



AUTONOMOUS TUNNEL EXPLOITATION (ATE) YEAR THREE OVERVIEW



Map Merging Description

ATE is a CWP effort between US and RoK to advance Robotics and Autonomous Systems (RAS) capabilities in support of the SubT Exploitation and Classification mission. Map merging between coalition partners is required for the Year 3 demonstration and a validation of the map merging approach was conducted in July 2021 using a mutually agreed upon simulation environment from the DARPA Subterranean Challenge. An Interface Control Document (ICD) covering the common tunnel map file formats was produced as part of the effort and includes exact software programs and commands to produce merged maps.

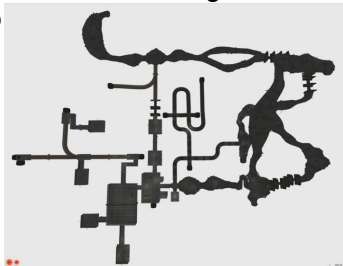
Timeline: June - July 2021

GVSC POC: Ty Howell, tyler.a.howell2.ctr@army.mil, (248)-379-8285

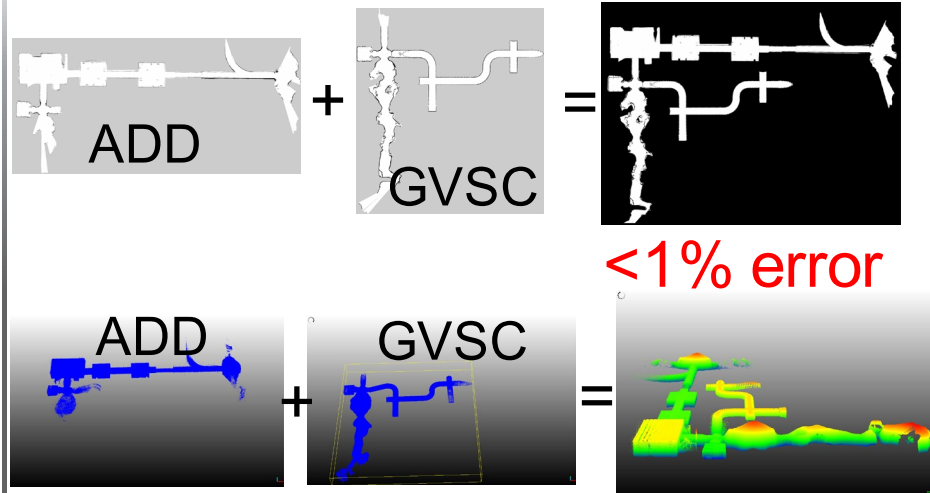
ADD POC: JungSuk Lee, Ph.D., jslee2011@add.re.kr, 042-821-0515

Validation and Lessons Learned

- GVSC and ADD both demonstrated capability to merge two-dimensional and three-dimensional representations of a mapped tunnel facility
- DARPA SubT Simulation world was leveraged due to COVID-19 travel restrictions, facility is greater than 100,000m² and consists of urban, cave, and mining areas with elevation changes and drop offs. Only a portion of the facility was exploited
- GVSC inadvertently left their magnetic declination set to Warren, Michigan which resulted in a 7 degree offset in map heading and a misaligned map



Execution and Results

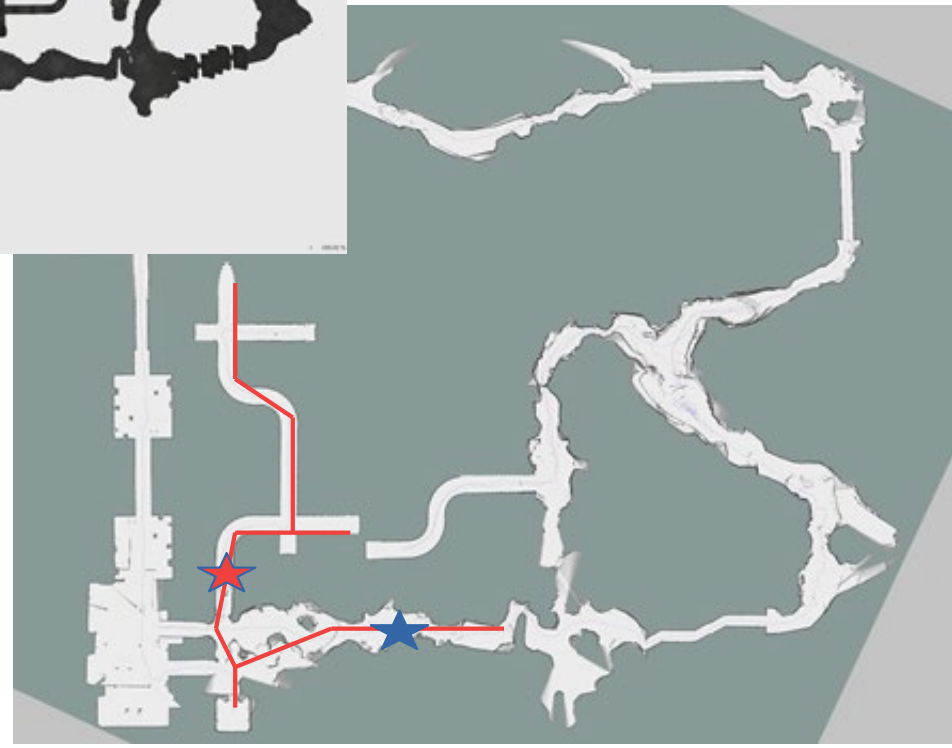
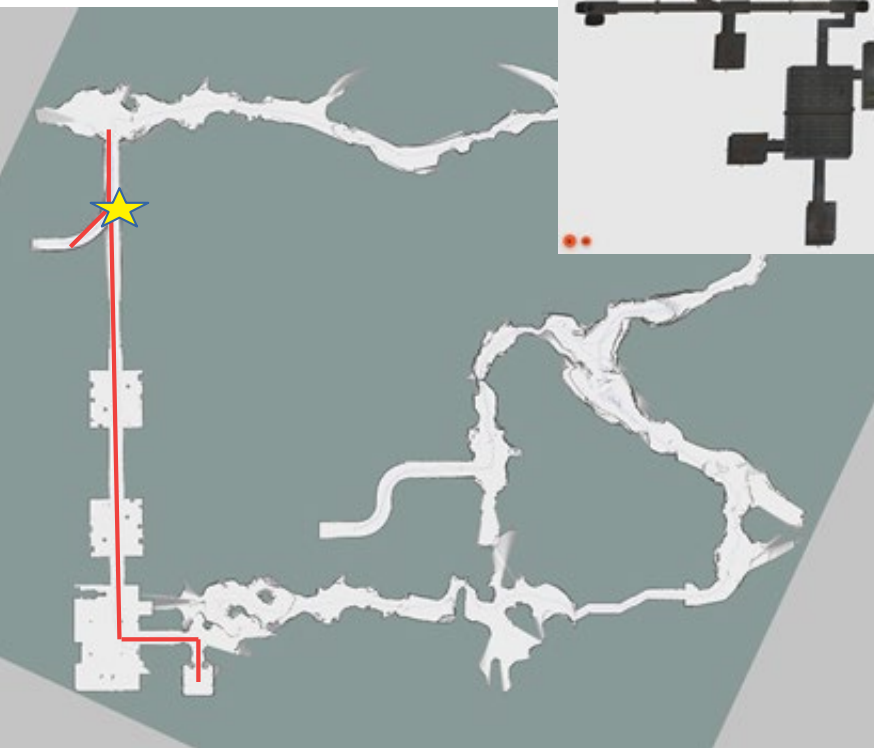
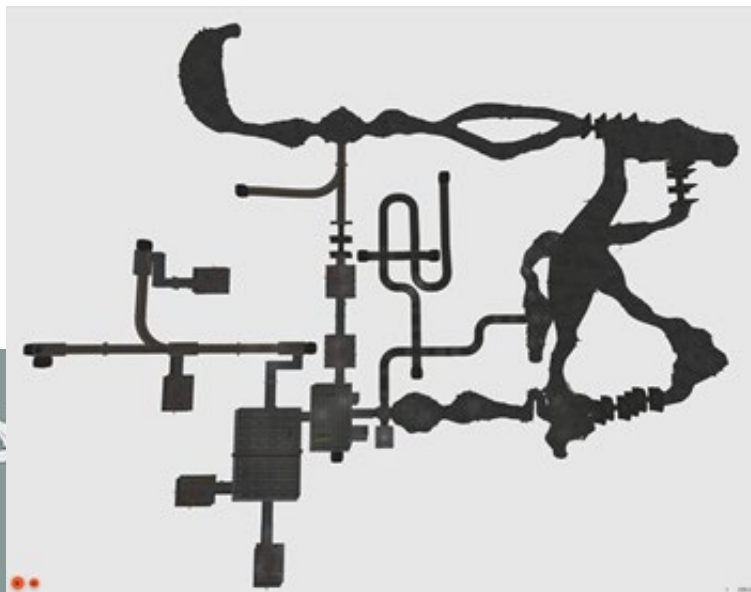


Interface Technique and Formats

- Leverage common and public domain formats for 2D and 3D models compatible with existing DTRA IMEA tool and open-source 3D visualization tools
- Use GeoTIFF format for 2D maps, which contain Latitude/Longitude coordinates of map corners for merging from any reference frame. Both teams independently selected Open Source Software (OSS) [GDAL](#) to produce the GeoTIFF and merge coalition GeoTIFF maps
- Use .ply format for 3D maps, which allow local coordinate frame for simple merging if using the same starting location (simply open both .ply in the same viewer), and two-step merging if GVSC and ADD conduct the exploitation from different starting locations (open both .ply in the same viewer, perform a rough manual alignment and then an automated registration). RoK selected OSS MeshLab and GVSC selected OSS CloudCompare for viewing and merging .ply



PROPOSED ROUTES



ADD

GVR

★ Railroad tracks

★ Steep Incline
★ Rough terrain