National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Communications

Conformal, Lightweight, Aerogel-Based Antenna

A Flexible Antenna for Active Aeronautical Satellite Communications

Innovators at the NASA Glenn Research Center have developed the Conformal, Lightweight Antenna for Aeronautical Communications Technology (CLAS-ACT), an active phased array antenna for Ku-band satellite communications on a mobile platform such as a UAV. The CLAS-ACT was developed for UAVs that require operations outside of radio line of sight which use a satellite link to increase operational coverage for command and control. The satellites typically used for this application fly a geostationary orbit at a very high altitude. The current state of practice for UAVs travelling out of line of sight is to use a large parabolic dish antenna that is pointed with a mechanical gimbal; this requires a significant volume within the UAV, adds unnecessary weight, and demands a large amount power. NASA's CLAS-ACT antenna improves upon current practice by offering a lightweight, small-sized antenna that can be mounted on the curved frame of an aircraft and has advanced beam steering/beam synthesis capabilities, enabling the efficient command and control of small or large UAVs used for a variety of purposes.

BENEFITS

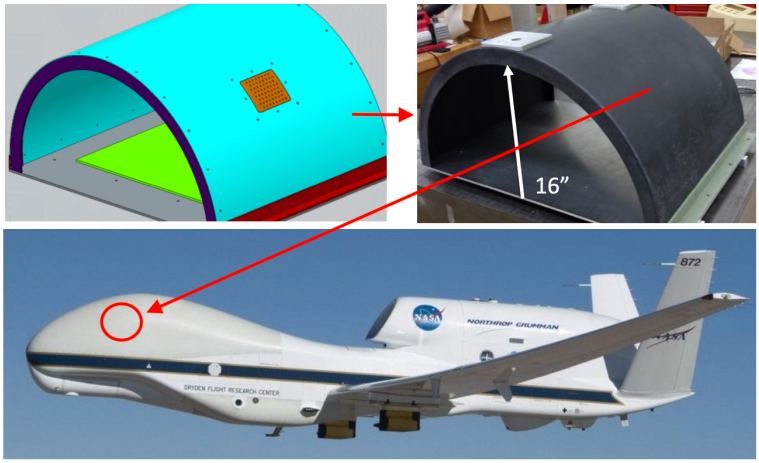
- Small-sized package: CLAS-ACT can be mounted on smaller UAVs than was possible with parabolic dish antenna systems, enabling small UAVs with increased command and control range (e.g., NASA's prototype was less than 0.5 sq. ft.)
- Increased responsiveness: provides the ability to quickly and effectively communicate with UAVs in order to redirect to prevent accidents, increase efficiency and coverage, and provide health and performance monitoring
- Optimized design: the new design can provide better aerodynamics for the airframe, and potentially offers more physical area for a scaled-up antenna to broadcast over further distances or at a higher data rate
- Avoids interference issues: CLAS-ACT uses advanced beam steering/synthesis techniques to form antenna patterns that are otherwise difficult to realize with traditional antenna designs

THE TECHNOLOGY

This CLAS-ACT is a lightweight, active phased array conformal antenna comprised of a thin multilayer microwave printed circuit board built on a flexible aerogel substrate using new methods of bonding. The aerogel substrate enables the antenna to be fitted onto curved surface. NASA's prototype operates at 11-15 GHz (Ku-band), but the design could be scaled to operate in the Ka-band (26 to 40 GHz).

The antenna element design incorporates a dual stacked patch for wide bandwidth to operate on both the uplink and downlink frequencies with a common aperture. These elements are supported by a flexible variant of aerogel that allows the material to be thick in comparison to the wavelength of the signal with little to no additional weight. The conformal antenna offers advantages of better aerodynamics for the airframe, and potentially offers more physical area to either broadcast further distances or to broadcast at a higher data rate. The intended application for this antenna is for UAVs that need more than line of sight communications for command and control but cannot accommodate a large satellite dish. Examples may be UAVs intended for coastal monitoring, power line monitoring, emergency response, and border security where remote flying over large areas may be expected. Smaller UAVs may benefit greatly from the conformal antenna. Another possible application is a UAV mobile platform for Ku-band satellite communication.

With the expectation that 5G will utilize microwave frequencies this technology may be of interest to other markets outside of satellite communications. For example, the automotive industry could benefit from a light weight conformal phased array for embedded radar. Also, the CLAS-ACT could be used for vehicle communications or even vehicle to vehicle communications.



Integration of CLAS-ACT Antenna on the Global Hawk High-Altitude Long-Endurance Science Aircraft

APPLICATIONS

The technology has several potential applications:

- Aerospace and Aviation: beyond line of sight communications for aircraft
- Antennas: conformal antennas that can be mounted on the curved frame of an aircraft
- Communications: UAV satellite, vehicle, or vehicle-to-vehicle communications
- Military: high-performance communications for defense UAVs
- Unmanned Vehicles: command and control communications for small to large UAVs, including swarm applications

PUBLICATIONS

Patent No: 11,658,398

"Phased Array Antenna for the Mitigation of UAS Interference," James M. Downey et al., April 10, 2018, https://ntrs.nasa.gov/citations/20180004542

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