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Atmospheric skimming satellites

A European company has a radical idea for how to make Earth-observing satellites smaller without sacrificing resolving power. Why not have them dip into the upper atmosphere to look at their targets? The optics could be smaller on such a satellite, because the camera would be closer to the ground, and the satellites could be launched on less-costly rockets or as secondary payloads.

The concept is called Skimsat and it was developed by engineers at Thales Alenia Space UK.

The thinking is: "If you halve the altitude, you halve the optics," said Andrew Bacon, a senior space systems engineer at Thales Alenia Space UK. Bacon presented the concept at the Reinventing Space conference in London in November.

A Skimsat would be placed in a very low Earth orbit, VLEO, with a perigee, or low point, of just 160 kilometers, he explained. By Bacon's calculation, such an orbit would allow a "four times reduction in the required aperture diameter and focal length, for the same 1-meter resolution, when compared to an optical imaging satellite at 650 kilometers altitude." The transmission power for the data downlink could be reduced by 10 times, he said. The overall cost of the mission could be cut "by at least an order of magnitude," he added, implying that a constellation of 10 Skimsats could be built for the price of a single conventional satellite.

The idea of flying close to the ground to enhance resolution harkens back to the early U.S. military reconnaissance programs of the 1960s, such as the Corona satellites, which flew below 300 kilometers and, according to Bacon, produced an image resolution as good as 0.3 meters.

A key problem with these low-altitude orbits is the density of the atmosphere. A Skimsat would have to cope with the erosive effect of atomic oxygen on spacecraft materials and it would need to be designed to fight off drag as long as possible. Each Skimsat would have a wedge-shaped leading edge coated in atomic-oxygen-resistant materials. Its optical surfaces would be recessed for protection. Drag would be countered as long as possible by an electric propulsion system deriving power from a "sun-tracking tail array" protected from the atmosphere by the satellite's body. The European Space Agency's GOCE spacecraft — Gravity Field and Steady-State Ocean Circulation Explorer — provides reason for optimism, Bacon said. GOCE "demonstrated sustained operation at about 260 kilometers using a drag compensating ion engine," he said. "The spacecraft operated for 55 months before running out of fuel."

Even with those technologies, "re-entry time at these low altitudes is measured in months rather than decades," Bacon conceded. On the bright side, VLEO satellites don't hang around to pose an orbital debris problem, he added.

Skimsat would be based on the company's Omnisat bus, a "modular nanosat architecture, built like a PC with a backplane and motherboard" and designed to compete with the unmanned aerial vehicles now challenging established satellite image providers.

"Skimsat is like a UAV at orbital velocity," said Bacon, who hopes to see commercial buyers flying constellations of Skimsats before too long. "If fully funded, we could do it in three years."

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Skimsats: Atomic-oxygen-resistant materials and electric propulsion would let these proposed satellites graze the atmosphere for closer looks at the ground.

Thales Alenia Space UK