

**RSTV: In Depth**  
**Space Debris**

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**Larger Background:**

- On March 27, 2019, India successfully tested a state-of-the-art missile technology by shooting down a satellite parked at low earth orbit.
- The anti-satellite test placed the country in an elite club of countries with such a capability.
- But, days following India's A-SAT test, American space agency NASA has come up with sharp criticism, saying the debris created due to shooting down of the satellite has increased the risk to the International Space Station.
- NASA administrator Jim Bridenstine has said the agency has identified at least 400 pieces from the wreck, and is tracking 60 of them that were larger than 10 cm in size.
- He says 24 of these 60 pieces have got near the International Space Station, posing a potential threat of collision. Indian space scientists have rubbished the NASA chief's assertion on various counts.
- According to experts, the International Space Station orbits Earth at an altitude of 330-435 km, while the test conducted by India is well within the 300km range. Besides, since the test was carried out in low-earth orbit, whatever little debris has been created would decay and fall back on to the earth within weeks.
- This edition of In-Depth analyses NASA chief Jim Bridenstine's remark on India's A-SAT test and his concerns regarding increasing space debris.
- We also try and understand in detail about the various treaties that govern space and the International Space Station.

**A Brief History:**

- A day after India successfully carried out its A-SAT test, acting US Defence Secretary warned that the event could create a mess in space. Almost a week later, NASA raised concerns that the debris could raise a threat to the International Space Station (ISS), that is stationed at an altitude between 330 and 435 kilometres in the Low Earth Orbit (LEO).
- The successful test of India's Mission Shakti put India in an elite club of the United States, Russia and China in owning and using anti-satellite technology.
- On 27<sup>th</sup> March, 2019, the A-SAT weapon was launched, from the DRDO's testing range in Odisha's Balasore, shooting down a live Indian Satellite target in the Low Earth Orbit (LEO).
- Jointly led by India's Defence Research and Development Organization (DRDO) and the Indian Space Research Organization (ISRO), mission Shakti was aimed at strengthening the country's overall security.
- However, a few days after the test, the National Aeronautics and Space Administration (NASA), expressed concern over India's A-SAT test, calling it a terrible thing that created 400 pieces of orbital debris, and led to new dangers to astronauts aboard the International Space Station (ISS).
- The Indian scientists have discounted the claims made by NASA and have said that there are no dangers. It is important to note that the International Space Station (ISS) operates at a much higher altitude than the

altitude at which this test was conducted, and when one destroys a satellite in orbit, the debris can only come down and it cannot go up. Thus, NASA's claim that the debris may damage the International Space Station (ISS) appears to be ill-founded.

- NASA officials had also asserted that as a result of the Indian tests, the risk of collision with the International Space Station (ISS) has increased by 44% over the last 10 days. NASA says that it will continue to track 24 of these 60 pieces which are about 10 centimetres or bigger in size which are travelling above the apogee of the International Space Station (ISS), but acknowledged that this risk is comparatively small and short-lived as the satellite was destroyed well below the International Space Station.
- It is important to note that space debris are quite dangerous as they travel at a very high speed.
- The debris arising from the recently conducted test by India would travel at the speed of 28,000 kilometres per hour, and even if a small piece of this debris hits a satellite or any object for that matter, it would damage the same. This is because the momentum depends on the velocity. Higher the velocity of the debris, higher would be the damaging potential. Thus, this is definitely a concern. However, the likelihood of it hitting the International Space Station (ISS), is very low.
- The U.S. military tracks objects in space to predict the collision risk for the International Space Station (ISS).
- They are currently targeting 23000 objects that are larger than 10 centimetres. These include about 10000 pieces of space debris, of which nearly 3000 were created by the 2007 Chinese experiment at an 800 kilometre altitude. This debris is still flying around due to lack of air pressure.
- ISRO and DRDO rejected NASA's claims of space debris caused by India's A-SAT test. Scientists say that the tests were conducted in a lower atmosphere to ensure that the debris disappeared eventually.
- Reacting to NASA's statement, the Indian scientists said that India's test was done in the lower atmosphere to ensure that there is no space debris.
- Tapan Mishra, Senior advisor to the ISRO Chairperson says that the debris from Mission Shakti experiment would burn out in the next 6 months. According to Mishra, the test was conducted 300 kilometres in space, where the wind pressure is low, but sufficient to burn the debris. The DRDO experiment was not an explosion, but more like a bullet. DRDO says that the test was calibrated and conducted in the low earth orbit to ensure that the debris would disappear in 45 days.

### **Contribution to Space Debris: A Perspective from different countries:**

- When we look at the issue historically, we find that till date, the bulk of launches have been conducted by two important countries, i.e. U.S. and the Soviet Union (present day Russia). In addition to this, the European Union, Japan, China, and then India, has also made a contribution. The other countries have also made a contribution, but they are fairly insignificant, amounting only to a few launches. According to Dr. M Annadurai, Director of ISRO Satellite Centre, Bangalore, the problem of space debris is a wider issue as it is composed of satellites and parts of launch vehicles. The difference is that while the debris from a satellite would be a larger piece, weighing a few tonnes, the debris from a destroyed satellite would be smaller.
- One important difference between space debris and a satellite, even a dysfunctional satellite for example, is that when a dysfunctional satellite is put in a particular orbit, it follows the same orbit. However, debris follows an eccentric orbit, which means that the height can vary. Thus, this can actually be a potential threat to objects at different heights.
- While the size and weight of the pieces are secondary, what is crucial is that these pieces move at very great speeds. In the low earth orbit, where the targeted Indian satellite was located, objects typically move at 28,000 kilometres per hour in order to stay in their orbits. At such speeds, even a tiny object, of just about 100 grams, would produce the same kind of impact on collision as a 30 kg stone, travelling at about 100kms per hour.
- Around 60 years ago, our space exploration began and the first satellite was launched by the Soviet Union.

From then onwards, a number of satellites have been launched by different countries. Various space missions have been launched and each of them creates some amount of debris in space. When a satellite becomes non-operational, it becomes debris. According to the European Space Agency, there are about 34000 objects of 10 centimetres or above in space, while another 90,000 objects of sizes 1 and 10 centimetres, and a further 128 million of sizes 1 mm and 10 mm are in space.

- There is a law known as the “International Space Law”. One of the points enshrined in this is if a satellite becomes dysfunctional, then the satellite should deorbit and its re-entry into the earth should be carried out instead of leaving it as space debris.
- In spite of this, considering the vastness of space, collisions even between space debris, not moving in any fixed orbit, are extremely rare.

### **The International Space Station:**

- According to NASA, even though India’s A-SAT mission was carried out in the low earth orbit, it still jeopardizes the safety of the International Space Station (ISS) and those on-board. The NASA chief has said that the risk to the International Space Station increased 44 % in just 10 days.
- The International Space Station (ISS) is a large spacecraft that orbits the earth.
- The multinational laboratory has hosted a rotating international crew since November 2000. It is also the largest single structure put into space by humans.
- As of January 2018, 230 individuals from 18 countries have visited the International Space Station. The United States and Russia are top participating countries. Since November 2000, astronauts of different countries have occupied the International Space Station continuously. The first piece of the International Space Station was launched in 1998 by a Russian rocket. In the following years, more pieces were added, and 2 years later, the station was ready for astronauts.
- On November 2<sup>nd</sup>, 2000: The first crew arrived at the Space Station.
- NASA and its partners completed the construction of the International Space Station in 2011.
- The International Space Station is made of several parts called modules.
- The First modules had parts needed to make the ISS work.
- Initially, astronauts also lived in these modules. The modules connect parts of the station together.
- Astronauts do their research in the laboratories on the space station.
- On the sides of the space station are solar arrays. These arrays collect energy from the sun, and turn sunlight into electricity.
- On the outside, robot arms are attached which help to build the space station.
- The arms can also move astronauts around outside and control science experiments.
- Airlocks on the space station are like doors. Astronauts use them to go outside on spacewalks.
- Docking ports on the space station are also like doors. These ports allow visiting space craft to connect to the space station. New crews and visitors enter the station through these docking ports.
- Astronauts fly to the space station on the Russian Soyuz. The crew members use the ports to move supplies onto the space station. The International Space Station is almost like a house with five bedrooms.
- The ISS has two bathrooms, a gymnasium, and a big bay window. Six people can live in it.
- The International Space Station is like an international laboratory in orbit. Here the scientists can do a lot of experiments on zero gravity. The experiments can include: How humans survive in zero gravity? Etc.
- Astronauts typically stay on the ISS for a couple of months. In fact, there are instances where an astronaut has stayed on the ISS for a year as well. After these astronauts return to earth one can study their physiology. In zero gravity, our bones become weaker, and all kinds of changes occur. This kind of study is not possible on the earth. Thus, the ISS offers a platform to do different kind of physiological and scientific

experiments.

- Scientists from many countries visit this space station regularly. The space station weighs nearly a million pounds and is big enough to cover a football field, including the end zones.
- The ISS has science labs from the United States, Russia, Japan, and Europe. The ISS includes contributions from 15 countries; America's NASA, Russia's Roscosmos and the European Space Agency (ESA), are the major partners of the International Space Station (ISS) who contribute most of the funding. The other partners are the Japanese Aerospace Exploration Agency and the Canadian Space Agency.
- Astronaut time and research time on the space station is allocated to space agencies according to the money or resources such as modules or robotics that each country contributes.
- From about 2001 till now, there have always been at least 3 people inside the space station. Thus, the ISS is permanently manned for almost 20 years now.
- The ISS flies at an average altitude of 248 miles or 400 kilometres above the earth. It circles the globe every 90 minutes at about 28,000 kilometres per hour.

In a day, the ISS travels about the distance it would take to go from the earth to the moon and back.

Astronauts working on the space station experience 16 sunrises and sunsets each day.

The space station appears as a bright, moving light across the night sky. It can be seen from the earth without a telescope by night sky observers.

The International Space Station will be operated till at least 2024, with partners discussing a possible extension till 2028. Thereafter, plans for the space station are not clearly laid out. It could either be deorbited, or recycled for future space stations in orbit.

#### **India's Mission Shakti:**

- India's Mission Shakti catapulted India into an elite league of countries with anti-satellite weapons. It is a joint programme of the Defence Research and Development Organization (DRDO) and the Indian Space Research Organization (ISRO). The United States of America (USA), Russia and China already have the A-SAT technology. This mission is aimed at strengthening India's overall security.
- In the field of space, March 27<sup>th</sup>, 2019 is a very special day for India. It was the day India became a space superpower in its own right. On this day, India shot down a live satellite 300 kilometres away in a low-earth orbit.
- Prime Minister Narendra Modi himself gave the information in an address to the nation. A live satellite was a predetermined target in a low earth orbit. An anti-satellite (A-SAT) weapon was used to shoot it down. The entire operation of Mission Shakti took just 3 minutes. The achievement made India the 4<sup>th</sup> country to shoot down a live satellite in the low-earth orbit.
- This satellite isn't aimed at any specific country as such- but will be used to protect Indian interests. For example, if an enemy satellite in the low-earth orbit is spying on India- such as its military installations, etc. India now has the ability to take down that enemy satellite. The anti-satellite missile will equip India with the new strength in terms of security and development. Prime Minister Narendra Modi said that the intent is to defend India's space assets without violating any international law or treaty. The Prime Minister said, to maintain peace and security in the space sector, it is important to have a strong India. He also underlined that our strategic objective is to maintain peace and not create an environment of war.
- A-SAT is completely an indigenous mission, that has been completed with the help of ISRO and DRDO.

#### **A Note on the Low Earth Orbit:**

- Low Earth Orbit refers to an altitude of up to 2000 kilometres. Most of the satellites made by scientists revolve in this orbit. Very little energy is used to send any satellite into LEO (Low Earth Orbit), due to which these satellites give high bandwidth and low communication latency.

- Most of the space stations are also installed in the LEO (Low Earth Orbit), with the help of which, activities in space are monitored.
- The Low Earth Orbit (LEO) is used in many communication applications. Most of the telecommunication satellites are put in the Low Earth Orbit (LEO).
- The satellite which was shot down in Mission Shakti belonged to India. The mission was the result of hard work of ISRO and DRDO scientists that enabled India to achieve this success in space.

