Astrea Constellation

Project Charter

Group 4

September 29, 2016

Contents

1 Aim of the project

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

2 Scope of the project

A project of such magnitude comprises a large number of tasks, nevertheless, some of them are beyond the scope of this project. The ones that are actually on its scope are:

- *Design of the orbits*
- *Design of the Cubesats*
- *Lunch system*
- *Lunching procedure*
- *Design of the ground station*
- *Communication protocols*
- *End of life procedure*

3 Basic requirements of the project

Table 1: Project Requirements

Feature	**Description**
1	Provide **low latency** communication relay between LEO nanosatellites and the ground.
2	Back-up systems in case some satellite subsystems fails. Therefore, **guarantee** the service.
3	Use modern and more efficient solutions in order to **reduce** mass, volume and other critical parameters. Examples are SDR, DTN, etc.
4	Combine satellite nodes with some ground nodes in order to improve reliability.

4 Justification

Nowadays, different universities, research centers and an incresing 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.

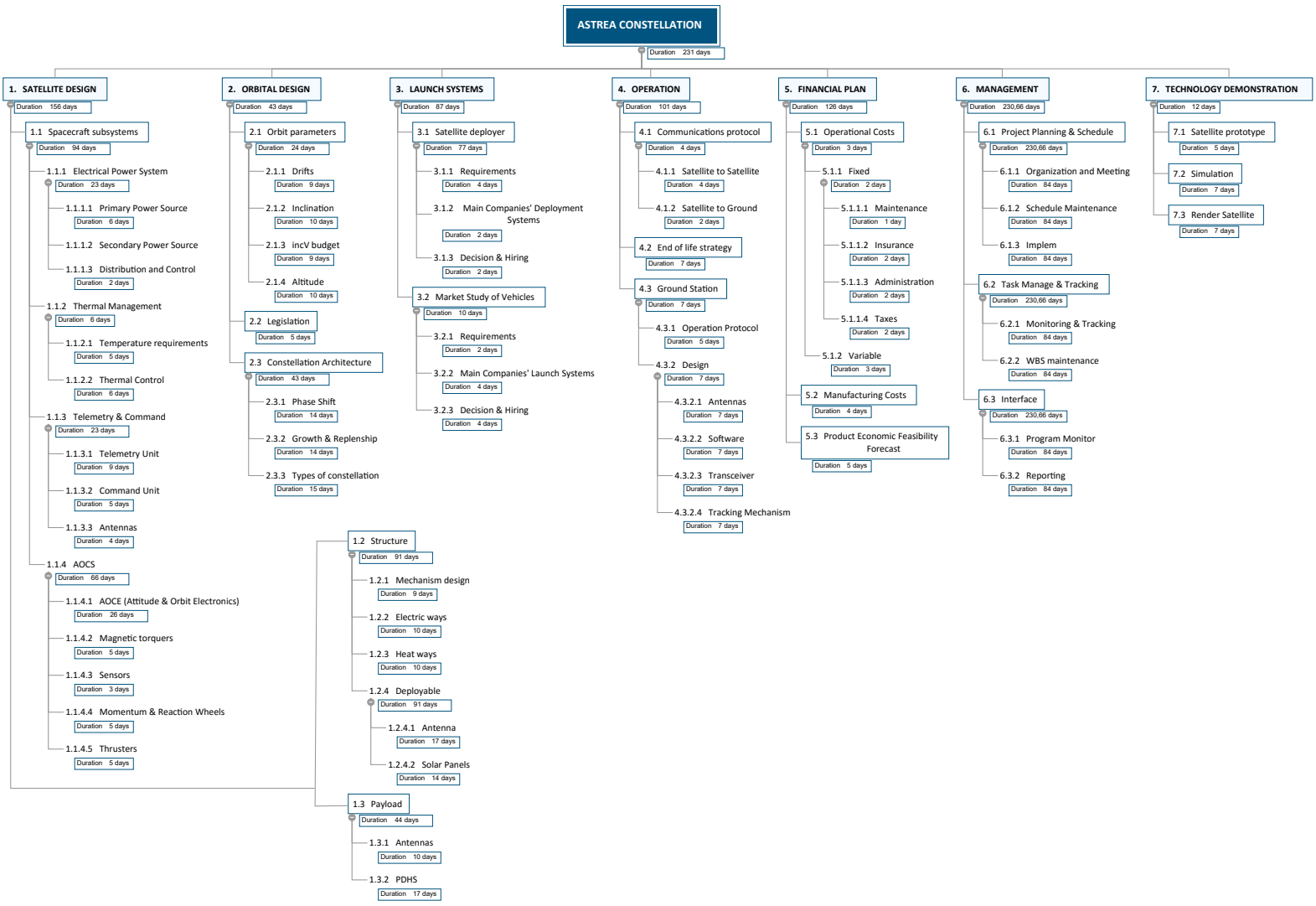
The principal communication tool used is *Slack* which is a platform specialised in team communication. *Slack* defines itself as a real-time messaging, achieving and search for modern team which is interesting for us because it allows the group to communicate at all times for punctual doubts and small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

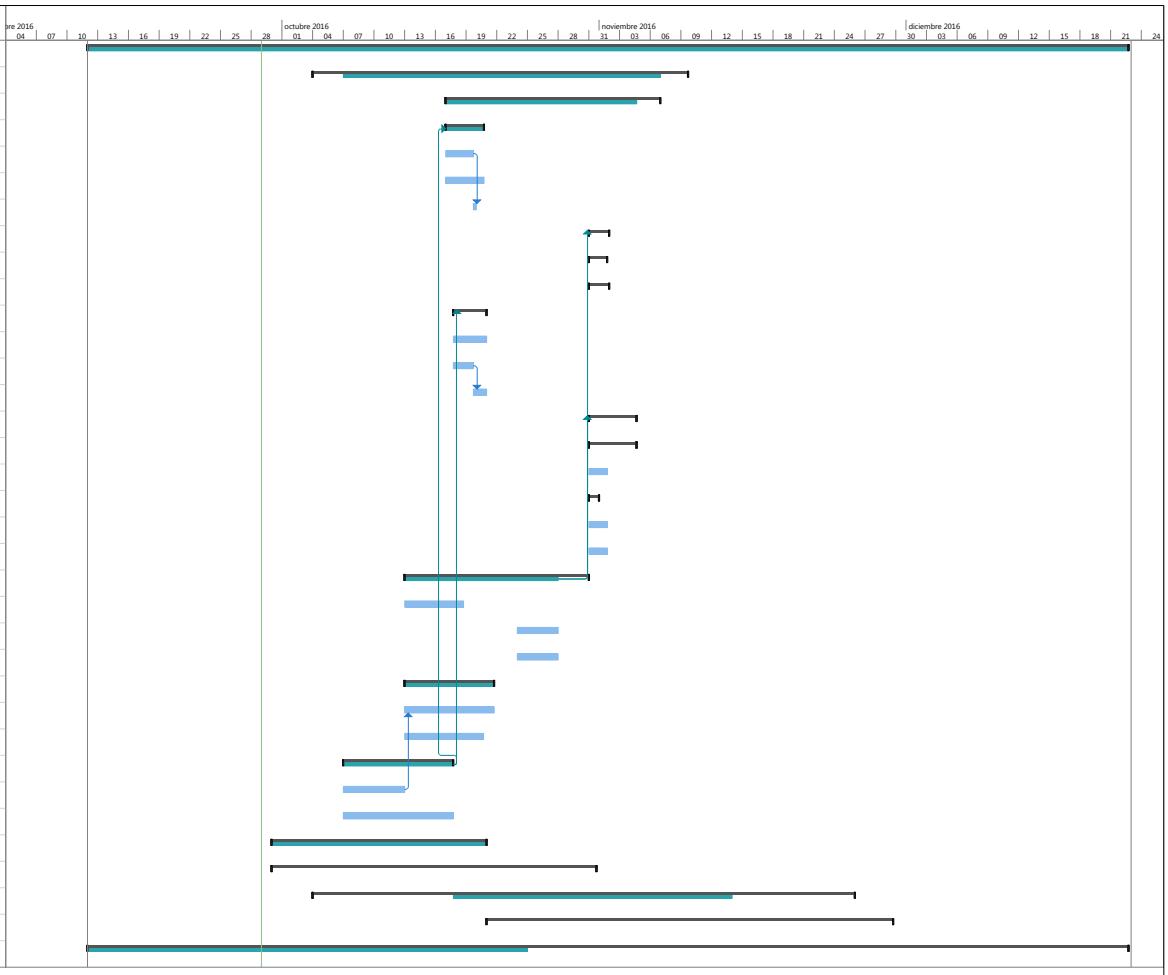
6.1 Tasks identification from work breakdown structure (WBS)


ASTREA CONSTELLATION
Duration 231 days
1. SATELLITE DESIGN
Duration 156 days
1.1 Spacecraft subsystems
Duration 94 days
1.1.1 Electrical Power System
Duration 23 days
1.1.1.1 Primary Power Source
Duration 6 days
1.1.1.2 Secondary Power Source
1.1.1.3 Distribution and Control
Duration 2 days
1.1.2 Thermal Management
Duration 6 days
1.1.2.1 Temperature requirements
Duration 5 days
1.1.2.2 Thermal Control
Duration 6 days
1.1.3 Telemetry & Command
Duration 23 days
1.1.3.1 Telemetry Unit
Duration 9 days
1.1.3.2 Command Unit
Duration 5 days
1.1.3.3 Antennas
Duration 4 days
1.1.4 AOCS
Duration 66 days
1.1.4.1 AOCE (Attitude & Orbit Electronics)
Duration 26 days
1.1.4.2 Magnetic torquers
Duration 5 days
1.1.4.3 Sensors
Duration 3 days
1.1.4.4 Momentum & Reaction Wheels
Duration 5 days
1.1.4.5 Thrusters
Duration 5 days
1.2 Structure
Duration 91 days
1.2.1 Mechanism design
Duration 9 days
1.2.2 Electric ways
Duration 10 days
1.2.3 Heat ways
Duration 10 days
1.2.4 Deployable
Duration 91 days
1.2.4.1 Antenna
Duration 17 days
1.2.4.2 Solar Panels
Duration 14 days
1.3 Payload
Duration 44 days
1.3.1 Antennas
Duration 10 days
1.3.2 PDHS
Duration 17 days
2. ORBITAL DESIGN
Duration 43 days
2.1 Orbit parameters
Duration 24 days
2.1.1 Drifts
Duration 9 days
2.1.2 Inclination
Duration 10 days
2.1.3 incV budget
Duration 9 days
2.1.4 Altitude
Duration 10 days
2.2 Legislation
Duration 5 days
2.3 Constellation Architecture
Duration 43 days
2.3.1 Phase Shift
Duration 14 days
2.3.2 Growth & Replenship
Duration 14 days
2.3.3 Types of constellation
Duration 15 days
3. LAUNCH SYSTEMS
Duration 87 days
3.1 Satellite deployer
Duration 77 days
3.1.1 Requirements
Duration 4 days
3.1.2 Main Companies' Deployment Systems
Duration 2 days
3.1.3 Decision & Hiring
Duration 2 days
3.2 Market Study of Vehicles
Duration 10 days
3.2.1 Requirements
Duration 2 days
3.2.2 Main Companies' Launch Systems
Duration 4 days
3.2.3 Decision & Hiring
Duration 4 days
4. OPERATION
Duration 101 days
4.1 Communications protocol
Duration 4 days
4.1.1 Satellite to Satellite
Duration 4 days
4.1.2 Satellite to Ground
Duration 2 days
4.2 End of life strategy
Duration 7 days
4.3 Ground Station
Duration 7 days
4.3.1 Operation Protocol
Duration 5 days
4.3.2 Design
Duration 7 days
4.3.2.1 Antennas
Duration 7 days
4.3.2.2 Software
Duration 7 days
4.3.2.3 Transceiver
Duration 7 days
4.3.2.4 Tracking Mechanism
Duration 7 days
5. FINANCIAL PLAN
Duration 126 days
5.1 Operational Costs
Duration 3 days
5.1.1 Fixed
Duration 2 days
5.1.1.1 Maintenance
Duration 1 day
5.1.1.2 Insurance
Duration 2 days
5.1.1.3 Administration
Duration 2 days
5.1.1.4 Taxes
Duration 2 days
5.1.2 Variable
Duration 3 days
5.2 Manufacturing Costs
Duration 4 days
5.3 Product Economic Feasibility Forecast
Duration 5 days
6. MANAGEMENT
Duration 230,66 days
6.1 Project Planning & Schedule
Duration 230,66 days
6.1.1 Organization and Meeting
Duration 84 days
6.1.2 Schedule Maintenance
Duration 84 days
6.1.3 Implem
Duration 84 days
6.2 Task Manage & Tracking
Duration 230,66 days
6.2.1 Monitoring & Tracking
Duration 84 days
6.2.2 WBS maintenance
Duration 84 days
6.3 Interface
Duration 230,66 days
6.3.1 Program Monitor
Duration 84 days
6.3.2 Reporting
Duration 84 days
7. TECHNOLOGY DEMONSTRATION
Duration 12 days
7.1 Satellite prototype
Duration 5 days
7.2 Simulation
Duration 7 days
7.3 Render Satellite
Duration 7 days

6.2 Brief tasks description

6.3 Interdependency relationship among tasks

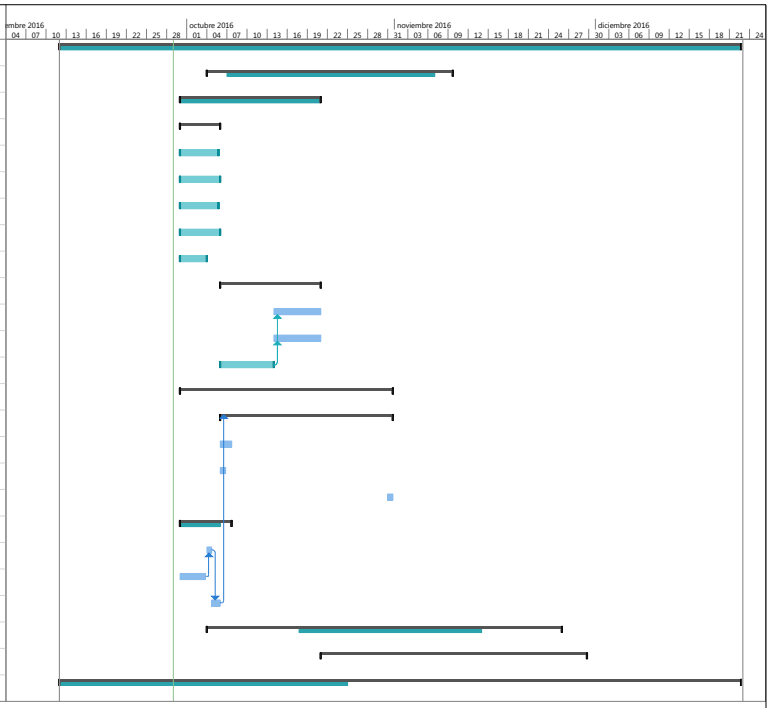
Id	Modo de tarea	Nombre de tarea	Duración
1		**ASTREA CONSTELLATION**	**197 días**
2		**SATELLITE DESIGN**	**70 días**
3		**Spacecraft subsystems**	**40 días**
4		**Electrical Power System**	**9 días**
5		Primary Power Source	6 días
6		Secondary Power Source	9 días
7		Distribution and Control	2 días
8		**Thermal Management**	**6 días**
9		**Temperature requirements**	**5 días**
12		**Thermal Control**	**6 días**
15		**Telemetry & Command**	**9 días**
16		Telemetry Unit	9 días
17		Command Unit	5 días
18		Antennas	4 días
19		**AOCS**	**12 días**
20		**AOCE (Attitude & Orbit Electronics)**	**12 días**
23		Magnetic torquers	5 días
24		**Sensors**	**3 días**
29		Momentum & Reaction Wheels	5 días
30		Thrusters	5 días
31		**Structure**	**31 días**
32		Mechanism design	9 días
33		Electric ways	10 días
34		Heat ways	10 días
35		**Deployable**	**17 días**
36		Antenna	17 días
37		Solar Panels	14 días
38		**Payload**	**17 días**
39		Antennas	10 días
40		PDHS	17 días
41		**ORBITAL DESIGN**	**40 días**
52		**LAUNCH SYSTEMS**	**57 días**
61		**OPERATION**	**104 días**
73		**FINANCIAL PLAN**	**73 días**
83		**MANAGEMENT**	**197 días**



Proyecto: ASTREA_masterplan
Fecha: jue 29/09/16

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

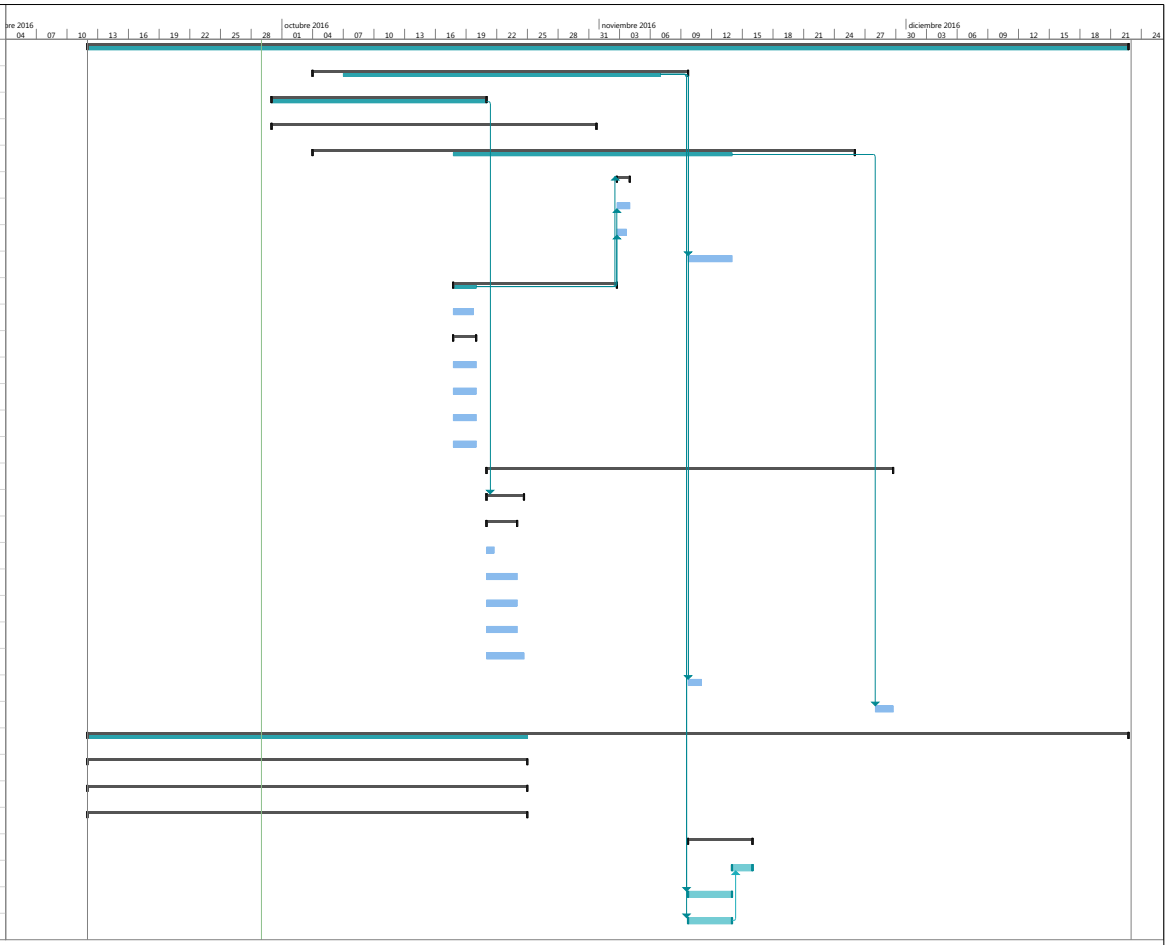
Id	Modo de tarea	Nombre de tarea	Duración
1		**ASTREA CONSTELLATION**	**197 días**
2		**SATELLITE DESIGN**	**70 días**
41		**ORBITAL DESIGN**	**40 días**
42		**Orbit parameters**	**10 días**
43		Drifts	9 días
44		Inclination	10 días
45		incV budget	9 días
46		Altitude	10 días
47		Legislation	5 días
48		**Constellation Architecture**	**29 días**
49		Phase Shift	14 días
50		Growth & Replenship	14 días
51		Types of constellation	15 días
52		**LAUNCH SYSTEMS**	**57 días**
53		**Satellite deployer**	**47 días**
54		Requirements	4 días
55		Main Companies' Deployment Systems	2 días
56		Decision & Hiring	2 días
57		**Market Study of Vehicles**	**14 días**
58		Requirements	2 días
59		Main Companies' Launch Systems	4 días
60		Decision & Hiring	4 días
61		**OPERATION**	**104 días**
73		**FINANCIAL PLAN**	**73 días**
83		**MANAGEMENT**	**197 días**



Proyecto: ASTREA_masterplan
Fecha: jue 29/09/16

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

Id	Modo de tarea	Nombre de tarea	Duración
1		**ASTREA CONSTELLATION**	**197 días**
2		**SATELLITE DESIGN**	**70 días**
41		**ORBITAL DESIGN**	**40 días**
52		**LAUNCH SYSTEMS**	**57 días**
61		**OPERATION**	**104 días**
62		**Communications protocol**	**4 días**
63		Satellite to Satellite	4 días
64		Satellite to Ground	2 días
65		End of life strategy	7 días
66		**Ground Station**	**32 días**
67		Operation Protocol	5 días
68		**Design**	**7 días**
69		Antennas	7 días
70		Software	7 días
71		Transceiver	7 días
72		Tracking Mechanism	7 días
73		**FINANCIAL PLAN**	**73 días**
74		**Operational Costs**	**3 días**
75		**Fixed**	**2 días**
76		Maintenance	1 día
77		Insurance	2 días
78		Administration	2 días
79		Taxes	2 días
80		Variable	3 días
81		Manufacturing Costs	4 días
82		Product Economic Feasibility Forecast	5 días
83		**MANAGEMENT**	**197 días**
84		**Project Planning & Schedule**	**84 días**
88		**Task Manage & Tracking**	**84 días**
91		**Interface**	**84 días**
94		**TECHNOLOGY DEMONSTRATION**	**12 días**
95		Satellite prototype	5 días
96		Simulation	7 días
97		Render Satellite	7 días



Proyecto: ASTREA_masterplan
Fecha: jue 29/09/16

Tarea | Resumen | Hito inactivo | solo duración | solo el comienzo | Hito externo | Progreso manual
División | Resumen del proyecto | Resumen inactivo | Informe de resumen manual | solo fin | Fecha límite
Hito | Tarea inactiva | Tarea manual | Resumen manual | Tareas externas | Progreso

7 Budget (initial estimation for engineering basic project)

	Product Cos	Hours	Labour Cost
SATELLITE DESIGN			
Spacecraft subsystems			
Electrical power system			
Primary Resources	17,000 €	17	340 €
Secondary Resources	3,000 €	25	500 €
Distribution & Control	2,000 €	4	80 €
Thermal Management			
Requirements	-	18	360 €
ACTS	-	18	360 €
PCTS	-	17	340 €
Telemetry & Command	8,500 €	25	500 €
AOCS			
AOCE	10,000 €	60	1,200 €
Sensors	5,000 €	15	5,000 €
Actuators	10,000 €	15	10,000 €
Structure			
Mechanical design	4,500 €	25	500 €
Thermal/rad protection	3,000 €	40	800 €
Antenna deployable	6,500 €	50	1,000 €
Solar panel deployable	16,000 €	40	800 €
Payload			
Antenna	6,000 €	30	600 €
PDHS	7,000 €	50	1,000 €

TOTAL	98,500 €	449	23,380 €	Total Cost
TOTAL ESTIMATED	98,500 €	449	23,380 €	121,880 €

	Product Cos	Hours	Labour Cost
ORBITAL DESIGN			
Parameters of the orbit			
General	-	25	500.00 €
Altitude	-	30	600.00 €
Inclination	-	30	600.00 €
Drifts	-	25	500.00 €
Legislation		15	300.00 €
Constellation Architecture			
Types of constellation	-	45	900.00 €
Growth and replenish	-	40	800.00 €
Phase shifts	-	40	800.00 €

TOTAL	250	5,000.00 €	Total Cost
TOTAL ESTIMATED	250	5,000.00 €	5,000 €

	Product Cos	Hours	Labour Cost
LAUNCH SYSTEMS			
Market study of vehicles			
Launch requirements	-	6	120 €
Main Companyies' Launch Systems	-	10	200 €
Decision and hiring			
Satellite deployer			
Deployment Requirements	-	6	120 €
Main Companies Deployment Systems	-	5	100 €
Decision and hiring	-		

TOTAL	27	540 €	Total Cost
TOTAL ESTIMATED	27	540 €	540 €

	Product Cos	Hours	Labour Cost
OPERATION			
Communication protocol			
On-orbit	-	16	320 €
Ground	-	6	120 €
End of life strategy	-	20	400 €
Ground station			
Operational protocol	-	5	100 €
Design			
Antenna	4,000 €	2	40 €
Transceiver	4,500 €	2	40 €
Tracking mechanism	1,500 €	2	40 €
Software	-	2	40 €

TOTAL	11,100 €	55	1,100 €	Total Cost
TOTAL ESTIMATED	11,100 €	55	1,100 €	12,200 €

	Product Cos	Hours	Labour Cost
FINANCIAL PLAN			
Operational cost			
Fixed	-	21	420 €
Variable	-	7	140 €
Manufacturing cost	-	10	200 €
Feasibility cost	-	15	300 €

TOTAL	-	53	1,060 €	Total Cost
TOTAL ESTIMATED	-	60	1,200 €	1,200 €

	Product Cos	Hours	Labour Cost
MANAGEMENT			
Project planning	-		
Organization and meetings	-	340	6,800.00 €
Project Charter	-	68	1,360.00 €
Task management & tracking	-		- €
Client updates	-	20	400.00 €
Team Tasks monitoring	-	20	400.00 €
WBS Update and Gant update	-	10	200.00 €

TOTAL	458	9,160.00 €	Total Cost	
TOTAL ESTIMATED	458	9,160.00 €	9,160.00 €	

	Product Cos	Hours	Labour Cost
TECHNOLOGY DEMONS.			
Constellation simulation		7	140.00 €
Satellite Rendering			
CAD design		10	200.00 €
Animation design		5	100.00 €
Satellite prototype			
Materials selection and acquisition		10	200.00 €
Manufacturing		20	400.00 €
Functionalities Testing		10	200.00 €
Other			
3DS Max License	200/month		
Row Materials (prototype)	30 €		
Tools (prototype	20 €		

TOTAL	250	62	1,240.00 €	Total Cost
TOTAL ESTIMATED	250	62	1,240.00 €	1,240.00 €

TOTAL	1361	151,220 €