Strengths and Weaknesses of Access Control Systems

Eric Schmiedl and Mike Spindel



Choosing a System

- Error rate
- Environment
- Cost
- Physical Vulnerability
- Additional Constraints





Error Rate

- False Reject Rate (Type I error)
- False Accept Rate (Type II error)
- Equal Error Rate





Environment

- Does it have to handle inclement weather?
- Vandals?
- Extreme temperatures?







• You're on a budget.

Physical Vulnerability

- Decreased resistance to forced and covert entry
 - Electromagnets can be bypassed with packing tape
 - Electric strikes can disable anti-loiding features on locksets
 - "Loiding": from the celluloid strips originally used to slip latches. Credit cards can also be used.
 - Request to exit sensors can be defeated with balloons, long pieces of plastic, etc.

Additional Constraints

- What load does the system need to handle? How fast does it have to process users?
- Do you need different levels of access for different users? An audit trail?
- Does the system have to talk to a separate alarm system?
- Will it detect or resist physical attacks?

How to improve the security of any access control system





Stacking

What you have + What you know + What you are

- Improve either FAR or FRR (in the most common configuration)
- Can reduce security
 - e.g. mechanical key bypass

Centralized systems

- Terminals
- Communication lines
- Servers

Categories of Systems

- Guard
- Token
- Knowledge
- Biometric



- Good:
 - Simple
 - Low initial cost
 - Fast
 - Not affected by the environment.





- Bad:
 - Easy to counterfeit ID cards
 - Cards can be stolen
 - People get complacent
 - Guards have salaries, not a one-time purchase cost.







Source: www.african-safari-pictures.com





• Ugly:



- Ugly:
 - 32.6% error overall



- Ugly:
 - 32.6% error overall
 - Paranoid: 3/6 cashiers rejected a recent, accurate photo at least once

- Ugly:
 - 32.6% error overall
 - Paranoid: 3/6 cashiers rejected a recent, accurate photo at least once
 - 34.09% of the time a blatantly wrong photo was accepted

- Ugly:
 - 32.6% error overall
 - Paranoid: 3/6 cashiers rejected a recent, accurate photo at least once
 - 34.09% of the time a blatantly wrong photo was accepted
 - 50% false accept rate

- Ugly:
 - 32.6% error overall
 - Paranoid: 3/6 cashiers rejected a recent, accurate photo at least once
 - 34.09% of the time a blatantly wrong photo was accepted
 - 50% false accept rate
 - 63.64% FAR for a similar-looking photo





Tokens

- Mechanical key locks
- Magnetic cards
- Barcodes
- Proximity / RFID
- Smart cards / CPU tokens
- BFV and Wiegand Wire
- VingCard



Mechanical key locks

- Very reliable and need no power supply
- No audit trail
- Lots of security issues
 - Picking
 - Bumping
 - Decoding
- Attacking the master key
- Many different mechanical lock technologies





VingCard

- Mechanical keycards
- Quick to rekey
- Easy to copy
 - Hotel thieves example
- Electronic lock decoding
- Low security





Magnetic Stripe cards

- Low vs. High Coercivity
- Reliable (as long as there's no magnet around)
- Audit trail limited by back-end
- Cheap
- Trivial to read, duplicate, and potentially modify



Barrium Ferrite Cards

- Preceded HiCo magstripe standard
- Embedded layer of Barium Ferrite
- Tough:
 - Weather-resistant
 - High Coercivity
- Easy to decode
- Last seen in an automated parking system

Wiegand Wire

- Processed magnetic alloy
- Single apparent domain wall
- Low coercivity core
- High coercivity shell



 \leftarrow | \Rightarrow



Wiegand







Wiegand Wire

- First attack published in 1996 on cypherpunks list:
 - Cut wires out of a card and rearrange
- Vulnerable to emulation style attacks





Barcodes

- Cheap, low security
- ID and 2D versions
- Easy to duplicate
- Invisible barcodes





Prox / RFID

- Many well-known issues
- Cloning
- Hybrid RFID / Magstripe systems

http://web.mit.edu/keithw/Public/MIT-Card-Vulnerabilities-March31.pdf



Richard M. Stallman's Office Key





CPU Tokens

- Smart cards, iButtons
- It's easy to make a 'virtual' token
- Cryptographic authentication is necessary for real security
- DirecTV vs. Hackers



Image from CA Technology Inc. / Keylessdepot.com





Knowledge

- Mechanical combination locks
- Electronic keypads
- Safe-type electronic locks





Mechanical combination locks



Mechanical combination locks

- Good:
 - Simple, reliable, and no power necessary


Mechanical combination locks

- Good:
 - Simple, reliable, and no power necessary
- Bad:
 - No audit trail
 - Can be manipulated (usually)
 - Brute force attack
 - <u>http://www.cs.berkeley.edu/</u> ~bh/v3ch2/math.html
 - <u>http://www.tech-faq.com/</u> <u>simplex-lock-</u> <u>combinations.shtml</u>







Simplex operation



 $\blacklozenge | \diamondsuit$

Opening Procedure





Which tumbler is binding?





Push I. Is a new tumbler binding?







Advance tumbler I by pushing a "throwaway" button -here, number 5 -- and check if another tumbler is binding







Reset, and try the combination 152



Check if any new tumblers are binding now





Reset, and try the combination 125



Check if any new tumblers are binding now





Reset and try the combination 123













• Attacks





- Attacks
- The UV powder trick
 - Attacker needs to enter very many combinations
 - So use a highlighter





- Attacks
- The UV powder trick
 - Attacker needs to enter very many combinations
 - So use a highlighter
- Shoulder surfing and hidden cameras









1 2 3 Clear 4 5 6 F1 7 8 9 F2 No 0 # Enter

al 2 Clear 4 5 6 F1 7 8 9 F2

1 2 3 Clear 4 5 6 F1 7 8 9 F2 *
No0#
YesEnter

1 2 Clear **4** 5 6 F1 7 8 9 F2 No 0 # Enter

1 2 3 Clear 4 5 6 F1 7 8 9 F2 No 0 # Enter

1 2 3 Clear 5 6 F1 7 8 9 F2 No 0 # Enter



1 2 3 Clear 4 5 6 F1 7 8 9 F2 No 0 # Enter

 $\langle \bullet | \bullet \rangle$

1 2 3 Clear 4 5 6 F1 7 8 9 F2 No 0 # Enter



1 2 3 Clear 4 5 6 F1 7 8 9 F2 No 0 # Enter







Electronic keypads



Photograph by Schlage

< | →

Electronic keypads

 Dynamically changing "scramble-key" high-security keypads fix most of these problems



Photograph by Schlage

- Dynamically changing "scramble-key" high-security keypads fix most of these problems
- Users can still distribute the combination



Photograph by Schlage

î



Safe-type electronic locks











• Very secure



- Very secure
- Audit trail usually available
 - LaGard Navigator
 - Web-based lock designed for ATMs, extensive audit trail
 - User connects smart phone or PDA loaded with client software that allows the lock to communicate with the server



- Very secure
- Audit trail usually available
 - LaGard Navigator
 - Web-based lock designed for ATMs, extensive audit trail
 - User connects smart phone or PDA loaded with client software that allows the lock to communicate with the server
- Some are vulnerable to spiking and other safe-technician tricks



Biometrics

- Voice
- Face
- Fingerprints
- Hand geometry
- Retina scan
- Iris scan
- Signature




Voice pattern recognition

- Reliability
 - Time, stress, illness
- Easy to defeat





Face recognition

Hold up a photo or a laptop







- Guess what your fingers leave behind on the sensor?
 - Use gummi bears, breath, water-filled bag (condom)



- Guess what your fingers leave behind on the sensor?
 - Use gummi bears, breath, water-filled bag (condom)
- Environment around the sensor has fingerprints too



- Guess what your fingers leave behind on the sensor?
 - Use gummi bears, breath, water-filled bag (condom)
- Environment around the sensor has fingerprints too
- Supervision by trained guards

î

Multispectral imaging

- The manufacturer claims that it:
 - Does not require contact between the finger and reader
 - Is capable of reading when the reader is immersed in water
 - Inherently differentiates between a live finger and any prosthetic



Multispectral Imager



Images from lumidigm.com



Multispectral imaging http://www.lumidigm.com

Hand geometry

- Hands are not unique
 - Privacy
- Dummy hands







Retina scan

- Nobody in the public literature has yet falsified a retina.
- Invasive





lris scan





lris scan

- Effectively zero error rate
 - I in I million Equal Error Rate
 - For FRR of 0.0001%, an FAR of 1 in a trillion (1×10^{-12})



lris scan

- Effectively zero error rate
 - I in I million Equal Error Rate
 - For FRR of 0.0001%, an FAR of 1 in a trillion (1×10^{-12})
- Defeating iris scan
 - Magazine covers
 - Printing on contact lenses



Signature

- Measure pressure and velocity
- 1% ERR
 - Banks demand 1% FAR and 0.01% FRR
- Forging signatures is easy to learn

Hanco Ck Rot Frear Painte In John Adams Gran 'Lewis Josiah Bartleto Jam Hunting Sten Argikisis John Hast Abra Clark Lewis Morns Matthew . Th William Ellery I Ben Frankling William, "Tras Hopkinson Thos Stone (harles arroll of Carrollin





Further reading

- Ross Anderson's <u>Security Engineering</u>
- Ross, et al. <u>Handbook of Multibiometrics</u>