

Astrea Constellation

Project Charter

Group 4

October 3, 2016

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1 Aim of the project

Design of a **satellite constellation** dedicated to communications relay between LEO Cubesats.

2 Scope of the project

This section establishes the scope of the project.

- **WP2:** Satellite development. the first step of this work package will consist on an establishment of the mission requirements that influence any parameter of the satellite. These requirements include size, weight, needed antennas, spacecraft sub-systems and payload. Based on these conditions a study of existing CubeSat and NanoSat structures will be carried out in order to find out the most appropriated. Once the structure will be selected, an adaptation to the mission requirements will be achieved if needed. According to spacecraft subsystems, the design will be in charge of a specialized enterprise that will work strictly following the requirements talked before.
- **WP3:** Orbital design. The orbit design will be accomplished according to the results of several studies such as visibility between satellites and between satellites and ground stations, collision avoidance, orbital decay avoidance and stated requirements as global coverage, low earth orbit, low latency. Also the number of satellites and the number of orbital planes will be deducted from those studies. It is needed to clarify if the Earth is the only celestial body that will influence the satellites or others, for instance, The Moon or Jupiter will also have to be considered. Another study will be carried out so as to reach a reliable conclusion about this issue. The specific existing legislation will be taken into an account and followed during all the orbit development.
- **WP4:** Launch systems. Concerning to launch systems, a comparison among the existing launch platforms will be carried out to find out the one that fulfills the mission requirements and a reasonable economical conditions. Also, a launching window/s will be reserved if the launch platform chosen requires it. The recommendations of Corporation Name will be followed and their application form will be filled up to ensure all the launch procedure accomplishes the legislation.
- **WP5:** Operation. An analysis will be done to clarify how many ground stations must operate and the possibility of placing a central one in UPC ESEIAAT. A suitable ground station will be selected among the existing ones. Regarding communication protocols between satellites of the constellation, external satellites and ground stations, the 1 common protocols used now a days will be adapted to the constellation needs. An end of life strategy will be designed according to CubeSat lifespan, orbit decay, replacement stratagem of the company and legislation procedures.

- **WP6:** Exhibition. In order to culminate de project, several exhibitions will be executed. Two of them related to the satellite itself, a satellite render and a mock-up, and one linked to the overall project that will consist on a simulation constellation at full service. 2

3 Basic requirements of the project

Table 1: Project Requirements

Feature	Description
1	Provide communication relay between two LEO nanosatellites with a latency lower than 1 minute .
2	Provide communication relay between a LEO nanosatellite and the ground with a latency lower than 5 minutes . (Iridium provides Earth Communications with a latency of 1800ms).
3	Back-up system prepared to handle up to two major failures in the system. A major failure can be defined as the loss of a client's satellite coverage.
4	Switch time after failure happens, shall be below 6 hours .
5	Each Satellite Node volume should be equal or lower than a 3U Cubesat .
6	Each Node should be able to handle at least 50 Mbit/s of data rate.

4 Justification

Nowadays, different universities, research centers and an increasing amount of companies are developing small satellites more and more. These are much more economic and therefore, today's space access achievability has increased substantially. With that, small satellite constellation missions have been proposed, such as **QB50** project.

These complex systems already need to configure and maintain dynamic routes, manage intermediate nodes, and reconfigure themselves to achieve mission objectives. Hence, inter-satellite is both important for satellites that fly in formation and need interconnection, and for single nanosatellites that may require low-latency communication with the ground.

5 Organization of the group

5.1 Hierarchy

Designing a nanosatellite constellation is quite ambitious and requires lots of work because there are many things to consider. In order to build a work strategy, the project is divided in tasks that will be described later on. As the different tasks depend on each other, the project members have decided to follow a hierarchy. Every task is developed by a small team between 2 and 5 people depending on the amount of work the task requires.

Each small team has to have a coordinator which has two principal functions. The first one is to manage the group so he is responsible for the good organisation and progression of the task. The second is that he is the voice of the team. That means that the coordinator is the one who represents his work team when transferring information to the other group coordinators and the project managers and vice versa.

Finally over all the teams there is the project manager who maintains order, ensures the project progress and manages people for major decisions. Finally there is also a secretary in charge to write the minutes of each meeting.

5.2 Documents Organisation

Nowadays, the internet is crucial for teamwork because it provides lots of tools that improve networking such as sharing documents, communicating and even collaborating working. The Astrea team has 17 members so it is essential to define protocol to organise all the documents and information found to take advantage of resources.

The principal communication tool used is *Slack* which is a platform specialised in team communication. *Slack* defines itself as a real-time messaging, achieving and search for modern team which is interesting for us because it allows the group to communicate at all times for punctual doubts and small decisions. For major decisions a date is specified by a *doodle* to meet.

Moreover, to share documents we use two platforms: *Slack* and *BSCW*. On *Slack* we put first drafts or documents that can be interesting. *BSCW* is the main information storage because information and documents are stocked and organised in folders.

At last, the text editor used to develop the project is Latex which combined with Git allows us to work remotely on a same document without overriding someone else's work. This work system is really interesting for such a big group in order to work on the same document while keeping a record of the changes.

6 Planning of the project

6.1 Tasks identification from work breakdown structure (WBS)

6.2 Brief tasks description

Astrea Project Charter - Management

Oscar Fuentes Muñoz

October 3, 2016

1 Planning of the project

1.1 Identification of the tasks and description of the tasks

ID	Work Package	Brief task description list
1.1	Meetings Documents	<u>Writing agendas of the meetings:</u> The team's secretary will take note of the topics pending to debate and make a list to be checked by the team. <u>Writing minutes of the meetings:</u> The team's secretary will take note of the debate and conclusions of the meeting.
1.2	Task tracking and scheduling	<u>Project Charter:</u> A description of the project to develop is going to be detailed by all the group members during the first weeks. <u>Team tasks monitoring:</u> The coordinator will ensure tasks compliance and register the progress. <u>WBS and Gantt update:</u> The documents summarizing the project organization will be updated with final dates and final topics assessed.

1.2 Interdependency relationships among tasks and human resources and level of effort

ID	Work Package	Time (h)	Predecessors
1.1	Meetings Documents	408	BF - 3
1.2	Task tracking and scheduling	50	BB - 1.1

2 Budget

2.1 Engineering hours budget

2.1.1 Cost criteria

The convenia stablished for the engineers salary is of 20 eur/hour, so a direct conversion will be applied to every time schedule assigned. No special software, tools or material is needed for the management since all the software used is license free for academic purposes.

Using the 100% criteria for the WBS decomposition, the global amounts of costs will be obtained by the sum of the different lower level values.

Work Package	Time (h)	Labour cost (eur)
1-Management		
1.1-Meetings documentation		
Meetings	340	6800
Meetings preparation		
Agendas	10	200
Minutes	10	200
1.2-Task tracking and scheduling		
Project Charter	135	2700
Team tasks monitoring	20	400
WBS and Gantt update	10	200
Total	525	10500
Total estimated	525	10500

2.2 Preliminary total cost budget

Work Package	Product cost(eur)	Time (h)	Labour cost (eur)
1-Management			
1.1-Meetings documentation			
Meetings		340	6800
Meetings preparation			
Agendas		10	200
Minutes		10	200
1.2-Task tracking and scheduling			
Project Charter		135	2700
Team tasks monitoring		20	400
WBS and Gantt update		10	200
Total	0	525	10500
Total estimated	0	525	10500

Astrea Project Charter - Planning of the project: Payload

October 1, 2016

1 Planning of the project

1.1 Identification of the tasks and description of the tasks

ID	Work Package	Biref task description list
1.3.1	Payload antenna	Task 1-Antenna: Calculation of the size of the antenna needed to communicate with the other satellites. Task 2-Antenna: Search the available antenna in the market that best fits the needs of the project.
1.3.2	Payload Data Handling System (PDHS)	Task 1-Selection of the configuration. Task 2-Establishment of the desired hardware and software. Task 3-Search the available PDHS in the market that best fits the needs of the project.

1.2 Interdependency relationships among tasks and human resources and level of effort

ID	Work Package	Time (h)	Prelations
1.3.1	Payload antenna	30	BF-2.3
1.3.2	PDHS	50	BF-2.3

2 Budget

2.1 Engineering hours budget

Work Package	Time (h)	Labour cost (eur)
Satellite design		
Payload		
Antenna	30	500
PDHS	50	1000
Total	80	1500
Total estimated	80	1500

2.2 Preliminary total cost budget

Work Package	Product cost(eur)	Time (h)	Labour cost (eur)
Satellite design			
Payload			
Antenna	6000	30	500
PDHS	7000	50	1000
Total	13000	80	1500
Total estimated	13000	80	1500

Astrea Project Charter - 2. Orbital design

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October 3, 2016

1 Planning of the project

1.1 Identification of the tasks and description of the tasks

ID	Work Package	Brief task description list
2.1	Constellation geometry	Determine the number of satellites needed. Define the distribution of the satellites.
2.2.1	General parameters	Define the general parameters of the orbit of each satellite.
2.2.2	Drifts	Compute the possible orbit deviations of each satellite.
2.3	Legislation	Study the legislation referred to nanosatellites. Implement the necessary measures to accomplish the legal requirements.

1.2 Interdependency relationships among tasks and human resources and level of effort

ID	Work Package	Time (h)	Predecessors
2.1	Constellation geometry	120	-
2.2.1	General parameters	80	BF - 2.1
2.2.2	Drifts	30	BB - 2.2.1
2.3	Legislation	20	BB - 2.1 BB - 1

2 Budget

2.1 Engineering hours budget

Work Package	Time (h)	Labour cost (eur)
2-Orbital design		
2.1-Constellation geometry	120	2400
2.2-Orbit parameters		
2.2.1-General parameters	80	1600
2.2.2-Drifts	30	600
2.3-Legislation	20	400
Total	250	5000
Total estimated	250	5000

2.2 Preliminary total cost budget

Work Package	Product cost(eur)	Time (h)	Labour cost (eur)
2-Orbital design			
2.1-Constellation geometry	0	120	2400
2.2-Orbit parameters			
2.2.1-General parameters	0	80	1600
2.2.2-Drifts	0	30	600
2.3-Legislation	¿Price of the license?	20	400
Total	¿Price of the license?	250	5000
Total estimated	¿Price of the license?	250	5000

Astrea Project Charter - 3. Launch Systems

Xavi Tió Malo
Josep Puig Ruiz

October 2, 2016

1 Planning of the project

1.1 Identification of the tasks and description of the tasks

ID	Work Package	Biref task description list
3.1	Vehicle	Study of the requirements for the launch of the cubesats. Research of the main companyies that offer launch services, including their features and costs. Decision of the best launch system for our goal, regarding the requirements and the available technology.
3.2	Satellite Deployer	Study of the requirements for the launch of the cubesats. Research of the deployment systems that the main companies offer. Decision of the best launch system for our goal, regarding the requirements and the available technology.

1.2 Interdependency relationships amogn tasks and human resources and level of effort

ID	Work Package	Time (h)	Prelations
3.1	Vehicle	16	BB 3.2
3.2	Satellite Deployer	11	BB 3.1

2 Budget

2.1 Engineering hours budget

Work Package	Time (h)	Labour cost (eur)
3.1-Vehicle	16	320
3.2-Satellite	11	220
Total	27	540
Total estimated	27	540

Astrea Project Charter - 5. Operation

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October 1, 2016

1 Planning of the project

1.1 Identification of the tasks and description of the tasks

ID	Work Package	Biref task description list
5.1	Communication protocol	Study the existing communication protocols. Adapt the existing protocols or create new ones.
5.2	Ground station	Determine the number of ground stations needed. Study the market of available ground stations that fulfil the needs of the project. Choose the more suitable ground stations.
5.3	End of life strategy	Study the existing end of life protocols. Choose the protocol that applies to the satellites.

1.2 Interdependency relationships among tasks and human resources and level of effort

ID	Work Package	Time (h)	Prelations
5.1	Communication protocol	15	BF - 3.2.1
5.2	Ground station	10	BF- 5.1 BF - 3.3
5.3	End of life strategy	15	BF - 3.2.1

2 Budget

2.1 Engineering hours budget

Work Package	Time (h)	Labour cost (eur)
5-Operation		
5.1-Communication protocol	15	300
5.2-Ground station	10	200
5.3-End of life strategy	15	300
Total	40	800
Total estimated	40	800

2.2 Preliminary total cost budget

Work Package	Product cost(eur)	Time (h)	Labour cost (eur)
5-Operation			
5.1-Communication protocol	0	15	300
5.2-Ground station	¿5000? per GS	10	200
5.3-End of life strategy	0	15	300
Total	¿5000? per GS	40	800
Total estimated	¿5000? per GS	40	800

Astrea Project Charter - 6.Financial Plan

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October 2, 2016

1 Planning of the project

1.1 Identification of the tasks and description of the tasks

ID	Work Package	Biref task description list
6.1	Costs	Develop the total costs of the project where are included both fix costs (maintenance, insurance, administration and taxes) and variable costs (manufacturing and launching)
6.2	Income	Study of the demand for our product and estimation of income
6.3	Economic Feasibility Report	Study of the costs and income of the project to determine if it can carry out

1.2 Interdependency relationships amogn tasks and human resources and level of effort

ID	Work Package	Time (h)	Prelations
6.1.1.1	Maintenance Cost Analysis	5	BF -1,2,3,4,5
6.1.1.2	Insurance Cost Analysis	6	BF -1,2,3,4,5
6.1.1.3	Administration Cost Analysis	6	BF -1,2,3,4,5
6.1.1.4	Taxes Cost Analysis	6	BF -1,2,3,4,5
6.1.2.1	Manufacturing Cost Report	10	BF -1,2,3,4,5
6.1.2.2	Launching Cost Report	10	BF -1,2,3,4,5
6.2.1	Price Analysis	6	BF -1,2,3,4,5
6.2.2	Revenue Forecast	6	BF -1,2,3,4,5
6.3	Economic Feasibility Report	30	BF -1,2,3,4,5

2 Budget

2.1 Engineering hours budget

Work Package	Time (h)	Labour cost (eur)
6-Financial plan		
6.1-Costs		
6.1.1 Fix		
6.1.1.1-Maintenance Cost Analysis	5	60
6.1.1.2-Insurance Cost Analysis	6	120
6.1.1.3-Administration Cost Analysis	6	120
6.1.1.4-Taxes Cost Analysis	6	120
6.1.1-Variable		
6.1.2.1-Manufacturing Cost Report	10	200
6.1.2.2-Launching Cost Report	10	200
6.2-Income		
6.2.1-Price Analysis	6	100
6.2.2-Revenue Forecast	6	100
6.3-Economic Feasibility Report	30	600
Total	85	1700
Total estimated	85	1700

2.2 Preliminary total cost budget

Work Package	Product cost(eur)	Time (h)	Labour cost (eur)
6-Financial plan			
6.1-Costs			
6.1.1-Fix			
6.1.1.1-Maintenance Cost Analysis	-	3	60
6.1.1.2-Insurance Cost Analysis	-	6	120
6.1.1.3-Administration Cost Analysis	-	6	120
6.1.1.4-Taxes Cost Analysis	-	6	120
6.1.1-Variable			
6.1.2.1-Manufacturing Cost Report	-	100	200
6.1.2.2-Launching Cost Report	-	10	200
6.2-Income			
6.2.1-Price Analysis	-	5	100
6.2.2-Revenue Forecast	-	5	100
6.3-Economic Feasibility Report	-	30	600
Total	-	85	1700
Total estimated	-	85	1700

Astrea Project Charter - Project Exhibition

Silvia González García

October 2, 2016

1 Planning of the project

1.1 Identification of the tasks and description of the tasks

ID	Work Package	Biref task description list
7.1	Constellation Simulation	Perform a simulation of the constellation
7.2	Satellite Render	Develop and assembly of the 3D CAD design by completing the elements previously modelled and creating the missing ones. Perform a animated demonstration of the different elements of the satellite.
7.3	Satellite mockup	Select the materials for the mockup Determine the manufacturing methods Set, test and record the functionalities implemented.

1.2 Interdependency relationships amogn tasks and human resources and level of effort

ID	Work Package	Time (h)	Prelations
7.1	Constellation Simulation	10	BF - 2 BF - 3
7.2	Satellite Render	15	BF - 2
7.3	Satellite mockup	25	BF - 7.2

2 Budget

2.1 Engineering hours budget

Work Package	Time (h)	Labour cost (eur)
7-Project Exhibition		
7.1-Constellation Simulation	10	200
7.2-Satellite Render	15	300
7.3-Satellite mockup	25	500
Total	50	1000
Total estimated	50	1000

2.2 Preliminary total cost budget

Work Package	Product cost(eur)	Time (h)	Labour cost (eur)
7-Project Exhibition			
7.1-Constellation Simulation	0	10	200
7.2-Satellite Render	0	15	300
7.3-Satellite mockup	50	25	500
Total	50	50	50
Total estimated	50	50	1000

7 Budget (initial estimation for engineering basic project)