

First Responder UAS Data Gatherer Challenge (UAS 6.0): Guidance for Stage 1

NIST Public Safety Communications Research Division

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Introduction

The Stage 1 contest is a best paper award. The goal of the Uncrewed Aircraft Systems (UAS) 6.0 Stage 1 contest is to help teams who may have no UAS experience but whose work has the potential to benefit the UAS in Public Safety application, to demonstrate their work on a physical UAS, and to compete in Stage 2 of the UAS 6.0 competition.

The purpose of this elaboration document is to expand on the rules document and provide additional commentary to help teams to better understand what is expected. It is not intended to replicate or override any information that appears in the rules document.

Why is Stage 1 Important

As discussed in the rules document, one unsolved problem in public safety is finding Target Objects of Interest, or ground sensors, and periodically inspecting them and connecting to any radio transmitters on the sensors that might be present. In today's deployment, these may range from IoT sensors to cell phones or radio tracking tags. Developing viable solutions to this problem will require a combination of varying technologies from a wide range of disciplines. The purpose of the Stage 1 Component Paper award is to expand the competitor pool by bringing together competitors from various and complementary disciplines. It is particularly directed at teams who fit into one of the disciplines and focus areas as described below, and have an interest in the UAS for public safety use case. Some teams may not have exposure to a real UAS or have the funding, expertise, or resources to demonstrate their work on a UAS, so Stage 1 is an avenue to introduce your technological ideas and bridge the gap to UAS.

This stage has three goals. The first is to support the efforts of researchers to transition their work to a physical UAS. The second is to encourage teams to disseminate their work, bringing it to the attention of the UAS and public safety communities. And finally, we encourage teams who do not have a UAS builder or designer on their team to seek collaboration with one and join Stage 2.

Disciplines and Topics of Interest

This application benefits from advancements in a wide range of research areas. Contestants are not restricted to any single research area but need to demonstrate an understanding of the

technology areas and build a team with the skills necessary to accomplish the contest deliverables. Papers may describe team member proficiencies in the body of the paper, or as an appendix (which is counted towards the page limit).

Examples of disciplines of interest include but are not limited to:

- Machine perception, machine vision, semantic environment understanding, world modeling, information fusion, and digital twin.
- Artificial intelligence, including action and path planning, environment understanding, and system modeling and prediction.
- Radio communications and radio mapping.
- IoT data processing, ad-hoc wireless IoT network systems, data collection, storage, delivery, and secure implementations of these functions.
- UAS mapping, camera, sensor, and optical systems to support the above systems.

Examples of specific topics of research include but are not limited to:

- Novel small and lightweight antenna and radio systems, such as UAS radio-link, telemetry, video transmitter and receivers, supplemental communications links for IoT and non-flight data, and secure implementations of these systems.
- Algorithms and radio systems for autonomously searching for and mapping radio sources from UAS in environments that are both physically and radio complex.
- Algorithms and methods for collection of IoT data from disparate sensors, securely storing that data on the flight vehicle, and secure delivery of that data to a centralized server for post-processing.
- Novel small and lightweight visual and 3D/navigation sensors for inspecting objects in, and mapping, complex environments from mobile robots.
- Algorithms for autonomously searching for objects in, and mapping, complex environments from mobile robots.
- Algorithms for autonomously inspecting 3D objects in complex and confined surroundings from mobile robots.

Authors are expected to address the impacts of their technologies from the perspective of managing cybersecurity and AI risks associated with their use on UAS in Public Safety. The NIST Cybersecurity Framework 2.0 and AI Risk Management Framework may be useful guides to helping authors find and contextualize the varied and potential cybersecurity and AI risks that their innovations might raise or lower for public safety operations. This includes the management of risks associated with sensing, perception, information fusion, human-system interaction, autonomy, communications, and connectivity.

Examples and descriptions may include but are not limited to, how the author's work incorporates or facilitates the adoption of:

- Cybersecurity best practices for networked systems used by UAS applications, data transfer and storage, secure configuration of UAS, and connected systems.
- Applicable use of encryption algorithms and methodologies in system designs, such as communication links, secure coding, secure data transfer, configuration, and storage.

- Processes and procedures used by first responders or cybersecurity professionals working in a first responder organization to ensure a secure UAS ecosystem.
- The responsible, ethical, and risk-managed use of AI (including, but not limited to, machine learning).
- Appropriate levels of trust and mistrust of AI, transparency, explainability, explicability, accountability, and repairability.
- Awareness of the supply chain risks associated with software, training data, and other information incorporated into their technology, including the use of foundational models and transfer learning.
- Identification and mitigation of potential risks for UAS and supportive systems mentioned above.

The cybersecurity and AI risk management requirements in this challenge are evaluated based on the understanding of the components and how they contribute to the Operational Use Case as discussed in the challenge rules and in this elaboration document. The purpose of this requirement is two-fold. First, it provides information necessary for a first responder, or a cybersecurity professional working in a first responder organization, to make an appropriately risk-managed decision to deploy UAS in complex, AI-enabled, networked, and internet-connected environments. It also seeks to encourage the by-design development of technologies that are appropriately risk-managed. While authors should address these risks in the context of the data gatherer application, they are also free to include other, more general, first responder use cases. If continuing on to Stages 2 and 3, contestants are encouraged, where possible, to implement these cybersecurity and AI risk management controls into their Stage 2 and/or Stage 3 solutions but are not required to do so.

Summary

Stage 1 of UAS 6.0 aims to facilitate the broad involvement of research groups with various areas of expertise, including those who do or do not have specific expertise in, or licenses to operate, specialized radio equipment. As a result, the radios designed for Stages 2 and 3 will all be represented by WiFi transmitters that are easy, and legal, for teams to procure, build, and operate. To further understand the Stage 2 design, a team that specializes in radio mapping or path planning is not locked out of the competition because they don't have expertise in, say, the radios necessary to simulate and decode 4G cellphone transmissions.

We welcome Component Papers that discuss specific technologies that may be utilized on UAS for public safety to solve operational tactics, such as those that take advantage of features of Bluetooth, 4G/5G cellphones, specific IoT technologies, machine learning to characterize and identify specific types of transmitters, and the like. However, teams should be prepared to demonstrate their fundamental, general research contribution within the framework of the UAS 6.0 competition.

Evaluation Criteria, Judging, Logistical Details

Refer to the official Challenge Rules for Stage 1 requirements, pages 8-9, for details on how component papers will be evaluated and awarded.