University of Padova
PhD course in Science, Technologies and Measurements for Space

Design and development of a mechanical rendezvous interface for satellites capture

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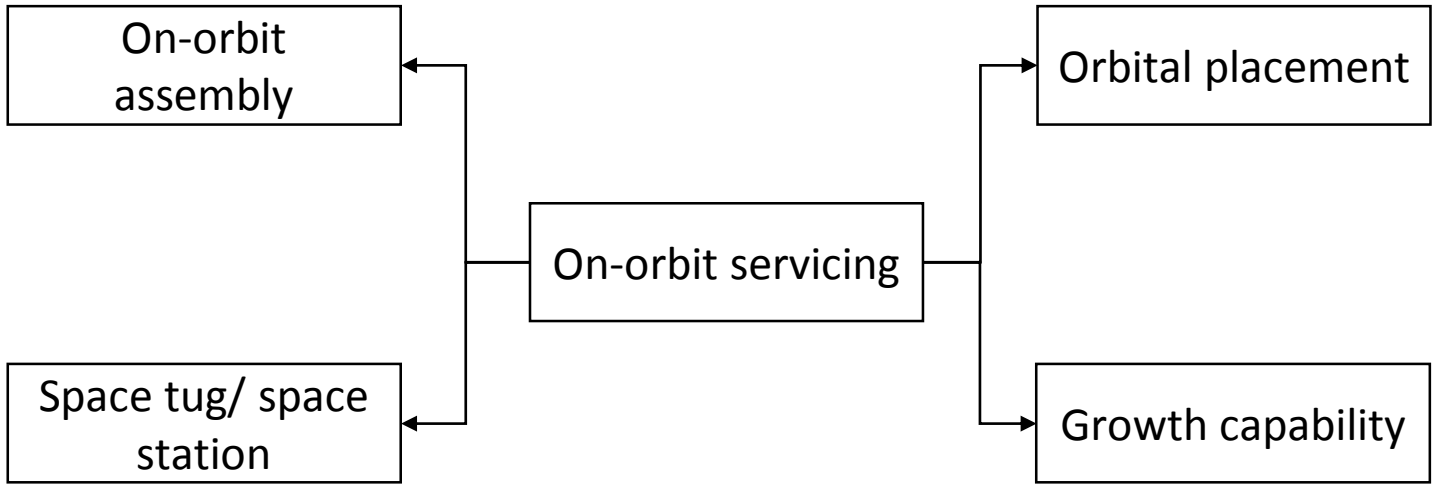
Introduction: On-Orbit Servicing missions

Question: what is On-Orbit Servicing?

OOS allows a variety of operations on orbiting satellites
All these operations require that the client satellite is properly captured by a servicer vehicle. Satellites which need to be captured could be divided in two categories:

1. Active satellites;
2. Defunct satellites (space debris).

In both cases, they could be Prepared or Unprepared for the capture.
This project has the main objective to design and development a capture interface for **Prepared satellites** (both active and defunct).

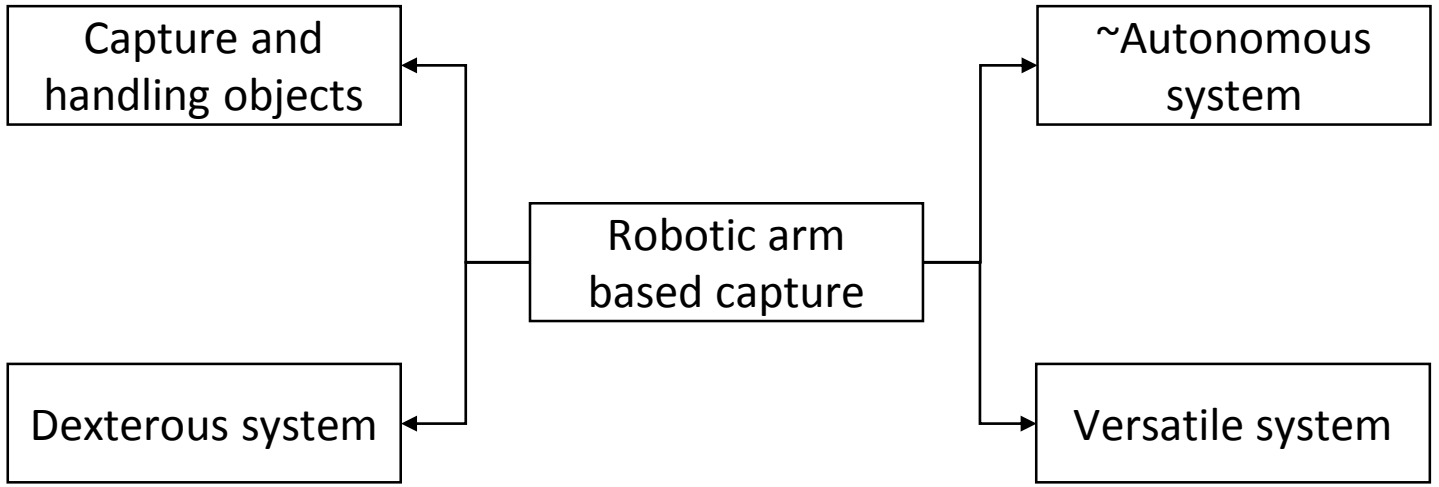


Robotic arm based capture

Complex OOS tasks such as the following:

- Build large structures in space reduces the launch cost and alleviates the design constraints (due to the absence of launch loads);
- Extend life and give new capabilities to existing satellites could reduce the cost of the mission through the years.

require a dexterous system able to capture and handle objects in space.

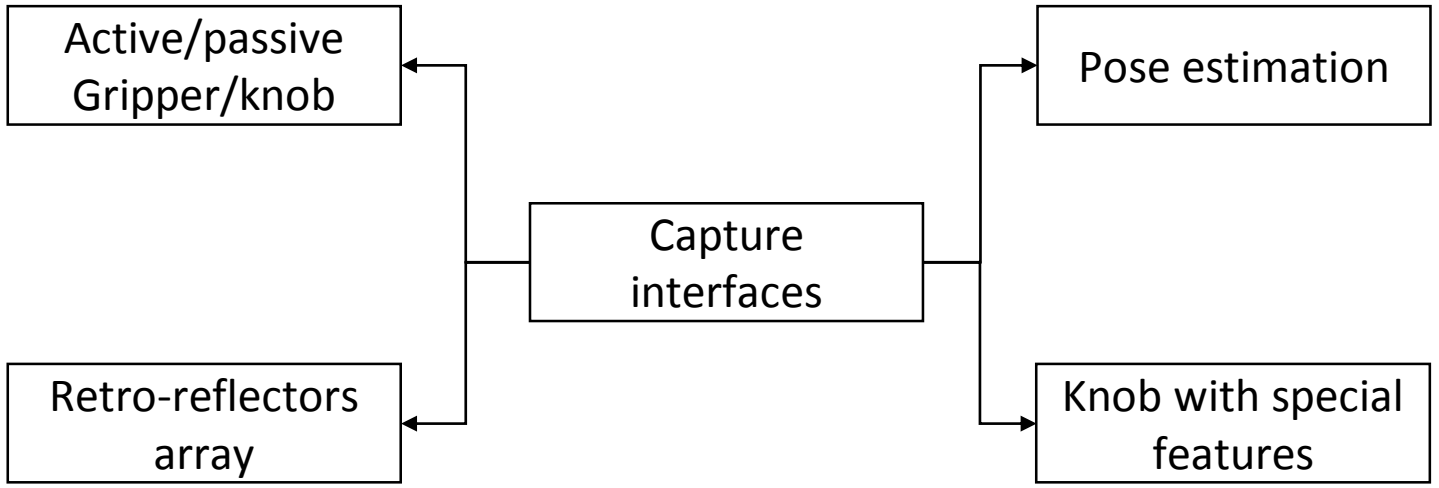


The Interfaces

All the mission mentioned above need capture interfaces.

In order to design the interfaces, we have to consider the worst case: the handled object may be without any source of power, then the object's interface might be completely passive. This brings us to considerer two aspects (functional requirements):

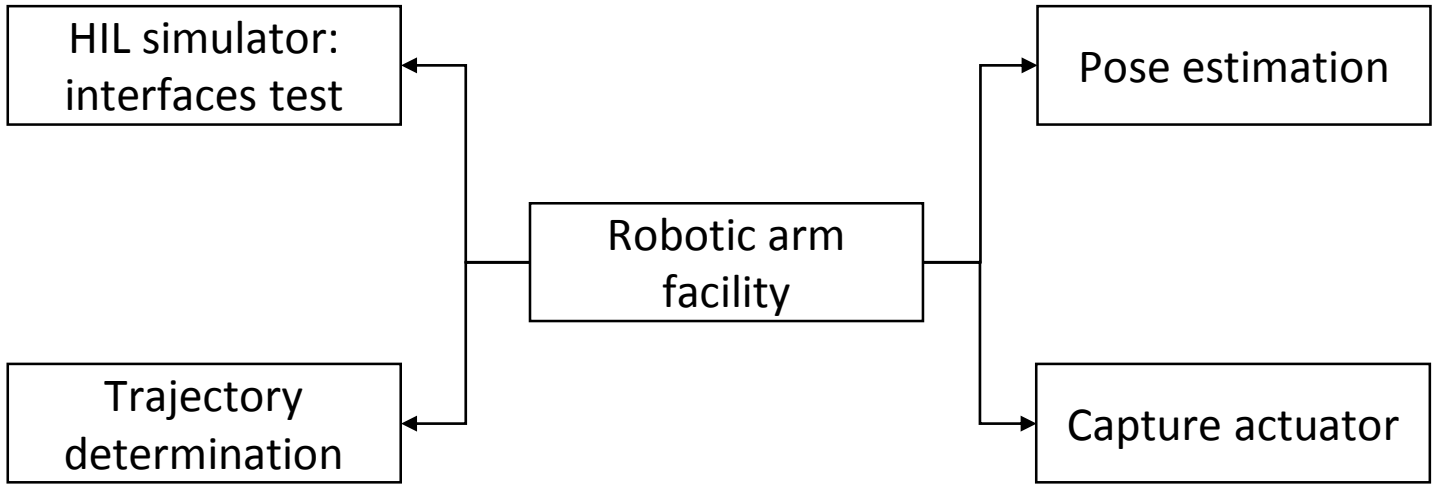
- The robotic arm must be able to determine the pose of the passive interface;
- The interface has to be able to perform a structural connection and to bear the loads …



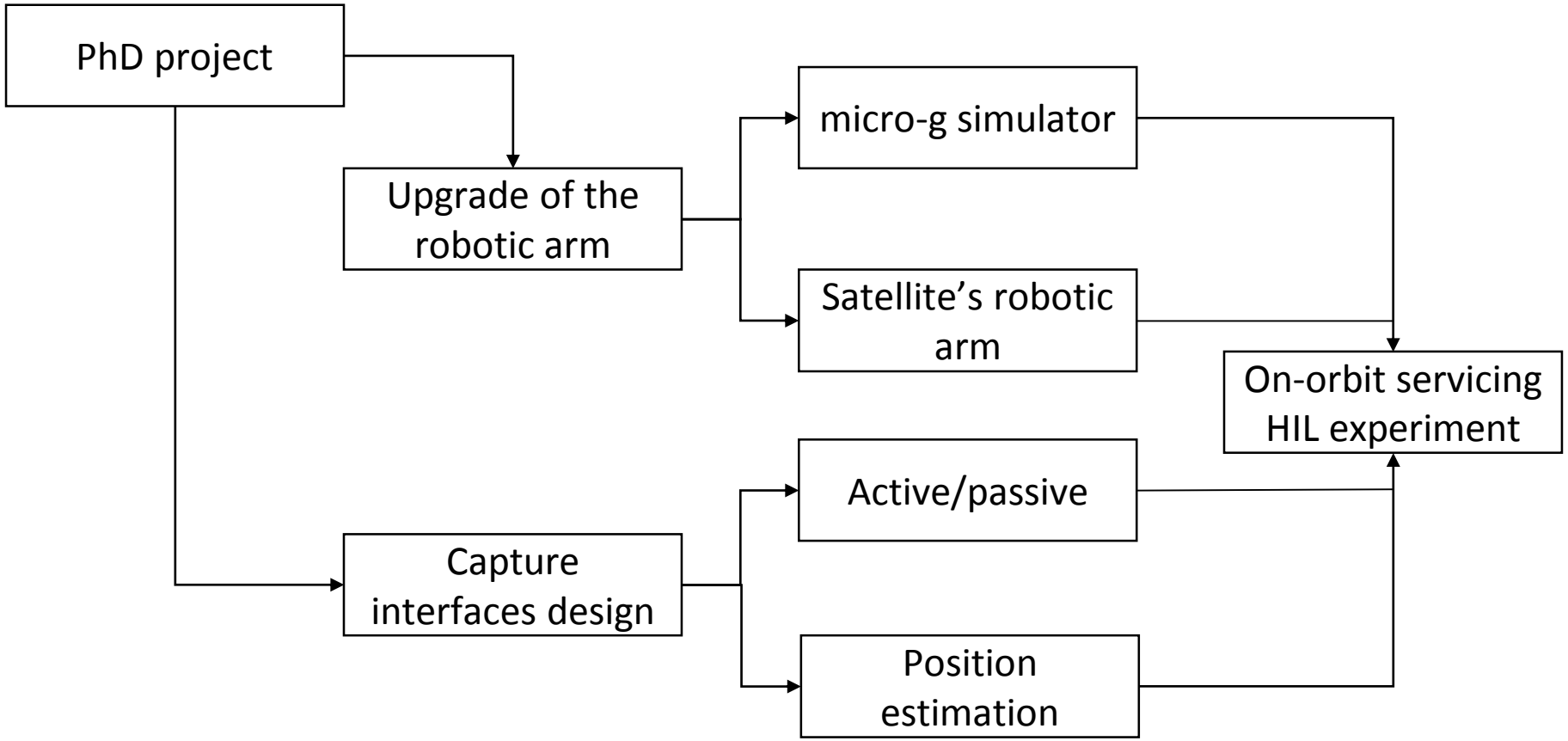
Robotic arm facility

We need a laboratory testbed to verify the behavior of the interface
Here comes the second objective of the project: the upgrade of an existing robotic arm based facility. This facility will be used to:

- To determine the relative pose of the interfaces and calculate a trajectory to finalize the capture. In this case the robotic arm is in Actuator mode
- To simulate the dynamical actions exchanged during the capture process (Hardware-In-the-Loop simulator). In this case the robotic arm is in **Simulation mode**



Conceptual map of the project

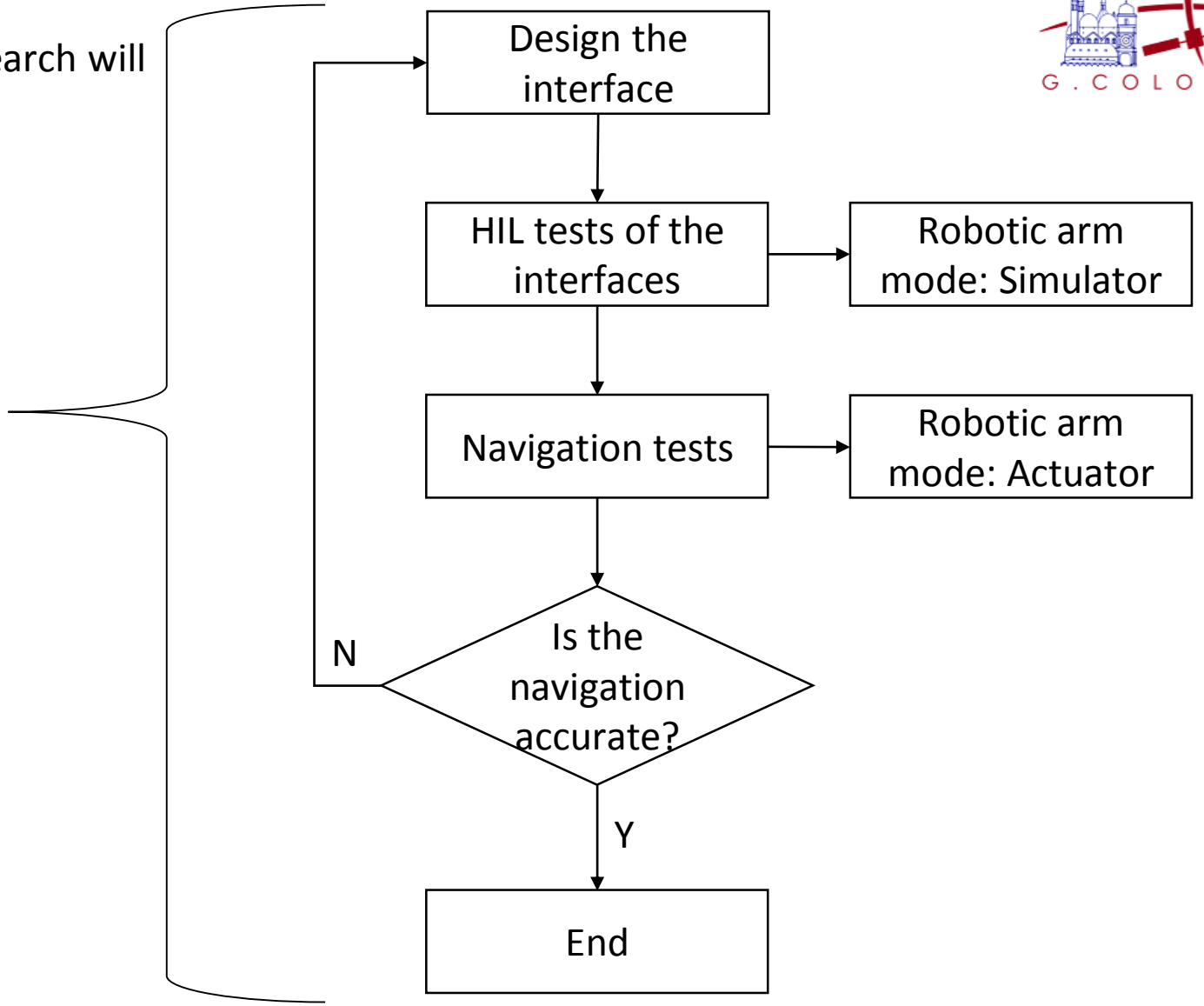


Schedule: four steps and the design iteration

In order to reach the final goal of the project, the research will be divided into 4 macro-steps:

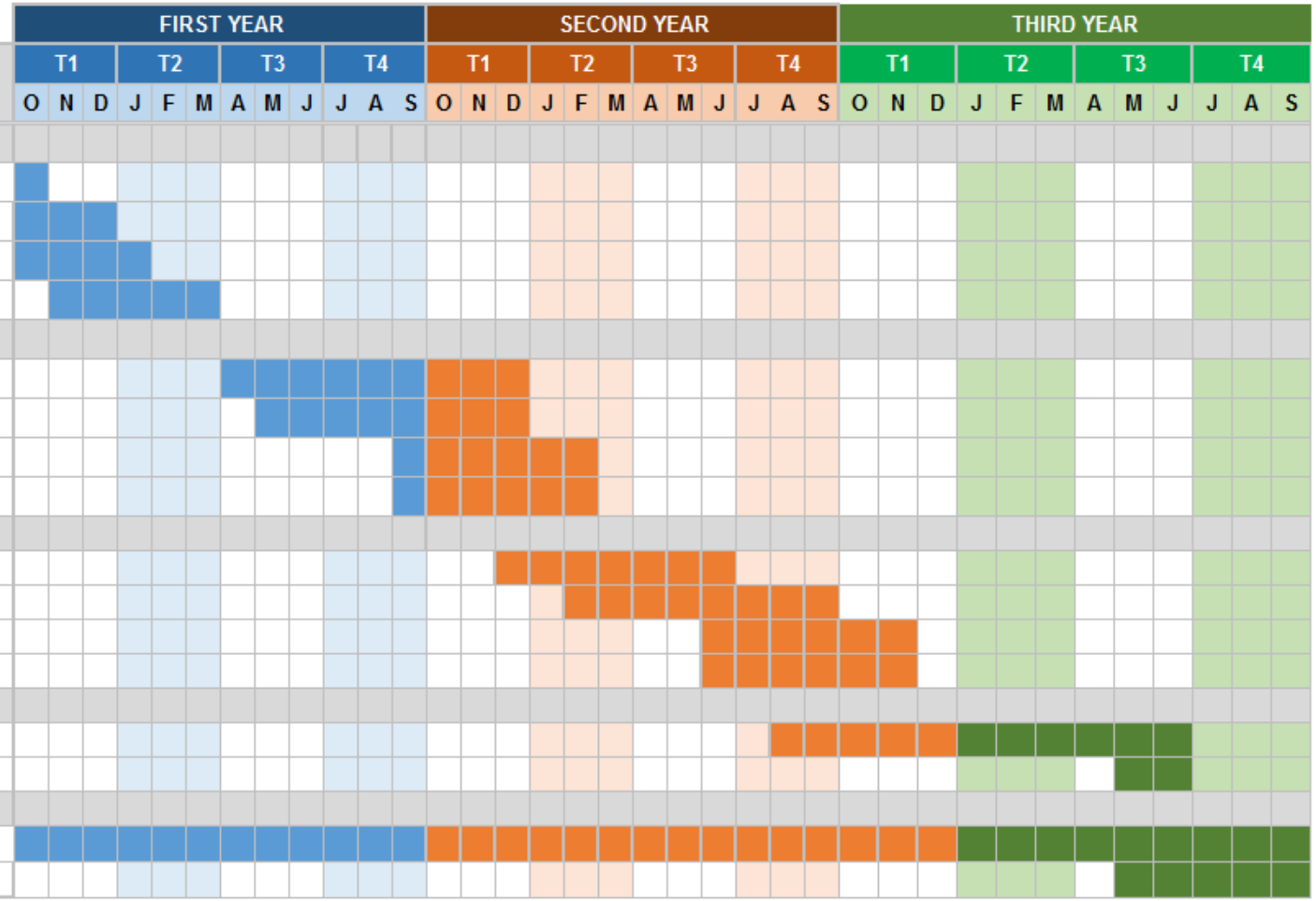
1. Upgrade the robotic arm-based facility
2. Instrumentation for the navigation
3. Design and manufacture the interfaces
4. Laboratory tests

The last two points are part of an iterative process:



When: Gantt chart

WBS NUMBER	TASK TITLE	% OF TASK COMPLETE
1	Upgrade the robotic arm-based facility	
1.1	Complete the low level software	90%
1.2	Write the trajectory generator software	50%
1.2.1	Write the torque-based control equations	50%
1.2.1	Write the force/torque sensor software	10%
2	Instrumentation for the navigation	
2.1	Literature review	50%
2.2	Implemetation of the position and attitude determination Hw and Sw	0%
2.2.1	Hardware imlplementation	0%
2.2.2	Software imlplementation	0%
3	Design and manufacture the interfaces	
3.1	Literature review	50%
3.2	Interface design and manufacturing	0%
3.2.1	First step iteration	0%
3.2.2	HIL tests	0%
4	Laboratory tests	
4.1	Interfaces iterative tests	0%
4.2	Final design	0%
5	Thesis and article	
5.1	Article redaction	0%
5.1	Thesis redaction	0%



Thanks for your attention