



Artifacts Specification Final Event

April 1, 2021



Defense Advanced Research Projects Agency

Tactical Technology Office
675 North Randolph Street
Arlington, VA 22203-2114

Approved for Public Release, Distribution Unlimited

Table of Contents

- 1. INTRODUCTION 3**
- 2. COMMON ARTIFACTS 4**
 - 2.1. ARTIFACT 1 - SURVIVOR4
 - 2.2. ARTIFACT 2 - CELL PHONE5
 - 2.3. ARTIFACT 3 - BACKPACK5
- 3. TUNNEL CIRCUIT ARTIFACTS 6**
 - 3.1. ARTIFACT 4 - DRILL.....6
 - 3.2. ARTIFACT 5 - FIRE EXTINGUISHER6
- 4. URBAN CIRCUIT ARTIFACTS 7**
 - 4.1. ARTIFACT 6 - GAS7
 - 4.2. ARTIFACT 7 - VENT.....7
- 5. CAVE CIRCUIT ARTIFACTS 8**
 - 5.1. ARTIFACT 8 - HELMET8
 - 5.2. ARTIFACT 9 - ROPE.....8
- 6. FINAL EVENT ARTIFACT..... 9**
 - 6.1. ARTIFACT 10 - CUBE.....9

1. Introduction

This document provides specifications for the artifacts expected to be used in the DARPA Subterranean (SubT) Challenge. An “artifact” is an object or feature of interest that could reasonably be found in subterranean environments. The main scoring objective of the competition is the need to search for, detect, and provide spatially referenced locations of artifacts relevant to each of the three subdomains (Tunnel Systems, Urban Underground, and Cave Networks).

The intent of this document is to provide the set of artifacts that will be used in the Final Event. This document supersedes the *SubT Challenge Artifacts Specification (Cave Circuit Event)* document dated April 21, 2020. Major revisions in this document are indicated by blue text.

This document is subject to change and may be superseded by later versions. The latest official versions of all documents will be posted to the [SubT Challenge Website](#) and the [SubT Community Forum](#).

Three artifacts are common to all three subdomains and appeared in all three Circuit Events (a.k.a. the Tunnel Circuit, Urban Circuit, and Cave Circuit). Two additional artifacts were specified for each Circuit Event that are event-specific and did not appear in the other Circuit Events. Thus, each Circuit Event had a total of five artifact types: the three common artifacts and two event-specific artifacts. The common and event-specific artifact types are illustrated in Figure 1. The Final Event will include a total of ten artifact types: the three common artifacts, all six event-specific artifacts, and a new artifact for the Final Event.

The sections below provide specifications and descriptions for each of the artifacts. The specifications include artifact names, vendors, model numbers, purchase hyperlinks, Artifact Report strings as specified in the Interface Control Document (ICD), and other relevant information. Teams are not required to purchase or use these exact items, but sufficient detail is provided for teams that want to use the specific artifacts in their development and testing.

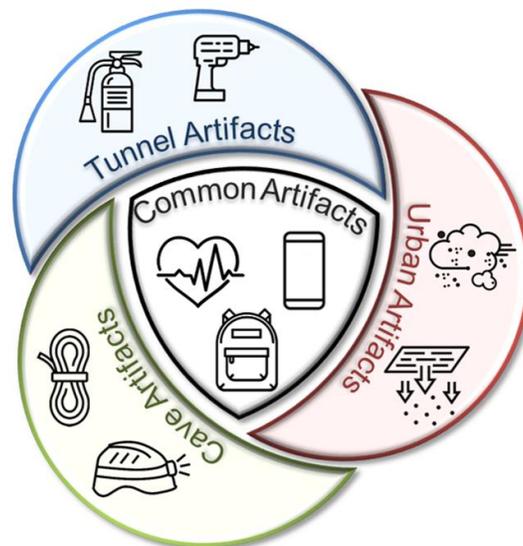


Figure 1: Common and event-specific artifacts for each of the SubT Challenge Events

2. Common Artifacts

The following three artifact types appeared in all three Circuit Events and are expected to appear in the Final Event.

2.1. Artifact 1 - Survivor

Overview:

The survivor manikin will emulate a human survivor using an anatomical, thermal manikin to represent both human shape and body temperature. The manikin will be wearing traditional subterranean worker apparel, which includes a yellow high-visibility jacket, grey work pants, and standard yellow steel-toed work boots. The manikin has heating elements to emulate human body temperature.

Specifications:

The manikin being used is a Smartdummy Thermal Manikin produced by LION. The manikin is 180 cm in height, weighs 30 kg, includes a voicebox that will provide auditory cues, and presents a thermal signature via heating elements throughout the head, torso, and limbs. The manikin will be wearing a black and yellow Fleece Bomber Safety Jacket by Pyramex, Dickies Slate Work Pants, and yellow Construction Boots by Everboots. The manikin will not have any headwear or gloves. The manikin is not expected to be actuated to generate movement. It is anticipated that the manikins will be placed in a static sitting position inside of the competition course.

Artifact Report String: Survivor

Localization Point: Intersection of the primary front zipper and the boundary between the yellow and gray portions of the jacket

Purchase Links:

- LION: [Smartdummy Thermal Mannequin](#)
 - NOTE: Less expensive manikins are available that do not have a thermal feature. Teams may also consider other manikins from other suppliers.
- Amazon: [Pyramex Safety Jacket, Lime, 2X Large](#)
- Amazon: [Dickies Carpenter Jean, Slate, 40Wx32L](#)
- Amazon: [Everboots Work Boots, Tan, 12M](#)



Figure 2: Survivor Artifact

2.2. Artifact 2 - Cell Phone

Overview:

The cell phone artifact represents any typical hand-held electronic device that would be carried by humans in subterranean environments. It acts as a surrogate for objects such as hand-held radios and surveying equipment, which when discovered are indicators of human presence and activity. The cell phone will be a standard smartphone.

Specifications:

The cell phone artifact will be a Samsung Galaxy J8 J819M/DS. It is approximately 160 mm x 76 mm x 8 mm in size and has a 154 mm diagonal screen. The phone is made of black plastic, with bezels on the top and bottom portions of the screen. During the scored run, the screen will be on and playing a full-screen video with audio. The phone's 2.4 GHz WiFi will be operating as an access point with a visible SSID, and the phone's Bluetooth radio will be on and in discovery mode. Each phone artifact will be assigned a unique name in the form of 'PhoneArtifactXX', where XX will be a combination of two characters that may be letters and/or numbers. The phone artifact's unique name is expected to be reflected in both the SSID and the Bluetooth Device Name. It is intended that the phone will be positioned with the screen facing outward and it may be located on the ground, walls, or other surfaces.



Figure 3: Cell Phone Artifact

Artifact Report String: Cell Phone

Localization Point: Centroid of the phone's bounding box

Purchase Link: [Samsung Galaxy J8. Black](#)

2.3. Artifact 3 - Backpack

Overview:

The backpack artifact represents a typical, adult sized backpack used for transporting personal items and equipment.

Specifications:

The backpack artifact will be a JanSport Big Student Backpack, in the Red Tape color. The front portion of the bag is all red, while the back portion and straps are black. All of the zippers will be closed. The backpack will be red in color, and may be found on the ground, hanging on a wall, or resting on a work surface in the competition courses. The front of the backpack will be facing outward or upward. The backpack will be weighted to aid in holding the backpack in place.



Figure 4: Backpack Artifact

Artifact Report String: Backpack

Localization Point: Top left corner of the "P" in the JANSPORT logo.

Purchase Link: [JanSport Backpack, Red Tape](#)

3. Tunnel Circuit Artifacts

There are two event-specific artifacts that appeared in the Tunnel Circuit and are expected to appear in the Final Event.

3.1. Artifact 4 - Drill

Overview:

The electronic hand drill artifact is a typical cordless power tool. It represents a multitude of hand tools (manual or powered) that can be found in a tunnel environment. This artifact is a standard electronic hand drill, with the battery attached.

Specifications:

The electric hand drill artifact is a Black & Decker GC960 cordless drill. It has an orange body, with a black battery and black chuck collar. A Phillips head driver will be located in the drill's chuck. It will not be in operation during the competition run and may be found on the ground or on other surfaces. The resting orientation of the drill is not specified.

Artifact Report String: Drill

Localization Point: Lower tip of the black trigger.

Purchase Link: [Black+Decker GC960](#)



Figure 5: Electric Hand Drill Artifact

3.2. Artifact 5 - Fire Extinguisher

Overview:

The fire extinguisher artifact is a typical hand-held, metal cylinder fire extinguisher commonly found in a variety of environments. Finding this artifact represents identifying the locations of general emergency equipment in the tunnel, which would aid responders who subsequently enter the environment to mitigate an emergency.

Specifications:

The fire extinguisher artifact will be a First Alert FE2A10GR Red Fire Extinguisher. It has a red cylinder, with a black hose and black operating handle. The fire extinguisher may be found on the ground, hanging from a wall, or on another surface. It will not be in operation, and its hose will be attached in the stored configuration.

Artifact Report String: Fire Extinguisher

Localization Point: Center of the pressure dial located near the handle.

Purchase Link: [First Alert FE2A10GR](#)



Figure 6: Fire Extinguisher Artifact

4. Urban Circuit Artifacts

There are two event-specific artifacts that are only expected to appear in the Urban Circuit and the Final Event competition courses.

4.1. Artifact 6 - Gas

Overview:

The gas artifact is a CO₂-emitting device used to simulate a range of hazardous air quality conditions including a gas leak, poor ventilation, or fumes and smoke. Finding this artifact represents identifying areas that would be hazardous for personnel, i.e., areas where breathing apparatus may be necessary.

Specifications:

The gas being used for this artifact is CO₂. The gas will be released into a confined area to maintain a concentration of at least 1500 parts per million (ppm). The confined area will be a room with a clearly defined ingress/egress passage (doorway). No visual identifier will be provided for this artifact.

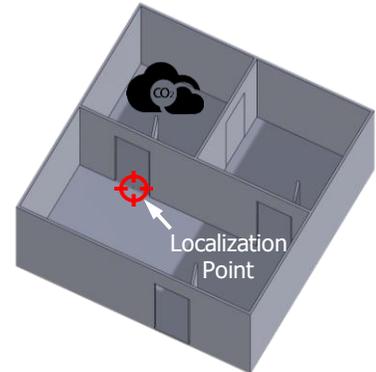


Figure 7: Gas Artifact

Artifact Report String: Gas

Localization Point: The center point of the entry door threshold (at floor level) of the room where the gas is detected. In rooms with multiple doorways, only one door will be open (i.e., any others will be closed or blocked) and will serve as the relevant localization point.

Purchase Link: [Sensirion SCD30](#)

- NOTE: Teams are permitted to use any sensors of their choice. This CO₂ sensor is provided as a low-cost example of a low-cost option that has been evaluated to consistently detect the gas artifact. Additional resources: [Datasheet](#), [Arduino Library](#), [Download Center](#)

4.2. Artifact 7 - Vent

Overview:

The vent artifact is a typical supply register commonly found in human-occupied or -working environments. Finding this artifact represents identifying potential areas with fresh air or an escape route to the surface.

Specifications:

The vent will be a Grainger 4MJV3 three-cone square ceiling diffuser. The face of the artifact is square with a distinct three-cone air diffuser design and is fabricated from sheet metal that is painted white. The vent artifact will be actively heated to present a distinct thermal signature that is at least 10°C above ambient. The air vent may be found on a wall or ceiling at any height, either flush to the wall/ceiling or protruding up to 300 mm.

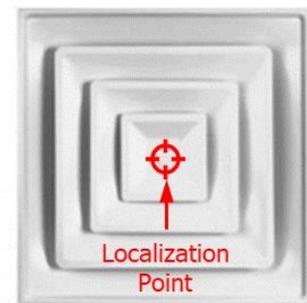


Figure 8: Vent Artifact

Artifact Report String: Vent

Localization Point: Center of the air vent

Purchase Link: [Grainger 4MJV3](#)

5. Cave Circuit Artifacts

There are two event-specific artifacts that are only expected to appear in the Cave Circuit and the Final Event competition courses.

5.1. Artifact 8 - Helmet

Overview:

The helmet artifact is a typical caving helmet and headlamp. Finding this artifact could indicate nearby human presence or represent a partially obstructed survivor awaiting rescue.

Specifications:

The helmet is a white medium/large Petzl BOREO. A Princeton Tec Apex (APX550-BK) headlamp will be installed as shown and turned on in the “low spot” setting. The helmet may be found on the ground, on a wall, or on a ledge. The localization point will be visible but the front of the helmet may be pointing in any direction.



Figure 9: Helmet Artifact

Artifact Report String: Helmet

Localization Point: Top of the helmet, designated by the buckle of the headlamp strap.

Purchase Links:

- [Petzl BOREO, White, Medium/Large](#)
- [Princeton Tec Apex, Black, \(APX550-BK\)](#)

5.2. Artifact 9 - Rope

Overview:

The rope artifact is a coiled 35 m length of rope commonly used for traversing vertical sections of caves. Finding the rope artifact represents identifying areas where humans may have traversed or the location of a vertical passage.

Specifications:

The rope is a coiled Black Diamond 9.9 mm Climbing Rope. The rope coil is held together with a 25.4 mm (1 in) wide black strap as shown in Figure 11. The rope coil is approximately 0.5 m long with the strap approximately located in the middle. The rope coil is approximately 0.1 m in diameter at the strap. The rope may be found on the ground,



Figure 10: Rope Artifact

on a ledge, or suspended from a wall. Additional uncoiled sections of the rope and/or other climbing equipment may be lying, hanging, or installed nearby.

Artifact Report String: Rope

Localization Point: Center of the black strap, on the outermost point aligned with the front of the rope coil as shown in Figure 10.

Purchase Link: [Black Diamond 9.9 mm Climbing Rope, Dual Blue Color, 35 m](#)

6. Final Event Artifact

The Final Event will include a total of ten artifact types: the three common artifacts, all six event-specific artifacts, and a new artifact that is only appearing in the Final Event.

6.1. Artifact 10 - Cube

Overview:

The cube artifact is a 3D representation of the SubT Challenge logo and serves as the tenth and final artifact in the Final Event.

Specifications:

The cube artifact is approximately 200 mm x 200 mm x 200 mm and will be 3D-printed using a translucent plastic material. The cube will be illuminated from within by RGB LEDs that rotate through the color spectrum and will include a Bluetooth radio that is on and in discovery mode. Each cube artifact will be assigned a unique Bluetooth Device Name in the form of 'CubeArtifactXX', where XX will be a combination of 2 characters that may be letters and/or numbers. The cube may be installed in any orientation and may be located on the ground, walls, or other surfaces.

Artifact Report String: Cube

Localization Point: Centroid of the cube's top face as shown in Figure 11.

Purchase Link: Not Applicable

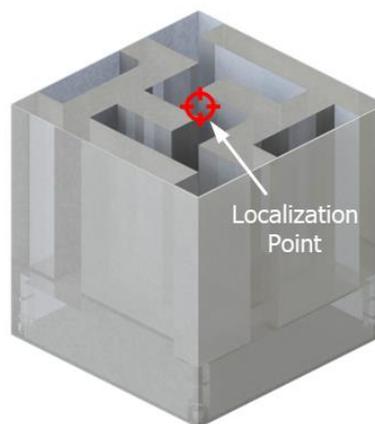


Figure 11: Cube Artifact