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EARTH CLIMATE CHANGE OBSERVATION

ECCO

Deliverable 2

Scope and Time Management

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1. Project Scope Statement

1.1. Product Scope Description

A new revolutionary design of a constellation of fractionated satellites is proposed to help the European Community to raise awareness of global warming. While combining the best characteristics of the classical satellites, this new technology allows an unprecedented maintainability, scalability, flexibility and responsiveness among others that customers will appreciate. Before explaining the services that ECCO can provide, it is fundamental to explain why this new concept for satellites is far better than the traditional existing ones, and how it could change the future of space missions.

The main difference between traditional and fractionated satellite is the distribution of the payload and subsystems. In fractionated satellites all sub-systems are in an isolated module transmitting data and power by wireless methods, instead of being assembled together into a common structure. The most evident impact of using highly modular satellites is on the development of each module, due to the fact that modules can be developed, manufactured, integrated and tested in parallel because no highly inter-connections are needed. This allows a faster development of the satellite, and thus, a strategic strength for the company with respect to the competitors.

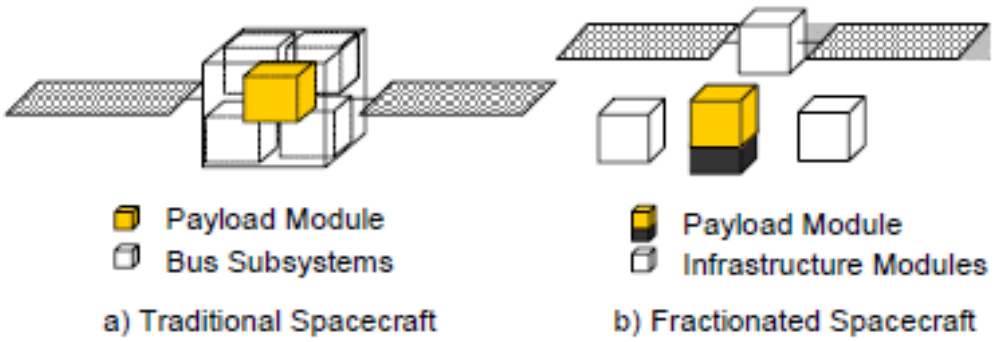


Figure 1. Traditional spacecraft versus fractionated spacecraft concepts from Fractionated Spacecraft Architectures Seeding Study

Moreover, the functional partitioning combined with the small size of modules allows reducing costs on designs and building cycles, sending leading technology to space without the high lags between design and launch. Also, an incremental deployment system leads to upgrading technology or simply to restore functionalities due to maintenance, taking profit of lower costs per module and the ease to put it into orbit due to its lower mass and volume. It must be emphasized that by using a highly modular satellite, an eventual failure of a module would not affect the others, increasing the overall robustness of the system.

There are two types of modules: infrastructure and payload modules. The payload modules include one instrument and the receptors for the communication with the infrastructure modules. The last ones are responsible for the data communication, guidance and navigation and power generation, among others.

The optimum number of infrastructure modules that will be used in the ECCO project has been obtained with the aim to minimize the overall weight of the satellite while maintaining the performance:

- Payload modules
- Communication an data handling
- Power unit supply
- Propulsion and navigation control

This configuration keeps fractionated satellite concept and join some similar sub-systems, for instance communication and data handling, or propulsion and navigation control, to reduce the overall mass. The Payload modules could be standardized, in terms of mass and power requirements, being able to launch small commercial modules with new necessities and exchange it in the future for an existing payload module, reusing the infrastructure modules. Moreover, the existence of different payload modules leads to acquire multiple data from the same objective, increasing precision of data and creating three-dimensional data maps, or from different objectives due to the different attitude control of each module. This is in fact an improvement in flexibility versus traditional satellites.

The specific sensors that ECCO will use cannot be completely specified in this phase of the project, however, there is a clear idea of the services that the ECCO satellites will be able to provide to the interested parts if the project is developed. Sensors would be integrated in three payload modules, each one containing only one of the following:

- Track temperature of the ground and ocean to determine the behaviour of the global temperature and be aware of climate changes.
- An image sensor to observe deforestation, desertification, ice melting rate, demography and water currents.
- Track principal greenhouse gasses, for instance, CO2, water vapour and methane. This information, combined with the image tracking, will be useful to determine pols of greenhouse gasses production, how it distributes over the world and the repercussion on temperature.

In order to validate the project, different tests and validations will be carried out. All the stakeholders should be interested in this part of the project, but INDRA and Airbus Defence & Space are in particular. The new developed simulation program used to perform the major part of GNC simulations is an expectation for INDRA enterprise that gives us financial support. Another stakeholder expectation is the communication systems that are financially supported by Airbus Defence & Space.

1.2. Project Deliverables

All the documents cited below will be in due time.

Table 1. List of project deliverables

Deliverable Name	Description
Project Management Plan	A document that defines a more detailed and technical vision of the project, specifying resources, their distribution in time to accomplish the project objectives, a detailed version of the project Charter, control and monitoring actions and level of implementation among others
Project Communication Plan	Develop a dissemination plan, design an own webpage to explain the overall objectives, organize congresses to spread the project and design instruments to reach the society
Mission Design	The mission design deliverable is related to the orbit elements, specifying type of orbit, height, ascending node, inclination… and the requirements to enable incremental deployment too
Communication Preliminary Design	Deliver of communication PD includes the state of the art related to communication, a first design of the communication hardware and a first approach to the simulator program
Navigation Preliminary Design	Deliver of navigation PD includes a first review to the navigation and attitude requirements, and a first design of the control software
Propulsion Preliminary Design	Deliver of propulsion PD includes a summary of the available propulsions systems and power supply requirements. A first design of propulsions and power unit, including its software is presented
Mechanical Preliminary Design	Deliver of mechanical PD includes all tasks developed to integrate all the systems designed and to create a preliminary design of the structure and thermal insulation of each module
Electronics Preliminary Design	Deliver of electronics PD includes the study of the environmental effects to the electronic systems, and a preliminary design of electronics to fit all the requirements of other departments
Intermediate Report	Intermediate report to check the state of the project and be validated by the all the participants, including stakeholders

Deliverable Name	Description
Communication Detailed Design	Deliver of communication DD includes the final design of the communication hardware and the software (simulator program too)
Navigation Detailed Design	Deliver of navigation PD includes the final software and the physical devices to enable attitude and navigation control
Propulsion Detailed Design	Deliver of propulsion PD includes the final propulsion design (related to navigation requirements) and power unit, including its software
Mechanical Detailed Design	Deliver of mechanical PD includes the final integration of all systems designed and the final structure and thermal insulation of each module
Electronics Detailed Design	Deliver of electronics PD includes the final design of electronics to fit all the requirements of other departments
Tests and Validations	A document that contains all tests and validations with the obtained results
Final Report	Final delivery that includes all development done in the project

1.3. Project Acceptance Criteria

All documents must be approved before the delivery date to ensure that objectives and scope have been accomplished. The following acceptance criteria are defined to accept the documents.

Table 2. List of acceptance criteria

Acceptance Criterion	Condition to be Accepted
Research and Innovation	The project must be ambitious, has innovation potential and beyond the state of the art, including trans-disciplinary considerations
Quality and Presentation	All documents must be done with the highest quality, presenting all the ideas, developments and conclusions linked, explained clearly. All documents must be printable
Performance Requirements	The efficiency and functionality of all systems designed must be enough to realise all the objectives indicated and the purpose of the proposal too
Stakeholders expectations	Deliverables for the stakeholders that has been set must be accomplished and validated
Technical Documentation	The documentation must be complete, specifying the development procedure, the final characteristics and the method to use the hardware and software developed
Test and Validations	All tests and validations must be indicated and successfully passed using the available regulations. All this information must be correctly written, with all the modifications done to improve functionality and allow its verification (and of course the results of the tests and validations)

1.4. Project Exclusions

The exclusions of the project are specified in the table below.

Table 3. List of project exclusions

Project Exclusions	Description
Prototypes	Development of complete module prototypes is excluded from the scope, so they will not be created during this project
Satellite launcher	The objective of this project is to design a new kind on satellite, and it will not focus on the system that put it into orbit
Rockets for attitude and navigation control	All rocket engines that would be needed due to navigation and attitude control requirements will not be designed. Instead of this, a selection of the available rockets on the market will be done
Sensors design	All sensors will be acquired from different developers, and no designs or changes will be applied to them
Long range satellite-satellite communication	Design of satellite-satellite communication system will focus on enabling communication into short distance (Range 100m – 1km), covering the typical distance in an instrument constellation
Ground station	Ground infrastructures needed to enable ground-satellite communication are out of the scope of this project
Post-processing data software	Project will focus on the satellite development and preliminary data treatment, but not on software related with post-processing data. This excludes formatting and interpretation of the results
Final satellite	Create a physical satellite is out of the scope of the project, and only virtual tests will be carried to validate the whole assembly

1.5. Project Constraints

The constraints of the project are specified in the table below.

Table 4. List of project constraints

Project Constraints	Description
Deadline	The deadline of the project must be accomplished, so it affects the distribution of the available resources and budget
Schedule	Is important for the project to follow the developed schedule, in order to reduce possible over costs and time, achieving the milestones on the specified date
Budget	A limited budget is available for the realization of the entire project and acts as a limitation factor
Resources	The available resources are limited and due to budget and schedule, must be distributed correctly
Stakeholder expectations	Expectations from stakeholders have to be checked and accomplished at the end of the project
Simulation software	The simulation program developed must accomplish the required performance to be accepted by the purchasing agent, INDRA in this case
Communication system	The communication system developed must accomplish the required performances to be accepted by the purchasing agent, Airbus Defence & Space in this case

1.6. Project Assumptions

The constraints of the project are specified in the table below:

Table 5. List of project assumptions

Project Assumptions	Description	Impact
Sensors functionality	Bought sensors are supposed to work 100% as expected and no tests or validations will be carried out	If sensors don't work correctly, maybe others must be selected and the software would have to be modified
Simulation software	Simulation software developed and verified, will be enough for tests and validate the other software developed, for instance navigation, propulsion and attitude control software	If simulation software is not enough to obtain reliable data from the tests and validations, some physical test will be carried, increasing the costs and times
Rocket engines functionality	Bought rockets are supposed to work 100% as expected and no tests or validations will be carried out	If rockets don't work correctly, maybe others must be selected and the software will have to be modified
Structure isolation	Thermal isolation designs will be done taking into account existent satellites, and no physical validations will be necessary	If thermal insulation offers less insulation than expected then it will be reinforced, increasing the overall costs
Budget	The budget is enough to achieve all the objectives and finish the project as indicated on the schedule	If the budget becomes insufficient to afford all the costs of development, a contingency plan will be carried out, supported by the stakeholders

2. Work Breakdown Structure (WBS)

The work breakdown structure (WBS) of the ECCO project is presented below. It contains of up to 5 levels of decomposition in some cases.

1. ECCO Project
    1.1. Project Management
        1.1.1. Project management plan
        1.1.2. Monitoring of project evolution
        1.1.3. Preliminary design review
    1.2. Administrative Services
        1.2.1. Human resources initial plan
        1.2.2. Monitoring of human resources evolution
        1.2.3. Financial plan
        1.2.4. Monitoring of financial evolution
    1.3. Partnership and Network
        1.3.1. Coordination and cooperation control
        1.3.2. Stakeholders contact control
    1.4. Communication
        1.4.1. Publishing and meetings
        1.4.2. Press communications
        1.4.3. Conferences
        1.4.4. Public relations, outreach and enquiries
        1.4.5. Media, social media and web
    1.5. Engineering
        1.6. Preliminary Design
        1.6.1. Mission Design
            1.6.1.1. State of the art
                1.6.1.1.1. Analyse mission requirements
                1.6.1.1.2. Research and analyse current earth orbit observations

1.6.1.2. Select optimum orbital parameters

1.6.1.3. Specify technological requirements

1.6.1.4. Specify incremental deployment requirements

1.6.1.5. Report of results and conclusions

1.6.2. Communication

1.6.2.1. State of the art

1.6.2.1.1. Analyse work environment

1.6.2.1.2. Analyse modules communication requirements

1.6.2.1.3. Analyse ground – space communications requirements

1.6.2.1.4. Analyse power transmission requirements

1.6.2.2. Hardware

1.6.2.2.1. Select modules communication system

1.6.2.2.2. Develop communication system

1.6.2.2.3. Select ground – space communication system

1.6.2.2.4. Develop ground – space communication system

1.6.2.3. Software

1.6.2.3.1. Communication control software

1.6.2.3.2. Simulation program

1.6.2.4. Report of results and conclusions

1.6.3. Navigation

1.6.3.1. State of the art

1.6.3.1.1. Analyse work environment

1.6.3.1.2. Analyse navigation requirements

1.6.3.1.3. Analyse attitude propulsion requirements

1.6.3.2. Hardware

1.6.3.2.1. Attitude control requirements

1.6.3.3. Software

1.6.3.3.1. Navigation and attitude control software

1.6.3.4. Report of results and conclusions

1.6.4. Propulsion

1.6.4.1. State of the art

1.6.4.1.1. Analyse available propulsion systems

1.6.4.1.2. Analyse power unit requirements

1.6.4.1.3. Analyse power unit transmission requirements

1.6.4.1.4. Analyse power unit receivers requirements

1.6.4.2. Hardware

1.6.4.2.1. Select a suitable propulsion system and its peripherals

1.6.4.2.2. Propulsion systems

1.6.4.2.3. Power unit system

1.6.4.2.4. Power storage system

1.6.4.3. Software

1.6.4.3.1. Power control software

1.6.4.3.2. Propulsion control software

1.6.4.4. Report of results and conclusions

1.6.5. Mechanical

1.6.5.1. State of the art

1.6.5.1.1. Analyse work environment

1.6.5.1.2. Analyse structural effects on Earth observation satellites

1.6.5.1.3. Analyse thermal effects on Earth observation satellites

1.6.5.1.4. Analyse radiation effects on Earth observation satellites

1.6.5.2. Integration of sub-systems

1.6.5.3. Structural design

1.6.5.3.1. Payload modules

1.6.5.3.2. Infrastructure modules

1.6.5.4. Thermal design

1.6.5.4.1. Payload insulation

1.6.5.4.2. Infrastructure insulation

1.6.5.5. Report of results and conclusions

1.6.6. Electronics

1.6.6.1. State of the art

1.6.6.1.1. Analyse work environment

1.6.6.1.2. Analyse electronic requirements

1.6.6.2. Hardware

1.6.6.2.1. Select suitable electronic components

1.6.6.2.2. Payload modules electronic systems

1.6.6.2.3. Infrastructure electronic systems

1.6.6.2.4. Determine sensors requirements

1.6.6.2.5. Contact and specify sensors from developers

1.6.6.3. Report of results and conclusions

1.7. Final Design

1.7.1. Communication Detailed Design

1.7.1.1. Hardware

1.7.1.1.1. Modules communication system

1.7.1.1.2. Ground – space communication system

1.7.1.1.3. Power transmission system

1.7.1.2. Software design

1.7.1.2.1. Protocol communications

1.7.1.2.2. Information control management software

1.7.1.2.3. Power transmission control system

1.7.1.2.4. Communication simulator program

1.7.1.3. Report of results and conclusions

1.7.2. Navigation Detailed Design

1.7.2.1. Hardware design

1.7.2.1.1. Attitude sensors

1.7.2.1.2. Attitude control systems

1.7.2.2. Software design

1.7.2.2.1. Constellation navigation control software

In the figure below, the work breakdown diagram structure is presented, including different work packages.

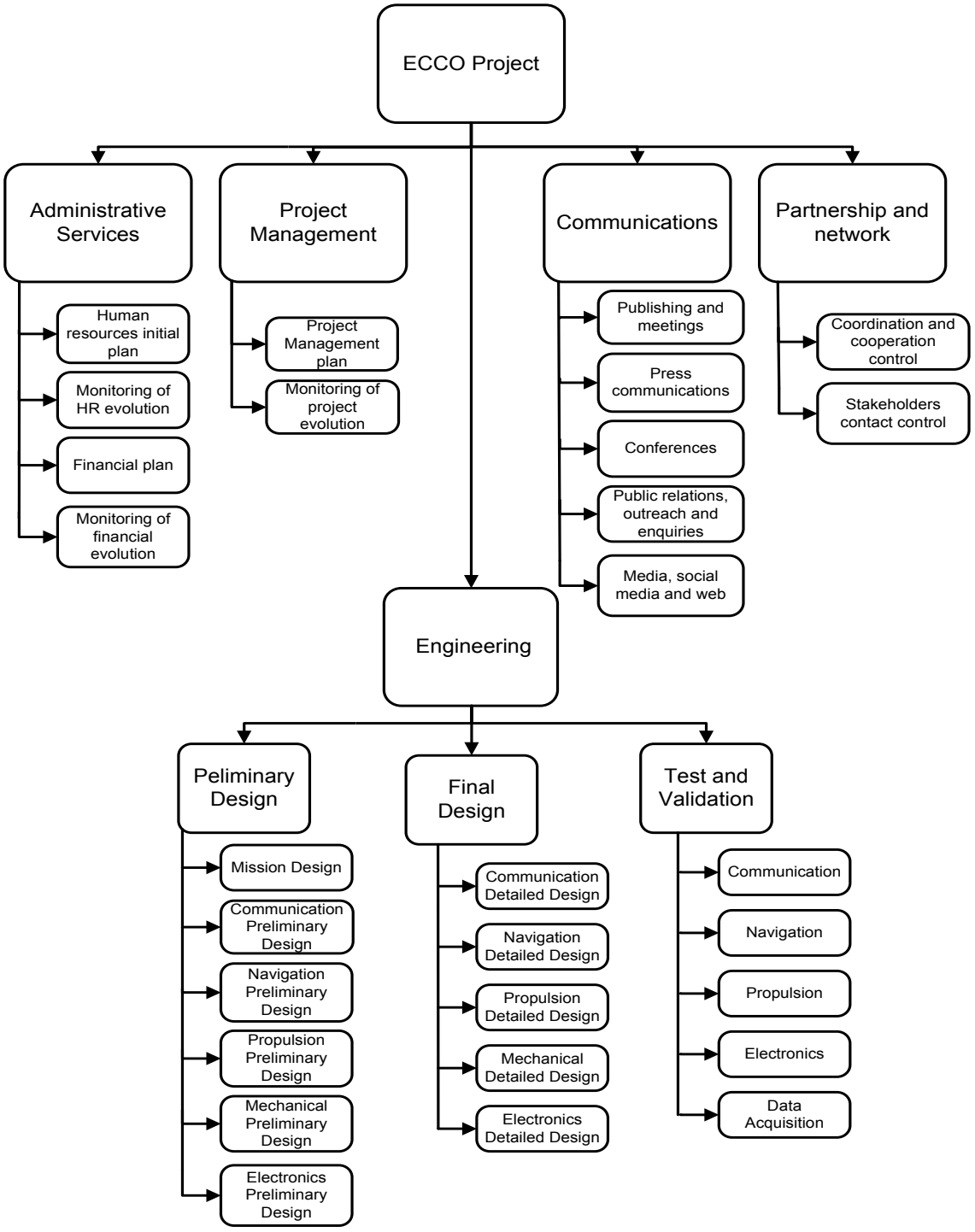


Figure 2. Work breakdown diagram structure

2.1. Activity list

All tasks are described in the table below, including its ID and a brief description of the work that must be done in that task.

Table 6. List of project activities

ID	Activity	Description of Work
PM	**Project Management**	
PM.1	Project Management Plan	A document that defines a more detailed and technical vision of the project, specifying resources, their distribution in time to accomplish the project objectives, a detailed version of the project Charter, control and monitoring actions and level of implementation among others.
PM.2	Monitoring of project evolution	Check and update the state of the project, be aware of any change in budget or deadline ensuring a satisfactory end of it.
PM.3	Preliminary design review	Check the preliminary design document and ensure the expectations, scope and objectives are achieved.
AS	**Administrative Services**	
AS.1	Human resources plan	Estimated plan of the human resources management department so as to evaluate the number and characteristics of the required employees and persons in charge.
AS.2	Monitoring of human resources evolution	Check and update the state of human resources, be aware of any change needed resources ensuring a satisfactory end of the project.
AS.3	Financial plan	Evaluate the cost required by each of the departments in order to carry on the project.
AS.4	Monitoring of financial evolution	Evaluates and control the costs in each phase of the project.
PN	**Partnership and Network**	
PN.1	Coordination and cooperation control	Coordinate and check the evolution of the project, and maintain the common scope between all the project partners
PN.2	Stakeholders contact control	Check and update the interests of the stakeholders and the company during the development of the project.
C	**Communications**	
C.1	Publishing and meetings	Make possible the interaction with the media, science and technologic field so as to let know the new advances,

ID	Activity	Description of Work
C.2	Press communications	Start the contact with the written press in order to state the past, the current and the future fractionated satellite technology advances.
C.3	Conferences	Planning and development of future conferences to attract possible stakeholders and keep the interest of the current ones.
C.4	Public relations, outreach and enquiries	Interact with general population so as to introduce the topic, its new technology and the benefits of providing useful data as to live in a better world.
C.5	Media, social media and web	Approach the whole project in a friendly way through many different channels of communication.
PD	**Preliminary Design**	
PD.M	**Mission Design**	
PD.M.SA.1	Analyse mission requirements	Search exhaustively information about the mission of this project in order to stablish a solid base to run the project.
PD.M.SA.2	Research and analyse current Earth orbit observations parameters	Make a careful analysis of the today orbit observations market to place this project in the sector.
PD.M.1	Select optimum orbital parameters	Selection of the optimum orbital parameters to track Earth information and specify operative data, for instance, height or type of orbit in order to start states of the arts of each department.
PD.M.2	Specify technological requirements	Listing specific technological requirements of the mission in order to accomplish the stablished scope
PD.M.3	Specify incremental Deployment requirements	Determine and specify the requirements of incremental deployment system.
PD.C	**Communication**	
PD.C.SA.1	Analyse work environment	Search, summarise and asses specific information about the particular needs of this project in communication systems.
PD.C.SA.2	Analyse modules communication requirements	Search for information to have a clear idea about the specific requirements for the communication between the modules.
PD.C.SA.3	Analyse ground – Space Communications requirements	Search for information to have a clear idea about the specific requirements for the communication between the ground station and the space station.

ID	Activity	Description of Work
PD.C.SA.4	Analyse power transmission requirements	Search for information that will provide a clear idea about the requirements of the power transmission in the conditions of this project
PD.C.HW.1	Select modules communication System	After an exhaustive research and assessment a selection of the communication has to be done, including frequency, bandwidth taking in account noise and possible undesired effects due to external factors.
PD.C.HW.2	Modules communication System	Preliminary design of communication hardware, including mixers, filters and amplifiers between modules has to be done. The design must fulfil all the specifications that have been indicated in related tasks.
PD.C.HW.3	Select ground – space communication system	After an exhaustive research and assessment a selection of the communication has to be done, including frequency, bandwidth taking in account noise and possible undesired effects due to external factors.
PD.C.HW.4	Ground – space communication system	Preliminary design of communication hardware, including mixers, filters and amplifiers between satellite and ground station has to be done. The design must fulfil all the specifications that have been indicated in related tasks.
PD.C.SW.1	Communication control software	Development of the software that controls and enables transmission data through hardware designed.
PD.C.SW.2	Simulation program	For making sure the correct performance of the communication system it will be developed a computational simulation to check communication software developed.
PD.N	**Navigation**	
PD.N.SA.1	Analyse work environment	Search, summarise and asses specific information about the particular needs of this project in navigation systems.
PD.N.SA.2	Analyse navigation requirements	Search, summarise and asses specific information about the particular needs of this project in the navigation system.
PD.N.SA.3	Analyse attitude propulsion requirements	Search for information to have a clear idea about the specific requirements for the attitude propulsion requirements.
PD.N.HW.1	Attitude control requirements	Study the attitude control of a module and determine the requirements in trust that includes position of rockets, thrust and an estimation of fuel consumption during its operative life.

ID	Activity	Description of Work
PD.N.SW.1	Navigation and attitude control software	Development of the attitude and navigation equations, and create a preliminary software to compute real trajectories and determine the reactions needed to change the orbit or attitude to the desired one.
PD.P	**Propulsion**	
PD.P.SA.1	Analyse available propulsion Systems	Search, summarise and asses specific information about the particular needs of this project in the propulsion systems.
PD.P.SA.2	Analyse power unit requirements	Search for information to have a clear idea about the specific requirements for the power unit.
PD.P.SA.3	Analyse power unit transmission requirements	Search, summarise and asses specific information about the particular needs of this project in the power unit transmission requirements.
PD.P.SA.4	Analyse power unit receivers requirements	Search for information to have a clear idea about the specific requirements for the power unit receivers.
PD.P.HW.1	Select a suitable propulsion System and its peripherals	After an exhaustive research and assessment it will be provided a selection of the most suitable modules for the propulsion system and its peripherals.
PD.P.HW.2	Propulsion Systems	A preliminary design of rockets that fulfil all the requirements has to be done.
PD.P.HW.3	Power unit System	It will be given a global approach to the power unit system.
PD.P.HW.4	Power storage System	It will be given a global approach to the power storage requirements and physical systems needed.
PD.P.SW.1	Power control software	Preliminary design of the software that control the power generation, charge/discharge of storage systems and transmission to other modules.
PD.P.SW.2	Propulsion control software	Preliminary design of the software that control and check status of integrated propulsion systems.
PD.ME	**Mechanical**	
PD.ME.SA.1	Analyse work environment	Search, summarise and asses specific information about the particular needs of this project in mechanics.
PD.ME.SA.2	Analyse structural effects on Earth observation satellites	Search, summarise and asses specific information about the particular structural effects of this project on Earth observation satellites.
PD.ME.SA.3	Analyse thermal effects on Earth observation satellites	Search, summarise and asses specific information about the thermal effects of this project on the Earth observation satellites.

ID	Activity	Description of Work
PD.ME.SA.4	Analyse radiation effects on Earth observation satellites	Search, summarise and asses specific information about the radiation effects of this project on Earth observation satellites.
PD.ME.1	Integration of sub-systems	Integration of all sub-systems in one so as to be able to do a general mechanical verification and start the preliminary design of structure, isolation and wire connexions.
PD.ME.ST.1	Structural design of payload modules	The payload modules need a structural support that will be design taking into account the requirements of this project.
PD.ME.ST.2	Structural design of infrastructure modules	The infrastructure modules need a structural support that will be design taking into account the requirements of this project.
PD.ME.T.1	Payload insulation	The insulation of the payload is a very important task in order to protect the information that can be received.
PD.ME.T.2	Infrastructure insulation	The insulation of the infrastructure is a very important task in order to protect the information that can be transmitted.
PD.E	**Electronics**	
PD.E.SA.1	Analyse work environment	Search, summarise and asses specific information about the particular needs of this project in electronic systems.
PD.E.SA.2	Analyse electronic requirements	Search for information to have a clear idea about the specific requirements for the electronic system.
PD.E.HW.1	Select suitable electronic components	The electronic components must be in accordance to the requirements of the projects claimed above, that includes the estimation of compute power, memory and buss bandwidth among others.
PD.E.HW.2	Payload modules electronic Systems	Specify the electronic system integrated in each payload module, including its performance and specifications.
PD.E.HW.3	Infrastructures electronic systems	Specify the electronic system integrated in each infrastructure module, including its performance and specifications.
PD.E.HW.4	Determine the sensors requirements	Determine the information to be tracked and specify the requirements desired taking in account stakeholders.
PD.E.HW.5	Contact and specify sensors from developers	The sensors that have been chosen to be integrated in the modules must be provided through a particular entity.
FD	**Final Design**	
FD.C	**Communication Detailed Design**	
FD.C.HW.1	Modules communication system	The final communication system between the modules must be well defined and implemented.

ID	Activity	Description of Work
FD.C.HW.2	Ground-space communication System	The final communication system between the Ground-Space stations must be well defined and implemented.
FD.C.HW.3	Power transmission system	The final power transmission between modules must be well defined and implemented
FD.C.SW.1	Protocol Communications	It must be developed a protocol in communications to be followed in a regular case or an emergency case.
FD.C.SW.2	Information control management software	A final control management software will be responsible of integrating the whole information that is received by the different modules.
FD.C.SW.3	Power transmission control System	Final stage in the design of the power transmission control system of the communication module.
FD.C.SW.4	Communication Simulator program	Final design of the communication simulator software developed to simulate the communication between modules and module-ground.
FD.N	**Navigation Detailed Design**	
FD.N.HW.1	Attitude sensors	Final stage in the design of the attitude sensors of the navigation system.
FD.N.HW.2	Attitude control Systems	Final stage in the design of the attitude control system.
FD.N.SW.1	Constellation navigation control software	The final control software responsible of navigation must be designed.
FD.N.SW.2	Module attitude control software	The final control software responsible of module attitude must be designed.
FD.N.SW.3	Navigation and attitude Simulator software	Operative software must be designed and checked to simulate the behaviour of the constellation in its working environment, using the navigation and attitude control software.
FD.P	**Propulsion Detailed Design**	
FD.P.HW.1	Propulsion systems	The design of the propulsion system reaches its final stage. It is fully defined and implemented.
FD.P.HW.2	Power unit system	The design of the power unit system reaches its final stage. It is fully defined and implemented.
FD.P.HW.3	Power storage system	The design of the power storage system reaches its final stage. It is fully defined and implemented.
FD.P.SW.1	Power control software	The final control software will be responsible of integrating the power system.
FD.P.SW.2	Propulsion control software	The final control software will be responsible of integrating the propulsion system.

ID	Activity	Description of Work
FD.ME	**Mechanical Detailed Design**	
FD.ME.MD.1	Material selection	Materials selection taking in account temperature, radiation, structural resistance during the launch and other kind of mission and space adverse conditions.
FD.ME.MD.2	Module structure	The module structure, that has to be big enough to enclosure all the sub-systems defined, and to protect them from space debris.
FD.ME.MD.3	Thermal insulation	Thermal insulation to protect sub-systems from the adverse conditions outside the module. Temperature levels inside the module must reach specific temperature to ensure the correct functionality of all electronic devices.
FD.ME.MD.4	Sub-systems Integration	Final integration of the Sub-systems into one.
FD.ME.ID.1	Material selection	Materials selection taking in account temperature, radiation, structural resistance during the launch and other kind of mission and space adverse conditions.
FD.ME.ID.2	Module structure	The module structure, that has to be big enough to enclosure all the sub-systems defined, and to protect them from space debris.
FD.ME.ID.3	Thermal insulation	Thermal insulation to protect sub-systems from the adverse conditions outside the module. Temperature levels inside the module must reach specific temperature to ensure the correct functionality of all electronic devices.
FD.ME.ID.4	Sub-systems Integration	Final integration of the Sub-systems into one.
FD.E	**Electronic Detailed Design**	
FD.E.HW.1	Payload modules electronic Systems	Final design of the payload modules. They must be fully defined and implemented.
FD.E.HW.2	Infrastructures electronic systems	Final stage in the design of the infrastructures of the electronic systems. They are fully defined and implemented.
FD.E.HW.3	Selection and integration of sensors	The sensors that will be installed are finally chosen between all the possible providers.
T	**Tests and Validations**	
T.C	**Communications**	
T.C.1	Test and validation for communication satellite-satellite	The final communication system between satellite-satellite is tested and validated.

ID	Activity	Description of Work
T.C.2	Test and validation for communication ground-satellite	The final communication system between ground-satellite is tested and validated.
T.C.3	Test and validation for power transmission	The power transmission system is tested and validated.
T.N	**Navigation**	
T.N.1	Test and validation of the navigation, attitude and control system using computer simulated programs	The navigation, attitude and control systems are tested and validated using simulation software assisted by computer.
T.P	**Propulsion**	
T.P.1	Test and validation of the propulsion system using computer simulated programs	The propulsion system is tested and validated using simulation software assisted by computer.
T.ME	**Mechanical**	
T.ME.1	Test and validation using computer simulation programs	The mechanical system is tested and validated using simulation software assisted by computer.
T.E	**Electronics**	
T.E.1	Test and validation using computer simulation programs	The electronics system is tested and validated using simulation software assisted by computer.
T.A	**Data acquisition**	
T.A.1	Validation of signal quality	The quality of the final signal received is tested and validated.
T.A.2	Test and validation for the 3D mapping and new acquisition systems developed	The 3D mapping and other new acquisition modes developed are tested and validated.

3. Sequence Activities

3.1. Logical Relationship between Activities

Table 7. List of logical relationships between activities

WBS-ID	Activity	Predecessors	Relation[1]	Lag
PM	**Project Management**			
PM.1	Project Management Plan	START	-	0
REP.PM.1	Project Management Plan deliverable	PM.1	FF	0
PM.2	Monitoring of project evolution	PM.1	FS	0
PM.3	Preliminary design review	REP.PD	FS	0
AS	**Administrative Services**			
AS.1	Human resources plan	START	-	0
AS.2	Monitoring of human resources	AS.1	FS	0
AS.3	Financial plan	START	-	
AS.4	Monitoring of financial evolution	AS.3	FS	0
PN	**Partnership and Network**			
PN.1	Coordination and cooperation control	REP.PM.1	FS	0
PN.2	Stakeholders contact control	REP.PM.1	FS	0
C	**Communications**			
C.1	Publishing and meetings	PM.1	FS	0
C.2	Press communications	PM.1	FS	0
C.3	Conferences	PM.1	FS	267 d
C.4	Public relations, outreach and enquiries	PM.1	FS	267 d
C.5	Media, social media and web	PM.1	FS	267 d
REP.C.1	Intermediate meeting			267 d
REP.C.2	ECCO International congress	PD	SS	0
PD	**Preliminary Design**	START	SS	0
PD.M	**Mission Design**			
PD.M.SA.1	Analyse mission requirements	PD	SS	0
PD.M.SA.2	Research and analyse current Earth orbit observations parameters	PD.M.SA.1	FS	0
PD.M.1	Select optimum orbital parameters	PD.M.SA	FS	0
PD.M.2	Specify technological requirements	PD.M.1	FS	0
PD.M.3	Specify incremental deployment requirements	PD.M.1	FS	0

[1] FS = Finish – to – Start; FF = Finish – to – Finish; SS = Start – to – Start; SF = Start – to – Finish

WBS-ID	Activity	Predecessors	Relation[1]	Lag
REP.M.1	Report of results and conclusions	PD.M.2 PD.M.3	FF	0
PD.C	**Communication**			
PD.C.SA.1	Analyse work environment	PD.M	FS	0
PD.C.SA.2	Analyse modules communication requirements	PD.C.SA.1	FS	0
PD.C.SA.3	Analyse ground – space communications requirements	PD.C.SA.1	FS	0
PD.C.SA.4	Analyse power transmission requirements	PD.C.SA.2 PD.C.SA.3	FS	0
PD.C.HW.1	Select modules communication system	PD.C.SA	FS	0
PD.C.HW.2	Modules communication system	PD.C.HW.1	FS	0
PD.C.HW.3	Select ground – space communication system	PD.C.SA	FS	0
PD.C.HW.4	Ground – space communication system	PD.C.HW.3	FS	0
PD.C.SW.1	Communication control software	PD.C.HW	FS	0
PD.C.SW.2	Simulation program	PD.C.SW.1	FS	0
REP.C.1	Report of results and conclusions	PD.C.SW	FF	0
PD.N	**Navigation**			
PD.N.SA.1	Analyse work environment	PD.M	FS	0
PD.N.SA.2	Analyse navigation requirements	PD.N.SA.1	FS	0
PD.N.SA.3	Analyse attitude propulsion requirements	PD.N.SA.2	FS	0
PD.N.HW.1	Attitude control requirements	PD.N.SA PD.E.HW.4	FS	0
PD.N.SW.1	Navigation and attitude control software	PD.N.HW.1	FS	0
REP.N.1	Report of results and conclusions	PD.N.SW	FF	0
PD.P	**Propulsion**			
PD.P.SA.1	Analyse available propulsion systems	PD.C.SA PD.E.SA	FS	0
PD.P.SA.2	Analyse power unit requirements	PD.C.SA PD.E.SA	FS	0
PD.P.SA.3	Analyse power unit transmission requirements	PD.P.SA.2	FS	0
PD.P.SA.4	Analyse power unit receivers requirements	PD.P.SA.2	FS	0
PD.P.HW.1	Select a suitable propulsion system and its peripherals	PD.E.HW PD.P.SA	FS	0
PD.P.HW.2	Propulsion systems	PD.P.HW.1 PD.N.HW.1	FS	0

WBS-ID	Activity	Predecessors	Relation[1]	Lag
PD.P.HW.3	Power unit system	PD.E.HW PD.P.SA	FS	0
PD.P.HW.4	Power storage system	PD.P.HW.3	FS	0
PD.P.SW.1	Power control software	PD.P.HW	FS	0
PD.P.SW.2	Propulsion control software	PD.P.HW	FS	0
REP.P.1	Report of results and conclusions	PD.P.SW	FF	0
PD.ME	**Mechanical**			
PD.ME.SA.1	Analyse work environment	PD.C.HW PD.N.HW PD.P.HW PD.E.HW	SS	0
PD.ME.SA.2	Analyse structural effects on Earth observation satellites	PD.ME.SA.1	FS	0
PD.ME.SA.3	Analyse thermal effects on Earth observation satellites	PD.ME.SA.1	FS	0
PD.ME.SA.4	Analyse radiation effects on Earth observation satellites	PD.ME.SA.1	FS	0
PD.ME.1	Integration of sub-systems	PD.ME.SA	FS	0
PD.ME.ST.1	Structural design of payload modules	PD.ME.1	FS	0
PD.ME.ST.2	Structural design of infrastructure modules	PD.ME.1	FS	0
PD.ME.T.1	Payload insulation	PD.ME.1	FS	0
PD.ME.T.2	Infrastructure insulation	PD.ME.1	FS	0
REP.ME.1	Report of results and conclusions	PD.ME.ST PD.ME.T	FF	0
PD.E	**Electronics**			
PD.E.SA.1	Analyse work environment	PM	SS	0
PD.E.SA.2	Analyse electronic requirements	PD.E.SA.1	FS	0
PD.E.HW.1	Select suitable electronic components	PD.E.SA PD.C.HW PD.N.HW	FS	0
PD.E.HW.2	Payload modules electronic systems	PD.E.HW.1	FS	0
PD.E.HW.3	Infrastructures electronic systems	PD.E.HW.1	FS	0
PD.E.HW.4	Determine the sensors requirements	PD.E.SA	FS	0
PD.E.HW.5	Contact and specify sensors from developers	PD.E.HW.4	FS	0
REP.E.1	Report of results and conclusions	PD.E.HW	FF	0
REP.PD	Preliminary Design Report	PD	FF	0

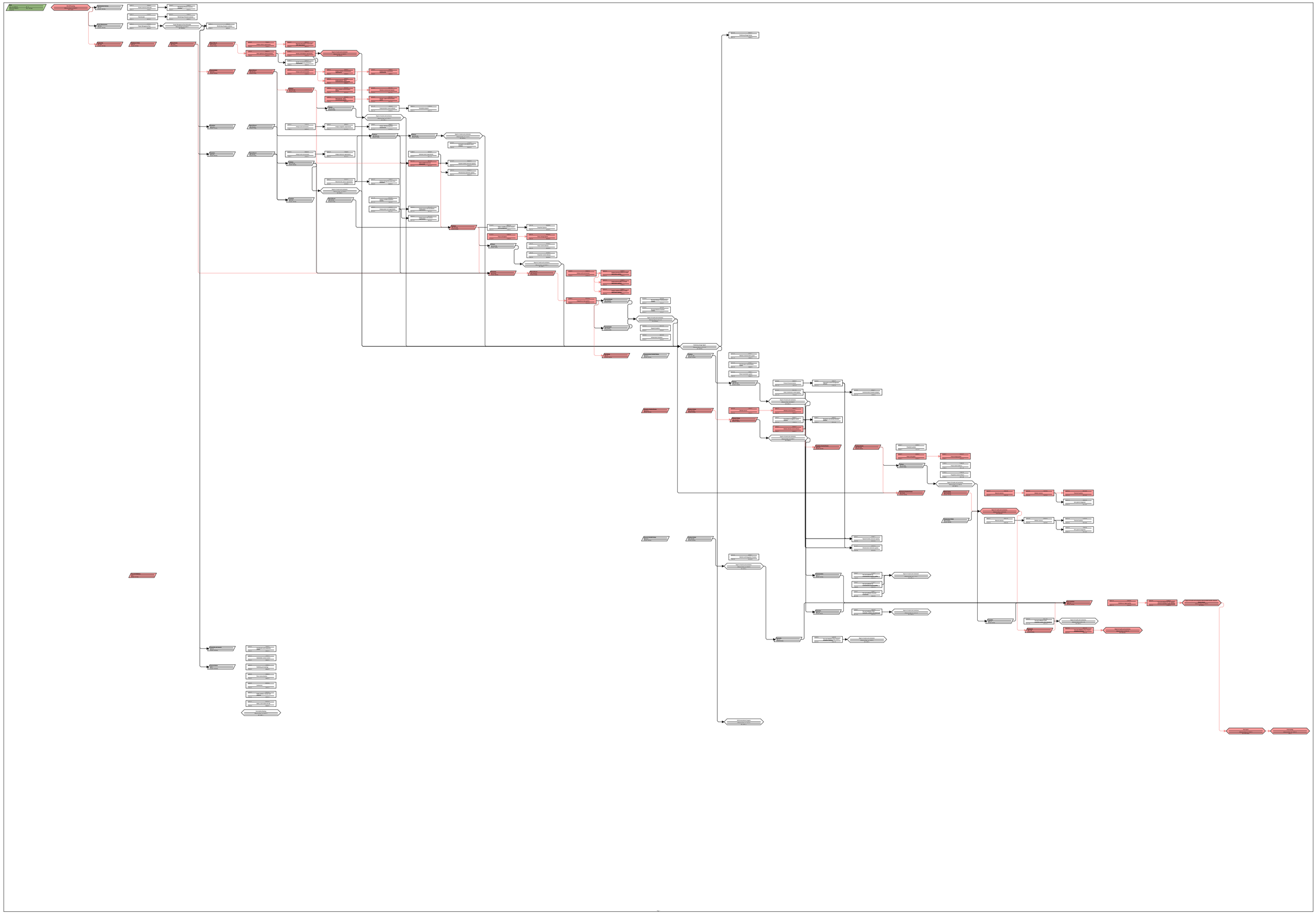
WBS-ID	Activity	Predecessors	Relation[1]	Lag
FD	**Final Design**			
FD.C	**Communication Detailed Design**			
FD.C.HW.1	Modules communication system	PD.ME.1	FS	0
FD.C.HW.2	Ground-space communication system	PD.ME.1	FS	0
FD.C.HW.3	Power transmission system	PD.ME.1	FS	0
FD.C.SW.1	Protocol communications	FD.C.HW	FS	0
FD.C.SW.2	Information control management soft.	FD.C.SW.1	FS	0
FD.C.SW.3	Power transmission control system	FD.C.HW	FS	0
FD.C.SW.4	Communication Simulator program	FD.C.SW.2 FD.C.SW.3	FS	0
REP.C.2	Report of results and conclusions	FD.C.SW	FF	0
FD.N	**Navigation Detailed Design**			
FD.N.HW.1	Attitude sensors	PD.ME.1	FS	0
FD.N.HW.2	Attitude control systems	FD.N.HW.1	FS	0
FD.N.SW.1	Constellation navigation control soft.	FD.N.HW	FS	0
FD.N.SW.2	Module attitude control software	FD.N.HW	FS	0
FD.N.SW.3	Navigation and attitude simulator soft.	FD.N.SW.1 FD.N.SW.2	FS	0
REP.N.2	Report of results and conclusions	FD.N.SW	FF	0
FD.P	**Propulsion Detailed Design**			
FD.P.HW.1	Propulsion systems	FD.N.SW.2	FS	0
FD.P.HW.2	Power unit system	FD.N.SW.2	FS	0
FD.P.HW.3	Power storage system	FD.P.HW.2	FS	0
FD.P.SW.1	Power control software	FD.P.HW	FS	0
FD.P.SW.2	Propulsion control software	FD.P.HW	FS	0
REP.P.2	Report of results and conclusions	FD.P.SW	FF	0
FD.ME	**Mechanical Detailed Design**			
FD.ME.MD.1	Material selection	FD.P.HW	FS	0
FD.ME.MD.2	Module structure	FD.ME.MD.1	FS	0
FD.ME.MD.3	Thermal insulation	FD.ME.MD.2	FS	0
FD.ME.MD.4	Sub-systems Integration	FD.ME.MD.3	FS	0
FD.ME.ID.1	Material selection	FD.P.HW	FS	0
FD.ME.ID.2	Module structure	FD.ME.MD.1	FS	0
FD.ME.ID.3	Thermal insulation	FD.ME.MD.2	FS	0
FD.ME.ID.4	Sub-systems Integration	FD.ME.MD.3	FS	0
REP.ME.2	Report of results and conclusions	FDE.ME.MD FDE.ME.ID	FF	0

WBS-ID	Activity	Predecessors	Relation[1]	Lag
FD.E	**Electronic Detailed Design**	FD.C FD.N	FS	0
FD.E.HW.1	Payload modules electronic systems	FD.C FD.N	FS	0
FD.E.HW.2	Infrastructures electronic systems	FD.C FD.N	FS	0
FD.E.HW.3	Selection and integration of sensors	PD.ME.1	FS	0
REP.E.2	Report of results and conclusions	FD.E.HW	FF	0
T	**Tests and Validations**			
T.C	**Communications**			
T.C.1	Test and validation for communication satellite-satellite	FD.C	FS	0
T.C.2	Test and validation for communication ground-satellite	FD.C	FS	0
T.C.3	Test and validation for power transmission	FD.C	FS	0
REP.C.3	Report of results and conclusions	T.C.1 T.C.2 T.C.3	FF	0
T.N	**Navigation**			
T.N.1	Test and validation of the navigation, attitude and control system using computer simulated programs	FD.N	FS	0
REP.N.3	Report of results and conclusions	T.N.1	FF	0
T.P	**Propulsion**			
T.P.1	Test and validation of the propulsion system using computer simulated programs	FD.P	FS	0
REP.P.3	Report of results and conclusions	T.P.1	FF	0
T.ME	**Mechanical**			
T.ME.1	Test and validation using computer simulation programs	FD.ME	FS	0
REP.ME.3	Report of results and conclusions	T.ME.1	FF	0
T.E	**Electronics**			
T.E.1	Test and validation using computer simulation programs	FD.E	FS	0
REP.E.3	Report of results and conclusions	T.E.1	FF	0

WBS-ID	Activity	Predecessors	Relation[1]	Lag
T.A	**Data acquisition**			
T.A.1	Validation of signal quality	T.C T.N T.P T.ME T.E	FS	0
T.A.2	Test and validation for the 3D mapping and new acquisition systems developed	T.A.1	FS	0
REP.A	Report of results and conclusions about possible benefits related to climate change	T.A.2	FS	0

3.2. Network Diagram (Precedence Diagram Method)

The Network Diagram of the ECCO project contains the relationships among the tasks. Since there are many tasks, the diagram is complex and big. In the next page the network diagram can be found.



4. Estimate Activity Resource

4.1. Resource Identification

Three different types of resources have been identified:

- Worker: person that works for the project. In the case of collaboration with stakeholders, this would also be considered as a worker.
- Cost: something that is paid to get something in return. Outsourcing of some activities to a stakeholder is considered to be a cost.
- Material: Expenditures required for the project. The main ones in the ECCO project are the costs associated with the software licenses and the three different sensors.

The list of resources for the project is presented below.

Table 8. List of resources

Resource ID	Description of the resource	Type of resource
PM.M	Project Manager	Worker
PM.S	Project Management Secretary	Worker
PM.EXT	E-TIS Euroconsultores outsourcing	Cost
AS.M	Administration Services Manager	Worker
AS.S	Administration Services Secretary	Worker
HR.W	Human Resources worker	Worker
F.W1	Financial Worker 1	Worker
F.W2	Financial Worker 2	Worker
C.M	Communication Manager	Worker
C.EXT	BCCI Communication Outsourcing	Cost
E.MD.M	Mech. Dept. Manager	Worker
E.MD.S	Mech. Dept. Secretary	Worker
E.MDD.M	Mission Design Dept. Manager	Worker
E.PD.M	Payloads Dept. Manager	Worker
E.MDD.S	Mission Design and Payloads Depts. Secretary	Worker
E.ED.M	Electronics Dept. Manager	Worker
E.CD.M	Communications Dept. Manager	Worker
E.CD.S	Communications and Electronics Dept. Secretary	Worker
SE1	Software engineer 1	Worker
SE2	Software engineer 2	Worker
SE3	Software engineer 3	Worker
TE1	Telecommunications engineer 1	Worker

TE2	Telecommunications engineer 2	Worker
TE3	Telecommunications engineer 3	Worker
EE1	Electronics engineer 1	Worker
EE2	Electronics engineer 2	Worker
EE3	Electronics engineer 3	Worker
SE1	Space engineer 1	Worker
SE2	Space engineer 2	Worker
SE3	Space engineer 3	Worker
MD.EXT1	Space engineer 4	Worker
MD.EXT2	Space engineer 5	Worker
MDD.EXT 1	Ball Aerospace Collaboration	Cost
MDD.EXT 2	Stuttgart University Collaboration	Worker
CD.EXT 1	Orbital ATK Collaboration	Worker
CD.EXT 2	Cranfield University Collaboration	Worker
PD.EXT 1	SENER Collaboration	Cost
PD.EXT 2	Polytechnic University of Catalonia Collaboration	Worker
PD.EXT 3	Southampton University Collaboration	Worker
SOFT.1	Silvanet Collaboration	Worker
SOFT.2	Surrey Satellites Collaboration	Worker
SOFT.3	Amptek Collaboration	Worker
SOFT.4	ANSYS Workbench Software	Material
SOFT.5	Keysight ADS Software	Material
SOFT.6	LTSpice Software	Material
SOFT.7	Matlab R2015b	Material
SOFT.8	Microsoft Office software	Material
LAB.COM	Microsoft Project	Material
LAB.ELE	STK Software	Material
LAB.GNC	Visual Studio	Material
LAB.INT	Communication laboratory	Cost
LAB.MEC	Electronics laboratory - UPV Collaboration	Cost
LAB.PRO	GNC laboratory	Cost

4.2. Activity Resource Requirement

Table 9. List of resource requirements

WBS ID	Resource ID	Quantity	Assumptions
PM	PM.M, PM.S, PM.EXT, SOFT.6	1, 1, 1, 1	The project management will be in part outsourced to E-TIS Euroconsultores
AS	AS.M, AS.S	1, 1	Administrative services include the Human Resources and Financial parts of the project
AS.1	HR.W	1	
AS.2	HR.W	1	
AS.3	F.W1, F.W2	1, 1	
AS.4	F.W1, F.W2	1, 1	
PN	AS.M, AS.S, HR.W	1, 1, 1	There PN tasks are developed by the workers of the AS Department
C	C.M, C.EXT	1, -	The dissemination of the project will be mostly done by BCCI Communications
PD.M	E.MDD.M, E.MDD.S	1, 1	The manager and secretary are working in all of the aspects of this group of tasks
PD.M.SA.1	SE1, SE2	1, 1	In the PD.M only Space Engineers work due to their broad knowledge in mission design concepts and in collaboration with Cranfield University
PD.M.SA.2	SE1, SE2	1, 1	
PD.M.1	SE1, SE3, SE4, SOFT.7	1, 1, 1, 2	
PD.M.2	SE1, SE2, SE3, SOFT.7	1, 1, 1, 2	
PD.M.3	SE1, SE4, MDD.EXT1, SOFT.7	1, 1, 3, 2	
PD.C	E.CD.M, E.CD.S	1, 1	The manager and secretary are working in all of the aspects of this group of tasks
PD.C.SA.1	TE1, TE2	1, 1	These tasks will be done in collaboration with Orbital ATK
PD.C.SA.2	TE1, TE3	1, 1	
PD.C.SA.3	SE2, SE3	1, 1	
PD.C.SA.4	TE1, SE2, MD.EXT 3	1, 1, 3	
PD.C.HW.1	SE1, TE2	1, 1	These task will be done in collaboration with University of Southampton
PD.C.HW.2	SE1, TE2, CD.EXT 2	1, 1, 3	
PD.C.HW.3	SE2, TE3	1, 1	
PD.C.HW.4	SE2, TE3	1, 1	

WBS ID	Resource ID	Quantity	Assumptions
PD.C.SW.1	SE1, IE3, TE2, SOFT.5	1, 1, 1, 3	Very interdisciplinary team for the preliminary design of the communication software
PD.C.SW.2	IE1, TE1, SE2, SOFT.5	1, 1, 1, 3	
PD.N	E.MDD.M, E.MDD.S	1, 1	The manager and secretary are working in all of the aspects of this group of tasks
PD.N.SA.1	SE1, TE3	1, 1	The Spatial engineer assists the Telecommunication engineer in technical things about the space working conditions and the specific requirements that must be accomplished
PD.N.SA.2	SE1, TE2	1, 1	
PD.N.SA.3	SE1, TE2	1, 1	
PD.N.HW.1	SE3, TE1	1, 1	
PD.N.SW.1	IE1, IE2, TE1, SOFT.5	1, 1, 1, 3	
PD.P	E.PRD.M, E.MD.S	1, 1	The manager and secretary are working in all of the aspects of this group of tasks
PD.P.SA.1	SE3	1	These tasks will be done in collaboration with Orbital ATK
PD.P.SA.2	MD.EXT3, SE4	3, 1	
PD.P.SA.3	MD.EXT3, SE3	3, 1	
PD.P.SA.4	MD.EXT3, SE4	3, 1	
PD.P.HW.1	SE2, SE3	1, 1	These tasks will be done in collaboration with Orbital ATK
PD.P.HW.2	SE2	1	
PD.P.HW.3	MD.EXT3, SE4	3, 1	
PD.P.HW.4	SE4	1	
PD.P.SW.1	IE1, SE2, SOFT.5	1, 1, 2	-
PD.P.SW.2	IE2, SE4, SOFT.5	1, 1, 2	
PD.ME	E.MD.M, E.MD.S	1, 1	The manager and secretary are working in all of the aspects of this group of tasks
PD.ME.SA.1	IE3	1	These tasks will be done in collaboration with the University of Stuttgart
PD.ME.SA.2	IE1	1	
PD.ME.SA.3	IE2, MD.EXT 2	1, 3	
PD.ME.SA.4	IE2	1	
PD.ME.1	SE1, SE3, SOFT.8	1, 1, 1	-
PD.ME.ST.1	SE3, SOFT.1, SOFT.8	1, 1, 1	
PD.ME.ST.2	SE3, SOFT.1, SOFT.8	1, 1, 1	
PD.ME.T.1	MD.EXT 2	3	These tasks will be done in collaboration with Stuttgart University
PD.ME.T.2	MD.EXT 2	3	
PD.E	E.ED.M, E.CD.S	1, 1	The manager and secretary are working in all of the aspects of this group of tasks

WBS ID	Resource ID	Quantity	Assumptions
PD.E.SA.1	EE1, EE2	1, 1	The electronics engineers that will develop these tasks have many experience already in space related projects
PD.E.SA.2	EE1	1	
PD.E.HW.1	EE1, EE2	1, 1	
PD.E.HW.2	EE1, EE2	1, 1	
PD.E.HW.3	EE1, EE2	1, 1	
PD.E.HW.4	EE1, EE2	1, 1	
PD.E.HW.5	EE1, EE2	1, 1	
FD.C	E.CD.M, E.CD.S	1, 1	The manager and secretary are working in all of the aspects of this group of tasks
FD.C.HW.1	SE4, TE2, CD.EXT 2	1, 1, 3	These tasks will be done in collaboration with Southampton University and Orbital ATK
FD.C.HW.2	SE3, TE3	1, 1	
FD.C.HW.3	SE2, TE3, MD.EXT 3	1, 1, 3	
FD.C.SW.1	IE3, SE5, TE3, SOFT.5	1, 1, 1, 3	These tasks will be done in collaboration with Orbital ATK
FD.C.SW.2	IE2, SE5, TE1, SOFT.5	1, 1, 1, 3	
FD.C.SW.3	IE3, SE2, MD.EXT 3, SOFT.5	1, 1, 3, 3	
FD.C.SW.4	IE1, SE1, TE1, SOFT.5	1, 1, 1, 3	
FD.N	E.MDD.M, E.MDD.S	1, 1	The manager and secretary are working in all of the aspects of this group of tasks
FD.N.HW.1	SE4, TE2	1, 1	-
FD.N.HW.2	SE1, TE3	1, 1	
FD.N.SW.1	IE3, SE1, MDD.EXT2, SOFT.5	1, 1, 3, 3	These tasks will be done in collaboration with SENER
FD.N.SW.2	IE1, IE2, TE1, SOFT.5	1, 1, 1, 3	
FD.N.SW.3	IE1, IE2, TE1, SOFT.5	1, 1, 1, 3	
FD.P	E.PRD.M, E.MD.S	1, 1	The manager and secretary are working in all of the aspects of this group of tasks

WBS ID	Resource ID	Quantity	Assumptions
FD.P.HW.1	SE1	1	These tasks will be done in collaboration with Orbital ATK
FD.P.HW.2	SE2, MD.EXT3	1, 3	
FD.P.HW.3	SE1	1	
FD.P.SW.1	IE1, SE2, SOFT.5	1, 1, 3	
FD.P.SW.2	IE1, SE2, SOFT.5	1, 1, 3	
FD.ME	E.MD.M, E.MD.S	1, 1	The manager and secretary are working in all of the aspects of this group of tasks
FD.ME.MD.1	SE3, SE4, MD.EXT1	1, 1, 3	These tasks will be done in collaboration with Stuttgart University, Ball Aerospace and UPV
FD.ME.MD.2	UPV, SOFT.1	3, 2	
FD.ME.MD.3	SE3, MD.EXT 2	1, 3	
FD.ME.MD.4	SE3, SE4, SE5, SOFT.8	1, 1, 1, 3	
FD.ME.ID.1	SE2, SE5, MD.EXT1	1, 1, -	These tasks will be done in collaboration with Stuttgart University
FD.ME.ID.2	SE1, SOFT.1	1, 2	
FD.ME.ID.3	MD.EXT 2	3	
FD.ME.ID.4	SE2, SE3, SOFT.8	2, 3	
FD.E	E.ED.M, E.CD.S	1, 1	The manager and secretary are working in all of the aspects of this group of tasks
FD.E.HW.1	EE1, EE2	1, 1	For these tasks it is required to have already the sensors developed by Amptek, Silvanet and Surrey Satellites
FD.E.HW.2	EE1, EE2	1, 1	
FD.E.HW.3	PD.EXT1, PD.EXT3, SOFT.3	3, 3, 3	
T.C	E.CD.M	1	These tasks will be developed in a subcontracted Communications laboratory
T.C.1	LAB.COM, SOFT.2	-, 2	
T.C.2	LAB.COM, SOFT.2	-, 2	
T.C.3	LAB.COM	1	
T.N	E.MDD.M	1	The mission design manager is the responsible for this testing
T.N.1	LAB.INT, SOFT.5, SOFT.7	-, 1, 1	
T.P	E.PRD.M	1	The propulsion manager is the responsible for this testing
T.P.1	SE5, SOFT.1	1, 2	
T.ME	E.MD.M	1	The mechanical manager is the responsible for this testing
T.ME.1	SE1, SOFT.1	1, 2	

WBS ID	Resource ID	Quantity	Assumptions
T.E	E.ED.M	1	These tasks will be developed in the electronics laboratory of UPV
T.E.1	EE1, LAB.ELE	1, -	
T.A	E.CD.M	1	The communication manager is the responsible for the testing
T.A.1	LAB.COM, S1.T, S2.C, S3.GD	-, 1, 1, 1	These tasks will be developed in a subcontracted Communications laboratory
T.A.2	UPC, IE1, SOFT.4, S1.T, S2.C, S3.GD	3, 1, 2, 1, 1, 1	UPC is the responsible for the testing of this task
Comments: since the project is developed in the framework of an existing company, some basic resources such as desks, computers and basic software are assumed to be already available. Also, the engineers of the company can be working in other projects during the duration of the ECCO project, so they may not be working in the project for a period of time.			

4.3. Resource Breakdown Structure

In the figure below, the resource breakdown diagram structure is presented.

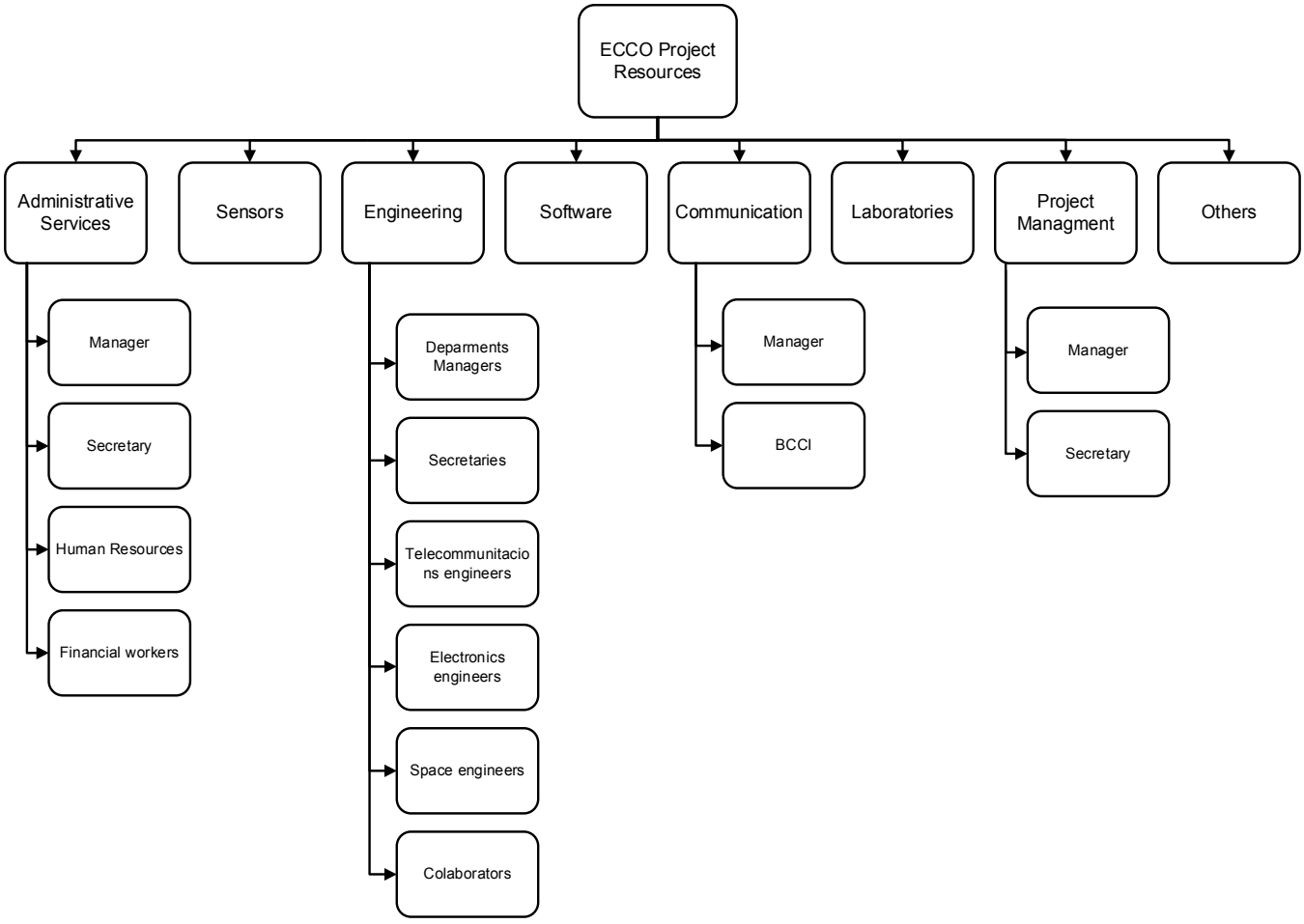


Figure 3. Resource breakdown structure

5. Estimate Activity Duration

For the estimation of the activity duration, the three point estimates method has been followed. Three different estimations are done for each task and then with the weighting equation the expected duration time is obtained.

In the table below the estimate activity duration for the ECCO project is presented.

Table 10. List of three point estimates

Three point estimates					
WBS ID	**Optimistic duration**	**Most likely duration**	**Pessimistic duration**	**Weighting equation**	**Expected duration estimate**
PM.1	20	30	40	(o+4m+p)/6	30
PM.2	950	1000	1494	(o+4m+p)/6	1074
PM.3	20	30	40	(o+4m+p)/6	30
AS.1	7	10	43	(o+4m+p)/6	15
AS.2	950	1000	1584	(o+4m+p)/6	1089
AS.3	20	30	40	(o+4m+p)/6	30
AS.4	950	1000	1494	(o+4m+p)/6	1074
PN.1	950	1000	1494	(o+4m+p)/6	1074
PN.2	950	1000	1494	(o+4m+p)/6	1074
C.1	950	1000	1494	(o+4m+p)/6	1074
C.2	950	1000	1494	(o+4m+p)/6	1074
C.3	680	720	1240	(o+4m+p)/6	800
C.4	680	720	1240	(o+4m+p)/6	800
C.5	680	720	1240	(o+4m+p)/6	800
PD.M.SA.1	10	15	50	(o+4m+p)/6	20
PD.M.SA.2	10	15	20	(o+4m+p)/6	15
PD.M.1	10	15	20	(o+4m+p)/6	15
PD.M.2	25	30	35	(o+4m+p)/6	30
PD.M.3	15	20	25	(o+4m+p)/6	20
PD.C.SA.1	10	15	20	(o+4m+p)/6	15
PD.C.SA.2	15	20	25	(o+4m+p)/6	20
PD.C.SA.3	10	15	50	(o+4m+p)/6	20
PD.C.SA.4	10	15	20	(o+4m+p)/6	15
PD.C.HW.1	10	15	20	(o+4m+p)/6	15
PD.C.HW.2	20	25	60	(o+4m+p)/6	30
PD.C.HW.3	10	15	20	(o+4m+p)/6	15
PD.C.HW.4	20	30	40	(o+4m+p)/6	30
PD.C.SW.1	30	40	50	(o+4m+p)/6	40

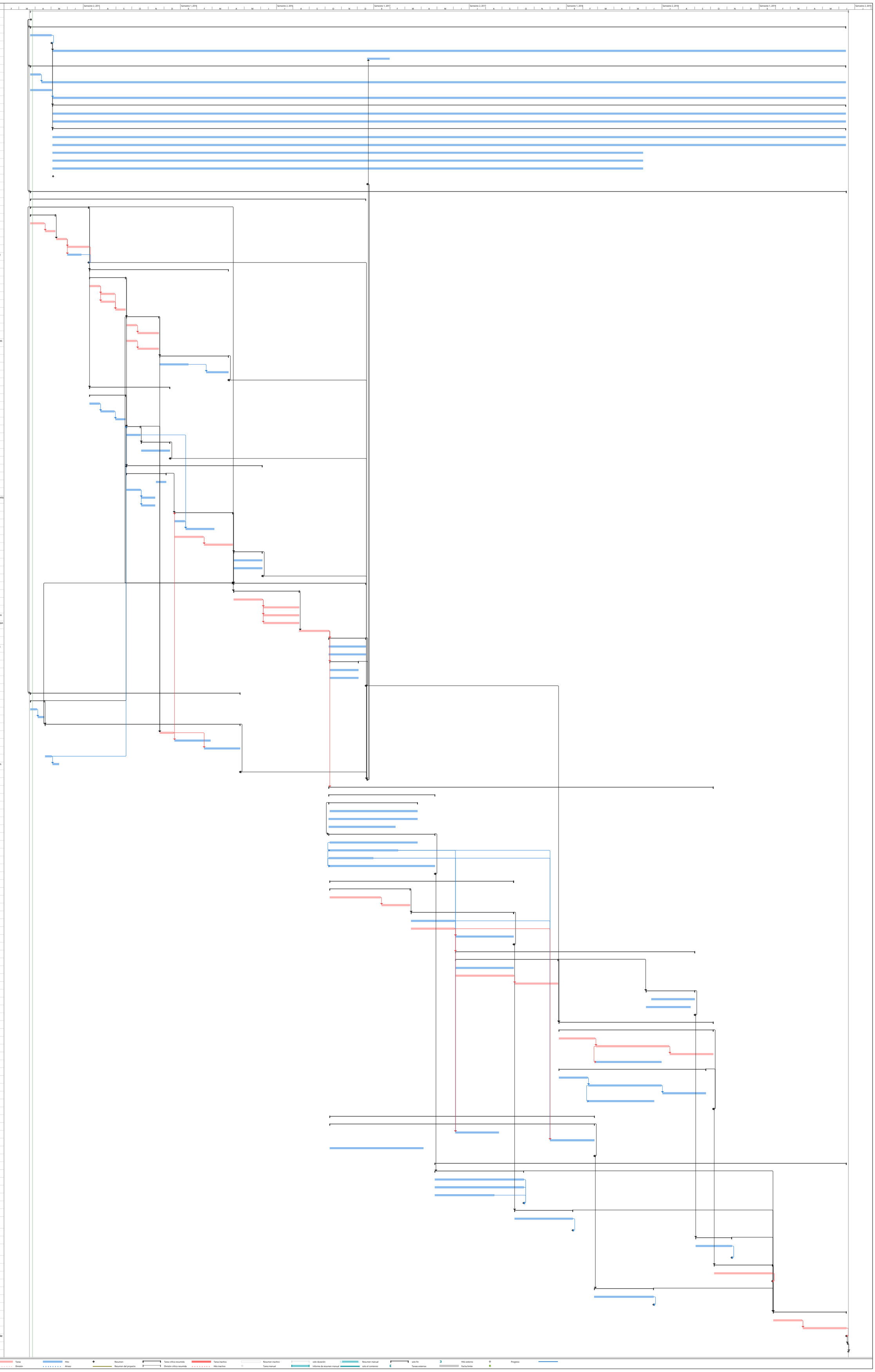
Three point estimates					
WBS ID	**Optimistic duration**	**Most likely duration**	**Pessimistic duration**	**Weighting equation**	**Expected duration estimate**
PD.C.SW.2	20	30	40	(o+4m+p)/6	30
PD.N.SA.1	10	15	20	(o+4m+p)/6	15
PD.N.SA.2	15	20	25	(o+4m+p)/6	20
PD.N.SA.3	10	15	20	(o+4m+p)/6	15
PD.N.HW.1	15	20	25	(o+4m+p)/6	20
PD.N.SW.1	25	35	75	(o+4m+p)/6	40
PD.P.SA.1	10	15	20	(o+4m+p)/6	15
PD.P.SA.2	15	20	25	(o+4m+p)/6	20
PD.P.SA.3	15	20	25	(o+4m+p)/6	20
PD.P.SA.4	15	20	25	(o+4m+p)/6	20
PD.P.HW.1	10	15	20	(o+4m+p)/6	15
PD.P.HW.2	30	35	70	(o+4m+p)/6	40
PD.P.HW.3	30	40	50	(o+4m+p)/6	40
PD.P.HW.4	30	40	50	(o+4m+p)/6	40
PD.P.SW.1	25	30	95	(o+4m+p)/6	40
PD.P.SW.2	30	40	50	(o+4m+p)/6	40
PD.ME.SA.1	25	38	63	(o+4m+p)/6	40
PD.ME.SA.2	15	20	205	(o+4m+p)/6	50
PD.ME.SA.3	15	20	205	(o+4m+p)/6	50
PD.ME.SA.4	15	20	205	(o+4m+p)/6	50
PD.ME.1	25	30	95	(o+4m+p)/6	40
PD.ME.ST.1	35	40	105	(o+4m+p)/6	50
PD.ME.ST.2	35	40	105	(o+4m+p)/6	50
PD.ME.T.1	35	40	45	(o+4m+p)/6	40
PD.ME.T.2	35	40	45	(o+4m+p)/6	40
PD.E.SA.1	7	10	13	(o+4m+p)/6	10
PD.E.SA.2	7	10	13	(o+4m+p)/6	10
PD.E.HW.1	7	10	73	(o+4m+p)/6	20
PD.E.HW.2	40	50	60	(o+4m+p)/6	50
PD.E.HW.3	40	50	60	(o+4m+p)/6	50
PD.E.HW.4	7	10	13	(o+4m+p)/6	10
PD.E.HW.5	7	10	13	(o+4m+p)/6	10
FD.C.HW.1	100	120	140	(o+4m+p)/6	120
FD.C.HW.2	100	120	140	(o+4m+p)/6	120
FD.C.HW.3	80	90	100	(o+4m+p)/6	90
FD.C.SW.1	80	90	280	(o+4m+p)/6	120

Three point estimates					
WBS ID	**Optimistic duration**	**Most likely duration**	**Pessimistic duration**	**Weighting equation**	**Expected duration estimate**
FD.C.SW.2	80	90	100	(o+4m+p)/6	90
FD.C.SW.3	50	60	70	(o+4m+p)/6	60
FD.C.SW.4	80	90	160	(o+4m+p)/6	100
FD.N.HW.1	50	60	130	(o+4m+p)/6	70
FD.N.HW.2	25	30	95	(o+4m+p)/6	40
FD.N.SW.1	50	60	70	(o+4m+p)/6	60
FD.N.SW.2	50	60	70	(o+4m+p)/6	60
FD.N.SW.3	60	80	100	(o+4m+p)/6	80
FD.P.HW.1	50	60	190	(o+4m+p)/6	80
FD.P.HW.2	50	60	190	(o+4m+p)/6	80
FD.P.HW.3	50	60	70	(o+4m+p)/6	60
FD.P.SW.1	60	80	-20	(o+4m+p)/6	60
FD.P.SW.2	60	80	-20	(o+4m+p)/6	60
FD.ME.MD.1	15	20	205	(o+4m+p)/6	50
FD.ME.MD.2	80	90	160	(o+4m+p)/6	100
FD.ME.MD.3	50	60	70	(o+4m+p)/6	60
FD.ME.MD.4	80	90	100	(o+4m+p)/6	90
FD.ME.ID.1	15	20	145	(o+4m+p)/6	40
FD.ME.ID.2	80	90	160	(o+4m+p)/6	100
FD.ME.ID.3	50	60	70	(o+4m+p)/6	60
FD.ME.ID.4	80	90	100	(o+4m+p)/6	90
FD.E.HW.1	50	60	70	(o+4m+p)/6	60
FD.E.HW.2	50	60	70	(o+4m+p)/6	60
FD.E.HW.3	80	90	322	(o+4m+p)/6	127
T.C.1	90	100	230	(o+4m+p)/6	120
T.C.2	90	100	230	(o+4m+p)/6	120
T.C.3	70	80	90	(o+4m+p)/6	80
T.N.1	80	90	40	(o+4m+p)/6	80
T.P.1	70	80	-90	(o+4m+p)/6	50
T.ME.1	70	80	90	(o+4m+p)/6	80
T.E.1	80	90	40	(o+4m+p)/6	80
T.A.1	30	40	50	(o+4m+p)/6	40
T.A.2	50	60	70	(o+4m+p)/6	60

6. Project Schedule

The project schedule of the ECCO project contains the start and finish dates of the different tasks and a summary of the whole project. For the ECCO project, a Gantt chart has been developed. Since there are many tasks, the diagram is complex and big. In the next page the Gantt chart can be found.

Id	Nombre
0	**ECCO**
1	Kick-Off meeting
2	**Project Management**
3	Project Management Plan
4	Project Management Plan Deliverable
5	Monitoring of project evolution
6	Preliminary Design Review
7	**Administrative Services**
8	Human resources initial plan
9	Monitoring of human resources evolution
10	Financial plan
11	Monitoring of financial evolution
12	**Partnership and network**
13	Coordination and cooperation control
14	Stakeholders contact control
15	**Communications**
16	Publishing and meetings
17	Press communications
18	Conferences
19	Public relations, outreach and enquiries
20	Media, social media and web
21	Intermediate Meeting
22	ECCO International Congress
23	**Engineering**
24	**Preliminary Design**
25	**Mission Design**
26	**State of the art**
27	Analyse mission requirements
28	Research and analyse corrent earth orbit observations
29	Select optimum orbital parámetres
30	Specify technological requirements
31	Specify incremental Deployment requirements
32	Report of results and conclusions
33	**Communication**
34	**State of the art**
35	Analyse work environament
36	Analyse modules communication requirements
37	Analyse ground – Space Communications requirements
38	Analyse power transmission requirements
39	**Hardware**
40	Select modules communication System
41	Modules communicatin System
42	Select ground – space communication system
43	Ground – space communication system
44	**Software**
45	Communication control software
46	Simulation program
47	Report of results and conclusions
48	**Navigation**
49	**State of the art**
50	Analyse work environment
51	Analyse navigation requirements
52	Analyse attitude propulsion requirements
53	**Hardware**
54	Attitude control requirements
55	**Software**
56	Navigation and attitude control software
57	Report of results and conclusions
58	**Propulsion**
59	**State of the art**
60	Analyse available propulsion Systems
61	Analyse power unit requirements
62	Analyse power unit transmission requirements
63	Analyse power unit receivers requirements
64	**Hardware**
65	Select a suitable propulsion System and its peripherals
66	Propulsion Systems
67	Power unit System
68	Power storage System
69	**Software**
70	Power control software
71	Propulsion control software
72	Report of results and conclusions
73	**Mechanical**
74	**State of the art**
75	Analyse work environment
76	Analyse estructural effects on Earth observation satelites
77	Analyse thermal effects on Earth observation satellites
78	Analyse radiation effects on Earth observation satellites
79	Integration of sub-systems
80	**Structural Design**
81	Structural design of insfrastructure modules
82	Structural design of payload modules
83	**Thermal Design**
84	Payload insulation
85	Infrastructure insulation
86	Report of results and conclusions
87	**Electronics**
88	**State of the art**
89	Analyse work environament
90	Analyse electronic requirements
91	**Hardware**
92	Select suitable electronic components
93	Payload modules electronic Systems
94	Infrastructures electronic systems
95	Determine the sensors requirements
96	Contact and specify sensors from developers
97	Report of results and conclusions
98	Preliminary Design Report
99	**Final Design**
100	**Communication Detailed Design**
101	**Hardware**
102	Modules communication system
103	Ground-space communication System
104	Power transmission system
105	**Software**
106	Protocol Communications
107	Information control management software
108	Power transmission control System
109	Communication Simulator program
110	Report of results and conclusions
111	**Navigation Detailed Design**
112	**Hardware Design**
113	Attitude sensors
114	Attitude control Systems
115	**Software Design**
116	Constellation navigation control software
117	Module attitude control software
118	Navigation and attitude Simulator software
119	Report of results and conclusions
120	**Propulsion Detailed Design**
121	**Hardware Design**
122	Propulsion systems
123	Power unit system
124	Power storage system
125	**Software**
126	Power control software
127	Propulsion control software
128	Report of results and conclusions
129	**Mechanical Detailed Design**
130	**Module Design**
131	Material selection
132	Module structure
133	Thermal insulation
134	Sub-systems Integration
135	**Infrastructure Design**
136	Material selection
137	Module structure
138	Thermal insulation
139	Sub-systems Integration
140	Report of results and conclusions
141	**Electronic Detailed Design**
142	**Hardware Design**
143	Payload modules electronic Systems
144	Infrastructures electronic systems
145	Selection and integration of sensors
146	Report of results and conclusions
147	**Test and Validations**
148	**Communication**
149	Test and validation for communication satellite-satellite
150	Test and validation for communication ground-satellite
151	Test and validation for power transmission
152	Report of results and conclusions
153	**Navigation**
154	Test and validation of the navigation, attitude and control system using computer simulated programs
155	Report of results and conclusions
156	**Propulsion**
157	Test and validation of the propulsion system using computer simulated programs
158	Report of results and conclusions
159	**Mechanical**
160	Test and validation using computer simulation programs
161	Report of results and conclusions
162	**Electronics**
163	Test and validation using computer simulation programs
164	Report of results and conclusions
165	**Data acquisition**
166	Validation of signal quality
167	Test and validation for 3D mapping and new acquisition modes developed
168	Report of results and conclusions about possible benefits related to climate change
169	Final report
170	Final meeting



Tareas críticas · Tarea · Hito · Resumen · Tarea crítica resumida · Tarea inactiva · Resumen inactivo · solo duración · Resumen manual · solo fin · Hito externo · Progreso
División crítica · División · Atraso · Resumen del proyecto · División crítica resumida · Hito inactivo · Tarea manual · Informe de resumen manual · solo el comienzo · Tareas externas · Fecha límite

7. Activity Attributes

In the following pages there is a table for each activity, where a summary of all the important attributes of the task can be found.

Table 11. Activity PM.1 attributes

ID: PM.1	**Activity:** Project Management Plan				
Description of Work: A document that defines a more detailed and technical vision of the project, specifying resources, their distribution in time to accomplish the project objectives, a detailed version of the project Charter, control and monitoring actions and level of implementation among others.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
START	-	-	REP.PM;PM.2;C	FF;FS;FS	-
Number and Type of Resources Required: PM.S PM.M PM.EXT		**Skill Requirements:** Average Expert Expert		**Other Required Resources:** SOFT.6	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and E-TIS Euroconsulting outsourcing					
Constraints: Project Management Report					
Assumptions: The project management will be in part outsourced to E-TIS Euroconsultores					

Table 12. Activity PM.2 attributes

ID: PM.2		**Activity:** Monitoring of project evolution			
Description of Work: Check and update the state of the project, be aware of any change in budget or deadline ensuring a satisfactory end of it.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PM.1	FS	-	PN	FS	-
Number and Type of Resources Required: PM.S PM.M PM.EXT		**Skill Requirements:** Average Expert Expert		**Other Required Resources:** SOFT.6	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and E-TIS Euroconsulting outsourcing					
Constraints: Project Management Report					
Assumptions: The project management will be in part outsourced to E-TIS Euroconsultores					

Table 13. Activity PM.3 attributes

ID: PM.3		**Activity:** Preliminary design review			
Description of work: Check the preliminary design document and ensure the expectations, scope and objectives are achieved.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
REP.PD	FS	-	FINISH	-	-
Number and Type of Resources Required: PM.S PM.M PM.EXT		**Skill Requirements:** Average Expert Expert		**Other Required Resources:** SOFT.6	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and E-TIS Euroconsulting outsourcing					
Constraints: Project Management Report					
Assumptions: The project management will be in part outsourced to E-TIS Euroconsultores					

Table 14. Activity AS.1 attributes

ID: AS.1		**Activity:** Human resources plan			
Description of Work: Estimated plan of the human resources management department so as to evaluate the number and characteristics of the required employees and persons in charge.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
START	-	-	AS.2	FS	-
Number and Type of Resources Required: AS.M AS.S HR.W		**Skill Requirements:** Expert Average Average		**Other Required Resources:** -	
Type of Effort: Fixed amount of time					
Location of Performance: In the company					
Constraints: -					
Assumptions: Administrative services include the Human Resources and Financial parts of the project.					

Table 15. Activity AS.2 attributes

ID: AS.2			**Activity:** Monitoring of human resources evolution		
Description of Work: Check and update the state of human resources, be aware of any change needed resources ensuring a satisfactory end of the project.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
AS.1	FS	-	FINISH	-	-
Number and Type of Resources Required: AS.M AS.S HR.W		**Skill Requirements:** Expert Average Average		**Other Required Resources:** -	
Type of Effort: Fixed amount of time					
Location of Performance: In the company					
Constraints: -					
Assumptions: Administrative services include the Human Resources and Financial parts of the project					

Table 16. Activity AS.3 attributes

ID: AS.3		**Activity:** Financial plan			
Description of Work: Evaluate the cost required by each of the departments in order to carry on the project.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
START	-	-	AS.4	FS	-
Number and Type of Resources Required: AS.M AS.S F.W1 F.W2		**Skill Requirements:** Expert Average Average Average		**Other Required Resources:** -	
Type of Effort: Fixed amount of time					
Location of Performance: In the company					
Constraints: -					
Assumptions: Administrative services include the Human Resources and Financial parts of the project					

Table 17. Activity AS.4 attributes

ID: AS.4		**Activity:** Monitoring of financial evolution			
Description of Work: Evaluate the cost required by each of the departments in order to carry on the project.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
AS.3	FS	-	FINISH	-	-
Number and Type of Resources Required: AS.M AS.S F.W1 F.W2		**Skill Requirements:** Expert Average Average Average		**Other Required Resources:** -	
Type of Effort: Fixed amount of time					
Location of Performance: In the company					
Constraints: -					
Assumptions: Administrative services include the Human Resources and Financial parts of the project					

Table 18. Activity PN.1 attributes

ID: PN.1		**Activity:** Coordination and cooperation control			
Description of Work: Coordinate and check the evolution of the project, and maintain the common scope between all the project partners					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
REP.PM.1	FS	-	FINISH	-	-
Number and Type of Resources Required: AS.M AS.S HR.W		**Skill Requirements:** Expert Average Average		**Other Required Resources:** -	
Type of Effort: Fixed amount of time					
Location of Performance: In the company					
Constraints: ECCO International Congress (REP.C.2).					
Assumptions: There PN tasks are developed by the workers of the AS Department.					

Table 19. Activity PN.2 attributes

ID: PN.2		**Activity:** Stakeholders contact control			
Description of Work: Check and update the interests of the stakeholders and the company during the development of the project.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
REP.PM.1	FS	-	FINISH	-	-
Number and Type of Resources Required: AS.M AS.S HR.W		**Skill Requirements:** Expert Average Average		**Other Required Resources:** -	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company and also where the stakeholders develop their activities.					
Constraints: ECCO International Congress (REP.C.2).					
Assumptions: There PN tasks are developed by the workers of the AS Department.					

Table 20. Activity C.1 attributes

ID: C.1			**Activity:** Publishing and meetings		
Description of Work: Make possible the interaction with the media, science and technologic field so as to let know the new advances.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PM.1	FS	-	FINISH	-	-
Number and Type of Resources Required: C.EXT C.M		**Skill Requirements:** Expert Expert		**Other Required Resources:** -	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company and also where BCCI Communication Outsourcing develop its activities.					
Constraints: ECCO International Congress (REP.C.2).					
Assumptions: The dissemination of the project will be mostly done by BCCI Communications					

Table 21. Activity C.2 attributes

ID: C.2		**Activity:** Press communications			
Description of Work: Start the contact with the written press in order to state the past, the current and the future fractionated satellite technology advances.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PM.1	FS	-	FINISH	-	-
Number and Type of Resources Required: C.EXT C.M		**Skill Requirements:** Expert Expert		**Other Required Resources:** -	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company and also where BCCI Communication Outsourcing develop its activities.					
Constraints: ECCO International Congress (REP.C.2).					
Assumptions: The dissemination of the project will be mostly done by BCCI Communications					

Table 22. Activity C.3 attributes

ID: C.3		**Activity:** Conferences			
Description of Work: Planning and development of future conferences to attract possible stakeholders and keep the interest of the current ones.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PM.1; START	FS;SS	-;267	FINISH	-	-
Number and Type of Resources Required: C.EXT C.M		**Skill Requirements:** Expert Expert		**Other Required Resources:** -	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company and also where BCCI Communication Outsourcing develop its activities.					
Constraints: ECCO International Congress (REP.C.2).					
Assumptions: The dissemination of the project will be mostly done by BCCI Communications					

Table 23. Activity C.4 attributes

ID: C.4		**Activity:** Public relations outreach and enquiries			
Description of Work: Interact with general population so as to introduce the topic, its new technology and the benefits of providing useful data as to live in a better world.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PM.1; START	FS;SS	-;267	FINISH	-	-
Number and Type of Resources Required: C.EXT C.M		**Skill Requirements:** Expert Expert		**Other Required Resources:** -	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company and also where BCCI Communication Outsourcing develop its activities.					
Constraints: ECCO International Congress (REP.C.2).					
Assumptions: The dissemination of the project will be mostly done by BCCI Communications					

Table 24. Activity C.5 attributes

ID: C.5		**Activity:** Media, social media and web			
Description of Work: Approach the whole project in a friendly way through many different channels of communication.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PM.1; START	FS;SS	-;267	FINISH	-	-
Number and Type of Resources Required: C.EXT C.M		**Skill Requirements:** Expert Expert		**Other Required Resources:** -	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company and also where BCCI Communication Outsourcing develop its activities.					
Constraints: ECCO International Congress (REP.C.2).					
Assumptions: The dissemination of the project will be mostly done by BCCI Communications					

Table 25. Activity PD.M.SA.1 attributes

ID: PD.M.SA.1			**Activity:** Analyse mission requirements		
Description of Work: Search exhaustively information about the mission of this project in order to stablish a solid base to run the project.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
START	SS	-	PD.M.SA.2;PD.M.1	FS	-
Number and Type of Resources Required: E.MDD.S E.MDD.M SE1 SE2		**Skill Requirements:** Average Expert Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.M.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. In the PD.M only Space Engineers work due to their broad knowledge in mission design concepts.					

Table 26. Activity PD.M.SA.2 attributes

ID: PD.M.SA.2			**Activity:** Research and analyse current Earth orbit observations		
Description of Work: Make a careful analysis of the today orbit observations market to place this project in the sector.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.M.SA.1	FS	-	PD.M.1	FS	-
Number and Type of Resources Required: E.MDD.S E.MDD.M SE1 SE2		**Skill Requirements:** Average Expert Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.M.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. In the PD.M only Space Engineers work due to their broad knowledge in mission design concepts.					

Table 27. Activity PD.M.1 attributes

ID: PD.M.1			**Activity:** Select optimum orbital parameters		
Description of Work: Selection of the optimum orbital parameters to track Earth information and specify operative data, for instance, height or type of orbit in order to start states of the arts of each department.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.M.SA	FS	-	PD.M.2;PD.M.3;PD.M.1	FS	-
Number and Type of Resources Required: E.MDD.S E.MDD.M SE1 SE3 SE4			**Skill Requirements:** Average Expert Senior Senior Senior		**Other Required Resources:** SOFT.7
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.M.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. In the PD.M only Space Engineers work due to their broad knowledge in mission design concepts.					

Table 28. Activity PD.M.2 attributes

ID: PD.M.2		**Activity:** Specify technological requirements			
Description of Work: Listing specific technological requirements of the mission in order to accomplish stablished scope.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.M.1	SS	-	REP.M.1;PD.M.1	FF;FS	-
Number and Type of Resources Required: E.MDD.S E.MDD.M SE1 SE2 SE3		**Skill Requirements:** Average Expert Senior Senior Senior		**Other Required Resources:** SOFT.7	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.M.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. In the PD.M only Space Engineers work due to their broad knowledge in mission design concepts.					

Table 29. Activity PD.M.3 attributes

ID: PD.M.3		**Activity:** Specify incremental deployment requirements			
Description of Work: Determine and specify the requirements of incremental deployment system.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.M.1	SS	-	REP.M.1;PD.M.1	FF;FS	-
Number and Type of Resources Required: E.MDD.S E.MDD.M SE1 SE4 MDD.EXT		**Skill Requirements:** Average Expert Senior Senior Senior		**Other Required Resources:** SOFT.7	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.M.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. In the PD.M only Space Engineers work due to their broad knowledge in mission design concepts.					

Table 30. Activity PD.C.SA.1 attributes

<table>
<tr><td colspan="3">ID: PD.C.SA.1</td><td colspan="3">Activity: Analyse work environment</td></tr>
<tr><td colspan="6">Description of Work:
Search, summarise and asses specific information about the particular needs of this project in communication systems.</td></tr>
<tr><td>Predecessors</td><td>Relationship</td><td>Lag</td><td>Successor</td><td>Relationship</td><td>Lag</td></tr>
<tr><td>PD.M</td><td>FS</td><td>-</td><td>PD.C.SA.2
PD.C.SA.3
PD.C.HW;PD.P</td><td>FS</td><td>-</td></tr>
<tr><td colspan="2">Number and Type of Resources Required:
E.CD.M
E.CD.S
TE.1
TE.2</td><td colspan="2">Skill Requirements:

Expert
Average
Senior
Senior</td><td colspan="2">Other Required Resources:
-</td></tr>
<tr><td colspan="6">Type of Effort:
Fixed amount of effort</td></tr>
<tr><td colspan="6">Location of Performance:
In the company</td></tr>
<tr><td colspan="6">Constraints:
Report of results and conclusions (REP.C.1).</td></tr>
<tr><td colspan="6">Assumptions:
The manager and secretary are working in all of the aspects of this group of tasks.</td></tr>
</table>

Table 31. Activity PD.C.SA.2 attributes

ID: PD.C.SA.2			**Activity:** Analyse modules communication requirements		
Description of Work: Search for information to have a clear idea about the specific requirements for the communication between the modules.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.C.SA.1	FS	-	PD.C.SA.4 PD.C.HW;PD.P	FS	-
Number and Type of Resources Required: E.CD.M E.CD.S TE1 TE3			**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 32. Activity PD.C.SA.3 attributes

ID: PD.C.SA.3			**Activity:** Analyse ground – space communications requirements		
Description of Work: Search for information to have a clear idea about the specific requirements for the communication between the ground station and the space station.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.C.SA.1	FS	-	PD.C.SA.4 PD.C.HW;PD.P	FS	-
Number and Type of Resources Required: E.CD.M E.CD.S SE.2 SE.3			**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 33. Activity PD.C.SA. 4 attributes

ID: PD.C.SA.4			**Activity:** Analyse power transmission requirements		
Description of Work: Search for information that will provide a clear idea about the requirements of the power transmission in the conditions of this project					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.C.SA.2;PD.C.SA.3	FS	-	PD.C.HW;PD.P	FS	-
Number and Type of Resources Required: E.CD.M E.CD.S TE1 SE2 MD.EXT 3			**Skill Requirements:** Expert Average Senior Senior Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of effort					
Location of Performance: In the company and also where Orbital ATK develops its activities.					
Constraints: Report of results and conclusions (REP.C.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These tasks will be done in collaboration with Orbital ATK.					

Table 34. Activity PD.C.HW.1 attributes

<table>
<tr><td colspan="3">ID: PD.C.HW.1</td><td colspan="3">Activity: Select modules of the communication system</td></tr>
<tr><td colspan="6">Description of Work:
After an exhaustive research and assessment a selection of the communication has to be done, including frequency, bandwidth taking in account noise and possible undesired effects due to external factors.</td></tr>
<tr><td>Predecessors</td><td>Relationship</td><td>Lag</td><td>Successor</td><td>Relationship</td><td>Lag</td></tr>
<tr><td>PD.C.SA</td><td>FS</td><td>-</td><td>PD.C.HW.2
PD.C.SW
PD.E.HW;PD.ME</td><td>FS</td><td>-</td></tr>
<tr><td colspan="2">Number and Type of Resources Required:
E.CD.M
E.CD.S
SE1
TE2</td><td colspan="2">Skill Requirements:

Expert
Average
Senior
Senior</td><td colspan="2">Other Required Resources:
-</td></tr>
<tr><td colspan="6">Type of Effort:
Fixed amount of effort</td></tr>
<tr><td colspan="6">Location of Performance:
In the company</td></tr>
<tr><td colspan="6">Constraints:
Report of results and conclusions (REP.C.1).</td></tr>
<tr><td colspan="6">Assumptions:
The manager and secretary are working in all of the aspects of this group of tasks.</td></tr>
</table>

Table 35. Activity PD.C.HW.2 attributes

ID: PD.C.HW.2			**Activity:** Modules communication system		
Description of Work: Preliminary design of communication hardware, including mixers, filters and amplifiers between modules has to be done. The design must fulfil all the specifications that have been indicated in related tasks.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.C.HW.1;PD.C.SA	FS	-	PD.C.SW PD.E.HW;PD.ME	FS	-
Number and Type of Resources Required: E.CD.M E.CD.S SE1 TE2 CD.EXT 2			**Skill Requirements:** Expert Average Senior Senior Junior		**Other Required Resources:** -
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These task will be done in collaboration with University of Stuttgart					

Table 36. Activity PD.C.HW.3 attributes

ID: PD.C.HW.3			**Activity:** Select ground – space communication system		
Description of Work: After an exhaustive research and assessment a selection of the communication has to be done, including frequency, bandwidth taking in account noise and possible undesired effects due to external factors.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.C.SA	FS	-	PD.C.HW.4	FS	-
Number and Type of Resources Required: E.CD.M E.CD.S SE2 TE3		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 37. Activity PD.C.HW.4 attributes

ID: PD.C.HW.4			**Activity:** Ground – space communication system		
Description of Work: Preliminary design of communication hardware, including mixers, filters and amplifiers between satellite and ground station has to be done. The design must fulfil all the specifications that have been indicated in related tasks.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.C.HW.3;PD.C.SA	FS	-	PD.C.SW PD.E.HW;PD.ME	FS	-
Number and Type of Resources Required: E.CD.M E.CD.S SE2 TE3			**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 38. Activity PD.C.SW.1 attributes

ID: PD.C.SW.1			**Activity:** Communication control software		
Description of Work: Development of the software that controls and enables transmission data through hardware designed.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.C.HW	FS	-	PD.C.SW.2;REP.C.1	FS;FF	-
Number and Type of Resources Required: E.CD.M E.CD.S SE1 IE3 TE2		**Skill Requirements:** Expert Average Senior Senior Senior		**Other Required Resources:** SOFT.5	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.1).					
Assumptions: Very interdisciplinary team for the preliminary design of the communication software.					

Table 39. Activity PD.C.SW.20 attributes

ID: PD.C.SW.2			**Activity:** Simulation program		
Description of Work: For making sure the correct performance of the communication system it will be developed a computational simulation to check communication software developed.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.C.SW.1;PD.C.HW	FS	-	REP.C.1	FF	-
Number and Type of Resources Required: E.CD.M E.CD.S IE1 TE1 SE2			**Skill Requirements:** Expert Average Senior Senior Senior		**Other Required Resources:** SOFT.5
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.1).					
Assumptions: Very interdisciplinary team for the preliminary design of the communication software.					

Table 40. Activity PD.N.SA.1 attributes

ID: PD.N.SA.1			**Activity:** Analyse work environment		
Description of Work: Search, summarise and asses specific information about the particular needs of this project in navigation systems.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.M	FS	-	PD.N.SA.2;PD.N.HW	FS	-
Number and Type of Resources Required: E.MDD.M E.MDD.S SE1 TE3		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.N.1)					
Assumptions: The Spatial engineer assists the Telecommunication engineer in technical things about the space working conditions and the specific requirements that must be accomplished.					

Table 41. Activity PD.N.SA.2 attributes

ID: PD.N.SA.2			**Activity:** Analyse navigation requirements		
Description of Work: Search, summarise and asses specific information about the particular needs of this project in the navigation system.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.N.SA.1;PD.M	FS	-	PD.N.SA.3;PD.N.HW	FS	-
Number and Type of Resources Required: E.MDD.M E.MDD.S SE1 TE2		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.N.1)					
Assumptions: The Spatial engineer assists the Telecommunication engineer in technical things about the space working conditions and the specific requirements that must be accomplished.					

Table 42. Activity PD.N.SA.3 attributes

ID: PD.N.SA.3		**Activity:** Analyse attitude propulsion requirements			
Description of Work: Search for information to have a clear idea about the specific requirements for the attitude propulsion requirements.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.N.SA.2	FS	-	PD.N.HW	FS	-
Number and Type of Resources Required: E.MDD.M E.MDD.S SE1 TE2		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.N.1)					
Assumptions: The Spatial engineer assists the Telecommunication engineer in technical things about the space working conditions and the specific requirements that must be accomplished.					

Table 43. Activity PD.N.HW.1 attributes

ID: PD.N.HW.1			**Activity:** Attitude control requirements		
Description of Work: Study the attitude control of a module and determine the requirements in trust that includes position of rockets, thrust and an estimation of fuel consumption during its operative life.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.N.SA;PD.E.HW.4	FS	-	PD.P.HW.2 PD.N.SW PD.E.HW;PD.ME	FS	-
Number and Type of Resources Required: E.MDD.M E.MDD.S TE1 SE3			**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.N.1)					
Assumptions: The Spatial engineer assists the Telecommunication engineer in technical things about the space working conditions and the specific requirements that must be accomplished.					

Table 44. Activity PD.N.SW.1 attributes

ID: PD.N.SW.1		**Activity:** Navigation and attitude control software			
Description of Work: Development of the attitude and navigation equations, and create a preliminary software to compute real trajectories and determine the reactions needed to change the orbit or attitude to the desired one.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.N.HW	FS	-	REP.N.1	FF	-
Number and Type of Resources Required: E.MDD.M E.MDD.S IE1 IE2 TE1		**Skill Requirements:** Expert Average Senior Senior Senior		**Other Required Resources:** SOFT.5	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.N.1)					
Assumptions: The Spatial engineer assists the Telecommunication engineer in technical things about the space working conditions and the specific requirements that must be accomplished.					

Table 45. Activity PD.P.SA.1 attributes

ID: PD.P.SA.1			**Activity:** Analyse available propulsion systems		
Description of Work: Search, summarise and asses specific information about the particular needs of this project in the propulsion systems.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.C.SA;PD.E.SA	FS	-	PD.P.HW	FS	-
Number and Type of Resources Required: E.PD.M E.MD.S SE3			**Skill Requirements:** Expert Average Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.P.1)					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 46. Activity PD.P.SA.2 attributes

ID: PD.P.SA.2			**Activity:** Analyse power unit requirements		
Description of Work: Search for information to have a clear idea about the specific requirements for the power unit.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.C.SA;PD.E.SA	FS	-	PD.P.SA.3 PD.P.SA.4;PD.P.HW	FS	-
Number and Type of Resources Required: E.PD.M E.MD.S MD.EXT3 SE4			**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also where Orbital ATK develop its activities.					
Constraints: Report of results and conclusions (REP.P.1)					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These tasks will be done in collaboration with Orbital ATK.					

Table 47. Activity PD.P.SA.3 attributes

<table>
<tr><td colspan="3">ID: PD.P.SA.3</td><td colspan="3">Activity: Analyse power unit transmission requirements</td></tr>
<tr><td colspan="6">Description of Work:
Search, summarise and asses specific information about the particular needs of this project in the power unit transmission requirements.</td></tr>
<tr><td>Predecessors</td><td>Relationship</td><td>Lag</td><td>Successor</td><td>Relationship</td><td>Lag</td></tr>
<tr><td>PD.P.SA.2</td><td>FS</td><td>-</td><td>PD.P.HW</td><td>FS</td><td>-</td></tr>
<tr><td colspan="2">Number and Type of Resources Required:
E.PD.M
E.MD.S
MD.EXT3
SE3</td><td colspan="2">Skill Requirements:

Expert
Average
Senior
Senior</td><td colspan="2">Other Required Resources:
-</td></tr>
<tr><td colspan="6">Type of Effort:
Fixed amount of work</td></tr>
<tr><td colspan="6">Location of Performance:
In the company and also where Orbital ATK develop its activities.</td></tr>
<tr><td colspan="6">Constraints:
Report of results and conclusions (REP.P.1)</td></tr>
<tr><td colspan="6">Assumptions:
The manager and secretary are working in all of the aspects of this group of tasks. These tasks will be done in collaboration with Orbital ATK.</td></tr>
</table>

Table 48. Activity PD.P.SA.4 attributes

ID: PD.P.SA.4		**Activity:** Analyse power unit receivers requirements			
Description of Work: Search for information to have a clear idea about the specific requirements for the power unit receivers.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.P.SA.2	FS	-	PD.P.HW	FS	-
Number and Type of Resources Required: E.PD.M E.MD.S MD.EXT3 SE4		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also where Orbital ATK develop its activities.					
Constraints: Report of results and conclusions (REP.P.1)					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These tasks will be done in collaboration with Orbital ATK.					

Table 49. Activity PD.P.HW.1 attributes

ID: PD.P.HW.1			**Activity:** Select a suitable propulsion system and its peripherals		
Description of Work: After an exhaustive research and assessment it will be provided a selection of the most suitable modules for the propulsion system and its peripherals.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.P.SA;PD.E.HW.1	FS	-	PD.P.HW.2 PD.P.SW;PD.ME	FS	-
Number and Type of Resources Required: E.PD.M E.MD.S SE2 SE3			**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.P.1)					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These tasks will be done in collaboration with Orbital ATK.					

Table 50. Activity PD.P.HW.2 attributes

ID: PD.P.HW.2			**Activity:** Propulsion systems		
Description of Work: A preliminary design of rockets that fulfil all the requirements has to be done.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.P.HW.1;PD.N.HW.1; PD.P.SA;PD.E.HW.1	FS	-	PD.P.SW PD.ME	FS	-
Number and Type of Resources Required: E.PD.M E.MD.S SE2			**Skill Requirements:** Expert Average Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.P.1)					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These tasks will be done in collaboration with Orbital ATK.					

Table 51. Activity PD.P.HW.3 attributes

<table>
<tr><td colspan="3">ID: PD.P.HW.3</td><td colspan="3">Activity: Power unit system</td></tr>
<tr><td colspan="6">Description of Work:
It will be given a global approach to the power unit system.</td></tr>
<tr><td>Predecessors</td><td>Relationship</td><td>Lag</td><td>Successor</td><td>Relationship</td><td>Lag</td></tr>
<tr><td>PD.P.SA;PD.E.HW.1</td><td>FS</td><td>-</td><td>PD.P.HW.4
PD.P.SW
PD.ME</td><td>FS</td><td>-</td></tr>
<tr><td colspan="2">Number and Type of Resources Required:
E.PD.M
E.MD.S
MD.EXT3
SE4</td><td colspan="2">Skill Requirements:

Expert
Average
Senior
Senior</td><td colspan="2">Other Required Resources:
-</td></tr>
<tr><td colspan="6">Type of Effort:
Fixed amount of work</td></tr>
<tr><td colspan="6">Location of Performance:
In the company and also where Orbital ATK develop its activities.</td></tr>
<tr><td colspan="6">Constraints:
Report of results and conclusions (REP.P.1)</td></tr>
<tr><td colspan="6">Assumptions:
The manager and secretary are working in all of the aspects of this group of tasks. These tasks will be done in collaboration with Orbital ATK.</td></tr>
</table>

Table 52. Activity PD.P.HW.4 attributes

ID: PD.P.HW.4			**Activity:** Power storage system		
Description of Work: It will be given a global approach to the power storage requirements and physical systems needed.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.P.HW.3; PD.P.SA;PD.E.HW.1	FS	-	PD.P.SW;PD.ME	FS	-
Number and Type of Resources Required: E.PD.M E.MD.S SE4			**Skill Requirements:** Expert Average Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.P.1)					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These tasks will be done in collaboration with Orbital ATK.					

Table 53. Activity PD.P.SW.1 attributes

ID: PD.P.SW.1		**Activity:** Power control software			
Description of Work: Preliminary design of the software that control the power generation, charge/discharge of storage systems and transmission to other modules.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.P.HW	FS	-	REP.P.1	FF	-
Number and Type of Resources Required: E.PD.M E.MD.S IE1 SE2		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** SOFT.5	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.P.1)					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 54. Activity PD.P.SW.2 attributes

ID: PD.P.SW.2		**Activity:** Propulsion control software			
Description of Work: Preliminary design of the software that control and check status of integrated propulsion systems.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.P.HW	FS	-	REP.P.1	FF	-
Number and Type of Resources Required: E.PD.M E.MD.S IE2 SE4		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** SOFT.5	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.P.1)					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 55. Activity PD.ME.SA.1 attributes

<table>
<tr><td colspan="3">ID: PD.ME.SA.1</td><td colspan="3">Activity: Analyse work environment</td></tr>
<tr><td colspan="6">Description of Work:
Search, summarise and asses specific information about the particular needs of this project in mechanics.</td></tr>
<tr><td>Predecessors</td><td>Relationship</td><td>Lag</td><td>Successor</td><td>Relationship</td><td>Lag</td></tr>
<tr><td>PD.M</td><td>FS</td><td>-</td><td>PD.ME.SA.2
PD.ME.SA.3
PD.ME.SA.4
PD.ME.1</td><td>FS</td><td>-</td></tr>
<tr><td colspan="2">Number and Type of Resources Required:
E.MD.M
E.MD.S
IE3</td><td colspan="2">Skill Requirements:

Expert
Average
Senior</td><td colspan="2">Other Required Resources:
-</td></tr>
<tr><td colspan="6">Type of Effort:
Fixed amount of work</td></tr>
<tr><td colspan="6">Location of Performance:
In the company</td></tr>
<tr><td colspan="6">Constraints:
Report of results and conclusions (REP.ME.1)</td></tr>
<tr><td colspan="6">Assumptions:
The manager and secretary are working in all of the aspects of this group of tasks. These tasks will be done in collaboration with the University of Stuttgart</td></tr>
</table>

Table 56. Activity PD.ME.SA.2 attributes

ID: PD.ME.SA.2			**Activity:** Analyse structural effects on Earth observation satellites		
Description of Work: Search, summarise and asses specific information about the particular structural effects of this project on Earth observation satellites.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.ME.SA.1;PD.M	FS	-	PD.ME.1	FS	-
Number and Type of Resources Required: E.MD.M E.MD.S IE1		**Skill Requirements:** Expert Average Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.ME.1)					
Assumptions: These tasks will be done in collaboration with the University of Stuttgart.					

Table 57. Activity PD.ME.SA.3 attributes

ID: PD.ME.SA.3			**Activity:** Analyse thermal effects on Earth observation satellites		
Description of Work: Search, summarise and asses specific information about the thermal effects of this project on the Earth observation satellites.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.ME.SA.1;PD.M	FS	-	PD.ME.1	FS	-
Number and Type of Resources Required: E.MD.M E.MD.S IE2 MD.EXT.2		**Skill Requirements:** Expert Average Senior Junior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also in Stuttgart University					
Constraints: Report of results and conclusions (REP.ME.1)					
Assumptions: These tasks will be done in collaboration with the University of Stuttgart.					

Table 58. Activity PD.ME.SA.4 attributes

ID: PD.ME.SA.4			**Activity:** Analyse radiation effects on Earth observation satellites		
Description of Work: Search, summarise and asses specific information about the radiation effects of this project on Earth observation satellites.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.ME.SA.1;PD.M	FS	-	PD.ME.1	FS	-
Number and Type of Resources Required: E.MD.M E.MD.S IE2			**Skill Requirements:** Expert Average Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.ME.1)					
Assumptions: These tasks will be done in collaboration with the University of Stuttgart.					

Table 60. Activity PD.ME.1 attributes

<table>
<tr><td colspan="3">ID: PD.ME.1</td><td colspan="3">Activity: Integration of sub-systems</td></tr>
<tr><td colspan="6">Description of Work:
Integration of all sub-systems in one so as to be able to do a general mechanical verification and start the preliminary design of structure, isolation and wire connexions.</td></tr>
<tr><td>Predecessors</td><td>Relationship</td><td>Lag</td><td>Successor</td><td>Relationship</td><td>Lag</td></tr>
<tr><td>PD.ME.SA
PD.M</td><td>FS</td><td>-</td><td>PD.ME.ST
PD.ME.T
FD
PD.ME.1</td><td>FS</td><td>-</td></tr>
<tr><td colspan="2">Number and Type of Resources Required:
E.MD.M
E.MD.S
SE1
SE3</td><td colspan="2">Skill Requirements:

Expert
Average
Senior
Senior</td><td colspan="2">Other Required Resources:
SOFT.1
SOFT.8</td></tr>
<tr><td colspan="6">Type of Effort:
Fixed amount of work</td></tr>
<tr><td colspan="6">Location of Performance:
In the company</td></tr>
<tr><td colspan="6">Constraints:
Report of results and conclusions (REP.ME.1)</td></tr>
<tr><td colspan="6">Assumptions:
-</td></tr>
</table>

Table 59. Activity PD.ME.ST.1 attributes

ID: PD.ME.ST.1			**Activity:** Structural design of payload modules		
Description of Work: The payload modules need a structural support that will be design taking into account the requirements of this project.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.ME.1	FS	-	REP.ME.1	FF	-
Number and Type of Resources Required: E.MD.M E.MD.S SE3		**Skill Requirements:** Expert Average Senior		**Other Required Resources:** SOFT.1 SOFT.8	
Type of Effort: Fixed amount of work					
Location of Performance: The company dependences					
Constraints: Report of results and conclusions (REP.ME.1).					
Assumptions: -					

Table 60. Activity PD.ME.ST.2 attributes

ID: PD.ME.ST.2			**Activity:** Structural design of infrastructure modules		
Description of Work: The infrastructure modules need a structural support that will be design taking into account the requirements of this project.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.ME.1	FS	-	REP.ME.1	FF	-
Number and Type of Resources Required: E.MD.M E.MD.S SE3		**Skill Requirements:** Expert Average Senior		**Other Required Resources:** SOFT.1 SOFT.8	
Type of Effort: Fixed amount of work					
Location of Performance: The company dependences					
Constraints: Report of results and conclusions (REP.ME.1).					
Assumptions: -					

Table 61. Activity PD.ME.T.1 attributes

ID: PD.ME.T.1			**Activity:** Payload insulation		
Description of Work: The insulation of the payload is a very important task in order to protect the information that can be received.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.ME.1	FS	-	REP.ME.1	FF	-
Number and Type of Resources Required: E.MD.M E.MD.S MD.EXT 2		**Skill Requirements:** Expert Average Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also in Stuttgart University					
Constraints: Report of results and conclusions (REP.ME.1).					
Assumptions: These tasks will be done in collaboration with Stuttgart University.					

Table 62. Activity PD.ME.T.2 attributes

ID: PD.ME.T.2			**Activity:** Infrastructure insulation		
Description of Work: The insulation of the infrastructure is a very important task in order to protect the information that can be transmitted.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.ME.1	FS	-	REP.ME.1	FF	-
Number and Type of Resources Required: E.MD.M E.MD.S MD.EXT 2		**Skill Requirements:** Expert Average Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also in Stuttgart University					
Constraints: Report of results and conclusions (REP.ME.1).					
Assumptions: These tasks will be done in collaboration with Stuttgart University.					

Table 63. Activity PD.E.SA.1 attributes

ID: PD. E.SA.1			**Activity:** Analyse work environment		
Description of Work: Search, summarise and asses specific information about the particular needs of this project in electronic systems.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PM	SS	-	PD.E.SA.2	FS	-
Number and Type of Resources Required: E.ED.M E.CD.S EE1 EE2		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.E.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. The electronics engineers that will develop these tasks have many experience already in space related projects					

Table 64. Activity PD.E.SA.2 attributes

ID: PD.E.SA.2		**Activity:** Analyse electronic requirements			
Description of Work: Search for information to have a clear idea about the specific requirements for the electronic system.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.E.SA.1	FS	-	PD.E.SA.2	SS	-
Number and Type of Resources Required: E.ED.M E.CD.S EE1		**Skill Requirements:** Expert Average Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.E.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. The electronics engineers that will develop these tasks have many experience already in space related projects					

Table 65. Activity PD.E.HW.1 attributes

ID: PD.E.HW.1			**Activity:** Select suitable electronic components		
Description of Work: The electronic components must be in accordance to the requirements of the projects claimed above, that includes the estimation of compute power, memory and buss bandwidth among others.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.C.HW PD.N.HW	FS	-	PD.E.HW.2 PD.E.HW.3;PD.P.HW	FS	-
Number and Type of Resources Required: E.ED.M E.CD.S EE1 EE2			**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.E.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. The electronics engineers that will develop these tasks have many experience already in space related projects					

Table 66. Activity PD.E.HW.2 attributes

<table>
<tr><td colspan="3">ID: PD.E.HW.2</td><td colspan="3">Activity: Payload modules electronic systems</td></tr>
<tr><td colspan="6">Description of Work:
Specify the electronic system integrated in each payload module, including its performance and specifications.</td></tr>
<tr><td>Predecessors</td><td>Relationship</td><td>Lag</td><td>Successor</td><td>Relationship</td><td>Lag</td></tr>
<tr><td>PD.E.HW.1</td><td>FS</td><td>-</td><td>PD.E.HW.2
PD.E.HW.3;PD.P.HW</td><td>FS</td><td>-</td></tr>
<tr><td colspan="2">Number and Type of Resources Required:
E.ED.M
E.CD.S
EE1
EE2</td><td colspan="2">Skill Requirements:

Expert
Average
Senior
Senior</td><td colspan="2">Other Required Resources:
-</td></tr>
<tr><td colspan="6">Type of Effort:
Fixed amount of work</td></tr>
<tr><td colspan="6">Location of Performance:
In the company</td></tr>
<tr><td colspan="6">Constraints:
Report of results and conclusions (REP.E.1).</td></tr>
<tr><td colspan="6">Assumptions:
The manager and secretary are working in all of the aspects of this group of tasks. The electronics engineers that will develop these tasks have many experience already in space related projects</td></tr>
</table>

Table 67. Activity PD.E.HW.3 attributes

ID: PD.E.HW.3			**Activity:** Infrastructure electronic system		
Description of Work: Specify the electronic system integrated in each infrastructure module, including its performance and specifications.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.E.HW.1	FS	-	PD.E.HW.2 PD.E.HW.3;PD.P.HW	FS	-
Number and Type of Resources Required: E.ED.M E.CD.S EE1 EE2			**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.E.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. The electronics engineers that will develop these tasks have many experience already in space related projects					

Table 68. Activity PD.E.HW.4 attributes

ID: PD.E.HW.4			**Activity:** Determine the sensors requirements		
Description of Work: Determine the information to be tracked and specify the requirements desired taking in account stakeholders.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.E.SA	FS	-	PD.E.HW.5;PD.N.HW	FS	-
Number and Type of Resources Required: E.ED.M E.CD.S EE1 EE2		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.E.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. The electronics engineers that will develop these tasks have many experience already in space related projects					

Table 69. Activity PD.E.HW.5 attributes

ID: PD.E.HW.5			**Activity:** Start the contact with developers of sensors		
Description of Work: The sensors that have been chosen to be integrated in the modules must be provided through a particular entity.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.E.HW.4	FS	-	PD.E.HW.5;PD.N.HW	FS	-
Number and Type of Resources Required: E.ED.M E.CD.S EE1 EE2		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.E.1).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. The electronics engineers that will develop these tasks have many experience already in space related projects					

Table 70. Activity FD.C.HW.1 attributes

ID: FD.C.HW.1		**Activity:** Modules communication system			
Description of Work: The final communication system between the modules must be well defined and implemented.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.ME.1	FS	-	FD.S.SW	SS	-
Number and Type of Resources Required: E.CD.M E.CD.S SE4 TE2 CD.EXT 2		**Skill Requirements:** Expert Average Senior Senior Junior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also in Southampton University					
Constraints: Report of results and conclusions (REP.C.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These task will be done in collaboration with Southampton University.					

Table 71. Activity FD.C.HW.2 attributes

<table>
<tr><td colspan="3">ID: FD.C.HW.2</td><td colspan="3">Activity: Ground – space communication system</td></tr>
<tr><td colspan="6">Description of Work:
The final communication system between the Ground-Space stations must be well defined and implemented.</td></tr>
<tr><td>Predecessors</td><td>Relationship</td><td>Lag</td><td>Successor</td><td>Relationship</td><td>Lag</td></tr>
<tr><td>PD.ME.1</td><td>FS</td><td>-</td><td>FD.C.SW</td><td>SS</td><td>-</td></tr>
<tr><td colspan="2">Number and Type of Resources Required:
E.CD.M
E.CD.S
SE3
TE3</td><td colspan="2">Skill Requirements:

Expert
Average
Senior
Senior</td><td colspan="2">Other Required Resources:
-</td></tr>
<tr><td colspan="6">Type of Effort:
Fixed amount of work</td></tr>
<tr><td colspan="6">Location of Performance:
In the company</td></tr>
<tr><td colspan="6">Constraints:
Report of results and conclusions (REP.C.2).</td></tr>
<tr><td colspan="6">Assumptions:
The manager and secretary are working in all of the aspects of this group of tasks.</td></tr>
</table>

Table 72. Activity FD.C.HW.3 attributes

ID: FD.C.HW.3		**Activity:** Power transmission system			
Description of Work: The final power transmission between modules must be well defined and implemented					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.ME.1	FS	-	FD.C.SW	SS	-
Number and Type of Resources Required: E.CD.M E.CD.S SE3 TE3 MD.EXT.3		**Skill Requirements:** Expert Average Senior Senior Junior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also where Orbital ATK develops its activities.					
Constraints: Report of results and conclusions (REP.C.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These task will be done in collaboration with Orbital ATK					

Table 73. Activity FD.C.SW.1 attributes

ID: FD.C.SW.1			**Activity:** Protocol communications		
Description of Work: It must be developed a protocol in communications to be followed in a regular case or an emergency case.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.C.HW	FS	-	FD.C.SW.2	SS	-
Number and Type of Resources Required: E.CD.M E.CD.S IE3 SE5 TE3		**Skill Requirements:** Expert Average Senior Senior Senior		**Other Required Resources:** SOFT.5	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.2).					
Assumptions: -					

Table 74. Activity FD.C.SW.2 attributes

ID: FD.C.SW.2			**Activity:** Information control management software		
Description of Work: A final control management software will be responsible of integrating the whole information that is received by the different modules.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.C.SW.1	FS	-	FD.C.SW.4 FD.E.HW.1;FD.E.HW.2	SS	-
Number and Type of Resources Required: E.CD.M E.CD.S IE3 SE5 TE3			**Skill Requirements:** Expert Average Senior Senior Senior		**Other Required Resources:** SOFT.5
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.2).					
Assumptions: -					

Table 75. Activity FD.C.SW.3 attributes

<table>
<tr><td colspan="3">ID: FD.C.SW.3</td><td colspan="3">Activity: Power transmission control system</td></tr>
<tr><td colspan="6">Description of Work:
Final stage in the design of the power transmission control system of the communication module.</td></tr>
<tr><td>Predecessors</td><td>Relationship</td><td>Lag</td><td>Successor</td><td>Relationship</td><td>Lag</td></tr>
<tr><td>FD.C.HW</td><td>FS</td><td>-</td><td>FD.C.SW.4
FD.E.HW.1;FD.E.HW.2</td><td>SS</td><td>-</td></tr>
<tr><td colspan="2">Number and Type of Resources Required:
E.CD.M
E.CD.S
IE3
SE5
TE1
MD.EXT.3</td><td colspan="2">Skill Requirements:

Expert
Average
Senior
Senior
Senior
Senior</td><td colspan="2">Other Required Resources:
SOFT.5</td></tr>
<tr><td colspan="6">Type of Effort:
Fixed amount of work</td></tr>
<tr><td colspan="6">Location of Performance:
In the company and also in Orbital ATK dependences.</td></tr>
<tr><td colspan="6">Constraints:
Report of results and conclusions (REP.C.2).</td></tr>
<tr><td colspan="6">Assumptions:
These tasks will be done in collaboration with Orbital ATK.</td></tr>
</table>

Table 76. Activity FD.C.SW.4 attributes

ID: FD.C.SW.4			**Activity:** Communication simulator program		
Description of Work: Final design of the communication simulator software developed to simulate the communication between modules and module – ground.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.C.SW.2 FD.C.SW.3	FS	-	FD.C.SW.4 FD.E.HW.1;FD.E.HW.2	SS	-
Number and Type of Resources Required: E.CD.M E.CD.S IE3 SE5 TE1			**Skill Requirements:** Expert Average Senior Senior Senior		**Other Required Resources:** SOFT.5
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 77. Activity FD.N.HW.1 attributes

ID: FD.N.HW.1		**Activity:** Attitude sensors			
Description of Work: Final stage in the design of the attitude sensors of the navigation system.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.ME.1	FS	-	FD.N.HW.2	FS	-
Number and Type of Resources Required: E.MDD.M E.MDD.S SE4 TE2		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.N.2).					
Assumptions: -					

Table 78. Activity FD.N.HW.2 attributes

ID: FD.N.HW.2		**Activity:** Attitude control system			
Description of Work: Final stage in the design of the attitude control system.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.N.HW.1	FS	-	FD.N.HW.2	FS	-
Number and Type of Resources Required: E.MDD.M E.MDD.S SE4 TE2		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.N.2).					
Assumptions: -					

Table 79. Activity FD.N.SW.1 attributes

ID: FD.N.SW.1			**Activity:** Constellation navigation control software		
Description of Work: The final control software responsible of navigation must be designed.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.N.HW	FS	-	FD.N.SW.3 FD.E.HW.1 FD.E.HW.2	FS	-
Number and Type of Resources Required: E.MDD.M E.MDD.S IE3 SE1 MDD.EXT2			**Skill Requirements:** Expert Average Senior Senior Senior		**Other Required Resources:** SOFT.5
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also where SENER develop its activities.					
Constraints: Report of results and conclusions (REP.N.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These tasks will be done in collaboration with SENER.					

Table 80. Activity FD.N.SW.2 attributes

ID: FD.N.SW.2			**Activity:** Module attitude control software		
Description of Work: The final control software responsible of module attitude must be designed.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.N.HW	FS	-	FD.N.SW.3;FD.E.HW.1 FD.E.HW.2;FD.P	FS	-
Number and Type of Resources Required: E.MDD.M E.MDD.S IE1 IE2 TE1			**Skill Requirements:** Expert Average Senior Senior Senior		**Other Required Resources:** SOFT.5
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.N.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 81. Activity FD.N.SW.3 attributes

<table>
<tr><td colspan="3">ID: FD.N.SW.3</td><td colspan="3">Activity: Navigation and attitude simulator software</td></tr>
<tr><td colspan="6">Description of Work:
An operative software must be designed and checked to simulate the behaviour of the constellation in its work environment, using the navigation and attitude control software.</td></tr>
<tr><td>Predecessors</td><td>Relationship</td><td>Lag</td><td>Successor</td><td>Relationship</td><td>Lag</td></tr>
<tr><td>FD.N.SW.1
FD.N.SW.2</td><td>FS</td><td>-</td><td>FD.N.SW.3
FD.E.HW.1
FD.E.HW.2;FD.P</td><td>FS</td><td>-</td></tr>
<tr><td colspan="2">Number and Type of Resources Required:
E.MDD.M
E.MDD.S
IE1
IE2
TE1</td><td colspan="2">Skill Requirements:

Expert
Average
Senior
Senior
Senior</td><td colspan="2">Other Required Resources:
SOFT.5</td></tr>
<tr><td colspan="6">Type of Effort:
Fixed amount of work</td></tr>
<tr><td colspan="6">Location of Performance:
In the company</td></tr>
<tr><td colspan="6">Constraints:
Report of results and conclusions (REP.N.2).</td></tr>
<tr><td colspan="6">Assumptions:
The manager and secretary are working in all of the aspects of this group of tasks.</td></tr>
</table>

Table 82. Activity FD.P.HW.1 attributes

ID: FD.P.HW.1			**Activity:** Propulsion systems		
Description of Work: The design of the propulsion system reaches its final stage. It is fully defined and implemented.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.N.SW.2	FS	-	FD.P.SW;FD.ME	FS	-
Number and Type of Resources Required: E.PRD.M E.MD.S SE1		**Skill Requirements:** Expert Average Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.P.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 83. Activity FD.P.HW.2 attributes

ID: FD.P.HW.2			**Activity:** Power unit system		
Description of Work: The design of the power unit system reaches its final stage. It is fully defined and implemented.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.N.SW.2	FS	-	FD.P.HW.3	FS	-
Number and Type of Resources Required: E.PRD.M E.MD.S SE1 MD.EXT.3		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also where Orbital ATK develops its activities.					
Constraints: Report of results and conclusions (REP.P.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These tasks will be done in collaboration with Orbital ATK.					

Table 84. Activity FD.P.HW.3 attributes

ID: FD.P.HW.3			**Activity:** Power storage system		
Description of Work: The design of the power storage system reaches its final stage. It is fully defined and implemented.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.P.HW.2	FS	-	FD.P.HW.3	FS	-
Number and Type of Resources Required: E.PRD.M E.MD.S SE2		**Skill Requirements:** Expert Average Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.P.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 85. Activity FD.P.SW.1 attributes

ID: FD.P.SW.1		**Activity:** Power control software			
Description of Work: The final control software will be responsible of integrating the power system.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.P.HW	FS	-	REP.P.2	FF	-
Number and Type of Resources Required: E.PRD.M E.MD.S SE2 IE1		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** SOFT.5	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.P.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 86. Activity FD.P.SW.2 attributes

ID: FD.P.SW.2		**Activity:** Propulsion control software			
Description of Work: The final control software will be responsible of integrating the propulsion system.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.P.HW	FS	-	REP.P.2	FF	-
Number and Type of Resources Required: E.PRD.M E.MD.S SE2 IE1		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** SOFT.5	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.P.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 87. Activity FD.ME.MD.1 attributes

ID: FD.ME.MD.1		**Activity:** Materials selection			
Description of Work: Materials selection taking in account temperature, radiation, structural resistance during the launch and other kind of mission and space adverse conditions.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.P.HW	FS	-	FD.ME.MD.2	FS	-
Number and Type of Resources Required: E.MD.M E.MD.S SE3 SE4 MD.EXT1		**Skill Requirements:** Expert Average Senior Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.ME.2).					
Assumptions: These tasks will be done in collaboration Stuttgart University, with Ball Aerospace and UPV					

Table 88. Activity FD.ME.MD.2 attributes

ID: FD.ME.MD.2		**Activity:** Module structure			
Description of Work: The module structure, that has to be big enough to enclosure all the sub-systems defined, and to protect them from space debris.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.ME.MD.1	FS	-	FD.ME.MD.3 FD.ME.MD.4	SS	-
Number and Type of Resources Required: E.MD.M E.MD.S UPV		**Skill Requirements:** Expert Average Junior		**Other Required Resources:** SOFT.1	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also in Polytechnic University of Valencia.					
Constraints: Report of results and conclusions (REP.ME.2).					
Assumptions: These tasks will be done in collaboration UPV.					

Table 89. Activity FD.ME.MD.3 attributes

ID: FD.ME.MD.3			**Activity:** Thermal insulation		
Description of Work: Thermal insulation to protect sub-systems from the adverse conditions outside the module. Temperature levels inside the module must reach specific temperature to ensure the correct functionality of all electronic devices.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.ME.MD.2	FS	-	FD.ME.MD.3 FD.ME.MD.4	SS	-
Number and Type of Resources Required: E.MD.M E.MD.S SE3 MD.EXT2		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.ME.2).					
Assumptions: These tasks will be done in collaboration Stuttgart University, with Ball Aerospace.					

Table 90. Activity FD.ME.MD.4 attributes

ID: FD.ME.MD.4		**Activity:** Sub-system integration			
Description of Work: Final integration of the Sub-systems into one.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.ME.MD.3	FS	-	FD.ME.MD.3 FD.ME.MD.4	SS	-
Number and Type of Resources Required: E.MD.M E.MD.S SE3 SE4 SE5		**Skill Requirements:** Expert Average Senior Senior Senior		**Other Required Resources:** SOFT.8	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.ME.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 91. Activity FD.ME.ID.1 attributes

ID: FD.ME.ID.1			**Activity:** Material selection		
Description of Work: Materials selection taking in account temperature, radiation, structural resistance during the launch and other kind of mission and space adverse conditions.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.P.HW	FS	-	FD.ME.ID.2	FS	-
Number and Type of Resources Required: E.MD.M E.MD.S SE2 SE5 MD.EXT1		**Skill Requirements:** Expert Average Senior Senior Junior		**Other Required Resources:**	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also in Stuttgart					
Constraints: Report of results and conclusions (REP.ME.2).					
Assumptions: These tasks will be done in collaboration with Stuttgart University.					

Table 92. Activity FD.ME.ID.2 attributes

ID: FD.ME.ID.2		**Activity:** Module structure			
Description of Work: The module structure, that has to be big enough to enclosure all the sub-systems defined, and to protect them from space debris.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.ME.MD.1	FS	-	FD.ME.ID.3;FD.ME.ID.4	FS	-
Number and Type of Resources Required: E.MD.M E.MD.S SE1		**Skill Requirements:** Expert Average Senior		**Other Required Resources:** SOFT.1	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.ME.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 93. Activity FD.ME.ID.3 attributes

ID: FD.ME.ID.3			**Activity:** Thermal insulation		
Description of Work: Thermal insulation to protect sub-systems from the adverse conditions outside the module. Temperature levels inside the module must reach specific temperature to ensure the correct functionality of all electronic devices.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.ME.MD.2	FS	-	FD.ME.ID.3;FD.ME.ID.4	FS	-
Number and Type of Resources Required: E.MD.M E.MD.S MD.EXT2			**Skill Requirements:** Expert Average Senior		**Other Required Resources:** **-**
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also in Stuttgart					
Constraints: Report of results and conclusions (REP.ME.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. These task will be done in collaboration with Stuttgart University.					

Table 94. Activity FD.ME.ID.4 attributes

ID: FD.ME.ID.4			**Activity:** Sub-system integration		
Description of Work: Final integration of the sub-systems into one.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.ME.MD.3	FS	-	FD.ME.ID.3;FD.ME.ID.4	FS	-
Number and Type of Resources Required: E.MD.M E.MD.S SE2 SE3			**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** SOFT.8
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also in Stuttgart					
Constraints: Report of results and conclusions (REP.ME.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 95. Activity FD.E.HW.1 attributes

ID: FD.E.HW.1		**Activity:** Payload modules electronic systems			
Description of Work: Final design of the payload modules. They must be fully defined and implemented.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.C ; FD.N	FS	-	REP.E.2	FF	-
Number and Type of Resources Required: E.ED.M E.CD.S EE1 EE2		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.E.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 96. Activity FD.E.HW.2 attributes

ID: FD.E.HW.2		**Activity:** Infrastructure electronic systems			
Description of Work: Final stage in the design of the infrastructures of the electronic systems. They are fully defined and implemented.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.C ; FD.N	FS	-	REP.E.2	FF	-
Number and Type of Resources Required: E.ED.M E.CD.S EE1 EE2		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** -	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.E.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks.					

Table 97. Activity FD.E.HW.3 attributes

ID: FD.E.HW.3			**Activity:** Selection of final sensors and their providers		
Description of Work: The sensors that will be installed are finally chosen between all the possible providers.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
PD.ME.1	FS	-	REP.E.2	FF	-
Number and Type of Resources Required: E.ED.M E.CD.S PD.EXT.1 PD.EXT.3		**Skill Requirements:** Expert Average Senior Senior		**Other Required Resources:** SOFT.3	
Type of Effort: Fixed amount of work					
Location of Performance: In the company and also where our collaborators develop their activities.					
Constraints: Report of results and conclusions (REP.E.2).					
Assumptions: The manager and secretary are working in all of the aspects of this group of tasks. For these tasks it is required to have already the sensors developed by Amptek, Silvanet and Surrey Satellites.					

Table 98. Activity T.C.1 attributes

ID: T.C.1			**Activity:** Test and validation for communication satellite-satellite		
Description of Work: The final communication system between satellite-satellite is tested and validated.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.C	FS	-	REP.C.3	FF	-
Number and Type of Resources Required: E.CD.M		**Skill Requirements:** Expert		**Other Required Resources:** LAB.COM SOFT.2	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.3).					
Assumptions: These task will be developed in a subcontracted Communications laboratory.					

Table 99. Activity T.C.2 attributes

ID: T.C.2			**Activity:** Test and validation for communication ground-satellite		
Description of Work: The final communication system between ground-satellite is tested and validated.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.C	FS	-	REP.C.3	FF	-
Number and Type of Resources Required: E.CD.M		**Skill Requirements:** Expert		**Other Required Resources:** LAB.COM SOFT.2	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.3).					
Assumptions: These task will be developed in a subcontracted Communications laboratory.					

Table 100. Activity T.C.3 attributes

ID: T.C.3		**Activity:** Test and validation for power transmission			
Description of Work: The power transmission system is tested and validated.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.C	FS	-	REP.C.3	FF	-
Number and Type of Resources Required: E.CD.M		**Skill Requirements:** Expert		**Other Required Resources:** LAB.COM	
Type of Effort: Fixed amount of work					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.C.3).					
Assumptions: These task will be developed in a subcontracted Communications laboratory.					

Table 101. Activity T.N.1 attributes

<table>
<tr><td colspan="3">ID: T.N.1</td><td colspan="3">Activity: Test and validation of the navigation, attitude and control systems using computer simulated programs</td></tr>
<tr><td colspan="6">Description of Work:
The navigation, attitude and control systems are tested and validated using simulation software assisted by computer.</td></tr>
<tr><td>Predecessors</td><td>Relationship</td><td>Lag</td><td>Successor</td><td>Relationship</td><td>Lag</td></tr>
<tr><td>FD.N</td><td>FS</td><td>-</td><td>REP.N.3</td><td>FF</td><td>-</td></tr>
<tr><td colspan="2">Number and Type of Resources Required:
E.MDD.M</td><td colspan="2">Skill Requirements:

Expert</td><td colspan="2">Other Required Resources:
LAB.INT
SOFT.5
SOFT.7</td></tr>
<tr><td colspan="6">Type of Effort:
Fixed amount of effort</td></tr>
<tr><td colspan="6">Location of Performance:
In the company</td></tr>
<tr><td colspan="6">Constraints:
Report of results and conclusions (REP.N.3).</td></tr>
<tr><td colspan="6">Assumptions:
The mission design manager is the responsible for this testing.</td></tr>
</table>

Table 102. Activity T.P.1 attributes

ID: T.P.1			**Activity:** Test and validation of the propulsion system using computer simulated programs		
Description of Work: The propulsion system is tested and validated using simulation software assisted by computer.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.P	FS	-	REP.P.3	FF	-
Number and Type of Resources Required: E.PRD.M		**Skill Requirements:** Expert		**Other Required Resources:** SE5 SOFT.1	
Type of Effort: Fixed amount of effort.					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.P.3).					
Assumptions: The propulsion manager is the responsible for this testing.					

Table 103. Activity T.ME.1 attributes

ID: T.ME.1		**Activity:** Test and validation of the mechanical system using computer simulation programs			
Description of Work: The mechanical system is tested and validated using simulation software assisted by computer.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.ME	FS	-	REP.ME.3	FF	-
Number and Type of Resources Required: E.MD.M		**Skill Requirements:** Expert		**Other Required Resources:** SE1 SOFT.1	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.ME.3).					
Assumptions: The mechanical manager is the responsible for this testing					

Table 104. Activity T.E.1 attributes

ID: T.E.1			**Activity:** Test and validation of the electronics system using computer simulation programs		
Description of Work: The electronics system is tested and validated using simulation software assisted by computer.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
FD.E	FS	-	REP.E.3	FF	-
Number and Type of Resources Required: E.ED.M EE1		**Skill Requirements:** Expert Senior		**Other Required Resources:** LAB.ELE	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions (REP.E.3).					
Assumptions: These tasks will be developed in the electronics laboratory of UPV.					

Table 105. Activity T.A.1 attributes

ID: T.A.1		**Activity:** Validation for the quality of the signal received			
Description of Work: The quality of the final signal received is tested and validated.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
T.C; T.N; T.P; T.ME; T.E	FS	-	REP.A	FF	-
Number and Type of Resources Required: E.CD.M		**Skill Requirements:** Expert		**Other Required Resources:** LAB.COMB S1.T S2.C S3.GD	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions about possible benefits related to climate change (REP.M.1).					
Assumptions: The communication manager is the responsible for the testing. These tasks will be developed in a subcontracted Communications laboratory.					

Table 106. Activity T.A.2 attributes

ID: T.A.2		**Activity:** Test and validation for the 3D mapping and the other new acquisition modes developed			
Description of Work: The 3D mapping and other new acquisition modes developed are tested and validated.					
Predecessors	**Relationship**	**Lag**	**Successor**	**Relationship**	**Lag**
T.A.1	FS	-	REP.A	FF	-
Number and Type of Resources Required: E.CD.M UPC IE1		**Skill Requirements:** Expert Junior Senior		**Other Required Resources:** SOFT.4 S1.T S2.C S3.GD	
Type of Effort: Fixed amount of effort					
Location of Performance: In the company					
Constraints: Report of results and conclusions about possible benefits related to climate change (REP.M.1).					
Assumptions: The communication manager is the responsible for the testing. UPC is the responsible for the testing of this task.					