BIG-R BAA (HM0476-20-BAA-0001)
Topic # 010 - Advanced 3D Analytic Tool Development, Enhancement, and Integration

Document Change History

Date	Description
06/01/2023	Topic 10 posted

Title

Advanced 3D Analytic Tool Development, Enhancement, and Integration

Expected Awards

The Government intends to make multiple awards within the base period, but may make only one award, or none. Proposers can submit proposals for only one of the Technical Elements outlined within this BAA, multiple Technical Elements, or all Technical Elements. Contract award(s) under this topic are subject to availability of funds.

Budget

Base Year: The government intends to make multiple awards. Total budget for the entire project, inclusive of all four technical elements listed in section 3 is $3M.

Option Period 1: Estimated range for this option is from $1M - $2M in total awards (covers work in all Technical Elements).

Option period 2: Estimated range for this option is from $2M - $3M in total awards (covers work in all Technical Elements).

Topic Technology Readiness Level (TRL)

Topic 10 is limited to projects that meet Technology Readiness Level (TRL) definitions in the TRL range 4-5. Upon completion of proposed developmental efforts, solutions should strive to meet a TRL in the range 5-6. TRL 6 is a system/subsystem model or prototype demonstration in a relevant environment.

Dates

Topic Posting	06/01/2023
Questions Due	**06/08/2023 @ 5:00pm EDT**
Q&A Posting	06/20/2023
Abstracts Due	**06/26/2023 @ 5:00pm EDT**
Abstract Feedback	07/12/2023
Proposals Due	**07/28/2023 @ 5:00pm EDT**
Estimated Period of Performance Start:	10/16/2023

Point of Contact (POC)

Please send all questions and submissions to the Contracting Officer (CO): Daniela Garavito

Email Address: BigRBAA@nga.mil

➔ Use the following email subject for all email correspondence: '**TOPIC 10'**

1. Topic Research Opportunity Description:

The National Geospatial-Intelligence Agency Research Directorate (NGA Research) is soliciting proposals for pioneering research in the analysis and real-time, interactive visualization of large, high-resolution 3D data (HR3D) sets and associated registered imagery sources, particularly its representations in the form of point cloud, mesh, or polygonal models. Proposals should investigate novel methods to advance the state-of-the-art in the automated analysis of 3D data, and be robust to the many challenges restricting comprehensive 3D analysis today. Utility of existing Electronic Light Table (ELT) capabilities extended to 3D data types is strongly encouraged.

Specifically, this topic call is seeking development/enhancement of software with a corresponding Application Program Interface (API) and Software Development Kit (SDK), capable of being integrated into existing Electronic Light Tables (ELTs). This topic call contains four (4) independent Technical Elements (see sections 3.1.1 to 3.1.4) and seeks to enhance and/or further develop, and integrate several ELT capabilities into a single exploitation and real-time visualization tool that analysts can use to conduct analysis of HR3D data. As stated earlier, proposers can submit proposals for only one of the Technical Elements, multiple Technical Elements, or all Technical Elements.

2. Background and Purpose:

This topic call seeks to integrate and enhance best-of-breed tools and capabilities into an environment that will enable seamless exploitation of 3D geospatial content, using a single tool.

NGA analysts use a number of commercial and open source ELTs, primarily QT Modeler, a product from Applied Imagery LLC. Other tools include ESRI's ArcGIS suite of tools and QGIS.

While these ELTs provide many 3D exploitation functions, the agency needs to integrate those capabilities into a single system that will enable and accelerate seamless HR3D data analysis workflows, as these data become more readily available in regions around the world where previously only (2D) imagery existed. Some of these capabilities will require enhancements and/or further development prior to integration.

This BAA topic call encourages collaborative relationships and multidisciplinary teaming between academic and industry partners. Experience integrating and operationalizing 3D tools is needed. Proposers may find developers with competencies in photogrammetry, lidar, computer vision, geospatial data, error modeling, and other 3D modeling topics to be of particular value.

3. Project Structure and Scope

3.1. Technical Elements

The project is divided into a Base Period and two Option Periods. The Base and Option Periods are 12 months each. Work is further broken down into four independent Technical Elements. Requirements for each technical element are listed in sections 3.1.1 – 3.1.4.

#	Technical Element	Section
1	Simultaneous Co-Exploitation of Digital Surface Model (DSM), Point Cloud (PC), Mesh Surfaces and Vectorized Geographic 3D Features	3.1.1
2	Automated Image and Surface Registration	3.1.2
3	Line-Of-Sight (LOS) Enhancements	3.1.3
4	Predictive Radio Frequency (RF) Mapping; Integrate Material or Acoustic Attributes	3.1.4

3.1.1. TECHNICAL ELEMENT 1 - Simultaneous Co-Exploitation of Digital Surface Model (DSM), Point Cloud (PC), Mesh Surfaces and Vectorized Geographic 3D Features

3.1.1.1 Description:

Task 1: NGA requires the ability to interact with multiple 3D data types concurrently within an ELT. This will enable analysts to efficiently overlay and analyze 3D data from disparate sources, scales, and methods of collection/generation.

Task 2: NGA also requires tools that will provide improvements in data interoperability and interpolation methods to enhance the accuracy of objects represented in 3D scenes.

➔ More information on Technical Element 1 is available in Appendix 1 of this Topic Call.

3.1.1.2 Technical Requirements:

Base Year:

- Task 1:

Development of a prototype toolset, algorithms or suite of tools that enables the interaction with multiple 3D data types concurrently within an ELT. Prototype shall meet Section 4 metrics.

- The proposer shall develop tools to allow a user to visualize, interact with, and exploit, simultaneously, in 3D1, the following Data Types:

  a) Point clouds (e.g., las/laz, bpf/bpz, cloud optimized point clouds (COPC));
  b) Digital Surface and Digital Elevation Models (e.g., GeoTIFF/cloud optimized geotiffs);
  c) Geospatial meshes (e.g., 3D Tiles Next, wavefront obj, i3s, gtlf).
     - The tool shall include tools to move, rotate, and scale imported 3D mesh objects.
  d) Vectorized 3D features (e.g., .kml/.kmz), and integrated data formats to include 3DTiles and SpatioTemporal Asset Catalogs (STAC).

- Task 2:
  The proposer shall develop tools that will provide improvements in data interoperability and interpolation methods to enhance the accuracy of objects represented in 3D scenes, to include:
  - A tool for advanced interpolation and/or conversion methods that do not seek to always interpolate to the ground surface. The proposer shall design the tool so it can convert point cloud data to DSM/DEM, mesh, or vectorized 3D formats.
  - A tool that provides the ability to mask or fence certain objects and/or areas for special treatment or exclusion when executing interpolation.
- Prototype shall meet Section 4 metrics.

Option Period 1:

Focuses on maturing the prototype and preparing for cloud implementation. Prototype shall meet Section 4 metrics.

- The proposer shall modify/enhance prototype toolsets, algorithms, or suite of tools developed in the base period, and get them ready for cloud implementation in the Unclassified Commercial Cloud Services (UC2S) and Commercial Cloud Services (C2S) environment.
- The proposer shall ensure modified/enhanced prototype toolsets, algorithms, and suite of tools developed under the base period continues to have the same functionality. The proposer shall conduct needed regression testing to ensure there is no loss of base period functionality.

Option Period 2:

Focuses on optimization and transition of the prototype to the cloud. Prototype shall meet Section 4 metrics.

- The proposer shall modify/enhance prototype toolsets, algorithms, or suite of tools developed in the Base Year and Option Period 1, to optimize them for transition and integration into the UC2S and C2S cloud environments. The proposer shall support NGA in the integration of the toolsets and algorithms into the cloud.
- The proposer shall ensure modified/enhanced prototype toolsets, algorithms, and suite of tools developed during the Base Year and Option Period 1 continue to have the same functionality once transitioned to the cloud. The proposer shall conduct needed regression testing to ensure there is no loss of functionality.
- The proposer shall ensure fully functional and transitioned toolset, algorithms, or suite of tools meet all requirements for this Technical Element.

3.1.2. TECHNICAL ELEMENT 2 - Automated Image and Surface Registration

3.1.2.1 Description:

NGA requires a tool to perform automated adjustment of overhead electro-optical (EO) imagery satellite, or airborne imagery, to 3D content for texturing and attribution purposes.

3.1.2.2 Technical Requirements:

Base Year:

The proposer shall develop a tool for automated image to 3D surface registration with the following characteristics:

- The proposer shall design the tool to utilize the overhead EO and airborne imagery and 3D data sensor models (where available) to perform a rigorous image to surface adjustment. If 3D data sensor model is unavailable, the proposer shall design the tool so it can provide additional, non-rigorous methods for image registration.

- The proposer shall design the tool so it can append available imagery information to the 3D dataset, at the point, vertex, or facet level, resulting in a single, exportable 3D file with integrated imagery information.

- The proposer shall design the tool so it can register multiple 3D datasets to one another.

- Prototype shall meet Section 4 metrics.

Option Period 1:

Focuses on maturing the prototype and preparing for cloud implementation. Prototype shall meet Section 4 metrics.

- The proposer shall modify/enhance prototype toolsets, algorithms, or suite of tools developed in the base period, and get them ready for cloud implementation in the Unclassified Commercial Cloud Services (UC2S) and Commercial Cloud Services (C2S) environment.

- The proposer shall ensure modified/enhanced prototype toolsets, algorithms, and suite of tools developed under the base period continues to have the same functionality. The proposer shall conduct needed regression testing to ensure there is no loss of base period functionality.

Option Period 2:

Focuses on optimization and transition of the prototype to the cloud. Prototype shall meet Section 4 metrics.

- The proposer shall modify/enhance prototype toolsets, algorithms, or suite of tools developed in the Base Year and Option Period 1, to optimize them for transition and integration into the UC2S and C2S cloud environments. The proposer shall support NGA in the integration of the toolsets and algorithms into the cloud.

- The proposer shall ensure modified/enhanced prototype toolsets, algorithms, and suite of tools developed during the Base Year and Option Period 1 continue to have the same functionality once transitioned to the cloud. The proposer shall conduct needed regression testing to ensure there is no loss of functionality.

- The proposer shall ensure fully functional and transitioned toolset, algorithms, or suite of tools meet all requirements for this Technical Element.

3.1.3. TECHNICAL ELEMENT 3 - Line-Of-Sight (LOS) Enhancements

3.1.3.1 Description:

NGA requires a more robust tool for viewshed (i.e., the geographical area visible from a location), and point to point LOS analyses over large scales, from multiple viewing angles, and able to incorporate multiple data types.

➔ More information on Technical Element 3 is available in Appendix 1 of this Topic Call.

3.1.3.2 Technical Requirements:

Base Year:

Proposer shall develop and test prototype toolsets, algorithms or suite of tools and integrate the following to the ELT user interface:

1. **Area Inter-Visibility:** An area inter-visibility tool that delivers to the user a heatmap or other output that coveys the exposure of every pixel or point in a scene.

2. **Non-Overlapping Observer/Data Surfaces:** A tool that models visibility to a point or area in a 3D model that simulates the placement of an observer point outside, or far above, the loaded dataset and is capable of modeling the effects of earth curvature on visibility over long distances.

3. **Area (Polygonal) Observers:** An area-based LOS tool that models visibility to and from user defined polygons in addition to traditional point to point modeling.

4. **Vegetation/Vertical Features:** The proposer shall develop LOS tools that run on 3D geospatial data of any type, i.e., DSM/DEM, point cloud, surfaces (Vectorized 3D features), and meshes.

    - The proposer shall design the tool so that observer points may be imported from external sources or user-defined within the tool.
    - Observer points and analytical results must be exportable to shapefile, KML/KMZ, and GEOTIFF.
    - The tool must be able to export scenes, or parts of scenes, as an interactive 3D PDF.

- Prototype shall meet Section 4 metrics.

Option Period 1:

- Proposer shall develop and test prototype toolsets, algorithms or suite of tools and integrate the following to the ELT user interface:

5. **Error/Uncertainly Representation:**
    - The proposer shall provide uncertainty metrics associated with LOS products derived from sensor models.
    - The proposer shall deliver a multi-variate or probabilistic tool that assesses the reliability of viewshed analyses by considering the differences between how objects are represented in 3D scenes and their real-world characteristics. For example, vegetation may not completely block LOS, building corners are often misrepresented in interpolated DSMs, and transient objects represented in 3D models may no longer be present on the ground at any given time.

- The proposer shall modify/enhance prototype toolsets, algorithms, or suite of tools developed in the base period, and get them ready for cloud implementation in the Unclassified Commercial Cloud Services (UC2S) and Commercial Cloud Services (C2S) environment.

- The proposer shall ensure modified/enhanced prototype toolsets, algorithms, and suite of tools developed under the base period continues to have the same functionality. The proposer shall conduct needed regression testing to ensure there is no loss of base period functionality.

- Prototype shall meet Section 4 metrics.

Option Period 2:

- The proposer shall modify/enhance prototype toolsets, algorithms, or suite of tools developed in the Base Year and Option Period 1, to optimize them for transition and integration into the UC2S and C2S cloud environments. The proposer shall support NGA in the integration of the toolsets and algorithms into the cloud.

- The proposer shall ensure modified/enhanced prototype toolsets, algorithms, and suite of tools developed during the Base Year and Option Period 1 continue to have the same functionality once transitioned to the cloud. The proposer shall conduct needed regression testing to ensure there is no loss of functionality.

- The proposer shall ensure fully functional and transitioned toolset, algorithms, or suite of tools meet all requirements for this Technical Element.

- Prototype shall meet Section 4 metrics.

3.1.4. TECHNICAL ELEMENT 4 - Predictive Radio Frequency (RF) Mapping; Integrate Material or Acoustic Attributes.

3.1.4.1 Description:

NGA requires a Radio Frequency (RF) propagation toolkit integrated within a 3D ELT software, capable of producing highly detailed models based on high-resolution 3D data derived from light imaging, detection, and ranging (LIDAR) and multi-view stereo (MVS).

3.1.4.2 Technical Requirements:

Base Year:

The proposer shall develop the following RF propagation tool and integrate it into the ELT user interface:

- A tool that models and displays the propagation of electromagnetic energy frequencies outside of the visible spectrum, as they travel through a 3D scene.

- Tool shall incorporate meteorological, ionospheric, and antenna / frequency information in addition to terrain and elevation considerations.

- Prototype shall meet Section 4 metrics.

Option Period 1:

- To further mature this tool, the proposer shall incorporate material types into RF propagation models. This would require a mechanism for modeling and/or tagging materials within a 3-dimensional scene, along with integration of propagation models for commonly utilized RF energy types – including interactions with terrain, buildings, and foliage.

- The proposer shall modify/enhance prototype toolsets, algorithms, or suite of tools developed in the base period, and get them ready for cloud implementation in the Unclassified Commercial Cloud Services (UC2S) and Commercial Cloud Services (C2S) environment.

- The proposer shall ensure modified/enhanced prototype toolsets, algorithms, and suite of tools developed under the base period continues to have the same functionality. The proposer shall conduct needed regression testing to ensure there is no loss of base period functionality.

- Prototype shall meet Section 4 metrics.

Option Period 2:

- The proposer shall modify/enhance prototype toolsets, algorithms, or suite of tools developed in the Base Year and Option Period 1, to optimize them for transition and integration into the UC2S and C2S cloud environments. The proposer shall support NGA in the integration of the toolsets and algorithms into the cloud.

- The proposer shall ensure modified/enhanced prototype toolsets, algorithms, and suite of tools developed during the Base Year and Option Period 1 continue to have the same functionality once transitioned to the cloud. The proposer shall conduct needed regression testing to ensure there is no loss of functionality.

- The proposer shall ensure fully functional and transitioned toolset, algorithms, or suite of tools meet all requirements for this Technical Element.

- Prototype shall meet Section 4 metrics.

3.2. Outside the Scope of this Topic

This solicitation is not intended to replicate, recreate, or invent a new ELT for 3D data types. Therefore, solicitations intending to pursue incompatible ELTs will be out of scope for this solicitation.

NGA will <u>NOT</u> consider submissions that propose the following:

1. Development of new 3D geospatial content.
   (For example, proposals to develop new 3D Multiview stereo processing pipelines or lidar collection systems.)

2. Invention of new hardware or display technology (stereo displays or Virtual Reality (VR) headsets).

3. Creation of new or proprietary data formats or standards.

4. Conception of a new ELT from scratch.

4. Performance Metrics

NGA has defined performance metrics to evaluate effectiveness of proposed solutions in achieving program goal and objectives, and to determine whether satisfactory progress is being made for continuation into option periods.

Table 1 Performance metrics

#	Performance Metric	Description	Base Period	Option Period 1	Option Period 2
1	**3D data types** (applies to <u>all</u> Technical Elements)	Software must be able to support visualization and exploitation of different 3D formats.	Point Clouds (LAS, LAZ, BPF, E57, XYZ) (Geo)Rasters (TIF, DTED, DEM, GRID, NITF) 3D Tiles (I3S) 3D Vectors (KML, STL, DXF) 3D Objects (OBJ, DAE, GLTF, STL, PLY, BIN)		
2	**3D Data Files** (applies to <u>all</u> Technical Elements)	File sizes *(Software must be able to quickly display data. Performers should make judicious use of visualization methods such as decimation and pyramiding/overviews)*	Point Clouds: Threshold: 1 TB in LAZ format. Objective: 3 TB in LAZ format. (Geo)Rasters: Threshold: 8 GB in TIF/Big GeoTIFF format. Objective: 80 GB in TIF/Big GeoTIFF format. 3D Tiles, Vectors, & Objects (cumulative): Threshold: 500 MB Objective: 1 GB		

#	Performance Metric	Description	Base Period	Option Period 1	Option Period 2
3	**Compute Environment** (applies to all Technical Elements)	Software must be able to run in the required environment.	Standalone workstation: Intel Xeon Silver 4108 CPU @ 1.8 GHz 32 GB RAM	Cloud: UC2S and C2S (containerized cloud enabled)	Cloud: UC2S and C2S (containerized cloud enabled)
4	**Image and surface registration** (applies to Technical Element 2)	Software must be able to register data collected at oblique angles	Oblique angles of at least 30° and up to 70° off nadir. Software must be robust to NITF formats, GEOTIFF, etc.		
5	**Line of Sight (LOS) Analysis** (applies to Technical Element 3)	Software must be able to perform Line of Sight analysis over a specified distance, with special consideration for the curvature of the Earth *(accuracy is defined as correctness)*	Analytic product performance increases over current ELT's. Execution speed threshold: 15 minutes Execution speed objective: 10 minutes	LOS tested against discrete points at 85% accuracy up to 6km distance from observer. Execution speed threshold: 10 minutes Execution speed objective: 5 minutes	LOS tested against discrete points at 90% accuracy up to 12km distance from observer. Execution speed threshold: 10 minutes Execution speed objective: 5 minutes
6	**Predictive RF Mapping** (applies to Technical Element 4)	Software can perform predictive mapping incorporating material properties and 3D topology. *(accuracy is defined as areal completeness and correctness)*	Development of an RF Propagation tool successfully embedded within a 3D ELT.	3D ELT integrated RF Propagation tool produces results up to 85% agreement with results from standalone GOTS RF tool, Builder. Execution speed threshold: 10 minutes Execution speed objective: 5 minutes	3D ELT integrated RF Propagation tool produces results up to 90% agreement with results from standalone GOTS RF tool, Builder. Execution speed threshold: 10 minutes Execution speed objective: 5 minutes

Notes:

1. The Government will start performing baseline metrics assessment within the first 6 months of contract performance for all Technical Elements.
2. Some Metrics may change or be dependent on findings from baseline metrics.

5. Deliverable Items

Table 2 Deliverables

#	ITEM	DESCRIPTION	FORMAT / DELIVERY	DUE DATE
01	**Kick-off Briefing**	Technical briefing which outlines the general research approach, internal schedule with expected accomplishments and milestones, and an execution plan.	In-person briefing to PM at proposer facility, not to exceed 8 hours. PowerPoint Presentation delivered 48 hours prior to kickoff date.	15 Days after period of performance start (Base Period and each Option Period)
02	**Monthly Status Report (MSR)**	Provide a summary of work accomplished on current reporting period, any challenges or issues that may impact cost/schedule/performance or needs input, and summary of intended actions for the next reporting period. Report shall also track expenditures (e.g., labor and ODC's) – budgeted, actuals, projected and cumulative totals.	Word Document sent to PM and COR (email)	Monthly
03	**Mid-Point Report, Briefing & Demo**	Report, briefing and demonstration to PM, providing/demonstrating project research progress towards key performance metrics, number of tests performed, algorithm performance analysis, data delivered, scheduled or anticipated tests, and any issues the government should know.	Word Document (report not to exceed 20 pages) and PowerPoint Presentation sent to PM and COR (email) 48 hours before briefing. The PM will receive an in-person briefing at proposer facility and demonstration, not to exceed 8 hours, but also provide sufficient time for Q&A.	Month 6 of base period and each option period.
04	**Algorithm(s) or Tool(s)**	Prototype algorithm or tool for 3D analysis. The algorithm or tool must be independently deployable by NGA as well as replicable to the performer's ELT of choice. An Algorithm Description Document (ADD) shall accompany the deliverable.	The proposer shall include in the deliverables commented source code and compiled binaries submitted to an NGA sponsored code or app repository (i.e. – NGA XC Gitlab). The proposer shall deliver all code and data available to the Government for initial performance evaluation at Month 9 and again for IV&V evaluation at Month 11	Prototype algorithm: Month 6 of base period and each option period Initial Performance and evaluation: Month 9 of base period and each option period IV&V ready algorithms: Month 11 of base period and each option period

#	ITEM	DESCRIPTION	FORMAT / DELIVERY	DUE DATE
05	**Algorithm Description Document (ADD)**	Documentation intended to assist NGA in deployment and use of the algorithm or tool. This documentation will describe the functions of the tool, and will serve as an analyst/user manual which can be disseminated upon larger deployment of the algorithm or tool.	Word document sent to the PM and COR (email). The same document will also accompany the algorithm or tool deliverables in an NGA-sponsored code or app repository	Prototype algorithm: Month 6 of base period and each option period Initial Performance and evaluation: Month 9 of base period and each option period IV&V ready algorithms: Month 11 of base period and each option period
06	**Close-out briefing and algorithm demo**	Final briefing and algorithm demonstration to the government on project results.	PowerPoint Presentation; can be presented virtually.	NLT 45 days before end of Base Period and each option period.
07	**Final report**	Final technical report summarizes the work performed and the results of the investigation.	Word Document sent to PM and COR (email)	NLT 15 days before end of Base PoP and each option period.

6. Intellectual Property Considerations

Data Rights: NGA anticipates that achieving the goals of the program will necessitate Government Purpose Rights or greater in all deliverables.

Software Licenses: The proposer shall secure for the government paid licenses of suitable scope for any third-party software incorporated into contract deliverables.

Notwithstanding these assumptions, the government acknowledges the possibility that other approaches proposed by proposers may also achieve program goals.

Proposers shall include Data Rights assertions within their proposals as required per BIG-R BAA General Solicitation. Proposers shall follow DFARS 252.227-7017 'Identification and Assertion of Use, Release, or Disclosure Restrictions' to make these assertions.

7. Government Furnished Information

The Government will provide data for this effort, including but not limited to a validation reference dataset as government furnished information. Data provided by the Government will not exceed the FOUO level of security.

Table 3 GFI

ITEM	DESCRIPTION	FORMAT/SIZE	DATE
GPM 1.1 Spec	Specification for Generic Point Model (GPM) Guidance document.	PDF file	To be provided within 10 days after base period of performance start.
3D SIG	Standard Implementation Guidance (SIG) document.	PDF file	To be provided within 10 days after base period of performance start.
GRiD API	Application Program Interface for GRiD	API SW	To be provided within 10 days after base period of performance start.
Reference 3-D Geospatial data	Validation Reference Data	Vector Dataset	To be provided within 10 days after base period of performance start.

8. Security Considerations

Work under this effort will be up to the Controlled Unclassified Information (CUI) level.

8.1. Unclassified Work Performance Security Requirements

8.1.1. Uncleared Contractor personnel are authorized to work on this contract at the Unclassified level, with access up to DoD Controlled Unclassified Information (CUI) at the Contractor site without the requirement of a security clearance.

8.1.2. Proposers shall state within their proposals whether developmental efforts will be subject to Export Control Classification Number (ECCN) 0D521 No. 1 in the 0Y521 series table, found in Supplement No. 5 to part 774 of the Export Administration Regulations (EAR), which can be found here: https://www.bis.doc.gov/index.php/regulations/export-administration-regulations-ear.

8.2. Uncleared Personnel Security Requirements

8.2.1. Any Contractor personnel working with CUI information must receive a favorable HSPD-12 and/or HSPD-12 Tier 1 adjudication prior to accessing CUI information. Contractor personnel who require access to CUI for 60 days or less must receive a favorable HSPD-12 adjudication. Contractor personnel who require CUI access for more than 60 days must receive a favorable HSPD-12 Tier 1 adjudication.

8.2.2. NGA will sponsor the HSPD-12 and HSPD-12 Tier 1 background investigation for Contractor personnel as needed. Per NGA policy, Contractor personnel submitted for SCI access cannot be submitted for an HSPD-12 or HSPD-12 Tier 1 adjudication while waiting for NGA to adjudicate their SCI access.

8.2.3. Foreign nationals are not permitted to perform unclassified work under the terms of this contract without prior written approval from the Contracting Officer (CO) or the COR. Should NGA identify the use of unauthorized personnel, the CO may direct the Contractor, at its own expense, to remove and replace any unauthorized Contractors, Subcontractors, or other personnel performing on the contract. Such action may be taken at the NGA's discretion without prejudice to its rights under any other contract provision, e.g., termination for default.

8.2.4. Uncleared Contractor personnel visiting NGA facilities or other sites may receive the appropriate visitor badge and be escorted, as appropriate. The Contractor will return the visitor badge at the end of each visit day.

8.3. Information Security Requirements

8.3.1. NGA shall have the sole authority to determine whether, and to what extent, protected information shall be provided to the Contractor under the terms of the contract. Access to classified information will be pursuant to the security requirements established in the DD254. The Contractor shall not access, download, print, or further disseminate any classified information outside the execution of the defined contract requirements without the guidance and written permission from the COR.

8.3.2. When the Contractor receives protected information under the terms of this contract, the Contractor will comply with all applicable NGA, DoD, and IC information security policies (including the Consolidated NGA (CoNGA) Security Classification Guide) for the proper marking, handling, processing, storing, and safeguarding of classified and unclassified material. The Contractor will ensure that document markings are given the lowest possible security classification to maximize dissemination while still maintaining the information's confidentiality and integrity as necessary.

8.3.3. Access to CUI will be pursuant to DFARS clause 252.204.7012. The prime contractor shall include this clause, including paragraph (m), in subcontracts, or similar contractual instruments, for operationally critical support or for which subcontract performance will involve covered defense information, including subcontracts for commercial items, without alteration, except to identify the parties. The Contractor shall determine if the information required for Subcontractor performance retains its identity as covered defense information and will require protection under this clause. Contractor personnel shall not release any unclassified information, regardless of medium (e.g., film, tape, document), pertaining to any part of this contract or any program related to this contract, unless the COR has given prior written approval or in performance of a project that has been scoped and negotiated by NGA.

8.3.4. NGA will assess and authorize Contractors to process classified information on government-owned information systems, conduct oversight of such information system processing, and provide information system security guidelines IAW with FAR clause 52.204-21 and other information system security control policies, standards, and procedures. Contractor will be responsible for executing specific provisions under the contract for the accreditation of classified information systems, and upon request, shall provide the COR a written statement confirming accreditation compliance with the minimum information systems requirements established in the DD254. The Contractor shall include the substance of FAR clause 52.204-21 in subcontracts under this contract (including subcontracts for the acquisition of commercial products or commercial services, other than commercially available off-the-shelf items), in which the Subcontractor may have federal contract information residing in or transiting through its information system.

8.3.5. In accordance with FAR Part 4.7 and FAR clause 52.215-2, the Contractor may retain one archival copy of any Government-furnished information provided to the Contractor during the course of performance of the contract, subject to Contractor following relevant data safeguarding practices and CUI restrictions. The disposition of such Government-furnished information and/or equipment is otherwise solely at the discretion of the Government. As directed by the NGA CO or COR, the Contractor will destroy or return to NGA such Government-furnished information and/or equipment upon contract termination or when no longer required for contract performance.

8.3.6. In situations when electronic transmission is not practicable, Cleared Contractor personnel may hand-carry contract-related classified information when authorized by the COR in writing. Approved Contractor personnel must obtain NGA courier authorization prior to hand-carrying of classified contract-related information. Only classified information related to the performance of this contract may be hand-carried. Contractor personnel will be limited to hand-carrying classified information between approved Contractor facilities and US Government facilities unless the COR approves other circumstances in writing, when applicable, on a case-by-case basis.

8.4. Cybersecurity Requirements

8.4.1. The Contractor must, at a minimum, implement 10 U.S.C. Sections 391 and 393 along with National Institute of Standards and Technology (NIST) Special Publication (SP) 800-171, "Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations" requirements.

8.4.2. If the Contractor intends to use an external cloud service provider to store, process, or transmit any covered defense information in performance of this contract, the Contractor shall require and ensure that the cloud service provider meets security requirements equivalent to those established by the Government for the Federal Risk and Authorization Management Program (FedRAMP) Moderate baseline (https://www.fedramp.gov/resources/documents/)

8.4.3. In the event that the Contractor discovers a cyber incident that affects a covered Contractor information system or covered defense information residing therein, or that affects the Contractor's ability to perform the requirements of the contract that are designated as operationally critical support and identified in the contract, the Contractor shall—

1. Notify the DoD Cyber Crime Center (DC3) and the COR in writing within 72 hours of incident discovery
2. Conduct a review for evidence of compromise of covered defense information, including, but not limited to, identifying compromised computers, servers, specific data, and user accounts. This review shall also include analyzing covered Contractor information system(s) that were part of the cyber incident, as well as other information systems on the Contractor's network(s), that may have been accessed as a result of the incident in order to identify compromised covered defense information, or that affect the Contractor's ability to provide operationally critical support.

8.4.4. In the event the Contractor discovers and isolates malicious software in connection with a reported cyber incident, the Contractor shall submit the malicious software to DC3 in accordance with instructions provided by the COR. The Contractor should NOT send the malicious software to the COR.

9. Abstract & Proposal Requirements

In addition to the submission requirements of the BIG-R BAA General Solicitation, Rev5, proposers shall include the following information within their abstracts and proposals.

9.1. Page Limitations

9.1.1. Abstracts

The following paragraphs list changed page limitations to BIG-R BAA General Solicitation, Part IV, Section 5.1.1.

- Abstracts are limited to 2 pages per Technical Element.
- If abstract covers all 4 Technical Elements, it shall not exceed 8 pages.

9.1.2. Proposals

The following paragraphs list changed page limitations to BIG-R BAA General Solicitation, Part IV, Section 6.2.

- Proposal Volume 2 is limited to 6 pages per Technical Element, not including the Statement of Work (SOW). SOW is limited to 5 pages.

- If proposal covers all 4 Technical Elements, Volume 2 shall not exceed 29 pages, to include the SOW.

9.2. Proposal Volume 3 – Cost/Price

The following paragraphs list additional requirements to BIG-R BAA General Solicitation, Part IV "Abstract and Proposal Submission Information", Section 6.3.3 Volume 3 – "Cost/Price".

The proposal shall separate cost/price by Technical Element and under each Technical Element by base and option periods.

Labor, material/equipment/other direct costs (ODC), and travel shall clearly be broken out on separate contract line items.

A sample CLIN structure for a procurement contract is listed below:

CLIN	Description	Length
0001	Technical Element 1 (R&D Labor)	12 months
0002	Technical Element 2 (R&D Labor)	12 months
0003	Technical Element 3 (R&D Labor)	12 months
0004	Technical Element 4 (R&D Labor)	12 months
0005*	Equipment/Material/ODC (Cost, No Fee)	12 months
0006*	Travel (Cost, No Fee)	12 months
1001	Technical Element 1 (R&D Labor)	12 months
1002	Technical Element 2 (R&D Labor)	12 months
1003	Technical Element 3 (R&D Labor)	12 months
1004	Technical Element 4 (R&D Labor)	12 months
1005*	Equipment/Material/ODC (Cost, No Fee)	12 months
1006*	Travel (Cost, No Fee)	12 months
2001	Technical Element 1 (R&D Labor)	12 months
2002	Technical Element 2 (R&D Labor)	12 months
2003	Technical Element 3 (R&D Labor)	12 months
2004	Technical Element 4 (R&D Labor)	12 months
2005*	Equipment/Material/ODC (Cost, No Fee)	12 months
2006*	Travel (Cost, No Fee)	12 months
TOTAL		**36 months**

* For simplicity reasons, these CLINs were not further broken out into sub-CLINs for each Technical Element in the above example.

10. Performance

10.1. Place of Performance:

The proposer shall perform work in a proposer facility anywhere in the United States.

10.2. Period of Performance (PoP):

Base Period: Twelve (12) Months

Option Period One (1): Twelve (12) Months

Option Period Two (2): Twelve (12) Months

11. Clauses

The following paragraphs list additional information to BIG-R BAA General Solicitation, Attachment 5.

5X52.209.9004 Use of Contractor Support (OCT 2009)

(a) The Government will use S2 Analytical Solutions, Vysnova Partners, Inc., InSPIRE, ProCleared, RTI Consulting, ACS, LBO Technology, Strategic ACI, Accolade, Princip, Arion Systems Inc., and MITRE for administrative and/or technical support during source selection and during the term of any resulting contract. The exclusive responsibility for source selection will reside with the Government.

(b) Proprietary information submitted in response to this solicitation will be protected from unauthorized disclosure as required by Subsection 27 of the Office of Procurement Policy Act as amended (the Procurement Integrity Act)(41 U.S.C. 423) (hereinafter referred to as "the Act") as implemented in the FAR. S2 Analytical Solutions, Vysnova Partners, Inc., InSPIRE, ProCleared, RTI Consulting, ACS, LBO Technology, Strategic ACI, Accolade, Princip, Arion Systems Inc., and MITRE are bound contractually by the Protection of Information and Nondisclosure Agreements clause with respect to proprietary information. By submitting a proposal in response to this solicitation, the Contractor consents to the Government disclosing Contractor proprietary information to the aforementioned contractors for the purposes indicated.

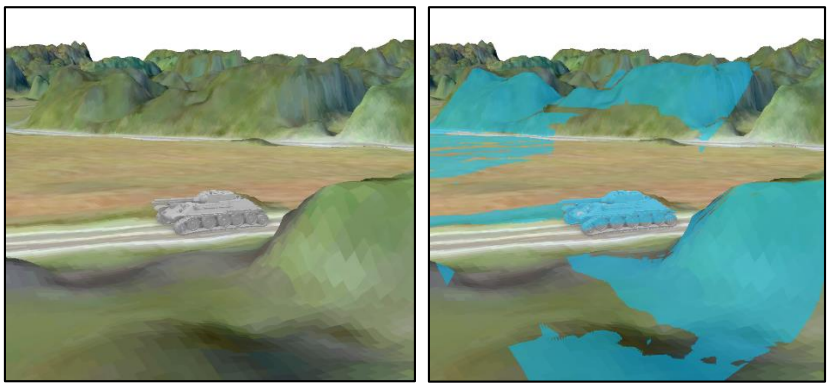
(End of Provision)

Appendix 1 Supplemental Information - Technical Elements

TECHNICAL ELEMENT 1 - Simultaneous Co-Exploitation of Digital Surface Model (DSM), Point Cloud (PC), Mesh Surfaces and Vectorized Geographic 3D Features (Section 3.1.1)

NGA requires the ability to interact with multiple 3D data types concurrently within an ELT. These data types include: a) point clouds; b) DSM/ Digital Elevation Model (DEM); c) mesh formats; and d) vectorized 3D features, including AI/ML derived features. Software tools must read, convert, and support analysis between all four of these data types, and facilitate interoperability between different 3D data types within the same platform. This will enable analysts to efficiently overlay and analyze 3D data from disparate sources, scales, and methods of collection/generation.

Interoperability between the four primary 3D data types described above will also enable a greater proportion of objects represented in 3D scenes to remain an accurate representation of the real-world 3D geometry of the scene. This will be useful in cases where an entire scene is represented in 2.5D, even though 3D content is present, as occurs in interpolated terrain data sets. For example, the images below demonstrate an example of how 3D objects from disparate sources should behave within a broader 3D scene. The image on the left shows an OBJ tank model imported into a 2.5D terrain scene, the image on the right demonstrates that the object is fully integrated into the scene and recognized by the software as an obstruction when running viewshed (i.e., geographical area visible from a location) analysis.

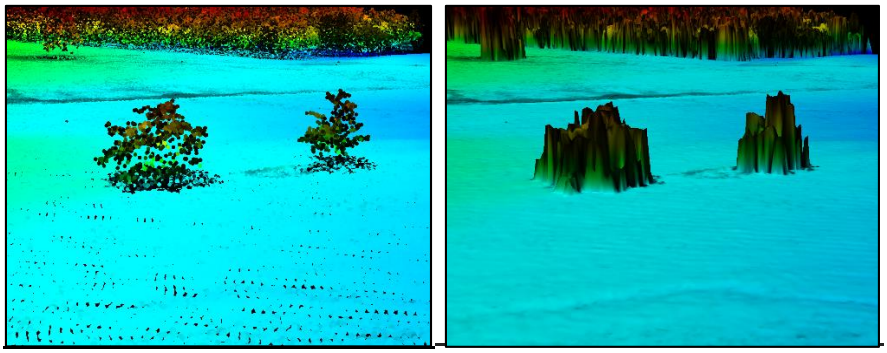


NGA also needs advanced interpolation methods to derive more accurate representations of 3D objects in 3D ELT software, to include vehicles, vegetation, and buildings. Examples of current deficiencies in 3D scenes include the following:

- Tree canopies are interpolated straight to the ground from the widest basal circumference in DSM's, giving a false representation of the effect of the tree on visibility in the scene.
- Features on the sides and lower part of vehicle frames are obfuscated by to-the-ground interpolation methods.
- Transparent features on building sides (windows and doors) that are captured in terrestrial scanning, or from sufficiently oblique airborne collection angles, become 'closed' in interpolation and buildings facades, and are usually obfuscated by standard terrain-based interpolation methods.

These examples have significant effects on 3D analysis and exploitation, especially for viewsheds, and may represent difficult and computationally intensive tasks when applied across an entire 3D scene. Therefore, it would be useful to allow users to specify or mask objects and/or regions, to then apply advanced interpolation or exclusion methods.

Finally, NGA requires a means to select and convert point cloud features into solid features, to better represent the area and structure of the object in question. The below images illustrate an example. The left image shows trees represented in point cloud form, viewed from near-ground level. When the data is interpolated into a gridded DSM, these trees become solid blocks of pixels and their impact on ground level visibility is misrepresented. NGA requires the ability to select or fence these areas, and convert or interpolate them in a manner that better represents the feature. The 3D datatype of the resulting features may be any mesh or vectorized 3D format.



TECHNICAL ELEMENT 2 - Automated Image and Surface Registration (Section 3.1.2)

No additional information for this Technical Element.

TECHNICAL ELEMENT 3 - Line-of-Sight (LOS) Enhancements (Section 3.1.3)

NGA requires a more robust tool for viewshed (i.e., the geographical area visible from a location), and point to point LOS analyses over large scales, from multiple viewing angles, and able to incorporate multiple data types. The enhanced tool should include the following capabilities:

1. Area Inter-visibility

NGA requires an area inter-visibility capability that can use previously described LOS enhancements, in which an analyst can accumulate visibility scores, and calculate a heatmap of cumulative "exposure" for every location in a scene. The capability should allow analysts to determine high visibility and low visibility areas in a scene using cumulative exposure heatmap (see example below), and develop optimal paths of travel from place to place, to reduce traveler exposure to observers without needing to know precisely where those observers may be.

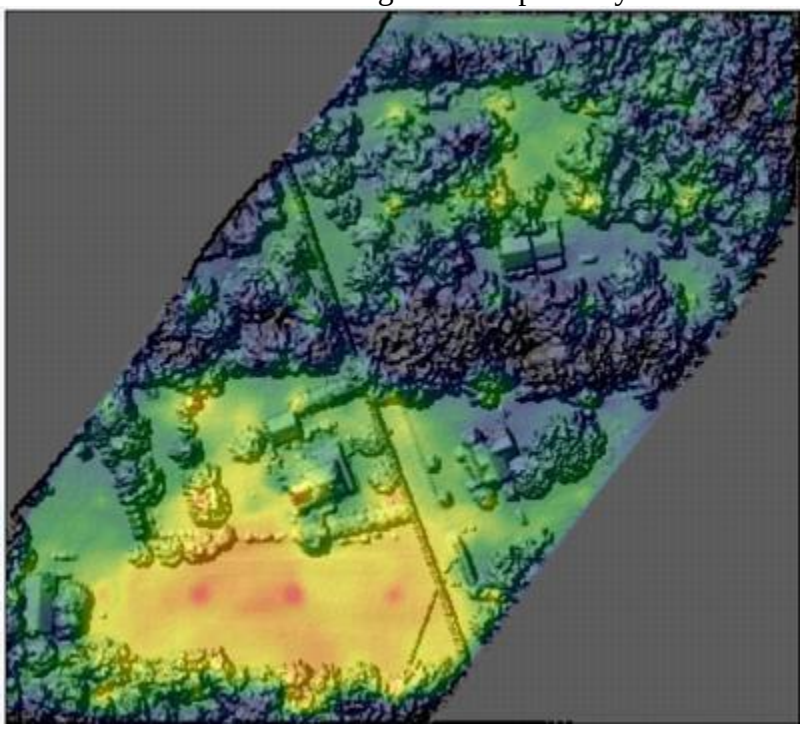


Figure 1. Inter-visibility example. Red areas in the scene are more exposed than blue areas

2. Non-overlapping observer/data surfaces

The tool will be capable of answering "what if" questions. For instance, modeling the visibility to a point on the surface model, from locations that are not within the boundaries of the loaded dataset, including modeling visibility from overhead azimuths to points on the surface, and accurate modeling of visibility over large distances where the curvature of the earth must be taken into consideration (e.g. from an aircraft or satellite to the ground). The tool should be able to simulate lighting conditions at different times of day/night.

643 *3. Area (polygonal) observers*

644 Existing LOS tools assume a single observer in a discrete location, but there are times when an
645 analyst may know the general area where an observer will be, but not exactly where an observer
646 will be at any given time (e.g., an observer patrolling a rooftop of a building in an urban setting).
647 Therefore, the LOS tool will possess the capability to determine inter-visibility by specifying an
648 area (or polygon) to act as the observation origin. For example, the tool can determine the
649 visibility from a soldier patrolling a rooftop on foot through a user defined polygon of the
650 rooftop, with the entire area enclosed within the polygon acting as the observation origin.
651
652 *4. Vegetation/Vertical Features*

653 NGA requires a LOS tool capable of functioning on 3D geospatial data of any type including,
654 but not necessarily limited to, DSM/DEM, point clouds, surfaces (Vectorized 3D features), and
655 meshes. Tools will be adjustable to account for the richness of point cloud data. Often,
656 performing LOS calculations on gridded elevation models is challenging, due to the way features
657 like trees and powerlines are represented as solid objects that prevent viewers from "seeing"
658 through them or under them. By utilizing point clouds as the basis for LOS measurements, many
659 of those issues can be avoided. There are multiple descriptions of various approaches to this
660 problem in the literature.
661 The images below illustrate this problem. The image in figure 1 shows a house with a tree,
662 bushes, and powerlines. Figure 2 is a line of sight analysis of the same observer on a Digital
663 Elevation Map (DEM), where the trees and powerlines are represented as solid features. This
664 LOS is obviously incorrect. Figure 3 shows a LOS from the same observer, but run on the
665 original point cloud, which produces a more accurate product.


Fig 1. Ground Truth

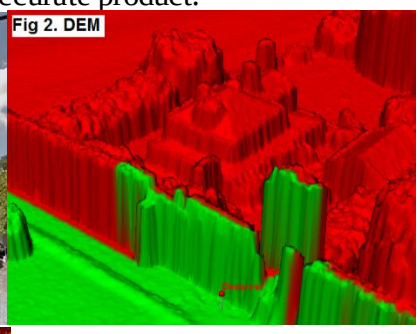


Fig 2. DEM

666

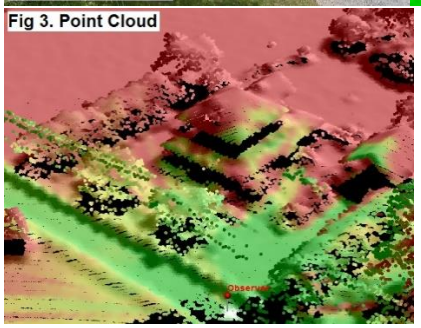


Fig 3. Point Cloud

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668

5. Error/Uncertainly Representation

NGA requires a LOS tool capable of conveying uncertainty. This uncertainty could come from positional uncertainty from incorporating an available sensor model (e.g. GPM 1.1) information, or the uncertainty stemming from land cover types, representations of buildings, or lighting conditions. Rather than a strictly binary representation of visible/not visible when running a LOS in a typical mixed urban environment consisting of buildings, vegetation/trees, and transient objects (e.g. vehicles/people), it would be useful for a LOS tool to provide a multi-variate or a probabilistic output. For example, the tool can convey to users that an observer may be able to see partly through vegetation, or that the transient features may or may not be there, or that buildings may not be represented with sharp edge features (e.g., helping to correct for the 'melted chocolate bar' appearance of geometric features found in some 3D products).

TECHNICAL ELEMENT 4 - Predictive Radio Frequency (RF) Mapping; Integrate Material or Acoustic Attributes (Section 3.1.4)

No additional information provided on Technical Element 4.