StratXX airships

Peter Lobner, 3 April 2021

1. Introduction

StratXX Holding AG was founded in 2005 by Kamal Alavi in Switzerland. StratXX led a team to develop a High Altitude Platform Station (HAPS) designed to operate in the stratosphere at an altitude of about 21 km (68,898 ft). The HAPS could be configured for a variety of missions, including telecommunications broadcast and cellular service, and a range of Earth observation, local ground positioning, and national security services. Strategic partners included the Swiss Federal Institutes of Technology at Zurich and Lausanne, RUAG Aerospace, the Universitié de Neuchâtel, the German Space Agency (DLR) and the University of York (UK).

At its operating altitude, the HAPS, known as the X-Station, would have a service area about 1,000 km (621 miles) in diameter. The X-Station's first business application was to be a platform for delivering 3G/4G wireless communications and digital broadcasting services.

StratXX also developed other unmanned lighter-than-air vehicles:

- **X-Tower:** A tethered aerostat designed to deliver telecommunications and other services from a low altitude (200 - 2,500 m / 656 – 8,202 ft).
- **PhoeniXX:** A smaller scale alternative to X-Station, designed for autonomous or remote control free-flying operation at altitudes up to 5,000 m (16,404 ft).
- **X-Bugs:** Very small (10m^3 / 353 ft^3 gas envelope volume) free-flying airships for ground surveillance and communication missions at altitudes up to 3,000 m (9,843 ft) in support of X-Station and PhoeniXX.

In January 2019, StratXX filed for bankruptcy and was liquidated in accordance with Swiss bankruptcy regulations.

The StratXX website is still available online at the following link: http://www.stratxx.com/products/x-station/

2. StratXX patents

StratXX claims that all X-Station intellectual property is covered by worldwide patents, either filed or in process of being patented, including:

- Structural design of the multilayer skin
- Concept for the ascent flight into the stratosphere
- Thermal control system
- Separate recovery of equipped Payload Plane and Lifting Body.

In this section, we'll take a look at the patents that describe the lightweight material for the X-Station gas envelopes and the design and operation of the X-Station stratospheric airship.

Patent US 2010/0239797A1, "Flexible Multi-Layer Material, Preferably for an Inflatable Balloon Casing, and Method for the Production of an Inflatable Casing"

StratXX developed and patented a high strength, ultra-light, flexible material they call "Super Material," which initially was developed for building their stratospheric airships, and also has much wider applications. The StratXX Smart Material product brochure is at the following link:
http://www.stratxx.com/files/downloads/supermaterial_leaflet_vrz_01.pdf

Patent US 2010/0239797A1, which was published on 23 September 2010, lists Kamal Alavi as the inventor. You can read this patent at the following link:
https://patents.google.com/patent/US20100239797A1/en?oq=20100239797

The patent describes the Super Material as follows:

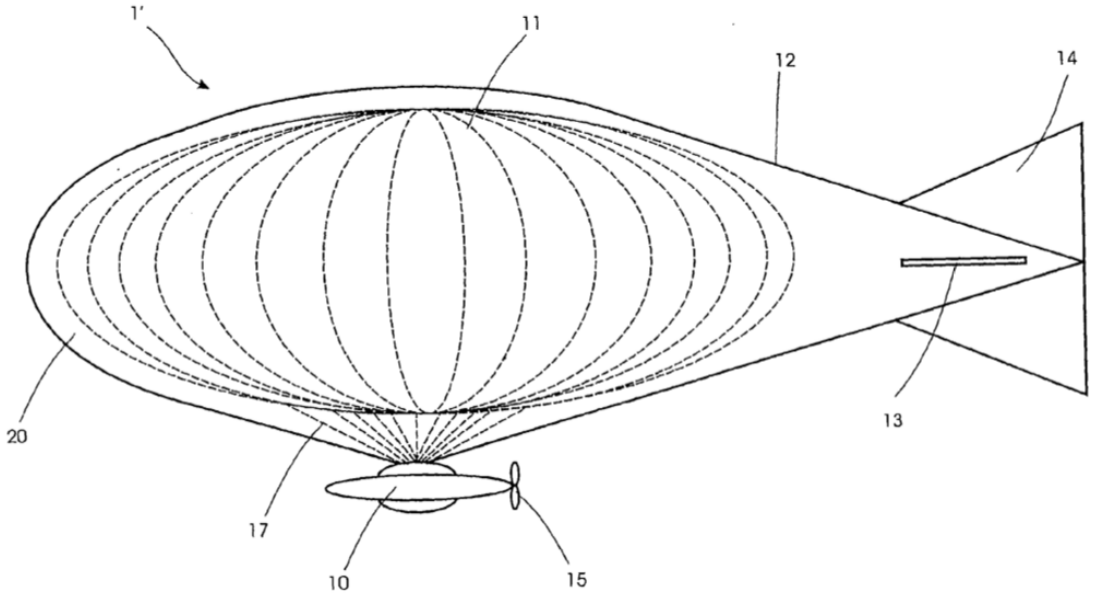
> "The invention relates to a flexible multi-layer material that can be used in particular for an inflatable balloon casing, a blimp, an airbag, a sail, a flexible solar cell, or a flexible antenna. At least one layer is provided, which is particularly made of ultra high molecular weight polyethylene (UHMWPE), or of ultra high

molecular weight polypropylene (UHMWPP). The same is surrounded on each of the two sides by a layer, or a film made of polyethylene or polypropylene, and connected thereto, wherein the layers, or films placed on top of each other can be connected to each other by means of heating. Such a material layer is lightweight and has high stability, or tear resistance, and a high modulus of elasticity."

Patent US 8286910B2, "Unmanned Aircraft for Telecommunicative or Scientific Purposes"

Patent US 8286910B2, granted on 16 October 2012, is one of four US patents that describe several variations of the X-Station stratospheric airship. The other patents are: US 8267348B2, US 2009/0189015A1 and US 2009/0114767A1. All lists Kamal Alavi as the inventor. You can read patent US 8286910B2 here: https://patents.google.com/patent/US8286910B2/en?oq=8286910

Fig.1



As shown in patent US 8286910B2 Figure 1, the stratospheric airship (1) consists of an aerodynamic outer balloon (12) with a rudder (14) and elevator (13), an pressurized inner balloon (11) containing the lift gas, an insulating gas chamber between the two balloons (20), and a detachable payload plane (10) with a propulsion system (15)

suspended (17) from the pressurized inner balloon (11). The payload plane contains the mission-related equipment, flight control and power systems, and the gas systems for the balloons.

The lift gas can be helium or hydrogen. In patent US 8286910B2, the insulating gas is a poor thermal conductor, preferably xenon or krypton. A different approach is offered in patent US 8267348B2, in which a heating and cooling system circulates air in the insulating gas chamber (20). All of the equipment for the gas system and, if used, the heating and cooling system, is located on board the payload plane (10).

In either case, when filled with the insulating gas, the insulating gas chamber (20) reduces the day-night temperature and pressure cycles experienced by the inner balloon (11). This allows the inner balloon to be produced from a lighter and cheaper material and increases its longevity.

As shown in patent US 8286910B2 Figure 2, the krypton or xenon insulating gas is stored in a reservoir (24) and is metered into the insulating gas chamber (20) by a control valve. Likewise, the lift gas is stored in a reservoir (43) and is metered into the inner balloon (11).

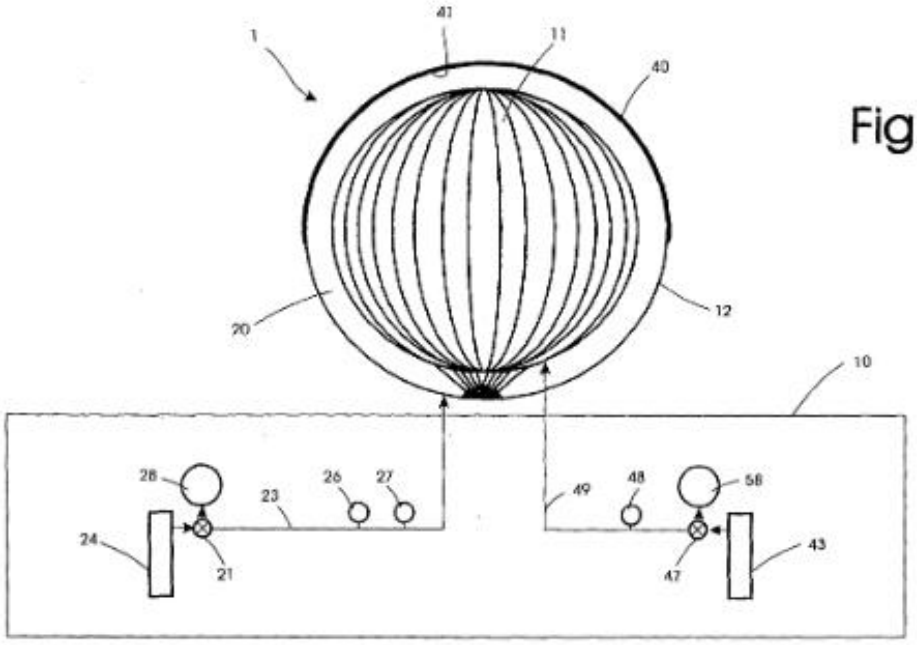


Fig.2

3. X-Station stratospheric airship

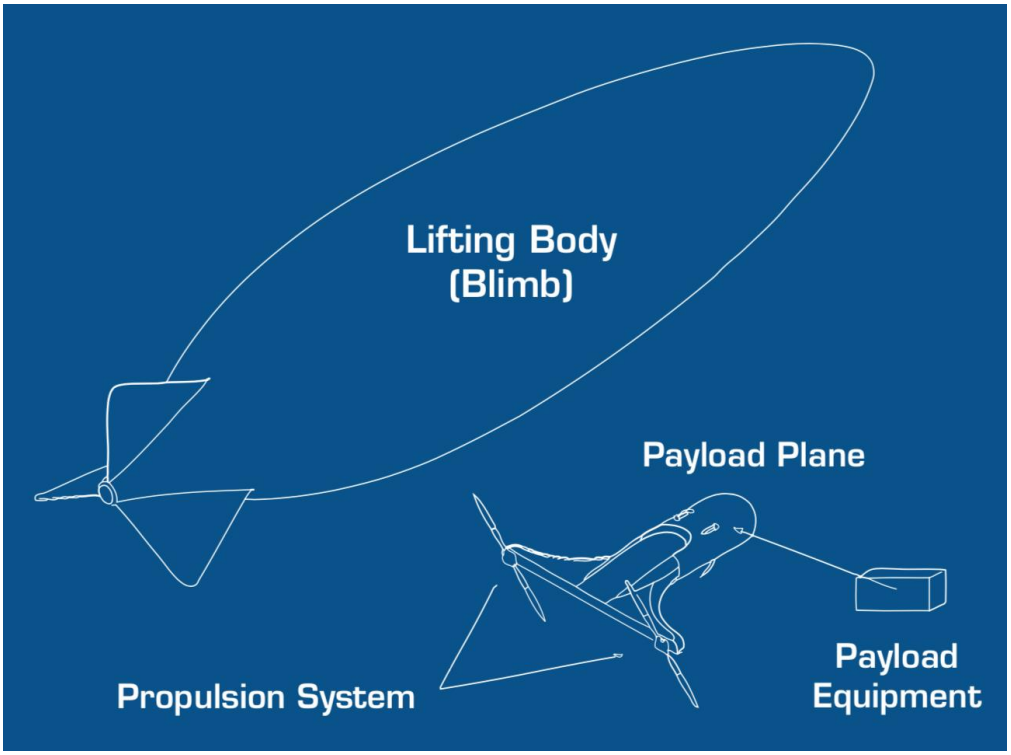
In 2006 – 2007, several sub-scale (12 – 30 meters / 39 – 98 ft), unpowered X-Station prototype blimps were launched to validate ascent and controlled expansion processes, thermal control, payload plane integration, flight termination procedures and safe parachute descent.

Tests of motorized sub-scale X-Station prototypes started in 2008 to validate the automatic navigation and guidance system, including flights into the stratosphere to continue development of airship subsystems. During the Zeppelin 100th anniversary celebration in Germany, an X-Station test flight was conducted to demonstrate WiMax broadcasting technology and optical free space technology developed by DLR to interconnect X-Stations and ground stations with data speeds of up to 6 Gbits/sec. In August 2008, a company airship burst 50 m (164 ft) above the ground in Engelberg.

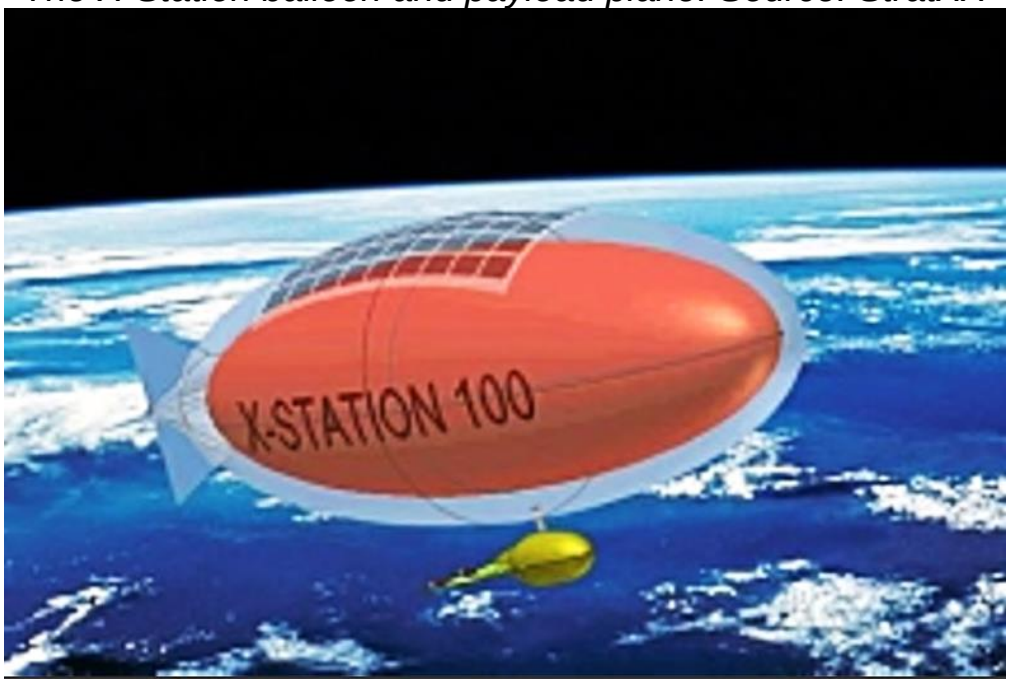
The first test of a complete X-Station prototype occurred in 2009.

18,000 m^3 (635,664 ft^3) X-Station prototype in the Zeppelin Hangar in Friedrichshafen, Germany, along with a Zeppelin NT (background). Source: StratXX.com

The X-Station stratospheric airship is a two-component vehicle with a 60 meter (197 foot) balloon “lifting body” carrying a small payload plane, as described in Patent US 8286910B2.



The X-Station balloon and payload plane. Source: StratXX



A double-skinned balloon carries the small payload plane to a geostationary position on the stratosphere. Source: StratXX

Technical specifications

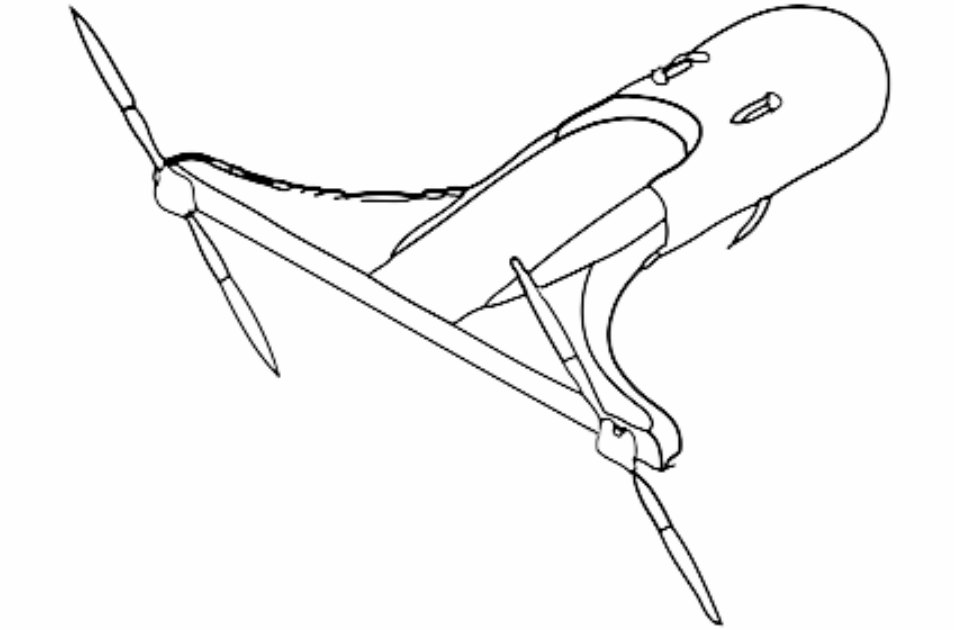
	X-Station™
Volume of lifting body	> 25,000 m^3
Length/Diameter	90 m / 22 m
Take-off weight	1800 kg
Payload weight	100 kg
Payload power	1 kW
Flight speed	25 – 50 km/h
Fight duration	Up to 1 year
Packing size **Payload bay**	8 x 2.2 x 2.2 m (LB) 6 x 2.2 x 2.2 m (PLP)
Deployment time	9 hours
Propulsion	Electromotor
Energy source	Batteries & Solar
Flight altitude	21,000 metres
Flight control	Autonomous piloting and / or remote control
Communication	WiMax, Free Space Optics
Coverage area	Up to 1,000 km diametre

Source: StratXX

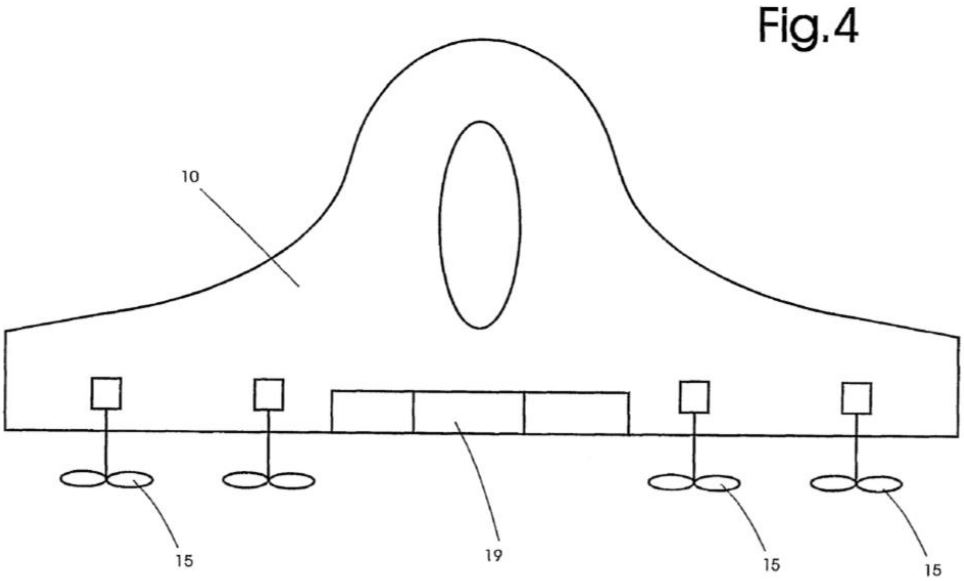
The airship is launched with the inner balloon inflated enough for liftoff and the outer balloon deflated. After reaching the stratosphere, the outer balloon is inflated with insulating gas by the onboard gas system and the outer balloon establishes its aerodynamic form for the duration of the mission. The airship is then capable of flying autonomously or by remote control to its assigned geo-location in the stratosphere at an altitude of 21 km (68,898 ft). The balloons are designed for a useful lifetime of five years.

The balloon serves as a “mothership” for the payload plane, which is essentially a small, recoverable unmanned aerial vehicle (UAV) that contains all of the mission equipment and antennas for 3G/4G mobile phone, digital broadcasting and other digital services. After the outer balloon is inflated, solar cells on its surface supply energy to the airship systems and the mission payload. Batteries aboard the payload plane supply power at night.

The payload plane is equipped with large electric motor driven propellers optimized for operation at high altitude and capable of maintaining the X-Station at a precise geo-location in the relatively light prevailing winds at high altitude. If the equipment on board becomes faulty, the payload plane can be uncoupled from the blimp and flown back to a base where repairs can be carried out.



Close-up view of the payload plane. Source: StratXX



An alternate payload plane configuration.
Source: Patent US 2009/0114767A1

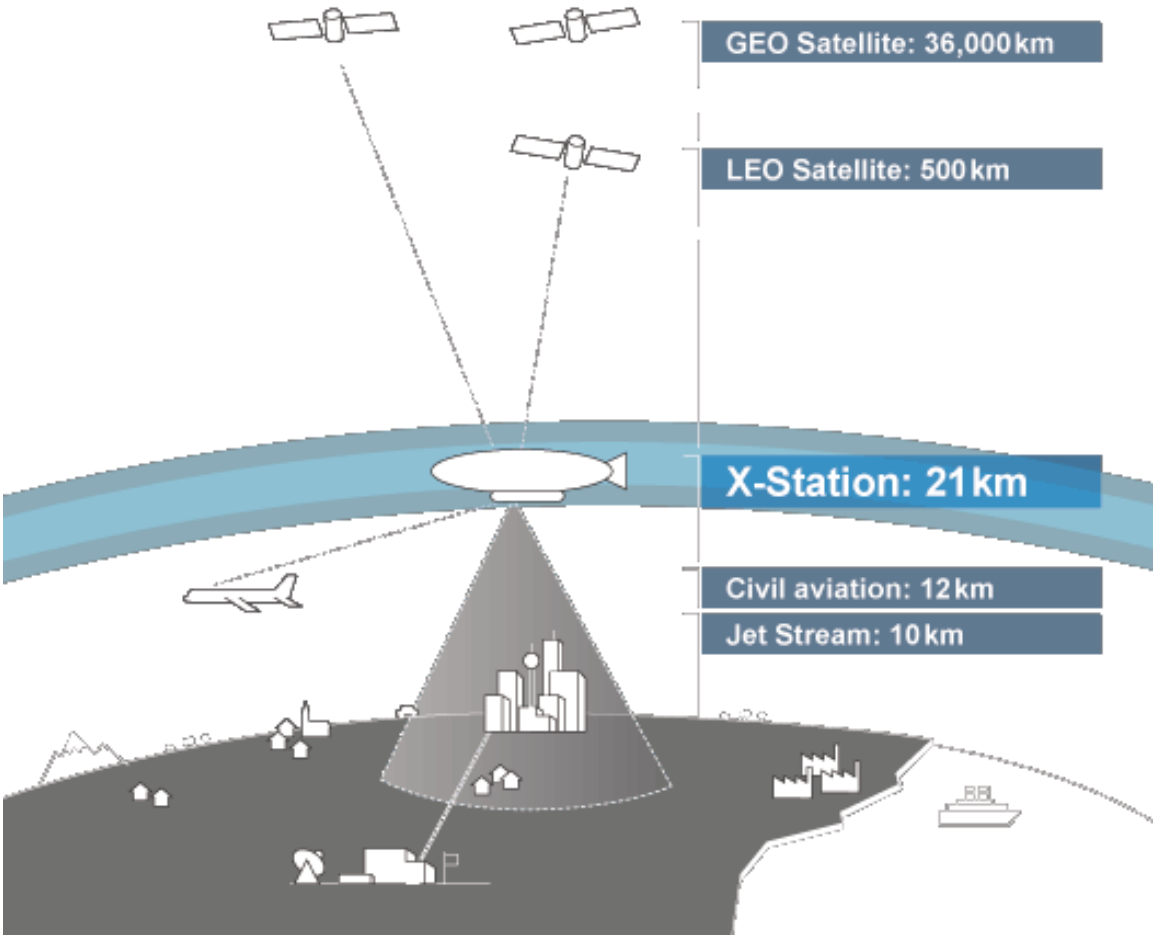
Artist's rendering of an X-Station operating in the stratosphere. Note the suspended payload plane. Source: StratXX

You'll find the X-Station product brochure, "StratXX near space technology – High altitude platforms – The X-Station," at the following link: http://www.stratxx.com/files/downloads/x-station_product_sheet.pdf

4. The X-Station network

At its operating altitude of 21 km (68,898 ft), the X-Station would have a service area about 1,000 km (621 miles) in diameter for delivering 3G/4G wireless communications, digital broadcasting, and other digital services. Communications could be provided outside the basic 1,000 km coverage area by linking multiple HAPS airships using the optical free space technology developed by DLR or by integrating with orbital satellite services.

The ability to deliver broadcast services from a balloon was demonstrated by StratXX in February 2014, when one of their X-Tower tethered balloons operated at an altitude of 1,000 meters (3,281 feet) and successfully delivered digital broadcast TV and radio service for 23 days to an area 100 km (62 miles) in diameter. The X-Tower used only 20 watts of power to broadcast 12 digital television and two FM radio channels.



System architecture for an X-Station. Source: StratXX

Switzerland needs about 1,000 terrestrial antennas for full 3G/4G mobile phone coverage of the country. A single X-Station would be enough to supply Switzerland with mobile phone, digital TV and radio and Internet service. Spot beam antennas developed in Switzerland allow coverage patterns to be adjusted according to real-time usage, reducing the allocation for regions with little activity and increasing the allocation for higher usage areas.

About 20 X-Station HAPs would be required to provide service to all of Europe. Africa would need twice as many.

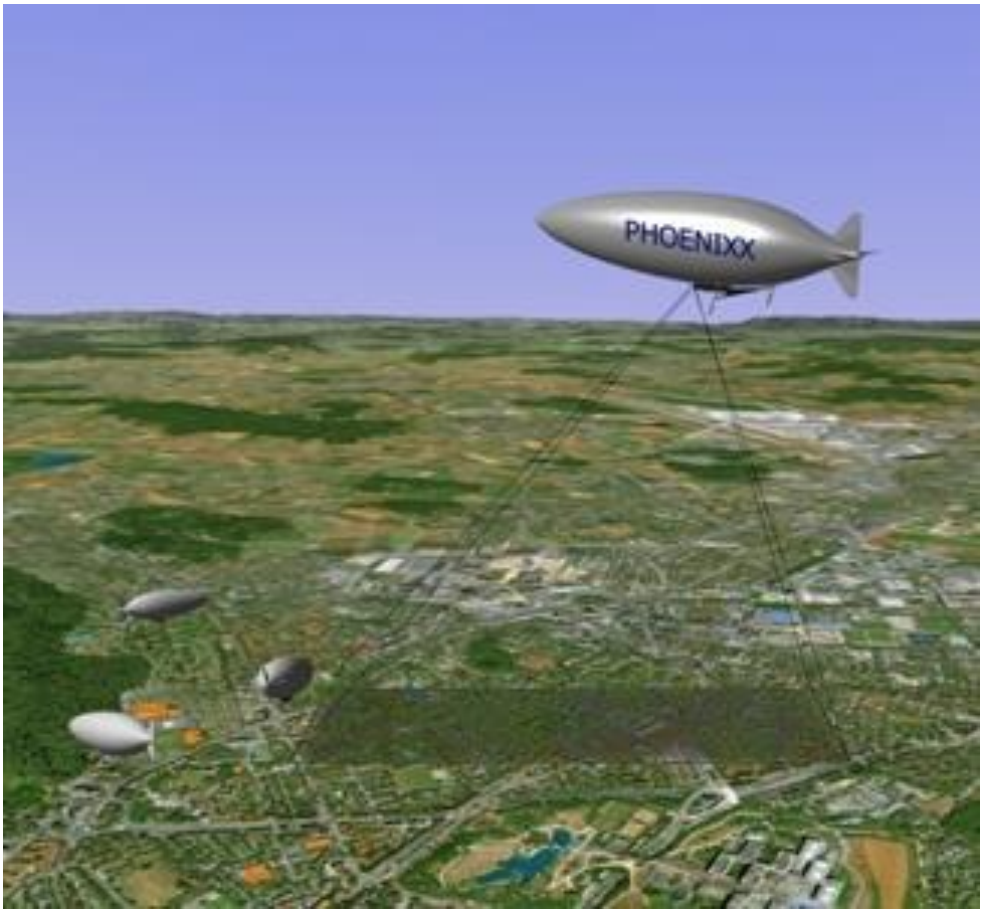
StratXX estimated that an X-Station airship will cost no more than SFr40 million ($32 million USD). In comparison, a single mobile phone antenna costs about SFr300,000 ($240,000 USD) while a communications satellite starts at SFr600 million ($480 million USD).

5. PhoeniXX low altitude, free-flying platform

The PhoeniXX is a free flying airship that is smaller than the X-Station and is designed for operation at medium altitudes, up to 5,000 meters (16,404 ft) above sea level. PhoeniXX has full autonomous and remote controlled flying capabilities in all weather conditions. It can operate in either a geostationary or a roaming mode. It is designed for low operating and maintenance cost.

The PhoeniXX can be configured for a variety of missions, such as scientific research, mineral exploration, commercial remote sensing, and emergency management applications. It can operate collaboratively with the StratXX small X-Bug lighter-than-air UAVs.

It appears that no PhoeniXX prototype was built and flown.



PhoeniXX working with small X-Bugs. Source: StratXX

6. X-Tower aerostat

X-Tower is a tethered aerostat designed to deliver telecommunications and other services from a low altitude (200 - 2,500 m / 656 – 8,202 ft). X-Tower made its first tethered flight in 2011.

Source: StratXX

The X-Tower product brochure (in German) is available here: http://www.stratxx.com/files/downloads/flyer-x-tower-d.pdf

7. For more information

- Peter Rüegg, “The StratXX Project - Flying mobile phone antenna,” ETHLife International, 6 July 2005: http://archiv.ethlife.ethz.ch/e/articles/sciencelife/stratosphaerenballon.html
- “Mobile phone airship to conquer stratosphere,” SWI swissinfo.ch, 10 July 2010: https://www.swissinfo.ch/eng/business/mobile-phone-airship-to-conquer-stratosphere/5302646
- “StratXX Airship Successfully Broadcasts Digital TV & Radio Over Large Area,” CISION PRWeb, 24 February 2014: https://www.prweb.com/releases/2014/02/prweb11605507.htm
- “Telecommunications provider StratXX in Obwalden is bankrupt” (in German), Bothe, 25 January 2019: https://www.bote.ch/nachrichten/wirtschaft/telekommunikations-anbieterin-stratxx-in-obwalden-ist-konkurs;art66370,1152123

8. Additional X-Station patents

- Patent US 8267348B2, “Unmanned aircraft as a platform for telecommunication or other scientific purposes,” granted 18 September 2012: https://patents.google.com/patent/US8267348B2/en?oq=8267348
- Patent US 2009/0189015A1, “Unmanned Aircraft for Telecommunicative or Scientific Purposes,” published 30 July 2009: https://patents.google.com/patent/US20090189015A1/en?oq=20090189015
- Patent US 2009/0114767A1, “Unmanned Aircraft as a Platform for Telecommunication or Other Scientific Purposes,” published 7 May 2009: https://patents.google.com/patent/US20090114767A1/en?oq=20090114767