2009 Iridium-Cosmos Collision Fact Sheet

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Main Author:
Brian Weeden
bweeden@swfound.org

www.SWFound.org

Summary

On February 10, 2009, an inactive Russian communications satellite, designated Cosmos 2251, collided with an active commercial communications satellite operated by U.S.-based Iridium Satellite LLC.[1] The incident occurred approximately 800 kilometers (497 miles) above Siberia. This collision produced almost 2,000 pieces of debris, measuring at least ten centimeters (four inches) in diameter, and many thousands more smaller pieces.[1] Much of this debris will remain in orbit for decades or longer, posing a collision risk to other objects in Low Earth Orbit (LEO). This was the first-ever collision between two satellites in orbit.

Although there was no prior warning of the collision, procedures could have been put in place by either the U.S. or Russian military to provide such warning.[2] Since the collision, the U.S. military has developed a process to perform daily screenings of close approaches between the almost 1,000 active satellites in Earth orbit, and is providing warning to all satellite operators of potential collisions.[3]

The Satellites Involved

Iridium 33

Iridium 33 was a 689-kilogram (1,518-pound) LM700 series satellite operated by U.S.-based Iridium Satellite LLC.[4] It was launched along with six other Iridium satellites aboard a Russian Proton launch vehicle on September 14, 1997 from Baikonur, Kazakhstan. The satellite, which was manufactured by Motorola and Lockheed Martin, represented one of a 66-member constellation orbiting at an altitude of 780 kilometers (485 miles) distributed across six orbital planes (about 10 satellites per plane along a "string of pearls" configuration).[4] These satellites provide L-band mobile telephone and communications services to users on the ground.

An Iridium satellite (Credit: Motorola)

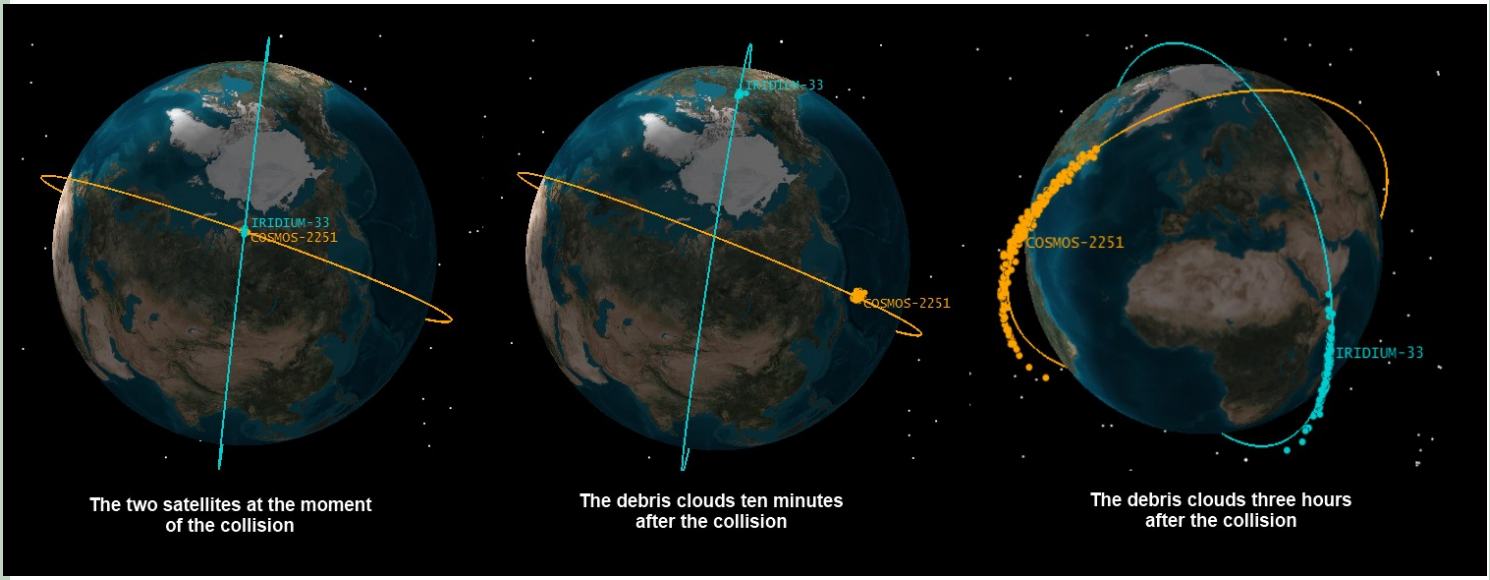
A Russian Strela 2-M satellite [5]

Cosmos 2251

The 900-kilogram (1,980-pound) Cosmos 2251 was a Strela 2M military store-and-forward communications platform launched on June 16, 1993 from Plesetsk, Russia aboard a Kosmos 3M launch vehicle.[5] Typically, Strela 2 series satellites have a service life of five years, and thus Cosmos 2251 was not functional at the time it collided with Iridium 33. Strela 2M uses the same KAUR-1 satellite bus as that of the Strela 1 series, pictured at right. Strela-2M satellites were launched one at a time into orbits of 800 kilometers (497 miles) altitude in three orbital planes inclined 74 degrees to the equator, each unit spaced 120 degrees apart.[5] The satellites are built by Reshetnev and operated by the Russian Ministry of Defense.

The Collision and Resulting Debris

Iridium 33 and Cosmos 2251 collided at almost right angles to each other, and at a relative speed of nearly 10 km/s (22,300 mph).[6] Although the exact geometry of the collision and point of contact on each satellite is known, video taken of the Iridium 33 after the collision indicated that at least two of the antennas at the bottom of the spacecraft were intact, thus suggesting that the Iridium was struck on the top, and much of the satellite was left intact.[6]



Evolution of the debris clouds over the first three hours [6]

As of September 3, 2010, the U.S. Space Surveillance Network (SSN) had cataloged 528 pieces of debris from Iridium 33 and 1,347 pieces of debris from with Cosmos 2251 larger than 10 cm (4 inches) in size.[7] Of these totals, 29 pieces of the Iridium have already decayed from orbit into the Earth's atmosphere along with 60 pieces from Cosmos 2251.[7] Analysis by both NASA and outside experts indicates that more than half of the Iridium debris will remain in orbit for at least 100 years, and much of the Cosmos debris will remain in orbit at least 20 to thirty years.[6] The Cosmos 2251 is the second-biggest breakup ever recorded in orbit, and the Iridium 33 is the fourth-biggest.[8]

The Legal Situation

International law applicable to the collision is mainly derived from the 1967 Outer Space Treaty and the 1972 Liability Convention. Under these treaties, the "Launching State" is responsible for objects on orbit. According to the common legal definition of Launching State established by these treaties, Russia is the Launching State for the Cosmos 2251. However, it is unclear whether the Launching State for Iridium 33 is Russia, the United States, or Kazakhstan as Iridium 33 was not registered with the United Nations, as required by the 1974 Registration Convention.[9]

The Liability Convention dictates that for damages which occur on orbit, fault must be determined. However, a legal definition does not currently exist for fault within the context of the Liability Convention. The Liability Convention has also never been formally invoked—all incidents to date that could have resulted in potential claims under the Convention, including the Iridium-Cosmos collision, have been settled by the respective countries outside of the Convention.[9]

The Lack of Pre-Event Warning

There was no warning issued of a potential collision between the Iridium 33 and Cosmos 2251 before the collision.[2] However, both the U.S. and Russian military had accurate tracking data on the two satellites well before the event, and if analyzed, this data would have shown a very close approach between the two satellites.[2] Although both the U.S. and Russian militaries had procedures for screening satellites for potential collisions, neither included the Iridium 33 or Cosmos 2251 in their screening.[2]

Such screening does not produce a yes/no answer as to whether or not two objects will collide in orbit because of the inability to determine the exact position of an object in orbit or how that orbit changes over time. The screening procedures, known as conjunction assessments, use statistical models to determine a probability of collision between two objects. If one of the objects is a functioning satellite with maneuvering capability, the owner-operator of that satellite must decide whether or not to perform a collision avoidance maneuver. Such a maneuver will use fuel onboard the satellite, which could shorten its useable lifespan and result in a financial cost, and conducting the maneuver could disrupt service to users.

New Procedures Since the Collision

In June 2007, the U.S. military had been providing daily warnings to Iridium of potential collisions between its satellites and other objects. However, as a result of the sheer number of these warnings and the inaccuracy of the data provided by the U.S. military, these warnings were stopped at some point prior to the collision in February 2009.[10]

After the collision, the U.S. military's Joint Space Operations Center (JSpOC) added the entire Iridium constellation to its daily conjunction assessment procedures, using the same high accuracy data and calculations as are used to screen human spaceflight and high-value U.S. military satellites.[11] As of the end of 2009, the JSpOC had expanded these screenings to cover all of the almost 1,000 active satellites in Earth orbit. The JSpOC is currently providing warnings 72-hours in advance to the operators of all these active satellites of close approaches within 1 km for LEO and 5 km for Geostationary Earth Orbit (GEO).

U.S. Strategic Command (STRATCOM) has also put in place a new program called Space Situational Awareness (SSA) Sharing.[11] This program is designed to share more information on the location and position of objects in orbit, as well as detailed analysis of that information, with program partners. This information is above and beyond the low accuracy Two-Line Elements that are currently made public by STRATCOM on the Space Track website (http://www.space-track.org).

Footnotes

1. Faulconbridge, Guy. "U.S. and Russia track satellite crash debris," *Reuters*, February 12, 2009. Also Wright, David. "Colliding Satellites: More Space Junk in Exactly the Wrong Place,"
2. Weeden, Brian, "Billiards in Space", *The Space Review*, February 23, 2009.. Online at: <http://www.thespacereview.com/article/1314/1>
3. A. Butler, "New technologies under development to improve satellite-crash predictions," Aviation Week Science and Technology (6 July 2009) at 18
4. Iridium Satellite LLC website (www.iridium.com, accessed February 12, 2009).
5. "Strela 2-M", Astronautix.com, online at: <http://www.astronautix.com/craft/strela2m.htm>
6. Kelso, TS, "Analysis of the Iridium 33 and Cosmos 2251 Collision", Advanced Maui Optical and Space Surveillance Conference, September, 2009, Online at <http://www.centerforspace.com/downloads/files/pubs/AMOS2009.pdf>
7. "China Debris Reaches New Milestone", *Orbital Debris Quarterly News*, NASA's Orbital Debris Program Office, October 2010.
8. "Top Ten Satellite Breakups", *Orbital Debris Quarterly News*, NASA's Orbital Debris Program Office, July 2010.
9. Jakhu, Ram, "Iridium-Cosmos Collision and its implications for space operations", *ESPI Yearbook on Space Policy. 2008/2009: Setting New Trends*. Wien: Springer Wien, NewYork: 2010. pp 254-275.
10. J. Campbell, "Forum on National Security Space: Examining Codes and Rules for Space," George Marshall Institute, 27 June 2007, at 7, Online: http://www.marshall.org/pdf/materials/554.pdf.
11. Kelher, Robert, Testimony before the Strategic Force Subcommittee, House Armed Services Committee, April 21, 2010.