Security building blocks: authentication

Markus Peuhkuri

2006-03-28

Lecture topics

- Authentication
- Different methods to authenticate
- Caveats in authentication

How one authenticates

- What one *knows*
  - passwords, PIN
- What one *has*
  - keys, smartcards
- *What* one *is*
  - biometric identification
- *Where* one *is*
  - terminal, geographic restrictions

Risks on authentication

- Masquerade
  - use of victim's resources
- Multiple identities
  - social benefits, voting, law enforcement
- Identity theft
  - victim's identity, attackers authentication
- Failed authentication

Attacks on authentication

- Trial and error
  - password guessing
  - token authenticator subverting
  - team attack on biometrics

  ⇒limit attack space: number of attempts. However, that may result a denial of service.

  For example, Microsoft recommends using indefinite locking on accounts after 5 failed attempts. NSA recommendation is 15 hours after 3 failed attempts – some may argue that 48 hours (over weekend) would be better.

- Replication of authenticator
- Stealing of authenticator
- Playback attack

Deploying authentication

- Enrolment
  - trusted administrator ⇔ self-enrolment
- Maintenance
  - password aging, update of biometrics
- Revocation
  - lost token, disclosed secret key
- Operational problems
  - re-establishing authenticator

Economics of authentication

- Software
  - for organisation, system
- Hardware
  - for site, user, workstation
- Enrolment costs
  - administration, per user costs
- Usage costs
  - time spent by a user to authenticate
- Maintenance
  - time spent to maintain system: for system administration and user time to renew password.
- Problem recovery
  - lost devices, forgotten passwords, flu
- Availability
  - cost of lost access
- Revocation costs
  - removing rights from user, lost authenticators

Passwords

- The prevailing method to authenticate
- No extra hardware needed
- Can be as strong as wanted
  - 8-character password of printable ASCII characters
    ⇒ 52-bit key
  - 20-character ⇒128 bits
- In reality, the key space is much smaller
- User memory overloading with passwords
  ⇒ post-it password manager®

Study on password quality [2]

- Students divided into 3 groups

  control group given traditional advice: Your password should be at least seven characters long and contain at least one non-letter.

  random password group selecting randomly letters from a sheet

  passphrase group using a mnemonic phrase to aid remembering

	Cracked %		Difficulty	
group	dictionary	+brute-force	1-5	weeks to learn
control	32	3	1.52	0.7
random	8	3	3.15	4.8
phrase	6	3	1.67	0.6
other	33	2		

So, what is a good password policy?

- Promote mnemonic-based passwords
  - easy to remember
  - difficult to guess
- Use long enough passwords[1]
- Advice using non-alphanumeric characters[2]
- Enforce user compliance
  - does a bad password endanger system or other users?[3]
  - random assigned passwords a method to enforce quality, providing risk of write-down

Password storage

- If stored in plain, system compromise leads to disclosure
  ⇒ possible large-scale compromise
- Most often stored in encrypted form: like a MD5 hash from password and salt
- Using external authentication server
  - is it possible to capture password on wire (e.g. PAP authentication)
- Distributed knowledge of the right authentication

[1] Minimum 8 characters, more if case does not matter.
[2] Note, that those position differs in different keyboards.
[3] Or, should users be protected from themselves.

Using passwords

- Password recovery on web sites
  - a new password or a link to reset the password emailed to the user on one's request
  - possibly a verification question, like what is mother's maiden name
  - all rely on the mail password
  - low-cost, self-service — mostly ok
- Initial passwords
  - often badly chosen
  - opens window of attack before user changes
  - latent accounts: accounts that are created but newer used

Authentication tokens

- A device with a cryptographic processor
  - the key is kept on device, only results communicated
  - may be in several physical forms: card, USB key
- GSM SIM module
- Challenge-response calculators
- Time-based tokens
- Should be tamper-resistant
- Ancient signet ring was an authentication token

Using authentication token

- Separates the authentication from a larger device
  - revocation costs less
  - class compromise may not be fatal
- Strictly controlled environment easier to analyse
- Less trust on third-party devices
- Less trust on software
- Provides keys for network communications

Multi-factor authentication

- Compromise of single factor does not endanger system
  - password on local terminal
  - ssh key authentication from a network (the private key protected by passphrase)
  - debit card and PIN
- Pluggable Authentication Modules (PAM)
  - possible to have any combination of authentication
  - for Unix and Windows

Biometrics

- 1997: year of biometrics... and since then
- The method used by humans

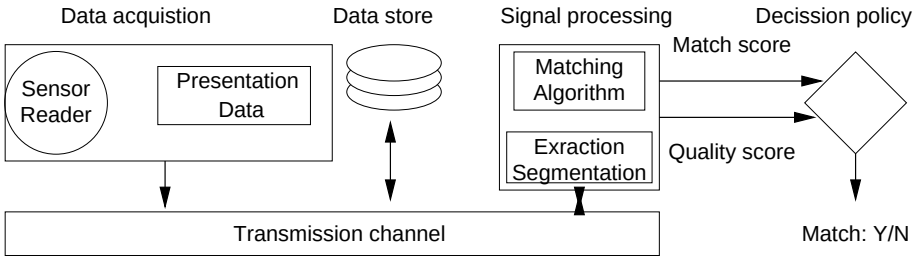
  > *She put the skins of the kids of the goats on his hands, and on the smooth of his neck. ... Jacob went near to Isaac his father. He felt him, and said, "The voice is Jacob's voice, but the hands are the hands of Esau." (Genesis 27:16)*

- Why to use biometrics
  - convenient: the authenticator is always with you
  - need for a strong authentication: difficult to steal or lose — however it may result in physical violence and injury on the person.
  - decreased cost of devices
  - government and industry adoption
  - embedded rfid tags

Trusted path

- How a user knows she is not talking to Trojan horse
  - attention key Crtl-Alt-Del
  - a small, external device with own keypad
- How the system knows there is a human
- Can someone record and replay the authentication tokens

Components of biometric system [1, p. 29]



[1]

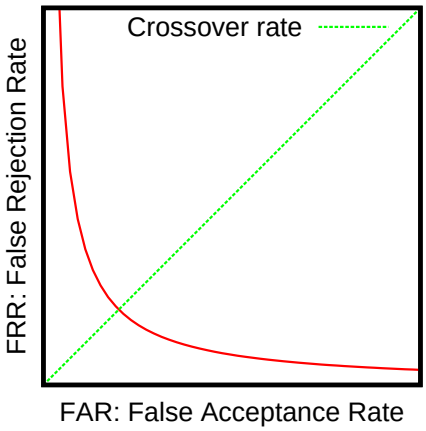
$$FAR = \frac{False\ acceptance\ count}{total\ number\ of\ samples} \qquad \text{(Type II error)} \qquad (1)$$

$$FRR = \frac{False\ rejections\ count}{total\ number\ of\ samples} \qquad \text{(Type I error)} \qquad (2)$$

- failure rate
- insult rate

Identification $\Leftrightarrow$ authentication

- Sheep $\Leftrightarrow$ goats



- Identification
  - who is this person?
  - selecting one from a large group
    $\Rightarrow$ high error rate
  - birthday paradox
- Authentication
  - is this person N.N.?
  - checking if the person matches to one's records

Biometric characteristics based on

- Genetics
- Phenotype
- Behavioural
- Liveness testing an important part

Biometrics

- Fingerprint
  - used for thousands of years, crime 1870s
  - 256 – 1200 B
  - degeneration of fingerprints
  - 1 – 3 % of population has problems authenticating
- Hand geometry
  - hand and finger length, width
  - 9 B
  - injury
  - 1.5 % error rate
- Facial
  - works best with "mug shots"
  - 80 – 2000 B
  - environmental factors
  - typical 10 – 25 % error rate

- Voice
  - 70 – 80 B/sec
  - illness, noise, communications
  - 2 % error rate
- Signature
  - 500 – 1000 B
  - lots of variable factors
- Keystroke dynamics
  - continuous monitoring
  - high FRR
- Iris
  - 256 – 512 B
  - glasses, positioning
  - 10 s authentication time
  - very low error rate
- Retina
  - 96 B
  - illness
  - awkward method, difficult to record without user knowledge
  - very low error rate

Experimental biometrics

- Vein patterns back of hand
- Facial thermography
- DNA
- Sweat pores
- Hand grip
- Fingernail bed
- Body odour
- Ear shape
- Gait: body motion (VTT has developed mobile phone security mechanisms using acceleration sensors)
- Skin luminance
- Brain wave pattern
- Footprint, foot dynamics

Location security

- Physical security well understood
  - radio waves does not stop on walls[4]
- Many problems solved with a human monitoring
  - voting
  - biometrics
- Restricts possibility of an attacker
  - the administrator password can be entered from the connected console in secure machine room
- Use of GPS or other positioning method
- Enforcing communication delay limits

Summary

- Password is still good
- If it is man-made, a man can break it
- Selecting right compromise between FAR — FRR
- Beware denial of service

References

[1] Jr. John D. Woodward, Nicholas M. Orlans, and Peter T. Higgins. *Biometrics*. McGraw-Hill/Osborne, 2003.

[2] J. Yan, A. Blackwell, R. Anderson, and A. Grant. Password memorability and security: empirical results. *IEEE Security & Privacy Magazine*, 2(5):25–31, September 2004.

[4] Unless you want to extend coverage of your WLAN network.