### **DHS SCIENCE AND TECHNOLOGY**

### The 2019 Biometric Technology Rally

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Science and Technology



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### 2019 Rally Testing Overview

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- Rally Test Location
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  - Data Collection Process
  - Acquisition System API
  - Acquisition System Metrics
  - Provider Responsibilities
  - Selection Process

#### Matching Algorithms

- Acquisition System API
- Matching Algorithm Metrics
- Provider Responsibilities
- Selection Process

## Timeline



## 2019 Rally Location

- The 2019 Biometric Technology Rally will be held at the Maryland Test Facility (MdTF)
  - Located just outside the DC Metropolitan Beltway
    (near Fedex Field)
  - Designed for testing large groups of volunteers in configurable scenarios
  - Provides software API for integrating biometric systems
- The Stakeholders VIP Day will be held at the MdTF
- All Acquisition Systems to be delivered to MdTF for the Rally
- All Matching Algorithms to be executed on MdTF systems





# Acquisition Systems

## **Rally Station Layout**



- Acquisition Systems will be installed within Rally Stations:
  - All equipment will be limited to 6'x8' area.
  - One 6 outlet power strip will be provided.
    - Power consumption will be monitored.
    - **5 amp maximum** power draw enforced.
  - One network drop will be provided for Rally API communication.
    - Acquisition System Providers must use own switch to network any hardware
- Internet access is not allowed for Acquisition Systems.

### Rally Test Bay Layout



### **Data Collection Process**

- Acquisition Systems will collect biometric images from demographically diverse volunteers.
  - Many volunteers will have some prior experience with biometrics.
  - Volunteers will not be briefed on how to use the Acquisition Systems.
  - The purpose of the Rally is to identify fast, accurate, and intuitive systems.
- Acquisition System Provider staff will not be allowed on the floor during testing.
- Volunteers will be divided into multiple groups, each led by a test guide.
- Test guides will move each group between Rally Stations in a unique order.
  - Order will be counterbalanced across all Acquisition Systems.
  - Test guides will direct volunteers to use the Acquisition Systems one at a time.
- Timing will be automated.
  - Each group will be allotted a fixed amount of time at each Rally Station.
  - Systems maintaining a 10 second transaction time will be able to process the full group.
  - The group will promptly move to the next station when the time has expired even if the system failed to process everyone.

### Data Collection at the Rally Station



### Acquisition System Rally API – Overview

- Acquisition Systems must:
  - provide at least one biometric image per volunteer. (Required)
- Acquisition Systems may:
  - provide up to 3 face images per volunteer. (Optional)
  - provide up to 3 sets of individual iris images per volunteer. (Optional)
  - provide up to 3 sets of individual fingerprint images per volunteer. (Optional)
- Images must be submitted prior to the next volunteer entering the Rally Station.
- Images will be submitted using a RESTful, HTTP based Rally API.
  - https://github.com/TheMdTF/mdtf-public
- Acquisition System Providers will be given:
  - Detailed API documentation.
  - An API instance available publically for testing / debugging prior to the Rally.
  - Limited troubleshooting support via Slack.
- During the Rally, the API will be available only on the MdTF local area network.
  - Acquisition Systems will be able to perform integration effort over a cloud-based API but will have to configure the API server address and their Station ID when arriving at the MdTF.

### Acquisition System Rally API – Face Capture

- face-captures POST request endpoint:
  - The "FaceImageData" field must be a base 64 textual representation of a PNG image.
  - The "StationID" field will be provided on Rally Acquisition System installation (i.e. should be configurable).
  - Only three (3) calls to this end-point will count toward Rally Metrics.



- System requirements satisfied:
  - provide at least one biometric image per volunteer. (Required)
  - provide up to 3 single face images per volunteer. (Optional)

### Acquisition System Rally API – Iris Capture

- iris-captures POST request endpoint:
  - The "{Left/Right}IrisImageData" field must be a base 64 textual representation of a PNG image.
  - The "StationID" field will be provided on Rally Acquisition System installation (i.e. should be configurable).
  - Left and right iris images captured in the same transaction should be posted together.
  - Only three (3) calls to this end-point will count toward Rally Metrics.

#### POST /v1/iris-captures

"LeftIrisImageData": "iVBORw0KGgoAAAANSUhEUgAAAAEAAAABCAIAAACQd1PeAAAAEELEQVR4nGJiYGAABAAA//8ADAADcZGLFwAAAABJRU5ErkJggg==", "RightIrisImageData": "iVBORw0KGgoAAAANSUhEUgAAAAEAAAABCAIAAACQd1PeAAAAEELEQVR4nGJiYGAABAAA//8ADAADcZGLFwAAAABJRU5ErkJggg==", "StationID": "MdTF\_Station"

- System requirements satisfied:
  - provide at least one biometric image per volunteer. (Required)
  - provide up to 3 sets of iris images per volunteer. (Optional)

### Acquisition System Rally API – Fingerprint Capture

#### • finger-captures POST request endpoint:

- The "FingerImageData" field must be a base 64 textual representation of a PNG image.
- The "StationID" field will be provided on Rally Acquisition System installation (i.e. should be configurable).
- Images of individual fingers must be marked with appropriate Finger Type:

{RightThumb, RightIndex, RightMiddle, RightRing, RightLittle, LeftThumb, LeftIndex, LeftMiddle, LeftRight, LeftLittle}

- Finger images captured in the same transaction should be posted together. Note, this json object is an array.
- Only three (3) calls to this end-point will count toward Rally Metrics.

#### POST /v1/finger-captures



- System requirements satisfied:
  - provide at least one biometric image per volunteer. (Required)
  - provide up to 3 sets of fingerprint images per volunteer. (Optional)

### Acquisition System Metrics – Overview

- 2019 Rally Metrics:
  - Designed to allow direct comparison with 2018 Rally results.
    <u>https://mdtf.org/Rally/Results</u>
  - High-throughput use-case and speed-accuracy tradeoff.
  - Allow a fair analysis of system performance.
  - Effectiveness
    - Performance of the biometric, encompassing any failures to acquire and match.
    - Images from Suitable Acquisition Systems should identify at least 95% of all volunteers.

#### Efficiency

- The amount of time required to complete a biometric transaction.
- Suitable Acquisition Systems should maintain an average transaction time of 10 seconds.
- Suitable Acquisition Systems will not exceed the maximum transaction time of 20 seconds.

#### Satisfaction

- Positive system ratings by volunteers.
- Suitable Acquisition Systems will be rated positively by at least 95% of all volunteers.

### Acquisition System Metrics – Efficiency

- Average Transaction Time
  - The time volunteers spent using the system (entrance to exit). Calculated by the difference between the exit beam break time  $(t_{BB2})$  and entry beam break time  $(t_{BB1})$ .
  - Directly comparable with 2018 Rally.



### Acquisition System Metrics – Effectiveness

#### Failure to Acquire Rate (FtAR)

- Percentage of transactions that result in a **failure to acquire or process** image captures within a given time interval.
- If no images are received, a FtA will be recorded.
- Directly comparable with 2018 Rally.



### Acquisition System Metrics – Effectiveness

#### MdTF True Identification Rate (mTIR)

- Percentage of transactions providing correct identity within a given time interval calculated by the <u>MdTF matching algorithm</u>.
- Directly comparable with 2018 Rally.



### Acquisition System Metrics – Effectiveness

#### Robustness Across Algorithms

- We will calculate TIR for each Acquisition System using all Matching Algorithms (*TIR<sub>Alg</sub>*).
- We will measure Robustness  $(R_s)$  of the Acquisition System to Matching Algorithm using a min-max metric. This quantifies the range of performance across algorithms.



### Acquisition System Metrics – Satisfaction

- **Percent Satisfaction** ullet
  - Proportion of positive satisfaction scores as rated by volunteers immediately following Acquisition System use.



### Acquisition System Responsibilities – Pre Test

- Acquisition System Providers are responsible for:
  - Acquiring all hardware to maintain and operate their system.
  - Integrating their device/system within the API developed by the MdTF. Minimal assistance from the MdTF staff to Rally Participants will be provided.
  - Any/all hardware/software testing, including proper communication with the MdTF API.
  - The full installation and breakdown of their own equipment within the MdTF.

### Acquisition System Responsibilities – During Test

- During testing, transactional data will be available from each Rally Station.
- Acquisition System Providers will be able to view data acquired by the Rally API following each volunteer transaction at their Station.
- Acquisition System Providers will be responsible for informing MdTF staff of any issues with their system's performance during testing.
  - The MdTF will log these issues and determine whether intervention is allowable.
  - Rally Participants will be given a chance to make up to two usability / human factors adjustments to their systems during the first two days of the rally.
  - Rally Participants may make repairs to their systems in case of breakage.
  - Any system modification must be made when volunteers have left the test environment.

### Human Factors Considerations

- Acquisitions Systems should include some form of signage or instructions to guide the volunteers:
  - Systems must operate in an unmanned mode, i.e. without an operator/instructor
- Assistance from test guides/staff will not be provided to volunteers if they ask for help
- Consider the following when creating instructional signage:
  - Size of display
  - Complexity of instructions
  - Amount of text
  - Complexity of text
  - Location of signage in relation to the system



### Acquisition System Selection Process

- DHS will have sole discretion in selecting Acquisition Systems for inclusion.
  - DHS S&T will down-select the number of Acquisition Systems.
  - DHS will be advised in this process by a panel of biometric experts.
- Whitepapers and videos will be judged based on how well they demonstrate the ability of the Acquisition System to:
  - Acquire high quality biometric images.
  - Operate within the required time / space constraint.
  - Have a process that does not require staffing.
  - Readily integrate into the test environment at MdTF.
  - Be relevant to known DHS use-cases.
- If a single organization submits multiple whitepapers, the preferred system for inclusion should be indicated, but no commitment is made to abide by this preference.

# Matching Algorithms

### Matching Algorithms API – Overview

- All Matching Algorithm System Providers will submit a `.tar` (created via `docker save`) of a docker container which will:
  - Provide an HTTP server on port 8080 for handling requests.
  - Conform to MdTF resource constraints (CPU/memory):
    - 8 i7 CPUs, 8 GB RAM, NO GPU.
  - Operate without internet access.
- Matching Algorithms containers will conform to a RESTful API:
  - Documentation is on https://github.com/TheMdTF/mdtf-public
  - Documentation will detail three endpoints:
    - 1. accepts, individual, base 64 encoded, PNG image data and returns a template. (Required)
    - accepts templates, performs matches, and *returns* similarity score. (Required)
    - 3. provides information on the algorithm (Required)

### Matching Algorithms API – Template

### • /v1/create-template POST request endpoint:

- Accepts individual (single), base 64 encoded, PNG images.
- Returns biometric feature templates in the form of a byte array.
- Note: no option to provide an image type, algorithms should be agnostic to specific image types (i.e. right and left iris treated the same).
- Failure to generate template should set 400 Status Code.
- Requirements satisfied:
  - accepts individual, base 64 encoded, PNG image data.
    (Required)
  - *extract* biometric features from image data and *return* template. (Required)

### Matching Algorithms API – Match

- /v1/compare-list POST request endpoint:
  - Accepts:
    - 1. A single template byte array as returned from **create\_template**.
    - 2. A list of template byte arrays as returned from several **create\_template** calls.
  - Returns matching scores of item 1) to array of items in 2).
- Requirements satisfied:
  - accepts templates, performs matches, and returns similarity score. (Required)

### Matching Algorithms API – Match

- /v1/info GET request endpoint:
  - Returns an object with:
    - AlgorithmName
    - AlgorithmVersion
    - AlgorithmType
    - CompanyName
    - TechnicalContactEmail
    - RecommendedCPUs
    - RecommendedMem
- Requirements satisfied:
  - provides information on the algorithm (Required)

### Matching Algorithms Metrics – Overview

- Matching Algorithms will template and match biometric images.
  - Collected on a variety of Acquisition Systems.
  - 300-400 images per Acquisition System participating in the Rally.
  - 2,000 enrollment images acquired using MdTF systems over 5 years.

- Metrics will measure:
  - Overall algorithm performance.
  - Robustness to collection conditions.



### Matching Algorithms Metrics – Effectiveness

#### Algorithm Provider True Identification Rate (TIR)

- Percentage of transactions with successful image captures that result in a correct identity for a set threshold <u>using the Matching Algorithm</u>.
- TIR will be evaluated for three match thresholds:
  - FMR in {1:10,000, 1:100,000, 1:1,000,000}.
- TIR will be evaluated for each Acquisition System (S).



### Matching Algorithms Metrics – Effectiveness

- Matching Algorithm Robustness to Acquisition System
  - Quantifies the variability in Matching Algorithm performance across participating Acquisition Systems. It is the range of observed TIR values across systems.
  - Threshold set at FMR = 1:10,000.



### Matching Algorithm Provider Responsibilities

- Matching Algorithm Providers are responsible for:
  - Delivering the container with Matching Algorithm to MdTF.
  - Conforming to the Rally Matching Algorithm API.
  - Ensuring the MdTF can perform a sufficient quantity of template and match operations to compute Matching Algorithm Metrics.

### Matching Algorithm Selection Process

- DHS will have sole discretion in selecting Matching Algorithms for inclusion.
  - DHS S&T will down-select the number of Acquisition Systems.
  - DHS will be advised in this process by a panel of biometric experts.
- Whitepapers will be judged on how well they demonstrate the ability of the Matching Algorithm to:
  - Achieve a high true identification rate.
  - Achieve a low failure to process rate.
  - Be appropriately containerized and integrated into the test environment.
  - Operate within set computational constraints.

# 001 Thank You!

- Questions?
  - peoplescreening@hq.dhs.gov
- For more information:
  - peoplescreening@hq.dhs.gov
  - http://mdtf.org
    - 2019 Biometric Technology Rally Information.
    - All 2018 Biometric Technology Rally Results.
    - Material from all webinars, briefings, outreach.
  - www.dhs.gov/science-and-technology

