U.S. Department of Homeland Security

SCIENCE AND TECHNOLOGY DIRECTORATE

Remote Identity Validation Rally (RIVR) Selfie Match to Document (SMTD) Results Webinar

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Agenda

- Introduction
- Remote Identity Validation Rally (RIVR)
- RIVR: Selfie Match to Document Evaluation
  - Data Used
  - System Requirements
  - Metrics and Benchmarks
- RIVR: Selfie Match to Document Results
  - Evaluation Criteria
  - Failure to Extract Rate
  - False Non-Match Rate
  - False Match Rate
- Summary & Conclusions

Science and Technology

We are the Department's Science Advisor and research and development arm.

Since 2003, the Department of Homeland Security (DHS) Science and Technology Directorate (S&T) has provided sound, evidence-based scientific and technical perspectives to address a broad spectrum of current and emerging threats.

Science and Technology

Biometric & Identity Technology Center

The Science & Technology Directorate (S&T) conducts foundational research to ensure advancements in science and technology are harnessed in the development of cutting-edge solutions to new and emerging operational challenges.

- ☑ Drive biometric and identity innovation at the Department of Homeland Security (DHS) through Research, Development, Test, and Evaluation (RDT&E) capabilities

- ☑ Facilitate and accelerate understanding of biometrics and identity technologies for new, DHS use cases

- ☑ Drive efficiencies by supporting cross-cutting methods, best practices and solutions across programs

- ☑ Deliver subject matter expertise across the DHS enterprise

- ☑ Engage industry and provide feedback

- ☑ Encourage innovation across industry and academia

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Remote Identity Validation

- Remote Identity Validation (RIV) technology is a tool to authenticate documents and verify the identity of users remotely

- These systems are complex, with multiple subsystems, and are increasing in popularity and adoption

- Industry performance benchmarks are not well defined, making it is difficult for organizations to test the effectiveness of these systems

- S&T is studying the current performance of RIV to help industry develop more secure, accurate, and robust technologies:
  - Remote Identity Validation Technology Demonstration (RIVTD) from 2023 to 2024
    - Comprehensively demonstrated performance of commercial RIV subsystems
    - Informed NIST digital identity guidelines
    - Identified metrics, performance gaps, and achievable performance benchmarks
  - Remote Identity Validation Technology Rally – currently ongoing

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Remote Identity Validation Rally (RIVR)

- **Building on RIVTD Insights**: RIVTD identified key areas where RIV vendors should focus improvements, shaping the next phase of evaluation

- **Establishing Achievable Benchmarks**: RIVR sets industry-informed performance benchmarks based on RIVTD results, providing clear targets for improvement

- **Encouraging Innovation & Retesting**: Vendors can refine their technologies and participate in re-evaluation

- **Confidential & Industry-Driven**: Vendor names are aliased, allowing companies to self-attest participation while fostering industry-wide progress


Remote Identity Validation Rally

VALIDATED

NOT VALIDATED

MdTF

Selfie Match to Document Track Process & Requirements

Image Sources

- Leveraged a large and growing collection of:
  - Images of genuine U.S. State-issued ID cards (e.g., driver's licenses)
  - Selfie photo images
- RIV selfie Match to Document Systems (MTDSs) were evaluated based on their ability to determine if a **selfie image** is the same person as pictured on a **U.S. State-issued ID card**.
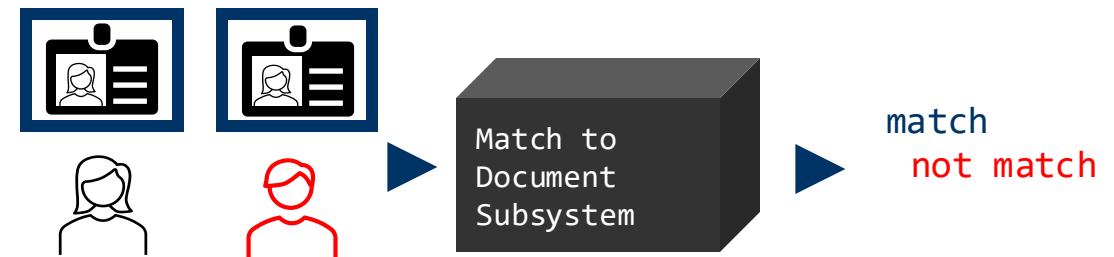
- Sample Images:
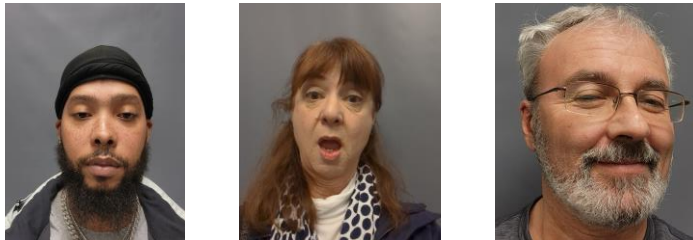
All volunteers shown here consented to have their images used in government presentations.

Sample driver license taken from:
What do the new Maryland driver's licenses look like? (wbaltv.com)

match
not match

Dataset Composition

- A total of 1,632 volunteers participated in two data collections
  - Maryland Test Facility (MdTF), May 2023
  - Remote Collection, September 2023

- Each volunteer used each of three smartphones to provide a controlled selfie image

- Test team personnel used each smartphone to collect one controlled document image
  - Only front of document used

- Demographics:
  - Age (self-reported)
  - Sex (self-reported)
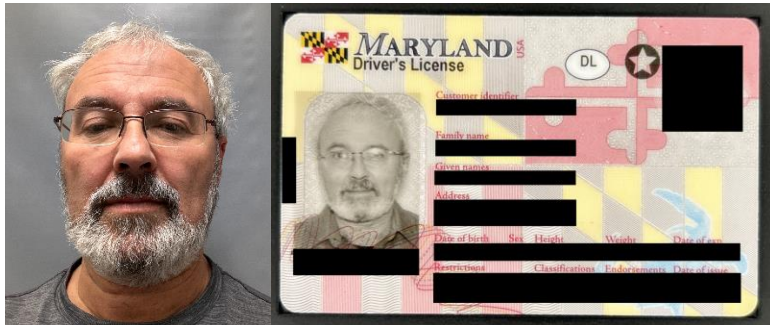 - Race (self-reported)
  - Skin-Tone (measured)

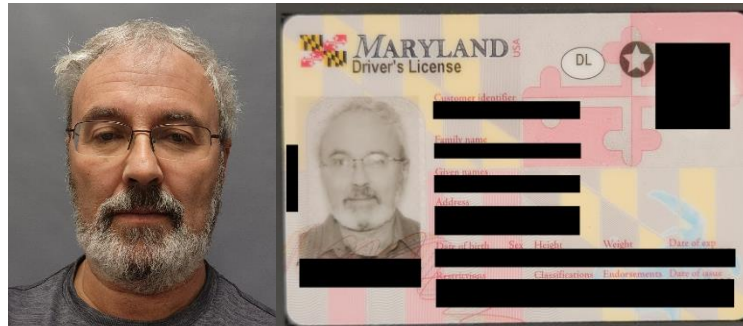| Category	Group	n
Sex	Female	923
	Male	702
	Other	7
Race	Asian	354
	Black or AA	285
	Hispanic	268
	Other	297
	White	428
Age Group	18-30	295
	31-45	525
	46-60	432
	61+	379
	Not reported	1
Total		1,632

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Sample Images Across Devices

- Selfies and document images were acquired on each of three smartphones

Apple iPhone 14

Samsung Galaxy S22

Google Pixel 7

*Volunteers shown consented to have images used in government presentations. ID documents redacted to protect privacy.

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Participating Systems

- 16 commercial selfie Match to Document Systems (MTDSs) participated in RIVR
  - Announced in March 2025
  - Applications due in April 2025
  - Submissions due in May 2025

- Representative of the state of the industry

- Each system was given a unique alias (MTDS 1, MTDS 2, etc.)

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System Requirements

- Implement the MdTF Match to ID Application Programming Interface (API)

- A single Linux-based docker container
  - HTTP server on port 8080
  - Less than 5 GB in size

- No outside functionality and no access to the internet

- Licensed to operate at MdTF

The Maryland Test Facility Match-to-ID Interface 0.0.1

OAS3

This document specifies the API requirements for MdTF testing of algorithms that match facial biometric samples to identity document images (``match-to-id"). Match-to-ID testing at the MdTF is supported by the Department of Homeland Security, Science and Technology Directorate (DHS S&T) as part of the Remote Identity Validation Technology Demonstration (RIVTD). For more information please visit https://mdtf.org and https://www.dhs.gov/science-and-technology/BI-TC

The MdTF - Website
Send email to The MdTF
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Biometric Operations

POST /v1/create-template   Generate a template from the provided facial biometric sample or the identity document image.

POST /v1/compare-list   Compare a single template to a list of target templates.

Algorithm Information

GET /v1/info   Returns basic information for the algorithm.

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Selfie Match to Document Metrics (ISO Standard)

- **Failure to Extract Selfie ($FTXR_{selfie}$)** – Proportion of selfie images that fail to extract a template for biometric matching
  - **Threshold: 0.05, Goal: 0.01**

- **Failure to Extract Document ($FTXR_{doc}$)** – Proportion of document images that fail to extract a template for biometric matching
  - **Threshold: 0.05, Goal: 0.01**

- **False Non-Match Rate (FNMR)** – Proportion of ID document templates that do not match to templates from mated selfie images
  - Computed and reported at the supplied FMR = 1:1e4 setting
  - **Threshold: 0.05, Goal: 0.01**

- **False Match Rate (FMR)** – Proportion of non-mated templates that match – for validation of supplied thresholds
  - **Threshold: 0.0005, Goal 0.0001 at the FMR = 1:1e4 setting**

- **Disaggregated to examine robustness for:**
  - State of issue
  - Smartphone type
  - Demographics
  - FMR setting

RIVR set performance benchmarks for each metric:
Threshold – maximum high-performance error rate
Goal – target high-performance error rate

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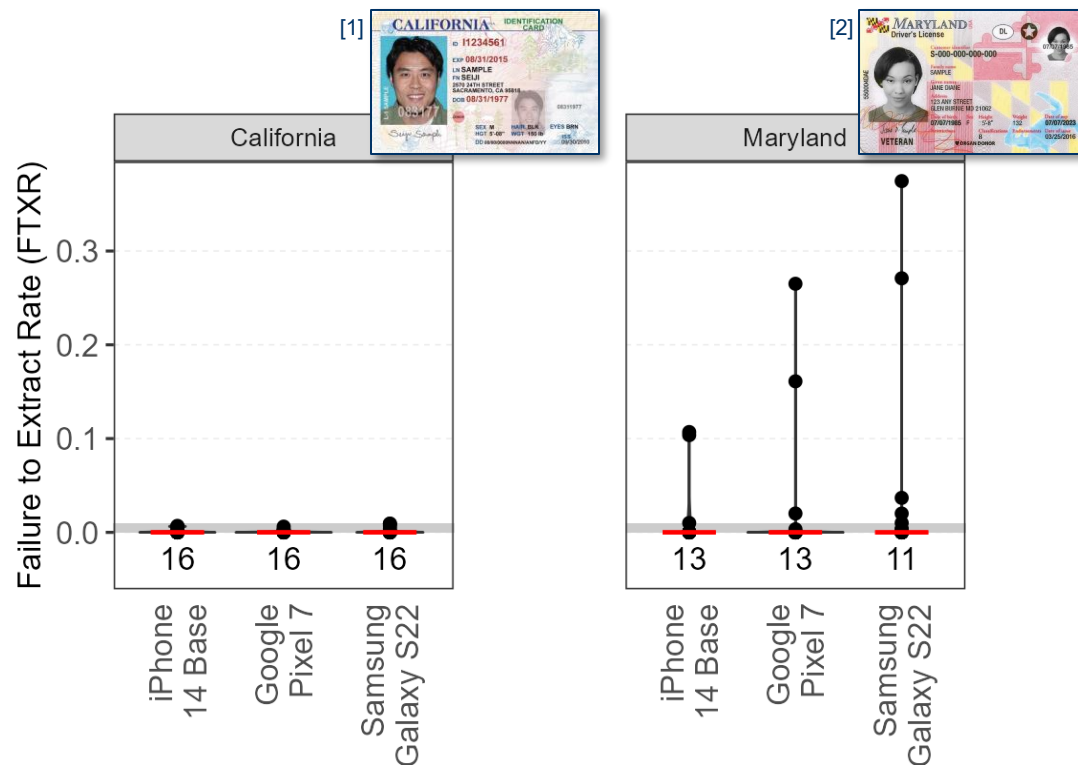# Selfie Match to Document Track Results

Methodology

- Selfie Match to Document systems were evaluated in combination with different smartphones and for different document states of issue

- Evaluation metrics were computed separately for different devices and document states of issue (where appropriate):
  - FTXR Selfie (3 smartphones = 3 values)
  - FTXR Documents (3 smartphones * 2 states = 6 values)
  - FNMR (3 smartphones * 2 states = 6 values)
  - FMR (3 smartphones = 3 values)

- Overall performance for each tested system was assessed based on the maximum error rate value observed for each metric (e.g., maximum FNMR across smartphone and document sate)

- Aggregate industry performance was assessed based on the performance of different system combinations of smartphone and matching systems
  - 48 system combinations (16 systems * 3 smartphones)

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Failure to Extract Rate - Selfies

All 16 MTDSs had 0% $FTXR_{selfie}$ for all collected selfies.

Failure to Extract Rate - Documents

Failure to Extract Rate (FTXR)

California · Maryland

[1] · [2]

- iPhone 14 Base · Google Pixel 7 · Samsung Galaxy S22 (California: 16, 16, 16)
- iPhone 14 Base · Google Pixel 7 · Samsung Galaxy S22 (Maryland: 13, 13, 11)

Points correspond to performance of combinations of smartphone, document state of issue, and MTDS. Gray shaded area indicates 1% or lower Document FTXR.
Red lines show median system combination Document FTXR.
Numbers indicate how many system combinations, out of 16, met the 1% or lower Document FTXR goal.

[1] https://commons.wikimedia.org/wiki/File:Identity_card_of_the_State_of_Califorinia,_sample_(2010).jpg
[2] https://www.delmarvanow.com/story/news/local/maryland/2016/05/09/mva-unveils-new-maryland-licenses-ids/84147078/

- **Most systems can extract templates from document images**
  - Median $FTXR_{doc}$ for all smartphones and states of issue was 0%
  - 14 of 16 MTDSs had $FTXR_{doc}$ below 5% across devices and states
  - 11 of 16 MTDSs had $FTXR_{doc}$ below 1% across devices and states
- **Minor impacts of document state of issue**
  - 43 of 48 system combinations had the same or lower $FTXR_{doc}$ on California IDs relative to Maryland IDs

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Demographics: Document Failure to Extract Rate


A — California

B — Maryland
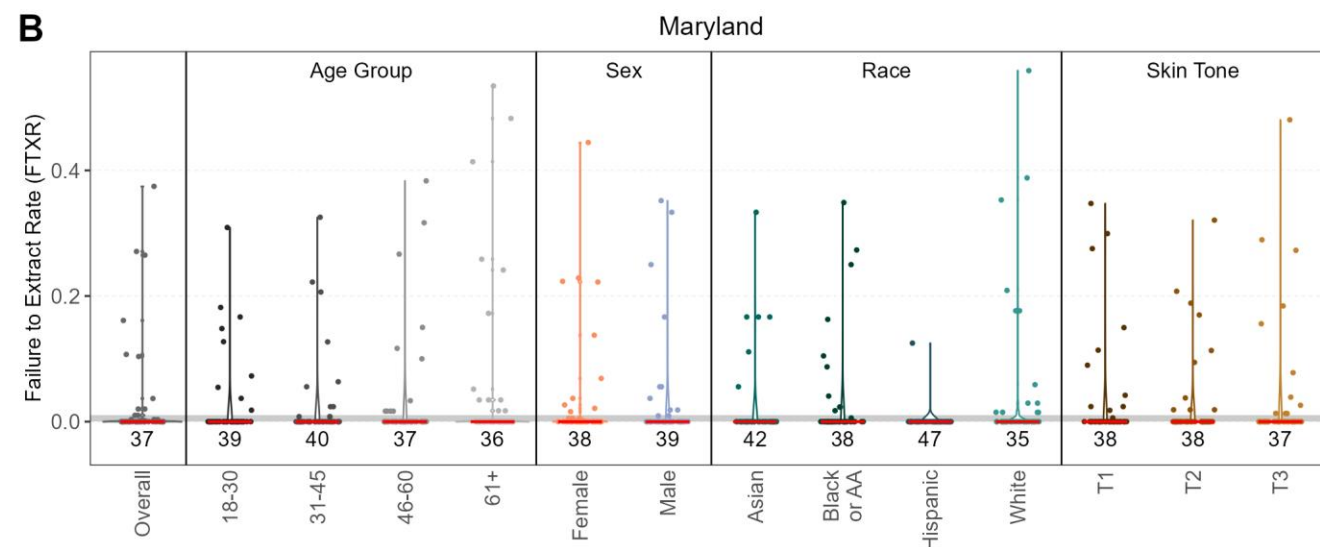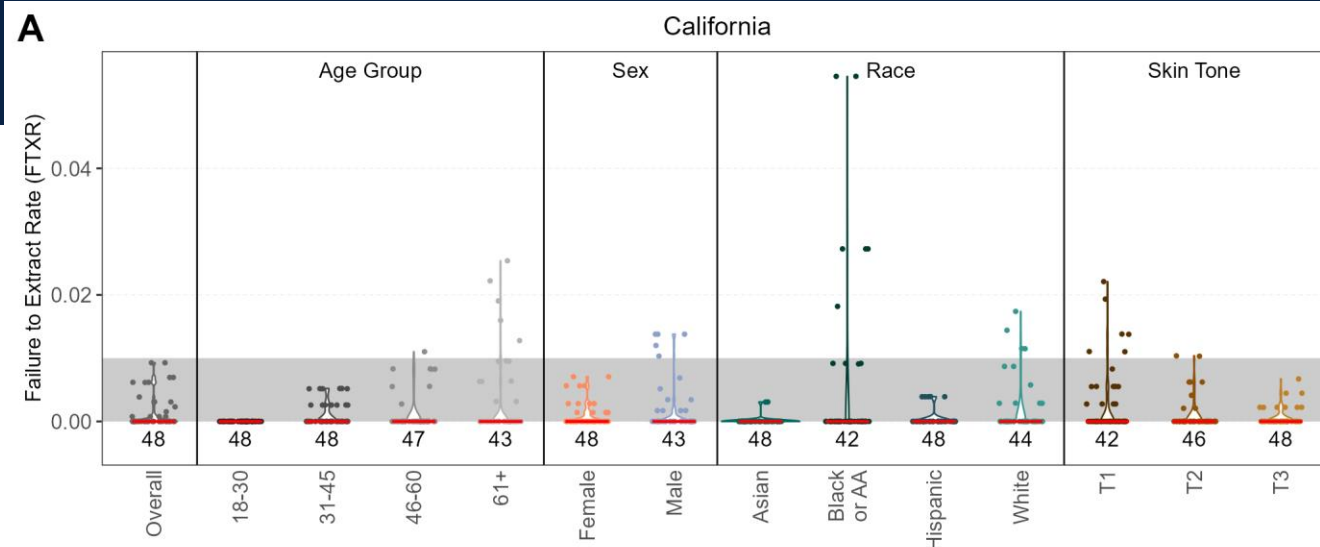
- **FTXR$_{doc}$ was consistently low across demographics for majority of MTDSs across states and smartphones**
  - Median error rate for all groups was 0%

- 16 MTDSs were assessed for FTXR, making 48 MTDS-smartphone combinations

System combinations robust to demographics had consistently low error rates across all groups		
Document State of Issue	FTXR$_{doc}$ < 5% (threshold)	FTXR$_{doc}$ < 1% (goal)
California	46	40
Maryland	40	34

Points correspond to performance of combinations of smartphone, document state of issue, and MTDS. Gray shaded area indicates 1% or lower Document FTXR. Red line shows median system combination Document FTXR. Numbers indicate how many system combinations, out of 48, met the 1% or lower Document FTXR goal.
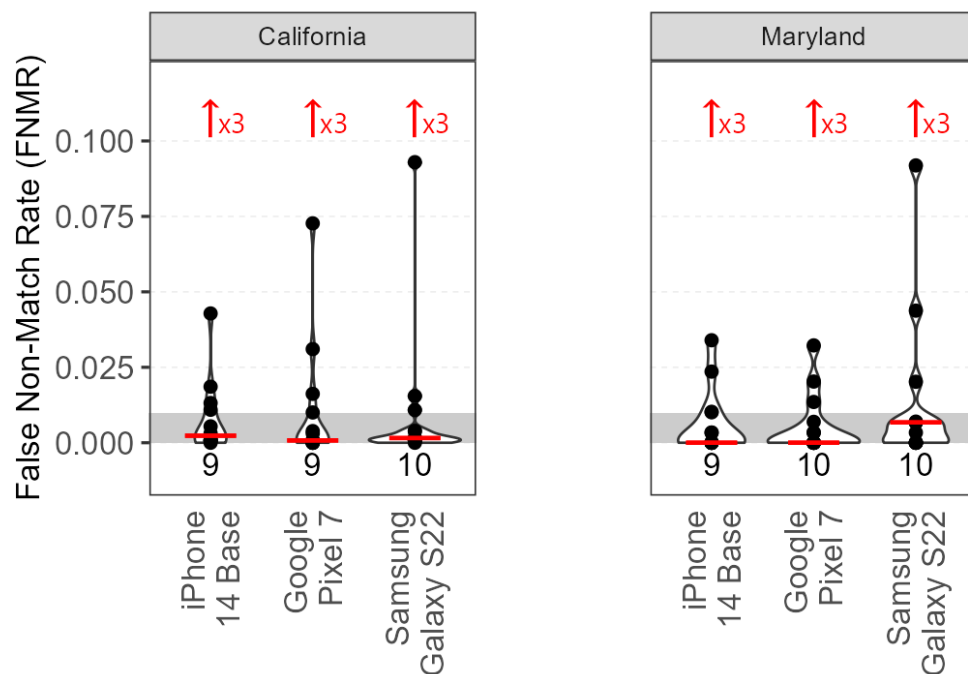
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False Non-Match Rate

Points correspond to performance of combinations of smartphone, document state of issue, and MTDS. Gray shaded area indicates 1% or lower FNMR.
Red lines show median system combination FNMR.
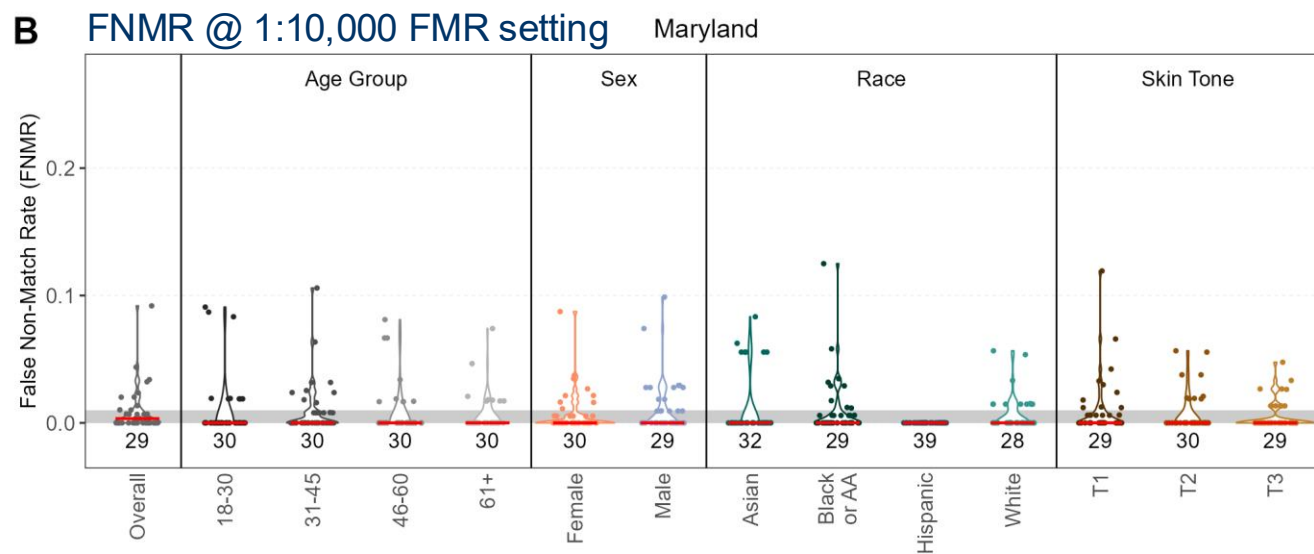Numbers indicate how many system combinations, out of 16, met the 1% or lower FNMR goal.

*All volunteers shown here consented to have their images used in government presentations.

Illustrative only, not an actual identity document.

- **Most systems had low FNMR:**
  - 9 of 16 MTDSs maintained FNMR below 1% across all states and smartphones
  - 12 of 16 MTDSs maintained FNMR below 5% across all states and smartphones

- **Outliers had high error rates:**
  - 3 systems had FNMR > 50% on all 3 smartphones

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Demographics: False Non-Match Rate

A. FNMR @ 1:10,000 FMR setting — California

B. FNMR @ 1:10,000 FMR setting — Maryland

- FNMR was calculated at the biometric threshold provided to achieve the RIVR goal FMR of 1:10,000

- **FNMR was consistently low across demographics for most MTDSs across states and smartphones**
  - Median FNMR ranged from 0% to 0.92%

- FNMR robustness was examined for the 13 MTDSs with overall FNMR < 50%, making 39 MTDS-smartphone combinations

System combinations robust to demographics had consistently low error rates across all groups		
Document State of Issue	FNMR < 5% (threshold)	FNMR < 1% (goal)
California	35	26
Maryland	30	21

Points correspond to performance of combinations of smartphone, document state of issue, and MTDS. Gray shaded area indicates 1% or lower FNMR. Red line shows median system combination FNMR. Numbers indicate how many system combinations, out of 39, met the 1% or lower FNMR goal.
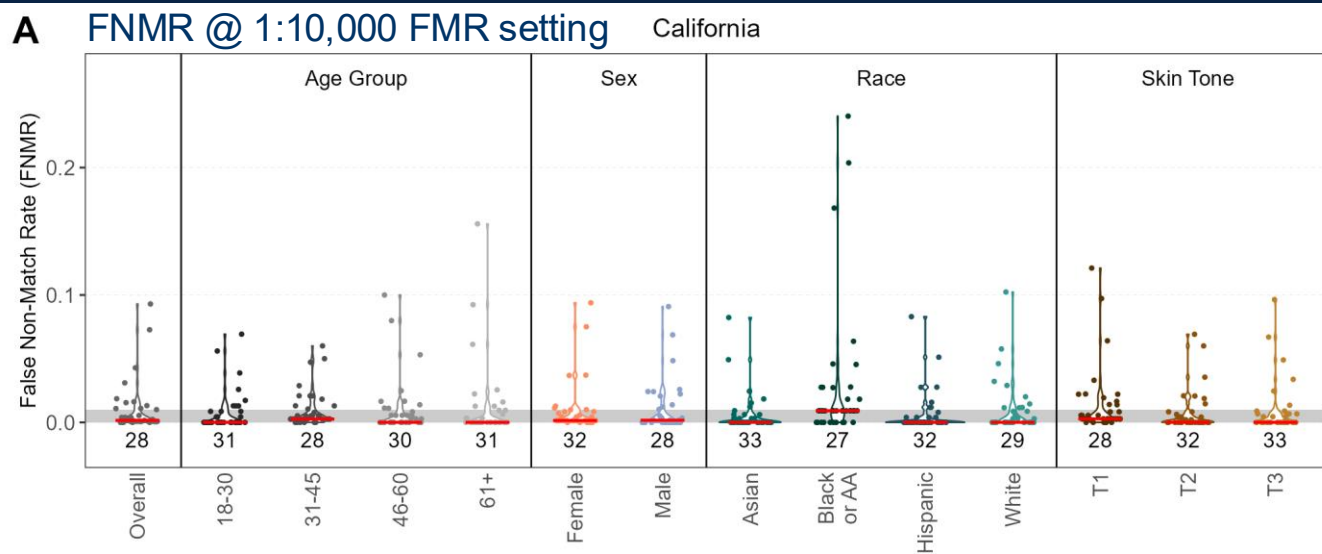
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False Match Rate

- FMR was independently calculated using the RIVR dataset by comparing selfie images of one person to an image of a document belonging to a different person (non-mated comparisons)

- FMR was calculated using the biometric thresholds provided with the SMTD systems configured to achieve the RIVR goal FMR of 1:10,000, consistent with NIST 800-63B

- FMR values were calculated for:
  - Random imposters
  - Demographically matched imposters[1,2]
    - Comparisons between people of the same sex, same race, and similar age

[1] Howard, John J., Yevgeniy B. Sirotin, and Arun R. Vemury. "The effect of broad and specific demographic homogeneity on the imposter distributions and false match rates in face recognition algorithm performance." *2019 IEEE 10th international conference on biometrics theory, applications and systems (BTAS)*. IEEE, 2019.
[2] Grother, P. , Ngan, M. and Hanaoka, K., "Face Recognition Vendor Test Part 3: Demographic Effects, NIST Interagency/Internal Report (NISTIR)," National Institute of Standards and Technology, Gaithersburg, MD, [online], 2019, https://doi.org/10.6028/NIST.IR.8280 (Accessed July 18, 2024)

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Threshold Assessment: False Match Rate
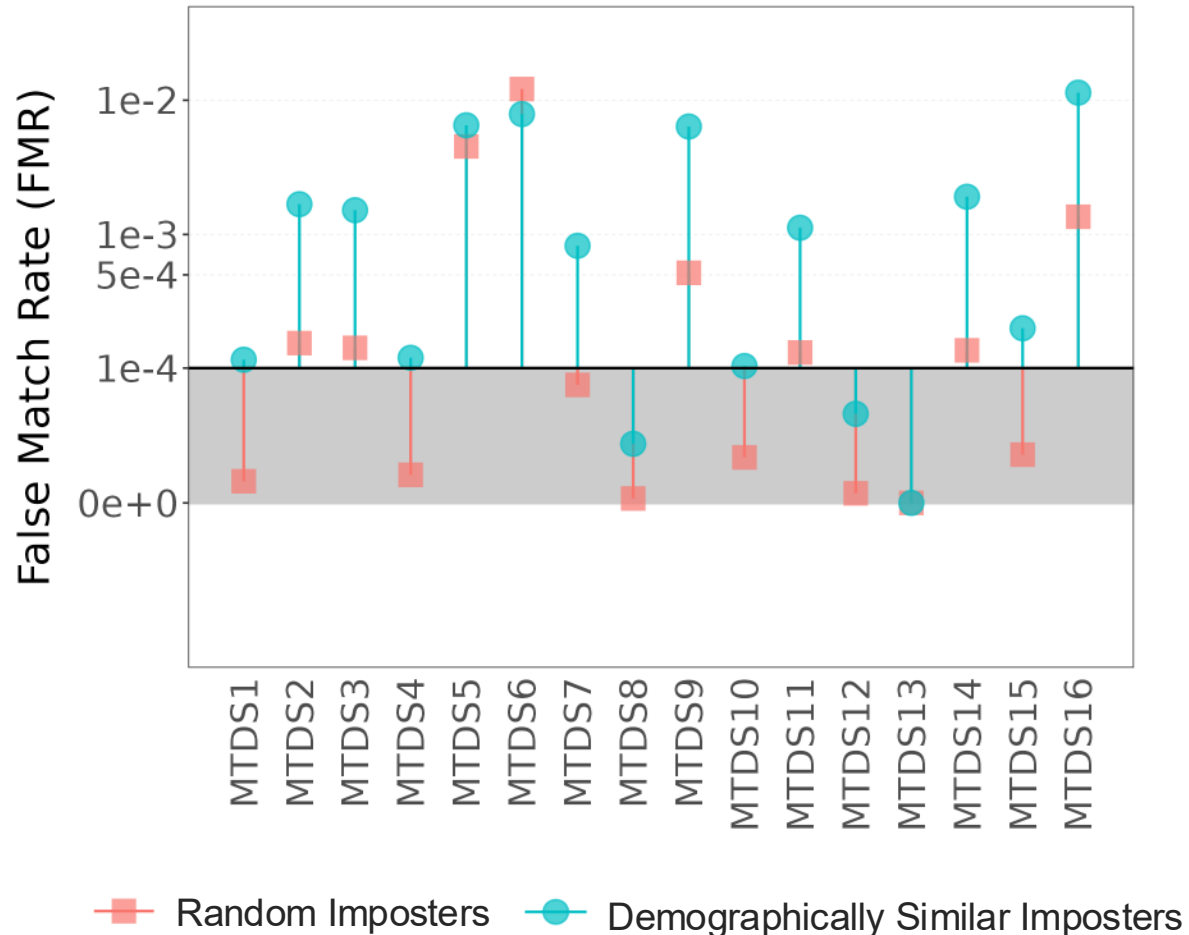
- MTDSs provided biometric thresholds to achieve the RIVR goal FMR of 1:10,000 (1e-4)
  - RIVR threshold FMR was 5:10,000 (5e-4)

- 3 of 16 MDTSs did not configure their biometric thresholds appropriately for the RIVR dataset (FMR > 5e-4 for random imposters)

- 8 of 16 MTDSs met the FMR goal for random imposters, and an additional 4 met the threshold

- 3 of 16 MTDSs met the FMR goal for demographically similar imposters, and an additional 4 met the threshold

- For the median system, the error rate for demographically similar imposters was ~11 times higher than for random imposters

Summary & Conclusions

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Results Summary

MTDS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Selfie FTXR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Document FTXR	0%	< 0.09%	0%	0%	< 27.1%	0%	< 2.02%	0%	< 3.69%	< 0.34%	0%	< 0.35%	< 37.47%	< 1.01%	0%	0%
FNMR	< 0.34%	< 0.68%	< 0.08%	< 0.08%	< 70.84%	< 99.66%	< 0.08%	< 58.11%	< 3.11%	< 0.68%	< 2.03%	< 0.08%	< 9.3%	0%	< 0.68%	< 4.38%
FMR	< 0.01%	< 0.02%	< 0.02%	< 0.01%	< 0.47%	< 1.66%	< 0.01%	< 0.01%	< 0.07%	< 0.01%	< 0.02%	< 0.01%	0%	< 0.02%	< 0.01%	< 0.15%

Legend

X	Met Goal	X	Met Threshold	X	Did not meet Threshold

- **31%** of tested systems (MTDS 1, 4, 10, 12, and 15) met RIVR goals for all metrics
- **63%** of tested systems met RIVR performance thresholds for all metrics
- **37%** of tested systems were unable to meet the threshold for at least one metric

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Conclusions

- Face recognition can perform well as part of the RIV process
  - Five (5 of 16) MTDSs met or exceeded the high-performance goal for all RIVR metrics
  - Ten (10 of 16) MTDSs were below the maximum high-performance error rate threshold for all RIVR metrics
  - Matching performance can be robust with respect to race, sex, and skin tone
    - Over half of the tested MDTSs met the FNMR high-performance goal for each of the 13 demographic groups examined

- However, the technical maturity of MTDSs can vary
  - Three (3 of 16) MTDSs had a greater than 50% FNMR, which is not appropriate for operational systems
  - Two (2 of 16) MTDSs had high document FTXR for Maryland IDs

- Some but not all MTDSs account for demographically similar imposters
  - Seven (7 of 16) MTDSs maintained acceptable FMRs for demographically similar imposters

- RIV systems should be validated to ensure they perform adequately for the intended users (i.e., on their devices, for their demographics, and for their documents)

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Questions & Answers

- Contact information
  - peoplescreening@hq.dhs.gov
  - rivr@mdtf.org

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  - For information about this and other DHS S&T technology evaluations, visit https://mdtf.org.

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