2007 Chinese Anti-Satellite Test Fact Sheet

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Summary

On January 11, 2007, China launched a ballistic missile from Xichang Space Launch Center. The payload was a kinetic kill vehicle (KKV) that collided with a non-operational Chinese weather satellite, the Fengyun-1C (FY-1C), at an altitude of 863 km (534 mi), completely destroying the satellite.[1] This is known as a direct ascent antisatellite (ASAT) attack, where the KKV does not enter into orbit but instead travels through space on a ballistic arc. The destruction created a cloud of more than 3,000 pieces of space debris, the largest ever tracked, and much of it will remain in orbit for decades, posing a significant collision threat to other space objects in Low Earth Orbit (LEO).

The Satellite[2]

The Fengyun 1 (FY-1) series represents China's first meteorological satellite system. Between 1998 and 2005, China launched a total of four FY satellites into Sun-synchronous orbits (SSO), FY-1C through FY-1D, with an average altitude of 900 kilometers and an inclination of 99°. The FY-1C and its support systems were designed and developed by the Shanghai Satellite Engineering and Research Centre of the China Academy of Space Technology (CAST), and FY-1's payload was developed by the Shanghai Technical Physics Institute of the Chinese Academy of Sciences.

FengYun-1C Satellite[2]

The Missile

The Chinese ballistic missile used for the 2007 ASAT test was labeled the SC-19 by the U.S. military, and is believed to be a modified version of the DF-21 two-stage, road-mobile, solid-fuel, medium-range ballistic missile (MRBM), also known as the CSS-5.[3] The DF-21 has a nominal ballistic range of 2,500 km for a 600 kg payload, which if it was used means the SC-19 has a rough upper altitude limit of 1,000 to 1,200 km when used as a direct-ascent ASAT. Other reports have indicated that the ballistic missile could have been a modified KT-1, a commercial derivative of the DF-21. However, the accuracy of this claim is doubtful given that the KT-1 was never successfully flight tested and may have been abandoned.[3]

The Kinetic Kill Vehicle

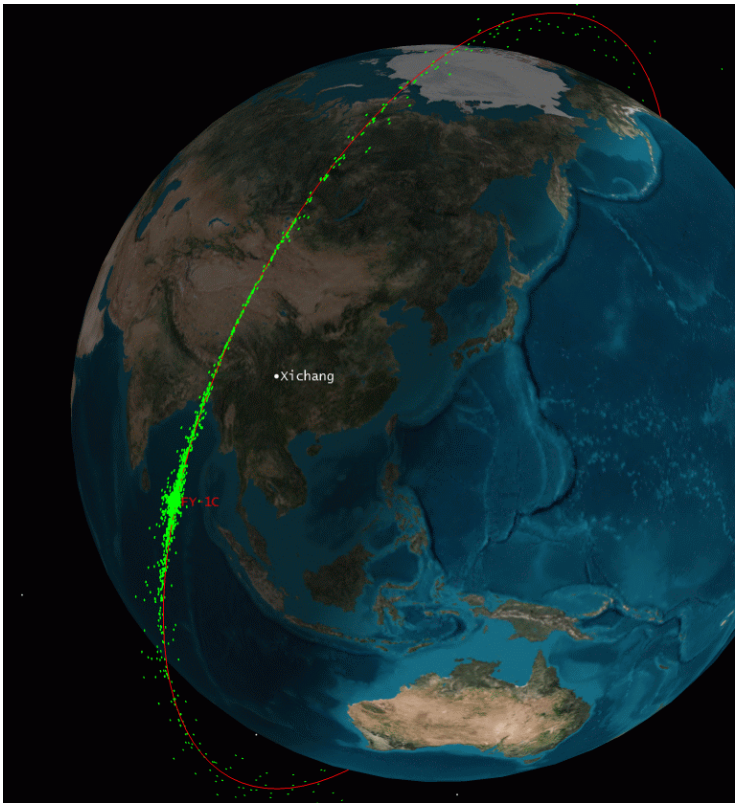
Little is publicly known about the KKV used to destroy the FY-1C. Experts estimate that the KKV weighed approximately 600 kg.[4] There is some evidence that the development of a KKV stretches back to the original Chinese anti-ballistic missile (ABM) program started in 1964, and that the project split into two branches, one for ABM and one for ASAT, in 2002.[5]

The Space Debris Created by the Test

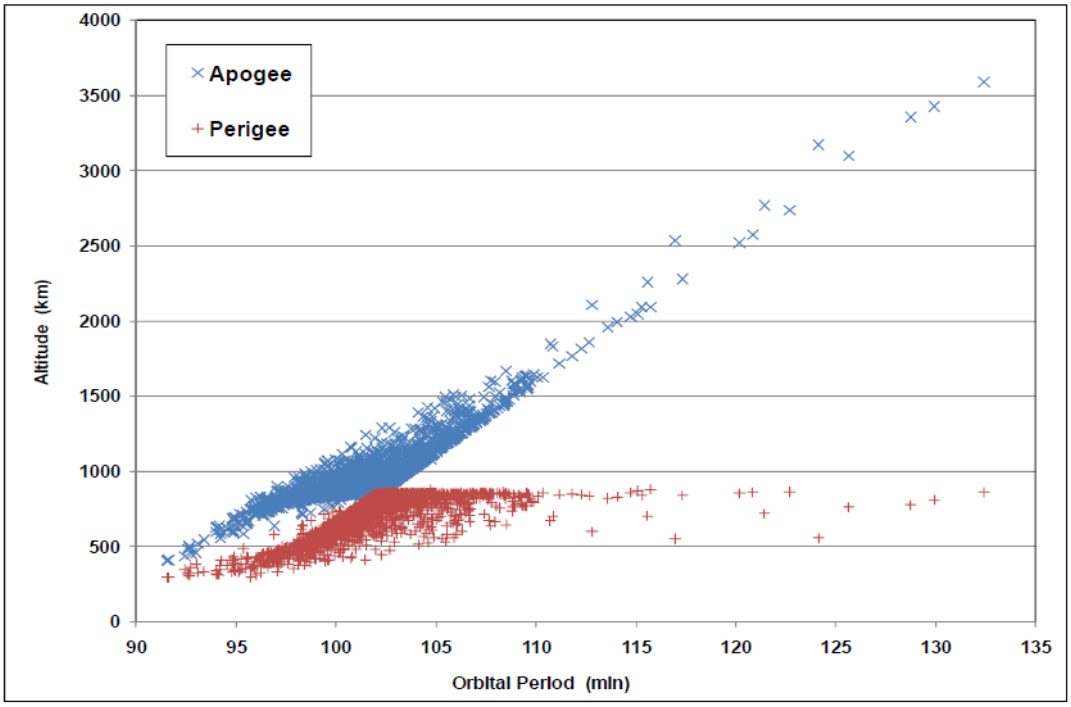
The KKV collided with the FY-1C at a relative velocity of over 32,400 km/hr. Although there were no explosives on board the KKV, the force of the impact completely destroyed the satellite. In hypervelocity impacts such as this ASAT test, normally solid objects behave like liquids. Thus, the FY-1C and KKV effectively passed through each other, and the resulting cloud of debris fragments from each object continued largely in the same direction and velocity as before.

Within minutes after the collision, the debris cloud started to spread around the satellite's original orbit. Ten days after the ASAT test, the debris had spread throughout the entire orbit, resulting in a "ring" of debris around the Earth. Three years after the test, the debris has spread out even more, effectively covering much of LEO.

As of mid-September, 2010, the U.S. military's Space Surveillance Network (SSN) has tracked a total of 3,037 pieces of debris from this event, 97% of which have remained in orbit.[6] Scientists estimate more than 32,000 smaller pieces from the event are currently untracked. The debris from the destruction of the FY-1C currently spreads from altitude as low as 175 km and as high as 3,600 km.[6] This is the largest debris cloud ever generated by a single event in orbit.



Simulation of the ASAT test 5 minute after impact [1]

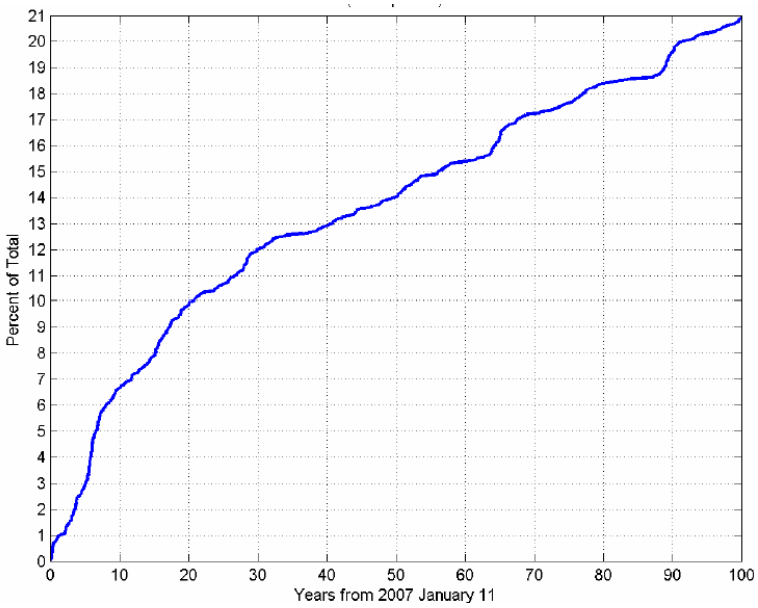


Distribution of the FY-1C debris as of 1 Sept 2010 [6]

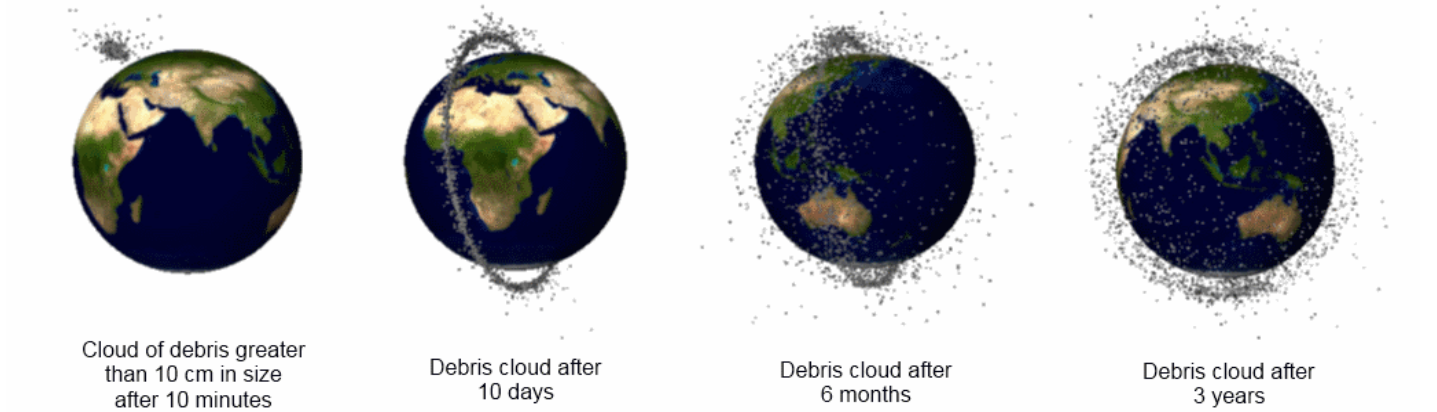
The Impact of the Test Debris on Operational Satellites

According to Celestrak, on January 22, 2007, there were 2,864 active or inactive satellites in Earth orbit with known positional data.[7] Of these, 1,899 pass through the regime now affected by the debris from the Chinese ASAT test—fully two-thirds of all payloads in Earth orbit.[7] The first acknowledged maneuver to avoid a piece of debris from the Chinese ASAT test occurred on June 22, 2007, when flight controllers at NASA's Goddard Space Flight Center briefly fired the thrusters on their TERRA satellite to avoid a seven percent chance of being struck the following day.[8]

On October 10, 2007, a detailed analysis of the FY-1C debris being tracked predicted that just over six percent of the debris (136 pieces) will have reentered the Earth's atmosphere by 2017 and 79 percent will still remain in orbit until about the year 2108.[7]



Predicted lifespan of FY-1C debris on orbit[7]



Evolution of the debris cloud from a kinetic kill ASAT attack [9]

Endnotes

1. Kelso, TS, "Chinese ASAT Test", Celestrak.com, http://www.celestrak.com/events/asat.asp (updated 30 August 2010)
2. *FengYun 1 Meteorological Satellite*, SinoDefence.com, http://www.sinodefence.com/space/spacecraft/fengyun1.asp (updated 28 September 2008)
3. "DongFeng 21 (CSS-5) Medium Range Ballistic Missile", SinoDefence, http://www.sinodefence.com/strategic/missile/df21.asp (updated 4 June 2010)
4. Mackey, James, "Recent US and Chinese Antisatellite Activities", *Air and Space Power*, Fall 2009.
5. "China's Successful Anti-missile test", *Strategic Comments*, Volume 16, February 2010, International Institute for Strategic Studies, http://www.iiss.org/publications/strategic-comments/past-issues/volume-16-2010/february/chinas-successful-anti-missile-test/
6. "Orbital Debris Quarterly News", Volume 14, Issue 4, October 2010, NASA Orbital Debris Program Office, http://www.orbitaldebris.jsc.nasa.gov/newsletter/newsletter.html
7. Kelso, TS, "Analysis of the 2007 Chinese ASAT Test and the Impact of Its Debris on the Space Environment", 2007 AMOS Conference, Maui, Hawaii.
8. Berger, Brian. "NASA's Terra Satellite Moved to Avoid Chinese ASAT Debris," *Space.com*. July 6, 2007.
9. Wright, David, "Space Debris", *Physics Today*, October 2007, http://ptonline.aip.org/journals/doc/PHTOAD-ft/vol_60/iss_10/35_1.shtml