High-altitude pseudo-satellite vehicles

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Why is in news? Why India wants to develop high-altitude pseudo-satellite vehicles, powered by the Sun

The Bengaluru-based National Aerospace Laboratories (NAL) **successfully flew a prototype of a new-generation unmanned aerial vehicle (UAV)** that is being seen as a huge technology breakthrough. It was **no ordinary UAV**.

The prototype tested by NAL spent eight and a half hours in the air. Next month, NAL, a unit of the Council of Scientific and Industrial Research (CSIR), plans to keep it in flight for at least 24 hours.

The full-scale machine that **NAL is trying to build by 2027**, would be aiming to remain in the air for 90 days at a stretch.

About HAPS:

Kamaraj IAS Academy
Plot A P.127, AF block, 6 th street, 11th Main Rd, Shanthi Colony, Anna Nagar, Chennai, Tamil Nadu 600040
Phone: **044 4353 9988 / 98403 94477** / Whatsapp : **09710729833**

Since the 1990s, a number of initiatives have been launched worldwide to explore the potential applications of High Altitude Pseudo Satellites, also called High Altitude Platform Stations (HAPS).

The HAPS can **fly at great heights about 20 km** from ground, runs entirely on solar power, and can remain in the air for months on end.

Such UAVs **belong to a class of flying objects** called **HAPS, or high-altitude pseudo-satellite vehicles**, or **HALE that is high-altitude long-endurance vehicles.** These unmanned aircraft may be **airplanes, airships or balloons**.

The primary utility of HAPS vehicles is in the **field of surveillance and monitoring**, but there are other situations, like disaster management, wherein it can be very useful.

HAPS technology is **still under development**. Several countries, and companies, have developed and flown such vehicles with encouraging success, **but none has mastered** the technology yet.

Features of HAPS:

These **solar-powered vehicles** have been designed to plug the missing link between unmanned aerial vehicles (UAVs) flying in lower altitudes and conventional satellites in space.

HAPS **operating cost is significantly lower** than than that of a satellite.

HAPS can reach altitudes of 18-20 km, **nearly double that of commercial airplanes**.

Need for HAPS:

The kind of jobs that HAPS are meant to do are currently done by UAVs and satellites, but both have certain limitations.

The **normal UAVs, or drones** as they are commonly called, are mostly battery-powered and **cannot remain in the air beyond a few hours.**

Continuous monitoring is **not something** these can do **very effectively**.

In addition, they **fly at relatively low levels**, because of which their vision is **restricted to small areas**.

Satellites can observe much larger areas, but the ones in **low-earth orbits** are continuously moving with respect to Earth. They **cannot be constantly keeping an eye** on the target area.

Geostationary satellites, located at a height of about 36,000 km above the ground, can keep a constant gaze over one area. But these are **fairly expensive**, and **once deployed, cannot be repurposed or reoriented**.

HAPS are meant to overcome all these shortcomings, and do more.

HAPS can be a very powerful solution for this kind of work. They **work like geostationary satellites** but with added flexibility. They can be **easily redeployed over another location**, or can be reequipped with a different payload, something that is not possible with a geostationary satellite.

Significance:

HAPS **enhance India's strategic capabilities** by providing a cost-effective and versatile platform for surveillance and reconnaissance.

In light of **geopolitical tensions and security challenges**, HAPS can play a crucial role in monitoring **border areas** and safeguarding national interests.

HAPS can be deployed for **disaster management and response efforts**, providing real-time data and communication support in areas affected by natural calamities.

In remote or underserved areas, HAPS can serve as a temporary or backup solution for **providing mobile communication networks**, especially during emergencies.

Equipped with high-definition optical and infra-red cameras, state-of-the-art sensors, these aerial platforms are suitable for round-the-clock missions, border patrolling, target tracking, maritime surveillance and navigation, and

even missile detection.

HAPS can provide services towards **efficient border patrolling, tracking movements deep into the enemy territory or in the deep seas** with their sharp focus on one area.

Challenges include **navigating minimal stratospheric flight regulations** and addressing **unpredictable weather** conditions at high altitudes.

Engineering challenges of HAPS:

But developing an autonomous flying machine **fuelled entirely by solar power** and capable of **remaining in the air for months** faces major technological hurdles. That is the reason why, despite decades of work, a full-fledged HAPS vehicle has still eluded engineers.

It is only now, **with advanced technologies in solar cells**, batteries and composite materials, that this vehicle looks possible in the near future.

The primary challenge is to **generate enough solar power** to keep the aircraft flying, the payloads operating, and the batteries charging.

The batteries need to be enough to continue the operations through the night. Then there are design-related challenges.

The aircraft needs to be **extremely lightweight** to minimise the power requirement, but it also has to be stable.

This is one of the reasons why this aircraft is **meant to fly in the stratosphere**. The region between 17 and 23 km above the earth's surface is **climatologically conducive** for their flight.

The wind speed is very low and ideal for light-weight aircraft to remain stable. It helps that this height, **much above the region in which civilian aircraft fly,** is favourable for observation and surveillance activities.

Because of limitations of space and weight, solar cells and batteries need to have very high efficiencies.

India and the HAPS:

For India, HAPS is another technology area where it is entering the race at a relatively early stage.

In the last few years, there has been great emphasis on promoting research in emerging technologies, so that the country is not dependent on others for critical technologies of the future.

Joining technology development at an early stage also results in capacity building, early adoption of technologies, control over patents, business opportunities and spin-off technologies.

India had moved into HAPS technology development at the right time, and the successful test flight showed that it had capabilities similar to some of the other countries trying to develop this technology.

We are not playing catch-up. We are not the leaders, for sure, at this moment, but we can confidently say that we have lead runners firmly in sight. We are very much in the race.

China, South Korea, and the UK are some of the other countries where this development is taking placeSome private companies are also developing HAPS, even in India.