A Concept of Space Framework

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This is the concept of an interplanetary *space framework*, aimed to introduce the resources of the Solar System into the current terrestrial economy, speeding up the economic transition in space and improving the safety and flexibility of space flight for space exploration.

To achieve these ambitious goals, it is necessary to focus on the development of new generation space stations, capable for advanced technological research and tourism and incorporating shipyard-like facilities, a new vehicle for atmospheric and extra-atmospheric transport of people and cargo, and new facilities on the main celestial bodies of the Solar System, for in-situ utilization of resources and working of the same directly in space.

Together with these technological developments, a parallel economic and political work is also needed. Following the release of the Outer Space Treaty in 1967, the actual laws and procedures in space are too weak for granting peace in the context that the framework is aiming to build. Following the development of these laws, the international partner will cooperate to make the program safe and sustainable for further development.

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I. Why building a space plan?

In recent years, the weight of space activities on the world economy is increasingly large and is expected to grow further in the years to come. The latest industrial revolution has highlighted the importance of preserving the world and its ecosystems for generations to come, by starting circular economies. New branches of science have seen the light and at the same time new market dynamics have established themselves, first with the digitization of banking transactions and then the advent of cryptocurrencies, but humanity is definitely destined to maintain its activities with more advanced technologies, greater energies and more efficient, effective and clean materials.

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Fig. 1 Shoemaker-Levy 9 approaching Jupiter.

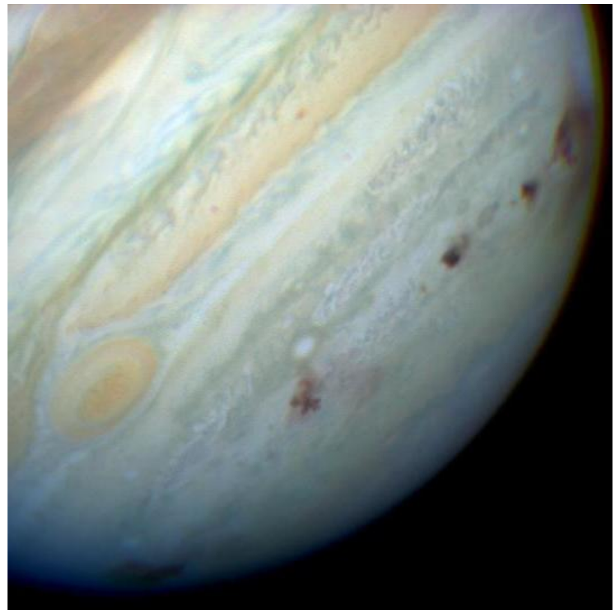

Fig. 2 Jupiter after the impact.

A. Jupiter and Shoemaker-Levy 9 and the need of space safety

At the beginning of the 90s one of the most spectacular collisions ever documented occurred: that between Jupiter and comet Shoemaker-Levy 9. Discovered on March 25, 1993, it had been captured between the second half of the sixties and the early seventy from Jupiter, and the tidal forces had caused it to break up into 21 fragments.

An extensive observational campaign was started involving numerous observers on Earth and probes in space to record the event. Between 16 and 22 July 1994, the fragments of the comet (already destroyed, having passer the Roche limit for Jupiter) fell in a veritable bombardment. The dark spots that formed on the planet were observable from Earth for several months before being reabsorbed by giant's atmosphere. The event had considerable media coverage, but also contributed significantly to scientific knowledge of the Solar System, having enabled to make measurements on the deep layers of the Jovian atmosphere, and underlined the role of Jupiter in reducing the space debris in the inner Solar System.

Spectroscopic observations showed that ammonia NH_3 and carbon disulphide CS_2 remained in the atmosphere for at least fourteen months after the event. In the major impact points, temperatures increased in a region ranging from 15,000 to 20,000 km, but dropped to normal values within a week of the event. At smaller spots, temperatures 10 K higher than at surrounding sites persisted for at least two weeks. Stratospheric temperatures rose immediately after the impacts, falling two to three weeks later to lower temperatures than before the impacts.

B. An interplanetary industry beyond planetary defense

There are similar objects in circumterrestrial space: they are called NEOs, Near-Earth Objects, and they are as interesting as they are dangerous for the Earth. Very similar to these objects, the largest fragments of Shoemaker-Levy 9 destroyed only at a pressure of 2.5 bar, and the marks left by the event remained visible for a long time and were described as more visible than the famous Great Red Spot. It is therefore quite evident that the consequences of an event like this would have been much more drastic on a planet like Earth. However, NEOs are not just threats: from these ojects, valuable injectable resources in the global economy can be undermined.

Metal-rich near-Earth asteroids represent a small fraction of the NEA population that is mostly dominated by S- and C-type asteroids. From the near-infrared spectroscopic data of NEAs 6178 (1986 DA) and 2016 ED85, it was determined that these objects were likely transported to the near-Earth space via the 5:2 mean motion resonance with Jupiter. Asteroid spectra were compared with the spectra of mesosiderites and bencubbinites. In particular, mesosiderites were found to have a similar pyroxene chemistry and produced a good spectral match when metal was added to the silicate component. Also, it was estimated that the amounts of Fe, Ni, Co, and the platinum group metals present in 1986 DA could exceed the reserves worldwide.

Fig. 3 An ARRM option was to deploy a container large enough to capture a free-flying asteroid.

In light of all this, the idea is very simple: from the spectroscopic analysis the composition of the object is detected, and on the basis of these it is decided whether to make it explode using a conventional H-bomb implanted with a suitable spacecraft, or to redirect it to a pre-existing network of asteroids responsible for to mining exploitation.

After the first flybys of the Galileo and Cassini spacecrafts, no probe has been interested in asteroids; this until the launch of Deep Space 1 and Dawn. The success of Deep Space 1, the first interplanetary spacecraft to use an electrostatic grid drive, laid the foundations for future spaceflights equipped with ion propulsion, in particular for Dawn, which successfully achieved all of its objectives, totaling over 51 thousand hours of ignition time of the NSTAR thruster. The basic concept is very simple: high voltage electrodes accelerate an ionized gas by electrostatic forces, producing thrust.

Nowadays, the studies underway within the Asteroid Redirect Robotic Mission (ARRM) are fundamental, and after the launch of the first probe directly aimed at planetary defense (the Double Asteroid Redirection Test, DART), it is also expected to have the first probe that will study a metallic asteroid, 16 Psyche, in October 2023. Note how all these missions use ion thrusters. Since NASA's DART spacecraft intentionally slammed into the asteroid moonlet Dimorphos on 26th September 2022 – altering its orbit by 33 minutes – the investigation team has been digging into the implications of how this planetary defense technique could be used in the future, if such a need should ever arise. It has been observed that DART's impact displaced over one million kg of dusty rock into space – enough to fill six or seven rail cars.

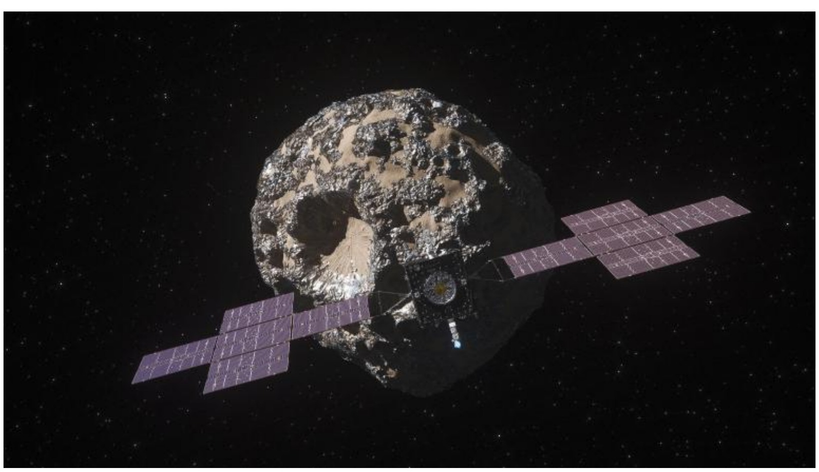

Fig. 4 The Psyche mission will orbit a metal-rich asteroid in the main asteroid belt to investigate its composition.

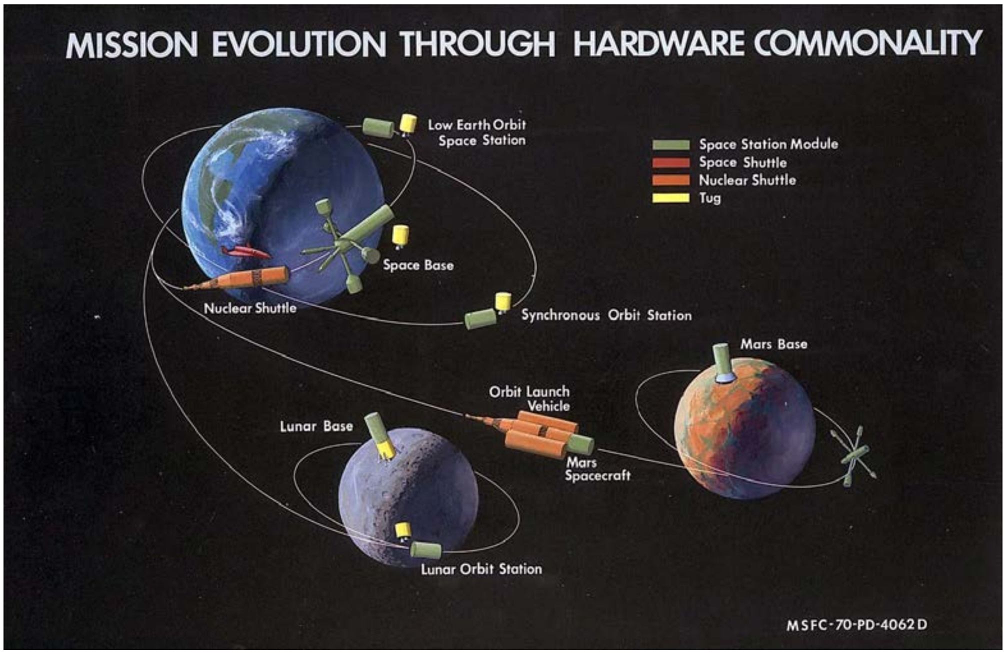

Fig. 5 Integrated Program Plan "Maximum Rate" Traffic Model (1970).

There is also the possibility of exploiting the rotational kinetic energy of a small asteroid with a magnetosphere strong enough to generate electricity in a similar way to what occurs in conventional synchronous alternators. Once the kinetic energy of a single asteroid is exhausted, the single generation system can be disassembled to exploit another one; the energy generated can be sent via electromagnetic waves where it is required, used in situ or stored in batteries. Furthermore, robotic systems can autonomously send, as done by numerous past missions the useful mineral resources located in these small celestial bodies, under the supervision of remote humans or, possibly, in the place itself.

C. The legacy and challenges of Space Exploration

The importance of the space programs from the past century won't never be emphasized enough. The thrust the Apollo program gave to the development of microelectronics and biomedical industries is just one of the thousands of examples that could be done in this sense.

When one reads documents connected with the 1969-1971 Integrated Program Plan (IPP), it is often difficult to decide whether to laugh or to cry. The IPP, a product of George Mueller's Office of Manned Space Flight, began to evolve as early as 1965, but did not take on the grandiose form NASA Administrator Thomas Paine stubbornly advocated to President Richard Nixon until May 1969. Paine, a Washington neophyte, expected that the IPP would be NASA's reward for winning the race to the moon. He believed that, having vanquished the Soviets, it was time for the U.S. civilian space agency to "think big." Nixon's Office of Management and Budget had made it clear that NASA should expect rapidly declining annual budgets, not rapidly growing ones. Nixon interpreted Paine's stubborn advocacy of the ambitious IPP as a clumsy effort at bureaucratic empire building, not as a real proposal for a bold space program.

This was the first stop to the aerospace industry, since the beginning of this era in late Fifties. It was the disaster of Space Shuttle Columbia, however, combined with a series of unfortunate events occurred in the late Nineties, to have drastically reduced the possibility of continuing on the same line of the Sixties for scientific research in space.

Here are just a few of the main research areas that are experiencing the greatest slowdowns in this historical period:

- Engineering of In-Situ Research Utilization techniques, for the establishment of colonies on other celestial bodies;
- Consolidation of knowledge on cryogenics and space awakening for long-duration flights;
- Deepening of the effects of the long permanence of space on the physical and psyche of living beings;
- Directly search for evidence of extraterrestrial life, in the Solar System and on the closest stars;
- Astrophysics, particle physics and matter physics experiments in space;
- Testing of terrestrial technologies in space and certification of industrial products;
- Study of the effects of solar wind and cosmic rays on materials and life forms at different levels of shielding.

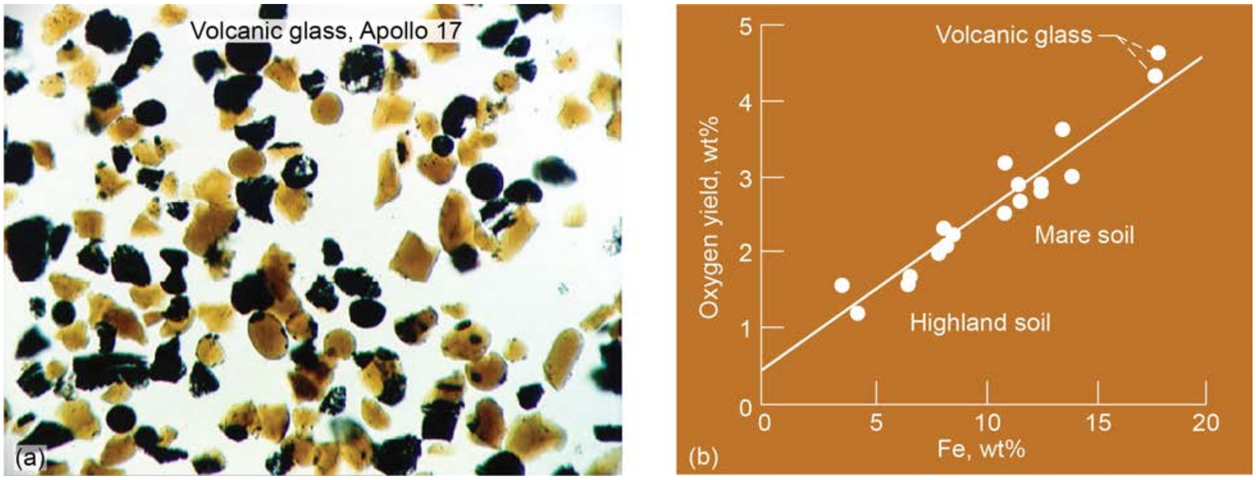

Fig. 6 Volcanic Glass Beads and Oxygen Yields from Full Range of Apollo samples.

This list clearly cannot be exhaustive, and will only get longer under pressure from the scientific community, due to the stalemate in which the aerospace industry finds itself.

Just for making an example, the first point could be analysed under the point-of-view of lunar missions.

Lunar-derived propellants (LDPs) will be essential to reducing the launch mass requirements from Earth and developing a reusable lunar transportation system (LTS) that can allow initial outposts to evolve into settlements supporting a variety of commercial activities like in-situ propellant production. Deposits of icy regolith found within permanently shadowed craters at the lunar poles can supply the feedstock material to produce liquid oxygen (LO_2) and hydrogen (LH_2) propellant needed by surface-based lunar landing vehicles (LLVs) using chemical rocket engines. Along the Moon's nearside equatorial corridor, iron oxide-rich volcanic glass beads from vast pyroclastic deposits, together with mare regolith, can provide the materials to produce lunar-derived LO_2 plus other important solar wind implanted (SWI) volatiles, including H_2 and helium-3. Megawatt-class fission power systems will be essential for providing continuous "24/7" power to processing plants, evolving human settlements, and other commercial activities that develop on the Moon and in orbit. Reusable LLVs will provide cargo and passenger "orbit-to-surface" access and will also be used to transport LDP to Space Transportation Nodes (STNs) located in lunar polar (LPO) and equatorial orbits (LLO). Spaced-based, reusable lunar transfer vehicles (LTVs), operating between STNs in low Earth orbit (LEO), LLO, and LPO, and able to refuel with LDPs, can offer unique mission capabilities including short transit time crewed cargo transports. Even a commuter shuttle service similar to that portrayed in *2001: A Space Odyssey* appears possible, allowing 1-way trip times to and from the Moon as short as 24 hours. If only 1% of the LDP obtained from icy regolith, volcanic glass, and SWI volatile deposits were available for use in lunar orbit, such a supply could support routine commuter flights to the Moon for many thousands of years!

D. Assessing the limitations of the Outer Space Treaty

The primary source for international law in space is a drastically outdated document from 1967 called the Outer Space Treaty, designed for an environment far simpler than the current field. That document was signed by the United States, the USSR, and sixty other nations on the evening of January 27, 1967, and it basically bans placing nuclear weapons and weapons of mass destruction into orbit. It says nothing of Earth-to-space or space-to-space arms, nor does it speak to kinetic weapons or the many subtler forms of attack developed since its drafting, and though it states that international law extends into space, there is no ready translation of earthly rules to a realm without national borders or gravity. As the years have gone by, the insufficiency of the Outer Space Treaty has become a significant danger.

The vast majority of satellites are split between the more accessible low Earth orbit (LEO), which begins about 500 km from the planet's surface and is ideal for telecommunications and imaging, and geosynchronous orbit (GEO), 36,000 km away, where satellites are stationary on given points and ideal for meteorology. Civilian dependence on satellites - for internet service, cell signals, weather monitoring, geolocation - is higher than ever, and American military reliance on satellites is near total. The military's space-based systems underpin everything: communications, surveillance, guided munitions, nuclear command and control.

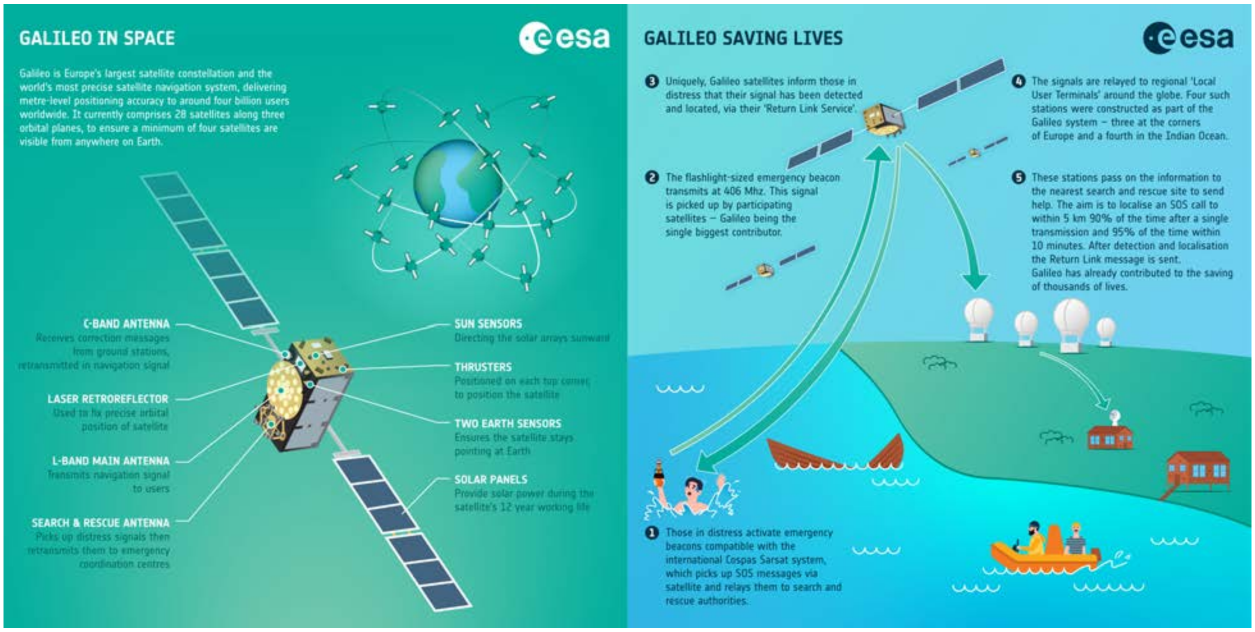

Fig. 7 Galileo is Europe's largest satellite constellation and the world's most precise satellite navigation system, delivering metre-level positioning accuracy to around four billion users worldwide. It currently comprises 28 satellies along three orbital planes, to ensure a minimum of four satellites are visible from anywhere on Earth.

Direct kinetic attacks on space assets, and the resultant debris, could create a cascading effect that would wreck the satellites we depend on. In the case of widespread destruction, hurricane tracking, search-and-rescue locators, financial transactions, and emergency messages could all go dark. The most important satellites, such as those communicating directives to the military, are hardened against attack, with protective shields and special maneuvering capabilities, and are backed up by others. So it would take dozens of successful shots to bring down a whole satellite constellation.

The new military doctrine embraced by U. S. Space Force inaugurates space as a distinct war-fighting domain, and "spacepower" as a military power in its own right. Among the Space Force's goals, it says, are to "destroy, nullify, or reduce" adversarial menaces in space, especially by deterrence through the flexing of enormous military muscle. The document is reverential of the international law, but at its core, the doctrine opposes the fundamental purpose of the OST, which was to define and preserve space as a place of peace. It explicitly says: "No domain in history in which humans contest policy goals has ever been free from the potential for war". The United States' position is that the extraction and use of resources on the moon and other celestial bodies does not violate that nonappropriation principle. But the United States' position is also for those resources to not be treated as the property of the whole international community.

All challenges to nuclear weapons remain on the far side of a bright line, but the tension between the Spacepower Doctrine and the OST makes clear that the treaty's authority is softening at its edges. The balance of international risk has shifted, though extreme shared risks remain. As in the Cold War, the United States is once again involved in a "great power competition," in which nations are projecting military might across many spheres. But now, if compared to the 1960s, there is a huge asymmetry in vulnerability, with China's power growing, and the United States the most sensitive to attack. Experts focused on pursuing peace, or at least safety, in space now see two paths to that end: through further diplomatic efforts and arms control, or through a new assertion of military supremacy. The problem is that there's a lack of willingness to limit the arsenals in order to achieve better global stability.

Both China and Russia have proposed drafts of a space arms-control treaties which would theoretically ban all types of weapons in space, but they lack of means of verification and their implicit allow direct-ascent ASAT weapons. Further, treaties such as this would put the United States at a disadvantage. The U.N. Committee on the Peaceful Uses of Outer Space, currently focused on establishing guidelines to limit the creation of space debris, says that any new binding treaty in the current geopolitical environment is impossible. But if deterrence fails, a war that begins or extends into space will be fought over great distances at tremendous speeds. Direct-ascent anti-satellite missiles can reach low Earth orbit in minutes. Electronic attacks and directed-energy weapons move at the speed of light, and on-orbit capabilities move at speeds greater than 17,500 mph. To plan for such warfare, we must be lean, agile, and absolutely fast.

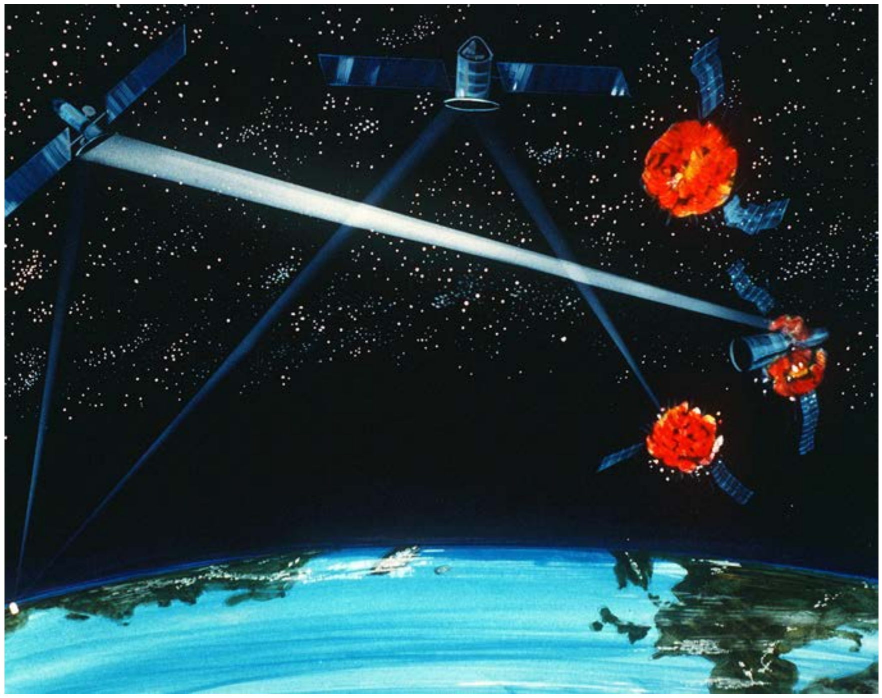

Fig. 8 An artist's concept of a ground and space-based hybrid laser weapon, Strategic Defense Initiative, 1984

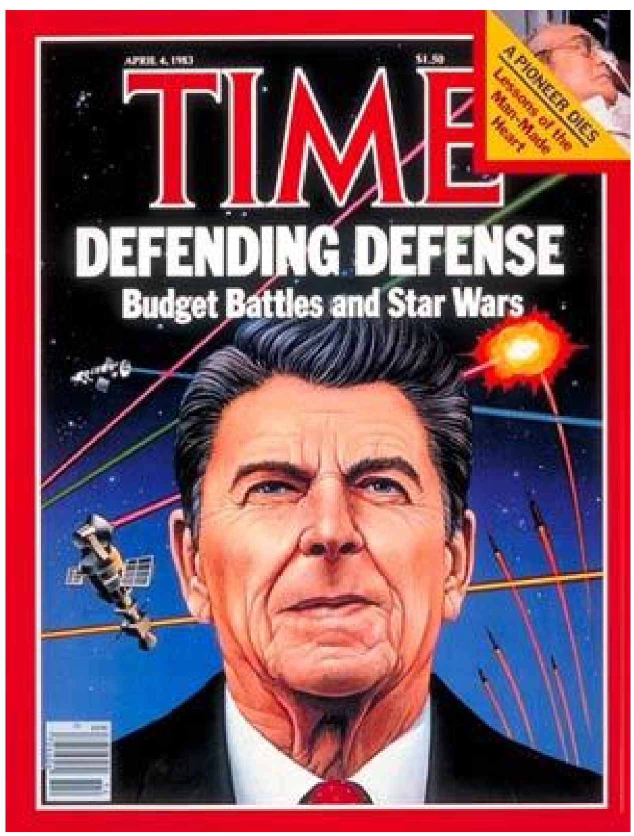

Fig. 9 Defending Defense: Budget Battles and Star Wars. Times, April 4th, 1983.

II. Transport systems and architecture

The framework here depicted consists of space stations temporarily called *Project Konigsberg* and interplanetary transport shuttles called *Kvants*. To reduce costs and development times, several centers called *Arrays* are planned to be built, for the collection, sorting and reconditioning of waste materials, design, construction, testing and launch of new orbital infrastructures, and assistance, management and administration of the framework. The first *Kvants* and *Project Konigsbergs* should be built in *Arrays*, but starting from a certain time the orbital network should already be able to sustain itself and replicate itself autonomously.

A *Project Konigsberg* space station would be indicated by an abbreviation KNGS-X-Y, with X a number representing the planet by distance from the Sun and Y a letter indicating the order of arrival on that planet. A *Kvant* would be similarily identified by an abbreviation KNT-XXY, where XX are the last two digits of the year of registration and Y is a letter indicating the order of registration in that year.

A. Project Ikarus multipurpose spacecraft

Kvant is a multipurpose spacecraft project capable of carrying a crew of 8 plus a payload of 150 t or 50 people. It is designed to perform long-duration manned flights to any destination in the Solar System and work on large orbital infrastructures; it is therefore an "enhanced" Space Shuttle. A fleet consisting of 6 units is expected: *Ranger*, *Aquila*, *Altair*, *Hydra*, *Lyra*, *Lazarus*. The names are inspired by some constellations of the northern sky and by the names of fictional vehicles. In Russian, *Kvant* means "quantum", "how much", a discrete and indivisible elementary quantity of a certain magnitude; in fact, *Kvant* is the first part of the Framework, the one that acts as a ferry between.

The *Ikarus* series saw the light of day in 2019, with the design and construction of *Ikarus-X*, the first of the series.

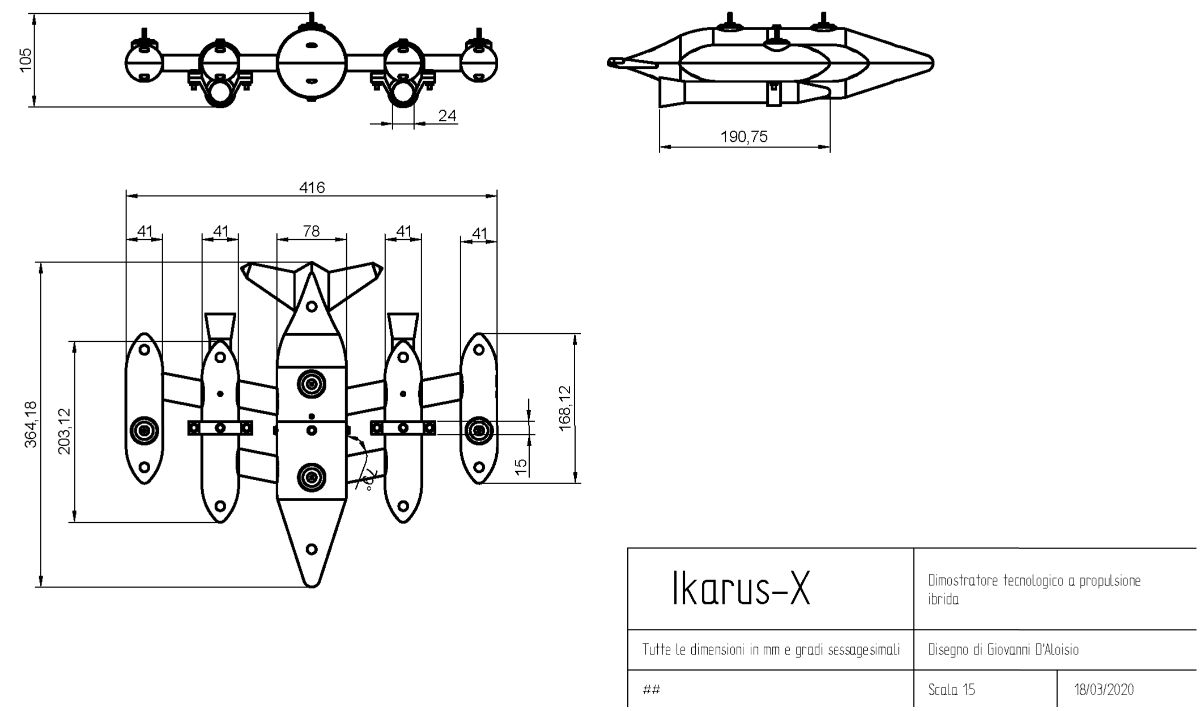

Fig. 10 Ikarus-X, the first aircraft of Project Ikarus.

It is made by 9 modules connected by several large corridors; the core module cannot be removed as it contains the bridge, crew quarters, electrical equipment, propellant, air and water tanks, two parachutes and *Kyber*. The other modules can be used as cargo holds or passenger bridges. Even if the base of the vehicle is in one piece, the primary superstructure can be removed to perform the appropriate fittings, between cargo configuration and passenger configuration.

The superstructure is in a composite material based on allotropic carbon, while the thermal protection system is integrated. The shuttle has two airlocks, with which it can dock with other spacecraft equipped with the NASA Docking System or allow spacewalks. The power supply for the electrical systems comes from *Kyber* or, in flights of shorter duration, from the covering in photovoltaic panels. To land on any surface in the Solar System, it is equipped with retractable landing gears, driven by small asynchronous motors, and a triple vertical parachute.

Fig. 11 Rendering of *Ikarus-Y*, second prototype of Project Ikarus.

The on-board systems are managed by a Unix-like system, which simultaneously perform the same calculations to assume the statistically best values. The autonomous inertial navigation system consists of an inertial measurement unit, optical groups connected to reference telescopes to stellar and radar for the altimeter data of the take-off and landing phases, in addition to the on-board computers, which are managed directly by the crew using touch screen displays.

B. Project Tallinn rocket engine

Project Tallinn is a thruster for aerospace applications, and it is the basis of the *Kvant* shuttles.

The original idea envisaged a turbofan derived from the GE LM6000 module, from which the blades in the turbines for the expansion of the exhaust gases were removed, the number of compression stages reduced to a third and the fuel injectors themselves removed, replaced by a uniformly arranged series of compressed hydrogen pellets on the inner crown of the throat section. An electrically operated gate valve could isolate the compression section from the others. At takeoff a three-phase synchronous motor would power the fan, as is the case in a conventional electric aircraft. At 20 km altitude, with supersonic flight regime, the compression section would have been closed and a series of laser beams would have caused the nuclear fusion of the hydrogen pellets. By the principle of action and reaction *Kvant* would have achieved the speed necessary to pass the Earth's atmosphere without the need for any propellant, and all orbital maneuvers would have been performed with ion grid thrusters. Possibly, also the entry maneuvers in trans-planetary orbits would have been made faster by reusing *Project Tallinn*, since in orbit the throat module would have been replaced to allow up to 5 ignitions, with a refurbishment system similar to that of a conventional magazine pistol.

The idea developed, however, foresees that *Kvant* is driven solely by a *Solar Electric Propulsion* (SEP) system, which will eventually replace the solar electricity source with *Kyber*, once the construction of the latter is completed. The final project plans to produce thrust from the compression and ionization of atmospheric gases (i.e. air), for electrostatic grids and/or the Hall effect. *Mark III* was designed to fly on *Ikarus-Y*, the last *Kvant Test Article* designed. After the deletion of Y's test flights' program, however, development of *Mark IV* eventually led into the model illustrated here.

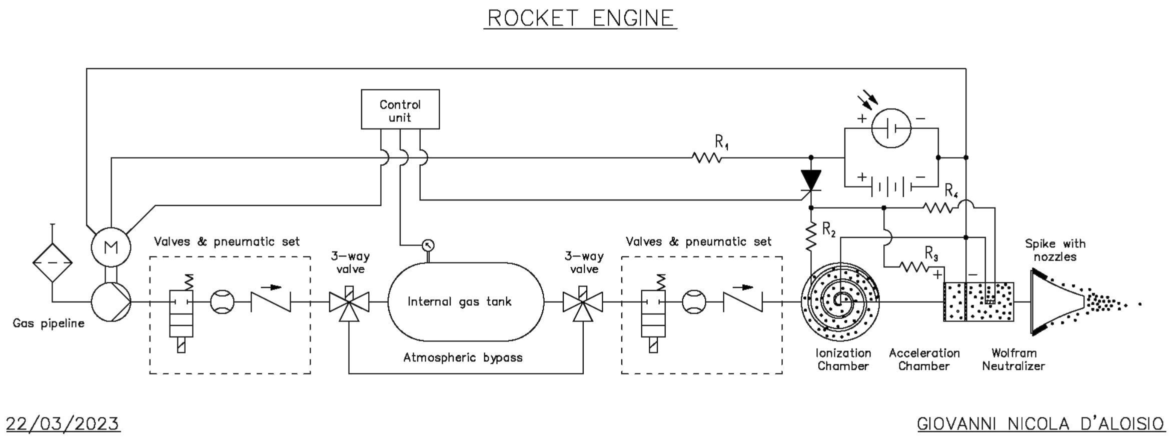

Fig. 12 ***Project Tallinn*** **rocket engine flow diagram.**

In looking at Fig. 12, it should be taken in consideration the fact that all these systems are inside the *Project Tallinn* itself; any further tank or subsystem should be implemented inside *Kvant*, but only if the flight requirements need it.

Another possible *Project Tallinn* project, called *Project Tallinn Mark VI*, is the following. Arrange a container containing one or more sources of alpha particles (possibly radioactive waste). A mobile wall, like a gate valve, houses a membrane permeable only to (He-4)2+ ions, which are collimated and accelerated with a speed selector, powered by solar energy. The outward thrust provides propulsion. The latter configuration is perhaps the cheapest, together with that of the *Mark I-IV*, as the technology already exists and only a purely engineering design is required. The final decision will be made based on the results of the experimental tests.

Design is underway for a higher performing model, internally called Mark V, which adopts an entirely different philosophy, based on the magnetic reconnection of plasmoids. For further information, see Ebrahimi, F. (2020) *.

C. Project Kyber fusion reactor

Kyber is the nuclear fusion reactor designed to power the farthest Project Konigsberg outposts and the *Kvant* spacecrafts for interstellar exploration. It exploits the properties of inertial nuclear fusion to produce electricity.

In a white dwarf, the energy produced by nuclear fusion reactions is no longer able to balance the gravitational force, which would cause the star to collapse; then a completely degenerate Fermi gas is formed, in which the degenerative pressure of the electrons manages to bring the star back to a relatively stable state. The gas is extremely hot but the radiative surface area is very small, so it takes an extremely long time interval for all the energy to radiate out.

By carrying out a nuclear fusion reaction of a light hydrogen compound by inertial confinement inside a sufficiently resistant hermetic vessel, the shock wave returning to the heart of the reaction can lead to the formation of a completely analogous gas to that found in the core of a white dwarf, but exponentially smaller. The high temperature reached, combined with the low irradiation surface and the degenerative pressure of the electrons, can therefore be exploited in a thermal cycle, with thermocouples or in other ways to produce electricity. The main problem with this technology is, of course, the maintenance of such an intense energy source inside a sealed container, which is the main reason for developing tokamaks instead of inertially-confined reactors.

*An Alfvenic reconnecting plasmoid thruster. Journal of Plasma Physics, 86(6), 905860614. doi:10.1017/S0022377820001476

The idea of *Kyber Mark I* is to exploit the magnetic field produced by the nucleus to induce a voltage which, in turn, can be used to generate an opposite magnetic field, which keeps the source in static equilibrium with the surrounding environment; the external radiative surface, spherical in shape, would have an extremely high albedo, in order to limit the heating by radiation of the external membrane. Appropriately shielded optical fibers would be mounted at the ends of one or more of the diameters, capable of carrying the electromagnetic waves produced by the nucleus towards photovoltaic cells and thus producing electricity.

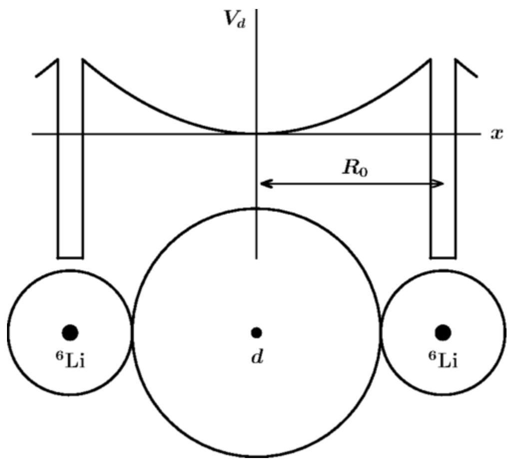

Fig. 13 Schematic of the potential energy of a deuteron nucleus of the two neighboring lithium atoms.

On the other hand, *Kyber Mark II* uses a heavily compressed crystal of lithium deuteride (LiD) doped by ion implantation with protium, deuterium and/or tritium atoms. This crystal is then placed in a chamber, where a series of laser beams irradiate the nuclei of hydrogen, triggering many nuclear fusion reactions whose products, α and γ rays, are picked up by particular transducers alternating with the lasers on the walls of the chamber. This scenario is supported by a study published by Belyaev et al. on 28 March 2016†. In this case the surrender of the crimetion is conditioned by the space available on board, but X-ray nuclear fusion appears to be a relatively cheap, simple and safe route. Moreover, the fusion products then remain confined in the crystal, which can be removed for renewal, and critical temperatures are not reached, except within the hotspots themselves.

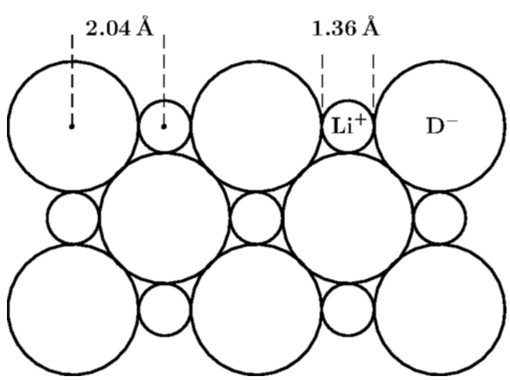

Fig. 14 Schematic of one layer of a LiD crystal.

It is quite evident that between the two, the scenario including *Kyber Mark II* is much more exciting, as it is achievable with much less expense and technical problems encountered.

†For further information, see Phys. Rev. C 93, 034622

D. Project Konigsberg space station

Project Konigsberg is a multifunctional orbiting infrastructure (*outpost*) capable of hosting scientists, engineers and even space tourists, made up of four sections, each of which has specific and interconnected structures and functions:

- *Li* is made up of four flexible modules, connected to each other through as many nodes/airlocks/docking compartments, forming a square. This section is used as a multipurpose orbiting laboratory, and each module is divided into several floors according to the TransHab [‡] model.
- *Pl* is made up of four flexible modules connected in the same way that communicate transversally with *Li*. This section is the outpost's guest living area, also in the TransHab style, and it is designed for commercial purposes. It is the only section in which there's no access to the outpost's main control system.
- *Si* is made up of four rigid modules, which contain the electrical equipment, the navigation and command systems and the food supplies. An unpressurized lattice structure houses the photovoltaic panels, the main antennas, the spare parts, the propellant tanks, the unpressurized hangars, four robotic arms and the solar electric propulsion. This is the most restricted area on board the station.
- *V* is made up of four rigid modules, from which the robotic arms of the reticular structure are managed. The arms build and test the Kvants and the components of other Project Konigsbergs inside the non-pressurized hangars, which are placed on the zenith and the nadir of the habitable modules. The security level of this section is analogous to the one of *Si*.

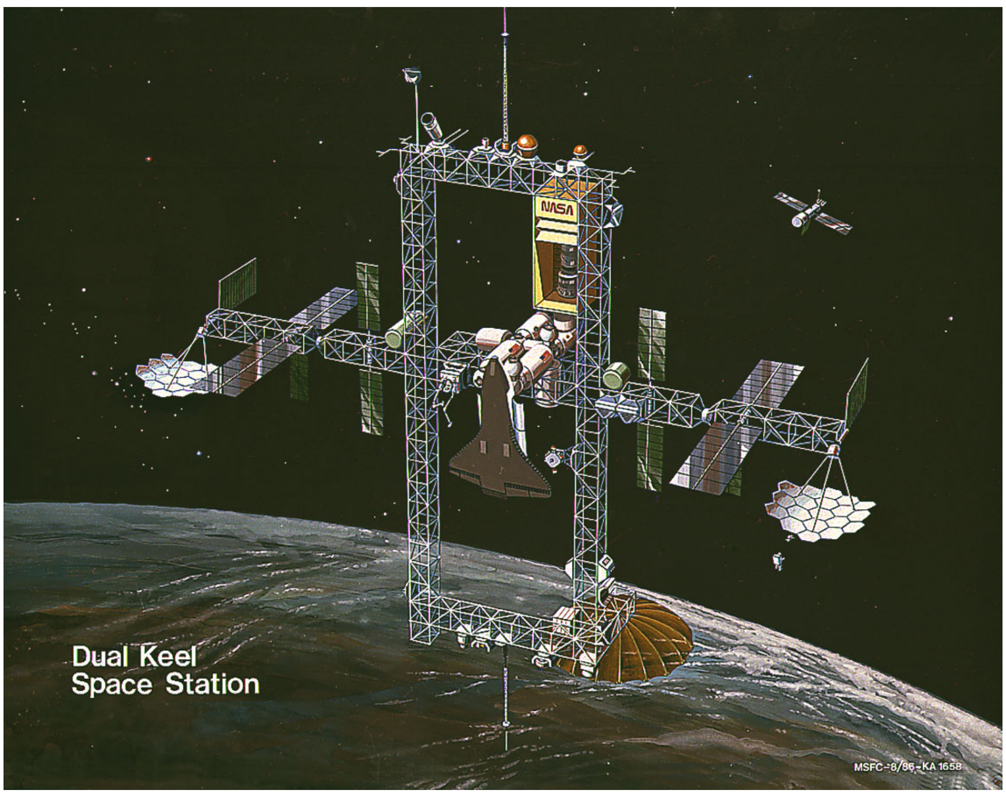

Fig. 15 Space Station Freedom, which greatly influenced Project Konigsberg.

The pressurized section of *Si* communicates with *Li* through the zenith of the latter's nodes; the reticular structure is hooked to the zenith of *Si* and *V*, which communicate transversally with each other.

It is estimated that each pressurized rigid module has a diameter and average internal length of at least 5 and 9 m, for a total of 2700 m^3 of habitable volume, more than 6 times that of the International Space Station. Each *Kvant* in cargo configuration is capable of transporting four modules at a time, consequently a dozen flights are sufficient for its completion. At that point the station should be inhabited by 50 people plus an emergency *Kvant*.

[‡] For further information, see AIAA Paper 2000-1822

A possible assembly sequence is as follows:

1) Pressurized section of *Si*;
2) Pressurized section of *V*;
3) Cross frame;
4) Electric-solar propulsion system, with photovoltaic panels;
5) Propellant tanks and main antennas;
6) Pressurized section of *Li*;
7) Pressurized section of *Pl*;
8) Vertical frame;
9) Spare parts, robotic arms and space yard systems.

Once completed, a *Project Konigsberg* is capable of reaching any orbit in the terrestrial and, if equipped with *Kyber*, also other planets of the Solar System, as well as possibly even more distant destinations.

III. Perspectives on human evolution enabled by the *Space Framework*

The *Space Framework* forms the basis of an entire space economy; consequently, acting as a foundation, it can only be fertile ground for the growth of entirely new technologies and lifestyles.

In the Design Reference Architecture 5.0 [§] some objectives to be pursued in the exploration of Mars have been defined; starting from these, here's a list some of the challenges of the present century:

- Definition of the scientific objectives of space exploration;
- Ability to perform certain operations in a robotized or supervised manner;
- Definition of new jobs, such as space miners, planetary scientists, space forces, etc.;
- Establishment of interplanetary governmental organizations, for the preservation of peace in the Solar System;
- Occupation of every body of the Solar System in a way functional to the needs of terrestrial species;
- Definition of new building materials for the construction of new extraterrestrial cities;
- Drafting of a *Space Navigation Code*, of *urban development plans* and international conventions that regulate relations between terrestrial and extraterrestrial nations;
- Obtaining full independence of space vehicles and extraterrestrial nations from terrestrial consumables, such as water, food, propellant and spare parts;

With more challenges on the way, as we have already seen in the first part of this report. The Space Framework could encourage the discussion of these and more topics in an international context.

At this point, one can ask what is the difference between this and other space programs, such as the on-going Artemis program and the defunct Constellation program, together with commercial partners such as SpaceX and Sea Launch.

The fact is that European (EU or not) countries are dependent from Russia and the USA, from the perspective of manned spaceflight, and the time required for doing great robotic interplanetary missions is too long for enabling advanced exploration in the short term. Also, it could be demonstrated that at the current rhythm, humanity could do the very first manned interstellar mission not earlier than in the half of the next century, and this mission could last a lot of years, if it could be effectively done.

Therefore, the difference here is that this is the very first entirely made-in-Europe space framework ever conceived, excluded Copernicus and other specialized networks, which are the state-of-the-art in the field of terrestrial observation, but are insufficient for giving a strong impulse in the direction of manned or unmanned space exploration. This is one of the reasons for which the *Space Framework* is here: to fill this empty space, this bottleneck leaving America all alone in manned space exploration.

[§] For futher information, see NASA-SP-2009-566-Mars-DRA5.

IV. Supportability, maintainability and public participation

An ambitious project like this is impossible to achieve without adequate funding. In 1970, a similar plan was budgeted to cost 9 billion 1970 dollars annually, equivalent to about 67 billion in 2022.

It is evident that such a plan involves a large number of variables to examine, in particular as regards the risks linked to the cosmos (space debris, high-energy particle beams, asteroids and comets) and to the human factor. It is for this reason that each study must be conducted with care and redundancy by a strongly ideologically cohesive team.

It is difficult to make estimates for the costs of the *Space Framework*, as the technologies involved are actually available, and public opinion on these issues has also changed dramatically since the Sixties. Precisely thanks to the experiments conducted during the last century it is possible to establish with absolute certainty the reliability of the technical solutions adopted, for periods of time that extend over 50 years from entry into service. Ion propulsion has proven to be the best means of transport for long duration interplanetary missions, celestial ferries and flights characterized by repeated firings over time and large total impulse values. Further economical studies have to be done for assessing the confidence level of these assumptions.

In the *Space Framework*, the players involved are potentially all the UN States, and the interests do not concern only scientists and researchers, but juridical and economic agents and above all natural persons. It is about the opportunity to generate new jobs, eliminate physically demanding occupations, overcome ideological barriers, give people one more reason to contribute to the development of society in the best possible way. It is the possibility of seeing that pale blue dot, which is the Earth, not as the place where everything began and everything will end, but as the place where everything started and nothing can ever end. It is the very nature ofman: the need for knowledge, from simple doorstep gossip to the big questions of Physics, and his survival instinct, the greatest source of inspiration in everyday life.

For this reason, the financing of the *Space Framework* and the entry of the individual into it can be in anyone's interest, and the economic return of the enterprise is implicit, as seen in other past space programs.

V. Aftermath

In conclusion, the *Space Framework* provides a very ambitious but feasible model of sustainable space economy in the long term and for many objectives.

The possibilities enabled by this framework are much wider; just think that the architecture of the system itself is flexible to successive incorporations, refurbishments and periodic refreshes, and therefore this is only a stepping stone towards an even more complex but effective system to enable human exploration in interstellar space, with future warp drives that can already be developed in the second half of this century, thanks to the countless studies conducted by the international scientific community.

As President J. F. Kennedy's once said:

> We set sail on this new sea because there is new knowledge to be gained, and new rights to be won, and they must be won and used for the progress of all people. For space science, like nuclear science and all technology, has no conscience of its own. Whether it will become a force for good or ill depends on man [...]. I do not say the we should or will go unprotected against the hostile misuse of space any more than we go unprotected against the hostile use of land or sea, but I do say that space can be explored and mastered without feeding the fires of war, without repeating the mistakes that man has made in extending his writ around this globe of ours.

May the *Space Framework* be the European follow-up of the Mercury, Gemini, Apollo and Space Shuttle missions.

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