DARPA Subterranean (SubT) Challenge

Dr. Timothy Chung
Tactical Technology Office

Proposers Day
January 18th, 2018
The goals of the Proposers Day are:

• To **introduce** the DARPA Subterranean Challenge program vision and goals to the broader community

• To **facilitate** interaction between researchers, developers, and stakeholders with capabilities and interests relevant to the DARPA Subterranean Challenge

• To **promote** the formation of cross-cutting teams responsive to the DARPA Subterranean Challenge program vision
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>8:15 am - 9:00 am</td>
<td>Registration</td>
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<tr>
<td>9:00 am - 9:15 am</td>
<td>Welcome and Introductions</td>
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<tr>
<td></td>
<td>Dr. Timothy Chung, DARPA TTO</td>
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<tr>
<td>9:15 am - 9:30 am</td>
<td>Security Briefing and Contract Management Office Briefing</td>
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<tr>
<td></td>
<td>Ms. Sonya Maldonado, DARPA SID</td>
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<td></td>
<td>Mr. Chris Glista, DARPA CMO</td>
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<tr>
<td>9:30 am - 9:45 am</td>
<td>TTO Overview</td>
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<td>Dr. Fred Kennedy, DARPA TTO</td>
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<tr>
<td>9:45 am - 10:15 am</td>
<td>DARPA Subterranean Challenge Vision and BAA Overview</td>
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<td></td>
<td>Dr. Timothy Chung, DARPA TTO</td>
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<tr>
<td>10:15 am - 10:30 am</td>
<td>Break</td>
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<tr>
<td>10:30 am - 11:15 am</td>
<td>Attendee Lightning Presentations Part I</td>
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<tr>
<td>11:15 am - 12:30 pm</td>
<td>Open Poster Session 1</td>
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<tr>
<td>12:30 pm - 1:30 pm</td>
<td>Lunch (on your own)</td>
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<tr>
<td>1:30 pm - 2:00 pm</td>
<td>Q&amp;A Session - Answers to Submitted Questions</td>
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<tr>
<td>2:00 pm - 2:45 pm</td>
<td>Attendee Lightning Presentations Part II</td>
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<tr>
<td>2:45 pm - 4:00 pm</td>
<td>Open Poster Session II</td>
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<tr>
<td>4:00 pm - 4:15 pm</td>
<td>Closing Remarks</td>
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<td></td>
<td>Dr. Timothy Chung, DARPA TTO</td>
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The purpose is to **inspire information exchange** and **facilitate potential teaming**

**Presenters Rules of Engagement**

- **Lighting Talks**
  - Receive your presenter number and time slot at registration
  - Take your assigned (numbered) seats up front before your session
  - Stay within your **two minutes** (you will be buzzed!)

- **Poster Session**
  - Find your assigned easel in poster area
  - Set up your poster before your session
  - Meet, share with, and learn from fellow attendees
Questions and Answers

DARPA Subterranean Challenge Proposers Day Q&A Session

Ask a Question

Questions
Tap an arrow to vote for a question

Will Proposers Day Q&As be made available online after the event?

• View, vote, and ask questions
• Questions are moderated
• FAQs to be posted on FedBizOpps.gov

DARPA SubTChallenge.socialqa.com
DARPA Subterranean (SubT) Challenge

Dr. Timothy Chung
Tactical Technology Office

Program Overview

January 18th, 2018
Current technologies fail to provide rapid mapping and persistent situational awareness of the diverse subterranean operating environment.
Introducing the DARPA Subterranean Challenge

3 Sub-domains
- tunnel systems
- urban underground
- cave networks

2 Competition Tracks
- Systems Track
- Virtual Track

1 Challenge Vision
Revolutionize how we operate in the underground domain

Distribution Statement A Approved for public release; distribution is unlimited
DARPA Subterranean Challenge: Technical and Program Description

Why

What

When

Where

Who

How

Phase 1 (12 mo)  |  Phase 2 (12 mo)  |  Phase 3 (12 mo)

Track A
DARPA-funded teams

Track B
Self-funded teams

Track C
DARPA-funded teams

Track D
Self-funded teams

Tunnel Circuit
Urban Circuit
Cave Circuit

Systems Tracks

Virtual Tracks

Virtual Final Event

Broad Agency Announcement
DARPA Subterranean (SubT) Challenge
Tactical Technology Office (TTO)
BAA# HR001118S0016

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Need for **rapid situational awareness** for warfighters or first responders operating in **unknown and dynamic environments**. The layout of the environment is **unknown**, could **degrade** or **change** over time, and is **too high-risk** to send in personnel.
Envisioned Gameplay for the DARPA Subterranean Challenge

1. Initialize challenge course
2. Deploy competitor solution
3. Commence competition run
4. Declare winning team
Challenge Elements to Inspire Technology Breakthroughs

Austere navigation
GPS-less and sparsely featured surroundings

Degraded sensing
Low-light, obscured, and scattering conditions

Severe comms
Physical impediments to reliable links

Dynamic terrain
Physical changes to the environment

Endurance limits
Operationally relevant spatial scales

Terrain obstacles
Mobility-stressing terrain features

Technologies Impact

Autonomy
Perception
Networking
Mobility
Challenge Elements to Inspire Technology Breakthroughs

- **Austere navigation**
  - GPS-less and sparsely featured surroundings

- **Degraded sensing**
  - Low-light, obscured, and scattering conditions

- **Severe comms**
  - Physical impediments to reliable links

- **Dynamic terrain**
  - Physical changes to the environment

- **Endurance limits**
  - Operationally relevant spatial scales

- **Terrain obstacles**
  - Mobility-stressing terrain features

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<tr>
<th></th>
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<th>Perception</th>
<th>Networking</th>
<th>Mobility</th>
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<tbody>
<tr>
<td>1. Austere Navigation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>2. Degraded Sensing</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>3. Severe Comms</td>
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<td>✓</td>
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<tr>
<td>4. Terrain Obstacles</td>
<td>✓</td>
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<tr>
<td>5. Dynamic Terrain</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>6. Endurance Limits</td>
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**Challenge Focus**: Drive innovation and investment to accelerate breakthroughs for exploring complex unstructured environments

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<thead>
<tr>
<th>Technology Area</th>
<th>Relevant Metrics</th>
<th>Stretch Goals</th>
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<tbody>
<tr>
<td>Autonomy</td>
<td>Number of manual interventions during mission</td>
<td>Zero interventions over four-hour mission</td>
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<tr>
<td>Perception</td>
<td>Resolution of multimodal 3D mapping</td>
<td>&lt;10cm map detail</td>
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<tr>
<td></td>
<td>Geo-localization of physical agents over mission duration</td>
<td>&lt;1m error over 1km traversed</td>
</tr>
<tr>
<td>Networking</td>
<td>Latency in situational awareness updates per traversal distance</td>
<td>&lt;1s per 500m path length</td>
</tr>
<tr>
<td>Mobility</td>
<td>Effective, team-aggregated mission endurance</td>
<td>Four-hour effective endurance</td>
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### Challenge Schedule and Tracks

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<thead>
<tr>
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<th>Phase 1 (12 mo)</th>
<th>Phase 2 (12 mo)</th>
<th>Phase 3 (12 mo)</th>
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<tr>
<td><strong>Systems Tracks</strong></td>
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<tr>
<td>Track A</td>
<td>DARPA-funded teams</td>
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<td>Urban Circuit</td>
<td>Cave Circuit</td>
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<td><strong>Virtual Tracks</strong></td>
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<td>Track B</td>
<td>Self-funded teams</td>
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<td>Self-funded teams</td>
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<td>Track C</td>
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<tr>
<td>Track D</td>
<td>Self-funded teams</td>
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**Legend:**
- **DARPA Contract**
- **Prize**

**Focus of the DARPA SubT Challenge BAA**
Challenge Circuits: Advancing Technologies through Cross-Training

Circuits offer focused challenge events to:

- Promote **frequent “build-test-compete”** iterations within and among teams
- Directly **involve operational needs** in design of circuit courses
- Explore both **illustrative and operational scales** via Systems and Virtual tracks

**Kickoff**

**Circuit Events**

**Finals**

**Tunnel Circuit**

**Urban Circuit**

**Cave Circuit**

© Southwest Regional Transit Authority
Virtual Competition: Jumpstarting Insights for Future Capabilities

Systems Track

Inform and calibrate physical course design and difficulty

Introduce Systems-track simulation models into virtual construct

Virtual Track

Physics-based simulator

camera-mounted quadrotor in a rendered cave

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What DARPA is looking for?

- Read the (draft) BAA!
  - Revolutionary and innovative technical approaches
  - Strong, integrated, agile, holistic teams

- Competition Tracks
  - Systems
  - Virtual

- Phases
  - Phase 1 (base)
  - Phase 2 (option)
  - Phase 3 (option)

- FAQs

- Contracting

Good luck!
The relationship between warfare and terrain demands “the faculty of quickly and accurately grasping the topography of any area.”

- Clausewitz, On War