

# CSC12001

## Security Issues in Information Systems

### C02 – User Authentication

Dr. Phạm Thị Bạch Huệ  
MSc. Lương Vĩ Minh

Information System Department – Faculty of Information Technology  
University of Science, VNU-HCM



## What is authentication?

- Positive verification of identity (man or machine)
- Verification of a person's claimed identity
- Who are you? Prove it.

- There exists two reasons for authenticating users:
  - The user identity is a parameter in access control decisions
  - The user identity is recorded when logging security-relevant events in the audit trail
- It is not always necessary or desirable to base access control on user identities, while there is a much stronger case for using identities in the audit logs

- When a user connects to a computer system is has to enter
  - *User name* – this step is called *identification*
  - *Password* – this step is called *authentication*
- Authentication: the process of verifying a claimed identity

## How to authenticate?

- 4 Categories:
  - What you know
  - What you have
  - Who you are
  - Where you are

## Authentication Process

- It consists of several steps:
  - Obtaining the authentication information from an entity
  - Analyzing the data
  - Determining if the authentication information is associated with that entity

## What you know

- Password
- Passphrase
- PIN

## Passwords

- Sequence of characters
  - Examples: 10 digits, a string of letters, *etc.*
  - Generated randomly, by user, by computer with user input
- Sequence of words
  - Examples: pass-phrases

Note: A *pass-phrase* is a sequence of characters that it is too long to be a password and it is thus turned into a shorter virtual password by the password system
- Algorithms
  - Examples: challenge-response, one-time passwords



# Passwords-based Authentication

- A *password* is information associated with an entity that confirms its identity.
- How can passwords be protected?
- A solution: *one-way hashing*

A user's password is encrypted and then stored. The stored password is never decrypted.

It should be difficult for an attacker to revert the stored password to the plaintext password.

A user A may try to guess the password of another user, B, and thus *impersonate* B.

- Store as cleartext
  - If password file compromised, *all* passwords are revealed
- Encipher file
  - Need to have encryption, decryption keys in memory
  - Reduces to previous problem
- Store one-way hash of password
  - If file read, attacker must still guess passwords or invert the hash

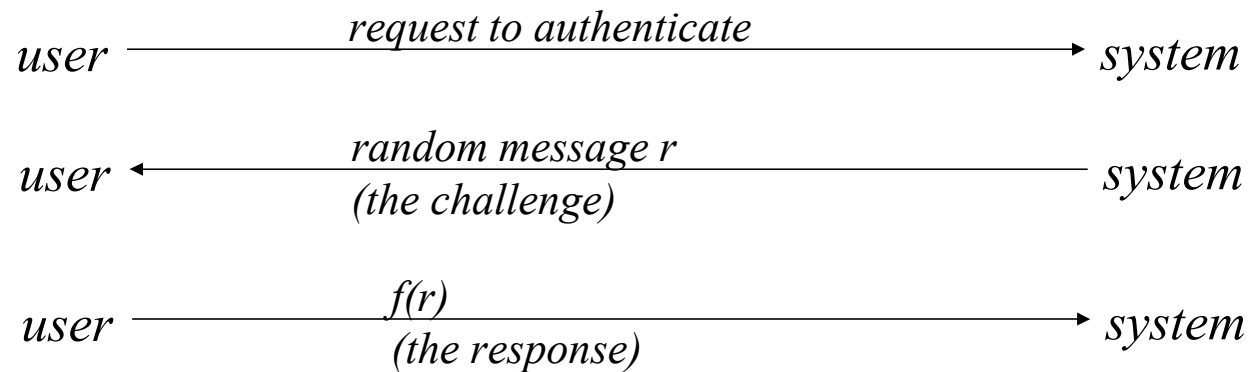
- Goal: slow dictionary attacks aimed at finding *any* user's password (as opposed to a *particular* user's password)
- Method: perturb hash function so that:
  - Parameter controls *which* hash function is used
  - Parameter differs for each password
  - To determine if the string  $s$  is the password for any of a set of  $n$  users, the attacker has to perform  $n$  complementations, each of which generates a different complement

## Challenge-Response

- Passwords have the fundamental problems that they are *reusable*
- If an attacker sees a password, she can later *replay* the password
- An alternative is to authenticate in such a way that the transmitted password changes each time
- Let a user  $u$  wishing to authenticate himself to a system  $S$ .
  - Let  $u$  and  $S$  have an agreed-on secret function  $f$ .
  - A *challenge-response* authentication system is one in which  $S$  sends a random message  $m$  (the challenge) to  $u$
  - Then  $u$  replies with the transformation  $r = f(m)$  (the response).
  - $S$  then validates  $r$  by computing it separately.

## Challenge-Response

- The user and system share a secret function  $f$  (in practice,  $f$  can be a known function with unknown parameters, such as a cryptographic key)



# Challenge-Response Pass Algorithms

- Challenge-response with the function  $f$  itself a secret
  - Example:
    - Challenge is a random string of characters such as “**abcdefg**”, “**ageksido**”
    - Response is some function of that string such as “**bdf**”, “**gkio**”
    - The algorithm is every other letter beginning with the second
  - Usually used in conjunction with fixed, reusable password

## One-Time Passwords

- Password that can be used exactly *once*
  - After use, it is immediately invalidated
- Problems
  - Synchronization of user and system
  - Generation of good random passwords
  - Password distribution problem

## Approaches: Password Selection

- Random selection
  - Any password from  $A$  equally likely to be selected
  - Such passwords are difficult to remember for users, especially when they have multiple randomly-selected passwords
- Pronounceable passwords
- User selection of passwords



## Pronounceable Passwords

- Generate phonemes randomly
  - Phoneme is unit of sound, eg. *cv*, *vc*, *cvc*, *vcv* where
    - *c* is a consonant
    - *v* is a vowel
  - Examples: *helgoret*, *juttelon* are pronounceable; *przbqxdfi*, *zxrptglfn* are not pronounceable
- Problem: the number of pronounceable passwords of length  $n$  is considerably lower than the number of random passwords of length  $n$

## User Selection

- Problem: people pick easy to guess passwords
  - Based on account names, user names, computer names, place names
  - Dictionary words
  - Too short, digits only, letters only
  - License plates, acronyms, social security numbers
  - Personal characteristics or foibles (pet names, nicknames, job characteristics, *etc.*)

## Selecting Good Passwords

- Good passwords can be constructed in several ways
  - A password containing at least one digit, one letter, one punctuation symbol, and one control character is usually a strong password
- “LIMm\*2^Ap”
  - Letters chosen from the names of members of 2 families

## PIN

- Consider the case of a 4-digit PIN
- Suppose that the number of possible passwords (PINs) is  $N=10^4$  (assuming that the digits 0-9 are allowed in each of the 4 positions of the PIN)
- Assume that an attacker can make  $G=10,000$  per second in an offline attack
- How long would it take to guess a PIN with absolute certainty?

## What you have

- Digital authentication
  - physical devices to aid authentication
- Common examples:
  - eToken
  - smart cards
  - RFID

- Can be implemented on a USB key fob or a smart card
- Data physically protected on the device itself
- On the client side, the token is accessed via password
- Successful client-side authentication with the password invokes the token to generate a stored or generated **passcode**, which is sent to the server-side for authentication.

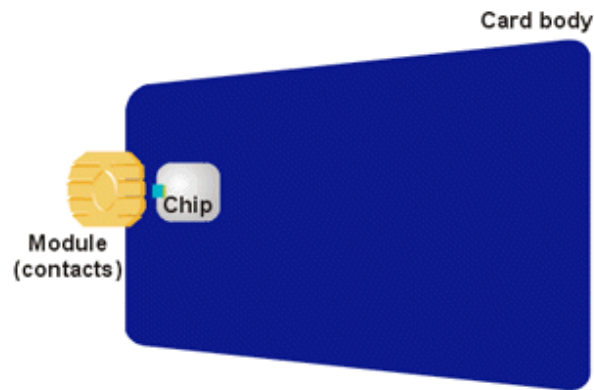
## eToken

- May store credentials such as passwords, digital signatures and certificates, and private keys
- Can offer on-board authentication and digital signing

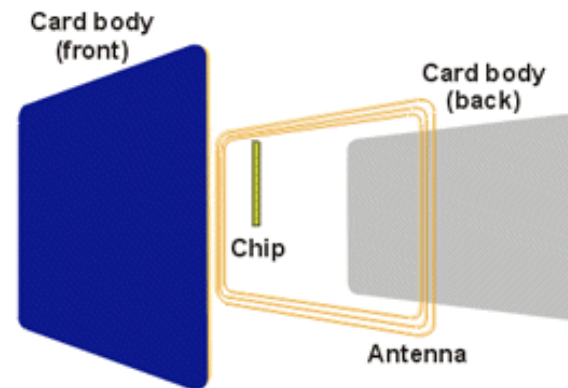


## Smart cards

- Size of a credit card
- Usually an embedded microprocessor with computational and storage capabilities
- Contact vs. contactless
- Memory vs. microprocessor



Source: Gemplus - All About Smart Cards



Source: Gemplus - All About Smart Cards



## RFID

- RFID - Radio Frequency IDentification
- Integrated circuit(s) with an antenna that can respond to an RF signal with identity information
- No power supply necessary—IC uses the RF signal to power itself
- Susceptible to replay attacks and theft
- Examples:
  - Smart Tag, EZPass
  - Garage parking permits



## Who you are

- Biometric authentication
  - Use of a biometric reading to confirm that a person is who he/she claims to be
- Biometric reading
  - A recording of some physical or behavioral attribute of a person

## Physical Biometrics

- Fingerprint
- Iris
- Hand Geometry
- Finger Geometry
- Face Geometry
- Ear Shape
- Retina
- Smell
- Thermal Face
- Hand Vein
- Nail Bed
- DNA
- Palm Print

## Behavioral Biometrics

- Signature
- Voice
- Keystroke
- Gait

## Fingerprints

- Vast amount of data available on fingerprint pattern matching
- Data originally from forensics
- Over 100 years of data to draw on
  - Thus far all prints obtained have been unique

## Fingerprint Basics

- Global features
  - Features that can be seen with the naked eye
  - Basic ridge patterns
- Local features
  - Minutia points
  - Tiny unique characteristics of fingerprint ridges used for positive identification

# Basic Ridge Patterns

- Loop
- 65% of all fingerprints



- Arch
- Plain and tented arch



- Whorl
- 30% of all fingerprints
- One complete circle



## Local Features

- Also known as *minutia points*
- Used for positive identification
- Two or more individuals may have the same global features, but different minutia
- Minutia points do not have to be inside the pattern area



## Types of Minutia

- Ridge ending
- Ridge bifurcation
- Ridge divergence
- Dot or island – ridge so short it appears
- Enclosure – ridge separates and then reunites around an area of ridge-less skin
- Short ridge – bigger than a dot



## Fingerprint Scanners



Digital Persona U.are.U Pro



HP IPAQ



IBM Thinkpad T42

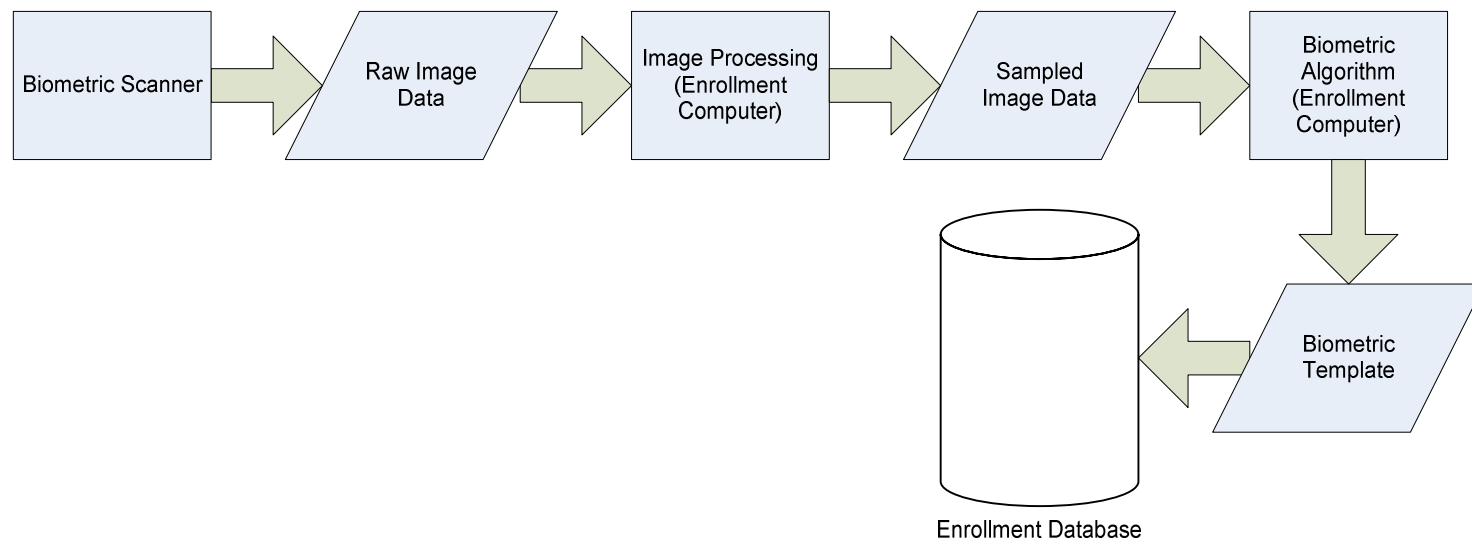
## Where you are

- If you know where user is, validate identity by seeing if person is where the user is
  - Requires special-purpose hardware to locate user
    - GPS (global positioning system) device gives location signature of entity
    - Host uses LSS (location signature sensor) to get signature for entity

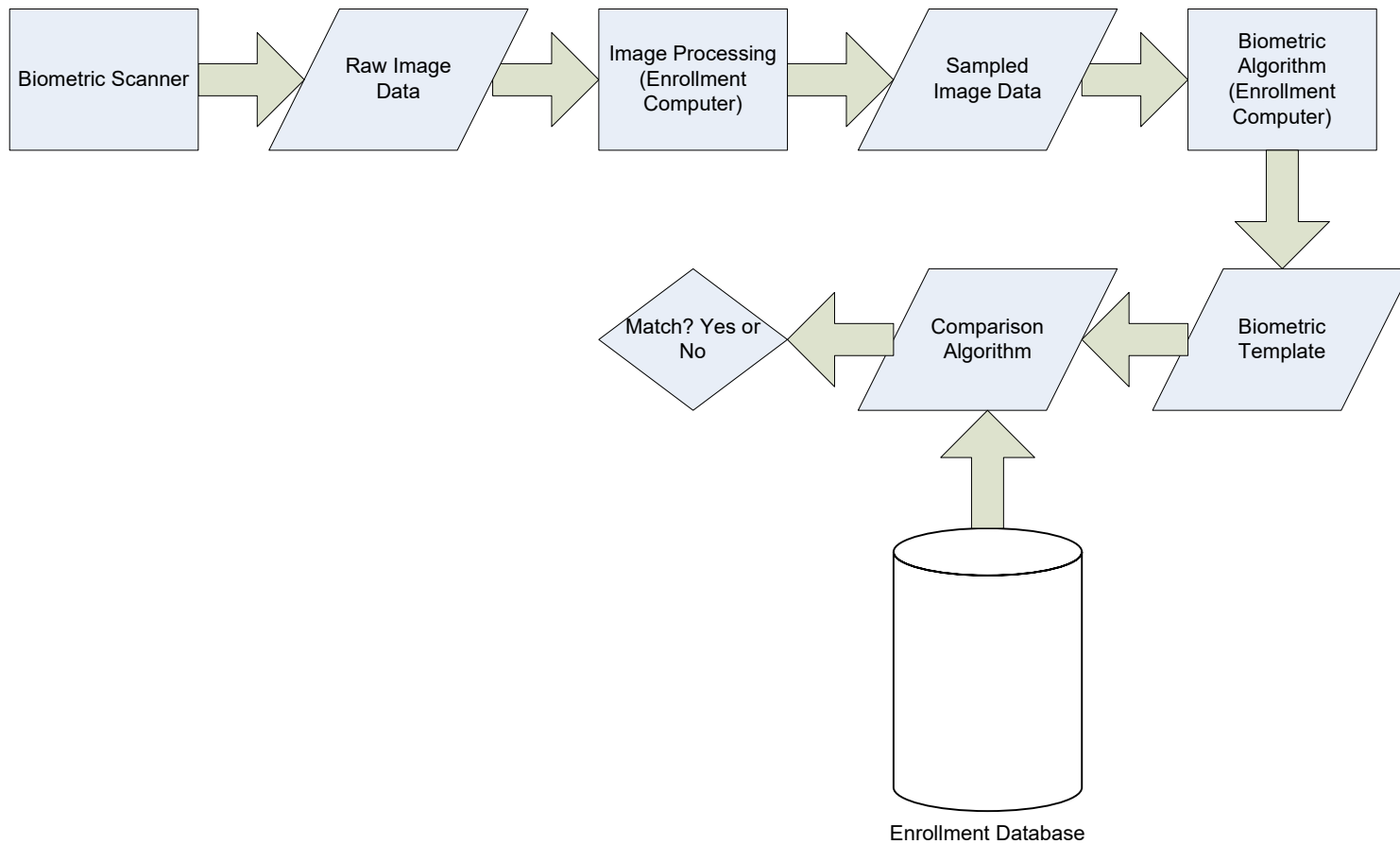
## Review: Four Categories

- What you know
  - Password
  - PIN
- What you have
  - e-Token
  - RFID
- Who you are
  - Biometrics
- Where you are
  - Location

## Example - Enrollment



## Example - Verification



## Motivation

- Real-world considerations:
  - What you know and what you have
    - Can be stolen or forgotten
    - Susceptible to replay attacks
  - Who you are
    - Unique biometrics that hinder replay attacks and imposters
    - Privacy issues arise

## Multiple Methods

- Example: “where you are” also requires entity to have LSS and GPS, so also “what you have”
- Can assign different methods to different tasks
  - As users perform more and more sensitive tasks, must authenticate in more and more ways (presumably, more stringently) File describes authentication required
    - Also includes controls on access (time of day, *etc.*), resources, and requests to change passwords
  - Pluggable Authentication Modules



## Bibliography

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# Q&A?

Dr. Phạm Thị Bạch Huệ - [ptbhue@fit.hcmus.edu.vn](mailto:ptbhue@fit.hcmus.edu.vn)

MSc. Lương Vĩ Minh – [lvminh@fit.hcmus.edu.vn](mailto:lvminh@fit.hcmus.edu.vn)

