# Project plan

# Search and Rescue - Underwater

Version 1.0

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**Status**

| | | |
|---|---|---|
| Reviewed | - | - |
| Approved | - | - |

## Project Identity

| | |
|---|---|
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## Group Members

| **Name** | **Responsibility** | **E-mail** |
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| David Andersson (DA) | Head of documentation | davan957@student.liu.se |
| Hampus Frick (HF) | Project leader | hamfr643@student.liu.se |
| Isac Lundin (IL) | Head of hardware | isalu162@student.liu.se |
| Ken Dahl (KD) | Head of software | kenda091@student.liu.se |
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| Oskar Philipsson (OP) | Head of design | oskph717@student.liu.se |

## Document History

| Version | Date | Changes made | Sign | Reviewer |
|---|---|---|---|---|
| 0.1 | 2022-09-16 | First draft. | DA, AR, HF, IL, KD, OH, OP | DA |
| 0.2 | 2022-09-24 | Second draft. | DA, AR, HF, IL, KD, OH, OP | DA |
| 1.0 | 2022-09-30 | First version. | DA, AR, HF, IL, KD, OH, OP | DA |

# Contents

# 1 Introduction and customer

The purpose of this document is to describe the plan of the project Search and Rescue Underwater in the course TSRT10, Reglerteknisk projektkurs, CDIO, given at Linköping University. The document describes the organization of the project, and how it will be executed.

## 1.1 Definitions

- UAS - Unmanned aircraft system, i.e., drone.
- GUI - Graphical user interface.
- ROS2 - Robot operating system.
- Session - The time span from which the UAS is turned on until the UAS is turned off.
- Mission - Contains all tasks produced by the task planner. Multiple missions can be executed in one session.
- UUV - Unmanned underwater vehicle.
- Emergency pinger - Transmitter of the emergency signal relayed by the UUV.
- Semi-autonomous mode - A mode where the user is coordinating where the UAS should go.

## 1.2 Background information

One of Saab Dynamics' largest departments designs UUV of various types. These are used for various tasks underwater, for example, inspecting infrastructure. When an UUV somehow gets stuck during a mission, an emergency pinger is activated to be able to find the UUV and retrieve it. You often then have to go out by boat and lowering hydrophones to find out where the emergency ping sound is coming from. In special environments, it can take a very long time to search an area. Therefore, instead of searching an area manually, an autonomous UAS can complete the task.

This project is part of a larger Search and Rescue project at Saab Dynamics which also include Search and Rescue Land.

## 1.3 Parties

In this project there are three parties involved. The customers, Andreas Gällström and Jonatan Olofsson at Saab Dynamics, the client Gustav Zetterqvist at Linköping University, three advisors, Daniel Bossér at Linköping University together with Philip Andersson and Erik Söderberg at Saab Dynamics and a project group working on the project. The members of the project group, their roles, and contact information can be found at the beginning of the document.

# 2 An overview of the project

In this section, an overall overview of the project will be given. The purpose and goal, along with the longtime goal for the larger Search and Rescue project, will first be stated. This will be followed by all the expected deliveries from the project group.

## 2.1 Purpose and goal

The goal of this project is to locate an UUV transmitting a distress signal from the bottom using a UAS equipped with a hydrophone. The UAS will need to fly out the hydrophone to well-chosen positions within a given area. After that, dip down the hydrophone and listen for the distress signal and locate the UUV. Part of the project is to process the signal chain of hydrophone data and filter out the emergency pinger's signal and choose some coordinates that streamline localization. The second part of the project is the control of the UAS with the weight and imbalance that comes with mounting the hydrophone. The UAS should be able to autonomously fly in a controlled manner to coordinates, descend the hydrophone into the water, process the data and raise the hydrophone again before flying on. To some extent this can be done in simulation, but a UAS should also be built to demonstrate a real operation.

As mentioned in the background information, the project is a part of the larger project Search and Rescue at Saab Dynamics, which has been developed over several years. The longtime goal is to create a system with cooperating crafts and vehicles with the aim of locating and rescuing those in distress both on land and in water environments.

## 2.2 Deliveries

All the expected deliveries from the project group during the project are stated in Table 1.

Table 1: Deliveries

| **Delivery** | **Tollgate** | **Date** |
|---|---|---|
| Time report | - | Every week |
| Status report | - | Every week |
| Presentation of the system | BP2 | 2022-09-21 |
| Requirement specification | BP2 | 2022-09-21 |
| Project plan | BP2 | 2022-09-21 |
| Time plan | BP2 | 2022-09-21 |
| Draft of design specification | BP2 | 2022-09-21 |
| Design specification | BP3 | 2022-10-06 |
| Test plan | BP3 | 2022-10-06 |
| First draft of a functioning simulation environment | BP4 | 2022-11-18 |
| Test protocol covering the simulation environment | BP4 | 2022-11-18 |
| All functionality | BP5 | 2022-12-07 |
| Test protocol | BP5 | 2022-12-07 |
| User manual | BP5 | 2022-12-07 |
| Presentation demonstrating that all requirements from the requirement specification are fulfilled | BP5 | 2022-12-07 |
| Technical report | BP6 | 2022-12-19 |
| After study | BP6 | 2022-12-19 |
| Poster presentation | BP6 | 2022-12-19 |
| Web page for the project | BP6 | 2022-12-19 |
| Demo film for publication | BP6 | 2022-12-19 |
| Installation guide | BP6 | 2022-12-19 |

# 3 Plan of the project phases

This project will be divided into three phases, *Start phase*, *During phase* and *After phase*. These phases are chosen according to the LIPS-model to create a clear framework of the main parts of the project.

## 3.1 Start phase

The *Start phase* will be dedicated mostly to plan the forthcoming tasks. A substantial part of this period will focus on understanding the task and to get acquainted with the associated theory. Decision points BP2 and BP3 will occur during this phase.

## 3.2 During phase

The main part of project will be executed in the *During phase*. The requirements decided in the document *Requirement Specification* will be explored further and implemented. Decision point BP4 will take place during this phase.

### 3.3 After phase

The last phase, the *After phase* will be focused on completing the project. This is done with a presentation and delivering of a user manual for instance. Decision points BP5 and BP6 will occur during this phase.

## 4 Organization plan

Section 1.3 describes who belongs to each party. Figure 1 illustrates the roles in the project's organization.

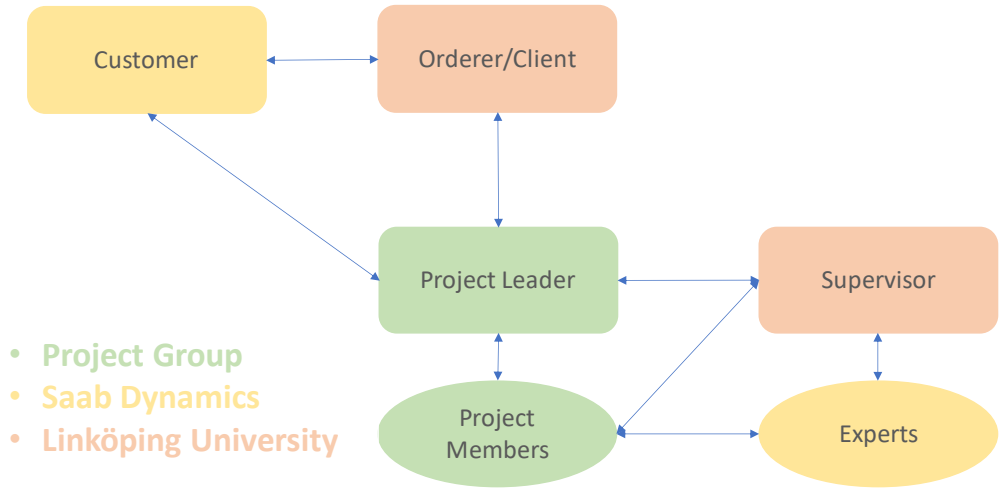


Figure 1: An Illustration of the Organization in the project. The color indicates to which party the role belongs.

### 4.1 The customer's organization

As seen in figure 1, the client is from Linköping University, whereas the customer is Saab Dynamic. Supervisor and Experts are provided by Linköping University and Saab Dynamics respectively.

### 4.2 Definition of work contents and responsibilities

Each project member has an area of responsibility. The following sections will describe each one of these areas.

#### 4.2.1 Project Leader

The project leader is responsible for leading the project and the main communication with the client. Another responsibility is to coordinate meetings.

### 4.2.2 Head of Design

Head of design is responsible for providing guidelines on how to implement the design. The guidelines should describe how to plan and coordinate the design of the product.

### 4.2.3 Head of Documentation

Head of documentation is responsible for all the documents. Ensures that the documents are finished in time, management of version history and that templates are available are some of the responsibilities. Another responsibility is to send in all documents to the designated receiver.

### 4.2.4 Head of Hardware

Head of hardware should ensure that the hardware is properly managed and working. Risk analyses should be done in order to ensure the quality. If a malfunction is detected in the hardware; head of hardware has the main responsibility to fix this.

### 4.2.5 Head of Software

Head of software is responsible over the quality of the code; that it's well-structured, commented and follows a high standard. Head of software is also responsible for the git-repository.

### 4.2.6 Head of Information

Head of information is responsible for designing the website and to structure presentations and videos.

### 4.2.7 Head of Testing

Head of testing is responsible for the various tests during the project. This includes planning, coordinating and evaluation of the tests.

# 5 Document plan

In this section, all documentation that the group has to provide is listed, together with their purpose and deadline.

Table 2: Documents to produce

| **Document** | **Purpose** | **Deadline** |
|---|---|---|
| Requirements specification | State the goals and requirements for the project. | BP2 |
| Project plan | Describe how the project is to be executed. | BP2 |
| Time plan | Show how much time each sub-task is estimated to take, and to be updated each week with the used time for each person in the group. | BP2 |
| Design specification | A description of the system and its subsystems in detail. | BP3 |
| Test plan | Describe how the testing will be performed. | BP3 |
| Test protocol | Describe the tests that have been performed and the outcome of the test. | BP5 |
| User manual | A guide for how to use the system. | BP5 |
| Technical report | A technical report of the system. | BP6 |
| After study | Evaluation of the project and project continuation. | BP6 |

# 6 Development methodology

The project will be divided into smaller teams, one for each component, where the work of each component will be split into smaller tasks. Alongside Lips, a Scrum-like agile planning methodology will be used in GitLab, where the code will be located as well, for smooth integration and transparent task assignment. Tasks assigned to a team or project member will not necessarily be fixed to the specific party. Instead, cooperation between team members and teams will be encouraged and, most likely, necessary.

# 7 Qualification plan

To ensure a high standard of the project, different strategies to deal with this have been established. These strategies are presented in this section.

## 7.1 Documentation

The documents will be written jointly in Overleaf. For each document that is to be submitted, one to two persons are responsible to read through the document before submission. Furthermore, the *Head of documentation* is over-all responsible for the quality of the documents.

## 7.2 Code & Functionality

Git will be used to ensure that code and software are shared and conflicts are easily handled. All members are responsible for writing comprehensible code, which is frequently commented. Automatic git-testing will be used to further ensure functionality. However, the *Head of software* is the final person responsible for the software.

# 8 Reporting plan

This section describes how the project's progress is going to be reported to the supervisor. It also includes what progress is to be delivered and how often.

## 8.1 Time report

The project leader should send a summarized time report to the supervisor each week. Each project member is responsible to report how much they have worked and what they worked on in an internal Excel sheet.

## 8.2 Status report

A status report of how the project is going and what everyone in the project group has done is to be updated each week and delivered by the project leader to the supervisor.

# 9 Resource plan

In this section, the resources available for the project are described.

## 9.1 Persons

The project will be executed by the project group consisting of seven members; two with a background from mechanical engineering and five with a background from applied physics and electrical engineering.

## 9.2 Material

The available material includes one UAS of the model "Holybro x500 v2", one hydrophone of model "AS-1 Hydrophone" connected to a 9 meters long cable, one sound card of model "Zoom F3 Field Recorder" - all provided by *Saab Dynamics*.

## 9.3 Workrooms

The project group has access to one office room at *Linköping university*, located in the B-building. One key to the room is provided as well. This room is shared with another project.

## 9.4 Economy

The project has around 240 working hours of work per student in the project group. All additional material is financed by Saab Dynamics, given their approval.

# 10 Milestones

To ensure the project is heading in the right direction, some milestones that are to be reached during the duration of the project are defined in this section and are listed in Table 3.

Table 3: The project milestones

| No | Description | Date |
|---|---|---|
| 1 | Hydrophone implemented in simulation environment | 2022-10-14 |
| 2 | UAS with hydrophone can be controlled | 2022-11-02 |
| 3 | Pinger signal can be detected in software | 2022-11-10 |
| 4 | Task planner works autonomously | 2022-11-11 |
| 5 | Pinger signal can be estimated in software | 2022-11-16 |
| 6 | Motion planner works autonomously | 2022-11-18 |
| 7 | User can send missions to UAS through GUI | 2022-11-25 |
| 8 | Drone can fly autonomously | 2022-12-02 |

# 11 Decision points

The LIPS model includes pre-decided decision points, which are described and listed in Table 4.

Table 4: The decision points of the project

| No | Description | Date |
|---|---|---|
| 2 | Verbal presentation of the project. Approval of requirement specification, project plan, and time plan. Draft of design specification. | 2022-09-21 |
| 3 | Approval of design specification and test plan. | 2022-10-6 |
| 4 | Draft of working simulation environment with pertaining test protocol. Decision regarding project continuation in simulation or expansion to hardware. | 2022-11-18 |
| 5 | All functionality implemented. Approval of test protocols and user manual. Demonstration of requirements. | 2022-12-07 |
| 6 | Approval of technical documentation, after study, web page, movie and installation guide. Presentation of poster. | 2022-12-19 |

# 12 Activities

In this chapter, all the identified activities in the project are listed in tables. Each activity has a reference number and a short description. Furthermore, all the other activities it depends on in order to be executed and the estimated time for the activity are also given. The activities are divided into subsections, depending on which part of the project they are associated to.

## 12.1 Documentation

The activities associated to documentation during the project are listed in Table 5.

Table 5: Documentation activities

| No | Activity | Description | Dependent of activity no | Estimated time[h] |
|---|---|---|---|---|
| 1 | Requirement specification | Work with the requirement specification document. | - | 42 |
| 2 | Project plan | Work with the project plan document. | - | 42 |
| 3 | Time plan | Work with the Time plan spreadsheet. | 1, 2 | 12 |
| 4 | Design specification | Work with the design specification document. | 1, 2, 3 | 119 |
| 5 | Test plan | Work with the test plan document. | 1, 4 | 18 |
| 6 | Test protocol | Work with the test protocol documents. | 5 | 28 |
| 7 | User manual | Work with the user manual document. | 8 | 28 |
| 8 | Technical documentation | Work with the technical documentation document. | 4 | 100 |
| 9 | Poster | Work with the poster document for the project conference. | 8 | 30 |
| 10 | After study | Work with the after study document. | 2, 3, 4, | 14 |
| 11 | Installation guide | Work with the installation guide document. | 8 | 28 |
| 12 | Time report | Fill in time report. Should be done once a week by all project members | 3 | 13 |
| 13 | Status report | Document the current status of the project work. Should be done once a week. | 3, 12 | 13 |
| 14 | Create a web page | Work with the creation of the project's web page. | 8 | 15 |
| 15 | Video editing | Work with a demo film of the project for publication. | 8 | 8 |

## 12.2 Meetings

The activities associated to meetings during the project are listed in Table 6.

Table 6: Meeting activities

| No | Activity | Description | Dependent of activity no | Estimated time[h] |
|---|---|---|---|---|
| 16 | Meetings with SAAB | Meetings with the customers and supervisors at Saab Dynamics. | - | 48 |
| 17 | Meetings with Daniel | Meetings with the supervisor Daniel Bossér at Linköping University. | - | 41 |
| 18 | Group meetings | Meetings with the project group. | - | 90 |

## 12.3 Hardware

The activities associated with the project's hardware are listed in Table 7.

Table 7: Hardware activities

| No | Activity | Description | Dependent of activity no | Estimated time[h] |
|---|---|---|---|---|
| 19 | Assembling sound card with hydrophone | Assemble the sound card with the hydrophone. | 4 | 3 |
| 20 | Assemble UAS | Assembling the UAS according to the manual. | 4 | 3 |
| 21 | Raspberry Pi setup and software installation. | Prepare the Raspberry Pi for the project. | 4 | 32 |
| 22 | Implement code from simulation in Raspberry Pi | Implementation of the code used in simulation environment. | 21, 31 | 38 |
| 23 | Testing of UAS | Manual testing of the UAS before used with simulation software. | 19, 20, 21, 22 | 24 |

## 12.4 Communication

The activities associated with meetings are listed in Table 8.

Table 8: Communication activities

| No | Activity | Description | Dependent of activity no | Estimated time[h] |
|---|---|---|---|---|
| 24 | Communication between sound card and Raspberry Pi | Make sure the sound card and the Raspberry Pi can send and receive information from one another. | 19, 21 | 38 |
| 25 | Communication between UAS and Raspberry Pi | Make sure the UAS and the Raspberry Pi can send and receive information from one another. | 20, 21 | 38 |
| 26 | Communication between laptop and Raspberry Pi | Make sure the laptop and the Raspberry Pi can send and receive information from one another. | 21 | 38 |
| 27 | Testing of communication | Test the communication between the components. | 24, 25, 26 | 12 |

## 12.5 Simulation

The activities associated to the simulation environment in the project are listed in Table 9.

Table 9: Simulation activities

| No | Activity | Description | Dependent of activity no | Estimated time[h] |
|---|---|---|---|---|
| 28 | Implement hydrophone physics | Implement the physics of the hydrophone connected to the UAS via a nine-meter-long cable in the simulation environment. | 39 | 30 |
| 29 | Autonomous control of UAS with hydrophone | Implement algorithm for autonomous control of the UAS with the connected hydrophone. | 28 | 32 |
| 30 | Task planning | Implement a working solution of the task planner in the simulation environment. | 41 | 30 |
| 31 | Motion planning | Implement a working solution of the motion planner in the simulation environment. | 42 | 30 |
| 32 | Testing of simulation | Test if the implementations in the simulation environment works as planned. | 28, 29, 30 | 22 |

## 12.6 External laptop

The activities associated with the external laptop are listed in Table 10.

Table 10: External laptop activities

| No | Activity | Description | Dependent of activity no | Estimated time[h] |
|---|---|---|---|---|
| 33 | Create a GUI | Create a GUI running on the external laptop. | - | 30 |
| 34 | Testing of laptop | Test the features implemented on the laptop. | 32 | 10 |

## 12.7 Signal Processing

The activities associated to signal processing in the project are listed in Table 11.

Table 11: Signal processing activities

| No | Activity | Description | Dependent of activity no | Estimated time[h] |
|---|---|---|---|---|
| 35 | Filtering the signal | Work on a solution for how to filter out the emergency signal from the UUV based on the collected data from the hydrophone. | 19, 21, 24, 26 | 28 |
| 36 | Signal detection | Detect the signal from the emergency pinger. | 35 | 36 |
| 37 | Signal estimation | Estimate the signal position from the emergency pinger. | 35 | 40 |
| 38 | Testing of signal processing | Test how well the developed solutions in activity 35,36 and 37 work. | 35, 36, 37 | 22 |

## 12.8 Education

The activities associated to education in the project are listed in Table 12.

Table 12: Education activities

| No | Activity | Description | Dependent of activity no | Estimated time[h] |
|---|---|---|---|---|
| 39 | ROS | Education in how to use Robot Operating System (ROS) in the project. | - | 34 |
| 40 | Signal processing | Educating in signal processing underwater. | - | 36 |
| 41 | Task planning algorithms | Education in how task planning algorithms can be used in the project. | - | 24 |
| 42 | Motion planning algorithms | Education in how motion planning algorithms can be used in the project. | - | 24 |
| 43 | Manual UAS maneuvering | Education in how to maneuver a UAS manually. | - | 42 |

## 12.9 Alternative tasks

The activities associated to alternative tasks in the project are listed in Table 13.

Table 13: Alternative task activities

| No | Activity | Description | Dependent of activity no | Estimated time[h] |
|---|---|---|---|---|
| 44 | Administration | Administration activities such as mailing, setting up meeting protocol and organizing. | - | 15 |
| 45 | General planning | General planning activities such as planning for group meetings and tests of the product. | - | 15 |
| 46 | Presentation | Prepare and hold presentations. This will mainly be topical at the end of the project when the group should present the implementation and the results of the project. | 8 | 56 |
| 47 | Buffer | Time that can be dispensed to make up for activities that have fallen behind schedule. | - | 181 |
| 48 | Lectures | Lectures in TSRT10 – Project Course. | - | 28 |

# 13 Timetable

The timetable for the project can be seen in appendix A, chapter 18.1.

# 14 Alteration plan

This section discusses possible sources of project plan alterations.

## 14.1 Covid-19

In writing, Covid-19 is no longer considered a public health hazard. In case the public health agency of Sweden (FHM) changes their recommendations, then the projects should follow the new recommendations.

## 14.2 Requirements

If the project group wants to change some requirements, this should be done through negotiations with the customer and supervisor.

## 14.3 Time plan

The time plan should be alternated according to how the project progresses and should be discussed with the customer and supervisors.

# 15 Risk analysis

A risk analysis was conducted, and the following risks were identified.

## 15.1 Project risks

A potential risk for the project not being completed on time is that a group member leaves and therefore decreases the time budget to the project. In that case, the requirements have to be renegotiated.

Other risks are damages to the hardware, for example crashing the UAS into the water. Therefore, the UAS and project member should follow the procedures under section 15.2.

## 15.2 Physical risks

There are several potential physical risks in the project. When flying the UAS, safety protocols and legal requirements should be followed to not damage either people or the hardware. Each mission should be simulated before attempted in the real world, especially when flying over water in order to avoid damaging the hardware.

Before the UAS is activated, every person in the vicinity of the UAS should be alerted and distance themselves from the UAS. This is so that the UAS's propellers cannot damage anyone. Nobody should ever stand directly underneath the UAS, in case it falls out of the air.

The UAS should have an emergency landing routine and when flying autonomously, an operator should always be able to take manual control of the UAS. The UAS should always be in line of sight when flown autonomously.

If the UAS's batteries are not charged properly, they could be a safety risk. Therefore, proper procedures should always be followed when charging batteries. Batteries should be charged under supervision or in Visionen's special battery charging cabinet and pouches.

When testing for real in Vättern, proper procedures should be followed regarding human water and ice safety.

# 16 Priorities

All the requirements that are stated in the requirement specification [1] has a priority order from 1 to 3. For this project, requirements with priority order 1 are to be first prioritized so that they are to be fulfilled to BP4. These requirements mostly focus on the simulations.
After that, requirements of priority order 2 to be prioritized, and they are to be fulfilled at BP5. These requirements also includes real use of the UAS and hardware.
Priority order 3 are then to be prioritized if time allows.

# 17 Project closing

The project will be considered closed when all documents listed in section 5 have been approved, a final presentation has been held and the product has been delivered to the customer. At this point, all hardware that has been supplied throughout the project will be given back to the customer.

# References

[1] Requirement specification. 2022-09-15.

# 18 Appendix

## 18.1 A. Timetable

**PLANNING**

| | | | |
|---|---|---|---|
| **Project:** | Search and Rescue - Underwater | | |
| **Project group:** | Search and Rescue - Underwater | **Date:** | **Reviewed:** |
| **Orderer:** | Gustav Zetterqvist | **Version:** 0.1 | |
| **Course:** | TSRT10 | **Issuer:** | |

| Nr | ACTIVITIES | TIME | WHO | TIME PLAN, week number | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Beskrivning | Hours | Initials | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | |
| | *Documentation/Deliveries* | 510 | | | | | | | | | | | | | | | | | | | |
| 1 | Requirement specification | 42 | All | | 14 | 14 | 14 | | | | | | | | | | | | | | 42 |
| 2 | Project plan | 42 | All | | | 28 | 14 | | | | | | | | | | | | | | 42 |
| 3 | Time plan | 12 | All | | | 6 | 6 | | | | | | | | | | | | | | 12 |
| 4 | Design specification | 119 | All | | | 28 | 35 | 28 | 28 | | | | | | | | | | | | 119 |
| 5 | Test plan | 18 | AR | | | | | 6 | 6 | 6 | | | | | | | | | | | 18 |
| 6 | Test protocol | 28 | AR | | | | | | | 3 | | | 3 | 4 | | | | 9 | 9 | | 28 |
| 7 | User manual | 28 | All | | | | | | | | | | | | | | | 10 | 18 | | 28 |
| 8 | Technical documentation | 100 | All | | | | | | | | | | | | | | 20 | 25 | 25 | 30 | 100 |
| 9 | Poster | 30 | All | | | | | | | | | | | | | | | | 20 | 10 | 30 |
| 10 | After study | 14 | All | | | | | | | | | | | | | | | | 7 | 7 | 14 |
| 11 | Installation guide | 28 | All | | | | | | | | | | | | | | | | 14 | 14 | 28 |
| 12 | Time report | 13 | DA, HF | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 |
| 13 | Status report | 13 | DA, HF | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 |
| 14 | Webpage | 15 | OH | | | | | | | | | | | | | | | 5 | 5 | 5 | 15 |
| 15 | Video | 8 | OH | | | | | | | | | | | | | | | | 4 | 4 | 8 |
| | *Meetings* | 179 | | | | | | | | | | | | | | | | | | | |
| 16 | Meetings with SAAB | 48 | All | | 6 | 7 | | 7 | | 7 | | | 7 | | 7 | | 7 | | | | 48 |
| 17 | Meetings with Daniel | 41 | All | | | 8 | 3 | 3 | 3 | 3 | | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 41 |
| 18 | Group meetings | 90 | All | | 6 | 7 | 7 | 7 | 7 | 7 | | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | | 90 |
| | *Hardware* | 100 | | | | | | | | | | | | | | | | | | | |
| 19 | Assemble soundcard with hydrophone | 3 | HF, AR, OP | | | | | 3 | | | | | | | | | | | | | 3 |
| 20 | Assemble UAS | 3 | DA, KD | | | | | 3 | | | | | | | | | | | | | 3 |
| 21 | Raspberry Pi setup and software installation | 32 | KD | | | | | | | | | | 14 | 18 | | | | | | | 32 |
| 22 | Implement code from simulation in Raspberry Pi | 38 | ALL | | | | | | | | | | | 14 | 14 | 10 | | | | | 38 |
| 23 | Testing of UAS | 24 | DA, KD | | | | | | | | | | | | | 12 | 12 | | | | 24 |
| | *Communication* | 128 | | | | | | | | | | | | | | | | | | | |
| 24 | Between sound card and Raspberry Pi | 38 | HF, AR, OP | | | | | | | | | | | 10 | 14 | 14 | | | | | 38 |
| 25 | Between UAS and Raspberry Pi | 38 | HF, AR, OP | | | | | | | | | | | 10 | 14 | 14 | | | | | 38 |
| 26 | Between laptop and Raspberry Pi | 38 | HF, AR, OP | | | | | | | | | | | | 10 | 14 | 14 | | | | 38 |
| 27 | Testing of communication | 12 | HF, AR, OP | | | | | | | | | | | | 4 | 4 | 4 | | | | 12 |
| | *Simulation* | 144 | | | | | | | | | | | | | | | | | | | |
| 28 | Implement hydrophone physics | 30 | HF, AR, OP | | | | | 10 | 10 | 10 | | | | | | | | | | | 30 |
| 29 | Autonomous control of UAS with hydrophone | 32 | DA, KD | | | | | | | 16 | | | 16 | | | | | | | | 32 |
| 30 | Task planning | 30 | IL, OH | | | | | | | 10 | | | 10 | 10 | | | | | | | 30 |
| 31 | Motion planning | 30 | DA, KD | | | | | | | | | | 10 | 10 | 10 | | | | | | 30 |
| 32 | Testing of simulation | 22 | AR | | | | | 4 | 4 | 4 | | | 4 | 4 | 2 | | | | | | 22 |
| | *External laptop* | 40 | | | | | | | | | | | | | | | | | | | |
| 33 | Create a GUI | 30 | KD | | | | | | | | | | | 10 | 10 | 10 | | | | | 30 |
| 34 | Testing of laptop | 10 | KD | | | | | | | | | | | | 5 | 5 | | | | | 10 |
| | *Signal processing* | 126 | | | | | | | | | | | | | | | | | | | |
| 35 | Filter the signal | 28 | HF, AR, OP | | | | | 14 | 14 | | | | | | | | | | | | 28 |
| 36 | Signal detection | 36 | HF, AR, OP | | | | | | 10 | 10 | | | 10 | 6 | | | | | | | 36 |
| 37 | Signal estimation | 40 | HF, AR, OP | | | | | | | 6 | | | 10 | 12 | 12 | | | | | | 40 |
| 38 | Testing of signal processing | 22 | HF, AR, OP | | | | | 2 | 4 | 4 | | | 4 | 4 | 4 | | | | | | 22 |
| | *Education* | 160 | | | | | | | | | | | | | | | | | | | |
| 39 | ROS | 34 | ALL | | | | | 14 | 10 | 10 | | | | | | | | | | | 34 |
| 40 | Signal processing | 36 | HF, AR, OP | | | | | 6 | 10 | 10 | | | 10 | | | | | | | | 36 |
| 41 | Task planning algorithms | 24 | IL, OH | | | | | | | 8 | | | 8 | 8 | | | | | | | 24 |
| 42 | Motion planning algorithms | 24 | DA, KD | | | | | | | | | | 8 | 8 | 8 | | | | | | 24 |
| 43 | Manual drone maneuvering | 42 | DA, KD | | | | | 7 | 7 | 14 | | | 14 | | | | | | | | 42 |
| | *Alternative tasks* | 295 | | | | | | | | | | | | | | | | | | | |
| 44 | Administration | 15 | ALL | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 15 |
| 45 | General planning | 15 | ALL | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 15 |
| 46 | Presentation | 56 | ALL | | | | | | | | | | | | | | | | 28 | 28 | 56 |
| 47 | Buffer | 181 | - | | 10 | 12 | 8 | 8 | 8 | 8 | | | 14 | 14 | 14 | 20 | 25 | 20 | 20 | | 181 |
| 48 | Lectures | 28 | ALL | 14 | 14 | | | | | | | | | | | | | | | | 28 |
| | *Milestones* | | | | | | | | | | | | | | | | | | | | |
| | Hydrophone implemented in simulation environment | | | | | | | | | fr | | | | | | | | | | | |
| | UAS with hydrophone can be controlled | | | | | | | | | | | | we | | | | | | | | |
| | Pinger signal can be detected in software | | | | | | | | | | | | | tu | | | | | | | |
| | Task planner works autonomously | | | | | | | | | | | | | fr | | | | | | | |
| | Pinger signal can be estimated in software | | | | | | | | | | | | | | we | | | | | | |
| | Motion planner works autonomously | | | | | | | | | | | | | | fr | | | | | | |
| | User can send missions to drone through GUI | | | | | | | | | | | | | | | fr | | | | | |
| | Drone can fly autonomously | | | | | | | | | | | | | | | | fr | | | | |
| | *Decision points* | | | | | | | | | | | | | | | | | | | | |
| | BP2 | | | | | | we | | | | | | | | | | | | | | |
| | BP3 | | | | | | | | thu | | | | | | | | | | | | |
| | BP4 | | | | | | | | | | | | | | | fr | | | | | |
| | BP5 | | | | | | | | | | | | | | | | | we | | | |
| | BP6 | | | | | | | | | | | | | | | | | | mo | | |
| | Sum hours: | 1680 | | 14 | 52 | 112 | 91 | 126 | 125 | 140 | 4 | 4 | 156 | 156 | 145 | 137 | 125 | 136 | 132 | 28 | 1680 |

Figure 2: Timetable.