



# High resolution fingerprint sensing – next generation in biometric identification



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EU Project No. 611019



# Outline

- Safran Identity & Security presentation
- Introduction to fingerprint biometrics
- The fingerprint recognition market and PIEZOMAT technology



# Introduction to fingerprint biometrics

## TWO COMPLEMENTARY CONCEPTS



### IDENTIFICATION

Find an individual in a database

1 to Many



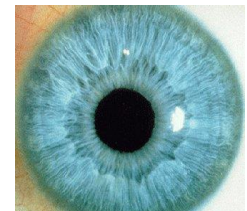
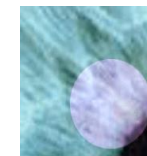
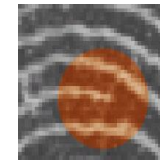
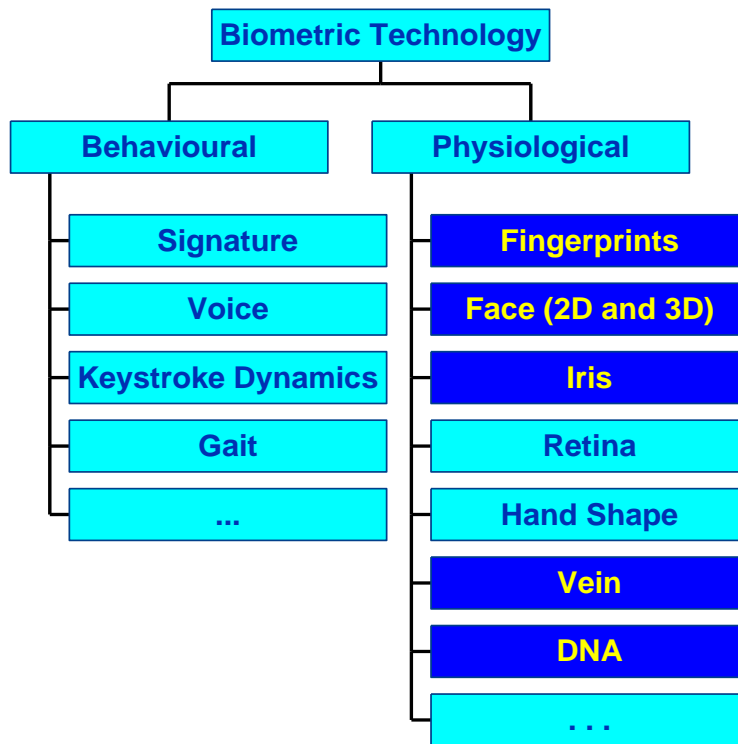
### AUTHENTICATION

Verify the stated identity of an individual

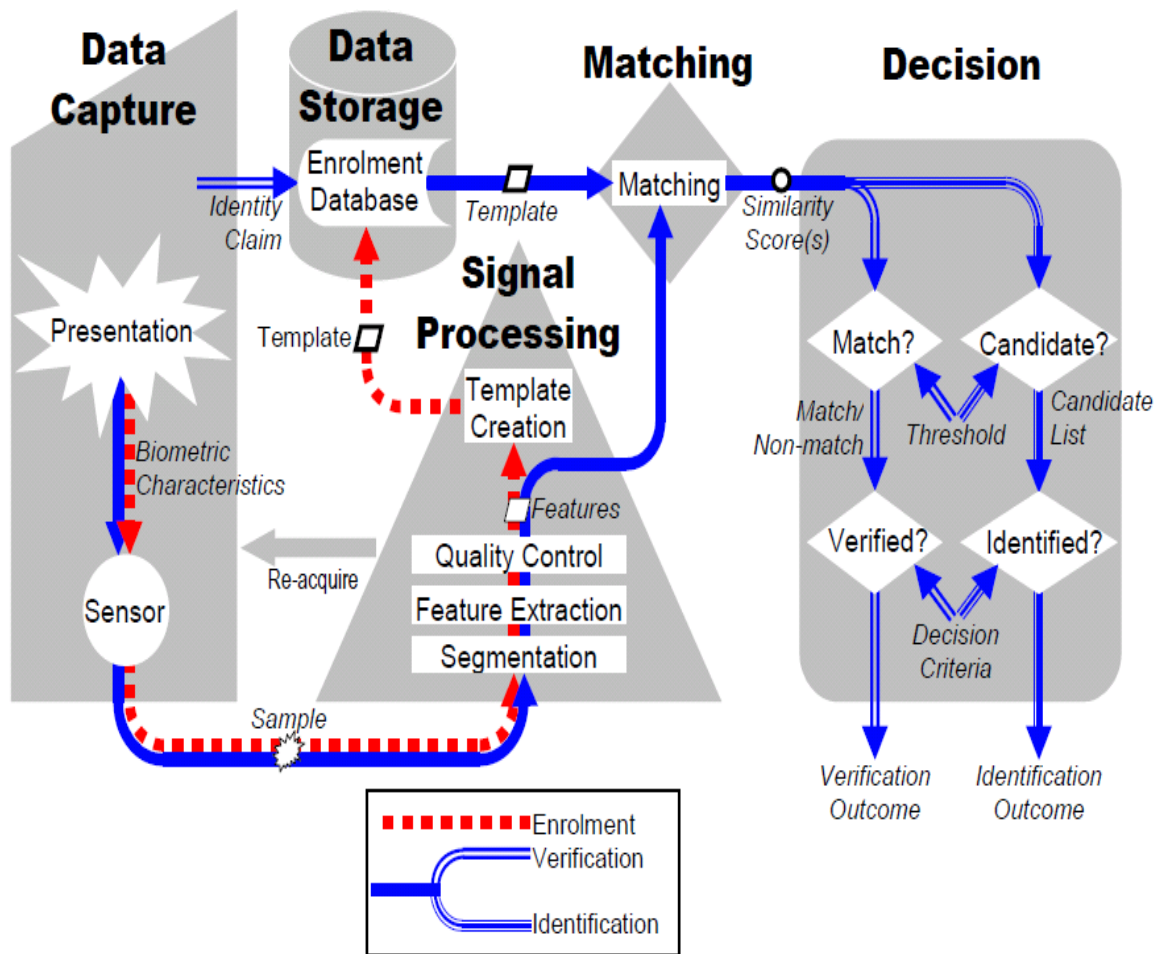
1 to 1

# BIOMETRICS TECHNOLOGY

- Looking for immutable, universal, and unique characteristics



## GLOBAL PROCESS



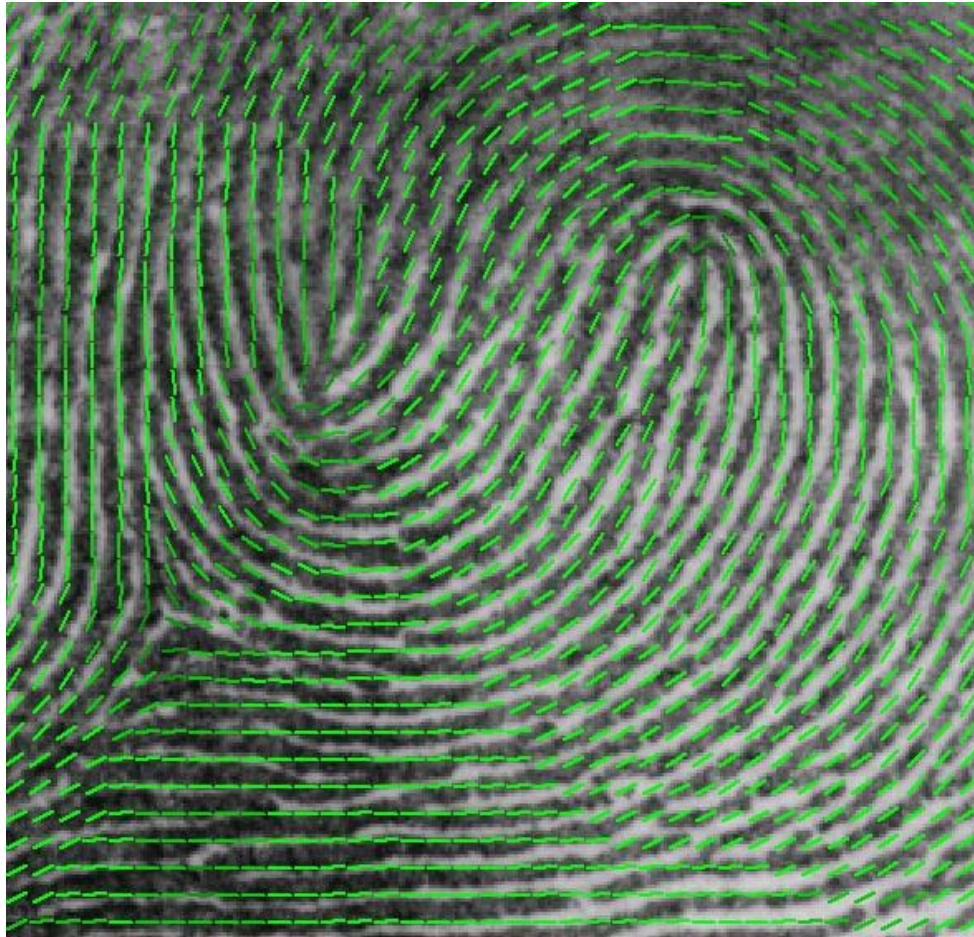
Source: ISO/IEC JTC 1/SC 37 N 1991

# FINGERPRINT RECOGNITION: WHAT IS PROCESSED ?

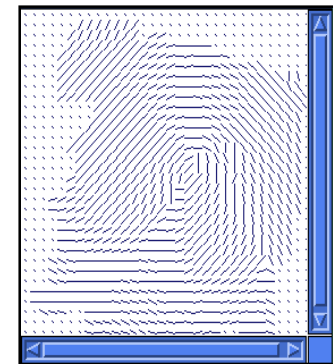
## 3 levels of information

- Level 1: ridge flow => classification
  - . Orientation, pattern, focal areas (core, delta), ...
- Level 2: ridge path => matching
  - . Features / absence of features
  - . Ridge ending, bifurcation, dot, ...
  - . Location, type, direction, relationship
- Level 3: ridge features => verification / advanced matching
  - . Pores, ridges/edges shapes/with, ...

## LEVEL 1 (GLOBAL): RIDGES DIRECTION FLOW

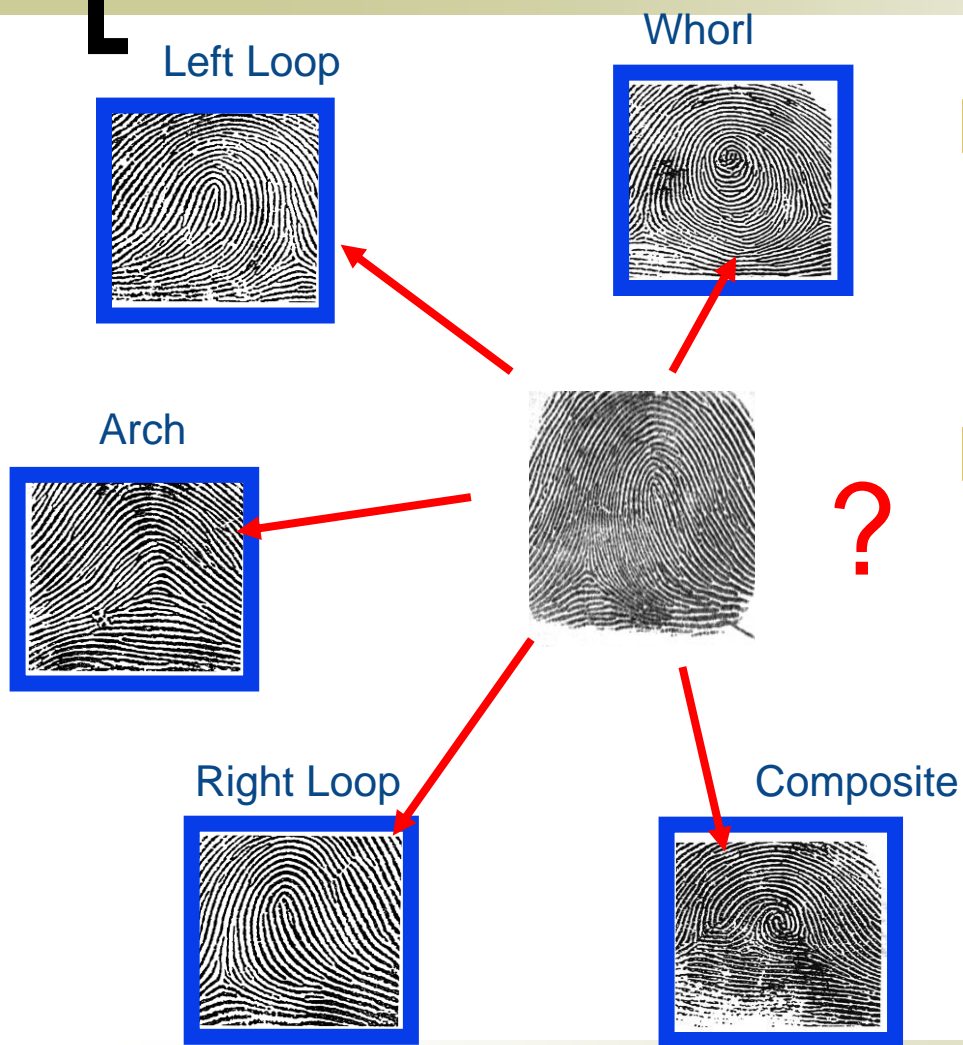


- Ridge Flow Matrix (RFM)
- The ridge flow matrix represents at each point of the image the general direction of the fingerprint's ridge flow



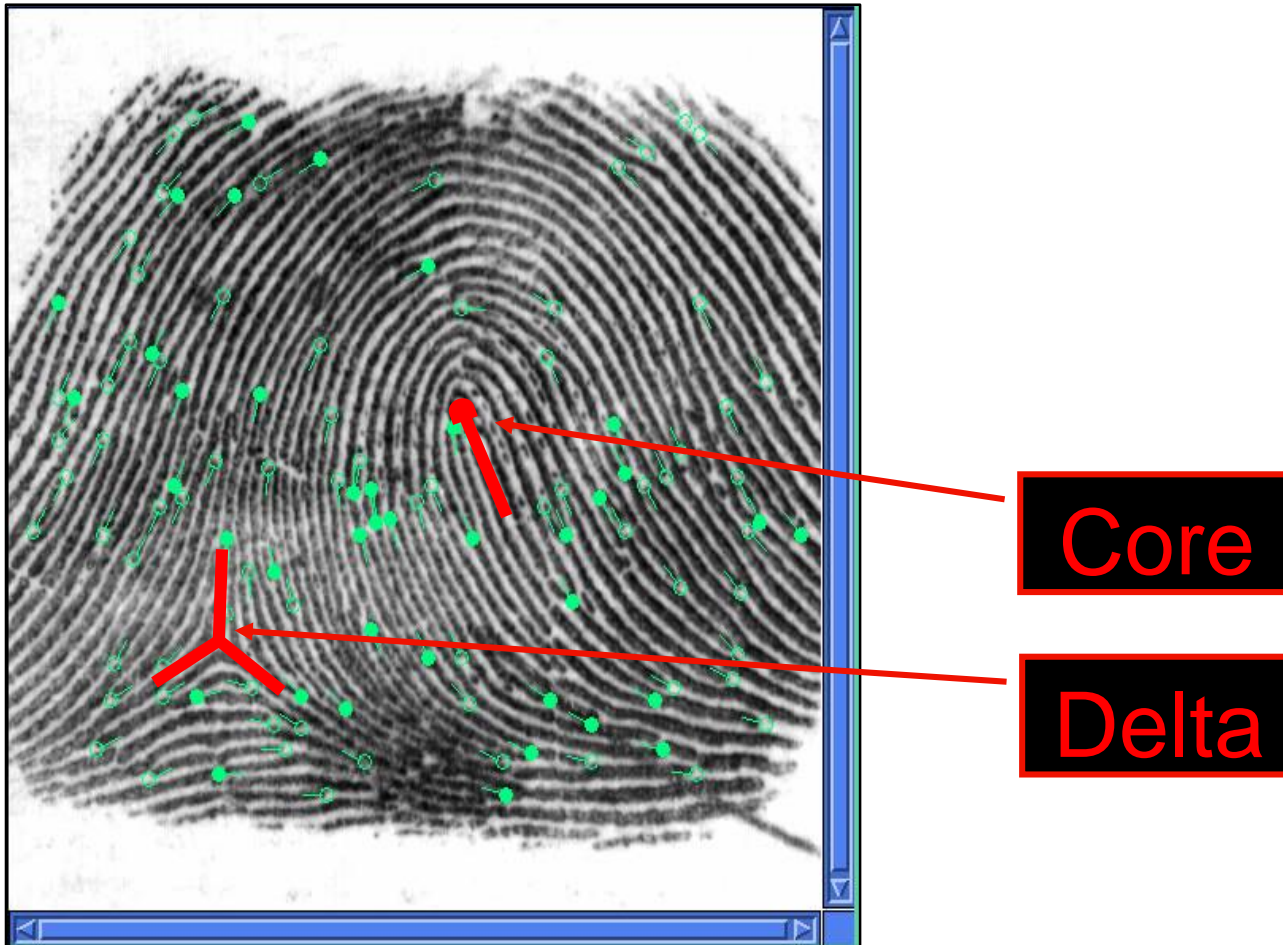


## LEVEL 1 (GLOBAL): RIDGES DIRECTION FLOW

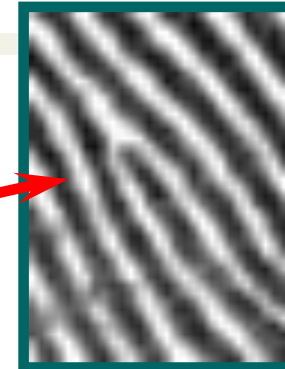


- ❑ Used for classification & filtering
- ❑ Reduce the number of finger comparisons actually performed

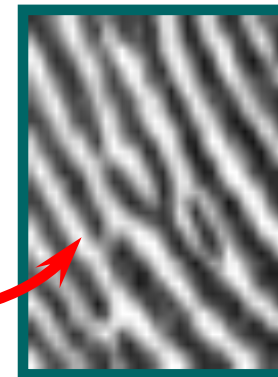
## LEVEL 1 (GLOBAL): CORES AND DELTAS



## LEVEL 2 (LOCAL): EVENT ON A RIDGE = MINUTIAE

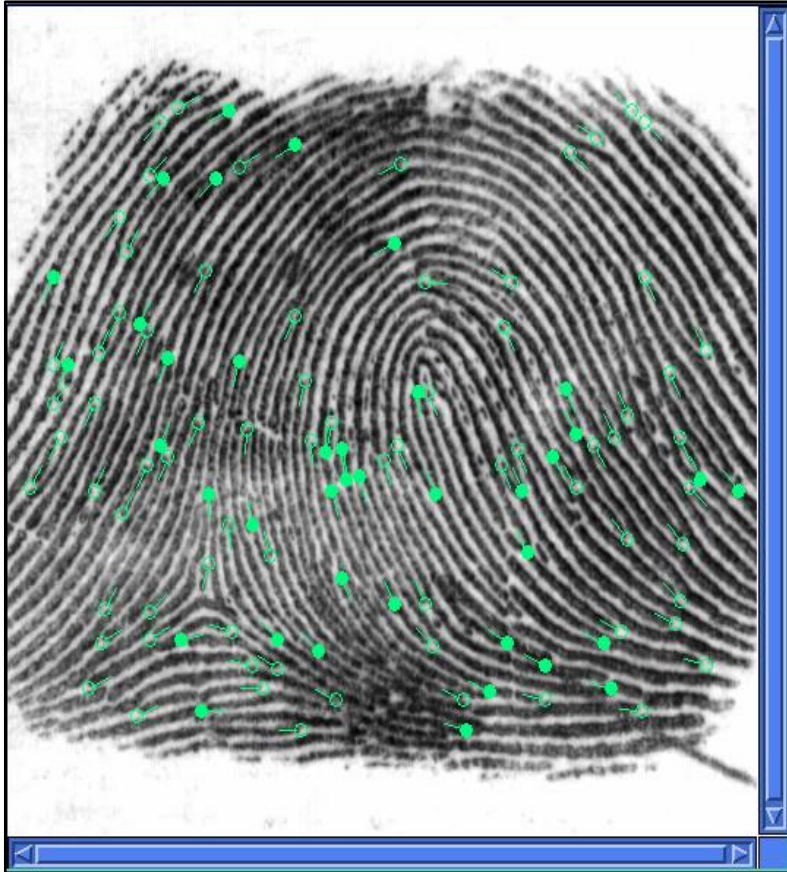


Ridge ending



Bifurcation

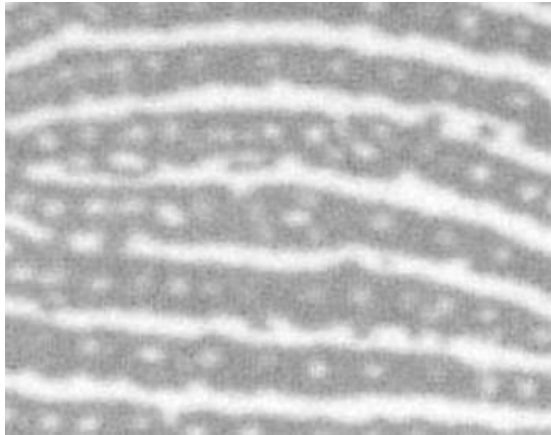
# LEVEL 2 (LOCAL): EVENT ON A RIDGE = MINUTIAE (2/2)



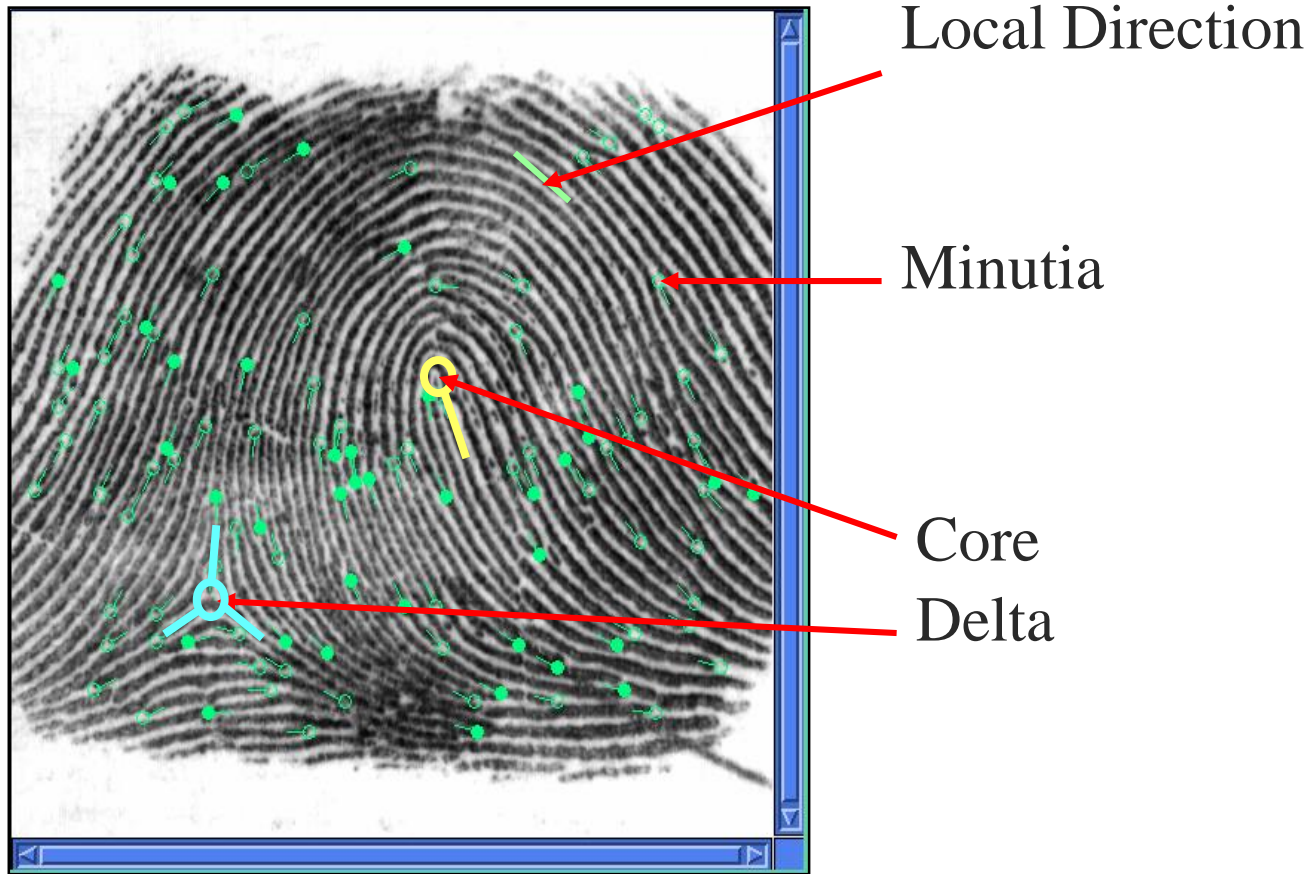
- Minutiae are : location + direction
- Used for matching → very important
- About 40 – 60 minutiae in average per finger for a fingerprint sensor
  - Up to 100 minutiae per finger depending on the sensor

# LEVEL 3: PARTICULARITIES OF THE RIDGES

- ❑ Pores, ridge shape, incipient ridges, scars, creases, deformations, ...
- ❑ Anything which is not level 1 nor level 2...
- ❑ Need high resolution ( $\geq 1000$  dpi)



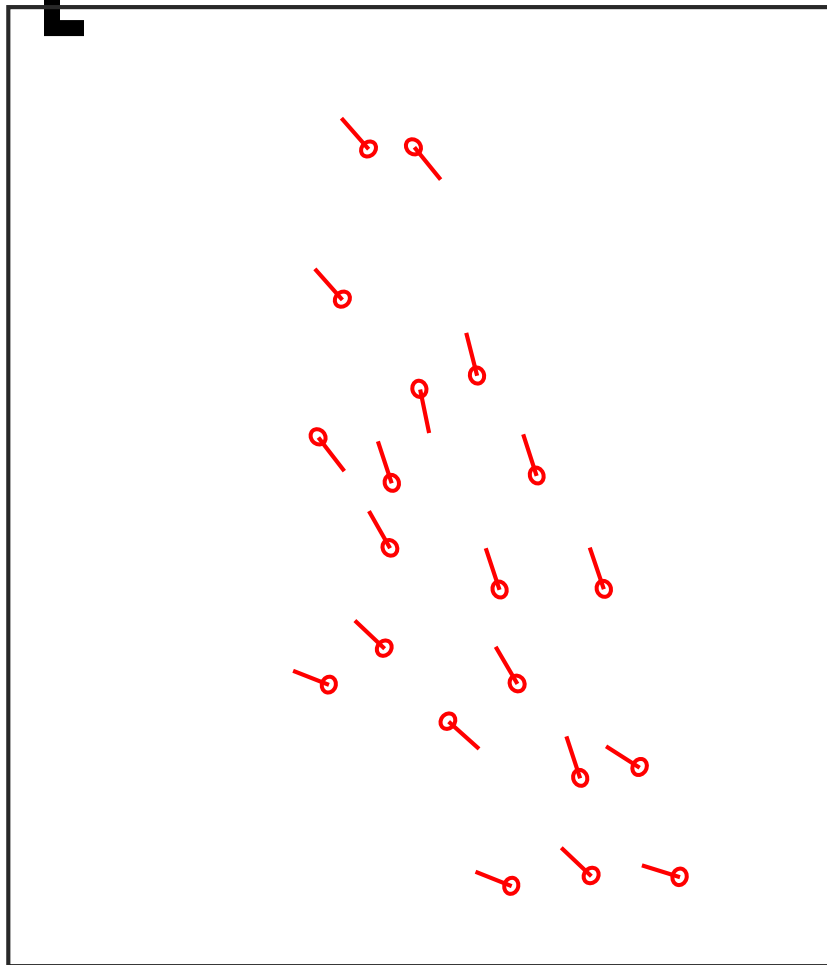
# MAIN FEATURES AUTOMATICALLY DETECTED ON FINGERPRINTS



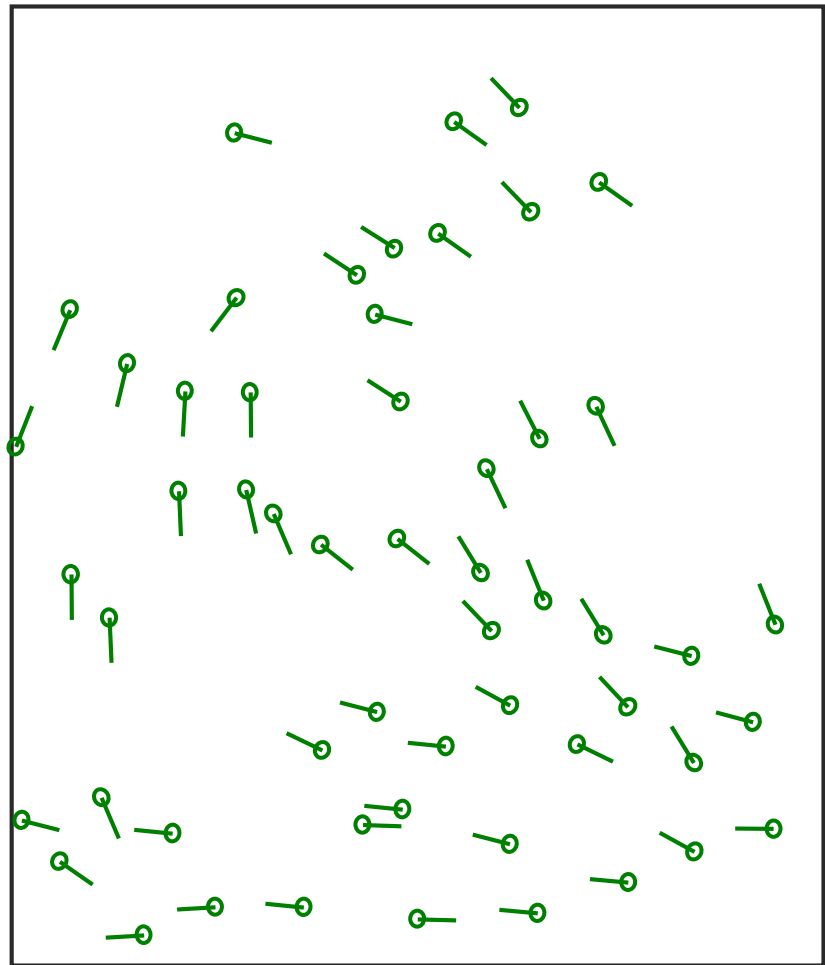
# Fingerprint matching: minutiae comparison

- ❑ Extract minutiae from fingerprint images to create the fingerprint template
- ❑ Compare minutiae template against template(s) in the database
- ❑ Compute a score and take a decision

# EXAMPLE OF MATCHING (1/3)



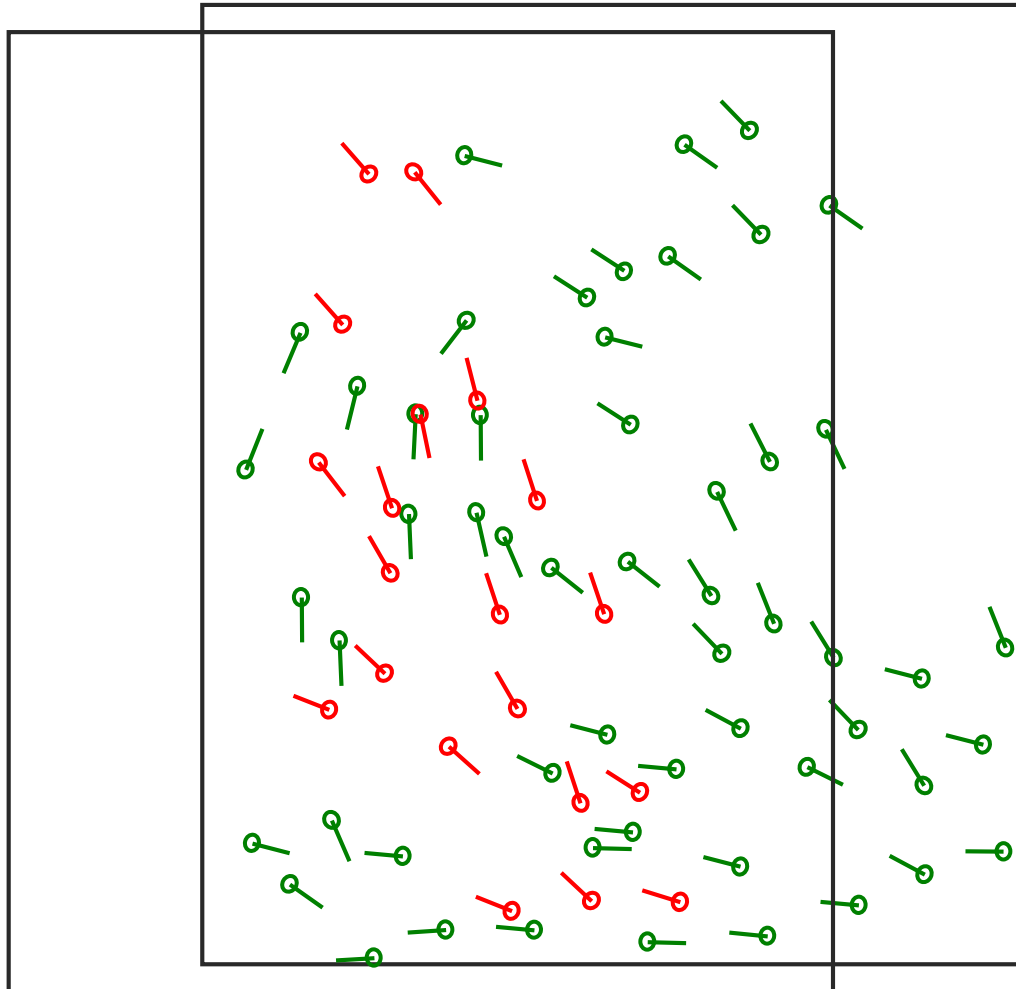
Fingerprint 1



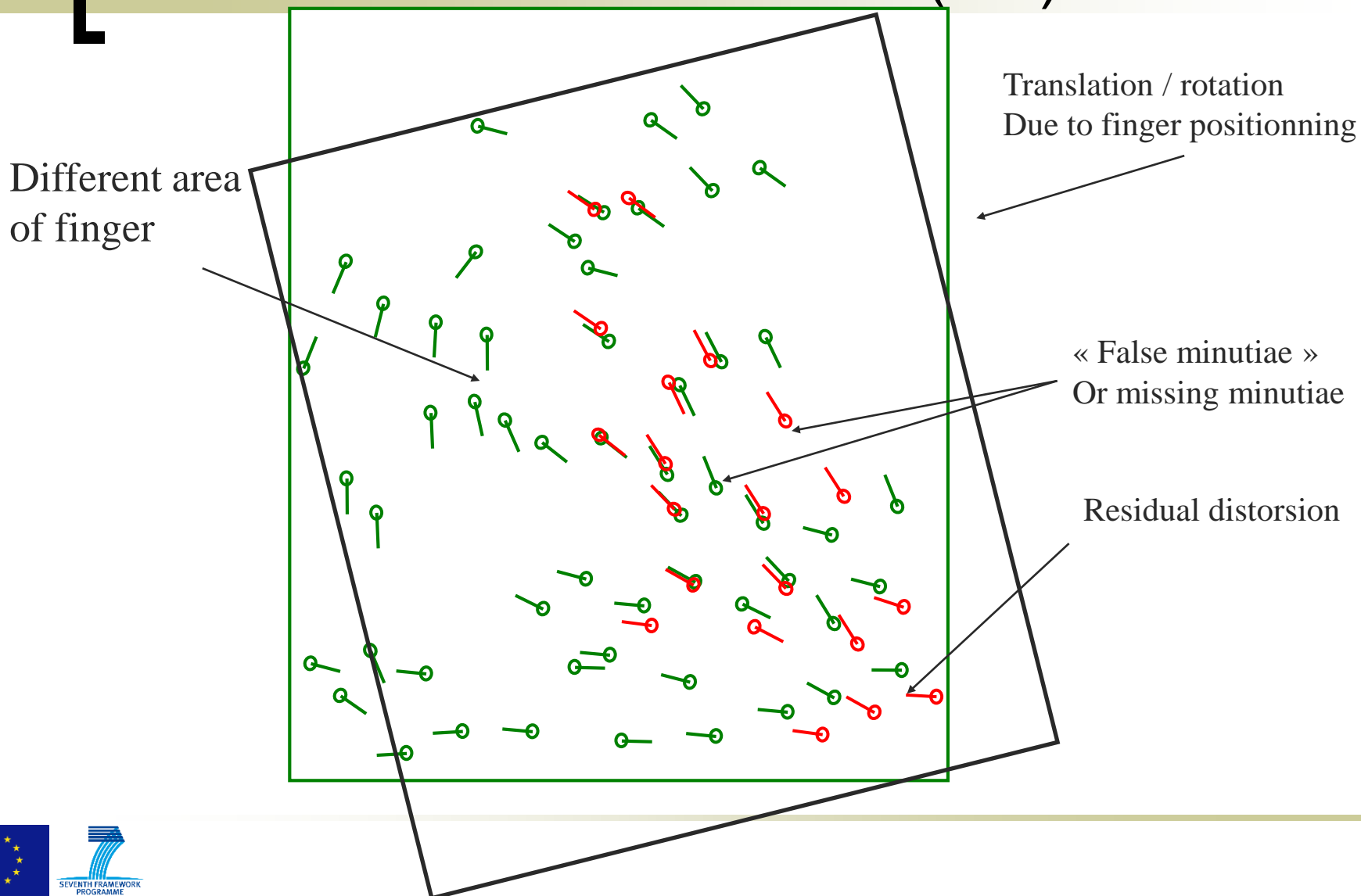
Fingerprint 2



## EXAMPLE OF MATCHING (2/3)



## EXAMPLE OF MATCHING (3/3)



# DECISION

- Compute a score
- Depends on application
  - Example : law enforcement
    - The system proposes a candidates list
    - Then the experts verify it
  - Example : border control
    - Automatic decision with a threshold on matching score



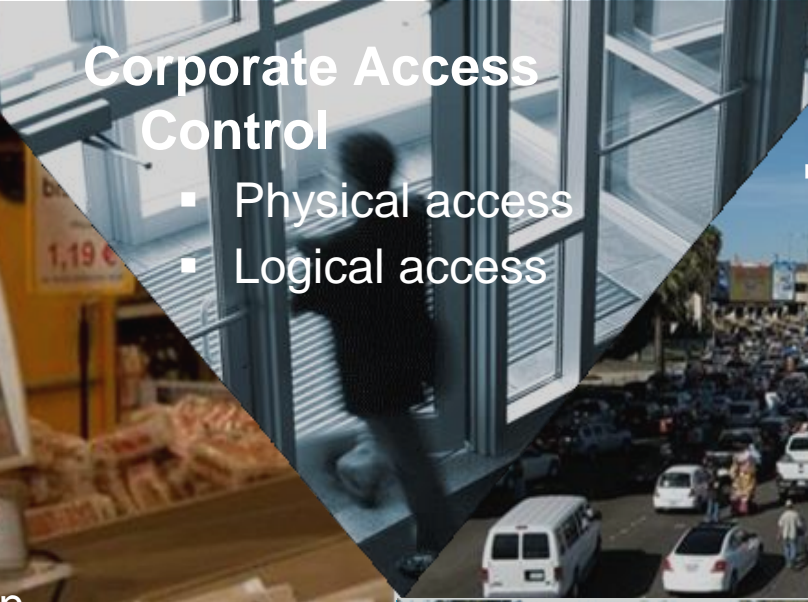
# The fingerprint recognition market and PIEZOMAT technology

## PANORAMA OF BIOMETRICS APPLICATIONS



### Financial Transaction

- Consumer ID management
- ecommerce
- Home banking
- Payment transaction



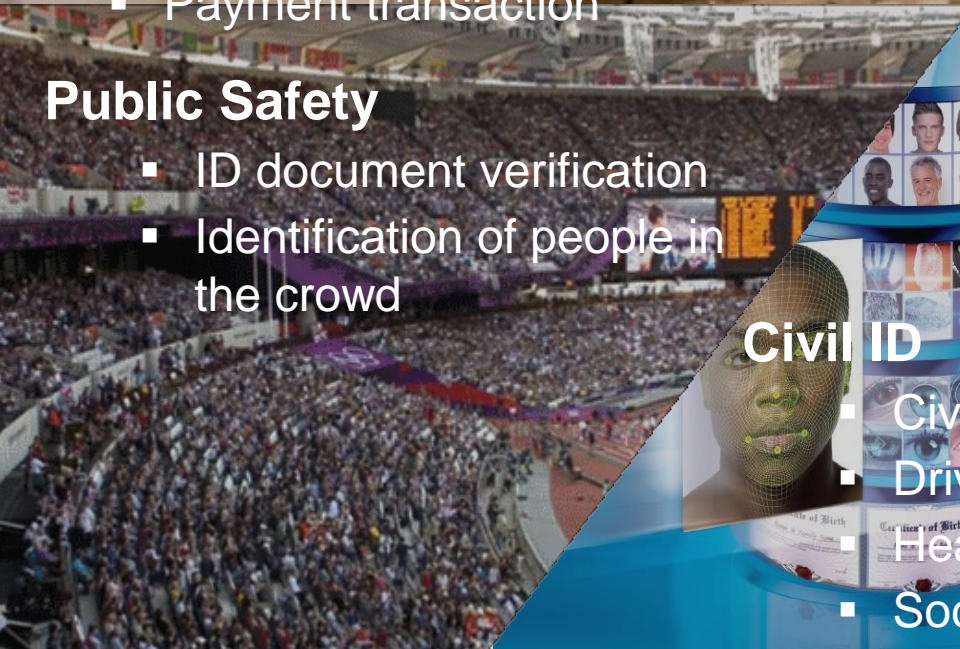
### Corporate Access Control

- Physical access
- Logical access



### Border Control

- Passport verification
- Citizen authentication



### Public Safety

- ID document verification
- Identification of people in the crowd



### Civil ID

- Civil Registry
- Driving licence
- Health care
- Social & financial inclusion



### Criminal Justice

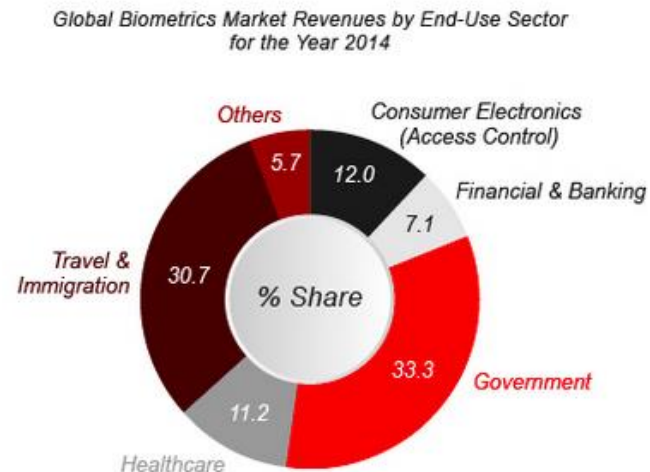
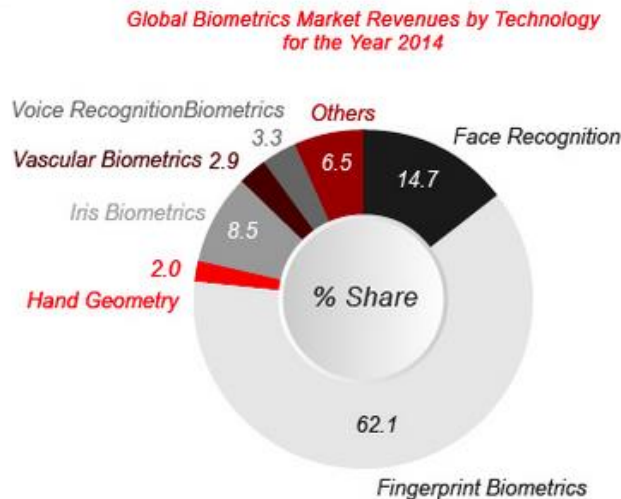
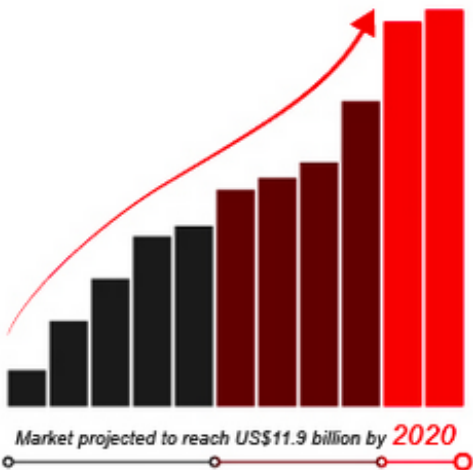
- Fast Identification of suspects
- Evidence capture
- Prisoners transfer

# Market context

- Traditional market (government oriented)
  - Criminal justice
  - Border control
  - Critical infrastructure protection
  - Identity document and digital identity
  
- Mobile market – Newly identified within project' scope
  - e-Banking
  - e-Health
  - e-Government
  - e-Commerce

# Traditional market

- ❑ Strong growth expected in next years
- ❑ High security expectations and requirements
- ❑ Projected revenues up to 2020 and market share by biometric modality and applications:

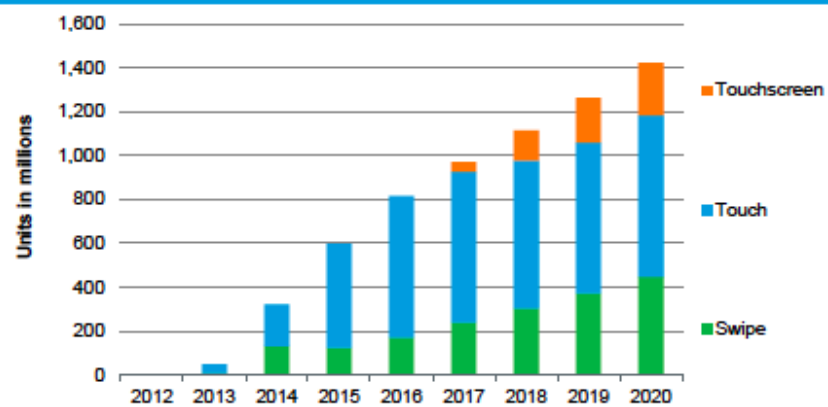


Source: Global Industry Analysts, Inc

# Mobile market

- ❑ Emerging and fast growing
- ❑ Smartphone manufacturer increasingly integrate fingerprint sensors (swipe, touch or touchscreen)
- ❑ Small surface: new comparison algorithms (no minutiae based)!
- ❑ Projection for implementation of fingerprint sensors in mobile

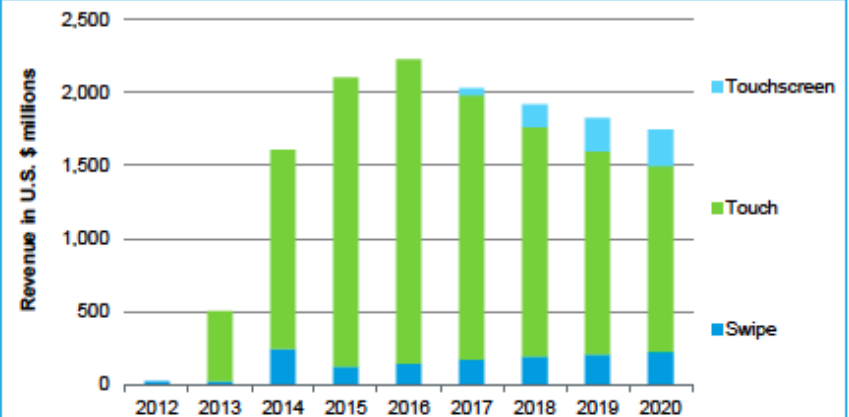
Fingerprint shipment forecast by implementation in smartphones and tablets



Source: IHS

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Fingerprint revenue forecast by implementation in smartphones and tablets



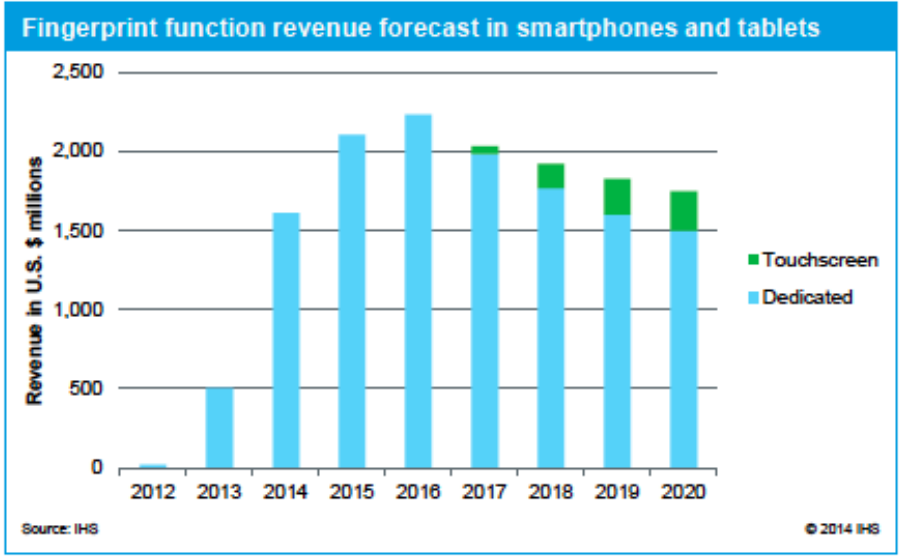
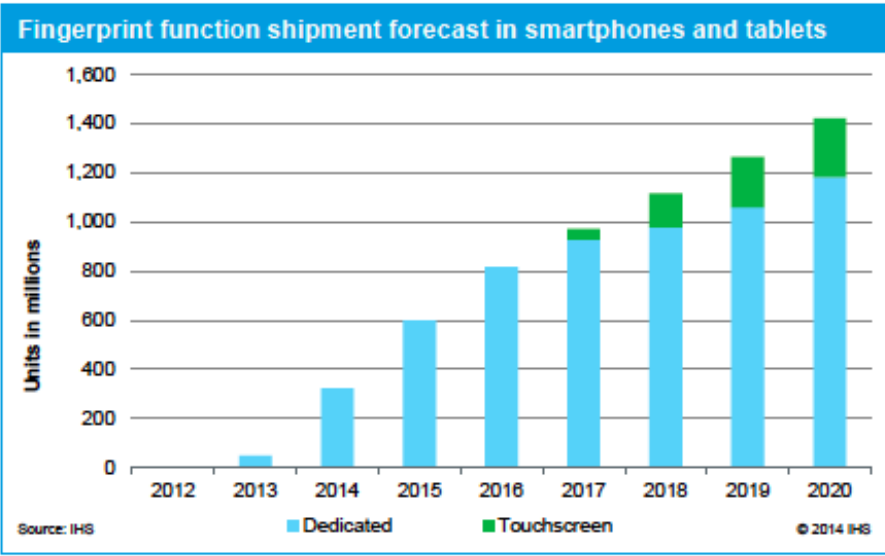
Source: IHS

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Source: IHS



# Mobile market



Source: IHS

# FINGERPRINT TECHNOLOGY

- A large number of fingerprint sensing techniques already exist or are emerging
  
- Fingerprint sensor
  - The sensing technology impacts the image quality
  - High resolution (500dpi) needed with a good sharpness and contrast

Sensor Technology	Sensor Embedded Technologies			Sensor Type	Maturity
	Sig. Generation	Sig. Capture	Sig. Conversion		
Optical	TIR		Camera	Touch	High
	Direct View		Camera	Contactless	High
	Direct view		Camera	Touch	High
	Electroluminescent Film		Camera	Touch	High
	Electroluminescent Film	TFT	Chip off sensor	Touch	Medium
	Direct view + Struct. light		Camera	On The Fly	Medium
	OCT		Camera	Touch	Very Low
Electrical field	Silicon only			Touch	High
	Flex		Chip off sensor	Touch	Low
	Silicon only			Swipe	High
Ultrasonic	Film Piezzo	TFT	Chip off sensor	Touch	Medium
Capacitive	Silicon only			Touch	High
	Film PVBF	TFT	Chip off sensor	Touch	Medium
	Silicon only			Swipe	High
Pressure	Polyurethane acrylate Film		Chip off sensor	Touch	Low
PyroElectric	Silicon only			Swipe	High

# FINGERPRINT SENSING CHALLENGES AND FUTURE

- ❑ Biometric sensors technical challenges
  - ❑ Security: Detection of fake / dead sample
  - ❑ Performance: Capacity to collect high quality biometric sample in any place, any conditions and from anybody
  - ❑ Usability: Ergonomic solution minimizing the number of retries
  - ❑ Price: Design of high quality and cost effective solution to address larger market opportunities
- ❑ Technology enablers
  - ❑ Increased processing power on embedded platform (smart camera, etc.)
  - ❑ Next generation camera sensors: High speed, light field, high resolution etc.
  - ❑ Progress from the consumer electronics
  - ❑ Etc.

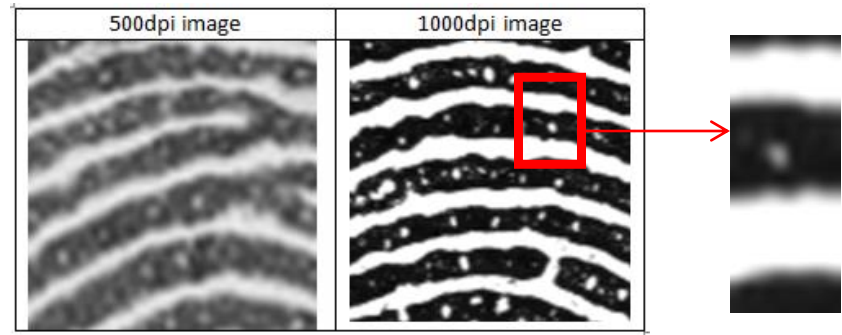
# Safran technology interest

- ❑ Monitoring of new/emerging technologies
- ❑ New products
- ❑ Market expertise to anticipate future customer needs:
  - ❑ Mobility
    - ❑ Embedded sensors in mobile devices (Smartphone, Tablet...)
  - ❑ Trust
    - ❑ Resistance to spoofing

# PIEZOMAT Technology advantages

- Very high resolution (>1000 dpi)

- High quality image
- Very precise description of fingerprint ridge structure



- Enhanced fingerprint representation

- Additional features (pore): standardisation opportunities within the ISO SC 37 Working group (ISO/IEC JTC 1/SC 37 Biometrics) to include new features in the template for fingerprint representation
- Anti-spoofing capabilities

- 3D capabilities for ridge structure representation

- Could also be used as anti-spoofing mechanism

- Form factor

- Flat form factor, even for large surface

# Position for PIEZOMAT sensor

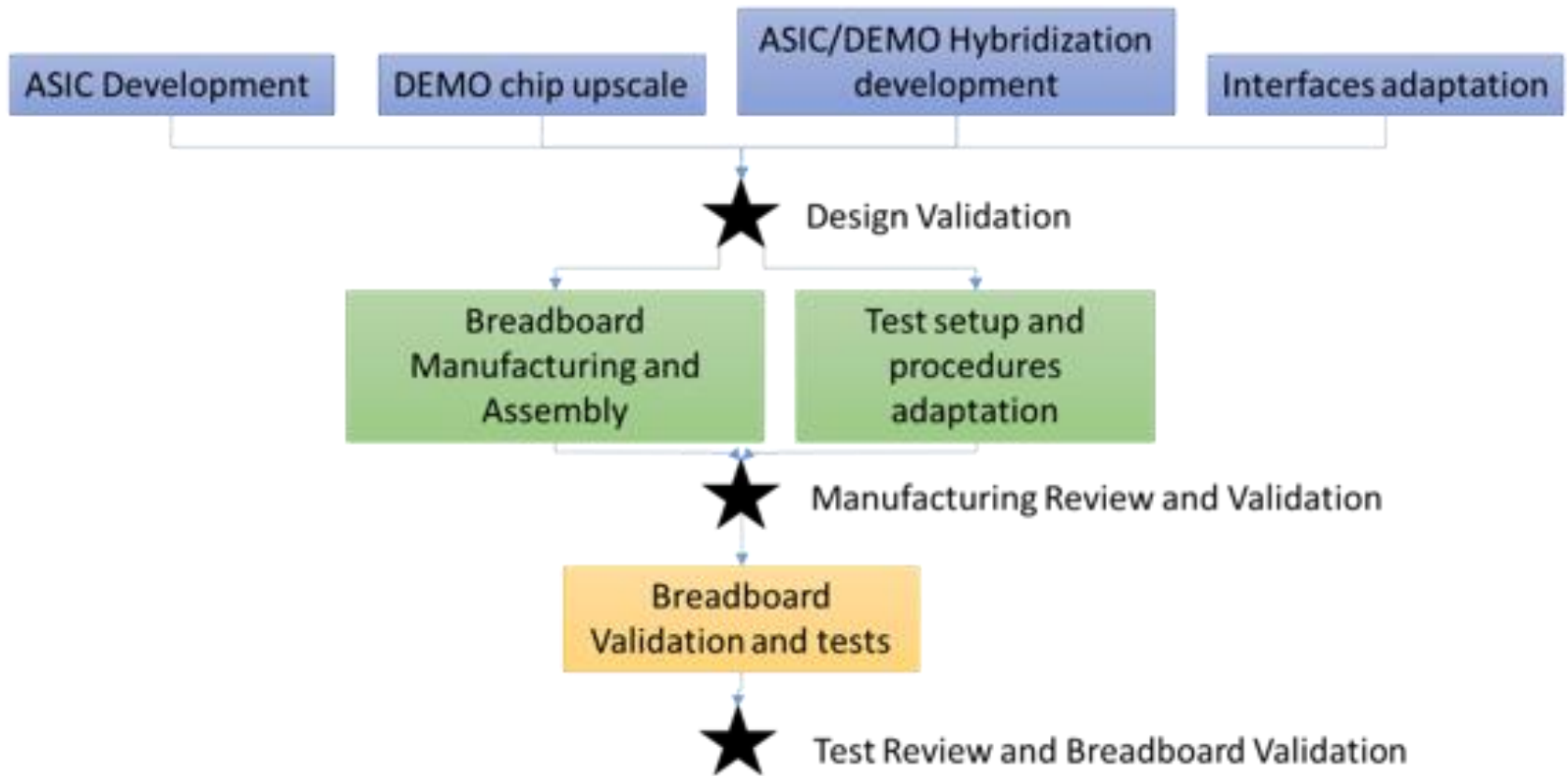
- ❑ DEMO sensor size: 0.250 x 0.625 mm (limited by bounding, cf. WP6)
- ❑ Strongly depends on the capability of achieving a sensor of sufficient surface at a reasonable cost
- ❑ Production cost could be dramatically reduced with the mass production effect
- ❑ Mobile market: new matching algorithms (no minutiae based) would benefit from very high resolution

Feature	Government/High End Security Specifications	Mobile market Specifications	PiezoMAT DEMO objective
Minimum size (mm x mm)	16,5 x 12,7	4 x 4	<1 x 1
Minimum resolution	500dpi	No standard but very high resolution is an advantage (1000 dpi min).	1000dpi

# Steps to go to mobile market

- ❑ Mobile market perspectives
  - ❑ Target: 4x4 mm – 1000dpi
  - ❑ Development of a specific integrated CMOS
  - ❑ Upscale of the DEMO chip Nanowire array
  - ❑ CMOS to NW seed layer technology development
  - ❑ Interfaces adaptation
  - ❑ Manufacturing and assembly of the breadboard
  - ❑ Test setup and procedures adaptation
  - ❑ Breadboard validation and tests

# Steps to go to mobile market





# Steps to go to traditional market

- Security and government applications perspectives
  - Target: 20x20 mm – 1000dpi
  - Development of a specific integrated CMOS
  - Upscale of the DEMO chip Nanowire array
  - CMOS to NW seed layer technology development
  - Interfaces adaptation
  - Manufacturing and assembly of the breadboard
  - Test setup and procedures adaptation
  - Breadboard validation and tests

# Possible business plan

## □ Security and government market

- The simplest to address (known customers and ecosystem...)
- The hardest to reach in the short term from the technological point of view (sensor surface size/cost)
- High expectation regarding image quality and accuracy

## □ Mobile market

- Seems the most appropriate in the short term
- Dependent on mobile phone manufacturer willingness
- Sensor encapsulation possibilities still to be confirmed

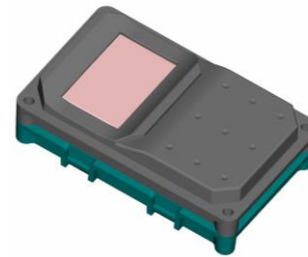


Thank you for your attention

# FINGERPRINT SENSORS

## ❑ Single fingerprint scanner (MorphoSmart)

- ❑ Optical: TIR, dark field illumination
- ❑ Contact sensor
- ❑ Indoor
- ❑ 500dpi



## ❑ 4-Slap scanner (Morpho Finger on the fly)

- ❑ Direct view, Structured light
- ❑ Contactless sensor
- ❑ Indoor
- ❑ 500dpi
- ❑ Depth of field: 2cm

