sddec24-01 HEIMDALL

Website

Team Members

- Alec Sutton
- Brandon Beaver
- Branden Buhler
- Cullen White
- George Cleaver
- Lex Somers

Faculty Advisor / Client

Matthew Nelson

Design Requirements

- **Functional Requirements:** Video transmission reliability, SDR integration, easily maintainable, 1240 MHz frequency, up to 200 km transmission distance.
- **Standards:** IEEE: 802.11ac (Wi-Fi standards), C95.7 (EM-Field Safety), 287.1-7 (Coaxial Connector Standards).
- FCC: 47 C.F.R, Part 97 (Amature Radio Regulations)
- FAA: 7110.65 § 9-6-1 Section 6 (Unmanned Free Balloon Regulations)
- **Constraints:** H.A.B.E.T. spacecraft, including Heimdall, must be less that 12 lbs. Power consumption must be minimized to limit battery requirements.

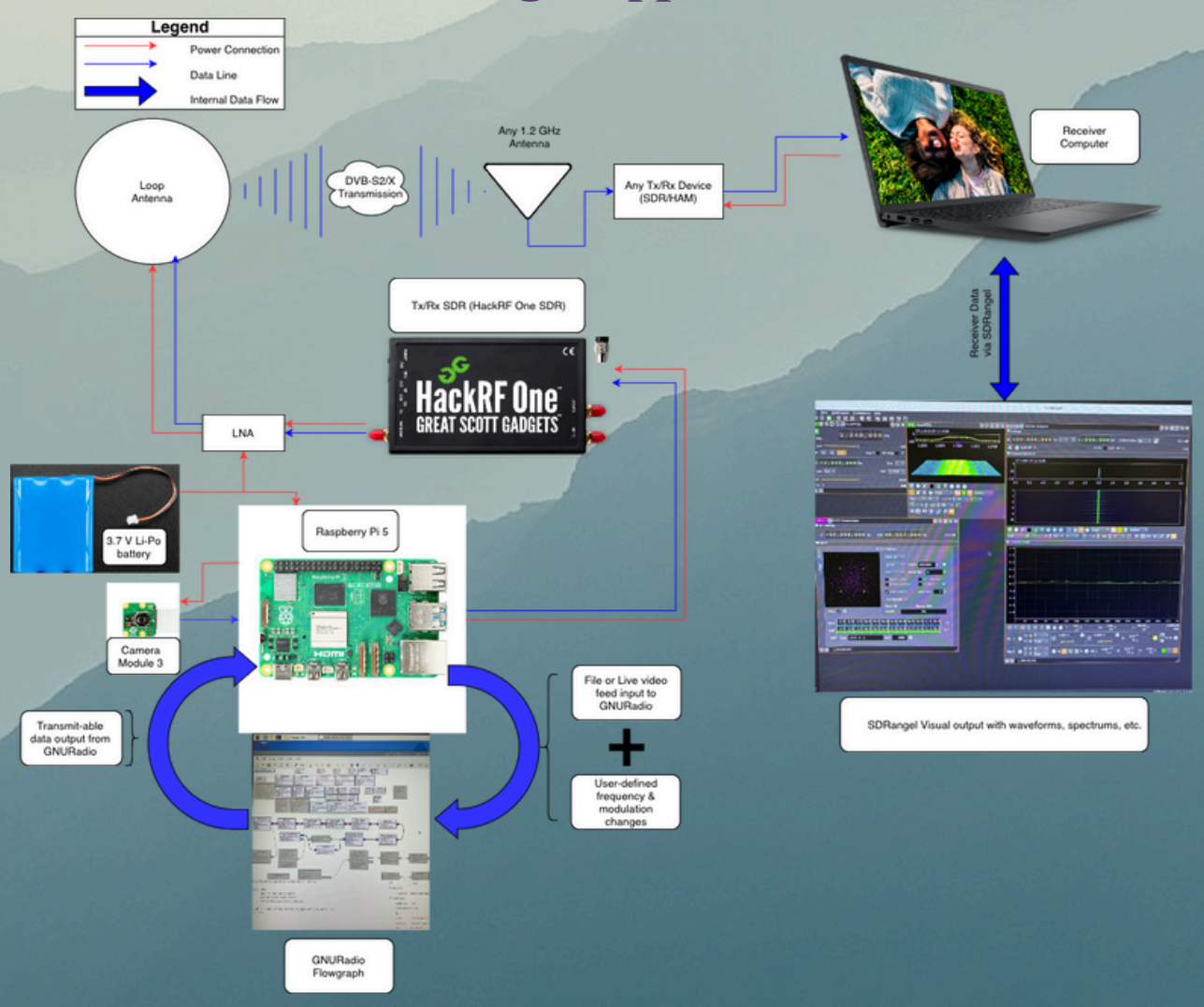
Technical Details

- **Module Details**: GNURadio used for flexible signal encoding and modulation schemes and SDRAngel used for ease of integration with required DVB-S2 demodulation scheme.
- **Concerns:** Limited air tests were available. Link Budget calculations had to be made with some assumptions due to components not arriving. Preliminary Calculation gives -102.2 dBm at altitude meaning further amplification will likely be needed.
- **Limitations:** Limited computational power on Raspberry Pi module. Limited transmission signal power output.

Introduction

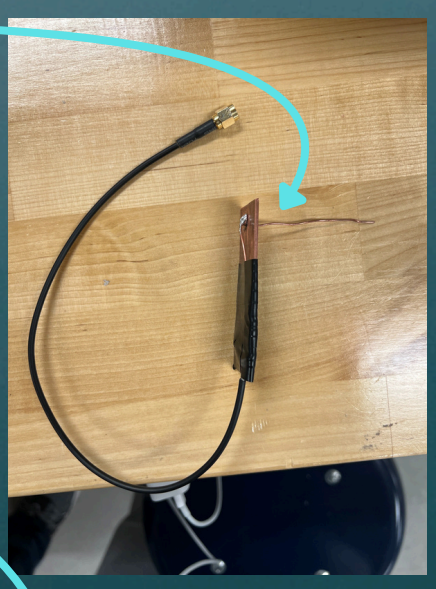
- **Problem**: The Heimdall project at Iowa State University is addressing the challenge of unreliable mid-flight video transmission from high-altitude weather balloons. Current technologies struggle with range and consistency, limiting data collection and the project's potential.
- **Solution**: Heimdall seeks to enhance transmission reliability using Software-Defined Radio (SDR), an open-source, flexible technology. SDR offers cost-effective, customizable solutions for long-range communication, supporting global research and education.
- **Users and Uses:** High altitude balloon interested companies and researchers (Stratostar/Aerostar/NWS/NASA), and educators that conduct field experiments.
- **Operating Environment:** Research Air/Spacecrafts (e.g. H.A.B.E.T. Spacecraft)

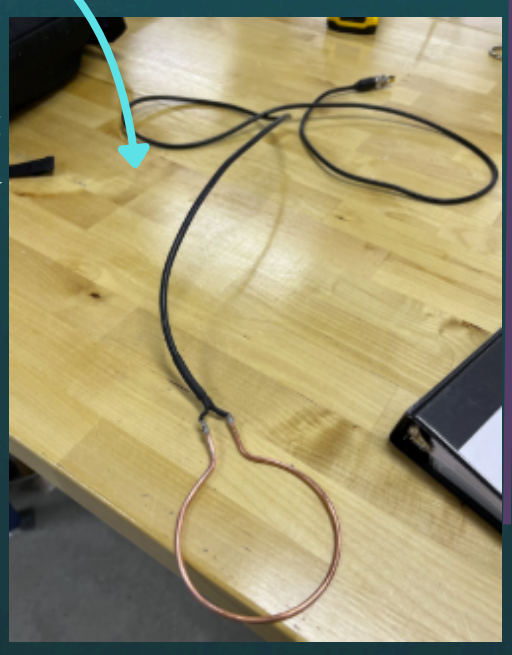
Design Approach



Antenna

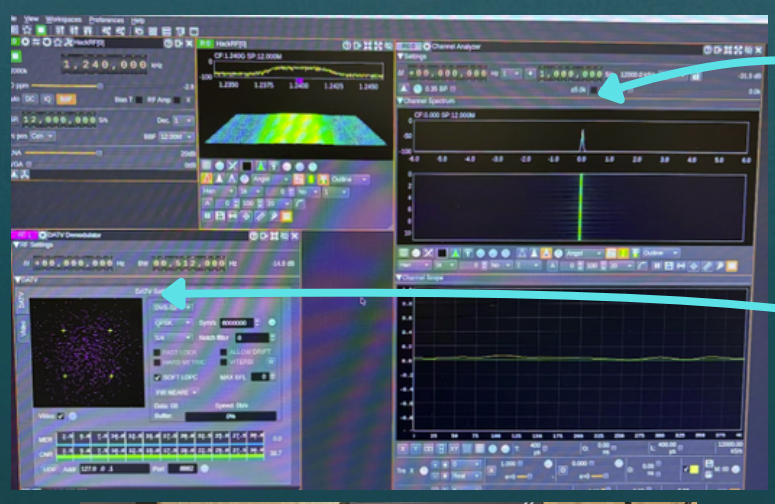
- **Antenna V1:**
  - A 1.2 GHz monopole, that ended up having a short connection from the monopole to the ground plane.
    - The monopole was selected due to time concerns presented.
- **Antenna V2:**
  - Moved to a radiating loop antenna. Ended up being a mismatch on the antenna.
    - Design was made using MATLAB toolbox and then later built.





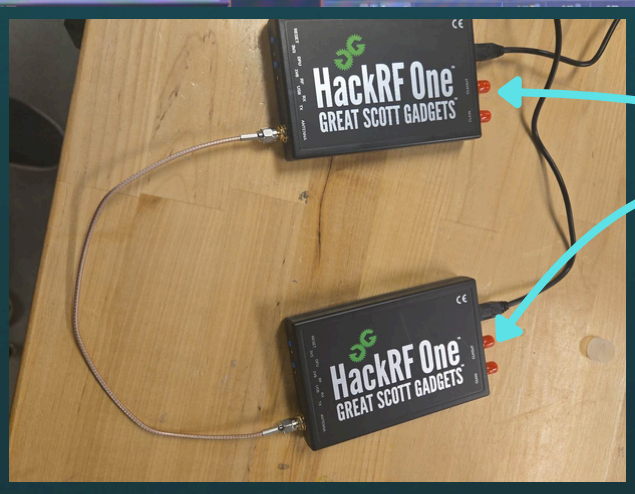
Block Diagram

- Over-the-line test
- Received DVB-S2 signal with QPSK modulation
- Signal received at desired frequency
- No images were recovered due to lack of transmission power



Channel Analyzer

Demodulator and constellation plot



HackRF One modules connected via coax for testing