SINTRA (Space debris Identification and Tracking) Proposers' Day

Dr. Alexis Truitt| Program Manager | 10 August 2022

Intelligence Advanced Research Projects Activity

IARPA

Creating Advantage through Research and Technology

SINTRA

Welcome to the SINTRA Proposers' Day!

- Thank you for your interest in SINTRA and your participation.
- To better ensure a clear broadcast stream, virtual attendees' microphones are muted, and their cameras are turned off.
- Comments and questions can be submitted to the alias dni-iarpa-SINTRA-proposersday@iarpa.gov during the meeting.
  - Chat feature is enabled. Questions may be sent to "Panelists".
  - Written questions submitted on index cards to Registration Desk.
- No questions will be fielded during talks.

Disclaimers

- This presentation is provided solely for information and planning purposes.
- Proposers' Day does not constitute a formal solicitation for proposals or proposal abstracts.
- **The Broad Agency Announcement (BAA) language supersedes anything presented or said by IARPA at Proposers' Day.**
- This meeting is being recorded for later public posting.
- For those viewing the recording, be aware that email addresses, links, and POCs may be outdated. Please refer to IARPA.gov for current information.

Proposers' Day Goals

1. Familiarize participants with IARPA's outline of the SINTRA Program and solicit questions and feedback
2. Foster discussion among potential Program participants
3. Introduce a sampling of USG capabilities
4. Additional information can be found at the following address: **https://www.iarpa.gov/research-programs/sintra**
   - Capability Statements, Lightning Talks, and Posters will be posted publicly on the SINTRA IARPA webpage until the BAA submission period closes.

Collaborations

- Collaboration is encouraged; SINTRA is a highly interdisciplinary endeavor.
- Lightning-Talk session at 1:35; Teaming Discussions at 3:55 pm EDT.
- Capability Statements will be received and posted publicly, pending minimal review for appropriateness.
  - Capability Statements can be submitted until the BAA closes.
  - Submit Capability Statements to dni-iarpa-SINTRA-proposersday@iarpa.gov .
- Lightning Talks, Capability Statements, Posters, etc. are professional material for peers to explore collaborations and resources, for forming the best proposal. The Government's evaluation resides only with the proposal.

Feedback and Questions

- We will break after the contracting presentation at 12:00 pm EDT.
- Questions submitted by **12:30 pm EDT** will be considered for a response in the afternoon session.
- Presentations resume at 1:00 pm EDT, with IARPA's responses to selected questions.
  - All questions will be captured but only a selected subset will be answered in this session.
  - Questions may be submitted to the IARPA team email at dni-iarpa-SINTRA-proposersday@iarpa.gov until a BAA is published (sam.gov).

Agenda

Time	Topic	Speaker
10:00am-10:30am	(Attendees can log in early)	
10:30am-10:40am	Welcome, Logistics, Proposers' Day Goals	Alexis Truitt, Program Manager
10:40am-10:50am	IARPA Overview	Pedro Espina, Office Director, Collection Research, IARPA
10:50am-11:40am	SINTRA Program Overview	Alexis Truitt
11:40am-12:00pm	Contracting Overview	Michelle Crecca, IARPA Contracting Officer
12:00pm-1:00pm	Break / No Host Lunch (Submit questions in chat before 12:00pm)	
1:00pm-1:30pm	Answers to Selected Technical Questions	Alexis Truitt
1:30pm-1:35pm	Introductions to Lightning Talks	Alexis Truitt
1:35pm-3:55pm (est.)	Lightning Talks*	Selected Presenters
3:55pm-5:00pm	Teaming Discussions*	In-Person Participants

* Government will not attend

Lightning Talks Agenda

Please submit questions in the Chat section before 12:30pm ET.

Number	Time (EDT)	Speaker	Organization	In person
	1:30 – 1:35 PM	Lightning Talk Intro	IARPA	YES
1	1:35 – 1:40 PM	David Brady	University of Arizona	YES
2	1:40 – 1:45 PM	Daniel Whalen	Axyde Analytics / Precursor SPC.	YES
3	1:45 – 1:50 PM	Alex Isaac	Calypso AI	YES
4	1:50 – 1:55 PM	Scott McCloskey	Kitware	YES
5	1:55 – 2:00 PM	Alexander Moskowitz	VISIMO	YES
6	2:00 – 2:05 PM	Paul Bernhardt	University of Alaska Fairbanks	YES
7	2:05 – 2:10 PM	George Hou	InterSystems	YES
8	2:10 – 2:15 PM	Dennis Lehan	II-VI Aerospace & Defense	YES
9	2:15 – 2:20 PM	Jeff Willey	RFNav	YES
10	2:20 – 2:25 PM	Lindy Dejarme	Battelle	YES
11	2:25 – 2:30 PM	Aroh Barjatya	Embry-Riddle Aeronautical University	YES
12	2:30 – 2:35 PM	Glenn Tyler	BlueHalo	YES
13	2:35 – 2:40 PM	Christine Hartzell	University of Maryland	YES
14	2:40 – 2:45 PM	Robin Dawson	SiOnyx	YES
15	2:45 – 2:50 PM	John Petillo	Leidos	YES
16	2:50 – 2:55 PM	Anne Hillegas	Arete	YES
17	2:55 – 3:00 PM	Denny Brisley	NorthStar Earth & Space Systems, Inc.	YES
18	3:00 – 3:05 PM	Nilton De Oliveira Renno	University of Michigan	YES
19	3:05 – 3:10 PM	Bill Amatucci	Naval Research Laboratory	NO
20	3:10 – 3:15 PM	Peter Zimmer	J.T. McGraw and Associates, LLC	NO
21	3:15 – 3:20 PM	Justin Greene	IERUS Technologies Inc	NO
22	3:20 – 3:25 PM	Will Dupree	Aptima, Inc.	NO
23	3:25 – 3:30 PM	Victor Bucklew	L3Harris Technologies	NO
24	3:30 – 3:35 PM	Brendan (Ben) Quine	ThothX LLC	NO
25	3:35 – 3:40 PM	Christopher Nebelecky	CUBRC, Inc	NO
26	3:40 – 3:45 PM	Chris Agh	Toyon Research Corp	NO
27	3:45 – 3:50 PM	Jeff Kuhn	MorphOptic	NO
28	3:50 – 3:55 PM	Ilana Heintz	Synoptic Engineering	NO

IARPA
High Risk/High Payoff Research for the IC

Pedro Espina| Director, IARPA Office of Collections | August 10, 2022

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IARPA Mission

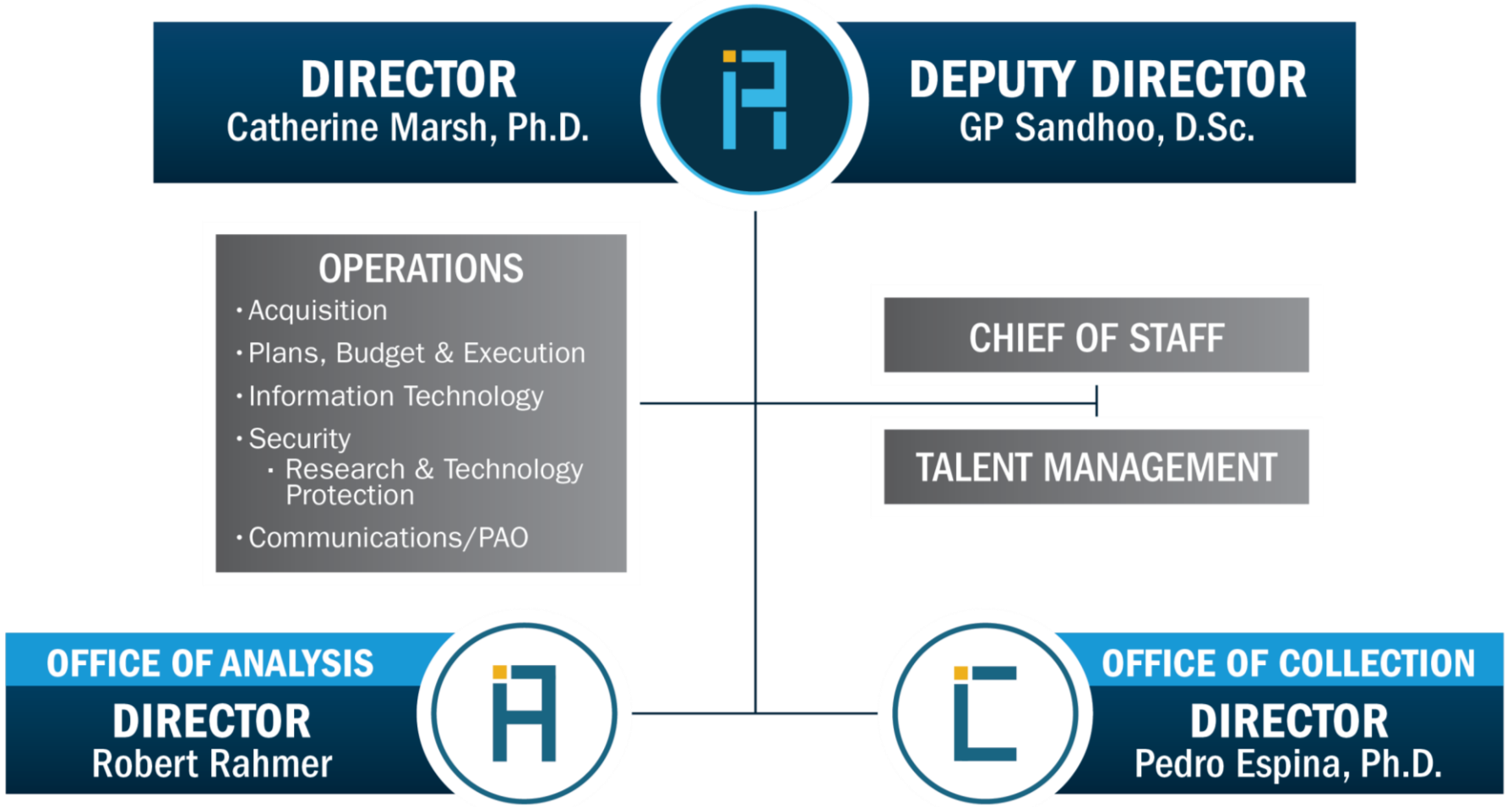
IARPA's mission is to invest in high-risk/high-payoff research that has the potential to provide the U.S. with an overwhelming intelligence advantage over our future adversaries

- **Our problems are *complex* and truly *multidisciplinary***
- **We emphasize *Technical Excellence & Technical Truth***
  - Scientific Method
  - Peer/independent review
  - Full and open competition

Chartered to be Different

- **About taking real risk**
  - NOT about “quick wins”, “low-hanging fruit”, “sure things”, etc.
  - Relatively small size
  - Lean, non-bureaucratic structure
- **Failure is completely acceptable as long as…**
  - It is not due to failure to maintain technical and programmatic integrity
  - Results are fully documented
- **Leverage the best and brightest**
  - Focus on potentially change-state technologies
  - Highly flexible and adaptive research program
  - Competitive awards and world-class Program Managers.
  - Every IARPA program will start with a great idea and a qualified program manager to lead it. Without both, IARPA will not start a program.
- **Maintain a cross-community focus**
  - Address cross-agency challenges
  - Leverage IC partner agency expertise (both operational and R&D)
  - Work transition strategies and plans

Organization



Office of Analysis

BETTER

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Advancing Biodosimetry

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Office of Collection

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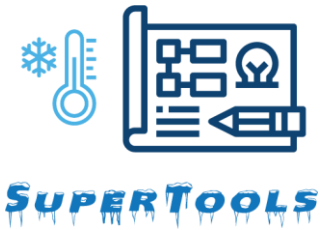

IARPA Summary

- **Invest in high-risk, high-payoff research to achieve an overwhelming intelligence advantage for the Nation**
- **Constantly developing new programs based on the problems and challenges facing the IC**
- **Use full and open competition, engaging the best of academia and industry, with challenging goals & rigorous, independent testing**
  - ~2,200 unique bidders to our programs
  - T&E with FFRDCs, UARCs, National Labs, Government Labs
- **3000+ journal articles published**
- **Have delivered technology to 17 IC agencies: >75% of our programs have resulted in at least one tech transition**

IARPA Highlights

"One of the government's most creative agencies"

– David Brooks, NYTimes

- **Process innovations:**
  - Security, Civil Liberty, & Privacy Protection reviews of all research
  - Research & Technology Protection: Executive Branch "best practice"
  - Internal R&D contracting shortening award timelines
  - Proposers' Days for industry-academia matchmaking
  - Prize Challenges cost-effectively drawing solutions from untraditional innovators
- **Research breakthroughs:**
  - Quantum Computing: Science Breakthrough of the Year
  - Privacy Assurance: MacArthur Genius Prize
  - Human Judgment: world's largest forecasting experiment
  - Microelectronics supply chain: security through split manufacturing

How to Engage with IARPA

ENGAGE WITH US

Throughout our website you can learn more about engaging with us on our highly innovative work that is having a positive impact in the Intelligence Community and society in general.

iarpa.gov | 301-243-1995

dni-iarpa-info@iarpa.gov

- Reach out to our Program Managers.
- Schedule a visit if you are in the DC area or invite us to visit you

Open BAAs

Broad Agency Announcements (BAAs) solicit research proposals for specific programs. Learn more about current BAA opportunities and ways to get involved...

Requests For Information

Requests for Information (RFIs) are designed to gather more information on an idea in an area in which our program managers are not fully informed...

Seedlings

Seedlings are typically 9 – 12 month research efforts that are less than $1M in cost. They are intended to address highly innovative ideas and concepts within...

SINTRA Overview

Dr. Alexis Truitt | Program Manager | SINTRA Proposers' Day, 10 August 2022

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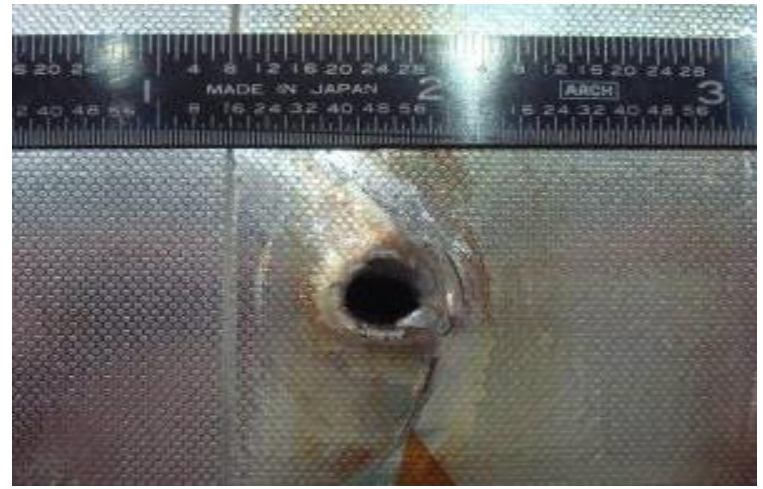
Disclaimer

- This talk contains illustrations, intended only for illustrative purposes.
- Any resemblance to specific architectures, protocols, hardware, and/or other infrastructure is purely accidental and not intended as a preference or endorsement of approach.

Orbital Debris

- The debris population is increasing.

  As of 2019:
  - 23,000 debris objects > 10 cm
  - 500,000 objects > 1 cm
  - 100 million debris objects > 1 mm



Orbital debris size approx 1.5mm created a 6mm entry, 15mm exit impact on Endeavor radiator [3].

- Objects less than 5 cm are difficult to detect even in low Earth orbit (LEO); estimates rely heavily on statistical sampling and modeling techniques.
- Orbital debris is hazardous to space assets and astronauts.
  - Average impact speed 10 km/s (22,000 mph) in LEO.
  - Large debris (>10 cm) impacts can result in catastrophic destruction of the satellite.
  - Smaller debris impacts can cause mission failure.
- **Less than 1 percent of the debris objects that could cause mission-ending damage are currently tracked.**
  - Debris > 10 cm are tracked, shields are effective for debris < 1 cm
  - The biggest threat is 1 - 10cm size debris
  - Risk is driven by debris 1-2cm, more smaller debris due to power law size distribution

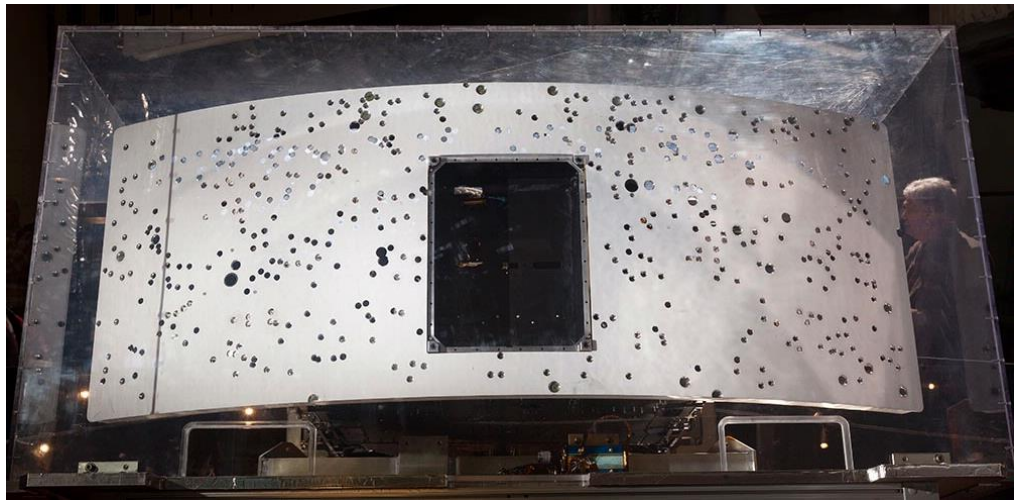
100 Million Debris Objects

Jan 2019
ESA.int

Distribution of 100 million debris objects, sizes not to scale.

Motivation

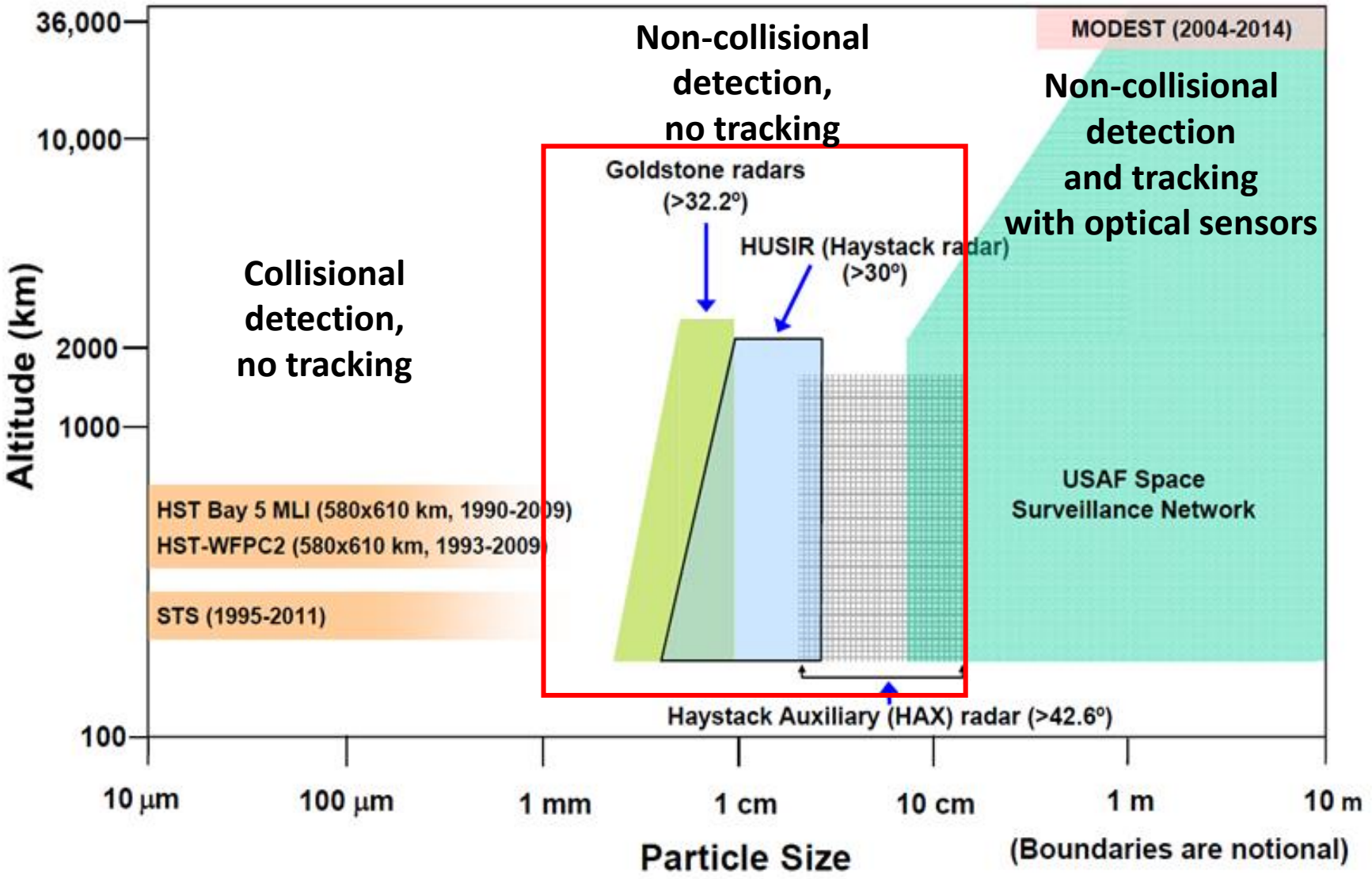
- The U.S. faces **the greatest risk** to an unstable debris environment.
  - Operates half of all LEO spacecraft, three times more than any other entity
  - Most likely to incur financial and operational loss
- There are **no international regulations** for safe and sustainable space operations, including debris mitigation.



Hubble radiator panel showing count of debris impacts (cut out for analysis) [25]

- We have reached the **point of no return (Kessler Syndrome)**.
  - By 2005, the amount of debris in LEO has grown to the point that collisions will continue even if no other objects were launched into orbit.
  - Instead, the largest increases of new spacecraft and debris generation have occurred since 2006.

Current Limitations



Problem Statement

The **world** does not have a reliable and persistent solution to track small space debris, which results in high risk for space assets being adversely affected by orbital debris impacts.

- Current Limitations
  - Debris less than 10 cm cannot be tracked, only detected
  - Debris is insufficiently characterized for accurate risk assessments. An object's size, shape, mass, and velocity all affect how much damage occurs upon impact.
  - Uncertainties are high in tracking objects and propagating orbits, due to compounding effects of atmospheric drag, space weather, and other nongravitational perturbations that may be difficult to predict.

Hypervelocity testing
Aluminum impacting aluminum
Left: A 1.2 cm sphere at 6.8 km/s.
Right: A 1.3 cm sphere at 7 km/s.
Figures from NASA.gov

SINTRA Objectives

SINTRA is planned as 48-month multi-phase program which will drive the state-of-the-art for exploitation of data from **existing sensors** and **new low-cost sensors** capable of:

- detecting orbital debris signatures,
- demonstrating signature detection, and
- developing automated methods for signature analysis, debris tracking, and debris characterization.

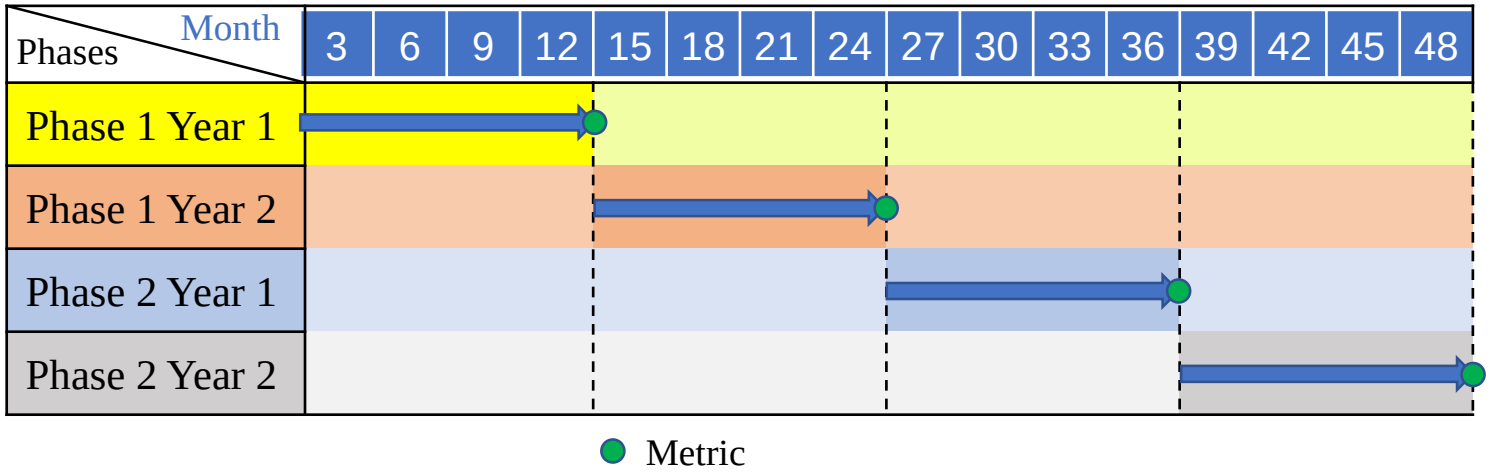
SINTRA will aim to:

- develop innovative technologies to improve orbital debris detection and tracking;
- reduce uncertainties of debris data in orbit propagation and prediction;
- characterize orbital debris size, density, and mass; and
- facilitate transition of debris research to be further developed into operational capabilities

Program Phases

- The SINTRA program is anticipated to be a 4-year (48 month) effort, comprised of two (2) Phases. Both Phases are being solicited under this BAA. Both Phases will be 24 months in duration.
- Phase 1 milestones:
  - (1) debris signature detection
  - (2) debris tracking
  - (3) debris characterization
- Phase 2 milestones:
  - (1) debris detection time
  - (2) detection rate
  - (3) revisit rate
- Regression testing will be conducted during Phase 2 to ensure that the Phase 1 performance of Performer software deliverables is maintained during Phase 2 development.

SINTRA Program Phases and Metrics



Final Metrics

Detection: > 90%
False alarm: < 2%
Tracking: 2 – 10 km (LEO – GEO)
Characterization: +/- 1000 (kg/m^3)
Revisit: < 2 hrs

Phase 1 Year 1 (12 months)	Phase 1 Year 2 (12 months)	Phase 2 Year 1 (12 months)	Phase 2 Year 2 (12 months)
Demonstrate capability to detect, track, and characterize known debris objects	**Extend capability to unknown debris objects 0.1 – 40 cm in size***	**Demonstrate ability to persistently monitor known tracked debris objects**	**Extend monitoring to unknown debris objects***
Size: 10 cm – 40 cm **Orbit: LEO**	**Size: 0.10 cm – 40 cm** **Orbit: LEO – GEO**	**Size: 10 cm – 40 cm** **Orbit: LEO**	**Size: 0.10 cm – 40 cm** **Orbit: LEO – GEO**

*Offerors must propose novel, explainable, techniques to establish accurate detection, tracking, and characterization of currently untracked debris and/or debris clouds to address this goal.

T&E Structure and Government Resources

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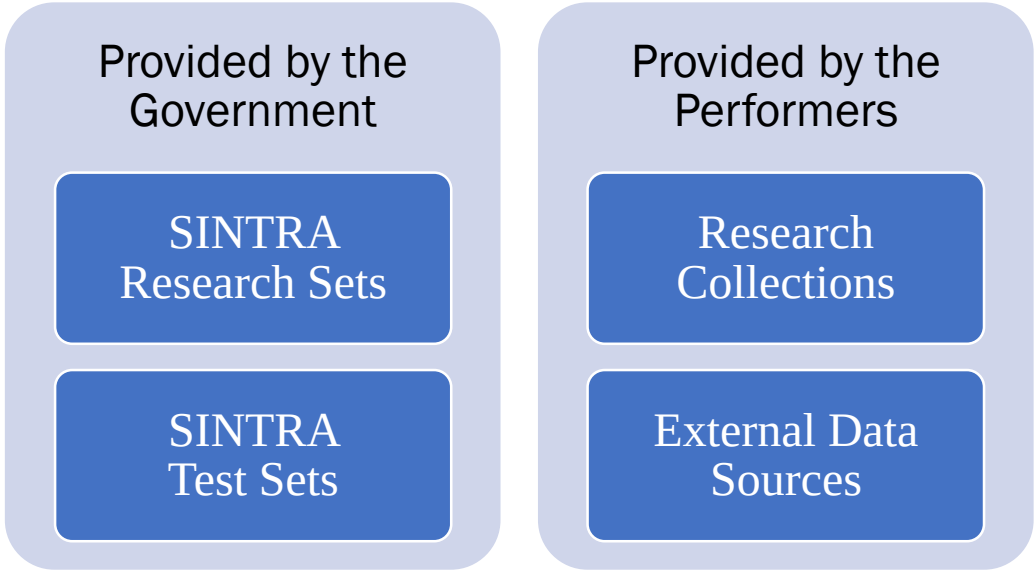
Evaluating Performer Success

- T&E will provide a test datasets based on known debris trajectories that pass within a field of view for observational facilities.
- Performers will submit a panel of their proposed signature simulations and detections to T&E for validation.
- T&E will assess the performers' accuracy of signature simulations compared to observed debris.
- Performers will incorporate lessons-learned and identify errors in simulations or detections, demonstrating further improvement in follow-up rounds of T&E testing.
- Performers will be deemed successful by meeting program metrics and demonstrating capability for their approach to continue to meet program and partner needs.

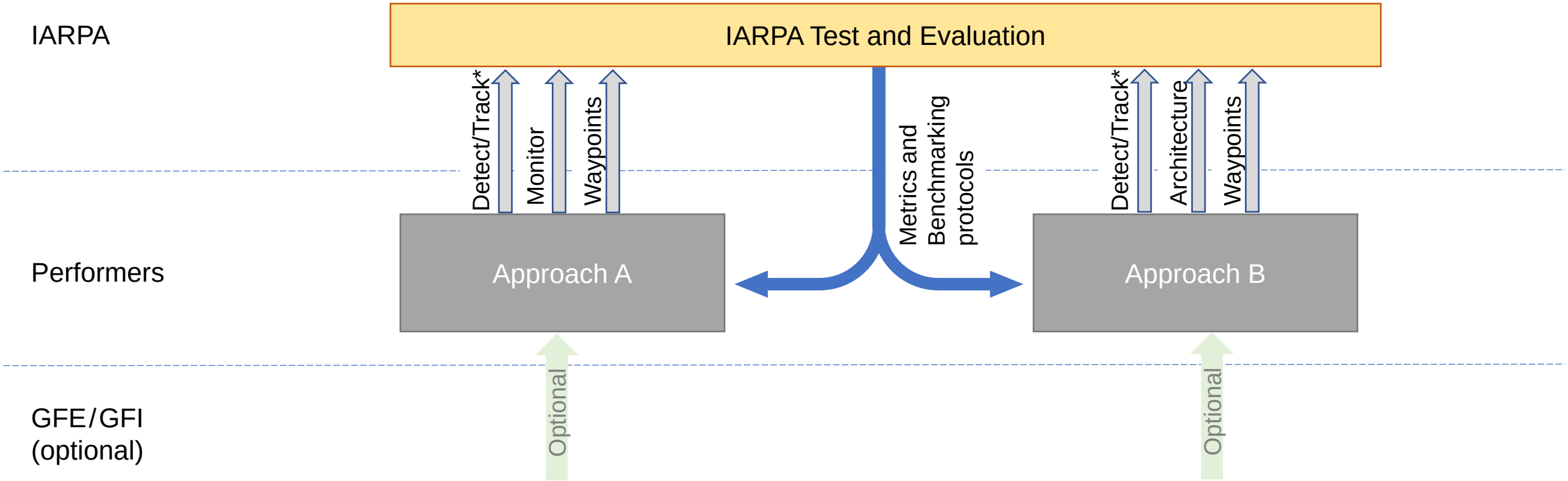
Development Data

There will be three types of development data used in the SINTRA program.

- **Government Research and Test Sets** – Datasets collected, annotated, and curated by the T&E Team. Most of these data will be sequestered, but a small portion will be provided to Performers for R&D (prior to evaluation) and error analysis (following evaluation).
- **Researcher Collections** – Datasets collected, annotated, and curated by R&D Performers. These datasets shall be delivered with Government Purpose Rights, in accordance with FAR 52.227-14.
- **External Data Sources** – Data obtained by Performers that are available from third parties or that have been collected by a Performer outside of SINTRA shall be delivered with sufficient rights to allow the United States Government (USG) and the T&E Team to share this data with all Performers for their use in connection with the SINTRA Program.



T&E and Government Resources



Offerors may draw on and request unique US Government resources in their proposed solutions. Details to appear in the BAA.

*System Performance

Government Furnished Equipment (GFE) and Information (GFI)

- **Plasma Lab Chamber GFE:** IARPA will furnish to Performers the use of the Naval Research Laboratory (NRL) Space Physics Simulation Chamber (SPSC).
  - Scaled near-Earth space-like plasmas are created in the SPSC's 5-m long by 1.8-m diameter main chamber and 2-m long by 0.55-m diameter source chamber.
  - Independently controllable electromagnets allow for control of the shape of the axial magnetic field.
  - As requested, each Performer will have the opportunity to conduct two separate two-week experiments per Program Phase.
- **Plasma measurement data GFI:** IARPA will provide several weeks of curated high-resolution ionospheric measurements made over the southern portion of the Mountain Time Zone and one year of lower resolution ionospheric measurements made along the East Coast of the Continental United States during the IARPA HFGeo Program.

Metrics Phase 1

	Task Area 1 Year 1 (TA1Y1):		Task Area 1 Year 2 (TA1Y2):	
	Debris detection, tracking, and characterization		Debris detection, tracking, and characterization	
	Range	+/-	Range	+/-
Debris radius (cm)	10-40	0.25	0.1-40	0.05
Debris/cloud speed (km/s)	6.90-7.79	0.25	6.90-7.79	0.1
Debris/cloud position (km)	200-4,000	5 (LEO)	200-38,000	5 (LEO) – 50 (GEO)
Debris density (kg/m^3)	1000 - 9000	2000	1000 - 9000	1000
Debris detection (hrs)	< 168	8	< 60	5
Detection rate	> 70%	5	> 80%	5
False alarm rate	< 10%	2	< 5%	1
Coverage (sr/km)	> 1 pi	0.5 pi	> 2 pi	0.5 pi
Revisit rate (hrs)	< 168	8	< 48	5
Sensor Size (cm^2)	< 30	5	< 25	2
Sensor weight (g)	< 350	50	< 250	25
Sensor Power (W)	< 5	2	< 2	0.5

Metrics Phase 2

	Task Area 2 Year 1 (TA2Y1):		Task Area 2 Year 2 (TA2Y2):	
	Persistent debris population monitoring		Persistent debris population monitoring	
	Range	+/-	Range	+/-
Debris radius (cm)	10-40	0.25	0.1-40	0.05
Debris/cloud speed (km/s)	6.90-7.79	0.1	6.90-7.79	0.1
Debris/cloud position (km)	200-4,000	2 (LEO)	200-38,000	2 (LEO) – 10 (GEO)
Debris density (kg/m^3)	1000 - 9000	1000	1000 - 9000	1000
Debris detection (hrs)	< 12	1	< 2	0.25
Detection rate	> 80%	5	> 90%	2
False alarm rate	< 5%	1	< 2%	0.5
Coverage (sr/km)	> 3 pi	0.5 pi	> 4 pi	0.25 pi
Revisit rate (hrs)	< 12	3	< 2	0.25
Sensor Size (cm^2)	< 20	2	< 16	1
Sensor weight (g)	< 250	25	< 150	10
Sensor Power (W)	< 1.5	0.5	< 1.5	0.25

Proposal Evaluation Factors

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Proposal Evaluation Factors

- Positive Factors:
  - Feasibility of overall plan
  - Multidisciplinary team of experts
  - Addressing both Task Areas
  - Focus on technical objectives
  - Clear description of the approach and/or strategies

Out of Scope

Out-of-scope topics for SINTRA include (but are not limited to):

- Research that does not have strong theoretical and experimental foundations.
- Approaches that do not pursue the detection, tracking, and characterization of debris.
- Approaches that aim at debris removal or debris damage mitigation.
- Approaches dependent on the currently unfunded development and launch of new satellites with debris detection sensors.
- Trade studies for the development of new satellites with debris detection sensors.
- Research that utilizes proprietary data that are not made available to other Performers.

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Q&A

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Q&A 1

- Q: "No satellites" is a budget or conceptual limitation? For example, microsats could fit within a fraction of this budget
  - Answer: IARPA will not fund the development of satellites under the SINTRA program.
- Q: What does debris detection time mean? Start at one spot & see something in x hours? Observe x debris object for y hours to characterize
  - Answer: The time it takes to detect debris after it is created.
- Our company's SME's envisioned and currently manage the Space Image Labeling Tool (SILT) as well as other company developed AI tools that are used to annotate high-contrast images of space objects and debris as part of the Space Surveillance Network (SSN). 1. Do you envision using the current resulting efforts of the SSN as GFI? 2. If so, does our company's efforts currently supporting the SSN constitute a potential OCI as a participant on the BAA?
  a. Answer: Tracks detected by the SSN are published on space-track.org and known tracks of interest will be provided by T&E to the performers. It is not OCI to participate in the BAA since SINTRA focused on 1mm-10cm objects and SSN published > 10 cm objects.

Q&A 2

- Q: You mentioned this program will not launch a new satellite. Would you consider solutions that develop a new ground-based sensor or required access to existing GFE sensors?
  - Answer: Yes. We are also open to space-based sensors provided they are tested and validated on the ground. Testing and validation cannot be dependent on launch.
- Q: How has IARPA's view of the solution framework changed since the review of RFI responses? What phenomena and sensing modalities has IARPA considered? Are there modalities with insufficient collected data such that a new effort would be particularly valuable?
  a. Answer: We will consider any phenomena and sensing modality.

Q&A 3

- Q: Are you open to developing extensions to SSN autonomous tracking methodology (MACHINA) for this effort?
  - Answer: Yes, as long as metrics established in the BAA can be met.
- Q. The SINTRA Objectives slide lists four aims, the fourth of which is "facilitate transition of debris research to be further developed into operational capabilities." However, none of the subsequent content regarding T&E, metrics, or proposal evaluation appears to be aligned with that aim. Is that more of an acknowledgement that transition to operations is an ambition of all IARPA programs but it won't really be a relevant consideration in SINTRA? Or do you anticipate the BAA will identify a clear approach and development of operationalization path as an explicit evaluation criteria for SINTRA proposals?
  - Answer: Thank you for your observation, we will drop requirements for transition from the BAA.

Q&A 4

- Q. Emphasis in the presentation seemed to be on LEO debris, but are you also interested in improved detection, tracking and characterization of small debris other orbit domains (e.g., MEO, GEO, cis-lunar…)?
  - Answer: Yes, Year 2 will extent to all orbits beyond LEO.
- Q. Are there any desired performance metrics involving "custody," i.e., the ability to consistently detect, associate and predict specific small debris?
  - Answer: Yes, - revisit rate is a metric for phase 2. The revisit rate is identified as less than 2 hours
- Q. Are Phase 1 1st year “known” entities currently being tracked particles?
  - a. Answer: To establish a proof of concept, the first year will focus on known tracked objects.

Q&A 5

- Q. Can you evaluate on how IARPA and the T&E will evaluate custom sensors? Will the T&E test performer provide hardware or simulate these sensors? If simulation is the plan, will T&E specify the inputs and an API for simulation?
  - Answer: IARPA evaluates performance against metrics. While IARPA will review and comment on sensor design, the final test is against the metrics. IARPA programs commonly provide APIs for interface with T&E systems

Thanks For Your Interest!

Backup

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Technical Challenges and Objectives

- **Task Area 1 (TA1) - Debris Detection, Tracking, and Characterization**: Research and develop novel, innovative techniques to detect, track, and characterize the size, mass, and density of space debris 0.1 – 10 cm in size, traveling in any orbital plane around the Earth.
- Task Area 1 Year 1 (TA1Y1): known tracked debris objects 10 – 40 cm in size in Low Earth Orbit (LEO), with orbital trajectories on publicly accessible databases (e.g., space-track.org).
- Task Area 1 Year 2 (TA1Y2), extend to debris 0.1 – 40 cm in size, from LEO to Geosynchronous Orbit (GEO).
    - Offerors must propose novel, explainable, techniques to establish accurate detection, tracking, and characterization of currently untracked debris and/or debris clouds to address this goal.
- **Task Area 2 (TA2) - Persistent Monitoring of the Debris Population:** Demonstrate the capability to persistently monitor the orbital debris population for objects 0.1 – 10 cm in size. Must incorporate the variations in orbital trajectory due to gravitational perturbations from the Sun and Moon, and non-gravitational forces, including solar radiation and atmospheric drag.
- TA2Y1: known tracked LEO debris objects 10 – 40 cm
- TA2Y2: debris 0.1 – 40 cm in size from LEO to GEO