

Presentation

by

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Contemporary Space Security Issues

**Common heritage of mankind/humanity, is a
*principle of international law***

**Arms control, Disarmament, Non-proliferation
are the terms for *international restrictions***

Global Commons

- Term used to describe international, supranational, and global resource domains in which common-pool resources are found
- A zone of land or water owned or used jointly by the members of a community. The global commons includes those parts of the Earth's surface beyond national jurisdictions — like the open ocean and the living resources found there, or say atmosphere. The only landmass that may be regarded as part of the global commons is Antarctica
- Today, the Internet, World Wide Web and resulting cyberspace are often referred to as global commons
- Other usages sometimes include references to open access information of all kinds, including arts and culture, language and science, though these are more formally referred to as the *common heritage of mankind*

Common Heritage of Mankind

- Ethical concept and a general concept of international law
- Some *localities* belong to all humanity and their resources are available for everyone's use and benefit
- It is important from the point of view of **future generations** and the needs of **developing countries**. Should be protected from exploitation by individual nation states or corporations

CHM...mentioned

- Preamble to the 1954 Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict
- The Antarctic Treaty (1961)...refers indirectly
- Specifically enunciated as an obligation under international law in the Outer Space Treaty of 1967 (Article 1, 2, 4)
- Appears in the Moon Treaty (1979). Article 11 states that “the Moon and its natural resources are the common heritage of mankind”
- Specified by Part XI of the Convention on the Law of the Sea (1982)

Limits of National Jurisdiction & Sovereignty

Outer space (including Earth orbits; the Moon and other celestial bodies, and their orbits)

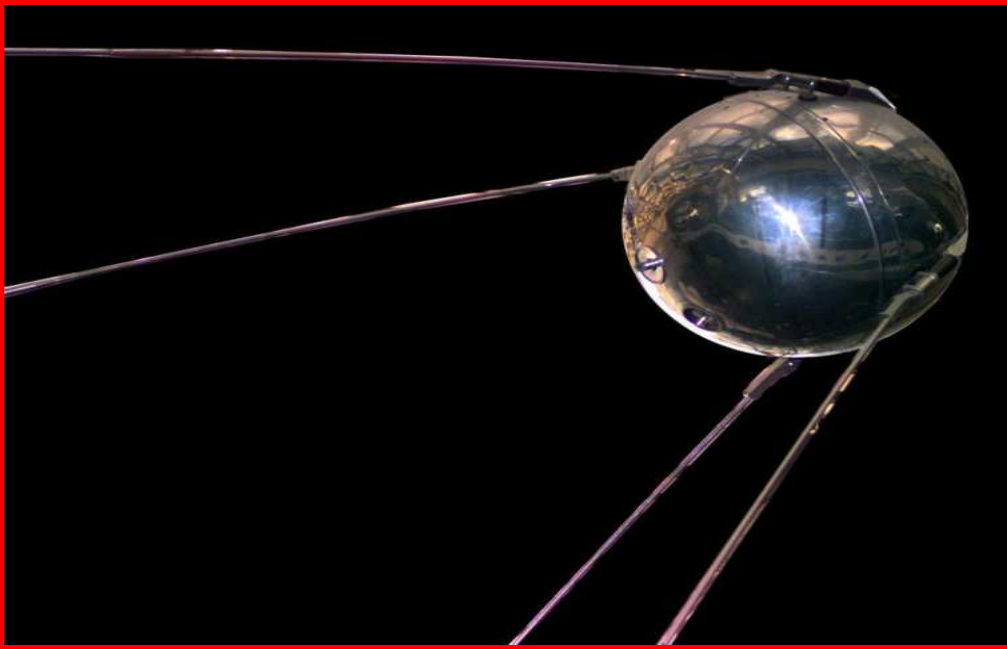
National airspace		territorial waters airspace	contiguous zone airspace	International airspace	
land territory Surface	internal waters surface	territorial waters surface	contiguous zone surface	Exclusive Economic Zone surface	International waters surface
internal waters		territorial waters	Exclusive Economic Zone		International waters
land territory underground		Continental Shelf surface		extended continental shelf surface	International seabed surface
		Continental Shelf underground		extended continental shelf underground	International seabed underground

Space Technology

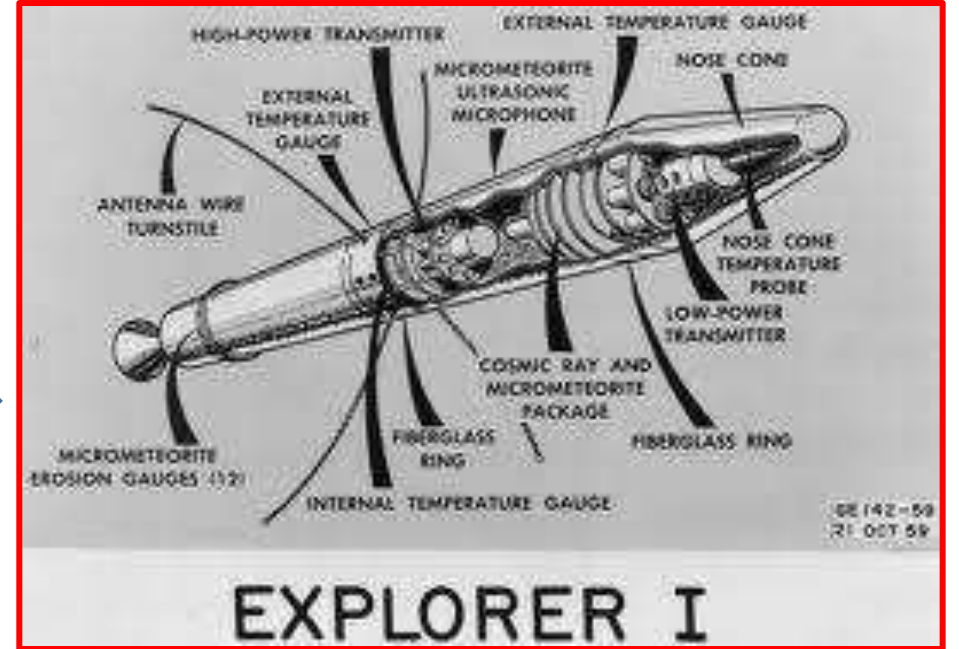
- Space technology is a term that is often treated as a category
- Various technologies ranging from *asteroid mining* to *rocket science* to *satellite operations* to *navigation* to *telemetry* to *reentry* to *artificial intelligence*
- Is the systematic application of engineering and scientific disciplines to the exploration and utilization of outer space

Politico-Strategic Backdrop
for the Development of
Space Regimes

Politics of Space

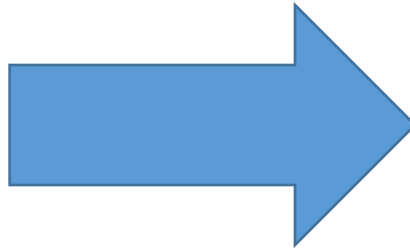


Sputnik 1
4 October 1957



1 February 1958

Politics of Space



Out in Space: The man who
didn't see God anywhere



Nikita Khrushchev



Yuri Gagarin

Why invest in Space.....



Scientific Discovery, Economic Benefits, National Security

✓ Social development to disaster management

✓ Curiosity

✓ Prestige

✓ Military

✓ Soft Power

✓ *Spinoffs*

WW II era 21st Century

Nuclear Backdrop

- Development of space technologies had a nuclear shadow
- Nuclear discourse remains relevant



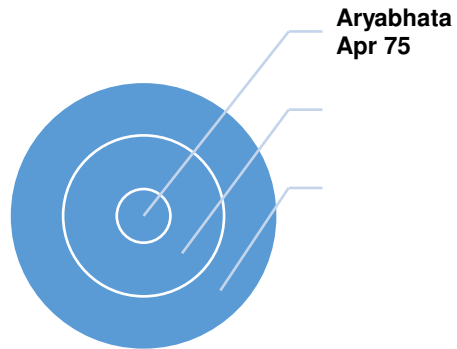
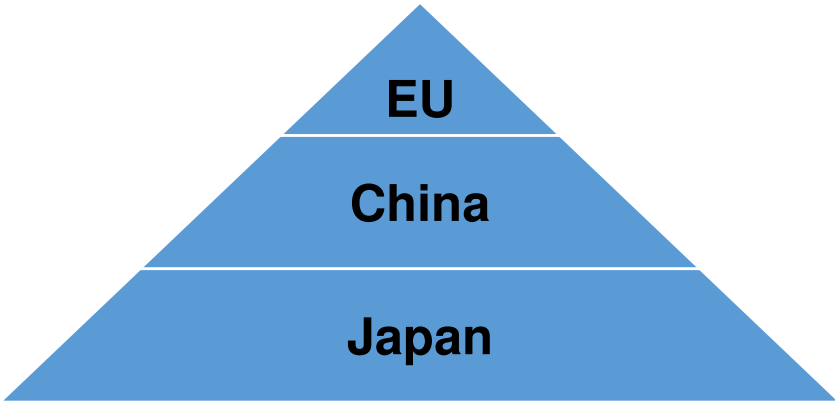
New Warfare

- Asymmetric Warfare
- Conventional Warfare with military modernization, Nuclear warfare
- UAVs/Robotic warfare



Space Journey

Explorer 1-Jan 58



Space for what?

- Remote Sensing, Meteorology
- Communication, Navigation
- Education, Astronomy, Scientific Research
- **Military**

Space Exploration

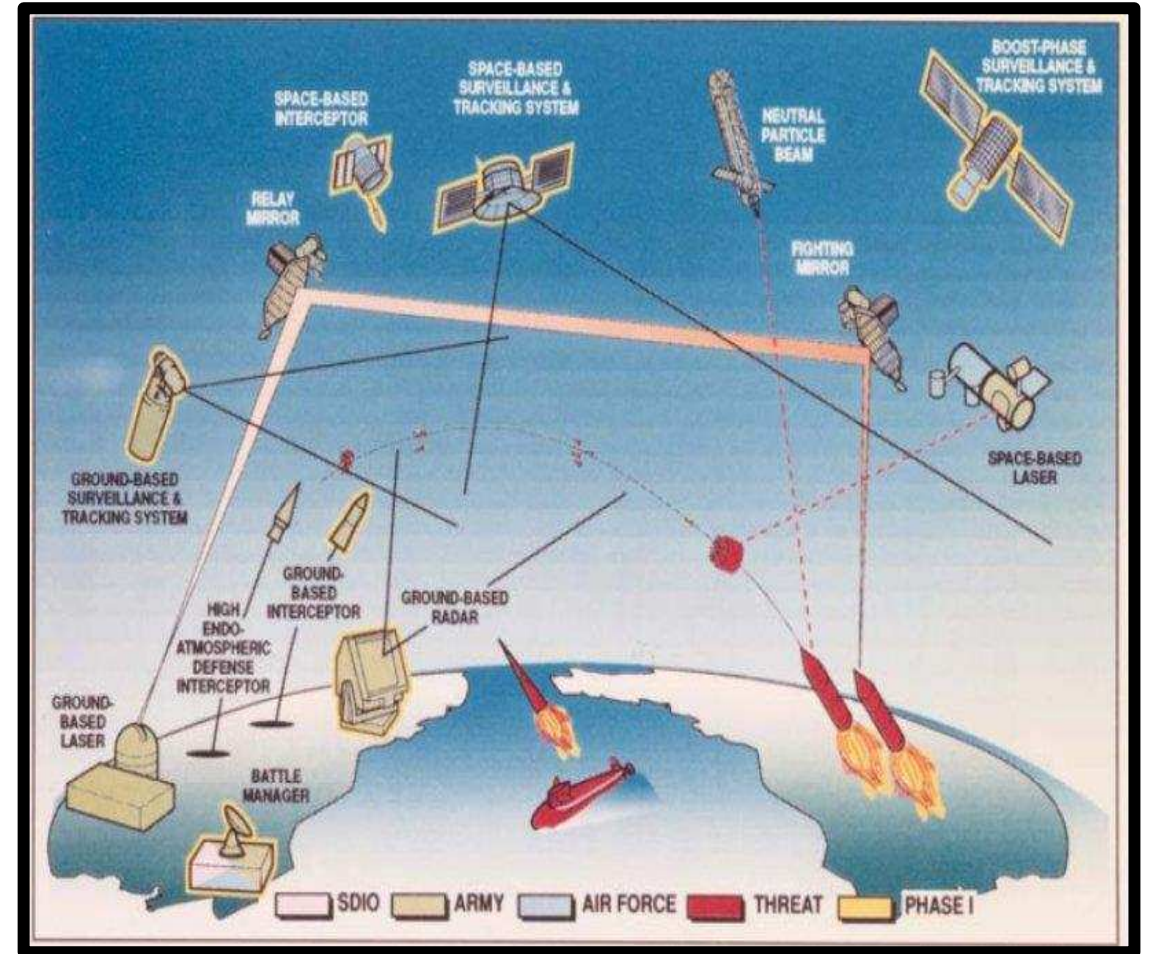
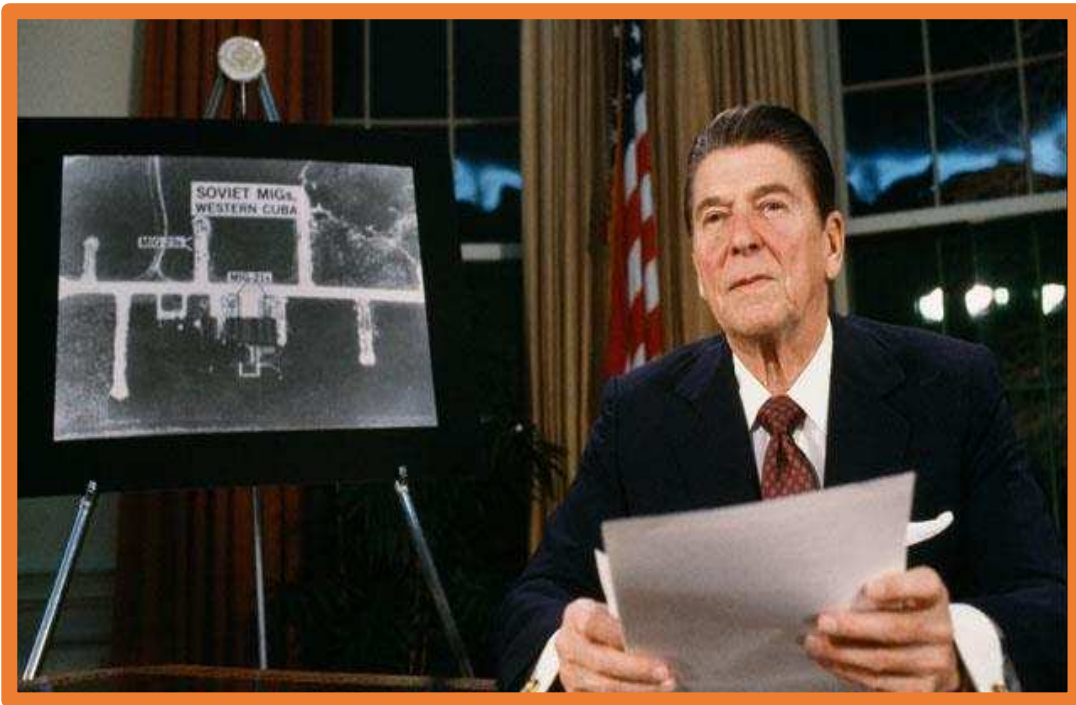
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graph TD; A[Space Exploration] --- B[Launch Capability]; A --- C[Satellite Manufacture]; A --- D[Ground Control];
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Launch Capability

Satellite Manufacture

Ground Control

Star Wars Programme



Past & Present

- The 'space era'-Sputnik-1 October 4, 1957
- Man on Moon
- Pre-1990: space race (US-USSR) - nuclear issue dominated the discourse and space was viewed as an instrument to strengthen nuclear agenda
- Era of collaboration-ISS (1998, above 400km)
- China: Manned flights (2003), Space walk (2008). Moon missions (2007,10,13 &14), Space Station (launched in 2011 and hosted astronauts in 2012 & 2013), Mars mission (2011 failed mission)
- Space as a cover for missile ambitions-Iran, DPRK

Global Space Agenda

- Work in Progress on ISS- space shuttle phase is over, Soyuz is the only option. US had planned the successor by 2014....never happened
- Hubble space telescope remains operational
- Moon & Mars Mission, Venus, Jupiter...deep space missions in progress/planned...Trump administration is keen for NASA to undertake human mission to Moon and Mars
- Galileo/GPS/Glonass/Compass (BeiDou)/IRNSS (NavIC)
- Routine missions including spy sat missions

Business Categories...

- Telecommunication
- Commercial space launch facilities
- Commercial satellite imagery
- Commercial satellite positioning
- Space Tourism

Key Trends....

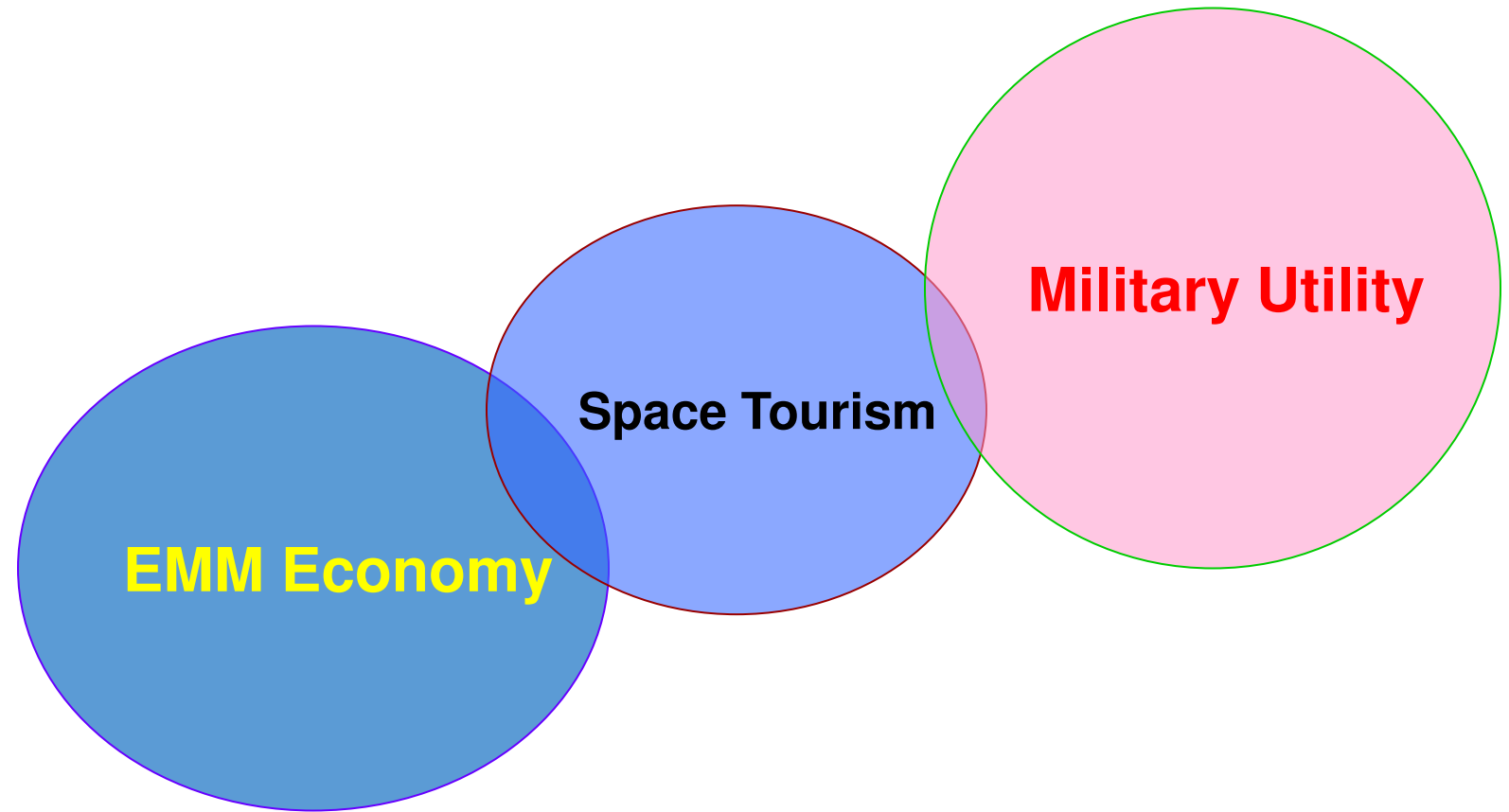
- Dramatic growth over past decade
- Major business associated with satellite services
- Bulk revenue- telecommunication sector
- During the 1990s, the commercial space industry flourished
- Disasters, cost overruns, and post-9/11 security measures have increased military ties to civilian space programmes

Acknowledged facts...

- It costs app \$10,000 per kg to launch anything into orbit (Space X....\$2000 per kg?). Nature of orbit would decide on the cost....
- Today's satellite is tomorrow's space debris. Average, one piece of space junk has fallen to Earth every day
- 60% of the orbital-debris population is owned by Russia and China
- No specific customary international law governs orbital debris

...the forecast is
next 50 years
are going to be *historic*

Major Futuristic Trends...



E-M-M Economy

- 21st century aim is to go to moon to stay/ one way trip to Mars
- Water, Helium 3, minerals could be the main attraction
- To develop EMM economy there is a need to create the LEO anchorage and industrial port element
- Moon could be outsourced and Mars could become state aim....Curiosity Mission, India's successful Mars mission

Global Space Estimates *(approximate)*

Name of the Country	In US\$ billion
United States	48.0
Europe	8.0
Russia	4.6
Japan	3.3
China	3.1
India	1.2
Canada	0.4

Shift in Global Policy?

From the militarization of space

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towards the weaponisation...

Weaponisation for What?

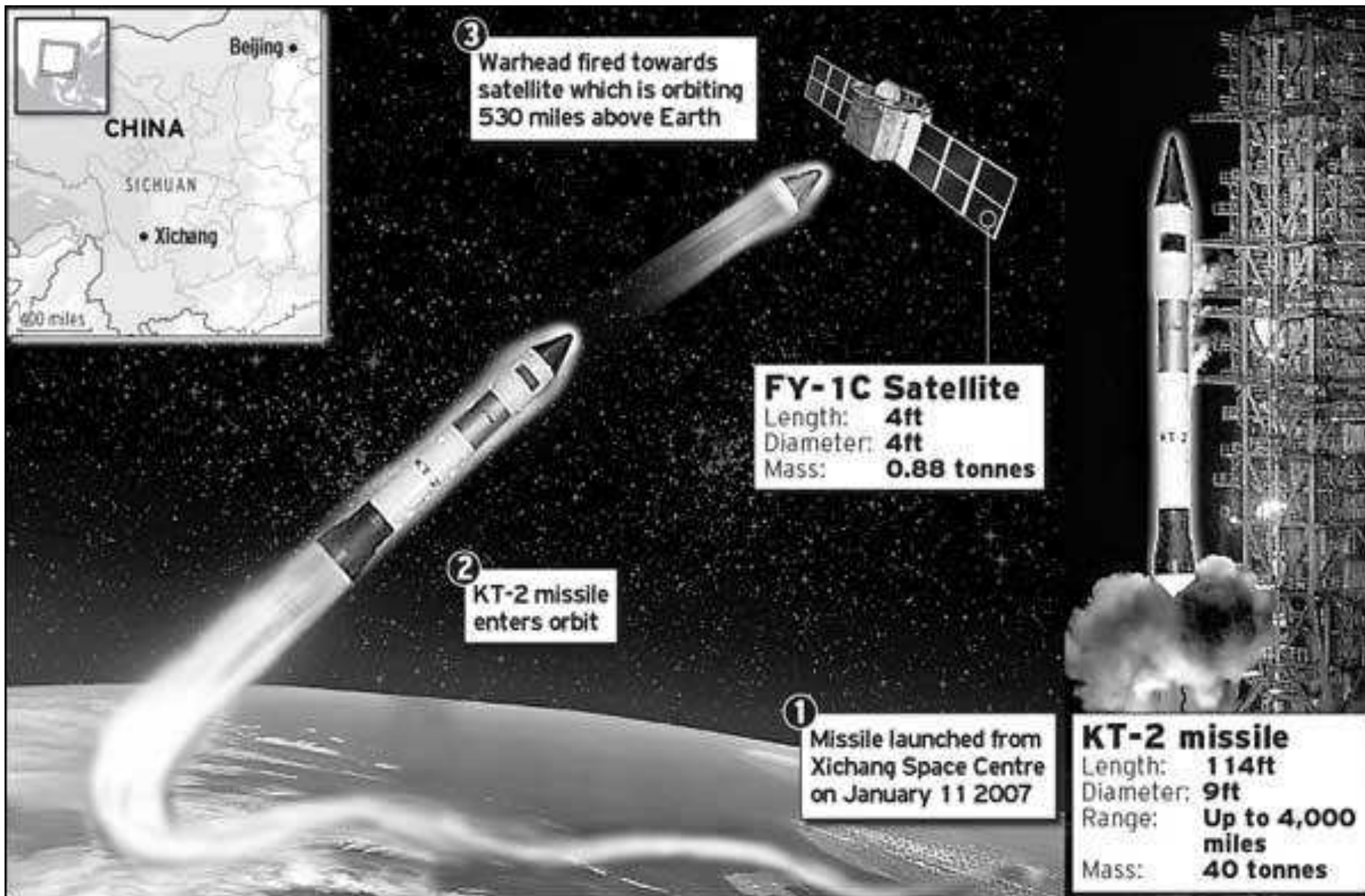
- Security
 1. Deterrence
 2. Space Race
- One-upmanship
 1. Drawing lessons from NPT Regime
 2. Drawing lessons from Antarctica

Future historians may well see Beijing's use of a missile to destroy an old weather satellite as having more lasting global impact than the Iraq war.

IHT, January 21, 2007

The Event...

- On January 11, 2007 China destroyed its own aging weather satellite
- The satellite had a mass of 750 kg and had been orbiting at an altitude of 850 km
- The anti-satellite weapon was a non-explosive "kinetic kill vehicle," which destroys its target simply by colliding with it



The 2nd Event...

- The US on Feb 20, 2008 smashed into small pieces their own defunct satellite
- Used a modified Standard Missile-3 interceptor
(essentially designed to counter 'short to intermediate' range ballistic missiles)
- Fuel tank of the satellite was hit at an altitude of 240 km

USA 193: A Hard kill on Feb 20, 2008



Third Event...Mission Shakti....

- 27 March, 2019 that India became the fourth country to acquire the capability of ASAT
- India had successfully conducted Mission Shakti by shooting down a live satellite in the low earth orbit (LEO)
- Deterrence and Disarmament

US Spy Plane X-37B

Orbital Test Vehicle (OTV)



- ✓ Launched on an Atlas rocket and put into a low orbit, a little over 300km up
- ✓ Space-to-space surveillance (stay at an orbit between 200 and 800 km)
- First vehicle launched on 22 Apr, 2010, lasted eight months..**224 days**
- Second mission 05 Mar 2011-16 Jun 2012...**468 days**
- Third mission 11 Dec 2012-17 Oct 2014...**674 days**
- Fourth mission 20 May 2015-07 May 2017...**717 days**
- Fifth Mission 07 September 2017...27 Oct 2019 ...**780 days** (Space X launch)
- Sixth Mission 17 May 2020 (continuing)....**1st launch by USSF**

Issues & Concerns...

- **Technical** : Space Debris
- **Legal**: Space Laws, Arms Control
- **Strategic**: Weaponisation of outer space, Arms (space) race
- **Market**: Impact on commercial satellite market, US\$ 120 billion; Insurance problems

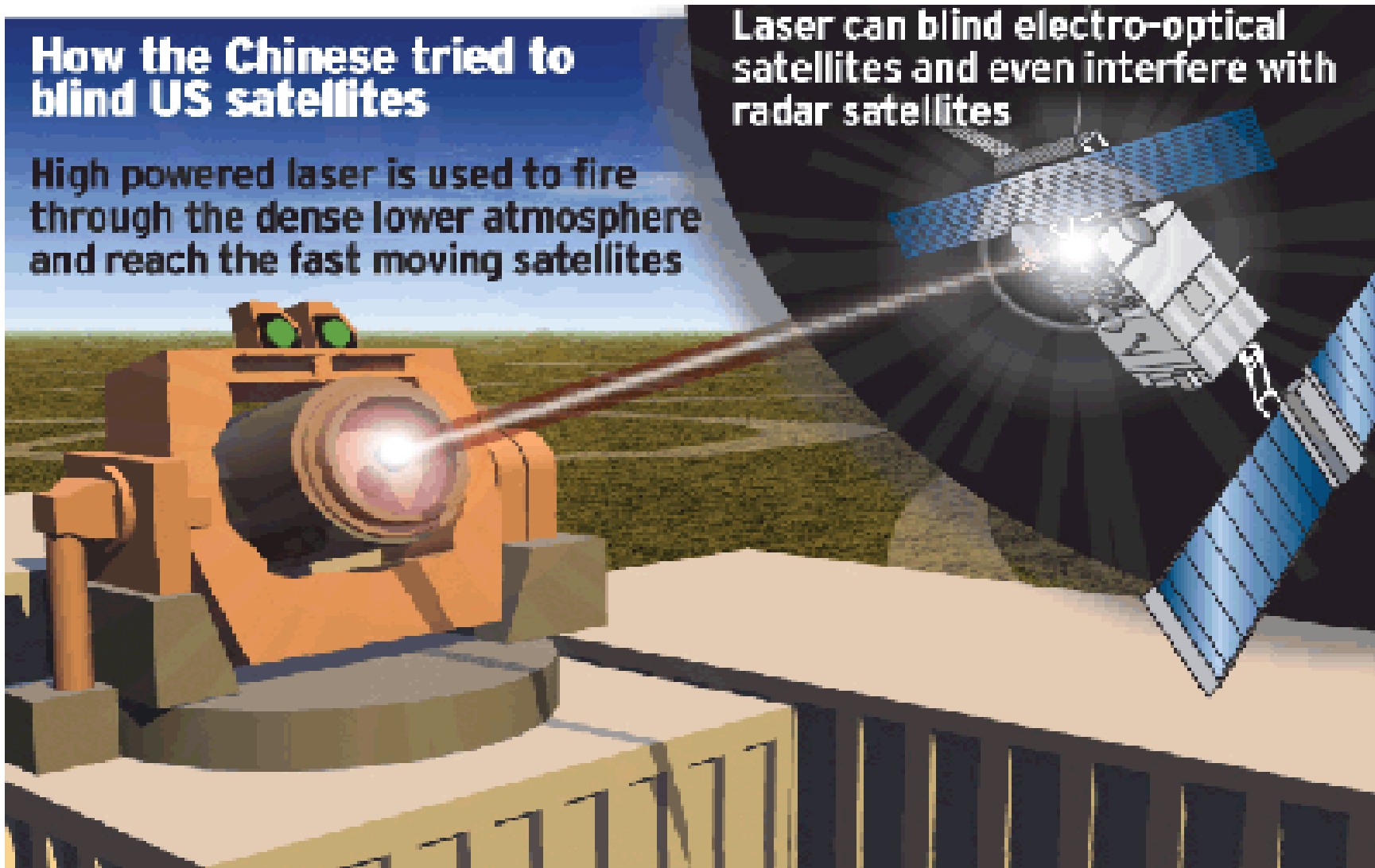
**Killing a satellite: is it
the only option?**

**What are alternative
approaches?**

How the Chinese tried to blind US satellites

High powered laser is used to fire through the dense lower atmosphere and reach the fast moving satellites

Laser can blind electro-optical satellites and even interfere with radar satellites



Usage of Lasers

- Sep 2006 Report: Beijing secretly fired lasers to disable US satellites
- Fired powerful laser weapons designed to disable American spy satellites by "blinding" their sensitive surveillance devices
- US admin mum: For fear that it would damage attempts to co-opt China in diplomatic offensives against North Korea and Iran

Usage of Lasers Contd.

- Blind American satellites with a ground-based laser firing a beam of light to prevent spy photography as they pass over China
- China has exercised this capability, Keyhole craft have come under attack *several times* in recent years
- *Aim is not to destroy American satellites but make them useless over Chinese territory*

The Impact...

The American military has been so alarmed by the Chinese activity that it has begun *test attacks against its own satellites* to determine the severity of the threat

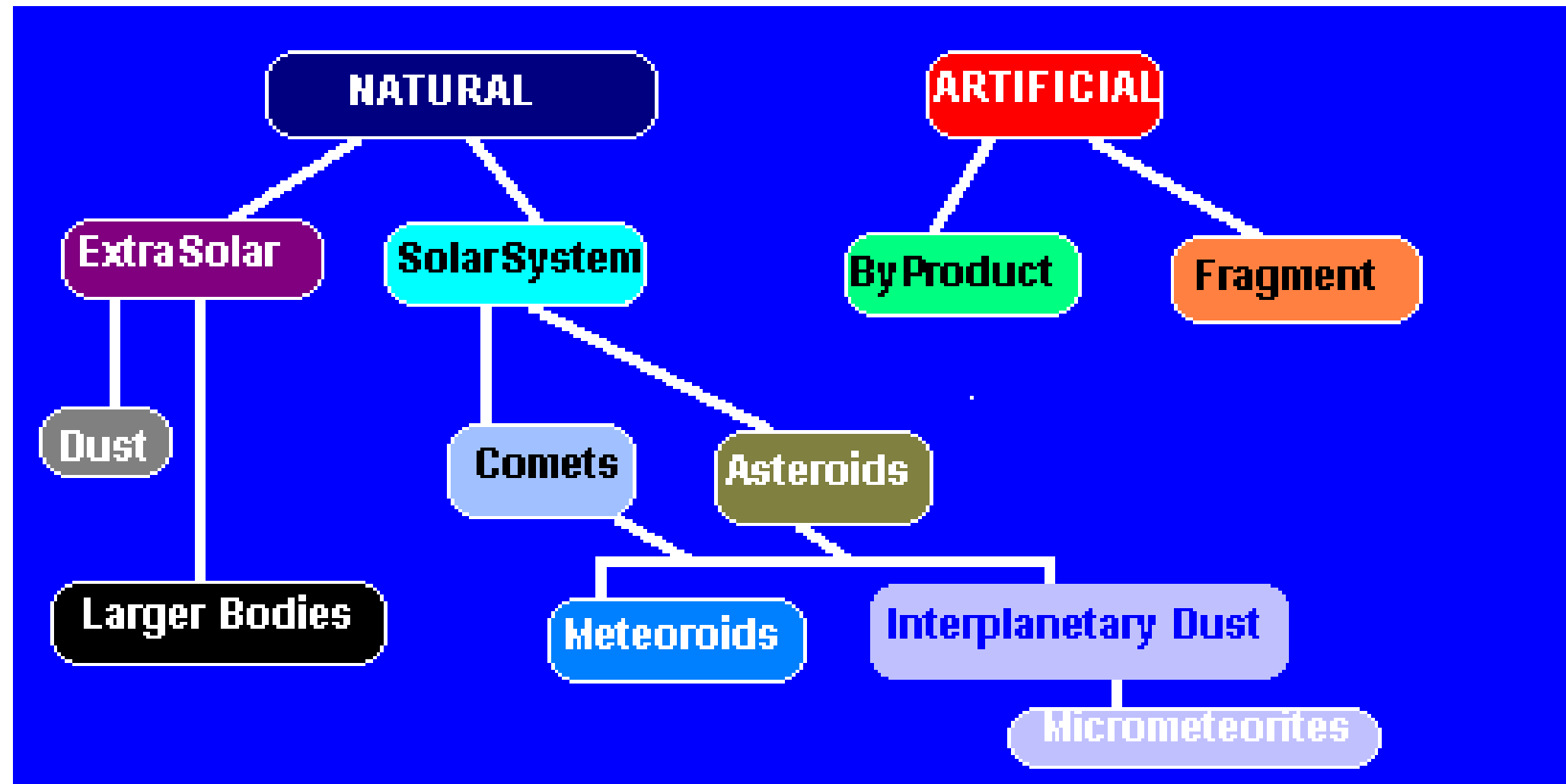
Actions that could lead to...

- Technologies and policies for debris removal
- On-Orbit Satellite Servicing
- Weapons in space
- SSA efforts
- Space tourism

Space Debris



Classification of Space Debris



Internationally agreed definition of Space Debris

- “Space debris are all man-made **objects** including fragments, and elements thereof, in Earth orbit, or re-entering the Earth’s atmosphere, that are non functional ”
- Such a clear (*and sweeping*) definition is of significance, because none of the UN’s approved treaties or international agreements or conventions refer to anything other than to “space objects”

Space Debris is an issue....

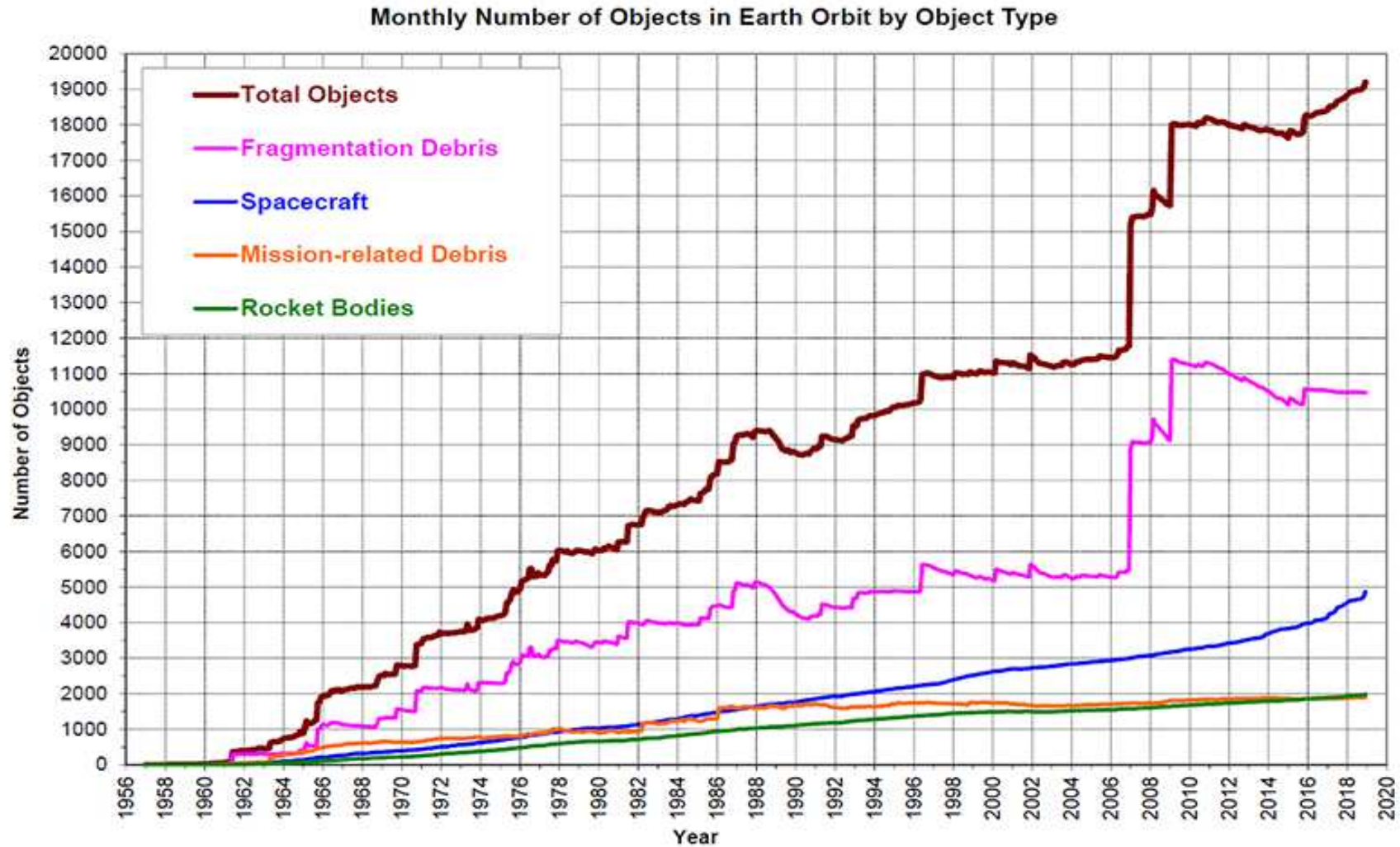
Kessler syndrome

- Collisions between objects in space. Each collision generates space debris that increases the likelihood of further collisions
- Threat to existing operational satellites (exponential increase is expected). Probability of debris hit increases
- The high distribution of debris in orbit (owing to more launches)....additional challenge to exploration of space...could this lead to *states avoiding ASAT?*

How many Debris are there in Space?

- There are estimated to be over 128 million pieces of debris smaller than 1 cm (0.39 in) as of January 2019. There are approximately **900,000 pieces from one to ten cm**. The current count of large debris (defined as 10 cm across or larger) is 34,000

Space Debris



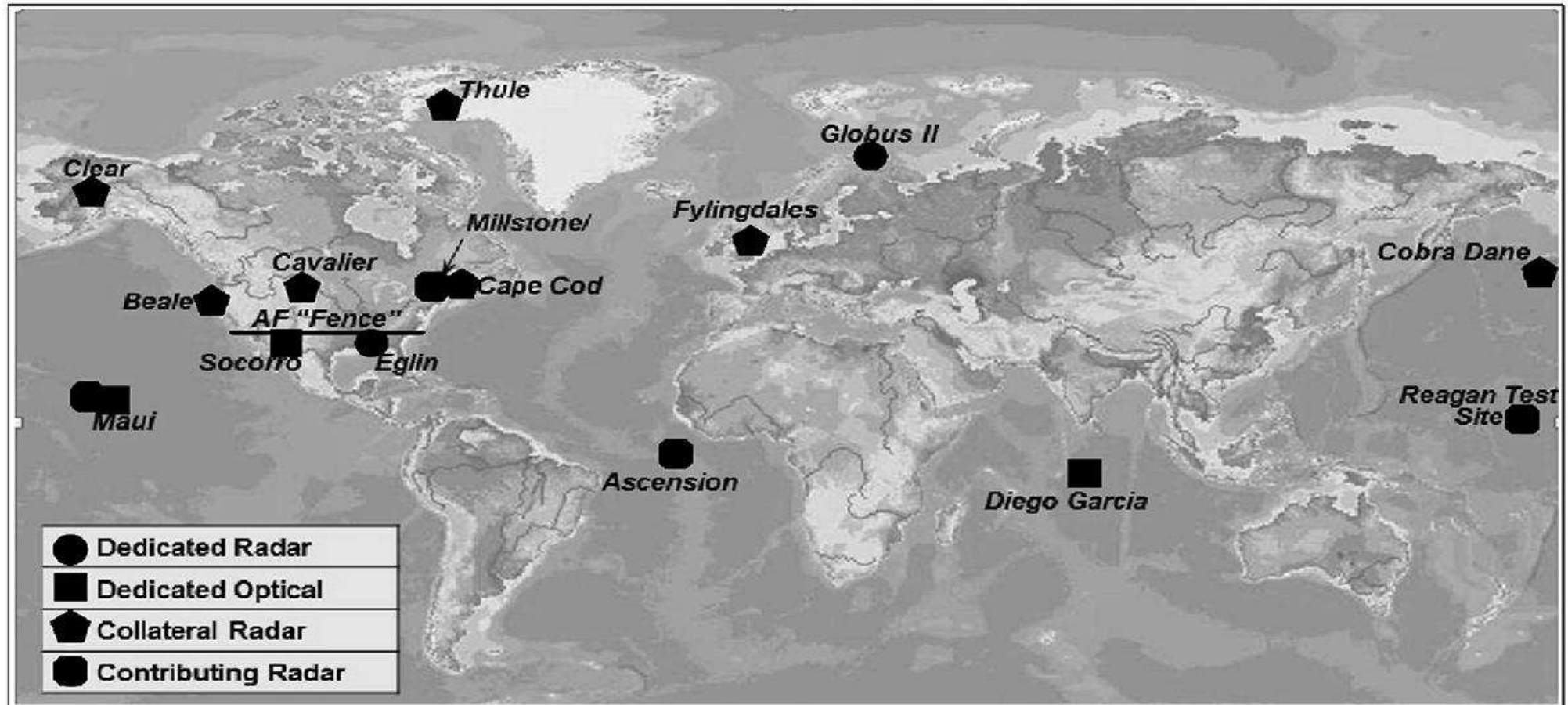
Debris Removal or Mitigation Technologies

- Electro Dynamic Debris Elimination
- Tether-Based De-Orbit Systems Using Electro Dynamic Techniques
- Much Higher-Powered Ground-Based Lasers
- Solar Sail Devices
- Tether-Deployed Nets
- Space Mist
- Robotic Systems
- Adhesives
- Ion Beam Shepherd Concepts

Cyber Threat.....

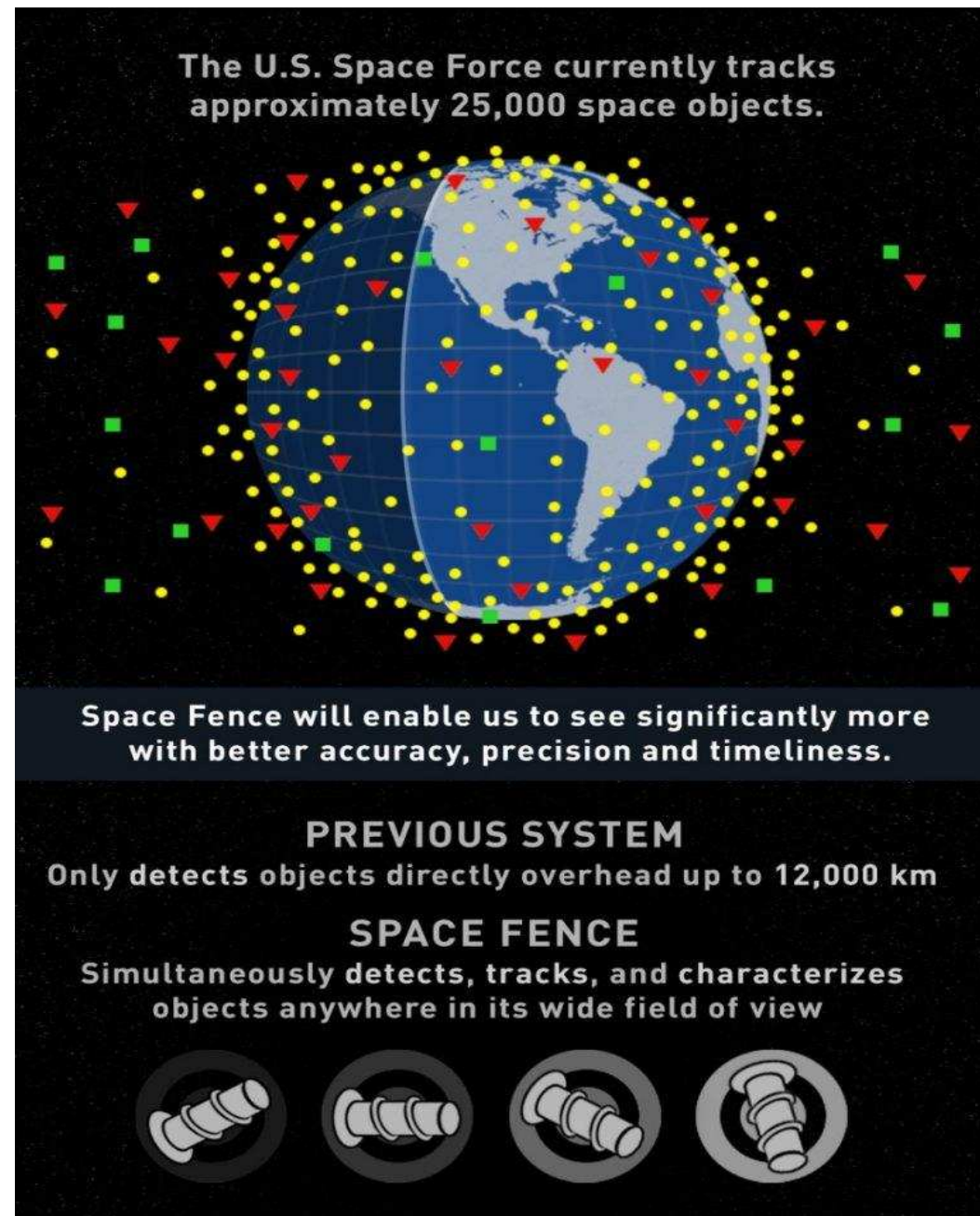
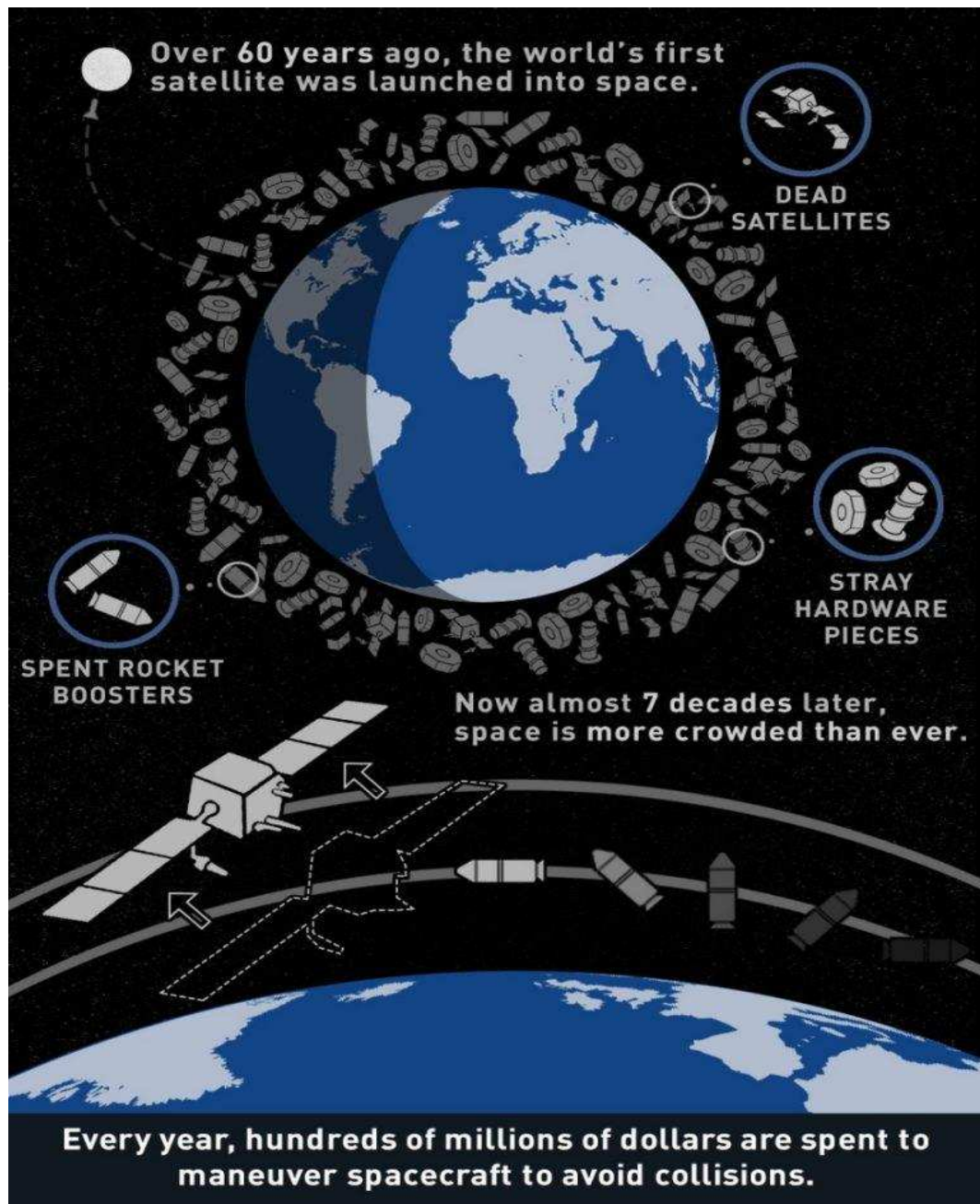
- Particularity post Stuxnet the concept of attack on space infrastructure
- Some unendorsed reports about....
- The threat is expected to 'swell' in coming days....
- Jamming

Space Situational Awareness



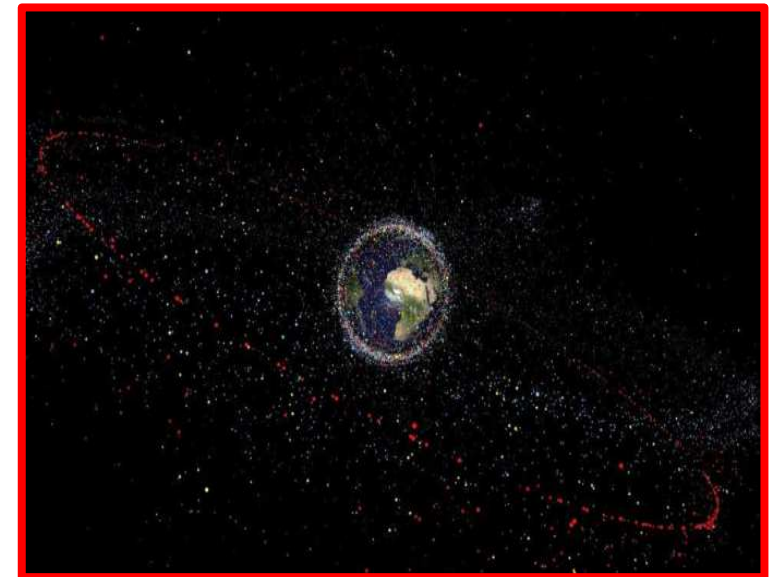
Space Fence Radar at the Republic of the Marshall Islands

- In March of 2020 the United States Space Force (USSF) declared operational acceptance
- Space Fence, is the world's most advanced radar, provides uncued detection, tracking and accurate measurement of space objects (Sat & debris), primarily in LEO, also provides coverage of objects in geosynchronous orbit
- The new radar permits the detection of much smaller microsatellites and debris than current systems. It also significantly improves the timeliness with which operators can detect space events



Extra-Vehicular Activity (EVA)/Debris Removal processes

- Hubble servicing missions
- ISS
- Possible to undertake repair activity in space
- Interesting suggestions on how to get the stuff that's already up there, down. Can it cause damage to active satellites? Who should do this?
- Humans could manipulate....



Space Tourism Industry

- This idea was a joke in 1990s
- Today, more than 100 people are ready to pay \$ 25 million price tag for space trip
- By 2030-5 to 10 million passengers/year may visit LEO
- 50,000 to 100,000 people staying in 'Orbit hotels'
- Space X-proposing to send 10-12 people in Moon's orbit...



SpaceShip Two

Virgin Galactic



Mother ship: White Knight Two

Spaceport Virgin Galactic

New Mexico



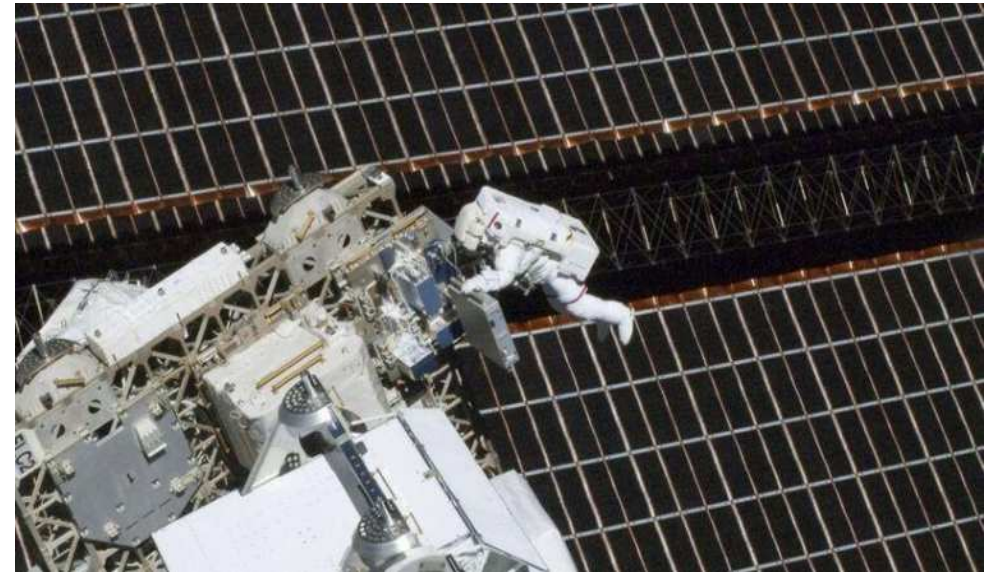
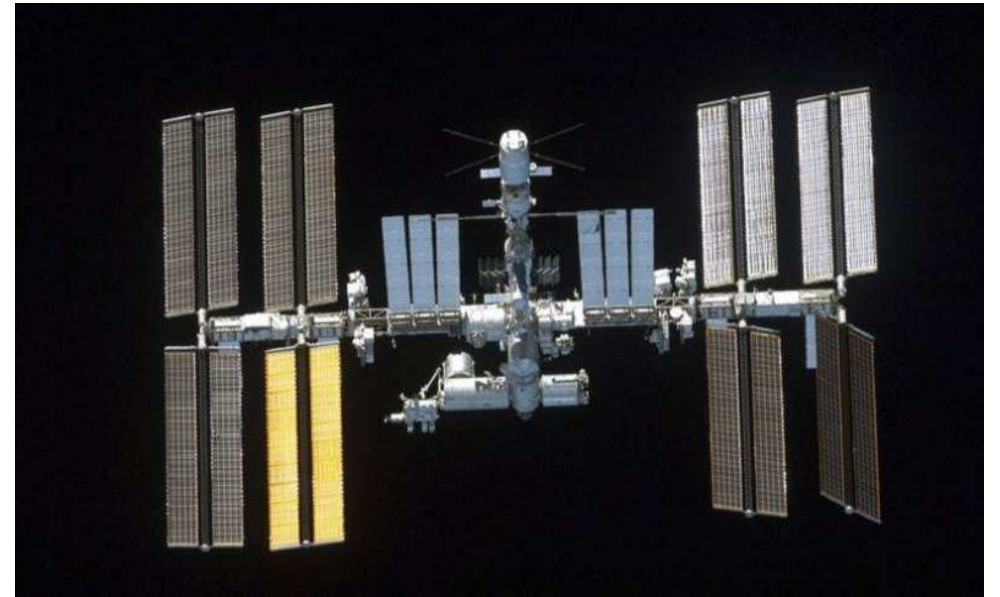
Presently developing one more port at Abu Dhabi.....to be a port for the space tourism industry

Space Stations

Mir: Journey of 15 year-old Russian space station ended Mar 23, 2001

International Space Stations (ISS)

- First piece of ISS was launched in 1998
Human are there since Nov 2, 2000. Six docking stations
- The ISS weighs about 420,000kg - that's about the same as 320 cars
- As per OST, the US & Russia are legally responsible for all modules they have launched
- To operate until 2028, and possibly beyond



Space Station: Private Participation

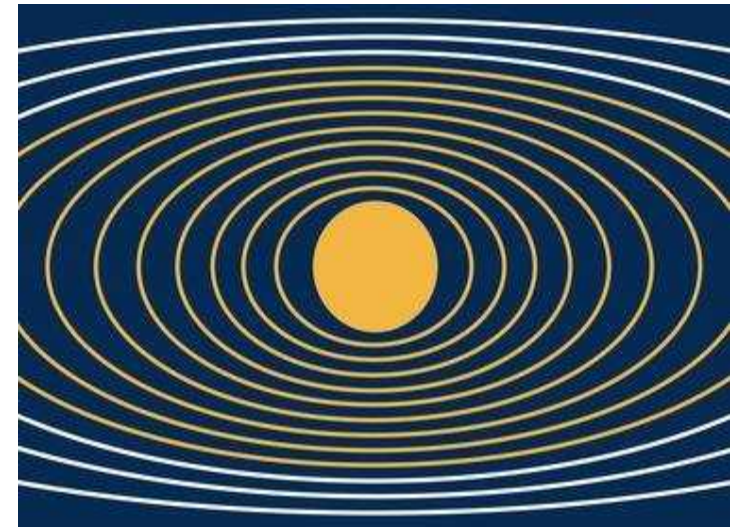
- Houston-based company Axiom Space plans to use the ISS as a jumping-off point for its own station in LEO. To start launching new commercial modules to the ISS in 2024. By that time ISS is retired.... ***tourist flights*** to the ISS aboard SpaceX Crew Dragon capsules
- California-based Orion Span plans LEO station called Aurora
- Bigelow Aerospace, has long been planning to set up private outposts in orbit and on the moon (post Covid-19 has laid off entire workforce)

Future Space Stations

- China plans to launch core module of space station in 2021. Fully assembled by the end of 2022. Tiangong programme. Have a mass between 80-100 tonnes. China has a willingness to cooperate further with other countries on crewed exploration, UN member-states can....
- The Indian space station would be at 400 km altitude. Smaller in size about 20 tonnes and could be there by 2027

Space Kingdom of Asgardia

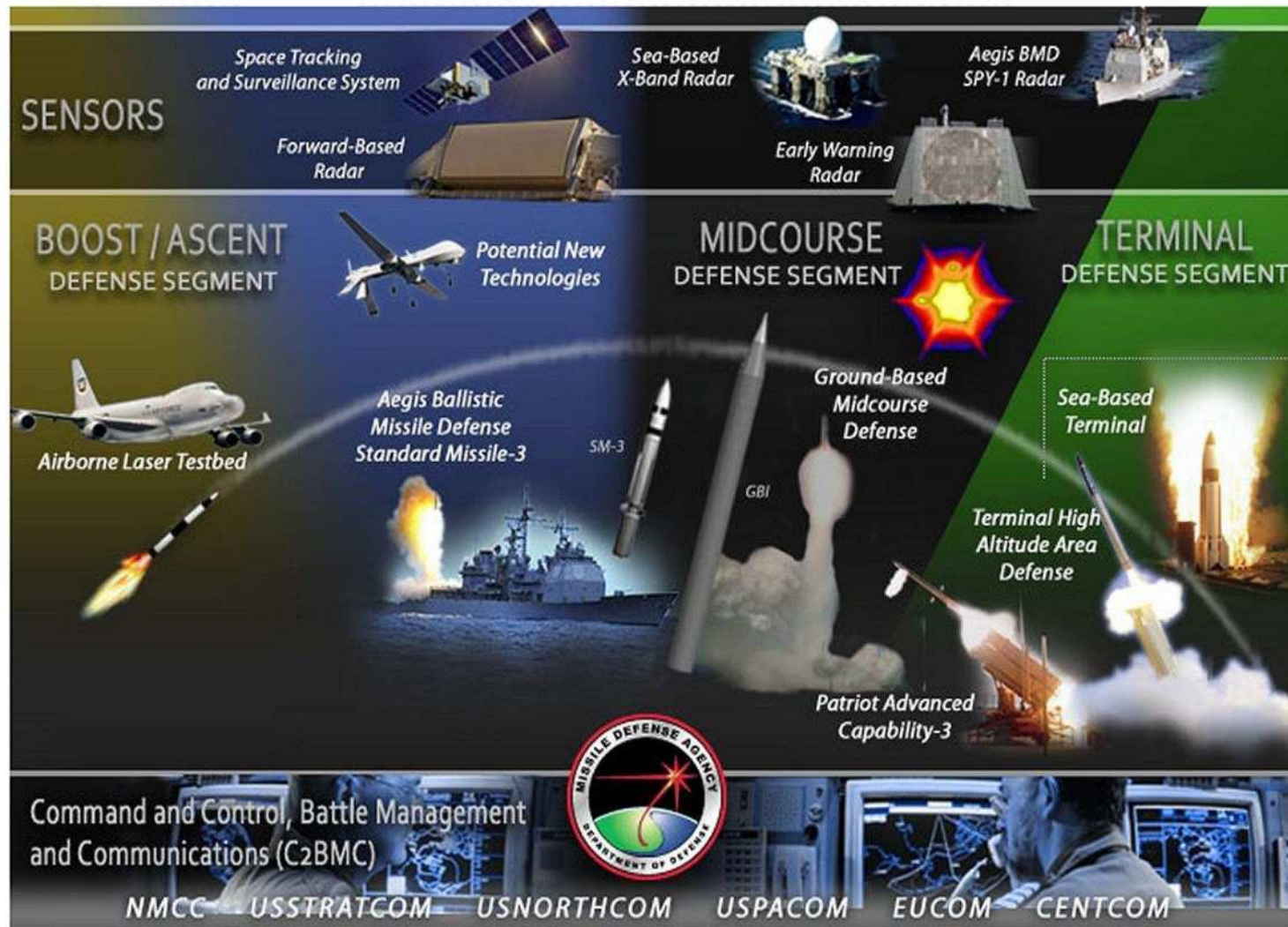
- Asgardia the “Space Nation”, is a micro-nation formed by a group of people who have launched a satellite into Earth orbit
- Claims to be “the first nation to have all of its territory in space”
- Constitution became effective on 9 September 2017



China Wants to Launch an Artificial Moon Into Space

- Chengdu, the capital of the Sichuan province, has proposed a plan to launch an artificial moon, or illumination satellite, into space
- It would be eight-times brighter than the Earth's actual moon, creating an opportunity for the streets of Chengdu to be illuminated by the satellite instead of street lights
- Artificial moon is made from a reflective coating that can aim the sun's light back to Earth and cover a span of 6 miles to 50 miles
- Officials on the ground can control the diameter of the light to ensure it focuses precisely on the city and nowhere else

THE BALLISTIC MISSILE DEFENSE SYSTEM (BMDS)



BMD can indeed act as a **Trojan Horse** for the weaponisation of space

BMD could be the first rung on a ladder leading to the weaponisation of space

**Activities from Low earth to Geostationary orbits...for
earth control, human presence in space...**

**Deep Space and the development of unmanned space
exploration missions, these missions are fully autonomous**

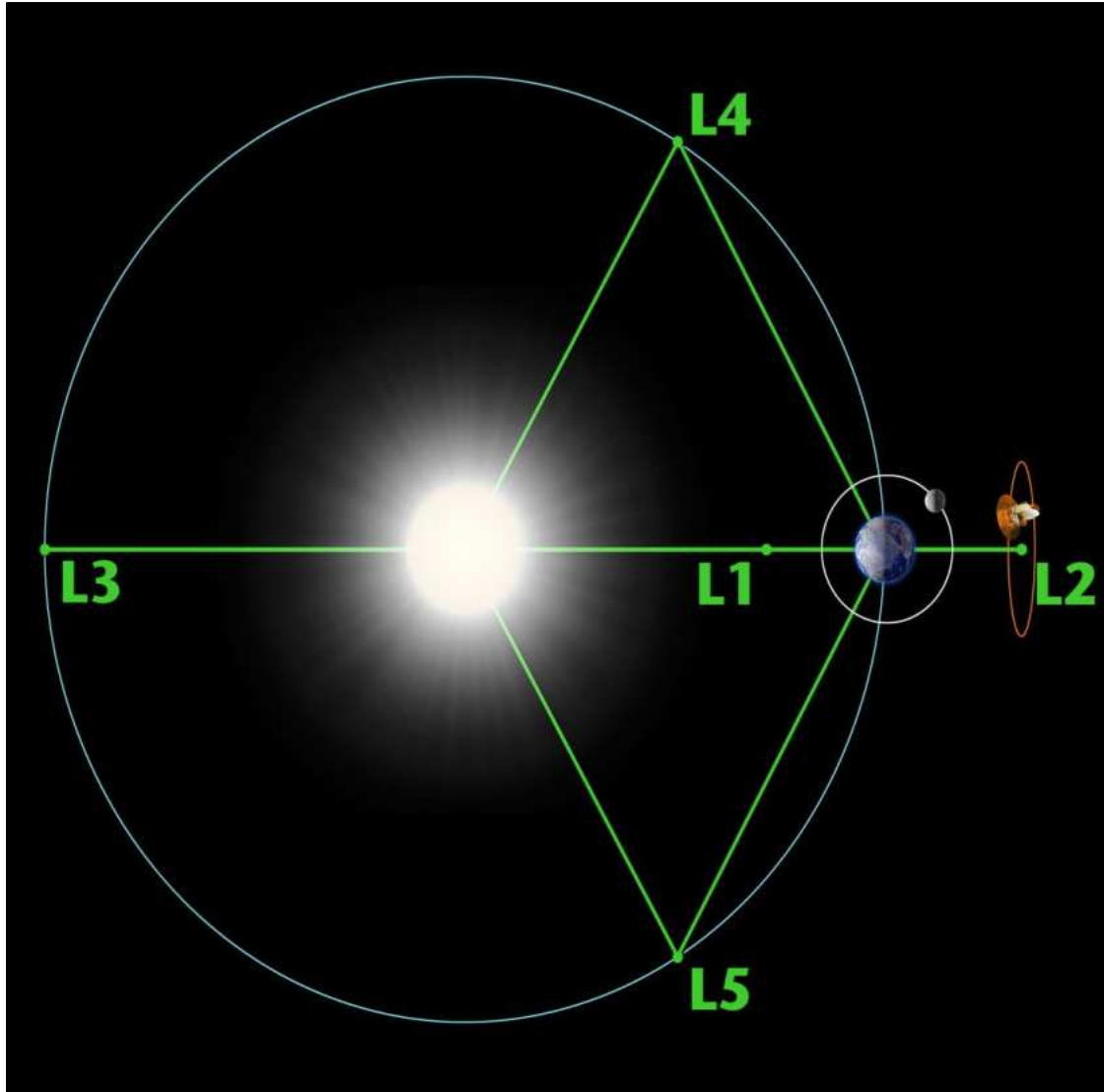
Deep Space Missions

- Moon and Mars missions.....new players are emerging
- Science, resources, economics, nationalism.....
- Private Payers are showing much interest. Tourism....
- The US government legalised space mining in 2015 by introducing the US Commercial Space Launch Competitiveness Act, 2015

Deep Space Future...

- China and Russia proposing to build a lunar space station. Roscosmos signed agreement with China's National Space Administration to develop research facilities on the surface of the moon and in orbit
- China is proposing to establish the first Earth-Moon economic zone. Could create an economy worth \$10 trillion a year....
- Missions to Venus and other plans are also been planned

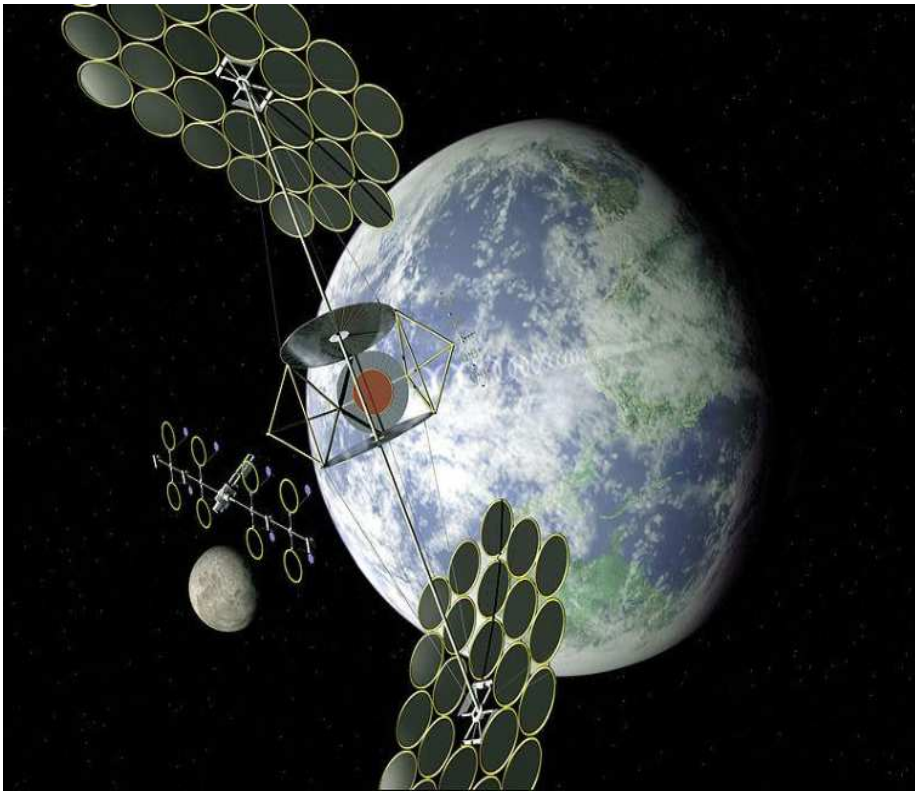
Lagrange Point



- The L1 point around 1.5 million km away from Earth, four times the distance of the Moon
- SOHO (Solar & Heliospheric Observatory), NASA+ESA, 1995
- L1, Earth-Sun system affords an uninterrupted view of the sun
- L3 point is of no use, since it remains hidden behind the Sun

- Lagrange points are positions in space where objects sent there tend to stay put. These can be used by spacecraft to reduce fuel consumption needed to remain in position
- Lagrange Points are positions where the gravitational pull of two large masses precisely equals the centripetal force required for a small object to move with them
- L4 and L5 colonies could be used as waypoints in future space travel, to expand the practical launch window for travel to and from Earth and the other planets. These positions are useful for colonies as they are ***only two stable*** without any need for station keeping.....

Space-based solar power (SBSP)



- Concept of collecting solar power in outer space & distributing it to Earth
- Considerable fraction of incoming solar energy (55–60%) is lost on its way through the Earth's atmosphere
- Idea is to gather this energy before reaching earth

Blanket the globe in satellite internet.....

- SpaceX...its fleet of Starlink satellites, aims to provide high speed connectivity to anyone on the planet. Total 12,000 small satellites are likely to be launched for this mega-constellation
- Amazon and the UK company OneWeb also have somewhat similar....
- The damage the satellites inflict on astronomical research will vary by project and observatory. *The simplest way to edit out the unwanted streaks left behind by satellites is to use software.....*
- Challenges to space security?

Space Arms Potential

- US, Russia, China are capable of developing ASAT systems, ground based and space based jamming technologies.
- Micro & nano satellites....converted to space weapons/space mines.....
- On Orbit Servicing, Space debris removal technologies...., Space Based weapons (???)
- **Spin-off benefits** from various projects in space...human space programme, space station, deep space missions.....

Counterpace Technologies...Concerns...

- ASAT is global challenge. Hence, to develop counter-space...
- Specific acts by states could increase the concerns of the other states. Even legitimate actions by states could come under criticism
- The reaction could be at different levels
 - Demand establishment of arms control/disarmament regime
 - Tit-For-Tat (TFT) strategy
 - Posturing
 - Arms race

Classification of Space Weapons

- Directed-energy weapons
- *Kinetic-energy weapons*
- Conventional warheads delivered to or from space
- Microsatellites, Parasitic satellites.....

Alternatives

- Ground based weapons to attack satellites
- Space based weapons for targets in space
- Weapons in space for targets on ground



Kinetic Bombardment (Orbital Strike)

- Destructive force comes from the KE of the projectile impacting at very high velocities
- “An orbiting tungsten telephone pole with small fins and a computer in the back for guidance”
- The weapon can be downscaled, an orbiting "crowbar" rather than a pole
- Impact speeds of Mach 10 has a kinetic energy equivalent to approximately 11.5 tons of TNT (Little Boy, Hiroshima $\approx$ 15 tons)

Project Thor/ "Rods from God"

Advantages

- Deliver projectiles from a very high angle at a very high speed, extremely difficult to defend against
- No explosive warheads, would consist of solid metal rods

Disadvantages

- The technical difficulties of ensuring accuracy and prohibitively high costs of positioning such system in the orbit

The Reality...

- The “Pearl Harbour” syndrome/Missile defence policies
- Legal regime unlikely in near future. Space disarmament and arms control debate in nascent stage. New Asteroid related law by the US....
- Line between militarization and weaponisation getting thin....

Terrestrial Confrontation...but... Orbital Cooperation

- Crimean peninsula annexed from Ukraine: Russian role Feb–Mar 2014
- US-Russia....Syrian Conflict, Cyber...elections...
- International Space Station (ISS)
- Russia under the US sanctions, but the US Senate voted (94-6) on June 15, 2017 to allow NASA to continue using Russian-made rocket engines.....RD-180...required for the US spy satellites
- *Investments space are for billions of dollars...total dependence on space....space conflict: untested waters.....hence???*

At present....

- COTS.....commercial satellite software, defence using commercial satellite derived products.....
- States are openly ending peaceful policies, adding military focus, launching spy satellites.... Ex Japan...
- Spy Planes (orbital UAVs)
- Private players catering for the needs of State agenda...ISS/Cargo delivery by Space X
- Making rockets reusable (we have airplanes reusable)

The Future

- Launch on demand (sea launch, mobile launching system)
- **Near Space, Era of micro satellites**
- 3D Printing, new materials,....
- Suborbital flights...major business expected
- **Resources over Moon and Mars....**
- Space colonization, **Interplanetary and Interstellar space agendas**
- ***New future technologies***

The US



Space Force

- Trump's idea of stand-alone military branch for space. Declared the establishment of a **Space Force as the sixth branch of the Armed Forces** (Jun 2018). **Initial problems, the US congress was not ready to pickup on Trump's idea.** The Pentagon had issues for the creation of a space force. Probably, there was no public and military support for this idea.....turf wars
- Became a reality during December 2019

Space Force

- The United States Space Force is the Space Warfare service branch of the United States Armed Forces
- Purpose.....intended to have control over military space operations
- Is a separate force required?
- Should there be *Indian Space Force*?

Thanks