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ESEIAAT

CleanOrbit: Laser-based Space Debris Deorbiter

(CO-LSDD)

Deliverable 2
Scope, Time and Cost Management

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1 Project scope statement

1.1 Product Scope Description

The aim of this project is to develop a ground-based laser system, to track and target unused satellites and other debris, so as to deorbit them safely. It will deal with equipment up to 1000 kg, which is located at orbits within a maximum altitude of 900 km, when required.

The expected outcome of this project, is a system capable of successfully deorbiting out-of-use equipment, so as to clean the lower orbits of the Earth (LEO) and contribute to safer and more sustainable space operations, thus leading to a paradigm shift.

The following sections describe in detail the project's requirements, along with the characteristics and technical specifications of the system.

1.1.1 Requirements

The project must fulfil a set of requirements in order to be considered successful. A differentiation between general requirements (coded as **R-GXX**) and technical (coded as **R-TXX**) has been considered.

In the matter of the project general requirements, the following aspects must be met:

R-G01: The project shall develop and balance 4 areas of technological interest: acquisition and tracking of the object to deorbit, illumination[1] of the targeted debris, analysis and clearance of the re-entry location and assurance of the laser clearing and tasking approval.

R-G02: The project shall reach a minimum Technology Readiness Level of TRL5 by the end of the project duration.

R-G03: The estimation of the overall duration of the project shall not exceed 4 years.

R-G04: The consortium shall be formed by a minimum of 3 independent partners from three Member States.

R-G05: According to the H2020 requirements, the budget contribution provided by the EU commission shall not exceed 2 million euros.

R-G06: The subcontracted activities shall not exceed 15% of the direct costs.

As regards the technical specifications the project must meet, these are:

R-T01: The debris-deorbiter system shall be based on a Laser Orbital Debris Removal (LODR) ground-based technology.

R-T02: The system shall be capable of slowing-down debris targets such that they are burnt up when re-entering the atmosphere.

R-T03: The LODR technology system shall be ground-based.

R-T04: The maximum re-targeting time of the LODR system shall be less than 1 minute in order to enable quick response against debris.

R-T05: The system shall be capable of removing small and large category objects. These are defined according to [1] as:

- Small debris: objects up to 0.75 kg and located at a maximum apogee of 700 km (LEO orbit). Minimum elevation of 30°.

[1] The process consisting in aiming and shooting with the laser at the debris target.

- Large debris: objects up to 1000 kg and located at a maximum apogee of 900 km (LEO orbit). Minimum elevation of 60°.

R-T06: The optical system shall use mirrors according to the following specifications:

- Mirrors up to 13 m of diameter to target small debris.
- Mirrors up to 25 m of diameter to target large debris.

R-T07: The technical solution developed shall be modular and capable of mounting different types of laser according to the characteristics of the debris target to be deorbited.

1.1.2 Technical specifications

In order to accomplish all the requirements described previously, both the product and service described trough this project must ensure the following characteristics:

Background

First of all, specific studies need to be done in the aim of ensure the technical solution.

- Preliminary design of the laser system based on Laser Orbital Debris Removal (LODR) technology, and its characteristics.
- A feasibility study that justifies the existence of a laser system of this characteristics at a cost that comply with the budget.

Technical Solution

A list of technical characteristics of the laser system is specified.

- Definition of configuration selection aiming on being optimal in different laser powers adapting to various densities and materials of space debris. Laser type will be pulsed-laser which will make plasma jets on the objects.
- The laser system designed in this project will be ground-based with a maximum re-targeting time of 1 minute in order to be fast-response.
- An analysis of the software required for tracking and its development by an specialized entity described in forward sections in order to automatize and monitoring the laser system and tracking the targets.
- The LODR system will be capable of removing objects up to 1000 kg at a maximum of 900 km of apogee (LEO orbit).
- The optical system shall use diverse mirrors which with be able to target large and small debris. Primary mirror may be of poor optical quality (reducing initial costs) because phase conjugation will correct for its distortions too. This concept should satisfy the basic requirements in terms of laser pulse delays, frequencies, and precise control of the pointing and signal tuning to compensate for the debris motion and Doppler shift.
- A prototype will be built in order to test and analyse the output data to ensure the correct behavior of the system.
- Implementation of technical documentation and maintenance protocol after testing the prototype.

In the following table, main characteristics for large and small debris that they must comply with are specified in order to be candidates for deorbiting.

Target parameters for large debris		**Optical parameters**	
Mass (kg)	1000	Wavelength (μm)	1.06
Areal mass density (kg/m^3)	820	Pulse length (ns)	10
Maximum Range (m)	1500	Mirror diameter D (m)	25
Maximum elevation (°)	60	Pulse energy (kJ)	140
Retargeting time (min)	1	Target spot size (m)	1.25
Number of interactions for reentry	135	Average optical power (kW)	370
Time to reentry one target (years)	3.7	Average interaction duration (s)	250
Targets addressed per day	167		

Table 1: Technical specifications: large debris.

Target parameters for small debris		**Optical parameters**	
Maximum mass (kg)	0.75	Wavelength (μm)	1.06
Areal mass density (kg/m^3)	10	Pulse length (ns)	5
Maximum Range (m)	1000	Active mirror diameter D (m)	15
Minimum permitted elevation (°)	30	Pulse energy (kJ)	7.3
Retargeting time (min)	1	Target spot size (m)	0.31
Number of targets accessible	100k	Average optical power (kW)	81
Time to reentry all targets (mo)	8.7	Average interaction duration (s)	100

Table 2: Technical specifications: small debris.

Although large debris would take 3.7 years to be deorbited (since massive objects cannot be directly leaded to a reentry trajectory) several large objects will be able to be pointed in one day.

Building a LODR system necessitates detection and tracking technology that enables location of targets with 1 meter of precision, far better than present practice. This capability will allow more accurate collision prediction.

1.2 Project Deliverables

The documents to be delivered throughout the project are listed in Table 3. Each deliverable is associated to a Work Package or task (see Section 2) by its identification code.

Note that the estimated due date of the deliverables is defined with respect to each year. In this way, T0 refers to the day in which the first kick-off took place and T1 to one year after T0. For instance, the Project charter will be delivered two months after the kick-off meeting, i.e., T0+2m, and the Technological Research, one year and three months after the kick off meeting (T1+3m).

Table 3: List of deliverables.

Code	Deliverable name	Description	Estimated due date
1.1.1	Project Charter	Document with the description of the core aspects of the project, such as the purpose, objectives, stakeholders, requirements, risks and internal organization, among others.	T0+2m
1.1.2	Project Scope Statement	Document that will detail the scope of the service and the project, the main deliverables and the assumptions, accepted criteria and constraints to take into account before starting to develop the project.	T0+3m
1.2.1	Organisational Breakdown Structure	Hierarchical diagram that will define the internal organisation of the consortium in terms of departments, roles and responsibilities and the relationship inside the consortium, with the stakeholders and with the external companies (subcontracted activities).	T0+3m
1.2.2	Work Breakdown Structure	Hierarchical diagram in which the main activities will be itemised in sub-activities, work packages (WPs) and tasks.	T0+3m
1.2.3	Resources Breakdown Structure	Hierarchical diagram of identified resources to plan the development of the project.	T0+3m
1.2.4.2	Gantt Diagram	Detailed schedule with the duration of the tasks and their sequence, which defines the relationship between them.	T0+3m
1.6.	Communication Plan	Document with the strategies and procedures to ensure an effective and fluent communication inside the company, inside the consortium, with the stakeholders and with the external companies.	T0+4m
1.3.3	Budget	Document with information relative to the funding of the project and the estimated cost of each task that will be carried out throughout the project.	T0+4m
1.3.5	Feasibility study	Analysis of the feasibility of the project taking into account economic parameters presented in 1.3.4.	T0+4m
1.4	Risks Management Plan	Document focused on identifying the main aspects of the different risks associated to the project and their corresponding response and re-assessment.	T0+4m
4.4	Quality Management Plan	Analysis of the main aspects in terms of quality, such as the necessary tools to carry out an effective control of the service, the costs associated or the possibles improvements of the process.	T0+5m

1.1.3	Standard Application Form (2020 Horizons Call)	Document to apply to the 2020 Horizons Europe Program. The main aspects that will be detailed are divided in two parts: the application form itself and the technical description of the project.	T0+6m
1.5.1	Security Regulations Study	Preliminary study of the security regulations of the European Space Agency.	T0+8m
1.5.1	Security Clearance Documentation	Documents that will be delivered to the ESA in which it is guaranteed that the workers of the consortium do not pose any risk when working with sensitive assets.	T0+8m
1.5.2	Tracking Data Legal Report	Legal study of the main aspects related to the data privacy associated to the tracking of the satellites.	T0+8m
1.5.3	Safety Environment Report	In-depth study to ensure a safe debris re-entry and clearance of the impact location.	T0+8m
3.1	Market Research	In-depth analysis of the market in which the service will operate, focusing specially on the offer and demand and its evolution. In addition to this, a forecast of the future situation of the industry will also be provided along some conclusions that could be drawn from the study.	T0+11m
3.2	Marketing Plan	Document with detailed explanations of the actions that will be carried out to publicize the service in different sectors (fairs, media, institutions, companies). A first report, at a relatively early stage, will be delivered in order to specify the objectives of the actions and the media presence strategy and a second report will be delivered later with the rest of information.	T1+3m / T2+5m
4.1	Technological Research	Document elaborated by the universities of the consortium describing the in-depth research carried out of the technology necessary to develop the project and offer the service. It will be focused specially on lasers, mirrors, de-orbit techniques, tracking and space debris, taking into account the current state of the art. This report will be essential to design the components and integrate the system.	T1+3m
4.5	Certification Report	Document with both ISO and non-ISO norms required to certify the design of the system and its performance.	T1+4m
4.2.4	Software Design Report	Document in which the design and creation of the software necessary to monitor space debris and operate the LODR system is described in detail.	T1+10m
4.2.1	Design and production report: Mechanical system	Report with in-depth explanations of the design of the mechanical components that will be part of the LODR (e.g., properties, materials, geometry, physical principles), as well as of the production procedure (e.g., techniques, equipment).	T2
4.2.2	Design and production report: Laser	Report with in-depth explanations of the design of the laser/s that will be part of the LODR (e.g., properties, materials, geometry, physical principles), as well as of the production procedure (e.g., techniques, equipment).	T2

4.2.3	Design and production report: Mirror	Report with in-depth explanations of the design of the mirror/s that will be part of the LODR (e.g., properties, materials, geometry, physical principles), as well as of the production procedure (e.g., techniques, equipment).	T2
2.3	Environmental study	Analysis of the environmental impact that the manufacturing and operation of the system designed could imply. and proposal of corrective/preventive actions if necessary.	T2+2m
2.4.	Nonconformance and corrective/preventive actions	Report with detailed actions to correct or prevent negative environmental effects in order to fulfill the company's policy.	T2+2m
5.1	Technical Specifications Report	Document in which the main technical characteristics of the components (electronics) or operations (logistics, integration) that have to be performed by external companies are identified and detailed.	T2+3m
5.2	Procurement Guidelines	Standards that will be delivered to all the supplier companies with core aspects related to their respective field. The electronics section will address the materials chosen for the components, the stock prioritisation and the lot-sizes; the integration one, the assembly conditions; and the logistics one, the delivery times and possible collaborations with local transport companies.	T2+8m
6a	Prototype Proposal Selection and Manufacturing	Report with the technical and physical details of the prototype that will be used to conduct different types of tests (size, requirements, functionality) and the manufacturing procedures (materials, techniques)	T2+11m
6b	Physical Prototype	Prototype of the LSDD system with the characteristics established in the Prototype Proposal Selection and Manufacturing	T3+4m
6.5	Prototype Testing Report	Document with the results of the tests conducted on the prototype and the conclusions that can be drawn from them. This report will dictate if the system and/or the components designed have to be modified because they do not meet the established requirements.	T3+5m
7.3	Mechanical Test Report	Document with the results of the mechanical tests conducted on the prototype and the conclusions that can be drawn from them. This report will dictate if the system and/or the components designed meet their technical specifications.	T3+5m
7.4	Thermal Test Report	Document with the results of the thermal tests conducted on the prototype and the conclusions that can be drawn from them. This report will dictate if the system and/or the components designed meet their technical specifications.	T3+5m
7.5	Software Test Report	Document with the results of the software tests conducted on the prototype and the conclusions that can be drawn from them. This report will dictate if the system and/or the components designed meet their technical specifications.	T3+5m

7.6	Performance Test Report	Document with the results of the performance of the prototype after carrying out different actions and the conclusions that can be drawn from them. This report will dictate if the system designed meet the requirements.	T3+5m
7.7	Results Verification Report	Comparison of the expected numerical results in terms of performance with the ones obtained in the test, taking into account what has been stated in the Performance Test	T3+5m
4.4.1	Maintenance Plan	Document with the schedule and the description of the actions that have to be carried out periodically on the LODR system to ensure a good functioning and the accomplishment of the requirements established in the Quality Plan.	T3+8m
		Periodic Reports	
4.1	Research Report	Bi-weekly report with the progress of the research regarding new technological discoveries and the work carried out during the week.	From T0+6m every 2w
4.2.1	Mechanical Design Report	Weekly report with the progress of the mechanical system in terms of design. This document is essential to monitor the work related to the Work Package 4.2.1 and ensure it is on schedule.	From T1+3m every 1w
4.2.2	Laser Design Report	Weekly report with the progress of the laser system in terms of design. This document is essential to monitor the work related to the Work Package 4.2.2 and ensure it is on schedule.	From T1+3m every 1w
4.2.3	Mirror Design Report	Weekly report with the progress of the mechanical system in terms of design. This document is essential to monitor the work related to the Work Package 4.2.3 and ensure it is on schedule.	From T1+3m every 1w
4.2.4	Software Functionality Report	Weekly report with the progress of the software in terms of design. This document is essential to monitor the work related to the Work Package 4.2.4 and ensure it is on schedule.	From T1+3m every 1m
6.3	Production Report	Weekly report with the progress of the manufacturing process of the different components and systems. This document is essential to monitor the work related to the Work Package 4.3.1 and ensure it is on schedule.	From T2 every 1w
4.4.2	Maintenance Checklist	List with the maintenance tasks that have to be performed each two week to ensure that all of them are done in time.	From T4 every 2w
4.4.5	Maintenance Report	Bi-weekly report with detailed explanations on the maintenance tasks performed to the components, taking into account the Maintenance Plan and the Maintenance Checklist.	From T4 every 2w
1.3.6	Economic Monitoring Report	Report with brief analysis of the main economic parameters that are used to monitor the project. This document is of extreme importance in order to ensure that the project is not over budget.	From T0+6m every 1m

1.6.6	Monthly Control Report	Report with the progress of the project that will be send every month to the institutions and companies of the consortium and the stakeholders with high power and interest on the project, so they can monitor and be informed of the work and results obtained throughout the different phases.	From T0 every 1m
6.6	RCA Report	Root Cause Analysis to determine which components are not working properly and why. It will include the actions necessary to mitigate or remove the failures of the components under study.	From T4 every 2m
1.6.7	Biannual Control Report	Report with the progress of the project that will be send every six months to the stakeholders with medium and low interest and power on the project, so they can monitor and be informed of the work and results obtained throughout the different phases.	From T0 every 6m

1.3 Acceptance criteria

Following the criteria used in §1.1.1, acceptance criteria are defined to accomplish both general requirements (**RA-GXX**) and technical requirements (**RA-TXX**).

In order to make sure that all the general requirements are fulfilled the following methods will be followed:

RA-G01: As advances are made in each department, a process of verification and review will be performed by the coordinator of each department to ensure it works correctly.

RA-G02: A Technology Readiness Assessment (TRA) will be performed to ensure that the TRL5 level is achieved.

RA-G03: Ensure the fulfilment and the viability of a four year calendar comprising all the different stages the project must fulfil. Every week an organisation meeting will be held in order to verify that all deadlines are respected.

RA-G04: An external audit will be performed in order to verify the independence of the members of the consortium and to identify possible incompatibilities.

RA-G05: The accounting manager will deliver a document specifying the economic contribution from each member of the consortium. The treasury will periodically verify that funding is provided on time.

RA-G06: The treasury will verify that all expenses are tracked accordingly to the established budget and that there is no presence of cost overrun regarding subcontracting activities.

As regards the technical specifications these will be checked by:

RA-T01: The viability of the usage of Laser Orbital Debris Removal (LODR) technology will be assessed in the Preliminary Design Review (PDR) document.

RA-T02: The operating principle of the deorbiter system will be studied in the Preliminary Design Review (PDR) document.

RA-T03: The LODR technology system will be installed in a ground base located in the Canary Islands as specified in the PDR document.

RA-T04: The capability of re-targeting debris in less than 1 minute will be verified in the First Prototype Building and Operational Test & Evaluation (OT&E) document.

RA-T05: The system will be tested to see if it is capable of removing objects from 0.75 kg to 1000 kg located at a maximum apogee between 700 km and 900 km (LEO orbit) with a minimum elevation between 30° and 60°. The results will be presented in the First Prototype Building and Operational Test & Evaluation (OT&E) document.

RA-T06: The specific sizing and technical details of the mirrors will be determined in the Critical Design Review (CDR).

RA-T07: The modular architecture of the the system will be proposed in the PDR and assessed in the CDR.

1.4 Project Exclusions

The aspects described below are considered to be out of the scope of this project, and should serve as guidelines for the stakeholders, so as to assess what is and what isn't considered within the project.

- **Second-phase data collecting and analysis.** Although the system developed in this project will collect data, mainly for tracking, it won't be processed and analyzed to study satellite ecosystems and their behavior tendencies.
- **Long term maintenance.** Once the project has reached its end and the final product is delivered, the maintenance tasks will be the responsibility of the customer only, as it is considered to be part of a second phase of long-term work. Nevertheless guidance and maintenance manuals will be provided at the moment of delivery, so as to ensure the laser system's correct behavior, and that it can be operated safely throughout its useful life.
- **Operation at higher orbits.** As stated previously in the technical specifications, the developed system will be able to work at a maximum altitude of 900 km. Therefore, orbits above are considered out of reach, and no attempt to deorbit equipment there will be performed during this project. Nevertheless, the resulting work might set the grounds for future technology which might aim at said altitudes.
- **Deorbiting heavy equipment.** The initial specifications establish that the systems or debris to be deorbited will have a maximum weight of 1000 kg. Thus the laser developed in this project isn't going to work with objects heavier than that. Instead it is going to focus on smaller debris, which are the ones that entail a bigger threat for orbiting satellites. Nevertheless, analogously to what happened for the operation at higher orbits, the work developed here might serve as a basis to future systems capable of disposing of larger equipment.
- **Space-based laser systems.** At the beginning of the project, when assessing the state of the art, a thorough study was performed in order to decide which system is more suitable, ground-based or laser-based. Since the conclusion was that ground-based systems are the optimal ones for this project, satellite-based systems are completely discarded, and thus out of scope.
- **Equipment retrieval.** The main aim of this project is to deorbit equipment by slowing it down and making it disintegrate when reentering into the Earth's atmosphere. Consequently, the actual retrieval of systems isn't considered. Furthermore, to get equipment or debris safely back to Earth would require other types of technology, very different from the ground-based laser developed here.

1.5 Project constraints

The constraints of the project can be classified into different areas: schedule, budget and economics, legal concerns, environmental restrictions and H2020 call constraints.

Schedule

- The estimation of the overall duration of the project shall not exceed 4 years.

Budget and economics

- According to the H2020 requirements, the budget contribution provided by the EU commission shall not exceed 2 million euros.
- The budget contribution coming from outside the European Commission shall not exceed a 60% of the entire budget.
- The subcontracted activities shall not exceed 15% of the direct costs.
- In light of the current situation with the economy inflation, all costs shall take into consideration the estimated rise of prices in the coming years.

Legal concerns

- If sensitive information is treated along the development, the project will have to go through the security appraisal process to authorise funding and may be made subject to specific security rules.
- A legal study concerning data protection and competencies regarding tracking of satellites shall be performed.
- A preliminary study of the Security Regulations of the European Space Agency shall be developed.
- The development and documentation of ESA's Security Clearance Procedure shall be followed.
- A study of a debris safe re-entry and clearance of the impact location shall be developed.
- The activity developed shall be based on the topic Innovative space capabilities: Space Situational Awareness (SSA).

Environmental restrictions

- An environmental and legal study that ensures that this project meets the standards imposed by ESA and does not become in conflict with European airspace shall be carried out.
- The operating principle shall comply with the security concerns established by ESA.
- No external space vehicles shall be affected during the operation of the LODR system.
- The system shall not cause unexpected airspace interferences.
- A safe re-entry and clearance of the impacted location shall be assured.

H2020 call constraints

- The application to the H2020 proposal shall consistent in a document not exceeding 45 pages.
- The consortium shall be formed by a minimum of 3 independent partners according to the following composition:
  - At least one independent legal entity established in a Member State.
  - At least two other independent legal entities, each established in different Member States or Associated Countries.
- The applying entity, in order to be eligible for funding, shall be established in one of the eligible countries, i.e.:
  - The Member States of the European Union, including their outermost regions.
  - The Overseas Countries and Territories (OCTs) linked to the Member States.
  - Eligible non-EU countries (countries associated to Horizon Europe and low- and middle-income countries).

2 Work Breakdown Structure (WBS)

In the next list, the different sub-projects, work packages (WPs) and tasks related to the development of the project are presented. In further subsections their description and dependency relationship will also be provided.

1. Project Management
    - 1.1 Initial Deliverables
        - 1.1.1 Project Charter
            - 1.1.1.1 General scope, description and objectives
            - 1.1.1.2 Initial requirements and acceptance criteria
            - 1.1.1.3 High-level risks
            - 1.1.1.4 Deliverables and milestones
            - 1.1.1.5 Estimated budget
            - 1.1.1.6 Initial organisation
            - 1.1.1.7 Stakeholders identification
        - 1.1.2 Project Scope Statement
            - 1.1.2.1 Product Scope Description
            - 1.1.2.2 Deliverables
            - 1.1.2.3 Acceptance Criteria
            - 1.1.2.4 Exclusions
            - 1.1.2.5 Constraints
        - 1.1.3 H2020 Deliverable
            - 1.1.3.1 Call requirements identification
            - 1.1.3.2 Call documentation identification
            - 1.1.3.3 Information gathering
            - 1.1.3.4 Call proposal generation
    - 1.2 Schedule
        - 1.2.1 Organizational Breakdown Structure
            - 1.2.1.1 Departments identification
            - 1.2.1.2 Role identification
            - 1.2.1.3 Consortium relationship definition
            - 1.2.1.4 Stakeholders relationship definition
            - 1.2.1.5 External companies relationship definition
        - 1.2.2 Work Breakdown Structure
            - 1.2.2.1 Work Package identification
            - 1.2.2.2 Task identification
            - 1.2.2.3 Activities dependencies
            - 1.2.2.4 Network diagram
        - 1.2.3 Resources Breakdown Structure
            - 1.2.3.1 Resources identification
            - 1.2.3.2 Resources allocation
        - 1.2.4 Time Management
            - 1.2.4.1 Task duration estimation
            - 1.2.4.2 Gantt Diagram

2.1 Activity list

In Table 4, a description of each task presented in the previous section is provided in order to know the work that will be developed in each case.

Table 4: Activity list

WBS-ID	Activity	Description of Work
		Project Management
1	Project Management	Tasks related to plan, organise and control different aspects of the project, such as the time, costs and resources.
1.1	Initial Deliverables	Documents that will be delivered within the first six months of the project development. They include general data and initial estimations.
1.1.1	Project Charter	Document with the initial description of the core aspects of the project defined.
1.1.1.1	General scope, description and objectives	Definition of the purpose, vision, SMART objectives, scope and description of the project.
1.1.1.2	Initial requirements and acceptance criteria	Definition of the conditions or capabilities that the service and the systems should fulfill and the methods to achieve it.
1.1.1.3	High-level risks	First estimation of the risks that will be encountered during the project development. A more in-depth analysis of the risks will be carried out in the 1.4 tasks.
1.1.1.4	Deliverables and milestones	Documents that will be delivered (associated to Work Packages) throughout the four years and definition of important dates related to the completion of specific activities.
1.1.1.5	Estimated budget	Initial estimation of the cost of different areas/activities of the project and its total amount.
1.1.1.6	Initial organisation	Definition of roles and responsibilities within the company and the consortium.
1.1.1.7	Stakeholders identification	Analysis and definition of the main stakeholders of the project.
1.1.2	Project Scope Statement	Description of the scope of the project, the main deliverables, the assumptions and constraints. It will be useful to plan and guide the work and determine what is out of scope in case a change in some activity is required.
1.1.2.1	Product scope description	In-depth description of the service to be provided and the system used to do it, taking into account what was stated in 1.1.1.
1.1.2.2	Deliverables	In-depth explanation of the documents that will be delivered throughout the project.
1.1.2.3	Acceptance criteria	Conditions to to be met and methods to be applied in order to consider as valid a deliverable, a physical element or a procedure.
1.1.2.4	Exclusions	Identification of the aspects that the project will not cover, so the stakeholders know what is out of scope.

1.1.2.5	Constraints	Identification of the limiting factors that affect the execution of the project.
1.1.3	H2020 Deliverable	Document necessary to apply to the 2020 Horizons Europe Program, which will include both general and administrative information and technical data of the project.
1.1.3.1	Call requirements identification	Identification of the necessary requirements to be accomplish to participate in the H2020 Call, paying special attention to the budget requirement.
1.1.3.2	Call documentation identification	Identification of the documents necessary to be delivered both to apply to the Program and during its development.
1.1.3.3	Information gathering	Gathering of the necessary information from each department or member of the consortium to fill the documents of 1.1.3.2.
1.1.3.4	Call proposal generation	Redaction of the documents necessary to apply for the H2020 Call.
1.2	Schedule	Activities related to the organisation of the project in terms of work, resources and time.
1.2.1	Organizational Breakdown Structure	Hierarchical diagram that will define the internal organisation of the consortium in terms of roles and the relationship with the external companies.
1.2.1.1	Departments identification	Definition of the departments necessary to organise the work within the company and the consortium.
1.2.1.2	Role identification	Definition of the roles of each person inside the company and the consortium. This tasks takes into account the initial definition made in 1.1.1.6.
1.2.1.3	Consortium relationship definition	Definition of the role of each company of the consortium and its relationship with the rest of members.
1.2.1.4	Stakeholders relationship definition	Definition of the relationship between the stakeholders and the consortium, taking into account what has been stated initially in 1.1.1.7.
1.2.1.5	External companies relationship definition	Definition of the role of each external company and its relationship with the consortium.
1.2.2	Work Breakdown Structure	Hierarchical diagram in which the main activities will be itemised in subprojects, work packages (WPs) and tasks.
1.2.2.1	Work Package identification	Definition of sub-projects and work packages, which are associated to one or more deliverables.
1.2.2.2	Task identification	Definition of all the activities that must be finished by a specific date and that are necessary to complete a work package.
1.2.2.3	Activities dependencies	Determination of the dependencies or logical relationships between the different tasks.
1.2.2.4	Network diagram	Graphical representation of the relationship between the tasks involved in the project taking into account what has been stated in 1.2.1.2, 1.2.1.3, 1.2.2.2 and 1.2.2.3.
1.2.3	Resources Breakdown Structure	Hierarchical diagram of identified resources to plan the development of the project.

1.2.3.1	Resources identification	Definition of the type of resources necessary to complete the project.
1.2.3.2	Resources allocation	Allocation of the previous resources to the different tasks of the project, specifying amount and any possible requirement associated.
1.2.4	Time management	Description of the schedule of the project in terms of tasks duration.
1.2.4.1	Task duration estimation	Estimation of the duration of each taking into account the computation method selected, the resources allocated to the task and other parameters which depend on the method.
1.2.4.2	Gantt Diagram	Detailed description, in diagram form, of the temporal distribution of the project, specifying the beginning and end month of each task.
1.3	Finances	Economic analysis of the project.
1.3.1	Cost estimation	Estimation of the costs taking into account all the tasks to be performed.
1.3.1.1	Level of accuracy	Degree at which the estimation of the cost of the activities will be rounded up or down taking into account the magnitude of the project and the scope of the activities.
1.3.1.2	Activity cost method selection	Selection of the best method to compute the cost of each activity and gathering of the required information. The possible methods that can be used are the parametric, the analogous or the three point estimations.
1.3.1.3	Activity cost computation	Computation of the costs taking into account the method selected and the available information and data.
1.3.2	Cost baseline	Time-phased budget in which the amount of money that will be spent at each time period will be specified in order to measure, monitor and control the cost performance of the project.
1.3.3	Budget at completion	Estimation of the expected total budget of the project.
1.3.4	Sources of funding identification	Identification of the main sources (European Union and others) from which the necessary funding will be obtained and their associated requirements, taking into account the budget of the project.
1.3.5	Feasibility study	In-depth analysis of the viability of the project, taking into account all its relevant economic factors.
1.3.6	Economic monitoring	Monitoring of the economic variables of the project, in order to ensure that the budget established is being followed. It is a crucial task since it will allow to correct any minimal cost deviation in time.
1.4	Risks	Definition of the events that can have an impact on the objectives of the project and the main aspects, such as its response or re-assessment, associated to them.
1.4.1	Risks identification	Identification of the risks of the project. They will be classified in different areas, such as business, quality or management.
1.4.2	Risks assessment	
1.4.2.1	Probability computation	Computation of the probability that each risk occurs.
1.4.2.2	Impact analysis	Analysis of the effect that each risk will have on different aspects of the project (objectives, scope, budget, time, quality).

1.4.3	Risk management plan	Plan with the main aspects related to the response to each risk.
1.4.3.1	Risk management strategies identification	Identification of the type of response (avoidance, mitigation, transfer or acceptance) for each risk.
1.4.3.2	Risk management strategies execution	Execution of each response.
1.4.4	Risk monitoring definition	Definition of the actions that will be carried out in order to monitor the evolution of the risks that have been reduced and of the parameters associated to those risks that have eradicated.
1.5	Legal	Definition of the documents and activities required to safely and legally operate the deorbiter.
1.5.1	Security	Documents explaining the security measures taken by both CO-LSDD and ESA, following the legal parameters given by the latter.
1.5.2	Data privacy	Study regarding the data protection of the tracked satellites.
1.5.3	Environment	Ensure that the re-entry of the deorbited satellites is made safely and lands in the designated areas.
1.6	Communication Management	Definition of the tools and procedures to ensure a fluent communication between all the interested parts in the project.
1.6.1	Internal (CO-LSDD)	Definition of the main aspects related to the communication between the members of the company.
1.6.1.1	Communication procedures definition	Definition of the techniques and procedures that will be used to make announcements and transmit/receive information and data inside the company.
1.6.1.2	Contact points identification	Identification of the people that will be in charge of the communication with the different departments of the company.
1.6.1.3	General information filtering	Identification and filtering of the information and data that must be transmitted to the different departments of the company due to its relevance and utility.
1.6.1.4	Meetings planning	Definition of the meetings between the internal contact point and the different managers of the company in terms of frequency, agenda and participants.
1.6.2	Consortium	Definition of the main aspects related to the communication between the members of the consortium.
1.6.2.1	Communication procedures definition	Definition of the techniques and procedures that will be used to make announcements and transmit/receive information and data inside the consortium.
1.6.2.2	Contact points identification	Identification of the people that will be in charge of the communication with the different members of the consortium.
1.6.2.3	General information filtering	Identification and filtering of the information and data that must be transmitted to the different institutions and companies of the consortium due to its relevance and utility.

1.6.2.4	Meetings planning	Definition of the meetings between the internal contact point and the different managers of the consortium in terms of frequency, agenda and participants.
1.6.3	Stakeholders	Definition of the main aspects related to the communication with the stakeholders of the project.
1.6.3.1	Communication procedures definition	Definition of the techniques and procedures that will be used to make announcements and transmit/receive information and data to/from the stakeholders.
1.6.3.2	Contact points identification	Identification of the people that will be in charge of the communication with the different stakeholders.
1.6.3.3	Sensitive information filtering	Identification and filtering of the information and data that must be transmitted to the different stakeholders due to its relevance and utility.
1.6.3.4	Meetings planning	Definition of the meetings between the internal contact point and the different stakeholders in terms of frequency, agenda and participants.
1.6.4	External companies	Definition of the main aspects related to the communication with the external companies of the consortium of the project.
1.6.4.1	Communication procedures definition	Definition of the techniques and procedures that will be used to make announcements and transmit/receive information and data to/from the sub-contracted companies.
1.6.4.2	Contact points identification	Identification of the people that will be in charge of the communication with the different external companies.
1.6.4.3	Sensitive information filtering	Identification and filtering of the information and data that must be transmitted to the different companies due to its relevance and utility.
1.6.4.4	Meetings planning	Definition of the meetings between the internal contact point and the different companies in terms of frequency, agenda and participants.
1.6.6	Monthly report	Report with the progress of the project that will be send to the institutions and companies of the consortium and the stakeholder with high interest and power on the project.
1.6.6.1	Information gathering	Gathering of the main information and data of each department generated each month.
1.6.6.2	Main information identification	Identification of the main information and data to be included in the report.
1.6.7	Biannual report	Report with the progress of the project that will be send to the stakeholder with medium and low interest and power on the project.
1.6.7.1	Main information identification	Based on the information and data gathered each month, identification of the main one in order to be included in the biannual report.
	Environmental Study	
2	Environmental study	Tasks related to the environmental aspect of the project, from the environmental impact of the manufacturing process up to the facility maintenance.
2.1	Environmental policy	Selection of which environmental legislation is more restrictive among possible clients (Europe, USA, Japan...).
2.2	Environmental impact	Has the aim of establishing the aspects/impacts of the activities carried out during the project.

2.2.1	Manufacturing environmental footprint	Related to identify the environmental impact of the different activities that are part of the manufacturing process of the project
2.2.1.1	Materials	Referred to the ambient cost of extraction, refinement, and transportation of the materials.
2.2.1.2	Industrial processes	Analysis of the industrial processes in depth.
2.2.1.3	Waste management	Seek for efficiency during the manufacturing process, focusing on hazardous waste managements.
2.2.2	Operational environmental footprint	Related to identify the environmental impact of the different activities that are part of the facility operation of the project.
2.2.2.1	Location ecology study	Evaluation of the environmental impact regarding natural resources, habitats, threatened species...
2.2.2.2	Laser operation socio-economic study	Investigation on how the operating laser could affect the nearby population.
2.2.2.3	Facility maintenance	Analysis on how the operating facility maintains itself from an environmental aspect, from electrical resources to waste management.
2.2.3	Logistics footprint	Related to identify the environmental impact of the different activities that are part of the logistics of the project.
2.3	Report	Document about the environmental impact of the project.
2.4	Nonconformance and corrective/preventive actions	Document development of the nonconformity and the actions necessary to fulfill the environmental policy.
2.5	Training and awareness	Tasks regarding the improvement of the manufacturing, operational and logistical aspect from an environmental point of view.
2.6	Monitoring and control of critical areas	Tasks regarding the supervision of the critical areas where improvements are applied.
	Marketing	
3	Marketing	Tasks related to the marketing dimension of the project, such as the study of the market or the actions to publicize the service.
3.1	Initial research	In-depth research focused on the past and current state of the market and other factors associated to it.
3.1.1	Market evolution	Analysis of the evolution of the debris deorbit market, paying special attention to the situation in the last few decades and the current one.
3.1.2	Offer and demand analysis	Analysis of the interest of the customers on the market in which the service will be offered and the competing companies that use a similar system.
3.1.3	Market forecast	Forecast on the future situation of the market and how it will evolve in terms of figures, technology, demand, offer and other relevant parameters.
3.1.4	SWOT analysis	Analysis of the strengths, weaknesses, opportunities and threats of the service proposed in order to establish solid strategies that will help to make it successful.

3.1.5	Business case	In-depth analysis, from a market perspective and taking into account the previous aspects, of the viability of entering the laser debris deorbit sector. It will complement the feasibility study and will be developed in a later phase than the previous.
3.2	Marketing actions	Actions that will be carried out throughout the project development and once the service has been launched in order to publicize the service and try to attract new customers.
3.2.1	Objectives definition	Definition of the objectives of the marketing actions.
3.2.2	Congress/Fairs attendance	Participation in congresses and fairs to publicize the service in specialised segments both before and after the system starts to operate.
3.2.3	Media presence	Presence in scientific publications, documentaries and other printed and visual formats to gain visibility in the market.
3.2.4	Social media management	Creation of multiple profiles in social media in order to publicize the service among a more general and non-specialized public.
3.2.5	Space debris awareness campaigns	Conferences aimed at private companies and public institutions to raise awareness on the danger of space debris and how the system proposed minimises their hazardous effects.
3.3	Key performance indicators identification	Identification of the parameters that can help determine if the marketing actions carried out are effective to increase the influence of the service in the market and attract new customers.
3.4	Success evaluation	Evaluation of the marketing actions, taking into account the previous key performance indicators, to determine if it is necessary to change them due to its irrelevance.
	Technical	
4.1	Research	Tasks related to all of the phases regarding the technical development of the deorbiter.
4.1.1	Research protocol	Set the basic parameters and laws regarding research, mainly as guidelines, of what and how the research must be done.
4.1.2	State of the art review	Review of the current technologies used in high power lasers and mirrors applied to space science, and current investigations to be considered.
4.1.3	Quality assessment	Evaluation of the information extracted from the studies and of our own research.
4.1.4	Reverse engineering	Study of the current solutions used by our competitors, and thorough analysis of their used methods.
4.1.5	Report	Periodic report about the development of research, in all fields considered in this project.
4.2	Design	Explanation of the processes required to design the parts in every segment for the deorbiter.
4.2.1	Mechanical design	Tasks to be carried out in the system governing the movement and calibration of the laser.
4.2.1.1	Preliminary design	Initial drawings and calculations, in order to get a rough estimate of the values for sizes, materials and weights
4.2.1.2	Parts definition & list	List of the parts required for the mechanical movement of the laser

4.2.1.3	Basic part layout	Drawings of the different parts of the mechanical system, more in-depth than the preliminary design, now using specialized CAD software.
4.2.1.4	Mechanical assembly scheme	Indications regarding how the different parts of the mechanical system will be put together, and how will the system move and respond as a function of said parts. Classification of most to least critical regarding the operation and precision of the deorbiter.
4.2.2	Laser design	Tasks to be carried out regarding the laser itself, and how it must be designed.
4.2.2.1	High power laser diode design	The laser requires a high-power diode in order to send the signal to the satellite to be deorbited.
4.2.2.2	Wavelength stabilizer	The sent signal should have a constant wavelength in order to avoid power input and output oscillations. Should be made via Volume Bragg Grating.
4.2.2.3	Heavy duty power supply	The laser of the deorbiter will send a signal of several kW, which will require a power source capable of supplying such power efficiently.
4.2.2.4	Laser lens design	In order to have a precise signal, a set of materials and a special design must be made to avoid, as much as possible, refraction and diffraction within the medium.
4.2.2.5	Laser assembly scheme	Instructions of how the laser parts should be put together, given that the parts it is made of are within the expected tolerances. Classification of said parts from most to least critical for the operation.
4.2.3	Mirror design	Tasks required in order to successfully design and test the mirrors in the deorbiter.
4.2.3.1	Mirror shape design	Selection of the optimal shape of the mirror system for the deorbiter.
4.2.3.2	Mirror material selection	Selection of the material to ensure optimal optical properties and avoid heat-caused distortions.
4.2.3.3	Surface treatment & coating	Definition of the necessary coatings to help the material withstand the deformations caused by thermal gradients.
4.2.3.4	Mirror assembly scheme	Instructions on how the mirrors should be set with respect to each other and the laser in order to optimize the performance of the laser.
4.2.4	Software design	Code to be compiled and run when operating the laser system and tasks to be carried out to continuously improve it.
4.2.4.1	Software planning	Before writing any code, an initial algorithm must be drawn, and a thorough study of the different variables affecting the laser must be carried out to consider them within the code and, thus, the automated response of the laser.
4.2.4.2	Software analysis	Writing of the code in the language of choice, and checking that it follows the previous algorithm.
4.2.4.3	Implementation	Implementing the software within the deorbiter, and checking that there are no bugs or incompatibilities between the two.
4.2.4.4	Testing & integration	Run the software with the deorbiter, and excite it in different manners to see how it responds to said excitations. Comparison of the obtained results with the expected ones.
4.3	Quality management	Set of activites to define the quality guidelines of the company.

4.3.1	Quality standard definition	Basics of what can and what cannot be accepted for each part and minimal assembly.
4.3.2	Quality plan	Writing regarding how the periodic checking and quality analysis of the laser system must be carried out.
4.3.3	Quality review	Quality analysis of the laser system, following the guidelines given by the previous points.
4.3.4	Quality standard evaluation	Re-evaluation of the quality standards gotten previously, in comparison with the actual performance of the laser. It is an iterative process, which means these might get tighter as time goes on.
4.3.5	Quality improvement	Set of rules defined by the quality standard evaluation which modify said standards in order to ensure optimal performance.
4.4	Maintenance	Set of tasks to be done to check and verify that the laser system is working correctly.
4.4.1	Plan	Writing of a master plan comprising all of the maintenance which must be made, and at which point in time.
4.4.2	Checklist	For each period, and following the maintenance plan, write a checklist containing all of the checks that must be made when reviewing the laser system.
4.4.3	Program	If necessary, write additional maintenance plans for parts which are more sensible or are in a more critical point.
4.4.4	Periodic maintenance	Separation between minor maintenance programs, which are written in the Short-term maintenance section, and major maintenance programs, or Long-term maintenance.
4.4.4.1	Short-term maintenance	All maintenance which must be made periodically every 30 days or less.
4.4.4.2	Long-term maintenance	All maintenance which must be made every X number of months or years, depending on each case.
4.5	Design certification	List of all of the certification documents required to certify the design.
4.5.1	List of ISO norms for design	Research the ISO norms that could affect the design and/or performance of the deorbiter.
4.5.2	Non-ISO design certifications	List of all the norms, not contained within ISO, which will be required to certify the design.
	Procurement	
5	Procurement	Process of finding and agreeing to terms, as well as acquiring goods or services.
5.1	Definition of specifications	List where electronic, mechanic, assembler and logistic needs are identified.
5.2	Procurement guide	Document with the procurement standards that must be followed by suppliers.
5.2.1	Electronics procurement guide	Document where material analysis, stock priorization and lot-sizes are established for electronic aspects of the design.
5.2.2	Integration procurement guide	Document where the assembly integration conditions are established following the design criteria.

5.2.3	Logistics procurement guide	Document where all the logistic requirements are listed, including delivery times and collaborations with local transport companies among others.
	Prototype	
6.1	Study of prototype providers	Market study involving prototype companies in the sector.
6.1.1	Quality standards for prototyping	Definition of the quality standards required for the prototype.
6.1.2	Provider comparison	Study of the different companies, and the different alternatives to build the prototype with.
6.1.2.1	Prototype manufacturing proposal	Receival of proposals from different companies to build the prototype, following our guidelines.
6.1.2.2	Budget proposal	Each prototype proposal build will also incorporate a budget estimation, which must be in accordance to the prototype itself.
6.1.3	Provider selection	Through the proposals and the budgets, the company will select the optimal case for the prototype.
6.2	Material selection	The materials of which the prototype is made might not all be the same as the ones in the real-scale model, depending on the kind of test that will be made afterwards. The analysis of how these affect the structure and the laser itself is made in this section.
6.2.1	Viability analysis	Some materials will be much more expensive than others in the real-scale laser system, but substituting some by others in order to obtain the prototype might make it cheaper without compromising the tests. The economical viability of these solutions will be made here.
6.2.2	Small-scale material analysis	Study of which elements can be substituted by cheaper alternatives in the different tests, and how this will (or will not) affect the results.
6.2.3	Scalability analysis	Study of how the results obtained from the tests might me extrapolable to the biggermodel.
6.3	Production	Tasks to be carried out regarding the production of the laser system and its different parts.
6.3.1	Manufacturing	After designing the different parts of the deorbiter, these must be manufactured separately, ensuring maximum quality without highly increasing costs.
6.3.1.1	Mechanical manufacturing	Manufacturing of the parts comprising the base of the laser and the different pivots, bearings, trusses and structures of the laser.
6.3.1.2	Laser manufacturing	Manufacturing of the power system and lenses for the laser, following the guidelines given by the design.
6.3.1.3	Mirror manufacturing	Manufacturing of the mirrors ensuring maximum quality and light absorption, so as to minimize losses in the laser power.
6.3.2	Assembly with electronics	Assembly of the system, considering the physical laser itself, the software written and the electronics made by RUAG.
6.4	Prototype assembly	Assembly of the parts of the prototype. Some might include electronics, and, thus, must be made in collaboration with OHB.
6.4.1	Mechanical assembly	Assembly of all the scaled pieces comprising the mechanical part of the laser.

6.4.2	Laser assembly	Assembly of the scaled laser pieces.
6.4.3	Mirror assembly	Assembly of the scaled mirrors, with the whole system.
6.4.4	Prototype integration	Build of the prototypes, fitting all the pieces and systems together.
6.5	Prototype testing	Testing of the prototypes, in accordance to 7.
6.6	Root cause analysis	Root analysis of the problems found during maintenance in order to find an optimal solution for said case to ensure optimal performance.
	Testing	
7.1	Test certification requirements	List of requirements, both international certifications and our own tests.
7.1.1	List of ISO norms	International guidelines for testing, in order to obtain the different behaviour of the parameters in the laser.
7.1.2	Non-ISO requirements	Own tests, based on the ISO, in order to obtain further parameters which might interest the company.
7.2	Test plan	Writing regarding how every test should be carried out and how the results should be presented and interpreted.
7.2.1	Test procedures	Depending on each test, the way of proceeding in each case must be clearly defined in this section.
7.2.2	Test reporting	Once the tests are done, they must be reported through the guidelines given in 7.2.
7.3	Mechanical test	Different structural tests in order to obtain the most critical points in the structure and predict possible failures.
7.3.1	Stress test	Test the structure under its most usual loads, increasing them in a certain percentage, until the expected point of analysis is reached.
7.3.2	Strain test	Set different strain gauges on the structure whilst the stress tests are made, and analyze the results.
7.3.3	Frequency analysis	The structure will have its own eigenmodes and, thus, eigenfrequencies, which must be analyzed in order to be avoided when operating the laser system.
7.3.3.1	Sine vibration - Fixed frequency	Under a quasi-stationary evolution, to avoid interaction between different frequencies. A sine sweep test from a frequency A to a frequency B would be a good option.
7.3.3.2	Random vibration - Random frequency	Make the same test as before, but now with different coupled frequencies. A multisine test would be a good option.
7.3.3.3	Frequency spectrum diagram	For the different studied cases, obtain the Bode diagram, and analyze the natural frequency of the systems.
7.4	Thermal test	Different elements within the laser might to extremely high temperatures because of the high power transmitted through the laser.
7.4.1	Heat transfer analysis: Laser system	The laser will transmit a lot of power, so it would be expected that causes such as the Joule effect will heat up the surroundings of the laser. A thermal analysis regarding the obtained temperature distributions would be required.

7.4.2	Heat transfer analysis: Electronics	In a smaller scale, but still important. Electronics will end up heating up, and its effect on the electronics themselves and the structure must be studied.
7.4.3	Cooling systems	In order to ensure optimal performance, a certain temperature must be maintained for the system. The efficiency of cooling systems is key in this case, which will allow for better overall performance.
7.5	Software test	The software must be adapted and tested on the smaller scale laser before being introduced to the real scale.
7.6	Performance test	Once the software has been checked and the mechanical and thermal analysis have been carried out, the performance of the laser under different working conditions can be measured.
7.6.1	Power output test	Measure the power output by the laser, thus obtaining the losses between the power supply and the laser itself.
7.6.2	Wavelength oscillation test	Measure how much the wavelength differs at each point in time during normal operation, and how that affects the power supply.
7.6.3	Beam divergence test	When travelling through the atmosphere, the laser will tend to have a slight angle of divergence, usually denoted by θ_0, which tells how much the beam width is amplified at each point.
7.6.4	Beam Parameter Product	Related to the beam divergence test, the Beam Parameter Product (BPP) is the product of the beam width at its narrowest point and the divergence angle, thus quantifying the quality of the beam.
7.6.5	Power loss test	Identify, for different atmosphere cases, how much the power of the beam is mitigated because of atmospheric effects, such as humidity, clouds, rain and/or snow, and how that affects the power necessary to deorbit the satellite.
7.7	Comparison to numerical results	The results obtained in the previous tests must be compared to the numerical results obtained in the simulations. Some might coincide and some might not, and the reasons for such discrepancy must be found.
7.8	Data adjusting & result verification	Once the discrepancies have been corrected, the changes resulting must be introduced within the numerical simulations in order to obtain a better fit for further progresses.

3 Sequence activities

3.1 Dependencies or logical relationship between activities

In Table 5 the dependencies between the task established in the previous sections are defined. The relationships are expressed with initials that refer to the following terms: Finish-to-finish (FF); Finish-to-start (FS); and Star-to-start (SS). Note that KOM refers to the Kick-Off Meeting.

Table 5: Dependencies between activities

WBS-ID	Activity	Predecessor	Relationship	Lag
	1. PROJECT MANAGEMENT			
	1.1 Initial Deliverables			
1.1.1 Project Charter				
1.1.1.1	General scope, description and objectives	KOM	FF	0
1.1.1.2	Initial requirements and acceptance criteria	1.1.1.1	FS	0
1.1.1.3	High-level risks	1.1.1.1 1.1.1.2	FS FS	0 0
1.1.1.4	Deliverables and milestones	1.1.1.1 1.1.1.2	FS FS	0 0
1.1.1.5	Estimated budget	1.1.1.1 1.1.1.2 1.1.1.3 1.1.1.4	FS FS FS FS	0 0 0 0
1.1.1.6	Initial organisation	KOM	FF	0
1.1.1.7	Stakeholders identification	KOM 1.1.1.1	FS FS	0 0
1.1.2 Project Scope Statement				
1.1.2.1	Project scope description	1.1.1.1	FS	0
1.1.2.2	Deliverables	1.1.1.4 1.2.1	FS FS	0 0
1.1.2.3	Acceptance criteria	1.1.1.2	FS	0
1.1.2.4	Exclusions	1.1.2.1	FS	0
1.1.2.5	Constraints	1.1.2.1 1.1.1.2	FS FS	0 0
1.1.3 H2020 Deliverable				
1.1.3.1	Call requirements identification	KOM	FS	1m
1.1.3.2	Call documentation identification	KOM	FS	1m
1.1.3.3	Information gathering	1.1.1 1.1.2 1.2. 1.3 1.4	FS FS FF FS FS	0 0 0 0 0

		4.4	FS	0
1.1.3.4	Call proposal generation	1.1.3.2 1.1.3.3	FS FS	0 0
	1.2 Schedule			
1.2.1 Organizational Breakdown Structure				
1.2.1.1	Departments identification	1.1.1.6	FS	0
1.2.1.2	Role identification	1.1.1.6 1.1.1.7 1.2.1.1	FS FS FS	0 0 0
1.2.1.3	Consortium relationship	1.1.1.6	FS	0
1.2.1.4	External companies relationship	1.1.2.1	FS	0
1.2.1.5	Stakeholders relationship	1.1.1.7 1.1.2	FS FS	0 0
1.2.2 Work Breakdown Structure				
1.2.2.1	Work Package identification	1.1.2.1	FS	0
1.2.2.2	Task identification	1.2.1.1	FS	0
1.2.2.3	Activities dependencies	1.2.2.2	FF	0
1.2.2.4	Network diagram	1.2.2.2 1.2.2.3	FS FS	0 0
1.2.3 Resources Breakdown Structure				
1.2.3.1	Resources identification	1.2.1	FS	0
1.2.3.2	Resources allocation	1.2.2.1 1.2.3.1	FS FS	0 0
1.2.4 Time Management				
1.2.4.1	Task duration estimation	1.2.2.2 1.2.3	FS FS	0 0
1.2.4.2	Gantt Diagram	1.2.4.1	FS	0
	1.3 Finances			
1.3.1 Cost estimation				
1.3.1.1	Level of accuracy	1.1.2	FS	0
1.3.1.2	Activity cost method selection	1.2.2 1.2.3	FS FS	0 0
1.3.1.3	Information gathering	1.3.1.2	FS	0
1.3.1.4	Activity cost computation	1.3.1.1 1.3.1.2 1.3.1.3	FS FS FS	0 0 0
1.3.2	Cost baseline	1.2.4 1.3.1	FS FS	0 0
1.3.3	Budget at completion	1.3.1 1.3.2	FS FS	0 0

1.3.4	Sources of funding identification	1.3.3	FS	0
1.3.5	Feasibility study	1.3.4	FS	0
1.3.6	Economic monitoring	1.1.3	FS	0
	1.4 Risks			
1.4.1	Risks identification	1.1.1.3 1.1.2	FS FS	0 0
1.4.2 Risks assessment				
1.4.2.1	Probability computation	1.4.1	FS	0
1.4.2.2	Impact analysis	1.4.1	FS	0
1.4.3 Risks management plan				
1.4.3.1	Risk management strategies identification	1.4.1 1.4.2	FF FF	0 0
1.4.3.2	Risk management strategies execution	1.4.3.1	FS	0
1.4.4	Risks monitoring	1.4.3.2	FS	0
	1.5 Legal			
1.5.1	Security	1.1.3.3	FS	0
1.5.2	Data privacy	1.1.3.3	FS	0
1.5.3	Environment	1.3.1.1 1.4	FS FS	0 0
	1.6 Communication Management			
1.6.1 Internal (CO-LSDD)				
1.6.1.1	Communication procedures definition	1.2.1.1	FS	0
1.6.1.2	Contact points identification	1.2.1.2	FF	0
1.6.1.3	General information filtering	1	SS	2w
1.6.1.4	Meetings planning	1.6.1.1	SS	1w
1.6.2 Consortium				
1.6.2.1	Communication procedures definition	1.2.1.3	FS	0
1.6.2.2	Contact points identification	1.2.1.2	FF	0
1.6.2.3	General information filtering	1	SS	2w
1.6.2.4	Meetings planning	1.6.2.1	SS	1w
1.6.3 Stakeholders				
1.6.3.1	Communication procedures definition	1.2.1.4	FS	0
1.6.3.2	Contact points identification	1.2.1.2	FF	0
1.6.3.3	Sensitive information filtering	1.3	SS	2w
1.6.3.4	Meetings planning	1.6.3.1	SS	1w
1.6.4 External companies				
1.6.4.1	Communication procedures definition	1.2.1.5	FS	0
1.6.4.2	Contact points identification	1.2.1.2	FF	0

1.6.4.3	Sensitive information filtering	4	SS	2w
1.6.4.4	Meetings planning	1.6.4.1	SS	1w
1.6.6 Monthly report				
1.6.6.1	Information gathering	1.6.1.3 1.6.2.3 1.6.3.3	FF FF FF	0 0 0
1.6.6.2	Main information identification	1.6.6.1	FS	0
1.6.7 Biannual report				
1.6.7.1	Main information identification	1.6.1.1	FS	0
2. ENVIRONMENTAL STUDY				
2.1	Environmental policy	1.1.1 1.5	FS FS	0 0
2.2 Environmental Impact				
2.2.1. Manufacturing environmental footprint				
2.2.1.1	Materials	4.2	FS	0
2.2.1.2	Industrial processes	4.3	FS	0
2.2.1.3	Waste management	4.3	FS	0
2.2.2. Operational environmental footprint				
2.2.2.1	Location ecology study	1.1	FS	0
2.2.2.2	Laser operation socio-economic study	2.2.2.1	FS	0
2.2.2.3	Facility maintenance	4.4.1	FS	0
2.2.3	Logistics footprint	4.3.2	FS	0
2.3	Report	2.2	FS	0
2.4	Nonconformance and corrective actions	2.3	FS	0
2.5	Training and awareness	2.4	FS	0
2.6	Monitoring and control of critical areas	2.4	SS	0
3. MARKETING				
3.1 Initial research				
3.1.1	Market evolution (past and present)	1.1.3	FS	2m
3.1.2	Offer and demand analysis	3.1.1	SS	2w
3.1.3	Market forecast	3.1.1 3.1.2	FS FS	0 0
3.1.4	SWOT analysis	3.1.3	FS	0
3.1.5	Business case	1.3.5 3.1.4	FS FS	0 0
3.2 Marketing actions				
3.2.1	Objectives definition	3.1	FS	0
3.2.2	Congress/Fairs attendance	4	SS	1y+2m

3.2.3	Media presence	4	SS	1y+2m
3.2.4	Social media management	3.1	FS	2m
3.2.5	Space debris awareness campaigns	4	SS	1y+2m
3.3	Key performance indicators identification	3.2	SS	0
3.4	Success evaluation	3.2 3.3	SS FS	2y 0
4. TECHNICAL				
4.1 Research				
4.1.1	Research protocol	1.1.2 1.1.3.3 1.2 1.6.3 1.6.6 1.6.7	FS FS FS FS FS FS	3m 3m 3m 3m 3m 3m
4.1.2	State of the art review	4.1.1	FS	0
4.1.3	Quality assessment	4.3.2	FS	0
4.1.4	Reverse engineering	4.1.1	FS	3m
4.2 Design				
4.2.1 Mechanical design				
4.2.1.1	Preliminary mechanical design	1.1.3 4.1	SS SS	0 0
4.2.1.2	Mechanical parts definition & list	4.2.1.1	SS	0
4.2.1.3	Mechanical basic part layout	4.2.1.1 4.2.1.2	SS SS	0 0
4.2.1.4	Mechanical assembly scheme	4.2.1.3	FS	0
4.2.2 Laser design				
4.2.2.1	High power laser diode design	1.1.3 4.1	SS SS	0 0
4.2.2.2	Wavelength stabilizer design	4.2.2.1	SS	0
4.2.2.3	Heavy duty power supply design	4.2.2.1	FS	0
4.2.2.4	Laser lens design	4.2.2.1	SS	0
4.2.2.5	Laser assembly scheme	4.2.2.1 4.2.2.2 4.2.2.3 4.2.2.4.	FS FS FS FS	0 0 0 0
4.2.3 Mirror design				
4.2.3.1	Mirror shape design	1.1.3 4.1	SS SS	0 0
4.2.3.2	Mirror material selection	4.2.3.1	SS	0
4.2.3.3	Surface treatment & coating	4.2.3.1 4.2.3.2	FS FS	0 0

4.2.3.4	Mirror assembly scheme	4.2.3.3	FS	0
4.2.4 Software design				
4.2.4.1	Software planning	4.2	SS	0
4.2.4.2	Software analysis	4.2.4.1	SS	0
4.2.4.3	Implementation	4.2.4.1	FS	0
		4.2.4.2	FS	0
4.2.4.4	Testing & integration	4.2.4.3	FS	0
4.3 Quality management				
4.3.1	Quality standard definition	1.1.2.3	FS	0
4.3.2	Quality plan	4.3.1	FS	0
4.3.3	Quality review	4.3.2	FS	0
		4.2.1.1	FS	0
		4.2.2.1	FS	0
		4.2.2.2	FS	0
		4.2.2.3	FS	0
		4.2.2.4	FS	0
		4.2.3.1	FS	0
		4.2.3.3	FS	0
		4.2.4.4	FS	0
4.3.4	Quality standard evaluation	4.3.3	FS	0
4.3.5	Quality improvement	4.3.4	FS	0
4.4 Maintenance				
4.4.1	Maintenance plan	4.2	FS	0
		6.3	FS	0
		6.4	FS	0
4.4.2	Maintenance checklist	4.4.1	SS	0
4.4.3	Maintenance program	4.4.1	SS	0
4.4.4 Periodic maintenance				
4.4.4.1	Short-term maintenance	4.4	SS	0
		6	FS	0
		7.6	FS	0
4.4.4.2	Long-term maintenance	4.4	SS	0
		6	FS	0
		7.6	FS	0
4.5. Design certification				
4.5.1	List of ISO norms for design	1.1.2.3	FS	0
		4.2	FS	0
4.5.2	Non-ISO design certifications	1.1.2.3	FS	0
		4.2	FS	0
5. PROCUREMENT				
5.1	Definition of specifications	4.2	FS	0
5.2. Procurement guide				

5.2.1	Electronics procurement guide	6.1.3 6.2.1	FS FS	0 0
5.2.2	Integration procurement guide	4.2	FS	0
5.2.3	Logistics procurement guide	4.2	FS	0
6. PROTOTYPE				
6.1 Study of prototype providers				
6.1.1	Quality standards for prototyping	4.2 4.3	FS FS	2m 2m
6.1.2.1	Prototype manufacturing proposal	6.1.1	SS	2w
6.1.2.2	Budget proposal	6.1.2.1	FS	0
6.1.3	Provider selection	6.1.2	FS	0
6.2 Prototype material selection				
6.2.1	Viability analysis	6.1	FS	0
6.2.2	Small-scale material analysis	6.2.1	SS	0
6.2.3	Scalability analysis	6.2.1	SS	0
6.3 Production				
6.3.1 Manufacturing				
6.3.1.1	Mechanical manufacturing	4.2.1 4.3	FS FS	0 0
6.3.1.2	Laser manufacturing	4.2.2 4.3	FS FS	0 0
6.3.1.3	Mirror manufacturing	4.2.3 4.3	FS FS	0 0
6.3.2	Assembly with electronics	6.3.1.1 6.3.1.2 6.3.1.3	FS FS FS	0 0 0
6.4 Prototype assembly				
6.4.1	Mechanical assembly	6.3	FS	0
6.4.2	Laser assembly	6.3	FS	0
6.4.3	Mirror assembly	6.3	FS	0
6.4.4	Prototype integration	6.4.1 6.4.2 6.4.3	FS FS FS	0 0 0
6.5	Prototype testing	6.4.4 7	FS FS	0 0
6.6	Root cause analysis	4.4 6.4	SS FS	3m 0
7. TESTING				
7.1 Test certification requirements				
7.1.1	List of ISO norms	1.1.2.3	FS	0

7.1.2	Non-ISO requirements	1.1.2.3	FS	0
	7.2 Test plan			
7.2.1	Test procedures	4.2 6.4 7.1	FS FS FS	0 0 0
7.2.2	Test reporting	4.2 6.4 7.1	FS FS FS	0 0 0
	7.3 Mechanical test			
7.3.1	Stress test	7.2	FS	0
7.3.2	Strain test	7.2	FS	0
7.3.3 Frequency analysis				
7.3.3.1	Sine vibration - Fixed frequency	7.2	FS	0
7.3.3.2	Random vibration - Random frequency	7.2	FS	0
7.3.3.3	Frequency spectrum diagram	7.3.3.1 7.3.3.2	FS FS	0 0
	7.4 Thermal test			
7.4.1	Heat transfer analysis: Laser system	7.2	FS	0
7.4.2	Heat transfer analysis: Electronics	7.2	FS	0
7.4.3	Cooling systems	7.2	FS	0
7.5	Software test	7.2	FS	0
	7.6 Performance test			
7.6.1	Power output test	7.3 7.4 7.5	FS FS FS	0 0 0
7.6.2	Wavelength oscillation test	7.6.1	SS	0
7.6.3	Beam divergence test	7.6.1	SS	0
7.6.4	Beam Parameter Product	7.6.3	FS	0
7.6.5	Power loss test	7.6.1	SS	0
7.7	Comparison to numerical results	7.3 7.4 7.5 7.6	FS FS FS FS	0 0 0 0
7.8	Data adjusting & result verification	7.7	FS	0

3.2 Network Diagram (Precedence Diagram Method)

Squares in yellow indicate activities taken from other sections, and squares in black indicate activities from the analyzed section. Lines in **black** indicate a FS dependency, lines in blue indicate a FF dependency and lines in teal indicate a SS dependency.

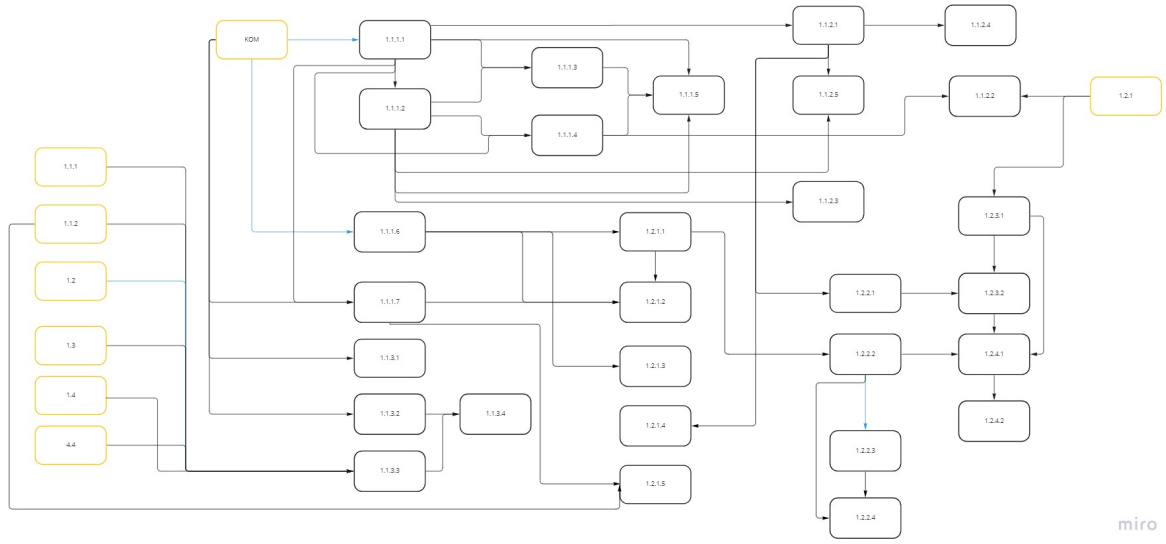

Figure 1: Sections 1.1-1.2 - PM Network Diagram

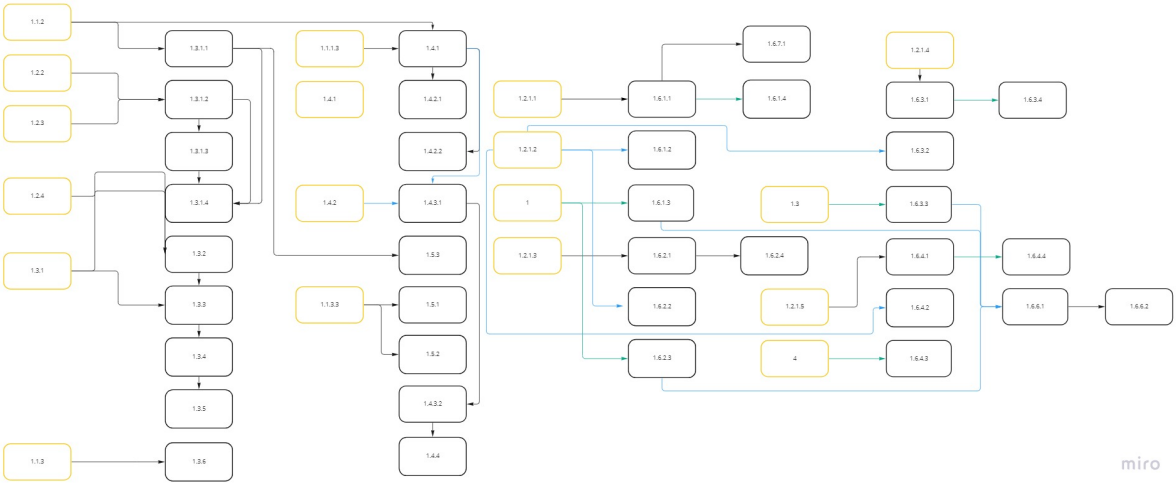

Figure 2: Sections 1.3-1.6 - PM Network Diagram

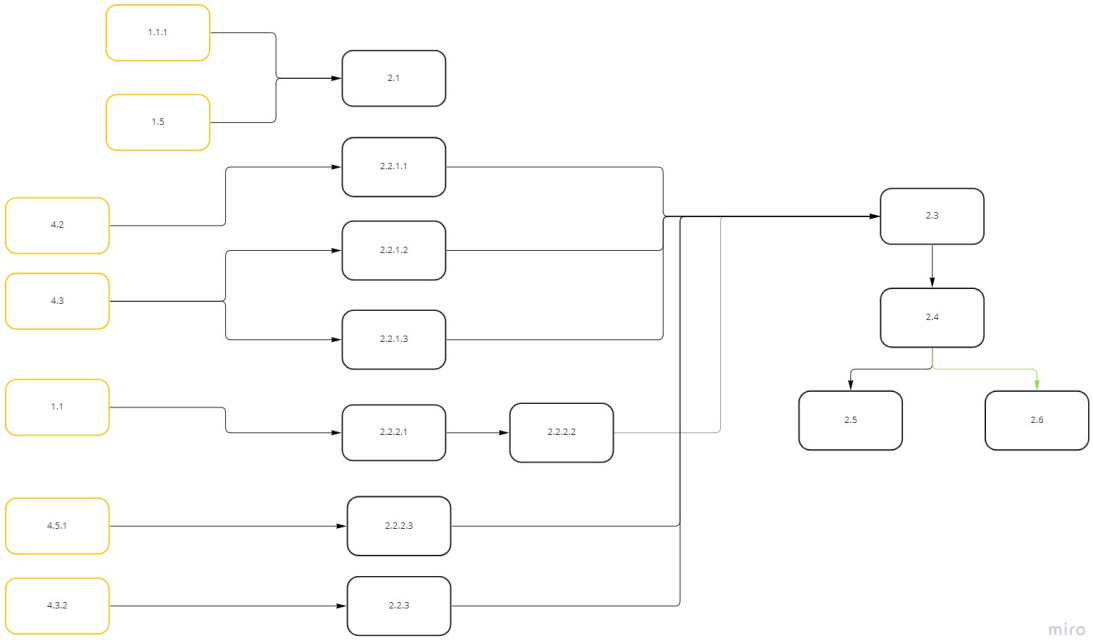

Figure 3: Section 2 - Environmental Network Diagram

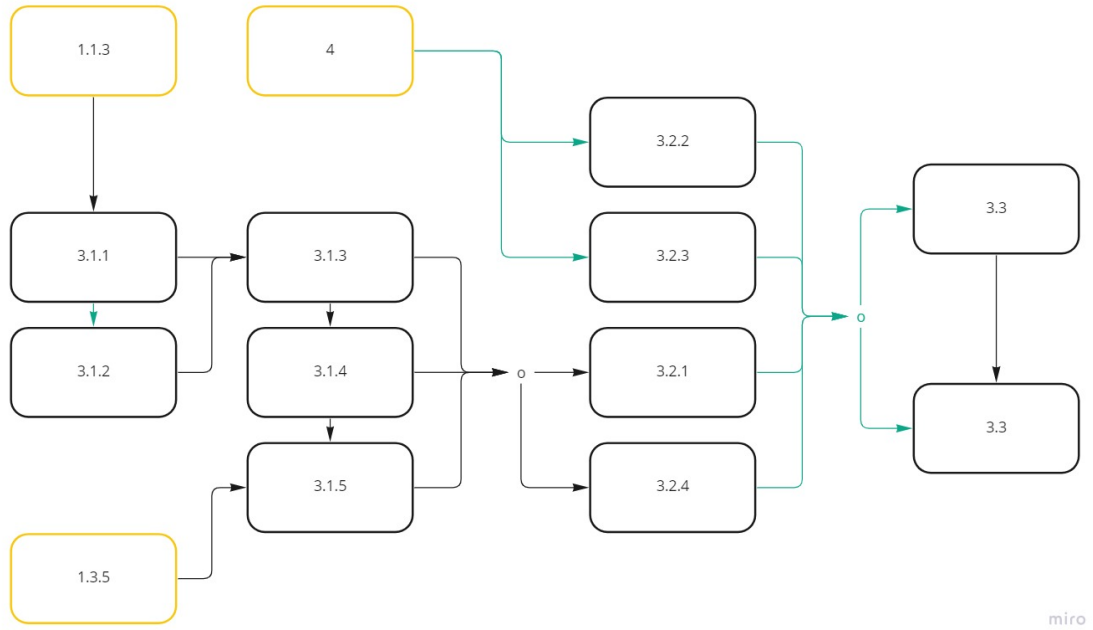

Figure 4: Section 3 - Marketing Network Diagram

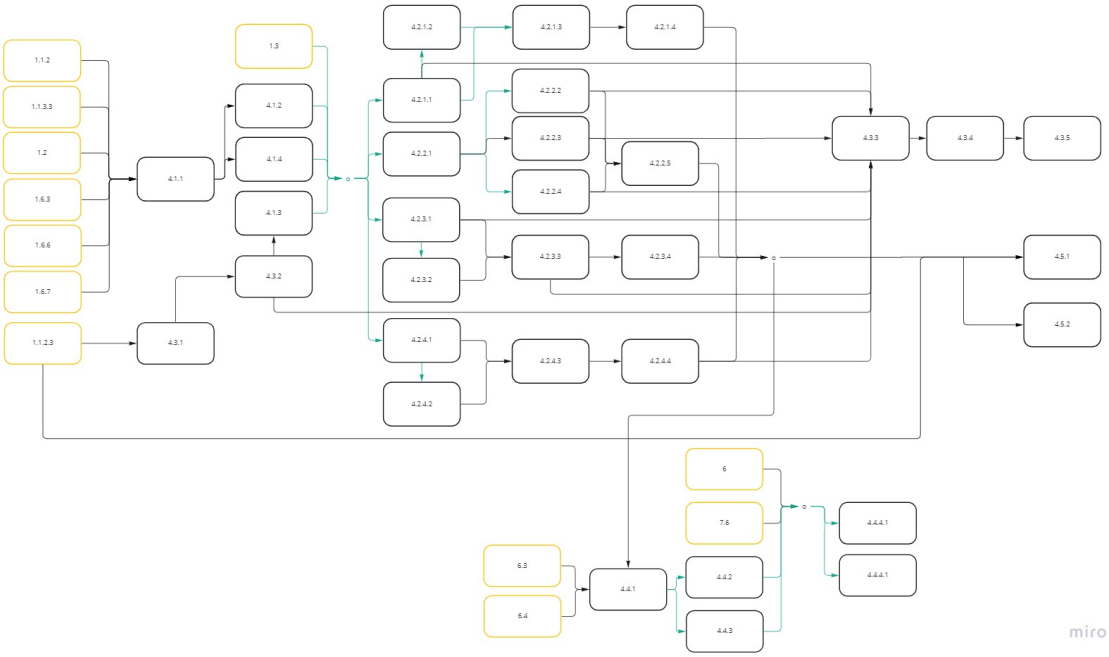

Figure 5: Section 4 - Technical Network Diagram

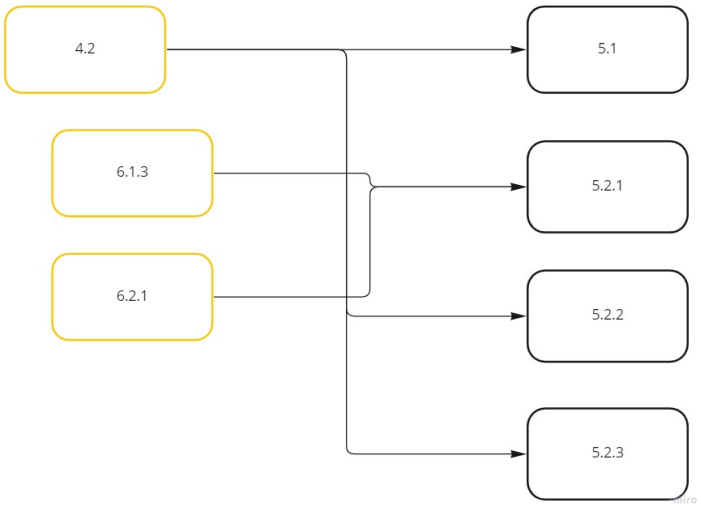

Figure 6: Section 5 - Procurement Network Diagram

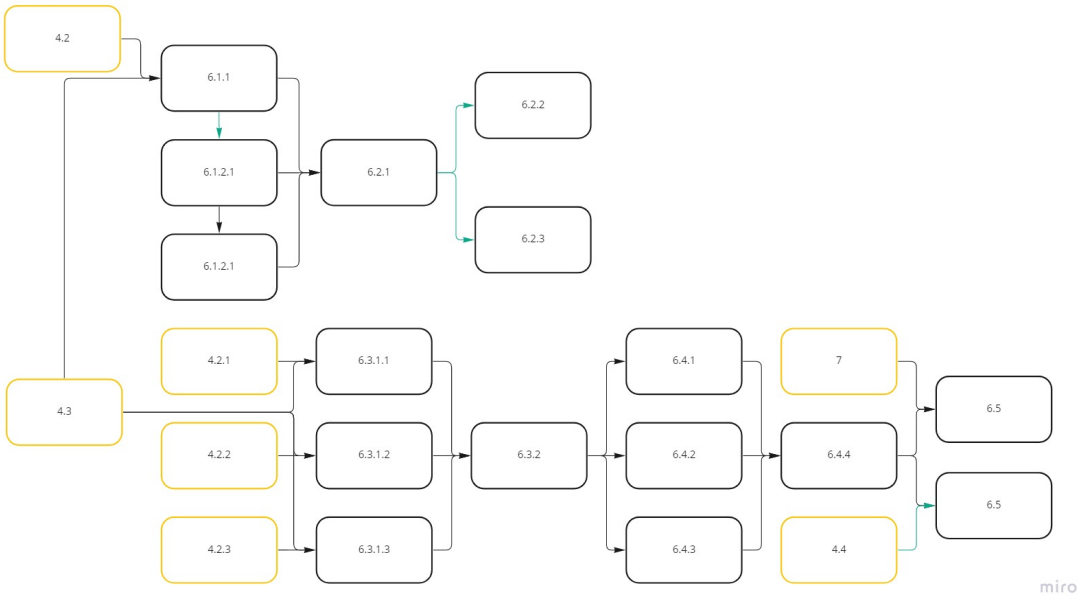

Figure 7: Section 6 - Prototype Network Diagram

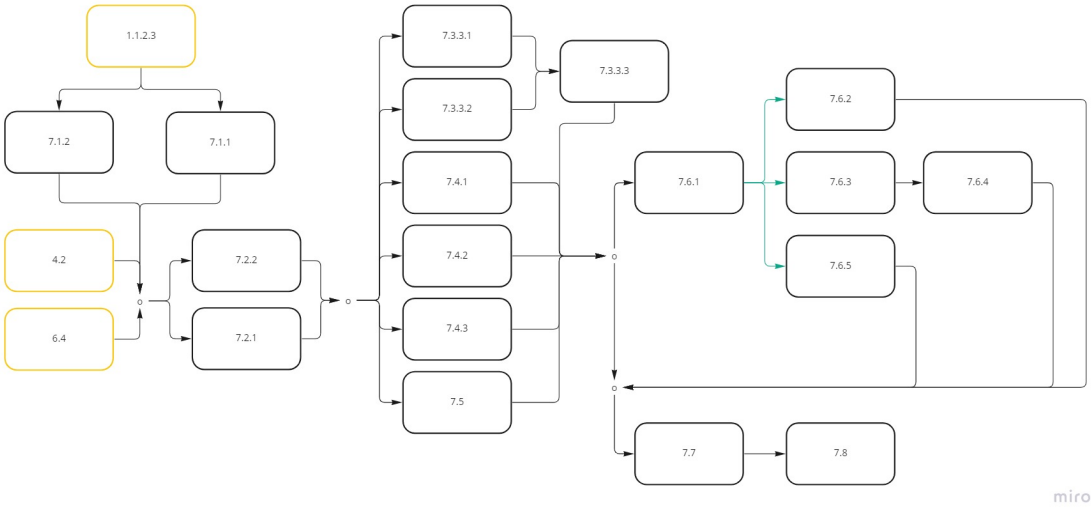

Figure 8: Section 7 - Testing Network Diagram

4 Estimate activity resources

4.1 Resource identification

Table 6: List of resources.

Resource ID	Type of resource	Resource Description	Comments
PR-1.1	People	Project Manager	Project manager with high management skills and experience in other engineering project.
PR-1.2	People	Project Secretary	Assistant to the project manager with administrative tasks mainly.
PR-1.3	People	Project Support	Assistant to the project management.
PR-1.4	People	Risk Assessment delegate	Risk Management assessor inside the Project Management staff.
PR-1.5	People	Financial Manager	Experienced in financial management with knowledge in finances. Responsible of project accounting.
PR-1.6	People	Comm. Manager	Person in charge of facilitating communications between the members of the consortium, as well as external communication.

PR-1.7	People	Marketing Manager	Responsible of developing market initial research, marketing actions key performance indicators identification and success evaluation.
PR-1.8	People	Commercial Manager	Person in charge of facilitating external communication and relationship with supply and equipment providers.
PR-1.9	People	Legal Advisor	Responsible of obtainment and maintenance of legal certification and validation in order to develop the activities.
TR-1.1	People	Space Engineer	With knowledge and experience on tracking satellites. Responsible of research and mechanical design.
TR-1.2	People	Optics Engineer (Laser)	With knowledge and experience on laser design. Responsible of research and laser design (assembly and testing).
TR-1.3	People	Optics Engineer (Mirror)	With knowledge and experience on mirror design. Responsible of research and mirror design (assembly and testing).

TR-1.4	People	Software Engineer	With knowledge and experience on tracking and optics software. Responsible of research, software design (implementation, testing and integration).
TR-1.5	People	Systems Engineer	With knowledge and experience on systems engineering. Responsible of system integration and assembly.
TR-1.6	People	Electronics Engineer	With knowledge and experience on electronics engineering. Responsible of electronics manufacturing and assembly.
TR-1.7	People	Physics Engineer	With knowledge and experience on systems mechanical design.
TR-1.8	People	Quality Manager	With experience with quality planning, standard evaluation and improvement.
TR-1.9	People	Maintenance Manager	With experience on laser equipment maintenance. Responsible of planning, doing checklists and periodic maintenance.
TR-1.10	People	Procurement Manager	Responsible of ensuring procurement of all activities, working along with Maintenance Manager and with experience on laser equipment.

TR-1.11	People	Mechanical Jr Engineer	Mechanical engineer responsible of doing the mechanical test.
TR-1.12	People	Operations Manager	Engineer with experience on laser equipment and tracking operations. Responsible of planning and monitoring testing,operations, analyzing the results and extracting conclusions.
TR-1.13	People	Testing Assistant	With experience on laser equipment and tracking operations. Responsible of reviewing testing operations, analyze the results and extract conclusions.
TR-1.14	People	Thermal Engineer	With experience on heat transfer analysis responsible of doing the thermal test.
TR-1.15	People	Environmental Jr Engineer	Environmental engineer responsible of doing the environmental study.
CR-1.1	Equipment	Computers	High performing computers to allow the personal developing the tasks properly.
CR-1.2	Equipment	Electronics Equipment	Tools to carry out electronic assembly of the laser and mirror design.

CR-1.3	Equipment	Testing Equipment	Instrumental tools to carry out the testing operations.
CR-1.4	Equipment	Tracking Software	Licensed software used for tracking and laser clean debris operations.
CR-1.5	Equipment	Laser Equipment	Tools needed to build-up the laser design.
CR-1.6	Equipment	Mirror Equipment	Tools needed to build-up the mirror design.
CR-1.7	Equipment	Telecomm. Equipment	Equipment incorporated to the assembly in order to track the satellite location at any time such as antennas.
CR-1.8	Equipment	Assembly Equipment	Equipment necessary to carry out the assembly properly.
CR-1.9	Equipment	Microsoft Office	Licensed software such as Excel or Word used as a tool for the Project Management staff.
CR-1.10	Equipment	Matlab	Licensed software to carry out the essential orbital satellite trajectory calculations at any time as well as read the lectures of the laser activity.

CR-1.11	Equipment	Python	Licensed software such as Python to process and store the tracking operations data properly.
SR-1.1	Supplies	Office equipment	Generic offices supplies to allow the staff working properly.
SR-1.2	Supplies	Energy	Electricity energy to operate all the devices properly
SR-1.3	Supplies	Internet Connection	Access to network to carry out the needed Project Management and Technical staff operations properly.
FR-1.1	Facility	Project Offices	Offices where the members of staff, PM & engineering in the company do the daily operations of the project.
FR-1.2	Facility	Telescope (IAC)	Laboratory where the laser infrastructure and Space Debris tracking systems are placed.
FR-1.3	Facility	Optics Lab. (TU Delft)	Laboratory where the laser cone direction mirrors are designed.
FR-1.4	Facility	Optics Lab. (UB)	Laboratory where the mechanical design of lasers is done.

FR-1.5	Facility	Manufacturing Lab. (CILAS)	Laboratory where the high power laser & mirror manufacturing is done.
FR-1.6	Facility	Design Lab. (ISAE-SUPAERO)	Laboratory where the high power laser & design is done. Operated by ISAE-SUPAERO.
FR-1.7	Facility	Assembly room	Facility where the different components of the main laser are assembled. Operated by OHB Systems AG.
FR-1.8	Facility	Electronics Lab. (RUAG)	Laboratory where the main laser electronics manufacturing is done.
IR-1.1	Infrastructure	Tracking Database	Database where essential tracking operations information is recorded.
IR-1.2	Infrastructure	Server Database	Server where all Project Management and Technical activity data is stored.

4.2 Activity Resource Requirement

All supplies comprising office equipment, energy and internet connection are resources supposed to be included in every activity resource requirement. Hence, they are not added at each task.

Table 7: List of activity resource requirement.

WBS-ID	Resource ID	Nº	Assumptions
1.1.1.1	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the General scope, description and objectives at the Project offices.
1.1.1.2	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Initial requirements and acceptance criteria at the Project offices.
1.1.1.3	PR-1.1 PR-1.2 PR-1.3 PR-1.4 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 1 6 6 1 1	The Project Managers, secretaries, support and risk assessment delegate work on the High-level risks at the Project offices.
1.1.1.4	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Deliverables and milestones at the Project offices.
1.1.1.5	PR-1.1 PR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The Project Managers and financial manager work on the Estimated budget at the Project offices.

1.1.1.6	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Initial organisation at the Project offices.
1.1.1.7	PR-1.1 PR-1.2 PR-1.3 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 1 6 6 1 1	The Project Managers, secretaries, support and community manager work on the Stakeholders identification at the Project offices.
1.1.2.1	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Project Scope Statement at the Project offices.
1.1.2.1	PR-1.1 PR-1.2 PR-1.3 TR-1.1 TR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 2 2 9 9 1 1	The Project Managers, secretaries support, space and systems engineers work on the Product Scope Description at the Project offices.
1.1.2.2	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Deliverables at the Project offices.

1.1.2.3	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Acceptance criteria at the Project offices.
1.1.2.4	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Exclusions at the Project offices.
1.1.2.5	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Constraints at the Project offices.
1.1.3.1	PR-1.1 PR-1.2 PR-1.3 PR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 1 6 6 1 1	The Project Managers, secretaries, support and financial manager work on the Call requirements identification at the Project offices.
1.1.3.2	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Call documentation identification at the Project offices.

1.1.3.3	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Information gathering at the Project offices.
1.2.1.1	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Departments identification at the Project offices.
1.2.1.2	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Role identification at the Project offices.
1.2.1.3	PR-1.1 PR-1.2 PR-1.3 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 1 6 6 1 1	The Project Managers, secretaries, support and the community manager work on the Consortium relationship definition at the Project offices.
1.2.1.4	PR-1.1 PR-1.2 PR-1.3 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 1 6 6 1 1	The Project Managers, secretaries, support and the community manager work on the Stakeholders relationship definition at the Project offices.

1.2.1.5	PR-1.1 PR-1.2 PR-1.3 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 1 6 6 1 1	The Project Managers, secretaries, support and the community manager work on the External companies relationship definition at the Project offices.
1.2.2.1	PR-1.1 PR-1.2 PR-1.3 IR-1.2	2 2 1 1	The Project Managers, secretaries and support work on the Work Package identification at the Project offices.
1.2.2.2	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Task identification at the Project offices.
1.2.2.3	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Activities dependencies at the Project offices.
1.2.2.4	PR-1.1 PR-1.2 PR-1.3 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 5 5 1 1	The Project Managers, secretaries and support work on the Network diagram at the Project offices.

1.2.3.1	PR-1.1 PR-1.2 PR-1.3 TR-1.1 TR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 2 2 9 9 1 1	The Project Managers, secretaries, support, space and systems engineers work on the Resources identification at the Project offices.
1.2.3.2	PR-1.1 PR-1.2 PR-1.3 TR-1.1 TR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 2 2 9 9 1 1	The Project Managers, secretaries, support, space and systems engineers work on the Resources allocation at the Project offices.
1.2.4.1	PR-1.1 PR-1.2 PR-1.3 TR-1.1 TR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 2 2 9 9 1 1	The Project Managers, secretaries, support, space and systems engineers work on the Task duration estimation at the Project offices.
1.2.4.2	PR-1.1 PR-1.2 PR-1.3 TR-1.1 TR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 2 2 9 9 1 1	The Project Managers, secretaries, support, space and systems engineers work on the Gantt Diagram at the Project offices.
1.3.1.1	PR-1.1 PR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project Manager and the financial manager work on the Level of accuracy at the Project offices.

1.3.1.2	PR-1.1 PR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project Manager and the financial manager work on the Activity cost method selection at the Project offices.
1.3.1.3	PR-1.1 PR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project Manager and the financial manager work on the Activity cost computation at the Project offices.
1.3.2	PR-1.1 PR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project Manager and the financial manager work on the Cost baseline at the Project offices.
1.3.3	PR-1.1 PR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project Manager and the financial manager work on the Budget at completion at the Project offices.
1.3.4	PR-1.1 PR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project Manager, the financial manager and the community manager work on the Sources of funding identification at the Project offices.
1.3.5	PR-1.1 PR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project Manager and the financial manager work on the Feasibility study at the Project offices.

1.3.6	PR-1.1 PR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project Manager and the financial manager work on the Economic monitoring at the Project offices.
1.4.1	PR-1.1 PR-1.3 PR-1.4 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 3 3 1 1	One Project Manager, the project support and the risk assessment delegate work on the Risks identification at the Project offices.
1.4.2.1	PR-1.1 PR-1.3 PR-1.4 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 3 3 1 1	One Project Manager, the project support and the risk assessment delegate work on the Probability computation at the Project offices.
1.4.2.2	PR-1.1 PR-1.3 PR-1.4 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 3 3 1 1	One Project Manager, the project support and the risk assessment delegate work on the Impact analysis at the Project offices.
1.4.3.1	PR-1.1 PR-1.3 PR-1.4 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 3 3 1 1	One Project Manager, the project support and the risk assessment delegate work on the Risk management strategies identification at the Project offices.
1.4.3.2	PR-1.1 PR-1.3 PR-1.4 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 3 3 1 1	One Project Manager, the project support and the risk assessment delegate work on the Risk management strategies execution at the Project offices.

1.4.4	PR-1.1 PR-1.3 PR-1.4 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 3 3 1 1	One Project Manager, the project support and the risk assessment delegate work on the Risk monitoring definition at the Project offices.
1.5.1	PR-1.9 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The legal advisor works on the Security at the Project offices.
1.5.2	PR-1.9 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The legal advisor works on the Data privacy at the Project offices.
1.5.3	PR-1.9 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The legal advisor works on the Environment at the Project offices.
1.6.1.1	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Communication procedures definition of he Internal (CO-LSDD) at the Project offices.
1.6.1.2	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Contact points identification of the Internal (CO-LSDD) at the Project offices.

1.6.1.3	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the General information filtering of the Internal (CO-LSDD) at the Project offices.
1.6.1.4	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Meetings planning of the Internal (CO-LSDD) at the Project offices.
1.6.2.1	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Communication procedures definition of he Consortium at the Project offices.
1.6.2.2	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Contact points identification of the Consortium at the Project offices.
1.6.2.3	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the General information filtering of the Consortium at the Project offices.
1.6.2.4	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Meetings planning of the Consortium at the Project offices.

1.6.3.1	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Communication procedures definition of he Stakeholders at the Project offices.
1.6.3.2	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Contact points identification of the Stakeholders at the Project offices.
1.6.3.3	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Sensitive information filtering of the Stakeholders at the Project offices.
1.6.3.4	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Meetings planning of the Stakeholders at the Project offices.
1.6.4.1	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Communication procedures definition of the External companies at the Project offices.
1.6.4.2	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Contact points identification of the External companies at the Project offices.

1.6.4.3	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Sensitive information filtering of the External companies at the Project offices.
1.6.4.4	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Meetings planning of the External companies at the Project offices.
1.6.5.1	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Information gathering of the Monthly report at the Project offices.
1.6.5.2	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Main information identification of the Monthly report at the Project offices.
1.6.6.1	PR-1.2 PR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The project secretaries and the communications manager work on the Main information identification of the Biannual report at the Project offices.
2.1	PR-1.9 TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	The legal advisor and the Environmental Jr engineer work on the Environmental policy at the Project offices.

2.2.1.1	TR-1.2 TR-1.3 TR-1.5 TR-1.6 TR-1.7 TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 2 2 2 2 1 10 10 1 1	The environmental Jr engineer, optics, systems, electronics and physics engineers work on the Materials environmental impact at the Project offices.
2.2.1.2	TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The environmental Jr engineer works on the Industrial processes environmental impact at the Project offices.
2.2.1.3	TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The environmental Jr engineer works on the Waste management environmental impact at the Project offices.
2.2.2.1	TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The environmental Jr engineer works on the Location ecology study at the Project offices.
2.2.2.2	TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The environmental Jr engineer and the optics engineer work on the Laser operation socio-economic study at the Project offices.
2.2.2.3	TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 9 1 1	The environmental Jr engineer works on the Facility maintenance at the Project offices.

2.2.3	TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The environmental Jr engineer works on the Logistics footprint at the Project offices.
2.3	TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The environmental Jr engineer works on the Report of the Environmental study at the Project offices.
2.4	TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The environmental Jr engineer works on the Non-conformance and corrective/preventive actions of the Environmental study at the Project offices.
2.5	TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The environmental Jr engineer works on the Training and awareness actions of the Environmental study at the Project offices.
2.6	TR-1.15 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The environmental Jr engineer works on the Monitoring and control of critical areas of the Environmental study at the Project offices.
3.1.1	PR-1.1 PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project manager and the the marketing manager work on the Market evolution at the Project offices.
3.1.2	PR-1.1 PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project manager and the the marketing manager work on the Offer and demand analysis at the Project offices.

3.1.3	PR-1.1 PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project manager and the the marketing manager work on the Market forecast at the Project offices.
3.1.4	PR-1.1 PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project manager and the the marketing manager work on the SWOT analysis at the Project offices.
3.1.5	PR-1.1 PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project manager and the the marketing manager work on the Business case at the Project offices.
3.2.1	PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The marketing manager works on the Objectives definition at the Project offices.
3.2.2	PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The community and marketing managers work on the Congress/Fairs attendance at the Project offices.
3.2.3	PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The community and marketing managers work on the Media presence at the Project offices.
3.2.4	PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The community and marketing managers work on the Social media management at the Project offices.

3.2.5	PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 1 1	The community and marketing managers work on the Space debris awareness campaigns at the Project offices.
3.3	PR-1.1 PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project manager and the the marketing manager work on the Key performance indicators identification at the Project offices.
3.4	PR-1.1 PR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 2 2 1 1	One Project manager and the the marketing manager work on the Success evaluation at the Project offices.
4.1.1	TR-1.1 TR-1.2 TR-1.3 TR-1.4 TR-1.5 TR-1.6 TR-1.7 TR-1.11 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 2 2 2 1 1 1 13 13 1 1	The space, optics, systems, software electronics, physics and mechanical Jr engineer work on the Research protocol at the Project offices.
4.1.2	TR-1.1 TR-1.2 TR-1.3 TR-1.4 TR-1.5 TR-1.6 TR-1.7 TR-1.11 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 2 2 2 1 1 1 13 13 1 1	The space, optics, systems, software electronics, physics and mechanical Jr engineer work on the State of the art review at the Project offices.

4.1.3	PR-1.3 TR-1.1 TR-1.2 TR-1.3 TR-1.4 TR-1.5 TR-1.6 TR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 2 2 2 2 2 2 1 14 14 1 1	The project support and space, optics, systems, software, electronics and physics engineer work on the technical Quality assessment at the Project offices.
4.1.4	PR-1.1 TR-1.1 TR-1.2 TR-1.3 TR-1.5 TR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 2 2 2 2 1 10 10 1 1	One project manager and space, optics, systems and physics engineer work on the Reverse engineering the Project offices.
4.1.5	TR-1.1 TR-1.2 TR-1.3 TR-1.4 TR-1.5 TR-1.6 TR-1.7 TR-1.11 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 2 2 2 1 1 1 13 13 1 1	The space, optics, systems, software electronics, physics and mechanical Jr engineer work on the Technical Report at the Project offices.

4.2.1.1	TR-1.2	2	The optics, physics, systems and mechanical Jr engineers work on the Preliminary mechanical design at the Optics Laboratory (UB).
	TR-1.3	2	
	TR-1.5	2	
	TR-1.7	1	
	TR-1.11	1	
	CR-1.1	8	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.9	8	
	CR-1.10	8	
	FR-1.4	1	
	IR-1.2	1	
4.2.1.2	TR-1.2	2	The optics, physics, systems and mechanical Jr engineers work on the Parts definition & list of the Mechanical design at the Optics Laboratory (UB).
	TR-1.3	2	
	TR-1.5	2	
	TR-1.7	1	
	TR-1.11	1	
	CR-1.1	8	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.9	8	
	FR-1.4	1	
	IR-1.2	1	
4.2.1.3	TR-1.2	2	The optics, physics, systems and mechanical Jr engineers work on the Basic part layout of the Mechanical design at the Optics Laboratory (UB).
	TR-1.3	2	
	TR-1.5	2	
	TR-1.7	1	
	TR-1.11	1	
	CR-1.1	8	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.9	8	
	CR-1.10	8	
	FR-1.4	1	
	IR-1.2	1	

4.2.1.4	TR-1.2 TR-1.3 TR-1.5 TR-1.7 TR-1.11 CR-1.1 CR-1.5 CR-1.6 CR-1.9 CR-1.10 FR-1.4 IR-1.2	2 2 2 1 1 8 1 1 8 8 1 1	The optics, physics, systems and mechanical Jr engineers work on the Mechanical assembly scheme at the Optics Laboratory (UB).
4.2.2.1	TR-1.2 CR-1.1 CR-1.9 CR-1.5 CR-1.10 FR-1.6 IR-1.2	2 2 2 1 2 1 1	The laser optics engineers work on the High power laser diode design at the Design Laboratory (ISAE-SUPAERO).
4.2.2.2	TR-1.2 CR-1.1 CR-1.9 CR-1.5 CR-1.10 FR-1.6 IR-1.2	2 2 2 1 2 1 1	The laser optics engineers work on the Wavelength stabilizer at the Design Laboratory (ISAE-SUPAERO).
4.2.2.3	TR-1.2 CR-1.1 CR-1.9 CR-1.5 CR-1.10 FR-1.6 IR-1.2	2 2 2 1 2 1 1	The laser optics engineers work on the Heavy duty power supply at the Design Laboratory (ISAE-SUPAERO).
4.2.2.4	TR-1.2 CR-1.1 CR-1.9 CR-1.5 CR-1.10 FR-1.6 IR-1.2	2 2 2 1 2 1 1	The laser optics engineers work on the Laser lens design at the Design Laboratory (ISAE-SUPAERO).

4.2.2.5	TR-1.2 CR-1.1 CR-1.9 CR-1.5 CR-1.10 FR-1.6 IR-1.2	2 2 2 1 2 1 1	The laser optics engineers work on the Laser assembly scheme at the Design Laboratory (ISAE-SUPAERO).
4.2.3.1	TR-1.3 CR-1.1 CR-1.9 CR-1.6 CR-1.10 FR-1.3 IR-1.2	2 2 2 1 2 1 1	The mirror optics engineers work on the Mirror shape design at the Optics Laboratory (TU Delft).
4.2.3.2	TR-1.3 CR-1.1 CR-1.9 CR-1.6 CR-1.10 FR-1.3 IR-1.2	2 2 2 1 2 1 1	The mirror optics engineers work on the Mirror material selection at the Optics Laboratory (TU Delft).
4.2.3.3	TR-1.2 CR-1.1 CR-1.9 CR-1.6 CR-1.10 FR-1.3 IR-1.2	2 2 2 1 2 1 1	The mirror optics engineers work on the Surface treatment & coating at the Optics Laboratory (TU Delft).
4.2.3.4	TR-1.3 CR-1.1 CR-1.9 CR-1.6 CR-1.10 FR-1.3 IR-1.2	2 2 2 1 2 1 1	The mirror optics engineers work on the Mirror assembly scheme design at the Optics Laboratory (TU Delft).

4.2.4.1	TR-1.4 CR-1.1 CR-1.4 CR-1.9 CR-1.10 FR-1.1 IR-1.2	2 2 2 2 2 1 1	The software engineers work on the software planning at the Project offices.
4.2.4.2	TR-1.4 CR-1.1 CR-1.4 CR-1.9 CR-1.10 FR-1.1 IR-1.2	2 2 2 2 2 1 1	The software engineers work on the software analysis at the Project offices.
4.2.4.3	TR-1.4 CR-1.1 CR-1.2 CR-1.4 CR-1.7 CR-1.8 CR-1.9 CR-1.10 FR-1.7 IR-1.2	2 2 1 2 1 1 2 2 1 1	The software engineers work on the software implementation at the assembly room.
4.2.4.4	TR-1.4 CR-1.1 CR-1.2 CR-1.4 CR-1.7 CR-1.8 CR-1.9 CR-1.10 CR-1.11 FR-1.2 IR-1.1 IR-1.2	2 2 1 2 1 1 2 2 2 1 1 1	The software engineers work on the software testing & integration at the Telescope (IAC).
4.3.1	TR-1.8 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The quality manager works on the Quality standard definition at the Telescope (IAC).

4.3.2	TR-1.8 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The quality manager works on the Quality plan at the Telescope (IAC).
4.3.3	TR-1.8 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The quality manager works on the Quality review at the Telescope (IAC).
4.3.4	TR-1.8 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The quality manager works on the Quality standard evaluation at the Telescope (IAC).
4.3.5	TR-1.8 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The quality manager works on the Quality improvement at the Telescope (IAC).
4.4.1	TR-1.9 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The maintenance manager works on the maintenance plan at the Telescope (IAC).
4.4.2	TR-1.9 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The maintenance manager works on the maintenance checklist at the Telescope (IAC).
4.4.3	TR-1.9 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The maintenance manager works on the maintenance program at the Telescope (IAC).

4.4.4.1	TR-1.9 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The maintenance manager works on the short-term maintenance at the Telescope (IAC).
4.4.4.2	TR-1.9 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The maintenance manager works on the long-term maintenance at the Telescope (IAC).
4.5.1	TR-1.2 TR-1.3 TR-1.5 TR-1.6 TR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 2 1 8 8 1 1	The optics, systems, electronics and physics engineers and quality manager work on the List of ISO norms for design at the Project offices.
4.5.2	TR-1.2 TR-1.3 TR-1.5 TR-1.6 TR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 2 1 8 8 1 1	The optics, systems, electronics and physics engineers and quality manager work on the Non-ISO design certifications at the Project offices.
5.1	TR-1.10 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The procurement manager works on the definition of specifications of procurement at the Project offices.

5.2.1	TR-1.6 TR-1.10 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The procurement manager and the electronics engineer work on the electronics procurement guide at the Project offices.
5.2.2	TR-1.2 TR-1.3 TR-1.5 TR-1.7 TR-1.10 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 2 1 1 8 8 1 1	The procurement manager and optics, systems and physics engineers work on the integration procurement guide at the Project offices.
5.2.3	TR-1.6 TR-1.10 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 1 3 3 1 1	The procurement and commercial managers work on the logistics procurement guide at the Project offices.
5.3.1.1	PR-1.8 TR-1.6 CR-1.1 CR-1.9 CR-1.10 FR-1.1 IR-1.2	1 2 3 3 2 1 1	The commercial manager and electronics engineers work on the materials analysis of electronics at the Project offices.
5.3.1.2	PR-1.8 TR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 2 3 3 1 1	The commercial manager and electronics engineers work on the existing stock prioritization of electronics at the Project offices.
5.3.1.3	PR-1.8 TR-1.6 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 2 3 3 1 1	The commercial manager and electronics engineers work on the minimum lot-sizes of electronics at the Project offices.

5.3.2.1	PR-1.8 TR-1.2 TR-1.3 TR-1.5 TR-1.7 TR-1.11 CR-1.1 CR-1.9 CR-1.10 FR-1.1 IR-1.2	1 2 2 2 1 1 9 9 8 1 1	The commercial manager and optics, physics, systems and mechanical Jr engineers work on the materials analysis of mechanical design at the Project offices.
5.3.2.2	PR-1.8 TR-1.2 TR-1.3 TR-1.5 TR-1.7 TR-1.11 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 2 2 2 1 1 9 9 1 1	The commercial manager and optics, physics, systems and mechanical Jr engineers work on the existing stock prioritization of mechanical design at the Project offices.
5.3.2.3	PR-1.8 TR-1.2 TR-1.3 TR-1.5 TR-1.7 TR-1.11 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 2 2 2 1 1 9 9 1 1	The commercial manager and optics, physics, systems and mechanical Jr engineers work on the minimum lot-sizes of mechanical design at the Project offices.
5.3.3	PR-1.8 TR-1.5 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 2 3 3 1 1	The commercial manager and systems engineers work on the integration suppliers list at the Project offices.
5.3.4	PR-1.8 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The commercial manager works on the Logistics suppliers list at the Project offices.

6.1.1	TR-1.8 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The quality manager works on the Quality standards for prototyping at the Telescope (IAC).
6.1.2.1	PR-1.8 TR-1.2 TR-1.3 TR-1.5 TR-1.6 TR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 2 2 2 2 1 10 10 1 1	The commercial manager, optics, systems, electronics and physics engineers work on the Prototype manufacturing proposal for prototyping at the Project offices.
6.1.2.2	PR-1.8 TR-1.2 TR-1.3 TR-1.5 TR-1.6 TR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 2 2 2 2 1 10 10 1 1	The commercial manager, optics, systems, electronics and physics engineers work on the Prototype Budget proposal at the Project offices.
6.1.3	PR-1.8 CR-1.1 CR-1.9 FR-1.1 IR-1.2	1 1 1 1 1	The commercial manager works on the Prototype provider selection for at the Project offices.
6.2.1	PR-1.8 TR-1.2 TR-1.3 TR-1.5 TR-1.6 TR-1.7 CR-1.1 CR-1.9 CR-1.10 FR-1.1 IR-1.2	1 2 2 2 2 1 10 10 9 1 1	The commercial manager and the optics, systems, electronics and physics engineers work on the Prototype Material Viability analysis at the Project offices.

6.2.2	PR-1.8	1	The commercial manager and the optics, systems, electronics and physics engineers work on the Prototype Small-scale material analysis at the Telescope (IAC).
	TR-1.2	2	
	TR-1.3	2	
	TR-1.5	2	
	TR-1.6	2	
	TR-1.7	1	
	CR-1.1	10	
	CR-1.2	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	10	
	CR-1.10	9	
	FR-1.2	1	
	IR-1.2	1	
6.2.3	PR-1.8	1	The commercial manager and the optics, systems, electronics and physics engineers work on the Prototype Scalability material analysis at the Telescope (IAC).
	TR-1.2	2	
	TR-1.3	2	
	TR-1.5	2	
	TR-1.6	2	
	TR-1.7	1	
	CR-1.1	10	
	CR-1.2	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	10	
	CR-1.10	9	
	FR-1.2	1	
	IR-1.2	1	
6.3.1.1	TR-1.2	2	The optics, systems, physics and mechanical Jr engineers work on the Mechanical manufacturing at the Manufacturing Lab. (CILAS).
	TR-1.3	2	
	TR-1.5	2	
	TR-1.7	1	
	TR-1.11	1	
	CR-1.1	8	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.9	8	
	CR-1.10	8	
	FR-1.5	1	
	IR-1.2	1	

6.3.1.2	TR-1.2 CR-1.1 CR-1.5 CR-1.9 CR-1.10 FR-1.5 IR-1.2	2 2 1 2 2 1 1	The laser optics engineers work on the Laser manufacturing at the Manufacturing laboratory (CILAS).
6.3.1.3	TR-1.3 CR-1.1 CR-1.6 CR-1.9 CR-1.10 FR-1.5 IR-1.2	2 2 1 2 2 1 1	The mirror optics engineers work on the Mirror manufacturing at the Manufacturing laboratory (CILAS).
6.3.2	TR-1.3 CR-1.1 CR-1.2 CR-1.7 CR-1.8 FR-1.8 IR-1.2	2 2 1 1 1 1 1	The software, systems, electronics, physics engineers work on the Assembly with electronics at the Electronics laboratory (RUAG).
6.4.1	TR-1.2 TR-1.3 TR-1.5 TR-1.6 TR-1.7 TR-1.12 CR-1.1 CR-1.5 CR-1.6 CR-1.8 CR-1.9 CR-1.10 FR-1.7 IR-1.2	2 2 2 2 1 1 10 1 1 1 10 10 1 1	The optics, physics, systems and mechanical Jr engineers work on the Prototype Mechanical assembly at the assembly room.
6.4.2	TR-1.2 CR-1.1 CR-1.5 CR-1.8 CR-1.9 CR-1.10 FR-1.7 IR-1.2	2 2 1 1 1 1 1 1	The laser optics engineers work on the Prototype laser assembly at the assembly room.

6.4.3	TR-1.3	2	The mirror optics engineers work on the Prototype mirror assembly at the assembly room.
	CR-1.1	2	
	CR-1.6	1	
	CR-1.8	1	
	CR-1.9	2	
	CR-1.10	2	
	FR-1.7	1	
	IR-1.2	1	
6.4.4	TR-1.5	2	The systems, electronics and physics engineers work on the Prototype integration at the assembly room.
	TR-1.6	2	
	TR-1.7	1	
	CR-1.1	5	
	CR-1.2	1	
	CR-1.4	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	2	
	CR-1.10	2	
	FR-1.7	1	
	IR-1.2	1	
6.5	TR-1.1	2	The space, optics, software, systems, electronics, physics engineers, operations manager and testing assistant work on the Prototype testing at the Telescope (IAC).
	TR-1.2	2	
	TR-1.3	2	
	TR-1.4	2	
	TR-1.5	2	
	TR-1.6	2	
	TR-1.7	1	
	TR-1.12	1	
	TR-1.13	1	
	CR-1.1	15	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.4	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	15	
	CR-1.10	15	
	CR-1.11	15	
	FR-1.2	1	
	IR-1.1	1	
	IR-1.2	1	

6.6	TR-1.9 CR-1.1 CR-1.9 FR-1.2 IR-1.2	1 1 1 1 1	The maintenance manager works on the maintenance root cause analysis at the Telescope (IAC).
7.1.1	TR-1.2 TR-1.3 TR-1.5 TR-1.6 TR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 2 1 8 8 1 1	The optics, systems, electronics and physics engineers and quality manager work on the List of ISO norms at the Project offices.
7.1.2	TR-1.2 TR-1.3 TR-1.5 TR-1.6 TR-1.7 CR-1.1 CR-1.9 FR-1.1 IR-1.2	2 2 1 2 1 8 8 1 1	The optics, systems, electronics and physics engineers and quality manager work on the Non-ISO requirements at the Project offices.
7.2.1	TR-1.1 TR-1.2 TR-1.3 TR-1.4 TR-1.5 TR-1.6 TR-1.7 TR-1.11 TR-1.12 TR-1.13 CR-1.1 CR-1.2 CR-1.3 CR-1.4 CR-1.5 CR-1.6 CR-1.7 CR-1.8 CR-1.9 CR-1.10 CR-1.11 FR-1.2	2 2 2 2 2 2 1 1 1 1 16 1 1 1 1 1 1 1 16 16 16 1	The space, optics, software, systems, electronics, physics and mechanical Jr engineers, operations manager and testing assistant work on the Test procedures at the Telescope (IAC).

	IR-1.1	1	
	IR-1.2	1	
	TR-1.1	2	The space, optics, software, systems, electronics, physics and mechanical Jr engineers operations manager and testing assistant work on the Test reporting at the Telescope (IAC).
	TR-1.2	2	
	TR-1.3	2	
	TR-1.4	2	
	TR-1.5	2	
	TR-1.6	2	
	TR-1.7	1	
	TR-1.11	1	
	TR-1.12	1	
	TR-1.13	1	
7.2.2	CR-1.1	16	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.4	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	16	
	CR-1.10	16	
	CR-1.11	16	
	FR-1.2	1	
	IR-1.1	1	
	IR-1.2	1	
	TR-1.12	1	The mechanical Jr engineer works on the Stress test at the assembly room.
	CR-1.1	1	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.5	1	
	CR-1.6	1	
7.3.1	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	1	
	CR-1.10	1	
	FR-1.7	1	
	IR-1.2	1	

7.3.2	TR-1.12	1	The mechanical Jr engineer works on the Strain test at the assembly room.
	CR-1.1	1	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	1	
	CR-1.10	1	
	FR-1.7	1	
	IR-1.2	1	
7.3.3.1	TR-1.12	1	The mechanical Jr engineer works on the Sine vibration - fixed frequency analysis at the assembly room.
	CR-1.1	1	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	1	
	CR-1.10	1	
	FR-1.7	1	
	IR-1.2	1	
7.3.3.2	TR-1.12	1	The mechanical Jr engineer works on the Random vibration - Random frequency analysis at the assembly room.
	CR-1.1	1	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	1	
	CR-1.10	1	
	FR-1.7	1	
	IR-1.2	1	

7.3.3.3	TR-1.12	1	The mechanical Jr engineer works on the Frequency spectrum diagram at the assembly room.
	CR-1.1	1	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	1	
	CR-1.10	1	
	FR-1.7	1	
	IR-1.2	1	
7.4.1	TR-1.14	1	The thermal engineer works on the laser system heat transfer analysis at assembly room.
	CR-1.1	1	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	1	
	CR-1.10	1	
	FR-1.7	1	
	IR-1.2	1	
7.4.2	TR-1.14	1	The thermal engineer works on the electronics heat transfer analysis at assembly room.
	CR-1.1	1	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	1	
	CR-1.10	1	
	FR-1.7	1	
	IR-1.2	1	

7.4.3	TR-1.14	1	The thermal engineer works on the cooling systems test at assembly room.
	CR-1.1	1	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	1	
	CR-1.10	1	
	FR-1.7	1	
	IR-1.2	1	
7.5	TR-1.4	2	The software engineers works on the software test at the Telescope (IAC).
	CR-1.1	2	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.4	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	2	
	CR-1.10	2	
	CR-1.11	2	
	FR-1.2	1	
	IR-1.1	1	
	IR-1.2	1	
7.6.1	TR-1.1	2	The space, optics, software, systems, electronics and physics engineers, operations manager and testing assistant work on the Power output test at the Telescope (IAC).
	TR-1.2	2	
	TR-1.3	2	
	TR-1.4	2	
	TR-1.5	2	
	TR-1.6	2	
	TR-1.7	1	
	TR-1.12	1	
	TR-1.13	1	
	CR-1.1	15	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.4	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	15	
	CR-1.10	15	
	FR-1.2	1	

	IR-1.2	1	
7.6.2	TR-1.1 TR-1.2 TR-1.3 TR-1.4 TR-1.5 TR-1.6 TR-1.7 TR-1.12 TR-1.13 CR-1.1 CR-1.2 CR-1.3 CR-1.4 CR-1.5 CR-1.6 CR-1.7 CR-1.8 CR-1.9 CR-1.10 FR-1.2 IR-1.2	2 2 2 2 2 2 1 1 1 15 1 1 1 1 1 1 1 15 15 1 1	The space, optics, software, systems, electronics and physics engineers, operations manager and testing assistant work on the Wavelength oscillation test at the Telescope (IAC).
7.6.3	TR-1.1 TR-1.2 TR-1.3 TR-1.4 TR-1.5 TR-1.6 TR-1.7 TR-1.12 TR-1.13 CR-1.1 CR-1.2 CR-1.3 CR-1.4 CR-1.5 CR-1.6 CR-1.7 CR-1.8 CR-1.9 CR-1.10 FR-1.2 IR-1.2	2 2 2 2 2 2 1 1 1 15 1 1 1 1 1 1 1 15 15 1 1	The space, optics, software, systems, electronics and physics engineers, operations manager and testing assistant work on the Beam divergence test at the Telescope (IAC).

7.6.4	TR-1.1	2	The space, optics, software, systems, electronics and physics engineers, operations manager and testing assistant work on the Beam Parameter Product test at the Telescope (IAC).
	TR-1.2	2	
	TR-1.3	2	
	TR-1.4	2	
	TR-1.5	2	
	TR-1.6	2	
	TR-1.7	1	
	TR-1.12	1	
	TR-1.13	1	
	CR-1.1	15	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.4	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	15	
	CR-1.10	15	
	FR-1.2	1	
	IR-1.2	1	
7.6.5	TR-1.1	2	The space, optics, software, systems, electronics and physics engineers, operations manager and testing assistant work on the Power loss test at the Telescope (IAC).
	TR-1.2	2	
	TR-1.3	2	
	TR-1.4	2	
	TR-1.5	2	
	TR-1.6	2	
	TR-1.7	1	
	TR-1.12	1	
	TR-1.13	1	
	CR-1.1	15	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.4	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	15	
	CR-1.10	15	
	FR-1.2	1	
	IR-1.2	1	

7.7	TR-1.1	2	The space, optics, software, systems, electronics and physics engineers, operations manager and testing assistant work on the Comparison to numerical results at the Telescope (IAC).
	TR-1.2	2	
	TR-1.3	2	
	TR-1.4	2	
	TR-1.5	2	
	TR-1.6	2	
	TR-1.7	1	
	TR-1.12	1	
	TR-1.13	1	
	CR-1.1	15	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.4	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	15	
	CR-1.10	15	
	CR-1.11	15	
	FR-1.2	1	
	IR-1.1	1	
	IR-1.2	1	

7.8	TR-1.1	2	The space, optics, software, systems, electronics and physics engineers, operations manager and testing assistant work on the Data adjusting & result verification at the Telescope (IAC).
	TR-1.2	2	
	TR-1.3	2	
	TR-1.4	2	
	TR-1.5	2	
	TR-1.6	2	
	TR-1.7	1	
	TR-1.12	1	
	TR-1.13	1	
	CR-1.1	15	
	CR-1.2	1	
	CR-1.3	1	
	CR-1.4	1	
	CR-1.5	1	
	CR-1.6	1	
	CR-1.7	1	
	CR-1.8	1	
	CR-1.9	15	
	CR-1.10	15	
	CR-1.11	15	
	FR-1.2	1	
	IR-1.1	1	
	IR-1.2	1	

4.3 Resource Breakdown Structure

1. Project
    - 1.1 People
        - 1.1.1 Project Management Staff
            - 1.1.1.1 Project Manager (2)
            - 1.1.1.2 Project Secretary (2)
            - 1.1.1.3 Project Support (1)
            - 1.1.1.4 Risk Assessment delegate (1)
            - 1.1.1.5 Financial Manager (1)
            - 1.1.1.6 Community Manager (1)
            - 1.1.1.7 Marketing Manager (1)
            - 1.1.1.8 Commercial Manager (1)
            - 1.1.1.9 Legal Advisor (1)
        - 1.1.2 Technical Staff
            - 1.1.2.1 Space Engineer (2)
            - 1.1.2.2 Optics Engineer (Laser) (2)
            - 1.1.2.3 Optics Engineer (Mirror) (2)
            - 1.1.2.4 Software Engineer (2)
            - 1.1.2.5 Systems Engineer (2)
            - 1.1.2.6 Electronics Engineer (2)
            - 1.1.2.7 Physics Engineer (1)
            - 1.1.2.8 Quality Manager (1)
            - 1.1.2.9 Maintenance Manager (1)
            - 1.1.2.10 Procurement Manager (1)
            - 1.1.2.11 Mechanical Jr Engineer (1)
            - 1.1.2.12 Operations Manager (1)
            - 1.1.2.13 Testing Assistant (1)
            - 1.1.2.14 Thermal Engineer (1)
            - 1.1.2.15 Environmental Jr Engineer (1)
    - 1.2 Equipment
        - 1.2.1 Computers (32)
        - 1.2.2 Electronics Equipment (1)
        - 1.2.3 Testing Equipment (1)
        - 1.2.4 Tracking Software (License) (6)
        - 1.2.5 Laser Equipment (1)
        - 1.2.6 Mirror Equipment (1)
        - 1.2.7 Telecommunications Equipment (1)
        - 1.2.8 Assembly Equipment (1)
        - 1.2.9 Microsoft Office (License) (32)
        - 1.2.10 Matlab (License) (16)
        - 1.2.11 Python (License) (16)
    - 1.3 Supplies
        - 1.3.1 Office equipment
        - 1.3.2 Energy
        - 1.3.3 Internet Connection

5 Estimate activity duration

The computation of estimate activity duration is performed in three different techniques: parametric, analogous and three-point.

Parametric estimation is computed with an algorithm using historical data. Performance factor and availability are estimated to allow for possible unforeseen and to take in to account the availability of the resources.

For all three methods the estimation is always rounded to the top to be more conservative.

Table 8: List of activity parametric duration estimation (Part 1).

WBS ID	Effort hours	Resources	Available	Performance Factor	Duration Estimate (h)
1.1.1.1	30	3	1	0.8	10
1.1.1.2	16	5	1	0.8	4
1.1.1.3	20	4	1	0.8	5
1.1.1.4	10	8	1	0.8	2
1.1.1.5	25	4	0,9	0.7	7
1.1.1.6	10	10	0,8	0.7	2
1.1.1.7	15	7	0,8	0.7	3
1.1.2.1	100	1	0,9	0.9	112
1.1.2.2	70	2	0,9	0.9	39
1.1.2.3	200	1	0,9	0.8	223
1.1.2.4	50	3	0,9	0.8	19
1.1.2.5	50	3	0,9	0.8	19
1.1.3.1	5	64	0,9	0.9	1
1.1.3.2	1	288	1	1	1
1.1.3.3	100	4	0,8	0.7	32
1.2.1.1	6	24	0,8	0.9	1
1.2.1.2	24	5	0,9	0.8	6
1.2.1.3	5	26	0,9	0.9	1
1.2.1.4	5	26	0,9	0.9	1
1.2.1.5	5	26	0,9	0.9	1
1.2.2.1	4	160	0,9	0.8	1
1.2.2.2	12	21	0,9	0.7	1
1.2.2.3	12	16	0,9	0.9	1
1.2.2.4	3	64	0,9	1	1
1.2.3.1	25	8	0,9	0.8	4
1.2.3.2	10	13	0,9	0.9	1
1.2.4.1	12	16	0,9	0.9	1
1.2.4.2	12	11	0,9	0.9	2
1.3.1.1	10	10	0,9	0.9	2
1.3.1.2	15	9	0,9	0.9	2
1.3.1.3	100	2	0,9	0.7	56
1.3.2	20	16	0,9	0.7	2
1.3.3	150	2	0,9	0.7	84
1.3.4	15	21	0,9	0.7	1
1.3.5	24	13	0,9	0.8	3

Table 9: List of activity parametric duration estimation (Part 2).

WBS ID	Effort hours	Resources	Available	Performance Factor	Duration Estimate (h)
1.4.1	20	19	0,9	0.8	2
1.4.2.1	40	6	0,9	0.9	8
1.4.2.2	20	13	0,9	0.8	2
1.4.3.1	15	17	0,9	0.8	1
1.4.4	40	13	0,9	0.7	4
1.5.1	200	2	0,9	0.9	112
1.5.2	30	14	0,9	0.9	3
1.5.3	25	17	0,9	0.8	2
1.6.1.1	16	8	0,9	0.7	3
1.6.1.2	8	16	0,9	0.7	1
1.6.1.3	100	1	0,9	0.8	112
1.6.1.4	8	32	0,9	0.7	1
1.6.2.1	16	8	0,9	0.7	3
1.6.2.2	8	16	0,9	0.7	1
1.6.2.3	100	1	0,9	0.8	112
1.6.2.4	8	32	0,9	0.7	1
1.6.3.1	16	4	0,9	0.7	5
1.6.3.2	8	8	0,9	0.7	2
1.6.3.3	100	1	0,9	0.8	112
1.6.3.4	8	16	0,9	0.7	1
1.6.4.1	16	4	0,9	0.7	5
1.6.4.2	8	8	0,9	0.7	2
1.6.4.3	100	1	0,9	0.8	112
1.6.4.4	8	16	0,9	0.7	1
2.1	20	32	0,9	0.8	1
2.2.1.1	500	1	0,9	0.7	556
2.2.1.2	100	3	0,9	0.7	38
2.2.1.3	300	1	0,9	0.7	334
2.2.2.1	200	2	0,9	0.8	112
2.2.2.2	100	3	0,9	0.8	38
2.2.2.3	200	2	0,9	0.8	112
2.3	40	2	0,9	0.9	25
2.4	20	64	0,9	0.9	1
2.5	1000	1	0,9	0.7	1112
2.6	500	1	0,9	0.7	556
3.1.1	20	38	0,9	0.8	1
3.1.2	20	38	0,9	0.7	1
3.1.3	20	38	0,9	0.8	1
3.1.4	20	38	0,9	0.8	1
3.1.5	50	15	0,9	0.7	4
3.2.1	20	38	0,9	0.9	1
3.2.2	200	4	0,9	0.7	56
3.2.3	200	4	0,9	0.7	56
3.2.4	250	3	0,9	0.8	93
3.2.5	200	4	0,9	0.7	56

Table 10: List of activity parametric duration estimation (Part 3).

WBS ID	Effort hours	Resources	Available	Performance Factor	Duration Estimate (h)
3.3	20	128	0,9	0.9	1
3.4	50	51	0,9	0.8	2
4.1.1	100	17	0,9	0.8	7
4.1.2	50	35	0,9	0.8	2
4.1.3	2000	1	0,9	0.7	2223
4.1.4	500	3	0,9	0.8	186
4.1.5	1500	1	0,9	0.9	1667
4.2.1.1	500	8	0.9	0.9	77
4.2.1.2	50	8	0.9	0.8	9
4.2.1.3	2000	8	0.9	0.8	348
4.2.1.4	1000	8	0.9	0.8	174
4.3.1	80	1	0.9	0.9	99
4.3.2	20	1	0.9	0.9	25
4.3.3	100	1	0.9	0.8	139
4.4.1	150	1	0.9	0.9	185
5.1	300	1	0.8	0.7	536
5.2.1	150	1	0.9	0.9	185
5.2.2	150	1	0.9	0.9	185
5.2.3	150	1	0.9	0.9	185
6.1.1	20	1	0.9	0.9	25

Analogous estimations has been used with identical or very similar previous activities. A multiplier of 1.2 is applied to be conservative.

Table 11: List of activity analogous duration estimation.

WBS ID	Previous Activity	Previous Duration	Current Activity	Multiplier	Duration Estimate (h)
6.3.1.1	Similar mechanical manufacturing	160	Mechanical manufacturing	1.2	192
6.3.1.2	Laser manufacturing	480	Laser manufacturing	1.2	576
6.3.1.3	Mirror manufacturing	480	Mirror manufacturing	1.2	576
6.3.2	Electronics assembly	80	Assembly with electronics	1.2	80
6.4.1	Mechanical assembly	80	Mechanical assembly	1.2	80
6.4.2	Previous assembly	40	Laser assembly	1.2	48
6.4.3	Previous assembly	40	Mirror assembly	1.2	48
7.3.1	Stress tests	50	Stress test	1.2	60
7.3.2	Strain test	16	Strain test	1.2	20
7.3.3.1	Frequency analysis	8	Fixed frequency test	1.2	10
7.3.3.2	Frequency analysis	8	Random frequency test	1.2	10
7.3.3.3	Frequency analysis	6	Frequency spectrum diagram	1.2	8

With the three-point estimation is used a beta distribution (optimistic + 4*most likely + pessimistic)/6 to compute the estimate duration.

Table 12: List of activity three point duration estimation (Part 1).

WBS ID	Optimistic Duration	Most Likely Duration	Pessimistic Duration (h)	Weighting Equation	Duration Estimate (h)
1.1.3.4	50	90	100	Beta distribution	85
1.3.6	1000	2000	5000	Beta distribution	2334
1.4.3.2	100	500	1000	Beta distribution	517
4.2.2.1	100	200	300	Beta distribution	200
4.2.2.2	100	300	500	Beta distribution	300
4.2.2.3	50	100	300	Beta distribution	125
4.2.2.4	100	200	300	Beta distribution	200
4.2.2.5	50	100	300	Beta distribution	125
4.2.3.1	100	200	300	Beta distribution	200
4.2.3.2	100	300	500	Beta distribution	300
4.2.3.3	50	100	200	Beta distribution	200
4.2.3.4	50	100	300	Beta distribution	125
4.2.4.1	100	150	200	Beta distribution	150
4.2.4.2	1000	2000	2500	Beta distribution	1917
4.2.4.3	100	150	200	Beta distribution	150
4.2.4.4	200	250	300	Beta distribution	250
4.3.4	100	200	300	Beta distribution	200
4.3.5	100	200	300	Beta distribution	200
4.4.2	50	75	100	Beta distribution	75
4.4.3	20	50	100	Beta distribution	54
4.4.4	20	30	40	Beta distribution	30
4.4.4.1	200	300	400	Beta distribution	300
4.4.4.2	50	100	150	Beta distribution	100
6.1.2.1	100	120	140	Beta distribution	120
6.1.2.2	100	120	140	Beta distribution	120
6.1.3	8	16	32	Beta distribution	16
6.2.1	20	50	80	Beta distribution	50
6.2.2	50	100	150	Beta distribution	100
6.2.3	20	50	80	Beta distribution	50
6.4.4	50	80	100	Beta distribution	79
6.5	50	80	150	Beta distribution	87
6.6	10	20	50	Beta distribution	24
7.1.1	35	40	50	Beta distribution	41
7.1.2	20	35	40	Beta distribution	34
7.2.1	30	45	50	Beta distribution	44
7.2.2	20	25	30	Beta distribution	25
7.4.1	8	12	10	Beta distribution	11
7.4.2	8	12	10	Beta distribution	11
7.4.3	8	12	10	Beta distribution	11
7.5	10	20	25	Beta distribution	20
7.6.1	4	6	8	Beta distribution	6
7.6.2	8	10	12	Beta distribution	10
7.6.3	10	20	25	Beta distribution	20
7.6.4	2	4	5	Beta distribution	4
7.6.5	8	12	10	Beta distribution	11

Table 13: List of activity three point duration estimation (Part 2).

WBS ID	Optimistic Duration	Most Likely Duration	Pessimistic Duration (h)	Weighting Equation	Duration Estimate (h)
7.7	8	10	16	Beta distribution	11
7.8	5	8	10	Beta distribution	8

6 Project Schedule

The Gantt diagram for this section will be added as an annex at the end of this deliverable. The critical path can be seen as the red coloured tasks that the software used has identified as those tasks that can not be delayed without having an overall delay in the whole project.

7 Cost estimating

7.1 Level of accuracy

The degree at which activity cost estimates are rounded up or down is selected according to the scope of the activities and magnitude of the project. In all the tasks, it has been decided to eliminate the decimal figures since it is an estimate. Therefore, the values have been truncated, thus allocating less funds for each task, and managing to carry out the project with the funds initially requested.

7.2 Cost estimation worksheet

In this section, the tasks defined in the WBS are assigned an estimated cost. Depending on the task, the parametric, analogous or 3 point estimates method is used.

Parametric estimating is a statistical and accuracy-based technique for calculating the time, cost, and resources needed for project success. Combining historical and statistical data, parametric estimating uses the relationship between variables to deliver accurate estimations.

Often used during a project or in the project planning phase, parametric estimating applies a formula or algorithm for making these calculations, using the specific cost or time needed to implement and finish a project or task. The following table uses the €/hour per worker variable, knowing the estimate of time assigned to each task, the resources required and its respective availability, expressed as performance factor in Table 8, which takes a value around 0.8-0.9 (see section 5: *Estimate activity duration*).

Table 14: List of parametric estimates (Part 1).

Parametric Estimates					
WBS ID	**Variable Cost**	**Cost per Unit (m.u./ud)**	**Hours**	**Resources**	**Cost Estimate (€)**
1.2.1.1	€/(h · pers)	20	6	24	2.308 €
1.2.1.2	€/(h · pers)	21	24	5	2.308 €
1.2.1.3	€/(h · pers)	20	5	26	2.308 €
1.2.1.4	€/(h · pers)	20	5	26	2.308 €
1.2.1.5	€/(h · pers)	20	5	26	2.308 €
1.2.2.1	€/(h · pers)	20	4	160	11.538 €
1.2.2.2	€/(h · pers)	20	12	21	4.615 €
1.2.2.3	€/(h · pers)	20	12	16	3.462 €
1.2.2.4	€/(h · pers)	20	3	64	3.462 €
1.2.3.1	€/(h · pers)	19	25	8	3.462 €
1.2.3.2	€/(h · pers)	20	10	13	2.308 €
1.2.4.1	€/(h · pers)	20	12	16	3.462 €
1.2.4.2	€/(h · pers)	19	12	11	2.308 €
1.3.1.1	€/(h · pers)	0	1	0	0 €
1.3.1.2	€/(h · pers)	19	15	9	2.308 €
1.3.1.3	€/(h · pers)	19	100	2	3.462 €
1.3.2	€/(h · pers)	20	20	16	5.769 €
1.3.3	€/(h · pers)	21	150	2	5.769 €
1.3.4	€/(h · pers)	20	15	21	5.769 €
1.3.5	€/(h · pers)	21	24	13	5.769 €
1.3.6	€/(h · pers)	20	27	12	5.769 €

Table 15: List of parametric estimates (Part 2).

Parametric Estimates					
WBS ID	**Variable Cost**	**Cost per Unit (m.u./ud)**	**Hours**	**Resources**	**Cost Estimate (€)**
1.4.1	€/(h · pers)	20	20	19	6.923 €
1.4.2.1	€/(h · pers)	21	40	6	4.615 €
1.4.2.2	€/(h · pers)	20	20	13	4.615 €
1.4.3.1	€/(h · pers)	20	15	17	4.615 €
1.4.3.2	€/(h · pers)	20	29	9	4.615 €
1.4.4	€/(h · pers)	20	40	13	9.231 €
1.5.1	€/(h · pers)	21	200	2	7.692 €
1.5.2	€/(h · pers)	20	30	14	7.692 €
1.5.3	€/(h · pers)	20	25	17	7.692 €
1.6.1.1	€/(h · pers)	20	16	8	2.308 €
1.6.1.2	€/(h · pers)	20	8	16	2.308 €
1.6.1.3	€/(h · pers)	26	100	1	2.308 €
1.6.1.4	€/(h · pers)	20	8	32	4.615 €
1.6.2.1	€/(h · pers)	20	16	8	2.308 €
1.6.2.2	€/(h · pers)	20	8	16	2.308 €
1.6.2.3	€/(h · pers)	26	100	1	2.308 €
1.6.2.4	€/(h · pers)	20	8	32	4.615 €
1.6.3.1	€/(h · pers)	20	16	4	1.154 €
1.6.3.2	€/(h · pers)	20	8	8	1.154 €
1.6.3.3	€/(h · pers)	13	100	1	1.154 €
1.6.3.4	€/(h · pers)	20	8	16	2.308 €
2.1	€/(h · pers)	20	20	32	11.538 €
2.2.1.1	€/(h · pers)	13	500	1	5.769 €
2.2.1.2	€/(h · pers)	21	100	3	5.769 €
2.2.1.3	€/(h · pers)	21	300	1	5.769 €
2.2.2.1	€/(h · pers)	16	200	2	5.769 €
2.2.2.2	€/(h · pers)	21	100	3	5.769 €
2.2.2.3	€/(h · pers)	16	200	2	5.769 €
2.4	€/(h · pers)	20	20	64	23.077 €
2.5	€/(h · pers)	13	1000	1	11.538 €
2.6	€/(h · pers)	26	500	1	11.538 €
3.1.1	€/(h · pers)	20	20	38	13.846 €
3.1.2	€/(h · pers)	20	20	38	13.846 €
3.1.3	€/(h · pers)	20	20	38	13.846 €
3.1.4	€/(h · pers)	20	20	38	13.846 €
3.1.5	€/(h · pers)	21	50	15	13.846 €
3.2.1	€/(h · pers)	20	20	38	13.846 €
3.2.2	€/(h · pers)	19	200	4	13.846 €
3.2.3	€/(h · pers)	19	200	4	13.846 €
3.2.4	€/(h · pers)	21	250	3	13.846 €
3.2.5	€/(h · pers)	19	200	4	13.846 €
3.3	€/(h · pers)	20	20	128	46.154 €
3.4	€/(h · pers)	20	50	51	46.154 €
4.1.1	€/(h · pers)	20	100	17	31.111 €
4.1.2	€/(h · pers)	20	50	35	31.111 €
4.1.3	€/(h · pers)	17	2000	1	31.111 €
4.1.4	€/(h · pers)	23	500	3	31.111 €
4.1.5	€/(h · pers)	23	1500	1	31.111 €

Analogous project estimates are calculated by taking values from past projects with similar scope and applying them to the current project. Analogous estimating is used where there is limited information about the project. It is a technique that centers on comparison. This means that the more data that is available, the better the estimate will be. This is why collecting data for each project will build up a database that can be used in future projects for comparisons of cost and time.

Since the deliverables must contain the same sections for all the H2020 proposals, their cost is estimated using the analogous method. The comparison is based on an H2020 proposal with a lower scope than the present one, involving less budget and duration of the project. For this reason, the multipliers obtain a value greater than 1, or equal to 1 in those tasks that require the same cost regardless of the magnitude of the project.

Table 16: List of analogous estimates.

Analogous Estimates					
WBS ID	**Previous Activity**	**Previous Cost (m.u.)**	**Current Activity**	**Multiplier**	**Cost Estimate (€)**
1.1.1.1	General scope	964 €	General scope	1,7	1.638 €
1.1.1.2	Initial requirements	1.489 €	Initial requirements	1,1	1.638 €
1.1.1.3	High-level risks	1.365 €	High-level risks	1,2	1.638 €
1.1.1.4	Deliverables and milestones	1.638 €	Deliverables and milestones	1	1.638 €
1.1.1.5	Estimated budget	1.092 €	Estimated budget	1,5	1.638 €
1.1.1.6	Initial organisation	1.638 €	Initial organisation	1	1.638 €
1.1.1.7	Stakeholders identification	910 €	Stakeholders identification	1,8	1.638 €
1.1.2.1	Product Scope Description	1.649 €	Product Scope Description	1,4	2.308 €
1.1.2.2	Deliverables	2.308 €	Deliverables	1	2.308 €
1.1.2.3	Acceptance Criteria	2.098 €	Acceptance Criteria	1,1	2.308 €
1.1.2.4	Exclusions	2.308 €	Exclusions	1	2.308 €
1.1.2.5	Constraints	2.308 €	Constraints	1	2.308 €
1.1.3.1	Requirements identification	3.606 €	Requirements identification	1,6	5.769 €
1.1.3.2	Documentation identification	3.606 €	Documentation identification	1,6	5.769 €
1.1.3.3	Information gathering	4.808 €	Information gathering	1,2	5.769 €
1.1.3.4	Call proposal generation	3.846 €	Call proposal generation	1,5	5.769 €

Three-point estimating is a management technique to determine the probable outcomes of future events based on available information. The term refers to the three-points it measures: the best-case estimate, the most likely estimate, and the worst-case estimate. To estimate the optimistic and pessimistic cases, fixed percentages are determined. Where the optimistic case takes a value of 66% of the most likely cost, while the pessimistic case is 166% of the most likely case.

Table 17: List of three point estimates (Part 1).

Three Point Estimates					
WBS ID	**Optimistic Cost (m.u.)**	**Most Likely Cost (m.u.)**	**Pessimistic Cost (m.u.)**	**Weighting Equation**	**Expected Cost Estimate (€)**
1.6.4.1	1.457 €	2.186 €	3.644 €	(o + 4m + p)/6	2.308 €
1.6.4.2	1.457 €	2.186 €	3.644 €	(o + 4m + p)/6	2.308 €
1.6.4.3	1.457 €	2.186 €	3.644 €	(o + 4m + p)/6	2.308 €
1.6.4.4	2.915 €	4.372 €	7.287 €	(o + 4m + p)/6	4.615 €
1.6.5.1	1.457 €	2.186 €	3.644 €	(o + 4m + p)/6	2.308 €
1.6.5.2	1.457 €	2.186 €	3.644 €	(o + 4m + p)/6	2.308 €
1.6.6.1	729 €	1.093 €	1.822 €	(o + 4m + p)/6	1.154 €
5.1	72.875 €	109.312 €	182.187 €	(o + 4m + p)/6	115.385 €
5.2.1	58.300 €	87.450 €	145.749 €	(o + 4m + p)/6	92.308 €
5.2.2	58.300 €	87.450 €	145.749 €	(o + 4m + p)/6	92.308 €
5.2.3	29.150 €	43.725 €	72.875 €	(o + 4m + p)/6	46.154 €

Table 18: List of three point estimates (Part 2).

Three Point Estimates					
WBS ID	**Optimistic Cost (m.u.)**	**Most Likely Cost (m.u.)**	**Pessimistic Cost (m.u.)**	**Weighting Equation**	**Expected Cost Estimate (€)**
6.1.1	27.068 €	40.601 €	67.669 €	(o + 4m + p)/6	42.857 €
6.1.2.1	13.534 €	20.301 €	33.835 €	(o + 4m + p)/6	21.429 €
6.1.2.2	13.534 €	20.301 €	33.835 €	(o + 4m + p)/6	21.429 €
6.1.3	13.534 €	20.301 €	33.835 €	(o + 4m + p)/6	21.429 €
6.2.1	11.278 €	16.917 €	28.195 €	(o + 4m + p)/6	17.857 €
6.2.2	11.278 €	16.917 €	28.195 €	(o + 4m + p)/6	17.857 €
6.2.3	11.278 €	16.917 €	28.195 €	(o + 4m + p)/6	17.857 €
6.3.1.1	13.534 €	20.301 €	33.835 €	(o + 4m + p)/6	21.429 €
6.3.1.2	13.534 €	20.301 €	33.835 €	(o + 4m + p)/6	21.429 €
6.3.1.3	13.534 €	20.301 €	33.835 €	(o + 4m + p)/6	21.429 €
6.3.2	27.068 €	40.601 €	67.669 €	(o + 4m + p)/6	42.857 €
6.4.1	13.534 €	20.301 €	33.835 €	(o + 4m + p)/6	21.429 €
6.4.2	20.301 €	30.451 €	50.752 €	(o + 4m + p)/6	32.143 €
6.4.3	20.301 €	30.451 €	50.752 €	(o + 4m + p)/6	32.143 €
6.4.4	13.534 €	20.301 €	33.835 €	(o + 4m + p)/6	21.429 €
6.5	67.669 €	101.504 €	169.173 €	(o + 4m + p)/6	107.143 €
6.6	33.834 €	50.751 €	84.586 €	(o + 4m + p)/6	53.571 €
7.1.1	7.017 €	10.526 €	17.544 €	(o + 4m + p)/6	11.111 €
7.1.2	7.017 €	10.526 €	17.544 €	(o + 4m + p)/6	11.111 €
7.2.1	14.035 €	21.052 €	35.087 €	(o + 4m + p)/6	22.222 €
7.2.2	14.035 €	21.052 €	35.087 €	(o + 4m + p)/6	22.222 €
7.3.1	8.421 €	12.631 €	21.052 €	(o + 4m + p)/6	13.333 €
7.3.2	9.825 €	14.737 €	24.562 €	(o + 4m + p)/6	15.556 €
7.3.3.1	2.807 €	4.210 €	7.017 €	(o + 4m + p)/6	4.444 €
7.3.3.2	2.807 €	4.210 €	7.017 €	(o + 4m + p)/6	4.444 €
7.3.3.3	4.211 €	6.316 €	10.527 €	(o + 4m + p)/6	6.667 €
7.4.1	8.421 €	12.631 €	21.052 €	(o + 4m + p)/6	13.333 €
7.4.2	9.825 €	14.737 €	24.562 €	(o + 4m + p)/6	15.556 €
7.4.3	9.825 €	14.737 €	24.562 €	(o + 4m + p)/6	15.556 €
7.5	28.070 €	42.105 €	70.175 €	(o + 4m + p)/6	44.444 €
7.6.1	5.614 €	8.421 €	14.035 €	(o + 4m + p)/6	8.889 €
7.6.2	5.614 €	8.421 €	14.035 €	(o + 4m + p)/6	8.889 €
7.6.3	5.614 €	8.421 €	14.035 €	(o + 4m + p)/6	8.889 €
7.6.4	5.614 €	8.421 €	14.035 €	(o + 4m + p)/6	8.889 €
7.6.5	5.614 €	8.421 €	14.035 €	(o + 4m + p)/6	8.889 €
7.7	28.070 €	42.105 €	70.175 €	(o + 4m + p)/6	44.444 €
7.8	28.070 €	42.105 €	70.175 €	(o + 4m + p)/6	44.444 €

7.3 Activity cost estimation

This section presents a list with the estimated cost of all the WBS tasks. The estimated total cost is broken down into direct cost; indirect cost, which is 25% of the direct cost; and contingency reserves. The level of confidence has been determined according to three degrees: low, medium and high. The percentage of contingency reserves will depend on it, being 15%, 10% and 5% of the direct cost, respectively. In addition, the type of resource involved in the task is presented.

Table 19: List of activity cost estimation (Part 1).

WBS ID	Resource	Direct cost	Method	Confidence level	Reserves	Indirect costs	Estimation
1.1.1.1	People	1.638 €	Analogous	High	82 €	410 €	2.130 €
1.1.1.2	People	1.638 €	Analogous	High	82 €	410 €	2.130 €
1.1.1.3	People	1.638 €	Analogous	High	82 €	410 €	2.130 €
1.1.1.4	People	1.638 €	Analogous	High	82 €	410 €	2.130 €
1.1.1.5	People	1.638 €	Analogous	High	82 €	410 €	2.130 €
1.1.1.6	People	1.638 €	Analogous	High	82 €	410 €	2.130 €
1.1.1.7	People	1.638 €	Analogous	High	82 €	410 €	2.130 €
1.1.2.1	People	2.308 €	Analogous	High	115 €	577 €	3.000 €
1.1.2.2	People	2.308 €	Analogous	High	115 €	577 €	3.000 €
1.1.2.3	People	2.308 €	Analogous	High	115 €	577 €	3.000 €
1.1.2.4	People	2.308 €	Analogous	High	115 €	577 €	3.000 €
1.1.2.5	People	2.308 €	Analogous	High	115 €	577 €	3.000 €
1.1.3.1	People	5.769 €	Analogous	High	288 €	1.442 €	7.500 €
1.1.3.2	People	5.769 €	Analogous	High	288 €	1.442 €	7.500 €
1.1.3.3	People	5.769 €	Analogous	High	288 €	1.442 €	7.500 €
1.1.3.4	People	5.769 €	Analogous	High	288 €	1.442 €	7.500 €
1.2.1.1	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.2.1.2	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.2.1.3	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.2.1.4	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.2.1.5	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.2.2.1	People	11.538 €	Parametric	High	577 €	2.885 €	15.000 €
1.2.2.2	People	4.615 €	Parametric	High	231 €	1.154 €	6.000 €
1.2.2.3	People	3.462 €	Parametric	High	173 €	865 €	4.500 €
1.2.2.4	People	3.462 €	Parametric	High	173 €	865 €	4.500 €
1.2.3.1	People	3.462 €	Parametric	High	173 €	865 €	4.500 €
1.2.3.2	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.2.4.1	People	3.462 €	Parametric	High	173 €	865 €	4.500 €
1.2.4.2	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.3.1.1	People	0 €	Parametric	High	0 €	0 €	0 €
1.3.1.2	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.3.1.3	People	3.462 €	Parametric	High	173 €	865 €	4.500 €
1.3.2	People	5.769 €	Parametric	High	288 €	1.442 €	7.500 €
1.3.3	People	5.769 €	Parametric	High	288 €	1.442 €	7.500 €
1.3.4	People	5.769 €	Parametric	High	288 €	1.442 €	7.500 €
1.3.5	People	5.769 €	Parametric	High	288 €	1.442 €	7.500 €
1.3.6	People	5.769 €	Parametric	High	288 €	1.442 €	7.500 €
1.4.1	People	6.923 €	Parametric	High	346 €	1.731 €	9.000 €
1.4.2.1	People	4.615 €	Parametric	High	231 €	1.154 €	6.000 €
1.4.2.2	People	4.615 €	Parametric	High	231 €	1.154 €	6.000 €
1.4.3.1	People	4.615 €	Parametric	High	231 €	1.154 €	6.000 €
1.4.3.2	People	4.615 €	Parametric	High	231 €	1.154 €	6.000 €
1.4.4	People	9.231 €	Parametric	High	462 €	2.308 €	12.000 €
1.5.1	People	7.692 €	Parametric	High	385 €	1.923 €	10.000 €
1.5.2	People	7.692 €	Parametric	High	385 €	1.923 €	10.000 €
1.5.3	People	7.692 €	Parametric	High	385 €	1.923 €	10.000 €
1.6.1.1	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.6.1.2	People	2.308 €	Parametric	High	115 €	577 €	3.000 €

Table 20: List of activity cost estimation (Part 2).

WBS ID	Resource	Direct cost	Method	Confidence level	Reserves	Indirect costs	Estimation
1.6.1.3	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.6.1.4	People	4.615 €	Parametric	High	231 €	1.154 €	6.000 €
1.6.2.1	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.6.2.2	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.6.2.3	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.6.2.4	People	4.615 €	Parametric	High	231 €	1.154 €	6.000 €
1.6.3.1	People	1.154 €	Parametric	High	58 €	288 €	1.500 €
1.6.3.2	People	1.154 €	Parametric	High	58 €	288 €	1.500 €
1.6.3.3	People	1.154 €	Parametric	High	58 €	288 €	1.500 €
1.6.3.4	People	2.308 €	Parametric	High	115 €	577 €	3.000 €
1.6.4.1	People	2.308 €	3 Point	High	115 €	577 €	3.000 €
1.6.4.2	People	2.308 €	3 Point	High	115 €	577 €	3.000 €
1.6.4.3	People	2.308 €	3 Point	High	115 €	577 €	3.000 €
1.6.4.4	People	4.615 €	3 Point	High	231 €	1.154 €	6.000 €
1.6.5.1	People	2.308 €	3 Point	High	115 €	577 €	3.000 €
1.6.5.2	People	2.308 €	3 Point	High	115 €	577 €	3.000 €
1.6.6.1	People	1.154 €	3 Point	High	58 €	288 €	1.500 €
2.1	People	11.538 €	Parametric	High	577 €	2.885 €	15.000 €
2.2.1.1	People	5.769 €	Parametric	High	288 €	1.442 €	7.500 €
2.2.1.2	People	5.769 €	Parametric	High	288 €	1.442 €	7.500 €
2.2.1.3	People	5.769 €	Parametric	High	288 €	1.442 €	7.500 €
2.2.2.1	People	5.769 €	Parametric	High	288 €	1.442 €	7.500 €
2.2.2.2	People	5.769 €	Parametric	High	288 €	1.442 €	7.500 €
2.2.2.3	People	5.769 €	Parametric	High	288 €	1.442 €	7.500 €
2.2.3	People	11.538 €	Parametric	High	577 €	2.885 €	15.000 €
2.3	People	11.538 €	Parametric	High	577 €	2.885 €	15.000 €
2.4	People	23.077 €	Parametric	High	1.154 €	5.769 €	30.000 €
2.5	People	11.538 €	Parametric	High	577 €	2.885 €	15.000 €
2.6	People	11.538 €	Parametric	High	577 €	2.885 €	15.000 €
3.1.1	People	13.846 €	Parametric	High	692 €	3.462 €	18.000 €
3.1.2	People	13.846 €	Parametric	High	692 €	3.462 €	18.000 €
3.1.3	People	13.846 €	Parametric	High	692 €	3.462 €	18.000 €
3.1.4	People	13.846 €	Parametric	High	692 €	3.462 €	18.000 €
3.1.5	People	13.846 €	Parametric	High	692 €	3.462 €	18.000 €
3.2.1	People	13.846 €	Parametric	High	692 €	3.462 €	18.000 €
3.2.2	People	13.846 €	Parametric	High	692 €	3.462 €	18.000 €
3.2.3	People	13.846 €	Parametric	High	692 €	3.462 €	18.000 €
3.2.4	People	13.846 €	Parametric	High	692 €	3.462 €	18.000 €
3.2.5	People	13.846 €	Parametric	High	692 €	3.462 €	18.000 €
3.3	People	46.154 €	Parametric	High	2.308 €	11.538 €	60.000 €
3.4	People	46.154 €	Parametric	High	2.308 €	11.538 €	60.000 €
4.1.1	People	31.111 €	Parametric	Medium	3.111 €	7.778 €	42.000 €
4.1.2	People	31.111 €	Parametric	Medium	3.111 €	7.778 €	42.000 €
4.1.3	People	31.111 €	Parametric	Medium	3.111 €	7.778 €	42.000 €
4.1.4	People	31.111 €	Parametric	Medium	3.111 €	7.778 €	42.000 €
4.1.5	People	31.111 €	Parametric	Medium	3.111 €	7.778 €	42.000 €
4.2.1.1	People	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.2.1.2	People	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.2.1.3	People	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.2.1.4	People	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.2.2.1	People	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.2.2.2	People	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.2.2.3	People	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.2.2.4	People	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.2.3.1	People	5.556 €	Parametric	Medium	556 €	1.389 €	7.500 €
4.2.3.2	People	5.556 €	Parametric	Medium	556 €	1.389 €	7.500 €
4.2.3.3	Equipment	5.556 €	Parametric	Medium	556 €	1.389 €	7.500 €
4.2.3.4	People	5.556 €	Parametric	Medium	556 €	1.389 €	7.500 €

Table 21: List of activity cost estimation (Part 3).

WBS ID	Resource	Direct cost	Method	Confidence level	Reserves	Indirect costs	Estimation
4.2.4.1	People	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.2.4.2	Equipment	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.2.4.3	Equipment	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.2.4.4	Equipment	11.111 €	Parametric	Medium	1.111 €	2.778 €	15.000 €
4.3.1	People	13.333 €	Parametric	Medium	1.333 €	3.333 €	18.000 €
4.3.2	People	13.333 €	Parametric	Medium	1.333 €	3.333 €	18.000 €
4.3.3	People	13.333 €	Parametric	Medium	1.333 €	3.333 €	18.000 €
4.3.4	People	13.333 €	Parametric	Medium	1.333 €	3.333 €	18.000 €
4.3.5	People	13.333 €	Parametric	Medium	1.333 €	3.333 €	18.000 €
4.4.1	People	16.667 €	Parametric	Medium	1.667 €	4.167 €	22.500 €
4.4.2	People	16.667 €	Parametric	Medium	1.667 €	4.167 €	22.500 €
4.4.3	People	16.667 €	Parametric	Medium	1.667 €	4.167 €	22.500 €
4.4.4.1	People	8.333 €	Parametric	Medium	833 €	2.083 €	11.250 €
4.4.4.2	People	8.333 €	Parametric	Medium	833 €	2.083 €	11.250 €
5.1	People	115.385 €	3 Point	High	5.769 €	28.846 €	150.000 €
5.2.1	People	92.308 €	3 Point	High	4.615 €	23.077 €	120.000 €
5.2.2	People	92.308 €	3 Point	High	4.615 €	23.077 €	120.000 €
5.2.3	People	46.154 €	3 Point	High	2.308 €	11.538 €	60.000 €
6.1.1	People	42.857 €	3 Point	Low	6.429 €	10.714 €	60.000 €
6.1.2.1	People	21.429 €	3 Point	Low	3.214 €	5.357 €	30.000 €
6.1.2.2	People	21.429 €	3 Point	Low	3.214 €	5.357 €	30.000 €
6.1.3	People	21.429 €	3 Point	Low	3.214 €	5.357 €	30.000 €
6.2.1	People	17.857 €	3 Point	Low	2.679 €	4.464 €	25.000 €
6.2.2	People	17.857 €	3 Point	Low	2.679 €	4.464 €	25.000 €
6.2.3	People	17.857 €	3 Point	Low	2.679 €	4.464 €	25.000 €
6.3.1.1	Equipment	21.429 €	3 Point	Low	3.214 €	5.357 €	30.000 €
6.3.1.2	Equipment	21.429 €	3 Point	Low	3.214 €	5.357 €	30.000 €
6.3.1.3	Equipment	21.429 €	3 Point	Low	3.214 €	5.357 €	30.000 €
6.3.2	Equipment	42.857 €	3 Point	Low	6.429 €	10.714 €	60.000 €
6.4.1	Equipment	21.429 €	3 Point	Low	3.214 €	5.357 €	30.000 €
6.4.2	Equipment	32.143 €	3 Point	Low	4.821 €	8.036 €	45.000 €
6.4.3	Equipment	32.143 €	3 Point	Low	4.821 €	8.036 €	45.000 €
6.4.4	Equipment	21.429 €	3 Point	Low	3.214 €	5.357 €	30.000 €
6.5	Equipment	107.143 €	3 Point	Low	16.071 €	26.786 €	150.000 €
6.6	Equipment	53.571 €	3 Point	Low	8.036 €	13.393 €	75.000 €
7.1.1	People	11.111 €	3 Point	Medium	1.111 €	2.778 €	15.000 €
7.1.2	People	11.111 €	3 Point	Medium	1.111 €	2.778 €	15.000 €
7.2.1	People	22.222 €	3 Point	Medium	2.222 €	5.556 €	30.000 €
7.2.2	People	22.222 €	3 Point	Medium	2.222 €	5.556 €	30.000 €
7.3.1	Equipment	13.333 €	3 Point	Medium	1.333 €	3.333 €	18.000 €
7.3.2	Equipment	15.556 €	3 Point	Medium	1.556 €	3.889 €	21.000 €
7.3.3.1	Equipment	4.444 €	3 Point	Medium	444 €	1.111 €	6.000 €
7.3.3.2	Equipment	4.444 €	3 Point	Medium	444 €	1.111 €	6.000 €
7.3.3.3	Equipment	6.667 €	3 Point	Medium	667 €	1.667 €	9.000 €
7.4.1	Equipment	13.333 €	3 Point	Medium	1.333 €	3.333 €	18.000 €
7.4.2	Equipment	15.556 €	3 Point	Medium	1.556 €	3.889 €	21.000 €
7.4.3	Equipment	15.556 €	3 Point	Medium	1.556 €	3.889 €	21.000 €
7.5	Equipment	44.444 €	3 Point	Medium	4.444 €	11.111 €	60.000 €
7.6.1	Equipment	8.889 €	3 Point	Medium	889 €	2.222 €	12.000 €
7.6.2	Equipment	8.889 €	3 Point	Medium	889 €	2.222 €	12.000 €
7.6.3	Equipment	8.889 €	3 Point	Medium	889 €	2.222 €	12.000 €
7.6.4	Equipment	8.889 €	3 Point	Medium	889 €	2.222 €	12.000 €
7.6.5	Equipment	8.889 €	3 Point	Medium	889 €	2.222 €	12.000 €
7.7	Equipment	44.444 €	3 Point	Medium	4.444 €	11.111 €	60.000 €
7.8	Equipment	44.444 €	3 Point	Medium	4.444 €	11.111 €	60.000 €

8 Cumulative costs

8.1 Cumulative cost curve

Below (Figure 9) can be found the overall cumulative cost curve of the project, where the blue vertical bars represent the monthly cost, referred in the left vertical axis, and the continuous red line represents the cumulative cost curve, referred in the right vertical axis.

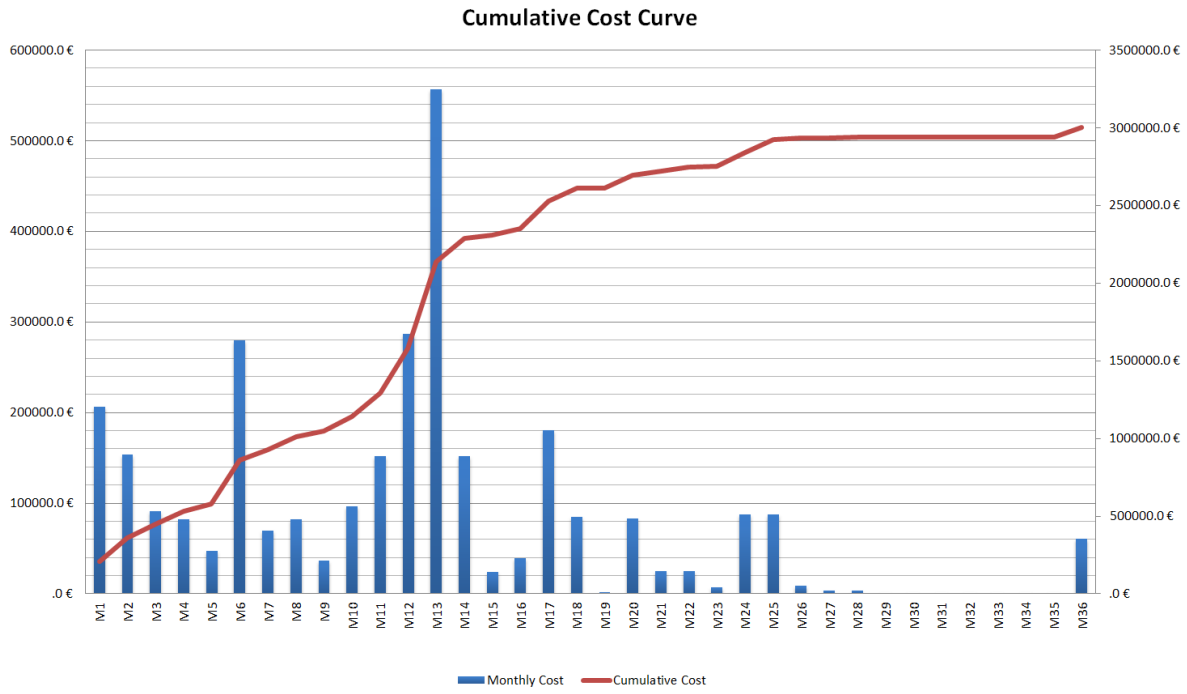

Figure 9: Cumulative cost curve

Some important notes that can be taken from the curve is that there the most significant expense is done both in the first six months of the project, because many tasks will be developed at the same time independently, and exactly one year after the start of the project, essentially because of the testing being done. After that, the expenses remains quite stable and the latter months of the project become nearly costless as the only tasks involved are the economic monitoring, maintenance and marketing actions such as social media management.
Finally, the last expense is the success evaluation, which marks the end of the project.

8.2 Budget at completion

The cost estimation of the project reaches a total value of 3.000.000 €. As seen in the previous section, the confidence level of each task causes a need for reserve cash, as well as indirect costs, which have also been taken into account.
The budget, then, consists of the addition of all these costs, which are:

Table 22: Budget's costs distribution

Direct costs	Reserves costs	Indirect costs
2.236.569 €	204.289 €	559,142 €

Next, the budget's distribution among the different divisions is presented both in the following table and more visually in Figure 10:

Table 23: Budget's costs distribution

Project division	Cost estimation
Project Management	300.000 €
Environmental Study	150.000 €
Marketing	300.000 €
Technical	600.000 €
Procurement	450.000 €
Testing	750.000 €
Prototype	450.000 €
Total	3.000.000 €

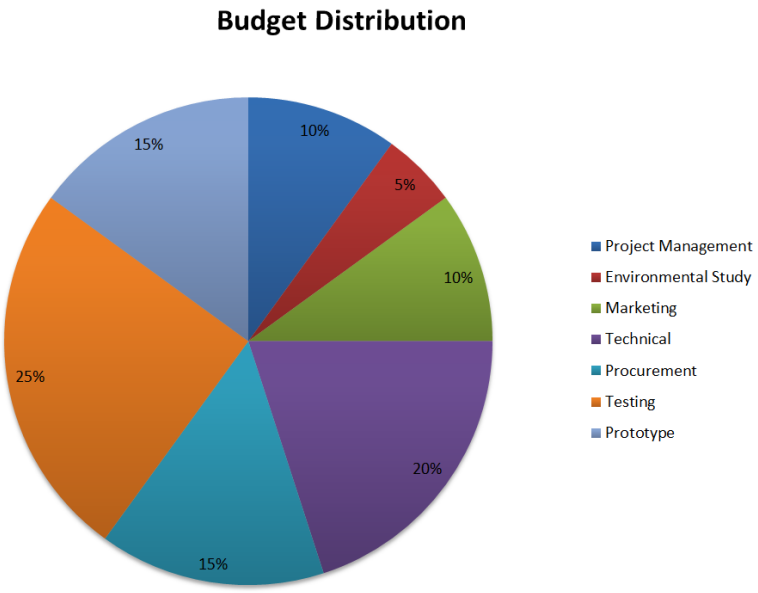

Figure 10: Distribution of the budget among partners

References

[1] Phipps, C. R., Baker, K. L., Libby, S. B., Liedahl, D. A., Olivier, S. S., Pleasance, L. D., Rubenchik, A., Trebes, J. E., George, E. V., Marcovici, B., Reilly, J. P., & Valley, M. T. (2012). Removing orbital debris with lasers. *Advances in Space Research*, *49*, 1283–1300. https://doi.org/10.1016/J.ASR.2012.02.003