National Aeronautics and Space Administration

NASAfacts

Space Technology
Game Changing Development
Towed Twin-Fuselage Glider Launch System First Test Flight Successful

NASA successfully flight-tested a prototype, twin-fuselage towed glider that could lead to rockets being launched from pilotless aircraft at high altitudes—a technology application that could significantly reduce cost and improve efficiency of sending small satellites into space. The one-third-scale twin fuselage towed glider's first flight took place Oct. 21, 2014, from NASA's Armstrong Flight Research Center in California.

The towed glider is an element of the novel rocket-launching concept of the Towed Glider Air-Launch System (TGALS). NASA Armstrong researchers are developing the system, which is funded as a part of the Space Technology Mission Directorate's Game Changing Development Program.

The TGALS demonstration's goal is to provide proof-of-concept of a towed, airborne launch platform. Distinct advantages are believed possible in cost, logistic efficiency, and performance when utilizing a towed, high lift-to-drag launch platform as opposed to utilizing a traditional powered "mothership" launch platform. The project goal is to examine the performance advantage, as well as the operational aspects, of a towed, airborne launch system.

A key performance parameter for this demonstration is carry efficiency. Carry efficiency is the ratio of weight carried to launch platform weight, where launch platform weight is equal to gross takeoff weight (GTOW) minus weight carried.

$$\text{carry efficiency} = \frac{Wcarried}{GTOW - Wcarried}$$

Project Manager Gerald Budd prepares the glider and Dryden Remotely Operated Integrated Drone (DROID) tow vehicle for flight.

The DROID aircraft tows the glider to launch altitude for release.

The dual-fuselage glider lands softly on the lakebed at Armstrong Flight Research Center. "It flies fantastic," said Robert "Red" Jensen, who piloted the glider.

The state of the art among existing air-launch platforms is a carry efficiency of approximately 0.7. However, a study has shown that it should be possible to build a high maximum lift-to-drag ratio (max L/D) aircraft structure that can carry twice its own weight for an efficiency of 2.0.

The max L/D ratio of the mated system is another key performance parameter. Because the launch platform is towed, the mated launch system's max L/D must be kept relatively high so that thrust required by the tow aircraft can be kept relatively low. A conceptual glider launch platform design has been produced that, when mated with a Minotaur-class launch vehicle, achieves a max L/D of 17.8. Therefore, the target max L/D for this demonstration is between 15 and 20.

The project's next step will be to demonstrate the horizontal launch of a small launch vehicle from the one-third-scale glider. That will be followed by the build up and demonstration of a one-third-scale "sustainer motor" top-mounted to the glider. This variable thrust motor will provide the energy to change the glider and launch vehicle orientation from horizontal to a highly inclined flight path angle to maximize launch efficiency.

The glider was built primarily with commercial-off-the-shelf components, but some parts were manufactured at NASA Armstrong's Experimental Fabrication Branch. Assembly was accomplished in NASA Armstrong's Small Unmanned Aircraft Systems Research Lab.

The TGALS team gathered around the glider fitted with a model of a Mini Sprite suborbital launch vehicle for a future launch demonstration.

Ultimately, full-scale glider development and testing is envisioned.

Potential benefits from TGALS are many. In terms of performance, the towed glider can potentially carry twice the load to altitude as the same size direct carry conventional aircraft. In terms of cost, it's relatively inexpensive to build a glider versus a conventional aircraft, and maintenance costs are lower. For safety, unmanned gliders eliminate human concerns for carrying launch vehicles, and the glider can land with the launch vehicle attached in the event of an abort. And for flexibility, inexpensive gliders can be staged at any airfield, ready for immediate launch, and tow planes can be existing aircraft that simply add towed launch to their duties.

TGALS is potentially game changing research with multiple industry and US Government applications.

The Game Changing Development (GCD) Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

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