Delft University of Technology

# Laser Swarm

Project Plan

Design Synthesis Exercise

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**Abstract**

The project plan provides an overview of the project management of group N13. This document contains the work flow, work breakdown and HR (Human Resource) management structures as well as the time planning involved in assessing the feasibility of using a swarm of satellites for laser altimetry.

# Contents

# Chapter 1

# General Summary

## 1.1 Introduction

The goal of this Design Synthesis Exercise is to design a constellation of satellites, consisting of one low-power LiDAR emitter and several photon counting receivers. Existing system mainly consist of single platforms, which are too large and too expensive, and require very precise and powerful instruments to acquire any form of useful data. The purpose of this project is to asses the possibility of reducing operational and manufacturing costs of satellite laser altimetry as well as increasing the accuracy of the processed data.

As part of the DSE, the primary goal of the project planning document is to describe the tasks and allocation of resources of the project group in the proper context. Through the use of appropriate System Engineering and Project Management concepts, a detailed plan is established.

The rest of this chapter will describe the project in general and specify the requirements of the system. The following chapter contains the Project Management information such as the Work Flow Diagrams, Work Breakdown Structure, human resource information and time allocation breakdown.

## 1.2 Mission Need Statement

Demonstrate that a satellite constellation, consisting of a single emitter and several receivers, would perform better (in terms of cost, lifetime and results) than existing systems.

## 1.3 Project Objective Statement

To design a satellite constellation of a single LiDAR emitter and a swarm of receivers, with a team of 10 people. Verify the results using an advanced simulation.

## 1.4 Requirements

In this section a short overview is given of the requirements for the mission. The system is based on a single nadir-pointing low-power LIght Detection And Ranging (LiDAR) emitter satellite with a swarm of receiver satellites in the vicinity of the emitter. The low power of the laser signal the receivers need to point to the point the laser signal is reflected. The photon detection performance of the system needs to be better than the performance of a comparable system with a single receiver on the same satellite as the transmitter.

## 1.5 System Description

The system under consideration for this project consits of a single LiDAR emitter satellite surrounded by a swarm of receivers. This system may replace the current system of bulky high energy lasers with large receiver telescopes. Contrary to that system the swarm uses a high frequency low energy laser combined with lot of small, very sensitive receivers in an orbit near the emitter. The receivers have to be able to distinguish up to single photons that reflect back from the Earth surface. With this data obtained from the swarm the topology of the scanned area is reconstructed.

# Chapter 2

# Technical Design Development

## 2.1 Work Flow Diagram

The work flow diagrams

## 2.2 Work Breakdown Structure

The work breakdown

## 2.3 Project Approach Description

The DSE project is approached by first establishing specific roles for the group members. Every group member has a clearly defined management and technical function. Then, group operational procedures are defined. They are as follows:

1. The Chairman will lead a scrum meeting every morning upon arrival of all members to establish what everyone has done the day before and what they will be doing the day of the meeting. This is done in order to keep all members up-to-date with all aspects of the project. The meeting concludes with updates on any external communications (with organizations and teaching staff) as well as any other points relevant at that point.
2. Whenever relevant, groups responsible for certain design tasks should present their results to the rest of the group.
3. A meeting with the tutor and coaches is held every week and before important deliverables.
4. Upon completion of a deliverable, a meeting is booked to establish a plan for the next deliverable.

The official start of the DSE project is marked with the establishment of the Mission Need Statement. At this point all members should be aware of what is the main goal of the assignment.

The design process is started by defining the tasks, requirements and functions. From the requirements, a set of design options will be created before the Mid Term Review (MTR) and based on an extensive functional and risk assessment a trade-off will be made. After the MTR, work on detailed design can begin. At this stage all subsystems will be given a careful consideration in terms of budgets. Final decisions of detail choices will be made. Leading up to the Final Review (FR), the feasibility study can be concluded based on earlier decisions.

Parallel to the design phase, the simulator software will be developed by a team of 3 to 4 people (depending on the timeframe). This software should be able to perform accurate enough calculation to aid the trade-off made before the MTR.

## 2.4 Organizational Breakdown Structure

The org breakdown

## 2.5 Timeline

The timeline and Gantt

## 2.6 Risk management plan

This chapter contains the risk management plan. First the possible risks are identified and in the next section they are prioritised. In the next and final section ways to reduce probility of the highest priority risks are derived. This last section will show contingency plans in case things do go wrong.

### 2.6.1 Risk identification

This section contains a list of possible management risks.

1. Fail to make the deadline for the project plan
2. Fail to make the deadline for the baseline report
3. Fail to make the deadline for the mid-term report
4. Fail to make the deadline for the final report
5. Fail to make the deadline for the symposium
6. Simulation is delayed

7. A task on the gannt chart (e.g. 3.1.1) is not finished on time
8. Several tasks are not completed on time
9. Team member is late
10. Absence of a team member
11. Unscheduled absence of the tutor or coaches
12. External emergency, e.g. fire/power outage/hostage situation
13. Someone is unable to properly perform his management fucntion designated in the organogram

### 2.6.2 Risk prioritisation

The risks will be assigned a probility and impact to determine the highest risks. The numbers in the list correspond to the numbers in the previous section.

1. The impact is severe, because the deadlines are set by the DSE organization. The probability of occurence is low, it would be negligble but it is a large project with a lot of work to complete in just 10 weeks.
2. The impact and probability of this point is the same as for the first.
3. The impact and probability of this point is the same as for the first.
4. The impact and probability of this point is the same as for the first.
5. The impact of not making this deadline is severe because a lot of people will be dissapointed. The probability of occurence is neglible, as six days are available to make the presentation.
6. The impact of this event is high, as the simulation is required on several occasions like the trade-off and the final report. The probability of occurence is low as 3 people are working the whole time.
7. The impact is medium because some tasks are required before another can be started. The probability of occurence is medium, because of the strict schedule.
8. The impact is severe because people will have to be pulled from their own tasks for an extended period of time. The probability of occurence is low, this is because of the previous item because if one task is delayed it is possible others are as well.
9. The impact is low as it may be possible for the team member to catch up on the same day. The probability of occurence is medium because it is possible for someone to, for example, miss his train.
10. The impact is high because that means someone else will have to do the work of the absent team member. The probability of occurence is neglible, it is unlikily to happen for a member to becomen sick. Other reasons should not play a roll.

| probality of ocurrence | | negligible | low | medium | high |
|---|---|---|---|---|---|
| | severe | 5,12 | 1,2,3,4,8 | | |
| | high | 10 | 6,13 | | |
| consequences | medium | | | 7 | |
| | low | 11 | | 9 | |
| | neglibible | | | | |

Table 2.1: Risk management matrix

11. The impact is low as other people can be asked instead. The probability of occurence is neglible, absence will be announced ahead of time. Illness is as unlikely as for the team members.

12. The impact is severe as it will most likely mean at least a day will be missed, in the worst case all our possessions or work are lost. The probability of occurence is neglible.

13. The impact is high as it can seriously degrade the report. The probability of occurence is low, as the assigned tasks are taken seriously.

As can be seen in -2.1 casesn1,2,3,4 and 8 are the highest risk cases along with 6,13 and 7.

### 2.6.3 Risk reduction and contigency plans

These risks can be reduced by striclty enforcing the measurement plan set up during the first week and at the beginning of the period where the mid-term report has to be made. For 13 the only thing that can be done to reduce the probability is to check whether the functions are performed properly during the exercise.

In case things do go wrong on points 6 to 8 the most obvious thing to do is to continue working into the evening to finish the job. Though it may also be possible to reassign people to another task if possible. Cases 1 to 4 are fixed deadlines, if they are not made then a penalty will be placed on the report, the only thing possible is to finish the report as soon as possible so there is as little delay as possible for the next. If case 13 is detected the person has to be pointed to his error or errors and if that does not work a replacement has to be found.

# Chapter 3

# Approach with respect to sustainable development