



AR-21032020-001

OFFICIAL – IPSA ONE 2019
ENGLISH



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XXXXXXX- Ref : AR-XXXXXXXXXX-XXX



CHANGE LOG

| Ed. | Rev. | Date | Modifications |
|-----|------|------------|-------------------|
| 1 | 0 | XX/XX/2019 | Document creation |
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Chapter 1

Introduction

IPSA ONE is a student association from the IPSA engineering school. We have been building a 3U cube-sat from scratch for 3 years now. It's name is AragoSat-1. We work on it as a passion and in a desire to learn. However, a satellite have to fit a lot of precise requirements. In result, the project have to be organised and managed professionally. The on-board computer (OBC) team received a list of requirements for the creation of the computer that will be inside AragoSat-1. In this document we will chose how to manage the writing and the implementation of the OBC to meet the quality requirements in time.

To do so, we will use the principles of project management. Project management stands for all the activities allowing to lead a project to its term. It consists in organising the steps of the project and the methods to progress efficiently. The project management also includes the management of human, material, financial and time resources. There are a lot of methods existing. We will chose the one that matches our goals and allows us to face the difficulties we could meet.

Project management is mainly present in companies. It was created to meet a client demand. Companies have to design products matching specifications with a lot of constraints. The management methods allow them to be the most efficient possible in every situation. That is why we will adapt those methods to our project. In our situation, the client will be the other teams of the association. Each team is working on a part of the satellite like communication system or energy management.

We don't have any experience in the making of a satellite so the specifications of each team are written but they can change with time. The OBC have to work with every component so it may have to change too. The OBC team hears the changes during concurrent engineering sessions. A concurrent engineering session is a meeting where each team shows its progress and its needs. Choices are made about the way that the project is following and compromises are done. These meetings allow the OBC team to adjust its specifications during all the duration of the project.

In result, the management of the OBC project have to be flexible. We have to be able to meet a changing demand. We have to include margins. The team can also face other problems like the leaving of some members. We also have to teach programming to newbies. Eventually we have to do with a lack of material and budget.

In conclusion, the methods and tools chosen in this document are the ones that provide flexibility and are adapted to the development of embedded programming.

Chapter 2

Steps of the project

2.1 Definition of the objectives and preconditions

This step consists in the formulation of the main objective. It correspond to the client demand. We have to traduce it into precise requirements for the project. Specifications are written during this step. For us it consists in writing the OBC specifications in accordance with other teams demand. The specifications have to respect quality norms. We also have to think about the budget and the time we have to finish the OBC. The main precondition of writing an OBC is to have some knowledge in C and C++. An experience with Arduino may also help a lot. That is why the whole team is invited to learn those programming languages. Knowledge in communication and computer security is also a precondition.

2.2 Definitions of tasks and their chronology

This step is mainly about dividing the project into little tasks. It is done very closely with the specifications. We have to know what have to be done first and what follows. Having a precise idea of what we have to do will help us not to lose time and not to be discouraged by the amount of work. We have to progress step by step and know what we are doing and why.

2.3 Definition of deadlines, human resources and material management

As the management of the project must be flexible, the deadlines may change. But having a goal helps to be productive. Because everyone isn't on the same level in C programming, the whole team won't be working on the same things. We have to know who wants to work on what and if they are capable to. Last, we have to know what material we can use and what we can bye if we need to. This step and the precedent represent the scheduling of the project.

2.4 Realisation of the project

As it is named, this step consists in making the project a real thing. We will have to write the tests, the code and apply the tests on the code. Those tests are unit tests, global tests, functionality tests, performance tests and non-regression test. Unit tests are made to test a module of the code separated from the others. A global test or integration test is testing that the modules are working together. A functionality test consists in testing if the code matches the requirements. A performance test puts to the test the time and energy efficiency of the

code. Finally a non-regression test makes us aware if a modification affects the functioning of the code. The code will be written by following the specifications. If the code doesn't pass a test, a modification is made and all the test have to be passed again until everything works.

To make sure that the code does not risk to encounter any bug, we are going to simulate or emulate it, then we will test it on an engineering model and then implement it on the real satellite. There is a difference between a simulation and an emulation. The simulation would recreate the inner electronic composition of the card we will use and the emulation would just imitate the actions of the card. Using a simulator would be better because it would be more precise. The problem is that simulating the whole OBC seems very difficult. Doing those three implementations and test them should allows us to detect any kind of problem that may happen.

2.5 Conclusion of the project

This is the last step. All the tests and adjustments have been made on the code. The final version of the OBC is ready and integrated into the satellite. As AragoSat-1 isn't a private project, all the documentation may be published and accessible to everyone. The goal is to share the knowledge. Therefore a report including the whole progression of the project, the problems and solutions found and the compromises should be written. This would also allow us not to do the same mistakes in the future. This report should be completed with an usage report retracing the problems of the OBC once in use.

Chapter 3

Project management and development methods

3.1 Methods of project management

The traditional method : This method is also called waterfall method. It consists in following steps one after another. At any moment, the whole team is working on the same part of the project. The client isn't involved in the progress of the project. He sees the product for the first time when he receives it at the end.

The traditional method is adapted for projects where the client demand is unlikely to change. It isn't a good method for us, we have to follow the changing of the demand. Plus, the skills of the OBC team are heterogeneous. Everyone will work on what he is the best at. If the whole team is on the same task, some of us won't do anything at some point. That would be unproductive.

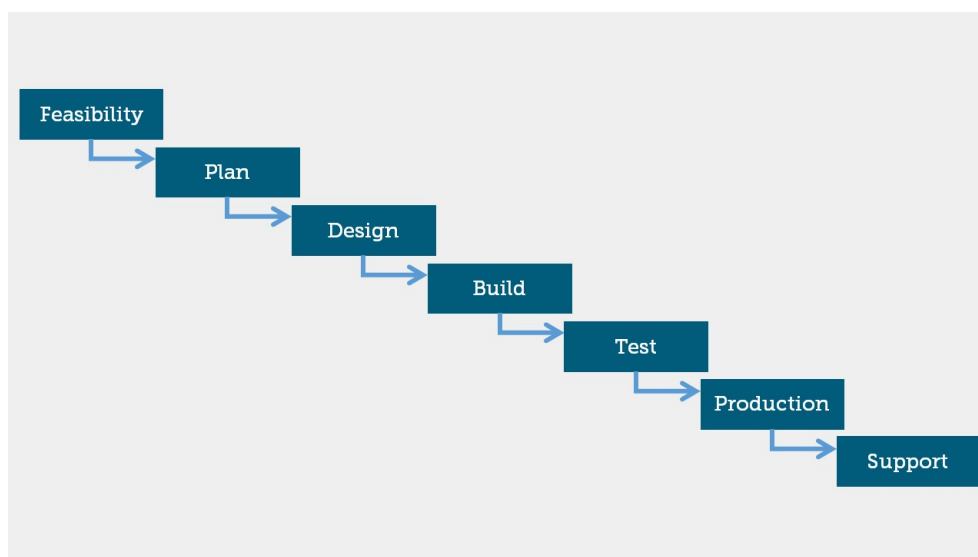


Figure 3.1: Waterfall management method

The agile method : This method is more flexible and let the client's demand at the center of the project. The idea is to cut the project into little tasks. Every task have to be validated by the client to continue on the next step. Also, meetings with the client are organised to hear a potential changing in the requirements. Each task have to be quit independent from the others in order that a little change doesn't affect the whole project.

The agile method is adapted for technical project with a changing demand. In the modern society, the tech grows sometime faster than the making of a product. A client may change its requirements. This method is also made for projects where time isn't the major factor because of delays introduced by the changing in requirements. This would be a good method for us. Moreover, the OBC team is in advance on some other teams we can have some delays.

The adaptive method : This method was created to face unexpected difficulties. The idea is to change the way that the project is managed to reach a maximal efficiency in any situation. Problems could be a lack of budget due to an augmentation of costs, delays, modifications of the team or materials problems for instance.

The adaptive method is adapted for projects with high risks of difficulties. Its goal is to reach profitability not to meet a changing demand. The advantage for us would be the possibility to face difficulties calmly. On the other hand our project doesn't aim profitability and we need a method that listen to client demand.

The critical path method : This method is designed to be the fastest possible. It consist in optimising the human resources. The team is divided into groups that work in parallel on different parts of the project. At the end all is assembled to form the final product. Changing in the client demand isn't allowed.

The critical way method is adapted for projects with short deadlines. In our case we don't want to go fast or we would make mistakes.

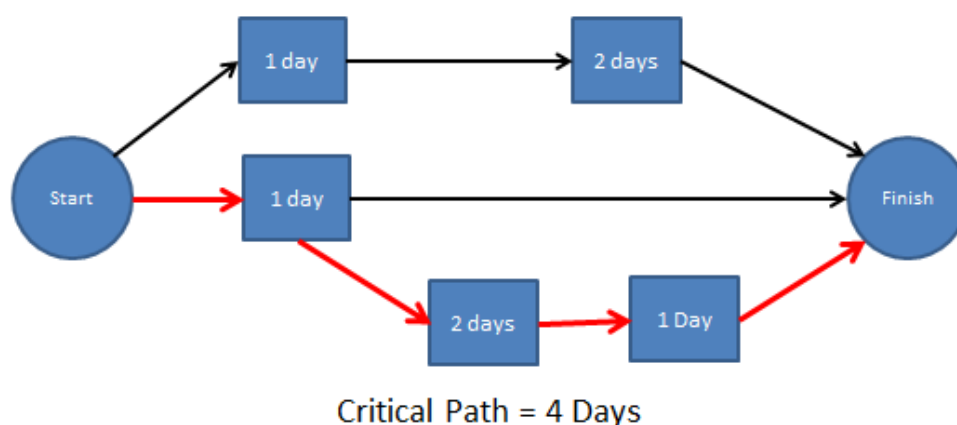


Figure 3.2: Example of critical Path

The lean management method : This method focuses on efficiency, quality and profitability. The idea is to cut down all the wastes. Unnecessary things are removed from the project. It allows to lead a project with little resources. The client demand is important for the quality of the product. Also this method is made to face unexpected difficulties.

The lean management method is adapted for low resources and high profitability projects. The advantage for us is that we don't have a lot of material and human resources.

There are a lot of other methods. The majority of them are more or less like the ones presented here. The differences can be seen on big projects taking years and with big teams. Some others aren't adapted to a programming project. These five methods represents the five possibilities we have to manage our OBC project. Once the choice made, we can change it for a better one easily.

3.2 Methods of development

Once the management method is chosen, we have to look for a development method. The methods presented here represent different ways of programming. Each one of them match more or less with the management methods presented previously. We have to take care that the one we pick work with the management method.

The traditional method : It consists in writing the parts of the code one after another. Once a part is done, it is tested. As developing is often obscure for non-programmers, the client can't get involved in the progress of the project. He only sees it at the end.

This method is adapted for project where the team is experimented and the requirements aren't likely to change. It works well with traditional management method.

The test driven development method : It consists in writing the tests before the code. The project is divided into modules of code. The tests are unit tests, global tests and smoke tests. They have to be precise and complete. They are written according to the specifications. This allow the team not to forget anything in the code.

This method is well adapted to write secure, efficient and clear code. As the project is divided in modules of code, they have to be written perfectly to work together. It is an advantage as the OBC have to be secure and light. The OBC mustn't use too much energy. It is adapted for the agile method. We can modify any module without having to rewrite all the others.

The feature driven development method : The idea here is to start building a working base of the future program. Then the team add features as the project goes on. It allows the client to see the progress and experience it. It also allows changes in the demand.

The FDD method is adapted for long projects that have a lot of functionalities. The client is assured of the progress.



Figure 3.3: Feature driven development method

The v-cycle method :

This method is derived from the waterfall method. The difference here is that there is a precise order to do the tests. First, unit tests are done, then integration tests are made and finally, global and system tests are made. All the tests are created very closely with specifications. In result, the code will be tested very precisely.

As the v-cycle method is derived from the waterfall method, the principles are quiet the same. It works well with traditional management method.

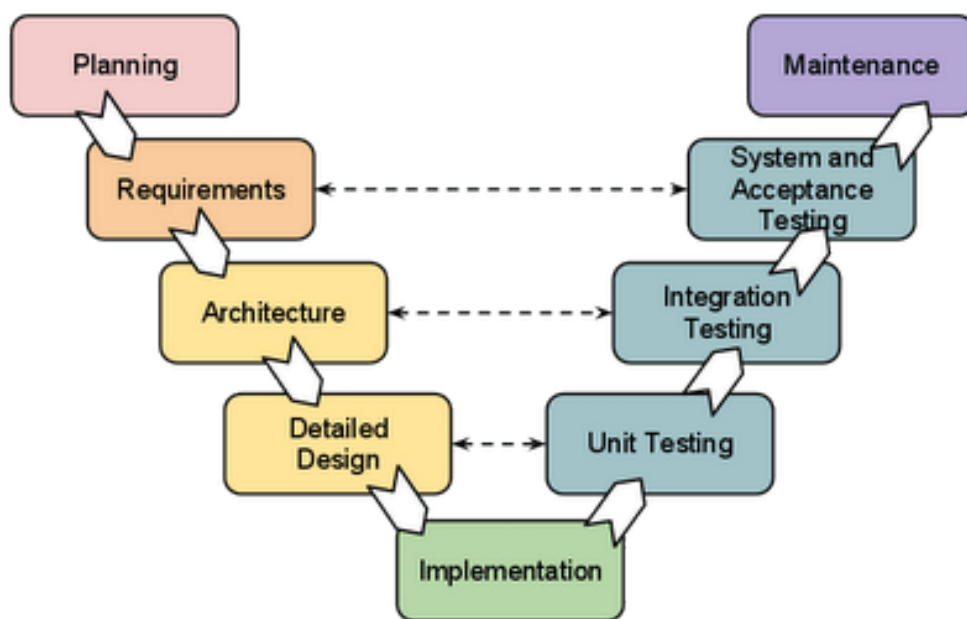


Figure 3.4: V-cycle management method

3.3 Chosen methods for the project

For the management, the method that we chose is the agile method. It allows the flexibility we need. The time isn't the biggest criterion for the success of the implementation. For the development, we chose the TDD method. We will separate the code into modules thanks to specifications. The team will be divided and everyone will work on what he can. Plus, it will allow us to write a clean code and secured code.

3.4 Methods deployment

To apply the agile method, concurrent engineering sessions are organised. Also, in the next part we are going to choose tools to help us setting up this method. The TDD method will start with cutting the code into little pieces. Then everyone will be asked on what they want to work on. Every member will have to write the tests for the module he is coding.

Chapter 4

Project management tools

In order to set up the management and development methods, we are going to use graphical and software tools. The graphical tools are visual representations of the progression. Everyone can understand where we are and what is left to do very clearly. The software tools will help us by providing all those graphical tools and all we need to apply the chosen methods.

4.1 Graphic tools

Here are some of the most common and useful graphical tools.

The Pert's diagram : This diagram is designed for the critical path method. It allows the team to represent the tasks that can be done in parallel with other tasks. The path that is the longer define the duration of the project. Is this path is delayed, all the project gets delayed.

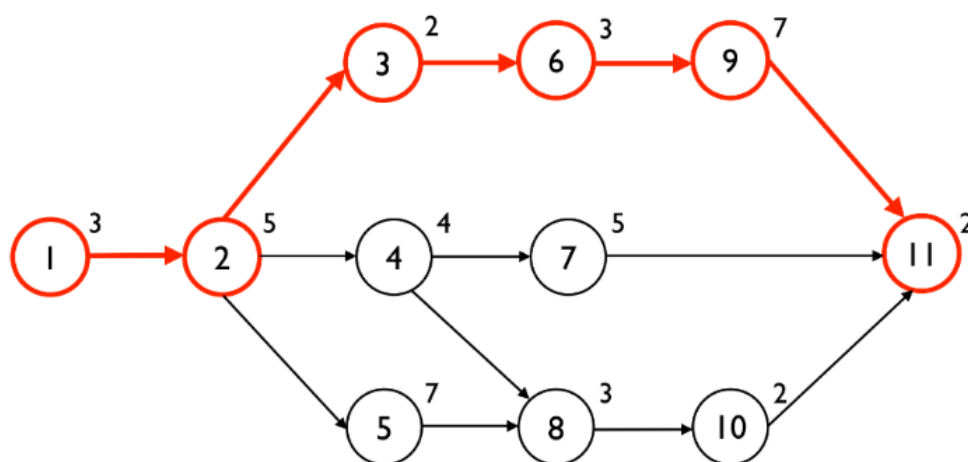


Figure 4.1: Exemple of Pert's diagram

The Kanban's method : This method consist in the use of board with all the tasks. A color code is used to determine if tasks are a must to do or not. When a task is done, it ends up at the ritght of the board. This tool is designed for the agile method. We can add or remove tasks at any time. It represent how much we got to do before the ed of the project.

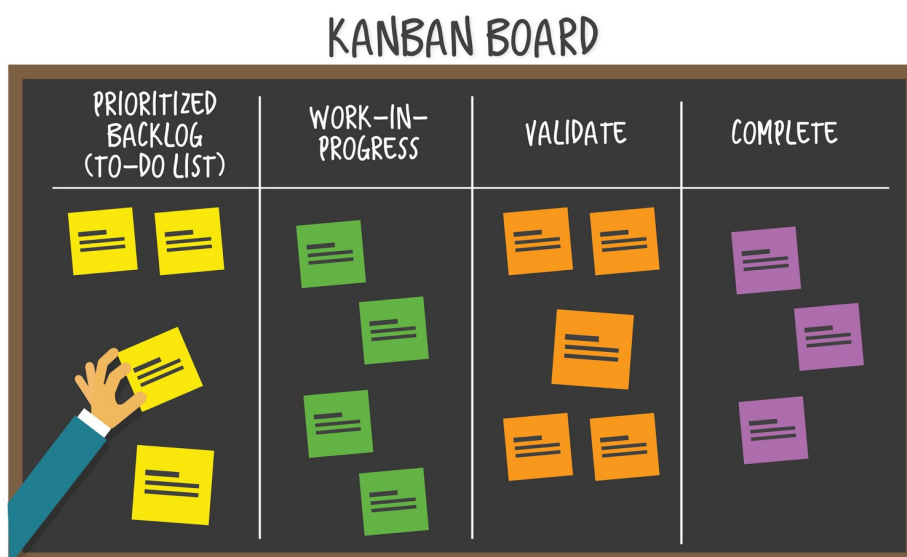


Figure 4.2: Exemple of Kanban's board

The Gantt's Diagram : This diagram is mainly used for the waterfall method. Meanwhile, some of the software allows the team to enter different path that are done in parallel as different cascades. It can be very useful to take in charge the possible delays.

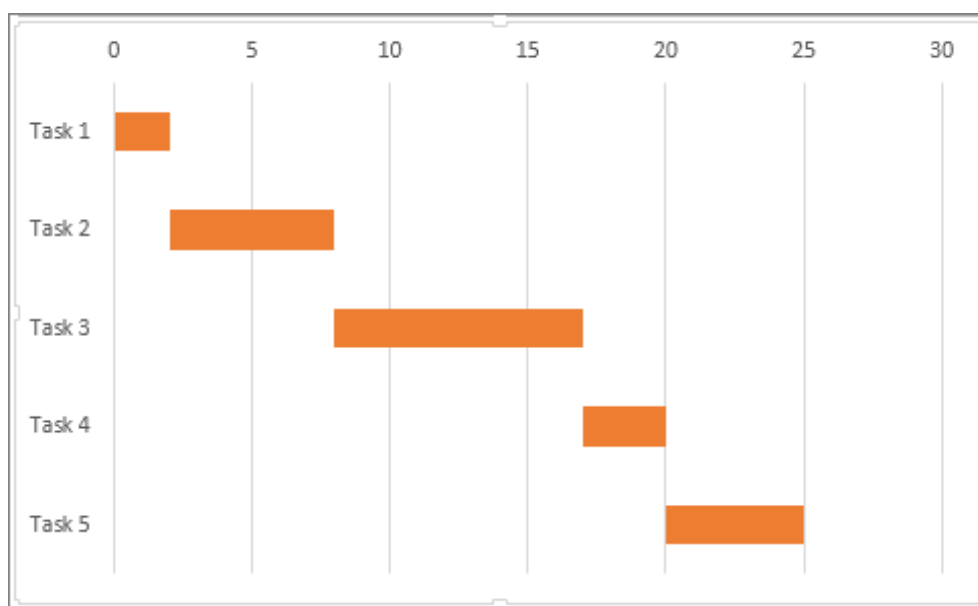


Figure 4.3: Exemple of Gantt's diagram

4.2 Software tools

As said a bit higher, we had to chose software tools to apply the methods we chose. In order to do this, we decided to use GanttProject. It is free and can run on Windows, Linux and OSX. It is easy to use and very complete. There is a Gantt diagram, a critical path tool, and a color code which is helpful to use the Kanban's code. There is a human resources management tool integrated. Ganttproject allows us to create a file with all the information of the project. This file can be shared with the team.

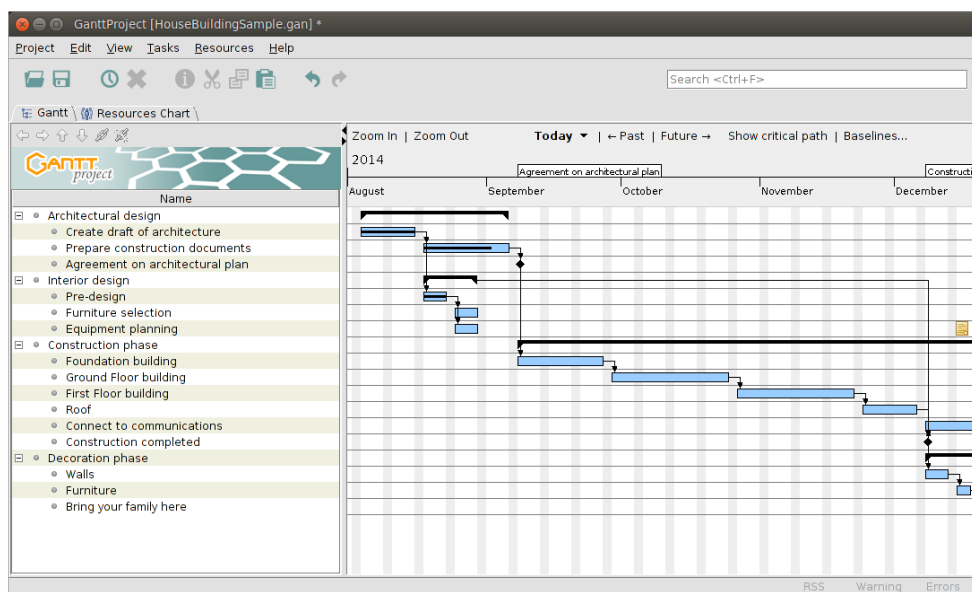


Figure 4.4: Example of GanttProject's board

Trello is an online tools that is base on the agile method. It is a board with all the tasks and

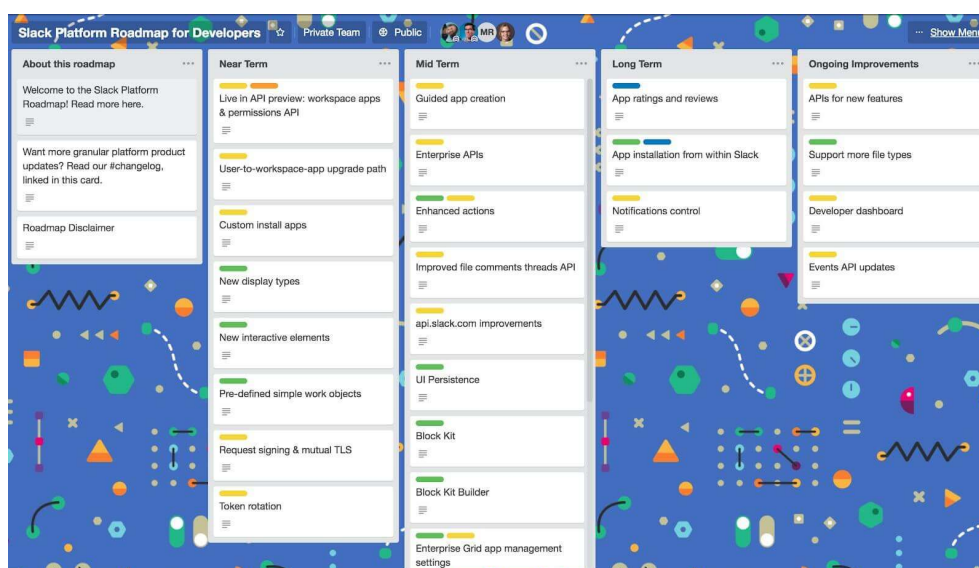


Figure 4.5: Example of Trello's board

4.3 Tools deployment

GanttProject is a free software. Plus, it is a small and light program. Every member of the association can download and run it. The project file will be shared so everyone can look in details the progress of the project. The file could be updated every week with eventual changes and shared again as a new version.

The Trello tool is accessible online and every member already have an account and access to the OBC planning board. The board is frequently updated and give access to all the documentation of the implementation.

Chapter 5

Conclusion

In conclusion, all the selected tools will allow a flexible management of the implementation. The agile method is done to deal with a changing demand. Those changes in demand are heard during concurrent engineering sessions with other teams. The TDD method allows the writing of a secured code that matches with precise specifications. Everyone in the team will be able to work on what he wants to. GanttProject and Trello are pieces of software that allow the management of a little team. They will help us setting up the selected methods with diverse graphical and management tools.

Chapter 6

Bibliography

6.1 Documentation (in French)

Documentation about steps of a project

<https://www.manager-go.com/gestion-de-projet/glossaire/cycle-de-vie->

Project management

https://fr.wikipedia.org/wiki/Gestion_de_projet

<https://www.planzone.fr/blog/methodologies-gestion-projet>

<https://www.wimi-teamwork.com/fr/blog/methodologie-gestion-projet/>

Development methods

<https://www.nutcache.com/fr/blog/les-methodes-agiles/>

6.2 Pictures

Figure 3.1 : Waterfall management method

<https://manifesto.co.uk/agile-vs-waterfall-comparing-project-managem>

Figure 3.2 : Example of critical path

<https://manifesto.co.uk/agile-vs-waterfall-comparing-project-managem>

Figure 3.3 : Feature driven development method

<https://www.toolsqa.com/agile/agile-methodology/>

Figure 3.4 : V-cycle management method

<https://melsatar.blog/2012/03/15/software-development-life-cycle-mod>

Figure 4.1 : Example of Pert's diagram

http://www.pmknowledgecenter.com/dynamic_scheduling/baseline/critical-path-or-critical-chain-difference-caused-resources

Figure 4.2 : Example of Kanban's board

<https://www.techalyst.com/products/laravel-kanban-board-based-on-vue>

Figure 4.3 : Exemple of Gantt's diagram

<https://support.office.com/en-us/article/present-your-data-in-a-gant>

Figure 4.5 : Example of GanttProject's board
<https://www.ganttproject.biz/>

Figure 4.6 : Example of Trello's board
<https://blog.trello.com/fr/exemple-feuille-route-projet>

6.3 Other links

GanttProject's website
<https://www.ganttproject.biz/>

Trello's website
<https://trello.com/fr>

IPSA ONE's website
<https://ipsaone.space/>