google search for "palin eloped" or some such in one of the tabs.

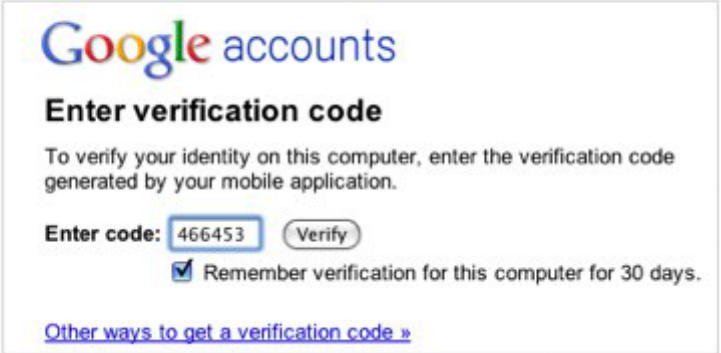
I found out later though more research that they met at high school, so I did variations of that, high, high school, eventually hit on "Wasilla high" I promptly changed the password to popcorn and took a cold shower...

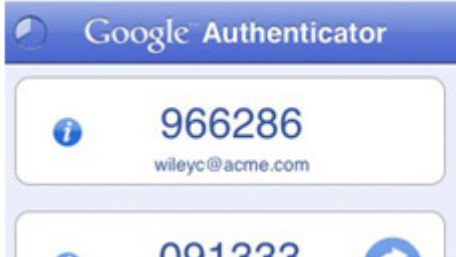
# Improving(?) Passwords


- Add biometrics
  - For example, keystroke dynamics or voiceprint
- Graphical passwords
  - Goal: easier to remember? no need to write down?
- Password managers
  - Examples: LastPass, KeePass, built into browsers
  - Can have security vulnerabilities...
- Two-factor authentication
  - Leverage phone (or other device) for authentication

# Multi-Factor Authentication

1.  Sign in with your Google Account  
Email: hikingfan@gmail.com  
ex: pat@example.com  
Password: .....  
 Stay signed in  
  
[Can't access your account?](#)

2.  Google accounts  
**Enter verification code**  
To verify your identity on this computer, enter the verification code generated by your mobile application.  
Enter code: 466453   
 Remember verification for this computer for 30 days.  
[Other ways to get a verification code »](#)

 Google Authenticator  
966286  
wileyc@acme.com  
001333

 Turn on Login Approvals  
What is Login Approvals?  
Login Approvals is a security feature that requires you to enter a code that we text to your phone when you log in from an unrecognized computer. You can enable this feature in a few simple steps.  
If you ever lose access to your phone, you can always return to a previously-recognized computer to regain access to your account.  
Note: You'll need to have your mobile phone with you to complete this process.



# FIDO + Hardware Two Factors



# Questions:

**Do you use 2-factor auth?**  
**Do you use a password manager?**  
**Why or why not?**

# Secondary Factors Do Help!

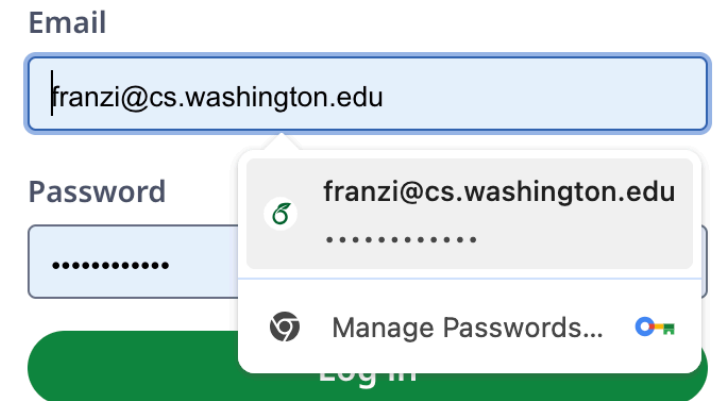
## Account takeover prevention rates, by challenge type



*Both device- and knowledge-based challenges help thwart automated bots, while device-based challenges help thwart phishing and even targeted attacks.*

# Password Managers

- **Forget** about remembering passwords
- Rely on browser or extensions to fill-in passwords
  - **Browsers:** Chrome, Firefox, Safari, Edge
  - **Extensions:** 1Password, LastPass, KeePass, Norton Identity Safe
- **Advantages**
  - Nothing to remember
  - Enables the use of complex/nonsensical passwords
  - Convenient



# Password Managers

- Disadvantages
  - Security now relies on a single entity
    - How much do you trust your browser or a third party extension?
    - Even if trustworthy, may have vulnerabilities
  - Requires a setup process

## Experts Fear Crooks are Cracking Keys Stolen in LastPass Breach

September 5, 2023

79 Comments

In November 2022, the password manager service **LastPass** disclosed a breach in which hackers stole password vaults containing both encrypted and plaintext data for more than 25 million users. Since then, a steady trickle of six-figure cryptocurrency heists targeting security-conscious people throughout the tech industry has led some security experts to conclude that crooks likely have succeeded at cracking open some of the stolen LastPass vaults.

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# Password Manager Vulnerabilities

- Should a password manager autofill text boxes when...
  - An iframe does not have the same origin as the parent?



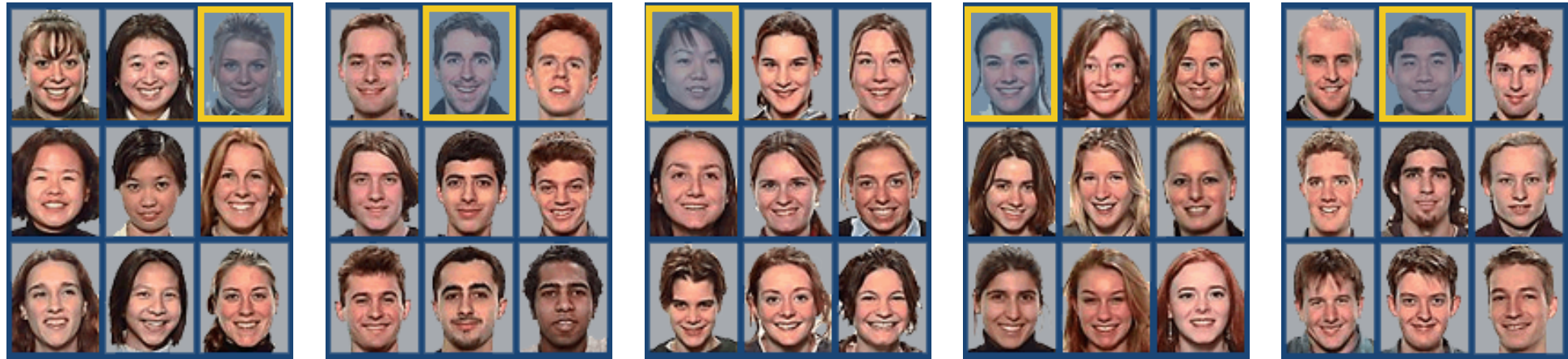
**Automatic Autofill:**



Silver et al. USENIX Security 2014

# Another idea: Graphical Passwords

- Many variants... one example: Passfaces
  - Assumption: easy to recall faces



- Problem: to make passwords easy to remember, **users choose predictable faces**

# Another idea: Graphical Passwords

- Another variant: draw on the image (Windows 8)



- Problem: **users choose predictable points/lines**



# Unlock Patterns



- Problems:
  - Predictable patterns (familiar issue by now...)
  - Smear patterns
  - Side channels: apps can use accelerometer and gyroscope to extract pattern!

# What About Biometrics?

- Authentication: **What you are**
- Unique identifying characteristics to authenticate user or create credentials
  - Biological and physiological: Fingerprints, iris scan
  - Behaviors characteristics - how perform actions: Handwriting, typing, gait
- Advantages:
  - Nothing to remember
  - Passive
  - Can't share (generally)
  - With perfect accuracy, could be fairly unique

**Q: What are some disadvantages with biometrics?**

# Shifting Threat Models...

 **The News in 2 minutes****News services**  
Your news when  
want it

Last Updated: Thursday, 31 March, 2005, 10:37 GMT 11:37 UK

[E-mail this to a friend](#) [Printable version](#)

## Malaysia car thieves steal finger

By Jonathan Kent  
BBC News, Kuala Lumpur

**Police in Malaysia are hunting for members of a violent gang who chopped off a car owner's finger to get round the vehicle's hi-tech security system.**

The car, a Mercedes S-class, was protected by a fingerprint recognition system.

Accountant K Kumaran's ordeal began when he was run down by four men in a small car as he was about to get into his Mercedes in a Kuala Lumpur suburb.

**SEE ALSO:**

- Malaysia to act against pirates  
16 Mar 05 | As

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# Issues with Biometrics

- Private, but not secret
  - Maybe encoded on the back of an ID card?
  - Maybe encoded on your glass, door handle, ...
  - Sharing between multiple systems?
- Revocation is difficult (impossible?)
  - Sorry, your iris has been compromised, please create a new one...
- Physically identifying
  - Soda machine to cross-reference fingerprint with DMV?
- Birthday paradox
  - With false accept rate of 1 in a million, probability of false match is above 50% with only 1609 samples

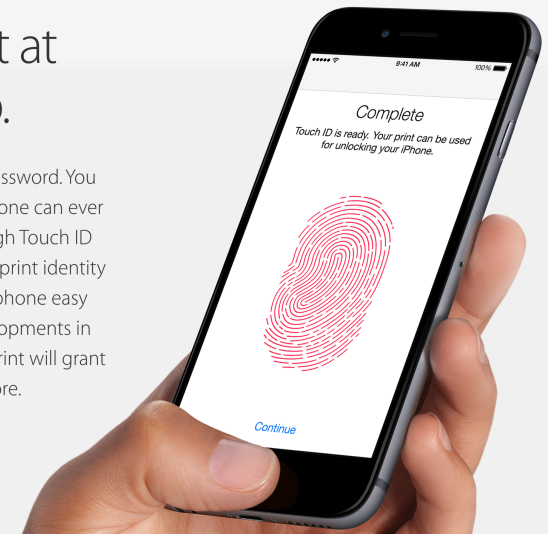
# Attacking Biometrics

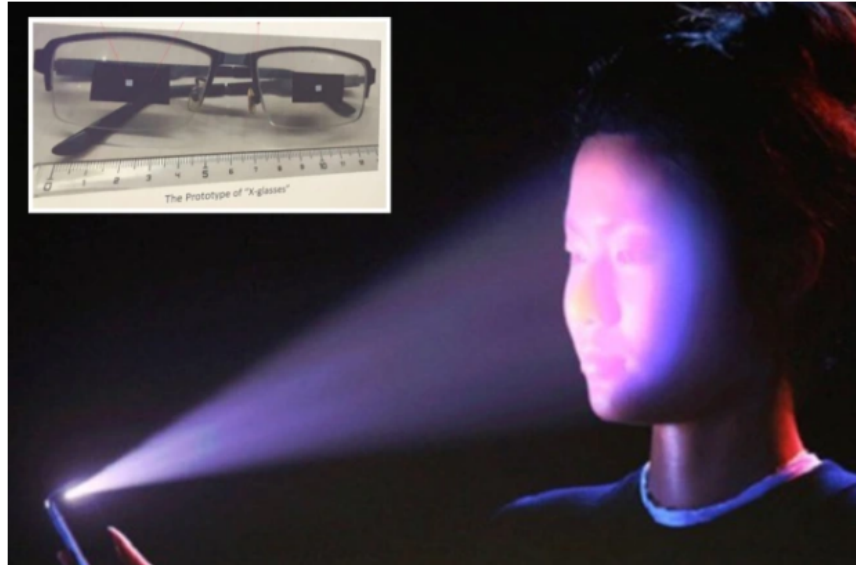
- An adversary might try to steal biometric info
  - Malicious fingerprint reader
    - Consider when biometric is used to derive a cryptographic key
  - Residual fingerprint on a glass
- Continuous back-and-forth with adversaries trying to compromise biometrics

Touch ID

Security. Right at your fingertip.

Your fingerprint is the perfect password. You always have it with you. And no one can ever guess what it is. Our breakthrough Touch ID technology uses a unique fingerprint identity sensor to make unlocking your phone easy and secure. And with new developments in iOS 8 and Touch ID, your fingerprint will grant you faster access to so much more.





Tech > Phones & Gadgets

## EYE SEE iPhones 'can be HACKED' by putting taped-up glasses on sleeping victims – letting crooks raid your bank, experts warn

**Sean Keach**, Digital Technology and Science Editor

11:49, 9 Aug 2019 | Updated: 11:51, 9 Aug 2019

## Sleeping Woman's Eyelids Lifted to Unlock Phone, Steal \$24K

Facial recognition is very convenient for unlocking a device, but far from secure under the right circumstances.



By [Matthew Humphries](#) December 15, 2021



As [Vice reports](#), a 28-year-old Chinese man whose surname is Huang visited his ex-girlfriend (surname Dong) in the southern city of Nanning in December last year on the premise of returning some borrowed money. Dong was ill, so Huang made her some food, gave her cold medicine, and let her sleep.

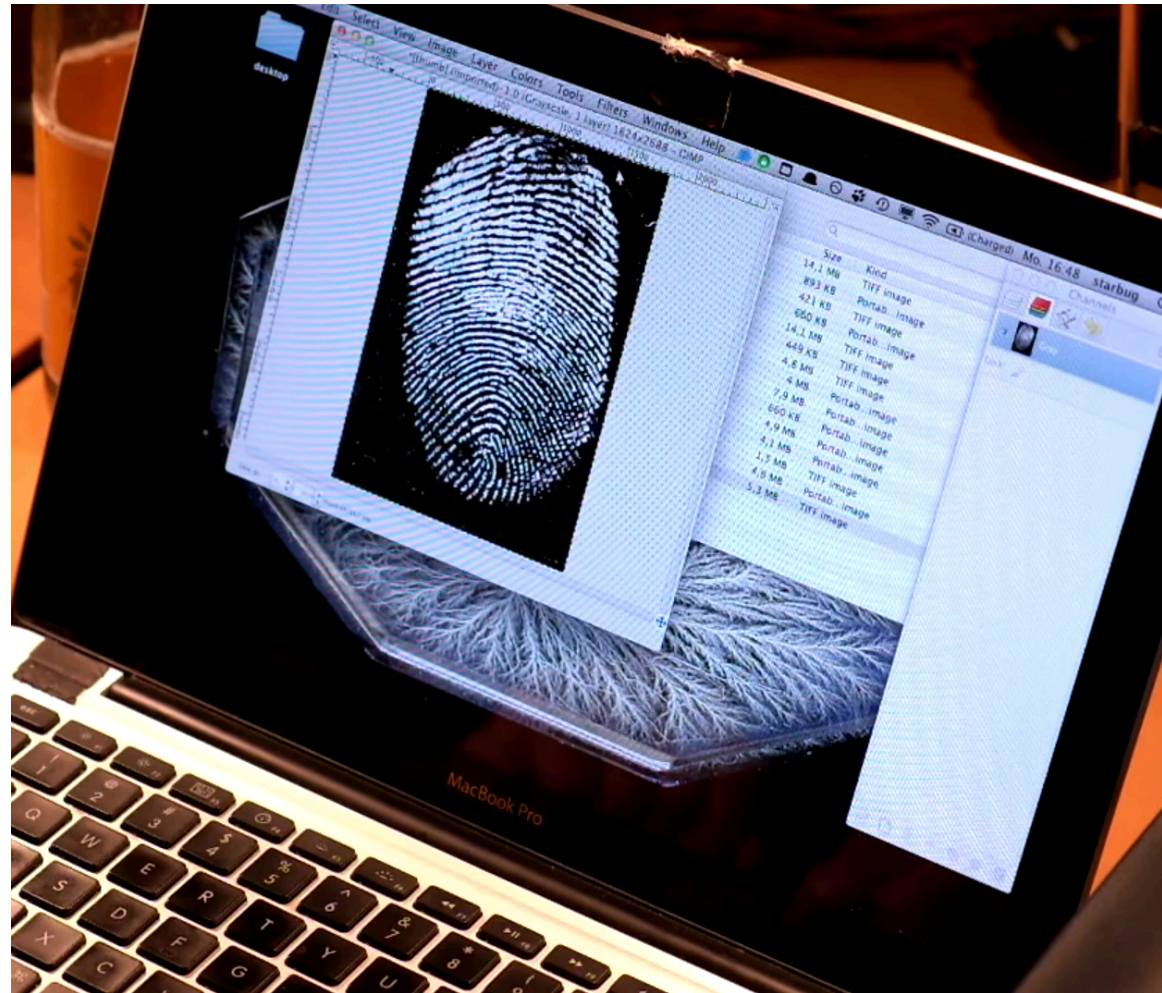
Once asleep, he proceeded to place her finger on her smartphone screen and opened her eyelids to allow facial recognition to unlock the handset. Huang then used the unlocked phone to transfer around \$24,000 from her accounts to his own using Alipay. He then left, taking the phone with him.

# Attacking Biometrics





# Attacking Biometrics



# Attacking Biometrics



# Attacking Biometrics

