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RETURN TO THE MOON

The new players

Part two
by Walter Cugno

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The Return to the Moon, with the critical contribution of the Italian Industry

“We rise together, to the Moon and beyond”

It's all there already, in those few words the NASA TV speaker proclaimed on 16 November 2022 at the launch of the Artemis I mission. A historic date: the beginning of the new era of space exploration.

One day we will be able to say “I was there”. There is a lot of America, which is pulling the allies towards this future of interplanetary civilisation. But there is also a lot of Italy, that has been holding a role of prestige in space exploration and also benefits from a privileged relationship with the United States for many years.

Many are the lunar exploration projects involving Italy and they infact cover all the main components of the Artemis programme.

The first question is: “what has changed in lunar exploration scenarios from the Apollo program to the Artemis program?” Several factors must be considered, although the primary goal is always the Moon. First of all, the participants: the Apollo missions belonged only to the United States, in close competition with the Soviet Union.

It was not possible to involve international allies because this would have significantly lengthened the decision-making process, a luxury that could not be afforded in those days. In addition, of course, there was in those years the technological gap between the United States and European countries. The Artemis missions are instead the result of an international collaboration, led by the Americans, where the contribution of other countries is essential thanks to the technological level which is now comparable with that of the United States.

Human Presence on the Moon

Secondly, the final objective: the Apollo program competition was focused on “touch down”, or simply on who would touch the lunar soil first. Today the Artemis program



Cover for the Artemis I mission launch on 16 November 2022.

aims at building a stable and sustainable human presence on the Moon, with all the infrastructure necessary to achieve this goal. It should also be remembered that the Moon is considered an intermediate stage on the path to sending humans to the planet Mars!

Finally, who is bearing the cost: Apollo was a programme entirely supported by the United States Government, but today the support comes through collaboration between several countries that have signed the multilateral Artemis Accords. For such a large and demanding undertaking, the joint effort of the governments and companies of many countries, mainly Western, is crucial.



Cover for the Thales Alenia Space Italia delivers the first PCM-Cygnus unit.

Artemis Accords

Italy was one of the first countries to sign the “Artemis Accords” within the now more than fifty-year collaboration in space with the USA. This Italy-USA collaboration began in the 1960s, with Prof. Broglio, when Italy became the third nation in the world to launch into space a satellite entirely on its own.

The San Marco 1 satellite - the result of a bilateral Italy-USA collaboration - was launched from the American base on Wallops Island, operated by Italian personnel. This collaboration then continued over the years through programs such as LAGEOS and IRIS, the first ever mission in which the United States placed a non-American launch system in the cargo bay of the Space Shuttle, and then continued with the Tethered satellite, and the programmes of the International Space Station, followed up today by the lunar programmes.

One fact above all: out of 135 Shuttle missions, Italy participated in 63.

Multi-purpose Logistic Module

With the International Space Station, then, the partnership has become even closer: the Multi-purpose Logistic Module (MPLM), the Nodes, the Cupola are the main fruits of NASA’s agreements with the Italian Space Agency (ASI) and the European Space Agency (ESA), not to mention the Business-to-Business (B2B) agreements between Thales Alenia Space Italia and Northrop Grumman for the Cygnus cargo modules and with the Nanoracks company for the Bishop commercial airlock.

The Italian Government signed, as many other Governments subsequently did, the Artemis Accords. These are non-binding bilateral agreements with the American Government, which, name aside, have little to do with the Artemis programme: they define principles and guidelines to be respected for the exploration of our satellite. Let us remember that in this case Europe is not a single entity: each European Government has decided independently whether to sign or not.

Adherence to the American principles and guidelines for lunar exploration generally leads to the creation of NASA collaborations with the Space Agency of the signatory country: it is in this context that the NASA-ASI bilateral agreements were created, and they are defining the contents of Italy-USA collaborations for lunar exploration. We speak in the plural because, following an initial joint statement, multiple implementation agreements can follow: they are generally called barter (barter in English) because they are very similar to an exchange in which each of the two parties provides some infrastructure or service.



Cover for the Bishop Airlock that launched to the ISS.

Thales Alenia Space Italy

The main Italian companies in this context are Thales Alenia Space Italy, as a large system integrator, Leonardo and Altec, accompanied by a galaxy of small and medium-sized Italian enterprises that have grown over time in the space sector and are



Cover for ESA's Orion service module that arrived at Kennedy Space Centre.

now an essential element of the Italian supply chain. On the American side, however, the main interlocutors are the large industries in the sector: Northrop Grumman, Lockheed Martin, Boeing, Dynetics, Sierra Space, with a careful eye on the developments of SpaceX and Blue Origin technologies, especially regarding the launchers, mandatory for access to Space.

In the scenario of orbiting lunar infrastructures, Italy is present both as part of ESA and as a subcontractor of American industries, through bilateral industrial agreements. The two main programs are **Orion** and the **Lunar Gateway**.

For Orion, the NASA capsule for Deep Space Explorations, ESA provides the Service Module which contains, among others, essential systems and components made in Italy such as the main structures, protection from micro-meteorites and debris, thermal control and the storage and distribution system of consumables (air and water) essential to guarantee the life support of astronauts.

To date, production contracts have been signed to cover up to the Artemis VI mission. Within the MoU between NASA and ESA for the Lunar Gateway, the future station in lunar orbit, and thanks to the partnership between Thales Alenia Space and Northrop Grumman, Italy participates with contributions to various modules of the station, the result of great experience gained with the International Space Station (ISS):

HALO (Habitation and Logistics Outpost): it is a 3-meter diameter NASA module, of which Northrop Grumman is the prime contractor. It will provide habitable space for astronauts and logistics and communications functions. Through a B2B agreement, Northrop Grumman engaged Thales Alenia Space in Italy for the development of the pressurized primary structure and micro-meteorite protection.

I-HAB (International-Habitat): it is also a



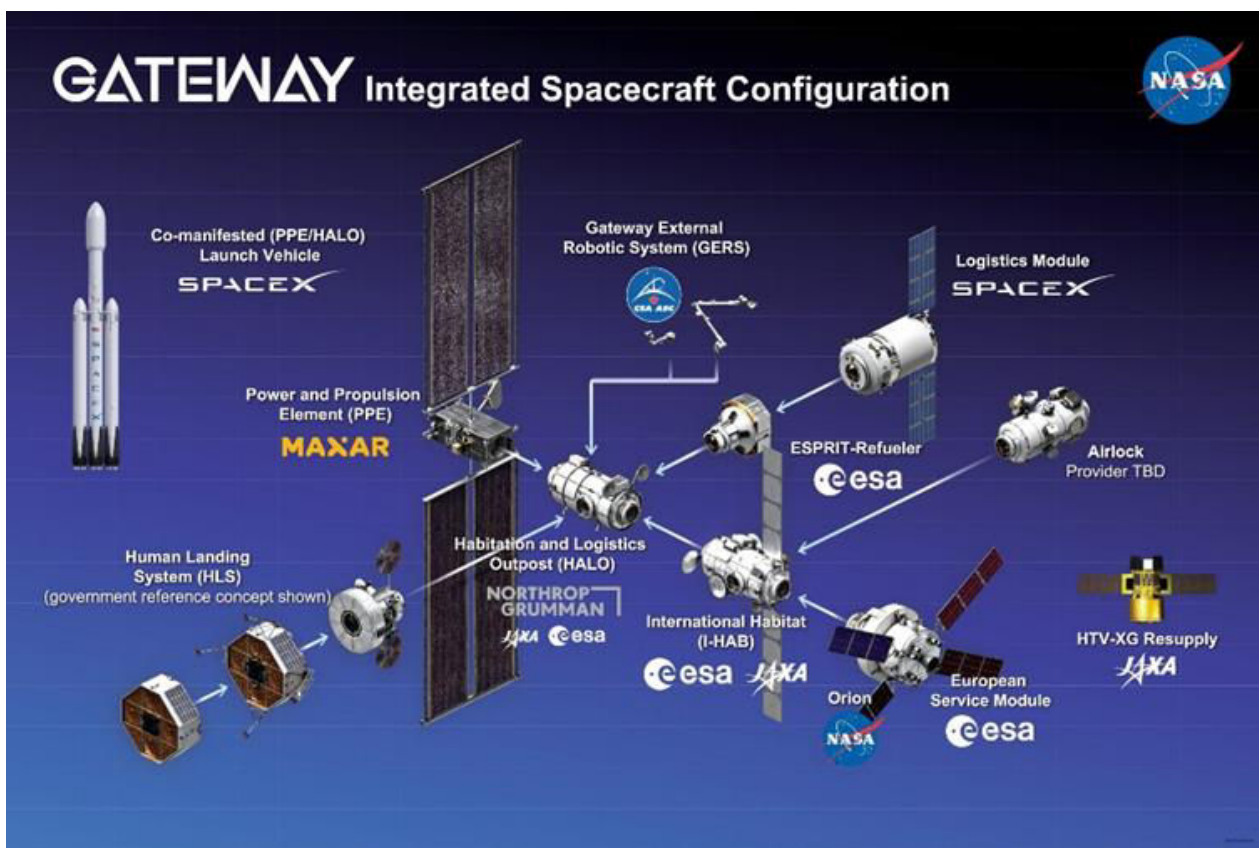
Cover for ESA's Orion ESM-3 service module that was delivered to Airbus in Bremen.

3-m ESA module, the main Gateway living element. It will be the first module of the station launched, together with the Orion capsule, by the NASA's SLS launcher which will provide the propulsion to reach the Gateway. Thales Alenia Space Italia is prime contractor and therefore designs, coordinates and manages the system, the integration and supply of the complete module whose various components are developed through other European industries or with contributions provided by other space agencies such as NASA, JAXA (Japanese Space Agency) and CSA (Canadian Space Agency) as a result of the agreement signed with ESA.

ESPRIT: it is also an ESA module consisting mainly of two blocks, the **HALO Lunar Communication System**, which will be mounted directly on the HALO module but is developed through the ESPRIT contract and the **Refueling Module**. The latter will consist of a pressurized module, with two cargo compartments for transport and storage and a compartment with windows (in the style of the ISS CUPOLA), all surrounded by a non-pressurized structure that will bring to the Gateway the propellant supply. Thales Alenia Space France is the



Cover for Thales Alenia Space Halo (Habitation and Logistics Outpost) module.



Gateway Integrated Spacecraft Configuration

prime contractor for ESPRIT while Thales Alenia Space Italia is responsible for the supply of the glass pressurized module.

Lunar Cargo Transport Systems

Italy, through Thales Alenia Space, also plays an important role in the development of lunar cargo transport systems and surface infrastructure, a role strongly supported by government policies implemented by the Italian Space Agency.

Transport systems, called **Landers**, are necessary for everything that needs to be brought to the surface of the Moon: payload or astronauts. Some of these will shuttle between the lunar surface and the Gateway. The architecture of the Artemis lunar surface base involves many elements and the transport of materials and humans is a key aspect.

Given this, the projects involved in this category are mainly: lunar surface **Multi-Purpose Habitat module (MPH)** and **Human Landing System (HLS)**.

MPH is an initiative resulting from bilateral NASA-ASI collaboration which is currently in its feasibility study phase. Thales Alenia Space Italia collaborates with ASI to design, together with NASA, the architecture and functions for an inhabited surface module, as a key unit of the future Artemis infrastructure used for human presence.

An important precursor of MPH was MPM (Multi-purpose Module), a study

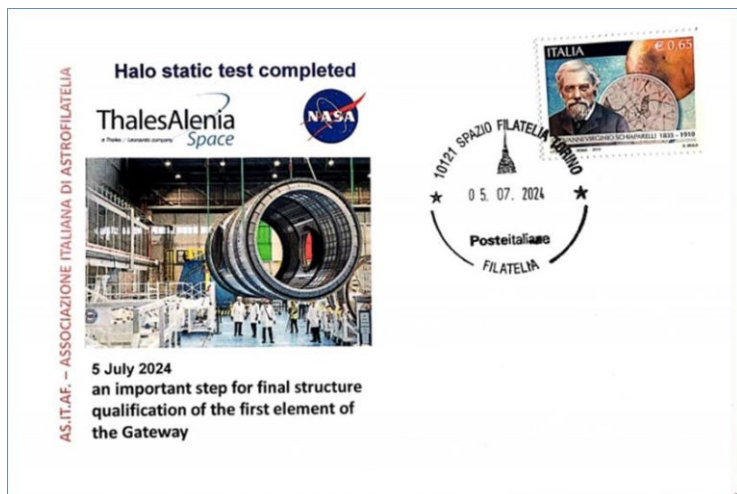
commissioned by ASI to Thales Alenia Space Italia in 2021 with the aim of defining the main components (such as structures, doors, windows, thermal blankets, avionics systems and power etc.) for a habitable pressurized infrastructure in a lunar environment.

The Human Landing System

The Human Landing System (HLS), on the other hand, is a NASA program with a dual objective of developing Moon landing capacity and making it sustainable in the long term (the latter called SLD or Sustainable Lunar Development).

The first competition was won by SpaceX with the Starship project conceived to transport astronauts to the Moon with the Artemis III mission, currently scheduled for 2027. In this competition, in addition to Jeff Bezos with his Blue Origin, also competing was an American consortium led by Dynetics, of which Thales Alenia Space was part. The second tender, for the choice of a second supplier for this service, was won by Blue Origin with its Blue Moon vehicle project. Also in this case Thales Alenia Space Italia participated in the consortium led by Dynetics.

Many are the initiatives in which Italy is involved thanks to its industrial capabilities, mainly when housing modules are the key components.



Cover for Thales Alenia Space Halo static test completed.

Van Allen Belts

But what are the main differences in the lunar environment, compared to low Earth orbit, as far as these infrastructures are concerned? There are actually many differences, and they all pose new challenges. The first is certainly the surrounding environment, both in orbit and on the lunar surface. Among these is the exposure to solar radiation, which is much higher than that of infrastructures in low orbit protected by the Van Allen belts, which shield us from what comes from the cosmos.

In addition, there is exposure to micrometeorites for which structures must be protected so that they are not irreparably damaged. The lunar night requires alternative energy sources in addition to solar panels. Finally, lunar dust is a contamination factor to take into account, as is the problem of heat dissipation: the temperature variations between day and lunar night are very high. All this requires the design of appropriate countermeasures.

The second important difference is the human presence, in particular on the Gateway: the ISS is permanently inhabited, while the lunar station will be uninhabited for long periods. This means that the modules must autonomously carry out some necessary periodic operations to allow the survival of the infrastructure, and this consequently requires the design of robotic systems.

On The Moon

The third important difference is the perceived force of gravity: on the ISS, in free fall around the Earth, we are in a micro-gravity environment: high and low are indistinguishable. On the Moon, instead, the gravity is low, but still perceivable: 1/6 of the Terrestrial gravity. This means an important change to the interior of the modules:

providing a floor and accommodating everything else in such a narrow space is not simple considering the transportable mass constraint that derives from the capabilities of current transport systems.

Compared to low Earth orbit, the transportable mass is reduced because the launcher has to travel much further to get there (therefore it must carry much more propellant). This factor has a significant impact on the design of on-board structures and components.

Projects are also being developed in Logistics services, both at an institutional and private level, the aim of which is to provide a complete service to potential customers and consequently these infrastructures remain the property of the companies that develop them.

Italy is involved, again with Thales, on various fronts regarding a European competition within ESA for the development of a cargo ship, called **Argonaut**, with the capacity to transport up to two tons on the lunar surface without passing through the Gateway and the development of fully commercial systems.

The program, European Lunar Logistic Lander (Argonaut) fits into the context of the Artemis program. Italy participates with an international industrial consortium led by Thales Alenia Space Italia while a second consortium is led by Airbus Defence & Space Germany.

The return to the Moon and subsequent development of a lunar economy as well as the future journey to Mars sees the decisive contribution of the Italian industry led by Thales Alenia Space Italia and in particular by its Turin-based site.



Cover for Thales Alenia Space Halo (Habitation and Logistics Outpost) module.