CSE 484 (Winter 2008)

User Authentication

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Thanks to Dan Boneh, Dieter Gollmann, John Manferdelli, John Mitchell, Vitaly Shmatikov, Bennet Yee, and many others for sample slides and materials ...

Goals for Today

- User Authentication
  - Biometrics
  - Password Managers
  - Authentication schemes

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?

Issues with Biometrics

- Criminal gives an inexperienced policeman fingerprints in the wrong order
  - Record not found; gets off as a first-time offender
- Can be attacked using recordings
  - Ross Anderson: in countries where fingerprints are used to pay pensions, there are persistent tales of "Granny's finger in the pickle jar" being the most valuable property she bequeathed to her family
- Birthday paradox
  - With false accept rate of 1 in a million, probability of false match is above 50% with only 1609 samples

Issues with Biometrics

- Anecdotally, car jackings went up when it became harder to steal cars without the key
- But what if you need your fingerprint to start your car?
  - Stealing cars becomes harder
  - So what would the car thieves have to do?

Risks of Biometrics

BBC NEWS | The News in 2 minutes | News services: Your news when want it

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

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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.

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Biometric Error Rates (Adversarial)

- Want to minimize "fraud" and "insult" rate
  - "Easy" to test probability of accidental misidentification (fraud)
  - But what about adversarial fraud
    - Besides stolen fingers
- An adversary might try to steal the biometric information
  - Malicious fingerprint reader
    - Consider when biometric is used to derive a cryptographic key
  - Residual fingerprint on a glass

Voluntary: Making a Mold

[Matsumoto]

Put the plastic into hot water to soften it.

Press a live finger against it.

The mold

It takes around 10 minutes.

http://web.mit.edu/6.857/OldStuff/Fall03/ref/gummy-slides.pdf

Voluntary: Making a Finger

[Matsumoto]

Pour the liquid into the mold.

Put it into a refrigerator to cool.

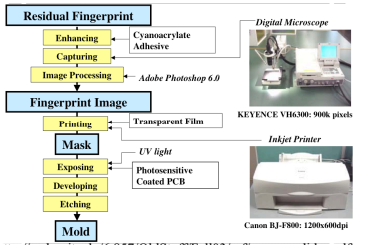
It takes around 10 minutes.

The gummy finger

http://web.mit.edu/6.857/OldStuff/Fall03/ref/gummy-slides.pdf

Involuntary

[Matsumoto]



KEYENCE VH6300: 900k pixels

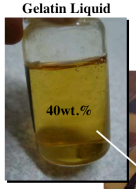
Canon BJ-F800: 1200x600dpi

http://web.mit.edu/6.857/OldStuff/Fall03/ref/gummy-slides.pdf

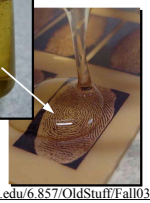
Involuntary

[Matsumoto]

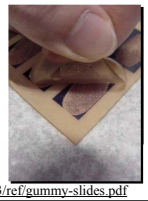
Gelatin Liquid



Drip the liquid onto the mold.



Put this mold into a refrigerator to cool, and then peel carefully.



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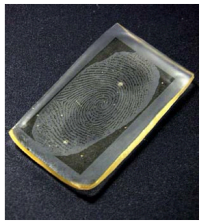
Involuntary

[Matsumoto]



http://web.mit.edu/6.857/OldStuff/Fall03/ref/gummy-slides.pdf

Authentication by Handwriting

[Ballard, Monrose, Lopresti]

- Maybe a computer could also forge some biometrics

Generated by computer algorithm trained on handwriting samples

Password Managers

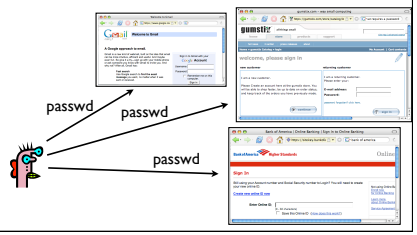
- Idea: Software application that will store and manage passwords for you.
  - You remember one password.
  - Each website sees a different password.
- Examples: PwdHash (Usenix Security 2005) and Password Multiplier (WWW 2005).

Key ideas

- User remembers a single password
- Password managers
  - On input: (1) the user's single password and (2) information about the website
  - Compute: Strong, site-specific password
- Goal: Avoid problems with passwords

The problem

Alice needs passwords for all the websites that she visits



Possible solutions

- Easy to remember: Use same password on all websites. Use "weak" password.
  - Poor security (don't share password between bank website and small website)
- More secure: Use different, strong passwords on all websites.
  - Hard to remember, unless write down.

Alternate solution: Password managers

- Password managers handle creating and "remembering" strong passwords
- Potentially:
  - Easier for users
  - More secure
- Examples:
  - PwdHash (Usenix Security 2005)
  - Password Multiplier (WWW 2005)

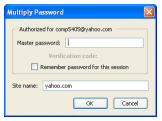
PwdHash

@@ in front of passwords to protect; or F2

sitePwd = Hash(pwd,domain)

Prevent phishing attacks

Password Multiplier



Active with Alt-P or double-click

sitePwd = Hash(usrname, pwd, domain)

Both solutions target simplicity and transparency.

Usenix 2006: Usabilty testing

- Are these programs usable? If not, what are the problems?
- Two main approaches for evaluating usability:
  - Usability inspection (no users)
    - Cognitive walk throughs
    - Heuristic evaluation
  - User study
  - Controlled experiments
  - Real usage

This paper stresses need to observe real users

[Chiasson, van Oorschot, Biddle]

Study details

- 26 participants, across various backgrounds (4 technical)
- Five assigned tasks per plugin
- Data collection
  - Observational data (recording task outcomes, difficulties, misconceptions)
  - Questionnaire data (initial attitudes, opinions after tasks, post questionnaires)

[Chiasson, van Oorschot, Biddle]

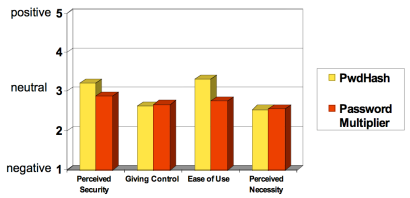
Task completion results

	Success	Potentially Causing Security Exposures			
		Dangerous Success	Failures		
			Failure	False Completion	Failed due to Previous
PwdHash					
Log In	48%	44%	8%	0%	N/A
Migrate Pwd	42%	35%	11%	11%	N/A
Remote Login	27%	42%	31%	0%	N/A
Update Pwd	19%	65%	8%	8%	N/A
Second Login	52%	28%	4%	0%	16%
Password Multiplier					
Log In	48%	44%	8%	0%	N/A
Migrate Pwd	16%	32%	28%	20%	N/A
Remote Login	N/A	N/A	N/A	N/A	N/A
Update Pwd	16%	4%	44%	28%	N/A
Second Login	16%	4%	16%	0%	16%

http://www.scs.carleton.ca/~achiasso/Chiasson_UsenixSecurity2006_PwdManagers.ppt

[Chiasson, van Oorschot, Biddle]

Questionnaire responses



http://www.scs.carleton.ca/~achiasso/Chiasson_UsenixSecurity2006_PwdManagers.ppt

Problem: Transparency

- Unclear to users whether actions successful or not.
  - Should be obvious when plugin activated.
  - Should be obvious when password protected.
- Users feel that they should be able to know their own password.

Problem: Mental model

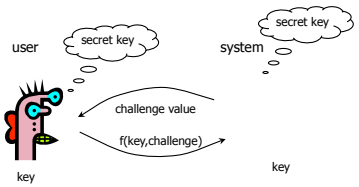
Users seemed to have misaligned mental models

- Not understand that one needs to put "@@" before *each* password to be protected.
- Think different passwords generated for each session.
- Think successful when were not.
- Not know to click in field before Alt-P.
- PwdHash: Think passwords unique to them.

When "nothing works"

- Tendency to try all passwords
  - A poor security choice.
  - May make the use of PwdHash or Password Multiplier *worse* than not using any password manager.
- Usability problem leads to security vulnerabilities.

Challenge-Response (Over Network)



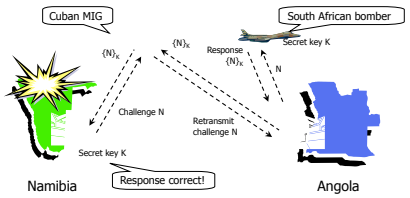
Why is this better than a password over a network?

Any problems remain?

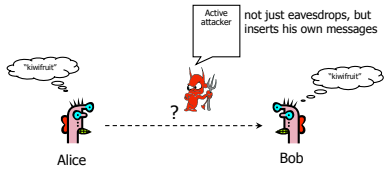
Challenge-Response Authentication

- User and system share a secret key
- Challenge: system presents user with some string
- Response: user computes response based on secret key and challenge
  - Secrecy: difficult to recover key from response
    - One-way hashing or symmetric encryption work well
  - Freshness: if challenge is fresh and unpredictable, attacker on the network cannot replay an old response
    - For example, use a fresh random number for each challenge
- Good for systems with pre-installed secret keys
  - Car keys; military friend-or-foe identification

MIG-in-the-Middle Attack [Ross Anderson]



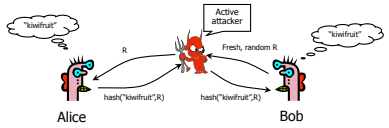
Authentication with Shared Secret



Alice and Bob share some secret.
How can they identify each other on the network?

What have we learned from the systems we've seen?

Challenge-Response

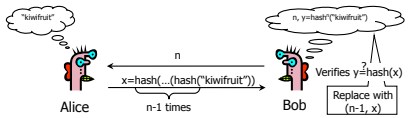


- Man-in-the-middle attack on challenge-response
  - Attacker successfully authenticates as Alice by simple replay
- This is an attack on authentication, not secrecy
  - Attacker does not learn the shared secret
- However, response opens the door to offline dictionary attack

Encrypted Timestamp

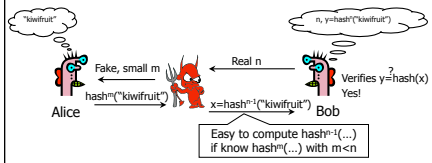
- Requires synchronized clocks
  - Bob's clock must be secure, or else attacker will roll it back and reuse an old authentication message from Alice
- Attacker can replay within clock skew window

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

Adversaries To Consider

- 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
- Offline vs online guessing attacks