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The ring-an optimized spaceship for the 21st century

Abstract

With NASA's anticipated return to the Moon and ambitious lunar plans by major spacefaring nations, a new era of space development is on the horizon. This marks a significant progression from the pioneering activities initiated with Sputnik in 1957. The Moon, followed by Mars and selected asteroids, will serve as the new frontier for human civilization, facilitating the transformation into a multiplanetary society. The exploration and development of these celestial bodies will necessitate the creation of new equipment, spaceships, and vehicles that are not only efficient but also cost effective, enabling rapid progress in our expansion into space. In this context, the Ring a proposed vehicle consisting of a lander and a container emerges as a potential solution to meet these evolving requirements. This article outlines the concept of the Ring and its potential role as an ideal solution for a cruiser feeder space transportation system, addressing the needs of future space exploration endeavors.

Keywords: space transportation system, space exploration, spaceship

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Giorgio Gaviraghi
Unispace Exponential Creativity, Italy

Correspondence: Giorgio Gaviraghi, Unispace Exponential Creativity, Italy, Email giogavi@yahoo.it

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Introduction

Traditionally, spaceships have been constrained by missile -like shapes, employing multistage launchers and limited payload capacity dictated by the dimensions of cylindrical fairings. The booster-launcher typically resided at the bottom of the rocket, with the payload situated on top. However, recent innovations, exemplified by SpaceX's reusable boosters equipped with foldable landing legs, have heralded a paradigm shift in space accessibility, drastically reducing costs and enhancing flexibility.

With the advent of booster reusability and the ability for rockets to land after launch, the conventional design booster at the bottom and payload on top may no longer be deemed the most optimal option. Moreover, as we look towards future lunar missions and the accompanying need for payloads to land directly on the lunar surface, alternative configurations become increasingly advantageous. In light of these considerations, our proposal, the "ring," emerges as a promising solution to meet these evolving requirements and challenges (Figure 1).

Figure 1 The ring components.

The concept

The proposed solution aims to revolutionize current space transportation methods with a novel vehicle design known as "the ring." As implied by its name, this innovative system consists of two key integrated components:

1. Space Tug Transporter/Lander: This component serves as the backbone of the system, facilitating the transfer of cargo, passengers, and even entire habitats between spacecraft in orbit or between space and planetary surfaces. The space tug transporter/lander is designed in a ring shape to accommodate the container inside. It houses essential features such as engines, fuel storage, navigation and communication systems, foldable landing gear, landing pads, and autonomous navigation equipment to ensure safe and efficient operations.
2. Modular Container: The modular container system complements the space tug transporter/lander. These containers are standardized with a diameter of 7.6 meters, precisely matching the dimensions of the transporter ring. This standardization allows for seamless integration and transfer of various payloads, including passengers and cargo, depending on mission requirements.

By combining these two components, the ring system enables rapid and risk free transfer of payloads between spacecraft in space or between space and planetary surfaces, spanning destinations such as Earth, the Moon, Mars, and even asteroids. This innovative approach promises to significantly reduce transit times and enhance overall mission efficiency while accommodating diverse payload types and mission objectives (Figures 2&3).

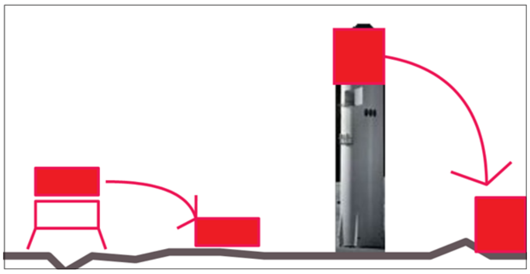

Figure 2 Conventional systems.

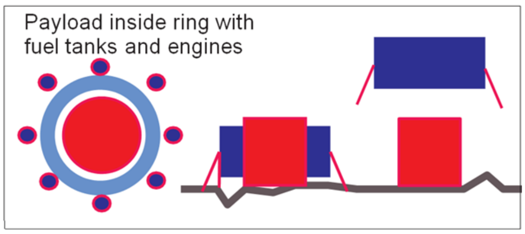

Figure 3 Proposed systems.

Design goals

To effectively realize the Ring proposal, we are establishing a set of comprehensive design goals:

1. Standard Reusable Booster System: Develop a standardized, reusable booster system capable of supporting operations between space to space, ground to space, and vice versa, ensuring versatility and cost-effectiveness.
2. Standard Modular Reusable Container System: Implement a standardized modular container system capable of accommodating every type of manned or unmanned payload, ensuring adaptability and efficiency across various missions.
3. Separate Booster/Payload System: Design a system that separates the booster from the payload, maximizing flexibility in mission planning and execution while accommodating payloads of different dimensions.
4. Flexible Payload Handling: Enable the capability to land, leave, return, or exchange containers with payloads of varying dimensions, facilitating diverse mission requirements and payload types.
5. Standardized Payload Transfer System: Establish a single, standardized system for seamless payload transfer between different spacecraft and stations, promoting interoperability and efficiency in space logistics.
6. Creation of a cruiser-feeder space transportation system for efficient and low cost requirements.
7. Simplified Utilization and Maintenance: Prioritize simplicity in both system operation and maintenance procedures to enhance user-friendliness and reduce operational complexity.
8. Standardized Loading and Unloading: Implement standardized loading and unloading systems capable of accommodating single and multilevel utilization scenarios, ensuring efficiency and ease of cargo handling.
9. Satellite Maintenance and Debris Removal: Incorporate the capability to grab satellites in orbit for repair, maintenance, or debris removal tasks, contributing to orbital sustainability and operational resilience.
10. NEO Asteroid Handling: Develop capabilities to dock, capture, and deflect small Near-Earth Objects (NEOs), with optional equipment for mining and mineral processing during return flights, fostering exploration and resource utilization beyond Earth's orbit.

By adhering to these design goals, the Ring proposal aims to establish a versatile, efficient, and adaptable system capable of addressing a wide range of space transportation and exploration needs.

Motivations

Upon analyzing current and proposed lander configurations for missions to the Moon and Mars, a common pattern emerges: they consist of two main elements arranged in a vertical semi-circular configuration:

i. The lower stage, housing the engines, fuel, and landing pad.
ii. The upper stage, containing the payload, and often the crew.

In missions involving human crews, the upper stage must depart from the surface after landing and completing its mission, while the lower component remains behind to reduce payload weight during ascent. However, this setup necessitates equipping the upper stage with its own set of rocket engines and fuel tanks, mirroring those left behind in the lower stage. Such a design results in costly functional duplication in terms of both finances and weight (Figure 4).

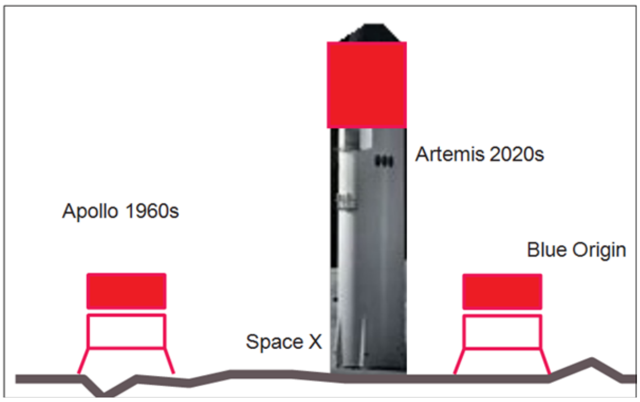

Figure 4 Artemis systems.

Remarkably, this concept, first employed during the Apollo missions to the Moon over sixty years ago, persists in current mission planning, including NASA's Artemis program[1] for returning humans to the lunar surface. Considering the advancements in technology since the Apollo era,[2,3] a more logical and cost effective approach would be to eliminate this duplication and instead reuse all components, including the lower stage, for both landing and takeoff.[4–9] This strategy not only streamlines mission architecture but also capitalizes on our more sophisticated technological capabilities to optimize efficiency and affordability in future space (Figure 5).[4–9]

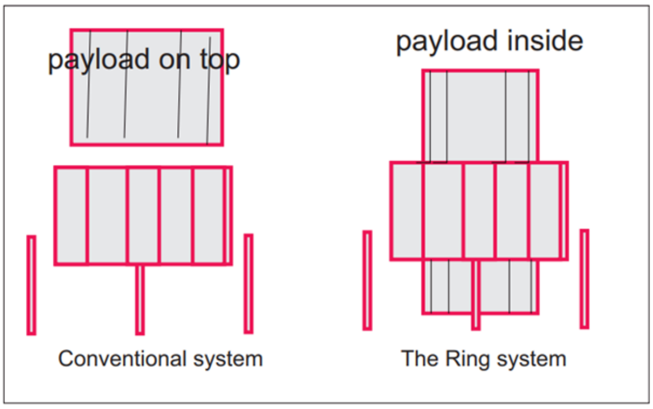

Figure 5 Payload locations.

Another crucial consideration pertains to payload positioning. In conventional layouts, the payload is situated atop the lower stage, effectively serving as an additional stage. Unfortunately, this configuration renders the lower stage unusable for takeoff and presents challenges in crew access to the ground and cargo unloading.

To address these limitations, we propose a ring-type layout with an empty central concentric space in the lower stage. This design enables the utilization of the space to position the container payload system, allowing for ground-level access by the crew and facilitating effortless cargo loading and unloading.

With this primary objective in mind, we introduce the Ring proposal, aimed at revolutionizing space transportation and payload handling by maximizing efficiency, accessibility, and operational flexibility.

The ring system components

1. **The booster:** The primary component of the Ring system is the ring-shaped lander. Enclosed within its approximately 160 cm thickness are the rocket engines, fuel tanks, folding landing gear, and landing pad, along with all necessary instrumentation for independent navigation, communication, and operations. The lander is divided into four equal sectors to facilitate operations such as docking, landing, and takeoff. Its main mission is to transport containers between orbital stations and lunar, Martian, or asteroid bases, and back as needed. The lander has dimensions of a 10 m external diameter and a height of 6 m without landing gear deployed. These dimensions can be expanded for larger payloads in the future, as the system is self-sufficient and not reliant on conventional missile launches (Figure 6).

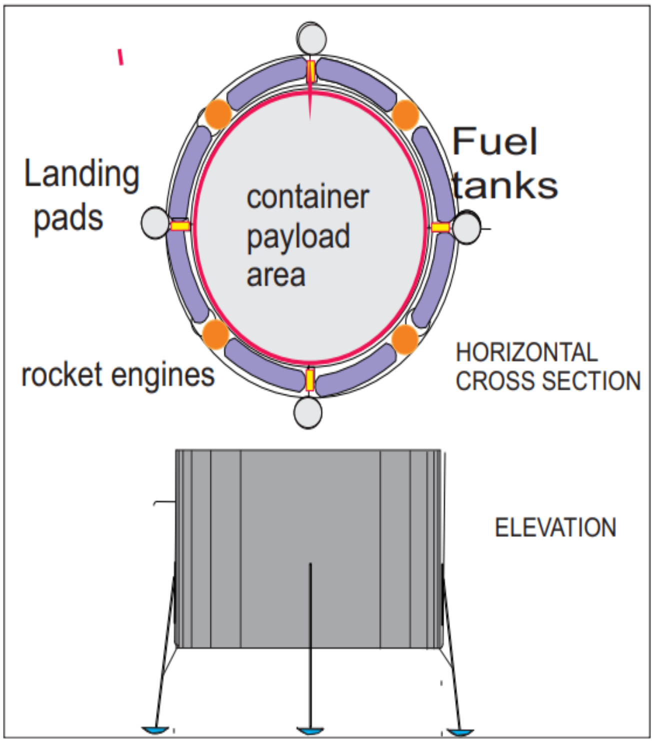

Figure 6 The booster.

2. **The container:** The second component of the Ring system is a modular container system designed to fit within the transporter ring's diameter. This cylinder shaped vessel is dimensioned to fit concentrically inside the booster, sharing a similar diameter but offering variable height options to accommodate different payloads, including habitats with crews. Such modularity ensures support for missions with varying payload dimensions. When on the ground, the container, supported by its landing pad legs, is positioned approximately 2.4 m above the ground, allowing easy access to the payload and facilitating crew movements. The containers have a standard diameter of 7.6 m and variable heights ranging from a minimum of 2.50 m to a maximum of approximately 15 m. internally, they are divided into platforms with a height distance of about 2.5 m between them, enabling accommodation of payloads at different levels. A mechanical system facilitates movement up and down the platforms for accessibility to payloads. Each container is equipped with an external door measuring approximately 1.6 m wide and 2.2 m high at the lower level, streamlining loading and unloading operations for efficiency and convenience (Figure 7).

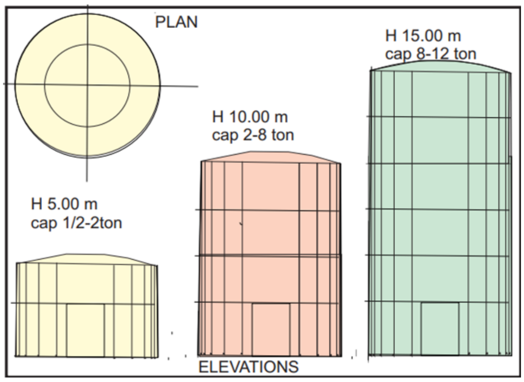

Figure 7 The modular container.

Concept of operations

The Ring system is designed to execute various operations to support space exploration and outpost construction efficiently. These operations include:

1. Preparations for Outpost Construction: The initial Ring lander, with or without a container, will be launched from a terrestrial base to the Gateway station in lunar orbit. Upon arrival at Gateway, it will dock at the node module and await containers from Earth. The container will dock directly to the lander, which will then undock from Gateway and descend to the selected lunar site for outpost construction. Access from the station to the container can be provided if necessary.

2. Shuttle Astronauts from Gateway to Lunar Base: Some containers will be man-rated, equipped, and dimensioned to shuttle astronauts between Gateway and the lunar base. These containers will feature a human rated cabin for the crew and a cargo section to transport necessary supplies.

3. Shuttle Equipment and Containers to the Moon and Back: The Ring system will transport equipment and containers between Earth, Gateway, and the moon, facilitating the movement of resources and supplies for lunar missions.[10–12]

4. Refueling: Refueling operations for the Ring will take place at the Gateway station. Fuel received from Earth during regular missions will be transferred directly to the vehicle or stored in Gateway's fuel tanks. In the near future, the Ring will also be refueled at the moon base using locally manufactured fuel derived from lunar water as raw material (LOX or LHX). This locally produced fuel will be transferred to Gateway's fuel tanks for station utilization.

By executing these operations, the Ring system plays a crucial role in supporting lunar exploration efforts and establishing sustainable outposts on the moon.

Operational activities

As an example of operations, let's consider the first manned lunar mission. A necessary subsystem for this mission is the robot rover:

This subsystem is utilized for most surface activities, including the initial unloading of container payloads. Equipped with webcams for remote human guidance and mechanical arms for cargo handling, the rover is powered by four electric motors, one for each wheel, and a rechargeable battery that can be recharged through a recharging post connected to the ground power system.[13–16]

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Unloading and loading payloads on the moon:

On the lunar surface, the landing pad provides approximately 2.50 m of free space between the lower part of the lander and the lunar soil to facilitate rover movements and access to the container, supported by four adjustable landing pads. The lower part of the container is equipped with a door that opens by rotating downwards to transform into a ramp for rover operations.

In the initial flight, the first level of the container houses the rover vehicle with mechanical arms to handle different payloads. The rover automatically exits the container, deploys itself, retrieves payloads from the first level, and returns inside to pick up other payloads. Once the first level is empty, the second level platform is lowered to the first level by a wall mechanism inside the container, granting access to its payloads for rover unloading. This process continues until the container is fully unloaded. The loading process follows the same maneuver in reverse.

After loading, the lander can take off while the rover remains on the lunar surface. Both the lander and the container can function as standalone vehicles, either connected together or separated and independent.

Transfer of the container in space

The Ring system is fully capable of operating in space, facilitating the transfer of entire containers from the Ring to a space station or another space vehicle, which may function as a space tug. One method involves accessing the other vehicle via the container's upper hatch, where it would be securely fastened. Alternatively, the entire container could be transferred inside a space station equipped with adequate storage space. Inside the station, loading and unloading operations could be conducted entirely, and the container could then be released back to the Ring for transport to its intended destination. This versatility allows for seamless movement of payloads between space vehicles and stations, optimizing mission flexibility and efficiency in space logistics (Figures 8–10).[17,18]

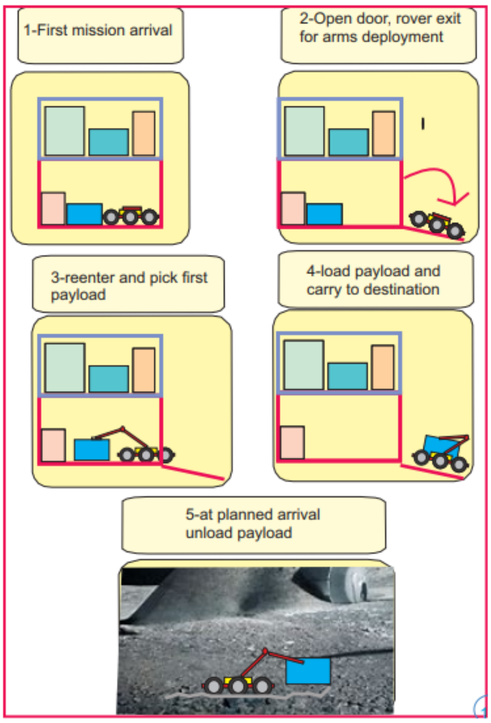

Figure 8 Downloading flow diagrams.

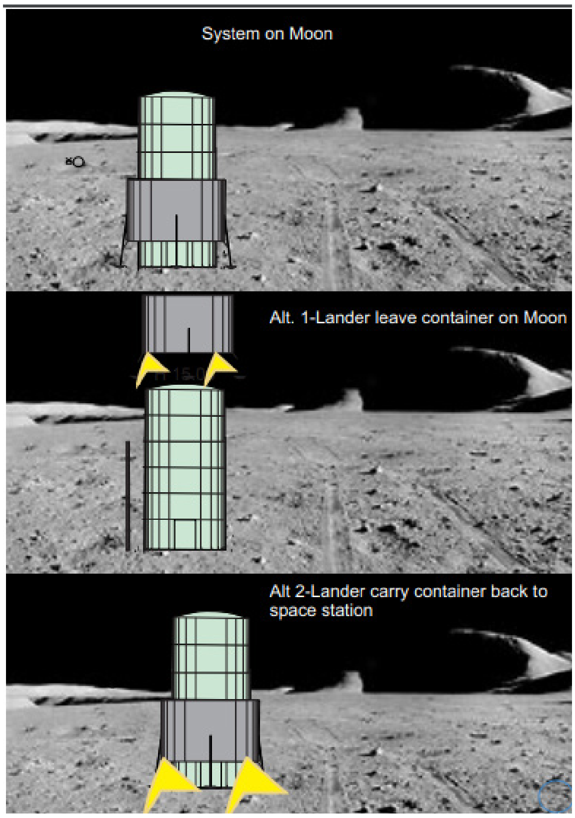

Figure 9 System on moon.

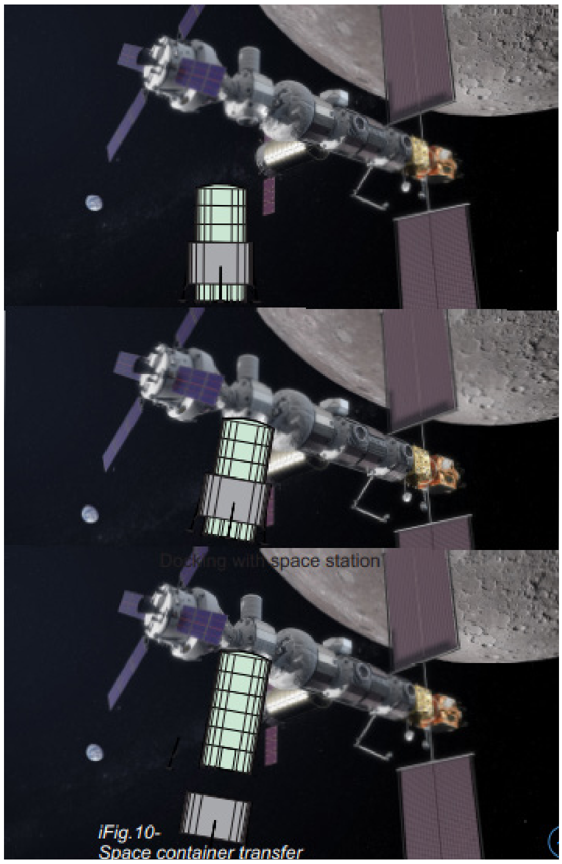

Figure 10 Space container transfer.

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Strengths and weaknesses

Strengths

i. Standardized Container Transfer System: The Ring system offers a standardized container transfer system that is versatile and capable of handling various scenarios, including in-space transfers to stations or other spacecraft, as well as ground delivery and transportation.

ii. Adaptability to Lunar and Martian Environments: The system is designed to operate effectively on both the Moon and Mars, thanks to its aerodynamic shape suitable for departure from Mars.

iii. Flexibility and Versatility: The Ring system's design allows for flexibility in accommodating different payload sizes and types, enhancing its adaptability to diverse mission requirements.

Weaknesses

i. Limitations on Dimensions: The system's dimensions are constrained by existing diameter sizes, potentially limiting the size of payloads it can transport.

ii. Trade-offs between Ring Width and Container Diameter: The width of the Ring may be constrained to maximize container dimensions. If more width is needed for engines and fuel, it may require expanding the diameter of the ring vehicle, potentially impacting payload capacity.

Overall, while the Ring system offers significant strengths in terms of standardization, adaptability, and versatility, it also faces challenges related to dimensional limitations and trade-offs between different design priorities. These factors should be carefully considered in the system's development and implementation to optimize its performance and effectiveness in future space missions.[19–21]

Conclusion

The Ring system holds the potential to revolutionize space activities, making operations more affordable through the use of entirely reusable vehicles and flexible modular containers for payloads. This approach simplifies accessibility and maintenance, paving the way for more efficient and sustainable space exploration.

By adopting a non-missile-shaped vehicle design, the Ring system breaks away from decades-old norms, offering a significant advancement in space ship design. This innovation signifies a step forward towards more efficient systems that can adapt to evolving mission requirements.

To transition humanity from a single -planet species to a multiplanetary society the ultimate goal of space development we must embrace new and unconventional ideas and concepts. The Ring system exemplifies such innovation and represents a promising step towards realizing this ambitious vision. With its versatility, affordability, and potential to transform space exploration, the Ring stands as a testament to human ingenuity and our quest for exploration beyond Earth.

Acknowledgments

None.

Conflicts of interest

The authors declare that there is no conflict of interest.

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