R7018R HT2017

Assignment 6: Design of OBDH for satellite

Indtroduction and goal

You will design the TT&C and OBDH system for a scientific satellite. For simplicity you may assume that the AOCS tasks are performed by a separate computer. The OBDH system only need to communicate with this system.

The goal is that you shall show an ability to design, analyze and critically evaluate different technical solutions for the data handling system for a given simplified mission case. The assignment is also intending to give you an overview over the system and its functionality, standards, subsystems and components included in today's systems as ”state of the art”.

Specification.

The satellite is a European project, and will be in a polar, circular orbit (~800km). The Mission Control Center as well as the ground station is situated in Kiruna. The satellite will have around 10 minutes of good contact with the ground station at passage. The satellite has around 14 orbits in 24 hours and a ground coverage temporal resolution of approximately 7 days (i.e. it will see the same place every seventh day). Attitude and orbit correction (+-10m) will be performed every fortnight. The satellite is three-axis stabilized. The life time is estimated to three years. A larger follower hosting more instruments is planned.

The payload consists of 6 instruments:

- **Mimmi**
  Mimmi is an instrument taking images of Earths surface. The concept for the instrument is new. During the test the main purpose is to take images over some areas where in-situ measurements can be performed at the same time. Every measurement series over such an area will give 5 x10^6 samples, each with 12-bits resolution. The instrument status is held in 10 different 8bit status bytes that may be read one at a time. The instrument has 5 modes. Each mode may need some uploaded parameters.

- **Musse**
  Musse can operate in three science modes. Typically each mode is held during a couple of days. Each mode needs 128 bytes of data from ground. One of the modes may need information from the GPS system hosted in the AOCS system. This is only done on demand from Musse. The GPS data is delivered from the AOCS in the NMEA standard. The raw data from the instrument consists of 4 measurements sampled at a rate of 12 Hz, with 12 bits of resolution.

- **Kajsa**
  Kajsa is a very simple instrument, controlled through 3 signals, and depending on signal it will perform a measurement with a resolution of 16 bits. How often and when these measurements are performed is determined from ground, but the maximum sampling rate is 1 Hz.

- **Kalle,Piff och Puff**
  are three instrument that may work separately or in combination in common measurement series in a number of combinations. The modes are controlled from ground. The three instruments shall in some modes exchange data, and the intermediate results may control the following measurement sequence. How this is performed and the amount of data that shall be exchanged is to some extent controlled from ground. The measurement series may also be combined with control of 5 mechanisms on the satellite. The status of the mechanisms are monitored by analog signals.

The system shall also monitor the following housekeeping-signals:

- 50 temperature measurements (8 bits).
- 10 voltage measurements on the power bus
- 20 currents
- 8 pressure
- 43 single status bits at 0.02 Hz sampling rate, plus some re-reads (#8) of digital 8 bit control registers that shall be read when they are changed.

Assume reasonable sampling rates and resolutions on house-keeping signals where this is not specified

Commands for the platform

The system must respond to direct ground control commands to control a couple of tasks through pulse commanding. Also, a couple of standard output signals are directly commanded from ground, or as a response to the status of the satellite. Some are analog; some are for transmitter and receiver, some for controllable amplifiers etc.

Your task

Form groups of four students. You shall design a system handling telecommands from ground and relaying them to the correct user (payload or subsystem). Your OBDH system shall also respond to some commands itself. Your system shall gather data from the payload, as well as housekeeping data and send this to ground through telemetry. You shall give a suggestion on the telemetry telecommand standard (what PUS shall be delivered for example). You shall make an approximate calculation on the uplink/downlink data rate. The RF part of your system is NOT part of this task. The system shall be a packet system. It shall as a minimum be correcting for single bit error.

You shall include a discussion on the different modes for the satellite, and if applicable a mapping to the instrument modes.

The telecommand part includes to decide upon the delivered service (PUS) and you should at least to some extent try to decide upon commands and subcommands for some instrument

The commands may be open, but you must have a security for non-authorized commanding to the satellite.

Hardware: You shall as far as possible map the functionality to the included hardware components. You do not need to have the same “level of abstraction” throughout the system. If you have a special interest you may dig deeper into some part, *BUT it should be clear from the report that this part is covered in more detail (at another abstraction level).*

Since you cannot calculate the size or the execution performance of the tasks you do noy need to calculate the program memory or verify the execution capacity. But try to discuss if there are some critical part putting special demands on the software.

The system shall be reprogrammable to some extent from ground in order to correct for errors or to meet unforeseen events.

Your design should
- have very small mass
- extremely low power
- be very cheap
- be very small
- have very short development period
- withstand all sorts thermal, mechanical and electrical loads
- be 100% reliable
- be extremely simple to test and

integrate etc, etc

All these requirement cannot be met at the same time so you must discuss and prioritize among the demands regarding the complete system and subsystems. Include the discussion in your report. The discussion may include why a functionality is implemented in software or hardware, why is centralized or distributed etc.

Report

One **oral** report per group (of four students). The report shall include functional blocks (diagrams), implementation of the functionality (mapping to hardware). TT&C standard. Uplink/downlink data rate calculations. Your main task is to *motivate* your choices.

One written report per group

If you think you need more information you may contact the lecturer (representing the “contractor)”

Good Luck!