

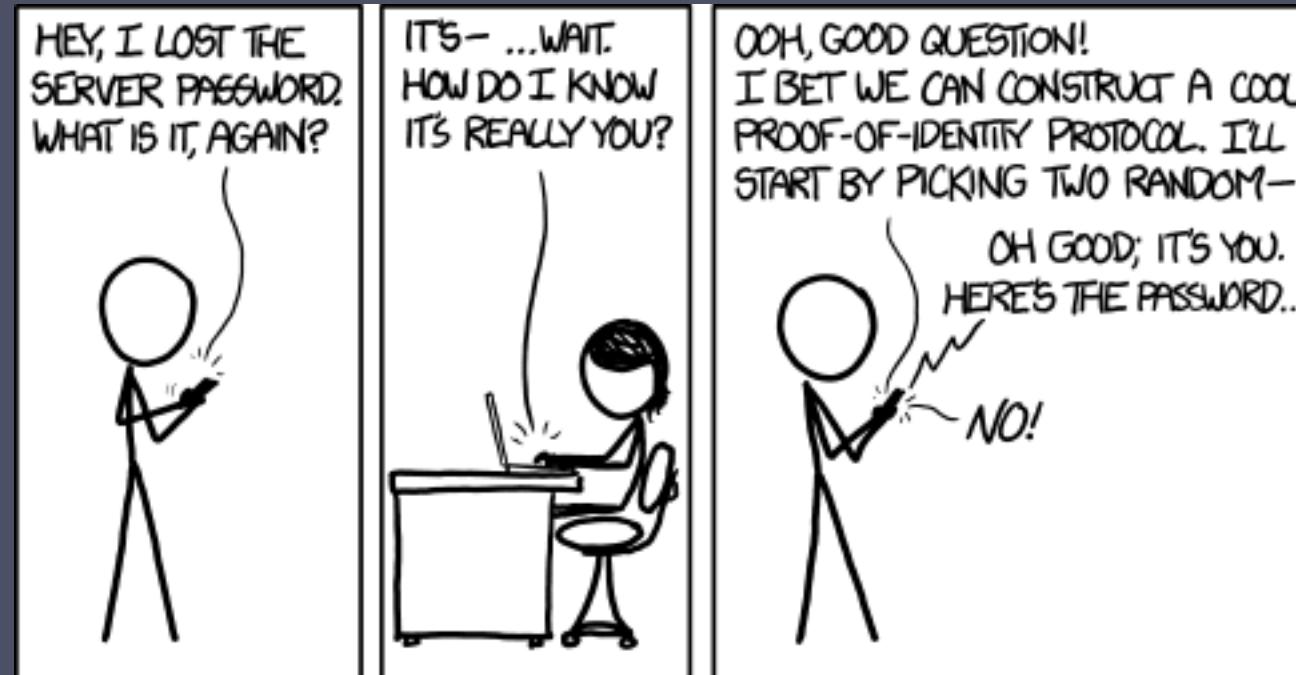
User Authentication

Introduction to Computer Security
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How do you know who you're talking to?



<https://xkcd.com/1121/>

System Identity and Authentication

- An **identity** on a system is typically a unique identifier
- All actions on a system are associated with at least one identity
- This identifier will be used to check what actions a user can perform – **Access Control**
- This identifier will be associated with the records in log files - **Accountability**
- The process by which a user, whether human or software, is associated with an identity is **User Authentication**
- To authenticate, the user is typically required to show evidence that they are who they claim
- This evidence is the **factor**

User identity attributes

The four factors of authenticating user identity are based on:

Something the individual knows

- Password, PIN, answers to prearranged questions

Something the individual possesses (token)

- Smartcard, electronic keycard, physical key

Something the individual is (static biometrics)

- Fingerprint, retina, face

Something the individual does (dynamic biometrics)

- Voice pattern, handwriting, typing rhythm

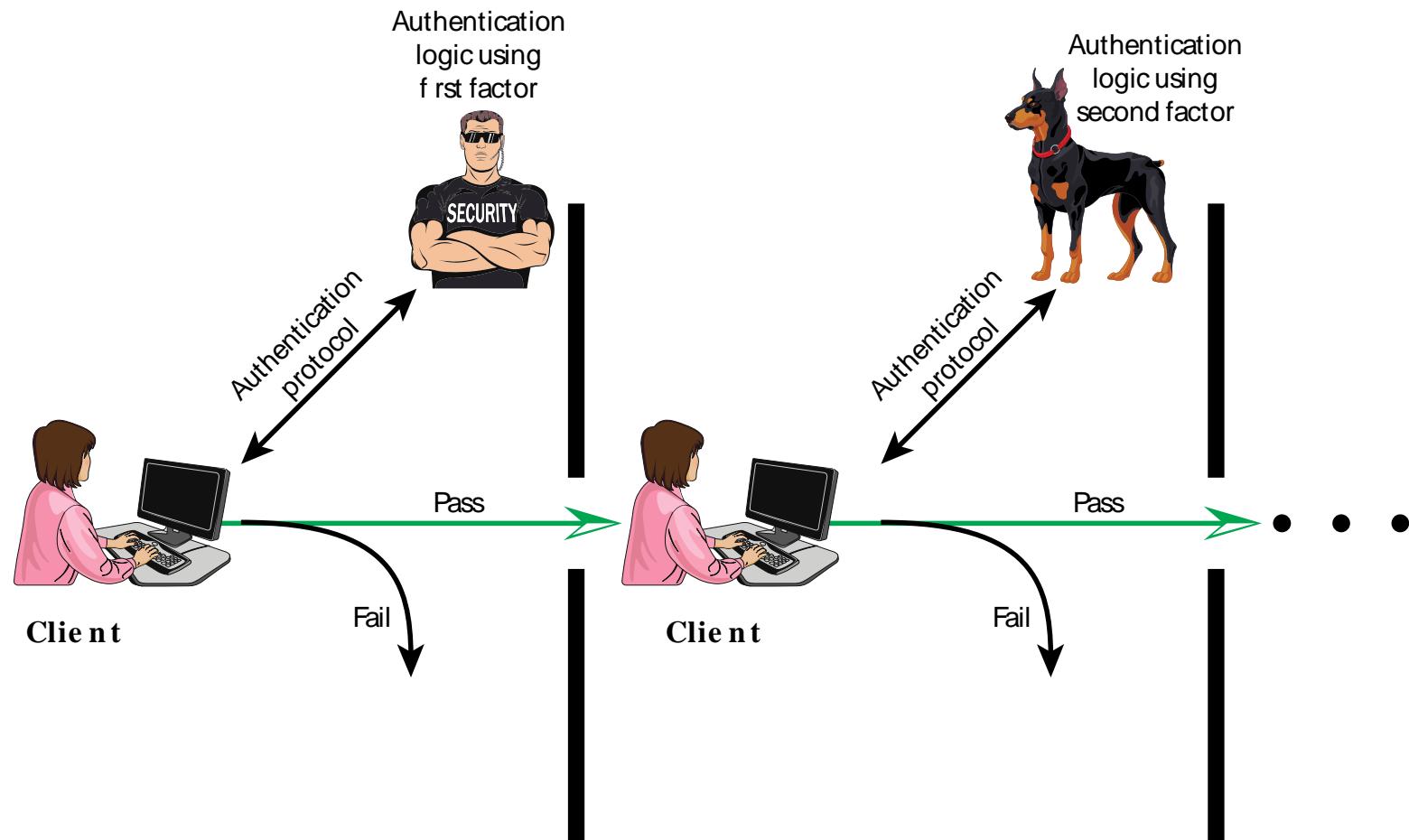
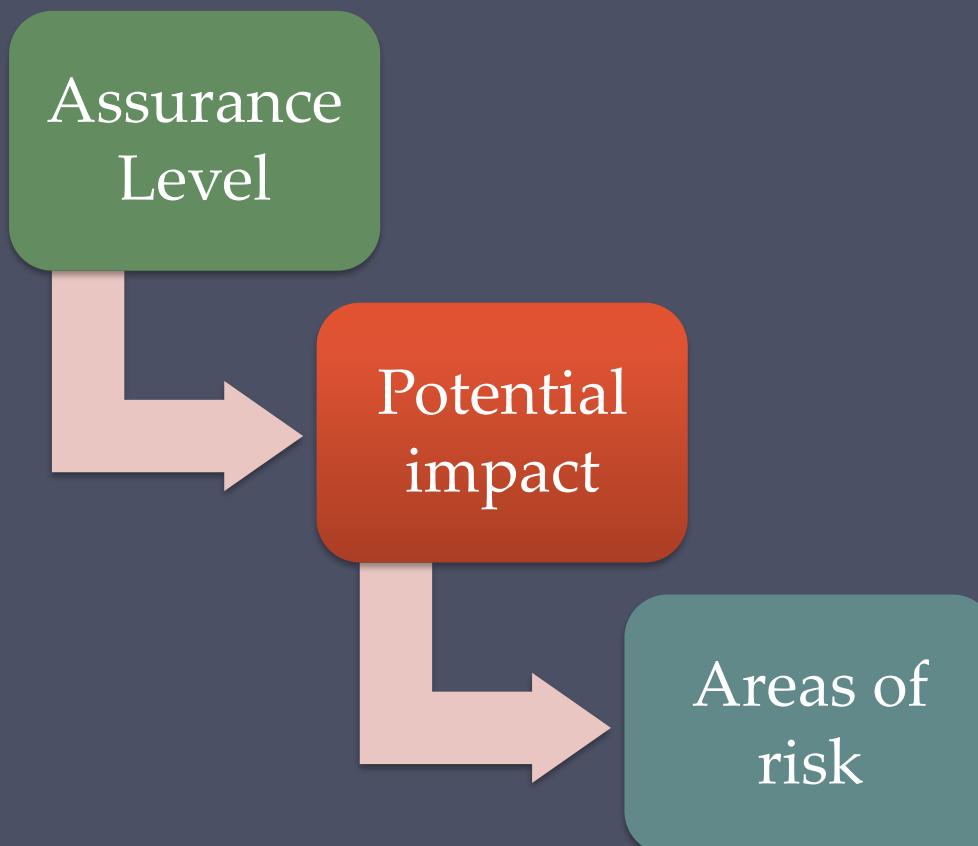


Figure 3.2 Multifactor Authentication

Risk Assessment for User Authentication

- There are three separate concepts:



Assurance Level

Describes an organization's **degree of certainty** that a user has presented a credential that refers to his or her identity

More specifically is defined as:

The degree of confidence in the vetting process used to establish the identity of the individual to whom the credential was issued

The degree of confidence that the individual who uses the credential is the individual to whom the credential was issued

Four levels of assurance

Level 1

- Little or no confidence in the asserted identity's validity

Level 2

- Some confidence in the asserted identity's validity

Level 3

- High confidence in the asserted identity's validity

Level 4

- Very high confidence in the asserted identity's validity

Potential Impact

- FIPS 199 defines three levels of potential impact on organizations or individuals should **there be a breach of security**:
 - Low
 - An authentication error could be expected to have **a limited adverse effect** on organizational operations, organizational assets, or individuals
 - Moderate
 - An authentication error could be expected to have **a serious adverse effect**
 - High
 - An authentication error could be expected to have **a severe or catastrophic adverse effect**

Maximum Potential Impacts for Each Assurance Level

Potential Impact Categories for Authentication Errors	Assurance Level Impact Profiles			
	1	2	3	4
Inconvenience, distress, or damage to standing or reputation	Low	Mod	Mod	High
	Low	Mod	Mod	High
Financial loss or organization liability	None	Low	Mod	High
Harm to organization programs or interests	None	Low	Mod	High
Unauthorized release of sensitive information				Mod/ High
Personal safety	None	None	Low	Mod/ High
Civil or criminal violations	None	Low	Mod	High

An example risk assessment: For each system, examine the likely effect of an authentication error to the organization; this will then determine how much assurance is needed for authentication

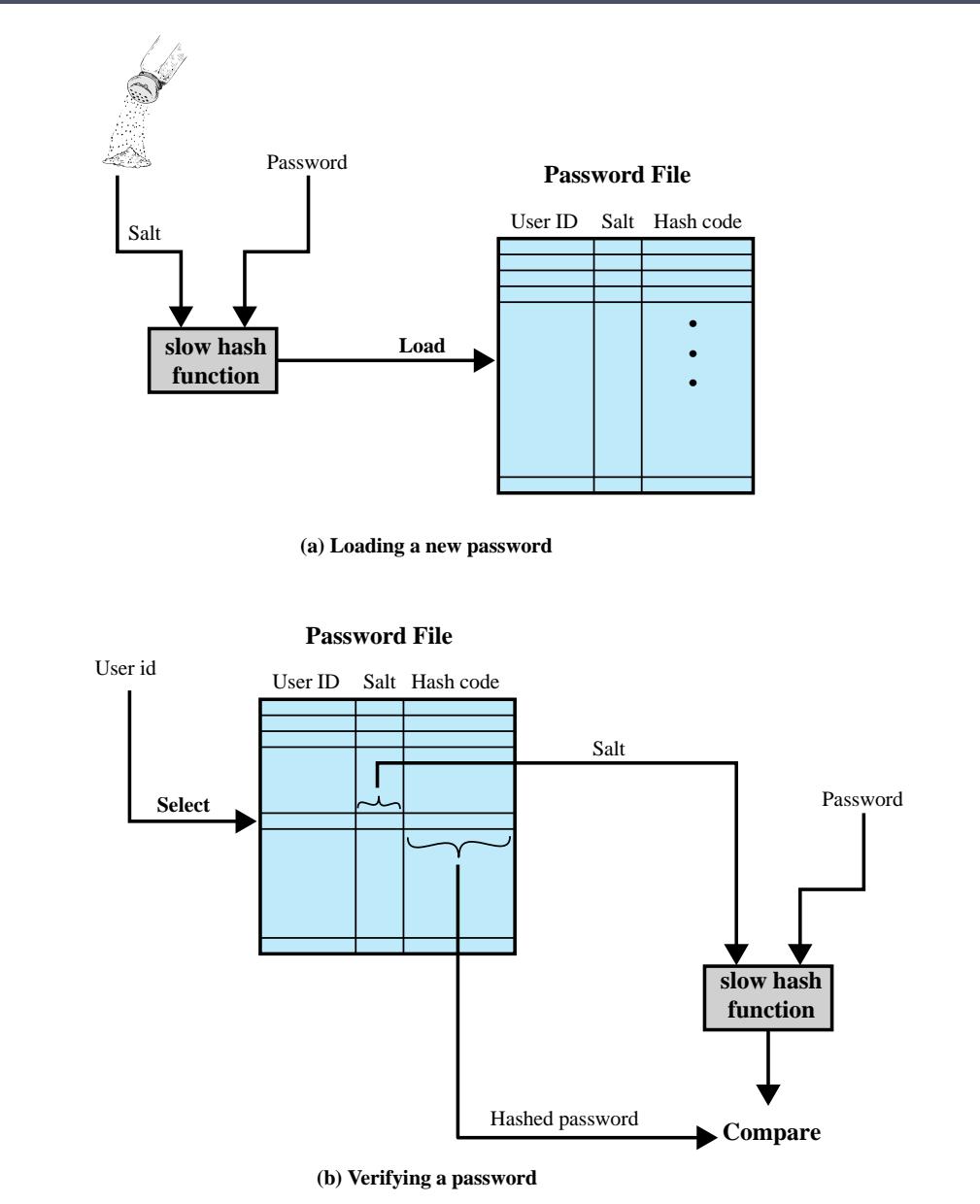
Password-Based Authentication

- Widely used line of defense against intruders
 - User provides name/login and password
 - System compares password with the one stored for that specified login
 - If passed, user is represented by their identity or user ID within the runtime
- The user ID is the token identifying the user in the system:
 - Determines that the user is authorized to access the system
 - Determines the user's privileges
 - Is used in discretionary access control
 - Used as part of the logging entry for logged actions

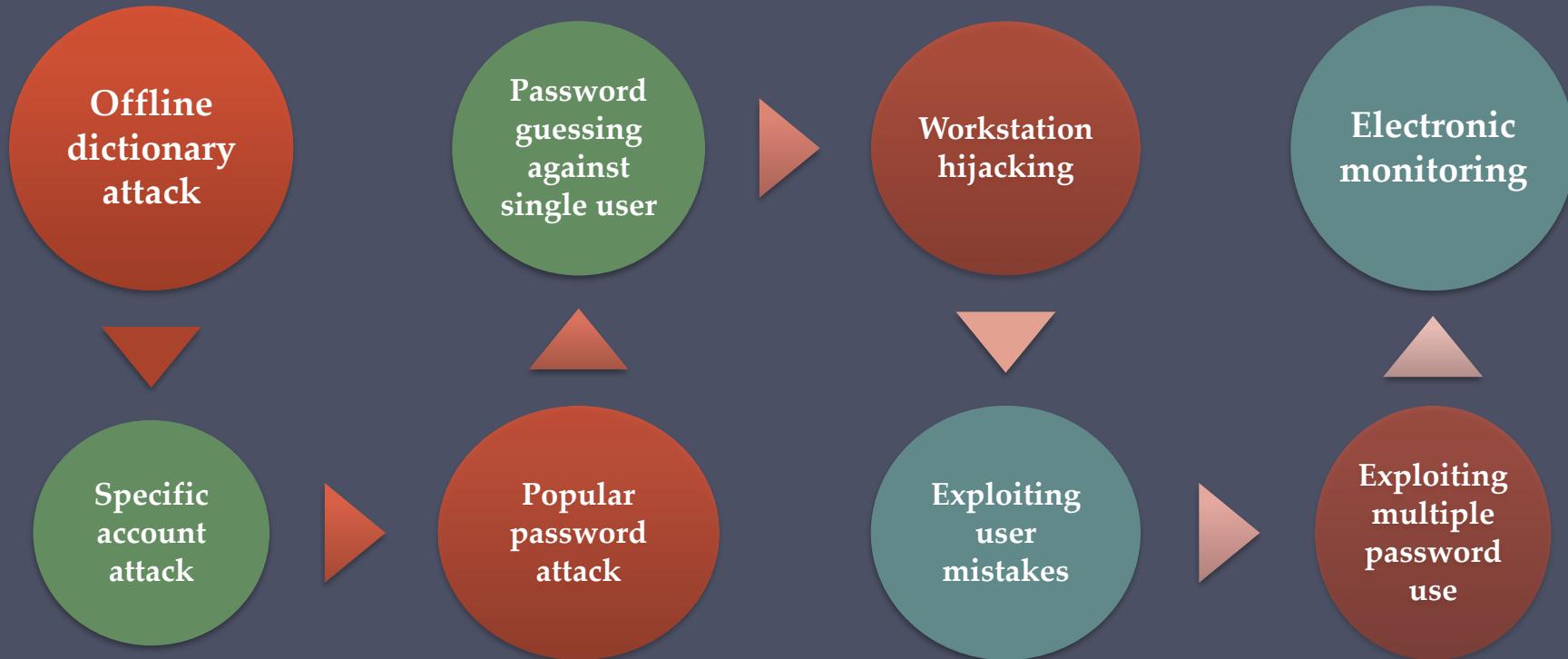
Password Storage

- Passwords need to be stored in the system
 - Should they be stored as the actual password?
 - **No!** When attackers **get the file/table** containing the passwords, no more security
- Can passwords be stored encrypted, e.g., by a Secure Hash Algorithm?
 - Hash function applied to password after entry and compared to hashed value in the file.
 - Prevents casual password scavenging, but...
- Dictionary Attacks
 - Attacker gets a dictionary, and applies hash function to each entry
 - Most passwords are single words, so attacker can search through password file to match entries
 - Attacker can apply **common password addition rules** to generate further match possibilities, such as numbers at the end, punctuation at the end, 1337 speak
- Salt
 - Using a **random number prefix** on the password reduces the effectiveness of dictionary attacks

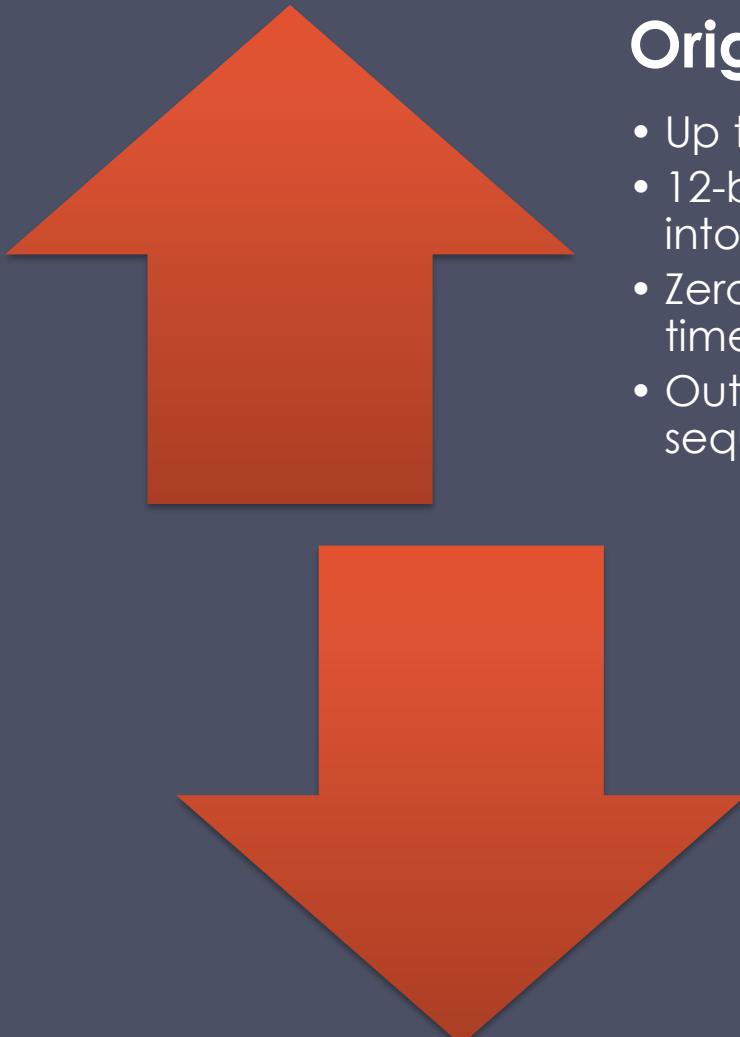
UNIX Password Scheme



Password Vulnerabilities



UNIX Implementation



Original scheme

- Up to eight printable characters in length
- 12-bit salt used to modify DES encryption into a one-way hash function
- Zero value repeatedly encrypted 25 times
- Output translated to 11 character sequence

Now regarded as inadequate

- Still often required for compatibility with existing account management software or multivendor environments

Improved Implementations

Much stronger
hash/salt schemes
available for Unix

OpenBSD uses Blowfish
block cipher-based
hash algorithm called
Bcrypt

- Most secure version of Unix
hash/salt scheme
- Uses 128-bit salt to create
192-bit hash value

Recommended hash function
is based on MD5

- Salt of up to 48-bits
- Password length is unlimited
- Produces 128-bit hash
- Uses an inner loop with 1000 iterations to
achieve slowdown

Password Cracking

Dictionary attacks

- Develop a large dictionary of possible passwords and try each against the password file
- Each password must be hashed using each salt value and then compared to stored hash values

Rainbow table attacks

- Pre-compute tables of hash values for all salts
- A mammoth table of hash values
- Can be countered by using a sufficiently large salt value and a sufficiently large hash length

Password crackers exploit the fact that people choose easily guessable passwords

- Shorter password lengths are also easier to crack

John the Ripper

- Open-source password cracker first developed in 1996
- Uses a combination of brute-force and dictionary techniques

Modern Approaches

- Complex password policy
 - Forcing users to pick stronger passwords
- However, password-cracking techniques have also improved
 - The processing capacity available for password cracking has increased dramatically (e.g., GPUs)
 - The use of sophisticated algorithms to generate potential passwords (e.g., standard Markov modeling techniques from natural language processing)
 - Studying examples and structures of actual passwords in use

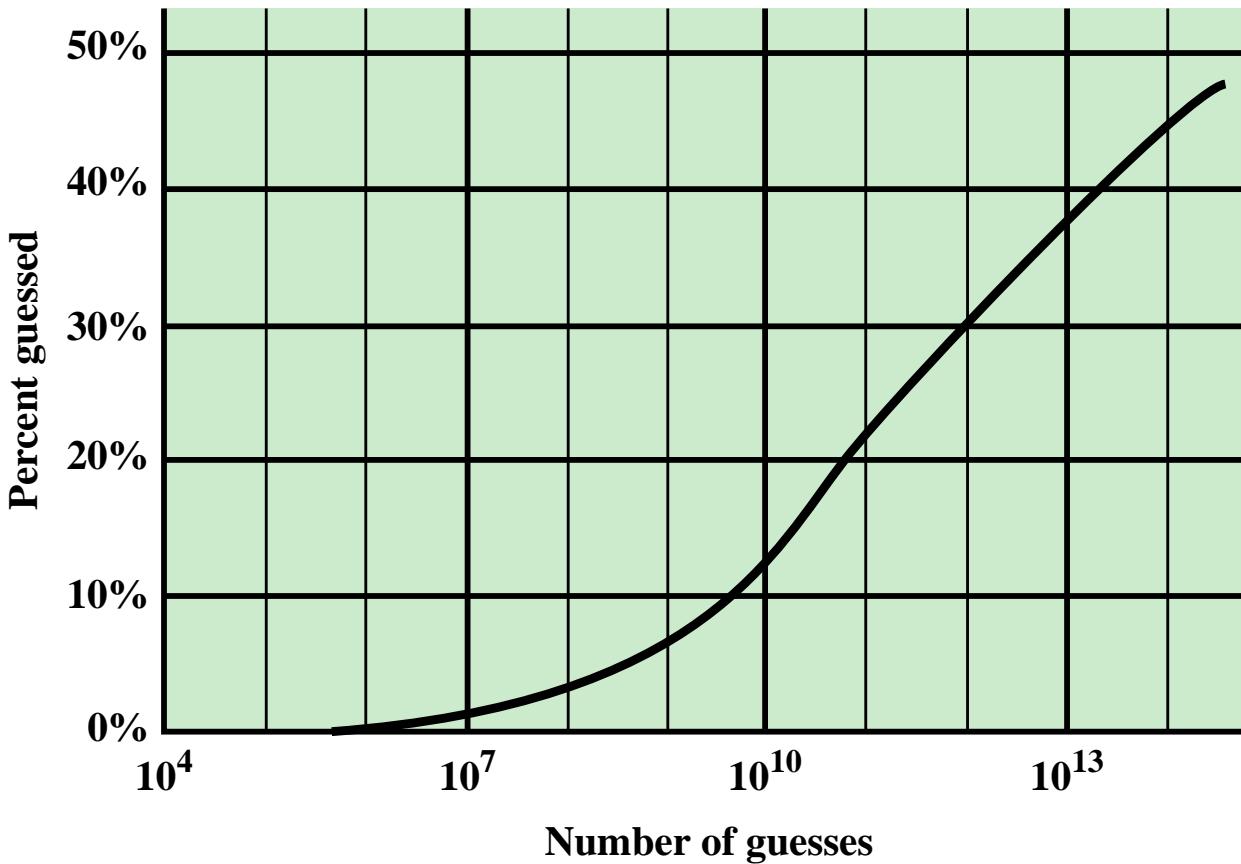


Figure 3.4 The Percentage of Passwords Guessed After a Given Number of Guesses

Password Selection Strategies

User education

Users can be told the importance of using **hard to guess** passwords and can be **provided with guidelines** for selecting strong passwords



Computer generated passwords

Users have trouble remembering them



Reactive password checking

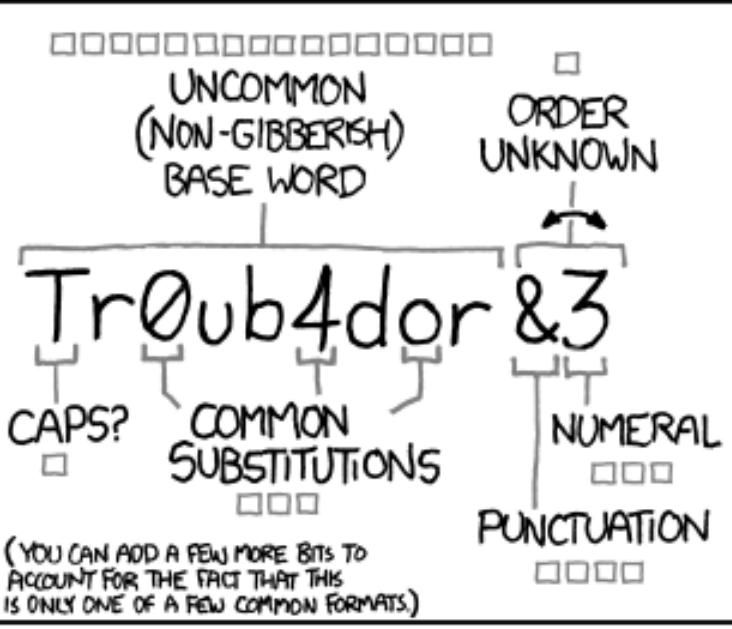
System periodically runs its own password cracker to **find guessable passwords**



Complex password policy

User is allowed to select their own password; however, the system checks to see if the password is allowable, and if not, rejects it

Goal is to eliminate guessable passwords while allowing the user to select a password that is memorable



~28 BITS OF ENTROPY

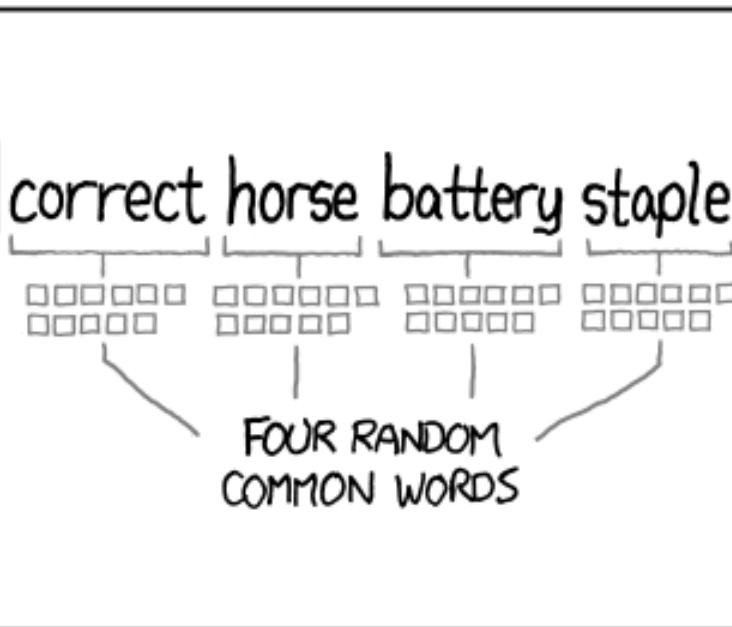
$$2^{28} = 3 \text{ DAYS AT } 1000 \text{ GUESSES/SEC}$$

(PLAUSIBLE ATTACK ON A WEAK REMOTE WEB SERVICE. YES, CRACKING A STOLEN HASH IS FASTER, BUT IT'S NOT WHAT THE AVERAGE USER SHOULD WORRY ABOUT.)

DIFFICULTY TO GUESS:
EASY

WAS IT TROMBONE? NO, TROUBADOR. AND ONE OF THE 0s WAS A ZERO?
AND THERE WAS SOME SYMBOL...

DIFFICULTY TO REMEMBER:
HARD



~44 BITS OF ENTROPY

$$2^{44} = 550 \text{ YEARS AT } 1000 \text{ GUESSES/SEC}$$

DIFFICULTY TO GUESS:
HARD

THAT'S A BATTERY STAPLE.

CORRECT!

DIFFICULTY TO REMEMBER:
YOU'VE ALREADY MEMORIZED IT

THROUGH 20 YEARS OF EFFORT, WE'VE SUCCESSFULLY TRAINED EVERYONE TO USE PASSWORDS THAT ARE HARD FOR HUMANS TO REMEMBER, BUT EASY FOR COMPUTERS TO GUESS.

<https://xkcd.com/936/>

Memory Cards

- Can store but do not process data
- The most common is the magnetic stripe card
- Can include an internal electronic memory
- Can be used alone for physical access
 - Hotel room
 - ATM
- Provides significantly greater security when combined with a password or PIN
- Drawbacks of memory cards include:
 - Requires a special reader
 - Loss of token
 - User dissatisfaction

Smart Tokens

- Physical characteristics:
 - Include an embedded microprocessor
 - A smart token that looks like a bank card
 - Can look like calculators, keys, small portable objects
- User interface:
 - Manual interfaces include a keypad and display for human/token interaction
- Electronic interface
 - A smart card or other token requires an electronic interface to communicate with a compatible reader/writer
 - Contact and contactless interfaces
- Authentication protocol:
 - Classified into three categories:
 - Static
 - Dynamic password generator
 - Challenge-response

Smart Cards

- Most important category of smart token
 - Has the appearance of a credit card
 - Has an electronic interface
 - May use any of the smart token protocols
- Contain:
 - An entire microprocessor
 - Processor
 - Memory
 - I/O ports
- Typically include three types of memory:
 - Read-only memory (ROM)
 - Stores data that does not change during the card's life
 - Electrically erasable programmable ROM (EEPROM)
 - Holds application data and programs
 - Random access memory (RAM)
 - Holds temporary data generated when applications are executed

Electronic Identity Cards (eID)

Use of a smart card as a national identity card for citizens



Can serve the same purposes as other national ID cards, and similar cards such as a driver's license, for access to government and commercial services

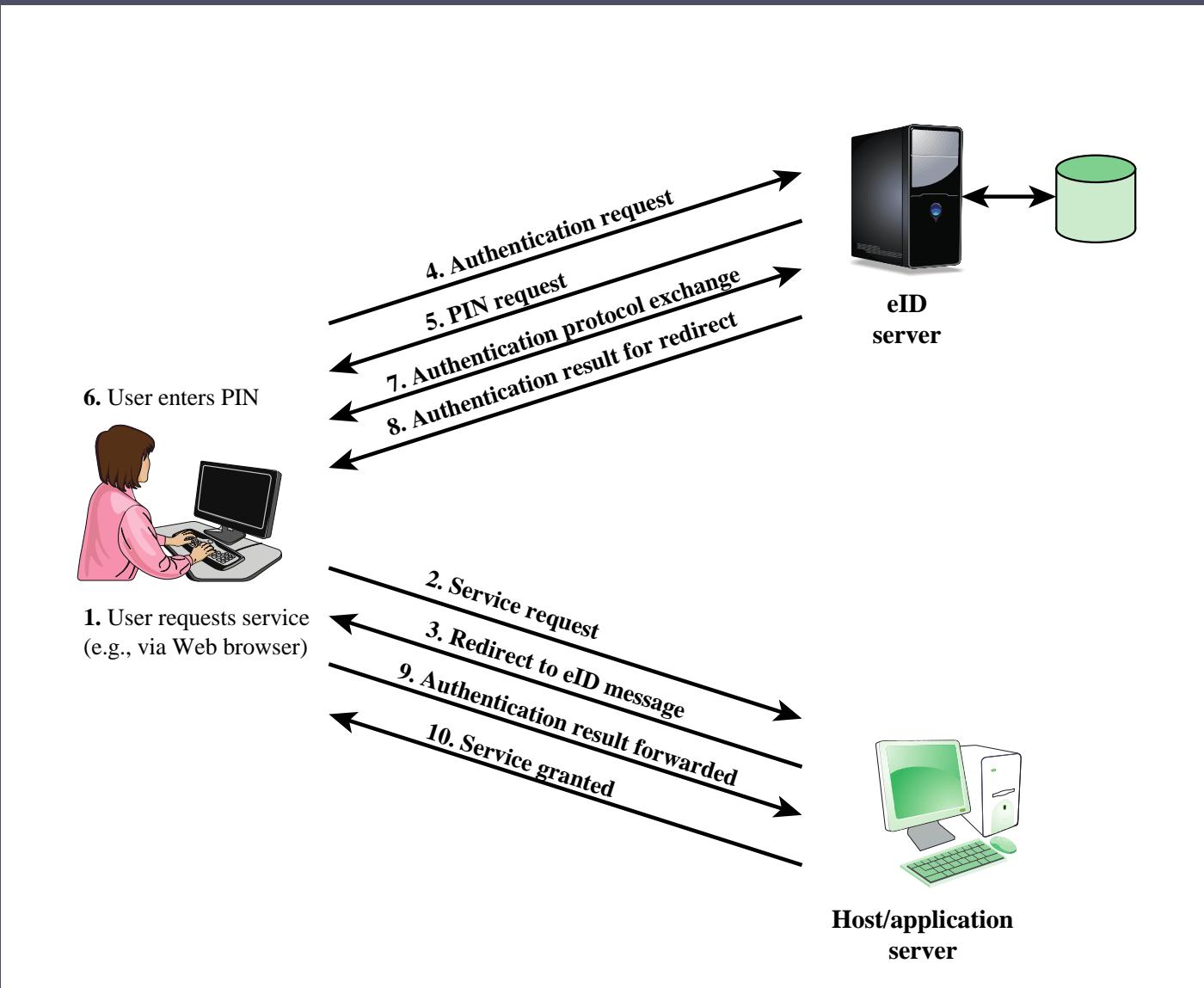


Can provide **stronger proof of identity** and can be used in a wider variety of applications



In effect, is a smart card **that has been verified by the national government** as valid and authentic – around 3.6 billion worldwide

User Authentication with eID



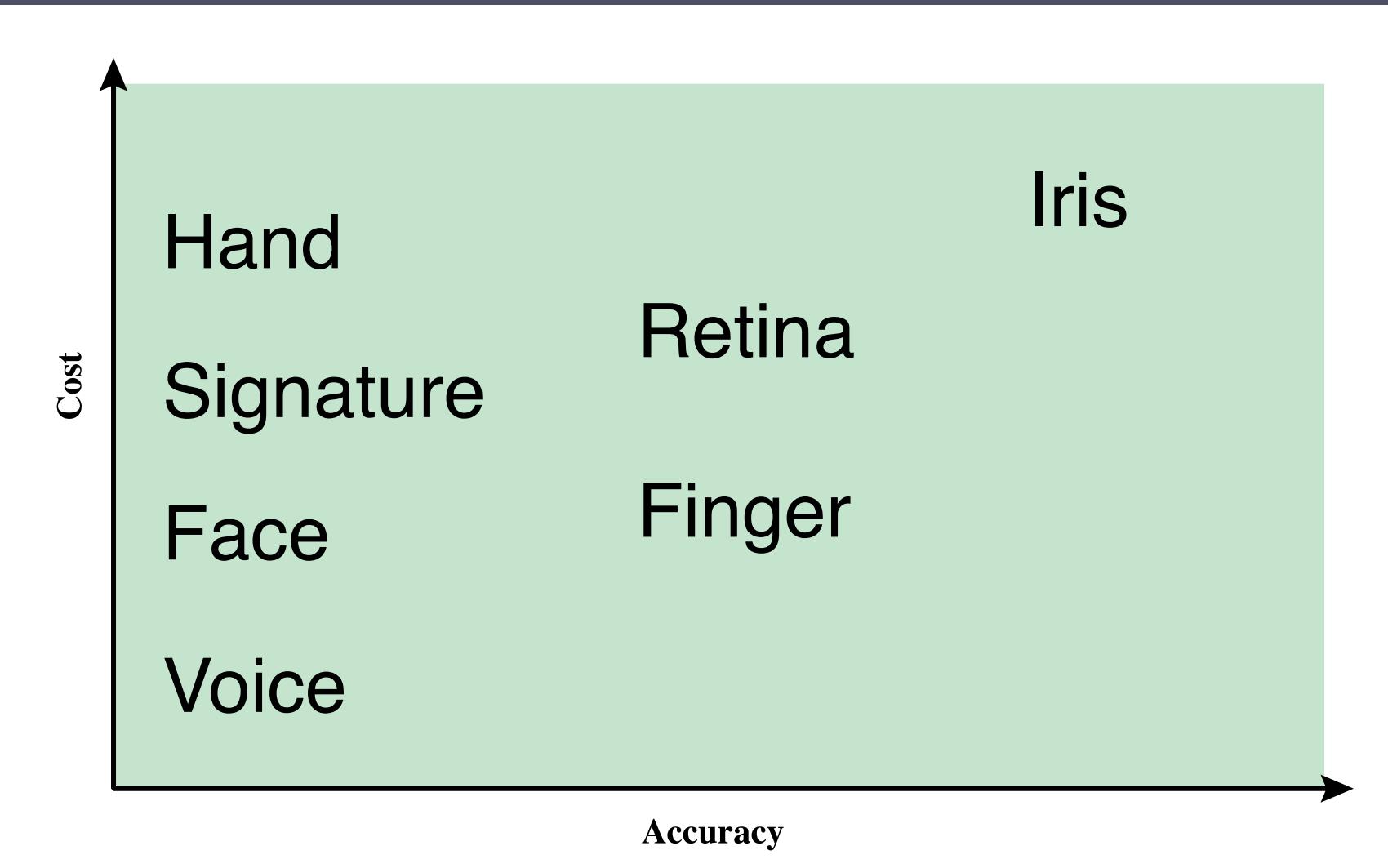
SmartPhones

- Physical characteristics:
 - Open market for software applications
 - Standard user interface experience
 - 6 Billion smartphone subscriptions worldwide
 - 83% Android, 15% Apple
- Authentication protocol:
 - Can utilize directly for two factor authentication, by SMS or other mechanisms
 - Install Authenticator apps
- We will discuss more in Internet authentication

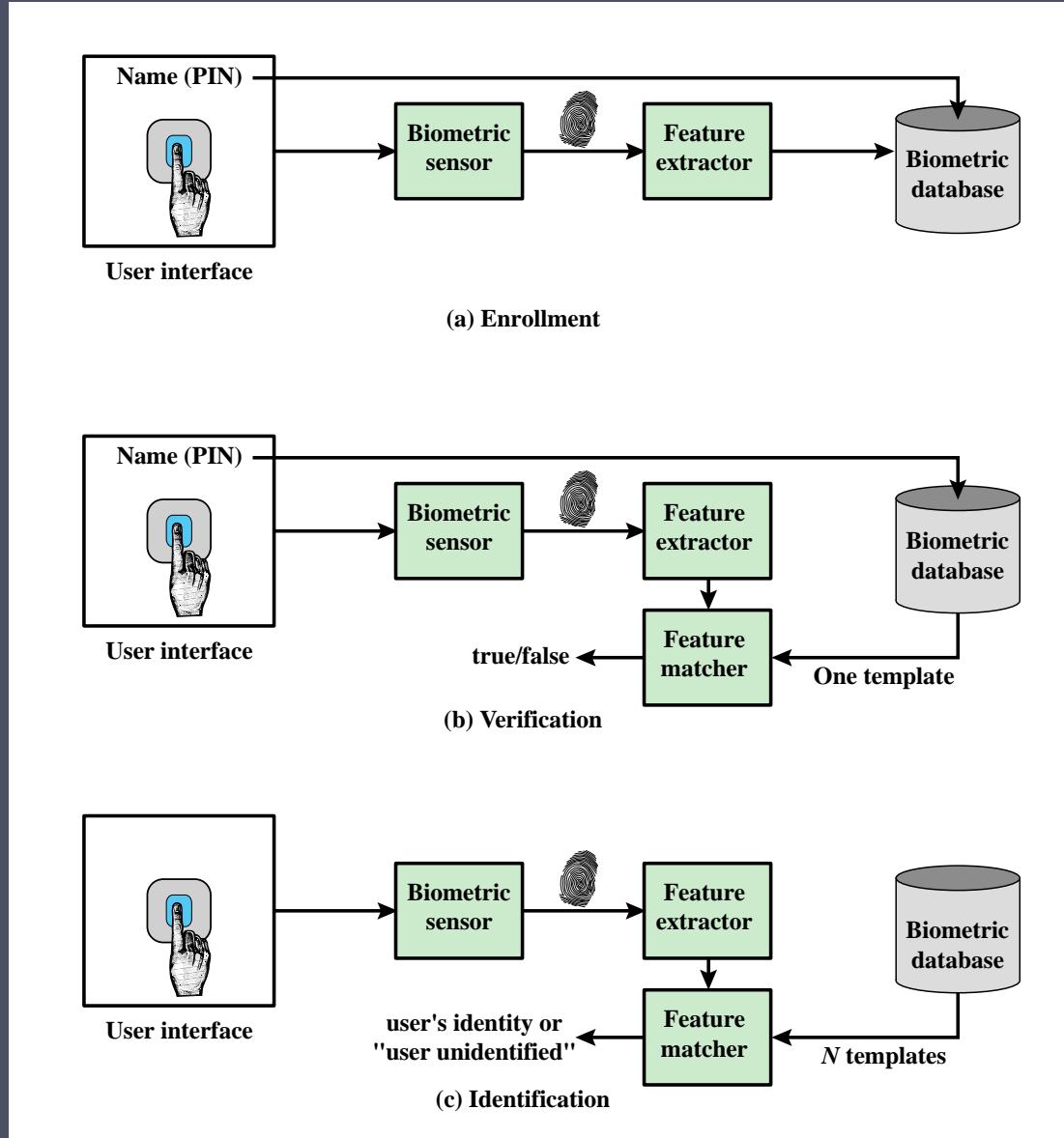
Biometric Authentication

- Attempts to authenticate an individual based on unique physical characteristics
- Based on pattern recognition
- Is technically complex and expensive when compared to passwords and tokens – but luckily, we have Google and Apple
- Physical characteristics used include:
 - Facial characteristics
 - Fingerprints
 - Hand geometry
 - Retinal pattern
 - Iris
 - Signature
 - Voice

Cost Vs Accuracy



A Generic Biometric System



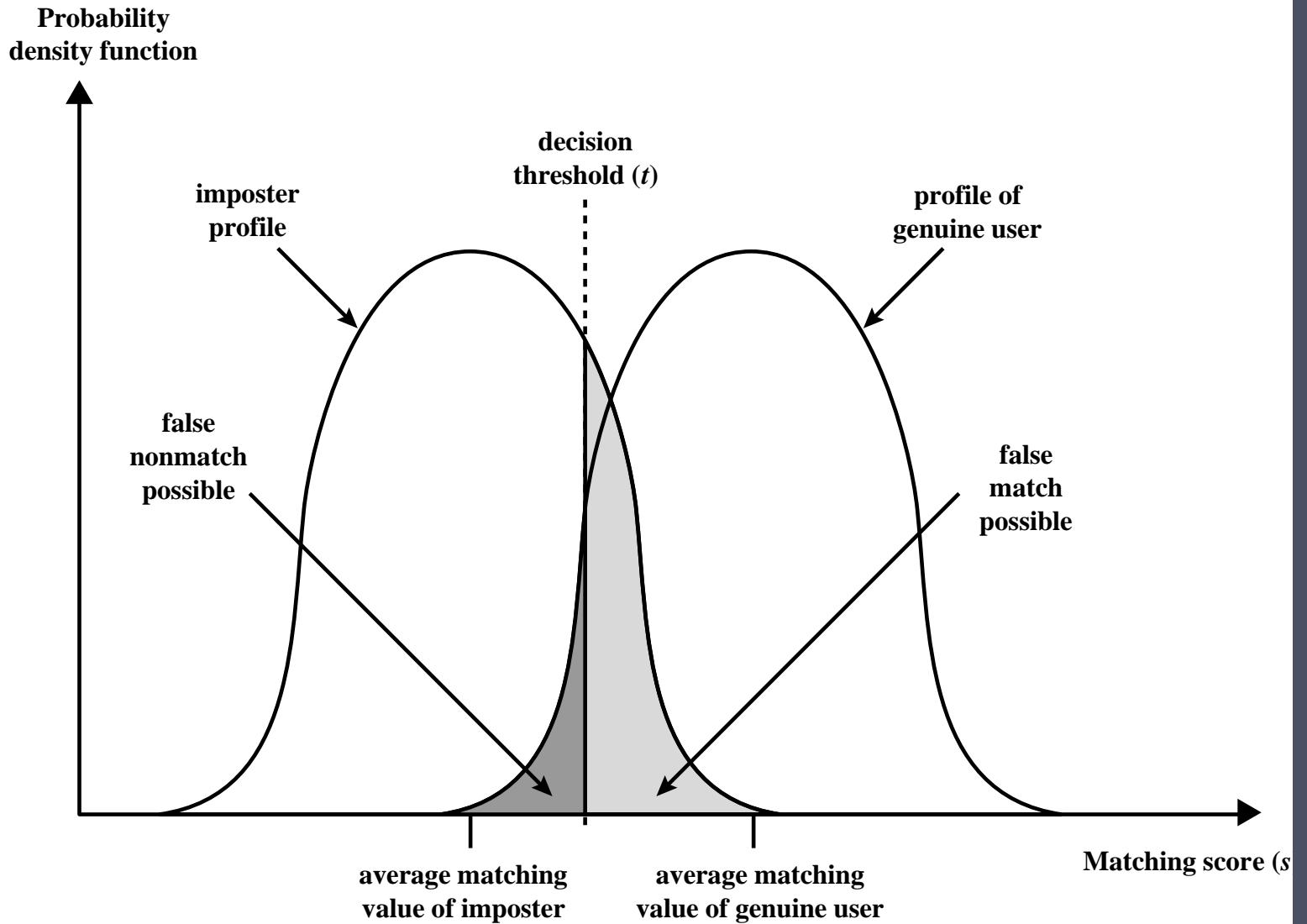


Figure 3.10 Profiles of a Biometric Characteristic of an Imposter and an Authorized Users In this depiction, the comparison between presented feature and a reference feature is reduced to a single numeric value. If the input value (s) is greater than a preassigned threshold (t), a match is declared.

Remote User Authentication

- Authentication over a network, the Internet, or a communications link is more complex
- Additional security threats such as:
 - Eavesdropping, capturing a password, replaying an authentication sequence that has been observed
- Generally, rely on some form of a challenge-response protocol to counter threats
- We will return to this in a later lecture for oauth and other approaches

Summary

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