

Use Case for Face Image Quality Assessment at eu-LISA

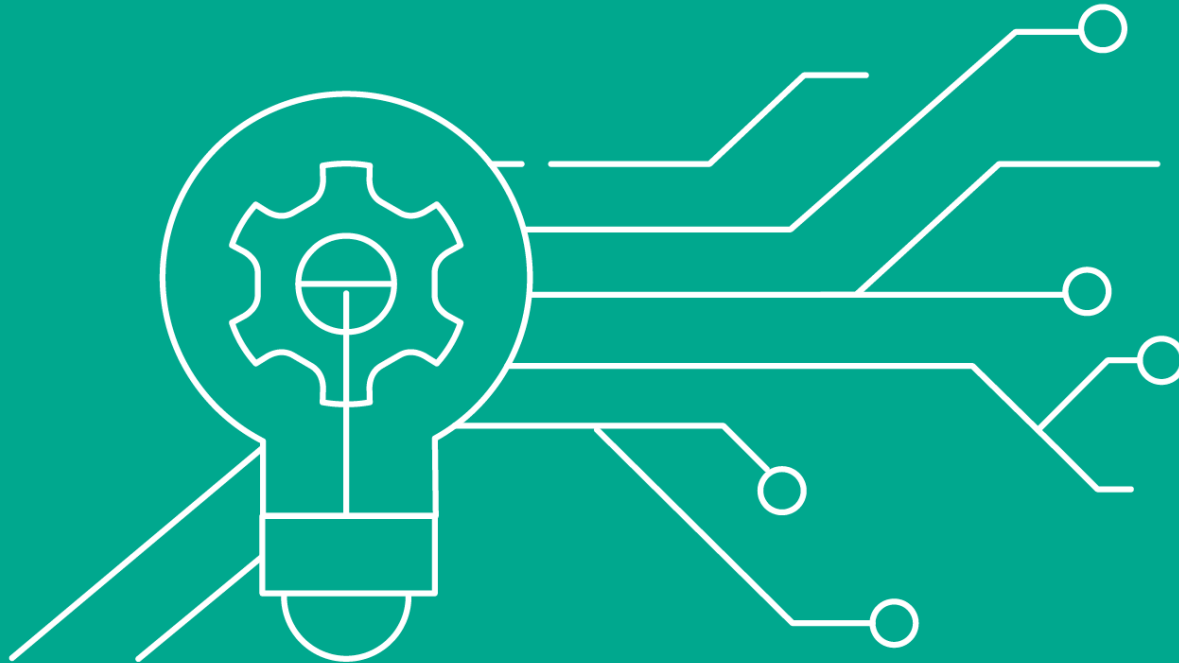
Interoperability of the EU large scale IT Systems

International Face Performance Conference (IFPC) 2022, 15-17 November, 2022

Agenda

- 1 Introduction to eu-LISA
- 2 eu-LISA Interoperability framework
- 3 Use case for FI: EES-VIS sBMS
- 4 sBMS Facial Image Quality (sFIQ)
- 5 Summary

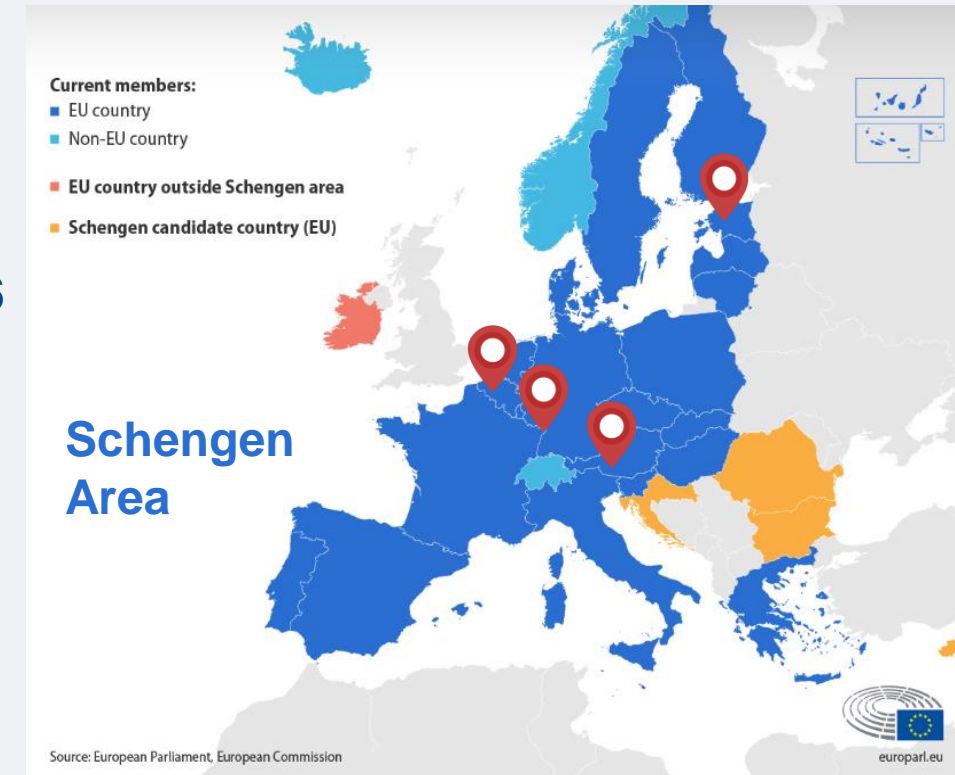
1 | Introduction to eu-LISA



European Union Agency for the Operational Management of Large-Scale IT Systems in the Area of Freedom, Security and Justice

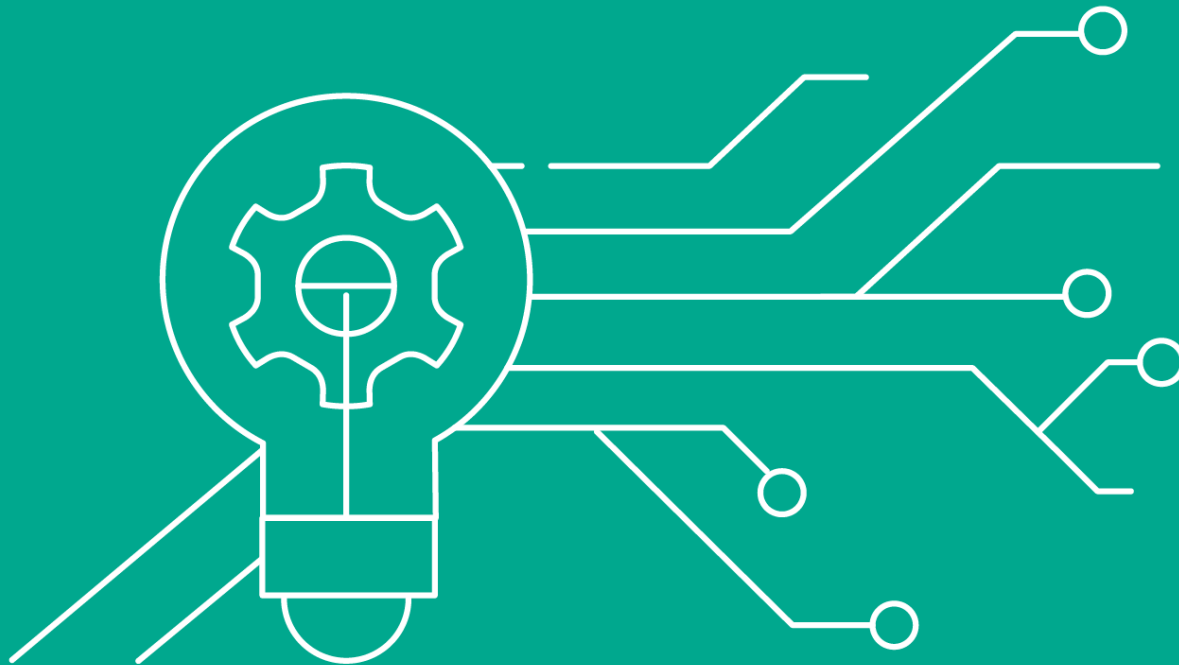


- **Established in 2011**, started operations on 2012-12-01
- Agency's **mandate** was **reinforced** with Regulation (EU) **2018/1726**
 - **Headquarters:** Tallinn (Estonia)
 - **Operations:** Strasbourg (France)
 - **Backup site:** Sankt-Johann im Pongau (Austria)
 - **Liaison office:** Brussels (Belgium)

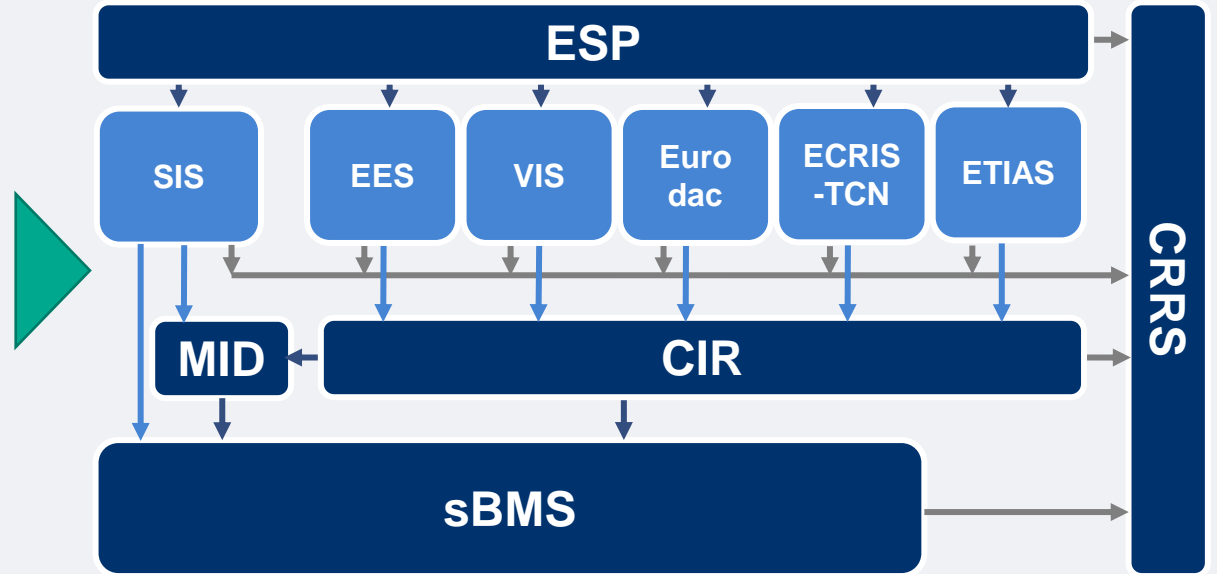
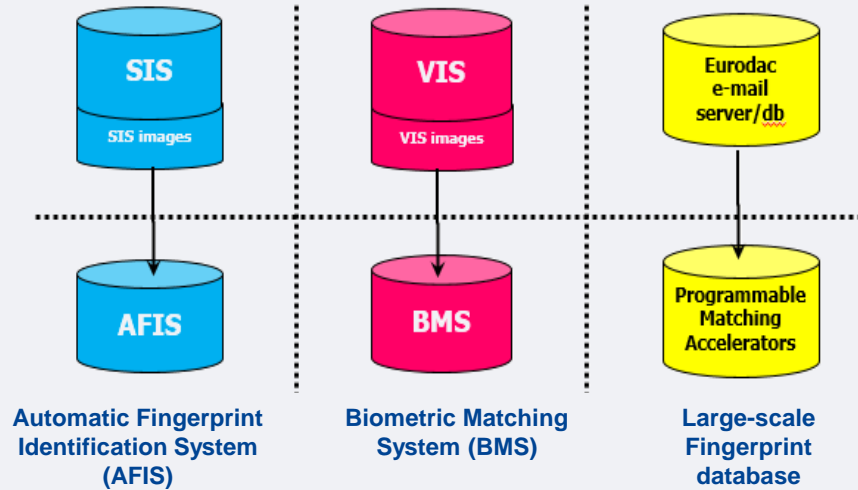


- The **Schengen Area: 26 countries** (22 are EU member states), with a population of ~420 million people
- **eu-LISA Core Business Systems and IO components** - Core part of EU law.

2 | eu-LISA Interoperability framework



Core Business System (CBS)
eu-LISA previous silos



European Search Portal (ESP)

Single window to simultaneous query CBSs.



Common Identity Repository (CIR)

- Stores data from the CBSs
- Creates individual files
- Drives the MID process



Multiple-Identity Detector (MID)

- Creates & stores identity confirmation files
- Stores links
- Allows manipulations of links by end-users



sBMS

Shared Biometric Matching Service (sBMS)

- Stores biometric templates from CBSs
- Provides biometric functionalities (CUD, 1:1, 1:N)
- Enables querying across the various CBS

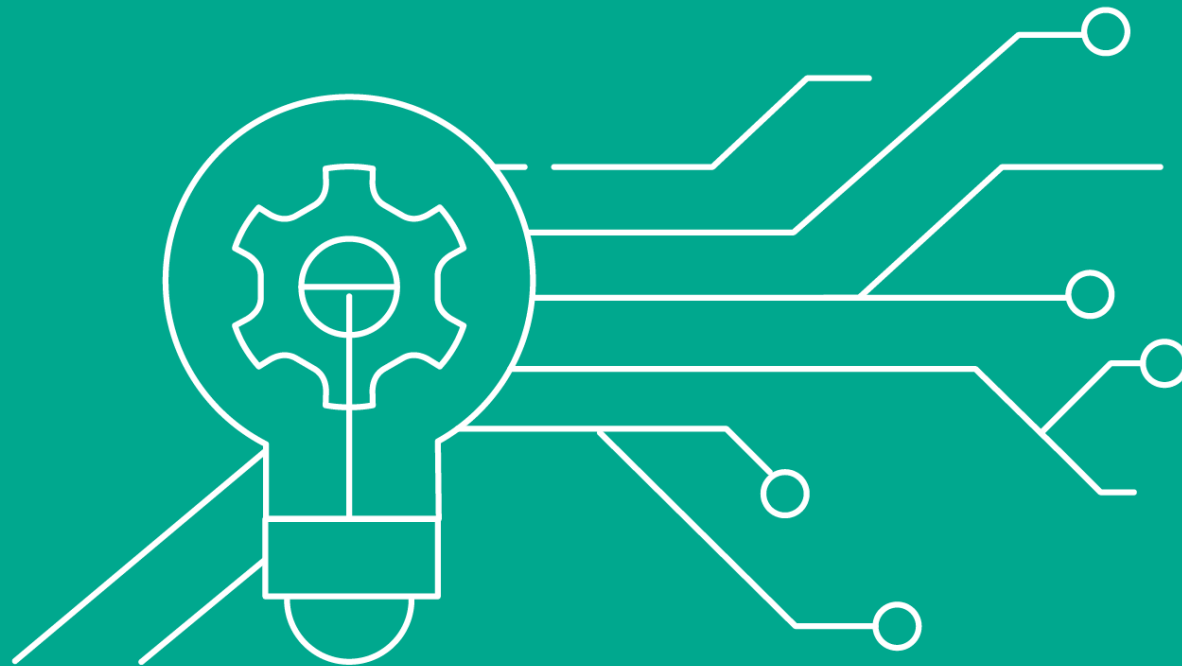


CRRS

Central Repository Reports & Statistics (CRRS)

Cross system statistical data and analytical reporting

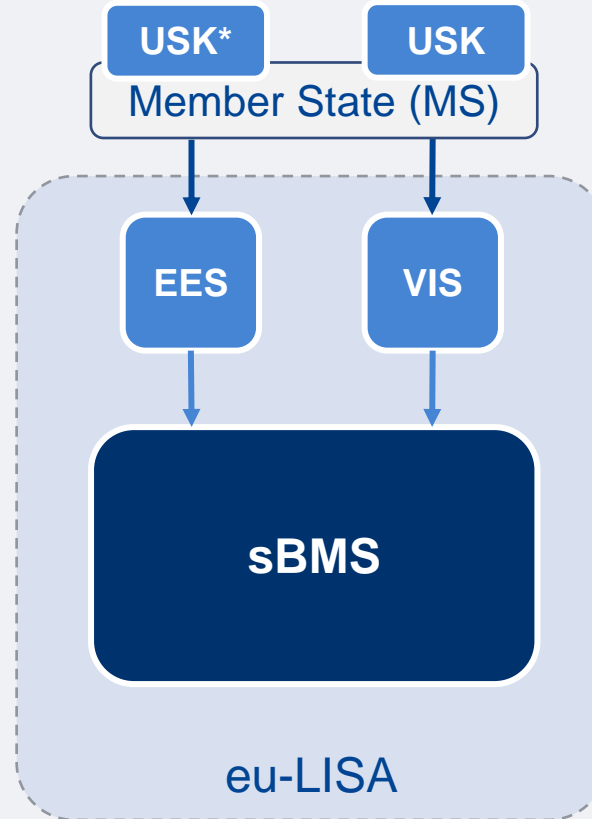
3 | Use case for FI: EES-VIS sBMS



VIS Biometric Operations

 Flat fingerprint (1 to 10)  1 Image file

- **Enrolment (FTE-0)**
Biometric references generated from 1 to 10 Flat FP Images
Quality values stored as a Boolean flag for information purposes
All templates are used for queries
- **Verification**
1:1 operation with 1, 2, 4 or 10 FPs
- **Identification**
1:N operation with 4 or 10 FPs
- **Identification LEA**
1:N operation with Latent Prints
1:N operation with FP
- **Fingerprint quality checking (NFIQ2)**
 - sBMS USK (NS) / BDP (CS)



EES Biometric Operations

 Flat fingerprint (1 to 4)  1 Image file

- **Enrolment (FTE-0)**
Biometric references generated from 1 to 4 Flat FP Images and FI Images
Quality values stored at the EES Central System and sBMS
Only templates above the quality threshold are used for 1:N queries
- **Verification**
1:1 operation with 1, 2 or 4 FPs
1:1 operation with FI
- **Identification**
1:N operation with 4 or 10 FPs
1:N operation with FP+FI
- **Identification LEA**
1:N operation with Latent Prints
1:N operation with FI / FP / FP+FI
- **Fingerprint quality checking (NFIQ2.0 and sFIQ**)**
 - sBMS USK (NS and CS)



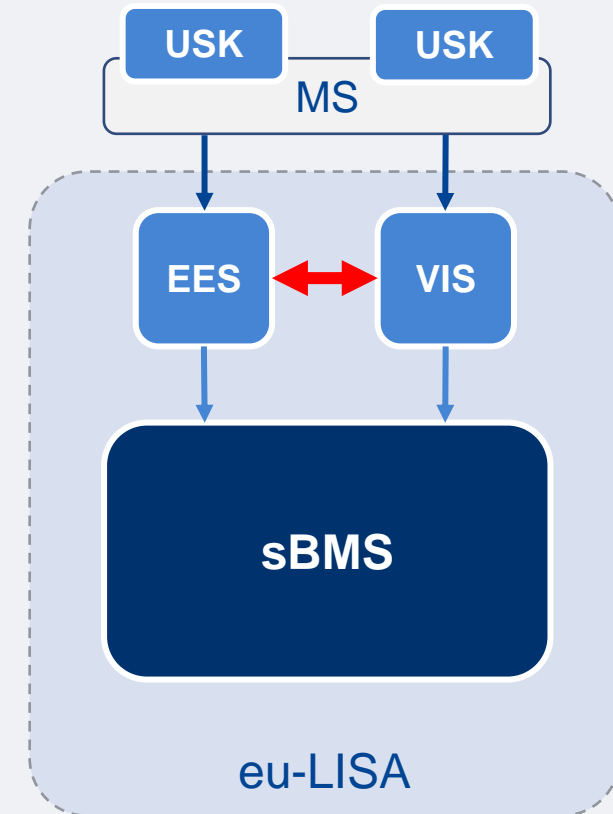
Regulation (EU) 2017/2226 – establishing an Entry/Exit System

VIS request to EES (Visa applications)

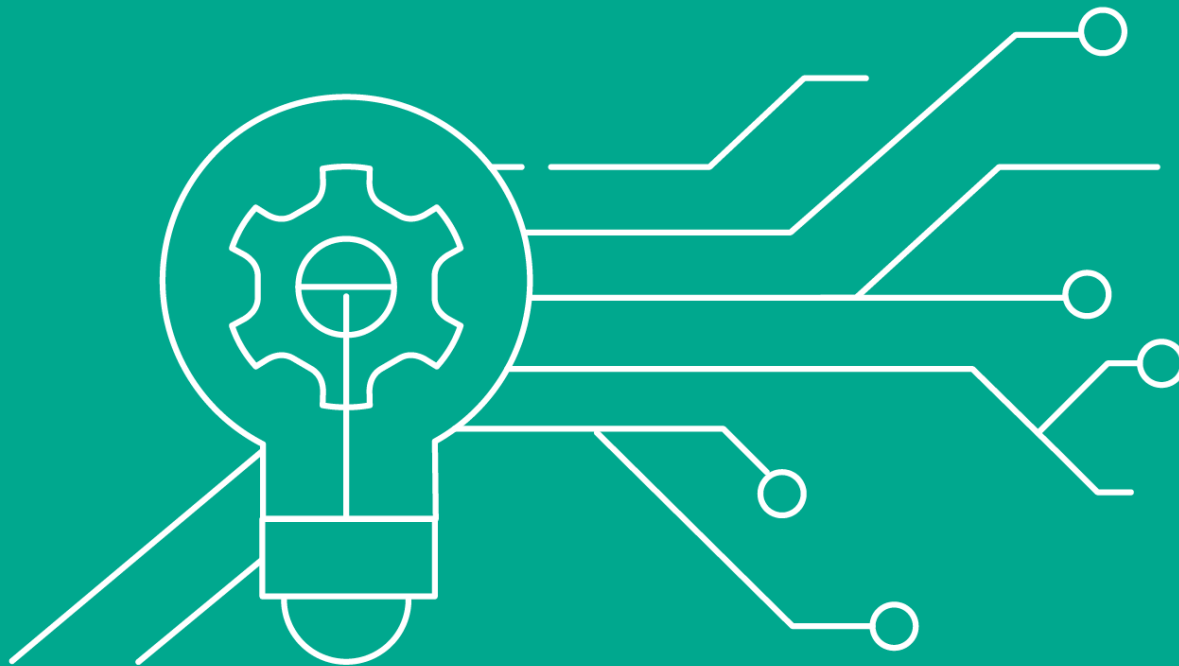
- **Identification**
 - 4 or 10 flap fingerprints
 - 4 or 10 flap fingerprints and face image

EES request to VIS (border control)

- **Verification by Fingerprint**
 - 1, 2 or 4 fingers flat (one hand)
- **Identification**
 - 4 fingers flat (one hand)



4 | sBMS Facial Image Quality (sFIQ)



sBMS Data Quality Control

1. Quality of alphanumeric data:

- First name(s), surname, age, nationality, dates, ...

Low quality data: **REJECTION**

2. Quality of the NIST container:

- Compliance with the ANSI NIST standard
- Quality of NIST data fields

Low quality data: **REJECTION**

3. Quality of the (raw) biometric sample

- Fingerprints: ISO/IEC 29795-4:2017 FP Image (NFIQ2.0)
- Facial Images: ISO/IEC 19794-5:2011 Frontal image type compliance

Low quality data: **ACCEPTANCE & WARNING**

National System



User Software Toolkit (USK)



check before submission



EES

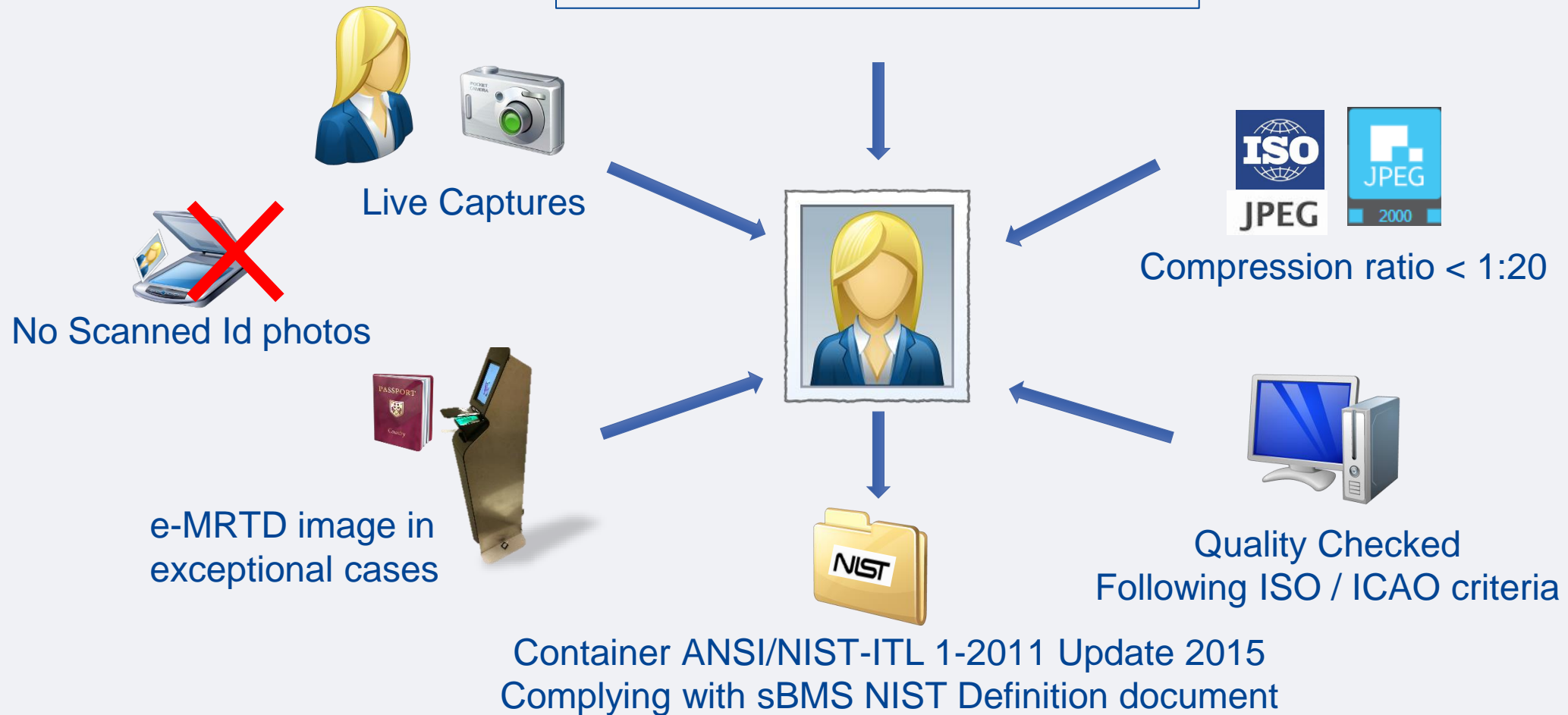
User Software Toolkit (USK)



check at reception

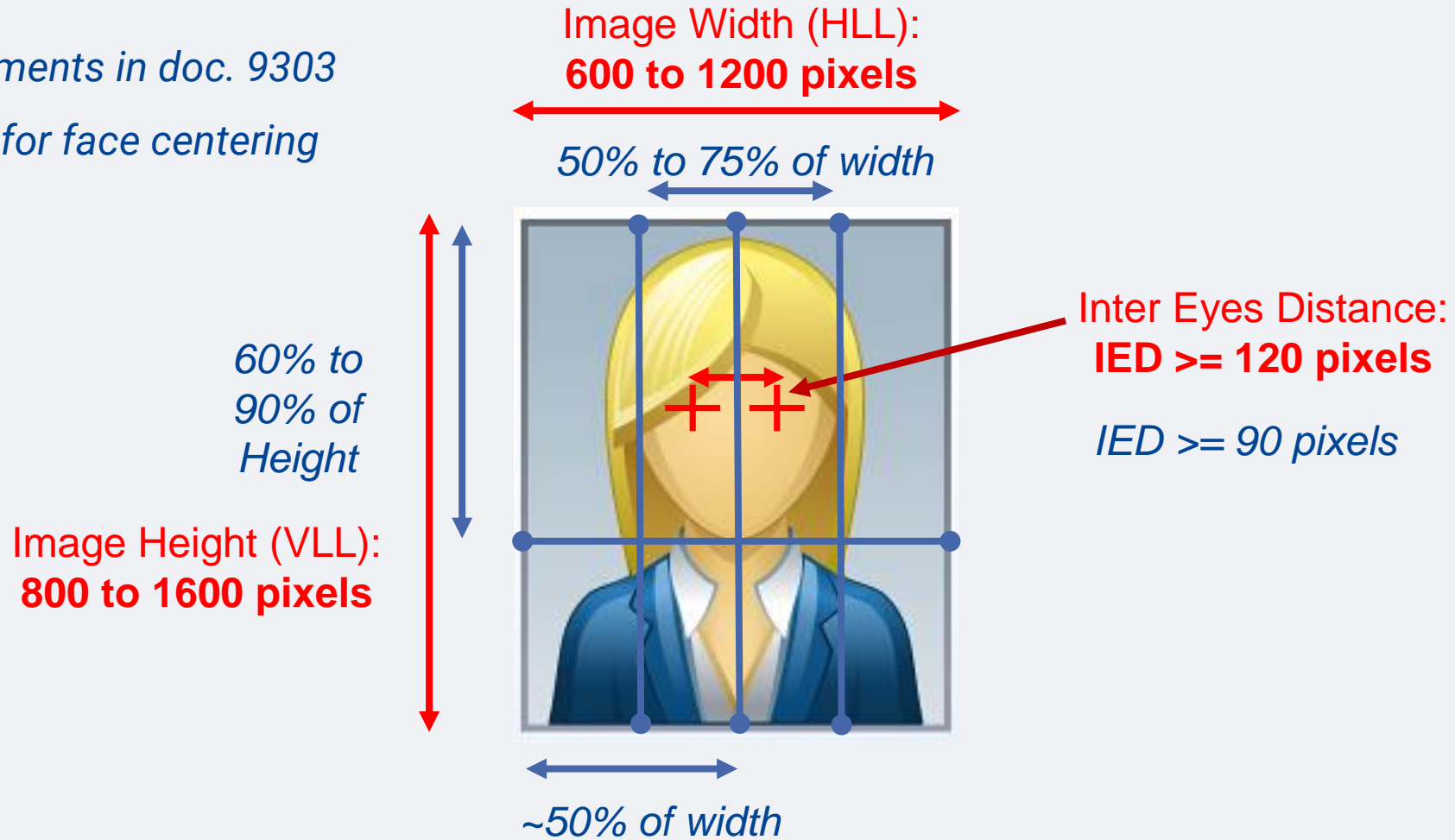
EES Facial Image Specifications

Frontal Facial Images only



EES Facial Image Specifications

- ICAO requirements in doc. 9303 as guidelines for face centering



sFIQ-2 : sBMS Facial Image Quality (Version 2)

- Multi criteria method

1. **Detection of Face and Eyes in Facial Image**

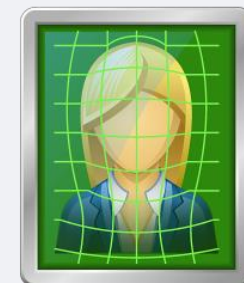
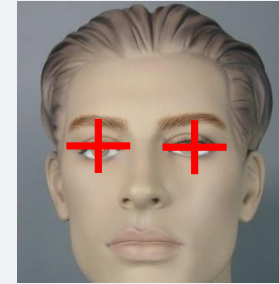
- Error if no face / eyes detected : Not usable

2. **Control of 7 relevant Image Quality Components**

- Measurable / Detectable
- Can be corrected easily by the subject or the operator
 - Remove sunglasses, look forward, etc.
- Impact the automatic face recognition accuracy
- May impact the operator verification

3. **Check a Biometric Quality Score**

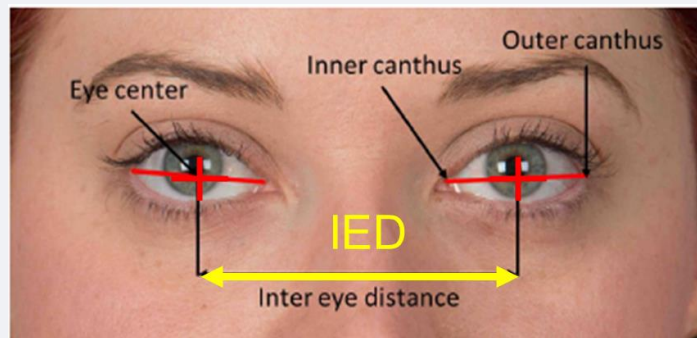
- AI-based Quality score between 0 and 100
- Linked with the automatic face recognition accuracy
- Should be above the “Quality threshold”



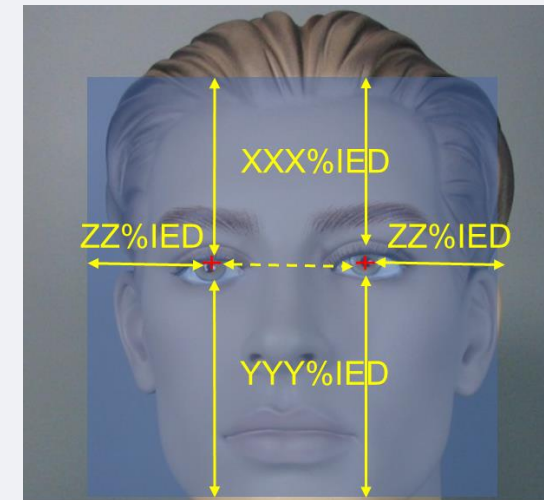
FI Low Quality Component n° 1 and 2 : Resolution and Cropping

→ Control of the Facial Image Resolution

- Resolution measured by the IED “Inter-Eyes Distance” in pixels
- Between the centres of the eyes
- IED must be above 120 pixels (EES)
- Warning message if IED below required value:
→ SUBJECT TOO FAR FROM CAMERA

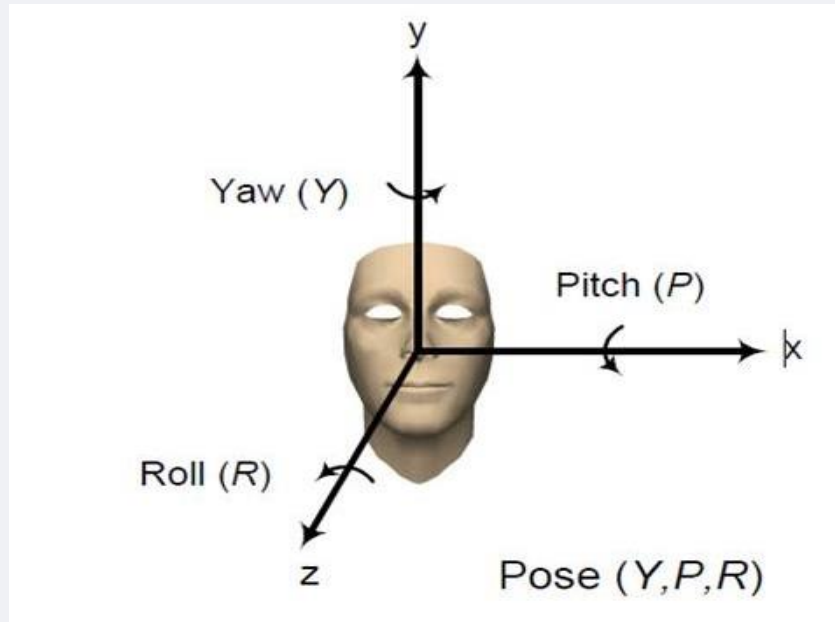


- Badly cropped image = Truncated / partial / Not centered
 - Need of minimal image distances around the face and eyes
 - Based on IED value of Facial Image



FI Low Quality Component n°3 : Not Frontal Pose

Examples of Unacceptable Images



Yaw $< -YY^\circ$



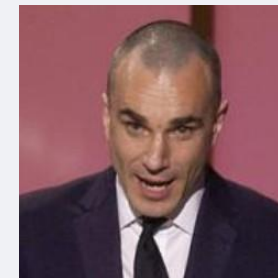
Yaw $> +YY^\circ$



Pitch $< -PP^\circ$



Pitch $> +PP^\circ$



Roll $< -RR^\circ$



Roll $> +RR^\circ$



Images are from LFW public dataset

FI Low Quality Component n°4 to 6

→ N°4 : Wearing Face Mask

- Or covering the Face



→ N°5 : Wearing Dark Glasses

- Or issue with glasses



→ N° 6 : Open Mouth Detection

- Means teeth visible if smiling
- Neutral expression required



Images are from LFW public dataset



FI Low Quality Component n° 7 : Bad Illumination

- Several quality components based on requirements from ISO/IEC 19794-5:2011
 - **Bad lighting** : Light shall be equally distributed on face
 - **Hot Spots** : No bright regions
 - **Unnatural colours** : Colour lighting not allowed
 - **Low Dynamic** : At least 7 bits of intensity in Facial region
 - **Bad Exposure** : No saturation (over or under exposure) on face
 - **Reflections** : No lighting artefacts of flash reflection on face/glasses



FI Low Quality Component n° 8 : Biometric Quality Score



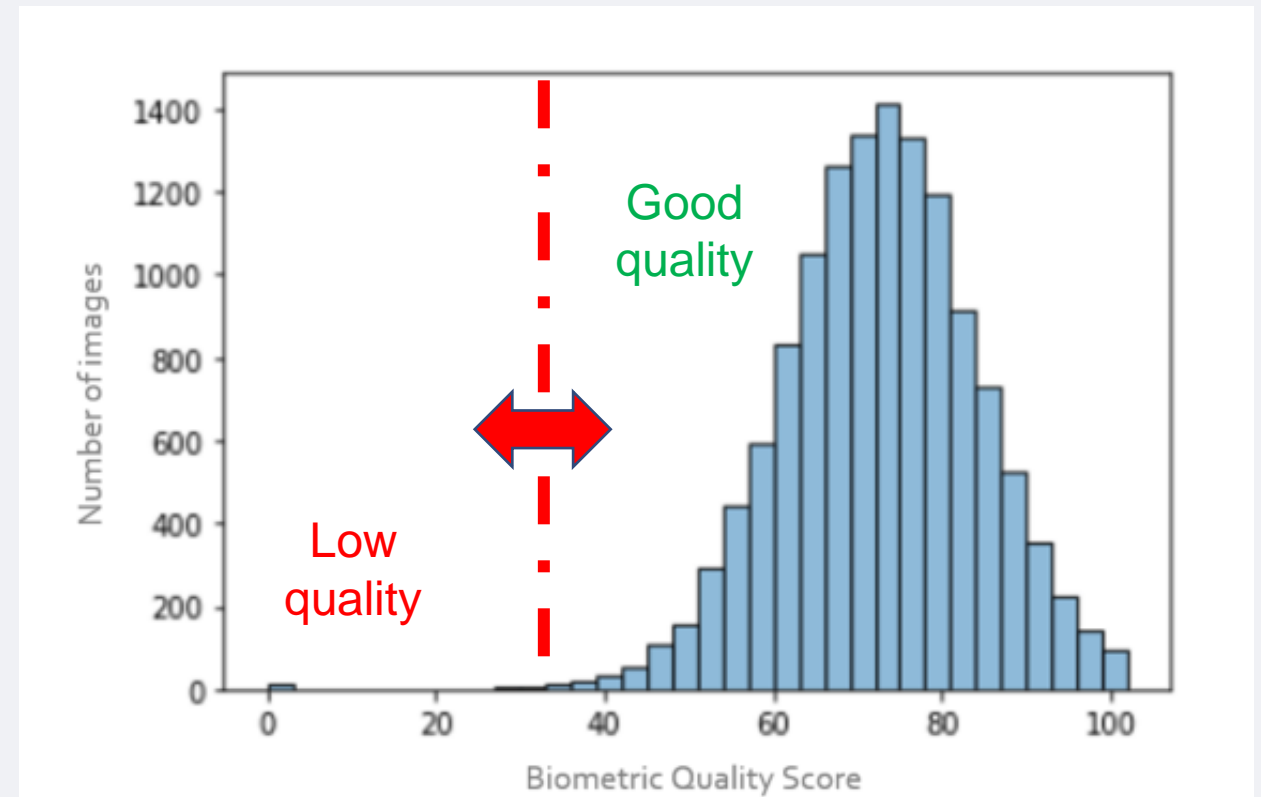
AI-based Biometric Quality predicts probability of successful match



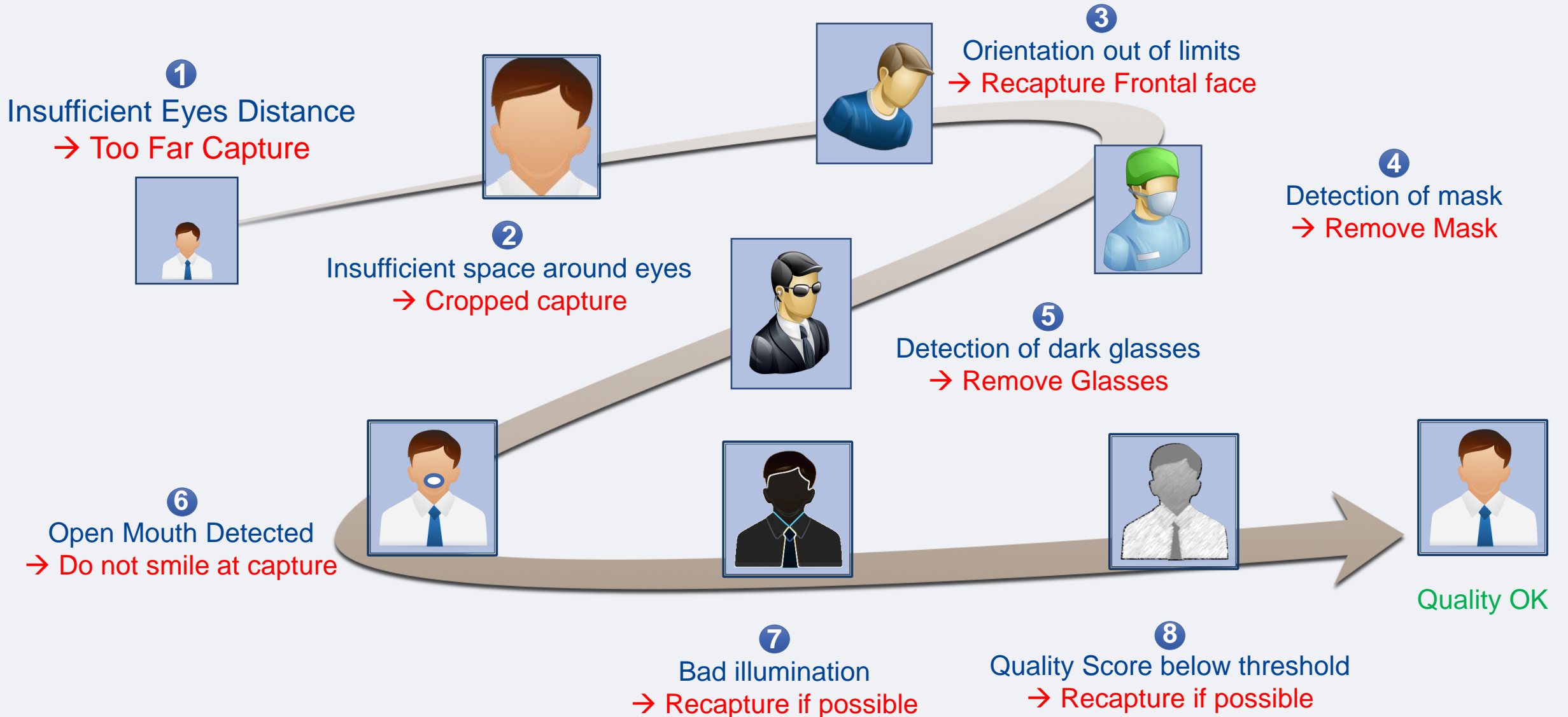
Quality Score **between 0 and 100**



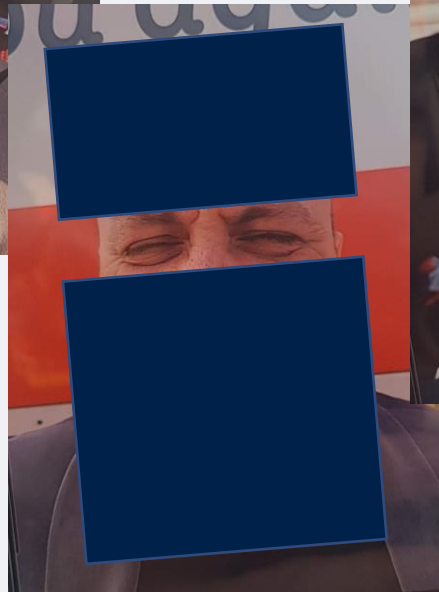
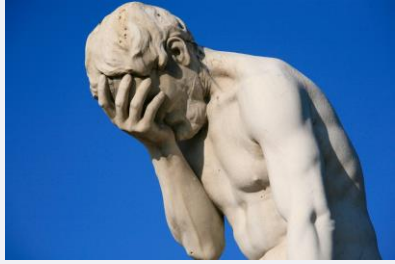
Threshold to be fine-tuned after pre go-live EES accuracy evolution



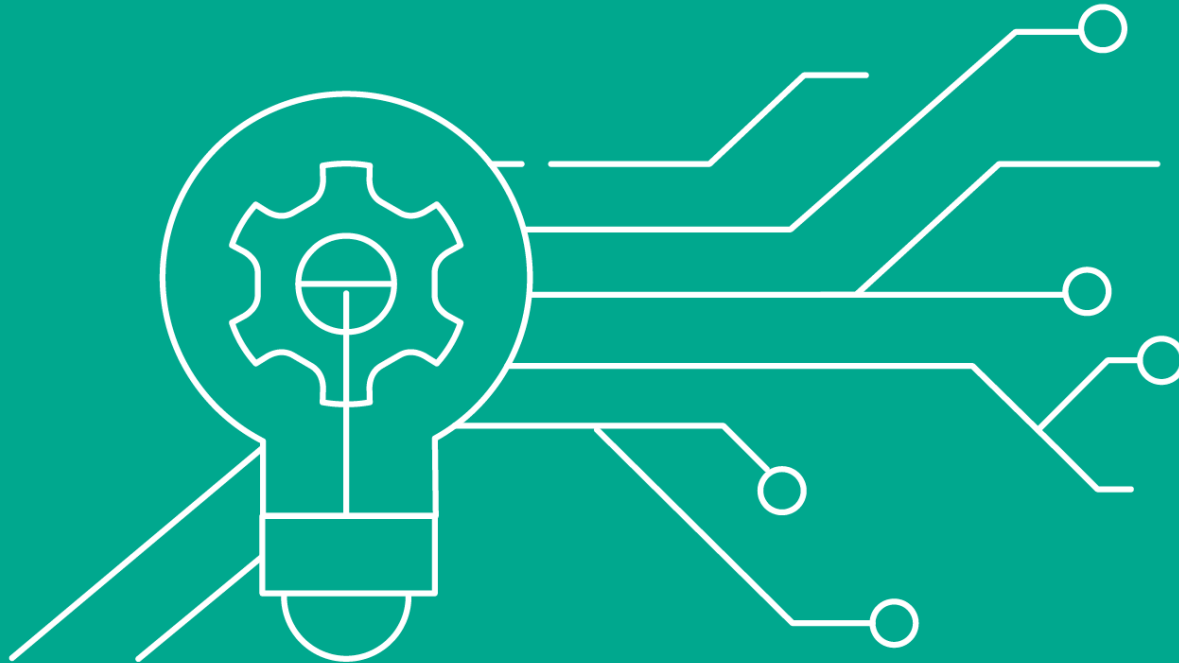
Actionable feedback to capture subjects and biometric attendants



Some pieces of reality...



5 | Summary



Use Case for Face Image Quality Assessment at eu-LISA - SUMMARY



- The EU Interoperability Framework will bring a complex scenario for 1:1 and 1:N operations, where facial image quality assessment will play a crucial role



- The EES Regulation (2017/2226)
 - anticipates the Interoperability Framework, enabling EES and VIS to search (1:N) and verify (1:1) identities across eu-LISA CBSs



- eu-LISA will provide the sBMS USK to the MS, biometric quality assessment of facial (and fingerprint) images before submission to eu-LISA CBSs



- sFIQ is based in ISO/IEC 19794-5:2011 and EES Regulation (2017/2226)
 - Best effort to meet the requirements
 - Certain factors relaxed to be tailored to operational constrains
 - Still proprietary
 - eu-LISA supports the standardisation projects ISO/IEC 29794-1 and ISO/IEC 29794-5 as well as the OFIQ (Open Source Face Image Quality toolkit) reference implementation

Thank you !

eu-LISA

European Union Agency for the Operational
Management of Large-Scale IT Systems in
the Area of Freedom, Security and Justice

Biometrics as a Service (BaaS)

DG_Biometrics@eulisa.europa.eu

www.eulisa.europa.eu

 facebook.com/agencyeulisa/

 twitter.com/EULISA_agency

 linkedin.com/company/eu-lisa/

 youtube.com/c/euLISAagency