Team Members/Role:
Brandon Beaver – Project Manager
Alec Sutton – Design and Power Team Lead
Branden Buhler – Communications and Program Team Lead
Cullen White – Power Systems and Logistics Manager
George Cleaver –Communications and Controls Advisor
**Lex Somers – Programming and Software Advisor**

- **Weekly Summary**
  - *This week was eventful, as much was learned in terms of the design aspect of Heimdall. Firstly, the team, with help from the faculty advisor, settled of antenna was settled upon; a loop antenna design. One of the major drawbacks of this and all the antenna designs thus far is the gain. Since this was anticipated, the design was run through simulation in MATLAB to obtain the best dimensions for this antenna. Due to the issues with the Linux machine that were mentioned in previous reports, a line-to-line transmission requires a reinstall of the Ubuntu operating system, which was also attempted. Once these are completed, tests can begin.*

- **Past week accomplishments**
  - *Brandon Beaver worked on:*
    - Another SDR module is needed for proper testing of the gnuradio system, of which one has already been obtained. To remedy this, another HackRF module was sourced from within the Make To Innovate lab, citing the CySAT team as a resource. The team had several extra HackRF modules in their possession and were not in need of them, allowing Heimdall to take advantage of the situation and acquire them for testing.

- The Linux Machine requires a fresh installation of the Ubuntu operating system to work properly as a basis for a comparable test with a Raspberry Pi running the Linux-based PiOS. Following the steps provided on the Ubuntu website, which was very helpful via a bulleted list of instructions. Even with these issues, due to time constraints over the week, another attempt must be made to troubleshoot the system's lack of installation.
- The antenna design **Brandon Buhler** was working on required some input from both the advisor and the project manager for an O.K. to begin building and testing. From these requirements based on the simulations ran in MATLAB, a loop antenna design with minimal loss can be sourced through purchase requests or materials provided from within the Make To Innovate lab space.
- Conversations with the faculty advisor shed more light on what is expected of the project, allowing for a restructuring of the Heimdall project goals. This included breaking the semester deliverables into "Phases," as mentioned previously in an earlier report. the conversation included a review of the previous semester's work. It led to a separate talk, though a list of what deadlines could and should be met was discussed loosely, with a target of the end of September for meeting the deliverables for Phase III(a). This is a fair deadline and complete-able task.

- *Alec Sutton worked on:*
- *Branden Buhler worked on* the MATLAB antenna toolbox to decide an appropriate antenna for the payload. Entertained a helical antenna but did not want to jack around with a ground plane, opted for a loop as of now. The design goals were to have the S11 dB at the operating be ~ less than –6 dB for no reflection within the antenna. The loop's thickness would be restricted to AWG sizes due to the ease of access, and the material would thus be copper. The input impedance of the antenna would also need to be in the range of 80 to 150 Ohms real resistance and less than 1 plus minus reactance for a purely real antenna. After running the sweep, the desired values were 0.04365 m for the radius and 0.003264 m 8-gauge wire) for the thickness. Below the input impedance and S11 parameter are shown:
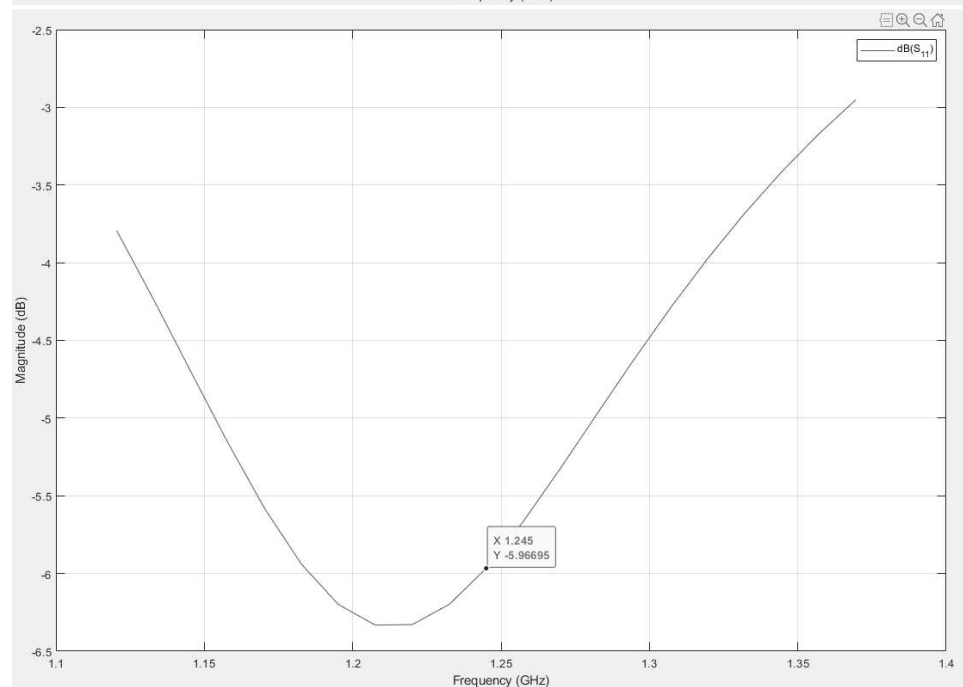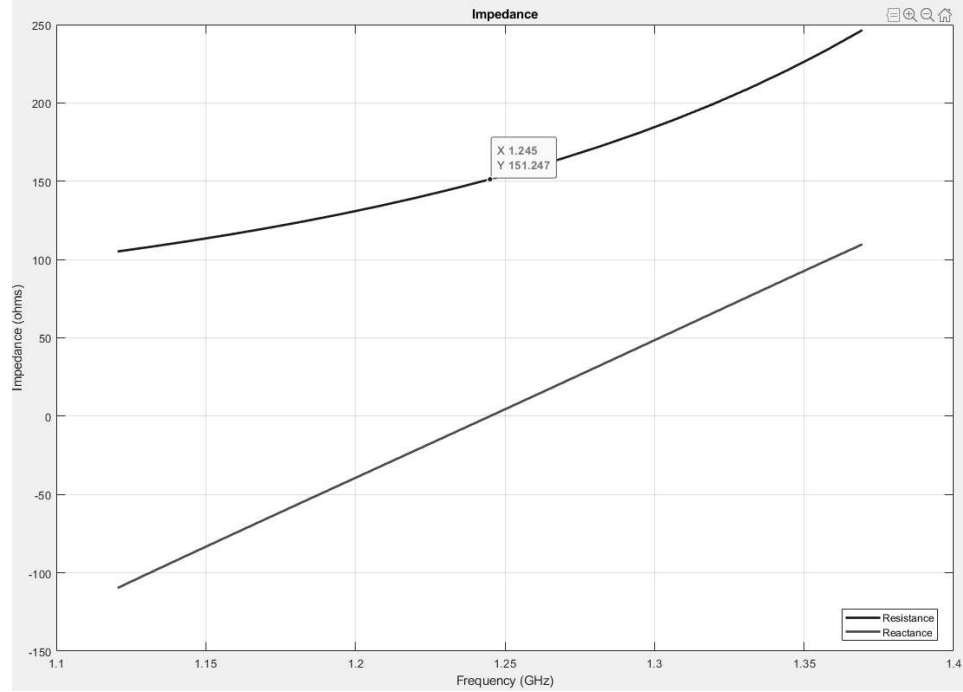
- o *Cullen White worked on:*
  - Finding out how to connect a coaxial cable to a loop antenna without causing a short, and to achieve a matched load.
    - **Use of a Balun:** Since a loop antenna is balanced and coaxial cable is unbalanced, a balun is essential to prevent RF currents from traveling down the shield of the coax, which could cause interference. A common choice is a 4:1 current balun, which will help to match the typical impedance of a loop antenna (around

200-300 ohms) to the 50-ohm coax feedline. This helps reduce mismatch losses and provides more efficient signal transfer.

- **Feeding the Loop Antenna:** The feed point impedance of a loop antenna can vary depending on the antenna design (shape, size, and frequency). For full-wave loops, the impedance can range between 80 and 150 ohms. Feeding the loop at a corner with a <u>4:1 balun</u> usually provides a good match for multiband operation. For best results, ensure proper antenna length adjustments based on the desired resonant frequencies (<u>Philpem</u>) (<u>Alpha Antenna</u>)

- **Balun Placement:** Place the balun at the feed point of the antenna, where the loop connects to the coaxial cable. Ensure you select a high-quality, high-power balun if used for transmission purposes. A <u>1:1 balun</u> may also work well for certain loop configurations but typically will not provide the impedance transformation needed for multiband use (<u>Practical Antennas</u>)

  - Sources:
    - <u>https://www.dxengineering.com/techarticles/balunsandfeedlinechokes/baluns-choosing-the-correct-balun</u>
    - <u>https://pe2bz.philpem.me.uk/Comm/-%20Antenna/A-121-FullWaveLoopAntennas/nloop.html</u>
    - <u>https://www.alphaantenna.com/community/hints-and-kinks/technical-articles/the-need-for-antenna-baluns-ensuring-efficient-signal-transmission/</u>
    - <u>https://practicalantennas.com/designs/loops/large/feeding/</u>

- ***George Cleaver worked on:***
  - Reviewing and exploring new documentation for HackRF and SDR Angle. This will allow me to make immediate progress once Heimdall obtains all the necessary testing equipment.
  - Setting up a shared drive on google to serve as a documentation appendix.

- **Lex Somers Worked on:**
  - Reviewed Ubuntu & SDR Angel installation instructions for lab desktop computer due to boot issue.

- <u>**Pending issues**</u>
  - ***Brandon Beaver worked on:*** N/A
  - ***Alec Sutton worked on:*** N/A

- o *Branden Buhler worked on:* Meet with advisor and get the green light for the loop antenna or go a different route. Find out about balun and how to connect.
- o *Cullen White worked on:* N/A
- o *Lex Somers:* Install Ubuntu and SDR Angel on desktop computer and personal laptop to fix boot issue.
- o *George Cleaver worked on:*
  - ▪ Once the necessary equipment is acquired, then testing and development of software will resume.

- o **Individual contributions**

NAME	Individual Contributions (Quick list of contributions. This should be short.)	Hours this week	HOURS cumulative
Brandon Beaver	• Sourced a second HackRF module • Advised the MATLAB simulations for the loop antenna with Branden Buhler • Met with faculty advisor outside of meeting times to investigate proper deadlines for the project • Began sourcing materials for the loop antenna, i.e., searching for RG58 coax cables for testing purposes, sourcing a ground antenna, a "Griddy RF" antenna, and 8 AWG copper wire for the antenna itself	5	7
Alec Sutton	• Reviewed documentation of Hack RF • Working on the install of SDR angel on personal computer for purposes of experimenting. Running into issues with the installation of ninja builder.	4	5
Branden Buhler	• Ran a ROUGH parametric sweep in MATLAB antenna toolbox to find parameters for loop antenna. • Deciding if loop antenna is the go…looked up problems that can come along with loop antenna and solutions (no short circuiting the feed and how to produce the appropriate radius – I will settle for up to 5% error.)	4	5
Cullen White	• Worked on figuring out how to feed a coax to a loop antenna without shorting it and how to connect a balun for a matched load.	4	5

George Cleaver	• Read HackRF documentation and SDR Angel documentation to be prepared for when Heimdall has access to proper equipment for testing and development. • Set up Shared google drive for a documentation appendix.	3	4
Lex Somers	• Researched how to reinstall Ubuntu on desktop computer to fix boot issue. • Researched SDR Angel installation for mac and Linux Ubuntu systems.	1	3

- **Plans for the upcoming week**

  - *Brandon Beaver will be working on:*
    - To create a proper line-to-line transmission, an RG58 coaxial cable is needed, as it has the necessary impedance rating for a proper transmission. The length will need to be considered when sourcing as well. This will set up the antenna design for a valid test as the results will tell if the devices are both transmitting and receiving properly at the desired frequency
    - As the HABET project begins to gain traction and start flight preparations, documentation stating the needs of the Heimdall project as a client payload will need to be filled, including a PSIP form with that very information. This will quickly be followed by timeline discussion, which is the purpose of discussing timelines for the Heimdall project's deliverables.
    - Setting up the Linux machine will require some troubleshooting, which should not take too much longer to fix. The goal is to have this machine operating within the week.
  - *Alec Sutton will be working on:*
    - Work with Lex on the installation of SDR angel on personal computer
    - Assist in the installation of SDR angel on the Linux machine in the m2i lab.
  - *Branden Buhler will be working on:*
    - An investigation into ordering a balun and 8-gauge wire with the approval from the advisor. The best method is to 3-D print a cylinder to appropriately bend the loop around for a tolerable radius as the size can be near-exactly what is needed.
    - Gather coax, solder coax to feed, test if it can pick up signal (this may be a bit early).
  - *Cullen White will be working on:*
    - Update the website with the new documents for this semester

- - Continue research on improving the antenna design.
  - *George Cleaver will be working on:*
    - Reviewing Changes made since last spring with GNU Radio and exploring SDR Angel applications.
  - **Lex Somers will be working on:**
    - Install Ubuntu with USB on desktop computer
    - Work with Alec on installing SDR Angel on personal laptops and desktop computer.
    - Research SDR Angel usage.

  - <u>**Summary of weekly advisor meeting**</u>

Professor Nelson gave feedback on the 491 report, asking for improvements in a few areas. First, Professor Nelson wants us to add more detailed research that ties into the project. This means we should find and include more information that directly supports what Heimdall is doing. This also suggests collecting integrated data with the HABET team. Second, Professor Nelson suggested that Heimdall works more closely with Professor Nelson as the advisor.