# LocUS (Location Using Sound) - Geolocating Multi-Modal Open-Source Information

## 1. Program Overview

The LocUS program aims to create technology that automatically and accurately geolocates multimedia content by maximally leveraging audio and visual information. LocUS will improve the geolocation capabilities of the Intelligence Community (IC) considerably beyond imagery-only methods and thereby increase the volume of content that can be accurately geolocated. This program will increase analysts' ability to rapidly and accurately determine where a video, image, or audio clip was collected in the absence of accurate metadata indicating location. Applications for national security include human trafficking interdiction, hostage recovery, localization of malign actors using social media or confiscated devices, and other intelligence and law enforcement use cases.

## 2. Objectives

The LocUS program aims to develop technology that can automatically and accurately geolocate an indoor or outdoor image, video, or audio clip taken anywhere in the world.

### Task Area 1 (TA1): Multimodal Geolocation

Develop capability to automatically and accurately geolocate multimedia content.

The Test and Evaluation (T&E) team(s) will collect and curate test data for LocUS test events.

## 3. Program Scope and Limitations

The LocUS program develops capabilities for indoor and outdoor terrestrial geolocation of previously unseen images, video, or audio clips. The LocUS program is collection-sensor agnostic.

The following areas of research and approaches are out of scope for the LocUS program:

- Methods that utilize biometric identification methods (e.g. facial recognition, voice recognition)
- Methods that work exclusively for single modalities (e.g. audio only), or only for types of data within single modalities (e.g. human speech data only)
- Solutions that work only outdoors, or only for specific regions, terrains, or architectures
- Development of hardware solutions, or solutions that require custom hardware
- Methods that require a human-in-the-loop as part of the integrated end-to-end system

Geolocation Explainability is within scope of the LocUS program, but not required. Geolocation Explainability refers to the ability of an automated system to provide plain language descriptions of features relevant to geolocation of the query. These may be features utilized by the system to arrive at, or dispense with, a candidate location or locations. The intention of Geolocation Explainability is to extract potentially meaningful features from image, video, or audio that

would (1) assist analysts to accurately geolocate the query, and (2) increase analyst confidence in automated system outputs.

Delivered software will be evaluated by an independent T&E team or teams on sequestered evaluation datasets. Performers will build prototype systems that will be run and evaluated by the T&E team(s). Testing protocols do not allow for expert operators, human-in-the-loop operation, or any operations not deemed "turnkey." However, systems or algorithms that have been trained using human-in-the-loop methods may be submitted, provided they run autonomously.

Proposers may offer novel partial solutions that achieve LocUS program goals, provided that they motivate the solution and articulate its value in reference to the program scope, schedule, and metrics.

### 4. Program Specific Terms/Definitions

**Geolocation Explainability** refers to the ability of an automated system to provide plain language descriptions of features relevant to geolocation of the query.

A **query** is the input image, video, or audio clip to be geolocated. The prototype system should be able to geolocate the camera (or, if requested, an object in the scene that will be specified with the query).

**Reference Data** are any type of information that could aid in geolocation and may be supplied by the T&E partner in advance of Test Events. T&E may distribute image, video, or audio materials with certain qualities or characteristics that will be representative of queries of interest in Test Events. For example, if a Test Event were to include indoor imagery from hotel rooms, reference data to aid geolocation of that query may potentially be supplied.

**Test Events** are T&E-conducted evaluations that will exercise performer solutions across technical challenges to be determined by the United States Government and T&E partner. Before each test event, performers will deliver prototype software to be evaluated by T&E against program metrics in a variety of challenge conditions. There are five test events planned for the LocUS program.

### 5. Human or Animal Subject Research applicable to this Program

N/A

### 6. Government Furnished Equipment/Information

With the exception of potential Reference Data (for example, imagery or video for the performers to optionally use to ensure that performer systems can process expected file types), the Government does not plan to furnish data or equipment to LocUS performers. Minimal reference data may be provided to ensure interoperability but is not expected to be enough data for training purposes. The LocUS T&E partner will supply queries for testing and evaluation, and may supply additional queries to performers for development.

## 7. Program Metrics

Candidate LocUS metrics include the following. Targets may be refined, and additional metrics may be added. Offerors are encouraged to include potential metrics as part of the white paper submission.

*Table 1: Notional LocUS Program Metrics*

| Task | Metric | Target |
|---|---|---|
| Geolocation Accuracy | Circular Error (CE) 90 | < 250 meters |
| Geolocation Time to Prediction* | Time | < 5 minutes |

*For a search area of Continent (2,500km).

250m Circular Error (CE) 90 refers to a confidence value (90%) that points or features fall within the horizontal radius (250m) of the true location.

Geolocation Time to Prediction refers to the time it takes for the prototype system to provide an answer to a geolocation query.

The LocUS program will evaluate program metrics over a variety of search areas, ranging from neighborhoods to continents, to better characterize solution performance.

## 8. Program Waypoints, Milestones, Deliverables

The LocUS program is planned as a 15-Month Program. Table 2 provides the notional LocUS Program Schedule for Task Area 1 (TA1):

*Table 2: Notional LocUS Program Schedule (Task Area 1)*

| Activities | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kickoff | X | | | | | | | | | | | | | | |
| Site Visits | | | | X | | | | | | X | | | | | |
| Software Delivery | | X | | | X | | | X | | | X | | | X | |
| Test Event | | | X | | | X | | | X | | | X | | | X |
| PI Meeting Workshop | | | | | | | X | | | | | | | | |
| Demo Day Workshop | | | | | | | | | | | | | X | | |
| Monthly Status Reports | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Final Report | | | | | | | | | | | | | | | X |

During the 15-Month Program, there will be a total of five test events, or one test event every ~3 months. Prior to each test event, performers will deliver performer systems as containerized software (e.g. Docker container) compatible with LocUS program API standards, to be

developed in Pre-program Phase. At test events, T&E will test and evaluate performer systems against numerous queries from T&E-collected, sequestered datasets. Performer systems are required to geolocate multimodal content. While image-only and audio-only performance will be evaluated at each test event to better characterize the contributions that individual modalities provide to overall geolocation capabilities, the goal of the program is improved geolocation using all available multimodal information. Proposed solutions for the LocUS program shall be a single complete system.

Images, videos, and audio clips will be highly varied in content, location, and in the quality of the query (e.g. length, blur, resolution, audio bit rate, bit depth, and sample rate). The queries will be provided in a file format that is widely available. Offerors should assume that the metadata will be removed from all queries.

Following each Test Event challenge, performance analysis results and challenge data may be provided, if appropriate, to performers for review and methodology improvement.

Performers may incorporate the use of other existing data sources, provided these sets can be made available to the Government for evaluation purposes.

The following table presents the waypoint, milestone, and deliverable schedule for the LocUS program (Task Area 1):

*Table 3: LocUS Waypoint, Milestone, and Deliverable Schedule (Task Area 1)*

| Month | Event | Description | Comment | Deliverable |
|---|---|---|---|---|
| All | Waypoint | Monthly Status Report (MSR), Technical and Financial | Due on 15th of each month | MSR in provided template |
| 1 | Waypoint | Kickoff | DC metro area and/or virtual | Overview presentation provided 1 week in advance of meeting |
| 2 | Deliverable | Containerized solution delivery for Test Event 1 | Interim | Container, Report Describing Container, and Source Code |
| 4 | Waypoint | Site Visit | At performer site | Presentation |
| 5 | Deliverable | Containerized solution delivery for Test Event 2 | Interim | Container, Report Describing Container, and Source Code |
| 7 | Waypoint | PI Meeting Workshop | DC metro area and/or virtual | Presentation, Demonstration |
| 8 | Deliverable | Containerized solution delivery for Test Event 3 | Interim | Container, Report Describing |

| | | | | |
|---|---|---|---|---|
| | | | | Container, and Source Code |
| 10 | Waypoint | Site Visit | At performer site | Presentation |
| 11 | Deliverable | Containerized solution delivery for Test Event 4 | Interim | Container, Report Describing Container, and Source Code |
| 13 | Waypoint | Demonstration Day Workshop | DC metro area and/or virtual | Presentation, Demonstration |
| 14 | Deliverable | Containerized solution delivery for Test Event 5 | Final | Container, Report Describing Container, and Source Code |

### 9. Software Deliverable Formatting

Performers will deliver containerized software (e.g. Docker container) compatible with LocUS program API standards, to be developed in Preprogram Phase. Source code for capabilities must be developed and delivered in a manner such that T&E can install, build and execute the software, including the ability to retrain models. Any external libraries or other dependencies must be included in deliverables. Offerors are encouraged to convey any specific software framework requirements or constraints as part of the white paper submission.

### 10. Place of Performance

Work will be performed at performer-recommended sites with Government concurrence.

### 11. Test & Evaluation

T&E will be performed by a team or teams selected by the IARPA LocUS Program Manager.

The LocUS T&E team(s) will compile robust sets of diverse and relevant multimedia corpora to support research goals. The T&E team(s) will conduct independent test and evaluation for the program with curated data sets and will be responsible for integrating containerized solutions. Performer systems will be evaluated on an interim basis to track progress and ensure compliance with system requirements.

### 12. Technical Exchange Meetings/Workshops/Site Visits/Travel Requirements

- One kick-off meeting in Washington DC Metro Area and/or virtual (Month 1)
- Two in-person Workshops in the Washington DC Metro Area and/or virtual (Months 7 and 13)
- Site visits (virtual and/or in-person where LocUS PM travels to Performer Site) every 6 months (Months 4 and 10)

Meetings, Workshops, Site Visits, and Travel Requirements are subject to revision.

## 13. Anticipated Timeline

*Table 4: LocUS Anticipated Timeline*

| Task Area (TA) | Period of Performance (PoP) |
|---|---|
| TA1 | 15 months (est.) |

LocUS is planned as a 15-Month Program.