Introduction to Space Security

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Outline

- Introduction to Space Security
  - Safety, Security and Sustainability
- Space Security Index
- Issues & Concerns to Space Security
- Militarization / Weaponization of Outer Space
- Constellation Satellites
- Space Debris Issues
- UN Initiatives to reduce Space Threats
- Conclusion

Safety Vs Security

- Safety is the condition of being protected from harm caused by non-intentional failure - *protection against accidental harm*
- Security is the condition of bring protected from harm caused by intentional human actions or behaviours- *protection against intentional harm*

(https://www.coursera.org/lecture/security-safety-globalized-world/what-is-safety-and-security-VXD42- University of Leiden)

Space -Safety, Security, Sustainability

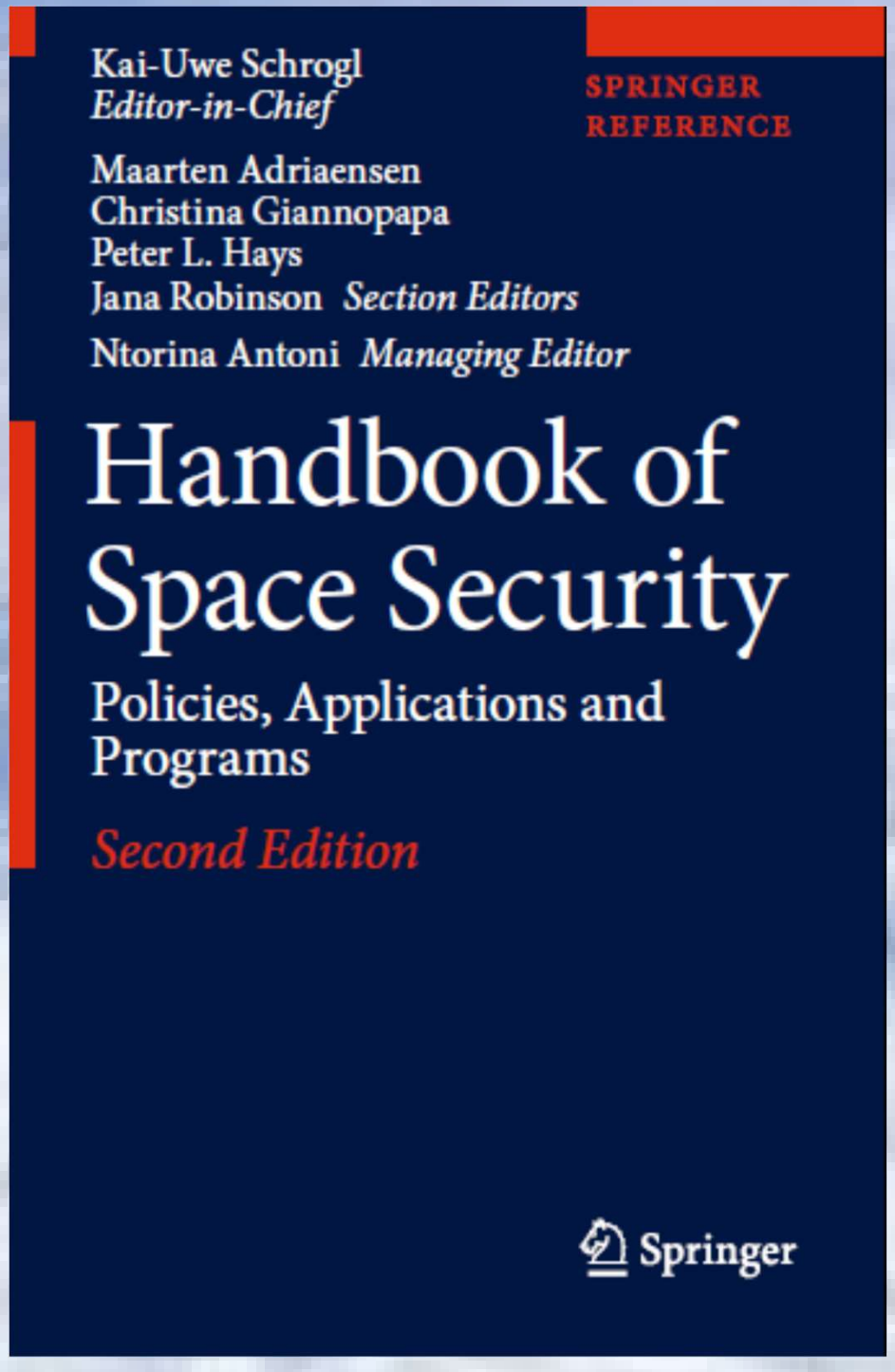
- **Space Safety** refers to cumulative measures drawn up towards precluding inherent malfunctions and mitigating the risks of accidental damage that would be caused by or experienced/ endured by a space object, including its component parts.
- **Space Security** refers to the protection of a space object, including its component parts, against the risk of intentional actions undertaken by external or unauthorized actors.
- **Space Sustainability** refers to ensuring that all humanity can continue to use outer space for peaceful purposes and socio-economic benefits now and in the long term. This will require international cooperation, discussion, and agreements designed to ensure that outer space is safe, secure, and peaceful.

Space Security - Definitions

- The secure and sustainable access to, and use of, space and freedom from space-based threats- *Space Security Index Reports (The Simon Foundation, Canada)*
- Secure and sustainable access to, and use of outer space in accordance with international laws and treaties, free from the threat of disruption - *Space Generation Advisory Council, Vienna*
- Security from space, where Space-based assets and systems are critical to ensuring security on Earth, and security of space, where these assets need to be protected in the difficult environment of outer space - *The European Commission*

Space Security – Definitions *…Contd.*

- The aggregate of all technical, regulatory and political means that aims to achieve unhindered access and use of outer space from any interference as well as aims to use space for achieving security on Earth - *N. Antoni, Eindhoven University of Technology, Eindhoven, The Netherlands in* ***Hand Book of Space Security, 2020 Edition***
- **From the above definitions, it can be construed that, Space Security has to offer and ensure'-**
  - **Freedom of Exploration**
  - **Freedom of Access**
  - **Freedom of Utilization for peaceful purpose**
  - **Protection of space systems and space environment from all threats**
  - **Compliance to all relevant international laws and treaties on outer space activities**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Why Space Security Issues?

- Increased use of space for civil, commercial and military purposes, besides exploration
- New and Multiple actors- More Space faring & Space active nations and Private players of these nations
- New technologies for access to space, spacecraft system, Space operations
  - Constellation satellites, Space Resources Mining, Space Tourism, Space Colonization etc.
- **Outer Space Is Congested, Contested and Competed**
- **Safety, Security and Sustainability under threat?!**
- **Contribution of Geo-Political issues - *Russia Vs Ukraine war***

Dimensions of Space Security

- **Security – in Space**
  - Security to Space Objects, Space station and all activities performed in outer space through human endeavours - Threats From Ground or Space
- **Security – From Space**
  - Services availed from space objects in outer space for military, economic (commercial) and national security
- **Security - To Space Environment**
  - Creation of space debris, Placement of conventional arms and weapons of mass destruction, accidental dumping of nuclear materials, contamination of outer space by earth bound biological systems (living organisms, bacteria etc.) - (***Israeli Lunar Lander Beresheet crashed on lunar surface in 2019 - Spilled Tardigrades on the Moon)***

Space Security Index Project

- The Space Security Index Project patronaged by Simon Foundation, Vancouver, Canada aims to improve trust and transparency related to space activities, and to provide a common, comprehensive, objective knowledge base to enhance capacity for dialogue and policies that contribute to the governance of outer space as a shared global commons.

- https://spacesecurityindex.org/

https://secureservercdn.net/45.40.146.28/9ac.6b8.myftpupload.com/wp-content/uploads/2019/10/SSI2019ExecutiveSummaryCompressed.pdf

Space Security Index

The Space Security Index publication surveys developments in space security by assessing annual changes in eight indicators of space security. These are:

1. **The space environment**
2. **Space situational awareness**
3. **Laws, policies, and doctrines**
4. **Civil space and global utilities**
5. **Commercial space**
6. **Space support for terrestrial military operations**
7. **Space systems protection**
8. **Space systems negation**

Issues & Concerns to Space Security

- Uncontrollable growth of Space Debris
  - Debris Mitigation, Debris Removal
- Trends of Military Space Activities of Major Spacefaring Nations tending towards weaponization
  - Development of Counter-Space Technologies
  - Demonstration of Counter -Space Capabilities
  - Establishment Specialized Space Command by Major Spacefaring Nations
- Others: Mega Constellations, Space Resources Exploitation & Utilization

Space Debris

Sources of Space Debris

- Mission related - Satellites, Rocket bodies
- Accidental – Satellite break-ups, On-Orbit Collisions, Drop-outs from astronaut's extra-vehicular activities
- Intentional or Avoidable – ASAT tests, Intentional Destructions, Abandonment of space objects in LEO, launching of Space Objects non-compliant to UN debris mitigation measures, micro and small satellites … …

Space Debris in motion

UNITED NATIONS
Office for Outer Space Affairs

esa

#SpaceCare

SATELLITES VS DEBRIS

2700 working satellites share their orbits with **8800** tonnes of **space debris**

≈ 1950
discarded rocket stages

≈ 2850
defunct satellites

≈ 21 000
unidentified debris objects and fragments

≈ 34 000
fragments larger than 10 cm

Debris objects travel many kilometres per second. In case of impact, they may destroy working satellites

≈ 128 million
debris fragments
1 mm–1 cm in size

≈ 900 000
fragments
1–10 cm in size

About **26 000 debris objects** are **monitored from Earth**

Smaller objects that cannot be monitored **estimated by statistical models**

Up-to-date as of December 2020

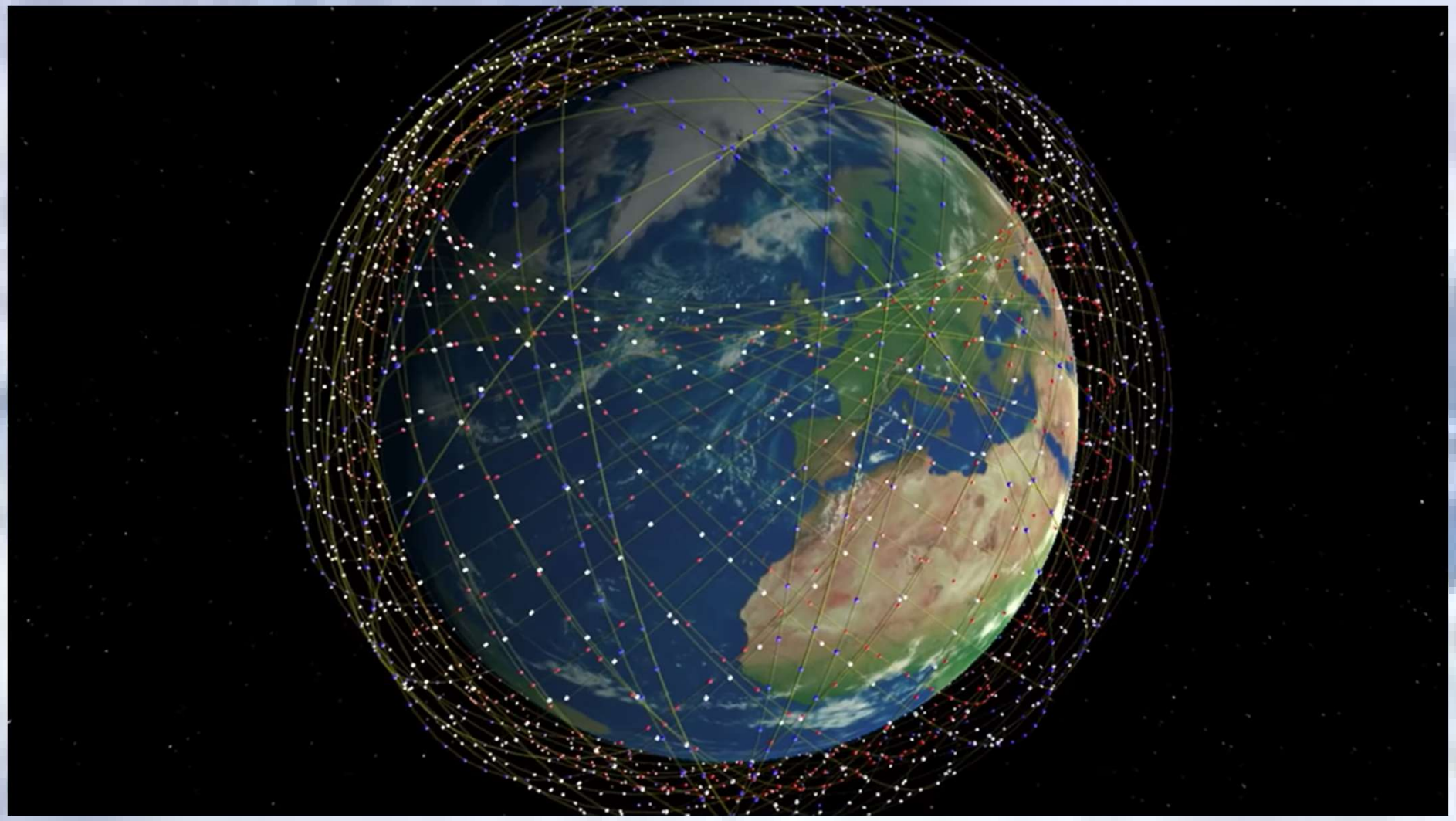
#SpaceSustainability

Space Debris – *Remedial Measures*

- **Alternate Measures**
  - **Active Removal of Debris (Active Debris Removal ADR)**
  - **On-Orbit Satellite Servicing**
- **Challenges**
  - **Technology – Development – Demonstration**
  - **High Cost – Sharing - International co-operation**
  - **Policy – Consensus – Willingness**
  - **Legal – Liability – Dispute Settlement**

Small / Nano Satellite Constellations

Proposed Starlink Satellite Constellation



Space Traffic Management

- **European Satellite Dodges Potential Collision with SpaceX Starlink Craft**

- **The European Space Agency's (ESA) Aeolus Earth Observation satellite fired its thrusters as an evasive maneuver on Sept. 2, 2019 to make sure it didn't collide with one of SpaceX's recently launched internet craft.**
- **Prior warnings/ Negotiations Failed**
- **ESA Calls for Space Traffic rules**

Starlink Satellites Near Collision with China's Space Station

- People's Republic of China, in a written submission to the UN General Assembly, stated that its under-construction space station had to perform evasive manoeuvres twice after the Starlink satellites launched by SpaceX came in close proximity.
  - In the first close encounter, Starlink-1095 satellite and the China Space Station came close on July 1, 2021; Starlink satellite was cruising in orbit at an average altitude of around 555 kilometres. However, between May 16 and June 24 2021, the Starlink-1095 satellite manoeuvred continuously to an orbit of around 382 km
  - second close encounter happened on October 21 when the Starlink-2305 satellite had a subsequent close pass with the Chinese Space Station.
- **China stated that "To ensure the safety and lives of in-orbit astronauts, the China Space Station performed an evasive manoeuvre again on the same day to avoid a potential collision between the two spacecraft,".**

Trends of Military Space Activities tending towards Weaponization

Trend of Space Weaponization

- The weaponization of space often refers to the deployment of conventional and nuclear weapons into orbit or their launch from orbit to Earth.
- This definition includes –
  - ground-to-space weapons (such as a direct-ascent anti-satellite missile),
  - Space-to-space weapons (such as manoeuvring one satellite close to another in order to be within range to interfere with its electronics), and
  - space-to-ground weapons (such as proposed space-based interceptors).

  These weapons categories are often referred to as counterspace weapons.

Space Weapon

The Union of Concerned Scientists has offered a series of definitions that attempt to address these issues.

- A space weapon is defined as “any device or component of a system designed to inflict physical harm through deposition of mass and/or energy on any other object.”
- “Weapons in space” are defined as “those that travel on a complete or partial orbit, or are placed at a stable point beyond Earth orbit.”
- In addition “a component that is part of a system not exclusively based in space, such as a relay for a ground-based laser, would be considered a space-based weapon” *(United Nations Institute for Disarmament Research 2004, pp. 45–46).*

Types Of Space Weapons

- **Kinetic Physical** - A direct-ascent ASAT
- **Non-Kinetic Physical** - lasers, high-powered microwave (HPM) weapons, and electromagnetic pulse (EMP) weapons
- **Electronic**- jamming, or spoofing radio frequency (RF) signals.
- **Cyber**- cyberattacks target the data itself and the systems that use this data.

Key Counterspace Concepts

- **Kinetic Energy Threats:** Kinetic energy threats, or antisatellite (ASAT) missiles, are designed to destroy satellites without placing the weapon system or any of its components into orbit. These systems typically consist of a fixed or mobile launch system, a missile, and a kinetic kill vehicle. These weapons could also be launched from aircraft. Once released, the kinetic kill vehicle uses an onboard seeker to intercept the target satellite. Ground-based ASAT missile attacks are more easily attributed than some other counterspace weapons, such as DEW, and their effects can create orbital debris.
- **Directed Energy Weapons (DEW):** DEW use directed energy to disrupt, damage, or destroy enemy equipment and facilities. These weapons, which can have effects ranging from temporary to permanent, include lasers, high-power microwaves, and other types of radiofrequency weapons. It can be difficult to attribute the origin of a DEW attack, depending on the type.

Key Counterspace Concepts

- **Electronic Warfare:** EW includes using jamming and spoofing techniques to control the electromagnetic spectrum. EW can be challenging to attribute and distinguish from unintentional interference. Uplink jamming is directed toward the satellite and impairs services for all users in the satellite reception area. Downlink jamming has a localized effect because it is directed at ground users, such as a ground forces unit using satellite navigation to determine their location. Spoofing deceives the receiver by introducing a fake signal with erroneous information.
- **Orbital Threats:** Orbital or space-based systems are satellites that can deliver temporary or permanent effects against other spacecraft. These systems could include payloads such as kinetic kill vehicles, radiofrequency jammers, lasers, chemical sprayers, high-power microwaves, and robotic mechanisms. Some of these systems, such as robotic technology for satellite servicing and repair and debris removal, have peaceful uses but can also be used for military purposes.

Key Counterspace Concepts

- **Cyberspace Threats:** Cyberspace pervades all other warfighting domains, including space, and many space operations depend on cyberspace and vice versa. With sophisticated knowledge of satellite and data distribution networks, actors can use offensive cyberspace capabilities to enable a range of reversible to non-reversible effects against space systems, associated ground infrastructure, users, and the links connecting them.
- **Space Situational Awareness (SSA):** SSA is having current knowledge of a space object's location and the ability to track and predict its future location; it also incorporates understanding of an actor's intent for their spacecraft.22 SSA is necessary for space operations, including the ability to successfully target space objects and assess the effectiveness of an attack. Space object surveillance and identification sensors, which can include telescopes, radars, and space-based sensors, provide the data for SSA.

Global Assessment of Counter Space Capabilities

	China	Russia	U.S.	France	India	Iran	Japan	North Korea
LEO Co-Orbital	Y	G	Y	R	R	R	R	R
MEO/GEO Co-Orbital	Y	Y	Y	R	R	R	R	R
LEO Direct Ascent	G	Y	Y	R	Y	R	R	R
MEO/GEO Direct Ascent	Y	Y	Y	R	R	R	R	R
Directed Energy	Y	Y	Y	Y	R	R	R	R
Electronic Warfare	G	G	G	Y	Y	Y	R	Y
Space Situational Awareness	G	G	G	Y	Y	Y	Y	R

Legend: none R some Y significant G

Demonstration of Counter-Space Capabilities

- **ASATs**
  - Development and demonstration of various types of ASAT tests were performed by the cold war rivalries, namely the U.S and the USSR during 1960 to mid-1980
  - 1983- StarWar Program of Regan Govt
  - 1985- Unilateral moratorium by USSR
  - 2007 – China's ASAT test – reignited the issue
  - 2008- US ASAT Test
  - 2019- India's ASAT test- Mission Shakthi
  - 2021- Russia's ASAT Test

Demonstration of Counter-Space Capabilities

- **Other major Counter Space activities – Cyber, Jamming , etc.….**
  - 2007- China made a cyber attack on U.S. remote sensing satellite, Landsat
  - 2008- NASA's earth observation satellite, Terra's control was taken over for a very few minutes by China, through intrusion into their mission control software
  - 2009- Russia reportedly dazzled a Japanese satellite through direct energy attack means
  - 2011- U.S satellite was reportedly blinded by direct energy attack by Iran
  - 2013- China demonstrated a High altitude direct ascent launch system (target Geo stationary orbit)
  - 2014- China's cyber-attack on a NOAA weather satellite of USA , which disrupted the downlink data transmission
  - 2019 - Russia launched a small satellite, Cosmos 2543 on November 25, 2019, into a "target orbit from which the state of domestic satellites can be monitored

China's grabbing of Geo Satellite

- On January 22, China's Shijian-21 satellite (SJ-21), went missing from its orbital slot for a few hours during daylight, making observations with optical telescopes difficult.
- SJ-21 was then seen performing a "large manoeuvre" to approach a dead BeiDou Navigation System satellite.
- SJ-21 then hauled the dead satellite out of its usual geosynchronous orbit and positioned it in a graveyard orbit a few hundred miles away.
- Link: https://youtu.be/UDCLpXCB62w

Establishment Specialized Space Command by Major Spacefaring Nations

- 2019- February, 19 – United States established its Space Force
- 2019- July, 13 – France – Space Command
- 2019- June,11 – India - Defence Space Research Agency (DSRA)
- 2020- May, 18 – Japan - Space Operations Squadron
- 2022 – Australia- Space Command under Royal Australian Air Force (RAFF) – Yet to be announced

UN Initiatives under Disarmament Affairs

- In 2020, UN General Assembly inter-alia passed a special resolution on Arms Control Measures in Outer Space, (No. RES/RES/75/36), on '**Reducing space threats through norms, rules and principles of Responsible behaviours'.**
- Through this resolution the UNGA *inter-alia*, encouraged the Member States to-
  - study existing and potential threats and security risks to space systems, including those arising from actions, activities or systems in outer space or on Earth,
  - characterize actions and activities that could be considered responsible, irresponsible or threatening and their potential impact on international security, and
  - share their ideas on the further development and implementation of norms, rules and principles of responsible behaviours and on the reduction of the risks of misunderstanding and miscalculations with respect to outer space.

UN Initiatives under Disarmament Affairs

- In pursuant to resolution 75/36, Member States made submissions without prejudice to their individual positions.
- This report provides a consolidated summary of elements from the submissions received from Member States to UN Secretary General.
- Based on these submissions, UN Secretary-General's Office prepared a Report on Reducing space threats through norms, rules and principles of responsible behaviours in July, 2021. **(https://documents-dds-ny.un.org/doc/UNDOC/GEN/N21/118/94/PDF/N2111894.pdf?OpenElement)**
- It presents existing and potential threats and security risks to space systems, including those arising from actions, activities or systems in outer space or on Earth;

UN Initiatives under Disarmament Affairs

- **Report of the Secretary-General … …**
- … … Contd..
- Deals on characterization of actions and activities that could be considered responsible, irresponsible or threatening and their potential impact on international security; and
- Provides ideas on the further development and implementation of norms, rules and principles of responsible behaviours and on the reduction of the risks of misunderstanding and miscalculations with respect to outer space
  - Approaches to reducing space threats through norms, rules and principles of responsible behaviours
  - Principles and objectives for reducing space threats through norms, rules and principles of responsible behaviours
  - Possible elements for reducing space threats through norms, rules and principles of responsible behaviours
  - Process for reducing space threats through the development of norms, rules and principles of responsible behaviours

Latest UN GA Resolution on PAROS

- 2021, November - UN GA (A/C.1/76/L.52) **'Reducing Space Threats Through Norms, Rules And Principles Of Responsible Behaviours'**
  - to convene in 2022, an open-ended working group to:

    (a) Take stock of the existing international legal and other normative frameworks concerning threats arising from State behaviours with respect to outer space;

    (b) Consider current and future threats by States to space systems, and actions, activities and omissions that could be considered irresponsible;

    (c) Make recommendations on possible norms, rules and principles of responsible behaviours relating to threats by States to space systems, including, as appropriate, how they would contribute to the negotiation of legally binding instruments, including on the prevention of an arms race in outer space;

    (d) Submit a report to the General Assembly at its seventy-eighth session

Latest UN GA Resolution on PAROS *..contd*

- UK Sponsored Resolution with 36 Co-Sponsors
- The resolution found overwhelming support with 163 states voting for it, eight against and nine abstentions.
- China, Iran, North Korea, and Russia were among the countries that voted against the resolution.
- India, Israel ,, were among those that abstained from voting.

The U.S. Pledge on ASAT Ban

- On April, 18, 2022 the Space Council of United States chaired by the Vice President Kamala Harris unilaterally announced that the U.S. will not conduct debris-generating direct-ascent anti-satellite tests, leading by example to establish international norms of responsible behaviour in space.
- This was a major boost to the Open Ended Working Group (OEWG) – The 1st Session was scheduled for 9-13, May,2022.
- This moratorium announced by USA was appreciated and supported by Nine other states namely Canada, New Zealand, Japan, Germany, the United Kingdom, South Korea, Australia, Switzerland and France. They also declared their position on the same line.
- Subsequently, three more States namely The Netherlands, Austria and Italy have also joined the pledge in this year, making the total number to 13 as of April, 2023.

India's Position

- India continues to support substantive consideration of the prevention of an arms race in outer space within the multilateral framework of the United Nations and remains committed to the negotiation of a universally acceptable and multilaterally negotiated legally binding instrument on the prevention of an arms race in outer space in the Conference on Disarmament. India remains committed to playing a leading and constructive role together with other Member States in deliberations and negotiations on legally binding measures to prevent an arms race in outer space, as well as transparency and confidence-building measures and long-term sustainability guidelines. … … C/o

India's Position

- B/f …. ….. **However, while universal and non-discriminatory transparency and confidence-building measures can play a useful complementary role, they cannot be a substitute for legally binding instruments in this field**. Any new international legal framework in outer space must be premised on the understanding that outer space should remain an operationally stable and safe environment that is maintained for peaceful purposes in the interest of all countries, without discrimination of any kind and with due regard for the principle of equity.

OEWG Sessions

- OEWG has held three sessions so far:
- 1st Session : 9-13 May, 2022
- 2nd Session : 12-16 September, 2022
- 3rd Session : 30 January to 3 February, 2023
- Agenda Points: 1. Norms, rules and principles (NRP) derived from existing international legal and other normative frameworks; NRP relating to - counter space capabilities, operations involving dual use capabilities, information exchange on space policies, information exchange and risk reduction notifications related to outer space activities and international cooperation including with respect to space surveillance and tracking and space situational awareness
- 4th Session : Scheduled to be during 07-11 August, 2023

Discussion on
Russia –Ukraine Ongoing issue

China's New ASAT Technology

Source: The Eurasian Times - https://eurasiantimes.com/china-develops-new-starlink-killer-anti-satellite-microwave-weapon/ DoA: April, 10, 2023

- China claims to have developed a compact power source that could drastically reduce the size of a high-power microwave weapon, which can produce up to 10 gigawatts of power, with a frequency of 10 pulses per second.
- The Chinese media report said that the high-intensity energy produced by this device could generate microwave beams that are potent enough to damage drones, airplanes, and even satellites.
- Defense Analysts predict that this device is capable of downing Starlink satellites
- Following the effective use of SpaceX's Starlink satellites against Russia in Ukraine, several experts noted that the Chinese military had accelerated the development of high-power microwave weapons.
- 'Starlink Killer' Anti-Satellite Microwave Weapon can cut Taiwan from US during war.

Conclusion

- **Outer Space – Province of All Humankind**
- **Outer Space environment to be used for peaceful purposes and to be sustained for future generation.**
- **Space Systems for wide variety of applications – Becomes critical national infrastructure**
- **Protection of Space Systems, and services and space infrastructure are very essential**
- **Fair & Responsible use of Outer Space Activities by all stake holders are warranted**
- **Creating a legal regime for 'Reducing space threats through norms, rules and principles of responsible behaviours', through consensus of nation states and their stakeholders is the need of the hour**
- ***Way Forward.. Cooperation all nation states towards reaching common security in outer space and ensuring a long term sustainability of outer space activities for the benefit of humanity***

- *Thank you for your kind attention!*
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