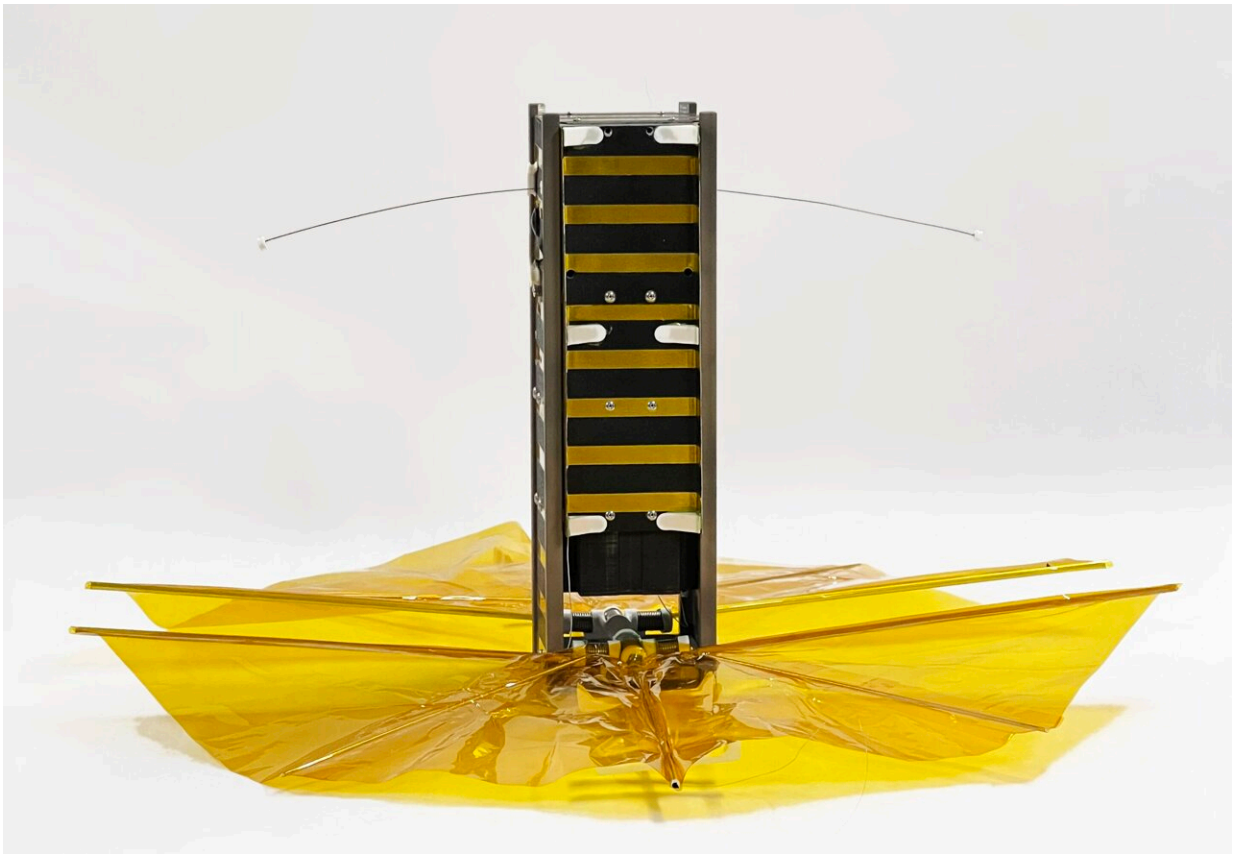
Satellite built as low-cost way to reduce space junk reenters atmosphere years early

August 24 2023



SBUDNIC, a bread-loaf-sized cube satellite with a drag sail made from Kapton polyimide film, designed and built by students at Brown reentered Earth's atmosphere five years ahead of schedule. Image courtesy of Marco Cross.

SBUDNIC, built by an academically diverse team of students, was

confirmed to have successfully reentered Earth's atmosphere in August, demonstrating a practical, low-cost method to cut down on space debris.

When it comes to space satellites, getting the math wrong can be catastrophic for an object in orbit, potentially leading to its abrupt or fiery demise. In this case, however, the fiery end was cause for celebration.

About five years ahead of schedule, a small cube satellite designed and built by Brown University students to demonstrate a practical, low-cost method to cut down on space debris reentered Earth's atmosphere sometime on Tuesday, Aug. 8 or immediately after—burning up high above Turkey after 445 days in orbit, according to its last tracked location from U.S. Space Command.

Called SBUDNIC, the satellite was built on a shoestring budget using off-the-shelf supplies available at most hardware stores, including 48 Energizer AA batteries. The students that built it were an academically diverse team of undergraduates led by Brown alumnus Marco Cross and Brown faculty member Rick Fleeter.

SBUDNIC was blasted into space on Elon Musk's SpaceX rocket last May as part of the Transporter 5 ridesharing mission and was designed to tackle the growing issue of space junk. For that purpose, the students added a key feature to the bread-loaf-sized cube satellite: a plastic drag sail made from Kapton polyimide.

The sail popped open like an umbrella upon deployment at about 520 kilometers, well above the orbit of the International Space Station, and helped push the satellite back down to Earth quicker than anticipated.

"We were trying to prove that there are ways of deorbiting space junk after mission life has ended that are not super costly," said Selia Jindal,

who graduated from Brown in May and was one of the project leads. "This showed that we can do that. We were successfully able to deorbit our satellite so that it's no longer taking up space in Earth's orbit. More importantly, the project really helped show there are significant plans we can put in place to combat the space junk problem that are cost effective."

The successful proof of concept could have far-ranging impacts on efforts to cut down on space debris, which poses a potential danger to all current and future space vehicles. This is especially poignant considering the total cost of the student-designed cube satellite—about $10,000.

"There are companies that are trying to solve this problem of space junk with concepts like space tow trucks or nets in space that will capture space junk and take them out of orbit," said Dheraj Ganjikunta, who graduated from Brown in 2022 and was SBUDNIC's lead program manager.

"What's amazing about SBUDNIC is that it's magnitudes less cost than any of those solutions. Rather than taking junk out of space as it after it becomes a problem, we have this $30 drag device you can just throw onto satellites and radically reduce how long they're in space."

According to NASA, there are now more than 27,000 pieces of what it calls orbital debris or space junk being tracked by the Department of Defense's global Space Surveillance Network. This orbital debris ranges from human-made objects in Earth's orbit that no longer serve a useful function to defunct satellites.

One worst case scenario with so much traffic is that if a satellite explodes in an orbit that a number of other satellites also follow, this would set off a chain reaction that hits all the other satellites as well, closing off that orbit until all the debris deorbits.

"These are horrible scenarios but unfortunately the numbers dictate probability wise that this will happen eventually, so we need to be prepared," said Marco Cross, who graduated from Brown last year with a master's degree in biomedical engineering and served as chief engineer for SBUDNIC.

A striking descent

Most satellites remain in orbit for an average of 25 years or more after they have served their purpose. To help combat this, the Federal Communications Commission adopted a new 5-year rule in 2022 for deorbiting satellites.

Looking at tracking data from Space Command, SBUDNIC represented an overwhelming success towards that goal, and it didn't take long. In fact, SBUDNIC's drop from orbit was visibly exponential.

In early March, for instance, SBUDNIC was at about 470 kilometers above the Earth while the other similarly-sized satellites deployed to the same altitude as part of the same SpaceX rideshare mission were still at altitudes of 500 kilometers or more. SBUDNIC's last known position was recorded on Aug. 8 at 146 kilometers, before burning up in the atmosphere due to heat generated from reentry.

As of mid-August, all other comparison satellites were still in orbit at altitudes of 450 kilometers or higher—tens of kilometers from their original deployment altitude. The figures are striking considering these other satellites are roughly the same size and weight of SBUDNIC.

In addition to the drag sail contributing to SBUDNIC's rapid deorbit, solar activity may have played a role, but how much is unclear. This year, for instance, satellite companies have reported dramatically increased and unanticipated deorbit rates related to particularly

aggressive solar activity.

SBUDNIC was created on the Brown campus and came out of the Design of Space Systems course, which Fleeter taught in Spring 2021. It was built in one year by a group of about 40 students. About half of the students that worked on it were from the School of Engineering, while others hailed from concentrations as diverse as economics, international relations and sculpture.

"This was an unusual circumstance and we took advantage of it," said Fleeter, an adjunct associate professor in Brown's School of Engineering. "In terms of depth of learning in this project, this is the kind of experience that I think students come to Brown for."

Provided by Brown University