High-altitude platforms by Christine Mengelle

Abstract:
Mainly used at the start for scientific purposes, high-altitude platforms have increasingly attracted interest since the 1990s as a complement to land and satellite networks. At a position above the altitude of commercial air traffic and the jet stream, such platforms — which are easy to deploy and necessitate a minimal infrastructure (networks and maintenance) on the ground — offer an additional advantage: a wide zone of coverage with very low latency. They are, therefore, of special interest for civil or military surveillance operations and for telecommunications in areas isolated by geography or a disaster. Technological progress and a propitious regulatory framework — established since 1997 by successive world radiocommunication conferences (WRCs) — open the possibility of rolling out high-altitude stations in the near future.

Initially used for scientific purposes (meteorology or monitoring of the environment), high-altitude platforms have, since the end of the 1990s, attracted ever more interest as a supplement for the radio connectivity of terrestrial and satellite networks. Positioning these platforms in the stratosphere has major advantages: a broader zone of coverage from a location above the levels of commercial air traffic and strong winds (jet streams).

For three decades, technological progress and better knowledge of the stratosphere have augmented the viability of plans for high-altitude platforms. Since 1997, the regulatory environment has evolved positively, and the ITU has allocated frequency bands on which these new services may be deployed.

The advantages of high-altitude platforms

High-altitude stations have undeniable operational advantages owing to the extent of their coverage (over a zone larger than conventional terrestrial networks) in association with very low latency (compared with satellites). For this reason, they are of special interest for (civilian or defense) monitoring operations and for telecommunications (broadband or terrestrial mobile applications). Another advantage is that these stations can be very easily deployed — with minimal network infrastructure and minimal maintenance on the ground — in isolated geographical areas (mountains, deserts, etc.) or following a catastrophe (earthquake, cyclone, etc.). Besides, they can be easily brought back to the ground for maintenance or modifications (to, for instance, change the platform’s assignment or replace its payload with more advanced technological devices).

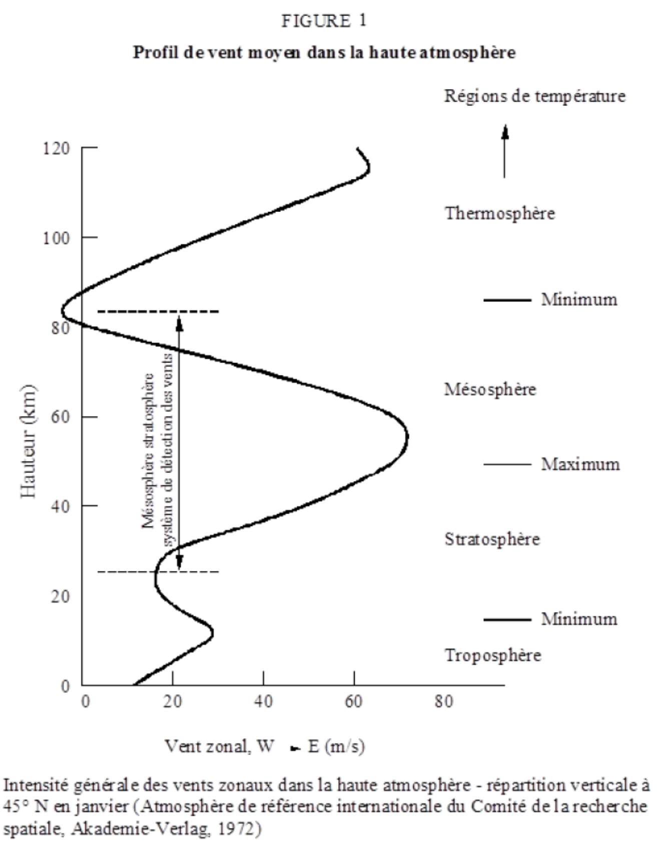
For these reasons, this type of platform offers an excellent synergy with terrestrial and satellite services in terms of radio connectivity.

Technical conditions and requirements

For platforms to operate in the stratosphere, major technological barriers must be lifted in fields as varied as avionics, the efficiency of solar panels, the storage of energy, composite materials and antennas. These barriers have long (since the first programs in the 1990s) stood in the way of developments, but programs in recent years are now focusing on them.

Technical requirements have to be met to operate high-altitude platforms. Since the platform has to maintain a nearly stationary position above the targeted zone on the ground, its altitude is typically about 20 km — above the jet streams (10-15 km) and in a layer of the stratosphere where winds are not so strong. The platforms can then hover or move predictably above the maximum altitude of controlled air space.

Figure 1: Average wind in the upper atmosphere



Platforms of two major types have been developed that satisfy these requirements: dirigibles (LTA: lighter than air) and drones (HTA: heavier than air). A manufacturer's choice between the two is often a matter of history and, too, a response to requirements related to avionics and the maintainability of the platform in the air.

***Figure 2**: A HAPS HTA on the drawing board*
Source: ©Thales Alenia Space

High-altitude platforms and the ITU

Regulatory requirements about the radio transmissions at an altitude of 20 km must also be met to operate a platform in the stratosphere. The radio spectrum's environment will have to be made viable for both these platforms and other uses of the spectrum.

WRC-97 decided to introduce a new type of station in the Radio Regulations (RR): high-altitude platform stations (HAPS): "*A station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth*" (RR 1.66A). This was the first time that a decision was made about allocating frequencies for this new service. WRC-97 listed the frequencies for HAPS to operate worldwide: 47.2-47.5 GHz and 47.9-48.2 GHz. In some areas (in particular tropical zones), this allocation has a heavy handicap: heavy rainfall weakens the signals transmitted in this range, and technical conditions make it very hard to access a high-altitude platform. To cope with this difficulty, WRC-2000 identified a set of new frequencies for HAPS: 28 GHz (27.9-28.2 GHz for downlinks, platform-to-Earth) and 31 GHz (31-31.3 GHz, for uplinks, Earth-to-platform) in 23 countries, most of them in Asia, but with no protection from other services using these bands or against interference from them.

On account of the upsurge in mobile networks, WRC-2000 decided, in addition, to authorize the use of HAPS as base stations for international mobile telecommunication (IMT) in the frequency bands between 1.9 GHz and 2.1 GHz. WRC-12 followed up on this decision by allocating HAPS frequencies (2x80 MHz in the 6 GHz band) for "gateway links" to connect IMT base stations. This is limited to five countries, subject to the same restrictions (no protection against interference or claims).

Given the difficulty of sharing bands in the spectrum, WRC-12 also decided to limit HAPS to the frequency bands specified under RR Article 5 (§4.23).

Future uses of HAPS

For a few years now, major advances in technology have been demonstrating the viability of HAPS. Since 2010, several projects have arisen (sponsored by Thales Alenia Space, Airbus and Lockheed Martin).

During WRC-15, on an initiative by Facebook, a new point was added to the agenda for WRC-19: to identify the HAPS frequencies for facilitating access to wideband applications worldwide. After four years of detailed studies carried out at the ITU, WRC-19 allocated the frequency bands 31-31.3 GHz (for downlinks) and 38-39.5 GHz for worldwide use by HAPS, as well as the bands 21.4-22 GHz and 24.25-27.5 GHz in Region 2 (the Americas).

Furthermore, WRC-19 assigned WRC-23 to examine whether HAPS may use the same frequency bands as IMT base stations on the ground in order to extend mobile broadband connectivity to communities that are poorly served or located in isolated areas, below the 2.7 GHz band.

Conclusion

Technological progress in composite materials, avionics, solar cells, batteries and electric motors now enable us to imagine that high-altitude stations will soon be rolled out.

Among its decisions, WRC-19 allocated harmonized bands at the world and regional levels for HAPS (for broadband applications) and foresaw studies about using high-altitude stations as IMT base stations. These decisions contribute to setting up the regulatory framework needed for, and conducive to, the development of these platforms.