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Metrics & Terminology for Identification System Performance addressing Watch-list and other open set applications

Tony Mansfield

Tony.Mansfield@NPL.CO.UK

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Outline

1. **Introduction & background**
   - Aspects of identification performance not covered by standards *ISO/IEC19795 Biometric performance testing and reporting*
2. **Terminology**
   - Are existing terms sufficient for the variety of identification applications?
3. **Metrics**
   - Image-level
   - Subject-level
   - Operator-level
4. **Implications for test methodology**

Background: Practical experience

Face recognition identification against watch-list (2004)

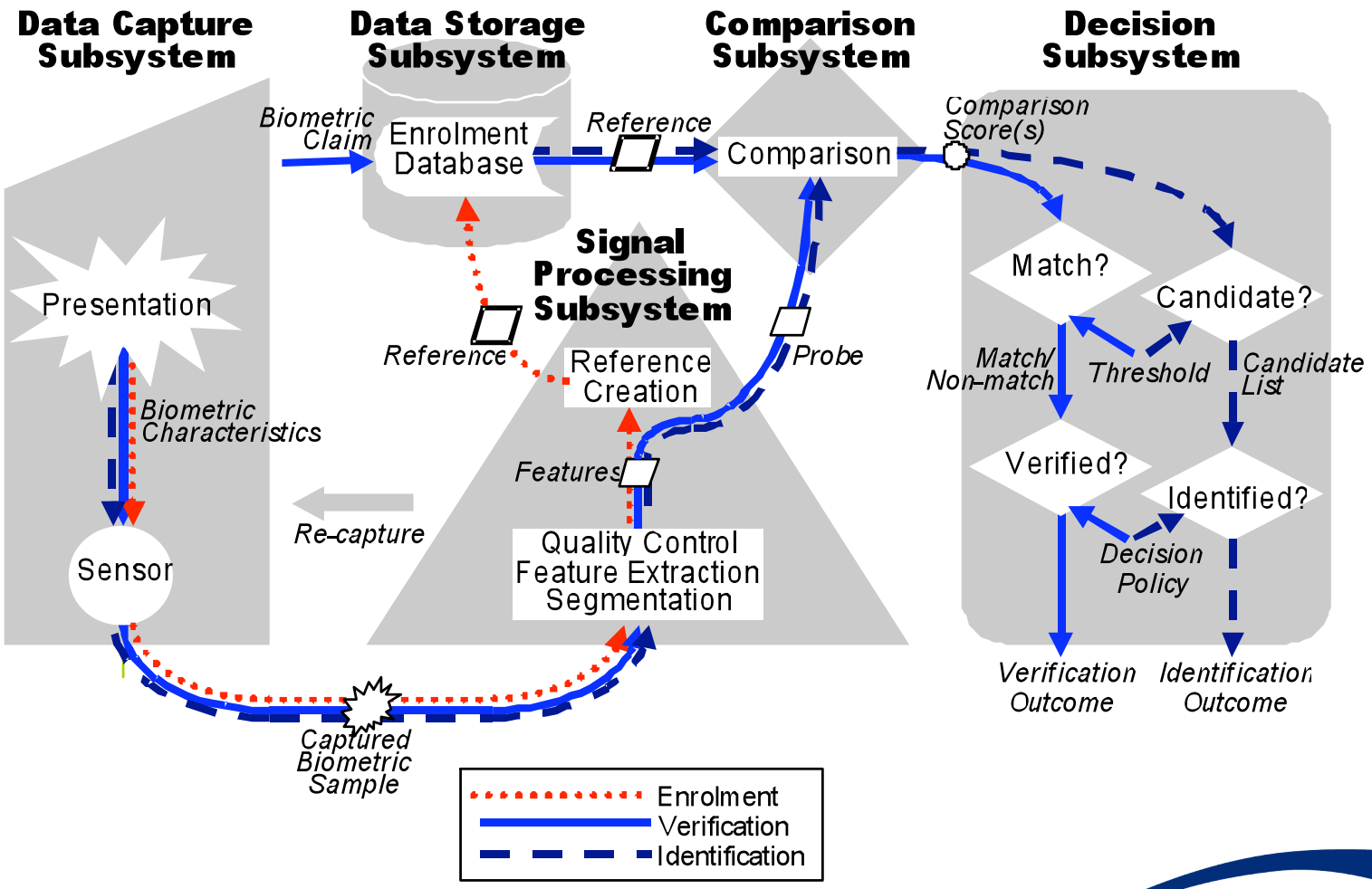
- CCTV set up in corridor
- Good quality face image photos for watch-list subjects
- Non-cooperative subjects - normal daily business - no operator involvement
- Ground truth established by RFID tag (with staff pass)
- Data collection over several days
  - RFID recognitions of test subjects
  - Face recognition candidate lists and probe image (if over threshold)
  - Presence and direction of travel count using IR beam
- Exploratory tests – what affects performance levels?

Background: Test standards

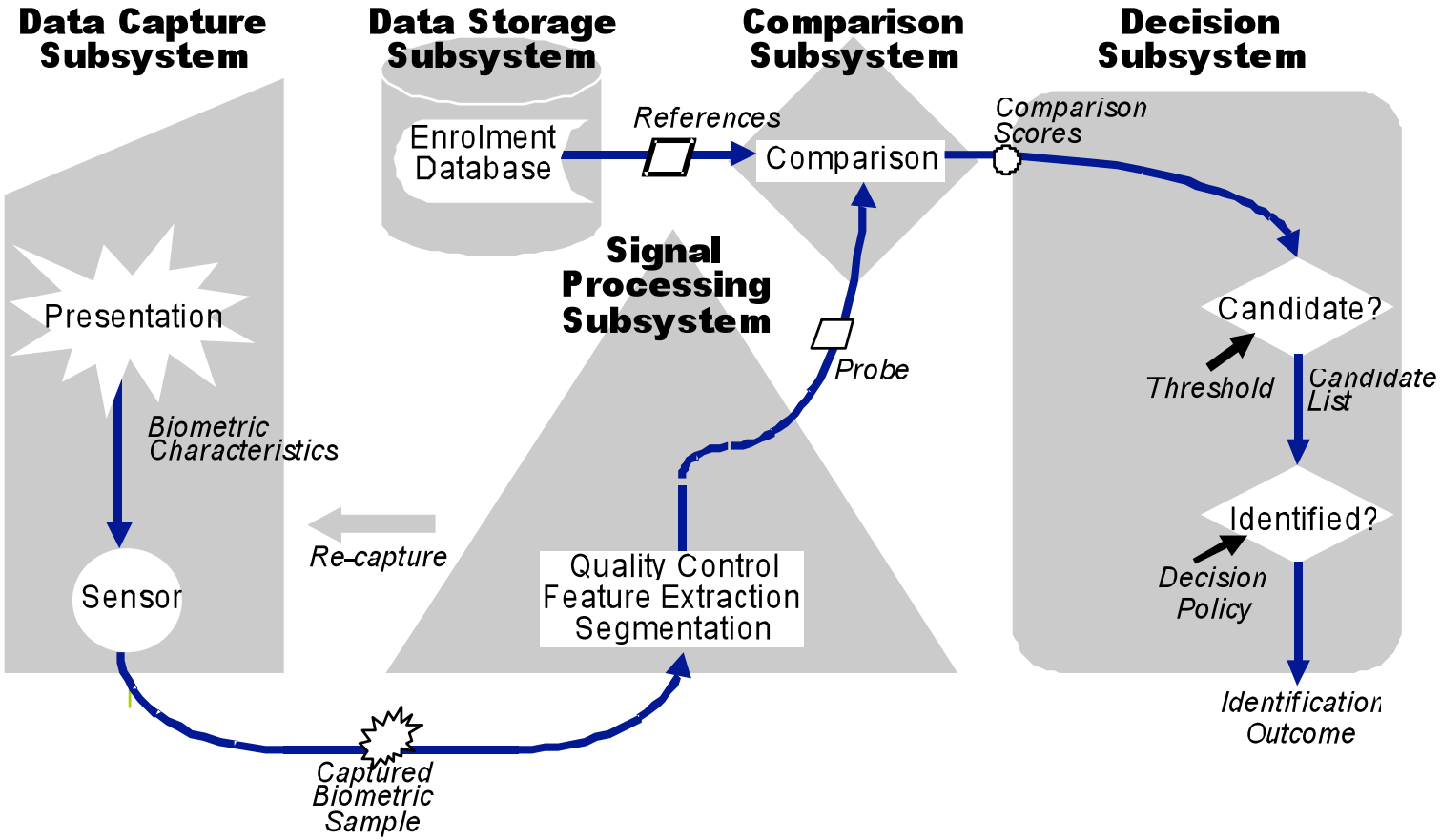
19795-1: Principles and framework

- Focus is on verification performance
  - Well established ground-truth
  - Cooperative test subjects
- Covers identification when the transaction is similar to that typical for verification
- Does not fully address complex identification applications
  - Example CCTV watch-list applications
    - Operator involvement
    - Multiple samples per subject
    - Overlapping between subjects
    - Multiple subjects per image

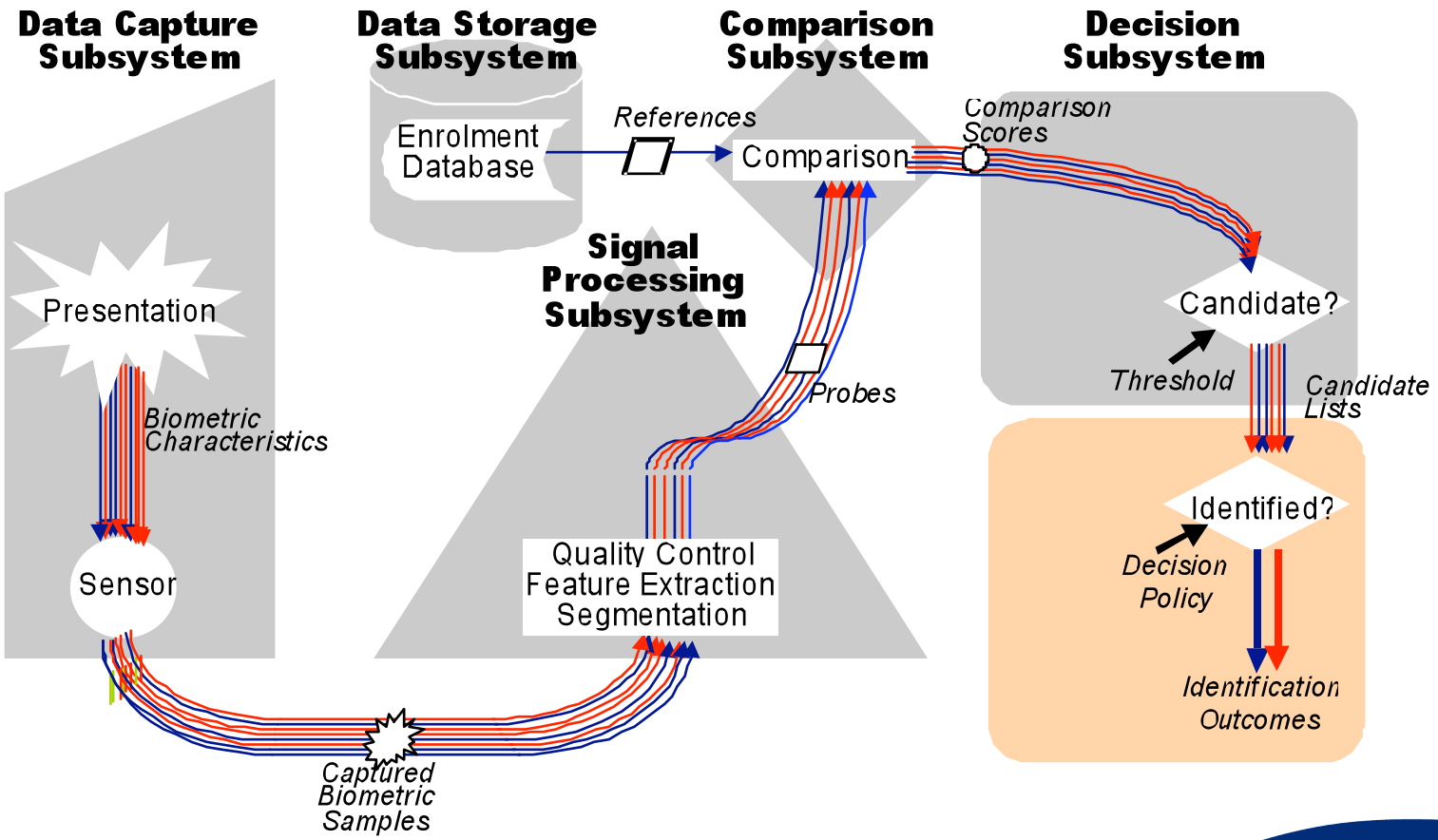
19795-1: General biometric system



19795-1: Model of biometric identification system



19795-1: Complex model of biometric identification system



Metrics for identification performance

Metrics from 19795-1 … Framework and Principles

- Failure to acquire
  - Do we have an image of the subject, and is it usable?
- Pre-selection error rate & penetration rate
  - Applies to binning / filtering algorithms,
  - Can be applied at final stage of refining the candidate list too (Reliability & Selectivity)
- False-positive & false-negative identification-error rates
  - Identification decision errors
  - Make assumptions on how the candidate list will be used to inform the identification decision

Identification errors?

If system requires candidate list of the top 10 matches

- Not an error to return matches for a subject not in the watch-list?

Correctness depends on the comparison scores assigned

- Not an error to ascribe incorrect identity if correctly assigned low probability
- E.g. DNA: proportion of population having an equal or better match between probe and reference DNA sample
- Not an identification error to fail to ascribe an identity when insufficient biometric evidence

Correctness may depend on application

- Not necessarily an to ascribe incorrect identity to subject known to the system if the resulting outcome is correct

Identification metrics: Image viewpoint

- Evaluated over BioAPI_IdentifyMatch calls
- Using the (segmented) image as a probe, is the correct reference returned in the candidate list.
- c.f. FMR and FNMR for verification
- Pros:
  - Easy to evaluate
- Cons
  - Does not show results of best match
  - Subjects where no segmented image acquired not represented in results
  - Biased by image segmentation (face finder) algorithms used

Identification metrics: Subject viewpoint

- Evaluated over instances where test subject is present at the identification station
- Using full sequence of images obtained, what is probability of detection if on watch-list, or probability of false alarm if not on watch-list
- c.f. false accept / false reject with verification
- Pros
  - Reflects actual use
- Cons
  - Difficulties /effort in establishing sequence of images per person
  - (without reliance on biometric algorithm)

Identification metrics: Operator viewpoint

Operator's interest

- Specifying and monitoring performance
- Adjustment of parameters to meet operational constraints
  - E.g. fixed resource to deal with number of false alarms per unit of time, and corresponding likelihood of detection
  - Performance achieved depends on **throughput** of subjects, and **probabilities** that subject is on watch-list.
- Metrics of primary interest application specific,
  - Influenced by subject viewpoint metrics.

Issues Arising

Establishing ground truth & test identity

- Presence & identity of test subjects
  - both on WL or not on WL
- Correct labelling of segmented images
  - Preferably without referring to biometric algorithm under test
  - Preferably not relying on operator markup

Measuring the extent of a subject's opportunity to be identified

- E.g., subject of interest may be partially obscured by other subjects while notionally “in shot”
- Some subjects visible for a long period, others not at all
- A complex notion of image quality

Issues Arising

Attribute errors to different stages of the process?

- Presentation: subject behaviour
- Capture: illumination, camera angle, ...
- Image quality: (of sequence of images of subject)
- Comparison / candidate list properties
- Decision process
  - Automated / or made by human operator (operator GUI?)

Time to update 19795 standards with more guidance on identification testing?

Questions?

Contact details

Tony Mansfield

National Physical Laboratory, Teddington, TW11 0LW, UK

+44 20 8943 7029

tony.mansfield@npl.co.uk

National Physical Laboratory