

Getting Started With Radio Tracking



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<https://www.ssl.berkeley.edu/about/>

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Courtesy of Orbital Sciences Corporation

- SPHERE_x
- TRACERS
- EOA



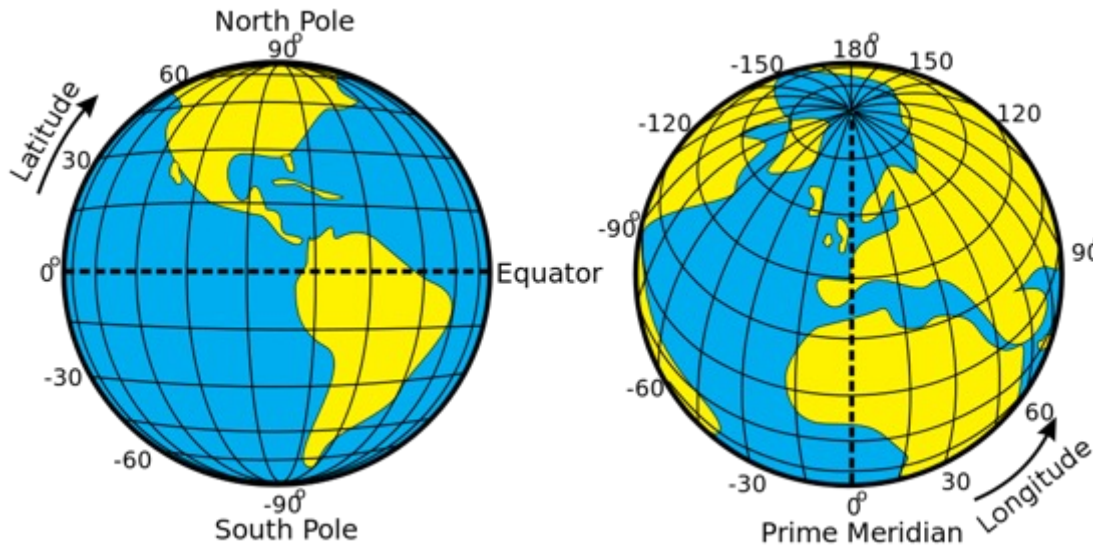
Tracking Considerations



- Radio Direction Finding (RDF) or Telemetry?
- Transmit frequency
 - Cell coverage?
 - Ham or not to ham?
 - Spread Spectrum

https://commons.wikimedia.org/wiki/File:Tracking_Mountain_Lions.jpg
USFWS Mountain-Prairie, Public domain, via Wikimedia Commons

Map Refresher



By Djexplor (Own work) [CC0], via Wikimedia Commons



https://en.wikipedia.org/wiki/Gladys_West

- Latitude, Longitude
 - Decimal degrees, DM and DMS
 - East is +, West is -
- Geodetic Datum
 - WGS84
 - World Geodetic System
 - NAD27, NAD83

Coordinate Refresher



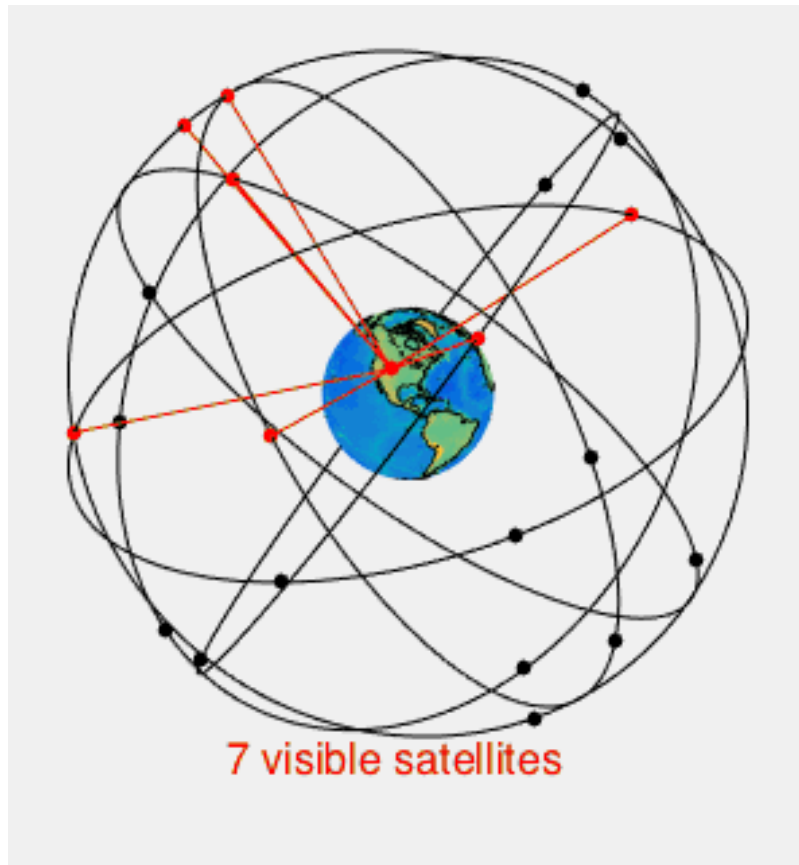
- VAST field in DMS:
 - $38^{\circ} 22' 34.1''$ N
 - $79^{\circ} 36' 30.9''$ W
- Decimal degrees
 - 38.376139,-79.608588
- Degrees Minutes
 - $38^{\circ} 22.5683$ N
 - $79^{\circ} 36.5153$ W

Global Positioning System (GPS)



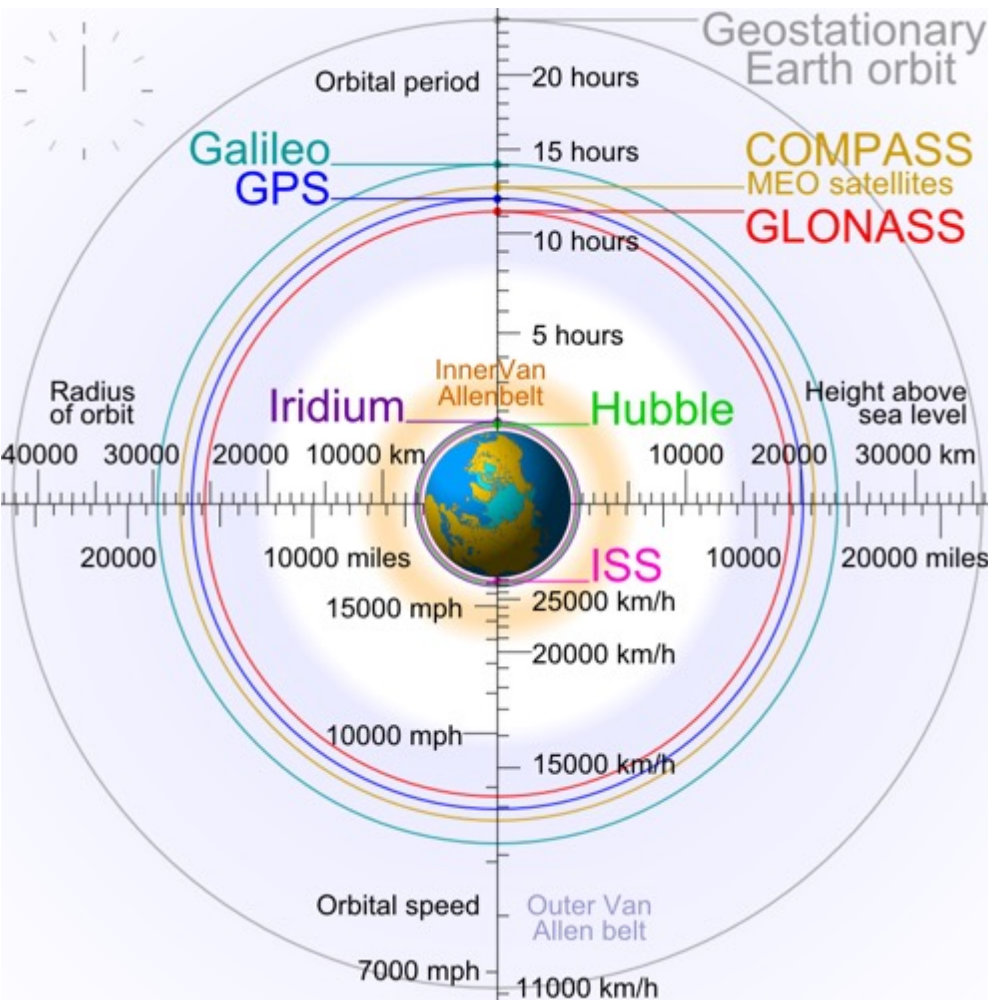
- Tracking
- On-board logging
- Dual-deploy?
- Research
- Flight/attitude control

What is GPS?



- Satellite based
- Global
- Time, position, velocity
- Receive only
- Military with civilian subset
- Compatible systems: GLONASS, Galileo, Beidou

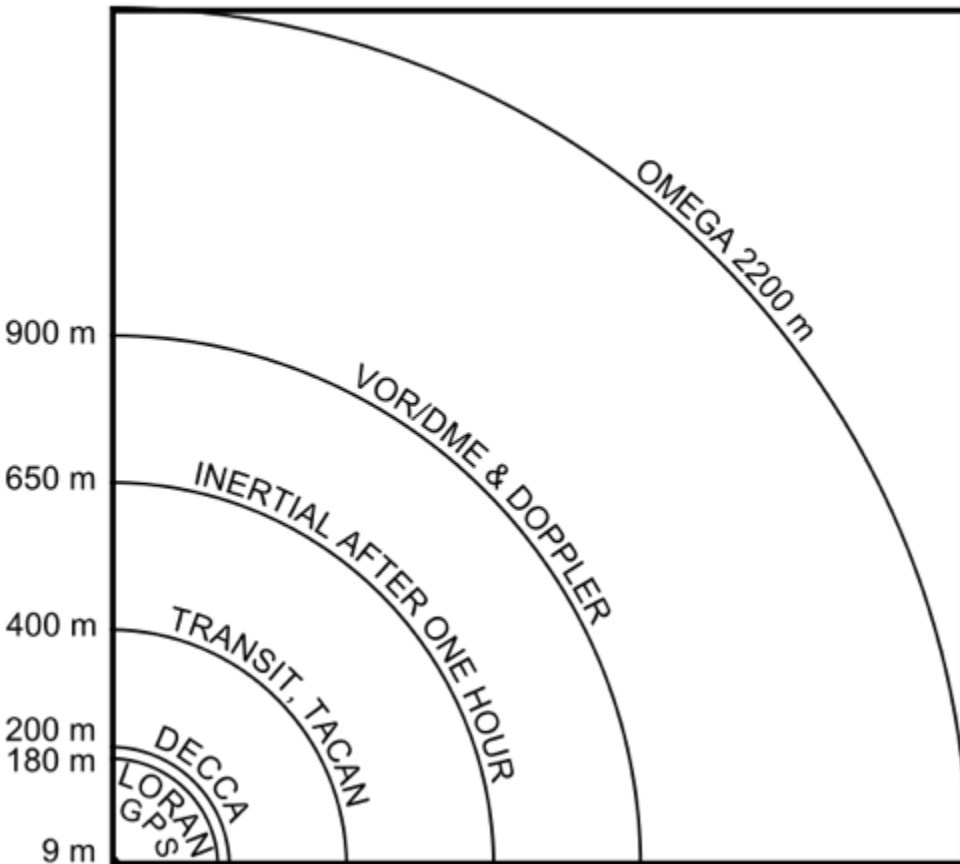
History of GPS



- Precision targeting
- Replaces celestial, radio, and early satellite navigation systems
- First launch 1978

GPS Limitations

ACCURACY OF NAVIGATION SYSTEMS
(2-dimensional)

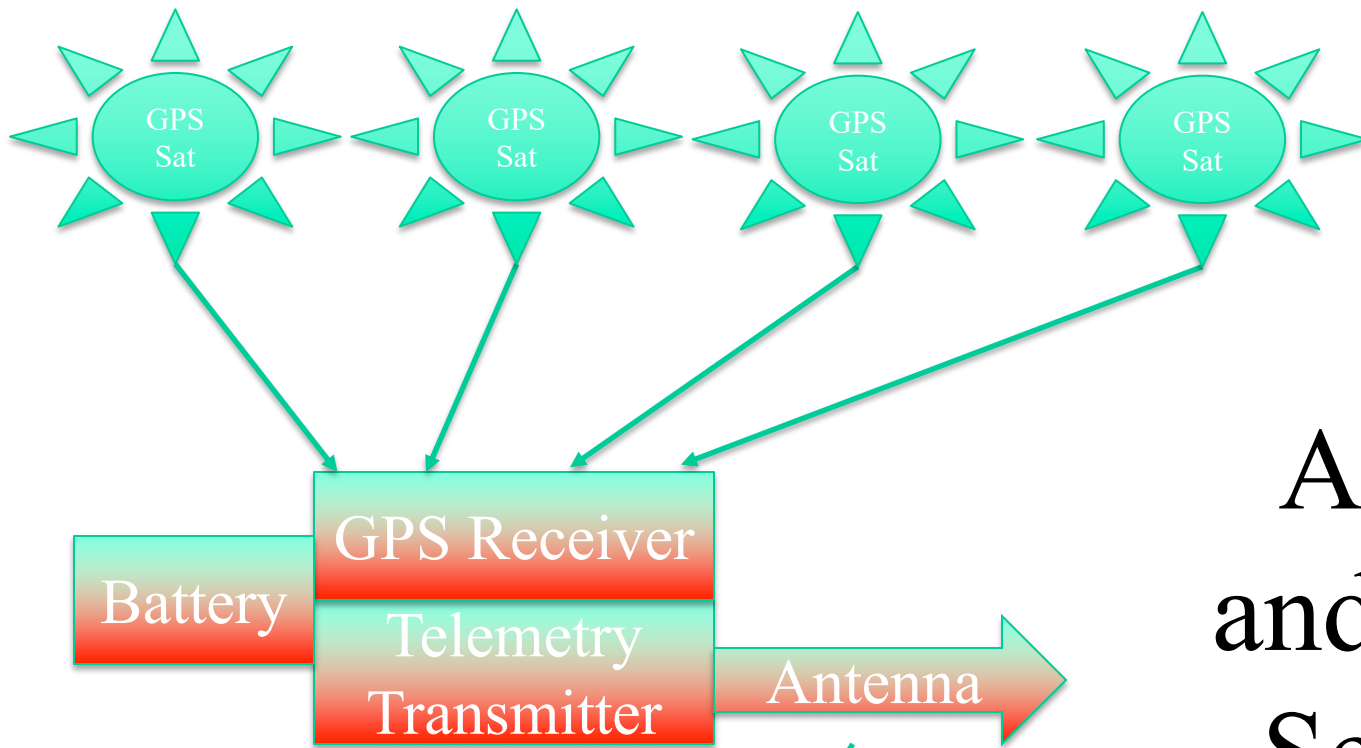


- Accuracy:
 - Selective Availability
 - Ionosphere
 - Geometry
- Signal blockage
 - Multipath

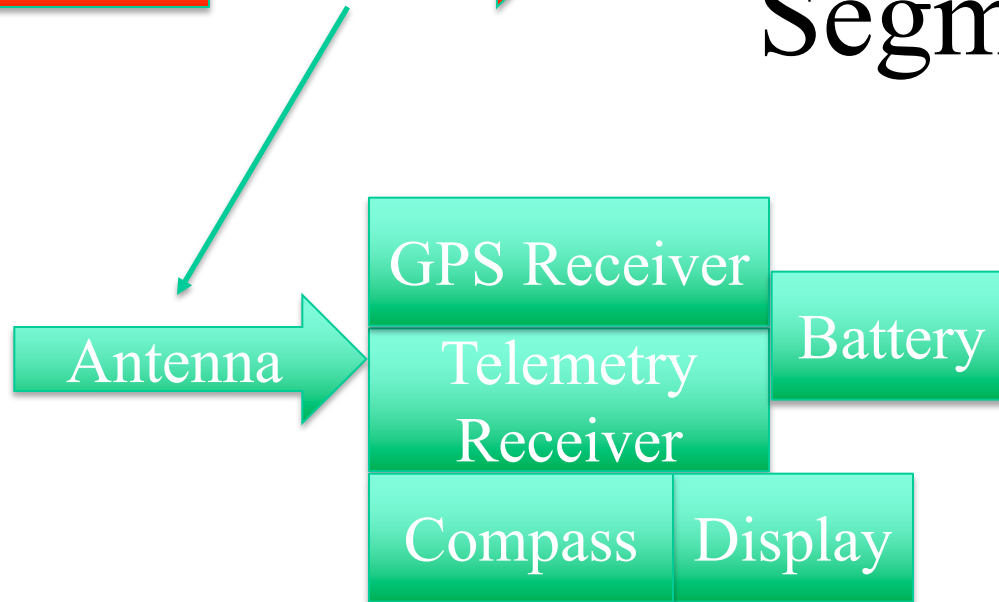
GPS Limitations (cont)



- Need telemetry for tracking
- Altitude & speed lockouts: 18km & 515 m/s
- Jerk



Airborne
and Ground
Segments



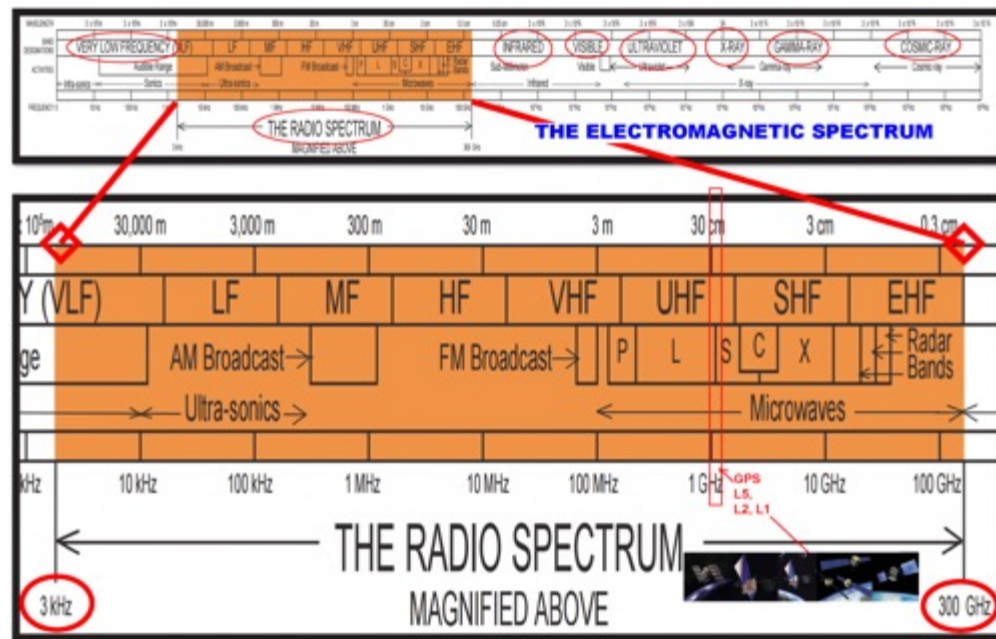
GPS Hints and Tips



- Set firmware to air mode
- Check for RF opaque materials
- Type of antenna and orientation
- “Soft” mounts to minimize jerk?

Frequency bands

- 145 MHz “ham radio”
- 216-219 “wildlife tracking”
- 222-225 ham band
- 440 MHz ham band
- 443.92 MHz
- 900 MHz
- 2 GHz spread spectrum
- Cellphone



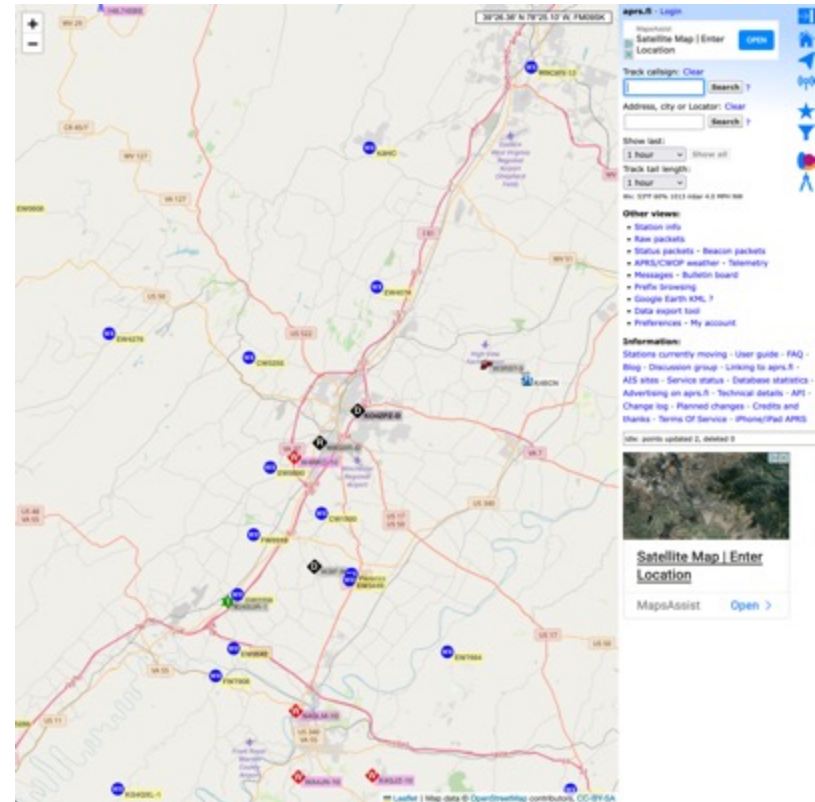
<https://www.transportation.gov/pnt/what-radio-spectrum>

Protocols

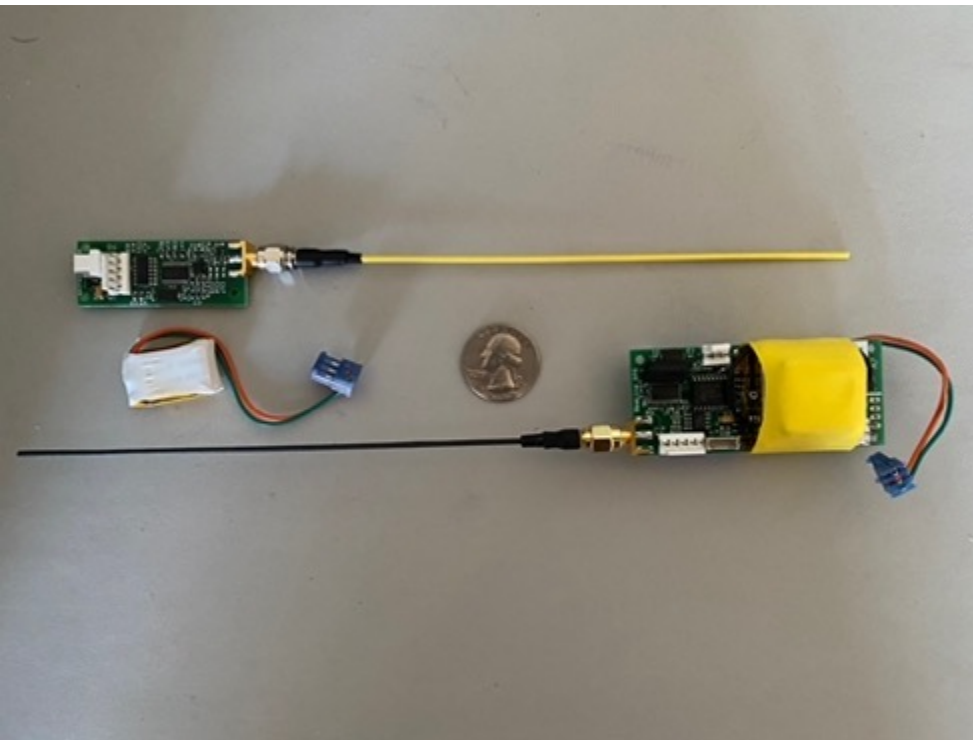
- Proprietary
 - Lots of hardware
 - Non-Ham
- APRS
 - 144.39 in the USA
 - 145.825 in space
 - No fixed 70cm



Yaesu FT5D APRS radio



Current Products



- Consumer
- UAS Platforms
- Rocketry specific

<http://www.bigredbee.com/>

How To Choose?

- Lots of options!
- Let's focus on three concrete examples:
 1. a no-solder build-your-own solution based upon the vNARCON-2022 "Arduino - Build it, Fly it" project
 2. a commercial a la-carte system consisting of a ground station and a dual-deploy altimeter with GPS
 3. a commercial "ready to fly" solution

1 - Roll Your Own

- Expanded from vNARCON 2022 “Make it, take it” Arduino altimeter
- Uses STEMMA peripheral daisy-chain
- Kilometer or two range?
- ~\$85 for airborne plus ~\$145 for ground

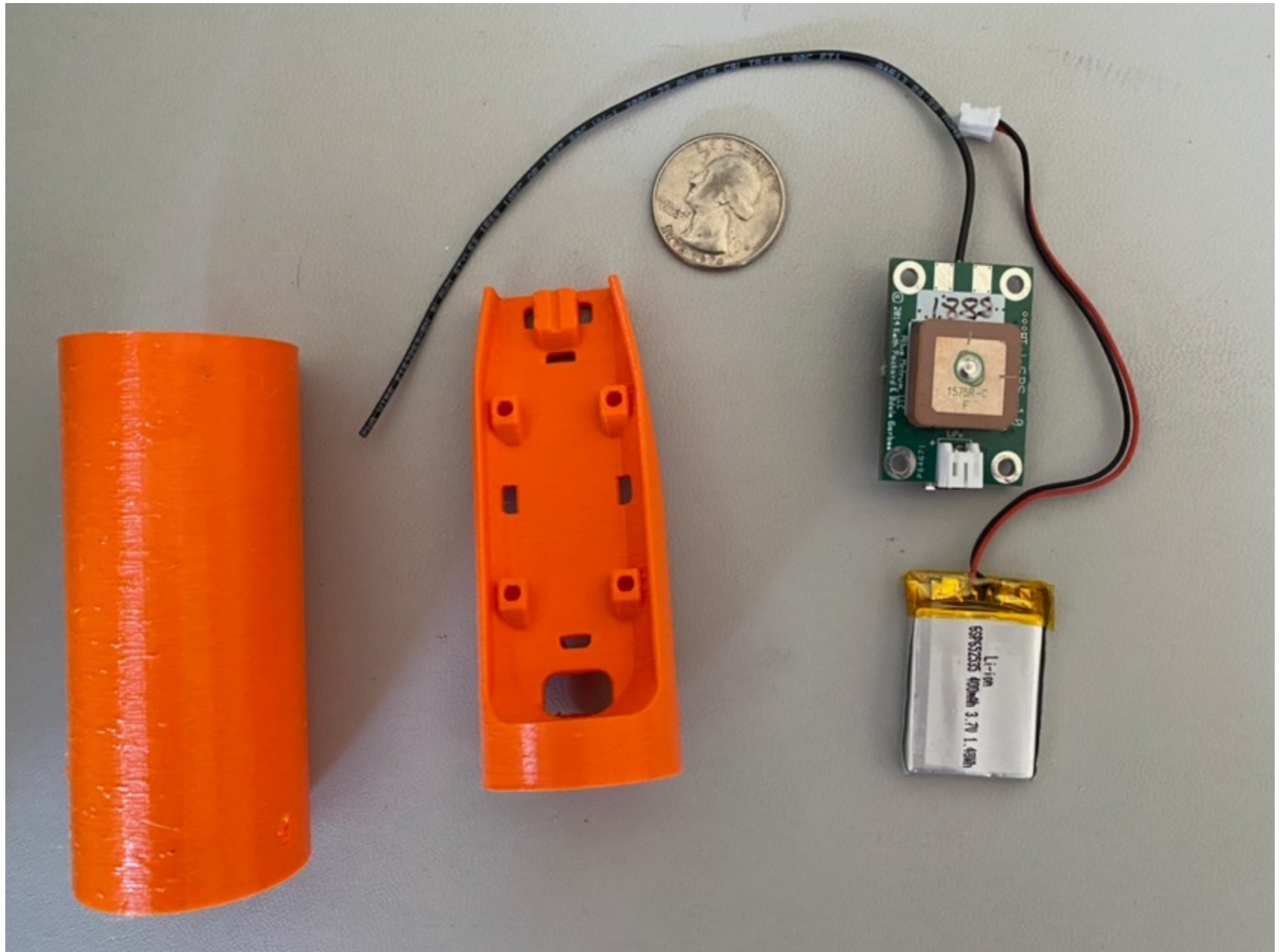


2 – Commercial A La Carte

- Altus Metrum
- Dual-deploy altimeter with GPS telemetry
- Ham radio 70cm band
- “Proprietary” and APRS
- 25k feet
- Laptop, iOS
- ~\$300 airborne plus
~\$230 for ground

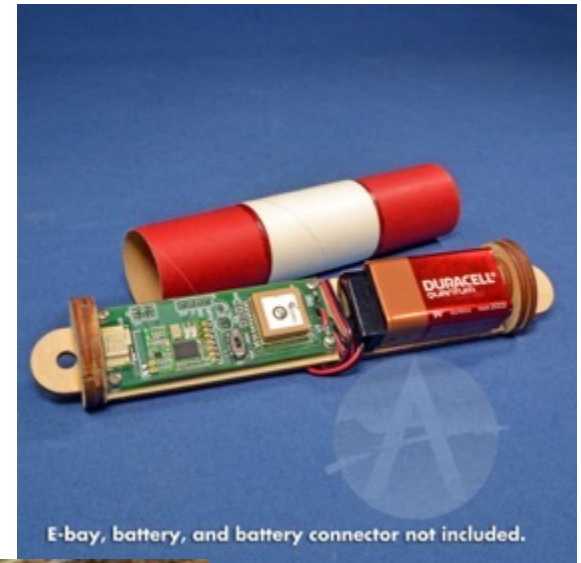


Altus Metrum GPS



3 – Ready To Fly

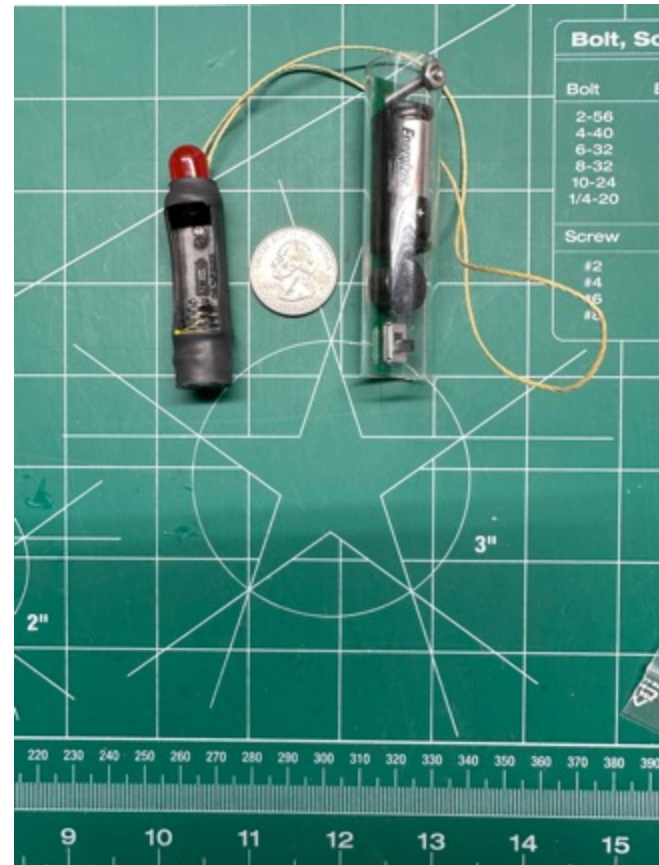
- Apogee Rockets
“Simple GPS Tracker”
- +5 mile range
- ~\$475



The Last 50 Feet...

Use an audible beacon!

- Pratt Hobbies
MicroBeacon ~\$12
- RadioTracking.com
beeping bell ~\$99
- TranSolve.com
MicroTransBeep ~\$14

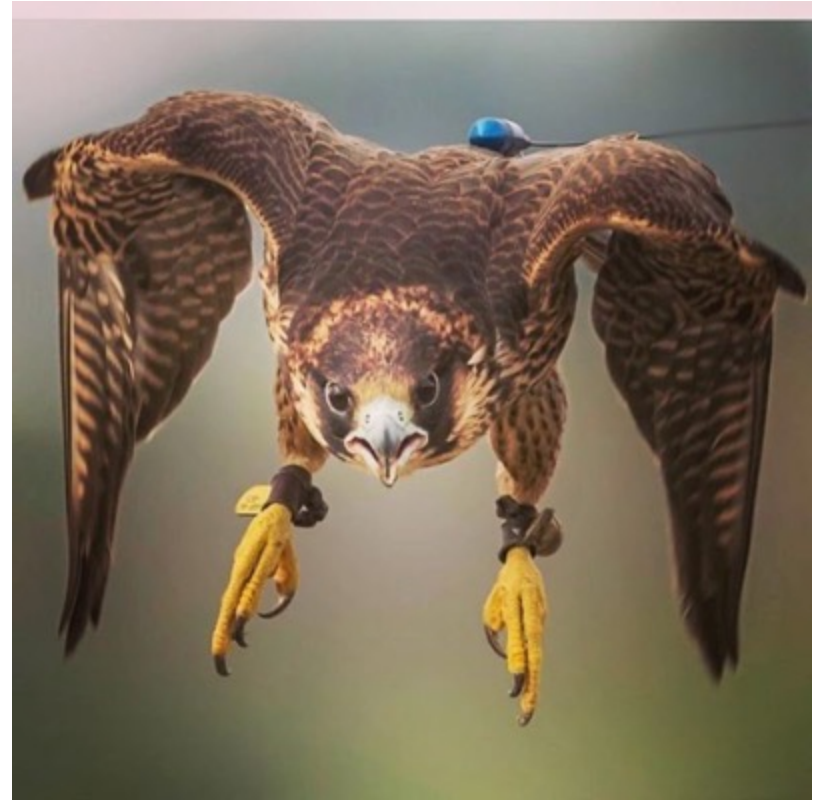


Flight Operations

- Check frequency and function before launch
- Record telemetry during flight
- Landmark on the horizon
- Re-check during recovery trek

High End Systems

- MarshallRadio.com
- ~\$2k
- 9 grams
- Ham radio



References

- <https://kw4wz.com/gps/>
- <https://groups.nar.org/g/MakeIt-TakeIt/wiki/28818>
- <https://altusmetrum.org/TeleMetrum/>
- Apogee Simple GPS <https://tinyurl.com/2rff4wpw>
- <https://www.arrl.org/>
- Email: will@kw4wz.com