DHS SCIENCE AND TECHNOLOGY

The 2020 Biometric Technology Rally

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Arun Vemury
Biometrics & Identity Technology Center
Department of Homeland Security
Science and Technology Directorate

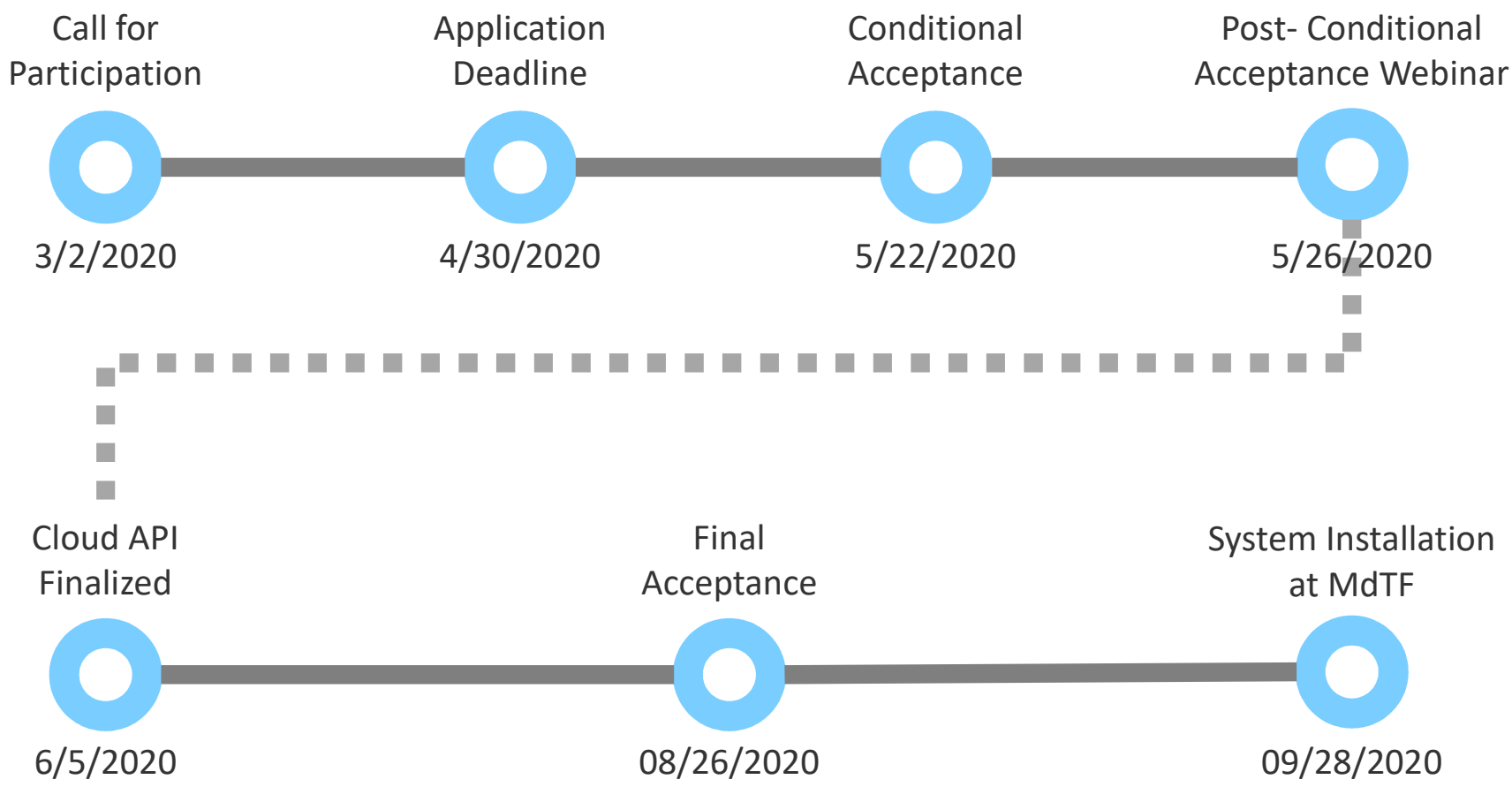
Jake Hasselgren, John Howard, Yevgeniy Sirotin

The Maryland Test Facility

Outline

- Rally Timeline
- Rally Test Location
- Acquisition Systems
  - Rally Physical Layout
  - Data Collection Process
  - Acquisition System API
  - Acquisition System Metrics
  - Selection Process
  - Responsibilities
- Matching Systems
  - Matching System API
  - Matching System Metrics
  - Selection Process
  - Responsibilities

Rally Timeline



Rally Test Location

- The 2020 Biometric Technology Rally will be held at the Maryland Test Facility (MdTF)
  - Located just outside the DC Metropolitan Beltway
  - 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 Systems to be executed on MdTF systems

Acquisition Systems

Rally Timeline
Rally Test Location
➔ **Acquisition Systems**
- Phase 1: Individual Processing
- Phase 2: Group Processing
- API
- Metrics
- Selection Process
- Responsibilities

Matching Systems
- API
- Metrics
- Selection Process
- Responsibilities

Acquisition System Overview

- Phase 1: Individual Processing
  - Same use-case as past Rallies
  - Face image required, iris/fingerprint optional
- Phase 2: Group Processing
  - New use-case: Acquire one face image per individual in a group
  - Opt-in and opt-out individuals
- Down-selection & VIP Day
  - VIP Day follows Phase 1 testing
  - Top-performing systems participate in VIP day
  - Top-performing systems move into Phase 2 testing

- The **same** hardware/software system expected to work in both Phases.

Acquisition Systems

Phase 1: Individual Processing

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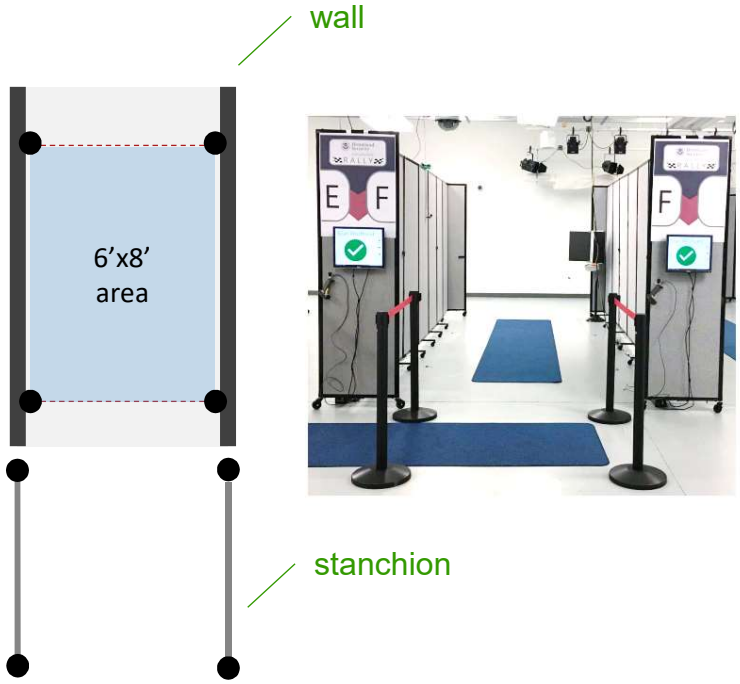
Phase 1 Station

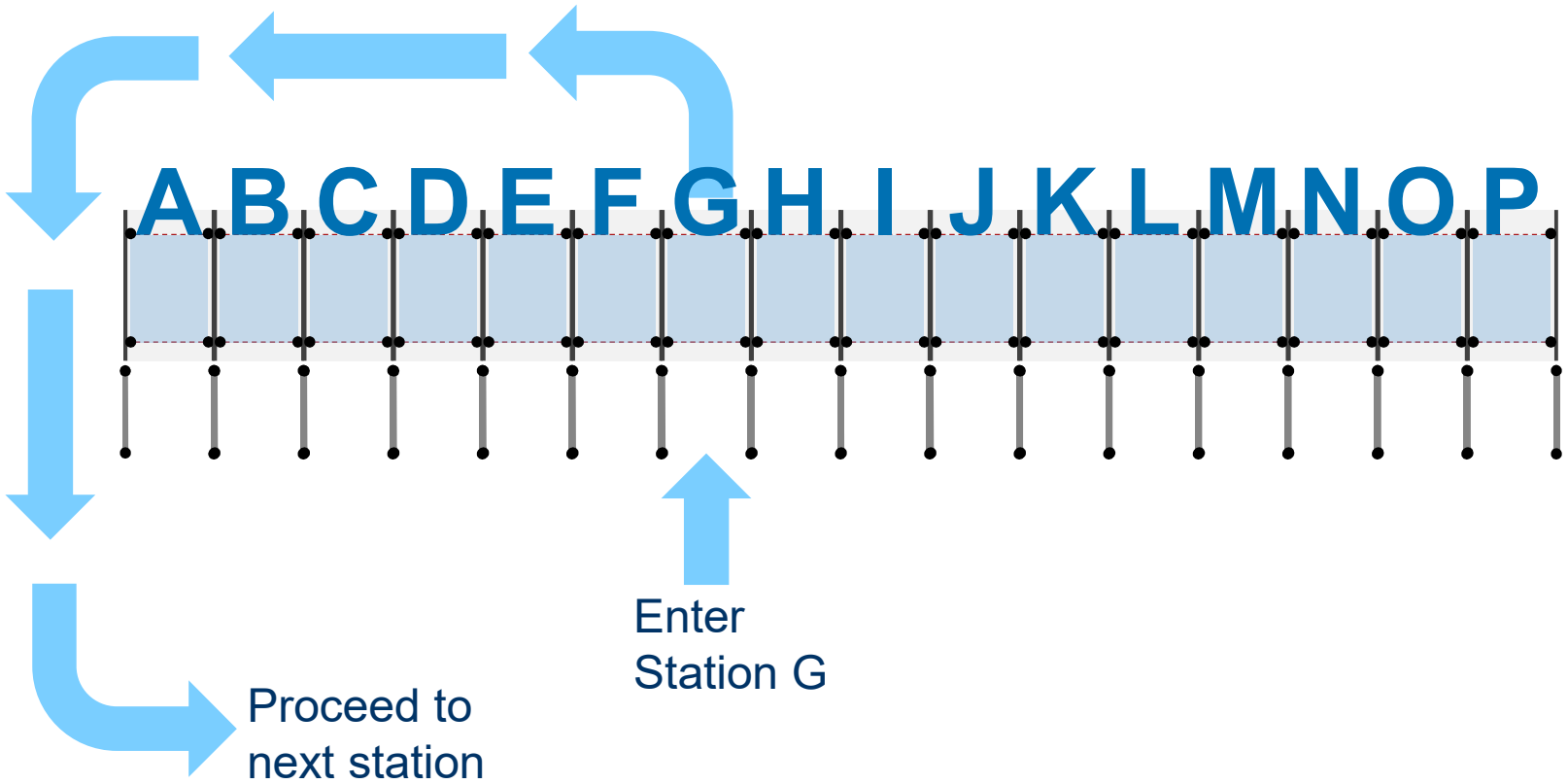


Phase 1 Station

- Installed equipment will be limited to a 6' wide x 8' long area (1.8 x 2.4 m)
- One six 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

- **No access to the internet will be allowed during scenario testing**

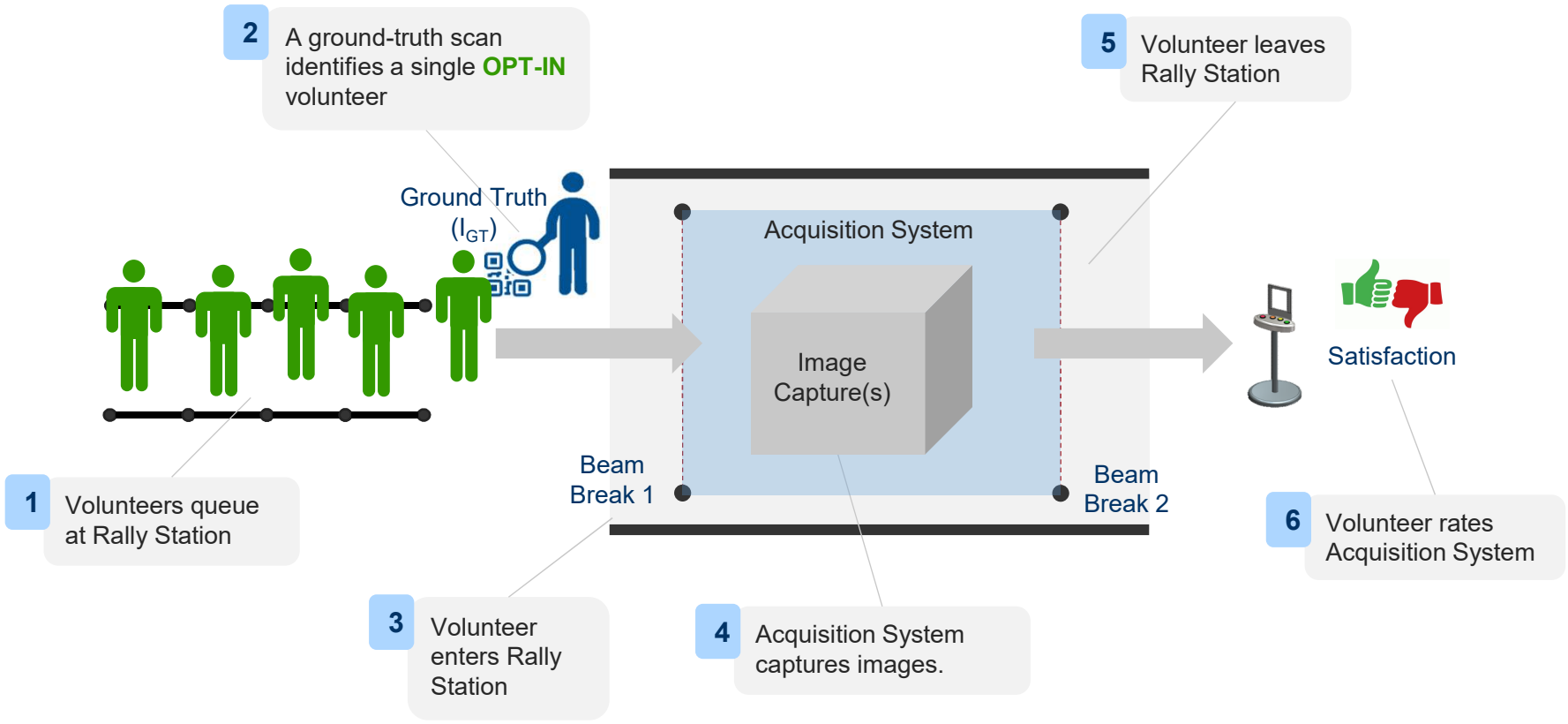
Phase 1 Layout



Phase 1 Process

- Acquisition Systems will collect biometric images from demographically diverse volunteers:
  - Volunteers will have prior experience with biometric devices and process
  - Volunteers **will be** told to comply with any Acquisition System instructions
  - Volunteers **will not be** briefed on how to use **specific** Acquisition Systems
- 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 counterbalanced order
  - For Phase 1, all volunteers in a group will **OPT-IN** to use the Acquisition Systems, passing through the station **one at a time**
- Test Timing will be automated:
  - Each group will be allotted a fixed amount of time at each Rally Station
  - Systems maintaining a 8 second average transaction time will be able to process the full group
  - Groups will promptly move to the next station when the time has expired even if the system failed to process everyone
- **No Acquisition System Provider staff will be allowed on the floor during scenario testing**

Phase 1 Station Process



Phase 1 Requirements

- The Acquisition Systems must:
  - *provide* **exactly one** face biometric image **per OPT-IN volunteer** on each pass **(Required)**
  - maintain an average transaction time of, at most, 8 seconds per volunteer

- The Acquisition Systems may:
  - *provide* **exactly one** set of individual iris images **per OPT-IN volunteer** on each pass **(Optional)**
  - *provide* **exactly one** set of individual fingerprint images **per OPT-IN volunteer** on each pass **(Optional)**

Acquisition Systems

Phase 2: Group Processing

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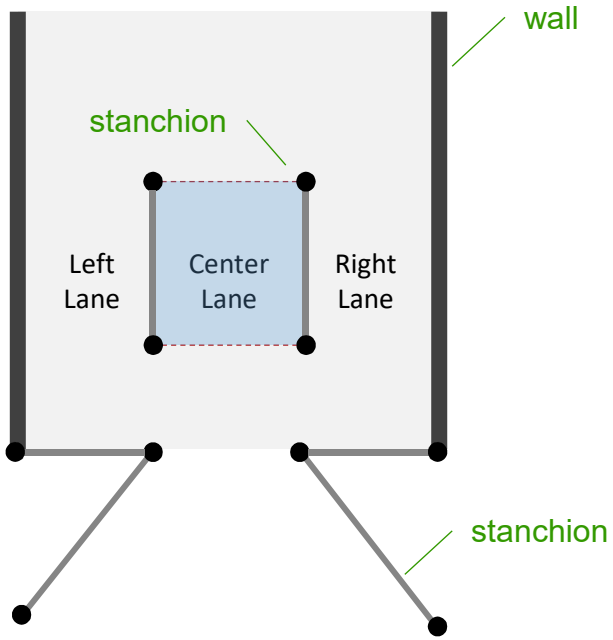
Phase 2 Station

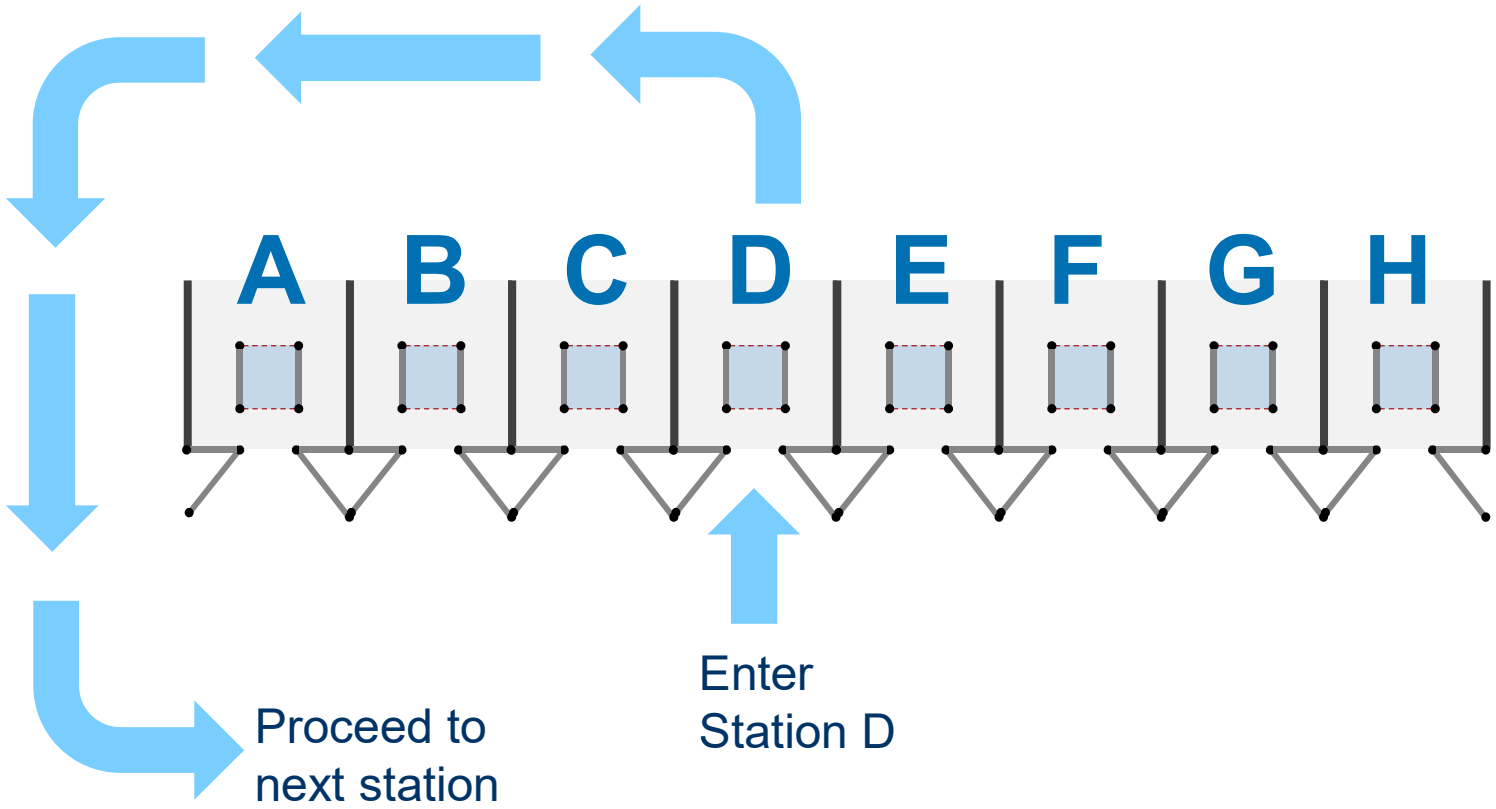


Phase 2 Station

- Acquisition Systems will fit within a 6'x8' area (center lane)
- One six- 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

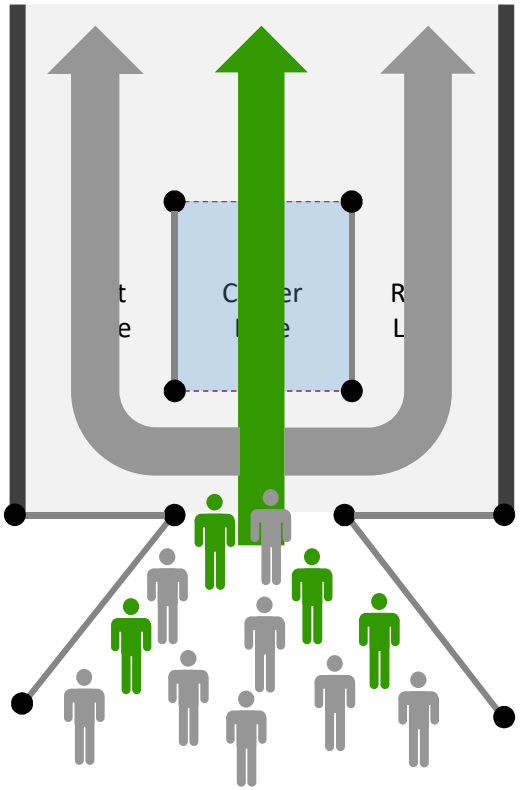
- **Two lanes added to the left and right of the 6'x8' area.**

Phase 2 Layout



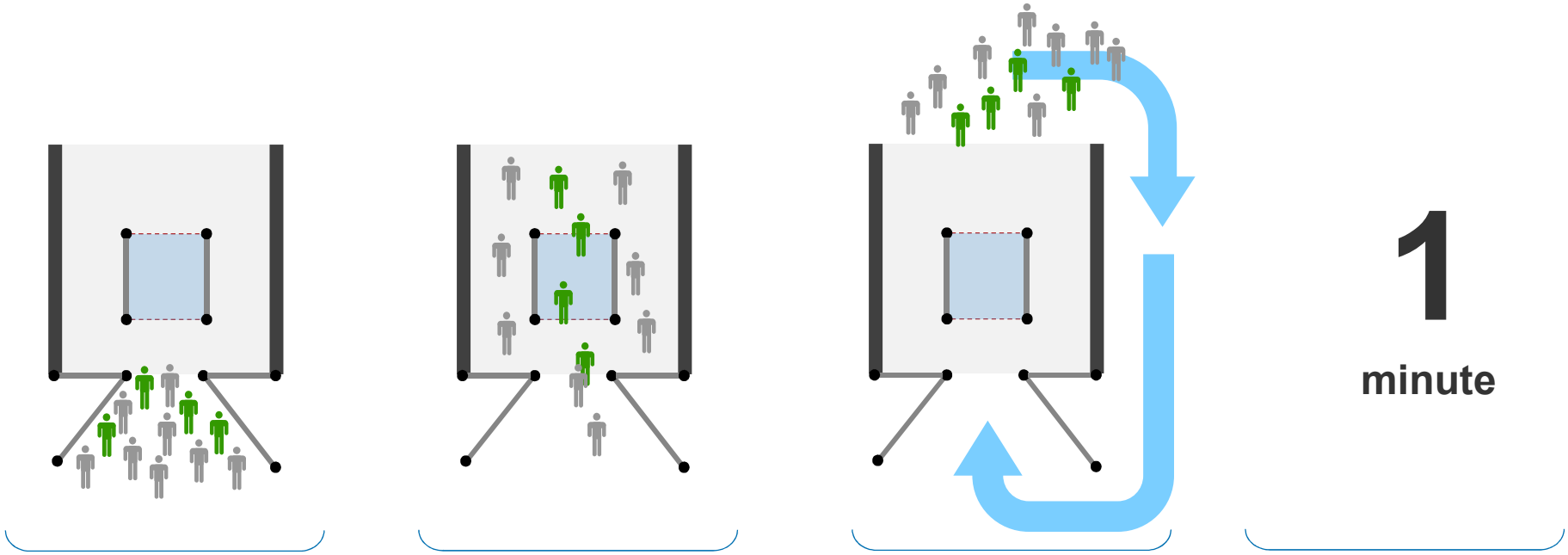
Phase 2 Station Process

- Each group of volunteers will pass through the station multiple times
- On each pass:
  - All volunteers will enter the station at the same time
  - **Some volunteers will OPT-IN:**
    - Instructed to use the Acquisition System
    - Proceed through center lane
  - **Other volunteers will OPT-OUT**:
    - Instructed NOT to use the Acquisition System
    - Proceed through the left AND right lanes
  - Different volunteers will OPT-IN or OPT-OUT on each pass
  - Different numbers of volunteers will OPT-IN or OPT-OUT on each pass
  - Each volunteer will OPT-IN twice



OPT-IN / OPT-OUT

Phase 2 Station Process



1 minute

- Group arrives at station
- OPT-IN / OPT-OUT assigned

- Volunteers pass through station
- **System returns ONE image per OPT-IN volunteer**

- Volunteers exit station and rate satisfaction
- Group returns for next pass

- **At least 1-minute wait between each pass**

Homeland Security
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DIVERSE PERSPECTIVES + SHARED GOALS = POWERFUL SOLUTIONS

Phase 2 Requirements

- The Acquisition Systems shall **(Required)**:
  - *provide* **exactly one** face biometric image **per OPT-IN volunteer** on each pass
  - maintain an average transaction time of, at most, 8 seconds per volunteer
  - provide **NO** images of anyone or anything other than **OPT-IN** volunteers

- The Acquisition Systems may **(Optional)**:
  - *provide* **exactly one** set of individual iris images **per OPT-IN volunteer** on each pass
  - *provide* **exactly one** set individual fingerprint images **per OPT-IN volunteer** on each pass

Acquisition Systems

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API - Overview

- All images will be submitted using the MdTF Rally API:
  - RESTful, HTTP based
  - **https://github.com/TheMdTF/mdtf-public**

- Prior to the Rally, 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 LAN:
  - 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

API - Face Capture

- **`face-captures`** POST request endpoint:
  - `FaceImageData` – is a base 64 text representation of a face PNG image
  - `StationID` – is configurable text and will be provided on Rally Acquisition System installation
- **POST only one face capture per OPT-IN volunteer**

POST `/v1/face-captures`


```
{
  "FaceImageData": "iVBORw0KGgoAAAANSUhEUgAAAAEAAAABCAIAAACQd1PeAAAAEElEQVR4nGJiYGAABAAA//8ADAADcZGLFwAAAABJRU5ErkJggg==",
  "StationID": "MdTF_Station"
}
```


- System requirements satisfied:
  - *provide* **exactly one** face biometric image **per OPT-IN volunteer** on each pass **(Required)**

API - Iris Capture

- **`iris-captures`** POST request endpoint:
  - `LeftIrisImageData` – is a base 64 text representation of the left iris PNG image
  - `RightIrisImageData` – is a base 64 text representation of the right iris PNG image
  - `StationID` – is configurable text and will be provided on Rally Acquisition System installation
- **POST only one iris capture per OPT-IN volunteer**
  - Left and right iris images captured for the same volunteer-pass should be posted together

POST `/v1/iris-captures`


```
{
  "LeftIrisImageData": "iVBORw0KGgoAAAANSUhEUgAAAAEAAAABCAIAAACQd1PeAAAAEElEQVR4nGJiYGAABAAA//8ADAADczGLFwAAAABJRU5ErkJggg==",
  "RightIrisImageData": "iVBORw0KGgoAAAANSUhEUgAAAAEAAAABCAIAAACQd1PeAAAAEElEQVR4nGJiYGAABAAA//8ADAADczGLFwAAAABJRU5ErkJggg==",
  "StationID": "MdTF_Station"
}
```


- System requirements satisfied:
  - *provide* **exactly one** set of individual iris images **per OPT-IN volunteer** on each pass **(Optional)**

API - Finger Capture

- **`finger-captures`** POST request endpoint:
  - `ImageCaptures` – array of individual finger `json` objects
  - `FingerImageData` – is a base 64 text representation of a single fingerprint PNG image
  - `FingerType` – the type of individual fingerprint image, one of:
    - `{RightThumb, RightIndex, RightMiddle, RightRing, RightLittle, LeftThumb, LeftIndex, LeftMiddle, LeftRight, LeftLittle}`
  - `StationID` – must be configurable and will be provided on Rally Acquisition System installation
- **POST only one fingerprint capture per OPT-IN volunteer**
  - Finger images captured in the same volunteer-pass should be posted together as `ImageCaptures`

POST `/v1/finger-captures`


```
{
  "ImageCaptures": [
    {
      "FingerImageData": "iVBORw0KGgoAAAANSUhEUgAAAAEAAAABCAIAAACQd1PeAAAAEElEQVR4nGJiYGAABAAA//8ADAADcZGLFwAAAABJRU5ErkJggg==",
      "FingerType": "RightThumb"
    }
  ],
  "StationID": "MdTF_Station"
}
```


- System requirements satisfied:
  - *provide* **exactly one** set individual fingerprint images **per OPT-IN volunteer** on each pass **(Optional)**

API - When to Submit Images?

- All images must be submitted while the volunteer is using your Acquisition System during a single pass

- Images submitted at other times may be mis-assigned and may reduce measured performance of your system

- **Phase 1**
  - After the volunteer enters the station
  - Before the volunteer exits the station
  - One capture (per modality if multi-modal) per volunteer

- **Phase 2**
  - After **OPT-IN** group enters the station on each pass
  - Before the last person in the **OPT-IN** group exits the station on each pass
  - One capture (per modality if multi-modal) per **OPT-IN** volunteer on each pass

Acquisition Systems

Metrics

- Rally Timeline
- Rally Test Location
- Acquisition Systems
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  - API
  - ➔ **Metrics**
  - Selection Process
  - Responsibilities
- Matching Systems
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Acquisition Metrics - Overview

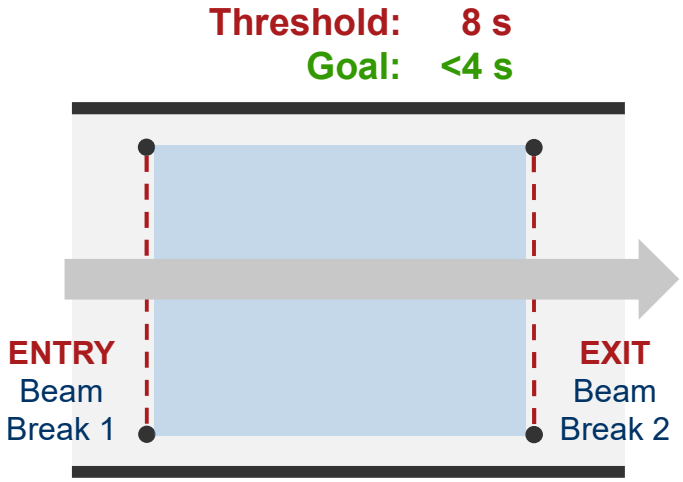
- Designed for a high-throughput, unattended use-case
- Measure ability to collect images from small groups in crowded environments
- Allow a fair analysis of system performance

  - **Efficiency –** amount of time required to complete a biometric transaction.
  - **Effectiveness –** performance of the biometric, encompassing failures to acquire and/or match.
  - **Satisfaction –** positive system ratings by volunteers.
  - **Privacy** –ability of the system to acquire only the required biometric data.

Acquisition Metrics - Efficiency

- **Average Transaction Time**
- The time, per volunteer, spent using the system

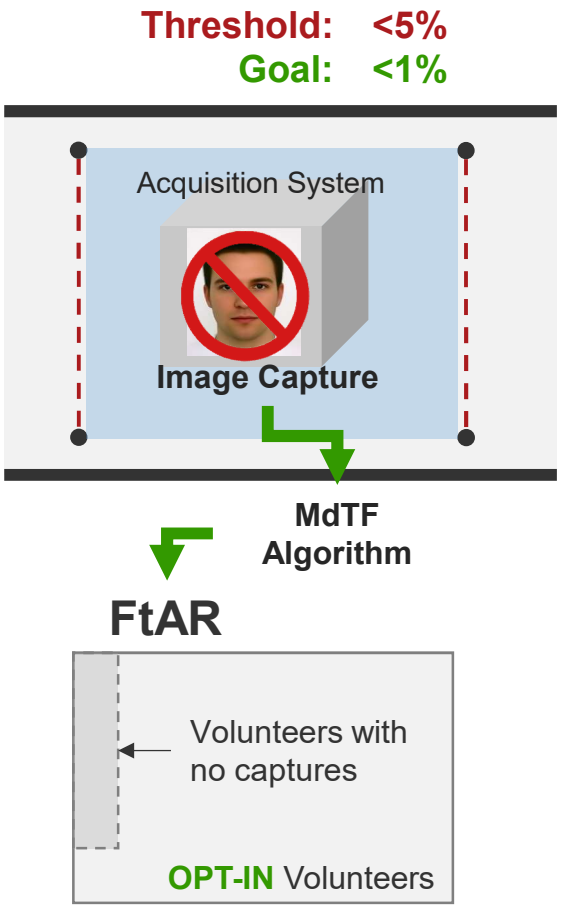
- **Phase 1**
  - The difference between the **EXIT** beam break time and **ENTRY** beam break time
- **Phase 2**
  - The difference between the **EXIT** beam break time and **ENTRY** beam break time divided by the number of volunteers in the **OPT-IN** group



Metrics - Effectiveness

- **Failure to Acquire Rate (FtAR)**
- Percentage of **volunteers using the system** for which an **image of sufficient quality** is not submitted
  - Calculated per modality using MdTF in house algorithm

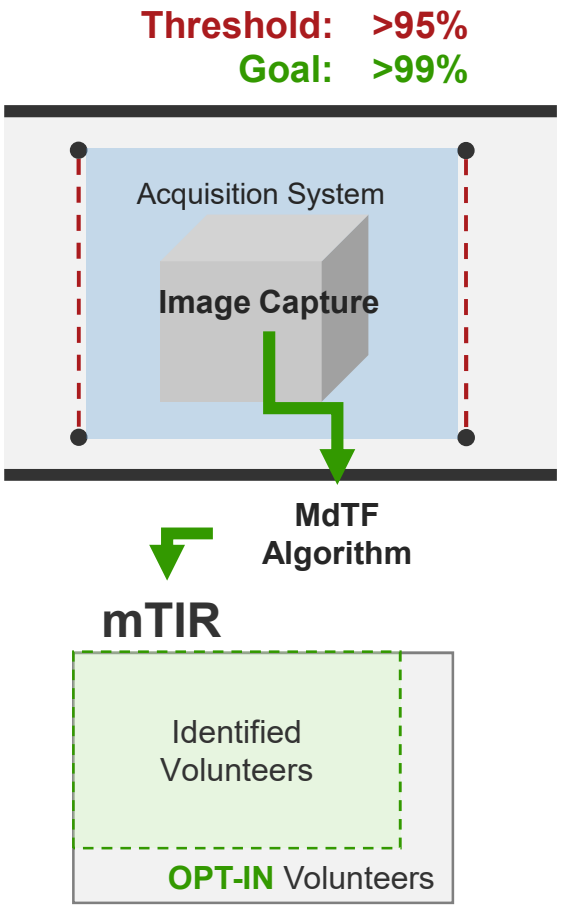
- **Phase 1**
  - Quality: image must generate a biometric template
- **Phase 2**
  - Quality: image must generate a template **and** match at Rank 1 against a high-quality same-day reference image



Metrics - Effectiveness

- **MdTF True Identification Rate (mTIR)**
- Percentage of **volunteers correctly identified** using acquired images
  - Calculated per modality using MdTF in house algorithm

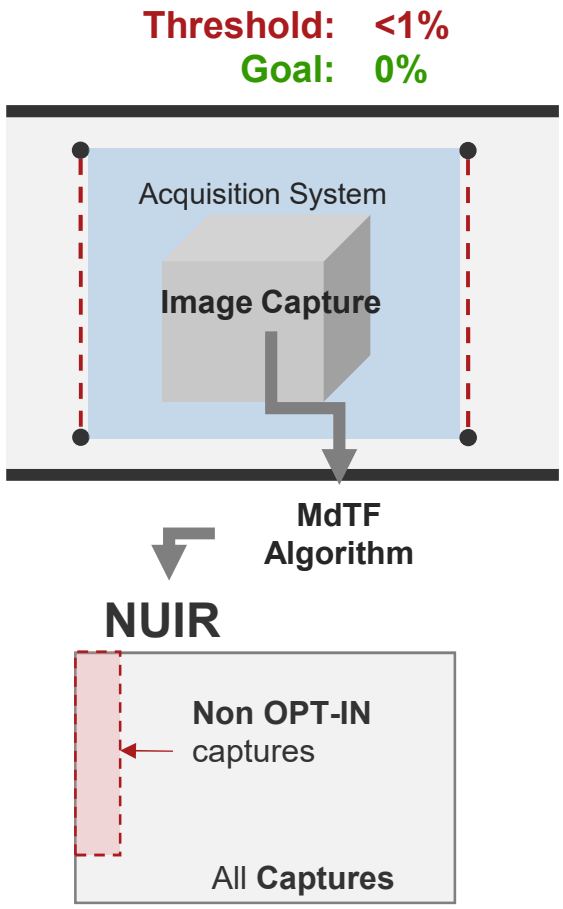
- **Phase 1**
  - A true identification is counted if **the last capture** can be identified as the volunteer
- **Phase 2**
  - A true identification is counted if **any** capture is identified as the **OPT-IN** volunteer



Metrics - Privacy

- **Non-User Identification Rate (NUIR)**
- Proportion of image captures that result in an **identification of an individual NOT using the system**
  - Calculated per modality using MdTF in house algorithm

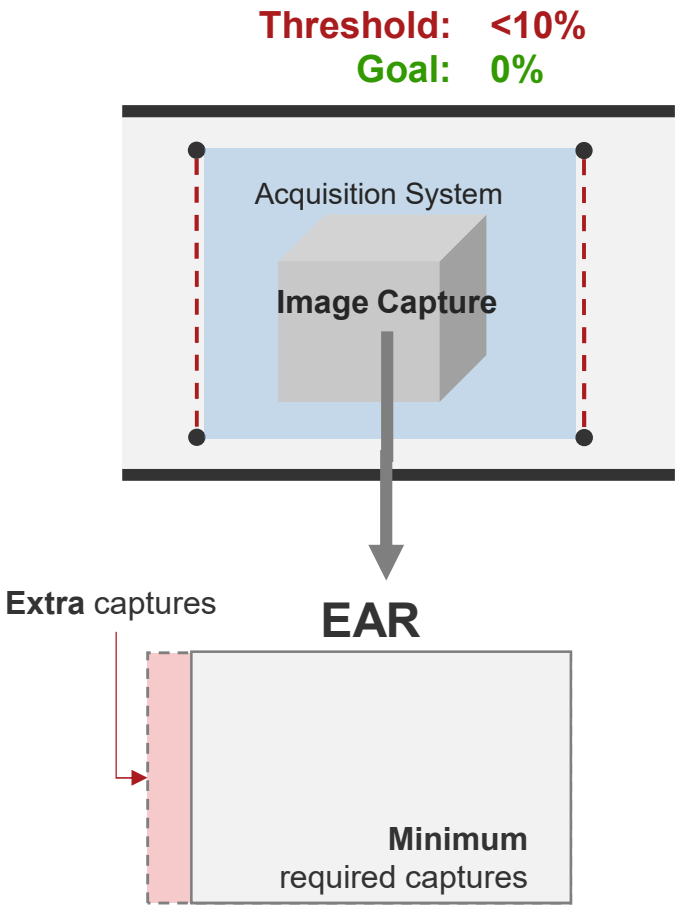
- **Phase 1 & 2**
  - A capture is counted as a non-user identification if it is identified as anyone other than an **OPT-IN** volunteer



Metrics - Privacy

- **Extra Acquisition Rate (EAR)**
- Actual number of **image captures in excess of the minimum** number of image captures required
  - Calculated per modality

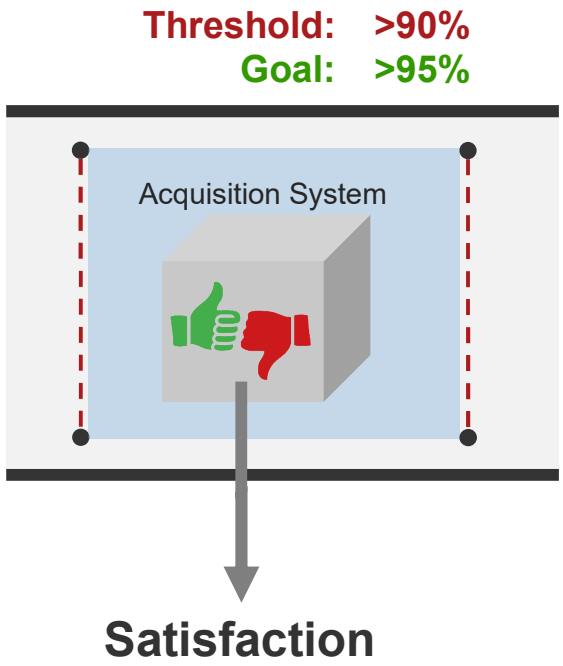
- **Phase 1 & 2**
  - Minimum required number of image captures is set to one capture per **OPT-IN** volunteer on each pass



Metrics - Satisfaction

- **Percent Satisfaction**
- Proportion of positive (“Happy” or “Very Happy”) satisfaction scores

- **Phase 1 & 2**
  - Rated by **OPT-IN** volunteers immediately following Acquisition System use



Acquisition Systems

Selection Process

Phase 1 Selection Process

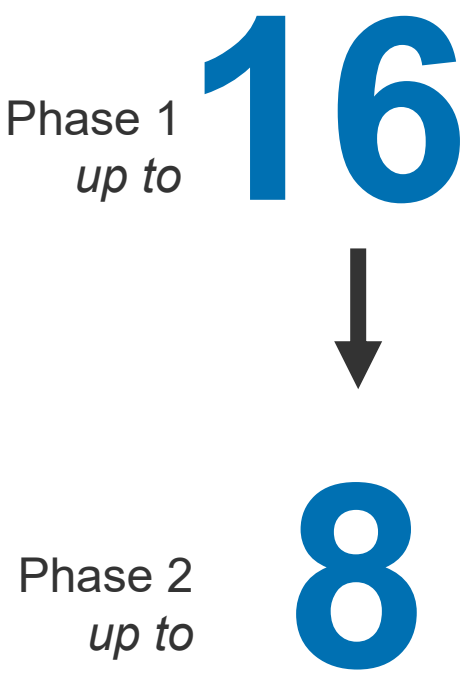
- DHS will have sole discretion in selecting Acquisition Systems for inclusion
  - Space is limited and DHS S&T will select only some of the Applications
  - DHS will be advised in this process by a panel of biometric experts

- Whitepapers and videos will be judged based on how well they demonstrate the ability of the Acquisition System to:
  - Acquire quality biometric images from small groups of users in crowded environments
  - Have provisions to ensure privacy of non-users
  - 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

Phase 2 Down-select

- A maximum of 8 Acquisition Systems from Phase 1 will be selected to participate in Phase 2
  - DHS S&T will select up to half of the systems tested in Phase 1
  - DHS will be advised in this process by a panel of biometric experts
- Down-selection will be informed by Phase 1 metrics:
  - Effectiveness
  - Efficiency
  - Satisfaction
- **DHS will make the final determination on which systems will be tested in Phase 2**



Acquisition Systems

Responsibilities

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Acquisition System Responsibilities - Before Test

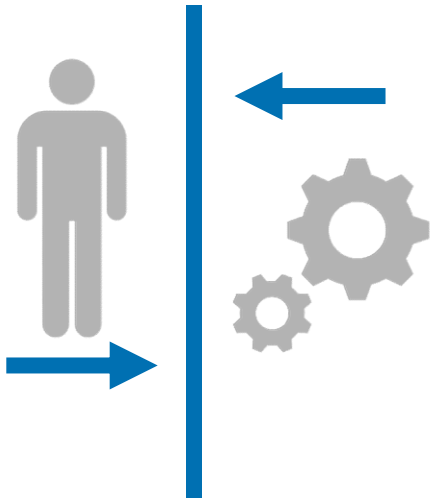
- Acquisition System Providers are responsible for:
  - Procuring all hardware to maintain and operate their system
  - Integrating their device/system within the MdTF API
    - MdTF staff will provide minimal assistance
  - Any/all hardware/software testing, including proper communication with the MdTF API
  - The full installation and breakdown of their own equipment within the MdTF
    - Phase 1 installation
    - Phase 1 teardown
    - Phase 2 installation
    - Phase 2 teardown

Acquisition System Responsibilities - During Test

- Acquisition System Providers will be able to view data sent to Rally API by their system following each volunteer pass through their station
- Acquisition System Providers will be responsible for informing MdTF staff of any issues with their system's performance during testing
  - MdTF staff will log these issues and determine whether intervention is allowable.
  - **Up to two usability / human factors** adjustments to Acquisition Systems will be allowed:
    - During the first day of Phase 1
    - During the first two days of Phase 2
  - Rally Participants may make repairs to their systems in case of breakage
- **All modifications/repairs must be made when volunteers have left the test environment**

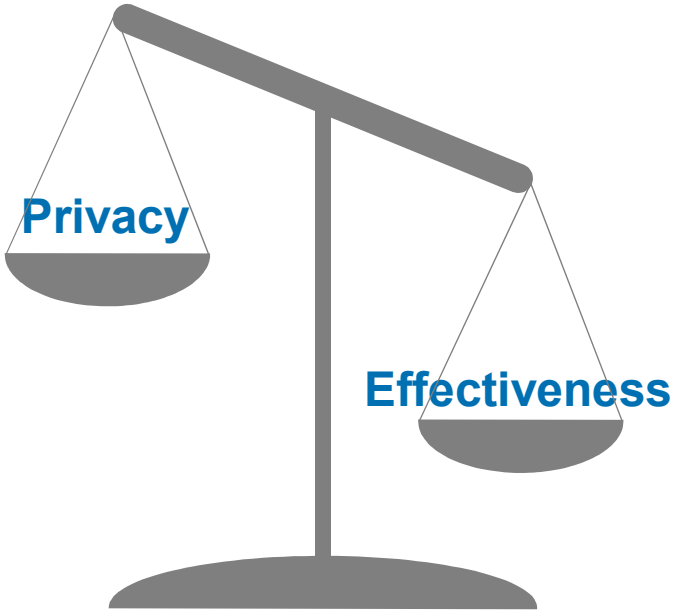
Human Factors Considerations

- Acquisitions Systems should include signage or instructions to guide the volunteers:
  - Systems must operate in an unmanned mode, i.e. without an operator/instructor
- Test guides/staff will not provide any assistance to volunteers asking for help using the system
- 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



Effectiveness vs. Privacy

- Acquisition System Providers should balance system effectiveness and privacy when designing their systems
- Systems should be selective regarding which captures are submitted to the API
- Systems should limit the number of captures only to those necessary
- Capturing more images may benefit effectiveness metrics, but may negatively impact privacy metrics



Matching Systems

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Matching Systems

- 2020 Rally will accept applications from providers of face, fingerprint, and iris matching systems
- Matching systems will be evaluated using images acquired by Acquisition Systems at MdTF
- Matching system performance will be reported paired with different acquisition systems

Matching Systems

API

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API

- All Matching System Providers will submit a Docker image `.tar` file created via `docker save`
- The Docker image must:
  - Provide an HTTP server on port 8080 for handling API requests
  - Conform to MdTF resource constraints (CPU/memory):
    - **8** i7 CPUs, **8** GB RAM, NO GPU
  - Operate without internet access
  - Implement the MdTF API specification documented on **https://github.com/TheMdTF/mdtf-public**
  - Satisfy the following requirements:
    - *accept* individual, base 64 encoded, PNG image data and return *a template* **(Required)**
    - *accept* templates, performs matches, and *return* similarity score **(Required)**
    - provide information on the algorithm **(Required)**

API - Template Generation

- `/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 a template should set an appropriate status code indicating a failure and return an explanatory error response

- Requirements satisfied:
  - *accept* individual, base 64 encoded, PNG image data and return *a template* **(Required)**

API - Template Matching

- `/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 template (1) to list of templates (2)

- Requirements satisfied:
  - accept templates, performs matches, and return similarity score **(Required)**

API - Algorithm Information

- **`/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 Systems

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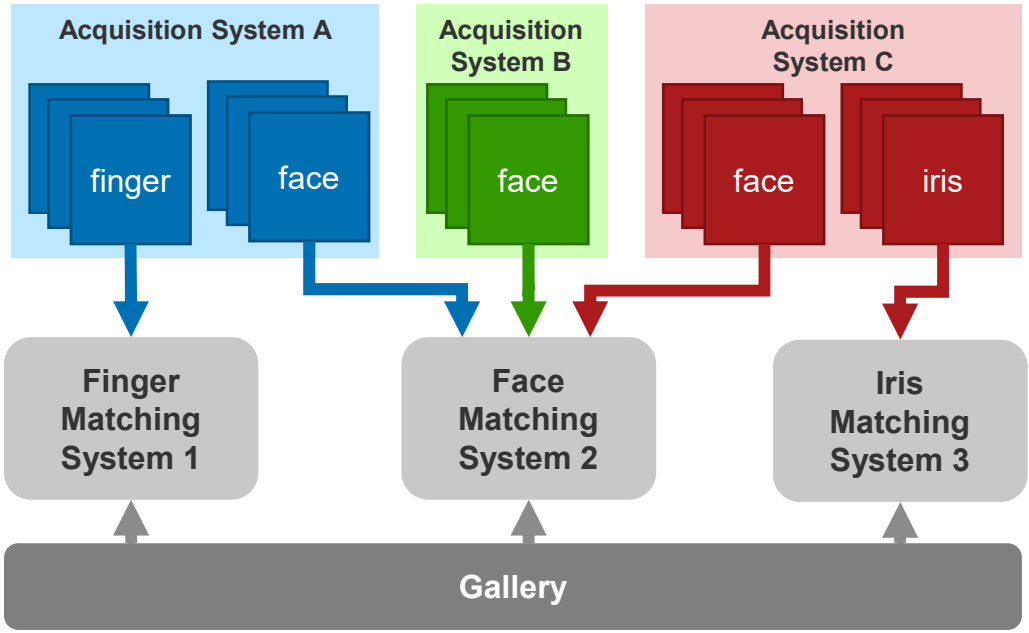
Metrics - Overview

- Matching Algorithms will template and match biometric images:
  - Collected on a variety of Acquisition Systems
  - >2,000 unique individuals acquired using MdTF systems over six years

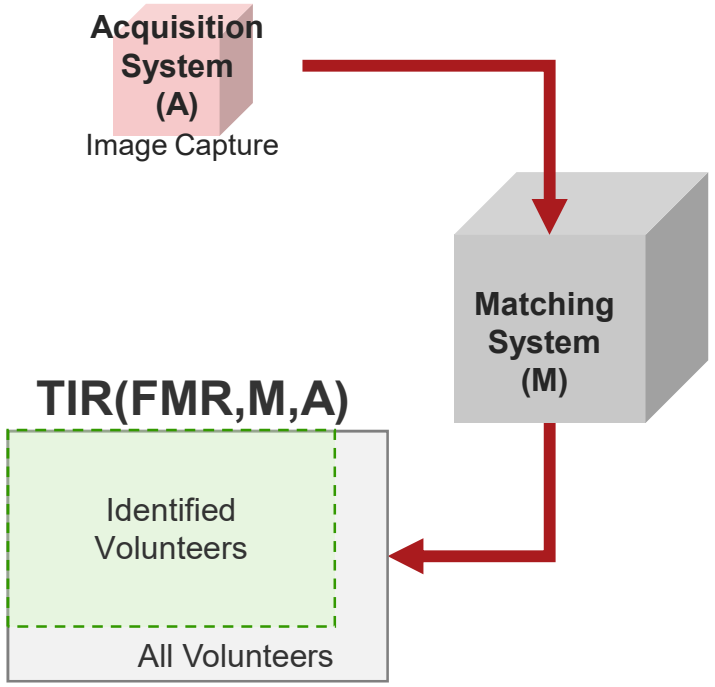
- Metrics will measure:
  - Overall algorithm performance
  - Robustness to collection conditions



Metrics - Effectiveness

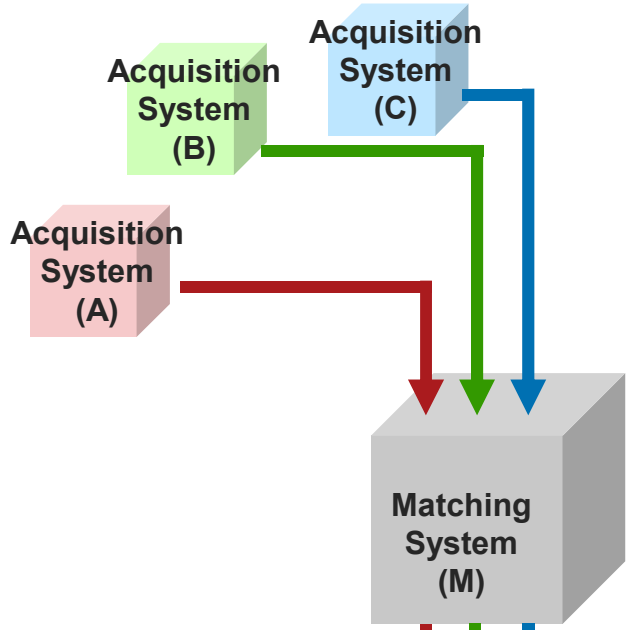
- **True Identification Rate (TIR)**
- Percentage of volunteers correctly identified using acquired images for each Acquisition-Matching System combination
  - Three match thresholds:
    - FMR in {1:10,000, 1:100,000, **1:1,000,000**}
- A true identification is counted for a volunteer if they can be correctly identified using the captured images at the specified threshold
- Reported separately including and excluding failures to acquire

Threshold: **>95% @ 1:1,000,000**
Goal: **>99% @ 1:1,000,000**



Metrics - Robustness

- **Robustness Across Acquisition Systems**
- Variability in Matching Algorithm performance across participating Acquisition Systems
- It is the range of observed TIR values across acquisition systems
  - Threshold set at FMR = 1:1,000,000



Threshold: **>10%**
Goal: **>1%**

R_A = 99% - 94% = 5%

97% TIR(1:1,000,000,**M**,**A**)

99% TIR(1:1,000,000,**M**,**B**)

94% TIR(1:1,000,000,**M**,**C**)

Matching Systems

Selection Process

- Rally Timeline
- Rally Test Location
- Acquisition Systems
  - Phase 1: Individual Processing
  - Phase 2: Group Processing
  - API
  - Metrics
  - Selection Process
  - Responsibilities
- Matching Systems
  - API
  - Metrics
  - ➔ **Selection Process**
  - Responsibilities

Matching System Selection Process

- DHS will have sole discretion in selecting Matching Systems for inclusion
  - DHS S&T will down-select the number of Matching 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

Matching Systems

Responsibilities

Matching System Provider Responsibilities

- Matching System Providers are responsible for:
  - Creating a Docker image that conforms to the Rally Matching System API, application, and computational resource requirements (Slide 44)
  - Delivering their Docker image to the MdTF. Docker images ill be uploaded via a webpage at https://mdtf.org/
  - Adhering to additional requirements:
    - The implemented matching algorithm must be commercially available from the Provider
    - Docker image is less than 1.5 GB in size
    - The Docker image will reliably return a template in less than 1000 milliseconds
    - A list of 1000-templates will reliably return a list of 1000 comparison objects in less than 300 milliseconds
    - All functionality will work for at least one calendar year without access to external networks and without license constraints
    - Operate without internet access

Matching System Provider Responsibilities

- Test and packaging scripts are available at **https://github.mdtf.org**. Please consider ease of integration into the MdTF infrastructure upon receipt of the algorithm. DHS has sole discretion in disqualification if the algorithm requires an excessive effort to achieve functionality

Thank You!

- Questions?
  - peoplescreening@hq.dhs.gov

- For more information:
  - peoplescreening@hq.dhs.gov
  - https://mdtf.org/Rally2020
    - 2020 Biometric Technology Rally Information
    - All 2018 and 2019 Biometric Technology Rally Results
    - Material from all webinars, briefings
  - www.dhs.gov/science-and-technology

For more information, contact: peoplescreening@hq.dhs.gov or http://mdtf.org

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Science and Technology

DIVERSE PERSPECTIVES + SHARED GOALS = POWERFUL SOLUTIONS