Possible Attacks on Match-in-Database Fingerprint Authentication

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By: Jadyn Sondrol

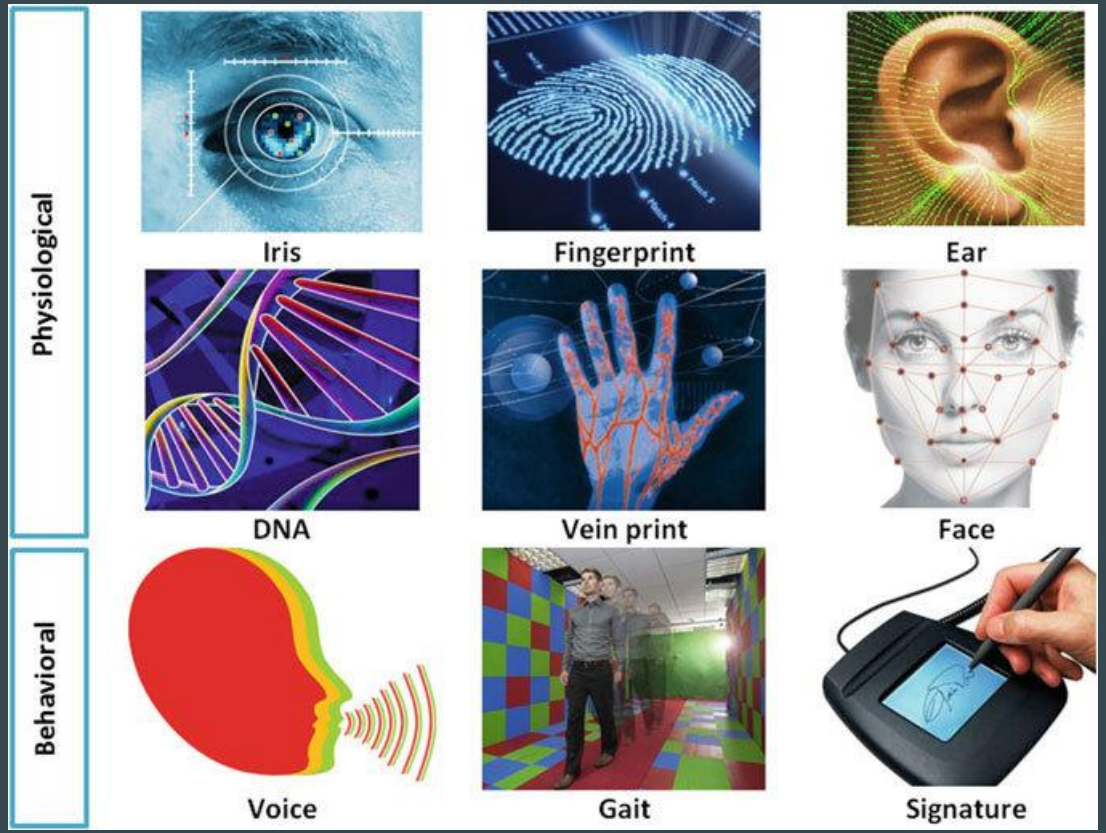
Introduction

Biometrics

Global Biometric market will exceed 70 billion by 2027

80% of Americans have used biometrics

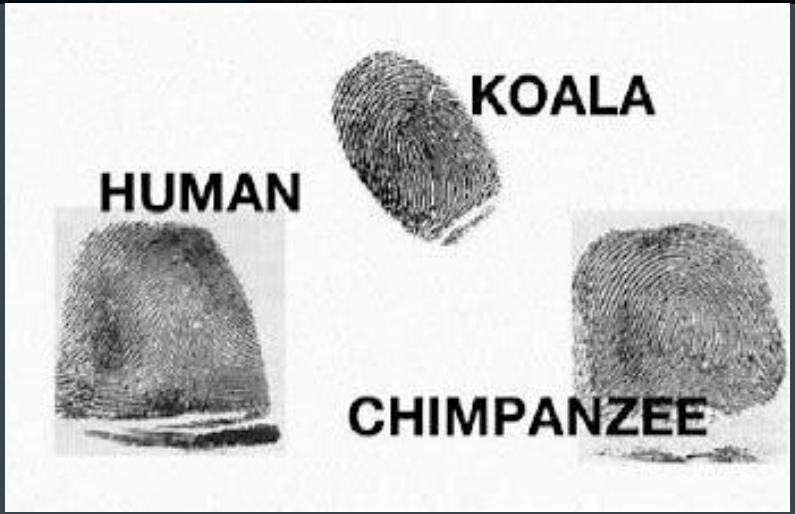
- What are they?
- Used For?
- Types?



Source: Gait Recognition (2018)

Fingerprint Fun Facts

- Unique to everyone
  - Identical twins
  - Formed from struggle in the womb
  - Friction ridges
- Loss of fingerprints
  - Gene mutation
    - 4 families
  - Bricklayers, lime workers, chemo drugs
  - Burning off
  - Will grow back
- Animals have them too
  - Apes, Chimpanzees, Koalas



Possible Attacks on Match-In-Database Fingerprint Authentication

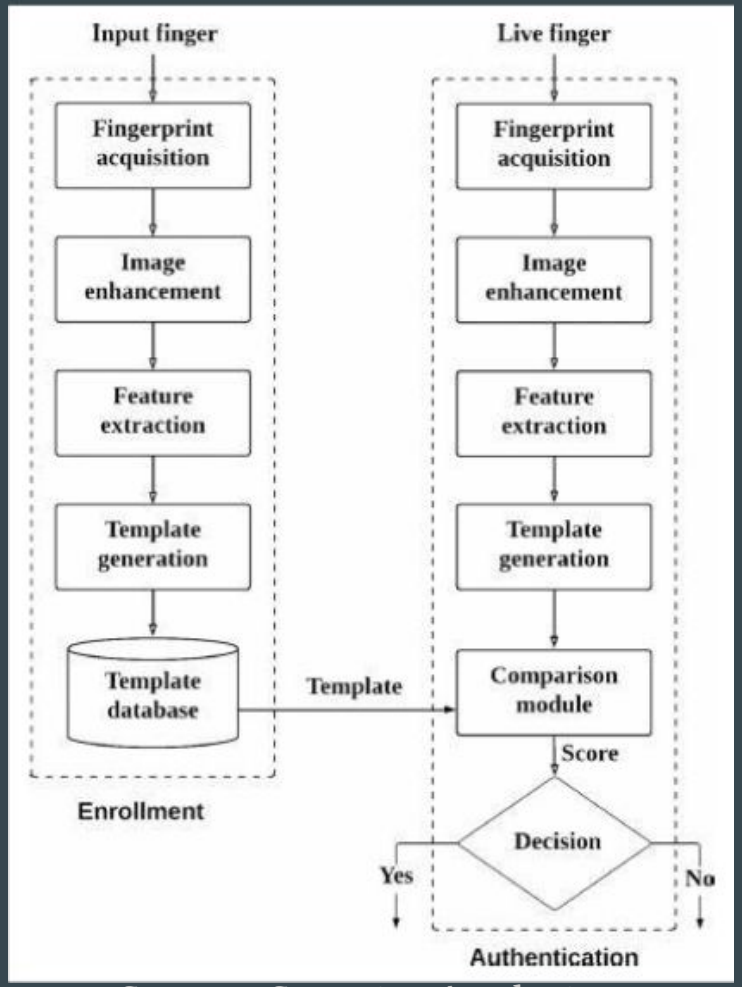
Outline

- Fingerprint Authentication
  - How it works/ modules
  - Threshold variants
- Threat Model
  - Proposed model
- Types of Attacks
  - Spoofing
  - Denial-Of-Service
  - Replay
  - Trojan Horse
- Conclusion

Source: PECB Insights (2018)

Match-in-Database Fingerprint Authentication System

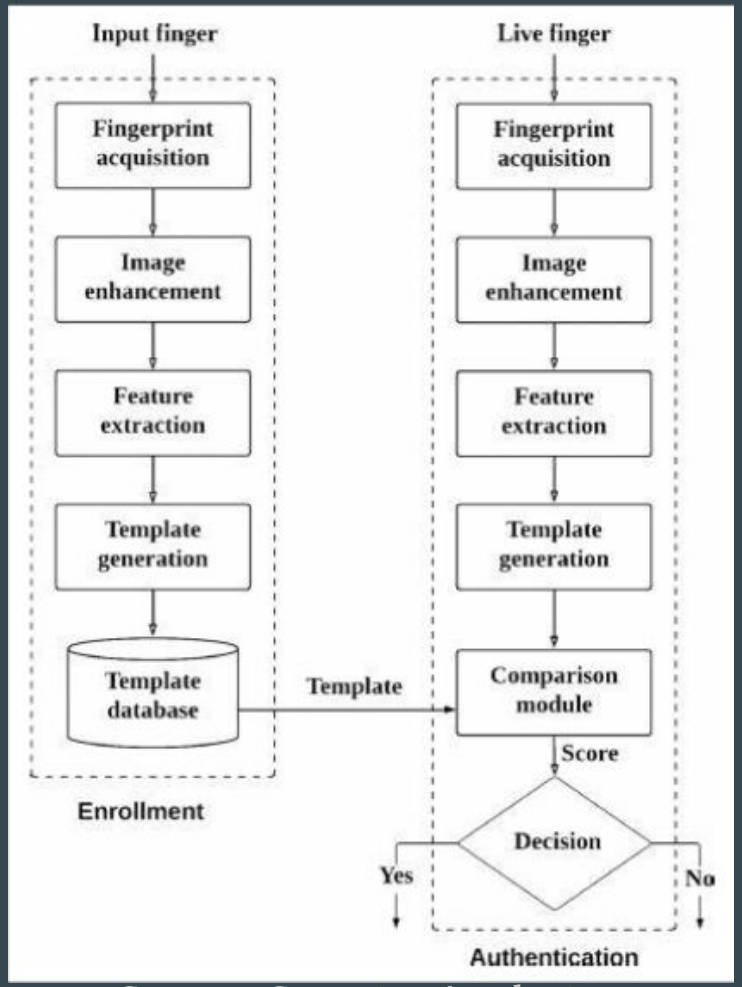
- MiD Fingerprint Authentication
  - Uses a remote database to store template
  - Template: digital representation of a fingerprint that has been encrypted
- Input Finger = Enrollment
- Live Finger = Authentication
- Verification vs. Identification
  - Fingerprint matches claimed registered user
  - Unknown identity



Source: Security Analysis

Fingerprint Acquisition/ Image Enhancement

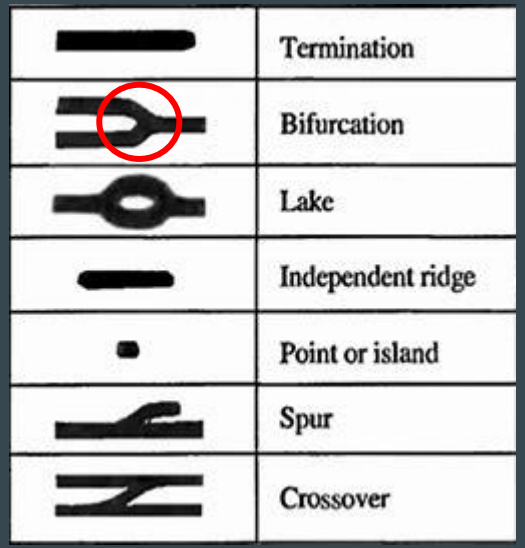
- Physical Factors
  - Sweat
  - Pressure
  - Cut
- Environmental Factors
  - Humidity
  - Temperature
  - Durability



Source: Security Analysis

Feature Extraction/ Template Generation

- Characteristic Features
  - Ridges/ Valleys
- Minutia



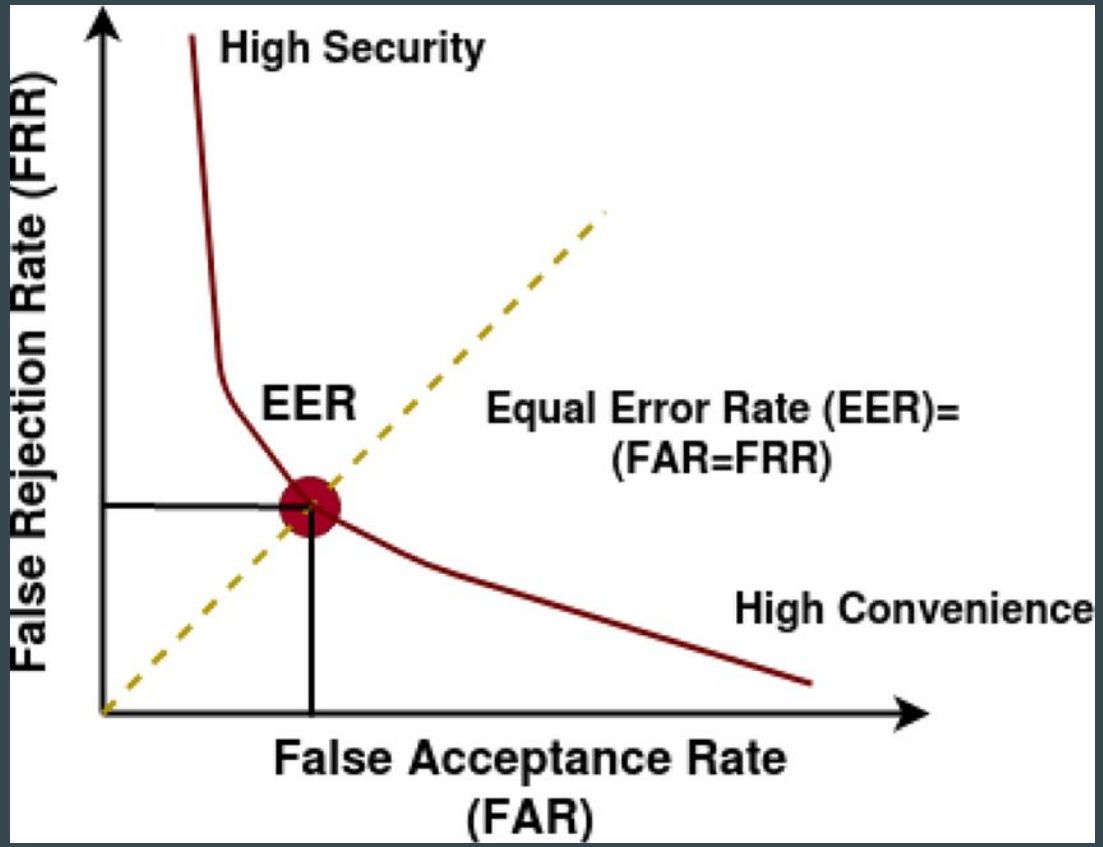
Source: Characteristic Features (2014)

Binary Strings

10001100
11001010
00110101
10011010
00110101
.
.
.
00010111

Comparison Module

- Threshold
- False Acceptance Rate (FAR)
- False Rejection Rate (FRR)
- Equal Error Rate (EER)



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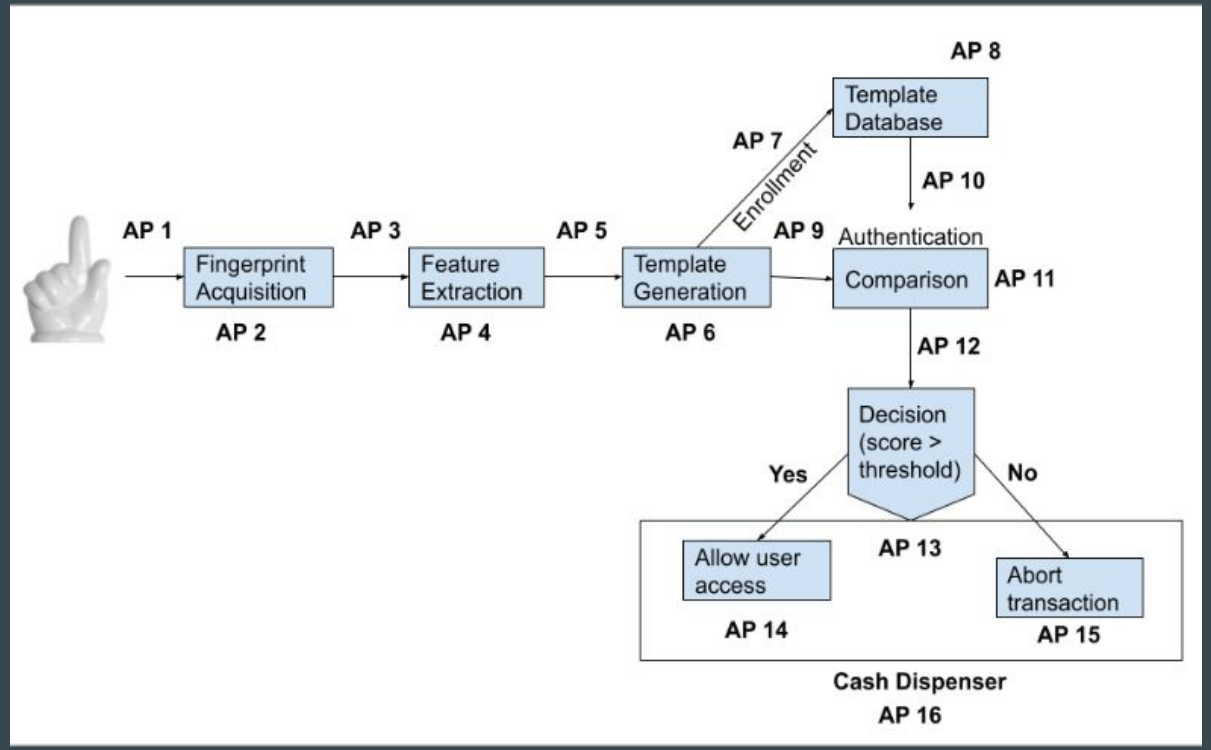
Source: PECB Insights (2018)

Threat Model

- Process of identifying, and prioritizing potential security threats
- Diagram the system
- Identify where threats could occur (Attack Points: 16)
- Threat Level
- Mitigation techniques



Proposed by: Security Analysis (2020)

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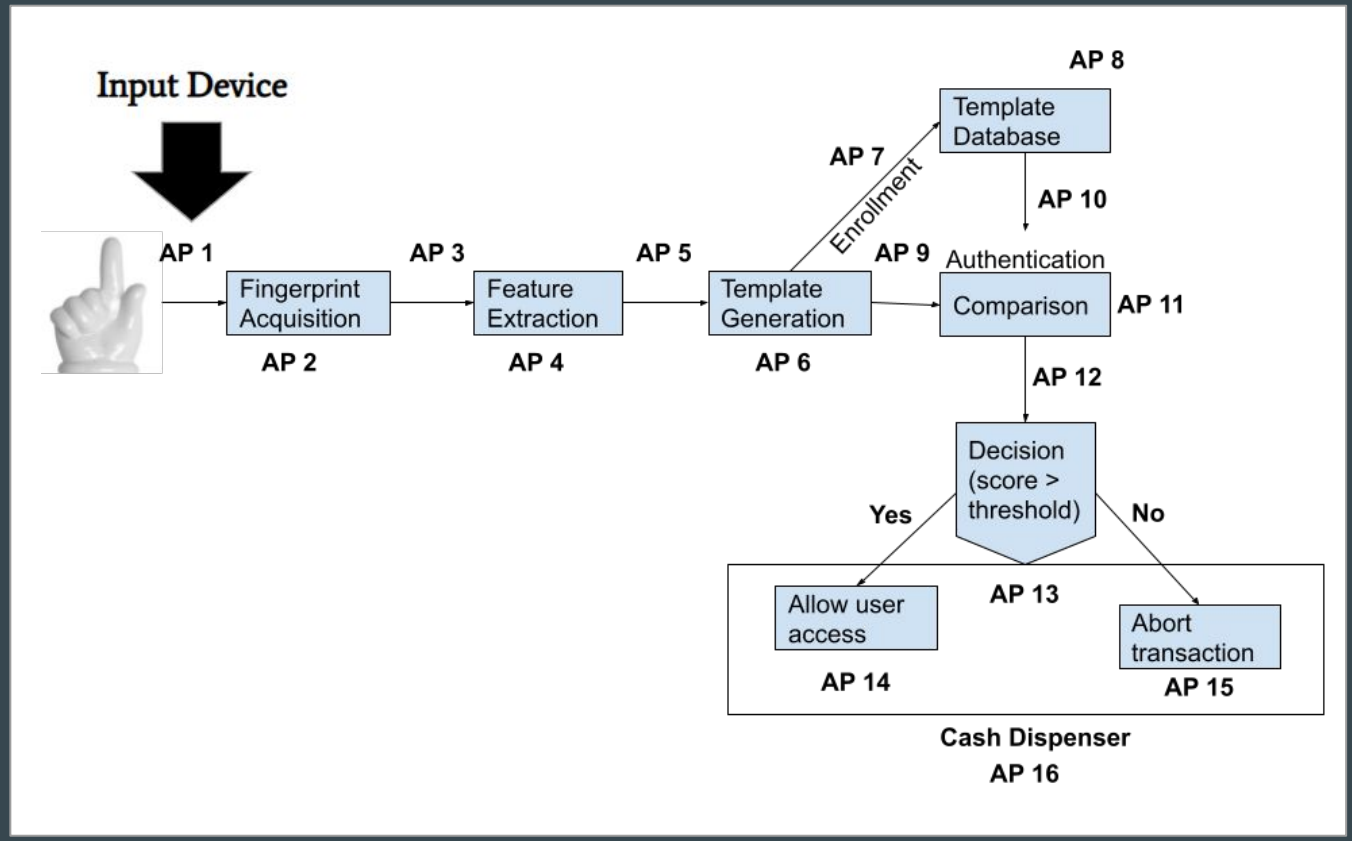
Source: PECB Insights (2018)

Types Of Attacks

- Direct: Attack to the scanner or cash dispenser itself
  - AP 1, 2, 16
- Indirect: Attack to a component within the system

Spoofing Attack

- Direct attack
- AP 1
- Provides false biometric data



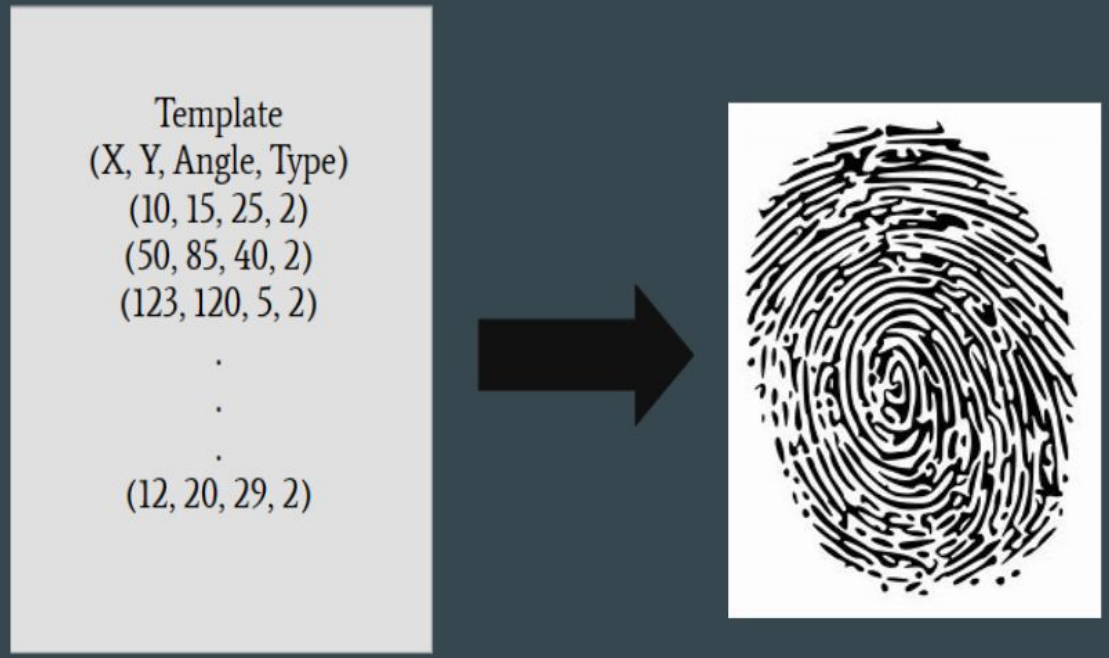
Spoofing Attack- spoofing methods

Cooperative

- ➢ Direct Mold

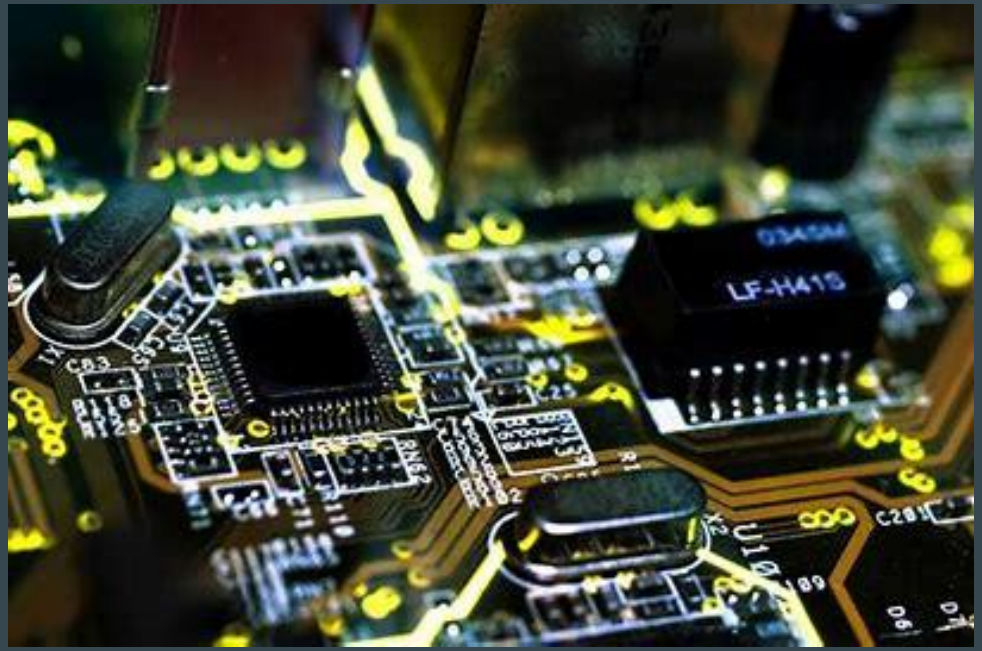
Non- Cooperative

- ❖ Latent Fingerprint
  - ➢ Invisible
  - ➢ Powder, Brush, Tape
- ❖ Fingerprint Reactivation
  - ➢ From scanner itself
  - ➢ Heavy breathing, water filled bag, graphite powder
- ❖ Cadaver
  - ➢ Enrolled user dead
- ❖ Fingerprint Synthesis
  - ➢ From template
  - ➢ Need access to database



Spoofing Attack- Anti-spoof methods -Hardware

- Costly
- Add another problem
  - Leak confidential info through patterns of electromagnetic waves
  - Power consumption



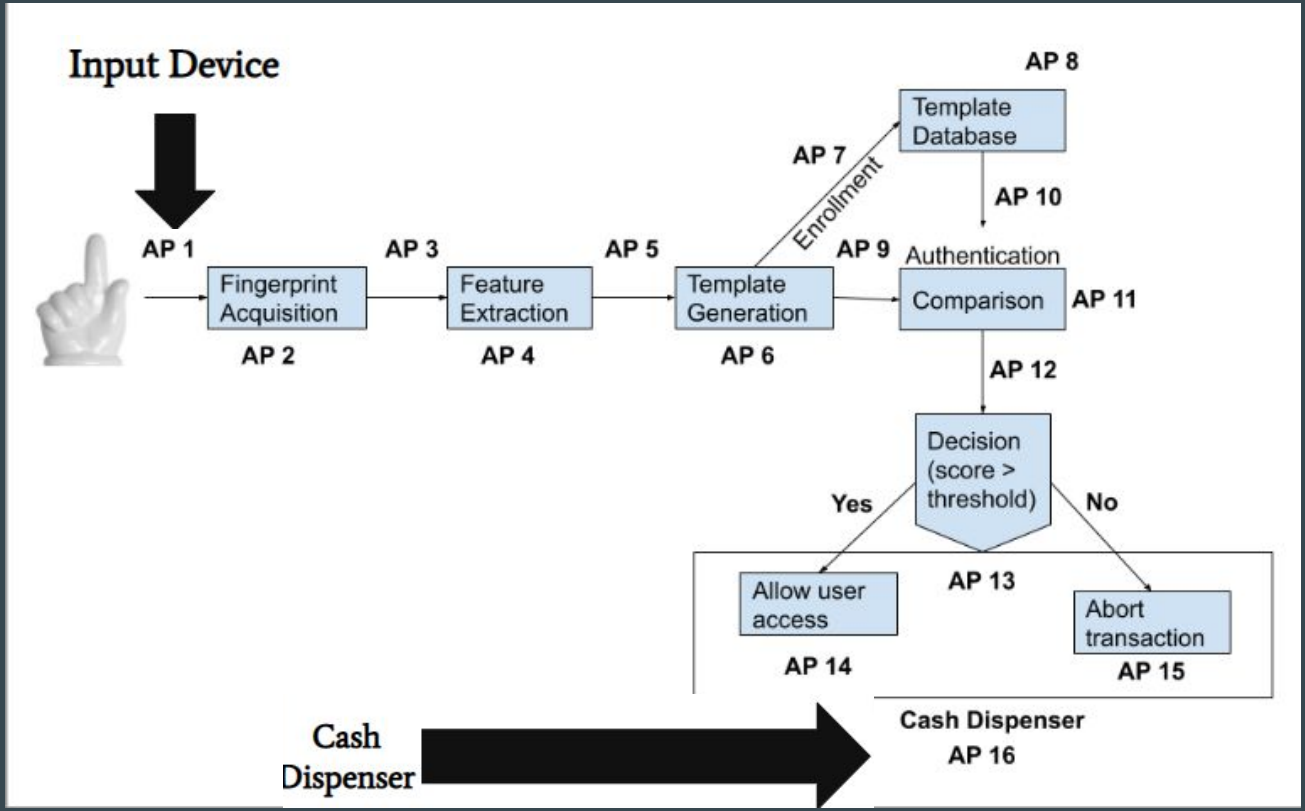
Spoofing Attack- Anti-spoof methods -Software

- Static
  - Pore-based
    - Quantity
    - Distribution
    - High resolution
  - Perspiration
    - Shading
    - Depends on pressure applied
  - Texture
    - Coarseness
    - Multi-resolution texture analysis
  - Commonly used together
- Dynamic
  - Snapshots
  - Perspiration
  - Ridge Distortion

- High Risk
  - Ease of creating fake fingerprint
  - Not implementing antispoof methods

Denial-Of-Service (DOS) Attack

- Direct
- AP 1, AP 16
- Overload the system
- Unusable for everyone

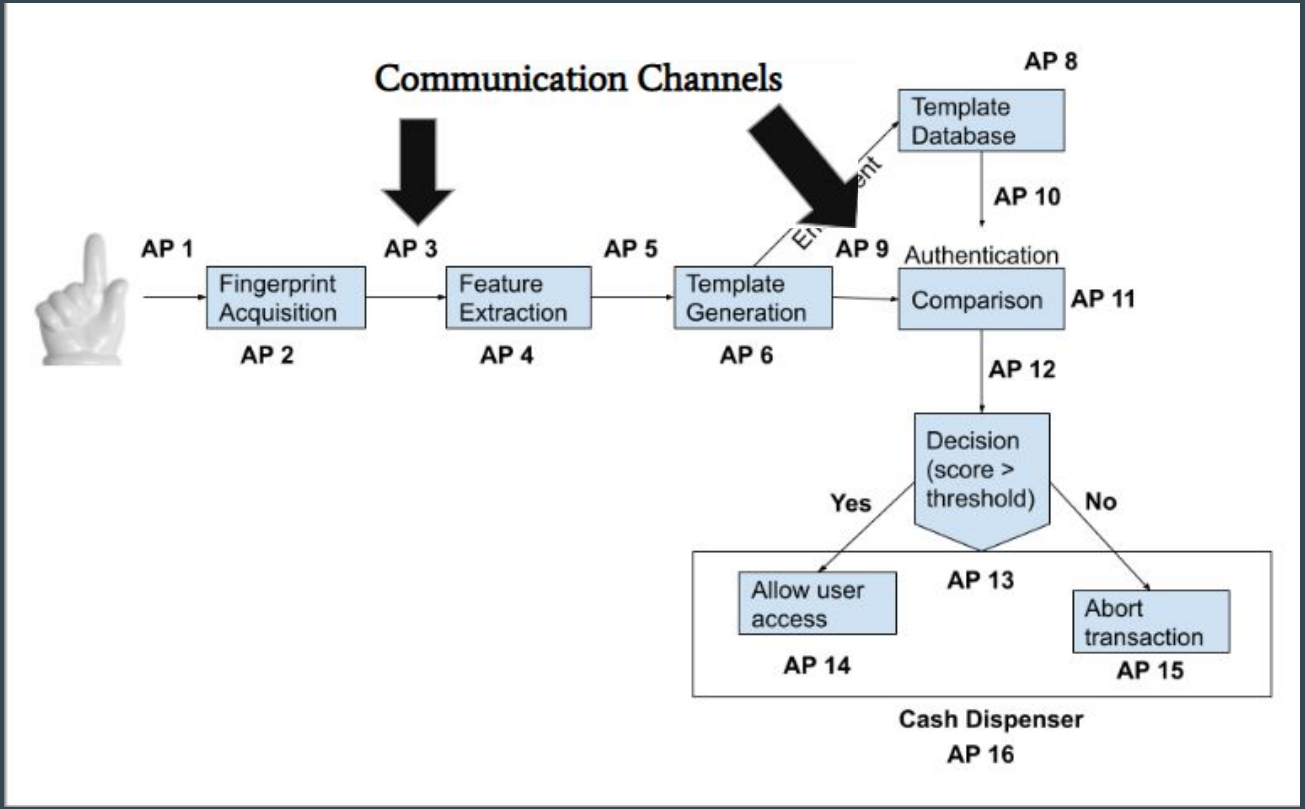


Denial-Of-Service (DOS) Attack- Mitigation

- Eye on the scanner
  - Video cameras
  - Security guards
- Rugged devices
  - Created to withstand unusual circumstances
- Low threat
  - No info
  - Annoyance

Replay Attack

- Indirect attack
- AP 3, AP 9
- Eavesdrops on the communication channels
- Intercepts
- Resends previous user input

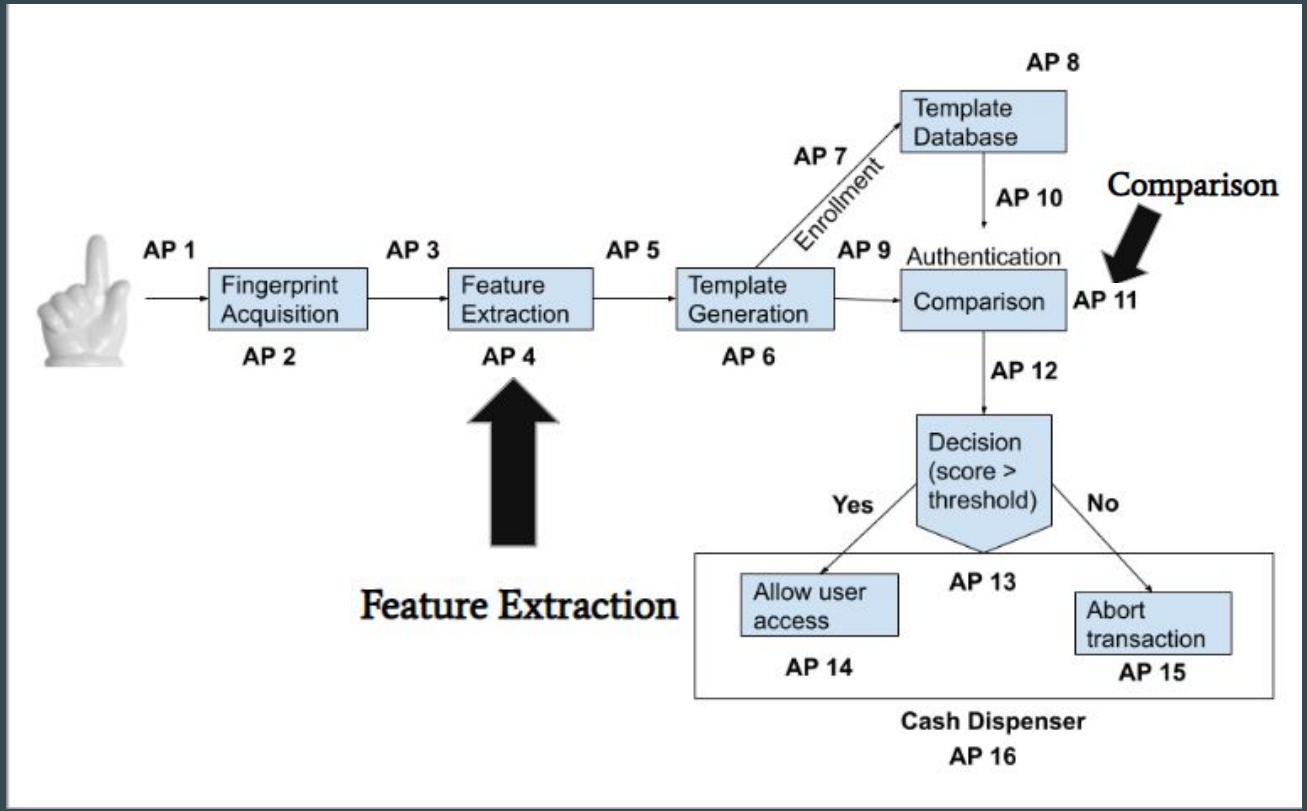


Replay Attack- Mitigation

- Challenge/Response method
  - Query system
  - Transaction server
    - Different pixel value sent every time
    - Scanner and Feature Extraction
    - Have to match
- Global Clock
  - Timestamps
- Liveliness Test
  - Active = swipe
  - Passive
    - Texture, pore distribution, ridge distortion
- Medium Threat Level
  - Challenging to gain access to the channel
  - Get all the info

Trojan Horse Attack

- Indirect
- AP 4, AP 11
- Trojan embedded
- Activated
  - Modify, copy, delete



Trojan Horse- Mitigation

- Trusted Biometric System (TBS)
  - Mutual Authentication
    - Both sides of channel verify each other at the same time
  - Increase computation power & time
- Code Signing
  - Each module's digital signature
- Hardware
  - Tamper resistant
  - Communication channels
- Medium Threat Level
  - Hard to introduce Trojan
  - Easy to modify software

Conclusion

Spoofing Attack | Replay Attack | Trojan Horse Attack | DOS Attack

Increase in biometrics - Threshold

- Biometrics are increasing
- With more users
  - 0.1% FAR currently
    - 1 out of 1000
    - FBI: 6,000 out of 6 million
    - US pop: 332,000 out of 332 million

Questions?

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