First Responder UAS Triple Challenge 3.1 FastFind 3.2 LifeLink

August 3rd, 2021

NIST National Institute of Standards and Technology U.S. Department of Commerce

FIRST RESPONDER UAS TRIPLE CHALLENGE
SPEED • RESILIENCE • SECURITY

PSCR

Challenge Information Webinar

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Prize Manager
Public Safety Communication Research
National Institute of Standards and Technology

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National Institute of Standards and Technology

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Kansas State University

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FIRST RESPONDER UAS TRIPLE CHALLENGE
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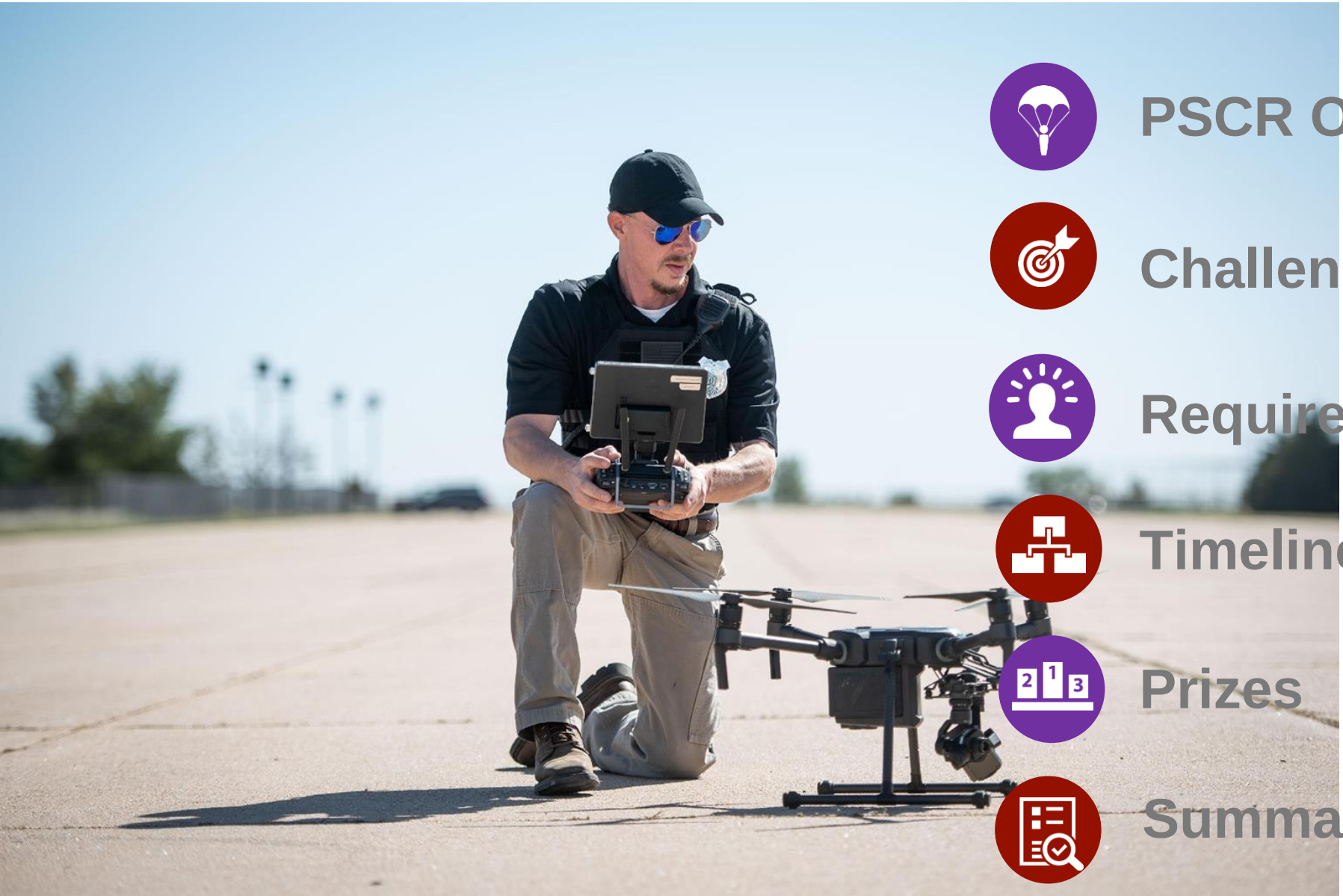
PSCR

Agenda



- PSCR Overview & Mission
- Challenge Goal
- Requirements & Objectives
- Timeline & Roadmap
- Prizes
- Summary of the Challenge

PSCR Overview

Department of Commerce

National Institute of Standards and Technology

Communications Technology Laboratory

National Telecommunications and Information Administration

First Responders Network Authority

Public Safety Communications Research

Primary federal laboratory conducting research, development, testing, and evaluation for public safety communications technologies

PSCR Mission

PSCR is driven towards **advancing public safety communications technologies** by accelerating the adoption and implementation of the most critical communications capabilities **to ensure the public safety community can more effectively carry out their mission** to protect lives and property during day-to-day operations, large scale events, and emergencies.

How does PSCR achieve their mission?

Triple Challenge Overviews

3.1 FastFind Challenge

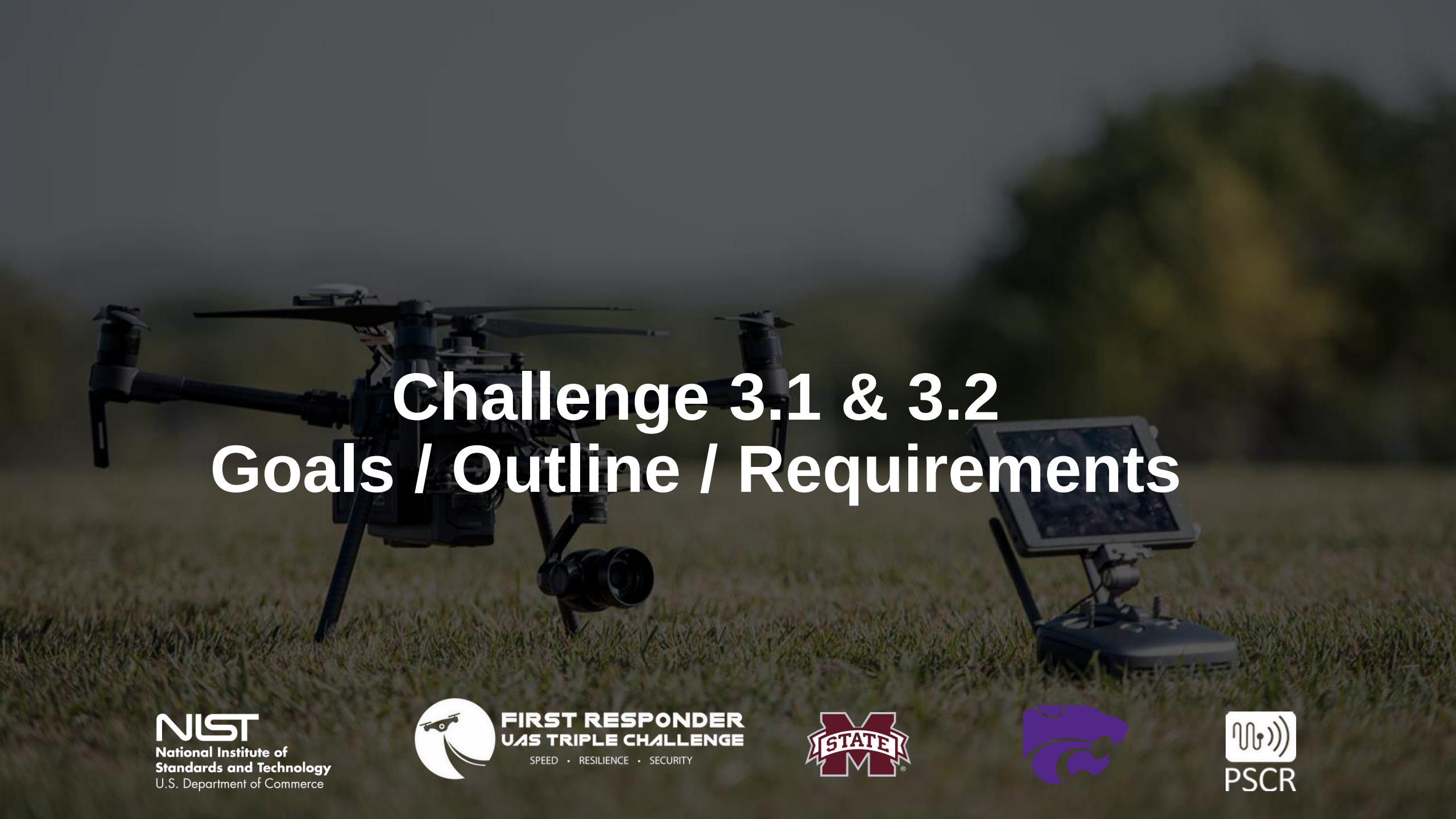
Goal: to design, build, and fly a UAS that helps a search & rescue team locate multiple missing persons in a thick forested area by improving image detection and enhancing navigation techniques to ‘close the distance’ more quickly.

3.2 LifeLink Challenge

Goal: to design, build, and fly a UAS that provides continuous IP or broadband connectivity to first responders dispersed in a thick forested area with degraded cellular coverage.

3.3 Shields Up! Challenge

Goal: to demonstrate attacks on open-source software for UAS navigation and/or control. The purpose is to explore and advance the cybersecurity of UAS technology to support first responders in their missions.



Challenge 3.1 & 3.2
Goals / Outline / Requirements

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FIRST RESPONDER UAS TRIPLE CHALLENGE
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3.1 FastFind Challenge

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FIRST RESPONDER UAS TRIPLE CHALLENGE
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STATE

PSCR

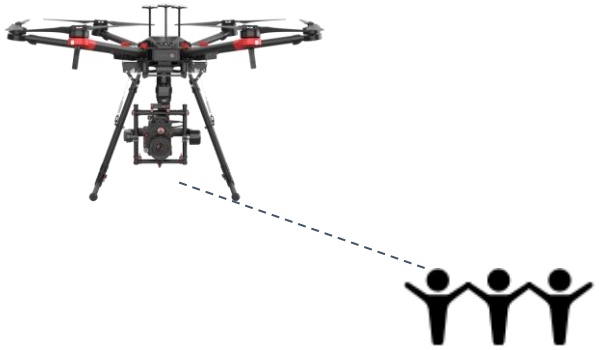
3.1 FastFind Challenge Goal

Scenario

A ‘lost person(s) in a heavily wooded area’ initiates a search & rescue operation by a public safety agency; A UAS is deployed to help locate the lost person(s) within the heavy leaf canopy.

Goal

To advance UAS technologies and operational procedures for first responders to locate missing persons faster and from farther away.



3.1 FastFind Challenge Grading Criteria

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These scoring criteria will differentiate each competitor between good, better, and best solution.

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- Completeness, understandability, feasibility, spelling and grammar.

Stage 2: Check-in review

- Presentation
  - Completeness and project logistics.
- Video submission
  - Completeness, validity of solution, composition, quality of manufacturing, and effectiveness of safety protocols.

Stage 3: Live event

- Deploy time, Recover time, Search time, Distance from target, Target identification accuracy, System cost.

https://www.challenge.gov/challenge/first-responder-uas-triple-challenge-fastfind/

3.1 FastFind Challenge Stage 1

Stage 1 consists of a **cover page** and abstract of your solution, a **word document** that is your solution description, **resume information** for key team members, and a **summary slide**.

- Each document must adhere to the "**Solution Description Content Requirements**".
- Items such as page and word count must be adhered.
- Items such as such as team name and points of contact are mandatory.

These documents **need** to confirm that your solution will conform to the **UAS Design Specifications**. For example, your submission must state:

- Your solution will be under the weight requirements
- Your solution must have an RTK-GPS
- Your team will have a liability insurance policy
- Etc.


FIRST NAME LAST NAME

Address - Phone

Email - LinkedIn Profile - Twitter/Blog/Portfolio

To replace this text with your own, just click it and start typing. Briefly state your career objective, or summarize what makes you stand out. Use language from the job description as keywords.

EXPERIENCE

DATES FROM – TO
JOB TITLE, COMPANY
Describe your responsibilities and achievements in terms of impact and results. Use examples, but keep it short.

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EDUCATION

MONTH YEAR
DEGREE TITLE, SCHOOL
It's okay to brag about your GPA, awards, and honors. Feel free to summarize your coursework too.

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SKILLS

- List your strengths relevant for the role you're applying for
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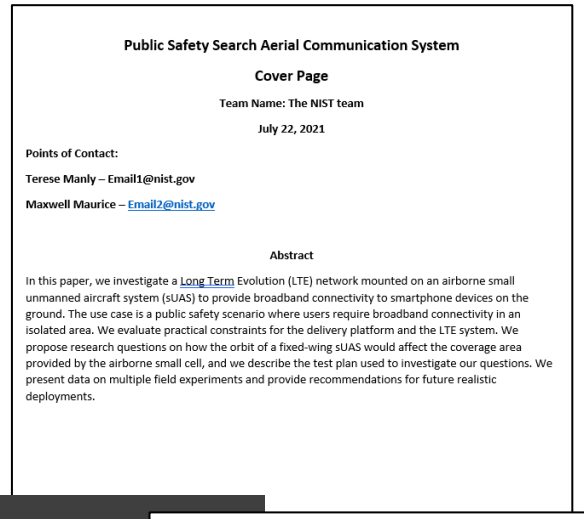

Public Safety Search Aerial Communication System

Cover Page

Team Name: The NIST team

July 22, 2021

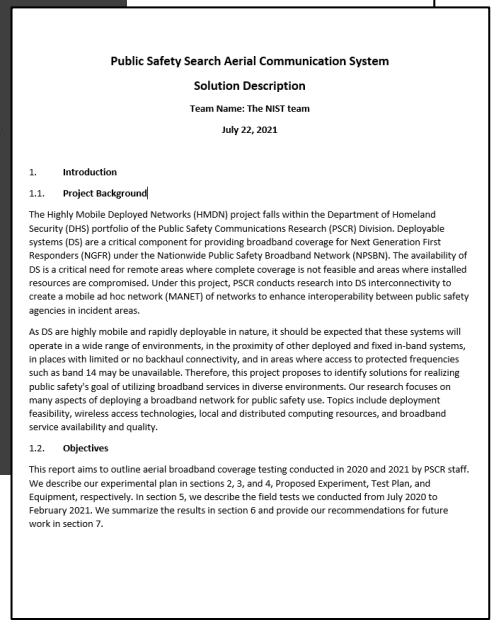
Points of Contact:

Terese Manly – Email1@nist.gov

Maxwell Maurice – Email2@nist.gov

Abstract

In this paper, we investigate a Long Term Evolution (LTE) network mounted on an airborne small unmanned aircraft system (sUAS) to provide broadband connectivity to smartphone devices on the ground. The use case is a public safety scenario where users require broadband connectivity in an isolated area. We evaluate practical constraints for the delivery platform and the LTE system. We propose research questions on how the orbit of a fixed-wing sUAS would affect the coverage area provided by the airborne small cell, and we describe the test plan used to investigate our questions. We present data on multiple field experiments and provide recommendations for future realistic deployments.


Public Safety Search Aerial Communication System

Solution Description

Team Name: The NIST team

July 22, 2021

1. Introduction

1.1. Project Background

The Highly Mobile Deployed Networks (HMDN) project falls within the Department of Homeland Security (DHS) portfolio of the Public Safety Communications Research (PSCR) Division. Deployable systems (DS) are a critical component for providing broadband coverage for Next Generation First Responders (NGFR) under the Nationwide Public Safety Broadband Network (NPSBN). The availability of DS is a critical need for remote areas where complete coverage is not feasible and areas where installed resources are compromised. Under this project, PSCR conducts research into DS interconnectivity to create a mobile ad hoc network (MANET) of networks to enhance interoperability between public safety agencies in incident areas.

As DS are highly mobile and rapidly deployable in nature, it should be expected that these systems will operate in a wide range of environments, in the proximity of other deployed and fixed in-band systems, in places with limited or no backhaul connectivity, and in areas where access to protected frequencies such as band 14 may be unavailable. Therefore, this project proposes to identify solutions for realizing public safety's goal of utilizing broadband services in diverse environments. Our research focuses on many aspects of deploying a broadband network for public safety use. Topics include deployment feasibility, wireless access technologies, local and distributed computing resources, and broadband service availability and quality.

1.2. Objectives

This report aims to outline aerial broadband coverage testing conducted in 2020 and 2021 by PSCR staff. We describe our experimental plan in sections 2, 3, and 4, Proposed Experiment, Test Plan, and Equipment, respectively. In section 5, we describe the field tests we conducted from July 2020 to February 2021. We summarize the results in section 6 and provide our recommendations for future work in section 7.

https://www.challenge.gov/challenge/first-responder-uas-triple-challenge-fastfind/

3.1 FastFind Challenge Stage 2

Stage 2 consists of a **status brief** and a **flight video**. The brief will be presented to the challenge implementers in the **middle of stage 2** on the progress made so far. The brief will include a submitted **Bill of Materials (BOM)** document that will help verify the total cost of the solution.

Additionally, contestants will submit a **flight video** at the **end of stage 2** showing a preliminary flight of the system. The goal is to demonstrate the flight worthiness of the drone.

NIST Team Bill of Materials

							AUW in lb's	92.15				
							System Weight in lbs	22.03				
									System Cost	$8,799		
Reference Designator	Title	Component Description	Manufact	Model or	Qty (each)	Weight (grams)	Total	Unit Cost	Total Cost	On Order	Link (to product supplier)	Comments
	Air Vehicle Subsystem 1											
	Electrical Equipment						460		$2,650			
1	Flight controller	Flight controler IMU			1	40	40	$200	$200	Ordered		
2	Optical Camera	Optical camera for SAR			1	40	40	$150	$150	Ordered		
3	IR Camera	IR camera for SAR			1	90	90	$1,000	$1,000	Received		
4	RTK GPS	Per competition rules			1	90	90	$1,000	$1,000	Not yet Ordered		
5	LiPo Batteries	Power supply			1	200	200	$300	$300	Received		

3.1 FastFind Challenge Stage 3

Stage 3 is the **live event** where we will simulate a search and rescue scenario and test your solutions. Contestants will travel to the test facility in Starkville, MS, operating their system in a realistic setting.

Teams will be evaluated based on the following criteria:

- Deploy time
- Recover time
- Search time
- Distance from target
- Target identification accuracy
- System cost

Systems at this stage must still comply with the **UAS Design Specifications** listed in the Rules document.

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3.1 FastFind Challenge Requirements

- We are looking for solutions that cater to a first responder operations.
- This includes **low cost** and **part 107** compliant solutions.
- These **mandatory** capabilities & **minimum acceptable** values are outlined in the rules document.

Refer to the official challenge rules:

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Requirement Title	Requirement Definition	Challenge Requirement	Motivation
Maximum Gross Takeoff Weight	The Maximum Gross Takeoff Weight (MGTW) is the maximum allowable takeoff weight for the UAS. This includes everything that is on-board or otherwise attached to the aircraft.	The UAS must have a MGTW less than 55 pounds.	Part 107
Total System Weight	Total System Weight is the weight of the entire system (to include UAS, Ground Control Station, spares, fuel, sensor, and storage).	Total System Weight shall not exceed 120 pounds.	Scenario
System Cost	System cost is the total cost of all components of the system to include (software, hardware, sensor, spares, and custom-made items), with exception of the RTK-GPS. All components are listed in the BOM.	The system cost shall not exceed $20,000.	First Responders
Degraded Takeoff/Landing Capability	A degraded takeoff/landing area is an area that is typically unsuited for standard flight operations. The area can be small, uneven, and does not have a conventional runway.	The UAS shall be capable of vertical takeoff and landing (VTOL) and must be able to operate in a degraded takeoff/landing area.	Scenario

indicates same requirement as Challenge 3.2 LifeLink
indicates unique requirement to Challenge 3.1 FastFind

3.1 FastFind Challenge Requirements

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Requirement Title	Requirement Definition	Challenge Requirement	Motivation
Loiter	Loiter is the ability of the UAS to fly in a specified sphere to a defined position in the air.	The UAS shall be able to loiter within a small defined box (750 ft x 750 ft x 20 ft) centered around a defined position and altitude.	Competition Design
Level of Autonomy	Level of Autonomy refers to the spectrum of independence that the UAS can operate.	The UAS must be capable of complete auto takeoff/landing and waypoint navigation.	First Responders
Real-Time Video	Real-time video is the ability to provide full motion video to the ground control station during anticipated mission operations.	The UAS shall provide real time full motion video to the ground control station at a minimum resolution of 1280 X 720 progressive (720p).	First Responders
GPS	GPS is a global navigation satellite system (GNSS) providing geolocation and time information to a GPS receiver.	The UAS shall be equipped with a Global Position System.	First Responders

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RTK-GPS	A real-time kinematic (RTK) global positioning system (GPS) enhances the accuracy of satellite-based positioning using corrections broadcast in real-time to a roving GPS receiver from a ground-based stable GPS receiver.	The UAS shall be equipped with an RTK-GPS, and stable ground station that is broadcasting the differential GPS corrections. Note that the cost of the RTK-GPS will not be factored into scoring nor will it be factored into the minimum system cost requirement.	Competition Design
UAS Insurance	UAS (liability) insurance covers damage to third party property and injury to other people.	The team shall have UAS (liability) insurance or demonstrate financial responsibility with a minimum coverage of $1M prior to conducting any flights outside of an enclosed test facility.	Competition Design
Flight termination system (FTS)	The FTS is a subsystem that is able to immediately cut power to all of the UAS motors at once when activated or initiates an inverted dive for a horizontal flight aircraft. Activation shall be possible for the following: 1. If the UAS passes a geofence set by the Contestant. 2. If the UAS is disconnected from the flight controller for a set amount of time. 3. To allow for a “kill” command to be sent to the UAS via the controller.	The UAS shall be equipped with an FTS (i.e., a Kill Switch) that when activated cuts power to all motors. Specific configuration for the FTS and geofence will be defined by the NIST Challenge team.	Competition Design

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3.2 LifeLink Challenge

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3.2 Lifelink Challenge Goal

Scenario

A wildfire is being contained by a group of wildland firefighters in a remote region; there is a lack of communication between the different groups of first responders and assets in the field.

Goal

To advance UAS technologies and operational procedures for first responders to support continuous broadband communications between each other in the field.

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- Etc.


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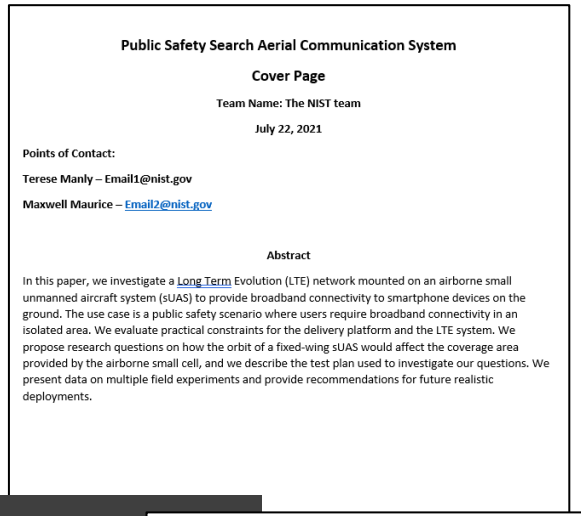
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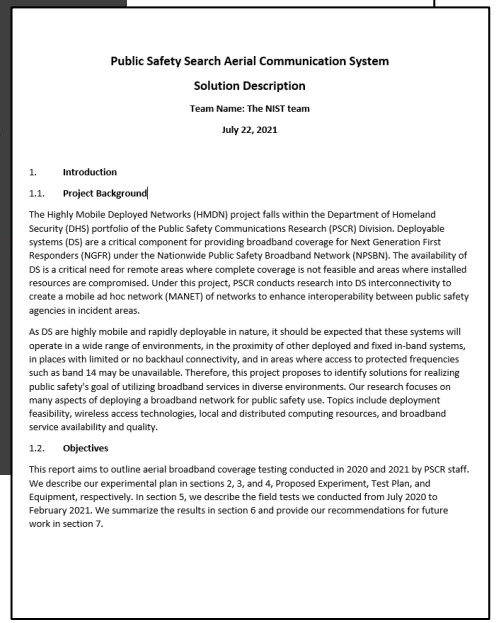
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3.2 LifeLink Challenge Stage 3

Stage 3 is the **live event** where we will simulate a search and rescue scenario and test your solutions. Contestants will travel to a test facility within the United States, operating their system in a realistic setting.

Teams will be evaluated based on the following criteria:

- Deploy time
- Recover time
- System cost
- Data transfer rate
- Data transfer distance
- Mass connectivity endurance

Systems at this stage still must comply with the **UAS Design Specifications** listed in the rules document.

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3.2 LifeLink Challenge Requirements

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Total System Weight	Total System Weight is the weight of the entire system (to include UAS, Ground Control Station, spares, fuel, sensor, and storage).	Total System Weight shall not exceed 120 pounds.	Scenario
System Cost	System cost is the total cost of all components of the system to include (software, hardware, sensor, spares, and custom-made items), with exception of the RTK-GPS. All components are listed in the BOM.	The system cost shall not exceed $20,000.	First Responders
Degraded Takeoff/Landing Capability	A degraded takeoff/landing area is an area that is typically unsuited for standard flight operations. The area can be small, uneven, and does not have a conventional runway.	The UAS shall be capable of vertical takeoff and landing (VTOL) and must be able to operate in a degraded takeoff/landing area.	Scenario

indicates same requirement as Challenge 3.1 FastFind

indicates unique requirement to Challenge 3.2 LifeLink

3.2 LifeLink Challenge Requirements

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Refer to the official challenge rules:

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Requirement Title	Requirement Definition	Challenge Requirement	Motivation
Hover	Hover is the ability of the UAS to remain suspended over a place or object.	The UAS shall be able to hover within a sphere with a radius of 30 meter centered at a defined position and altitude in space for as long as possible.	Scenario
Level of Autonomy	Level of Autonomy refers to the spectrum of independence that the UAS can operate.	The UAS must be capable of complete auto takeoff/landing and waypoint navigation.	First Responders
Wireless Transceiver	A wireless transceiver is a device that can communicate with a user's smartphone, or User Equipment (UE).	The UAS must be equipped with a wireless transceiver capable of transmitting internet protocol (IP) based data to several first responder UE while in the air. UE used for the test will be a Samsung Galaxy S10, an iPhone 11, and a Google Pixel 4.	Scenario
Payload Server	The payload server is a small computer located on the UAS that connects to the wireless transceiver. The payload server measures the throughput from the UAS to UE on the ground and will potentially hold files to be transmitted. The payload server will be provided to Contestants by the NIST Challenge team.	This server requires an ethernet connection to the wireless transceiver and a power source from the UAS. The server will require a 5 volt, 15 Watt power source. The UAS shall be capable of hosting this payload which will weigh no more than 0.2 kg and be no larger than 14 x 8 x 8 cm. NIST reserves the right to alter the server payload weight, size, and power source.	Scenario

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indicates unique requirement to Challenge 3.2 LifeLink

3.2 LifeLink Challenge Requirements

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Requirement Title	Requirement Definition	Challenge Requirement	Motivation
Real-Time Video	Real-time video is the ability to provide full motion video to the ground control station during anticipated mission operations.	The UAS shall provide real time full motion video to the ground control station at a minimum resolution of 1280 X 720 progressive (720p).	First Responders
GPS	GPS is a global navigation satellite system (GNSS) providing geolocation and time information to a GPS receiver.	The UAS shall be equipped with a Global Position System.	First Responders
RTK-GPS	A real-time kinematic (RTK) global positioning system (GPS) enhances the accuracy of satellite-based positioning using corrections broadcast in real-time to a roving GPS receiver from a ground-based stable GPS receiver.	The UAS shall be equipped with an RTK-GPS, and stable ground station that is broadcasting the differential GPS corrections. Note that the cost of the RTK-GPS will not be factored into scoring nor will it be factored into the minimum system cost requirement.	Competition Design
UAS Insurance	UAS (liability) insurance covers damage to third party property and injury to other people.	The team shall have UAS (liability) insurance or demonstrate financial responsibility with a minimum coverage of $1M prior to conducting any flights outside of an enclosed test facility.	Competition Design

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- We are looking for solutions that cater to a first responder operations.
- This includes **low cost** and **part 107** compliant solutions.
- These **mandatory** capabilities & **minimum acceptable** values are outline in the rules document.

Refer to the official challenge rules:

https://www.challenge.gov/challenge/first-responder-uas-triple-challenge-lifelink/

Requirement Title	Requirement Definition	Challenge Requirement	Motivation
Tethers	A tether is a physical connection between the drone and the ground that can provide power and communications and/or can be used to simply attach the drone to the ground.	The system shall not have any tethers and must be free flying.	First Responders
Flight termination system (FTS)	The FTS is a subsystem that is able to immediately cut power to all of the UAS motors at once when activated or initiates an inverted dive for a horizontal flight aircraft. Activation shall be possible for the following: 1. If the UAS passes a geofence set by the Contestant. 2. If the UAS is disconnected from the flight controller for a set amount of time. 3. To allow for a "kill" command to be sent to the UAS via the controller.	The UAS shall be equipped with an FTS (i.e., a Kill Switch) that when activated cuts power to all motors. Specific configuration for the FTS and geofence will be defined by the NIST Challenge team.	Competition Design

indicates same requirement as Challenge 3.1 FastFind
indicates unique requirement to Challenge 3.2 LifeLink

Challenge 3.1 & 3.2
Stages / Prizes / Timeline

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

FIRST RESPONDER UAS TRIPLE CHALLENGE
SPEED • RESILIENCE • SECURITY

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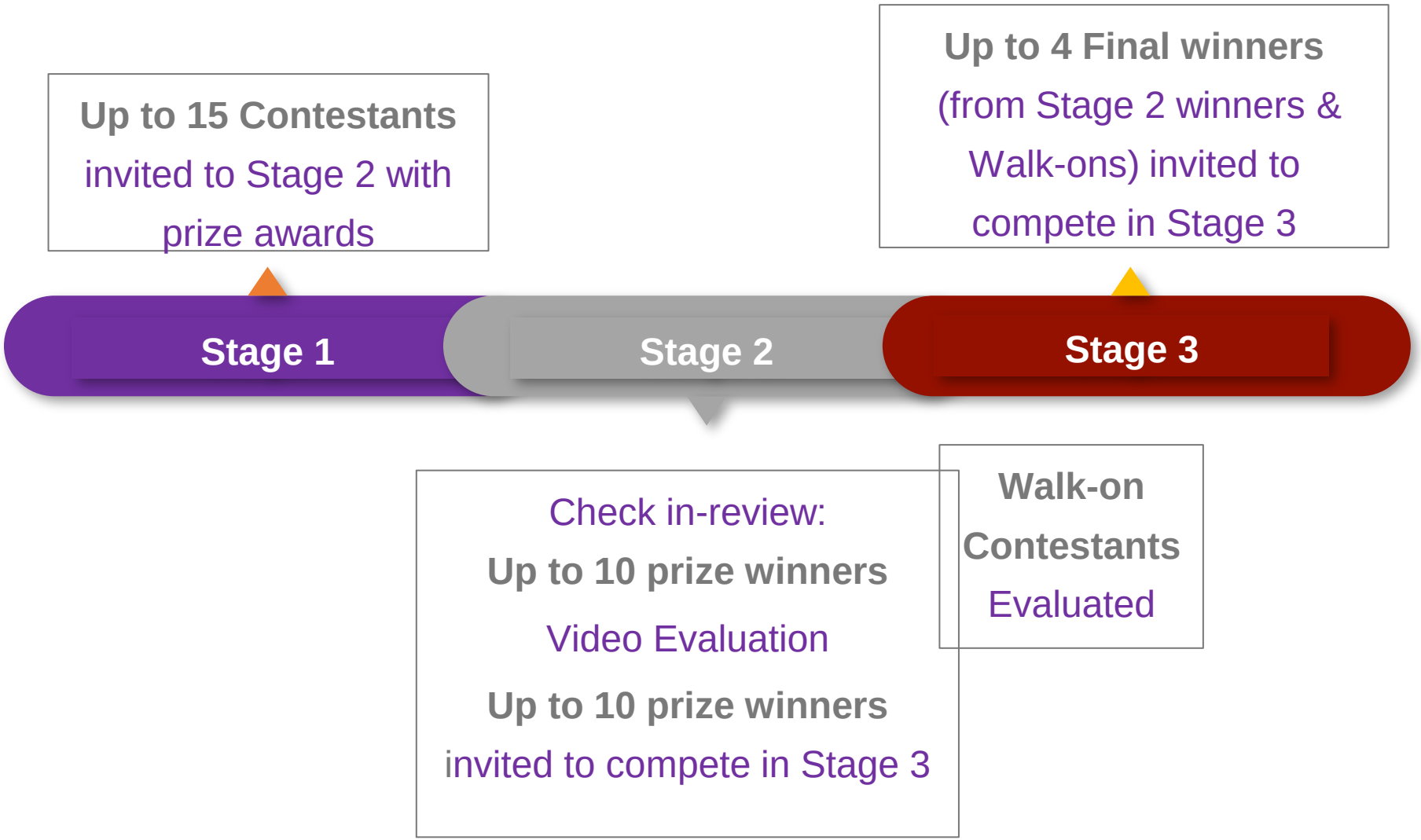
3.1 FastFind / 3.2 LifeLink Summary



3.1 FastFind / 3.2 Lifelink Prizes

Award Ranking	Number of Awards	Award Value
Stage 1	Up to 15 awards	$7,000 (each), up to $105,000 total
Stage 2	Up to 10 awards Up to 10 awards	Check in-review: $3,000 (each), up to $30,000 total Video Evaluation: $5,000 (each), up to $50,000 total in travel prize awards for invitations to compete in Stage 3
Stage 3		
First Place	1 award	$40,000
Second Place	1 award	$20,000
Third Place	1 award	$10,000
First Responder's Choice Award	1 award	$5,000

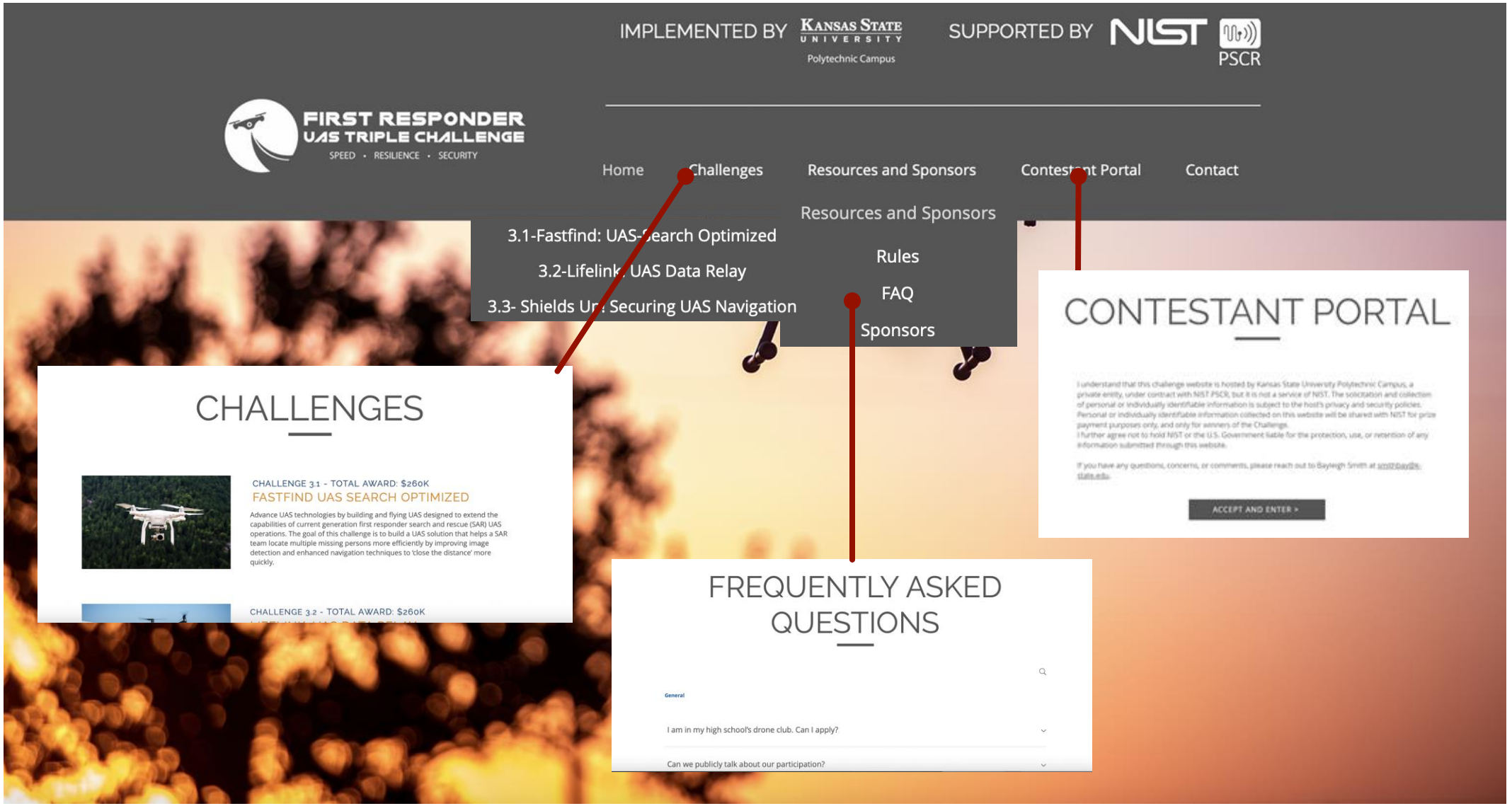
3.1 FastFind Challenge Timeline

Note: NIST reserves the right to revise the dates at any time.

3.2 LifeLink Challenge Timeline

Note: NIST reserves the right to revise the dates at any time.

Challenge Website



Connect with Us

- Go to the **Challenge Website** for next steps , including how to use the Contestant Portal.
- The **official rules** for each challenge, including the Drone Design Specifications, are found on the Website.
- Recruit team members on UAS Challenge Facebook **page**.

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https://www.uastriplechallenge.com/ /faq.php

https://www.facebook.com/uastriplechallenge

https://www.youtube.com/channel/UCu-9kfDt6aoIkGQN-OZFrtA

https://www.instagram.com/uastriplechallenge/

https://www.linkedin.com/company/uas-triple-challenge/

NIST PSCR Webinar

PSCR Webinar:
UAS Triple Challenge
Drones for First Responders
August 24, 2021

Event (registration) website
Event information will be posted on the challenge website
www.uastriplechallenge.com

PSCR

Public Safety Communications Research
Primary federal laboratory conducting research, development, testing, and evaluation for public safety communications technologies


Questions?
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