Drone Team Organization and Management

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Weber County Sheriff's Search & Rescue Team

Ogden, Utah

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Goals and Learning Outcomes

- Advanced Crew Resource Management (CRM)
- Maintaining and Expanding your program
- Advanced systems (videogrammetry, multispectral cameras, etc.)
- Future Stuff (BVLOS, swarms, gas sensors, shallow grave detection, etc.)

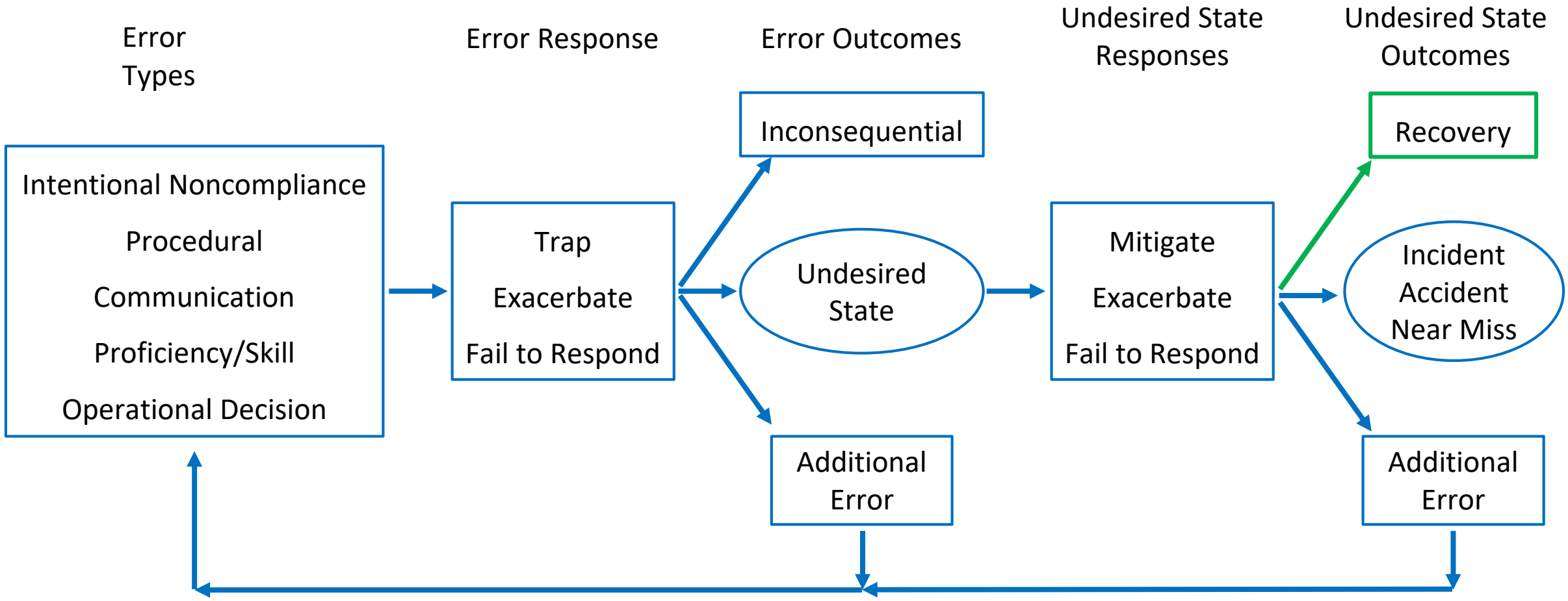
Crew Resource Management = CRM

A protocol for environments where human error can have catastrophic results.

- **Two-way communications**
- **Use all available skills**
- **Follow the SOPs**
- **Delegate flying to someone else while solving bigger problems**

- Training mandated by the FAA for all commercial pilots.
- Mandated for all DoD air crews by the USAF and Naval Air Force.

CRM: Management of Error Response



True for all SAR, not just drones!

Based on figure 7 in
Culture, error, and crew resource management.
R. Helmreich, J. Wilhelm, James Klinect, A. Merritt (2001)

Advanced CRM to Foster Effective Teamwork

- Training and awareness
- Clearly defined roles and responsibilities
- Effective communication
  - Open lines of two-way communication regardless of rank
- Shared mental models: Common understanding of
  - mission objectives
  - operational environment
  - team structure

Advanced CRM to Foster Effective Teamwork

- Situational awareness improves with communication
  - Communication fosters informed decisions
  - Anyone can share urgent issues with RPIC
- Clear decision-making process
  - Flight checklists
  - Risk assessment
  - Mission planning
  - All team members involved in process

WEBER COUNTY SEARCH & RESCUE

M300 Checklist

Preflight

1. Briefing From Command.....Receive
2. Air Commander/RPIC/VO.....Designate
3. Flight Operations Area (FOA).....Establish
4. WX and NOTAMS.....Check
5. Surrounding Hazards.....Check
6. Trailer/Command View.....Setup

Before Motor Start

1. AC (legs, payloads, SD card).....Assemble
2. AC Batteries, Controllers, & Cables.....Check
3. Master/Payload Controllers.....Power On
4. AC.....Power On
5. Pilot App Checklists.....Normal and Reviewed
6. Cameras Settings.....Verified
7. Gimbals.....Responsive & Married
8. Mode Selector.....P Mode
7. Obstacle Avoidance.....On
8. Time Stamp.....Verified On

Motor Start

1. Clear Area.....**"Clear Prop"**
2. Motors.....Start
3. Hover at Safe Altitude.....Acomplish
4. Control Inputs.....Check All
5. Video Recording.....Record
6. **Proceed on Mission**
7. At safe altitude and when operationally prudent allow gimbal optr to take gimbal control

Battery Hot Swap

1. AC.....Land
2. Power.....Keep On
3. Battery Lock.....Rotate
4. One Battery at a Time.....Replace
5. Preflight Inspection.....Perform
6. "Motor Start" Checklist.....Repeat

Post Flight

1. AC/Controller Electrical.....Power Down
2. Post Flight Inspection.....Perform
3. AC Condition .....Dissemble and Stow
4. Batteries.....Charge and Stow
5. Debrief w/Command & Crew.....Perform
6. SD Card Data .....Download & Review
7. AirData.....Sync

WCSAR DRONE TEAM

CRM for Resource Management & Learning

- Resource management – effective use of
  - all personnel
  - all hardware (don’t forget that cool accessory you have not used in a while)
- Resource management – advanced identification of
  - constraints
  - weaknesses
- Culture of learning
  - After Action Reports (AAR) and debriefs
  - Incident reporting and analysis
  - Near-miss reporting and analysis
  - All team members report safety issues and operational challenges

CRM applies to all phases of flight
Adopted from aviation industry, you should train as crewed pilots do.

- Preflight
- Takeoff
- Departure and en route to station
- On mission
- Approach
  - Constant glide slope
- Landing
- Post-flight

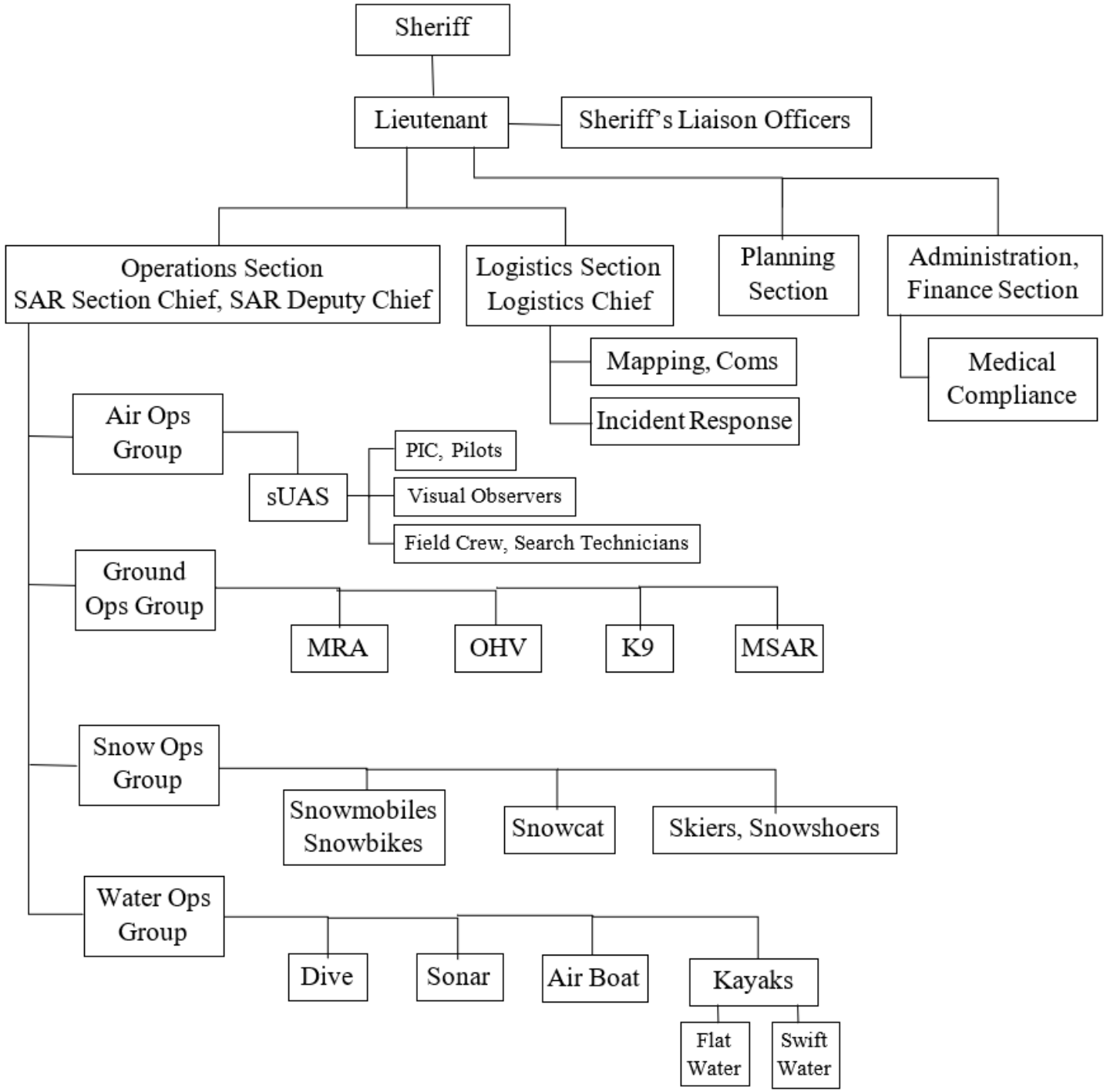
Maintaining and Expanding Your Drone Program

- Success breeds success!
- A successful program will be easy to “sell” to funding agencies/groups.
- Tout your successes!
  - Pictures worth 1 kiloword
  - Videos worth 1 megaword, make them
    - Short and easy to share
    - Tell a human story
    - Make the AHJ and SAR team look good
    - Social media
- If we had “this” we could do “THIS!”

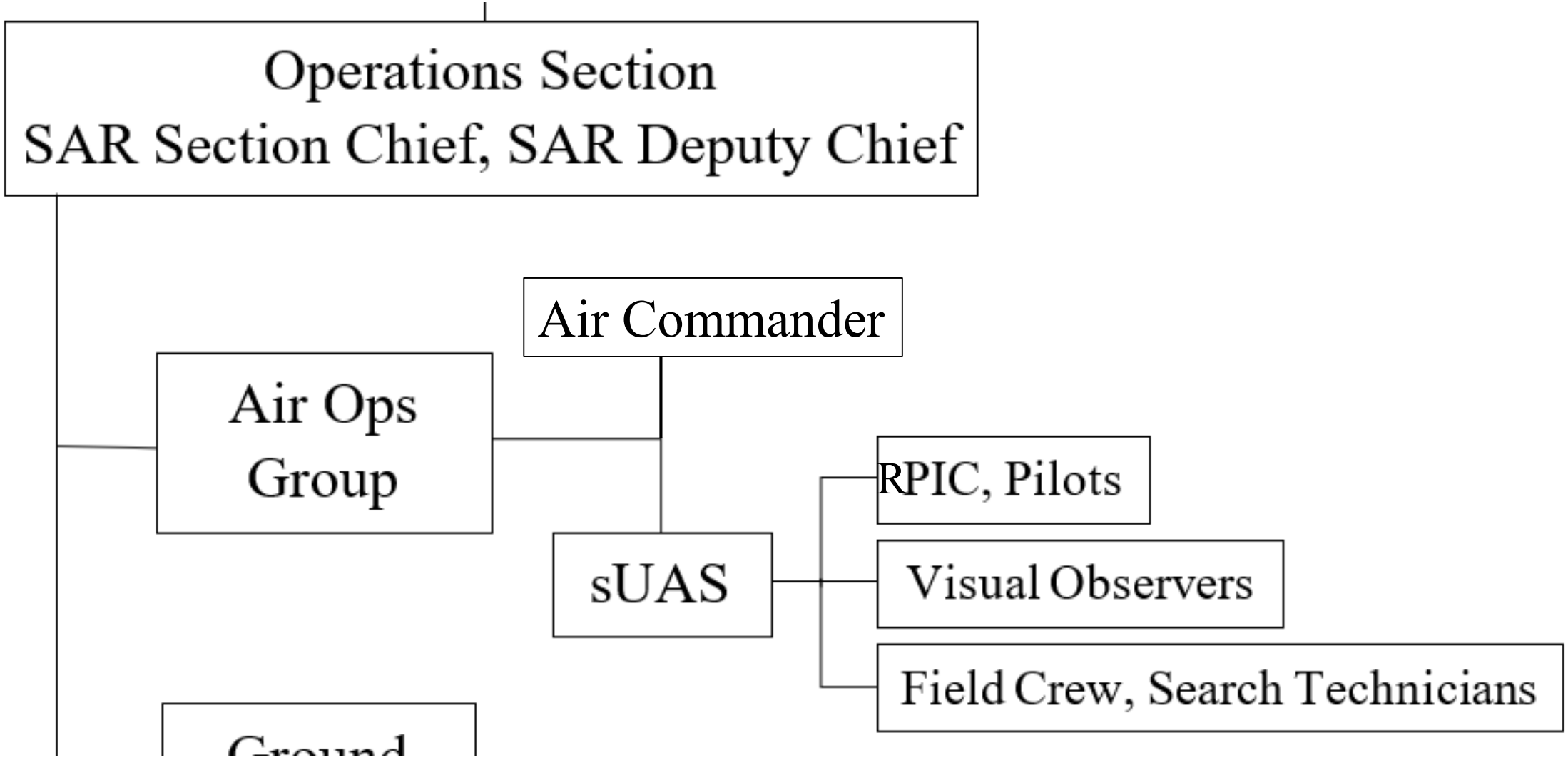
Maintaining and Expanding Your Drone Program

- The best ways to expand your program is to:
- Integrate within the entire emergency response structure for your team or agency.
- Operate within the ICS
- Operate as a professional flight team
- Constantly ask “how could we have been more help to you?” Constantly remind the teams you are there to support them.

Weber County Sheriff's SAR ICS Org Chart



The Drone part of the overall org chart



Drone Team ICS Structure

- Pilots, RPIC is ultimately responsible
- VOs
- Ground support or Field Crew
  - Searchers
  - Batteries
  - LZ setup on arrival
  - LZ security
- Air Commander – all air assets, liaison to teams and IC, helicopters, airspace deconfliction, etc.

Training was in the previous class, but…

- Pilot certification (Part 107 RPIC)
- Classroom
- Stick Time – Aircraft Familiarity
  - Practice alone
  - Practice with drone team members
  - Practice with rest of SAR team
  - Day vs. night
- Understanding of SOPs and Best Practices

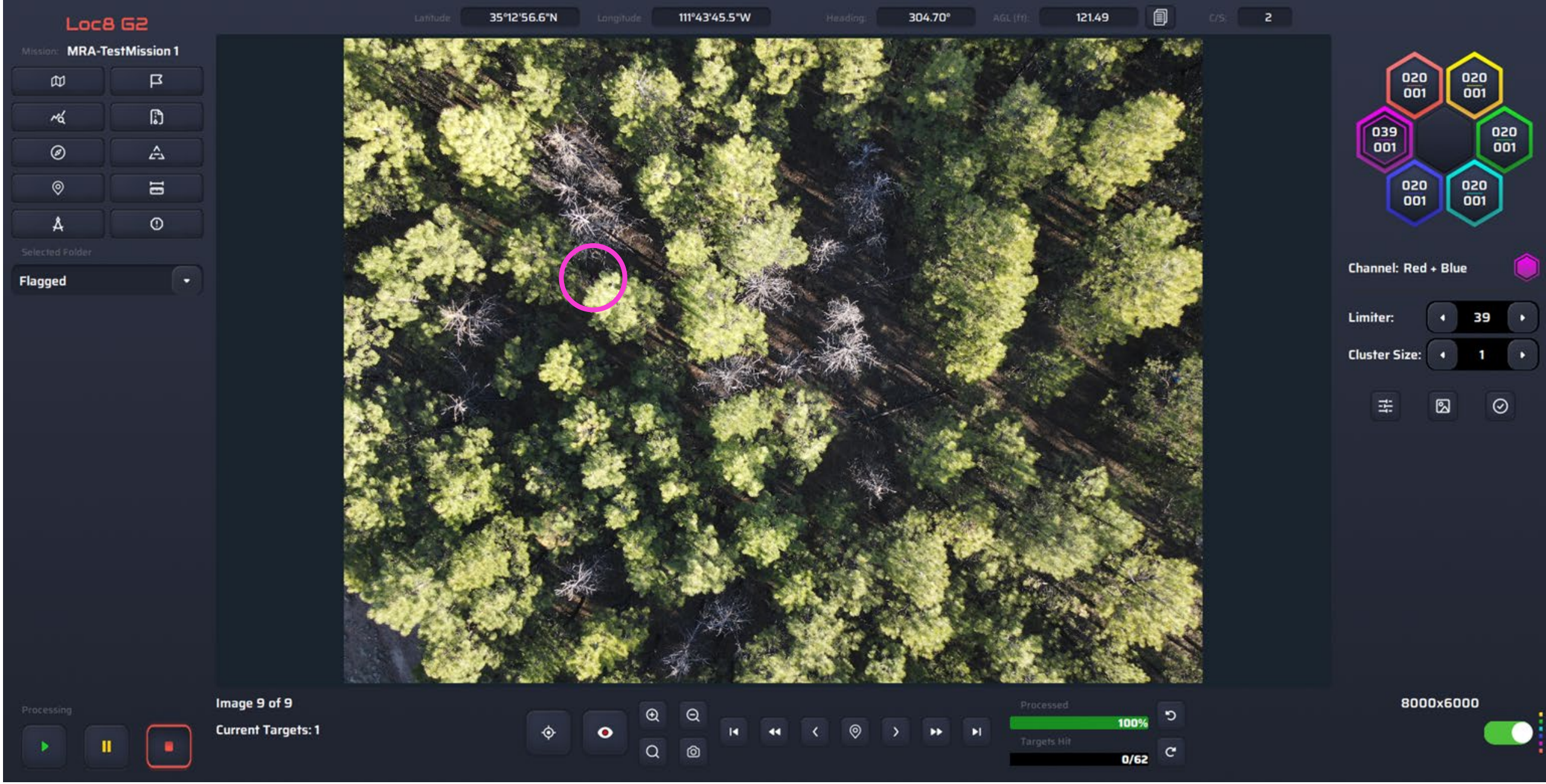
Advanced Options

- Loc8 (There was a pre-conference workshop on this and RDT.)
- Radiometric Data Toolset (RDT) = automated pixel level Thermal Analysis tool
- Mission mapping
- Dronesense, Motorola Cape, etc.
- Live drone tracking
- Airborne repeaters

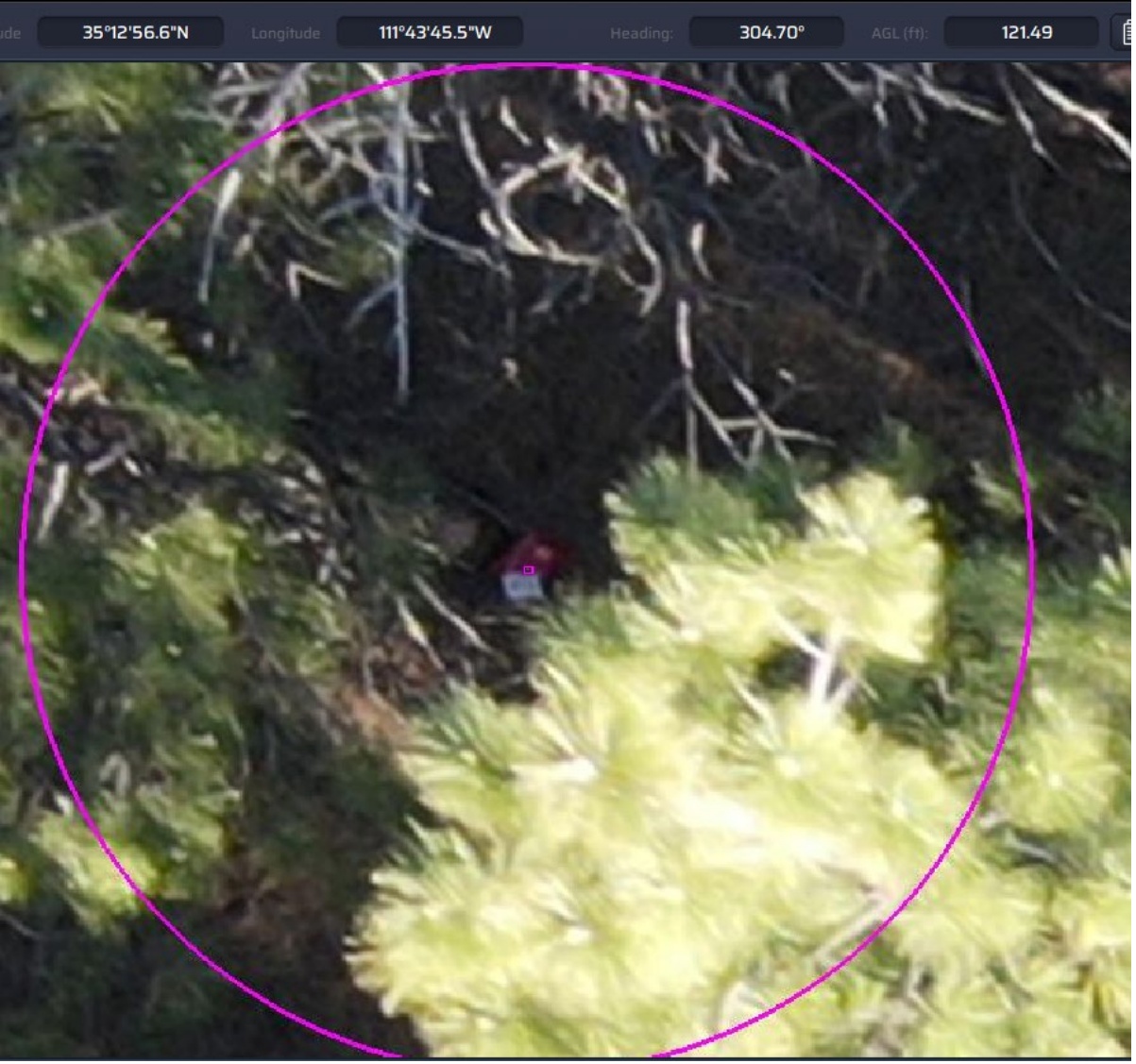
Loc8

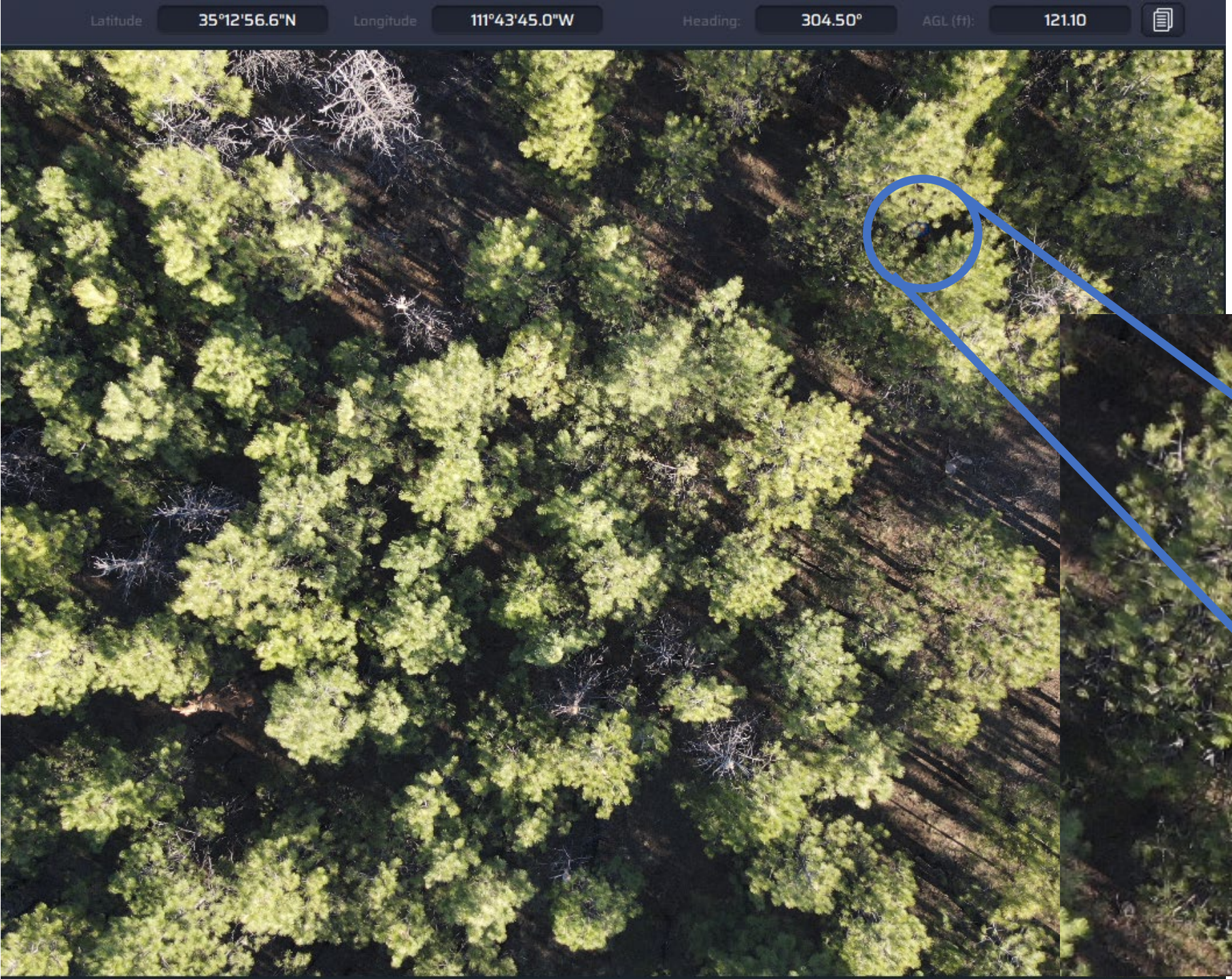
- Powerful image analysis
- Expensive = $700 per year
  - Non-profit discount is $499/yr
- Post flight processing
- Will run on a laptop in the field
- Windows 10/11 only

- Learning curve is not very hard.
- Excellent customer support
- Probably worth it if you do lots of multiday searches, evidence searches, and/or lost person searches in very complex terrain.



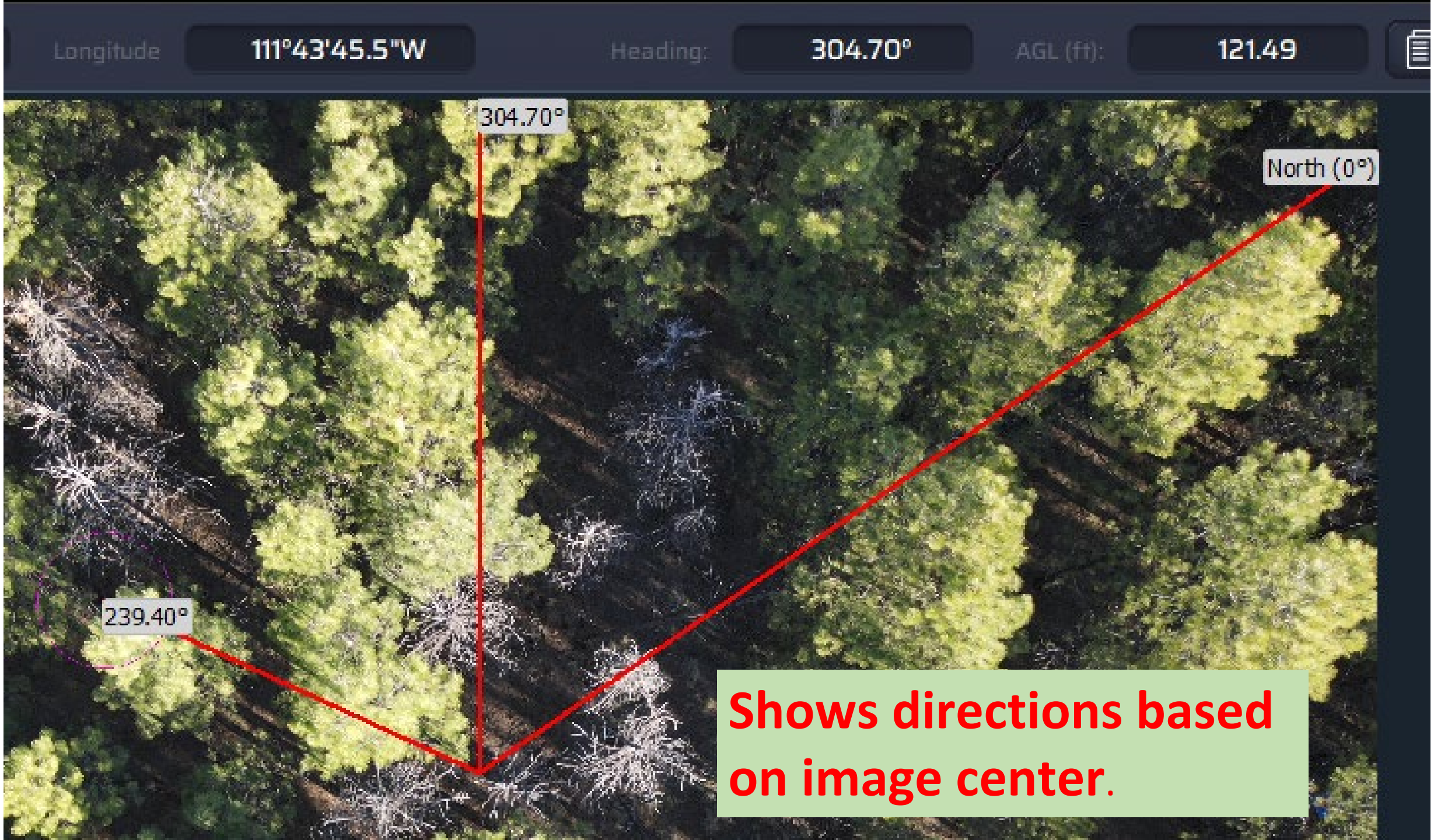
Do you see the clue? Hint, it is a package with white sign showing an arrow.


35°12'56.6"N
Longitude
111°43'45.5"W
Heading:
304.70°
AGL (ft):
121.49


Latitude
35°12'56.6"N
Longitude
111°43'45.0"W
Heading:
304.50°
AGL (ft):
121.10

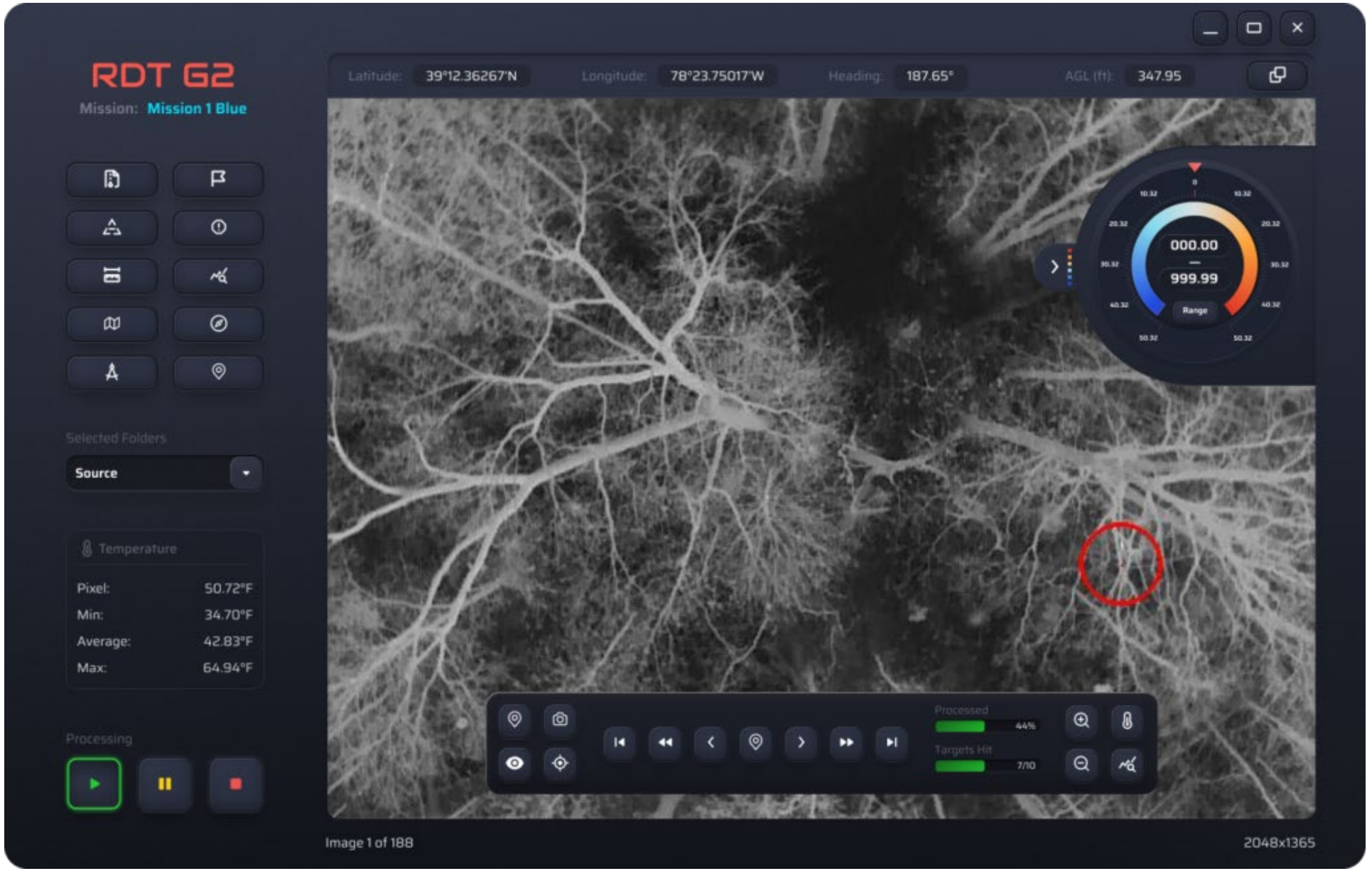
Notice the coordinates.

These are the drone's coordinates, but it also gives the camera's heading.


Longitude
111°43'45.5"W
Heading:
304.70°
AGL (ft):
121.49
304.70°
North (0°)
239.40°
Shows directions based on image center.

Radiometric Data Processing

RDT = Radiometric Data Toolset



Radiometric Data Toolset (RDT)

- Thermal data analysis
- Expensive = $699/year
  - RDT & Loc8 bundle = $1199/yr
  - Non-profit discount is $499/yr for Loc8
- Post processing, not “live”
- Runs on a laptop in the field
  - Better laptop = better performance
- Windows 10/11 only

- Shallow grave detection
- Recently deceased detection
- Still alive detection
- Definitely a learning curve to use
- New G2 version due out in the next few weeks.
- Probably worth it if you do lots of multiday searches

EagleEyesSearch https://www.eagleeyessearch.com/

- Note: We have zero direct experience with this software.
- Does both live video and post-mission video analysis.
- Places a highlight square on possible points of interest
- Works with IR camera feed
- Desktop: MacOS and Windows
- Android but no iOS
- Working on SARTopo integration

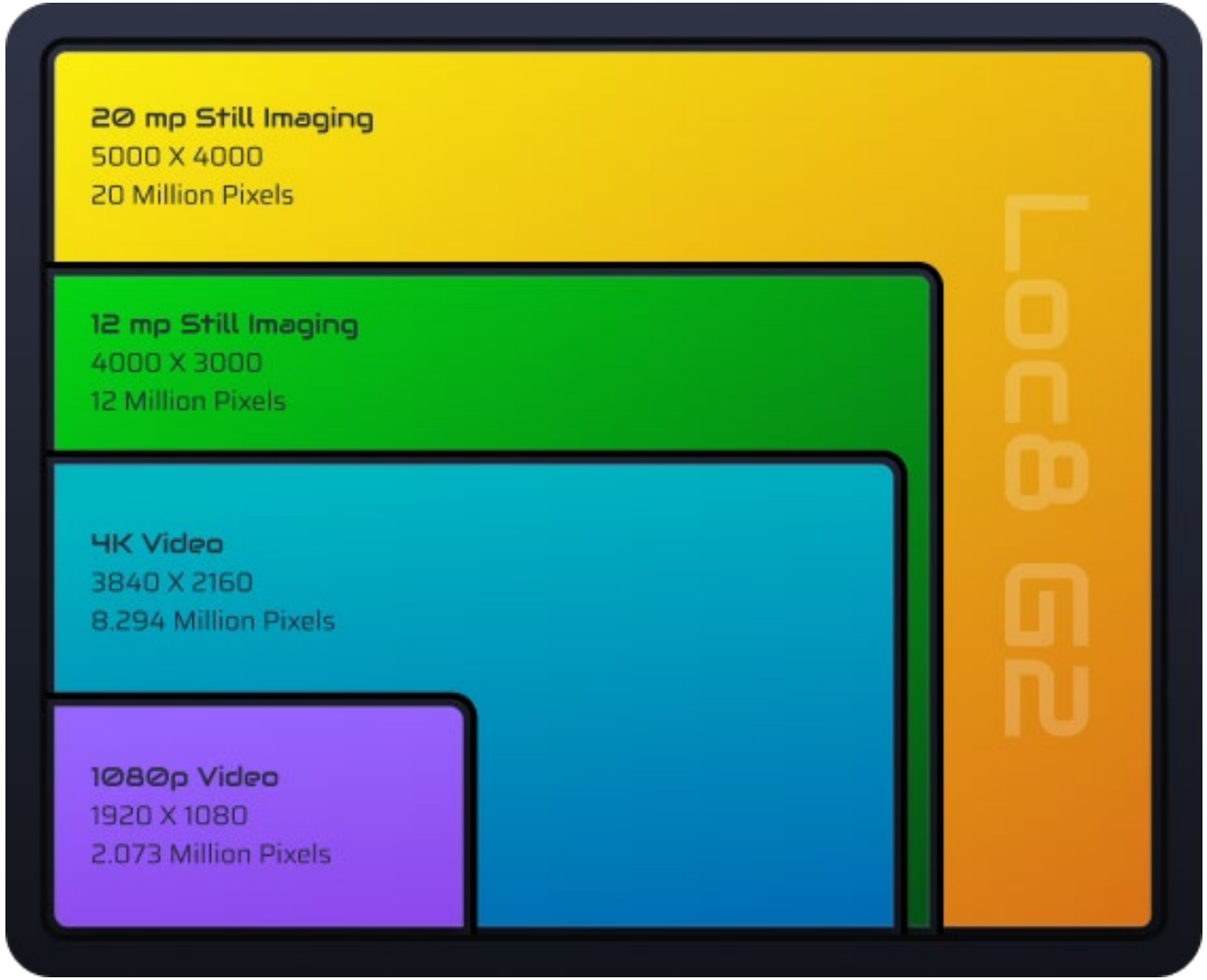
- NOTE: They are looking for beta testers if you are game to try it…

“Eagle Eyes Search – Pilot” for DJI

Image is a screenshot from a demo video on the EagleEyesSearch website.

All of these pixel analysis tools work best with still images vs. video capture.

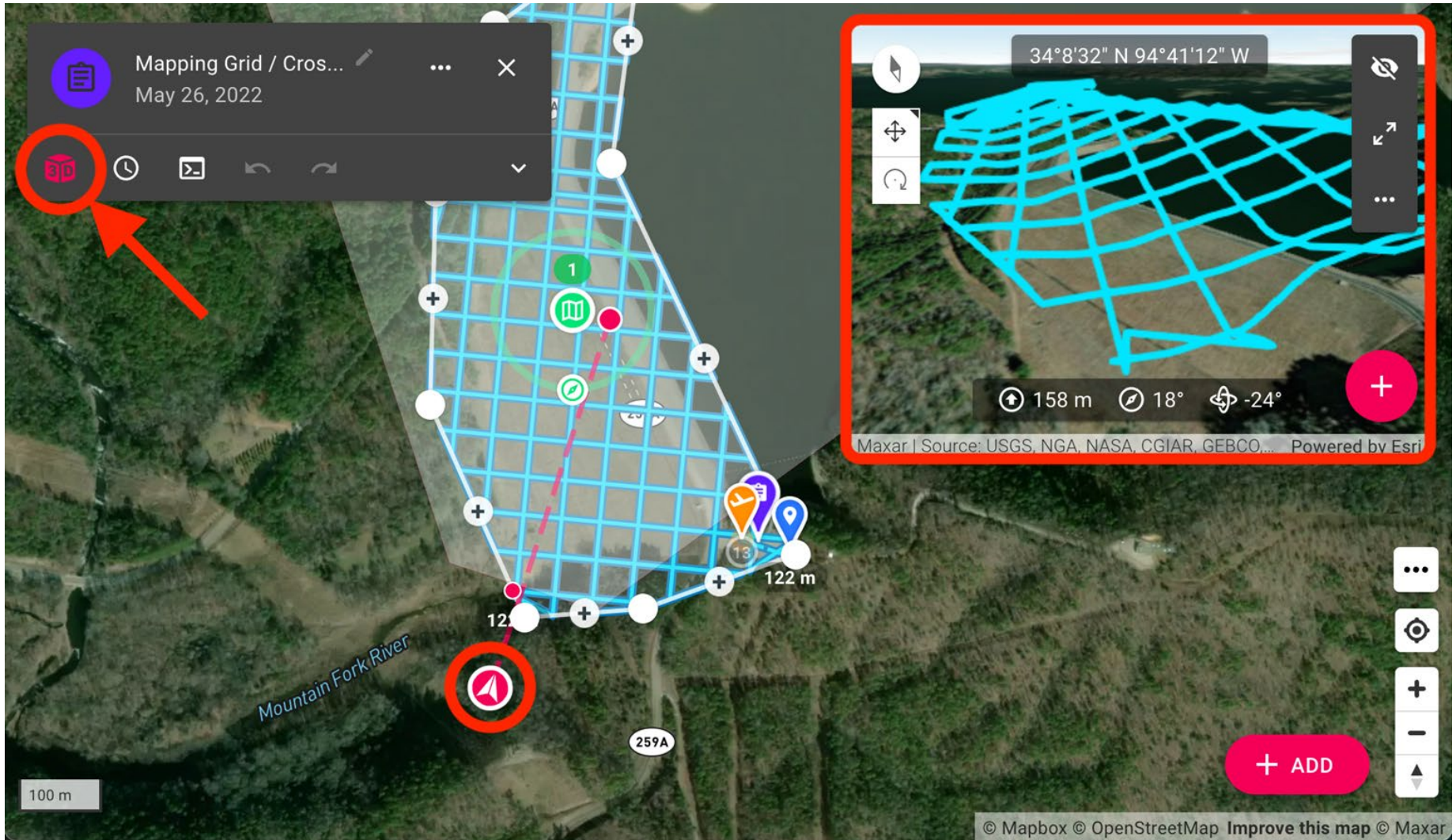
- Resolution depends on
  - Altitude
  - Number of pixels
  - Zoom settings/focal length
  - Image quality
- Graphic shows ground footprint for a fixed resolution for different pixel counts.
- Resolution = ground spacing between two pixels.



Graphic from USR
Unmanned Systems Research

Mission Mapping with Terrain Following

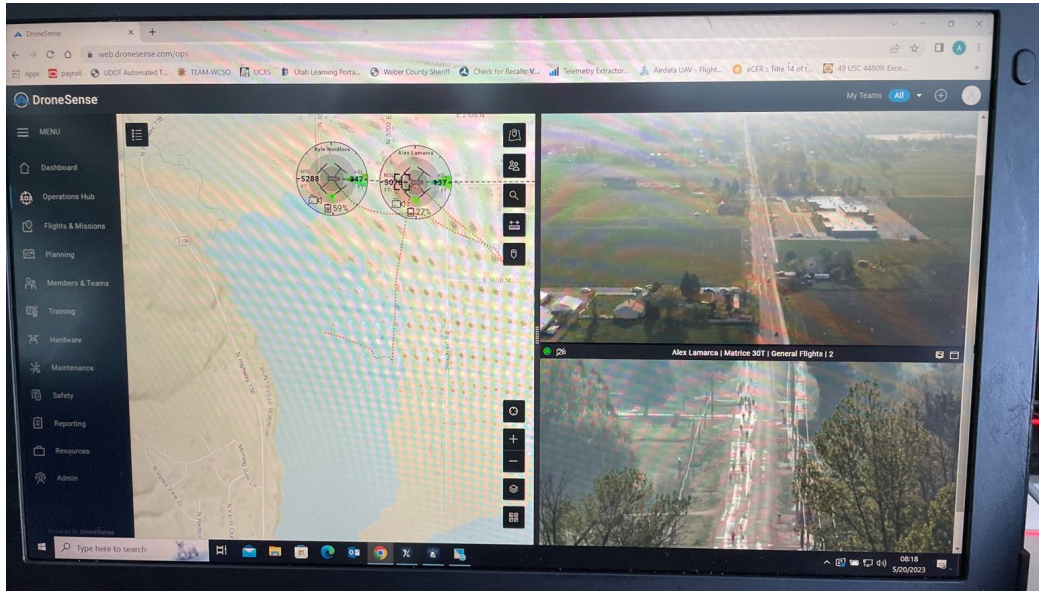
- Autonomous flight
- Many vendors
- This example is from Dronelink which is $25
- (I've not used this software, but I liked their graphic.)



https://support.dronelink.com/hc/en-us/articles/6529977980179-3D-Planner-3D-Preview-and-Virtual-Drone

DroneSense, Motorola Cape & others

- Live real-time image sharing
- RPIC can hand off control to a Remote Operator (RO).
- Automated Case Logs
- Identify emergency landing sites
- Automatic mission logs
- Resource tracking



Advanced Systems

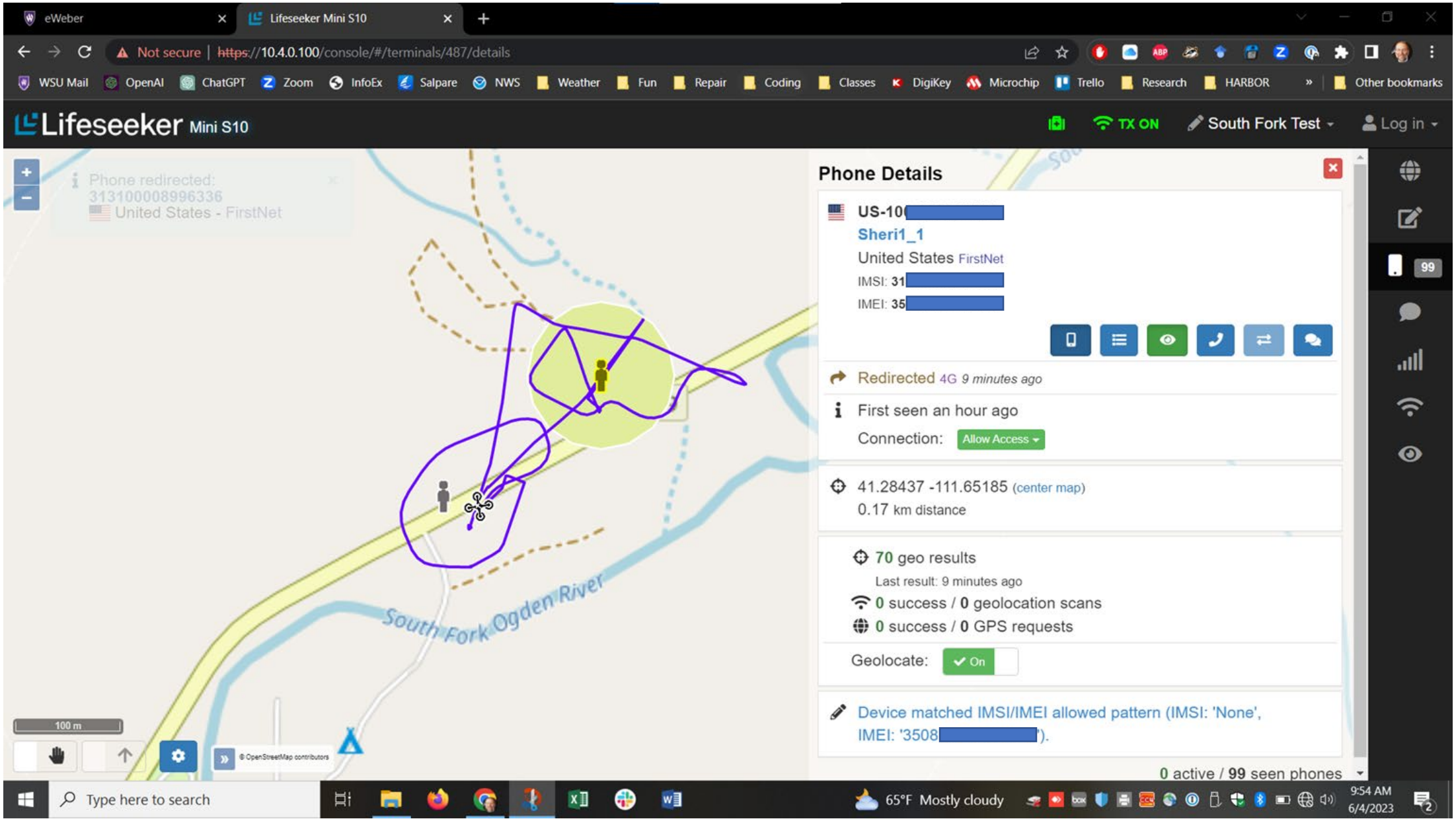
- Lifeseeker (vs. Stingray, DRT box)
- Multispectral cameras (IR cameras act this way)
- Mission mapping with terrain following

Multispectral camera example.
Prices range from $8k to $30k+
Currently for agricultural and environmental monitoring. Ongoing research is exploring other uses.

https://www.dronenerds.com/products/cameras-sensors/enterprise-cameras/sentera/sentera-6x.html

Lifeseeker

Lifeseeker


eWeber
Lifeseeker Mini S10
Not secure | https://10.4.0.100/console/#/terminals/487/details
WSU Mail
OpenAI
ChatGPT
Zoom
InfoEx
Salpare
NWS
Weather
Fun
Repair
Coding
Classes
DigiKey
Microchip
Trello
Research
HARBOR
Other bookmarks
Lifeseeker Mini S10
TX ON
South Fork Test
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313100008996336
United States - FirstNet
South Fork Ogden River
100 m
© OpenStreetMap contributors
Phone Details
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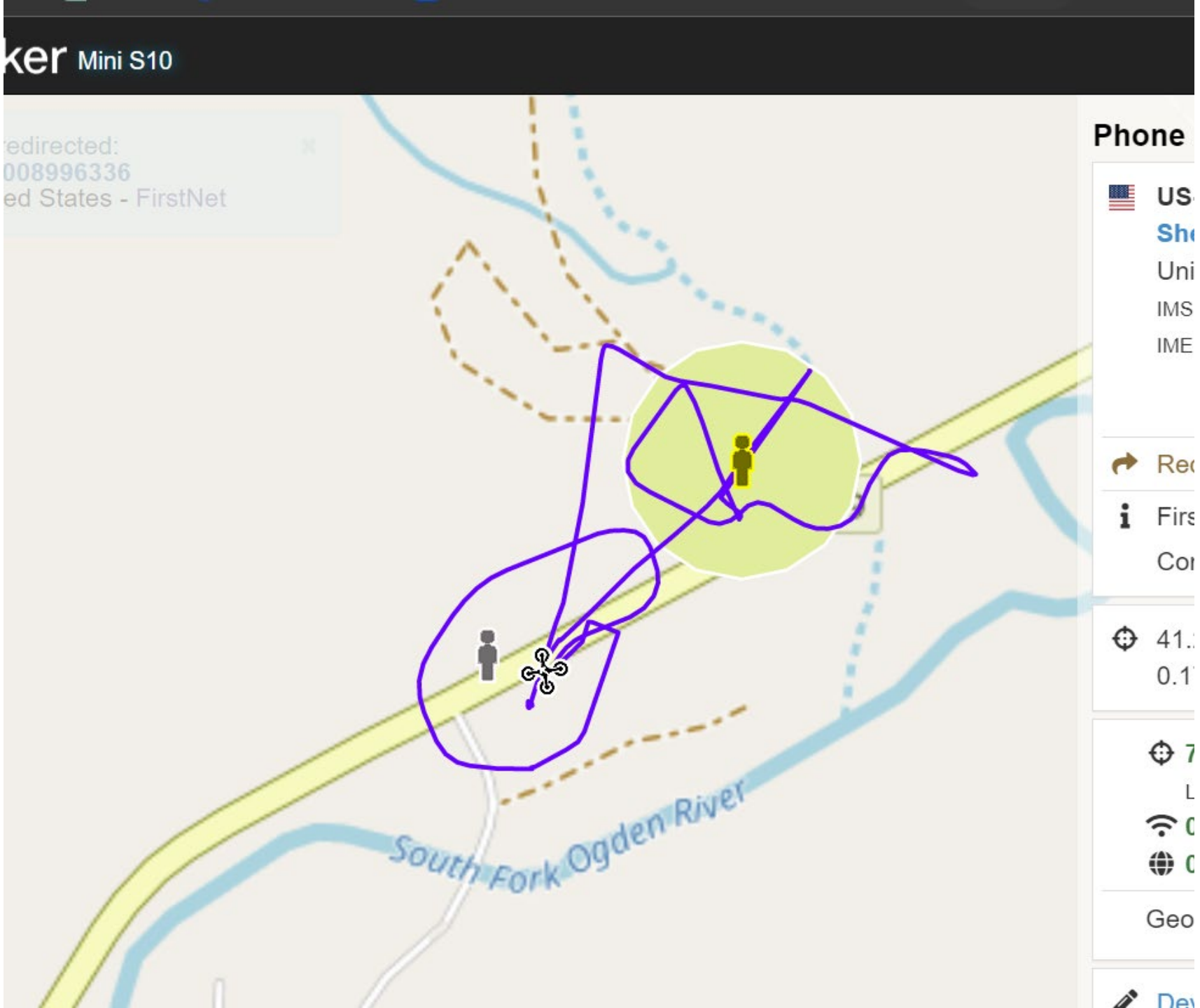
Sheri1_1
United States FirstNet
IMSI: 31
IMEI: 35
Redirected 4G 9 minutes ago
First seen an hour ago
Connection:
Allow Access
41.28437 -111.65185 (center map)
0.17 km distance
70 geo results
Last result: 9 minutes ago
0 success / 0 geolocation scans
0 success / 0 GPS requests
Geolocate:
On
Device matched IMSI/IMEI allowed pattern (IMSI: 'None',
IMEI: '3508
').
0 active / 99 seen phones
99
Type here to search
65°F Mostly cloudy
9:54 AM
6/4/2023

Lifeseeker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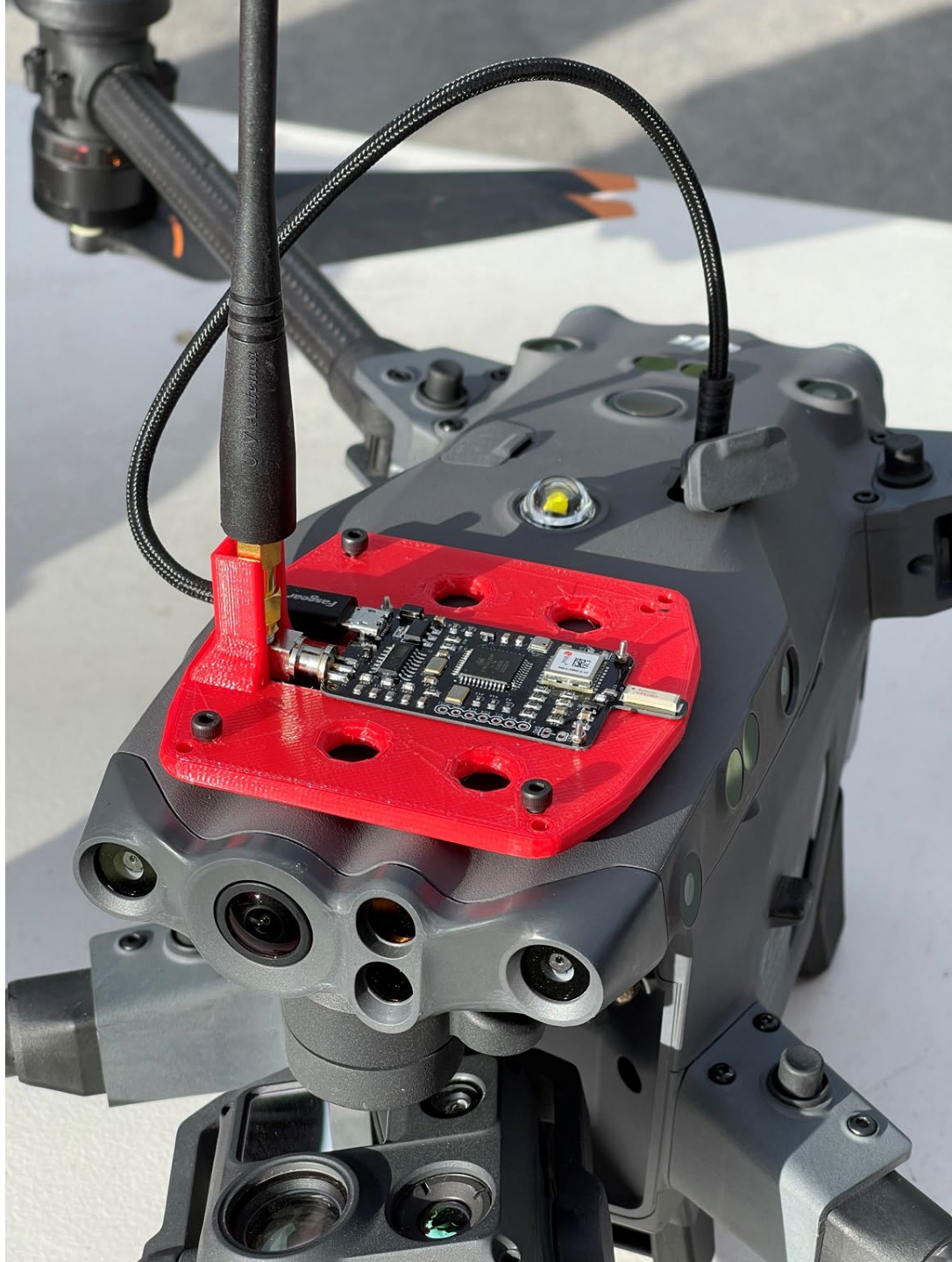
Lifeseeker – Our Personal Opinions

- If you have frequent extensive searches in large areas without cell towers, then you should consider it.
- Expensive, but half the price of a Stingray or DRT Box.
  - If you have a local agency that needs such a device, partner up with them.
- If you have lots of cell coverage, especially 5G, it doesn’t work.
- I was not able to send texts or make calls, but it might have been operator error. OTOH, it uses 2G or 3G for that and our phones didn’t respond.
- Excellent customer care.

Live Drone Tracking

- AirData, DroneSense, many others will link if you have Internet.
- Other solutions will soon be on the market.
- APRS broadcast
  - Uses alternate APRS channel
  - Live feed to ground station
  - USB from ground station to computer with SARTopo.

Homemade system by John Sohl



TAK, **ATAK**, CivTAK, iTAK, WinTAK, etc., etc.

- TAK = Tactical Assault Kit (military) or Team Awareness Kit (civilian)
- Commonly called ATAK = Android Team Awareness Kit
- ATAK UAS Tool.
  - Drone position location
  - Sensor Point of Interest (SPoI)
  - Field of View (FOV), four corners
  - Telemetry data
  - Full Motion Video (FMV)
- ATAK is still in development and requires some IT knowledge to setup.
- Free (?) Unclear to me if a fully functional version (e.g. video) is free.
- iOS iTAK is not fully functional but catching up.

ATAK screenshot

Image from:
https://apkpure.com/atak-plugin-uas-tool/com.atakmap.android.uastool.plugin#com.atakmap.android.uastool.plugin-2

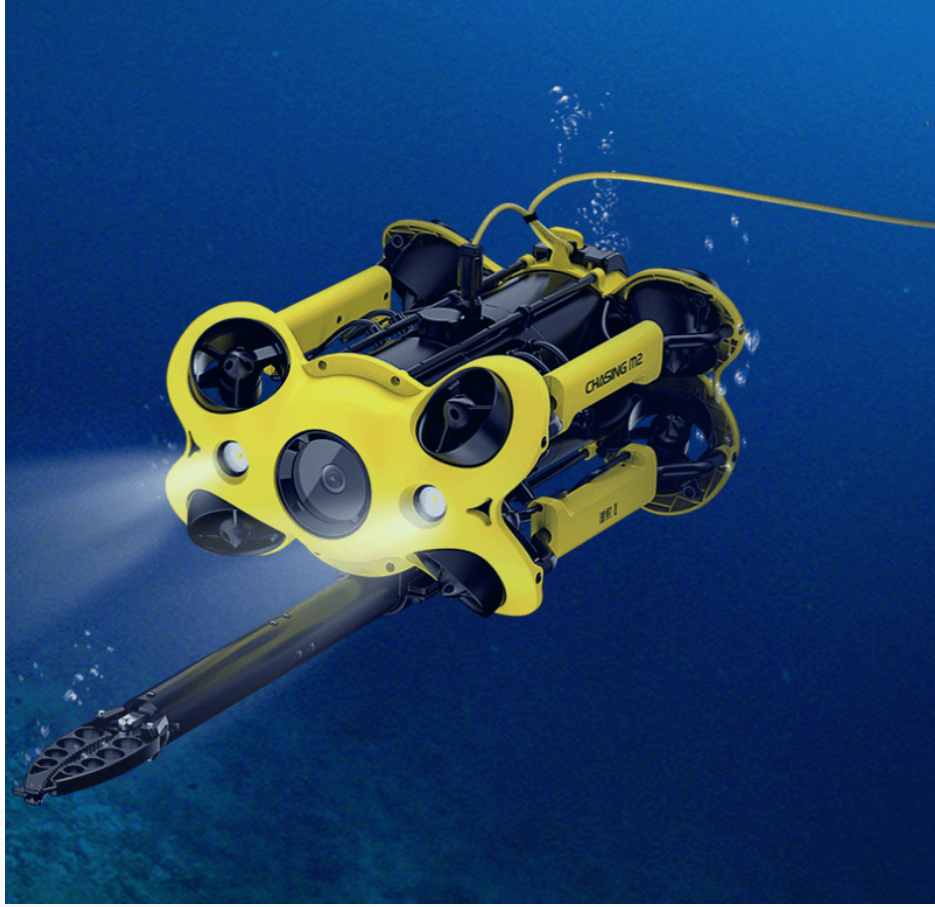
Airborne Repeaters

- Possible FCC and FAA violations (especially flying a cell phone)
- Batteries are “hazardous”

GoTenna will mesh network multiple cell phones sending text messages.

Beyond airborne assets

- **Underwater drones**
- Cave drones
- Indoors/SWAT drones



Cost = $2.5k base, Robotic arm = $800
Pro version base = $3.5k

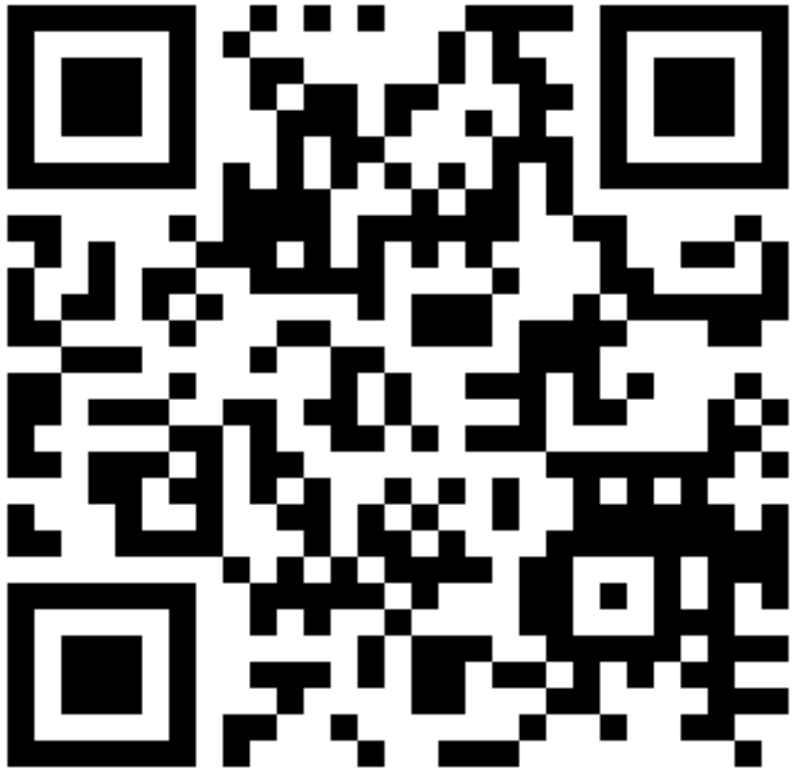
https://www.uavfordrone.com/product/chasing-m2-professional-industrial-underwater-drone-robot-rov/

The Future of Drones: Current Research

- BVLOS and ACAS-Xu
- Swarms and mesh networking
- Shallow grave detection
- Stereovision to head-up display
- LIDAR or videogrammetry
- Hyperspectral imaging
- *Real-time* video analysis
- Gas/chemical sensors and response to things like train derailments

Summary and Questions?

- CRM is critical to a successful team.
- Define where drones “fit” in your team.
- Define a drone team structure.
- Training and currency is critical.
- These are fragile and expensive assets – manage them!



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Right after the BBQ & Keynote

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