Authentication
CS 239
Computer Security
February 15, 2006

Outline

- Introduction
- Basic authentication mechanisms
- Authentication on a single machine
- Authentication across a network

Introduction

- Much of security is based on good access control
- Access control only works if you have good authentication
- What is authentication?

Authentication

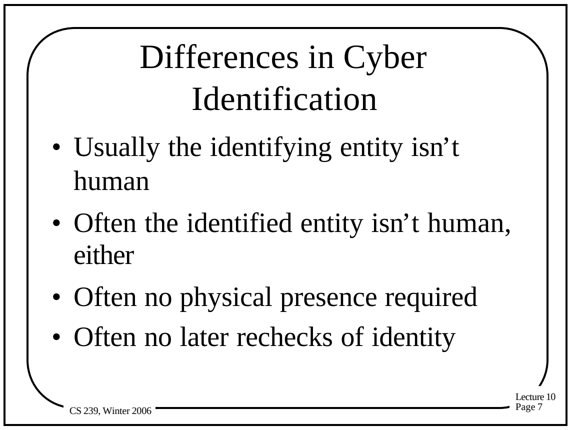
- Determining the identity of some entity
  - Process
  - Machine
  - Human user
- Requires notion of identity
- And some degree of proof of identity

Proving Identity in the Physical World

- Most frequently done by physical recognition
  - I recognize your face, your voice, your body
- What about identifying those we don’t already know?

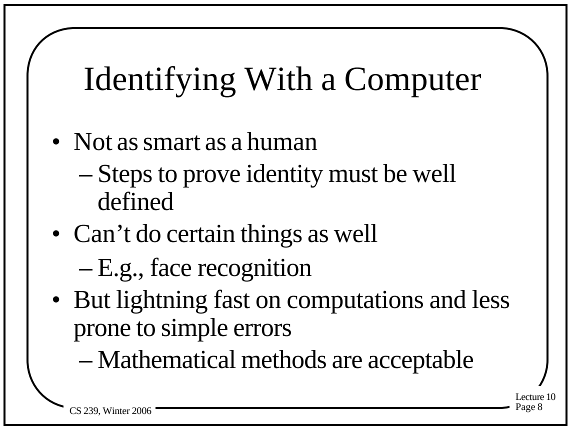
Other Physical World Methods of Identification

- Identification by recommendation
  - You introduce me to someone
- Identification by credentials
  - You show me your driver’s license
- Identification by knowledge
  - You tell me something only you know
- Identification by location
  - You’re behind the counter at the DMV
- These all have cyber analogs



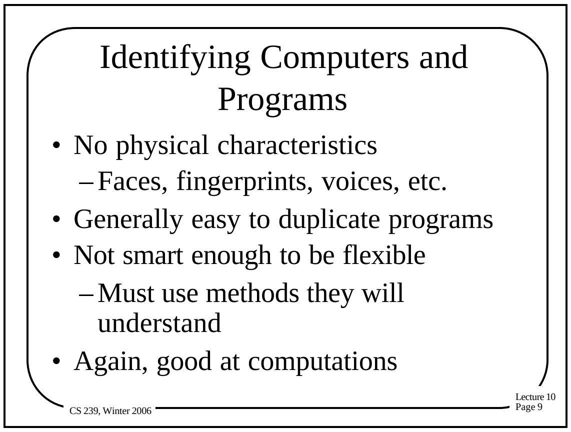
Differences in Cyber Identification

- Usually the identifying entity isn't human
- Often the identified entity isn't human, either
- Often no physical presence required
- Often no later rechecks of identity



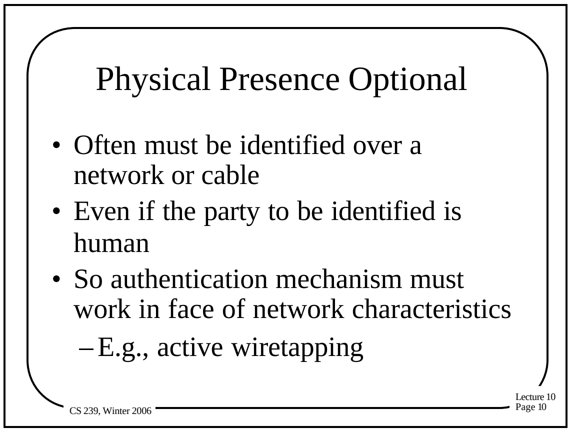
Identifying With a Computer

- Not as smart as a human
  - Steps to prove identity must be well defined
- Can't do certain things as well
  - E.g., face recognition
- But lightning fast on computations and less prone to simple errors
  - Mathematical methods are acceptable



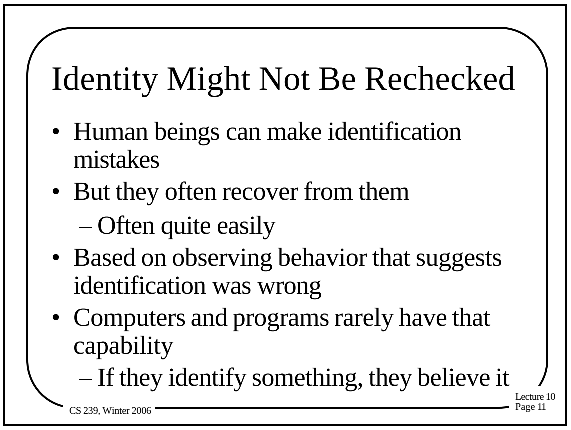
Identifying Computers and Programs

- No physical characteristics
  - Faces, fingerprints, voices, etc.
- Generally easy to duplicate programs
- Not smart enough to be flexible
  - Must use methods they will understand
- Again, good at computations



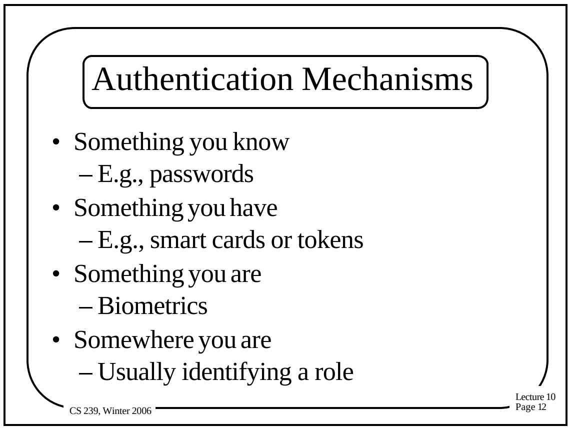
Physical Presence Optional

- Often must be identified over a network or cable
- Even if the party to be identified is human
- So authentication mechanism must work in face of network characteristics
  - E.g., active wiretapping



Identity Might Not Be Rechecked

- Human beings can make identification mistakes
- But they often recover from them
  - Often quite easily
- Based on observing behavior that suggests identification was wrong
- Computers and programs rarely have that capability
  - If they identify something, they believe it



Authentication Mechanisms

- Something you know
  - E.g., passwords
- Something you have
  - E.g., smart cards or tokens
- Something you are
  - Biometrics
- Somewhere you are
  - Usually identifying a role

Passwords

- Authentication by what you know
- One of the oldest and most commonly used security mechanisms
- Authenticate the user by requiring him to produce a secret
  - Known only to him and to the authenticator
  - Or, if one-way encryption used, known only to him

Problems With Passwords

- They have to be unguessable
  - Yet easy for people to remember
- If networks connect terminals to computers, susceptible to password sniffers
- Unless fairly long, brute force attacks often work on them

Proper Use of Passwords

- Passwords should be sufficiently long
- Passwords should contain non-alphabetic characters
- Passwords should be unguessable
- Passwords should be changed often
- Passwords should never be written down
- Passwords should never be shared

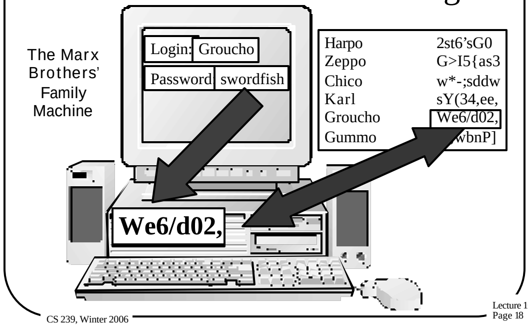
Passwords and Single Sign-On

- Many systems ask for password once
  - Resulting authentication lasts for an entire “session”
- Unless other mechanisms in place, complete mediation definitely not achieved
- Trading security for convenience

Handling Passwords

- The OS must be able to check passwords when users log in
- So must the OS store passwords?
- Not really
  - It can store an encrypted version
- Encrypt the offered password
  - Using a one-way function
- And compare it to the stored version

Standard Password Handling

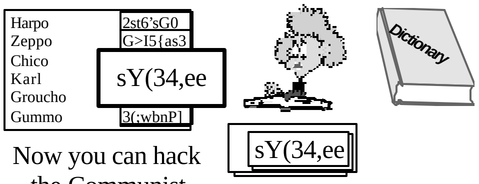


Harpo	2st6’sG0
Zeppo	G>I5{as3
Chico	w*-;sddw
Karl	sY(34,ee,
Groucho	We6/d02,
Gummo	wbnP]

Is Encrypting the Password File Enough?

- What if an attacker gets a copy of your password file?
- No problem, the passwords are encrypted
  - Right?
- Yes, but . . .

Dictionary Attacks on an Encrypted Password File



Now you can hack the Communist Manifesto!

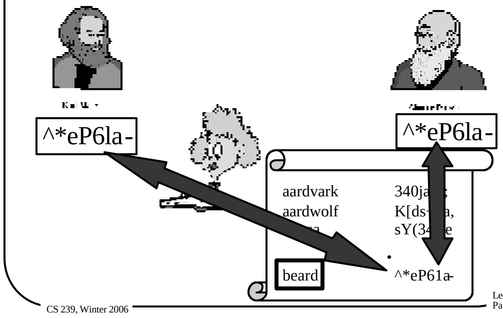
sY(34,ee

Rats!!!!

A Serious Issue

- All Linux machines use the same one-way function to encrypt passwords
- If someone runs the entire dictionary through that function,
  - Will they have a complete list of all encrypted dictionary passwords?

Illustrating the Problem



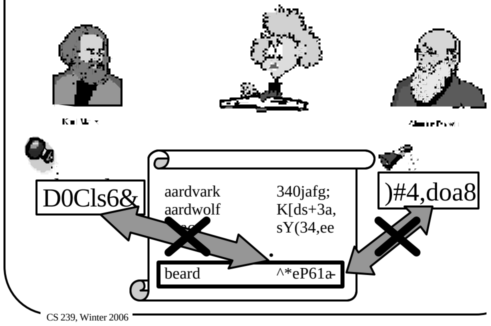
The Real Problem

- Not that Darwin and Marx chose the same password
- But that anyone who chose that password got the same encrypted result
- So the attacker need only encrypt every possible password once
- And then she has a complete dictionary usable against anyone

Salted Passwords

- Combine the plaintext password with a random number
  - Then run it through the one-way function
- The random number need not be secret
- It just has to be different for different users

Did It Fix Our Problem?



What Is This Salt, Really?

- An integer that is combined with the password before hashing
- How will you be able to check passwords by hashing them, then?
- By storing the salt integer with the password
  - Generally in plaintext
- Why is it OK (or OK-ish) to leave this important information in plaintext?

Protecting the Password File

- So it's OK to leave the encrypted version of the password file around?
- No, it isn't
- Why make it easy for attackers?
- Dictionary attacks against single accounts can still work
- Generally, don't give access to the encrypted file, either

Challenge/Response Authentication

- Authentication by what questions you can answer correctly
  - Again, by what you know
- The system asks the user to provide some information
- If it's provided correctly, the user is authenticated

Differences From Passwords

- Challenge/response systems ask for different information every time
- Or at least the questions come from a large set
- Best security achieved by requiring what amounts to encryption of the challenge
  - But that requires special hardware
  - Essentially, a smart card

Problems With Authentication Through Challenge/Response

- Either the question is too hard to answer without special hardware
- Or the question is too easy for intruders to spoof the answer
- Still, commonly used in real-world situations
  - E.g., authenticating you by asking your childhood pet's name

A Short Digression on “Security Questions”

- Common in web sites
- If you forget your password, answer a “security question”
- Answering that properly gets you access
- Which means knowing the security question’s answer is as good as knowing the password
- How secure are these “security questions?”
- How could the concept be improved?

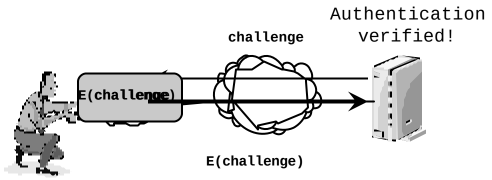
Identification Devices

- Authentication by what you have
- A smart card or other hardware device that is readable by the computer
- Authenticate by providing the device to the computer

Simple Use of Authentication Tokens

- If you have the token, you are identified
- Generally requires connecting the authentication device to computer
  - Unless done via wireless
- Weak, because it’s subject to theft and spoofing

Authentication With Smart Cards



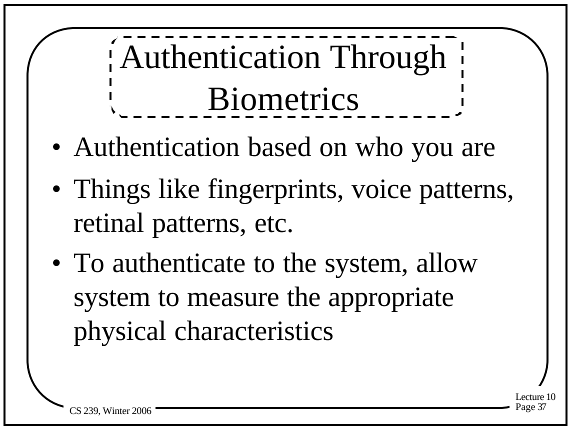
How can the server be sure of the remote user’s identity?

Some Details on Smart Cards

- Cryptography performed only on smart card
  - So compromised client machine can’t steal keys
- Likely to use PK cryptography
- Often user must enter password to activate card
  - Should it be entered to the card or the computer?

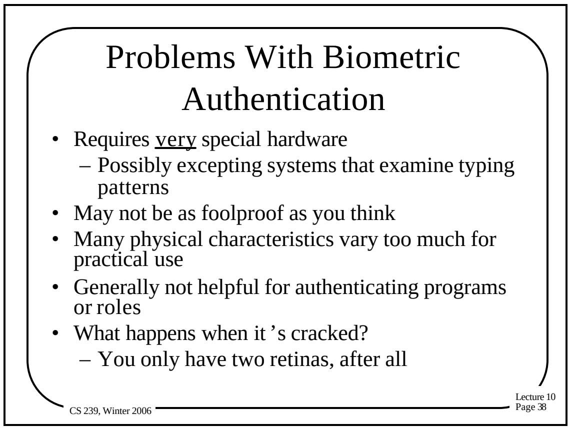
Problems With Identification Devices

- If lost or stolen, you can’t authenticate yourself
  - And maybe someone else can
  - Often combined with passwords to avoid this problem
- Unless cleverly done, susceptible to sniffing attacks
- Requires special hardware



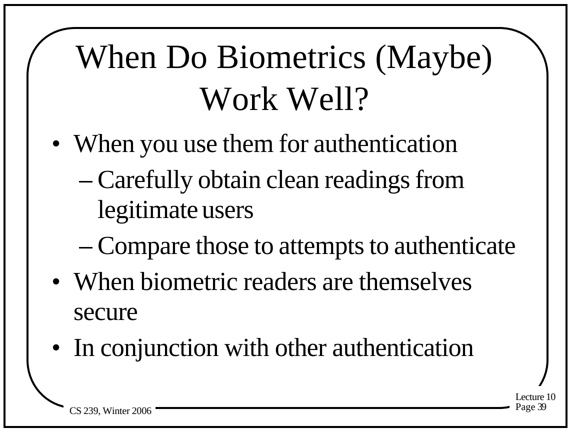
Authentication Through Biometrics

- Authentication based on who you are
- Things like fingerprints, voice patterns, retinal patterns, etc.
- To authenticate to the system, allow system to measure the appropriate physical characteristics



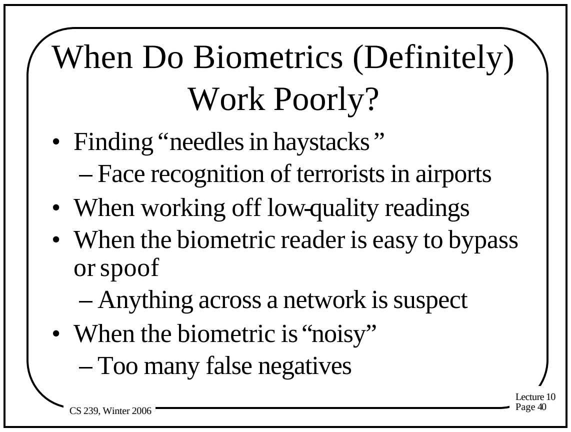
Problems With Biometric Authentication

- Requires very special hardware
  - Possibly excepting systems that examine typing patterns
- May not be as foolproof as you think
- Many physical characteristics vary too much for practical use
- Generally not helpful for authenticating programs or roles
- What happens when it’s cracked?
  - You only have two retinas, after all



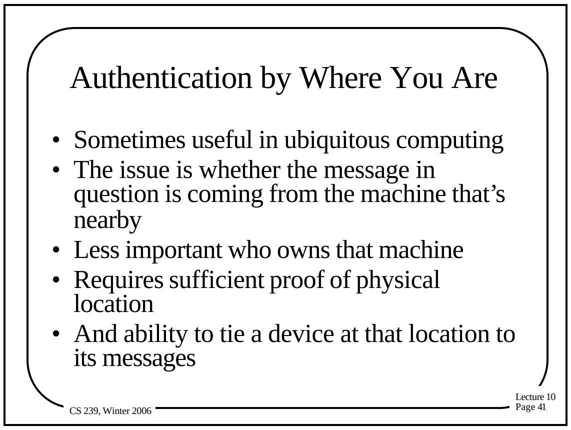
When Do Biometrics (Maybe) Work Well?

- When you use them for authentication
  - Carefully obtain clean readings from legitimate users
  - Compare those to attempts to authenticate
- When biometric readers are themselves secure
- In conjunction with other authentication



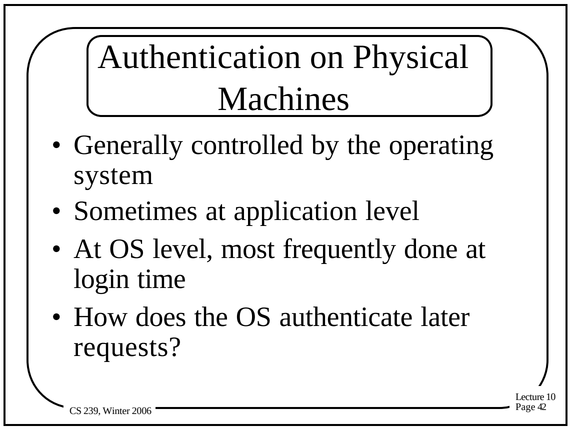
When Do Biometrics (Definitely) Work Poorly?

- Finding “needles in haystacks”
  - Face recognition of terrorists in airports
- When working off low-quality readings
- When the biometric reader is easy to bypass or spoof
  - Anything across a network is suspect
- When the biometric is “noisy”
  - Too many false negatives



Authentication by Where You Are

- Sometimes useful in ubiquitous computing
- The issue is whether the message in question is coming from the machine that’s nearby
- Less important who owns that machine
- Requires sufficient proof of physical location
- And ability to tie a device at that location to its messages



Authentication on Physical Machines

- Generally controlled by the operating system
- Sometimes at application level
- At OS level, most frequently done at login time
- How does the OS authenticate later requests?

Process Authentication

- Memory protection is based on process identity
  - Only the owning process can name its own virtual memory pages
- Because VM is completely in OS control, pretty easy to ensure that processes can’t fake identities

How the OS Authenticates Processes

- System calls are issued by a particular process
- The OS securely ties a process control block to the process
  - Not under user control
- Thus, the ID in the process control block can be trusted

How Do Processes Originally Obtain Access Permission?

- Most OS resources need access control based on user identity or role
  - Other than virtual memory pages and other transient resources
- How does a process get properly tagged with its owning user or role?
- Security is worthless if OS carefully controls access on a bogus user ID

Users and Roles

- In most systems, OS assigns each potential user an ID
- More sophisticated systems recognize that the same user works in different *roles*
  - Effectively, each role requires its own ID
  - And secure methods of setting roles

Securely Identifying Users and Roles

- Passwords
- Identification devices
- Challenge/response systems
- Physical verification of the user

Authenticating Across the Network

- What new challenges does this add?
- You don’t know what’s at the other end of the wire
- So, when does that cause a problem?
- And how can you solve it?