CHASING BALLONS:

AN OVERVIEW OF EOSS

Rocky Mountain Ham University
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EDGE OF SPACE SCIENCES (EOSS)

- Edge of Space Sciences is a Denver, Colorado based non-profit organization with the mission of promoting science and education through high altitude balloons and amateur radio.
- Payloads to above 99% of Earth's atmosphere - "The poor man's space program".
- Directly or indirectly involved with 75,000+ students and 55 schools.
- 15-20 balloon flights per year supporting Colorado Space Grant Consortium, Metro State University Intro to Space, CU Bolder Gateway to Space, National Defense Industrial Association, Ball Aerospace, and STEM school programs of all ages.
- 353 launches AND 353 recoveries!
- Web site is www.eoss.org
- EOSS is hosting Great Plains Super Launch (GPSL) in Colorado Springs
  - August 1 through August 3 (August 4 as backup for launch)
  - August 3 will be a launch day for balloons
- Website For GPSL: www.superlaunch.org

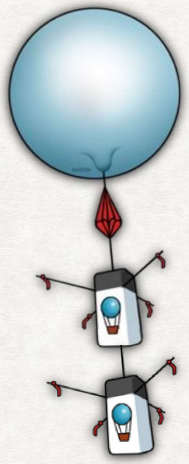
OPERATIONS

FAA RULES REGARDING BALLOONS

- Federal Aviation Administration (FAA) regulations which regards unmanned balloons is in Part 101
- Balloons can be exempt or non-exempt (must meet criteria)
  - Exempt can be flown without FAA permission
  - Non-exempt requires notification to the FAA and need to have additional items
- Exempt criteria is outline in Part 101. Subpart A (101.1 through 101.7)
  - Examples: No payload is over 6 pounds, Total payload wait cannot exceed 12 pounds
- Non-exempt criteria is outline in Section 101, Subpart D (101.31 through 101.39)
  - Examples: Requires notification to FAA prior to flight with predicted path, Reports of position to the FAA
- EOSS does have a waiver for some item regarding the regulations, but has other requirements as part of the wavier
- For exempt flights, we do some of the same items as Non-exempt flights for good relations which the FAA

TYPICAL FLIGHT

Coordination with FAA and Denver Air Traffic Control (Part-101 Waiver)



~90 Minute Ascent

80-100k Feet

Parachute

~45 Minute Descent

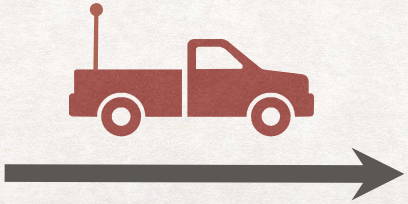
Hike in And Recover

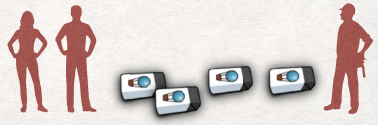
Tracking Teams

- Locate Payloads
- Identify Landowner
- Obtain Landowner Permission to Access

One of Seven FAA Approved Locations

LAUNCH SITE



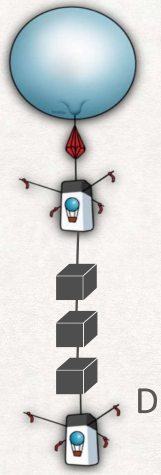


LANDING

HAM RADIO IS INTEGRAL

Amateur Radio Usage:
- UHF (70cm) for voice
- VHF (2m) APRS for telemetry

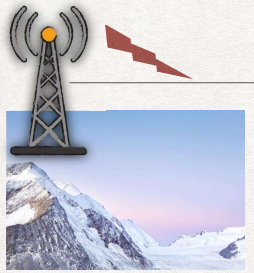
Launch Site/Ground Station:
- Analog and DMR radio comms
- SDR-based APRS system
- APRS IGate
- FAA coordination (APRS data push)



Flight String
- Redundant APRS beacons
- Automatic Dependent Surveillance – Broadcast ADS-B Beacon (flight beacon with tail number, if available)

Digipeater/APRS beacon

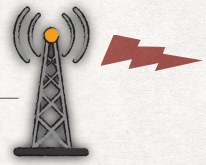
Tracking Teams
- Analog and DMR radio comms
- SDR-based APRS system
- Some have APRS IGate



Linked Repeaters

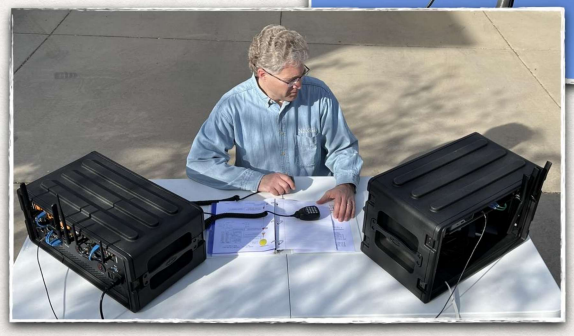
Repeater

LAUNCH SITE/GROUND STATION/PRE-FLIGHT NET



Repeater

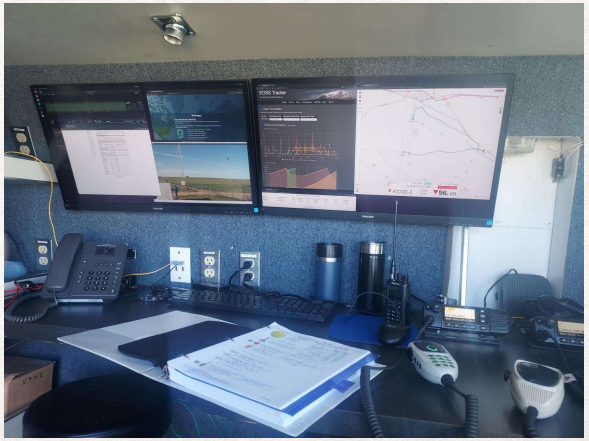
AEØSS GROUND STATION



- 70cm FM and DMR repeaters comms / net
- 2m SDR-based APRS system
- APRS IGate, Cellular data modems, Wi-Fi, SkyLink
- ADS-B reception and upload (FlightRadar24)
- FAA coordination (voice and APRS data push)

MOBILE GROUND STATION

DONATION FROM DENVER CBS CHANNEL 4



BALLOON FILLING

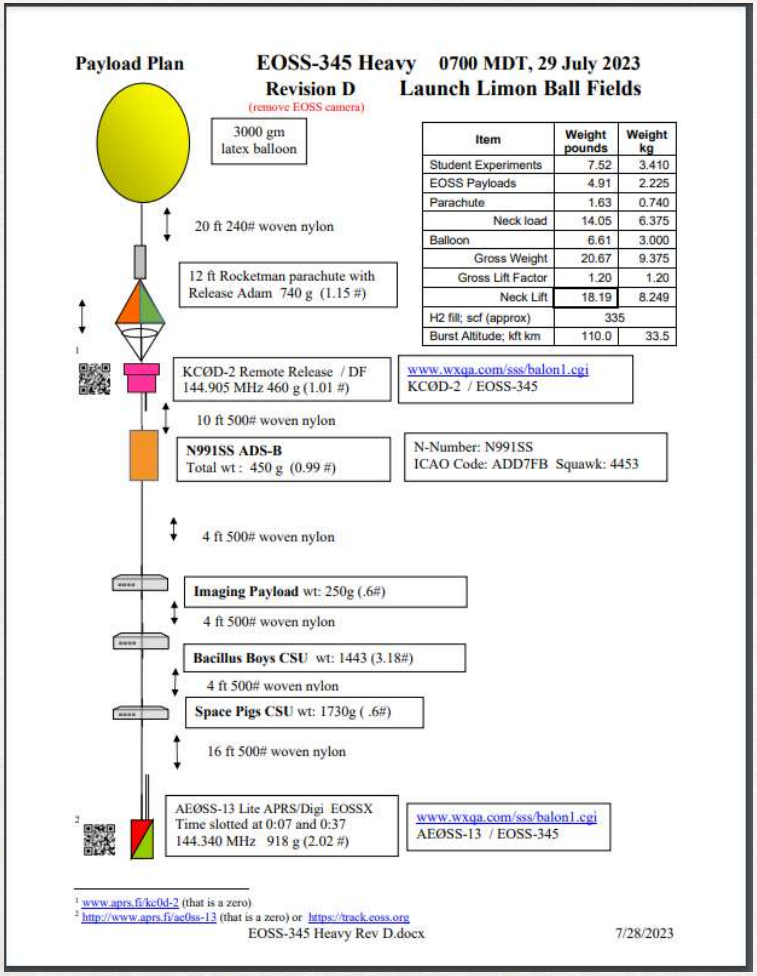
- Typical sized of balloons which are used are:
  - 3000g balloon (Non-exempt)
  - 1500g balloon (Exempt)
  - Weather will determine which balloon size will be used (3000g split into two 1500g if visibility is < 5/10)
- Items are weighed to determine the amount of lift needed and a factor is added
- Hydrogen is used in filling the balloons
  - Helium has been become expensive and hard to obtain
- Usually takes at least 1 ½ bottles for filling the balloon

NEW ENCLOSED LAUNCH EQUIPMENT TRAILER

NEW ENCLOSED LAUNCH EQUIPMENT TRAILER

BALLOON FILL

PAYLOAD PLAN



Payload Plan **EOSS-345 Heavy** **0700 MDT, 29 July 2023**
Revision D **Launch Limon Ball Fields**
(remove EOSS camera)

3000 gm
latex balloon

20 ft 240# woven nylon

12 ft Rocketman parachute with
Release Adam 740 g (1.15 #)

KCØD-2 Remote Release / DF
144.905 MHz 460 g (1.01 #)

www.wxqa.com/sss/balon1.cgi
KCØD-2 / EOSS-345

10 ft 500# woven nylon

N991SS ADS-B
Total wt : 450 g (0.99 #)

N-Number: N991SS
ICAO Code: ADD7FB Squawk: 4453

4 ft 500# woven nylon

Imaging Payload wt: 250g (.6#)

4 ft 500# woven nylon

Bacillus Boys CSU wt: 1443 (3.18#)

4 ft 500# woven nylon

Space Pigs CSU wt: 1730g (.6#)

16 ft 500# woven nylon

AEØSS-13 Lite APRS/Digi EOSSX
Time slotted at 0:07 and 0:37
144.340 MHz 918 g (2.02 #)

www.wxqa.com/sss/balon1.cgi
AEØSS-13 / EOSS-345

Item	Weight pounds	Weight kg
Student Experiments	7.52	3.410
EOSS Payloads	4.91	2.225
Parachute	1.63	0.740
Neck load	14.05	6.375
Balloon	6.61	3.000
Gross Weight	20.67	9.375
Gross Lift Factor	1.20	1.20
Neck Lift	18.19	8.249
H2 fill; scf (approx)	335	
Burst Altitude; kft km	110.0	33.5

[1] www.aprs.fi/kcf0d-2 (that is a zero)
[2] http://www.aprs.fi/ae0ss-13 (that is a zero) or https://track.eoss.org

EOSS-345 Heavy Rev D.docx 7/28/2023

- Payload Plan show the plan and has information regarding payloads and layout for stringing the payloads
- EOSS usually has 4 standard payloads (Release, 2 tracking beacons and/or digipeater, and ADS-B transmitter)
  - Tracking beacons broadcast at different times
- Student payloads/projects vary by size purpose: (Examples)
  - Enviromental data (CO level, UV Level, Temperature, Pressure)
  - Photos/videos
  - Observation of changes in plants/fungus/mold
  - Plans for a flight are on the web site

ICAO
INTERNATIONAL CIVIL AVIATION ORGANIZATION

STRING UP THE FLIGHT LINE

STRING UP THE FLIGHT LINE

LAUNCH

Balloon

RELEASE - cutdown system

Parachute

TOP APRS beacon

Customer payloads

ADS-B beacon

BOTTOM APRS beacon

TRACKING TEAMS

- Typically 5-7 vehicles - a team in each vehicle
- Pre-positioned down range to track and recover payloads
- Leverage amateur radio to coordinate and communicate
  - Trackers and Ground stations
- Most teams use SDR tracking system
- Will transmit cut-down to balloon if necessary
- After landings, trackers will find the landowner to get permission to retrieve the items
- Coordinates retrieving the items

RECOVERY

RECOVERY

EOSS PAYLOADS

EOSS PAYLOADS

RELEASE
- Custom designed release mechanism, Bluetooth linked to TOP
- Placed between parachute and latex balloon
- Will release balloon from flight string upon command

TOP
- Custom designed APRS beacon and balloon release controller
- Uses accelerometer to sense balloon burst
- Commands RELEASE to release balloon from flight string upon burst
- Bluetooth linked to the RELEASE
- ~1-Watt 2m radio (different frequency from the BOTTOM)

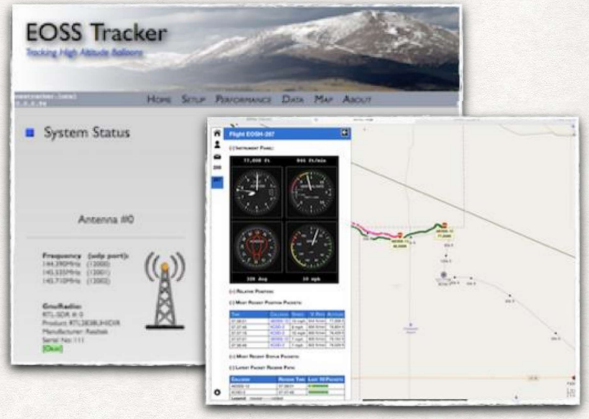
ADS-B
- uAvionix ping200XR ADS-B Mode S Transponder
- Uses 1090MHz

BOTTOM
- Byonics-based APRS digipeater and beacon
- < 1-Watt 2m radio (different frequency from the TOP)

NEWTON'S 4TH LAW: RELEASE THE LATEX!!

TRACKING TECH

SDR-BASED APRS TRACKER



What

- APRS application to aid operators in payload recovery

Primary Features

- Software based (no traditional radios)
- Simultaneous reception of APRS packets on multiple frequencies
- Offline maps (OpenStreetMap)
- Landing predictions
- Light weight user interface leverages a web browser
- Receive only, nothing transmitted or uploaded to the Internet (**)

** With a valid ham radio callsign, IGating and RF beaconing are configurable

SOFTWARE DEFINED RECEIVER - BASIC IDEA

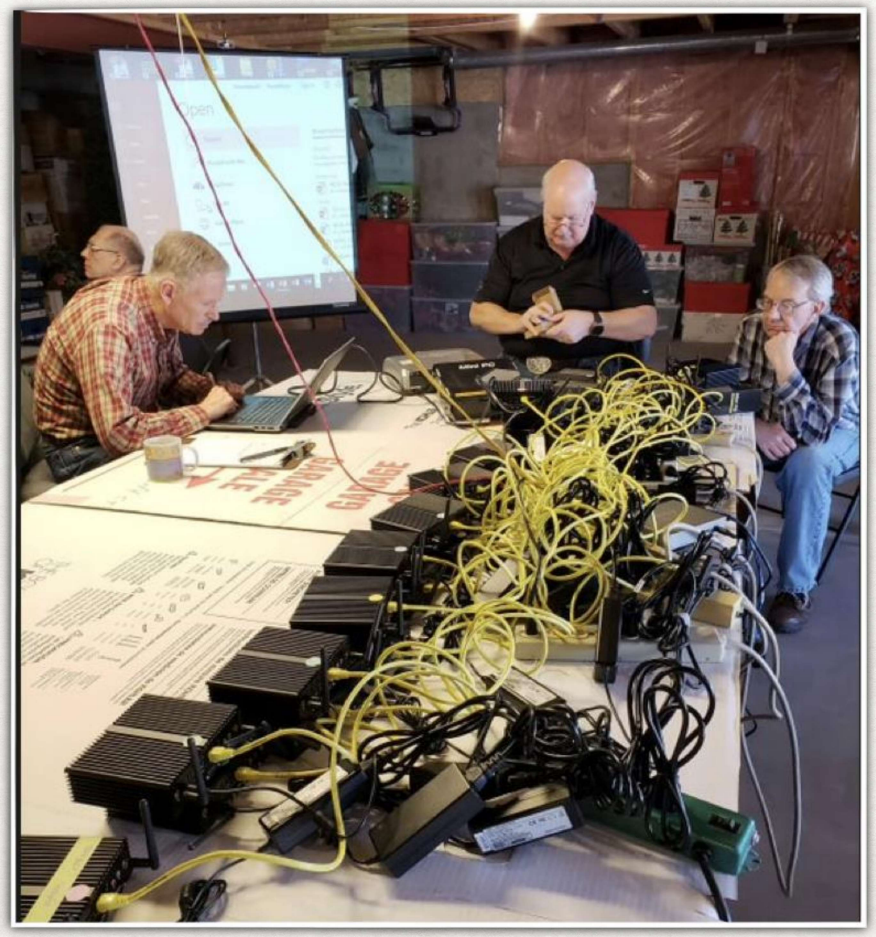
- Small computer *
- SDR USB dongle
- 2m antenna
- USB GPS puck
- Ubuntu Linux
- Open-source software

Wifi Network

- Web-based interface
- Device of choice
- No wires
- Multiple device/user connections

* Specs: Intel I5-4200U (4 core), 8GB Mem, 512GB storage

BUILD PARTY



KIOSK VERSION

- You can track balloons, weather stations, radiosondes, and APRS traffic with any web enabled device connected to Internet by going to the EOSS Kiosk.
- Limited version of the SDR Tracker
- The web address for the tracking is:
  - http://track.eoss.org

CONTACT INFORMATION

PLEASE REACH OUT TO…

Who	Callsign	Email
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THANK YOU

QUESTIONS?