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GeoProcessing 2020

A Data-Driven System for Probabilistic Lost Person Location Prediction

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Agenda

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- Problem Space / Motivation
- LandSAR Overview
- Required Inputs: Geospatial and other data
- Algorithms and Models
- Evaluation
- Conclusions

Problem Space / Motivation

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- Problem space: inland search and rescue
- Current state:
  - Very few technologies exist to help search planners best locate lost persons
  - Ad hoc, manual processes are used
  - Rely on human expertise, and thus operate at human speed, accuracy and scale
  - Weather, sustenance requirements and injuries all impose a time clock on the search teams, thus human speed is often not fast enough

Problem Space / Motivition

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- Geospatial data exists, and algorithms and systems are emerging, however, that can help
- Geospatial Data
  - Digital elevation data
  - Land cover data
- Algorithms and Systems
  - LandSAR → focus of this talk

LandSAR Overview

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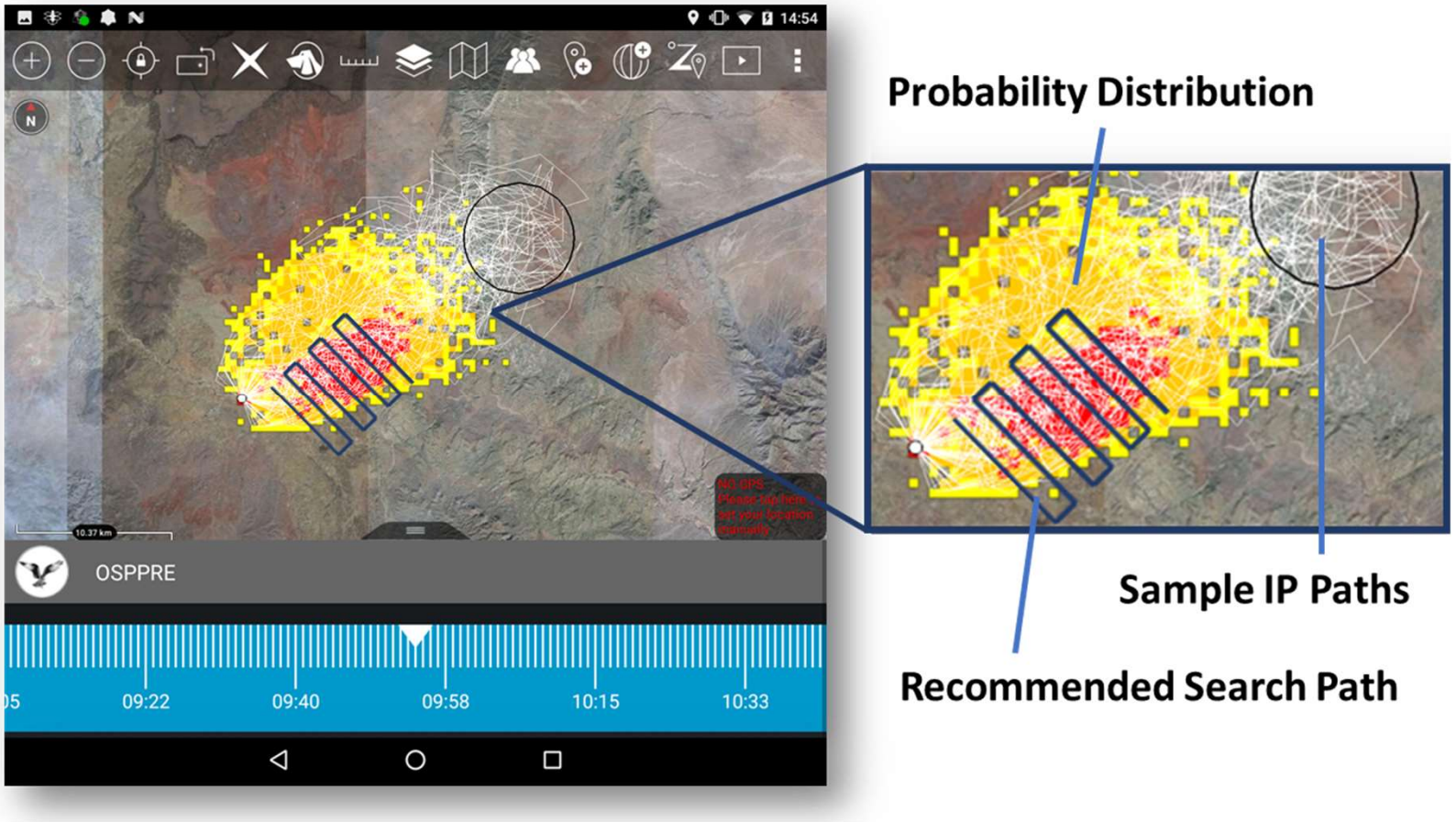
- Presents probabilities of lost person locations over time
- Given search asset (e.g., 5 people on foot, 2 helicopters) presents search recommendations



LandSAR Overview

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- LandSAR can be accessed via two client types
  - Android Team Awareness Kit (ATAK) 

    - A map-based mobile team situational awareness tool
    - Used by local and state law enforcement, fire departments, search teams, among other organizations
  - Web Version
    - Custom web user interface
    - Can run hosted on a network for distributed use, or in the back of a truck for more local use

LandSAR Overview

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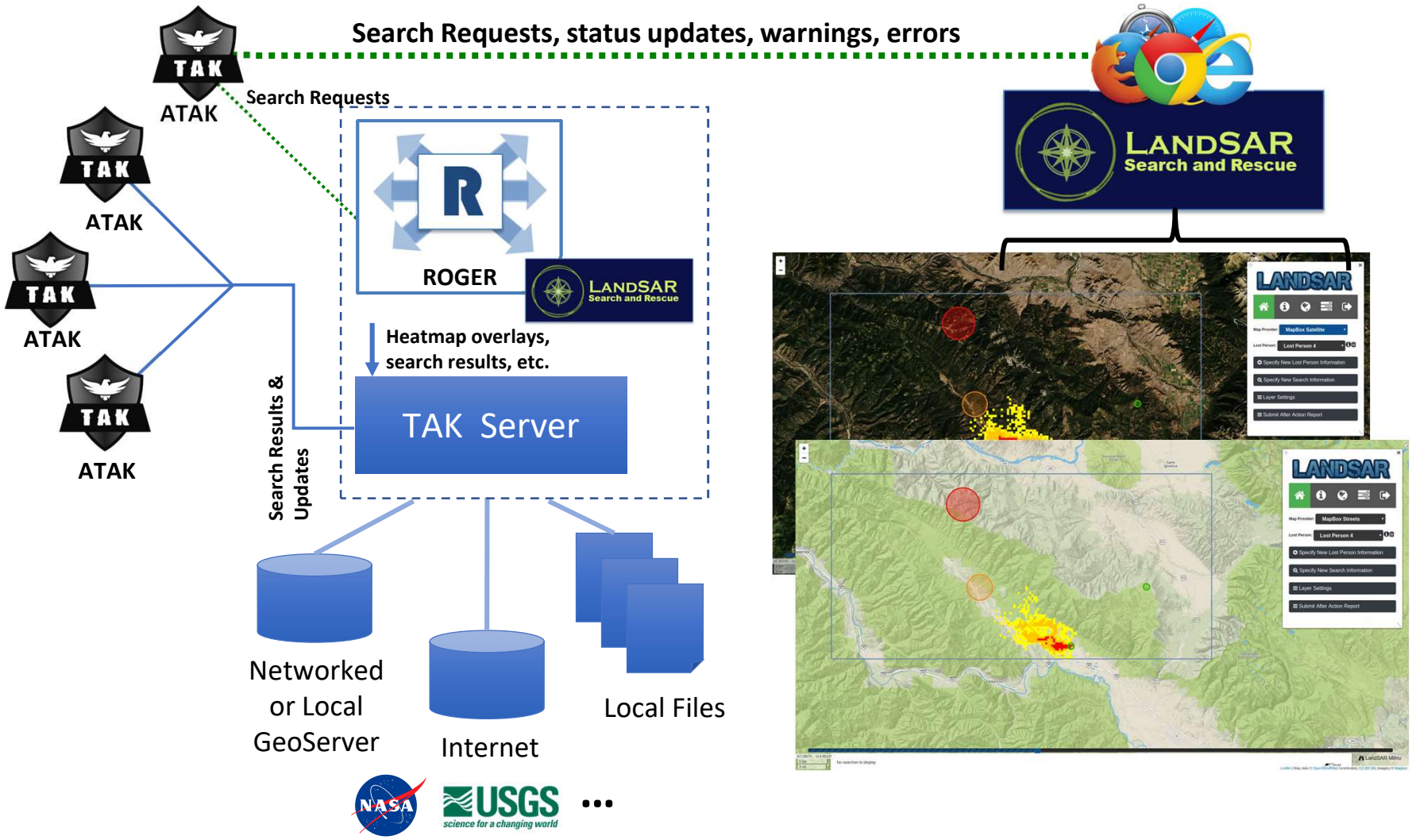

Required Inputs

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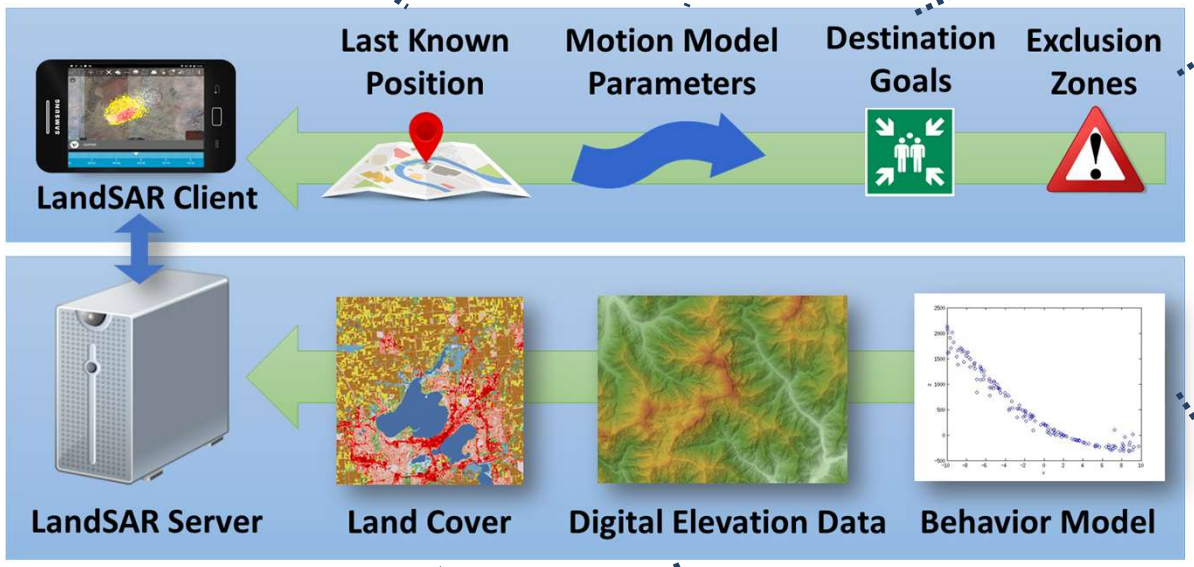
- LandSAR requires numerous inputs – geospatial and other forms
- Some are required on the client, others only needed server-side



The last point or last area that a lost person was seen

Will the lost person only move during daylight?

Was there a specific destination they had in mind?

Are there areas that they would know to avoid, or would avoid if they encountered them?

Type of terrain, e.g., deciduous forest, grasslands → impacts speed of advance

What do the elevation changes look like → impacts what is feasible, what is more likely appealing to the lost person

Models of host the lost person will act in this situation (e.g., a lost child may act very differently from an experienced hiker)

Geospatial Data

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- Data sources are configurable, but default sources employ the following
- Digital Elevation Data
  - Shuttle Radar Topography Mission (SRTM)
  - 30m resolution
  - Post processed to cleanup “voids”, remove single pixel errors, define coastlines among other items
- Land Cover Data
  - US National Land Cover Database (NLCD)
  - Available from the Multi-Resolution Land Characteristics (MRLC) consortium

Algorithms

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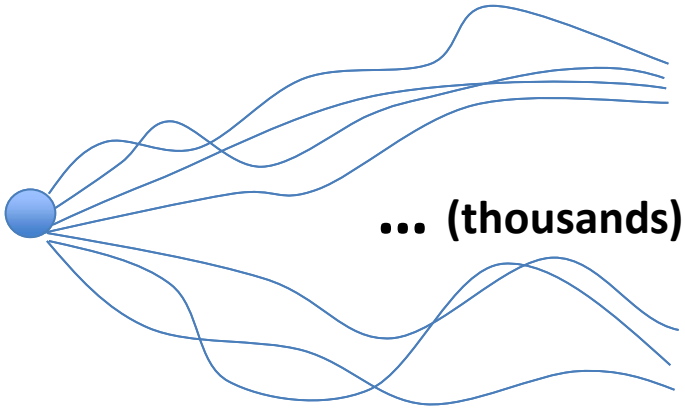
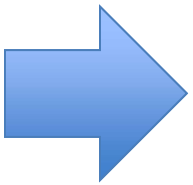
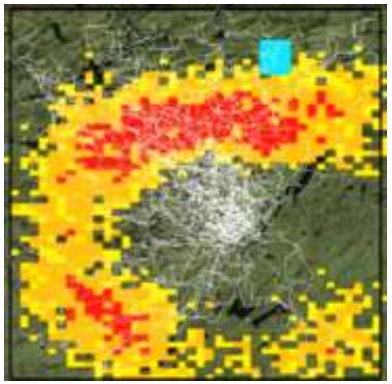
- Today, human search planners have to deal with two many variables
- LandSAR helps by modeling many possible outcomes given starting area distribution, land cover, elevation, model parameters



Sample Paths





Probability Distribution at Time T_X

Models

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LandSAR models a lost person's starting point, initial movement, subsequent decision making, and speed of advance

Example Motion Models

Model	Description
Stationary	The LP is assumed to be injured
Lost Hiker With Destination	The LP knows where they are and where they must go. They move in the terrain that best affords success in reaching their goal.
Trails-Based	The LP will move until they reach a trail and then follow it in one direction until found.
Easiest Short-Term Path	The person does not know where they are nor do they have an idea of where help may be, and will take the easiest short-term path

Evaluation

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- LandSAR has been initially measured and evaluated across 2 dimensions
  - Efficacy
    - How well do the algorithms predict lost person location?
    - Evaluated to date via parallel tests (used in parallel to current methods during real world events)
    - Future evaluation planned
  - Performance / Resource Cost
    - How much memory, CPU is required?
    - How was does the system run?

Evaluation

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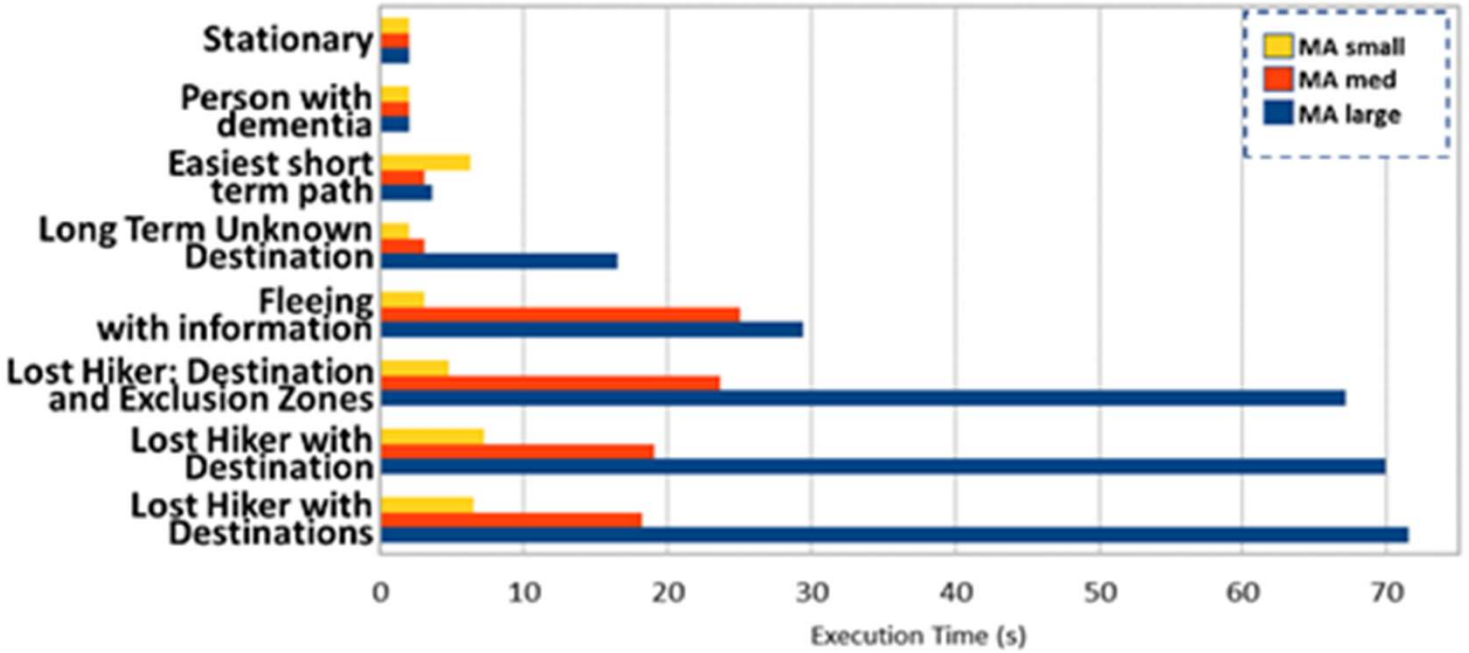

All tests run on an Intel® Xeon® Dual 4-core laptop with 32GB of RAM

Large: 107 km east to west by 125 km north to south
Medium: 35.8 km east to west by 36.6 km north to south
Small: 12.0 km east to west by 14.0 km north to south

Area Name	Area Description	Center Point (lan/lon)
NM	New Mexico / Arizona border	32.0, -109.1
MA	Massachusetts	42.187279, -73.005823
MI	Michigan	44.017543, -84.252951
NW	Near Coeur d'Alene National Forest, Idaho	47.75, -116.6
RockyMs	Rocky Mountains	44.268656, -109.786399

Evaluation

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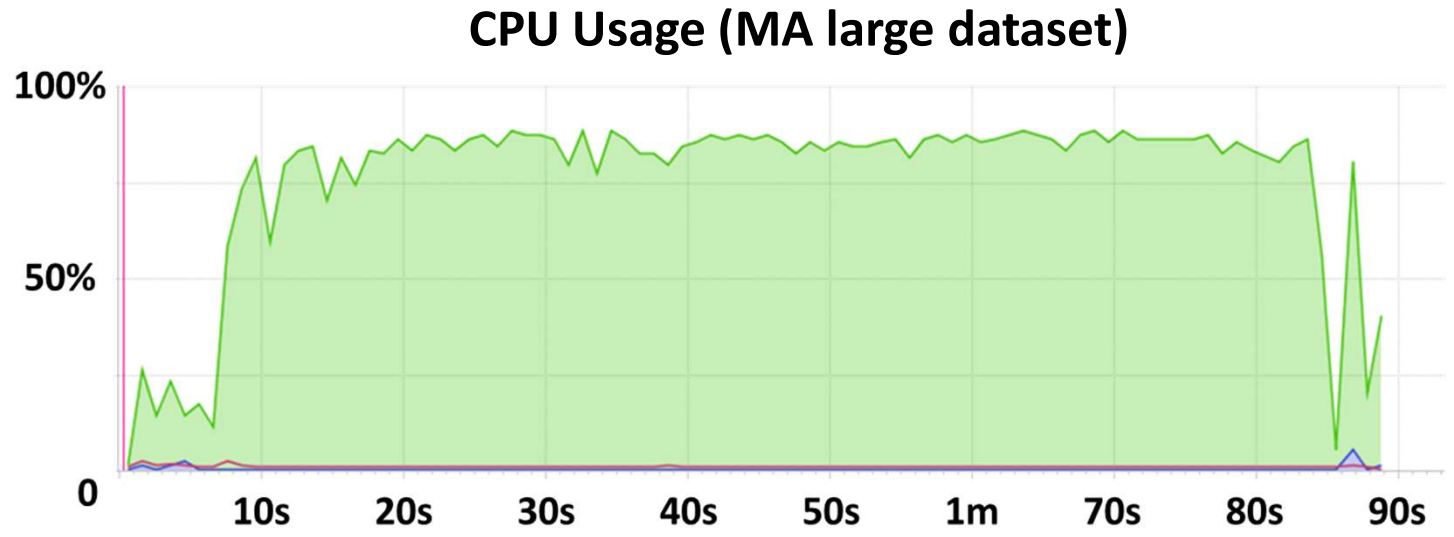

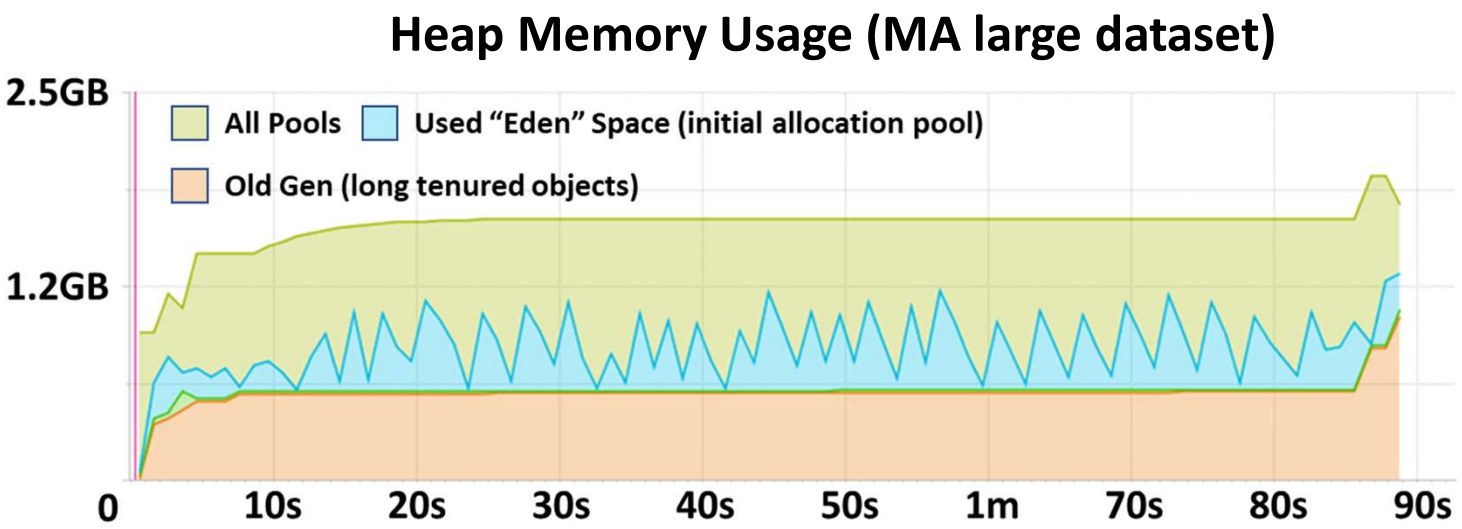

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Conclusions and Future Work

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- LandSAR has shown initial promise in evaluations and demonstrations
- Deployment to a real world SAR team is planned
- Future technical work:
  - Enhanced accuracy and precision through ingestion of situational awareness data that is already natively flowing through TAK devices
  - Automated and semi-automated tasking of small unmanned aerial systems (sUAS) based on LandSAR-generated search recommendations
  - Employing streaming color-coded QR codes for increased bandwidth when sharing search information with teams that may not have compatible radios
  - Extending the LandSAR format-centric compression techniques tailored at reducing size of the KMZ files through the use of point reduction algorithms

Other Q&A

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