University of Southampton; CANOPUS-LOCOL-CADS

Executive Summary

There is a space technology implication to Moore's law (the observation that the density of components on an integrated circuit doubles each year): the capabilities of spacecraft of a given mass increase exponentially with time. This means that we are approaching a point where even a payload as light as a kilogram packs tremendous science and commercial potential. However, the cost of lifting such payloads into space, as well as the associated lead time, eschew the very positive 'performance per kilogram' trend and, in practical terms, it therefore makes the latter little more than an academic observation.

Project CANOPUS aims to give the UK a space launch capability that exploits the potential of the increasingly potent kilogram class payloads by cutting the cost of access to space in this market segment quite drastically, as well as reducing lead times from years to days. The concept is simple: use a high altitude, airborne rocket launch pad to obviate the need for the familiar expensive, large launch vehicles and their associated complex ground infrastructure, while, serendipitously, slashing the carbon footprint of the operation in the process (the overwhelming majority of the energy of such systems is consumed penetrating the dense lower atmosphere). The idea is a proven one at larger scales (payloads in the hundreds of kilograms bracket), but the CANOPUS argument is that at the low end of the payload spectrum scale lies a real 'sweet spot' in terms of the engineering and the economics of air launching.

CANOPUS-LOCOL-CADS (Carbon Neutral Optionally Piloted Unmanned System – Low Cost Launcher – Conceptual Analysis and Design Study) was the pilot phase of the project, conducted by a team at the University of Southampton, funded by UK Space Agency through a grant managed by the Centre for Earth Observation Instrumentation and Space Technology. It considered the first step – the development of a suborbital launch system capable of lifting a 1kg payload over the Kármán line (which marks the boundary of space at 100km) – and it demonstrated, through full mission cycle simulations, that a viable system could be developed in the UK over the next two years. An off-the-shelf, self-launching glider, modified for unmanned operations, was selected to serve as the launch platform. Requiring virtually no ground facilities and a very small amount of fuel, the aircraft will lift a 1kg payload mounted atop a 30kg, two-stage, solid fuelled rocket to its launch altitude of 8km, where it will execute a loop; the ignition of the rocket and separation will occur at the 90 degree pitch up point of the loop. Two short burns and a ballistic ascent later the small rocket will deliver the 1kg payload to the just over 100km high apogee of its suborbital flight, while the 'mother ship' glides to a landing.

A low cost launch capability of this type will have abundant science applications (effectively replacing much costlier sounding rockets) as well as enabling commercial operations, such as the qualification testing of space hardware or re-entry systems. The following phase of the project will scale up the system to a level where the combined performance of the glider-rocket system will enable the insertion of a similar payload into low Earth orbit, opening up tremendous opportunities, for example in terms of the low cost, fast response launch of large constellations of communications satellites.