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Sustainability of Earth and Cislunar Orbit

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Presentation of the proposed research program

13/11/2024



- The number of objects in orbit is constantly growing due to:
 - the increase of the launch rate;
 - the deployment of constellation of satellites;
 - multiplications of space debris caused by fragmentation events.
- Also the cislunar space will be overpopulated: more than **140** scheduled missions towards the Moon during 2023-2033.
- Extending the concept of Space Situational Awareness (**SSA**) and Space Traffic Management (**STM**) to the cislunar realm will be crucial.





Cislunar Space



The region of space in the Earth-Moon system from **Earth's geosynchronous orbits**, including the **Moon's orbit** and all the Earth-Moon Lagrange points

Space Situational Awareness



The **comprehensive knowledge on all objects** in a specific region without necessarily having direct communication to them

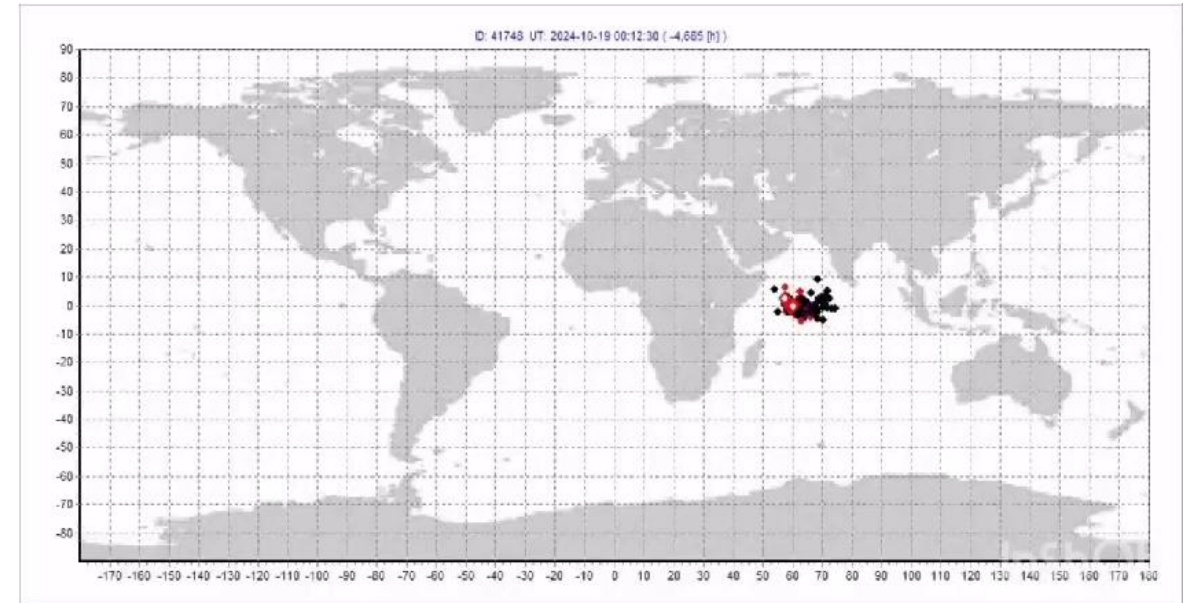
Space Traffic Management



Engineering solutions, methods and protocols that allow **regulating space environment** in order to **provide access** but also enable **sustainable use of space** simultaneously



- The **GEO belt** is inhabited by almost **600** satellites. Despite its apparent quietness, on October 19, 2024 the communication satellite *Intelsat 33 E* experienced a significant breakup event, currently under investigation.
- Around the **lunar environment** there are **6** active orbiters. Just the *Chandrayaan-2* was forced to perform 3 collision avoidance manoeuvres to mitigate critical close approaches.



Russian simulation of the *Intelsat 33 E* breakup event.

Necessity to deepen knowledge of long-term sustainability of space activities around Earth to apply it properly within the cislunar space

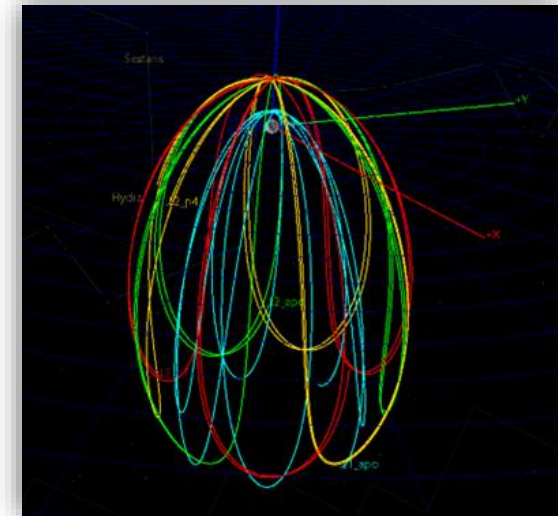
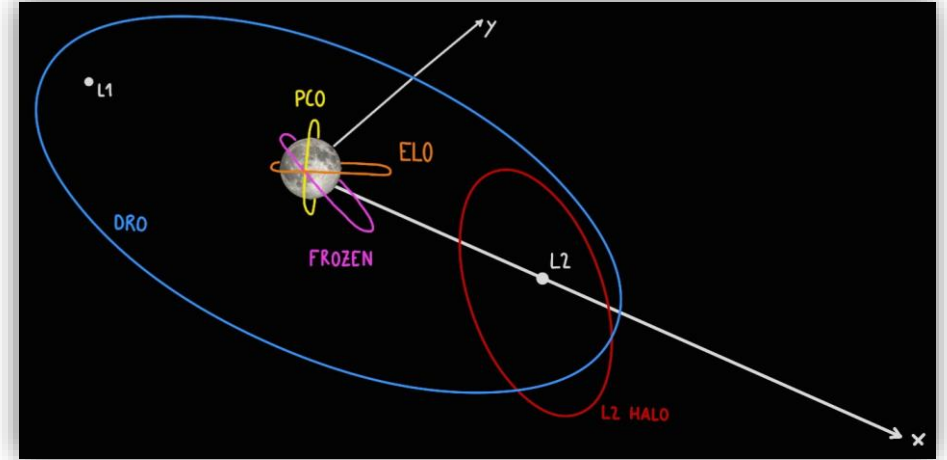


This project work could be divided in 3 main topics:

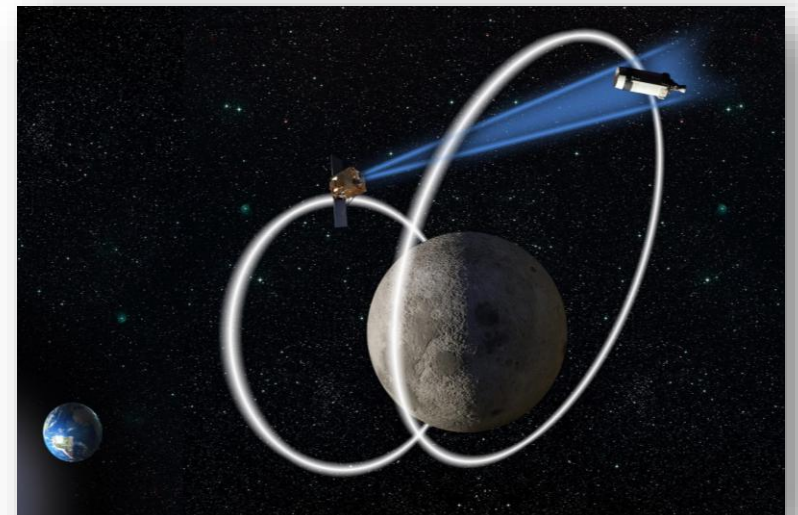
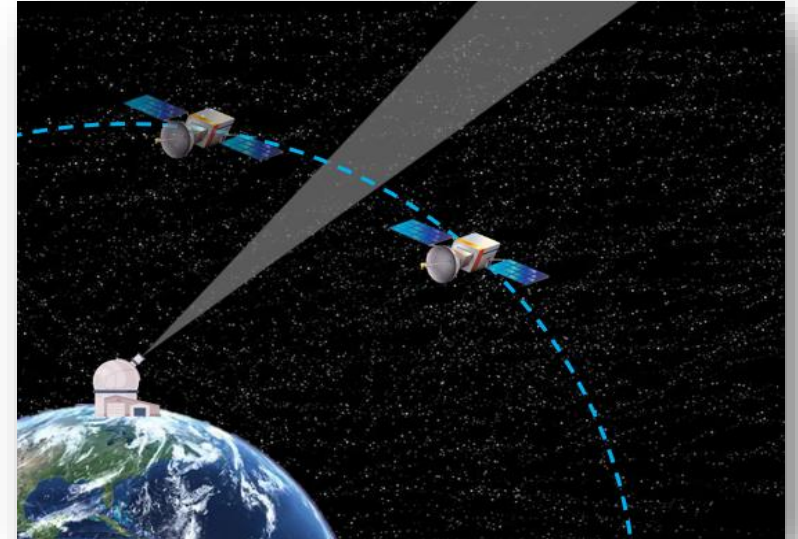
- Participate to the activities promoted by the Italian Space Agency (**ASI**) and the Inter-Agency Space Debris Coordination Committee (**IADC**) in support of CISAS involvement in this programs.
- Dealing with the **orbital mechanics** of the cislunar space in order to simulate both scenarios of potential future missions and **fragmentation events**.
- Study the **feasibility** of monitoring and **real-time tracking** objects within this environment.

The research core can be organized in 5 different work packages:

- **WP1: Definition of the orbits to be simulated.** Identification of the planned potential cislunar orbits for the next future and their simulation within low fidelity models. A dedicated focus will be given to the GEO belts.
- **WP2: High fidelity simulations.** Low fidelity models provide good starting points but they may differ from reality; thus, introducing more accurate gravitational perturbations will be fundamental.

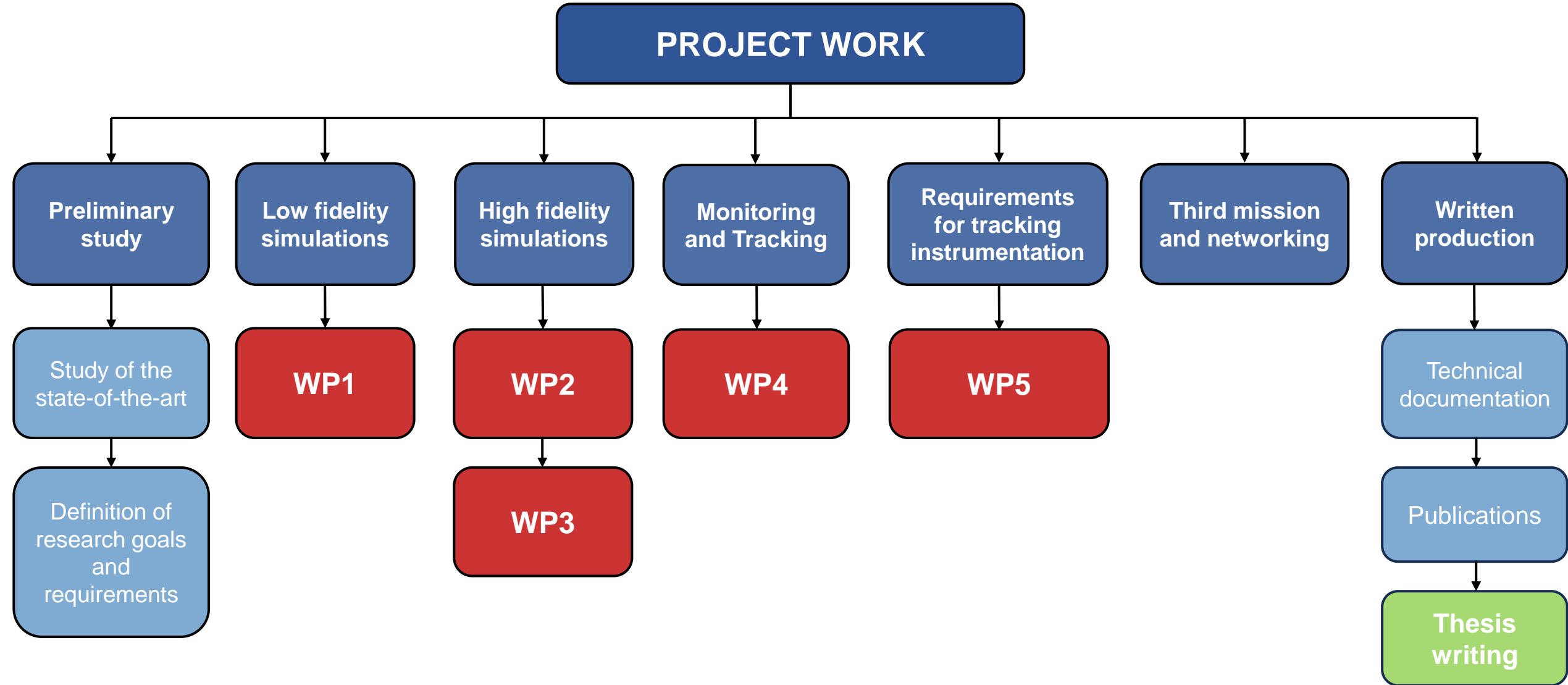


- **WP3: Breakup events in lunar orbits.**
Developing fragmentation scenarios around the Moon to deepen the dynamical behaviour of the debris cloud in this environment and its consequences.
- **WP4: Monitoring and tracking the cislunar space.** Study the feasibility of controlling and real-time tracking objects both with **ground** and **space** based solutions.
- **WP5: Requirements definition.** Comparisons with current technologies for space surveillance to achieve a list of requirements for cislunar tracking instrumentation.

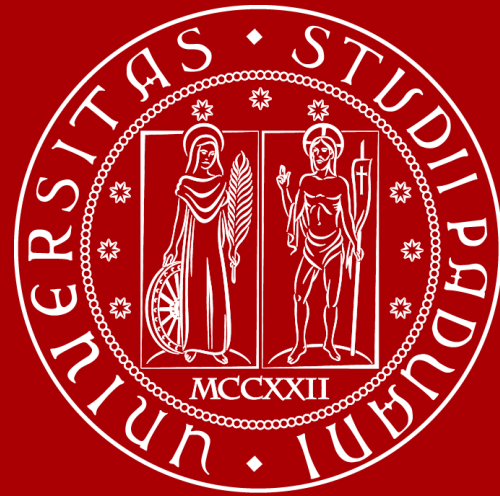




Work Breakdown Structure



Thanks for the attention



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