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

Portable Signs of Life Identifier

TECHNOLOGY SCOUTING RESEARCH SUMMARY

Date: August 2019

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Overview: Subject matter experts, proprietary commercial datasets, and open-source research were utilized to compile a preliminary list of Solution Options. A summary is outlined below, and the **top 18 Solutions** identified thus far are displayed on the following pages.

Problem Description:

DHS S&T, through subject matter experts, proprietary commercial datasets, and open-source research sought technology solution options to identify the location of injured, trapped, and deceased victims on the scene of an incident through detection of signs of life. Signs of life may include breathing, blood pressure, body heat, pulse, movement, and/or speech. Often first responders are required to find and extract victims in the aftermath of a disaster, such as an earthquake, fire, or tornado. First responders may also be precluded from observing and accessing victims in the event of hostile threat environments, such as active shooter incidents, mental health emergencies where someone is presenting a weapon, or post-blast situations in which there is uncertainty of secondary devices. In both disaster and hostile situations, first responders must be able to remotely recognize both living and deceased causalities during operations. First responders would benefit greatly from a signs of life indicator that is easily portable in order to identify and execute more efficient responses and consequently increase victim survivability.

This report will examine Solutions that provide portable signs of life indication capabilities. The identifier could be used by first responders across the law enforcement, fire, and emergency medical services (EMS) communities in a variety of environments. The solution should be able to penetrate through fallen metal, water, organic materials and concrete to detect an individual under rubble. Ideally, the portable signs of life could be integrated existing equipment, such as a heads-up display or thermal imaging camera (TIC). This solution would be government-off-the-shelf (GOTS) or commercial-off-the-shelf (COTS) and available for purchase in the next 8-12 months.

Desired Use Case:

First Responders would be able to easily deploy this solution in the aftermath of a disaster situation. For example, responders that are called to a large natural gas explosion that has leveled a brick building the length of one city block would use the identified technology solutions to assist with locating victims trapped under rubble. The solution would be portable, lightweight and either handheld or integrated into existing equipment. The portable signs of life detector would be able to penetrate through all materials on the scene, such as brick, wood, metal, electric wiring to identify any signs of life, and allow responders to make more targeted rescues and extrications. In incidents like the one described above, seconds count and this tool could help increase survivability by limiting the time spent sifting through debris by hand. It would also increase responder safety, as they would only make targeted rescue attempts in areas where signs of life had been dedicated, rather than combing the entire collapse zone exposing themselves to a multitude of hazards.

Technology Requirements:

The solutions identified were assessed against the following technology requirements:

Battery	Able to run a minimum of 1 hour on battery life. Contains a rechargeable battery.
Detection	Detects signs of life, including include breathing, blood pressure, body heat, pulse, movement, and/or speech
Multi-medium Penetration	Detection signal is able to penetrate concrete, cinderblock, woods, water, grain, metal, soil, glass, and other substances
Portable	Able to be easily carried by first responders and deployed in emergency scenarios or integrated with existing gear

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Wireless Connectivity	Able to transmit to information to other first responder systems
Durable	Ruggedized for first responder environmental conditions. Maintains a service life of at least 5 years.
Standards	Meets ANSI/ISA 12.12.01, NFPA 1982, or equivalent international standards

Solution Categories

Signs of life can be detected via frequencies that are able to transmit cardiac, respiratory, and thermal imaging data. These frequencies work by sending out an energy wave that can read data from individuals and reflect the wave back into the device to appear on a graphical user interface (GUI). These frequencies can range from as low as 3kHz (Radio Frequency) to as high as 300GTHz (Infrared Frequency). Following the initial technology scan, four categories of detection frequencies were identified:

1. **Radio Frequency (3kHz - 300GHz):** Radio Frequencies overarch many different types of frequencies, such as UWB and FM frequencies. Solutions in this category were not able to be specifically identified by the product. Frequencies that fall under Radio are often described as Radar Signals as well.

2. **Ultra-Wideband (UWB) Frequency (>500MHz):** UWB Frequencies are useful for short-range and multi-medium penetration applications because of their high data rate frequency. In particular they struggle to penetrate anything metallic.

3. **Frequency-Modulated (FM) Carrier Waves (>30MHz):** FM Frequencies sends out carrier waves that are capable of transmitting data from multiple people at a single time. The frequencies can penetrate through walls and other materials.

4. **Infrared Frequency (300 GHz - 405 THz):** Infrared Frequencies use thermal imaging to detect changes to infrared light due to blood flow. Infrared sensors are particularly useful for long range detection but cannot pierce through rubbish and walls.

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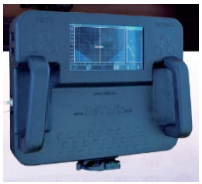
Legend:					
Key Performance Parameter Criteria:					
✓	Solution Meets Criteria	?	Additional Information Required from Vendor to Determine if the Solution Meets Criteria	✗	Solution Does Not Meet Criteria

Technology Solutions

In total, **18 Solution Options** were identified. As displayed in the table, Solutions that rely on radar and UWB frequency detection often have higher technology readiness levels (TRL) and are accurate in determining presence of life, but cannot distinguish between stationary and decreased individuals because they do not detect vital signs. Solutions found that do detect vital signs are able to make this distinction, but often lack other requirements such as multi-medium penetration and generally have lower TRLs. There were a range of Solutions found that meet many of the technology requirements specified by the requestor, however additional vendor outreach may be required to determine if certain solutions meet all requirements. Low TRL Solutions would likely not be available to the requestor in the next 8 to 12 months.

#	Solution	Description	Battery	Detection	Multi-Medium	Portable	Wireless Connectivity	Durable	Standards
1	Xaver™ 100 by Camero Tech 	The Xaver 100 is a portable, handheld and durable presence of life detector with a GUI to visualize a scene. It is designed for first responder and military environments to aid search and rescue operations, tactical entry/assault, hostage recovery, breaching, and force protection. It can be used at a stand-off distance (not in contact with a wall) up to 20 meters. Xaver 100 detects moving and static people behind most common wall materials. It runs on 4 lithium 123 batteries and weighs ~23 oz. It cannot distinguish between stationary and deceased people. **Signs of Life:** Movement **Category:** Ultra-Wideband (UWB) Frequency **TRL:** 9 **Additional Information**	✓ 3.5 hrs	✓	✓	✓	✓	✓	✗ Only Meets MIL-STD-810F Standard
2	ReTWis 5 by Retia 	The ReTWis 5 detects people behind solid barriers from a radar range of up to 40 meters. It detects small movements and enables localization of a human being based only on breathing. The device weighs about 7 lbs and has a startup time of about 20 seconds. It is ruggedized and waterproof and dust proof for disaster environments. It contains a 2D or 3D GUI. The ReTWis 5 only detects living persons. **Signs of Life:** Breathing, movement **Category:** Ultra-Wideband (UWB) Frequency **TRL:** 9 **Additional Information**	✓ 5 hrs	✓	✓ Except metals	✓	✓	✓	?

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#	Solution	Description	Battery	Detection	Multi-Medium	Portable	Wireless Connectivity	Durable	Standards
3	Range-R Link by L3 Harris 	The Range-R Link is a compact, handheld radar system with wireless capability that provides real-time tactical information on the presence of people inside buildings. It has specific first responder capabilities for search and rescue to locate injured people inside buildings and for firefighters to discover where people are trapped in a building. It runs on AA batteries and weighs 1 lb. It is ruggedized for first responder and military environments. It cannot distinguish between stationary and deceased people. **Signs of Life:** Movement **Category:** Radio Frequency - Radar **TRL:** 9 **Additional Information**	1 hr	✓	✓	✓	✓	?	✓	?
4	HTMI v2.0 by SPI Infrared 	The HTMI v2.0 mini FLIR monocular is a small, handheld thermal imaging camera. It is specifically designed for search and rescue missions carried out by first responders, firefighters, and the Federal Emergency Management Agency (FEMA). The camera can be mounted on a helmet picatinny rail. It runs on a lithium battery and weighs 8.5 oz. The HTMI v2.0 is waterproof and Bluetooth capable. **Signs of Life:** Body heat **Category:** Infrared Frequency **TRL:** 9 **Additional Information**	Up to 9 hrs	✓	?	✓	✓	✓	?
5	CPR4+ by ACUSTEK 	The CPR4+ detected movement, distance, speed and direction behind walls or solid objects in a light ergonomic military specification unit using narrow band Doppler radar effect. It can detect a human from a distance of 3m to 5m behind a 20cm concrete wall, 10 meters behind an interior wall, 25 meters without any obstacles. It has a long battery life and is lightweight. It is ruggedized for military environments. The CPR4+ has a remote web application which can make the information available on a private access web browser so that data can be viewed in real time. It cannot distinguish between stationary and deceased people. **Signs of Life:** Movement **Category:** Radio Frequency - Radar **TRL:** 9 **Additional Information**	✓	✓	✓	✓	?	✓	?
6	LEADER Search by LEADER North America 	LEADER Search detects the presence of buried victims under rubble and identifies their exact location using wireless and/or wired ultra-sensitive seismic sensors. It allows two-way communication with the victim once they are found through a communication probe, which is waterproof up to 6.5 ft. It has a GUI to view location. It was specifically designed as for specialized rescue teams. Using 3 sensors, it can detect over a range of 98 ft. It runs AAA batteries and weighs between ~2 and 3 lbs. It cannot distinguish between stationary and deceased people. **Signs of Life:** Movement **Category:** Non- radiofrequency (seismic sensors) **TRL:** 9 **Additional Information**	5 hrs	✓	?	✓	✓	✓	?

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#	Solution	Description	Battery	Detection	Multi-Medium	Portable	Wireless Connectivity	Durable	Standards
7	Eagle10-B by TiaLinx Inc. 	The Eagle10-B is a probe-based sensor for breathing and movement detection under rubble of a collapsed building. The Eagle 10-B can also be used as a stand-alone system to probe hard-to-access areas to detect trapped or concealed people. It is specifically designed for post-earthquake casualty detection. TiaLinx also offers a man-portable version, the Eagle45W, that has a GUI that attaches to a user's wrist. **Signs of Life:** Breathing, movement **Category:** Vendor Outreach Required **TRL:** 9 Additional Information	?	✓	✓	✓	?	✓	?
8	ND-SV004 by NQ Defense 	The ND-SV004 is a newly developed ruggedized portable through wall radar. The system can scan and detect an area within seconds and display the accurate number of people and their position in real time. The ND-SV004 radar can penetrate only non-metal materials, including concrete, mixed brick, floor, wood, and material with low water content. It weighs ~6 lbs and has a lithium battery. It cannot distinguish between stationary and deceased people. **Signs of Life:** Movement **Category:** Ultra-Wideband (UWB) Frequency **TRL:** 9 Additional Information	✓	✓	✓ Except metals	✓	?	✓	?
9	STTW Radar Imaging System by Enforcement Technology Group 	The STTW Radar Imaging System detects the presence of life in the room, the number of people and their location inside a room, the tracking of target movement patterns, and room general layout, including dimensions and major infrastructure elements. It provides reliable detection to distances of up to 65 ft. (20m) through most common wall materials, including cement, plaster, brick, concrete, and drywall. Users can visualize a room on the graphical user interface (GUI). This solution is designed and ruggedized for military environments, has rechargeable battery, and weighs 7.05 lbs. It cannot distinguish between stationary and deceased people. **Signs of Life:** Movement **Category:** Radio Frequency - Radar **TRL:** 9 Additional Information	✓ 2.5 hrs	✓	✓	✓	?	✓	?
10	ASTIR by AKELA Inc. 	The ASTIR is a see-through-wall imaging system that was created through sponsorship by the National Institute of Justice (NIJ). The system provides the ability to detect and track the presence of both moving and stationary individuals within a building structure. ASTIR provides stand-off detection of up to 30 meters (rather that needing direct contact with a wall). It contains a corresponding software and GUI to visualize the scene. Given the suitcase size of the ASTIR, it may not have the small footprint that the conditions stipulate but it is less than 15 pounds. Additional vendor outreach is needed to determine exactly which materials the ASTIR penetrates. It cannot distinguish between stationary and deceased people. **Signs of Life:** Movement **Category:** Radio Frequency - Radar	?	✓	?	✓	?	✓	?

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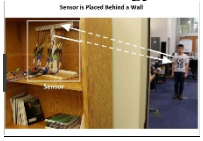
#	Solution	Description	Battery	Detection	Multi-Medium	Portable	Wireless Connectivity	Durable	Standards
		TRL: Additional Vendor Outreach Needed Additional Information							
11	Umain UWB Sensor 	Umain's UWB (Ultra-wideband) sensor detects heartbeats and respiration up to 2 meters. The device provides both wired and wireless data communication. It has specific applications for searching for missing people in disaster areas and detecting signs of life in firefighting environments. **Signs of Life:** Heartbeat, breathing **Category:** Ultra-Wideband Frequency **TRL:** 9 Additional Information	?	✓	✗	?	✓	✓	✓ EN 60950-1 2006
12	Jetson 	The Jetson is an infrared laser heartbeat identifier created by the U.S. Defense Department for Special Operations Command (SOCOM). Jetson can detect cardiac signatures using the technique of laser vibrometery, and works by detecting surface movement caused by the heartbeat. The device can detect heartbeats of up to 200 meters; however, there are limitations such as the laser only being able to pierce through thin material (shirts and jackets). Jetson is meant to use heartbeat as a biometric identifier, rather than to find casualties. Since it is in the early stages of development, integration capabilities, durability, portability, and energy sources are not yet known. **Signs of Life:** Heartbeat **Category:** Infrared Frequency **TRL:** 5 Additional Information	?	✓	✗	?	?	?	✗
13	Remote Drone Monitoring by University of South Australia 	University of South Australia researchers have developed an unmanned drone that can detect signs of life within three meters of a human. Video footage from the drone can detect changes in human skin tone and minute head movements to read heart rate. The remote monitoring drone is designed specifically for victims in disaster zones. While this solution may not work at a building collapse it could be useful for victim triage at an active shooter scene. **Signs of Life:** Movement, heart rate **Category:** Video-photoplethysmography (PPG), a remote-sensing imaging system that uses low intensity infrared light **TRL:** 5 Additional Information	✗ Most drones cannot fly 1 hr	✓	✗	✓	✓	✓	✗
14	WiZ by Massachusetts Institute of Technology 	MIT's CSAIL (Computer Science and Artificial Intelligence Laboratory) created a technology that uses radio waves to detect heart rate and respiration from behind a wall. This technology can locate four people in a room and track the respiratory functions of the individuals simultaneously. The product was in the prototype phase in 2014 and additional outreach is needed to determine current status. **Signs of Life:** Heart rate, breathing, movement **Category:** Frequency-Modulated Carrier Waves (FMCW) **TRL:** 6 Additional Information	?	✓	✓	?	?	✗	?

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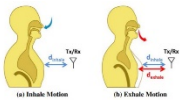
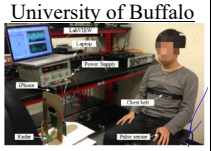
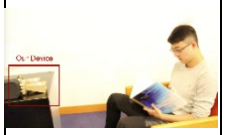
15	Vital-Radio by Massachusetts Institute of Technology (MIT) 	MIT researchers have created a prototype of the Vital-Radio, a wireless sensing technology that monitors breathing and heart rate without body contact. Vital-Radio uses radio frequency to detect motion in the environment, including chest movements due to inhaling and exhaling and skin vibrations due to heartbeats. In a user study, it tracked users' breathing and heart rates with a median accuracy of 99%, even when users are 8 meters away from the device, or in a different room. It can monitor the vital signs of multiple people simultaneously. Vital-Radio is designed for smart homes to monitor infants and the elderly. Given the low TRL and non-portability, this is not a good solution for the use case, but this sensing technology could be useful in the future with form factor modifications. **Signs of Life:** Heart rate, breathing **Category:** Radio Frequency **TRL:** 5 **Additional Information**	✗	✓	✓	✗	✓	✗	✗
16	Cardiac Scan by University of Buffalo 	The University of Buffalo (UB) has experimented using a heartbeat as a digital signature due to its unique shape and size. The device is able to detect how the heart moves by using radio waves that can penetrate through obstacles. Instead of using this technology as a digital signature, it can be used as a way of detecting signs of life. The form factor is still in the prototyping phase, but a lead of the project is planning on installing it onto the corners of a keyboard. This can potentially be a solution to first responders with a few technological adjustments such as developing a durable form factor, an external battery, and wireless connectivity. **Signs of Life:** Heartbeat **Category:** Radio Frequency **TRL:** 6 **Additional Information**	✗	✓	✓	✗	✗	✗	✗
17	EQ-Radio by Massachusetts Institute of Technology 	MIT has developed a wireless emotional intelligence detector that uses heartbeat and breathing rhythms to determine an individual's emotion. The emotional intelligence detector sends a wireless signal that deflects off an individual's body to measure their heartbeat as accurately as an ECG monitor. Although this device is not particularly used to detect signs of life the technologies behind the EQ-Radio could be of use. As of 2016, EQ-Radio still a prototype and additional vendor outreach is needed to determine current status. **Signs of Life:** Heart rate, breathing **Category:** Radio Frequency **TRL:** 6 **Additional Information**	?	✓	✗	✗	?	✗	✗

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#	Solution	Description	Battery	Detection	Multi-Medium	Portable	Wireless Connectivity	Durable	Standards
18	Novelda X4M200 UWB Radars by Novelda 	Novelda developed a respiratory sensor that can be hand-held and is able detect respiration at up to five meters. This size of the device makes it easy for first responders to carry when facing obstacles that can prohibit movement. The UWB radar can detect through light building materials such as thin walls and detect sub-mm movements. The Novelda sensor is still in need of a prototype to enclose the open sensor. **Signs of Life:** Breathing **Category:** Ultra-Wideband Frequency **TRL:** 5 Additional Information	?	✓	✓	✗	✓	✗	✗