Underminer

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Briefing prepared for ARPA-E Undergrounding Workshop

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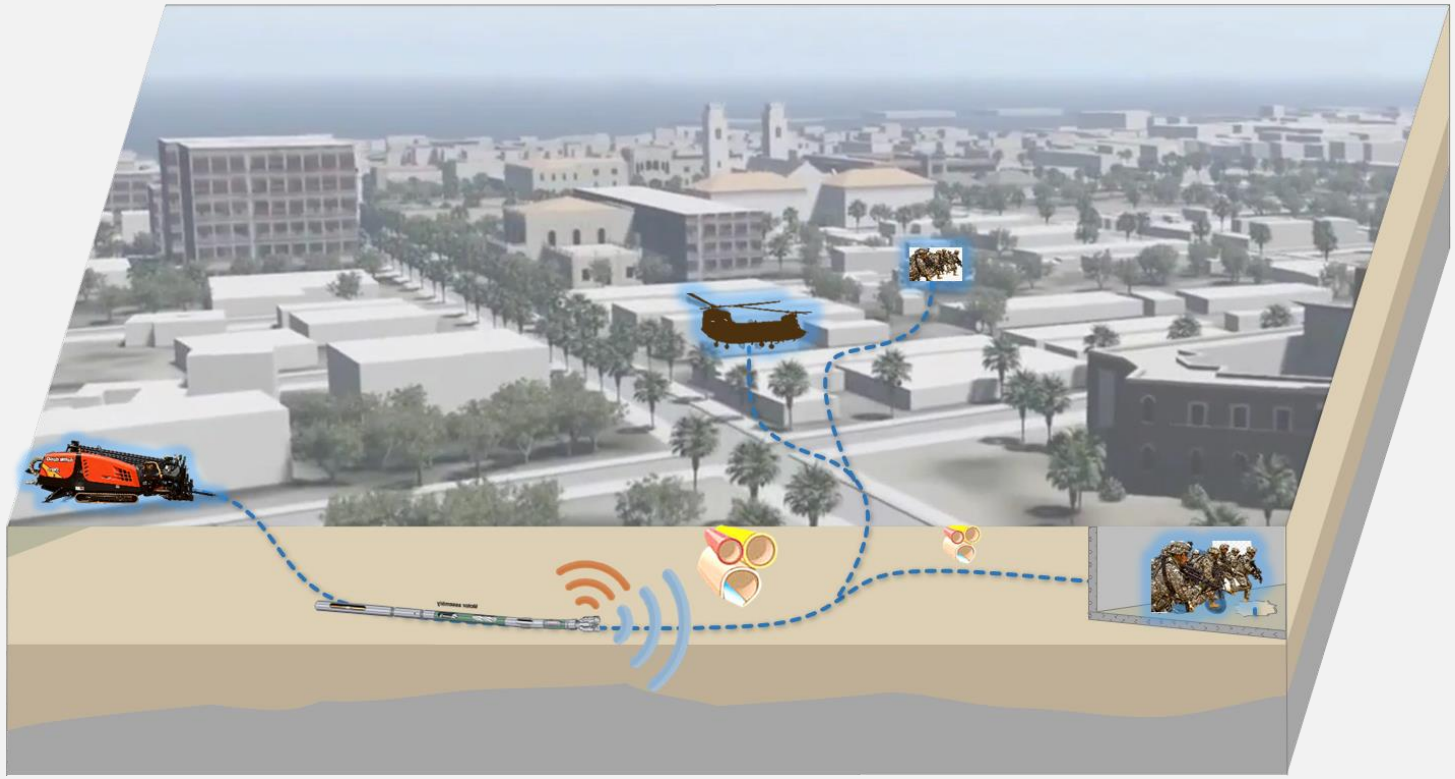
Underminer snapshot



Underminer Mission Cycle

1. Mission Preparation and Planning
2. Site Preparation
3. Drilling Operations — ** Phase 1 Focus **
4. Payload Delivery / Mission Execution
5. Site Breakdown / Abandonment

Major Program Goals

- ✓ 10-20x speed / distance improvement over commercial industry
- ✓ Remove reliance on “walk over” beacons for navigation and obstacle avoidance
- ✓ Emphasize adaptation of commercial technology

Phase 1 Program Metrics

Bore Diameter	|	>100 mm
Bore Length	|	500 m
Speed	|	0.1 m/s

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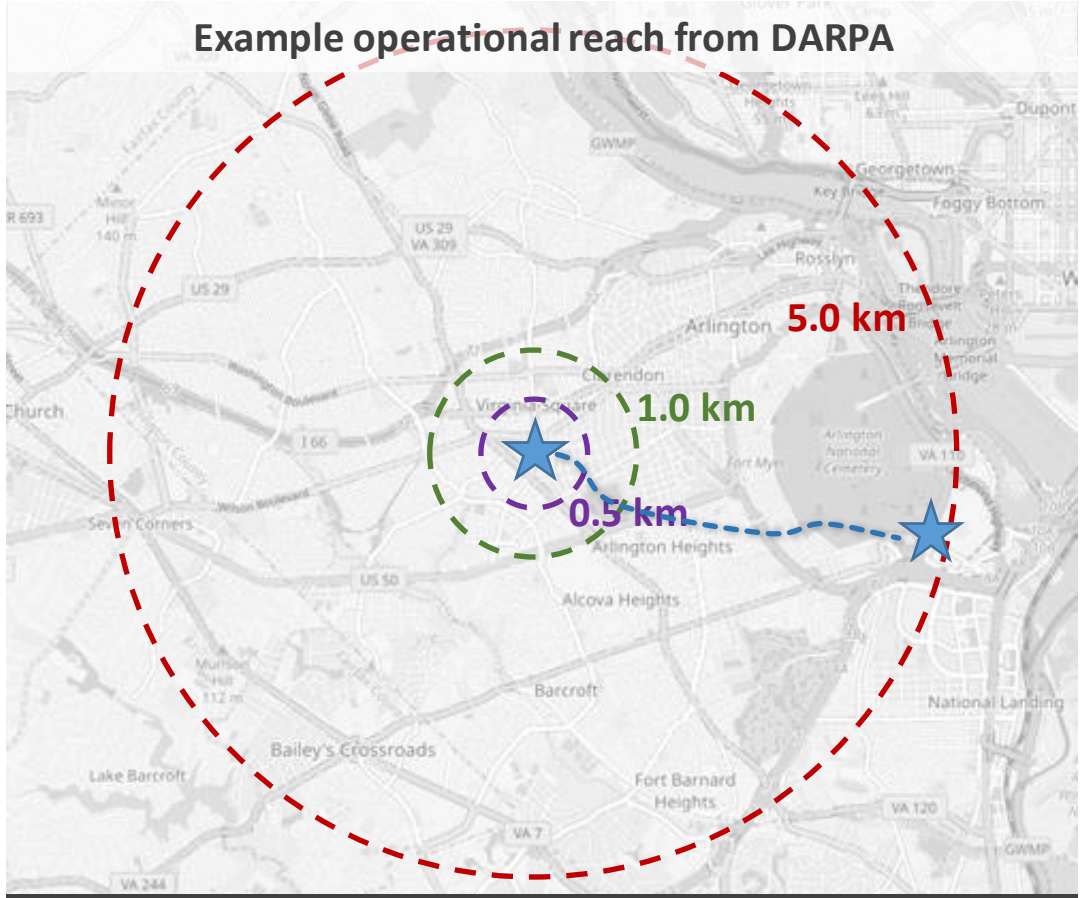
Rapid tunneling → rapid access



Distance	0.1 m/s ROP	0.5 m/s ROP
0.5 km	83 min	16 min
1.0 km	2hr 45 min	32 min
5.0 km	13hr 53 min	2hr 7 min

Novel, secure tactical resupply is available to ground forces for time critical operations

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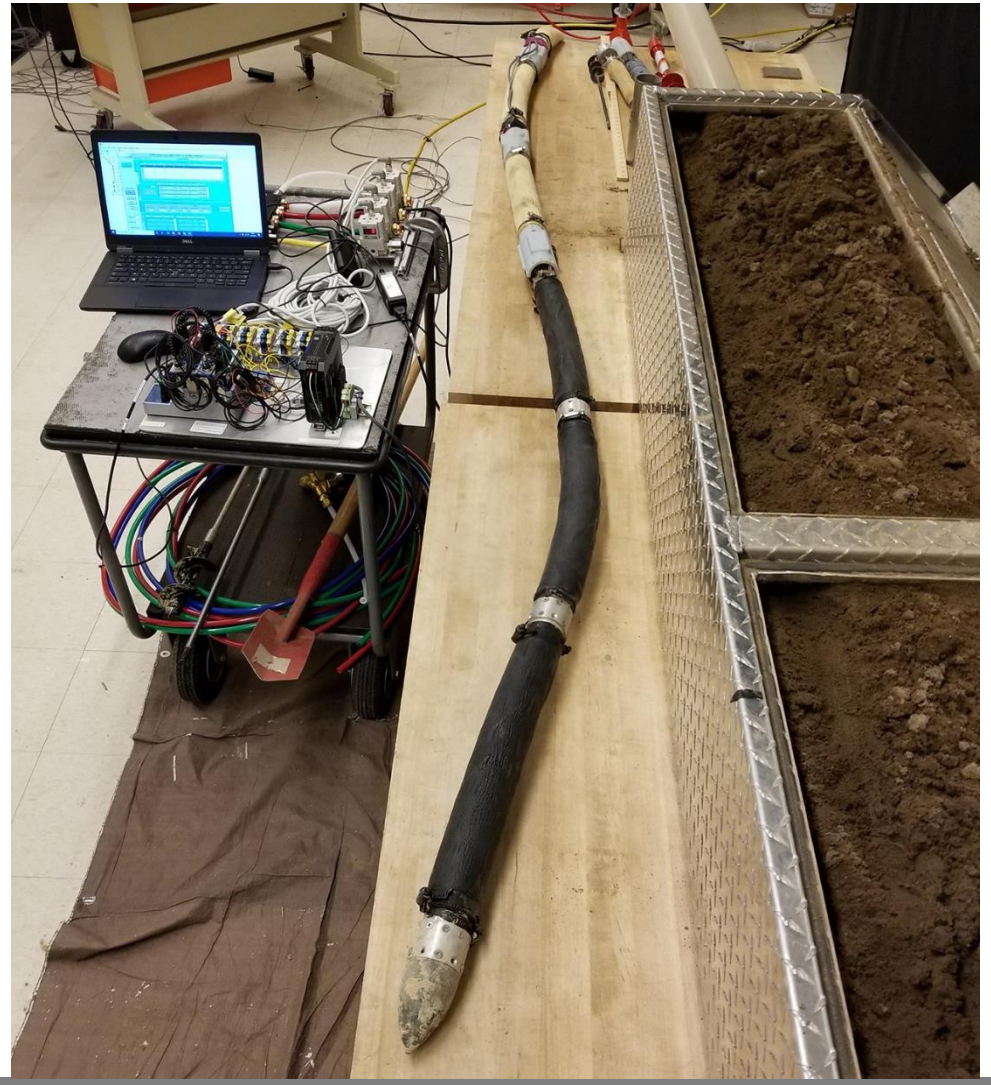
GE Research Center Overview



Early lab prototype

Develop and demonstrate bioinspired tunneling capability using soft robotics with advanced locomotion controls

- Pneumatic Artificial Muscles (PAMs) penetrate axially and grow radially at high frequency to enlarge tunnels
- Robot front end creates initial cavity for PAMs and creates full diameter tunnel system
- Soil expansion approach eliminates any spoils
- Complex controls architecture development to control seven segment PAM, plus piloting tools, plus pre-expanders

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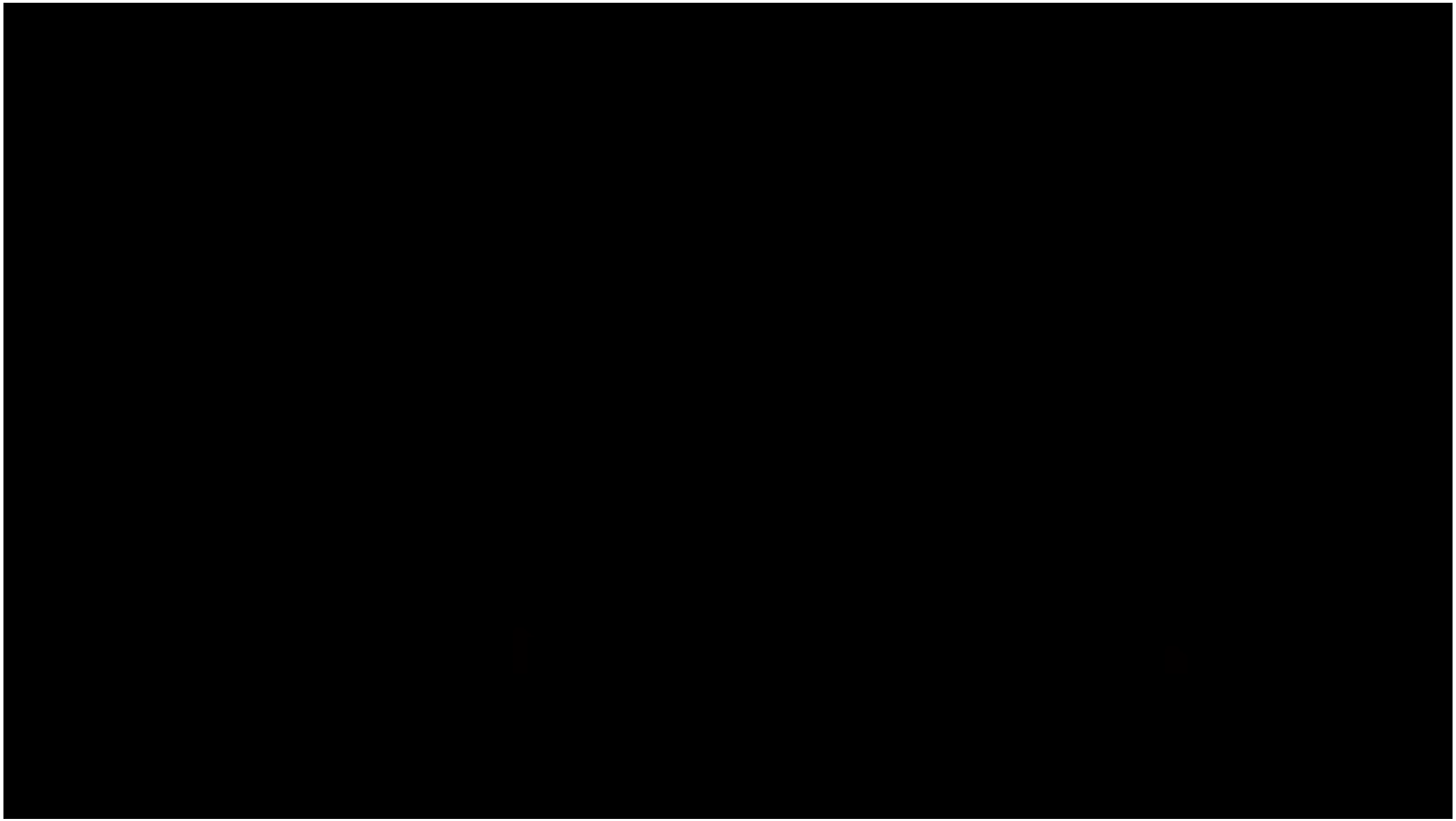
Example field trials with early prototypes



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Sandia National Laboratories Overview

Ditch Witch JT24 field testing (representative high bend radius shown)

Develop and demonstrate advance drilling capabilities by augmenting existing commercial systems

- Specific technology focus areas included:
  - Rapid drilling
  - Precision navigation
  - Casing the borehole
  - Branching
  - Short bend-radius drilling
- Leveraged existing commercial HDD systems to baseline commercial capabilities augmented with new developments in specific subsystem areas

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Colorado School of Mines Overview

Ft Polk field testing

Develop and demonstrate directional drilling solutions with continuous feed systems

- Continuous feed drilling enables high rate of penetration with little downtime
- Implement novel distributed drilling fluid system to maintain high pressures, remove cuttings, and protect borehole
- Advance and implement intelligent drilling support to enable real time data driven system changes
- Novel tech insertion throughout the design leveraging core COTS hardware components

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Underminer Snapshot

Overview

- Created a new underground frontier using fast tactical tunnels for secure and responsive operations

Benefits

- Enabled undeterrable underground presence

Program Details

- High speed underground infrastructure development
- Enhance underground navigation and obstacle avoidance
- Adaptation of commercial technology
- Explore operational integration

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