STUDENTS' SPACE ASSOCIATION

THE FACULTY OF POWER AND AERONAUTICAL ENGINEERING
WARSAW UNIVERSITY OF TECHNOLOGY

PW-SAT2

PRELIMINARY REQUIREMENTS REVIEW

Mission Analysis

Phase A of the PW-Sat2 project

1.0 EN

pw-sat.pl

2014-05-08

Abstract

The following paper is a part of Phase A summary of student satellite project PW-Sat2. This part describes the tasks of Mission Analysis team.

The document is published as a part of:

PW-Sat2 – Preliminary Requirements Review

REVISIONS

Version	Date	Changes	Responsible
0.1	2014-03-21	First edition of the document in Polish	Artur Łukasik
1.0 PL	2014-04-07	Editing	Dominik Roszkowski
1.0 EN	2014-05-08	English edition	Artur Łukasik Dominik Roszkowski
1.0.1 EN	2014-07-02	Small editorial changes	Dominik Roszkowski

This document is also available in Polish.

TABLE OF CONTENTS

LIST OF TABLES

1 TEAM OBJECTIVES

The tasks of the Mission Analysis mission are:

1. Finding a way to launch the satellite into orbit
2. Mission and orbit analysis in Mission Analysis software
   - 2.1. Contact with software distributors
   - 2.2. Organization of training mission analysis software
   - 2.3. Mission modelling
     - 2.3.1. Modelling of solar panels' exposure to light
     - 2.3.2. Modelling of communication session with ground station
     - 2.3.3. Calculation of suitable time to test sun sensor
3. Implementation a of detailed mission plan
4. Preparation of the satellite operators' team (OPER)
   - 4.1. Radio amateur training organization
   - 4.2. Obtaining of radio amateur licenses
   - 4.3. Process mission plan to a set of telecommands
   - 4.4. Develop contingency plans for emergency response of individual sub-systems
5. Risk analysis for satellite mission

2 WORK PROGRESS

2.1 CURRENT ACTIVITIES

1. Looking for launch opportunity [see Table 3-1]
2. Looking for educational licenses of mission analysis software.

2.2 ACTIVITIES PLANNED FOR PHASE B

1. Acquisition of educational licenses for mission analysis software
2. (Alternatively) Feasibility study of team's own simulation software creation
3. Internal team trainings of new software
4. Conducting analyses mention in "Use of mission analysis software for PW-Sat2" document.
5. Preparation of preliminary mission plan
6. Maintaining contact with launch providers, possible launch opportunities list updates
7. Looking for 1U CubeSat teams willing to share launch with PW-Sat2
8. Radioamateur trainings for future satellite operators (OPER team)
9. Negotiations with Nicolaus Copernicus Astronomical Center for operators internships in BRITE-PL ground station

2.3 LOOKING FOR LAUNCH PROVIDERS

For the purpose of making the choice of the most suitable offer the following priorities were set:

1. Possibility to communicate with satellite from Poland during the day
2. Cost
3. Additional services included in the price (such as tests, legal assistance)
4. Reliability of the rocket

3 LAUNCH OFFERS FOR A CUBESAT 2U TYPE SATELLITE (2,6KG; 100X100X217MM)

Table 3-1 Launch providers' offers

Company	Rocket	Country	Possible orbits	Possible launch dates	P-Pod	Tests	Included in price	Price
Alcantara Cyclone Space / Gauss	Cyclone 4	Ukraine + Brazil / Italy	Sun-synchronous orbit (SSO) 700km	4Q 2015	Not included	Ground test included – integration and ejection tests.	• 4 meetings: o Kick off o Preliminary Design Review o Interface Control Document o Preparation & Ground tests • translations • customs/export help • assistance on cosmodrome	80 000 €
ISILaunch	Dnepr, PSLV, LM, Soyuz	Netherland	Various, some SSO	2015-2016	ISIPOD included in price	Qualification tests included	• Documentation assistance • "Interface meeting" • customs/export help	120-145 000 €
Nanoracks	Progress, ATV, HTC, Dragon, Cygnus	USA	ISS orbit	Any –about 9 months after the decision	Included	Safety, vibration and vacuum test. Documentation.	• Tests, launch assistance	136 000 €

Spaceflight services	Falcon 9, Soyuz	USA	• SSO (450-550 / 600-830 / 500-600) • HEO (1500 x 39000) • LEO (400 / 500 x 27000) • From decision to launch: o Russian 2-1.5 yrs. o Falcon 9: 2-1.5 yrs. o ISS – 1 yr.	2nd half of 2015 – 1st half of 2016	Included in price	Not included in price	• Help with passing the requirements. • Certification for the rocket providers and safety tests. • Integration on a rocket • P-Pod • Visa help	< 185 000 €
Spaceflight services	ISS	USA	ISS orbit	x	x	As above	As above	126 000 €
United Start Launch	Start1	USA	SSO 500 km (10:30am) / 400-500 i=70-90deg	2015 / 2015-2018	?	Not included	• Documentation assistance • customs/export help	90000€ (up to 2 kg)
Arianespace	Vega / Soyuz	France	No details at the moment (last contact in March 2014)					
JAMSS	HTV ?	Japan	Do not have a schedule for 2015 yet. (last contact in March 2014)					

CGWIC	LM-2D	China	SSO 600 km	3Q 2015	Not included in price	Cosmodrome tests laboratory: • cosmodrome tests • integration with the P-Pod and rocket	• Interface meeting • Integration with rocket • Ejection tests • Visa assistance • Travel and accommodation	150 000 €
EADS Astrium	*No details*	ESA	ISS Orbit	*No details*	Standard service			180 000 €
Kosmotras	Dnepr	Russia	No offer for CubeSats					

4 ESTIMATED MANPOWER REQUIRED

No.	Task	Required amount of work
2.2.1	Acquisition of educational licenses for mission analysis software	4h (1 person.) (altogether) + waiting time up to 2 months
2.2.2	Alternatively -feasibility study of team's own simulation software creation	2h/ week (3 persons) (2 months)
2.2.3	Internal team trainings of new software	4h/ week (3 persons) (1 months)
2.2.4	Conducting analyses mention in "Use of mission analysis software for PW-Sat2" document	4h/ week (3 persons) (2 months)
2.2.5	Preparation of preliminary mission plan	4h/ week (3 persons) (2 weeks)
2.2.6	Maintaining contact with launch providers, possible launch opportunities list updates	0,5h/ week (1 person) (continuous task)
2.2.8	Looking for 1U CubeSat teams willing to share launch with PW-Sat2	0,5h/ week (1 person) (continuous task)
2.2.9	Radioamateur trainings for future satellite operators (OPER team)	1h/ week (1 person) (1 month)
2.2.10	Negotiations with Nicolaus Copernicus Astronomical Center for operators internships in BRITE-PL ground station	1h/week (1 person) (2 months)

Table 4-1 Estimated required amount of time and work for main tasks

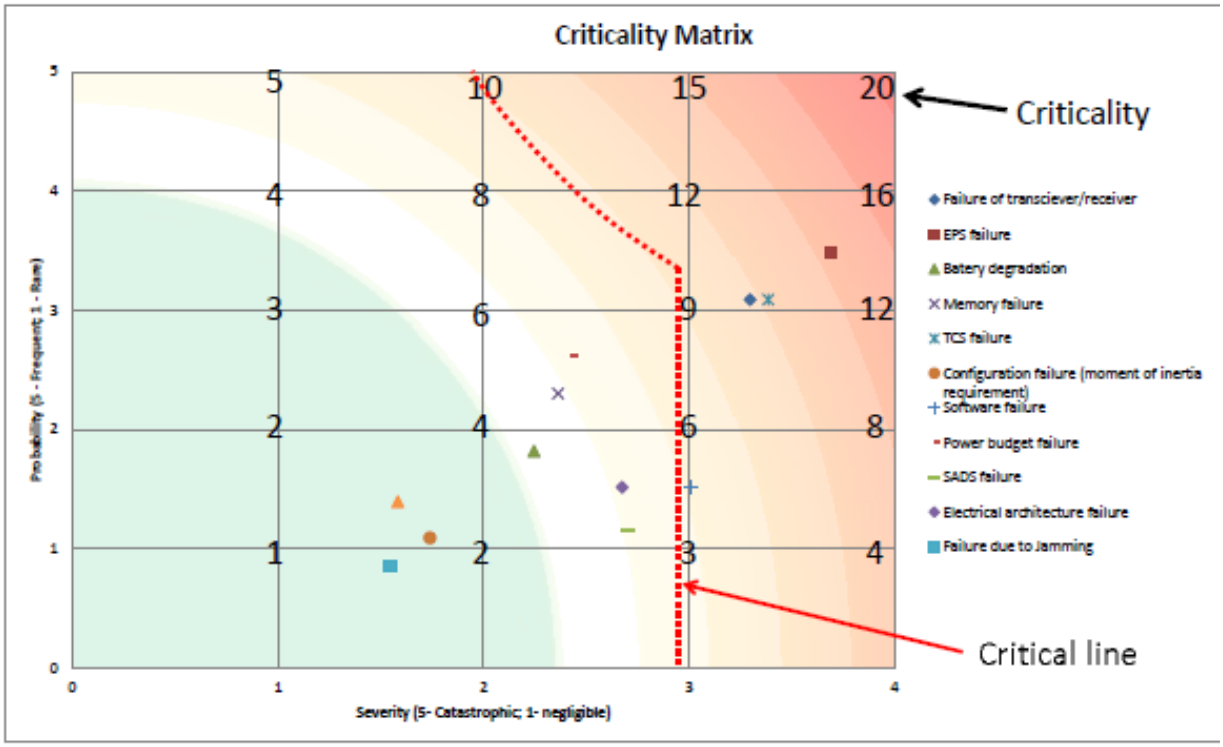
Altogether it is estimated that there will be four people needed for the Mission Analysis team: coordinator and 3 people responsible for analyses. Assuming that team will have appropriate software available in two months, since then 3 people will have to work approx. 4hrs a week for 4 months to complete tasks planned for phase B.

In case that software will not be available, it would be necessary to create this kind of simulator (for example based on available open-source software). For this task, team would need 5 people with at least one of them specialized in Information Technology.

During the negotiations with software companies, MA team is already investigating feasibility of the idea of creating new software to prepare for this possibility.

5 RISK ANALYSIS FOR MISSION

Work on risk analysis for satellite project is conducted in cooperation with faculty's employees within the framework of the thesis. The team made the initial identification and analysis of possible adverse events during the project. In a preliminary study team obtained a risk matrix:



Currently, it is planned to make the initial risk analysis more detailed, taking into account changes made in the project since its creation. It is planned to compare the results with the available databases of student satellite missions and others nano- and micro-satellite missions. The ultimate goal of risk analysis is to define areas that require special care or redundancy systems to ensure the success of the mission.