Sky Station

Peter Lobner, 3 April 2021

1. Introduction

Sky Station International, Inc. was founded in the mid-1990s in Washington, DC, and lists former US Secretary of State, General Alexander M. Haig Jr., among its founders. The business goal was to develop a fleet of unmanned Sky Station high altitude platforms (HAPs) and deploy them to geo-stationary positions above 250 or more major metropolitan areas worldwide to deliver high capacity wireless broadband internet and 3G cellular services. Multiple Sky Station platforms may be needed over very large population centers, such as Tokyo and London.

The telecommunications system onboard each Sky Station stratospheric platform was designed to deliver high-speed wireless communications (T1/E1) directly to millions of subscribers within its 400 kilometer (249 mile) diameter service area. From its operating altitude of 21 km (70,000 feet), each Sky Station could generate about 700 to 1,000 dynamically steerable spot beams within a single metropolitan area. Sky Station International planned to offer T1/E1 service (2 Mb/s uplink & 10 Mb/s downlink) for as little as $1/ day. Users could access the wireless Internet service with a dedicated broadband user terminal costing less than $100, or by adding a PCMCIA card to their laptops. 3G cellular services could be accessed with a standard 3G cellphone handset.

Remote sensing and monitoring systems also could be installed on the Sky Station HAPs to increase the range and value of services offered to customers.

In connection with their business, Sky Station International filed trademarks in 1997 and 1998 for the following terms: Sky Station, SkyMessage, Sky Chat, Video Messaging, Stratus Communicator, and Corona Ion Engine. Only “Sky Station” was issued, but was subsequently cancelled in 2006.

In November 1997, the International Telecommunication Union (ITU) granted worldwide regulatory approval for the use of stratospheric platforms.

On 23 April 1998, Sky Station International announced their global industrial team for the Sky Station stratospheric project, which included Aerospatiale (France), Alenia Spazio (Italy), Dornier Satellitensysteme GmbH (Germany), Thomson CSF (France), Comsat Labs, United Solar, Stanford Telecom and NASA's Jet Propulsion Laboratories (USA). Lindstrand Balloons Ltd. (UK) was contracted to build the hull. In September 1999, Sky Station International designated Lockheed Martin Global Telecommunications as its system integrator.

On 1 July 1998, the formation of Sky Station Africa was announced. This was the corporate entity intended to provide Sky Station technology and service throughout Africa.

On 31 July 1998, the US Federal Communications Commission (FCC) approved, for the first time ever, the use of stratospheric platforms as telecommunications stations. The ruling stated that stratospheric platforms were expected to be the dominant use of 1000 MHz of spectrum in the range from 47.2 to 48.2 GHz.

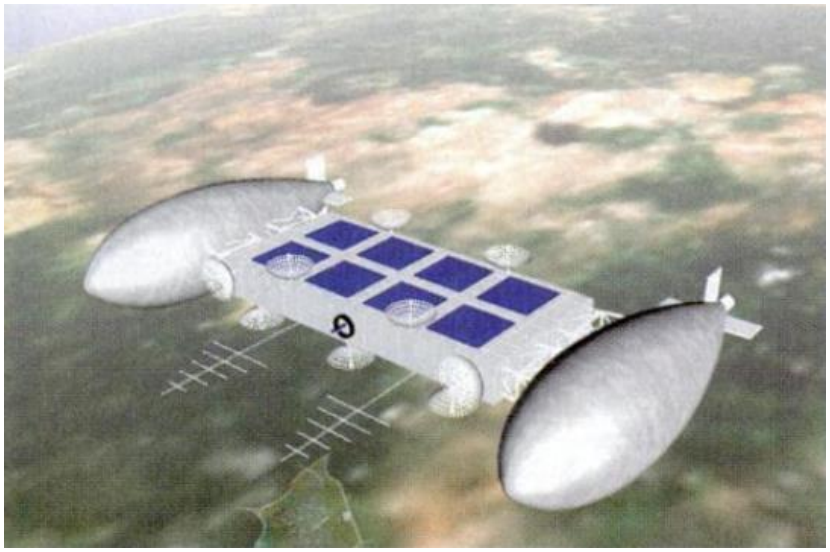
The Platform Conceptual Design Review was completed in June 1999 by Airship Technologies Services, Ltd.

In spite of a very successful startup period from 1997 to 1999, no Sky Station HAP was ever built and the firm failed in the early 2000s.

The Sky Station International website is archived here: http://anciensdefcr.eu/histoire/ASE_web_janv2000/19nov99/d014/www.skystation.com/

2. The Sky Station stratospheric airship

Dr. Alfred Wong's catamaran airship design, originally proposed for Platform Communications Corp., may have been the first Sky Station concept. The platform, shown below, supported the solar array and the antennas for transmission and reception of signals from users on the ground.

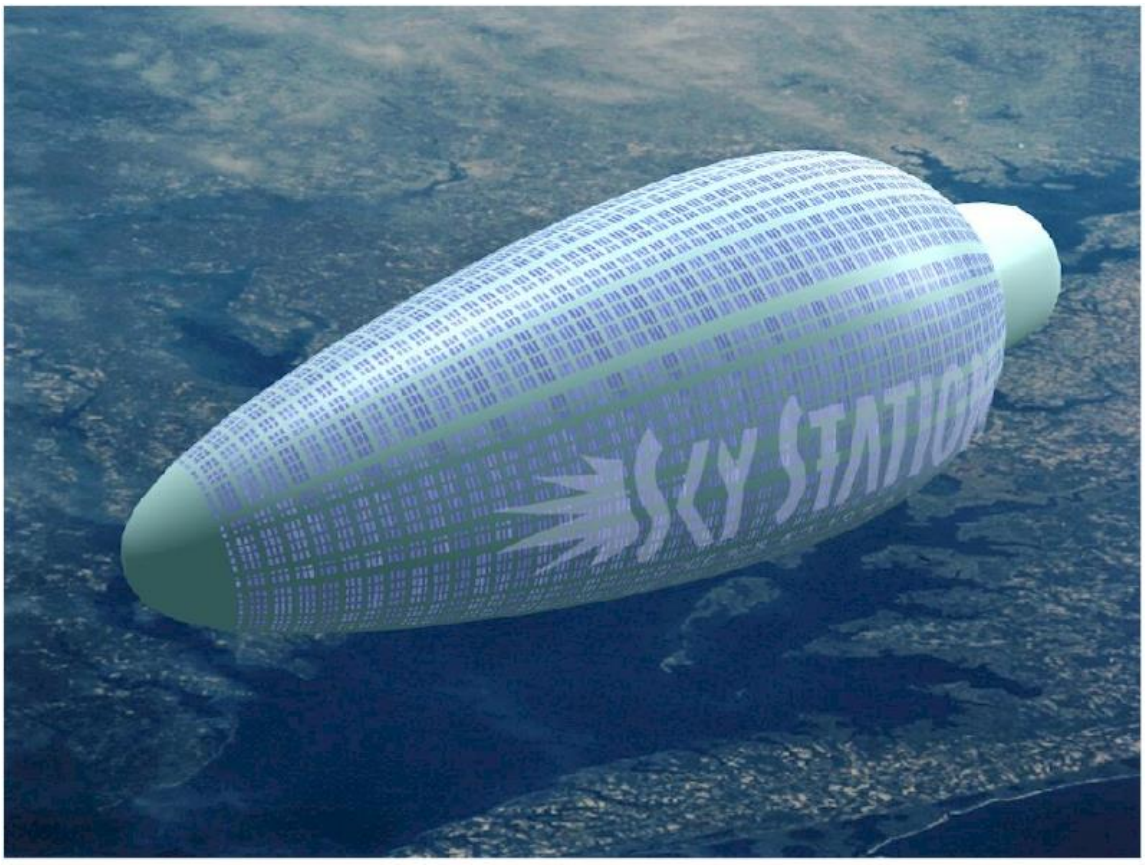


Source: Popular Science, Oct 1996, p. 40

Later Sky Station airship designs had a more compact single hull.

Source: Source: Sky Station International

The final conceptual design (circa mid-1999) had a somewhat unusual ellipsoidal hull that would be built in different sizes and deployed to match the airship's communications capacity with the local market service demand. The Sky Station hull appears to have shared the basic laminar flow shape (without the aerodynamic fins) of the ESA / Lindstrand HALE high altitude airship design.

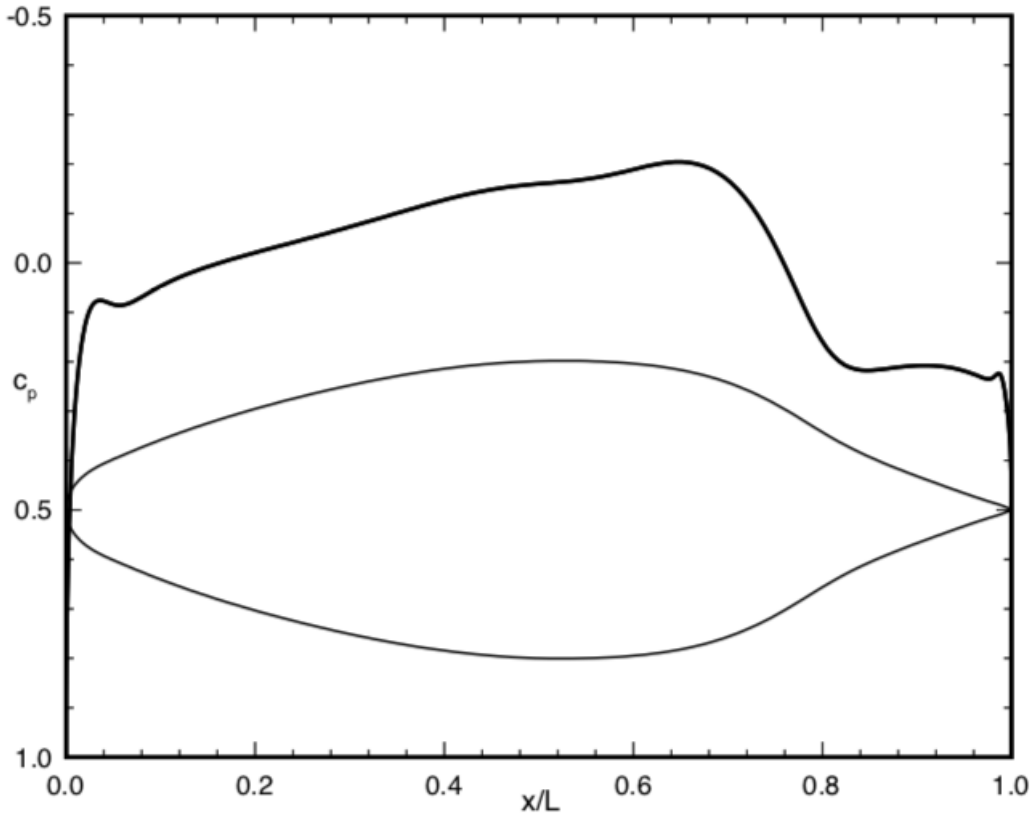


Artist's rendering of the Sky Station platform at high altitude above a metropolitan area. Source: Sky Station International

The unusual profile shape of the SkyStation airship resembles the shape of a hull optimized for laminar flow. An example of such optimization is described by Lutz and Wanger (1997) and is shown in the following figure.

> "This …. body is characterized by its far aft position of the maximum thickness point and by moderate, almost constant acceleration upstream of this point. This slightly favorable pressure gradient is sufficient to keep the boundary layer

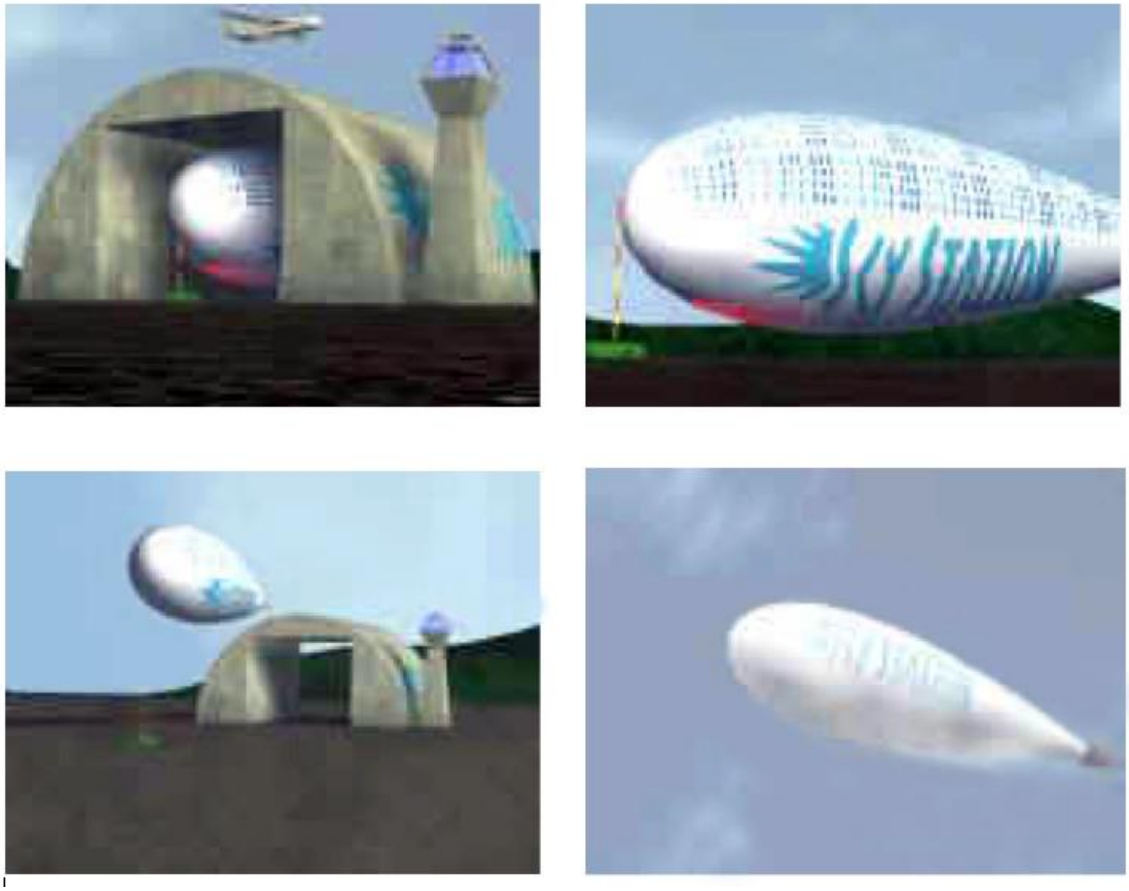
laminar up to 75% of the body length… Enlarging the body diameter is limited by the maximum pressure recovery possible without boundary-layer separation arising in the rear part of the body. “



Source: Lutz and Wanger (Fig. 9, 1997)

General characteristics for a “typical” Sky Station are summarized below:

- Length: 157 m (515 feet)
- Maximum diameter: 62 m (203 feet)
- Mass: 11 tons
- Operating altitude: 21 km (70,000 ft)
- Payload: 1,000 kg (2,200 lb)
- Power: thin film solar array generating up to 157 kilowatts to supply loads & charge batteries for operation at night.
- Propulsion: ion engines for station keeping
- Platform lifetime: 10 years



Animated sequence of a notional Sky Station airship launching from its hanger. Source: Sky Station International

3. Ion propulsion for station keeping

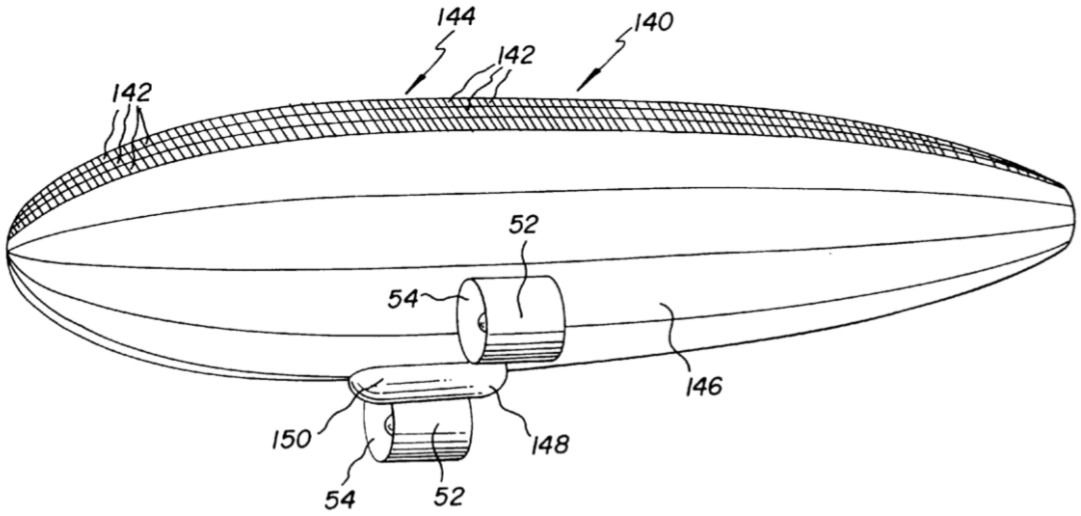
From the beginning, Sky Station was intended to use ion engines for station keeping in the stratosphere. Scientist Alfred Wong, director of the Plasma Physics Laboratory at UCLA, designed the original corona ion engine. Wong, who helped found Sky Station International, left the firm in 1997. The Washington Post reported, "The departure was not amicable: He sued Silansky, Darlington and co-founder Moses Thompson in a Virginia district court, but the case was quietly settled. Sky Station now plans to use engines with propellers powered by solar cells." Wong separately filed for an international patent in 1996 for his corona ion engine, and, in September 1997, was granted patent WO19970344491A, which you can read here:
https://patents.google.com/patent/WO1997034449A1/en

Recognizing that propellers are not efficient at high altitudes, it appears that Sky Station International sponsored a separate patent application in May 1997 by inventor Kenneth Burton, Jr. The resulting patent, US6145298A, “Atmospheric Fueled Ion Engine,” was granted on 14 November 2000 and assigned to Sky Station International. This ion engine design is described as follows:

> “The invention relates to propulsion systems for accelerating charged particles to generate propulsive force particularly adapted for use at high altitudes. More particularly the invention pertains to an ion engine having a cathode ion thruster or emitter for ionizing an ambient atmospheric gas in combination with an electrically insulative housing and a ring-shaped anode in which ions are accelerated and propelled through the ion engine to generate thrust from an ambient atmospheric gas.”
>
> “The novel ion engine ionizes only a portion of the ambient atmospheric gas which ions are accelerated through an electric field from the cathode to the anode at which point ions bombard and collide with the remaining portion of ambient atmospheric gas to create propulsion during the lifetime of the ions existing between the cathode and anode. The cathode is charged to a potential of from about -18 to -110 kilovolts (kV) and possibly less in high altitude applications.”
>
> “The novel ion engine is designed to produce low thrust and operate at low velocities which as used herein means a thrust sufficient to maintain an airship in a geostationary position in the stratosphere.”

The following Figure 19 from the patent shows an example application on a generic stratospheric airship (140), where solar cells (142) charge batteries (150) that power the novel ion engines installed within nacelles (52) with non-conducting inlets (54).

FIG. 19

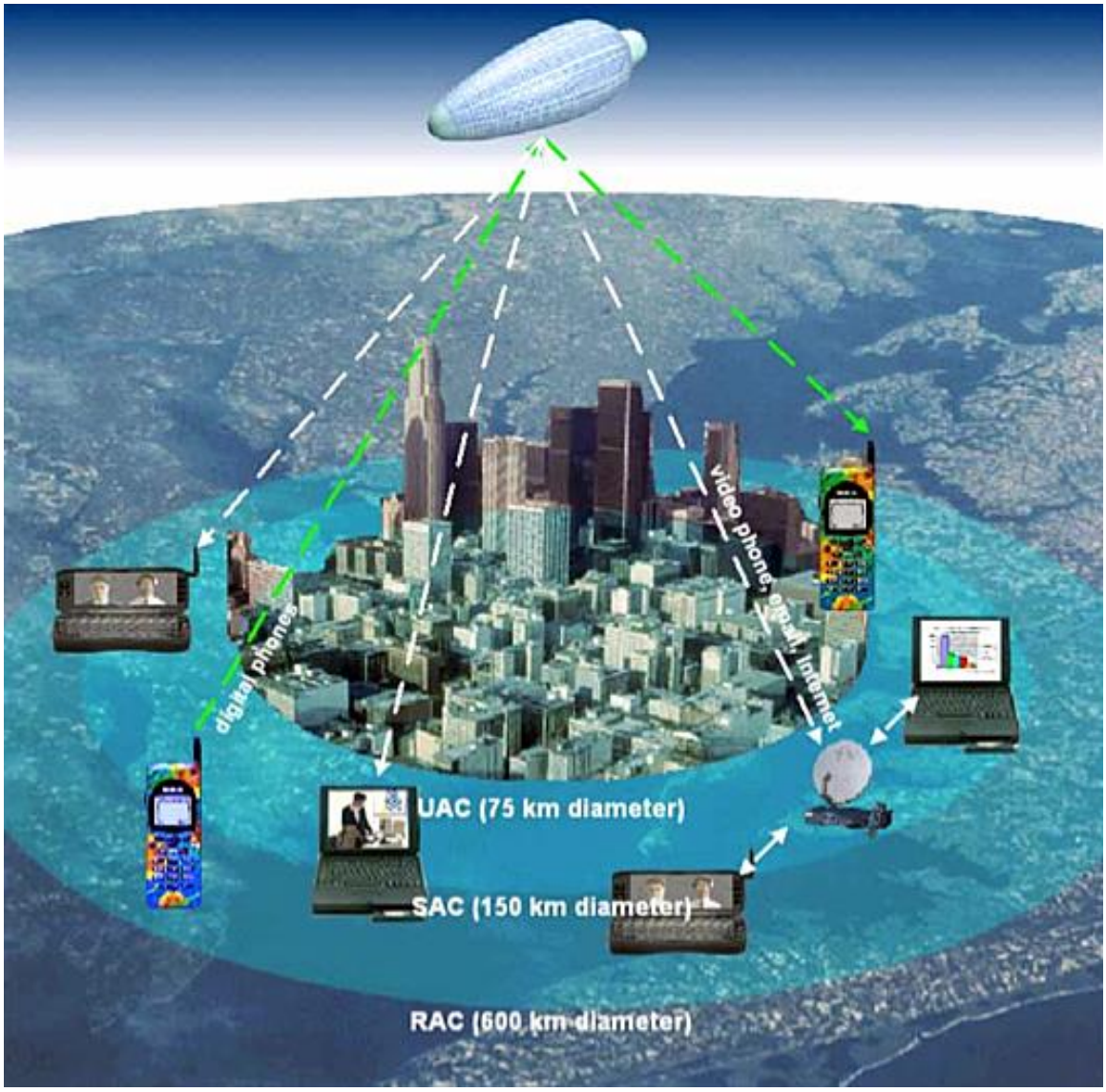


You'll find details on the design and operation of this ion engine in patent US6145298A, which you can read at the following link: https://patents.google.com/patent/US6145298A/en

4. Sky Station's worldwide deployment plan

Sky Station International's business plan was to deploy at least 250 Sky Station platforms at about 21 km (68,898 feet) above every densely populated major city in the world. From this altitude, each Sky Station would have a service area of approximately 19,000 square kilometers (7,500 square miles), giving the company access to a very large base of potential customers.

Each Sky Station platform was equipped with a telecommunications payload providing high speed, high capacity wireless broadband and cellular service. The data rates foreseen for the fixed services were 2 Mbps for the uplink and 10 Mbps for the downlink. The data rates foreseen for the 3G mobile services were 9.6 - 16 kbps for voice and 384 kbps for data. A single Sky Station could deliver 3G cellular service to about three million customers. With dynamically steerable spot beams, capacity can be reallocated during the day to match changing patterns of user demand for service.



Typical Sky Station platform delivering a range of customers services via a variety of devices in three service zones: UAC (urban access area), SAC (suburban access area) and RAC (rural access area). A ground station (not shown) provides the link to the terrestrial Internet. Source: Sky Station International via The University of York

The original plan was for the first Sky Station platform to be deployed in 2000, but that deployment date continued to slip year by year. After the first unit was deployed, Sky Station International planned to launch at least one Sky Station platform per week until service was established in all populous parts of the world. The cost of the entire project for worldwide broadband infrastructure was estimated at $2.5 billion.

While not part of the original deployment plan, individual Sky Station platforms within line-of-sight of each other could be linked (i.e., via laser optical or microwave) later to better integrate service in very large metropolitan areas or to offer broader regional coverage.

The Sky Station platforms were designed for a 10-year operating life. They were designed to fly back to base for maintenance or repair if necessary. A new platform would be deployed in advance to replace the existing one so there would be no interruption of service.

No Sky Station platform was ever built.

5. For more information

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- Jason Goodman, “How does the corona ion engine work? What are the involved principles?” MadSci Network, 11 Aug 1997: http://www.madsci.org/posts/archives/aug97/871360882.Ph.r.html