

# **DHS S&T Benchmarking Biometric & Remote Identity Vetting Solutions – Key Metrics on Biometric Testing & Results**

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U.S. Department of Homeland Security

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# SCIENCE AND TECHNOLOGY DIRECTORATE



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Technology

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DHS Science & Technology Directorate

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

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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.

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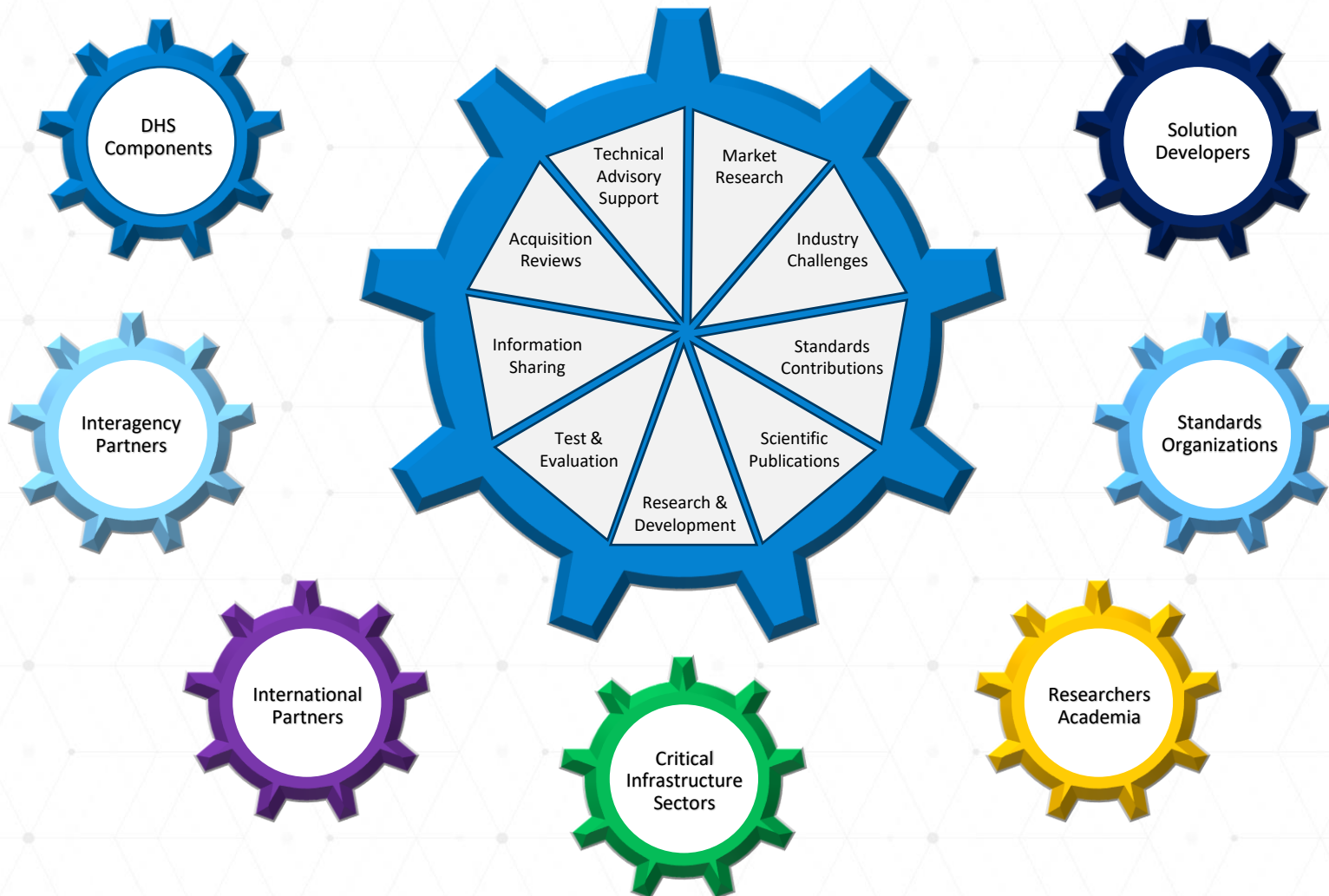
# Biometric & Identity Technology Center

S&T conducts foundational research to ensure advancements in science and technology are harnessed for cutting-edge solutions to new and emerging operational challenges.

- ✓ Drive biometric and identity innovation at DHS through 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 with Industry and Academia



# Biometric & Identity Technology Center Engagement



- Sponsor research (e.g. university and government applied research)
- Conduct technology evaluations and industry challenges
- Participate in industry voluntary consensus standards development
- Advise components in shaping acquisitions and regulations
- Assist stakeholders in evaluating and improving systems

# Past Biometric Technology Rallies



2018  
Biometric  
Technology  
Rally at  
MdTF

2018 Rally assessed acquisition systems



2019  
Biometric  
Technology  
Rally at  
MdTF

2019 Rally assessed acquisition systems *and* matching systems



2020  
Biometric  
Technology  
Rally at  
MdTF

2020 Rally assessed acquisition *and* matching systems *with* face masks



2021  
Biometric  
Technology  
Rally at  
MdTF

2021 Rally assessed acquisition *and* matching systems *with* face masks *and* system equitability

- Since 2018, the Rallies have demonstrated progress in the performance and maturity of biometric acquisition and matching systems
  - Rally results provide insights into how people interact with biometric systems to improve usability
  - Rally results have been used to inform participating vendors, leading to improved performance of both acquisition and matching systems
  - **There are continuing challenges with respect to reliable image acquisition in this use case**

<https://youtu.be/imv82Cuo2Pw?si=HbfM7SqmThsjNXbR>

DIVERSE PERSPECTIVES + SHARED GOALS = POWERFUL SOLUTIONS

# Overview of the 2021 Biometric Technology Rally

## 1 INFORMED CONSENT.

601 diverse people from the local area were briefed about the Rally and consented to participate.

## 2 GROUND TRUTH:

Volunteers self-report their gender and race. Staff measures their skin tone.

Our research shows that skin tone is related to face recognition performance. Skin tone values are measured using specialized colorimeters.

## ACQUISITION WITHOUT MASKS:

Each acquisition system takes a photo of each person **without** masks.

3

5 Camera Systems

## ACQUISITION WITH MASKS:

Each acquisition system takes a photo of each person **with** masks.

4

## 5 MATCHING:

Matching systems find the face in each photo and compare it to known people to identify the person in the photo.

10 Algorithms

## REPORTING:

6

Performance was measured for each of the 50 possible combinations of acquisition and matching systems.

50 System Combinations Tested



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# Key Takeaways from the 2021 Biometric Technology Rally

## DO MASKS AFFECT PERFORMANCE?

MASKS REDUCE FACE RECOGNITION PERFORMANCE.\*

Without Masks



**95%**  
Of All People  
Successfully  
Identified

With Masks



**86%**  
Of All People  
Successfully  
Identified



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## WHAT CAUSES ERRORS?

MOST ERRORS ARE DUE TO PHOTO CAPTURE, NOT MATCHING.\*\*

**75%**  
of Systems

More  
Camera  
Errors



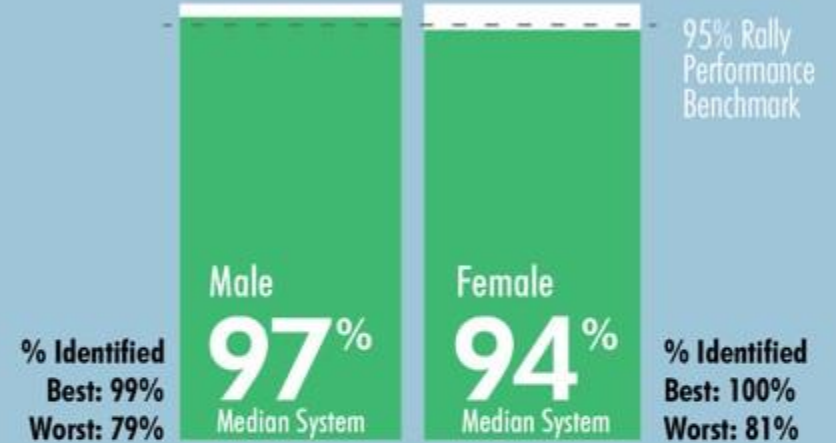
**25%**  
of Systems

More  
Algorithm  
Errors



## HOW DOES PERFORMANCE VARY?

PERFORMANCE VARIES BY GENDER AND SKIN TONE.\* \*\*



\*Numbers are representative of the median system combination (25th best system out of 50 total systems) in each test condition.

\*\*Results from system combinations tested without masks.



# Biometric System Performance By Gender

## 1 INFORMED CONSENT:

601 diverse people from the local area were briefed about the Rally and consented to participate.

## 2 GROUND TRUTH:

Volunteers self-report their gender to staff.

## 3 ACQUISITION:

Each acquisition system takes a photo of each person without masks.

% Not Acquired:	Male	Female
⬆ Best	0.7%	0%
⊖ Median	1.8%	4.6%
⬇ Worst	14.9%	14.3%

## 4 MATCHING:

Matching systems find the face in each photo and compare it to known people to identify the person in the photo.

% Not Matched:	Male	Female
⬆ Best	0%	0%
⊖ Median	0.7%	1.3%
⬇ Worst	7.6%	5.8%

## 5 REPORTING:

Performance was measured for each of the 50 possible combinations of acquisition and matching systems.

% Identified:	Male	Female
⬆ Best	99.2%	100%
⊖ Median	97.4%	94.1%
⬇ Worst	78.6%	80.7%



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# Biometric System Performance By Skin Tone

## 1 INFORMED CONSENT:

601 diverse people from the local area were briefed about the Rally and consented to participate.

## 2 GROUND TRUTH:

Volunteers skin tone measured by staff.

**Why Skin Tone?**  
Research shows that skin tone is related to face recognition performance. Skin tone values are universal.

## 3 ACQUISITION:

Each acquisition system takes a photo of each person without masks.

% Not Acquired:	Lighter Skin	Darker Skin
⬆ Best	0%	0%
⊖ Median	2.0%	5.6%
⬆ Worst	10.1%	17.4%

## 4 MATCHING:

Matching systems find the face in each photo and compare it to known people to identify the person in the photo.

## 5 REPORTING:

Performance was measured for each of the 50 possible combinations of acquisition and matching systems.

% Not Matched:	Lighter Skin	Darker Skin
⬆ Best	0%	0%
⊖ Median	1.0%	1.6%
⬆ Worst	6.1%	9.9%

% Identified:	Lighter Skin	Darker Skin
⬆ Best	100%	100%
⊖ Median	97.0%	92.8%
⬆ Worst	84.4%	74.3%



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With Masks



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## WHAT CAUSES ERRORS?

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Camera Errors

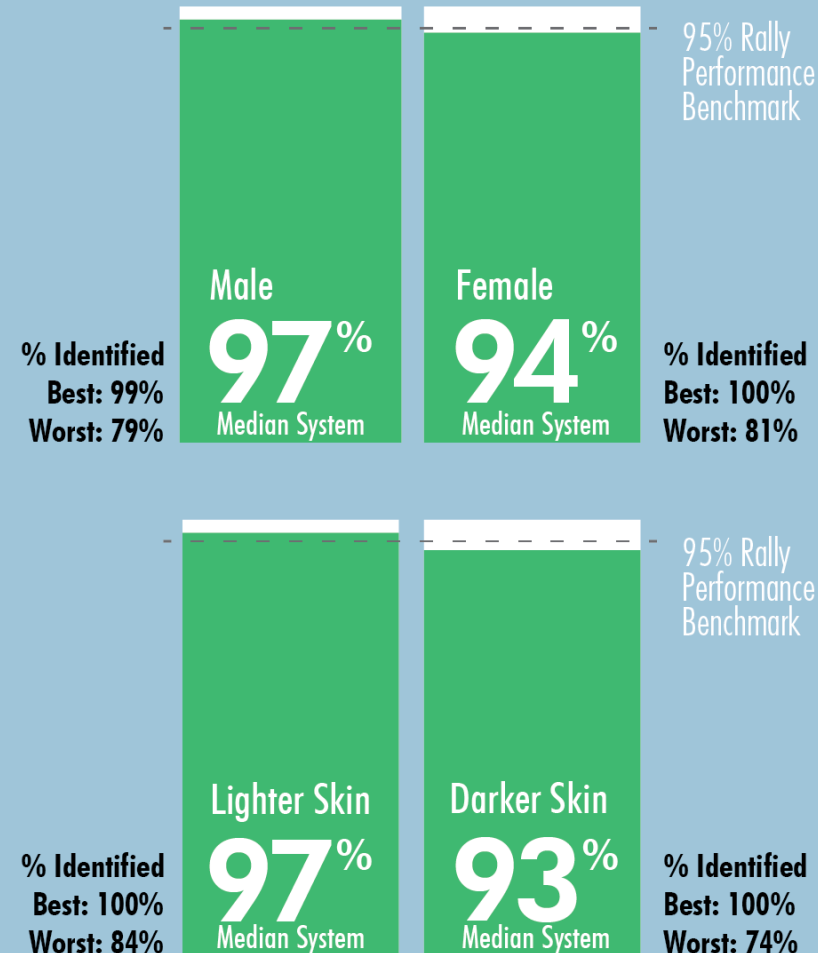


Algorithm Errors



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# Demographic Differentials: Standard for Measuring

## ISO/IEC WD 19795-10

Information technology — Biometric performance testing and reporting — Part 10: Quantifying biometric system performance variation across demographic groups

General information 

Status :  Under development

Edition : 1

Technical Committee : ISO/IEC JTC 1/SC 37 Biometrics

- S&T is serving as editor of new International Standard on Performance Testing for demographic factors
- Measuring categorical and continuous demographic factors
- Computing demographic differentials
  - Differential performance
  - Similarity score differential measures
- Planning and executing an evaluation
  - Statistical sampling, including appropriate sample size
- Reporting evaluation results
  - Technology, scenario, operational

# Remote Identity Validation

## ID Document Authentication moves online

- Photo IDs are commonly used to verify people for many applications including opening financial services accounts, crossing borders, or applying for government services or benefits.
- COVID-19 related stay-at-home orders and social distancing measures prevented many organizations from performing in person ID verification, which accelerated the use of smartphone based mobile apps to enroll or assert ID information remotely.



# Remote Identity Validation Tech Demo (RIVTD)

- Industry has developed new tools to authenticate documents and verify the identity of users remotely:
  - Remote Identity Validation (RIV)
- Difficult for industry to test the effectiveness and fairness of these systems:
  - Hard to obtain fraudulent documents
  - Testing for demographic differentials is costly
- DHS S&T is interested in understanding the current performance of RIV and helping industry to develop more secure, accurate, and equitable technologies

# 2023 Remote Identity Validation Technology Demonstration (RIVTD)

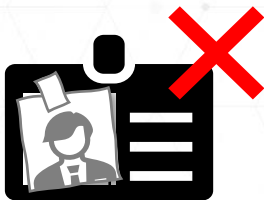
- DHS S&T is looking for full RIV systems and/or component technologies that are capable of:
  1. Assessing the validity of an identity document (US driver's license)
  2. Matching a “selfie” photo to the photo on the identity document
  3. Assessing the “liveness” of the “selfie” photograph
- DHS S&T encourages providers of technologies that can perform any portion of the RIV process to apply to participate in this demonstration
- The demonstration will follow a phased approach such that each step in the RIV process will be demonstrated separately



# RIVTD Tracks

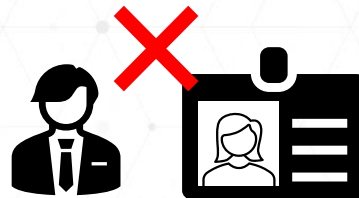
## Track 1: ID Validation

- Information Check
- Tamper Check
- Security Check



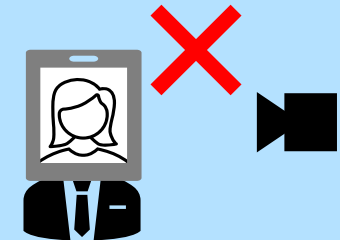
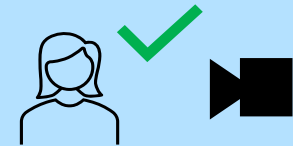
## Track 2: Match to ID

- 1:1 Verification



## Track 3: Liveness and Presentation Attack Detection (PAD)

- Reject screens and printouts
- Reject masks and other PAs



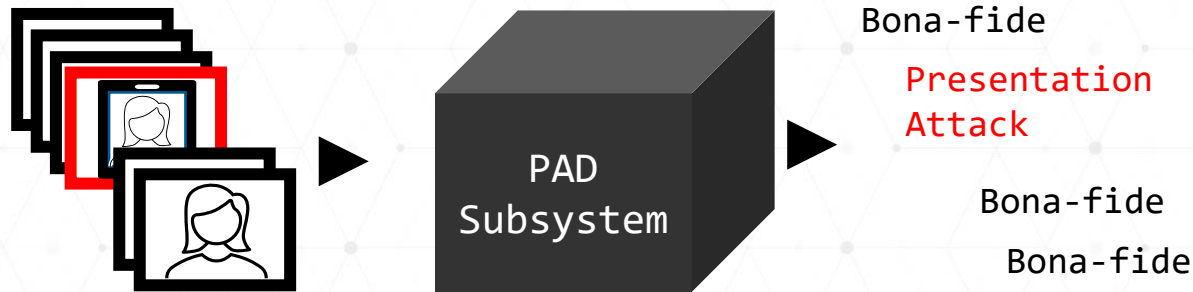
Current focus is Track 3: Liveness and Presentation Attack Detection



# Technology Tests vs. Scenario Tests

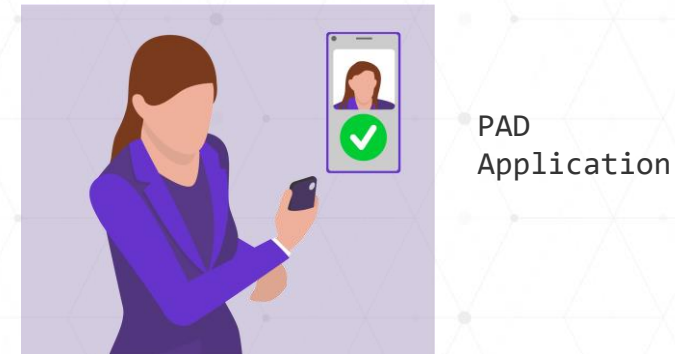
- Technology Testing:

- Focus on performance of a multiple presentation attack detection subsystems (e.g., bona fide biometric samples, masks, replay videos)
- Passive PAD Subsystems
- Easily repeatable



- Scenario Testing:

- Assess performance of PAD application in the context of use
- Real people interact with the system
- Active PAD subsystems
- Costly to repeat



Track 3 will include both technology and scenario testing of PAD subsystems.

# Track 3: Presentation Attack Detection

- PAD subsystems will demonstrate their ability to differentiate between presentation attacks and bona-fide users
- Presentation attacks will be performed through use of various attack instruments
- Two PAD subsystem types are in scope:
  - Passive PAD
  - Active PAD

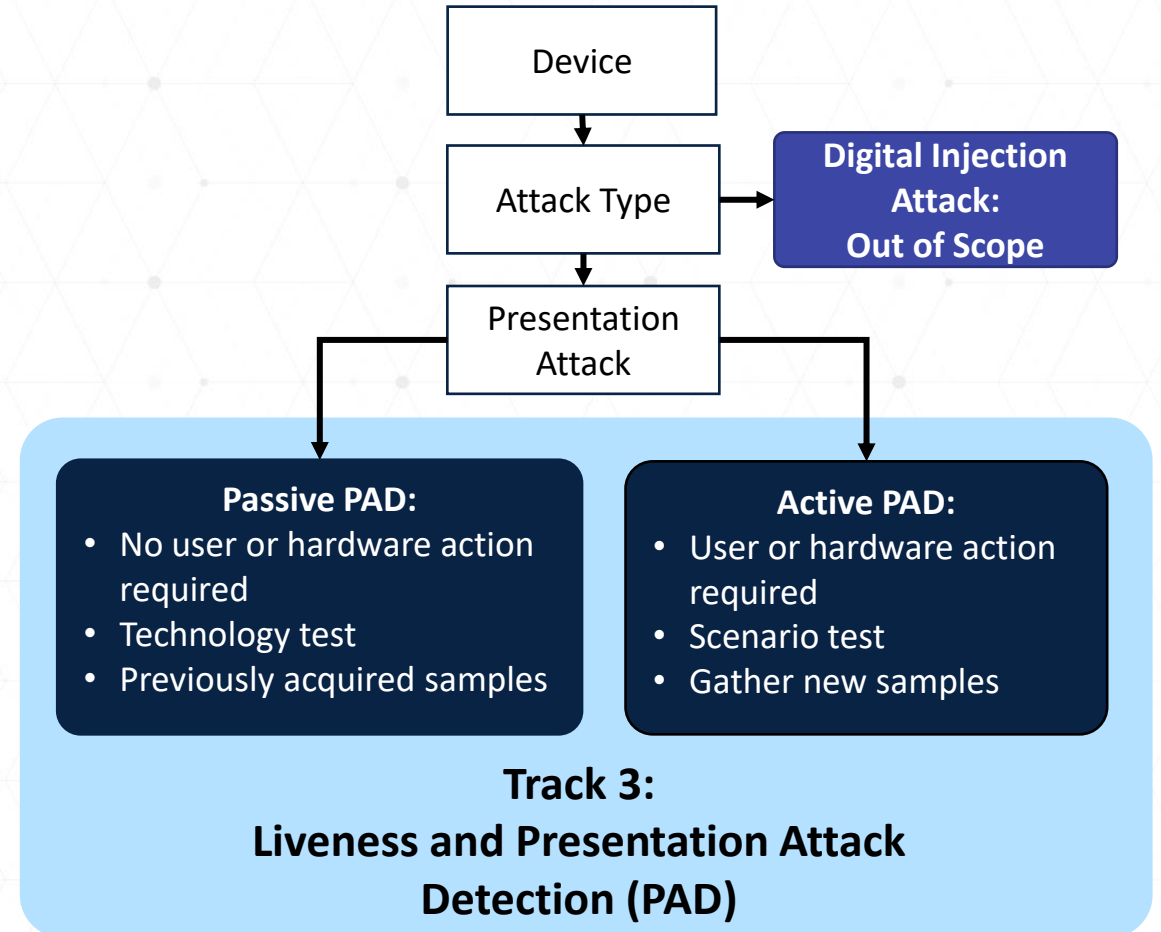


Active PAD user action:

- Turn / Rotate head, blink, etc.

Active PAD hardware action:

- On-board cameras, sensors, etc.



# Track 3: Presentation Attack Instruments

Level A	Level B	Level C
<ul style="list-style-type: none"><li>• Printout on Paper</li><li>• Display on Screen</li></ul>	<ul style="list-style-type: none"><li>• Paper Masks</li><li>• Video Replay on Screen</li></ul>	<ul style="list-style-type: none"><li>• Attacks requiring special hardware and significant effort/cost to perform</li></ul>

- The number and specific species of PAIs will not be disclosed
- PAD performance will be assessed per PAI species

# Application Package Requirements

- Provide an application package (limit five pages), in the form of a white paper addressing each of the following:
  1. Description of the company
  2. Presentation attack detection system technical capabilities
    1. Passive PAD system, or
    2. Active PAD system
  3. Mobile Device **and** OS support
  4. System inputs and data processing steps
  5. System outputs
  6. Description of the complexity and maturity of the remote identity validation system, including any active deployments
  7. Any measurements of the performance characteristics of the system and how they were tested
- Optional demonstration video of system functionality
- **Optional description or demonstration video of video injection attack testing**
- Submit application package to [RIVTD@mdtf.org](mailto:RIVTD@mdtf.org) by **11:59pm (EST) February 29, 2024**



These webinar slides and detailed application package instructions will be made available at <https://mdtf.org/rivtd>



# Questions & Answers

- Contact information
  - [peoplescreening@hq.dhs.gov](mailto:peoplescreening@hq.dhs.gov)
- Visit our websites for additional information
  - To see additional work DHS S&T supports, visit [www.dhs.gov/science-and-technology](http://www.dhs.gov/science-and-technology)
  - For information about this and other DHS S&T technology evaluations, visit <https://mdtf.org>



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