Safe and efficient de-orbit of space junk without making the problem worse

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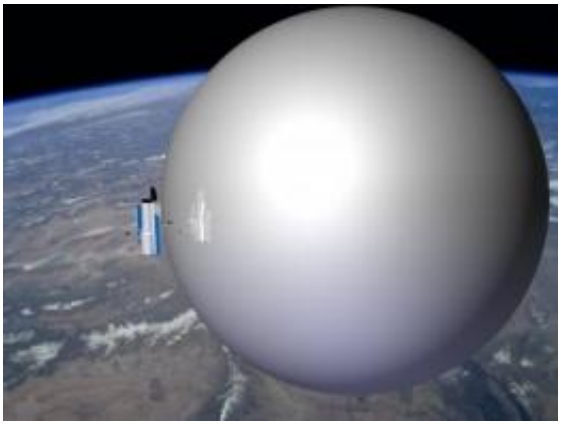

This computer-generated figure illustrates a Gossamer Orbit Lowering Device (GOLD) envelope de-orbiting a large scientific observatory. Credit: Global Aerospace Corporation computer-generated drawing against a NASA background image of the Earth from orbit.

Global Aerospace Corporation (GAC) announced that Dr. Kristin L. Gates will present a paper on de-orbiting space junk at the August 2 Artificial and Natural Space Debris session of the AIAA Astrodynamics Specialists Conference in Toronto, Ontario, Canada. Dr. Gates will describe GAC's Gossamer Orbit Lowering Device (GOLD) for safe and efficient removal from Low Earth Orbit (LEO) of dangerous space objects. The patented GOLD system concept uses a very large ultra thin balloon envelope to increase the aerodynamic drag by a factor of several hundred. This will cause the space junk to enter the earth's atmosphere

quickly and burn up. It will reduce the natural orbit decay of some objects from centuries to months. The computer-generated figure illustrates a GOLD system de-orbiting a large scientific observatory.

The envelope material is thinner and lighter than sandwich bag material. It takes a very small amount of gas to inflate it in the almost perfect vacuum of space. The system will work even though it will get punctured many times by small debris objects and tiny meteoroids. Despite these small holes, the total leak rate will be very small. The pressurization system will very easily keep up with the leakage. In the very unlikely event that a large object hits the very thin envelope, it will not cause that large object to break up into new fragments. Therefore, the operation of GOLD itself cannot make the orbital debris environment worse as could be the case with some alternative approaches that others have suggested.

Although the ultra thin envelope could be the size of a sports field (100 m diameter) when inflated, it is so thin that it can be folded and stowed in a surprisingly small volume (a medium size suitcase). It is most economical to attach it to a spacecraft or rocket upper stage before launch and deployed after the end of mission. However, GOLD could be attached to existing large debris objects using an orbital robot. For large, dense objects that could pose a hazard to people or property on the ground during reentry, GOLD can be used to aim the reentry safely into an ocean.

Space debris is a growing problem in many orbital regimes despite international debris mitigation guidelines and policies. The recent collision of an operational Iridium satellite and a defunct Russian satellite underscores the need for an ability to safely de-orbit large objects from popular, congested orbital regions. Currently, there are many hundreds of old spacecraft and rocket bodies orbiting the Earth at the same altitudes as operating spacecraft. As these abandoned objects continue moving through space, collisions with other objects create a

shotgun effect of new debris objects, each of which could kill an operating spacecraft. Orbital debris - or space junk - refers to all these large orbiting objects as well as the cloud of smaller objects due to explosions of these systems and collisions with other objects. Even if we do nothing, the problem will get worse for centuries to come. But it's a difficult problem to solve. People have suggested many approaches to de-orbiting space junk, such as using existing on-board chemical propulsions systems, electrodynamic tethers, gravity gradient-oriented drag tapes, boom-deployed drag sails or solar pressure sails. In many cases, while these de-orbit devices are operating there is an increased chance of having a collision with something else and creating new junk. With GOLD there is a negligible increase in the chance of creating new dangerous orbital debris and once the object is removed from orbit, that particular threat is gone forever.

Although the use of on-board propulsion systems do not increase the chance of creating new debris, many spacecraft do not have such propulsion systems, and for those that do, there is always the temptation to use the propulsion system to extend the mission, depleting the fuel that would be needed to bring the spacecraft down. The GOLD system actually weighs less than the propellant needed to do the same job and it is very inexpensive, and this means it is more cost-effective to add a GOLD system before launch than to carry the extra fuel.

We tend to think of space as being a complete vacuum, but there are enough molecules and atoms out to several hundred miles to produce a small but noticeable drag that slowly reduces the orbital altitude of spacecraft. GOLD takes advantage of this effect and increases it by a factor of several hundred. The air out at these altitudes has a very small density. Sun spot activity is known to follow an eleven-year cycle, with an associated cycle in the radiation coming from the sun. At "solar max", the extra radiation causes the Earth's atmosphere to bloom outward, increasing the average air density in LEO by a factor of three. When

GOLD is attached to a spacecraft, it is usually beneficial to wait until solar max to use it because it then brings down that satellite three times faster than average.

There are three basic applications for GOLD. The first application is to attach GOLD to satellites and rocket stages that are planned for launch. GOLD is then inflated, de-orbiting the object at the end of its useful life. The second application is in an active debris removal program, which may be important if the orbital debris problem is ever to be reduced. Several GOLD devices could be carried to orbit by an orbital robot and placed on existing space junk like the defunct spacecraft that struck the Iridium satellite, permanently removing them from orbit and making the environment safer. GAC has found that that GOLD is very effective in the 750 to 900 km altitude, high inclination orbit regime, which is a highly used portion of space and where the Iridium satellite was located. In a third application, some large space objects require controlled, targeted de-orbit and reentry because too much material survives reentry and reaches the Earth's surface where it can jeopardize the safety of people or property. In this application, when GOLD has reduced the orbit to the point of imminent entry, the large envelope is allowed to deflate under natural conditions to reduce drag and defer reentry a few days. After making good orbit predictions and using careful timing, the envelope is fully inflated at the correct point in the orbit to achieve a substantial atmospheric drag sufficient for prompt and safe reentry into the ocean.

In summary, the operation of GOLD has a lower risk of disabling other operational satellites and a lower risk of creating large orbit debris objects than competing de-orbit concepts or the derelict satellite itself. In addition, GOLD does not require an operating satellite to provide attitude stabilization or power as with propulsive de-orbit. GOLD can be integrated onto the satellite prior to launch or attached to derelict satellites by robots. De-orbit from LEO can be reduced, in some cases,

from many centuries to as little as a few months. Finally, GOLD can assist civilian, commercial and military space satellite operators in meeting their obligations to mitigate the growing space debris problem in a cost effective and low risk way.

Provided by Global Aerospace Corporation