THE CSIR-NAL HIGH ALTITUDE PLATFORM (HAP)

L. Venkatakrishnan
Program Director – High Altitude Platform
Chief Scientist and Head
Experimental Aerodynamics Division
CSIR-National Aerospace Laboratories
Post Box No. 1779, HAL Airport Road
Bangalore-560 017, India
Email : venkat@nal.res.in

A High-Altitude Platform or HAP is essentially an unmanned aerial vehicle or UAV, stationed at a height of 20km in the stratosphere, as part of a telecommunication or earth observation network. This altitude is chosen so as to be above flight corridors and above the weather. HAP have extreme endurance of up to 90 days continuously and are persistent over a single geographical location. This feature distinguishes them from other High-Altitude Long Endurance (HALE) UAVs such as a Global Hawk or Predator. A HAP with payload is often called a High Altitude PseudoSatellite or HAPS.

HAPS combine the location persistence of a geostationary satellite with the flexibility of re-tasking or re-deployment of an aircraft. This makes them unique in capability and fills an existing gap between aircraft and satellites. Additionally, their lower data latency Round Trip Time (RTT) of less than 10ms as opposed to geostationary satellites (600 ms) allows them to be exploited for a range of diverse uses.

While lighter-than-air balloons and airships have been tried over decades, there is virtually no control over their position due to winds and solar heating. Station keeping therefore for such vehicles is a challenge.

The CSIR-National Aerospace Laboratories HAP is a heavier-than-air UAV with a conventional aircraft configuration but with a solar and secondary battery energy system. The full-scale version would have a wingspan greater than 30m – more than an A320, but at the weight (~150kgs) of a typical motorcycle! The extreme low weight design is called for as the entire energy of flight and payload has to be generated by solar photovoltaic and stored in batteries for the night, for months on end. This is a grand challenge for an extremely energy efficient design. So far worldwide, only the Zephyr, now a part of Airbus has achieved the feat of a non-stop 64-day flight.

The design challenges are tremendous, beginning with the low Reynolds number due to the very low forward speed at cruise altitude of around 250,000. Additionally, the low structural weight also brings with it challenges of aeroelasticity and aero servo elasticity. The propeller has to be designed with a fixed pitch and yet operate optimally from sea level to 20km where the air density is 7% that at sea level. The harsh environment of low temperatures reaching -85 degree centigrade and low pressures, pose severe challenges to both the avionics as well as the payload systems. The design and operation of very high energy density battery packs, which can be re-charged using ultra-thin photovoltaic strips – so as not to disturb the airflow are other complications.

Presently, CSIR-NAL's subscale aircraft has successfully completed a 11-hr flight, reaching an altitude of 25000 feet above sea level which demonstrates the capability to take on the challenge of the full-scale vehicle.

Close-up View

Afternoon View

Evening View