An Overview of Biometrics

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An Overview of Biometrics

Continued

Voice Template

The frequency response, or wave composition, of the sample.

Voice System

Voice - History

- Technology is called Speaker Verification or Voice ID
  - Speech recognition technology spin-off
- DOD funding helped drive industry
  - NSA R&D area in the 1990s and earlier
  - University and corporate R&D labs
- Late 1980s first companies
  - By 1995 20+ companies including VARs

Voice - Technology

- Capture using existing devices
  - PC microphone or telephone
- Sample ambient noise
  - Calibrate capture device
- Prompt user
  - Predefined utterance (prompted or memorized)
  - Random utterance (random - requires more collection)

Voice - Technology

- Extract features
  - Analog to Digital conversion
    - 12 to 16 bits of resolution
    - 8 to 20 K samples per second
  - Statistical noise reduction
  - Need to balance acoustic parameters:
    - Behavioral patterns (e.g., accent)
    - Physiology features (e.g., resonance of vocal track)

Voice - Technology

- Preprocess
  - Feature extraction
    - Activity detection
    - Mel-scale Cepstral coefficients
    - Subtract channel coefficients
- Save tokens (one of these ways):
  - Templates
  - Hidden Markov models
  - Neural networks

Voices - Technology

- The Cepstrum separates the glottal frequency from the vocal tract resonances. It is obtained in two steps.
  - A logarithmic power spectrum is calculated on 256 samples and declared to be the new analysis window.
  - An inverse FFT is performed on it.
- Result - vector with a time axis & an amplitude axis. Allows for the similarity between two cepstral feature vectors to be computed as a simple Euclidean distance.
  - Input to Speaker verification processes

Voice - Technology

- Text-independent: Gaussian Mixture Models
  - Observe feature vectors
  - Compare probabilities with enrolled features
- Text-dependent - Hidden Markov models
  - Statistical information about sound patterns and their statistical variability
  - Transitions between states can be predicted
- Neural networks
  - Pattern matching

Voice - Technology

- Speaker recognition technology is very sensitive to:
  - Speaker's stress level and health
  - Length of time since enrolment
  - Time of day
  - Background noises
  - Electronics noises
    - Phone, switchboard, network route, etc.

Voice - ID Decisions

- Fixed and Dynamic thresholds
  - Random prompted utterances permit more flexibility in scoring
  - Adjustable for high-use enrollees
- Cohort Models
  - Can be used in Template and Hidden Markov models
  - At enrollment all *similar* speakers are flagged
  - At verification - compare sample to whole cohort

Voice - Status

- In commercial production systems
  - Home incarceration programs
  - Home Shopping Network
  - Phone cards (Sprint)
  - Insurance companies
- Interoperability standards for templates proposed.

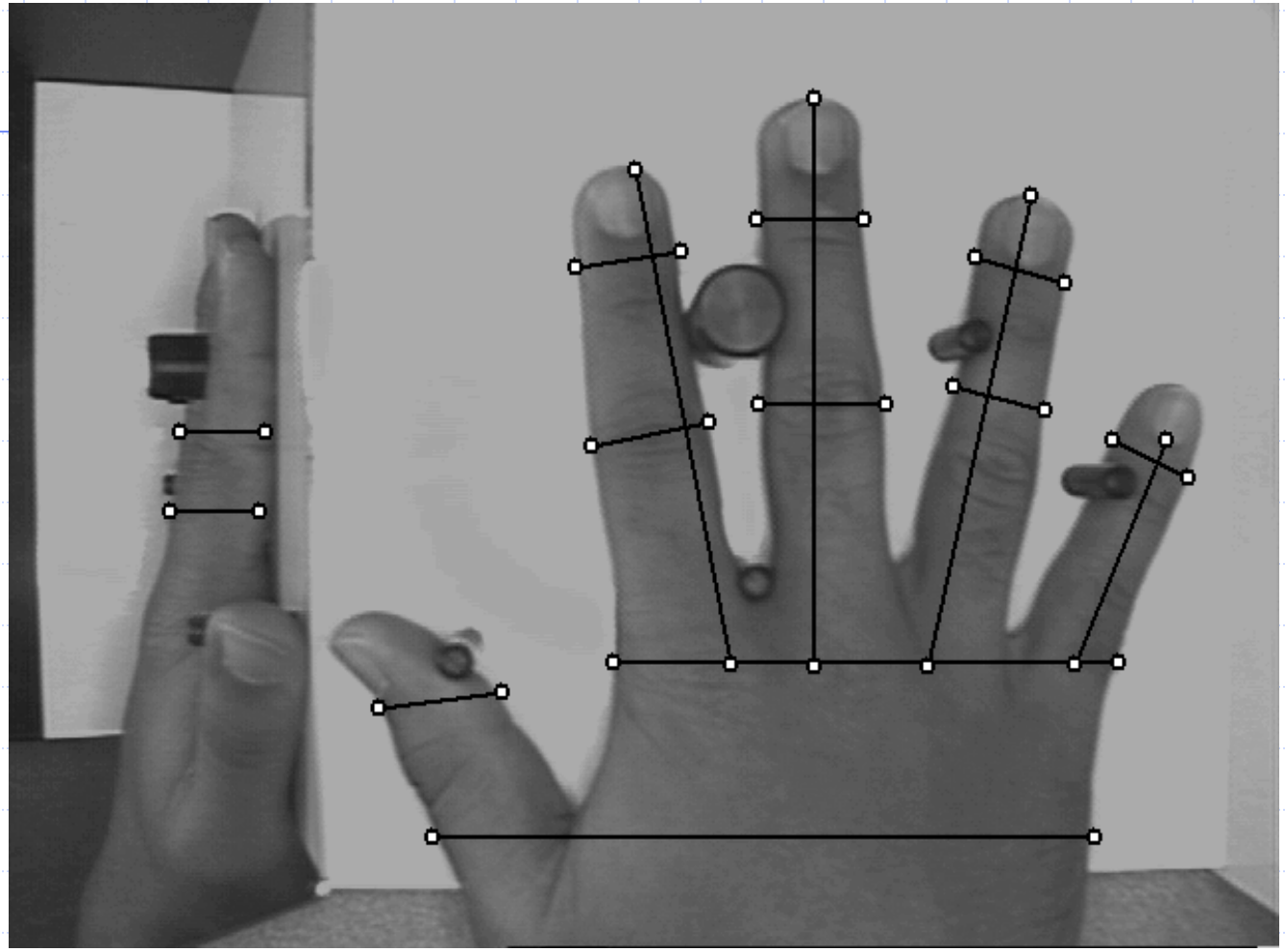
Voice - Future

- Law enforcement and intelligence applications
  - Identify speakers from wiretaps and intercepted cell phone or radio intercepts
    - Requires more data (utterances), ideally over several days
    - Normal speech not reading a document

Voice - Performance

- Performance
  - From Jain et al. August 2004

FTE	FNM	FMR1	FMR2
1%	15%	3%	-



Hands - History

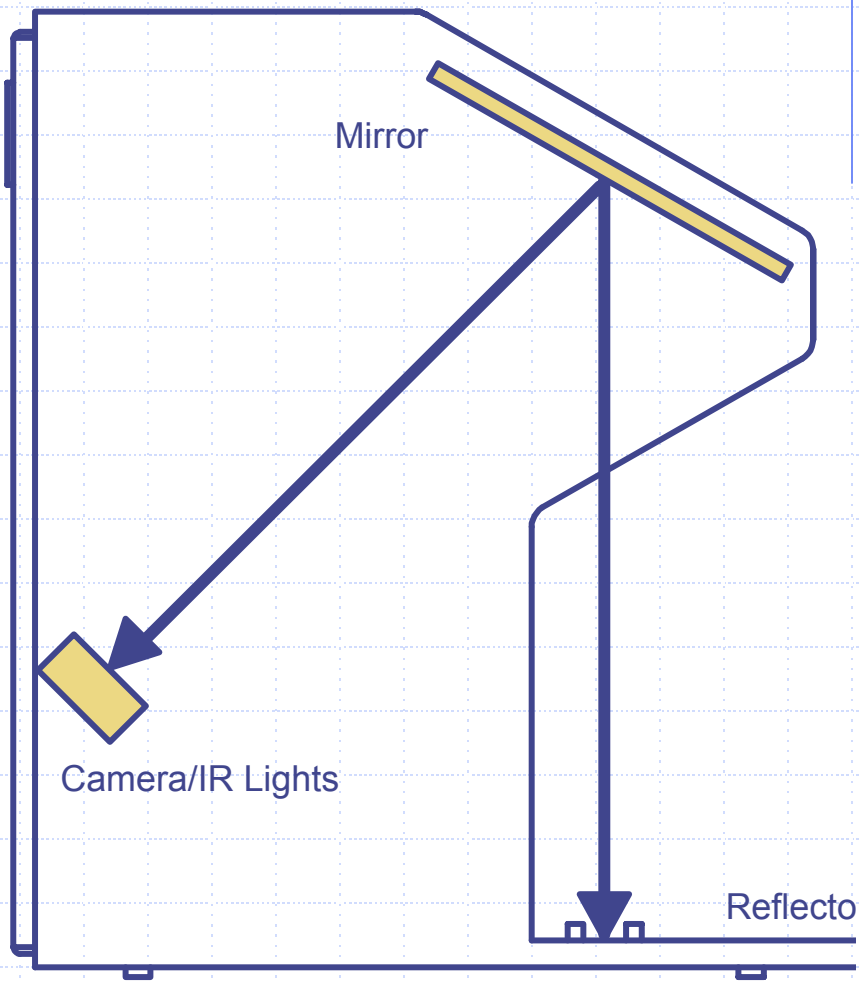
- Automation matured in late 1980s
  - Patents in 60s and 70s as well as first products in 70s and 80s
  - Various competitors introduced:
    - Two finger devices
    - Vein checking
    - Heat sensing
- Verification-only devices

Hand - Technology

- Digital camera system
  - Pins guide hand placement
  - Images top view and side view
  - No color - just the hand and the highly reflective (in Infrared portion of the spectrum) background surface

How it Works

- Low level infra-red light illuminates hand via optical path
- CCD camera captures 3-D image of the user's hand
- Template extracted and compared to enrolled electronic template



How Hand Geometry Works

- A 3D image of the hand is acquired
- Over 90 distinct measurements are made
  - Length
  - Width
  - Thickness
  - Surface Area
- 9 Byte template is generated

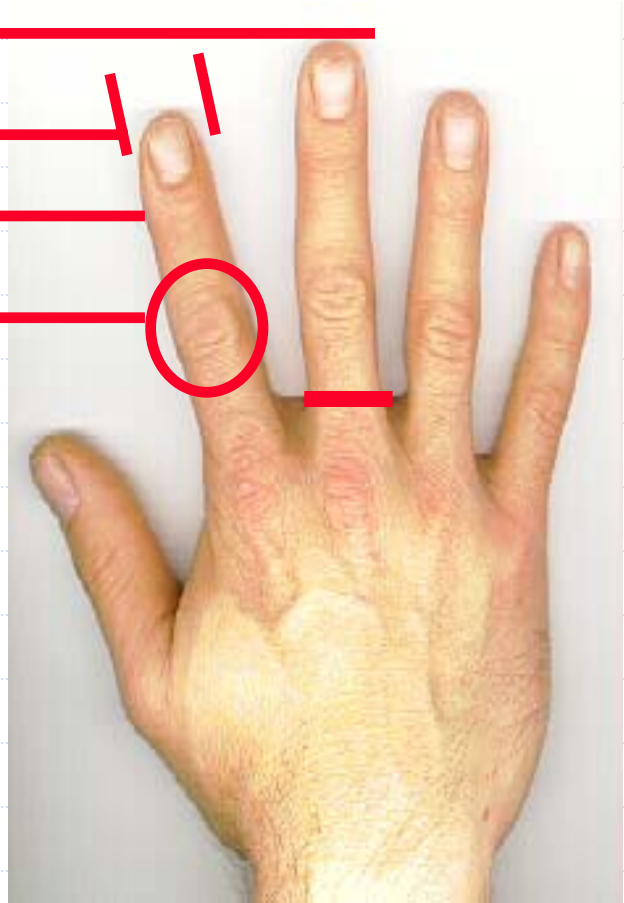


Image courtesy of Recognition Systems.

Hand - Status

- Mass production
- Easy to use
- Single company dominates industry
  - Recognition Systems Inc. - an Ingersol Rand Corporation
- Low reject rate at time of use

Hands - Status

- Recognition Systems Unit for time and Attendance
  - ~$1,500 US
  - Just uses 4 fingers but requires placement of whole hand
- Biomet Partners
  - ~$400 US for standalone unit
  - Just uses two fingers

Hand - Performance

Performance from Jain et al. August 2004

FTE	FNMR	FMR1
2%	1.5%	1.5%

Hand - Applications

- System used for trusted travelers in many countries
  - Reduce labor content per transaction
  - Stays alert all day!
- Widely used at Nuclear Power Plants - for over 10 years
- Widely used in employee time clock applications.

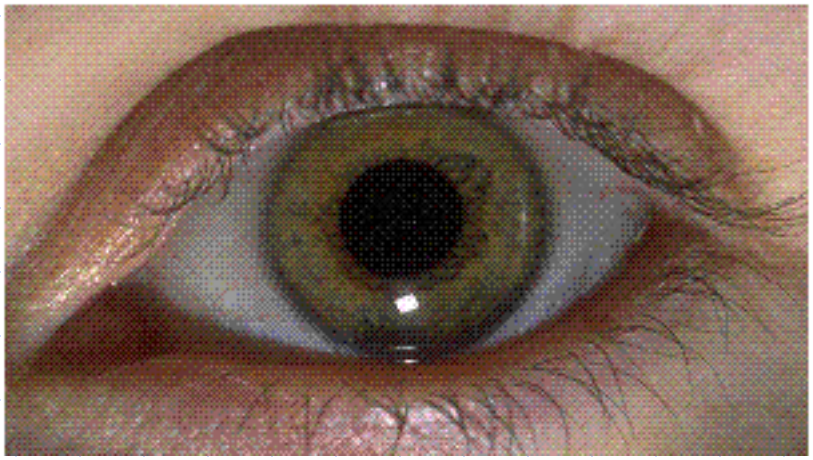
Hand - Technology

Time and attendance system

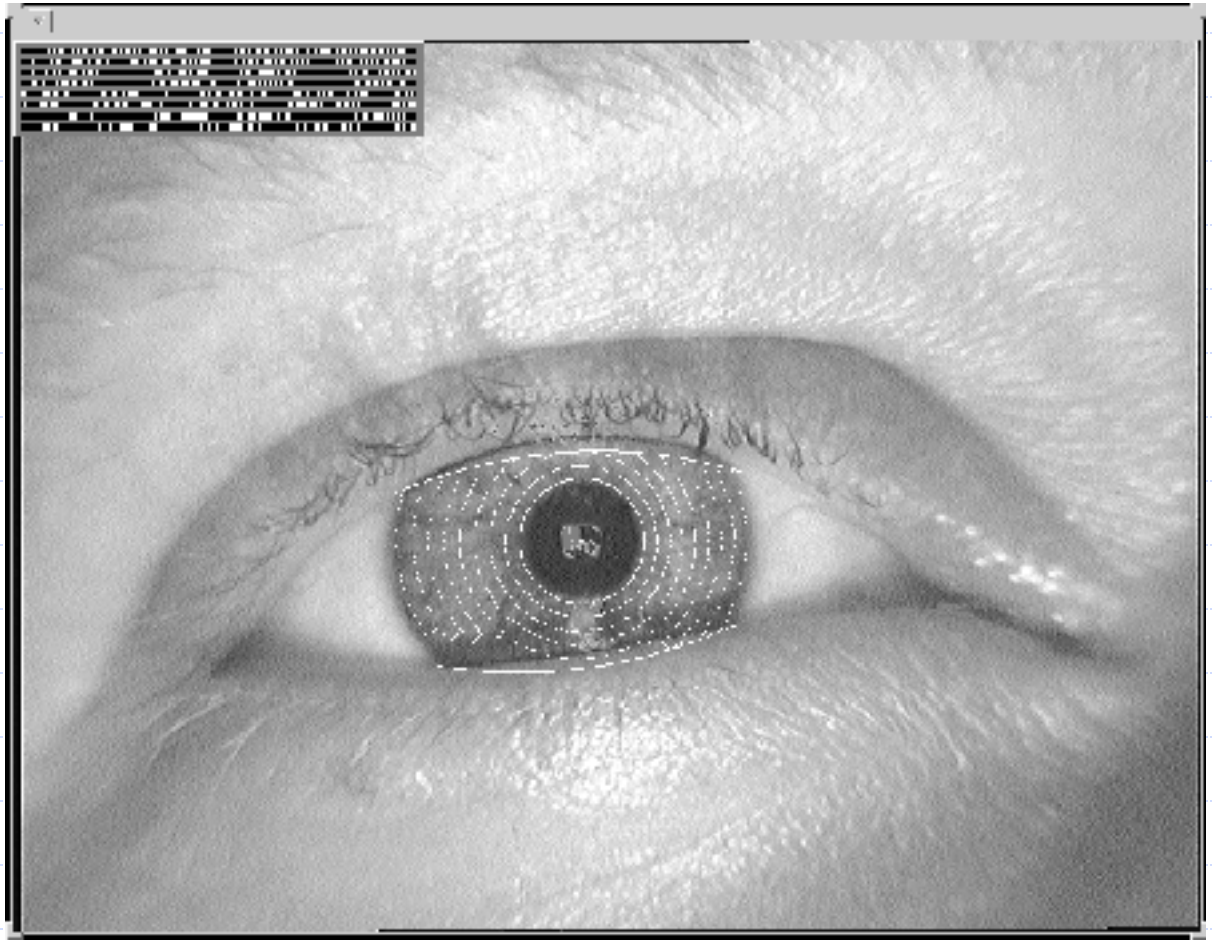
Image courtesy of Recognition Systems.

Hand - Applications

- Two finger version in use at Disney
  - Biomet Partners
  - ~2 million plus transactions per year
  - ~11 seconds per transaction
    - Lots of time and motion studies end experiments to get to this timeline
  - No pre-enrollment



Eyes - Sample Token



Eyes – History

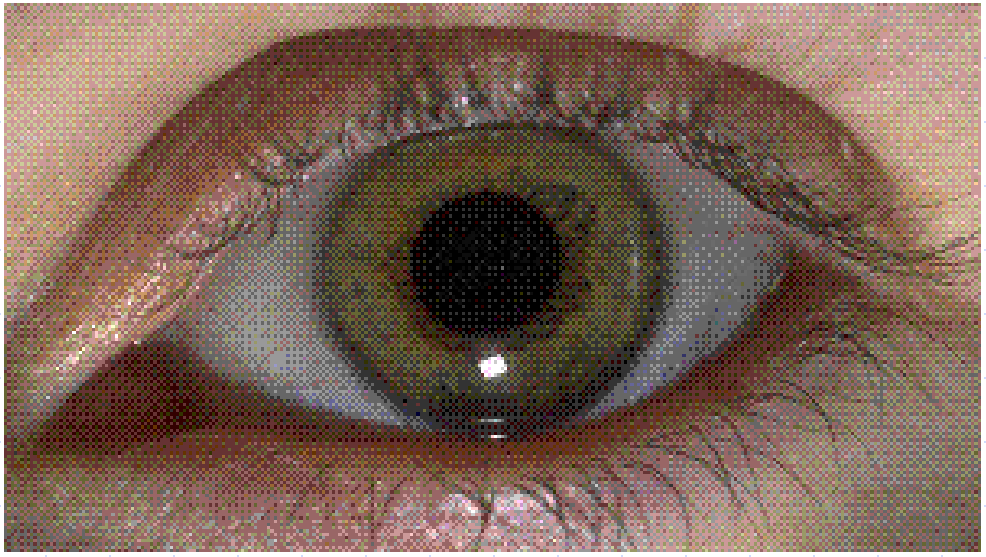
- **Retina:** Back of eye imaging
  - 20 years or more (First paper in 1929)
  - High collection error rate
  - Possible medical - privacy issues
    - More hype than threat
  - New product announcements
    - Little sign of life

Eyes – History

- **Iris:** Eye surface imaging
  - Mid 1990s
    - Sarnoff - NSA - Sensar
      - Patents
    - IriScan - Medical - Dr. Daugman
      - Patents
      - Defense Nuclear Agency
    - Iridian - merger in late 2000

IRIS – Technology

- Near IR cameras to find & capture eye
- Segment eye constituents
  - Gausian filters used to find Sclera, Iris and Pupil boundaries



IRIS – Technology

- How the Iridian technology works:
  - Perform 192 radial measurements
  - Map iris into 256 sectors within 8 concentric rings
  - Run multiple Gabor transforms on each sector - use the Phase output
  - The local phase of the iris texture is quantized into one of four phase states
  - Generate and store 256 byte string IrisCode™
    - Many zeros fields for glint, obscuration, etc.

Iris - Performance

Performance from Jain et al. August 2004

FTE	FNMR	FMR1
7%	6%	<0.001%

Iris Technology

- Iris recognition is sensitive to obscuration from:
  - Eyelids
  - Eyelashes
  - Reflections

IRIS – Technology (Continued)

- Can perform identification as well as verification
- Very fast search times
  - Tokens (bit strings) held in RAM
  - Exclusive OR instruction
  - ~30% match threshold (Hamming Distance)
- Sensitive to certain contact lens styles and possibly eye color

IRIS – Status

- Limited large scale use to-date
  - UNHCR - Afghanistan refugees - over 700 K enrollees
  - Not a test - no good way to measure error rates

IRIS – Performance

- No reported false matches
- **Some** Failure-to-Match events
- Vulnerabilities
  - Spoof under unsupervised use
  - Mask with special contact lens

IRIS Applications

- ATM studies
- Computer login
- Benefits management
  - UNHCR
  - Saudi Arabia
- Physical access control
  - Airport access control pilots

Challenges & Issues

Performance Factors

- Population Demographics
- Application
- User physiology & appearance
- User behavior
- User interface
- Environment
- Sensor hardware

Challenges

- Selecting appropriate biometric
- Developing operational concept with failure mode recovery
- Integrating it with current systems
- Educating and enrolling users
- Maintaining performance levels
- Testing system

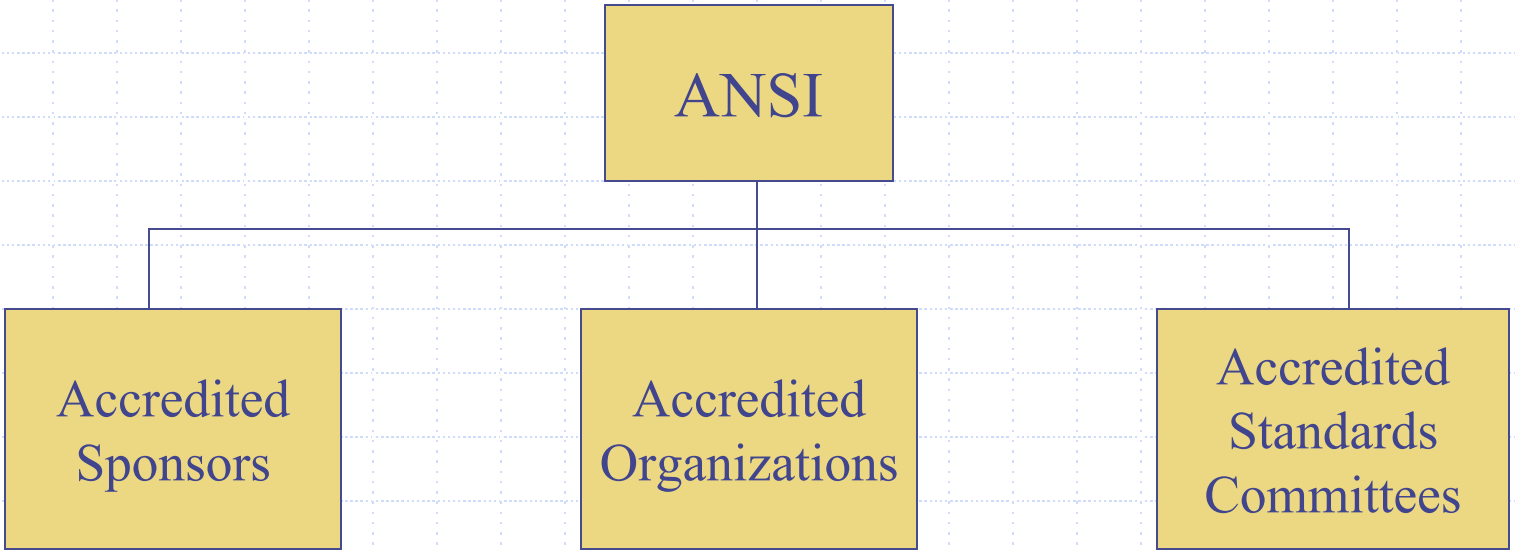
Role of Standards

- What are Standards
- Who establishes them
- What biometric standards are available
- How stable are they?

IT Standards

The deliberate acceptance, by a group of people having common interests, of a quantifiable metric that influences their behavior and activities by permitting a common interchange.

American Standards



Technical Committee M1

- Technical Committee M1, **Biometrics**
  - Established by the Executive Board of INCITS
  - Four Task Groups on biometrics

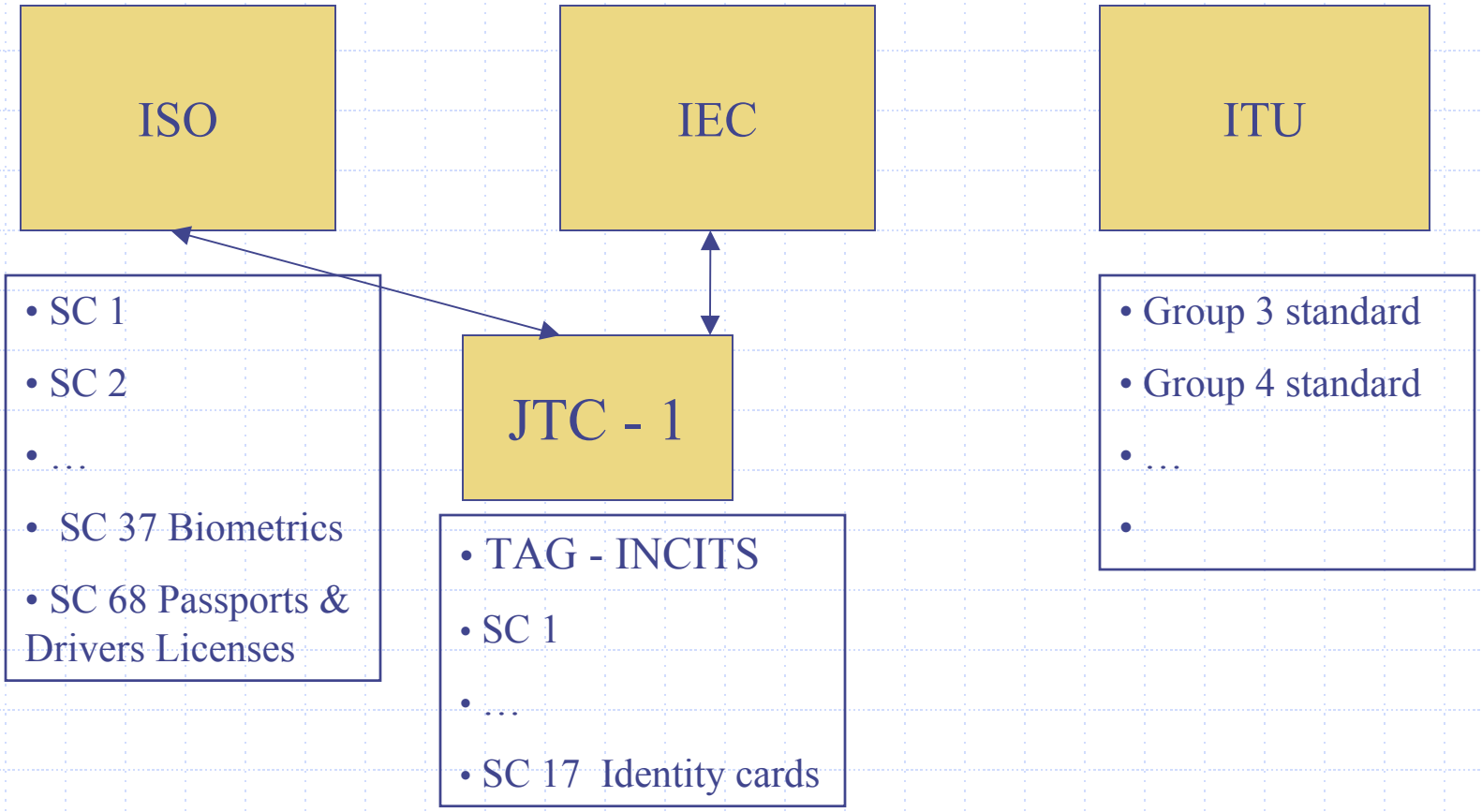
INCITS - M1 Task Groups

- M1.1 Biometric Data Interchange Formats
- M1.2 Biometric Technical Interfaces
- M1.3 Biometric Profiles
- M1.4 Biometric Performance Testing and Reporting

International Standards

- International Standards Groups
  - International Organization for Standards (ISO)
  - International Electrotechnical Commission (IEC)
  - International Telecommunication Union (ITU)

International Standards



Fingerprint Standards

Ten print

Standards Evolution

- Fingerprints:
  - 1993 Electronic Image Exchange - ANSI-NIST
  - 1994 Image Quality followed in the FBI's "EFTS"
  - 1997 Facial images added to ANSI-NIST
  - 2000 Palm & variable density finger images added to ANS-NIST

ANSI NIST Standard (Continued)

- Key items in ANSI/NIST
  - Record types (1 - 16)
    - Headers, fingerprint images, minutiae, mug shots, etc
  - Scan and transmission rates
  - Flexibility for different user communities of interest
    - US, UK, Interpol, RCMP, DOD, etc.

ANSI NIST Standard (Continued)

- Key items not in ANSI/NIST
  - Image quality
    - The AFIS performance driver
  - Data compression
    - The communications and storage cost driver
  - Single finger system standards

Image Quality Standards

- Six criteria
  - Geometric Image Accuracy
  - Modulation Transfer Function
  - Signal-to-Noise ratio
  - Gray-scale Range of Image Data
  - Gray-scale Linearity
  - Output Gray Level Uniformity

Image Quality Standards

- Captured in EFTS Appendix F
  - A way to define minimum quality parameters for:
    - livescans, card scanners, and printers
  - Intended as:
    - FBI procurement guide
    - Threshold for submittal to the FBI
    - Now – widely used in procurements

Fingerprint Standards

Single Finger

INCITS Standards

INCITS Standards

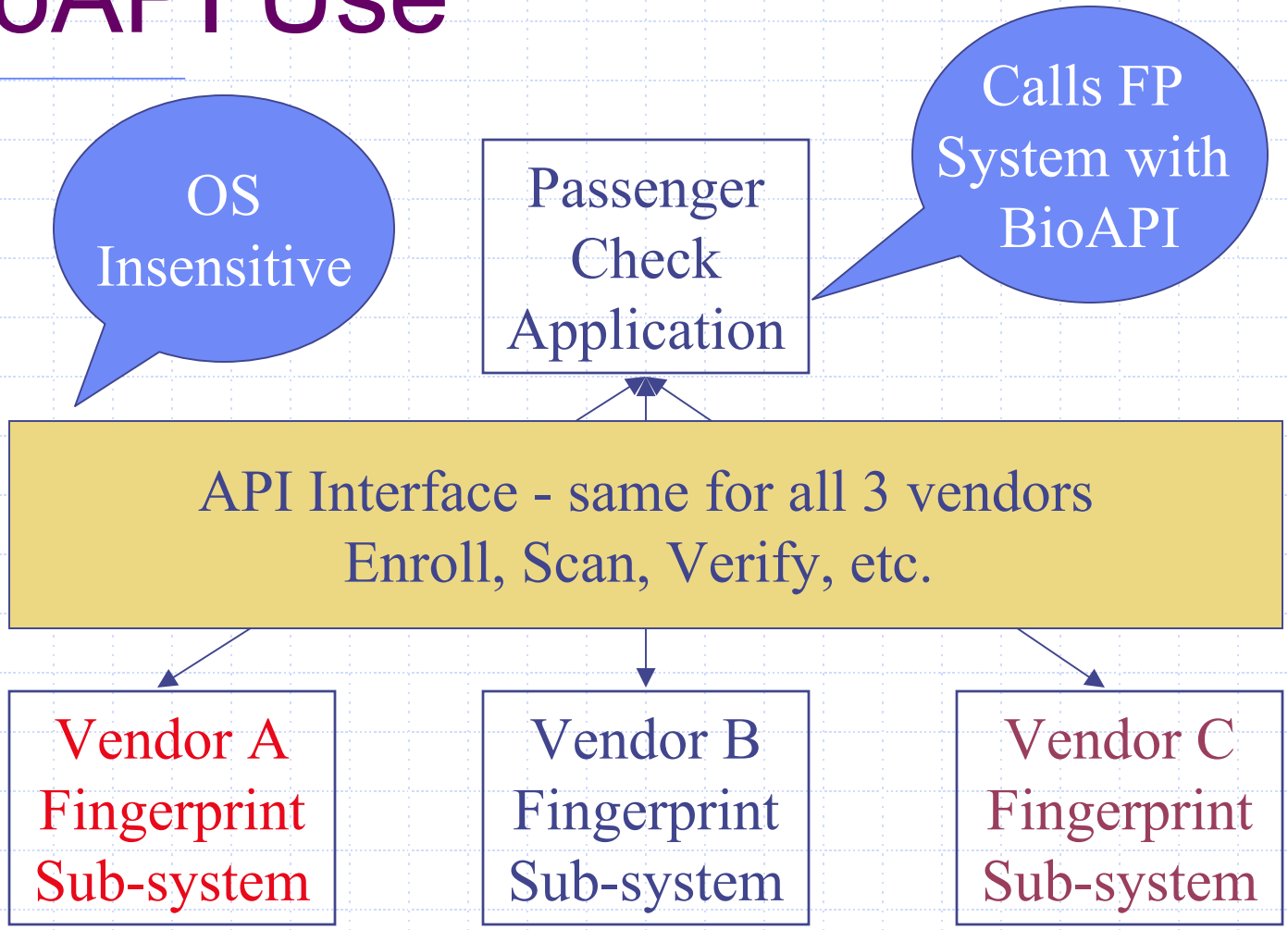
- ANSI/INCITS 358-2002, Information Technology: Biometric Application Programmers Interface (BioAPI) Standard
- ANSI/INCITS 377-2004, Information Technology: Finger Pattern Data Interchange Format
- ANSI/INCITS 378-2004, Information Technology: Finger Minutiae Data Interchange Format
- ANSI/INCITS 379-2004, Information Technology: Iris Image Interchange Format
- ANSI/INCITS 385-2004, Information Technology: Face Recognition Format for Data Interchange

BioAPI Standard

BioAPI Standard

- Late 1990s parallel development of biometric APIs to permit applications to make standard calls independent of the biometric or vendor:
  - Novel SVAPI
  - BC HA-API
  - SafeLink Corp BioAPI
  - I/O Software BAPI
- Biometric Consortium took the lead to merge the efforts under BioAPI umbrella with strong NIST support

BioAPI Use


OS Insensitive
Passenger Check Application
Calls FP System with BioAPI
API Interface - same for all 3 vendors
Enroll, Scan, Verify, etc.
Vendor A Fingerprint Sub-system
Vendor B Fingerprint Sub-system
Vendor C Fingerprint Sub-system

Common Biometric Exchange File Format (CBEFF)

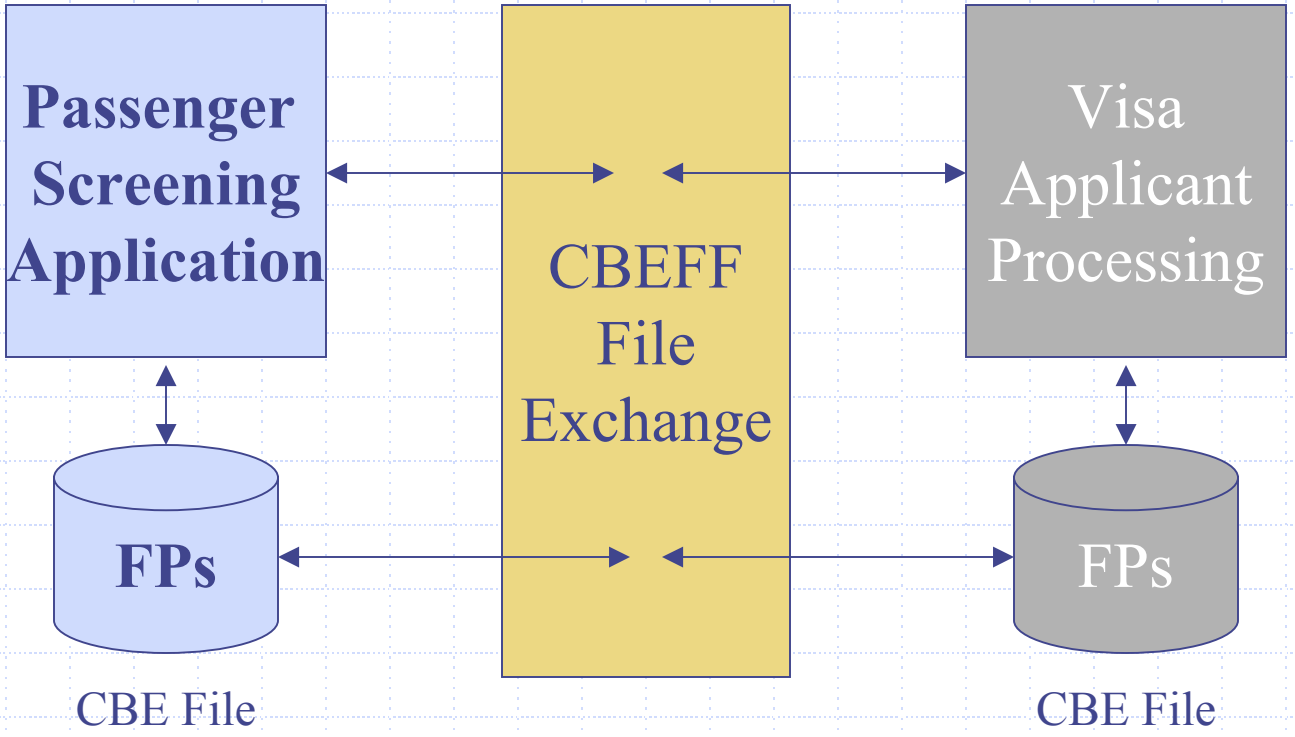
CBEFF Standard

- Purpose:

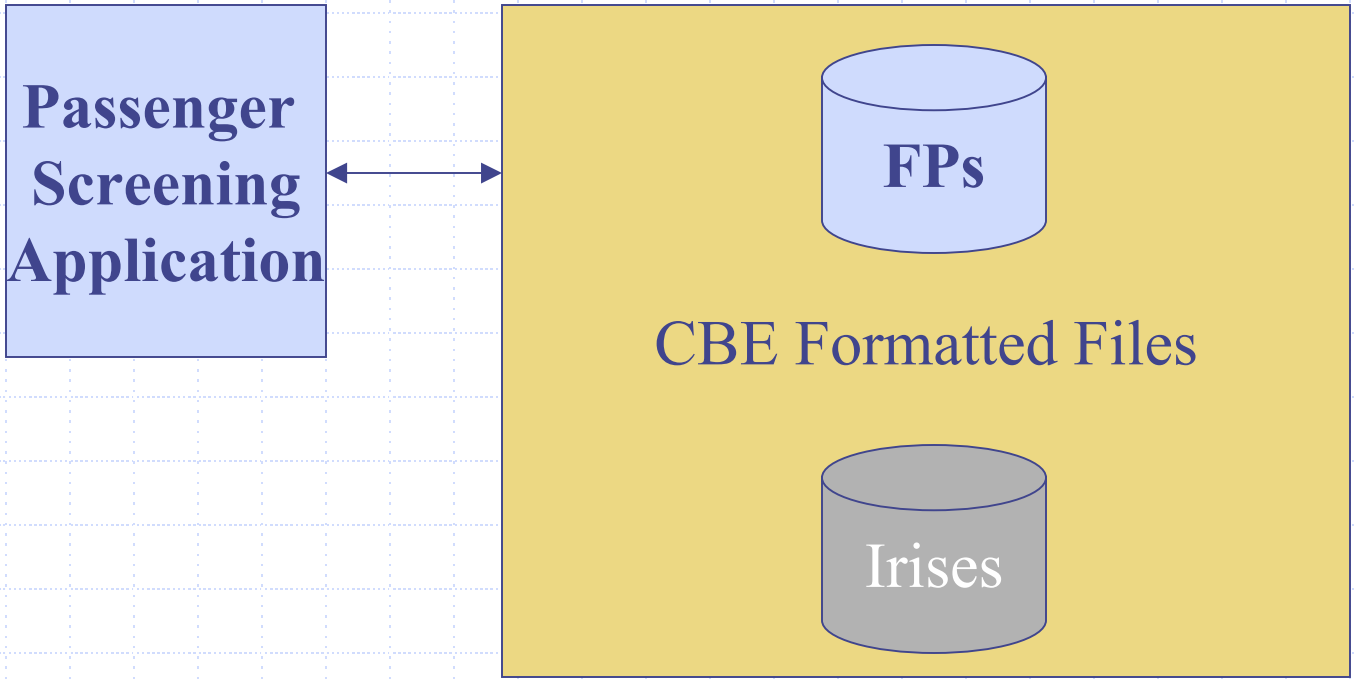
  *Define a common set of elements necessary to **support multiple biometric technologies** and to promote interoperability of biometrics based application programs **and** systems by **allowing biometric database exchanges**.*

- Requires an exchange agreement for an *Interoperability Domain*
  - Patrons - Standards Bodies (e.g., BioAPI)
  - Clients - Vendors and other standards bodies
  - Registration Authority - The IBIA

CBEFF Use 1


Passenger Screening Application
CBEFF File Exchange
Visa Applicant Processing
FPs
FPs
CBE File
CBE File

CBEFF Use 2


Passenger Screening Application
FPs
CBE Formatted Files
Irises

Biometrics on Smart Cards

- Biometric Application Programming Interface (API) for Java Card
  - Published by the Java Card Forum with the support of the NIST/Biometric Consortium Interoperability, Assurance, and Performance Working Group.
  - See http://www.javacardforum.org
- This API supports secure biometric Match-on-Card so that sensitive biometric data never leaves the smart card.

Stability of Standards

- Many committees & much politics
  - Great concern by industry not to slight ***their*** biometric or its template
- Major effort required to:
  - Follow processes
  - Select standards to build and design systems around
  - Specify as mandatory in procurements

Questions?

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