

**Department of Homeland Security
(DHS) Science and Technology (S&T)**

Remote and Rapid Rescue

**TECHNOLOGY SCOUTING
RESEARCH SUMMARY**

Date: August 2019



**Homeland
Security**

Science and Technology

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Remote and Rapid Rescue



Overview: Commercial datasets and open-source research were utilized to compile a list of solution options. A summary of the request is outlined below, and the top identified solutions thus far are displayed on the following pages.

Problem Description:

Identifying technologies that can provide remote and rapid rescue support in search and rescue scenarios that put first responders in danger. Specifically, the ability to easily deploy unmanned systems that evacuate victims from hazardous environments (e.g., swift water, ice, active shooter, cliff-side environments) is key to decreasing injuries and death of emergency responders of all disciplines (i.e., law enforcement, fire, emergency medical services (EMS)) who often must respond to victims that are situated in difficult to reach or dangerous to enter locations.

While the use of unmanned aerial, ground, and maritime systems is increasingly common in first responder scenarios, there are few examples of proven solutions that can extract victims autonomously or without manual assistance from rescuers. Many existing unmanned systems can help rescuers find and locate victims (e.g., using an Unmanned Aircraft Systems (UAS) to surveil large areas), but do not have the payload capacity or modular attachments to lift and transport victims.

Additionally, the Federal Aviation Administration (FAA) imposes strict restrictions on the operation of UAS. Regulation requires government entities to obtain a Certificate of Waiver or Authorization (COA) for public UAS operations and requires individual responders to either obtain a pilot certification or register as a civil aircraft. While FAA regulations permit the addition of an external load up to 55lbs on a UAS device, further testing and regulations would need to be enacted to allow for the extraction of victims. Similarly, the use of automated water or land vehicles may also require waivers or permits to allow for extraction and transport of victims.

Desired Use Case:

Currently, emergency responders use various search and rescue techniques, but those techniques are often time consuming and may place the rescuers in harm's way. Depending on the type of environment, responders may have to use a technical rope or other technology to rescue a victim that is stranded on a cliff edge or other hazardous environments, placing responders in a vulnerable position. The ideal technology solution could be applied across emergency responder disciplines in any incident in which there are victims situated in difficult-to-access and/or dangerous locations. Specific incidents may include individuals trapped in a trench, tower, arroyo (i.e., natural waterway), swift or blue (open) waters, cave, mine, confined space, on a cliff or high-rise building, and in an agricultural or industrial setting.

In all these types of situations, the survival of victims is strongly time-dependent; therefore, the solution should be able to be rapidly deployed by emergency responders and enable them to perform a quick, life-saving rescue without endangering first responders. Additionally, the proposed solution should have a built-in or modular functionality that ensure safe and stable transport of victims (e.g., a stretcher-like function to make sure the victim is secured and laid properly in transport).

Solution Option Categories:

Technologies included in this report are categorized by the type of operating vehicle, including Ground, Maritime, and Aircraft. Due to the variety of hazardous environments that first responders must operate in, different types of vehicles may be better suited to certain environments than other types, and there is not one device that has the capabilities to respond to all scenarios.

For each category, the findings of this report focus on solutions that have the payload capacity and modular attachments to extract victims (e.g., an attached gurney that can lay an injured adult in a safe position). For

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solutions included under the Aircraft category (where there are more limitations in moving victims), technologies that have the payload to move and transport supplies are included. The findings within each category are intended to be comprehensive of various use cases but are likely not an exhaustive list of all available technologies.

Detailed descriptions of the Solution Option Categories are as follows:

Solution Option Category	Description
Unmanned Ground Vehicles (UGV)	Solutions that allow access to victims located in land environments (e.g., cave, active shooter, confined space, structurally unsound buildings, etc.)
Unmanned Maritime Vehicles (UMV)	Solutions that allow maritime access to victims located in water environments (e.g., riptide, fast current, open water).
Unmanned Aircraft Systems (UAS)	Solutions that have the payload capacity to either carry supplies or extract victims in the air, allowing access to environments that may be inaccessible to responders or other types of unmanned vehicles (e.g., cliff-faces, ice, etc.)

Technology Requirements:

A variety of requirements (or Key Performance Parameters, KPPs) have been identified, this report will focus on highlighting a few in greater detail.

The list of the requirements assessed for this report are listed below:

- Deploys within 5 minutes
- Includes audio and video (for two-way communication)
- Rechargeable Battery
- Day/Night Operation
- Generates Lighting
- Operates 1 to 4 hours
- Weighs less than 100 lbs.
- Range is greater than 1 mile
- Can attach EO/IR camera

****Note:** The Solution Options highlighted in this report focus on technologies that have been designed for, used, or tested to extract victims, and in the case of UAS designed to carry supplies to ensure fit to various potential scenarios.*

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Solution Options: Ground Vehicles (UGV)			
#	Solution	Description	Requirements
1	 <p>Robocue by Kikuchi Manufacturing (Japan)</p>	<p>Designed by the Tokyo Fire Department to rescue victims in environments where human rescuers cannot go (e.g., dirty bomb blasts, earthquake zones, burning buildings). The vehicle is tethered to a 328-foot cable and equipped with infrared cameras, a megaphone, and ultrasonic sensors that can locate victims.</p> <p>The device also includes an onboard oxygen canister. To load victims, the device has two feeler appendages and an inclined sleigh bed to wheel a single victim to safety.</p>	Deploys within 5 Minutes N
			Includes Audio and Video *
			Rechargeable Battery *
			Day/Night Operation *
			Generates Lighting *
			Operates 1 to 4 hours *
			Weighs less than 100 lbs. N
			Range is greater than 1 mile *
			Can attach EO/IR camera Y
			<i>*More Information Required for Detailed Product Specifications</i>
2	 <p>Colossus by Shark Robotics (France)</p>	<p>Used by the Paris Firefighter Brigade, this is an autonomous ground vehicle built for firefighting scenarios. The device can drive on stairs, side slopes, water and uneven ground.</p> <p>Various modular attachments can be changed out in less than 30 seconds, including water cannon, tool transport, and wounded persons transport stretcher. The device has a payload of 1200 lbs and includes hazmat and chemical, biological, radiological, and nuclear (CBRN) sensors.</p> <p><i>*The device would require manual assistance to load unresponsive victims.</i></p>	Deploys within 5 Minutes *
			Includes Audio and Video Y
			Rechargeable Battery Y
			Day/Night Operation *
			Generates Lighting *
			Operates 1 to 4 hours Y
			Weighs less than 100 lbs. N
			Range is greater than 1 mile N
			Can attach EO/IR Camera Y
			Additional Product Specifications
3	 <p>Multiscope Rescue Transport by Milrem Robotics (Estonia)</p>	<p>Provides a flexible platform to allow various types of payloads. Firefighting modes include a hose cartridge to extinguish hard-to-reach areas, and a rescue transport that could be used to mount a gurney.</p> <p><i>*The device would require manual assistance to load unresponsive victims.</i></p>	Deploys within 5 Minutes *
			Includes Audio and Video Y
			Rechargeable Battery Y
			Day/Night Operation Y
			Generates Lighting Y
			Operates 1 to 4 hours Y
			Weighs less than 100 lbs. N
			Range is greater than 1 mile Y
			Can attach EO/IR Camera Y
			Additional Product Specifications

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4	 <p>Ironclad UGV by BAE Systems (UK/USA)</p>	<p>Has a modular connection system that allows two vehicles to be connected to handle additional loads, such as a specialized stretcher. While not yet fully autonomous, each device is built with a hardware interface that supplies both power and command from the main vehicle chassis and is designed so that autonomous capability can be added. The rubber treads can surface uneven ground, including inclines up to 45 degrees.</p> <p><i>*The device would require manual assistance to load unresponsive victims.</i></p>	<table border="1"> <tr><td>Deploys within 5 Minutes</td><td>Y</td></tr> <tr><td>Includes Audio and Video</td><td>Y</td></tr> <tr><td>Rechargeable Battery</td><td>Y</td></tr> <tr><td>Day/Night Operation</td><td>*</td></tr> <tr><td>Generates Lighting</td><td>*</td></tr> <tr><td>Operates 1 to 4 hours</td><td>Y</td></tr> <tr><td>Weighs less than 100 lbs.</td><td>N</td></tr> <tr><td>Range is greater than 1 mile</td><td>Y</td></tr> <tr><td>Can attach EO/IR Camera</td><td>Y</td></tr> <tr><td colspan="2">Additional Product Specifications</td></tr> </table>	Deploys within 5 Minutes	Y	Includes Audio and Video	Y	Rechargeable Battery	Y	Day/Night Operation	*	Generates Lighting	*	Operates 1 to 4 hours	Y	Weighs less than 100 lbs.	N	Range is greater than 1 mile	Y	Can attach EO/IR Camera	Y	Additional Product Specifications	
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5	 <p>Mission Master by Rheinmetall (Germany)</p>	<p>Allows users to perform various mission scenarios. The device features a platform that allows the operators to install different payloads onto the vehicle, including transport rescue, fire suppression, and CBRN detection. The device can also serve as a radio relay station.</p> <p><i>*The device would require manual assistance to load unresponsive victims.</i></p>	<table border="1"> <tr><td>Deploys within 5 Minutes</td><td>N</td></tr> <tr><td>Includes Audio and Video</td><td>Y</td></tr> <tr><td>Rechargeable Battery</td><td>*</td></tr> <tr><td>Day/Night Operation</td><td>*</td></tr> <tr><td>Generates Lighting</td><td>*</td></tr> <tr><td>Operates 1 to 4 hours</td><td>Y</td></tr> <tr><td>Weighs less than 100 lbs.</td><td>N</td></tr> <tr><td>Range is greater than 1 mile</td><td>Y</td></tr> <tr><td>Can attach EO/IR Camera</td><td>Y</td></tr> <tr><td colspan="2">Additional Product Specifications</td></tr> </table>	Deploys within 5 Minutes	N	Includes Audio and Video	Y	Rechargeable Battery	*	Day/Night Operation	*	Generates Lighting	*	Operates 1 to 4 hours	Y	Weighs less than 100 lbs.	N	Range is greater than 1 mile	Y	Can attach EO/IR Camera	Y	Additional Product Specifications	
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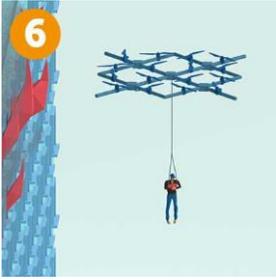
Solution Options: Maritime Vehicles																							
#	Solution	Description	Requirements																				
1	 <p>Emergency Integrated Lifesaving Lanyard (EMILY) by Hydronalix (USA)</p>	<p>A remote-controlled device that is designed to speed through heavy surf. The device has buoyancy to rescue up to 5 people at a time. Rescuers can deploy from a boat, shoreline or aircraft to get to victims at a speed of 30 miles per hour. The device can deliver life jackets or provide a recovery rescue line 800 yards.</p> <p><i>*The device would require manual assistance to load unresponsive victims.</i></p>	<table border="1"> <tr><td>Deploys within 5 Minutes</td><td>Y</td></tr> <tr><td>Includes Audio and Video</td><td>N</td></tr> <tr><td>Rechargeable Battery</td><td>Y</td></tr> <tr><td>Day/Night Operation</td><td>*</td></tr> <tr><td>Generates Lighting</td><td>N</td></tr> <tr><td>Operates 1 to 4 hours</td><td>Y</td></tr> <tr><td>Weighs less than 100 lbs.</td><td>Y</td></tr> <tr><td>Range is greater than 1 mile</td><td>Y</td></tr> <tr><td>Can attach EO/IR Camera</td><td>N</td></tr> <tr><td colspan="2">Additional Product Specifications</td></tr> </table>	Deploys within 5 Minutes	Y	Includes Audio and Video	N	Rechargeable Battery	Y	Day/Night Operation	*	Generates Lighting	N	Operates 1 to 4 hours	Y	Weighs less than 100 lbs.	Y	Range is greater than 1 mile	Y	Can attach EO/IR Camera	N	Additional Product Specifications	
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2		<p>An unmanned full modular surface platform that is designed to integrate different sensors and payloads to suit various mission types. The device includes features that allows for manual control by means of joystick/keyboard, automatic planned tracks, and autonomous mode without radio-link.</p> <p><i>*The device would require manual assistance to load unresponsive victims.</i></p>	Deploys within 5 Minutes	*
			Includes Audio and Video	*
			Rechargeable Battery	*
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			Generates Lighting	*
			Operates 1 to 4 hours	*
			Weights less than 100 lbs.	N
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			Can attach EO/IR Camera	Y
			Additional Product Specifications	

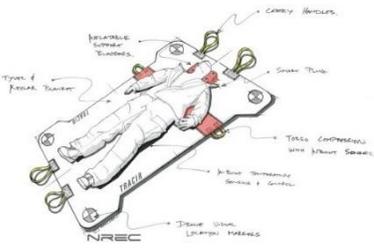
Calzoni Unmanned Surface Vehicle by Calzoni (Italy)

Solution Options: Aircraft Systems				
#	Solution	Description	Requirements	
1		<p>A high-payload capacity vehicle that has been used to carry standard firehoses to tall buildings. The manufacturer has also tested these devices on human rescue scenarios in hard-to- reach places such as water drowning, cracked ice, and fire using a harness for the victim to manually wrap around and then using the drone to airlift the individual away from the hazard.</p> <p><i>*The device would require manual assistance to load unresponsive victims. FAA regulations would likely limit the use of this solution.</i></p>	Deploys within 5 Minutes	N
			Includes Audio and Video	Y
			Rechargeable Battery	N
			Day/Night Operation	*
			Generates Lighting	*
			Operates 1 to 4 hours	Y
			Weights less than 100 lbs.	Y
			Range is greater than 1 mile	*
			Can attach EO/IR Camera	Y
			<p><i>*More Information Required for Detailed Product Specifications</i></p>	

Human Rescue Drone by Aeronex (USA)

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<p>2</p>	 <p>Griff Saviour by Griff Aviation (Norway)</p>	<p>A quadcopter drone that has the payload capacity to lift to a maximum of 441lbs and features attachments, allowing the device to lift a gurney into air.</p> <p><i>*The device would require manual assistance to load unresponsive victims. FAA regulations would likely limit the use of this solution.</i></p>	<table border="1"> <tr><td>Deploys within 5 Minutes</td><td>Y</td></tr> <tr><td>Includes Audio and Video</td><td>*</td></tr> <tr><td>Rechargeable Battery</td><td>Y</td></tr> <tr><td>Day/Night Operation</td><td>*</td></tr> <tr><td>Generates Lighting</td><td>*</td></tr> <tr><td>Operates 1 to 4 hours</td><td>N</td></tr> <tr><td>Weighs less than 100 lbs.</td><td>*</td></tr> <tr><td>Range is greater than 1 mile</td><td>Y</td></tr> <tr><td>Can attach EO/IR Camera</td><td>Y</td></tr> <tr><td colspan="2"><i>*More Information Required for Detailed Product Specifications</i></td></tr> </table>	Deploys within 5 Minutes	Y	Includes Audio and Video	*	Rechargeable Battery	Y	Day/Night Operation	*	Generates Lighting	*	Operates 1 to 4 hours	N	Weighs less than 100 lbs.	*	Range is greater than 1 mile	Y	Can attach EO/IR Camera	Y	<i>*More Information Required for Detailed Product Specifications</i>	
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<p>3</p>	 <p>TRACIR by University of Pittsburgh, Carnegie Mellon & Department of Defense (USA)</p>	<p>An autonomous trauma care system that fits in a backpack and can treat and stabilize soldiers injured in remote locations. The system incorporates a hard and soft robotic suite, into which an injured person can be placed. Monitors embedded in the suit can assess the injury, and artificial intelligence algorithms can guide the appropriate critical care interventions, while robotically applying treatments such as intravenous fluids and medications. In first responder scenarios, could be deployed by drone to hikers or mountain climbers injured in the wilderness.</p> <p><i>*The device would require transport by another autonomous system and manual assistance to load unresponsive victim.</i></p>	<table border="1"> <tr><td>Deploys within 5 Minutes</td><td>Y</td></tr> <tr><td>Includes Audio and Video</td><td>*</td></tr> <tr><td>Rechargeable Battery</td><td>*</td></tr> <tr><td>Day/Night Operation</td><td>*</td></tr> <tr><td>Generates Lighting</td><td>N</td></tr> <tr><td>Operates 1 to 4 hours</td><td>*</td></tr> <tr><td>Weighs less than 100 lbs.</td><td>Y</td></tr> <tr><td>Range is greater than 1 mile</td><td>N/A</td></tr> <tr><td>Can attach EO/IR Camera</td><td>N/A</td></tr> <tr><td colspan="2"><i>*More Information Required for Detailed Product Specifications</i></td></tr> </table>	Deploys within 5 Minutes	Y	Includes Audio and Video	*	Rechargeable Battery	*	Day/Night Operation	*	Generates Lighting	N	Operates 1 to 4 hours	*	Weighs less than 100 lbs.	Y	Range is greater than 1 mile	N/A	Can attach EO/IR Camera	N/A	<i>*More Information Required for Detailed Product Specifications</i>	
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<p>4</p>	 <p>Flirtey Delivery Drones by Flirty (USA)</p>	<p>An autonomous, FAA compliant device that the Department of Transportation is using in its UAS Integration Pilot Program. The device was the first in the US to complete a fully autonomous, FAA-approved drone delivery in the United States. Has a partnership with the Regional Emergency Medical services to bring Automated External Defibrillators to cardiac arrest sufferers.</p> <p><i>*The device is only intended to transport supplies and does not have functionality to transport victims.</i></p>	<table border="1"> <tr><td>Deploys within 5 Minutes</td><td>Y</td></tr> <tr><td>Includes Audio and Video</td><td>*</td></tr> <tr><td>Rechargeable Battery</td><td>Y</td></tr> <tr><td>Day/Night Operation</td><td>*</td></tr> <tr><td>Generates Lighting</td><td>*</td></tr> <tr><td>Operates 1 to 4 hours</td><td>*</td></tr> <tr><td>Weighs less than 100 lbs.</td><td>Y</td></tr> <tr><td>Range is greater than 1 mile</td><td>Y</td></tr> <tr><td>Can attach EO/IR Camera</td><td>Y</td></tr> <tr><td colspan="2"><i>*More Information Required for Detailed Product Specifications</i></td></tr> </table>	Deploys within 5 Minutes	Y	Includes Audio and Video	*	Rechargeable Battery	Y	Day/Night Operation	*	Generates Lighting	*	Operates 1 to 4 hours	*	Weighs less than 100 lbs.	Y	Range is greater than 1 mile	Y	Can attach EO/IR Camera	Y	<i>*More Information Required for Detailed Product Specifications</i>	
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5	<p>Medical Delivery Drones by Zipline (USA)</p>	<p>Small UAS that have been designed to deliver medical products. Originally designed to deliver products in rural areas of Rwanda and Ghana, the FAA has now given the company approval as part of its UAS Integration Pilot Program to test these drones in rural areas of the United States.</p> <p><i>*The device is only intended to transport supplies and does not have functionality to transport victims.</i></p>	Deploys within 5 Minutes	*
			Includes Audio and Video	*
			Rechargeable Battery	*
			Day/Night Operation	*
			Generates Lighting	*
			Operates 1 to 4 hours	Y
			Weighs less than 100 lbs.	Y
			Range is greater than 1 mile	Y
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