

# THE QUEST FOR SPACE CONTROL

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*Control of space means control of the world.*

– Lyndon B Johnson

(President of the United States from 1963-69)

Space is one of the less explored dimensions of modern warfare. Dependence on space is increasingly becoming a necessity, as an enabler of enhanced military capabilities, as an alternative for building deterrence, and as a resource which can be exploited for societal and commercial benefit. There is also growing dependence of a nation's economy on space commerce and industry. While dependence on space for military applications has seen an exponential rise over the years following the Gulf War of 1991 (Operation Desert Storm), the asymmetry in space capabilities is distinct even today. A handful of space-faring nations are poised to take conflict into the final frontier: space. A resource which is vast and seems unlimited is being conquered at a pace beyond imagination.

About 1,800 active satellites orbit the Earth, providing worldwide communications, navigation, weather forecasting, remote sensing, imagery and space surveillance. For militaries, which rely on some of these satellites for modern warfare, space has become the ultimate high ground, with the US being the undisputed leader. With China now attempting to aggressively

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challenge US superiority in space with ambitious military space programmes, and Russia with similar capability as the US, the power struggle risks sparking a conflict that could cripple the entire planet's space-based infrastructure. And though it might begin in space, such a conflict could easily ignite a full-blown war on Earth. The emergence of new space powers like Japan, India, Brazil, Israel, Iran and Korea is bound to see new possibilities.

The situation is much more complicated as Low Earth Orbits (LEOs) and Geo-stationary Earth Orbits (GEOs)

have become hotbeds of scientific and commercial activity, filled with hundreds of satellites from about 70 different nations. Despite their largely peaceful purposes, each and every satellite is at risk, because of the growing threat of anti-satellite weapons and a diminishing space legal regime. To understand the criticality of the issue, it is necessary to see the growing reliance of mankind on space and its applications.

## **APPLICATIONS OF SPACE-BASED ASSETS**

Satellites remain at the core of human exploitation of space, despite the many advances in space exploration. The impact of space technology can be felt in many aspects of our day-to-day life. Some of the benefits that have changed our lives include knowing exactly where we are on the planet using Global Positioning System (GPS) applications, weather forecasts, watching TV from remote locations, robotic surgeries, with doctors sitting at distant locations, mobile phone communications from anywhere in the world, networked banking systems, networked airline and railway ticketing, etc. Remotely sensed data reveals an unparalleled view of the Earth for systems that require periodic observation such as surveying, agriculture, mineralogy,

hydrography, geology, landmass cover, land utilisation and environment monitoring. The advancement of remote sensing has made remote sensed data more affordable and available, and finds applications in a variety of data sources.

There is a growing number of emerging space applications which have the potential to provide enormous opportunities for the benefit of mankind. Some of the emerging applications are listed below <sup>1</sup>:

- Global resource management (protection of terrestrial, coastal and marine resources).
- Oceanography.
- Oil spill detection.
- Innovative tele-health applications - satellite-based telemedicine networks.
- Innovative communications-satellite-based personal communications systems.
- Space-borne tsunami warning system.
- Disaster monitoring, mitigation and damage assessment.
- Drought risk reduction.
- Managing energy resources on the Earth.
- Convergence of the internet and space technology.
- Weather applications such as climate change studies and weather conditioning to weaken hurricanes, tornadoes, etc.
- Remote sensing for precise farming and mining operations, response to emergencies, traffic management, etc.
- Surveillance capabilities from space for domestic border surveillance, precise fire monitoring from space, marine/wildlife resource management, and better data for mapping, etc.

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1. Phillip Olla, "Space Technologies for the Benefit of Human Society and Earth", at <https://link.springer.com/content/pdf/bfm%3A978-1-4020-9573-3%2F1.pdf>. Accessed on November 1, 2017.

- Enabling services such as earthquake detection and warning.
- Energy generation in space and sunlight reflection to the Earth.
- A new satellite-based air traffic control system known as the Automatic Dependent Surveillance Broadcast (ADS-B).
- Weather satellite system called the National Polar Orbiting Environmental Satellite System (NPOESS).

Looking even farther into the future, possible applications of space can be envisioned to provide additional revolutionary capabilities such as<sup>2</sup>:

- Production of unique products in orbital factories.
- Planetary defence.
- Space tourism.
- Orbital and lunar resorts.
- Helping to meet the Earth's energy needs.
- Commercial lunar and asteroidal resource exploitation.

Space applications support both private and government users of space services. These applications attract billions of dollars of business for industries that provide communication systems, mobile telephones and data, direct-to-home TV, satellite radio, wideband data services, remote sensing (including mapping, agriculture, resource management, land use, etc.), and positioning, navigation, and timing services based on the GPS and similar satellite constellations. The satellite industry, space launch, tracking and monitoring services comprise another segment which is attracting investments and is now a thriving industry. Government users will exploit space for military and other national security-related purposes, as well as a number of well-known civil government functions. The important point is that new and innovative space applications are developing faster than ever before. The future holds exciting prospects for space capabilities to improve life on Earth.

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2. Stan Rosen, "Future Space Applications Promise Revolutionary Improvements in our Quality of Life", at <http://www.nss.org/adastra/HowSpaceCanImproveLifeOnEarth.pdf>. Accessed on November 1, 2017.

## SPACE COMMERCE

Space commerce broadly involves the construction of satellites and their ground control stations, launch of satellites, sale of space systems components, sale and leasing of satellite services, commercial remote sensing and weather forecasting, navigation by GPS satellites, the design and deployment of space laboratories for scientific research and product development, mineral exploration and mining on celestial bodies, space tourism, etc. The space industry and commerce already comprise the new space race that is in the nascent stages of evolution and is set to become the next industrial revolution.<sup>3</sup>

Space commerce has had a major influence on world space policy and research. Though the first space race proved the technological and military prowess of the two superpowers, the post Cold War scenario is a multinational struggle to command the commercial opportunities of space. The commercial space age was born in 1965 when the US satellite 'Early Bird', the first commercial communications satellite, went into orbit. In 1980, private entities like Space Services Inc. began testing rockets. In 1982, the company launched its first rocket, Conestoga-1. This set the trend for garnering billions of dollars per year from space-based products and services. The US took the lead in emerging technologies for space-based applications. In 1985, the Soviet Union began marketing contracted satellite launches on the Proton and Zenit rockets. In 1988, the US announced a new space policy that included a new commercial space initiative to encourage US commercial satellite launches to be privatised and limit the National Aeronautics and Space Administration's (NASA's) involvement in commercial space operations.<sup>4</sup>

The global space industry revenue is valued at \$ 335 billion (as of 2015). A significant portion of this goes towards communication services. In the satellite launch segment, the number of satellites launched was 209 in 2016 and 242 in 2017. This is likely to go up to 300 in the next two years. The

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3. 'How Can Space Support the Fourth Industrial Revolution?', at <http://spacenews.com/sponsored/industrial-revolution/>. Accessed on December 8, 2017.

4. "Commercial Satellite Launch History", at <http://www.ilslaunch.com/node/33>. Accessed on November 14, 2017.

**India's success with the Polar Satellite Launch Vehicle (PSLV) since 1994 in launching foreign satellites on a rideshare basis and its success with the Chandrayaan and Mangalyaan missions has been a major contributor in propelling India into the world space industry.**

number of satellites launched into LEO will see an exponential rise.<sup>5</sup> The growth rate of the space industry has been 9.7 percent in 2014 and 10 percent in 2015<sup>6</sup>.

India is emerging as a significant player in the space business though its market share is a mere 3 percent. India's success with the Polar Satellite Launch Vehicle (PSLV) since 1994 in launching foreign satellites on a rideshare basis and its success with the Chandrayaan and Mangalyaan missions has been a major contributor in

propelling India into the world space industry. A launch by Ariane-5, the most successful commercial rocket in use right now, costs more than \$100 million, while that by SpaceX's Falcon 9 costs around \$62 million. When SpaceX introduced Falcon 9, there was serious disruption in the market, with Arianespace and other firms scrambling to bring costs down. In comparison, a PSLV launch costs \$15 million, which has put India in the category of preferred launch services provider.<sup>7</sup> However, the Indian Space Research Organisation's (ISRO's) competency is restricted to the LEO segment.

There is a growing demand for satellites for weather forecasting, Earth observation, remote sensing, broadband and emerging innovative space applications. To cater for the growing demand, space entrepreneurship, privatisation of space manufacturing and facilities, and commercialisation of space are being seen on a large scale across the world. Governments are no longer the dominant space operators. Today, a range of private companies like SpaceX, Boeing, Blue Origin, Orbital ATK and Virgin Space are developing space launch systems and competing with government run space agencies like NASA, Roscosmos, Arianespace, etc. Space

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5. Rudraneil Sengupta, "India's Space Business is Ready for Lift-off", June 15, 2017, at <http://www.livemint.com/Science/tWvAvnsZ7GQEiYhopKU6tM/Indias-space-business-is-ready-for-liftoff.html>. Accessed on November 14, 2017.

6. Ram Jakhur, *Global Space Governance: An International Study* (Springer International Publishing, 2017), p.6.

7. Sengupta, n. 5.

commercialisation is among the dominant contemporary themes. In the coming years, space commerce will clearly be a major contributor to a nation's economy.

#### **MILITARY APPLICATIONS OF SPACE**

During the history of space exploration, the motives have had more reasons than just scientific potential. People generally believe that leading space organisations are exploring the universe purely for academic purposes, but the fact is that space plays a huge role in military planning and execution.

In fact, much of the exploration that space powers have already achieved would not have been possible but for the military motives that underpin most space missions.

The Cold War era necessitated a strategic reconnaissance capability which arose out of intense competition and mutual suspicion amongst the superpowers. The Soviet Union's positioning of nuclear weapons around the world threatened the very existence of the USA. Hence, developing capabilities for reconnaissance on areas which could not be filmed despite aerial reconnaissance by aircraft like the U2 was vital for the survival of the USA. This led to the creation of the world's first military satellites by the US in 1959, which were under project 'Corona'—recce satellites using recoverable film. The utility of satellites for military purposes kept on increasing thereafter through the wars of the 20th century, and the Gulf War of 1991 was a clear watershed moment and came to be known as the "first space war". Since the space race of the early 1960s, the US and Russia (erstwhile USSR) have increasingly utilised military satellites as a key component of military strategy and national defence for the purposes of communication, navigation, surveillance, and reconnaissance.

Space-based systems are becoming an increasingly important component of military power. The military applications of satellites being widely

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employed by space-faring nations are communications, imagery/Earth observation, navigation, mapping, meteorology, early warning, search and rescue, Signals Intelligence (SIGINT), geodesy and surveillance. With these applications now covering almost the entire spectrum of war as an enabler, space-based assets are being viewed as a 'force multiplier'—which multiplies the effectiveness of combat forces.

#### **ADVANTAGES OF SPACE-BASED ASSETS OVER AIRBORNE ASSETS**

Most of the space applications of satellites, specifically surveillance and reconnaissance, can be done through airborne platforms also. However, spaceborne platforms will have the advantage of greater standoff and less risk to the platform itself. Space platforms have enormous durability on station, whereas, those in the atmosphere are limited in endurance by fuel supplies and /or crew endurance. One of the greatest advantages of space recce assets is that of freedom of operation in the medium without violating a nation's air space. One cannot transit through the air space above any state without its consent, but the same is not true for space platforms. Sea-based air power has also had a great advantage in the freedom of the seas, and in space, the benefit is even greater.

#### **DUAL USE CONUNDRUM**

Owing to its civilian and military value, satellite technology is considered dual-use. Although outer space is meant to be used only for peaceful purposes, the term "peaceful purposes" was never clearly defined and it is now accepted that this would include commercial, scientific and developmental activities as well as military applications. However, the limits to military utilisation of space are not clearly defined in any international treaty. While this shortcoming is an advantage for countries with advanced space technologies in military adventurism, it goes against the underlying principles of peaceful exploitation of outer space. Space technologies and satellites, in particular, are intrinsically of dual-use nature and, hence, concerns of proliferation and misuse will trigger serious attempts to control the spread of technology. There are about 1,800 artificial satellites orbiting

the Earth, and around 50 per cent have been used for military purposes at some point in their lifespan. Typical dual-use capabilities are illustrated in Table 1 below:

**Table 1**

<b>Satellite Type / Space System</b>	<b>Civilian Application</b>	<b>Military Application</b>	<b>Specific Military Application</b>
Earth Observation	Yes	Yes	Imagery for ISR
Communication	Yes	Yes	Datalinks for real time targeting, military communication, ELINT
Navigation / GPS	Yes	Yes	Accuracy of navigation and targeting, precise location
Weather	Yes	Yes	Route and target area weather forecasts for success of operations
Launch Vehicle	Yes	Yes	Can be converted to ICBM / ASAT vehicle

Dual-use technologies pose a unique challenge to the proponents of peaceful uses of outer space. Most civilian applications would also have a military use which is difficult to assess. Moreover, there can be several payloads on a satellite, and the purpose of the payloads cannot be ascertained after launch by an inspecting agency. There are no reliable means of pre-launch verification under the existing international space law. The development of the space launch vehicles in itself is treated as possessing the technical prowess to convert space launch vehicles into Intercontinental Ballistic Missile (ICBM) rocket launchers. The dual-use potential of satellite technology promotes an environment of suspicion, and the potential space capability of a state is perceived as an imminent threat which produces

enmity and further heightens existing security dilemmas, as demonstrated by events related to North Korea.

Talks on 'space arms control' have been on for many years under the ambit of the United Nations Office for Outer Space Affairs (UNOOSA) and the UN General Assembly (Committee on Disarmament) with the sole purpose of preventing misuse of space for military purposes which would eventually progress to weaponisation of space. This is an irreversible process, and many countries are lobbying against weaponisation. However, little progress has been made as the main player in the space superpower lobby, the US, is reluctant to take a stance in favour of peaceful utilisation of space, mainly because of its necessity to dominate outer space and secure its interests.

The quest to remain dominant in space technologies also necessitates control of space technology proliferation. Acquiring these technologies from a space superpower is, hence, not an easy option for the developing nations. Sanctions imposed on a country violating technology proliferation norms and seen as crossing weaponisation capability barriers, often also involve isolation from space technology sharing agreements.

As seen from the Indian perspective, India has achieved significant capabilities in satellite manufacture, launch and monitoring. Enviably progress is being made in space exploration. However, for historical reasons, much of the Indian expertise is directed towards peaceful exploitation of space. The space technologies possessed by India are all dual-use in nature, and thereby closely monitored by the technology control regimes of the advanced countries. India will, thus, have to strike a delicate balance between civil and military use of its space-based assets to avoid sanctions.

## SPACE SECURITY

Across the world, around 70 government space agencies are encouraging and enhancing space capabilities, which means that space activities are expected to expand exponentially as more satellites are launched in the near future. Today, more than 1,793 operational satellites (Table 2)<sup>8</sup> are orbiting

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8. Union of Concerned Scientists, "UCS Satellite Database", at <http://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database#.WgvYy7aWbIU>. Accessed on November 15, 2017.

the Earth, including 55<sup>9</sup> Indian satellites. Interestingly, there are 8,048 objects launched into outer space and registered with the United Nations Office for Outer Space Affairs (UNOOSA)<sup>10</sup>. Table 2 below is merely indicative of the large numbers of satellites in operation and the US' share of satellite holdings (it includes launches upto August 31, 2017).

**Table 2: Composition of Satellites Launched into Space**

Total number of operating satellites: 1,738			
United States: 803	Russia: 142	China: 204	Other: 589
LEO: 1,071	MEO: 97	Elliptical: 39	GEO: 531
Total number of US satellites: 803			
Civil: 18	Commercial: 476	Government: 150	Military: 159
Total number of Indian satellites : 55			
Civil / Government: 54	Military : 01 (GSAT-7 : Navy)	Commercial : Nil	

The use of space for military purposes is expanding. Military entities are increasing their use of, and reliance on, commercial and civil satellites. Dual-use and hosted payloads complicate the traditional divide among military, civilian, scientific and private commercial ventures. Having seen the applications of space-based assets and the dual-use conundrum, it is amply clear that any intrusion, manipulation or damage to these vital orbiting assets can cause severe disruption in livelihoods and social well-being on Earth. More importantly, a space dependent nation can become militarily impotent if its satellites are impeded by an opposing force. There are increasing concerns with regard to the weaponisation of space by states. The fear that terrorists / rogue states might use space as their next battleground is also beginning to emerge. Security of space-based assets, thus, assumes vital importance in a nation's security objectives.

9. ISRO, "Indian Spacecraft", at <https://www.isro.gov.in/spacecraft>. Accessed on October 4, 2017.

10. United Nations Office for Outer Space Affairs, "Online Index of Objects Launched into Outer Space", at [http://www.unoosa.org/oosa/osoindex/search-ng.jsp?lf\\_id=](http://www.unoosa.org/oosa/osoindex/search-ng.jsp?lf_id=). Accessed on November 15, 2017.

**While it is difficult to compare the advantages of US military space systems with those of the rest of the world, it would be a mistake to underestimate the rapidity with which other states are beginning to use space-based systems to enhance their security.**

The US is currently investing billions of dollars annually in the development and deployment of a wide range of space systems which are revolutionising the conduct of warfare. At present, no country can rival, or contest, US space dominance or the advantages that this provides to its terrestrial military operations. While it is difficult to compare the advantages of US military space systems with those of the rest of the world, it would be a mistake to underestimate the rapidity with which other

states are beginning to use space-based systems to enhance their security.

It is well known that although the Outer Space Treaty (OST) was formulated in 1967, to preserve outer space for peaceful activities, it did not prohibit utilisation of space systems for military purposes as long as Weapons of Mass Destruction (WMDs) like nuclear weapons were not involved. While use of outer space for military support functions such as reconnaissance, communication and weapon guidance through GPS can certainly not be classified as peaceful purposes, these are nevertheless not considered unlawful acts because there are no international treaties prohibiting such military oriented space applications. Network-Centric Warfare (NCW) capabilities are increasingly dependent on outer space capabilities. The role of space in a nation's security infrastructure is, thus, increasing rapidly, and its impact on the regional and global balance of power equations is slowly altering global stability and security. It is becoming increasingly clear that the deterrence value of space capabilities will play a major role in national security.

Outer space has today become integral to the global and national socio-economic development activities of most progressive countries, and at the same time, militarisation of space is also on the increase as space capabilities are getting embedded into security and war-fighting doctrines of leading space-faring nations. Several countries are striving to build indigenous space capabilities to ensure the security of space assets for exploiting the space applications optimally

during peace-time as well as war-time. Besides the leaders in space technology (the US, Russia, the EU and China), other countries like India, Japan, Israel, North Korea and Brazil are gaining self-reliance in space technology. It is only a matter of time that space infrastructure gets embedded in the war-fighting doctrines of the emerging space powers.

#### VULNERABILITY OF SPACE INFRASTRUCTURE

The degree of dependence of a nation on its space infrastructure is a source of its vulnerability. Space infrastructure and space

capabilities would, in the years to come, represent an easier target than other conventional terrestrial targets as these have no direct implications of human casualties, and, hence, we should expect interference with them. As seen in the unprecedented US military capability, the space-based infrastructure is its nervous system. Though the land, sea and air forces will continue to fight the surface war, these missions will not succeed if not supported through space. A US Space Commission's findings have described the US as an attractive candidate for a "Space Pearl Harbour".<sup>11</sup> Inability or lack of vision to protect satellites, their ground infrastructure or the data links from an enemy attack would result in total disruption of services for a considerable time as these assets cannot be replaced quickly. Each of these elements of space infrastructure has its own unique vulnerabilities, which can be targeted by distinctive methods using emerging technologies. The ground infrastructure is vulnerable to conventional attacks from the ground, air and space. The data links can be jammed, spoofed or even hacked using electronic and cyber warfare techniques. Satellites and other space-based assets are vulnerable to a range of attacks, including Anti-Satellites (ASATs), space planes, directed

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11. Charles V Pena and Edward I Hudgins, "Should the United States 'Weaponise' Space? Military and Commercial Implication," *Policy Analysis*, No.427, March 18, 2002.

energy weapons (land or space-based) like laser and Electro-Magnetic Pulse (EMP) weapons or space-based weapons like space mines and parasite micro/nano satellites. The options are endless. Hence, the importance of *space control*, an area in which countries like the US, Russia and China have taken the lead.

## SPACE CONTROL

As the military and commercial reliance on satellites has grown in unimaginable ways, so has the realisation that space-based assets comprise a '*Centre of Gravity*', likely to be targeted both in war and peace by unfriendly countries. The '*Centre of Gravity*' is described as "an area of critical vulnerability, a successful attack against which can be decisive in the outcome of a war (Warden's model)".<sup>12</sup> This can also be extended to peace-time when a satellite can be made dysfunctional to deny the adversary information superiority. While space systems have proven to be force enhancement tools in wars of the past, and proven enablers of war, the focus is now shifting to control space for national objectives while denying it to the adversary. The national space policies and military space doctrines are gradually shifting beyond utilisation of space as an *enabler* to seeing space as a vital resource, thus, competing for control of the environment, which we call 'outer space'. Many nations are now embarking on programmes for space control and space force projection. This will inevitably see a transition from 'militarisation of space' to 'space weaponisation'. *Space control is, hence, the next logical step in dominating the ultimate high ground, as space in the years to come is not just an emerging battlefield, but a gateway to prosperity for those who have control over it.*

There have been many theories on space power and its applications related to space control. However, military doctrines are still evolving to include space power. Today, the importance of space for economic and military activity resembles the conditions of maritime commerce and naval power in the late 19th century. In view of the similarities between space and the seas as a common heritage of mankind which we know as the global commons, space comprises an arena for development, technological upgradations, commerce, transportation, observation, exploration and

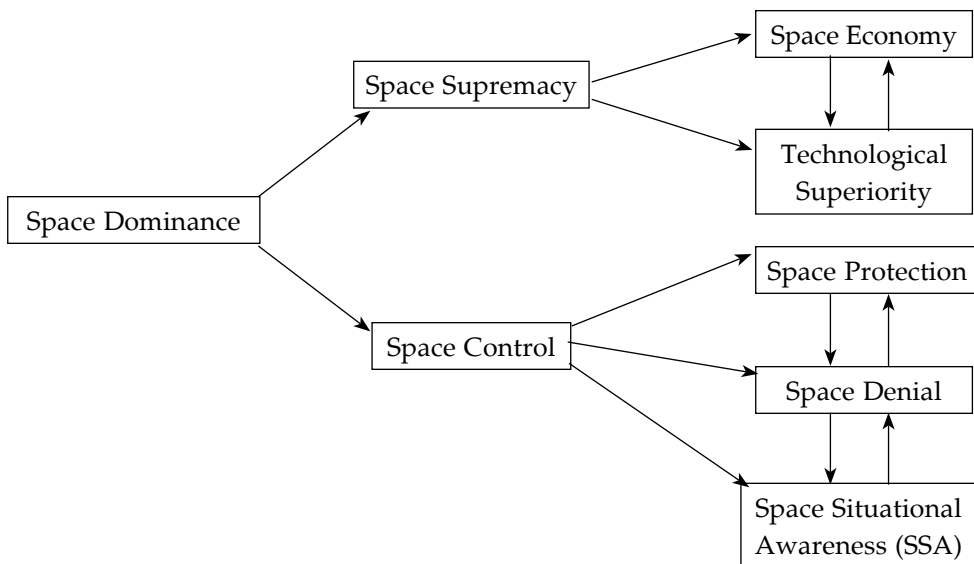
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12. Milan N Vego, "Joint Operational Warfare: Theory and Practice," available at <https://books.google.co.in>. Accessed on November 15, 2017.

future conflict. Comparisons can be drawn between A.T. Mahan's elements of sea power<sup>13</sup> and the emerging form of space power as seen today, and current interpretations of space control are in contrast with those of sea control. Mahan, in one of the many sea power theories, stated that "great powers will necessarily have to be maritime powers" and "control of the seas is essential for control over the world". An analogy with space highlights the importance of space control.

Ostensibly, the space economy is a major driver for space security. A well-established space economy and technological superiority is a precursor to space supremacy. Space control is essential to maintain space supremacy. A combination of space supremacy and space control, thus, gives a condition of 'space dominance', also called *full spectrum dominance* (Fig 1). Thus, it can be stated that the economy, technology, and security are interdependent activities and one flows from the other. They represent the economic, technological and military dimensions of national power.

Fig 1



13. Alfred Thayer Mahan's, "The Influence of Sea Power Upon History 1660-17," is widely regarded as the first important study of the relationship between naval affairs and international politics.

Starting in the early 1980s, both civilian and military scholars have tried to systematically analyse the different ways in which one can think about the role of the space environment and its use for military operations. A number of schools of thought have been developed by scholars such as David Lupton, Peter Hays and James Clay Moltz. Col. David E. Lupton of the Air Power Research Institute, USA, described these schools of thought and differentiated among the *sanctuary*, *survivability*, *control* and *high-ground* schools in his work on space power doctrine<sup>14</sup>. These schools of thought display the role and nature of military activities in space. These are summarised below:

**Table 3**

<b>School of Thought</b>	<b>Space Doctrine</b>
Sanctuary	Space assets are used to stabilise the standoff between nuclear powers, but offensive capabilities are not deployed so as to prevent triggering a war that would put at risk the benefits derived from these assets.
Survivability	Space systems are considered invaluable to support war-fighting on Earth, but are also inherently vulnerable.
Control	Conflict in space is considered inevitable and it is essential to ensure one's freedom of operation and deny the use of space to adversaries, which requires both defensive and offensive space capabilities
High Ground	Space is considered as high ground from which future wars will be decided, and, therefore, it is essential to possess the entire spectrum of war-fighting capabilities in space, including space-based assets for force projection on the ground

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14. David E. Lupton, "A Space Power Doctrine", downloaded web document, at [www.dtic.mil/get-tr-doc/pdf?AD=ADA421942](http://www.dtic.mil/get-tr-doc/pdf?AD=ADA421942). Accessed on November 7, 2017.

The sanctuary regime in space existed till 1985, when President Reagan's Strategic Defence Initiative (SDI) altered the prevailing "peaceful" status of space. Two major events in 1990-91 changed the way world powers viewed the utility of space. Firstly, the Gulf War (Operation Desert Storm) demonstrated how space-based Command, Control, Communication, Computers, Intelligence, Surveillance, Reconnaissance (C4ISR) and navigation capabilities could play a crucial role in winning a conventional war. Secondly, the break-up of the Soviet Union changed the geopolitical stability of the world, restructuring the world into a multipolar space order which also resulted in the US, Russia and China emerging as the dominant space powers. The break-up of Soviet Union witnessed the emergence of new space powers, especially the European Union (EU), Japan and India. Russia inherited the space heritage of the erstwhile Soviet Union and remains a dominant space power along with the US. The SDI created a situation that destroyed the sanctuary regime in space. The dual-use applications of space assets and research on new space weapon technologies changed the nature of space in a fundamental way. Hence, the 'sanctuary' regime of the Cold War era transitioned into a 'survivability' regime in space during the early 1990s, and the 21st century is seeing a clear shift to a 'control' regime in space.

While the US government never endorsed any of these schools of thought or engaged in public debates about them, statements by US officials suggest that it is leaning towards the 'control school'. This was best demonstrated by the then Secretary of Defence, Ash Carter, in his testimony at a hearing before the Senate Appropriations Committee in April 2016:

*While at times in the past, space was seen as a sanctuary, new and emerging threats make clear that's not the case anymore, and we must be prepared for the possibility of a conflict that extends into space.<sup>15</sup>*

This statement is indicative of the shifting focus in US military thinking about space activities. It no longer treats space as a conflict-free environment,

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15. Maximilian Betmann, "A Counterspace Awakening?", at <http://www.thespacereview.com/article/3247/1>. Accessed on November 7, 2017.

but rather as a war-fighting domain in which it has to be able to deal with hostile threats. The US explicitly seeks complete freedom of action in space to fulfill its national security and foreign policy interests. The US is not seen to accept any limitations on the access to space or its utilisation in the pursuit of its national security interests. It would seek to achieve full spectrum dominance in space – a dominating space economy and the entire spectrum of space control capabilities. At the same time, it would aim to deny others' access to, and use of, space to secure its own interests. The US is, therefore, opposed to any international legal regime regulating or restricting the use of space.

Russia, being the second most advanced space-faring nation, has space as an important part of its military modernisation programme, along with promotion of a multipolar space world order to counter the US hegemony. Russia has developed an offensive space control and space denial programme, and is in possession of Anti-Satellite (ASAT), and other military space technologies; however, it is opposed to weaponisation of space. While the European Space Agency (ESA) maintains its leadership role in space systems, it is oriented towards securing the benefits of space to its citizens. China is an emerging space power and is slowly reaching a position that is capable of challenging US predominance in space. It has a well-developed space programme with an orientation towards military applications and offensive space capabilities, as evidenced from its ASAT tests since 2005. All other emerging space powers are mostly oriented towards 'peaceful purposes' barring North Korea whose capabilities are doubtful. India, on the other hand, is well poised to develop space control and space denial capabilities, but is committed to peaceful exploitation of space.

Space control essentially involves protecting space infrastructure and space-based assets from disruption or damage by an enemy or any other agency, knowingly or otherwise. It can be said to comprise *space protection*, *space denial* and *space situational awareness* (Fig 1). While *space protection* involves securing own space assets from disruption / damage, *space denial* means denying an enemy access to its space resources during a conflict. *Space control* and *space supremacy* together contribute towards *space dominance* which

will be crucial for any nation for achieving its national security objectives. The strategy for *space control* can be either defensive (protecting own space assets) or offensive (degrading / destroying the enemy's space assets). *Space situational awareness* would be a prerequisite for any space mission. While space dominance is an overwhelming superiority in space and offers unrestricted freedom of operation of space assets, space control, through space protection and space denial, will be limited in time and space, and will be more practical in a multipolar space order.

*Space protection, space denial and space situational awareness* are, hence, the primary requirements towards space security through military means and need a doctrinal approach for planning, training and execution. Contemporary military space missions could, thus, be broadly classified as given in Table 4 below:

**Table 4**

<b>Broad Purpose / Scope</b>	<b>Space Role / Mission</b>
Control of space environment	Counter-space missions : space denial (offensive) and active defence (space-based force application).
Protecting space-based assets	Space protection : space enabling operations through passive protection measures.
Military enabling and combat sustaining applications through satellites	Combat enabling operations (in support of ground, sea and air military operations).
Tracking and manoeuvring space assets for avoiding collisions, and for space surveillance.	Space situational awareness operations

Space power is an extension of air power in the fourth dimension – space – and, hence, parallels can be drawn with air power doctrines on executing each of the above space missions. A well-orchestrated space doctrine, coupled with organisational and infrastructural support and demonstrated capabilities has an effective deterrence value.

**A USAF manual**  
*(Functions and Basic Doctrine of the USAF), published in 1979, asserted that space support, force enhancement and space defence were the three missions that air force space operations should execute.*

**SPACE PROGRAMMES AIMED AT SPACE CONTROL (US, RUSSIA AND CHINA)**

**USA:** The American Space Act of 1958 was an important development creating NASA to pursue civilian space programmes, thus, restricting the Department of Defence (DoD) military space development. The Advanced Research Projects Agency (ARPA), later DARPA, was created under the DoD in the same year for creating breakthrough technologies for national security. In 1962, the

DoD published a White Paper called the “Air

Force Space White Paper” which put emphasis on the air force’s two reasons for being in space as: (1) enhancing the US military posture; and (2) having military patrol ability in space. It went on to stress the need to protect US scientific activities in space and advocated development of space weapons.<sup>16</sup> The Outer Space Treaty of 1967 prevented nuclear weapons being put into orbit in outer space, but did little to prevent militarisation of space and non-nuclear weaponisation of space. A major push to the US space programme came through a decision in 1972 to construct a space shuttle. The shuttle was a revolutionary concept of improving mission flexibility and capability by on-orbit check-out of payloads, recovery of malfunctioning satellites for repair and re-use, re-supply of payloads on orbit, thus, extending their lifetime. These concepts are also reflected in the US Air Force (USAF) policy of fulfilling its militarisation requirements. In 1976, the Soviet decision to resume ASAT weapons testing after a four-year moratorium following the Anti-Ballistic Missile Treaty (ABM) Treaty in 1972, led to a number of US policy developments that increased the role of space in the US military’s operational planning. The realisation of space’s growing military importance was reflected in the 1977 USAF document that affirmed the USAF’s primary responsibility in space as involving development of weapon systems, military space operations and protecting the free use of space by providing

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16. Bert Chapman, *Space Warfare and Defense* (California, ABC-CLIO, 2008), p.19.

essential space defence capabilities.<sup>17</sup> This served as a stepping stone for discussion and action on space issues of the future. A USAF manual (*Functions and Basic Doctrine of the USAF*), published in 1979, asserted that space support, force enhancement and space defence were the three missions that air force space operations should execute. This document went on to assert that using space systems multiplied the effectiveness of surface, sea and aerospace forces. The onset of President Reagan's Administration in 1981 saw a major defence space policy review. The Air Force Space Command (AFSPACECOM)

was established in 1982, and a unified US Space Command (USSPACECOM) was established in 1984<sup>18</sup>. A revised USAF manual (*Military Space Doctrine*) was released in 1982, which described space as the outer reaches of the air force's operational medium, and an environment useful for conducting air force missions. It also asserted that aerospace power provided credible war-fighting capability, from the battlefield to the highest orbit in space, and air force interests included performing war-fighting missions with space-based weapon systems, consistent with the national security requirements. The Air Force Space Plan was published in 1983 and it identified four terms for space operations: space control, space support, force enhancement and force application, each term having its own distinctive definition. The Air Force Space Plan described *space control* as maintaining freedom of action in space and denying such autonomy to an enemy. President Reagan's Strategic Defence Initiative (SDI) provided the necessary boost for the space programmes, mainly intended to provide a shield from the ground to space against Soviet nuclear missiles. In 1989, the USAF issued a plan to implement

**The Air Force Space Plan was published in 1983 and it identified four terms for space operations: space control, space support, force enhancement and force application, each term having its own distinctive definition. The Air Force Space Plan described *space control* as maintaining freedom of action in space and denying such autonomy to an enemy.**

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17. Ibid., pp.24-25.

18. Ibid., pp.29, 31.

a Blue Ribbon panel recommendation. The roadmap was intended to project military space policy into the 21st century by linking space systems to war-fighting requirements, global strategy and space warfare. The collapse of the Soviet Union was thought to have ended the role of the Soviet military space policy in prompting US military space programmes, however, a series of domestic and global events in the early 1990s influenced, and accelerated US efforts to develop a viable military space programme. Operation Desert Storm was a watershed event for space systems as it enhanced space as a major military operational player. Successive DoD directives and air force manuals have thereafter represented a growing emphasis on integrating military space into the air force and military operational doctrines. A notable addition was the Air Force Counter-Space Doctrine of 2004 which stressed on threats like Radio Frequency (RF) jamming, laser systems, EMP weapons, ASAT weapons and information operations against satellites and how to deal with them.<sup>19</sup> Highlights of the US anti-satellite programmes are given below:

- **Kinetic Energy Kill Vehicles:** The US pursued ABM/ASAT systems partly because of a perceived threat of Soviet “orbital bombardment systems,” in which a weapon would be placed into orbit and then accelerated down to Earth in an attack. In February 2008, the US demonstrated the ASAT capability of its Aegis sea-based missile defence system by destroying a non-responsive US satellite at an altitude of 240 km.
- **Inspection / Interception / Destroyer Satellites:** US space shuttles had the ability to rendezvous with a satellite and pull the satellite into its cargo bay. After the shelving of the space shuttle projects, the NASA Demonstration for Autonomous Rendezvous Technology (DART) programme launched a satellite in 2005 on a short mission to approach a target satellite without assistance from ground personnel. The mission failed when the DART satellite collided with its target. The USAF, reportedly has had more success with its Experimental Satellite System 11 (XSS-11) programme, and has been developing “rendezvous and proximity operations, autonomous

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19. Ibid., pp.32-52.

mission planning, as well as other enabling space technologies.<sup>20</sup> The US has conducted a number of interception missions: XSS-10 (2003), DART (2005), XSS-11 (2005-2006), MiTeX (2006-2009), GSSAP (2014), ANGELS (2014)<sup>21</sup>.

- **Air Launched Miniature Vehicle (ALMV):** In June 1982, the United States announced its intention to test a new-generation ASAT weapon: the Air-Launched Miniature Vehicle (ALMV), which consisted of a two-stage missile launched from an F-15 aircraft flying at high altitude. The missile could hit a satellite in LEO and destroy or disrupt the satellite in a high-speed collision. The first and only test against a satellite was performed in October 1985 when an ageing satellite—Solwind—was destroyed at an altitude of 555 km. This test highlighted in a dramatic way the consequences of destructive ASAT technology. The USAF intended to pursue the ALMV programme vigorously, scheduling a number of tests for 1986, but in December 1985, the US Congress banned further testing of the system on satellites. The air force continued to test the ALMV, but stayed within the limits of the ban by not engaging a spaceborne target. In 1987, the political opposition to the ALMV system appeared entrenched, and the air force ended the programme.<sup>22</sup>
- **Laser Weapons:** In 1988, the air force began plans for other ASAT programmes, in particular a ground-based laser system, in response to the development of a laser system by the Soviet Union that could pose a significant threat to both satellites and ballistic missiles. The US Navy coupled its ground-based, megawatt-class Mid-Infrared Advanced Chemical Laser (MIRACL) to the Sea Lite beam director, a large and agile mirror that can direct the MIRACL's beam, at a missile range in New Mexico. In 1997, the MIRACL laser and Sea Lite beam director were tested to illuminate a satellite orbiting at an altitude of 420 km. The results of the test were classified, but the DoD did report that the system tracked and illuminated the satellite, and the lower-power laser either temporarily

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20. Laura Grego, "A History of Anti-Satellite Programs", January 2012, at [http://www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/a-history-of-ASAT-programs\\_lo-res.pdf](http://www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/a-history-of-ASAT-programs_lo-res.pdf). Accessed on November 28, 2017.

21. "Russia and Anti-Satellite Programs", at [www.globalsecurity.org/space/world/russia/asat.htm](http://www.globalsecurity.org/space/world/russia/asat.htm). Accessed on November 27, 2017.

22. Chapman, n.13. p.144.

**The US Airborne Laser (ABL) programme, whose goal is to create a megawatt-class laser small enough to be carried in an aircraft and powerful enough to destroy missiles during their boost phase, can also be used to attack and damage satellites at low altitudes.**

dazzled or damaged the satellite's sensor. This system has not been tested on a satellite since 1997.<sup>23</sup>

- The US Air Force Airborne Laser, (ABL), designated the YAL-1A, is carried on a modified Boeing 747-400F freighter aircraft, and is a megawatt class high-energy laser weapon system for the destruction of tactical theatre ballistic missiles. In February 2007, the ABL began a series of flight tests which included the first in-flight firing of the targeting laser at a simulated target in March 2007. The YAL 1A laser travels at the speed of

light to destroy ballistic missiles in their boost phase of flight. In January 2010, the high energy laser was fired to intercept a test missile. The US Airborne Laser (ABL) programme, whose goal is to create a megawatt-class laser small enough to be carried in an aircraft and powerful enough to destroy missiles during their boost phase, can also be used to attack and damage satellites at low altitudes.<sup>24</sup> While technically successful, several limitations led to the ABL programme's cancellation in 2011.

- **Satellite Jamming:** In 2004, the United States deployed the ground-based counter-communications system. However, the specific capabilities of this system have not been disclosed. There were plans to upgrade the system in 2007.<sup>25</sup>
- **Space Planes:** In April 2010, the US Air Force launched a space plane prototype, the X-37B. It stayed in orbit for almost a year. A second prototype was launched in March 2011. The mission profile of the space plane programme is a mystery; however, some observers have inferred that the X-37B has a specialised military purpose towards counter-space

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23. Grego, n. 20.

24. "Airborne Laser System (ABL) YAL 1A", at <http://www.airforce-technology.com/projects/abl/>. Accessed on December 5, 2017.

25. Jeremy Singer, "U.S. Air Force to Upgrade Satcom Jamming System", June 29, 2004, at <http://spacenews.com/us-air-force-upgrade-satcom-jamming-system/>. Accessed on December 5, 2017.

operations or as a space-based weapon testbed.<sup>26</sup>

**Russia:** The only country to have invested efforts and resources comparable to the US in developing space weapons is Russia (erstwhile Soviet Union). The Russians' efforts to develop a military space programme began towards the end of World War II, when they sought to gain information about the German V-2 rockets. Sergei Korolev, a Soviet aeronautical engineer, was working in a Soviet military supported Research and Development (R&D) centre before World War II. He was instrumental in conceiving the Soviet space programme, having conducted assessments of captured German rocket equipment, and played a key role in the launch of the Sputnik in 1957. Korolev became the chief developer of the Soviet long range ballistic missiles like the R-1 and R-2 and later the R-5 and R-7, gradually progressing from Intermediate Range Ballistic Missiles (IRBMs) to nuclear Intercontinental Ballistic Missiles (ICBMs). The Soviet leadership under President Khrushchev recognised the potential of the space programme as a focus of national unity and pride. Though it was projected as peaceful in nature, the Soviet government shared this technology with ideologically compatible nations like China. The Soviet military space developments were seen way back in 1963, when a satellite – the Polet-1 – was launched, which was the first satellite to manoeuvre in space by changing orbits, an essential capability for performing anti-satellite operations. The evolving organisational structure of the Soviet military space programme was reflected in the creation of the Central Directorate of Space Assets (TSUKOS) within the Ministry of Defence in 1964. TSUKOS was the primary organisation for directing Soviet military space programmes. The launch of a Tsylkon-2 rocket in 1967, capable of carrying anti-satellite weapons,

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26. Leonard David, "What Will the X-37B Military Space Plane Do on Its Next Mystery Mission?", May 19, 2015, at <https://www.space.com/29442-x37b-space-plane-fourth-mission.html>. Accessed on December 1, 2017.

was evidence of the Soviet intent to deploy such weaponry. During 1967, the Soviet Union also launched the Cosmos 139, which was the first test of its Fractional Orbital Bombardment System (FOBS). The 1968 Soviet military strategy echoed the Soviet military space policy of creating space weapon systems to enhance overall military combat effectiveness, to prevent other countries from using space, and for developing strategic offensive systems for space war-fighting. During the 1960s and 1970s, the Soviets made extensive efforts to develop ASATs, with some recognition of these efforts occurring as early as 1962. Between 1968 and 1982, an ASAT was tested 20 times in space. During each test, a dedicated target vehicle was launched into LEO. Five of the seven ASAT tests between 1968-71 were judged successful, with the tests being conducted at altitudes ranging from 230 to 1,000 km above the Earth's surface. Further tests brought in more improvements in sensors and intercept profiles. By the early 1980s, the Soviet military had significant anti-satellite capabilities. A US DoD assessment of Soviet military space programmes contended that the Soviets could launch the initial prototype of a space-based laser ASAT system in the late 1980s or early 1990s and the Russians were in a position to test a space-based ABM system in the 1990s.<sup>27</sup> As per a 1985 Central Intelligence Agency (CIA) assessment, the Soviets had acquired relevant technologies in areas such as space-based lasers, directed energy weapons and anti-missile defence systems. Post the collapse of the Soviet Union, their space launch rates had fallen by about 15 percent initially, and subsequently, the budget for military space programmes was slashed by 90 percent. Though this had not degraded Russian military space capabilities, there was no further R&D on new projects and there was a negative impact on space research. The last known test of a Russian ASAT took place in 1982, and the 2001-2002 edition of *Jane's Space Directory* described the Russian ASAT programmes as "inactive".<sup>28</sup> The lack of testing after 1982 raised some doubts about the operational status of the co-orbital ASAT. However, the Tsyklon-2 was flown frequently in support of ocean reconnaissance programmes. Nearly three years later, a Russian publication appeared to confirm its operational

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27. Chapman, n.13, pp.189-191.

28. Ibid., pp.195-197.

status.<sup>29</sup> In the early 2000s, the Russians began considering cooperating with the United States on aspects of missile defence, and both nations continued to respect the ASAT weapons-testing moratorium until the US destroyed a satellite during a 2008 test.

The highlights of the Russian anti-satellite programmes are given below:

- **KE Kill Vehicles:**
  - The ‘Briz-k’(Naryad programme), a kinetic energy ASAT was developed in the mid-1980s as an ASAT to be launched on top of the SS-19 ICBM. It was tested a few times in suborbital flights in the early 1990s, but never deployed operationally.<sup>30</sup> The Briz-K was apparently designed to release one or several rocket-powered “kill vehicles” capable of intercepting orbiting satellites at altitudes of up to 40,000 km—much higher than the reach of earlier systems.
  - The test of a PL-19 Nudol missile took place on December 16, 2016. The launch, which was the fifth of the Nudol tests, originated from a facility near Plesetsk, about 500 miles north of Moscow, and was apparently successful, despite reports that no debris was detected by US monitoring stations, implying that no test target was destroyed<sup>31</sup>.
- **Military Interceptor/Inspector/Destroyer Satellites:** Russia’s main and only dedicated ASAT system uses a co-orbital strategy.
  - In 2010, the space troops commander, who later headed the Russian space agency, said that Russia had again taken up the development of “inspection” satellites.
  - On December 25, 2013, a rocket was launched carrying a trio of Rodnik communications satellites to replenish the constellation which had been operational since 2005. The previous six launches had carried three Rodnik satellites, but this launch carried four— Kosmos-2488, -2489, -2490 and -2491. For several weeks in 2014, the object manoeuvred

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29. “Co-orbital ASAT”, at [www.globalsecurity.org/space/world/russia/coorb.htm#ref107](http://www.globalsecurity.org/space/world/russia/coorb.htm#ref107). Accessed on November 27, 2017.

30. “Briz [Breeze]”, at [www.globalsecurity.org/space/world/russia/briz.htm](http://www.globalsecurity.org/space/world/russia/briz.htm). Accessed on November 27, 2017.

31. Weston Williams, “Russia Launches Anti-Satellite Weapon: A New Warfront in Space?”, December 22, 2016, at [www.csmonitor.com/USA/Military/2016/1222/Russia-launches-anti-satellite-weapon-A-new-warfront-in-space](http://www.csmonitor.com/USA/Military/2016/1222/Russia-launches-anti-satellite-weapon-A-new-warfront-in-space). Accessed on November 27, 2017.

towards other Russian space objects, culminating in November 2014 when it rendezvoused with the upper stage that had placed it in orbit. That extra satellite was acknowledged as a satellite by the Russian Federation in a note to the United Nations in May 2014.<sup>32</sup>

- In May 2014, Russia announced that it had launched three Russian communications satellites, the Kosmos-2496, -2497, -2498. An additional object was along for the ride, orbiting a few kilometres away from the declared payloads. It manoeuvred under its own power, eventually making a close approach to the rocket stage that launched it in early November. The object was reclassified as the Kosmos-2499 by the US.<sup>33</sup>
- **Laser Weapons:** From the 1970s, the USSR was involved in an extensive, multifaceted programme to develop high-powered, ground-based lasers and microwave weapons. In 1991, a number of reports began to emerge about an effort to deploy Space-Based Lasers (SBLs) in conjunction with a strategic defence programme. The first mission in 1987 included the launch of a 'Skif-DM' payload, which was intended for testing the laser weapon. The Skif-DM failed to reach the orbit due to an attitude control problem and fell into the Pacific Ocean after separating from the booster. No further launch has been attempted.<sup>34</sup>
  - Russia resumed work on its airborne laser anti-satellite system with the 'Sokol Eshelon' system that included a laser deployed on the A-60 aircraft (a modification of the Il-76). The Sokol Eshelon system apparently has a capability to blind sensors of satellites in all types of orbits. A test of the system was conducted in August 2009. The aircraft was scheduled to perform its first test flight in 2013. It is unlikely to be capable of anything more than dazzling or partially blinding the sensors of observation satellites.<sup>35</sup>

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32. Grego, n. 20.

33. Laura Grego, "Russia's Small Maneuvering Satellites: Inspectors or ASATs?", Union of Concerned Scientists (blog), at <http://allthingsnuclear.org/lgrego/russias-small-maneuvering-satellites-inspectors-or-asats>. Accessed on November 27, 2017.

34. "Lasers", at <https://www.globalsecurity.org/space/world/russia/lasers.htm>. Accessed on November 27, 2017.

35. "Russia to Resume Work on Airborne Laser ASAT", at [http://russianforces.org/blog/2012/11/russia\\_to\\_resume\\_work\\_on\\_airbo.shtml](http://russianforces.org/blog/2012/11/russia_to_resume_work_on_airbo.shtml). Accessed on November 27, 2017.

- **ALMV:** A more conventional ASAT programme was also underway in the late 1980s and early 1990s. A specially configured MiG-31 was designed to carry an air-launched missile equipped with a satellite-homing, kinetic-kill warhead. This was very similar to the US F-15 air-launched ASAT, successfully tested against a satellite in September, 1985. The status of the Russian air launched ASAT today is unclear, but Russian officials in 1992 indicated that future space tests were possible. The effort was suspended in the early 1990s and details are sketchy.<sup>36</sup>
- **Electronic Jamming:** Russia is likely to have jamming capabilities that are effective out to geosynchronous orbit, especially against non-military targets, which are relatively unprotected from such attacks.
- **ABM:** Moscow's current missile defence system features use of nuclear-tipped interceptors. Although such interceptors can be used against satellites, they have long been recognised as a poor ASAT option, partly because nuclear explosions in space result in collateral damage and would destroy all nearby satellites. Also, for weeks after the detonation, many more satellites could be damaged by radiation in LEOs. Use of such weapons would also violate the Partial Test Ban Treaty (PTBT) of 1963.<sup>37</sup>

**China:** China's space programme drew inspiration from the success of the Soviet space ventures and as a follow-up of their ballistic missile programme. China joined the group of space-faring nations when it launched its first satellite, the Dong Fang Hong-1 (DFH-1), on April 1, 1970. Apparently spurred by Soviet and American ASAT and ABM technology developments in the 1970s and 1980s, China began its own research on hit-to-kill technology in the 1980s. China's unease over the US SDI and the 1985 US ASAT test was the trigger for it to actively pursue ASAT technology and prompted creation of a research programme. While the China National Space Administration (CNSA), created in 1993, was the equivalent of NASA and controlled the civilian space programme, the military space research, production and operation was under the

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36. "USSR/CIS Miniature ASAT", at [www.globalsecurity.org/space/world/russia/mini.htm](http://www.globalsecurity.org/space/world/russia/mini.htm). Accessed on November 27, 2017.

37. Grego, n. 20.

**China claims that the Aolong-1 is tasked with cleaning up space junk and collecting man-made debris in space. However, other reports suggest that the spacecraft, equipped with a robotic arm, is a dual-use ASAT weapon.**

Ministry of National Defence. The decade from 2000 to 2010 saw many achievements for China, including the manned space missions and testing of ASAT weapons. In October 2008, a Shenzou-VII mission involving a space walk by three astronauts drew international attention and caused a stir because a 40 kg Picosat (BX-1) released by the spacecraft came as close as 25 km from the International Space Station (ISS), and there was an apparent risk of collision. It was perceived by the international community as a test of a multipurpose killer

satellite.<sup>38</sup> A brief survey of recent tests by China (as given below) confirms that it is rapidly improving its counter-space programme and making advances in its anti-satellite systems. China's first ASAT test was conducted in May 2005 and its capabilities have come a long way since then. China's capabilities in hard and soft kill techniques are largely speculative, and shrouded in secrecy. The highlights of the Chinese anti-satellite programmes are given below:

- **Military Interceptor/Inspector/Destroyer Satellites:** China conducted a satellite interception, the 'SJ-12' mission, in 2010.<sup>39</sup> China has autonomous rendezvous and close-proximity capabilities in various stages of development. In June 2016, China launched the 'Aolong-1' spacecraft on a 'Long March 7' rocket. China claims that the Aolong-1 is tasked with cleaning up space junk and collecting man-made debris in space. However, other reports suggest that the spacecraft, equipped with a robotic arm, is a dual-use ASAT weapon. The 'Aolong-1' is believed to be the first in a series of spacecraft that will be tasked with collecting man-made space debris. It is also learnt that China is developing various co-orbital ASATs.<sup>40</sup>

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38. James Clay Moltz, *Asia's Space Race* (New York: Columbia University Press, 2012), Ch 3.

39. Grego, n. 20.

40. Harsh Vasani, "How China Is Weaponizing Outer Space", January 19, 2017, at <https://thediplomat.com/2017/01/how-china-is-weaponizing-outer-space/>. Accessed on November 30, 2017.

- **KE Kill Vehicles:** In 2007, China used a mobile ground-based missile to launch a homing vehicle that destroyed one of its decommissioned FY-1C weather satellite via a direct impact. China had been developing this 'hit-to-kill' technology since the 1980s, as an ASAT weapon and for ballistic missile defence, though the first test was undertaken in 2005. Subsequently, four tests took place in 2010, 2013, 2014 and 2017. The 2013 test involved a new missile, the DN-2 or Dong Neng-2, and the test was conducted in 'near geosynchronous orbit', where most of the US' ISR satellites are located. The direct ascent test, reached an altitude of 18,600 miles. In 2015, China tested the DN-3 exoatmospheric vehicle, reported to be capable of destroying US satellites at all altitudes.<sup>41</sup>
- **Laser Weapons:** In 1995, at defence exhibitions in Manila and Abu Dhabi, China displayed the ZM-87 laser weapon. In 2006, reports surfaced that China had illuminated a US satellite with a ground-based laser, perhaps more than once. While the details and purpose of the incidents were unclear, it is certain that China (and many other countries) have the capability to track satellites using low-power ground-based lasers.
- **Hypersonic Glide Vehicles (HGVs):** China has been developing HGVs since 2015 and has carried out two tests on the DF-17 missile in November 17, 2017. Though this is meant to be a land attack system, the HGV separates from the missile during the re-entry phase after transiting through space and glides to the target.

**Going by the events in space during the past decade, Russia and China seem to have perceived a need to offset any US military advantage derived from military, civil, or commercial space systems and are increasingly considering attacks against satellite systems as part of their future warfare doctrine.**

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41. Ibid.

military, civil, or commercial space systems and are increasingly considering attacks against satellite systems as part of their future warfare doctrine. Both Russia and China have demonstrated a desire to pursue a full range of ASAT weapons as a means to reduce US military effectiveness. Some new Russian and Chinese ASAT weapons, including destructive systems, will probably complete development in the next several years. Russian military strategists view counter-space weapons as an integral part of broader aerospace defence objectives and are very likely pursuing diverse capabilities to affect satellites at all orbital altitudes and patterns. These diverse capabilities include directed energy (laser) weapons that could blind or damage sensitive space-based optical sensors, robotics technology designed for satellite servicing and space-junk removal (which can also be used to damage satellites), and electronic warfare attacks against space systems. Development is likely to focus on jamming capabilities against dedicated military satellite communications, imaging satellites, and Global Navigation Satellite Systems (GNSS), such as the US Global Positioning System (GPS).<sup>42</sup>

## CONCLUSION

The space doctrines of major space-faring nations like the US, Russia and China recognise space for socio-economic progress, and space commerce and space as another medium of warfare besides the land, sea and air. Their navigation, remote sensing and communication satellites are for peaceful civilian as well as military purposes, and their space doctrines exploit the dual-use conundrum. Other space-faring nations like the EU, Brazil, Iran, Israel and North Korea are following suit. Japan and India are following the peaceful exploitation of space. The increasing reliance on space and space-based assets necessitates adoption of a strategy towards space security.

In future wars, the side that knocks down the largest number of enemy satellites stands to gain a strategic lead. American and Russian ASAT weapons and other counter space capabilities existed during the Cold War,

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42. Leonard David, "China, Russia Advancing Anti-Satellite Technology, US Intelligence Chief Says", May 18, 2017, at <https://www.space.com/36891-space-war-anti-satellite-weapon-development.html>. Accessed on November 27, 2017.

but due to military and ISR space assets being mainly used for strategic purposes, both sides exercised a certain degree of restraint, at least when it came to putting ASATs into operational use, since they were considered to be destabilising. China is the new entrant in ASAT capabilities with a potential to expand rapidly. With increasing reliance on space assets for conventional war-fighting, the situation which existed during the Cold War era and in the late 1990s has changed. The space-based assets of nations have become more vulnerable than ever before. Targeting of satellites or making them dysfunctional can change the course of a war. Any country which possesses Ballistic Missile Defence (BMD) technology can easily convert the weapon to target a satellite. Other options involving soft kill are also being aggressively developed. Hence, control of space and protection of space-based assets is vital for any country which relies on satellites for war-fighting. The most compelling reason for moving forward for acquiring at least the essential elements of a serious space control capability is that the space enabled nations are now heavily invested in, and dependent on, space capabilities, both military and commercial. Since these capabilities can only be expected to grow in importance over time, it is fair to presume that they will eventually be challenged by potential opponents.

*Space superiority is not our birthright, but it is our destiny.... Space superiority is our day-to-day mission. Space supremacy is our vision for the future.*

– Gen Lance Lord, head of the US Air Force Space Command<sup>43</sup>

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43. Anup Shah, "Militarization and Weaponization of Outer Space", January 21, 2007, at <http://www.globalissues.org/article/69/militarization-and-weaponization-of-outer-space>. Accessed on November 13, 2017.