2012-01-10

SDR Meeting

Overview

Meeting Purpose:

- System Design Review

Materials to be Reviewed:

1. Project Description/Background
2. Customer Needs and Engineering Specifications (Rev. 5)
3. Functional Decomposition (Rev. 3)
4. Work Breakdown Structure
5. Design Concepts and Analysis
6. Proposed Design
7. Project Plan
8. Risk Management

Meeting Location:

- Building 9; Room 2129

Meeting Time:

- 14:30 - 16:20

Present:

- Mike Hudak
- Jake Emenheiser
- Bill Dorney
- Steve Giannotti
- Donny Lucas
- Leo Farnand
- Vince Burolla
- Gordon Davies
- Dr. Dorin Patru
- Dr. Edward Hensel
- Mark Smith

Notetaker:

- Mike Hudak

Notes:

These notes were re-transcribed from the original meeting notes for increased clarity and organization.

Introduction

14:37 - 14:37

- **Steve** discussed the SDR overview.

Overview

14:37 - 14:42

- **Jake** discussed the project summary and talked about Brent and Bryce as customers.

Near Space Description

14:42 - 14:44

- **Steve** talked about Near Space.

HAB Configuration

14:44 - 14:46

- **Steve** talked about the HAB Configuration Diagram and FAA Regulations.
- **Mark Smith** asked about why the module would be below the main payload.
    - **Donny** talked about why we chose to hang below the payload as well as possibly mounting directly to payload.
- **Dr. Hensel** asked that they (payload) have the responsibility of supporting the module weight.
    - **Donny** replied that this is the case.

Customer Needs

14:46 - 14:50

- **Jake** discussed the customer needs.
- **Mark Smith** asked about our budget.
    - **Jake** responded that this is $1000.
    - **Steve** added that the solar panels would be possibly the largest cost.

Engineering Specifications

14:50 - 15:02

- **Jake** explained the Engineering Specifications.
- **Dr. Hensel** asked about where the data would be sent.
    - **Jake** said that data will be sent to the main payload.
- **Dr. Hensel** asked why we used 40 C for the relative humidity spec.
    - **Steve** said that we were using conformal coating specs as an example for our spec.
    - **Jake** added that this is a military spec.
    - **Dr. Hensel** said that this seems like a high degree and asked what is the problem that we're trying to solve.
    - **Jake** said that it was condensation.
    - **Dr. Hensel** asked what is the source of the vapor that will be condensing.
    - **Jake** said that it would be from the air.
    - **Dr. Hensel** asked if the package will be sealed or open.
    - **Donny** said that it won't be guaranteed to be airtight.
    - **Dr. Hensel** said that this is a very strict spec.
    - **Dr. Patru** agreed, considering we won't fly in that temperature.
    - **Dr. Hensel** said that if we try to meet this spec, it may result in higher cost or weight.
    - Patru added that we should protect against rain at low altitudes.
    - **Steve** said we weren't sure how to measure the spec.
- **Jake** mentioned our external temperature range and asked if anyone knows how to test over this range.
    - **Dr. Hensel** said that imaging science has a freezer that goes down that low but they don't have it anymore. We could go into a deep freezer and operate the module inside there but it would be difficult to do in a vacuum. He suggested we ask our customer what they want for this spec. Ultimately, the flight is the test.
    - **Dr. Patru** added that collecting as much data as we can during the flight is important.

Functional Decomposition

15:02 - 15:05

- **Donny** described the Functional Decomposition.

Concept Analysis

15:05 - 15:47

- **Donny** talked about Solar Collection Concept A.
- **Steve** talked about solar power concepts.
- **Dr. Hensel** asked where they energy is being dissipated on the module.
    - **Steve** talked about the radio transceiver on RITCHIE-1.
- **Gordon** asked about PEP.

- **Steve** mentioned that the output will be post regulated.
- **Mark Smith** asked about the Pugh Matrix.
    - **Steve** mentioned that we did an unweighted Pugh matrix first but needed to change it to weighted.
    - **Mark Smith** wanted to know if we did it first. He said it becomes more difficult because the criteria is subjective (ranked) instead of objectively compared to baseline.
- **Bill** talked about battery technology.
- Incorrect mechanical structure was shown (unweighted).
    - **Donny** talked about his argument for what he chose.
- **Dr. Hensel** asked about how much power is required. He stated the average 3 watts over 24 hour period with a 10 Watt maximum. That would give us nominally 10 hours of rechargability.
    - **Dr. Hensel** asked what we were assuming our energy efficiency of our system from incoming radiation to solar power and stored in the battery. He said that assuming our battery is 95% efficient, what is our efficiency for storing energy into the battery. How many Watt-hours do we need to put into the battery to achieve that and what is our conversion efficiency from solar to battery.
    - **Jake** said that we haven't calculated a number.
    - **Dr. Hensel** asked what our battery charging efficiency would be. He also asked what would our solar panel efficiency be.
    - **Steve** said 10-20%.
    - **Dr. Hensel** said that would be for a really good panel. In reality, he said it would be more 5-8%. He asked what our charging efficiency would be.
    - **Bill** said 90% charging efficiency.
    - **Dr. Hensel** asked what would our discharge efficiency from battery to customer be. He guessed at 95%.
    - **Steve** said that it would be a loss with conditioning and transfer across cable.
    - **Dr. Hensel** said that the efficiency would be 95% -> 90% -> 8% and asked what the incoming solar radiation is at that altitude.
    - **Dr. Patru** replied about 1000 Watts/Square Meter.
    - **Dr. Hensel** asked how many square meters we would need and how many panels will be incident to the sun. He also asked if we have an active pointing system to keep the panels pointed toward the sun.
    - **Dr. Hensel** asked us about this order of analysis calculation and is concerned because we don't have any. He suggested that we estimate it right now.
        - **Dr. Hensel** asked how many Watts out of a square meter at 5% efficiency?
            - 1000 * 0.05 = 50 W per sq. meter
        - **Dr. Hensel** said that 90% of that will be stored into the battery (~45 Watts). He said that we lose another 5% from battery to payload. There would be 42 Watts potentially out of our system for 10 hours assuming that this is perfectly pointed at the sun for 10 hours. We would result in 400 Watt-hours.
        - **Dr. Hensel** added that 3 W * 24 = 72 Watt-hours and that a 1 square meter panel is about 6 times what we need.

    - **Steve** mentioned that we're looking at size and weight of solar panels.
    - **Dr. Patru** said that this shows we can build this thing. Before we did this calculation, we didn't know how much solar panel power we would need. We should know this and it should be included in system design.
    - **Dr. Hensel** said that this calculation is for the total presented surface and not all sides will be productive at the same time. He said that this gives us some grounding for future intuition. He said that we need a feeling of how the system is together.
- **Mike** talked about the communication standards.
- **Gordon** asked about the immunity to noise.
    - **Mike** said that RS-485 is more immune to noise because it uses differential signalling.
- **Dr. Hensel** asked about the speed of RS-232 versus RS-485 and that both should be adequate for our needs.
- **Dr. Patru** said that one standard not mentioned was CAN bus which is widely used in industrial applications and very noise immune.
- **Dr. Hensel** said that some communication protocols are supported by the microcontroller and those will simplify the overall system. He said that there are many benefits to keeping it on-chip if it is good enough.
- **Mike** explained the microcontroller selection.
- **Dr. Patru** mentioned the environmental tolerance and asked what was the criteria used.
    - **Mike** said -40 C to 80/85 C.
- **Gordon** asked if the customer knows about the microcontroller and communication standard selection since they have to interface with it.
    - **Mike** said they do.
- **Donny** talked about the concepts overview.

System Block Diagram

15:47 - 16:00

- **Steve** talked about the high level system diagram.
- **Steve** noted concerns about heating being only conduction.
- **Dr. Hensel** asked only conduction.
    - **Donny** mentioned radiation as well.
    - **Dr. Hensel** said that radiation can be both a pro and a con.
- **Dr. Hensel** said that many projects try to vent excess heat. He asked if we considered harvesting this energy.
    - **Bill** mentioned that we looked into Peltier devices as a heater/cooler but as an energy harvester as well.
- **Dr. Hensel** asked what is going to be the toughest tradeoff in our system. What are we most worried about?
    - **Steve** said that our temperature environment and pressure effects on components and battery chemistry is our biggest concern.
    - **Jake** summarized that environmental concerns are our biggest concern.
    - **Donny** added that this is our biggest uncertainty.

    - **Dr. Hensel** asked what we were going to do to mitigate that.
        - **Donny** said that we're going to look at what's been done and see what other people have done in the same environment.
        - **Jake** added that our customers work at SpaceX.
        - **Dr. Hensel** said that this data should be available from NASA. He added that at his old school, he operated a HAB facility and they had large data packages. He asked if we had been looking at space journals.
        - **Steve** added that we've been looking at components and if they could survive the trip and that we are going to look at NASA more.
        - **Dr. Hensel** said that there have been some projects within RIT. He asked if they recorded data.
- **Dr. Patru** said that designing to our current constraints should be sufficient.
- **Gordon** said that the solar and regulation blocks are considerably simplified at this stage. He imagines that these will get considerably more complex and that we define the complexity of our system. He asked how we will set up MPPS and will they be summed into power storage?
    - **Dr. Patru** said this points back to what **Dr. Hensel** had us do on the board. He asked how much active material do we need. Each panel design will be repetitive and redundant once we figure it out.
- **Mark Smith** asked about the integrity as it returns to Earth.
    - **Donny** said that, in our specs, the panels aren't expected to survive.
    - **Gordon** asked if the customer payload will be expected to sink or float.
        - **Donny** said that this is up to the customer.

Work Breakdown Structure

16:00 - 16:05

- **Jake** talked about the Work Breakdown Structure. He added that this is not a flowchart.
- **Dr. Patru** said that we need to come up with fault models for each subsystem.
    - **Jake** said that most of the faults will come down to the microcontroller.
    - **Dr. Patru** said that the electronics and firmware need to work together. He added the idea of using the microcontroller's internal temperature to shutdown or sleep the microcontroller if it gets too hot to save the transistors.

Project Plan

16:05 - 16:06

- **Bill** described the project plan. He mentioned that the msot up-to-date project plan has linked tasks and will be uploaded to EDGE shortly.

Risk Management

16:06 - 16:10

- **Donny** talked about risk management and talked about what risks (adverse weather) we've come into contact with today.
- **Donny** asked if they have any suggestions for risks.
    - **Dr. Hensel** asked what are we most nervous about earlier and why it wasn't listed here. He said we should be actively managing the document and the intent is to keep our eyes on what is most important. He said we should add environmental concerns to the risk management document.

High Level Software Flowchart

16:10 - 16:20

- **Mike** described the software flowchart.
- **Gordon** asked for a rough guess on how often the payload would request the status so that we could use it in our power budget.
- **Dr. Patru** said that we should double check the power profile of the main payload and said that a timing diagram would also be useful. He also asked if the payload assumes that it has its own battery and does it store this energy or use it directly.
    - **Jake** said that we planned this for immediate use and that we recommend that the payload have a non-rechargeable emergency backup battery.
- Meeting ends at 16:20

Post-SDR Discussion

16:20 -

- **Jake** asked if the group had seen the changes since Tuesday's Pre-SDR and if there anything that they want to comment on.
- **Dr. Patru** commented on the efficiency equation and that he's seen it so many times he knew the project was feasible.
- **Leo** told us to look at the efficiency spreadsheet again.
- **Dr. Patru** said that we need to think of a form factor quite quickly so that **Donny** can begin work on the structure. He is still worried about outgassing since our components won't be military grade. He also suggested that we pressurize the enclosure for 7 days and see if it stays pressurized.
- **Leo** asked **Dr. Patru** if he is recommending pressurizing the container at say 10 atmospheres and letting it dissipate over time.
- **Vince** suggested that **Donny** build in some desiccant material to the inside of the enclosure.
- **Dr. Patru** suggested that we will probably need radiator fins.
- **Leo** asked if METEOR has a lessons learned website.
    - **Dr. Patru** said that they have a website but METEOR's sensor data didn't always work reliably.
- **Dr. Patru** asked if RITCHIE-1 collected temperatures.
    - **Jake** explained the issues encountered.

- **Leo** asked if our module needs to look at external temperature if the payload is also looking at external temperature.
- **Bill** asked about radiation and hot/cold. If we pressurize, we have convection. If we don't, we only have radiation and conduction.
    - We could take heat from the sun and radiate it on the other side of the enclosure.