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Lunar infrastructure, space defence domain, and exploring blockchain for space law implementation

SPACE INDUSTRY REPORT

MAY 2025

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CONTENTS

INTRODUCTION

Between 5-16 May, the **United Nations Committee on Peaceful Uses of Outer Space** (COPUOS) held the 64th meeting of the Legal Subcommittee (LSC). The meeting will be held before the main committee meeting, which begins in June, also in Vienna. The work of the LSC brings together delegations and permanent observers in order to discuss and debate the development and implementation of space law, while also hosting discussions and technical presentations relating to the challenges within space governance. The LSC also brings together work carried out by its Working Groups, which include:

- Working Group on the Status and Application of the 5 United Nations Treaties on Outer Space
- Working Group on the Definition and Delimitation of Outer Space
- Working Group on Legal Aspects of Space Resource Activities

Establishing and implementing space law is perhaps more critical than ever, as innovation and geopolitical challenges continue to outpace the law-making process. Fora such as the COPUOS and the LSC remain highly important in order to face the challenges of maintaining peaceful uses of outer space. In this month's report, we take a brief look at one of the key takeaways from the meeting, which could define what could be a transformative industry: space resources activities.

Draft principles on space resource activities: Considering areas of conflict and harmonisation

The Working Group on Legal Aspects of Space Resource Activities was initially established in 2021, and was given a 5-year working plan from 2022, in order to carry out research and collect information and inputs from delegations and observers to assess the benefits of creating a new framework for resource governance. At the 2025 LSC meeting, the group published an initial set of draft principles regarding resource activities, written by the new chair of the committee, Pr Steven Freeland. One aspect that the principles do represent is that it is evident to some that the current legal framework may not be sufficient to govern such activities, and that the Outer Space Treaty (OST) remains somewhat ambiguous on this subject.

However, it may be difficult to implement a new binding treaty at the UN, not least because of current divisional geopolitical crises, but also due to the position of some States' satisfaction to use the provision of the OST to legislate for resource extraction and utilisation. The **United States delegation** at the LSC said that, concerning Article 2 of the OST, which prohibits

appropriation of space, it does not view this prohibition as extending to '...resources that have been removed from their place on or below the surface of the Moon or other celestial bodies...'. They added that Article 1 of the OST (stating that outer space '...shall be free for exploration and use by all States') permits the removal of resources.

However, the delegation also added that they do '...see potential benefits of a general, high-level initial set of non-binding principles to help ensure that all nations engaged in space resource activities share a common set of fundamental beliefs.' The initial set of principles, titled 'Initial draft set of recommended principles for space resource activities', would then provide soft law provisions, which can be more easily adopted given their non-binding nature. Similar attempts at implementing soft law has been used in regard to sustainable uses of space, such as the Long-Term Sustainability Guidelines and the Space Debris Mitigation Guidelines.

The draft principles firstly outline the need for compliance with existing space law, particularly the OST. This is also what the US-led legal framework the Artemis Accords also sets out to do. Also, principle 2 states that resource activities '...shall be conducted in a manner that preserves free access...', while activities must also be '...conducted in a manner that does not constitute [, or purport to constitute] [, directly or indirectly,] national appropriation.' This again then aligns very much with the US position, and somewhat differentiates between 'territorial appropriation' and 'resource appropriation', and that activities can be carried out, as long as free access for others is maintained. The principles also require States to provide assistance to any other person in case of an accident, aligning with the OST article 5, the Rescue Agreement 1968, and also section 6 of the Accords.

Principle 5 discusses sustainable resource activities, '...in order to meet the needs of the present generations while preserving the outer space environment...' This has similarities to the Moon Agreement 1979 article 4, which outlines that 'due regard shall be paid to the interests of present and future generations...' This may potentially be conflicting with US interests, with a **2020 US executive order** denouncing the Moon Agreement as not

representing customary international law. However, the provision to carry out resource activities in a sustainable manner does align with China, which **submitted a paper** to the working group last year, requesting that resources are protected from '...depletive exploitation...'

Some areas could also provide alignment on all sides. Principle 6 allows for '...freedom of scientific investigation of outer space...', and that States shall give priority to scientific research. The paper from China also calls for the mitigation of resource activities that may harm scientific investigation, while section 4 of the Accords calls for the sharing of scientific data. The latter would also align with principle 7 of the draft principles, which calls for States to '...share relevant scientific and technical data...'

Part 2 (possible additional draft provisions), principle 1, also broadly aligns with the US position, stating that 'the extraction of space resources [and/or the utilization of space resources do] does not inherently constitute national appropriation under Article II of the Outer Space Treaty.' Furthermore, part 2, principle 4 gives provision for States to implement the use of 'temporary safety zones', to prevent harmful interference. This is broadly in-line with the Accords, which in section 11 calls for the use of safety zones. However, although the Accords call for the use of these zones as a means of preventing harmful interference, **Walker A Smith writes** that concerns '...certainly exist about safety zones turning into de facto areas of national appropriation or influence.'

There are, though, clearly areas where harmonisation can be found, and as an initial set of non-binding principles, it may play a significant role in establishing standard practices and soft law governance for space resource activities. There will still be areas that require more research and discussion, while the group aims to deliver its recommendations by 2027. Furthermore, the work of the new COPUOS **Action Team on Lunar Activities Consultation (ATLAC)** will also need to be considered. Their mandate also focuses on similar areas which the draft principles address, while researching the possible implementation of an 'international mechanism', or agency, for improving consultations related to lunar activities.

The two mandates, while working independently within COPUOS, could complement each other. Following the LSC, ATLAC produced its workplan, which will be presented for approval at the 68th meeting of COPUOS in June 2025. Here is then also where continued research and observation on these matters will be needed.

Best wishes,

Joseph Holden
Senior Commercial Space Strategist

NEWS ANALYSIS

Lunar Infrastructure, Space Defence Domain, and Space Law Implementation: Space Industry Review May 2025

(Image: Unsplash)

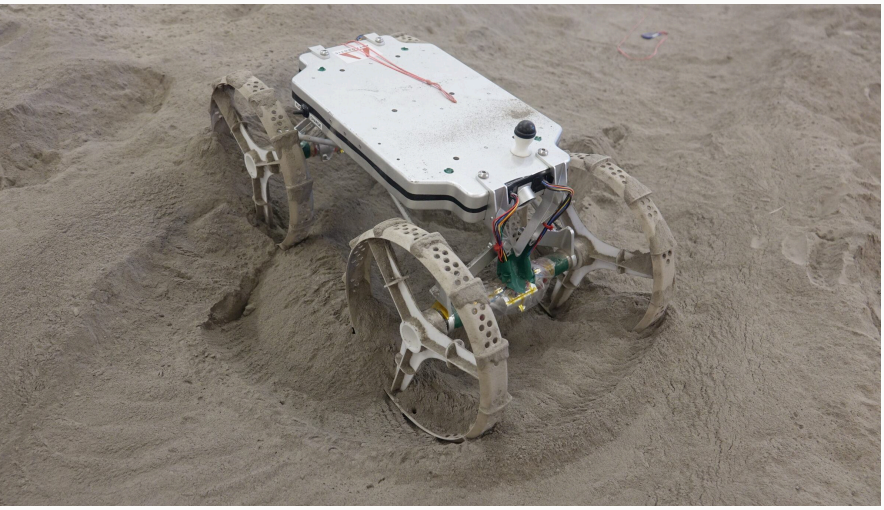
iSpace line-up for landing, lunar excavator revealed, nuclear reactor for the Moon and more...

On 6 May, iSpace's 'Resilience' lunar lander entered orbit around the Moon, gearing up for a landing attempt no earlier than 5 June. This marked milestone 7 out of 10 in their approach to the surface; their second try since a hard landing back in April 2023. Like Firefly Aerospace and Intuitive Machines before them this year, iSpace shared images of the lander passing over the Moon. The target site is Mare Frigoris on the near side, though backup landing zones are ready if needed.

What makes this mission stand out isn't just the growing momentum of private lunar ventures, but that it is set to become the first to collect and commercially transfer lunar resources backed by a resource license under Luxembourg's 2017 space resources law. What seems like a small step is actually a significant one, potentially shaping future legislation and setting new precedents in space resource utilisation. The topic of resource usage is gaining more debate, including recently at the UN COPUOS Legal Subcommittee, which published a draft set of guiding principles on resource activities.

Getting consensus on these principles is becoming critical. While hard law isn't likely soon, soft law frameworks could be easier to implement. These principles are expected to be agreed upon by 2027, right on time for companies like US based Interlune, who plan to launch their first helium three prospecting mission that year.

Interlune recently revealed a full scale prototype of their lunar excavator, developed with industrial equipment developer, Vermeer. This autonomous machine can process up to 100 metric tons of lunar regolith per hour, extracting helium three, a potential fuel for advanced energy systems and quantum computing. But they are not alone. US company Magna Petra became the first commercial firm to access NASA's Mass Spectrometer Observing Lunar Operations instrument through a Cooperative Research and Development Agreement with Kennedy Space Center. Originally designed to detect lunar water ice, MSOLO is being repurposed to analyse gases like helium three in the regolith and will be mounted on a commercial rover selected by Magna Petra. They're aiming to fly on Artemis 3 in 2027 and have signed an agreement to collaborate with iSpace on resource extraction.



Testing of a 2U CubeRover (Astrobotic)

> LunaGrid is the first-ever commercial power service for the lunar surface
>
> **Astrobotic**

Blue Origin is pushing ahead with its Blue Moon Mark 1 lander, aiming for a demo mission to the Moon's south pole by the end of 2025. This uncrewed flight will test key technology; the BE7 engine, cryogenic fluid systems, and precision landing, critical for future crewed Artemis missions, and also carry payloads under NASA CLPS

Meanwhile, Astrobotic has completed flight model acceptance testing for its lunar wireless charging system, a major step toward sustained Moon operations. Developed with WiBotic, Bosch, the University of Washington, and NASA Glenn Research Center, this lightweight charger is built to power systems through the brutal 14 day lunar night. Power harvested via their lander or Vertical Solar Array Technology will be wirelessly distributed through tethered CubeRovers. Astrobotic hopes to deliver the 'Lunagrid' system by 2026, pending validation of their lander technology. Reliable energy like this will be vital for long term presence on the Moon.

On the international front, China and Russia are moving forward with plans to build a nuclear power station on the Moon by 2033 to 2035, as part of their International Lunar Research Station project. Construction is set to start in 2026, aiming for a fully operational, crewed base at the lunar south pole by 2050.

NASA meanwhile may still be struggling to revive its Trailblazer water prospecting satellite. Launched February 26, 2025, as a secondary payload on a Falcon 9 with Intuitive Machines' IM2 lander, the spacecraft lost contact within 12 hours. A brief signal came the next day, but no sustained communication since. NASA suspects it's stuck in a low power, slow spin state, unable to orient solar panels properly to recharge. There's hope that changing orientation over time will allow enough sunlight to wake it up. Water remains a crucial resource , for fuel, oxygen, and drinking water. Starpath Robotics is another private player aiming to demonstrate lunar water extraction, while iSpace is carrying a water electrolyser experiment for Takasago Thermal Engineering on its current mission.

The race to unlock the Moon's resources and establish sustained operations is accelerating With private and public players accelerating, all eyes will be on how these upcoming missions will shape the next chapter of lunar exploration.

The future of Artemis, calls to increase ESA spending and Chinese leadership

The US Artemis programme continues to face ongoing uncertainty. The recent NASA budget proposal under the Trump administration recommends phasing out the Space Launch System (SLS) and Orion spacecraft after their third mission, redirecting funds towards more cost-effective commercial lunar systems. The proposal also includes a six billion dollar cut to NASA's funding, around 24 percent less than the previous year, and calls for scaling back International Space Station operations, with planned decommissioning by 2030. The shift towards commercial options has been a continuing strategy, covering launch, transportation, and the development of commercial space stations.

However, the administration may have reason to hesitate. Commercial systems are not yet fully proven. While Starship is considered a potential alternative to the SLS rocket, it has yet to complete a fully successful flight. Likewise, there are currently no commercial space stations in orbit.

Meanwhile, the Artemis Accords appear to be gaining traction. On 15 May, Norway became the 55th state to sign the Accords, adding weight and legitimacy to these non-binding principles for safe space exploration. But even here, caution may be warranted. China is moving forward with its '555' project, aiming to involve 50 countries, 500 research institutions, and 5,000 researchers in its International Lunar Research Station.

They plan to launch Chang'e 7 and 8 in 2026 and 2028 for initial in situ resource utilisation missions, and recently launched the Tianwen-2 asteroid sampling mission. With geopolitical tensions remaining high, it will also be seen how these dynamics also inlfuence the changing shape of alliances and relations in space exploration.

Artist's view of Europe's launcher family from 2024 onwards (ESA–D. Ducros)

> ...it is crystal clear in a more volatile geopolitical situation the need for more autonomy is there
>
> **Josef Aschbacher**
> **(speaking with The Guardian)**

Facing these global challenges, Josef Aschbacher, Director General of the European Space Agency, has called for a substantial boost in Europe's space investment to strengthen global competitiveness and strategic autonomy. Addressing the European Parliament on 13 May 2025, Aschbacher pointed out that while Europe leads in areas such as Earth observation and navigation, its space spending falls short compared to the US and China. Given Europe's economic position and rising geopolitical challenges, he proposed a three-year ESA budget exceeding 20 billion euros, an 18 percent increase , to enhance Europe's space capabilities.

At the same time, South Korea is seeking non-member status within ESA, diversifying its approach to global cooperation. A meeting was held between ESA and the Korea Aerospace Administration at the 40th Space Symposium in Colorado Springs, United States.

In an increasingly contested and competitive space industry, shaped by shifting relationships, new partnerships are constantly emerging, in what may be becoming a more multi-polar landscape.

Ukraine prep space force, Russia to develop constellation, North Korea reject US Golden Dome

In a space industry defined by growing competition and shifting alliances, new space relationships are constantly emerging, driven especially by the expanding recognition of space's strategic importance for defence.

In line with this trend, the Ukrainian government has introduced legislation to establish its own space force. Members of its new Space Policy Directorate will include military command, the Ukrainian space agency, partner countries, research institutions and state institutions. It aims to improve legislative development, technological innovation and to establish international governmental and commercial partnerships.

Meanwhile, Russia is actively developing its own low Earth orbit satellite internet system, called 'Rassvet'. Announced on 20 May, the project aims to provide broadband internet and enhance the accuracy of the GLONASS navigation system, improving drone control precision to 2.5 meters. While this development echoes some themes discussed in our recent legal review, particularly concerns over applications extending beyond the peaceful use of outer space, it arguably falls short of the scale envisioned by the Trump administration's 'Golden Dome' missile defence initiative.

North Korea has strongly condemned the US-proposed 'Golden Dome' missile defence system, warning that it risks escalating tensions in space and could even trigger a 'space nuclear war.' The system, promoted by former President Donald Trump, is designed to counter advanced aerial threats, including ballistic and cruise missiles. Pyongyang denounced the plan as 'the height of self-righteousness and arrogance,' accusing Washington of attempting to militarise outer space. At the same time, North Korea itself faces accusations of developing missile and space technologies with Russian support. Oleh Ivashchenko, chief of Ukraine's Foreign Intelligence Service, stated, 'They are providing them with rocket and space technologies. We do not discount the possibility that these may also include technologies related to nuclear weapons or their improvement.'

While these claims and counterclaims will no doubt be contested, one fact remains clear: space is increasingly becoming a contested and defensive domain. These developments demand a robust response from diplomats and lawmakers to ensure that space remains a realm for peaceful and cooperative use.

SPACE LAW REVIEW

SPACE LAW & POLICY

SUSTAINABLE & PEACEFUL USES OF OUTER SPACE

Discussing the challenges, threats and opportunities to international space law and governance, arising out of evolving international relations, geopolitical dynamics and more

Key terms: Blockchain; Cryptocurrency: Outer Space Treaty; LTS Guidelines; Artemis Accords; Ledger; Transparency; DAO

Can the application of blockchain technology support the governance for peaceful uses of outer space?

Blockchain was conceived in 2008, with the release of the cryptocurrency bitcoin, a peer-to-peer electronic currency.[1] The chain is a decentralised, distributed ledger, and '...securely stores records across a network of computers in a way that is transparent, immutable, and resistant to tampering.[2] Since its inception, blockchains have been established and cryptocurrency has become synonymous with creating and breaking wealth, while its market volatility has now become tied to public interjections and support from individuals such as Elon Musk with is supposedly favoured 'memecoin', Dogecoin.

However, beyond the infamy of crypto lies the technology beneath it, which has been applied in diverse industries and for diverse applications. Some use cases include its application in healthcare where patients can securely access and share medical records with healthcare providers.[3] It has also been proposed for use in the maritime industry, with the Singapore Shipping Association (SSA), in collaboration with the International Chamber of Commerce (ICC) and blockchain startup Perlin, developing the International E-Registry of Ships (IERS).

This blockchain-based system aims to streamline and digitise the ship registration and renewal process, reducing time, costs, and errors.[4]

Furthermore, the United Nations has trialled the use of blockchain for use at UNICEF in order to manage funds which support projects. In 2021 they announced 8 startups who would create blockchain solutions toward greater financial inclusion.[5] This was done after a call for applications to '...digital tools for people to access decentralised financial instruments, marketplaces, and decision making mechanisms to empower local communities...'[6]

Blockchain technology can then garner transparency, inclusion, trust and efficiency. This brief article will explore how blockchain can not only be applied in the rapidly transformative space sector, but also be used in order to support the enforcement and development of law and governance toward a peaceful and sustainable future in outer space.

Enabling transparency through blockchain

The transparent nature of blockchain broadly compliments the need to encourage and enable trust in space exploration and utilisation. Firstly, consider the requirement within article 8 of the Outer Space Treaty, which requires States to retain jurisdiction and control over space objects.[7] This is also required within the Registration Convention 1974, under which article 2 requires States to register the launch of space objects within a national registry and with the UN.[8]

However, the use of blockchain and a transparent, tamper-roof register could also here be expanded, firstly in order to address the growing need for data and information sharing in regard the space traffic management (STM) and space situational awareness (SSA). Sadiku et al further argue that the transparency and traceable nature of blockchain data allows for fostering more trust among stakeholders.[9]

The trust-based nature of the blockchain could allow for access to honest data about space traffic, enabling a safer environment, which would also broadly align with the UN Long Term Sustainability Guidelines, namely B.2 (1), which recommends that 'States and international organisations should promote the development and use of techniques and methods to improve the accuracy of orbital data for spaceflight safety...'.[10]

This could furthermore provide more transparency for funders and insurers, allowing for a more robust business investment and licensing.

Enabling trust through blockchain could also support the principle of 'due regard', which is embedded within article 9 of the OST, which reads:

> "States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty. States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose."[11]

If we break this down into its component parts we can interpret due regard as providing a means of assisting others, avoiding interference to others' activities and avoiding contamination of the space environment. Firstly, in regard to mutual assistance, somewhat embodied in the Rescue Agreement 1968,[12] transparent sharing of data would better enable the 'due regard to others' principle, for attending to missions in destress, perhaps. Secondly, preventing interference to others could also be facilitated in providing mission data on location, nature and duration (among other details). If this were to be adopted in the lunar context, due regard could be paid by providing detailed and accessible data on the blockchain which stipulates where a vehicle has landed, and what nature of activities are being carried out; which could include informing others about the potential spread of dust and regolith, in order to ensure safety of operations. In fact, this principle is expanded on with the US Artemis Accords, within section section 11, requiring the use of safety zones in lunar operations to prevent harmful interference.[13] It continues to state that the '...the nature and existence of safety zones is expected to change over time reflecting the status of the relevant operation.'[14] Blockchain can provide real-time data sharing to allow for urgent and evolving information to be relayed in this instance, and in regard to the Moon, could be enabled and facilitated by edge computing innovations being developed companies such as Lonestar Data Holdings.[15]

Sadiku et al further add that this aspect of blockchain could also be used to combat space debris, saying that its could help '...space debris tracking efforts by providing a means for real-time open source data sharing on space debris, while developing new incentive mechanisms to promote sustainable space exploration.'[16] This could potentially combine two perspectives we have discussed; of improving SSA via data sharing, and also perhaps providing more accessible data on mission design which supports the mitigation of space

debris, such as proving information on how your space vehicle will be maintained and later removed at its end-of-life. This would align with LTS Guideline B.8 (2), which reads that States and others should '...encourage manufacturers and operators of space objects, regardless of their physical and operational characteristics, to design such objects to implement applicable international and national space debris mitigation standards...'[17]

Additionally, discussion under the Working Group on the Status and Application of the the United Nations Treaties on Outer Space at the UN COPUOS have been focussed, in one area, on the implementation and utilisation of article 11 of the OST, which requires States to '... inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results...' of activities in outer space.[18] In reality there have been few registrations under article 11; only 65 since 1996.[19] However, recent commercial lunar missions from Astrobotic (US), Intuitive Machines (US) and iSpace (Japan/Europe) have been registered. The latter mission also provided details of the mission regarding lunar regolith acquisition.[20] Blockchain could then feasibly be applied in order to streamline article 11 implementation, and perhaps also as a means of registering and sharing data on resource activity.

The contentious matter of resource appropriation has resulted in accusations of a 'race' between the US and China to secure lunar resources. Meanwhile, in December 2023 members of the oversight and investigation subcommittee of the US House Natural Resources Committee discussed the matter, with some suggesting to utilise safety zones as a means of securing resource-rich areas of the Moon ahead of their competition.[21] Furthermore, in early 2024, a paper submitted by China to the COPUOS Working Group on Legal Aspects of Space Resource Activities asked that the group '...consider formulating initial recommended principles to prevent depletive exploitation of space resources which fails the requirements of sustainability.'[22] This included a reminder about States' obligation under article 6 of the OST to regulate and supervise the activities of private actors on the Moon. The use of a blockchain ledger for resource management could then enable more transparency on the utilisation, quantities and locations of resources, in order to ease tensions, and furthermore enable space to be used as a benefit for all countries, required under article 1 of the OST.[23] This though would prove difficult given the position of the US in that they do not see resources as a global commons.

Finally, for this article, blockchain can also be considered as means of encouraging cooperation and sourcing funding through the use of digital currencies. As discussed, blockchain can allow for the dissemination and sharing of information on a transparent basis, which could help establish cooperative missions towards shared goals for people and planet

e.g. projects for the benefit of humankind, or to build joint missions to support the sustainable development goals. Digital currencies, or cryptocurrencies, could also be utilised on the chain in order to maintain accountability as well as a means of raising funding for shared objectives.

This may work particularly well as a means of building trust between parties where it is otherwise absent. The spirit of space exploration is through cooperation, and the OST embodies this in its preamble, reaffirming '...the importance of international cooperation in the field of activities in the peaceful exploration and use of outer space...'[24]

Conclusion

This article was only brief introduction to the potential uses of blockchain in space exploration and utilisation, and looked centrally at the concept of transparency in enabling data-sharing, safety, registration, resource management and cooperation for the benefit of humankind. It looked also at the concept of fundraising via the use of cryptocurrencies, which could also be explored much deeper.

This article though comes from a legal perspective, in aiming to understand how blockchain can support the use and implementation of the space treaties, as well as some non-binding guidelines, specifically for encouraging sustainable practices. Further research from a technical perspective could of course dive deeper into how the intricacies of the blockchain could utilised, such as through voting rights via tokenisation, and the construction of independant DAO organisations.

There are also risks associated with blockchain, which would also need to be explored before its application. This could include a reluctance to share information with adversaries, and sensitivity to intellectual property rights, or security information. Nonetheless, there is the potential for many diverse applications, would could each be explored in far more detail, individually.

Joseph Holden | Senior Strategist
31 May 2025

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