Space Resources and Its Benefits

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Potentials of Space Resources

- **The Moon, other planets and asteroids contain a rich diversity of minerals, gases and water that could be used to provide raw materials, energy and sustenance to sustain human life and enable exploration deeper into space.**
- **The Moon is the closest near-Earth object at a distance of around 385,000 kilometers, bound by the Earth's gravity. Analysis of the Moon and the 400 kilos of lunar rock and regolith surface material already brought back to Earth indicate that it is rich in important and useful elements.**
- **Other NEOs include asteroids that can be rich in carbon (C-type), metals (M-type) or silica (S-type). The number of near-Earth asteroids already identified now exceeds 20,000 and it continues to rise; more than 1,800 were discovered in 2018 alone.**

--- Luxembourg Space Agency

What is Space Resource

- **TITLE IV—Space Resource Exploration And Utilization ***
- **§ 51301. Definitions**

In this chapter:

(1) Asteroid Resource:

– The term ‘asteroid resource’ means a space resource found on or within a single asteroid.

(2) Space Resource:

(A) In general—The term ‘space resource’ means

- **an abiotic resource in situ in outer space.**

(B) Inclusions—

- **The term ‘space resource’ includes water and mineral**

*** U.S. Commercial Space Launch Competitiveness Act**

Why Space Mining?

- **Objectives*:**
  - **i. To obtain elements that are critical for basic sustenance on Earth.**
    - the asteroid belt in our solar system contains eight-percent metal-rich (M type) asteroids and 75-percent volatile-rich carbonaceous (C type) asteroids
  - **ii. To haul precious minerals and cargo raw materials to Earth to fuel its fast depleting resources.**
    - would significantly increase the mining company's valuation and greatly impact the global economy.
      - *(According to a 2012 Reuters interview with Planetary Resources, a 30-meter-long (98-foot) asteroid can hold platinum worth somewhere from US$25 billion to US$50 billion. These metals are highly useful and valuable, both on Earth and in space).*

**** Source:*** ***SENJUTI MALLICK, RAJESWARI PILLAI RAJAGOPALAN- If space is 'the province of mankind', who owns its resources? – ORF, N'Delhi***

Why Space Mining?

- **Objectives:** *(contd)*

iii. Asteroids give humans the potential to create tools in space, since iron, nickel and cobalt are in abundance.

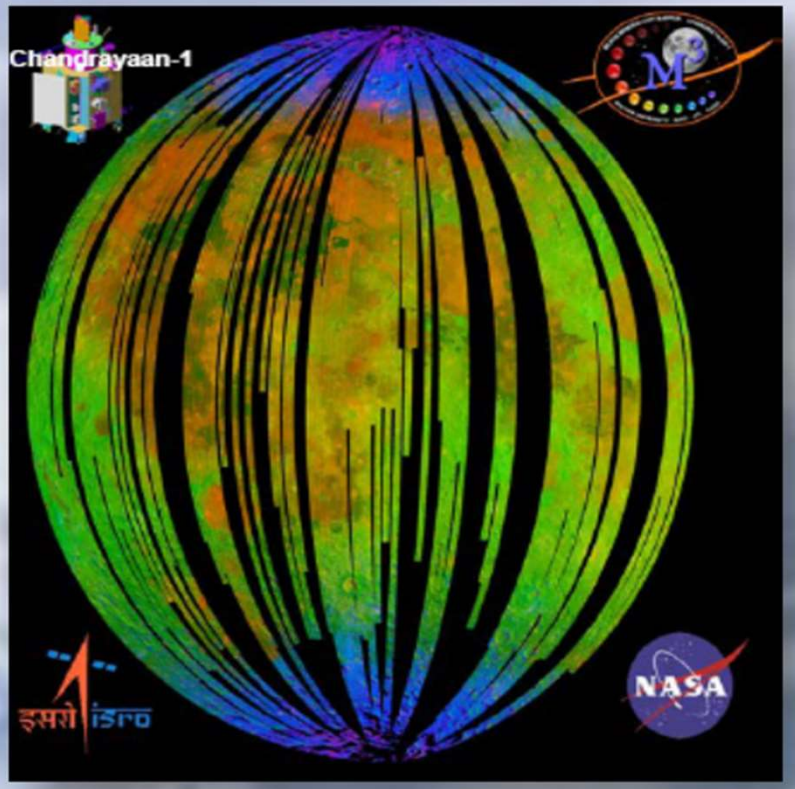
iv. Resource extraction is also becoming a focus for many Middle Eastern nations

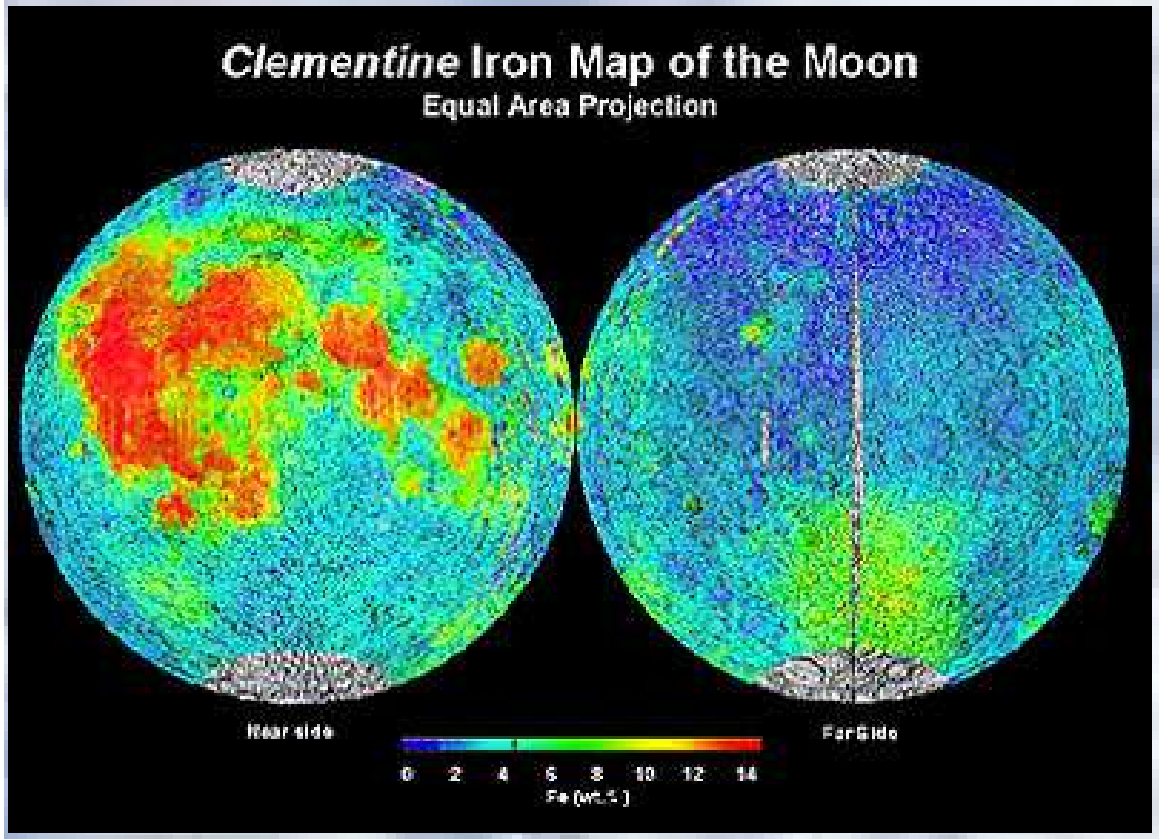
- The Middle Eastern oil States, such as Saudi Arabia and the United Arab Emirates are investing heavily in this industry as they are looking at space as a way to diversify out of the earthly benefits of fossil fuel.

v. countries such as India and China are looking to mine the Moon for extracting Helium-3, which is considered a clean and efficient form of energy.

vi. The water available in outer space could be used to make rocket propellants; since water is abundant in outer space, in some or the other form, it could be extracted and electrolysed to derive hydrogen and oxygen, the key ingredients of rocket fuel.

Important Discoveries from Lunar Resources





High Value Asteroid Materials

ASTEROID ELEMENTAL ABUNDANCE RELATIVE TO EARTH'S CRUST

- H Hydrogen — 17x
- C Carbon — 75x
- N Nitrogen — 74x
- O Oxygen — 1x
- Fe Iron — 4x
- Co Cobalt — 27x
- Ni Nickel — 155x
- Ru Ruthenium — 810x
- Rh Rhodium — 180x
- Pd Palladium — 44x
- Os Osmium — 440x
- Ir Iridium — 540x
- Pt Platinum — 196x

VOLATILES AND H_2O

to fuel the growth of humanity into new frontiers

Potable Water
Radiation Shielding

Fuel

Refrigerant

Agriculture
Metallurgy

INDUSTRIAL METALS

to construct and sustainably service space platforms

PLATINUM GROUP METALS

to support demand growth on Earth

Catalytic Converters

LCDs

Advanced materials

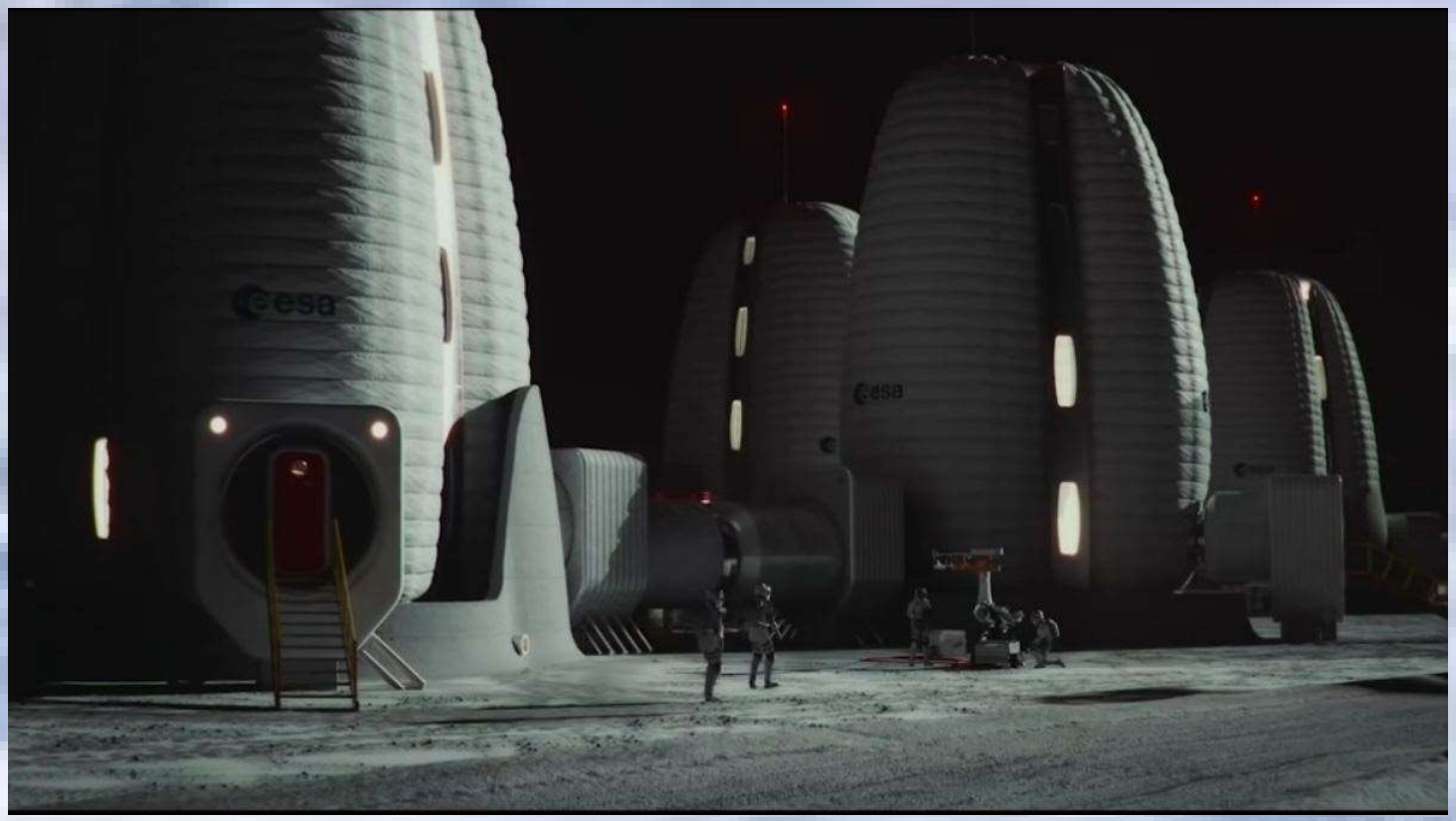
Cancer treatments

Despite desire to reduce dependency, one-in-four manufactured goods require PGMs.

PLANETARY RESOURCES

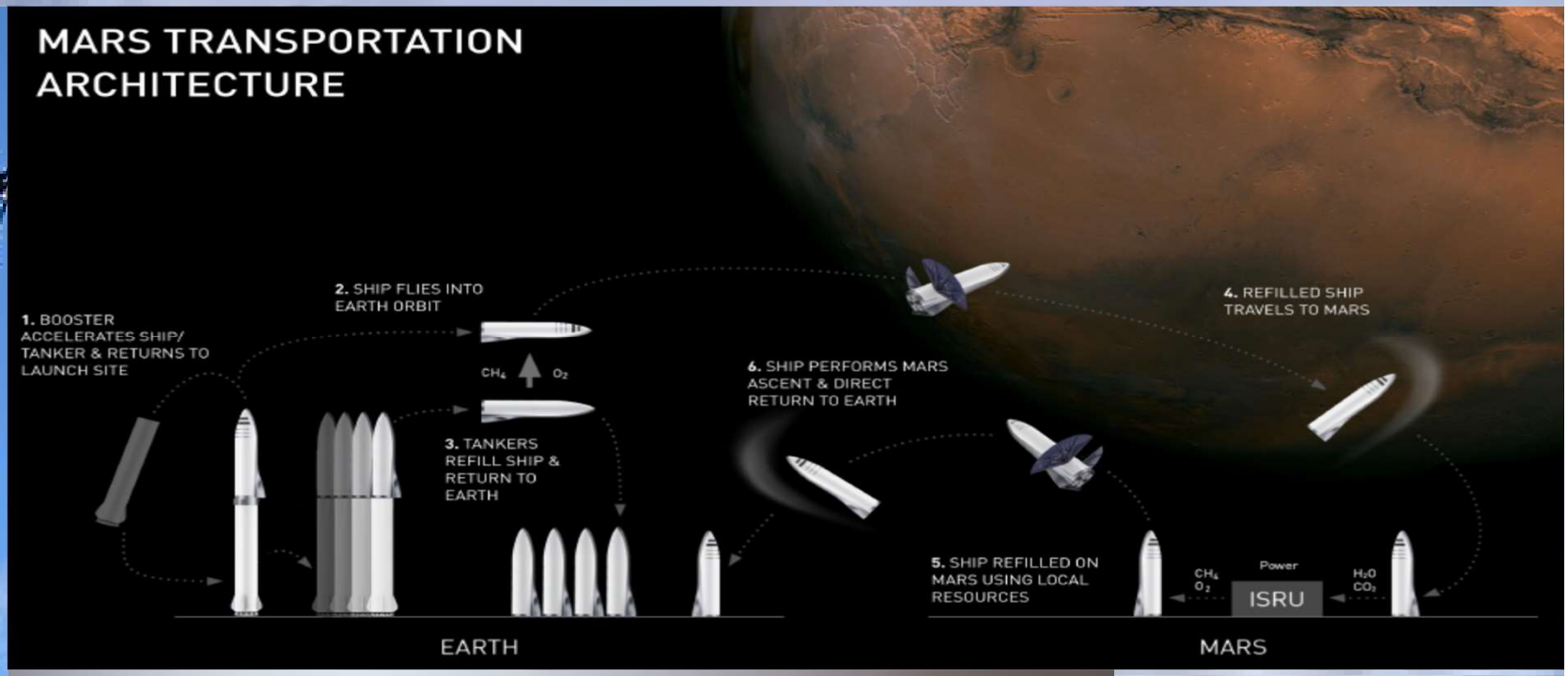

THE SPACE ECONOMY: A MODERN DAY GOLD RUSH
Asteroid Mining Will Create A Trillion-Dollar Industry
As our population grows we need to find a sustainable supply of natural resources to fuel exploration in space and prosperity on Earth.
PLATINUM-RICH ASTEROID
Could contain more Platinum Group Metals than what's been mined on Earth in all of history
NEAR-INFINITE SUPPLY OF PRECIOUS RESOURCES
MORE ASTEROIDS DISCOVERED NEAR EARTH EVERYDAY
1,500 EASIER TO REACH THAN MOON
8,800 DISCOVERED TO DATE
1000+ NEARLY 1K+ FOUND EVERY YEAR
USES OF PLATINUM GROUP METALS ON EARTH
REDUCE COST OF ELECTRONICS
ELECTRIFY TRANSPORTATION
DRIVE INNOVATION, AND CREATE A GREENER EARTH
ONE SINGLE 500M

Lunar Habitats



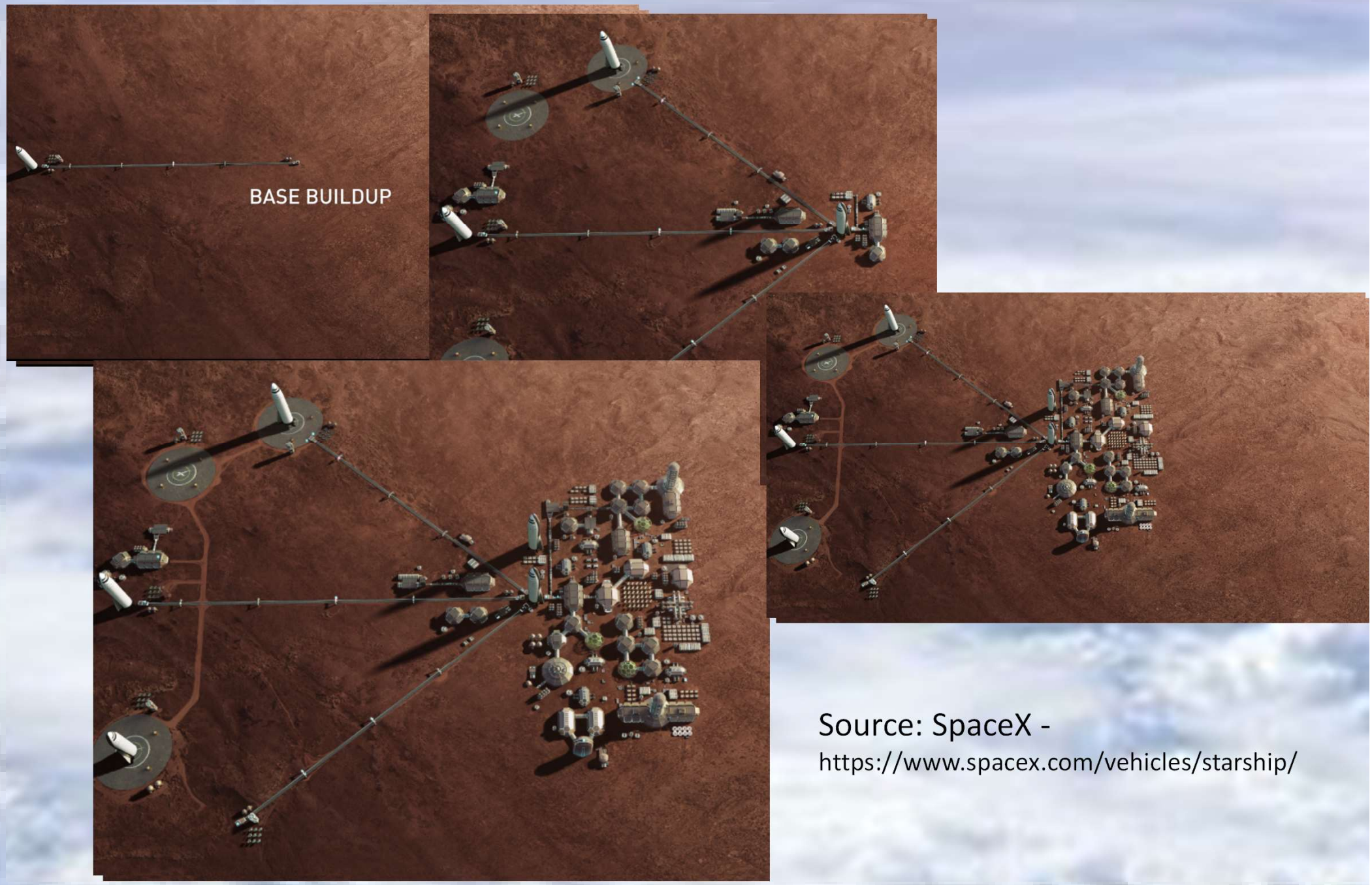
- NASA planning for sustainable human presence on the surface of Moon. Artemis Programme is initiated already.
- ESA is also working on a plan to create an “International Moon Village.”

Mars Colonization Plan of SpaceX



Credit: SpaceX

Base Build up on Mars - SpaceX



Source: SpaceX -
https://www.spacex.com/vehicles/starship/

Legality of Space Resources Utilization

Relevant Articles in OST

- **Article – II of OST: Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.**
- **Article III of OST: States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding.**

What Does Moon Agreement Permit?

- **Article - 4:**
  - **Exploration and Use –**
  - **Province of All Mankind**
  - **Interests of present and future generation**
  - **Need to promote higher standards of living and conditions of economic and social progress and development'**
- **Article 6:**
  - **Freedom of scientific investigation without discrimination of any kind, on the basis of equality, and in accordance with international law**
  - **Permission to collect & remove samples**
- **Article 8:**
  - **Permits exploration and use on or below surface,**
  - **Permits : Landings and re-launch from the Moon**
  - **Placement of personnel, space vehicles, equipment, facilities, stations and installations anywhere on or below the surface of the Moon and their free movement over or below the surface of the Moon**
- **Article 9 :**
  - **Establishment of manned and unmanned stations**

Article 11

1. The Moon and its natural resources are the CHM
2. National appropriation prohibited
3. Right of ownership prohibited
4. Right to exploration and use of the Moon without discrimination of any kind, on the basis of equality and in accordance with international law and the terms of this Agreement
5. Establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the Moon in accordance with §18 as such exploitation is about to become feasible
6. Inform UNSG, the public & the scientific community of any discovery of resources

Article 11 *…Cond*

7. The main purposes of the international regime
   - The orderly and safe development of the natural resources of the Moon;
   - The rational management of those resources;
   - The expansion of opportunities in the use of those resources;
   - An equitable sharing by all States Parties in the benefits whereby the interests and needs of the developing countries, as well as the efforts of those countries, which have contributed, to the exploration, shall be given special consideration.
8. Activities to be compatible with the purposes specified

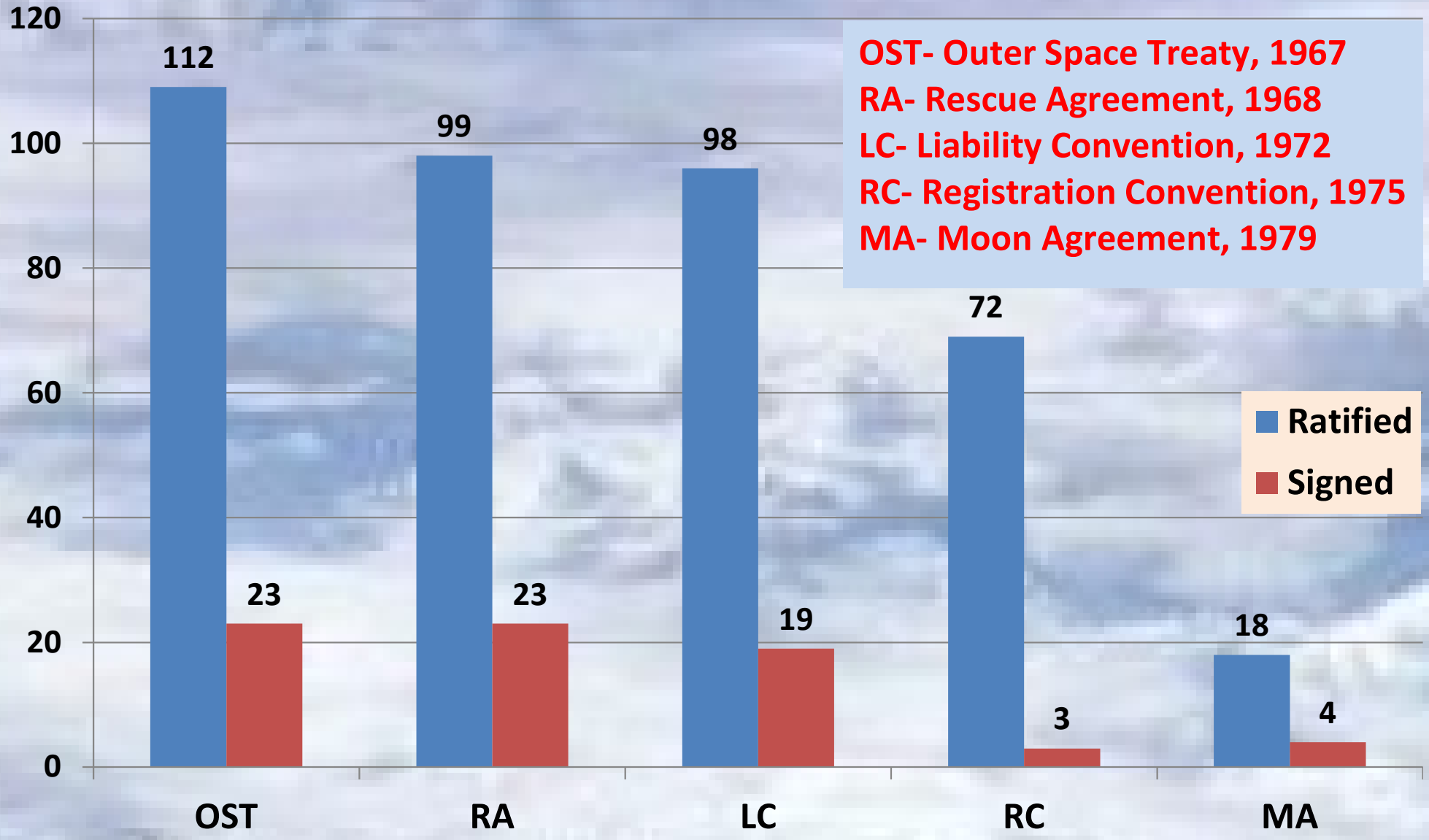
Article 18

Provisions for Review of Moon Agreement

- Ten years after entry into force
  - In the light of the past application of the agreement – through provisional agenda of UNGA
- At any point of time ..
  - After the agreement is in force for five years
  - At the request of 1/3rd of States Parties
  - With the concurrence of majority of State Parties
  - Secretary General shall convene a conference to review the Agreement
- A review conference shall also consider the question of the implementation of the provisions of Art.11, Para.5, on the basis of the principle referred to in Para.1 of that article and taking into account in particular any relevant technological developments.

Status of UN Treaties on Outer Space –

As on January 2022



Subsequent Developments

- **Space Resources Utilization:**
  - USA-Space Resource Exploitation and Utilization Act **2015 -** Popularly known as Asteroid Mining Act *(As part of U.S. Commercial Space Launch Competitiveness Act, 2015- H.R 2262)*
  - Luxembourg's Law on the Exploration and Use of Space Resources (2016)
  - Hague Space Resources Working Group- **Building Blocks** towards reaching international Framework for celestial Resources Utilization
- **Asteroid Sample Recovery Missions**
  - JAXA's **Hayabusa 2** – Sample recovery mission to asteroid **Ryugu**
  - NASA's *Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (**OSIRIS-REx**) to asteroid **Bennu***

US Act 2015

- **U.S. Commercial Space Launch Competitiveness Act (H.R. 2262), Dt. November 25, 2015, some salient features of it are given below:**
  - **It states *inter-alia* that the US President shall -**
    - **facilitate commercial exploration for and commercial recovery of space resources by United States citizens;**
    - **discourage government barriers to the development in the United States of economically viable, safe, and stable industries for commercial exploration for and commercial recovery of space resources in manners consistent with the international obligations of the United States; and**
    - **promote the right of United States citizens to engage in commercial exploration for and commercial recovery of space resources free from harmful interference, in accordance with the international obligations of the United States and subject to authorization and continuing supervision by the Federal Government.**

US ACT 2015 .. Contd..

- ***Asteroid resource and space resource rights: A United States citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States.".***

- **Disclaimer of Extraterritorial Sovereignty: "It is the sense of Congress that by the enactment of this Act, the [US] does not thereby assert sovereignty or sovereign or exclusive rights or jurisdiction over, or the ownership of, any celestial body."**

IISL Position Papers on property rights in outer space and space resources mining

- **2004 Statement** - Emphasized the provision under Article II of OST and reiterated that the object and purpose of this provision was to exclude all territorial claims to outer space, including the Moon and other celestial bodies. Nevertheless, a note under this statement, conveyed that other private activities on the Moon and other celestial bodies are permitted and put the responsibility of authorization and supervision of such activities on the State Party, as per Article VI of the OST.
- **2009 statement**: Emphasized the Article VI of OST, and further conveyed its opinion that a specific legal regime for the exploitation of such resources should be elaborated through the United Nations, on the basis of present international space law, for the purposes of clarity and legal certainty in the near future.

IISL Position Papers … contd..

- **2015 Statement:** In the context of the enactment of the U.S. Commercial Space Launch Competitiveness Act (H.R. 2262), IISL issued another position paper that conveyed the legal position that –
  - ***in view of the absence of a clear prohibition of the taking of resources in the Outer Space Treaty one can conclude that the use of space resources is permitted.***
  - Nevertheless, this legal position was thrown as an open question as to how other states would follow the interpretation of Article II of OST by the US. It concluded that,
  - ***It can be a starting point for the development of international rules to be evaluated by means of an international dialogue in order to coordinate the free exploration and use of outer space, including resource extraction, for the benefit and in the interests of all countries.***

Luxembourg Law on Space Resources, 2017

- **Luxembourg aims to play a leading role in the exploration and utilization of these resources- Encouraging entrepreneurs**
- **Passed the law on 13 July and came in to force on 1st August 2017,**
- **Law provides a unique legal, regulatory and business environment enabling private investors and companies to explore and use space resources**
- ***"Its goal is to ensure that space resources explored under its jurisdiction serve a peaceful purpose, are gathered and used in a sustainable manner compatible with international law and for the benefit of humankind. Luxembourg's vision is built on support for advanced research activities and technological capabilities, drawing on the country's existing expertise in the space sector and its ongoing strategy of economic diversification into future-oriented high-tech industries"***

UAE's National Law

- **The UAE Space Agency announced the details of the new UAE Space Law issued by President His Highness Sheikh Khalifa bin Zayed Al Nahyan, on 24 February 2020.**
- **The law *inter-alia* addresses - space-launch activities, organising manned trips, space tourism and related activities, training and science activities, high-altitude activities, building and using man-made facilities in space and on other planets, ownership and usage rights of space resources, and other commercial activities like mining operations and space logistics services, in addition to the mechanism for dealing with space debris, meteorites, and managing space risks**

Japan's Initial Approach

- **The National Diet of Japan adopted a resolution on November 8th, 2016, to discuss *inter-alia* necessary steps to support the space resource industry.**

Excerpt from the Resolution:

- ***'The Supplementary Resolution attached to the Bills concerning launch and control of satellites, and ensuring adequate handling of satellite remote sensing data'***
  - **With regards to the law enforcement related to satellite launch and management as well as appropriate handling of remote sensing data, the government should cautiously consider the following:**
    1. **Following the examples in the United States, the government should secure necessary personnel and strengthen the enforcement system to promote new entries. At the same time, the government should pay attention to the situation surrounding domestic and international enterprises.**
    2. **The government should monitor the international movement surrounding the space resource industry, as well as discuss necessary steps to support related industries**

(Ispace, Japan)

Japan's Law on Space Resources

- On 16th June 2021, The Law Concerning the Promotion of Business Activities Related to the Exploration and Development of Space Resources was passed by the National Diet of Japan.
- The law provides that Japanese private business operators shall be permitted to engage in the exploration and development of space resources, such as water, minerals, and other non-living resources in outer space, on the Moon and other celestial bodies.

ARTEMIS ACCORDS

- **PRINCIPLES FOR COOPERATION IN THE CIVIL EXPLORATION AND USE OF THE MOON, MARS, COMETS, AND ASTEROIDS FOR PEACEFUL PURPOSES**
  - **SECTION 1 - PURPOSE AND SCOPE**
  - **SECTION 2 – IMPLEMENTATION**
  - **SECTION 3 – PEACEFUL PURPOSES**
  - **SECTION 4 – TRANSPARENCY**
  - **SECTION 5 – INTEROPERABILITY**
  - **SECTION 6 – EMERGENCY ASSISTANCE**
  - **SECTION 7 – REGISTRATION OF SPACE OBJECTS**
  - **SECTION 8 – RELEASE OF SCIENTIFIC DATA**
  - **SECTION 9 – PRESERVING OUTER SPACE HERITAGE**
  - **SECTION 10 – SPACE RESOURCES**
  - **SECTION 11 – DECONFLICTION OF SPACE ACTIVITIES**
  - **SECTION 12 – ORBITAL DEBRIS**
  - **SECTION 13 – FINAL PROVISIONS**

https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf

SECTION 10 – SPACE RESOURCES

1.The Signatories note that the utilization of space resources can benefit humankind by providing critical support for safe and sustainable operations.

2. The Signatories emphasize that the extraction and utilization of space resources, including any recovery from the surface or subsurface of the Moon, Mars, comets, or asteroids, should be executed in a manner that complies with the Outer Space Treaty and in support of safe and sustainable space activities. The Signatories affirm that the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty, and that contracts and other legal instruments relating to space resources should be consistent with that Treaty.

SECTION 10 – SPACE RESOURCES …contd

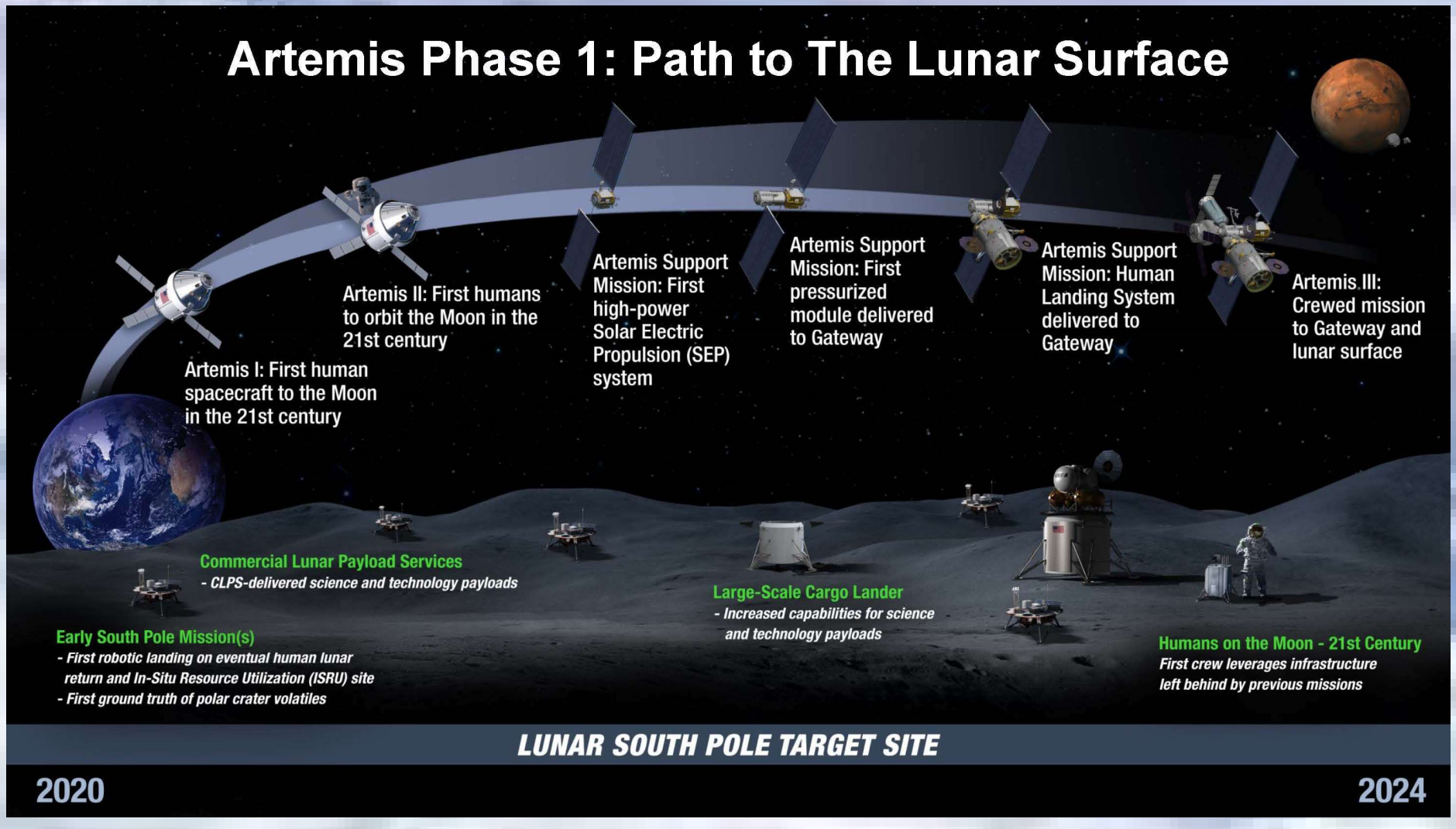
3. The Signatories commit to informing the Secretary-General of the United Nations as well as the public and the international scientific community of their space resource extraction activities in accordance with the Outer Space Treaty.

4. The Signatories intend to use their experience under the Accords to contribute to multilateral efforts to further develop international practices and rules applicable to the extraction and utilization of space resources, including through ongoing efforts at the COPUOS.

ARTEMIS ACCORDS - Signatories

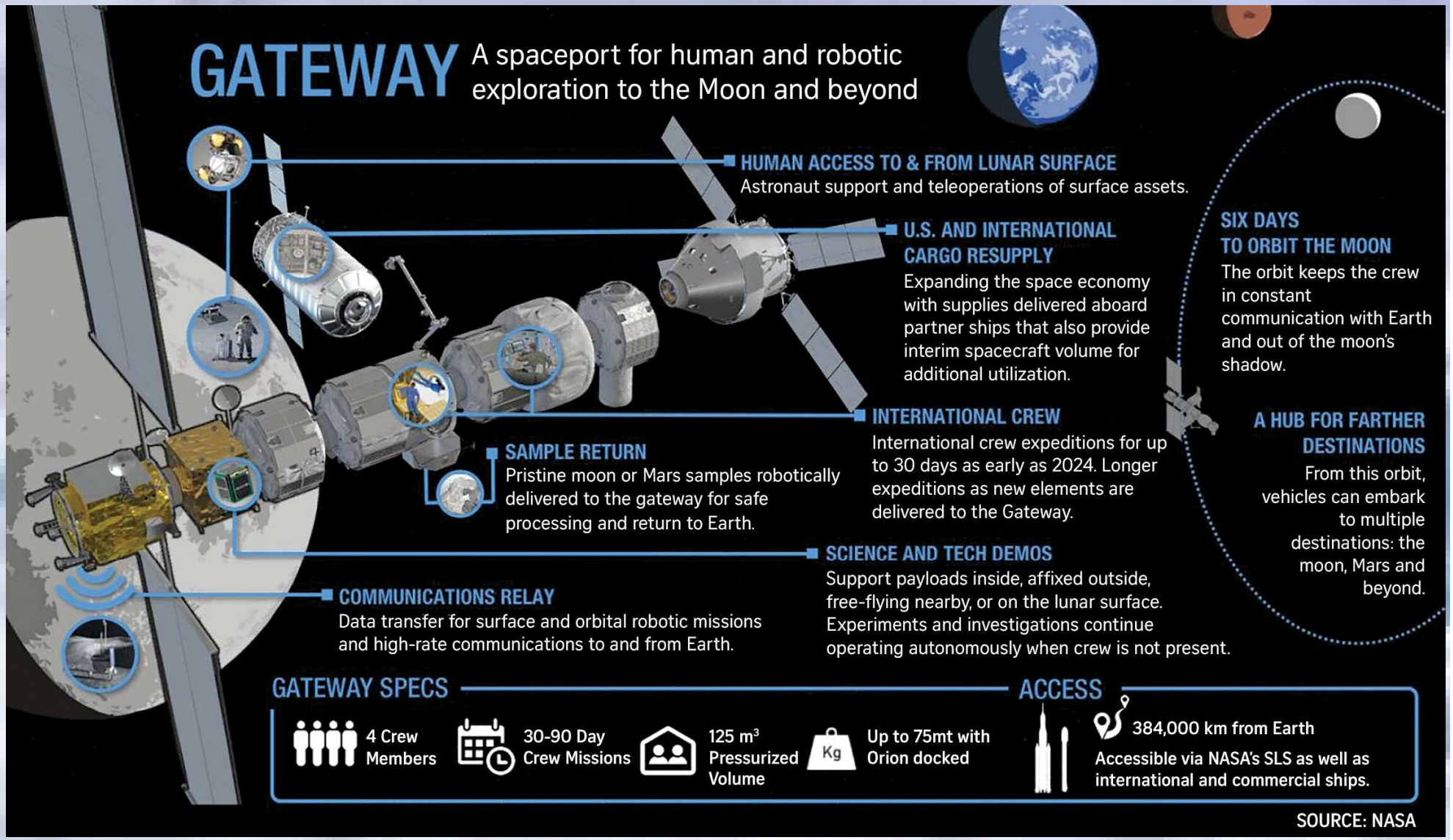
- As of October 2022, 20 countries have signed the Artemis Accords individually with US: Australia, Bahrain, Brazil, Canada, Colombia, France, Israel, Italy, Japan, the Republic of Korea, Luxembourg, Mexico, New Zealand, Poland, Romania, Singapore, Ukraine, the United Arab Emirates, the United Kingdom, and the United States
- The signing of the accords represents a significant political attempt to codify key principles of space law and apply them to the programme.
- The Artemis accords are bilateral agreements and not binding instruments of international law. It is expected by the signatories that it would develop a customary law by establishing practice in the area, which could have a significant influence on any subsequent governance framework for human settlements on Mars and beyond.

ARTEMIS Program



Lunar Gateway Program

- **Lunar Gateway program, an advanced planned mini-space station to orbit the moon and intended to serve as a home base for missions to the moon's surface, including the Artemis 3 mission to land the first woman and next man on the moon by 2024.**
- **From facilitating short-term missions, the station will evolve and pioneer what will become the first sustainable human presence on the moon.**
- **Artemis Programme to facilitate NASA to land the first woman and next man on the Moon by 2024, using innovative technologies to explore more of the lunar surface than ever before. The learning through Artemis programme, to take the next giant leap of sending astronauts to Mars.**


GATEWAY
A spaceport for human and robotic exploration to the Moon and beyond
HUMAN ACCESS TO & FROM LUNAR SURFACE
Astronaut support and teleoperations of surface assets.
U.S. AND INTERNATIONAL CARGO RESUPPLY
Expanding the space economy with supplies delivered aboard partner ships that also provide interim spacecraft volume for additional utilization.
SIX DAYS TO ORBIT THE MOON
The orbit keeps the crew in constant communication with Earth and out of the moon's shadow.
INTERNATIONAL CREW
International crew expeditions for up to 30 days as early as 2024. Longer expeditions as new elements are delivered to the Gateway.
A HUB FOR FARTHER DESTINATIONS
From this orbit, vehicles can embark to multiple destinations: the moon, Mars and beyond.
SAMPLE RETURN
Pristine moon or Mars samples robotically delivered to the gateway for safe processing and return to Earth.
SCIENCE AND TECH DEMOS
Support payloads inside, affixed outside, free-flying nearby, or on the lunar surface. Experiments and investigations continue operating autonomously when crew is not present.
COMMUNICATIONS RELAY
Data transfer for surface and orbital robotic missions and high-rate communications to and from Earth.
GATEWAY SPECS
4 Crew Members
30-90 Day Crew Missions
125 m³ Pressurized Volume
Kg
Up to 75mt with Orion docked
ACCESS
384,000 km from Earth
Accessible via NASA's SLS as well as international and commercial ships.
SOURCE: NASA

Concluding Remarks

- The Moon Agreement has permitted peaceful missions to the Moon
- The Treaty has served the cause of science very well
- Enabling Technology for commercial exploitation is round the corner
  - Revised programs to Lunar landing
  - Lunar Colonies
  - Technology for assembly and manufacturing
- Exploitation of resources of the moon is inevitable.
- The Treaty also provides a way for commercial exploitation subject to Article 11 provision.
- The treaty also permits review and reconsideration of the Treaty

Time for Revision of Moon Agreement ! ?

- **Renewed interests on -**
  - **Lunar missions for sample recovery**
  - **Private entities' interests Human landing on Moon and Mars**
  - **More Asteroid Sample Recovery Missions**
- **Enactment of enabling legal regimes by a few Countries – USA, Luxembourg, UAE, and Japan**
- **Establishment of New Private industries - *Planetary Resources, Deep Space Industries, Ispace, … ..***
- **Initiatives of international Working Groups – The Hague Space Resources Governance Working Group**
- **Discussions in UNCOPUOS - Legal Sub Committee**
  - **Working Group has been constituted in LSC 2020**

- ***Thank you for your kind attention!***

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Additional References

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