
EE/CprE/SE 491 WEEK 3 REPORT

Feb 14 – Feb 20

Group 01

Project title: Heimdall

Client &/Advisor: Matthew Nelson

Team Members/Role:

Alec Sutton – Design and Power Team Lead

Cullen White – Power Systems and Logistics Manager

George Cleaver – Communications and Controls Advisor

Lex Somers – Programming and Software Advisor

Branden Buhler – Communications and Program Team Lead

Brandon Beaver – Project Manager

o Weekly Summary:

- **The investigation into specific applications for DVB-S for the SDR continues with the availability of the client's resources on DVB-S for Heimdall's goals. While research is still ongoing in that regard, the Communications and Program team began an investigation on the efficiency of using MATLAB's Simulink or the GNURadio programs in the Pluto board, explained in detail below. The Design and Power team spent most of the week performing research as well, with the recommendation of calculating the Link Budget, or a list of requirements for transmitting the signal at any given distance based on the output capabilities. With these new tools, the following week's outlook appears to be busy with testing these theories.**

o Past week accomplishments

- **Preliminary Research (All Members)**
 - With the new documentation provided as direction for what to do with the current equipment, i.e. the Pluto board, The entirety of Heimdall is looking into these resources.
 - Starting with an [example](#) from an enthusiast by the username "PH4X," the range of the Pluto board is anywhere from 70 MHz and 6 GHz at a bandwidth of 56 MHz after simple modifications. This is great for Heimdall's applications for a targeted range of 1.2-1.6 GHz, though the bandwidth has yet to be determined.
 - This setup doesn't require RF (radio frequency) shielding or filtering if using a low-pass filter setup to allow lower frequency

signals through and cutoff higher frequencies.

- Easy firmware updating that uses a simple “drag, drop, reboot” method.
- A DVB-S/2 that takes advantage of D.A.T.V. (Digital Amature Television) received from the I.S.S. (International Space Station) and the QO-100 Geostationary Transponder by a C++-based software demodulator [leandvb](#). More investigation is needed, as there is ample documentation.
- A git repository for D.A.T.V. For the Raspberry Pi capable of output directly to the GPIO (General-Purpose Input/Output) called [rpidatv](#) by user F5OEO. Again, more investigation/testing needed.
- A more DVB-S2 transmission/reception using SDR [blog](#) by user nickhansenrf that uses GNURadio.
- Finally, an [article](#) from Ettus Research on DVB-S2 using GNURadio and USRP B210, complete with accompanying git files.
- Testing
 - *Branden, George, Lex - GNURadio vs Simulink Findings/thoughts*
 - *Using GNURadio is a safer option than MATLAB because of a liscensing issue. In order to do SDR applications, we need to have the communications toolbox in MATLAB, which is no longer included in the standard student license. (Cancelled a couple of years ago 😞). However, since we have at least one source on MATLAB to operate SDR, we will continue doing parallel development on both platforms in case later problems arise.*
 - *Cullen & Alec - Link Budget Calculations (if performed) or initial estimates*

o Pending issues

- GNURadio and MATLAB both hold similar uses for assembling code for the SDR, but the real question is whether or not one is more efficient in terms of compiling time and RAM (Random Access Memory) usage. Over the next week, the Communications and Program team will investigate this by building similar visual scripts in Simulink and GNURadio and comparing the two on the Pluto board and the ARM Linux installed on the Raspberry Pi board.
 - Potential MATLAB licensing issue mentioned above
- In order to determine what the hardware capabilities will be, the Link Budget will need to be calculated. This includes what our distance is, what the output power, bandwidth, gains, and losses will be for the system. This will determine what hardware needs to be ordered.
- A solder workshop will be held the week before spring break to help prepare both projects (Heimdall and H.A.B.E.T.) for assembling the new hardware as necessary. This will use hardware that the M2I lab has available, preventing unnecessary costs, and display critical soldering skills, such as temperature, practical uses for solder paste, flux, etc., type of appropriate solder for different applications, and surface-mount solder techniques.

- A desktop in the M2I lab is capable of being used for testing the capabilities of the ARM Linux OS that the raspberry pi utilizes, but it needs to be installed. Matthew Nelson is required for this step, as IT will need to install it properly onto the desktop. This will likely take a few days to complete as IT is hard to plan for.

o **Individual contributions**

<u>NAME</u>	<u>Individual Contributions</u> <i>(Quick list of contributions. This should be short.)</i>	<u>Hours this week</u>	<u>HOURS cumulative</u>
Alec Sutton	<ol style="list-style-type: none"> 1) began review of DVB-S documentation <ol style="list-style-type: none"> a. first 5 second of leandvb documentation 2) Gained access H.A.B.E.T github 3) found and began experimenting with link budget tool for MATLAB 4) found online link budget calculator and began experimenting with it. 	3.5	11
Cullen White	<ol style="list-style-type: none"> 1) Learning how to access and use the teams website. 2) Working with our client with hardware ideas and possibilities for our project 	4	10
George Cleaver	<ol style="list-style-type: none"> 1) Used MATLAB to connect to the PLUTO SDR board 2) Studied a method of generating C/C++ code from a Simulink model and compared it to GNURadio code generation 3) installed PLUTO learning modules from Mathworks File Exchange to learn further how SDR works. 4) Researched MATLAB functionality with RaspberryPi, various SDR controllers, and ability on Linux. 	5	14
Lex Somers	<ol style="list-style-type: none"> 1) Read chapters 5-7 of Matthew Nelson's Thesis on SDR 2) First pass review of DVB-S documentation 3) Gained access to H.A.B.E.T. github repository and began to review codebase 4) Preliminary research on GNURadio vs MatLab's Simulink applications for SDR 	4	14.5
Branden Buhler	<ol style="list-style-type: none"> 1) Used MATLAB file exchange to gather files needed to test PLUTO SDR board through Simulink. In the coming weeks I will gather information from Lex to compare Simulink and GNU Radio. 2) Read through DVB-S documentation and how to transmit video streams with GNU Radio. 	4	13.5
Brandon Beaver	<ol style="list-style-type: none"> 1) Organized the collaborative Solder Workshop for both H.A.B.E.T. And Heimdall for March 4th.(1hr) 2) Gathered and reviewed DVB-S documentation from Advisor/client, and resources for the Senior Design Website. 3) Organized a second mock-launch for Friday, Feb. 23rd. (1hr) 4) began assembling weekly report presentation templates for each client/advisor meeting for better 	6	19

	communication/visualization.(2hr) 5) looked more into DVB-S/2 (2hr)		
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o **Comments and extended discussion**

- **After the last mock-launch, Heimdall should see a more complete mock/test launch, complete with setup of the ground station and tracking during flight for H.A.B.E.T., which would be helpful in displaying some of the key issues that need to be addressed in the Heimdall project's goals. These issues include tracking problems, data/video transmission issues with the current setup and the specifics that come with it, and so on. With the link budget calculations, the hardware can start to be purchased as needed, but this requires an approval process, previously outlined in the Heimdall Team Contract. This will help to plan power needs from H.A.B.E.T.'s power supply(-ies).**

- **Plans for the upcoming week**
- **As a Team:**
 - Review DVB-S/2 documentation from the advisor.
 - Attend the next H.A.B.E.T. Launch for a better understanding of the client's needs and technical needs of the project.
 - Test Simulink vs. GNURadio efficiency and settle on approach. Multiple tests may be required.
 - Collect and investigate an extra Raspberry Pi board to run any at-home tests from H.A.B.E.T.
 - Write a short, professional bio for the website
 - Get a professional Headshot for the website
- **Individual (bolded tasks are the tasks to be focused on):**
 - **Alec Sutton:**
 - **Link budget calculations**
 - better understand what our losses will look like and where they will come from in the system for calculations
 - learn the gain and power of the existing HABET reciever
 - Continue reading DVB-S documentation
 - finish reading leandvb documentation
 - **Cullen White:**
 - Link budget calculations
 - **Website building**
 - Acquire professional Headshots from each project member
 - Add project description
 - Add/gather team member bios
 - Add Weekly Reports & presentations
 - Add I.S.G.C.(Iowa Space Grant Consortium), H.A.B.E.T., and M2I logos to the website, accompanied by descriptions of each entity
 - **George Cleaver:**

- **Make introductory conclusions about using MATLAB vs. GNURadio**
 - Get set up on one of the campus Linux machines to test software communication with the SDR controller used with HABET.
 - Research/Learn how a Simulink model generates code and determine if it is more optimal than GNURadio code generation.
- Install GNURadio drivers on personal computer to begin local development and understanding of the program.
- Attempt to use PLUTO SDR with GNURadio if possible
- Lex Somers:
 - Research and test GNURadio and Simulink, focusing on comparing performance and ease of use.
 - **Set up GNURadio to be used and tested on the PLUTO SDR board and local machines.**
 - **Research DVB-S/2 further using the client provided documentation.**
 - Assist Cullen White with the setup of Heimdall's website.
- Branden Buhler:
 - Install GNU Radio on personal computer and run modulation tests and use the PLUTO SDR board with the application.
 - Gather information from Lex to make informed decision about using either MATLAB Simulink or GNU Radio.
 - Start video transmission tests within the next two weeks.
- Brandon Beaver:
 - *Continued from last week-* Further scheduling with the H.A.B.E.T. leadership and Engineering team to understand what requirements integration of the Heimdall system, power demands and wireless connectivity with H.A.B.E.T.'s Raspberry Pi requires.
 - Research DVB-S/2 further, using more of the materials given by the client.
 - Finish presentation template and gather information from each project member on tasks, plans, etc.
 - Finalize a time for the Solder workshop with the advisor using M2I resources. This will be led by Professor Nelson.
 - Due to a family emergency, next week will be more research than active testing. Attempts will be made to keep the project on track as needed.

o **Summary of weekly advisor meeting**

A large portion of the meeting was dedicated to catching Professor Nelson up on the current progress of the team's observations with the ARM Linux software, as most of the computers available to the ECprE department with Linux use a different version of the OS, which does not properly support the needs of the Heimdall software. After this was brought to the attention of the advisor, an action item was put into place for installing ARM Linux onto a desktop in the M2I Anti-static Room, previously used by the CySat project group. The Communications and Program team had several questions about this, as well as

if GNURadio was the preferred method for programming the system. After some discussion, as noted above, the group has decided to try both systems in a high-level test to find if there is any measurable difference between using Simulink and using GNURadio. Pressure to receive proper documentation and website assets was also discussed, leading to the newly-acquired DVB-S/2 documentation being the new priority for research. Discussion of attending the April Eclipse launch was touched on, but further budgeting and planning is required.