HAPS Alliance

HIGH ALTITUDE PLATFORM STATION

Driving the potential of the stratosphere

Humans have explored space since 1957.
And made big discoveries.

On the edge of Space, just beyond the Earth' surface is an untapped, relatively unused region with huge potential.

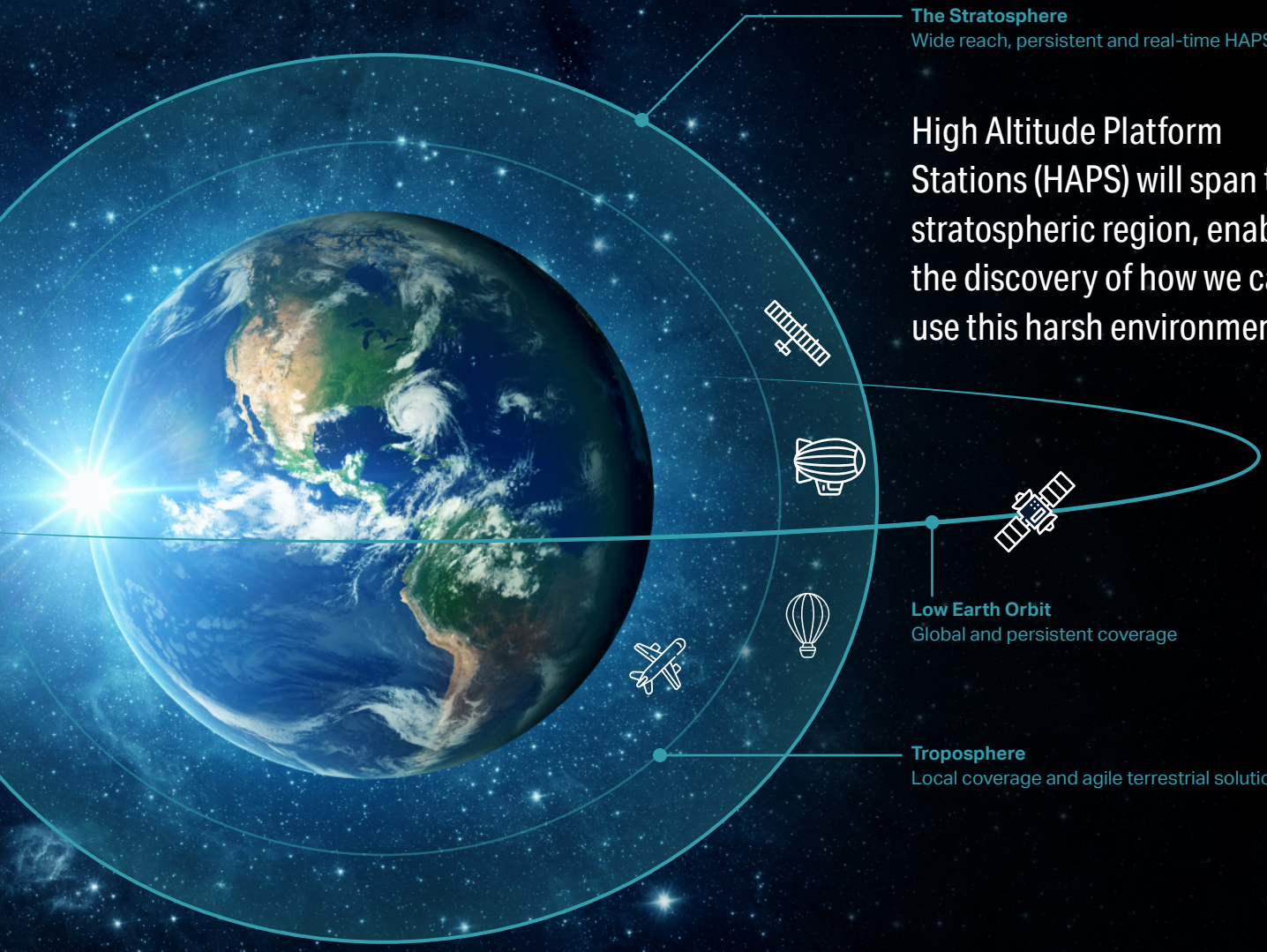
The Stratosphere.

"Raven balloons have been flying in the stratosphere since the company's beginning in 1956, with thousands of successful flights in this harsh environment. Today, we remain committed to delivering stratospheric solutions and paving the way for the future of stratospheric flight. Raven Aerostar is proud to be a member of the HAPS Alliance, which works toward airspace management, encourages industry collaboration, and will enable the development of new and exciting applications in the stratosphere. The Alliance's core mission to enhance connectivity around the globe has the potential to improve millions of lives."

– Jim Nelson, Raven Aerostar Division Manager

The Stratosphere is a global opportunity.

The Stratosphere extends from 18 km to 50 km above the jet stream, where low thermal conditions, falling to -90°C, cosmic radiation and ozone make for harsh operating conditions. 80% of atmospheric air mass is below 15 km; above 20 km there is very little, making operating in the Stratosphere extremely challenging.



High Altitude Platform Stations (HAPS) will span this stratospheric region, enabling the discovery of how we can use this harsh environment.

While HAPS technology has existed for around 20 years, it is still relatively new. Significant progress during the last decade for HAPS includes advancements in solar cells, battery technology and platform design, tailored for effective operation at stratospheric heights.

HAPS technology can leverage and enhance existing infrastructure, while filling a capability gap between terrestrial networks, manned, Unmanned Aerial Systems (UAS) and satellites. Completing and enhancing existing aerial platforms will offer a flexible but persistent solution. These technologies will work together to serve different use cases around the globe.

Did you know?

CONNECTING THE UNCONNECTED

Over 40% of the world's population remains unconnected, without access to the internet, especially in remote areas where there is a lack of stable power.

We are living in an increasingly virtual world, which has become smaller thanks to the digital age.

HAPS offers a capability to provide internet connection in locations unserved by legacy telecommunications networks, offering persistent communications. HAPS will close the digital divide, providing network latency comparable to that of terrestrial cellular towers but with wider geographic coverage.

HELP FOR NATURAL DISASTER RECOVERY

During 2020, there were 416 natural disasters worldwide. Natural disasters have significant impacts, often disrupting communication systems on the ground, which debilitates essential emergency and military communication.

Being based in the Stratosphere and above air traffic and weather events, HAPS is unaffected by disasters on the ground, enabling sufficient freedom of movement and the ability to assist rescue and recovery efforts during times of disaster. If a ground gateway is damaged, HAPS can provide connectivity by relaying network coverage from a working ground gateway to enable humanitarian assistance with critical data in near real-time.

Reference: Statista 2020

RESPONDING TO INCIDENTS TRIGGERED BY CLIMATE CHANGE

Climate change has been a key factor in increasing the risk and extent of wildfires.

HAPS offers a solution to enable response latency by providing real time situational awareness and communication to emergency responders. HAPS lets responders analyze risks prior to the spread of raging wildfires. Solutions enable the improvement of mission prioritization, deployment of fire fighters, and increasing decision making in areas where rescue and evacuation missions are required.

HAPS offers opportunities to tap into new market demand and enter markets that were once deemed unobtainable from the Stratosphere.

The HAPS market is gaining traction with a steady increase of in-service units, from 310 in 2019 reaching 710 by 2029, growing at an annual rate of 8.7%. HAPS technology is developing, generating new market demand and disrupting the current landscape, providing new business potential for companies in the HAPS ecosystem. By 2029 the HAPS market is expected to generate $4 billion, driven by market demand and a rise in scientific research and funding from business, university and government space agencies.

Market Source NSR, High Altitude Platforms 4th Edition, 2020

"The stratosphere has optimal conditions for telecommunications of the future: HAPs can generate an alternative network in 60.000 m feet for data transfer and telecommunication without any space debris. HAPs are eco-friendly, recyclable and reusable like our segmented airship SkyDragon, which can be started and landed on a meadow. HAPS have a huge impact in different areas, ranging from monitoring marine pollution through to topography mapping of land registries. They can be used to monitor and assess the status of, and changes in, natural and manmade environments, such as monitoring plastic flows and supporting disaster management. HAPS are the future of alternative and efficient data transfer of the future."

Regine C. Henschel, CEO of TAO Group, Germany

HAPS platforms are designed with a focus on mass minimization and simplicity in design, large wings, high-volume airships and balloons manufactured using space-grade materials. This all ensures platforms can withstand harsh stratospheric conditions and remain persistent in the Stratosphere for months at a time.

STRATOSPHERIC BALLOONS

Stratospheric balloons have been used for decades, with the first flights dating back to the end of the 19th century. Modern super pressure balloons, used for long-term stratospheric flights are designed with simplicity and payload scalability, with the capability to carry payloads ranging from a few kg up to several tons. A classic flight train consists of PE Balloon, parachute, avionics and payload. Length can be up to 300 meters.

Key Characteristics and Benefits:

- Long duration – capabilities to stay afloat for months at a time
- Rapid deployment
- Wide area coverage
- Large payload capacity
- Low-cost stratospheric access

AIRSHIPS

The first recorded flight was in 1785, but for the next 150 years airships struggled due to lack of power and heavy structure. With technological advancements in light-weight materials and batteries, airships can now reach an altitude of around 20 km, taking advantage of high solar irradiance and mild winds. Airships are designed as a blimp or ridged structure, with the propulsion system providing maneuverability and station-keeping capabilities.

Key Characteristics and Benefits:

- High maneuverability
- Large payload capacity
- Station keeping abilities, remain in the Stratosphere for months at a time
- Rely on buoyancy (Helium, Hydrogen) and not on lift by cruising
- Large solar cell surface area – structure

HEAVIER THAN AIR HAPS

This solution is predominantly solar powered, with the array used to generate power for flight and secondary batteries storing power captured during the day for overnight operations. Recent advancements in battery and solar panel technology have enabled heavier-than-air HAPS, which are primarily fixed wing platforms. This approach has seen significant developments and achievements in the market.

Key Characteristics and Benefits:

- High maneuverability due to small size and low drag
- Wider operational envelope
- Endurance, with flight duration months at a time
- Greater flexibility in operation - enabling persistent coverage or readily re-tasked
- Due to being located approximately 20 km in the Stratosphere, HAPS platforms have low latency and high-quality telecommunications

"Our mission is long-term presence in the Stratosphere. Stratospheric platforms enable targeted provision of data in the highest quality to people all around the world thanks to their unique operation capability. We will no longer have to face a world where some people are excluded from access to internet and connectivity in general. We are keen on walking down the path to a safer world, therefore HAPS can be also used on Earth observation and prevention of natural disasters."

Jan Snížek, Chief Technology Officer, Stratosyst

New platforms, new progress

Over the past decade technological advancements have paved the way for stratospheric technology to continue gaining traction. Continuous improvements have been made to materials, with a focus on durability and miniaturization, bringing costs down and driving forward the possibilities to design stratospheric vehicles that can operate effectively to perform unique missions.

Power is key to operations and capabilities for platforms to remain persistent during day and night operations. This is achieved with new battery technology and improvements in power management, ensuring platforms remain in the Stratosphere at an altitude above 20 km. The battery accounts for a large percentage of the overall aircraft weight; a reduction in weight can contribute to a reduction of aircraft weight, resulting in a significant increase in flight range. Modern battery technology helps ensure that in-flight power sources can stand the harsh conditions in the Stratosphere.

Since the Stratosphere is above the clouds, solar-powered vehicles can be continuously charged throughout the day, storing power to charge secondary batteries that power overnight flight. The solar array ensures that solar energy is converted into power and increased efficiency in solar technology leads to longer and more effective missions.

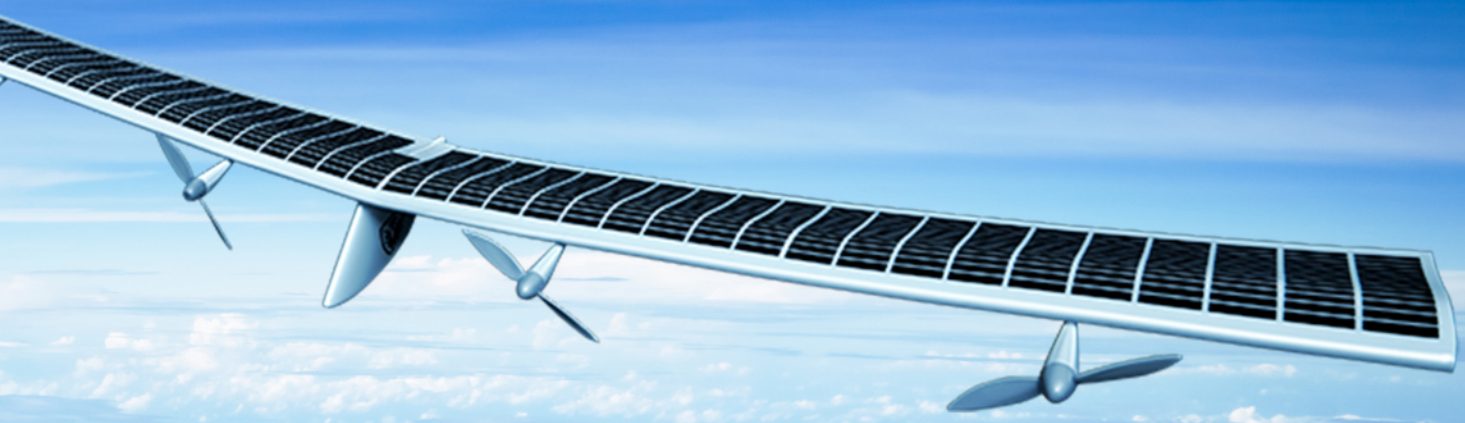
Further developments in solar cell technology enables HAPS platforms to reduce mass of cells on board, leading to opportunities for larger payload capacity and batteries for broader customer service and use cases.

Key Applications

Pushing the boundaries of the Stratosphere.

HAPS has the potential to bring a wide array of use cases to Commercial, Military and Institutional customers. HAPS may be adapted to different customer needs, providing the opportunity to advance markets across the globe.

- Connectivity
- Earth Observation
- Disaster Management
- Security and Defense
- Maritime
- Surveillance
- Monitoring and Detection
- Critical Infrastructure inspections
- Government
- Mapping and Humanitarian Missions



CONNECTIVITY

The Stratosphere can drive significant growth in the $3.9T mobile technologies and services business by connecting millions of people living in unconnected areas online, reconnecting people after disasters, building out the next generation of 5G networks, and connecting the future of Internet of Things (IoT) devices.

HAPS have a unique proposition when it comes to Direct to Device connectivity. The ability to combine a high-speed data link to the nearest terrestrial Mobile Network Operator (MNO) Gateway and then, with the appropriate on-board node and antenna configuration, connect end users utilizing their existing mobile handset. Thus the HAPS platform itself becomes another 'cell' in the mobile operators' network, with all the seamless benefits that brings the end user: Mobile package, call quality, internet access, data usage and billing.

Furthermore, HAPS can cover hard to reach areas and bring connectivity to those who do not have access, such as isolated islands, mountainous areas and deserts. Where there is no ground infrastructure, HAPS can provide coverage of approximately 250 cellular towers to expand the footprint of terrestrial solutions in a flexible and scalable way. HAPS enables us to build stable internet connection at locations unserved by telecommunication networks. Users can have seamless connectivity, without disruption even when individuals using their device move from a base station covered area to a HAPS covered area.

In addition to expanding telecom coverage into rural and challenging terrains, HAPS operate above the weather and can be moved at will, enabling emergency coverage in times of outages and disasters. Supporting critical communication, rescue and recovery efforts as platforms do not interfere with the networks of terrestrial base stations.

COMPLEMENTARY CONNECTIVITY FOR MOBILE NETWORK OPERATORS

According to a GSMA report, *"Deployment of base stations in rural and remote areas is twice as costly compared to in urban areas, as well as three times more expensive to run for Mobile Network Operators (MNO). The exploration of innovative technologies can reduce the cost of deploying and operating networks in remote areas. "*

HAPS will make it easier for MNOs to deliver Internet connectivity to regions without fixed infrastructure, with lower capex barriers. End-users can use their existing handsets, which is another reason why HAPS is easier to implement.

HAPS allows the design of a broad range of network coverage, providing connectivity to not only mobile devices but to Internet of Things (IoT) devices in these areas. It can provide the foundation for any IoT service, including digital agriculture, farming, mining, smart mobility, and infrastructure surveillance.

HAPS is capable of covering wide area ranges at low cost, which enables migration from previous communication generations (2G/3G) to next generations (4G/5G) in broad areas comprehensively.

"In our base station recovery efforts following the Great East Japan Earthquake in 2011, we keenly felt the need for a new telecommunications structure that is resilient even during times of disasters and emergencies. We developed and operated tethered balloon radio relay systems, but we later studied stratosphere-based telecommunications as a means of providing wide-area coverage that is unaffected by the weather on the ground. Unlike satellite-based telecommunications, HAPS uses the same spectrum as terrestrial base stations, which makes it possible to deliver connectivity directly to mobile devices, which is another major advantage."

Junichi Miyakawa, President & CEO of SoftBank Corp. and of HAPSMobile Inc.

Source: https://www.softbank.jp/en/sbnews/entry/20190425_01

EARTH OBSERVATION

The HAPS value proposition enables users to make decisions and solve real-world problems through various Earth observation and sensing applications. A HAPS system can provide a range of operational benefits to extend surveillance opportunities which fit the observational needs of users. Capabilities include endurance, with long term and uninterrupted flight duration up to several months, enabling persistent coverage for specific targeted areas or wider reaching regions. HAPS platforms also provide the flexibility to be re-tasked in minutes.

Fitted with Earth Observations payloads, HAPS platforms can deliver high quality imagery and video 24/7 day and night, from the Stratosphere.

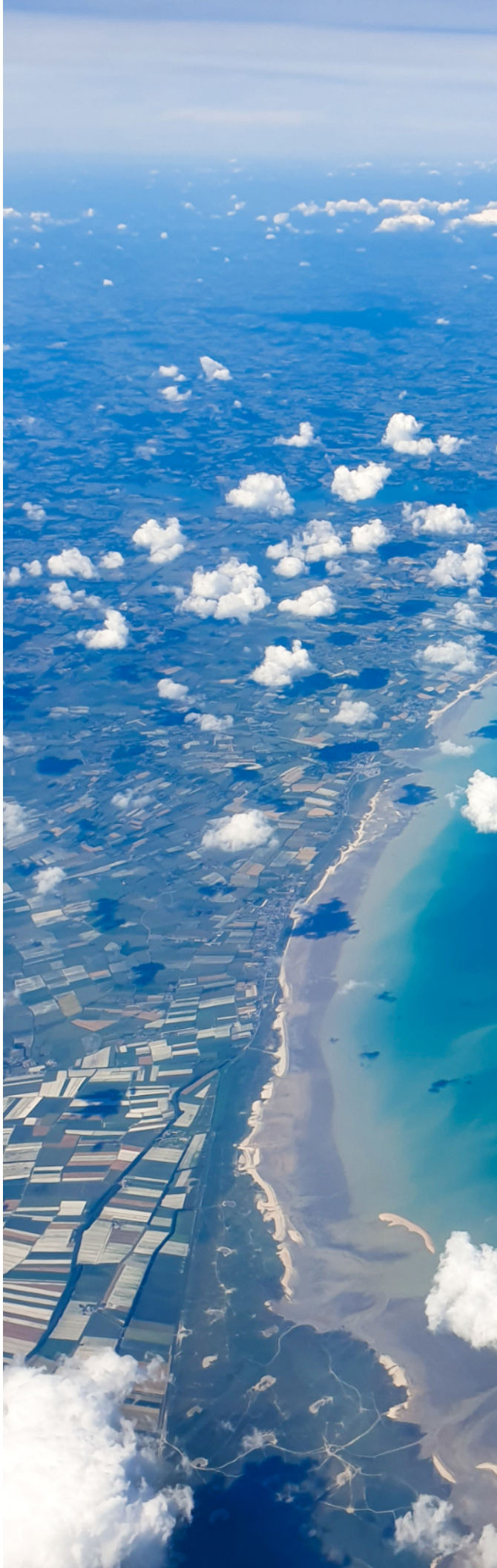
Supporting key applications:

- Disaster Management, where HAPS provides real time situational awareness, gathering data around disasters, supporting decision making and effective response in areas where rescue and evacuation missions are required.
- HAPS can support the strategic domain of Maritime Surveillance, providing monitoring and supporting safety in our waters.

Remote Sensing:

Since HAPS flies in the Stratosphere, 20 km above ground, sensors can allow the acquisition of key information to monitor and provide live data feeds of activities on the ground.

- Resource mapping: coal, oil, mineral, water resources
- Surveillance situational awareness
- Navigation: Service for autonomous driving, unmanned aircraft systems (UAS) and agriculture
- Disaster prevention and reduction: highly accurate weather prediction, immediate study of affected areas
- Environmental conservation: waste detection, protection of forests



HAPS in action

HAPSMobile

As part of its efforts to contribute to the achievement of Sustainable Development Goals, SoftBank Corp.'s majority-owned joint venture with AeroVironment, HAPSMobile, is developing HAPS services. HAPSMobile aims to contribute to the SDGs by:

- Connecting societies around the world by bridging the digital divide
- Providing a new communication system that uses the Stratosphere
- Deploying wide-area coverage
- Operating a sustainable system

HAPSMobile has developed Sunglider, a fixed-wing solar-powered stratospheric aircraft. In 2020, Sunglider succeeded in a stratospheric test flight, reaching an altitude of 20 km. The test flight lasted 20 hours and 16 minutes, with 5 hours and 38 minutes of this in the Stratosphere. Sunglider demonstrated its high-performance capabilities under demanding conditions and strong wind. Prior to this, Sunglider successfully completed four previous test flights.

Source: https://www.hapsmobile.com/en/news/press/2020/20201008_01/

HAPS in action

AIRBUS

The maiden flight of Zephyr S broke persistence records for fixed wing HAPS, still held, remaining in the Stratosphere for almost 26 days with uninterrupted day and nights operations. Zephyr achieved a dawn altitude of 18,288 meters, climbing to the highest altitude of 21,640 meters.

Having proven stratospheric flight, Airbus Zephyr has continued to work with its launching customers to model, develop, integrate, test, and deploy multiple payloads with a comprehensive flight test campaign.

The target of Zephyr is to provide local persistence, being able to station keep and to re-localize within the stratosphere, using a re-usable solar-powered aircraft, which will bring see, sense, and connect capabilities to military and civil users.

"HAPS technology offers transformative opportunities and unique capabilities with a wide range of applications. It is able to accelerate digital inclusion and revolutionize the ways we map our planet. As technology advances we are seeing great achievements being made across the industry, stepping closer towards operational reality in the Stratosphere."

Simon Taylor, Head of Zephyr Program Airbus

The Loon Legacy

Loon — established in 2011 within Google's research and development lab and made public in 2013 — pioneered the development of HAPS and the commercial application of stratospheric technologies. Over a decade, Loon made a number of scientific breakthroughs in the fields of hardware and software engineering, materials science, machine learning, artificial intelligence, meteorology, and more — many of which have gone on to advance the world's understanding of the Stratosphere and how to operate a production fleet within it. In 2021, Loon's journey came to an end when Google's parent company Alphabet announced the wind down of the project.

Loon's unmanned free floating balloons were capable of operating in the Stratosphere for months at a time, with the record-setting balloon remaining aloft for 312 days. Networking software developed by the Loon team was capable of connecting dozens of flight vehicles to one another, creating mesh networks of connectivity that spanned thousands of kilometers from ground-based installations. Loon's autonomous navigation software, powered by artificial intelligence and machine learning algorithms, was capable of safely coordinating and navigating the Loon fleet, which included dozens of balloons at any given time. All in all, Loon's balloons flew over 40 million kmv in the Stratosphere.

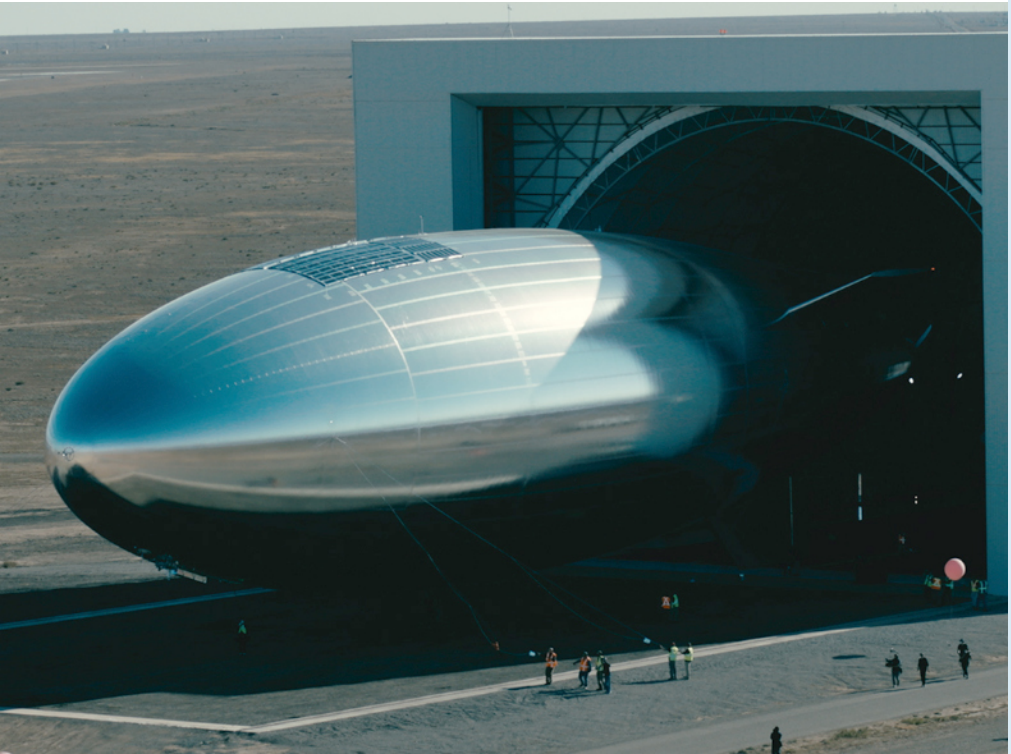
Just as Loon's technology was built on pioneering work done by others in fields from aviation to meteorology to artificial intelligence, the hope is that some of Loon's technology will live on to support the next generation of innovators working to connect more people, places, and things around the world.

HAPS Alliance

The HAPS Alliance unites companies from telecommunications, technology, aviation and aerospace industries to collectively accelerate the promotion of HAPS, building an ecosystem to provide education, industry collaboration and global awareness of the benefits this advanced technology can bring to people, places and things worldwide, eliminating the global digital divide.

A consortium of leading voices catalyzing the HAPS ecosystem:

- Accelerating Commercial Adoption: Identification of commercial use cases and business models, building industry-wide standards.
- Cross-Industry Collaboration: Delivering guidance on HAPS technology and market opportunities to organizations
- Safety and Regulatory Advocacy: Build HAPS ecosystem in a safe way, in collaboration with telecommunication and aviation regulators.
- Thought Leadership and Education: Coalesce the voices of HAPS industry leaders into a compelling message for partners, regulators and members of the public.



"HAPS enable service providers to provide universal access to mobile broadband internet service. As a leading 4G and 5G protocol software provider to OEMs building terrestrial and non-terrestrial wireless base stations, Radisys fully supports the HAPS alliance initiatives to address the digital divide."

Munish Chhabra, Senior Vice President and General Manager, Software and MobilityEngine Marketing, Radisys Corporation

"Our passion for innovation and connectivity is driving us to explore new markets. We recognise HAPS as a core element within the converging terrestrial and non-terrestrial telecoms ecosystem moving forward. We at Filtronic are excited about exploring the stratosphere as a viable solution to address the lack of broadband connectivity in developing countries."

Richard Gibbs, CEO, Filtronic

"HAPS is The Great Equalizer. With a field of vision broad enough to transmit over thousands of square kilometers but is close enough to eliminate the need for ground infrastructure, HAPS offers the advantages of a networked world in the most equitable way as everyone can access the same speed and quality of service.

HAPS offers Universal Accountability by providing real time data and transparency of our planet's health and most vital ecosystems."

Mikkel Vestergaard Frandsen, CEO, Sceye

The Alliance work has been driving forward advancements to the HAPS ecosystem as concluded by Ken Riordan, president of the HAPS Alliance.

"We know that the opportunity for HAPS is broader than just telecoms – but the focus is there, and over the past 12 months and even before, the narrative within our industry has very much been about 5G and the Internet of Things. The challenges that some of these new use cases represent can be, we believe, very meaningfully enhanced by a stratospheric HAPS layer.

At the same time, it's even more important that solutions like HAPS can be brought to commercial viability, to address the digital divide and to meaningfully improve upon coverage in developing countries. In areas like North and Sub-Saharan Africa, Latin America, there still exist huge challenges that HAPS is fundamentally well-targeted to pursue."

Discover more about the HAPS Alliance
https://hapsalliance.org/

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