CompTIA Security+ Guide to Network Security Fundamentals, Sixth Edition

Chapter 11

Authentication and Account Management

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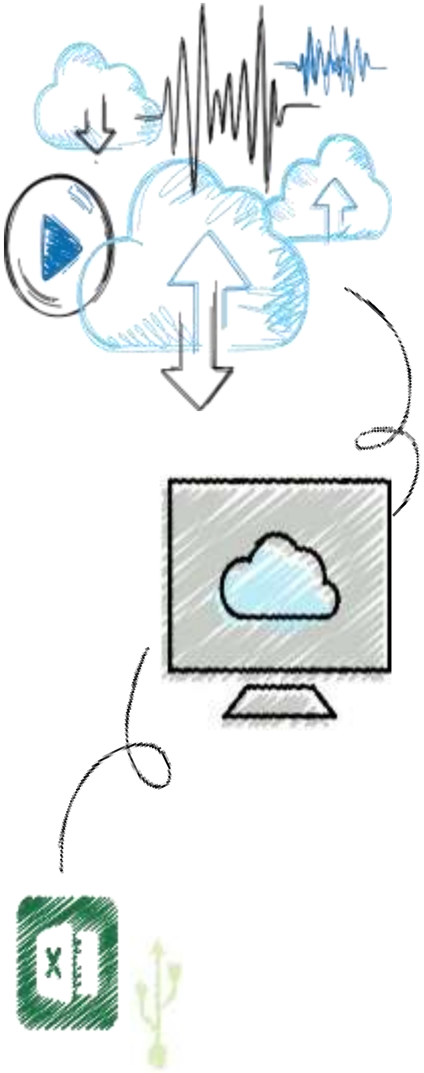


Objectives

11.1 Describe the different types of authentication credentials

11.2 Explain what single sign-on can do

11.3 List the account management procedures for securing passwords

Authentication Credentials (1 of 2)

- Types of authentication credentials
  - Where you are
    - Example: a military base
  - What you have
    - Example: key fob to lock your car
  - What you are
    - Example: facial characteristics recognized
  - What you know
    - Example: combination to health club locker
  - What you do
    - Example: do something to prove authenticity

Authentication Credentials (2 of 2)

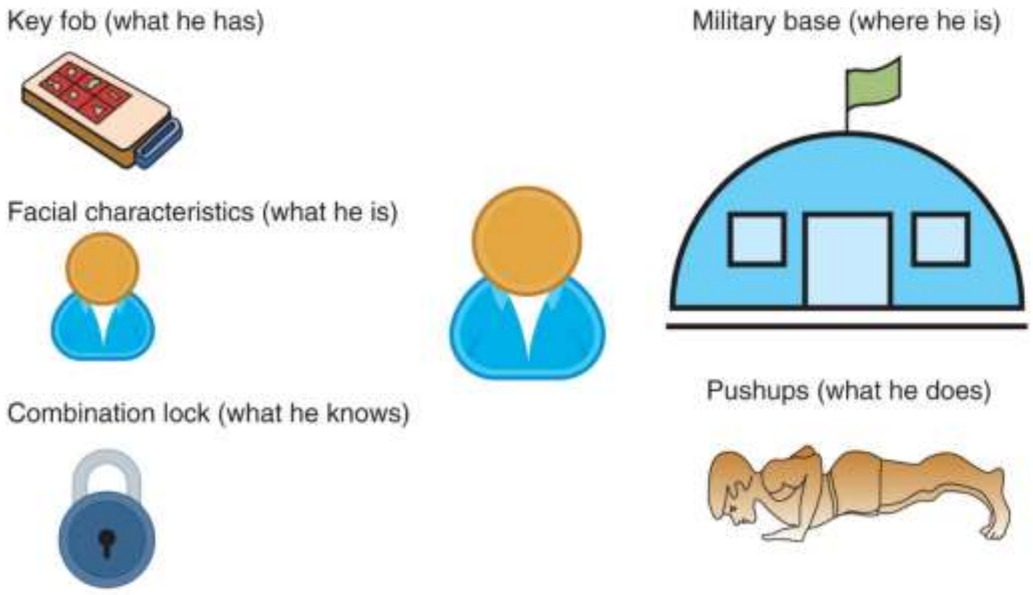

Key fob (what he has)
Facial characteristics (what he is)
Combination lock (what he knows)
Military base (where he is)
Pushups (what he does)

Figure 11-1 Ermanno's authenticity

What You Know: Passwords

- User logging in to a system
  - Asked to identify himself
    - User enters username
  - User asked to authenticate
    - User enters password
- Passwords are the most common type of authentication today
- Passwords provide only weak protection
  - Actions can be taken to strengthen passwords

Password Weaknesses (1 of 3)

- Weakness of passwords is linked to human memory
  - Humans can memorize only a limited number of items
- Long, complex passwords are most effective
  - Most difficult to memorize
- Users must remember passwords for many different accounts
- Each account password should be unique
- Security policies mandate passwords must expire
  - Users must repeatedly memorize passwords

Password Weaknesses (2 of 3)

- Users often take shortcuts
  - Using a weak password
    - Examples: common words, short password, or personal information
  - When attempting to create stronger passwords, they generally follow predictable patterns:
    - Appending: using letters, numbers, and punctuation in a pattern
    - Replacing: users use replacements in predictable patterns

Password Weaknesses (3 of 3)

Rank	Password
1	123456
2	123456789
3	abc123
4	password
5	password1
6	12345678
7	111111
8	1234567
9	12345
10	1234567890

Attacks on Passwords (1 of 9)

- Attacks that can be used to discover passwords:
  - Social engineering
    - Phishing, shoulder surfing, dumpster diving
  - Capturing
    - Keylogger, protocol analyzer
    - Man-in-the-middle and replay attacks
  - Resetting
    - Attacker gains physical access to computer and resets password

Attacks on Passwords (2 of 9)

- Offline attack
  - Method used by most password attacks today
  - Attackers steal file of password digests
    - Compare with their own digests they have created
- Offline password attacks include:
  - Brute force
  - Mask
  - Rule
  - Dictionary
  - Rainbow tables
  - Password collections

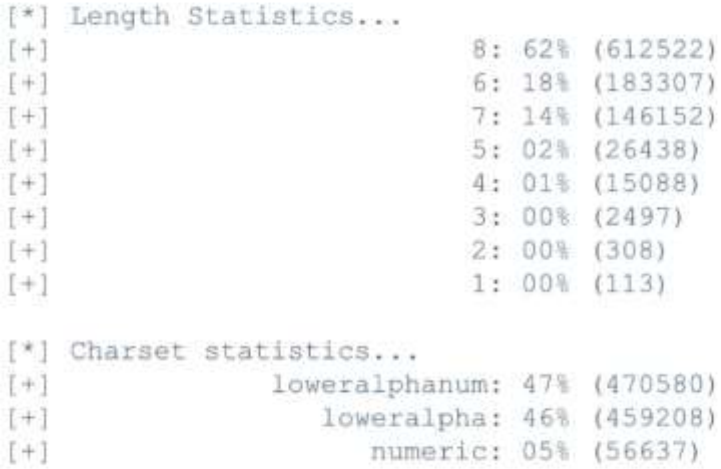
Attacks on Passwords (3 of 9)

- Brute force
  - Every possible combination of letters, numbers, and characters used to create encrypted passwords and matched against stolen file
  - Slowest, most thorough method
  - NTLM (New Technology LAN Manager) hash
    - An attacker who can steal the digest of an NTLM password would not need to try to break it
    - He would simply pretend to be the user and send that hash to the remote system to then be authenticated
    - Known as a pass the hash attack

Attacks on Passwords (4 of 9)

- Mask Attack
  - A more targeted brute force attack that uses placeholders for characters in certain positions of the password
  - Parameters that can be entered in a mask attack include:
    - Password length
    - Character set
    - Language
    - Pattern
    - Skips
- Rule Attack
  - Conducts a statistical analysis on the stolen passwords that is used to create a mask to break the largest number of passwords

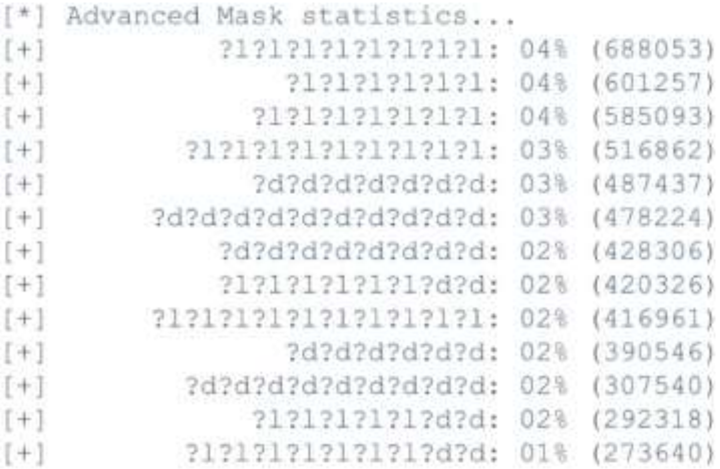
Attacks on Passwords (5 of 9)



```
[*] Length Statistics...
[+]                         8: 62% (612522)
[+]                         6: 18% (183307)
[+]                         7: 14% (146152)
[+]                         5: 02% (26438)
[+]                         4: 01% (15088)
[+]                         3: 00% (2497)
[+]                         2: 00% (308)
[+]                         1: 00% (113)

[*] Charset statistics...
[+]              loweralphanum: 47% (470580)
[+]                 loweralpha: 46% (459208)
[+]                    numeric: 05% (56637)
```

Figure 11-2 Rule attack statistical analysis



```
[*] Advanced Mask statistics...
[+]          ?l?l?l?l?l?l?l?l: 04% (688053)
[+]              ?l?l?l?l?l?l: 04% (601257)
[+]            ?l?l?l?l?l?l?l: 04% (585093)
[+]        ?l?l?l?l?l?l?l?l?l: 03% (516862)
[+]            ?d?d?d?d?d?d?d: 03% (487437)
[+]      ?d?d?d?d?d?d?d?d?d?d: 03% (478224)
[+]          ?d?d?d?d?d?d?d?d: 02% (428306)
[+]          ?l?l?l?l?l?l?d?d: 02% (420326)
[+]      ?l?l?l?l?l?l?l?l?l?l: 02% (416961)
[+]              ?d?d?d?d?d?d: 02% (390546)
[+]        ?d?d?d?d?d?d?d?d?d: 02% (307540)
[+]            ?l?l?l?l?l?d?d: 02% (292318)
[+]        ?l?l?l?l?l?l?l?d?d: 01% (273640)
```

Figure 11-3 Rule attack generated masks

Attacks on Passwords (6 of 9)

- Dictionary Attack
  - Attacker creates digests of common dictionary words
  - Compares against stolen digest file
  - Pre-image attack - a dictionary attack that uses a set of dictionary words and compares it with the stolen digests
  - Birthday attack - the search for any two digests that are the same

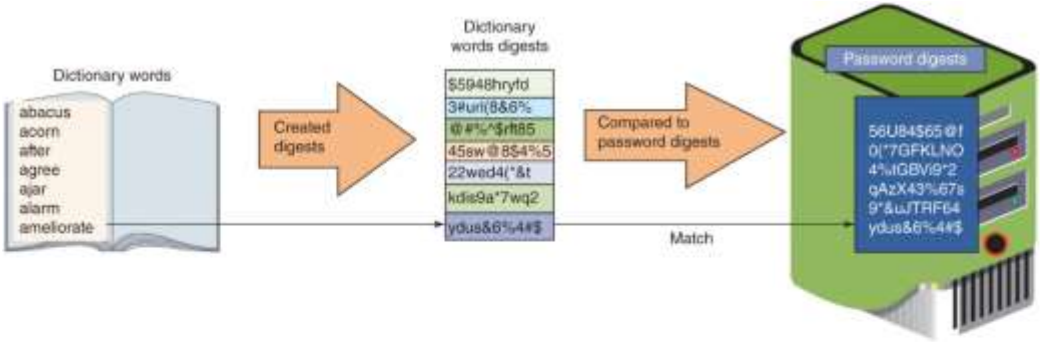


Figure 11-4 Dictionary attack

Attacks on Passwords (7 of 9)

- Rainbow Tables
  - Creates a large pregenerated data set of candidate digests
- Steps for using a rainbow table
  - Creating the table
    - Chain of plaintext passwords
    - Encrypt initial password
    - Feed into a function that produces different plaintext passwords
    - Repeat for a set number of rounds
  - Using the table to crack a password
    - Run encrypted password though same procedure used to create initial table
    - Results in initial chain password

Attacks on Passwords (8 of 9)

- Using the table to crack a password (cont'd.)
  - Repeat, starting with this initial password until original encryption is found
  - Password used at last iteration is the cracked password
- Rainbow table advantages over other attack methods
  - Can be used repeatedly
  - Faster than dictionary attacks
  - Less memory on the attacking machine is required

Attacks on Passwords (9 of 9)

- Password Collections
  - In 2009, an attacker used an SQL injection attack and more than 32 million user passwords (in cleartext) were stolen
  - These passwords provided two key elements for password attacks:
    - Gave attackers a large corpus of real-world passwords
    - Have provided attackers advanced insight into the strategic thinking of how users create passwords

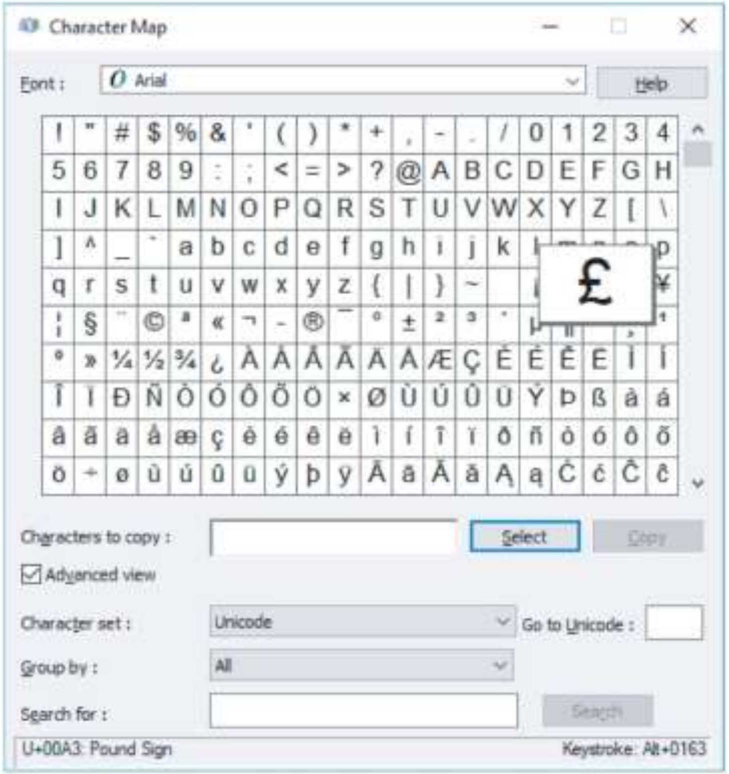
Password Security (1 of 5)

- Securing passwords from attacks depends upon the user as well as the enterprise
- For the user
  - It involves properly managing passwords
- For the enterprise
  - It involves protecting password digests

Password Security (2 of 5)

- Managing Passwords
  - Most critical factor in a strong password is length
  - In addition to having long passwords, other recommendations are:
    - Do not use passwords that consist of dictionary words or phonetic words
    - Do not repeat characters or use sequences
    - Do not use birthdays, family member names, pet names, addresses, or any personal information
  - Also, use non-keyboard characters
    - Created by holding down the ALT key while typing a number on the numeric keypad

Password Security (3 of 5)



Font : Arial

Characters to copy :

☑ Advanced view

Character set : Unicode

Go to Unicode :

Group by : All

Search for :

U+00A3: Pound Sign

Keystroke: Alt+0163

Figure 11-5 Windows character map

Password Security (4 of 5)

- Password managers
  - Technology used for securing passwords
  - Three basic types of password manager:
    - Password generators
    - Online vaults
    - Password management applications
- Protecting Password Digests
  - One method is to use salts
    - Consists of a random string that is used in hash algorithms
    - Passwords can be protected by adding a random strong to the user’s cleartext password before it is hashed
    - Make dictionary attacks and brute force attacks much slower and limit the impact of rainbow tables

Password Security (5 of 5)

- Protecting Password Digests (continued)
  - Another method is to use key stretching
    - A specialized password hash algorithm that is intentionally designed to be slower
    - Two key stretching algorithms: brypt and PBKDF2
- Recommendation for enterprises using salts and key stretching:
  - Use a strong random number generator to create a salt of at least 128 bits
  - Input the salt and the user’s plaintext password into the PBKDF2 algorithm that is using HMAC-SHA-256 as the core hash
  - Perform at least 30,000 iterations on PBKDF2
  - Capture the first 256 bits of output from PBKDF2 as the password digest
  - Store the iteration count, the salt, and the password digest in a secure password database

What You Have: Tokens, Cards, and Cell Phones

- Multifactor authentication
  - When a user is using more than one type of authentication credential
  - Example: what a user knows and what a user has could be used together for authentication
- Single-factor authentication
  - Using just one type of authentication
- Most common items used for authentication:
  - Tokens, cards, and cell phones

Tokens (1 of 3)

- Tokens
  - Used to create a one-time password (OTP)
    - Authentication code that can be used only once or for a limited period of time
  - Hardware security token
    - Typically a small device with a window display
  - Software security token
    - Stored on a general-purpose device like a laptop computer or smartphone
- Two types of OTPs
  - Time-based one-time password (TOTP)
    - Synched with an authentication server
    - Code is generated from an algorithm
    - Code changes every 30 to 60 seconds

Tokens (2 of 3)

- Two types of OTPs (continued)
  - HMAC-based one-time password (HOTP)
    - “Event-driven” and changes when a specific event occurs
- Advantages over passwords
  - Token code changes frequently
    - Attacker would have to crack code within time limit
  - User may not know if password has been stolen
    - If token is stolen, it becomes obvious and steps could be taken to disable account

Tokens (3 of 3)

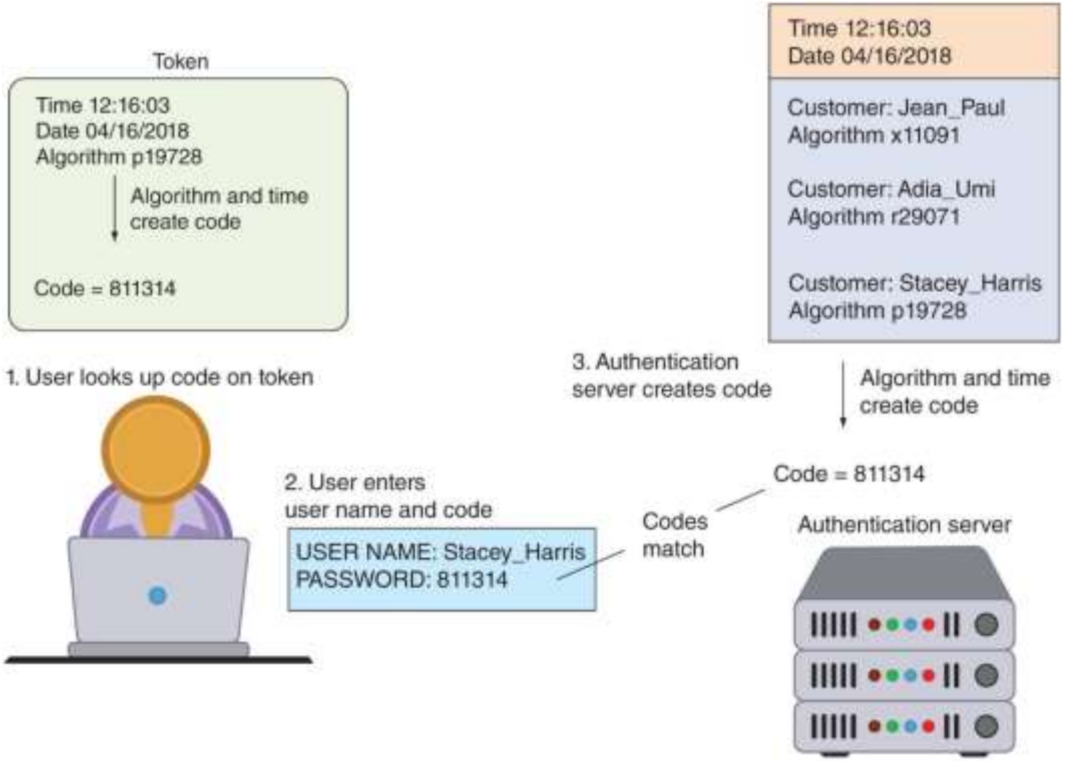


Figure 11-7 Time-based one-time password (TOTP)

Cards (1 of 2)

- Smart card contains integrated circuit chip that holds information and can be either:
  - Contact card – a “pad” that allows electronic access to chip contents
  - Contactless cards (proximity cards)
    - Require no physical access to the card
  - Common access card (CAC)
    - Issued by US Department of Defense
    - Bar code, magnetic strip, and bearer’s picture
- The smart card standard covering all U.S. government employees is the Personal Identity Verification (PIV) standard

Cards (2 of 2)

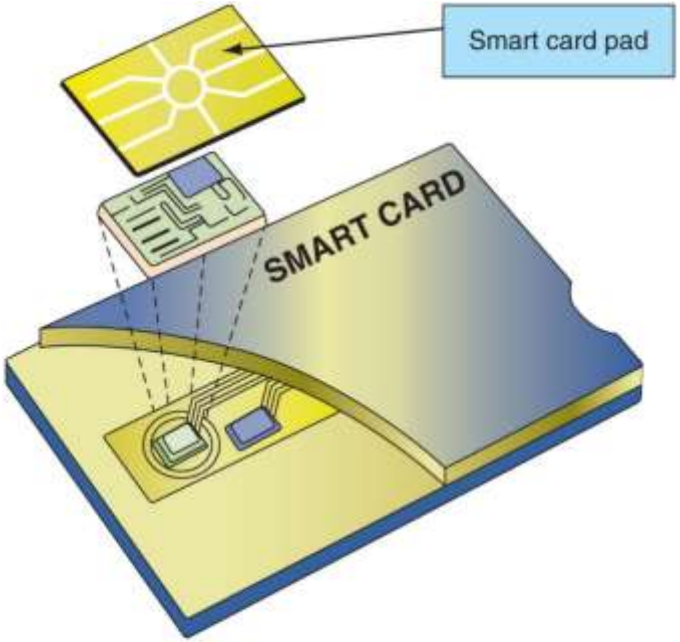


Figure 11-8 Smart card

Cell Phones

- Cell Phones are increasingly replacing tokens and cards
  - A code can be sent to a user’s cell phone through an app on the device
  - Allow a user to send a request via the phone to receive an HOTP authorization code

What You Are: Biometrics

- “Something you are” biometrics involves:
  - Standard biometrics
  - Cognitive biometrics

Standard Biometrics (1 of 4)

- Standard biometrics
  - Uses a person’s unique physical characteristics for authentication
  - Face, hand, or eye characteristics are used to authenticate
- Specialized Biometric Scanners
  - Retinal scanner uses the human retina as a biometric identifier
    - Maps the unique patterns of a retina by directing a beam of low-energy infrared light (IR) into a person’s eye
  - Fingerprint scanner types
    - Static fingerprint scanner - takes a picture and compares with image on file
    - Dynamic fingerprint scanner - uses small slit or opening

Standard Biometrics (2 of 4)

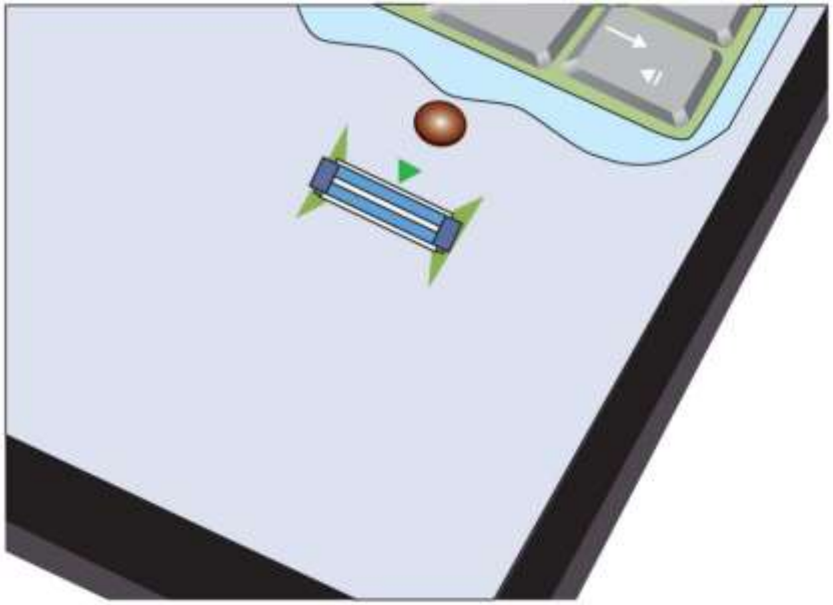


Figure 11-9 Dynamic fingerprint scanner

Standard Biometrics (3 of 4)

- Standard Input Devices
  - Voice recognition uses a standard computer microphone to identify users based on the unique characteristics of a person’s voice
  - Iris scanner uses a standard webcam to identify the unique characteristics of the iris
  - Facial recognition uses landmarks called nodal points on human faces for authentication

Figure 11-10 Iris

creativemarc/Shutterstock.com

Standard Biometrics (4 of 4)

- Biometric Disadvantages
  - Cost of hardware scanning devices
  - Readers have some amount of error
    - Reject authorized users
    - Accept unauthorized users
  - Biometric systems can be “tricked”

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Cognitive Biometrics (1 of 2)

- Cognitive biometrics
  - Relates to perception, thought process, and understanding of the user
  - Easier for user to remember because it is based on user’s life experiences
  - Difficult for an attacker to imitate
- Picture password
  - Introduced by Windows
  - Users select a picture to use for which there should be at least 10 “points of interest” that could serve as “landmarks” or places to touch
- Other examples of cognitive biometrics:
  - Requires user to identify specific faces
  - User selects one of several “memorable events”

Cognitive Biometrics (2 of 2)

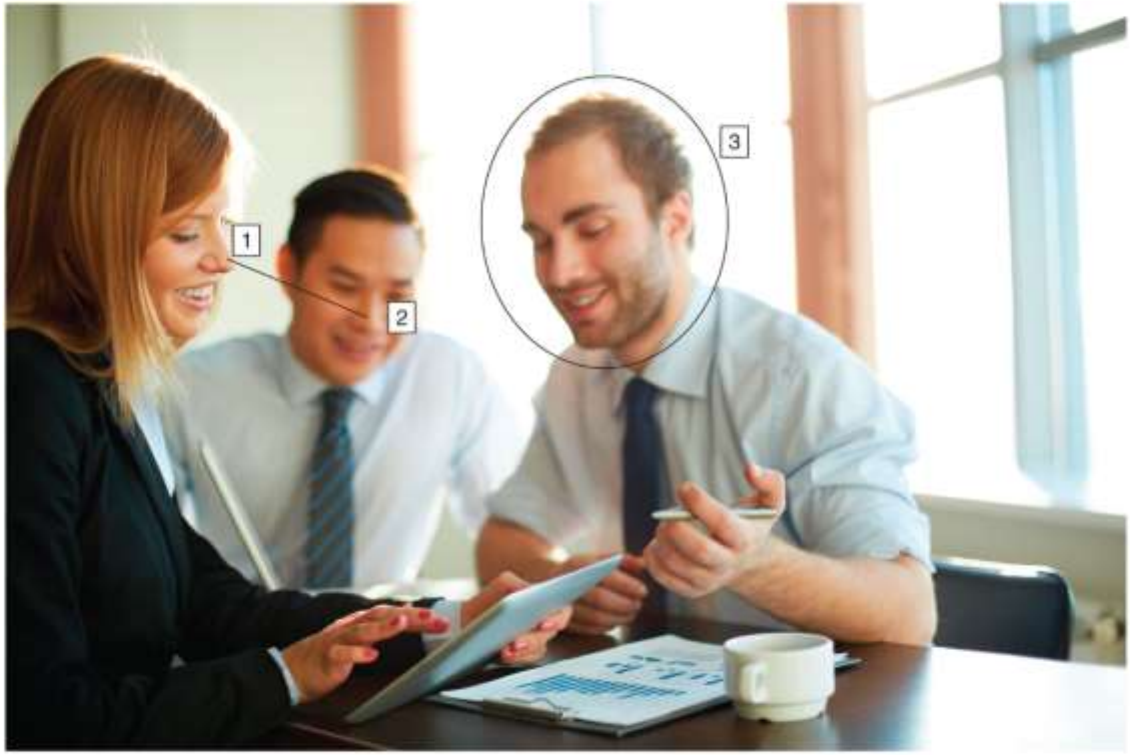

Figure 11-11 Picture password authentication

Pressmaster/Shutterstock.com

What You Do: Behavioral Biometrics (1 of 2)

- Behavioral biometrics
    - Authenticates by normal actions the user performs
- Keystroke dynamics
    - Attempts to recognize user’s typing rhythm
        - All users type at a different pace
        - Provides up to 98 percent accuracy
    - Uses two unique typing variables
        - Dwell time (time it takes to press and release a key)
        - Flight time (time between keystrokes)
    - Holds a great amount of potential
        - It requires no specialized hardware

What You Do: Behavioral Biometrics (2 of 2)

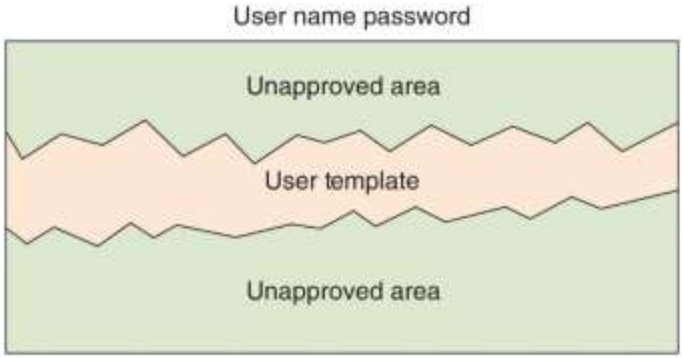

Figure 11-12 Typing template

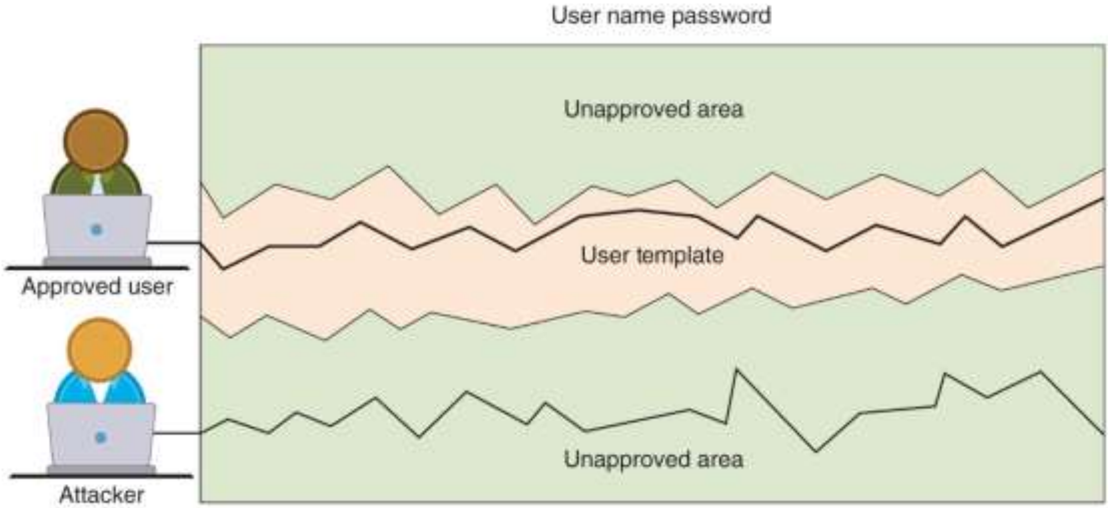

Figure 11-13 Authentication by keystroke dynamics

Where You Are: Geolocation

- Geolocation
  - The identification of the location of a person or object using technology
- Used most often to reject imposters instead of accepting authorized users
  - Can indicate if an attacker is trying to perform a malicious action from a location different from the normal location of the user
  - Many websites will not allow a user to access an account if the computer is located in a different state
  - Some websites may require a second type of authentication
    - A code sent as a text message to a cell phone number on file

Single Sign-on

- Identity management
  - Using a single authentication credential shared across multiple networks
  - It is called federated identity management (FIM) when networks are owned by different organizations
  - Single sign-on (SSO) holds promise to reduce burden of usernames and passwords to just one
- Examples of popular SSOs:
  - OAuth, Open ID Connect, and Shibboleth

Account Management (1 of 2)

- Managing user account passwords
  - Can be done by setting password rules
  - Too cumbersome to manage on a user-by-user basis
    - Security risk if one user setting is overlooked
- Preferred approach: assign privileges by group (group policy)
  - Microsoft Windows group password settings
    - Password Policy Settings
    - Account Lockout Policy

Account Management (2 of 2)

- Other steps to take:
  - A shared account, a generic account, and a guest account should be prohibited
  - Closely monitor any privileged accounts
  - Disable account passwords instead of deleting accounts no longer being used
  - Create strict policies regarding password recovery
- Transitive trust
  - A two-way relationship that is automatically created between parent and child domains in a Microsoft Active Directory Forest
  - When a new domain is created, it shares resources with its parent domain by default
    - Can enable an authenticated user to access resources in both the child and the parent

Chapter Summary (1 of 2)

- Authentication credentials can be classified into five categories: what you know, what you have, what you are, what you do, and where you are
- Passwords provide a weak degree of protection
  - Must rely on human memory
- Most password attacks today use offline attacks
  - Attackers steal encrypted password file
- A dictionary attack begins with the attacker creating digests of common dictionary words, which are compared with those in a stolen password file
- Securing passwords from attacks depends upon the user as well as the enterprise
  - Security experts recommend that technology be used to store and manage passwords called password managers

Chapter Summary (2 of 2)

- Another type of authentication credential is based on the approved user having a specific item in her possession
  - A hardware token is a small device that generates a code from an algorithm once every 30 to 60 seconds
- Biometrics bases authentication on characteristics of an individual
  - Standard and cognitive biometrics are examples
- Behavioral biometrics authenticates by normal actions the user performs
- Single sign-on (SSO) allows a single username and password to gain access to all accounts
- Group Policy settings allow an administrator to set password restrictions for an entire group at once