GNSS / ENSS - StarLight

Peter Lobner, updated 16 June 2023

1. Introduction

StarLight was developed under Naval Air Systems Command's (NAVAIR's) "steerable balloon" program, which intended to develop a powered balloon with a stratospheric station-keeping capability similar to a high altitude airship. The StarLight vehicle was a solar electric hybrid airship / unmanned aerial vehicle (UAV). It was developed under a Navy contract by Global Near Space Services (GNSS) and their subcontractor Bye Aerospace of Denver, CO (https://byeaerospace.com).

Founded in 2006 in Colorado Springs, CO, the privately-held firm Near Space Systems, Inc. (NSS) operated under the "doing business as" (dba) name GNSS between 2006 and 2011. After the NAVAIR StarLight contract ended in 2011, NSS dropped its GNSS dba trade name and then was acquired in 2012 by Enerbay to form Enerbay – Near Space Systems (ENSS), all without ever leaving Colorado Springs. The new firm continued to promote the StarLight vehicle, as well as two other LTA vehicles, StarTower and StarShadow, that had been developed by NSS / GNSS.

Artist's rendition of StarLight on station in the stratosphere. Source: sUAS (2012)

StarLight was a two-component vehicle comprised of a large balloon that provided the lift into the stratosphere, and a detachable fixed-wing, solar powered UAV that carried the flight controls and mission systems. At the end of the mission, the UAV separates from the balloon and semi-autonomously flies to a designated recovery site. This type of UAV generically was called a "payload recovery vehicle" (PRV). The balloon was expendable.

GNSS developed the StarLight stratospheric balloon and subcontracted to Bye Aerospace to design and build the detachable UAV, which they called a "stratospheric recovery vehicle" (SRV).

2. StarLight mission

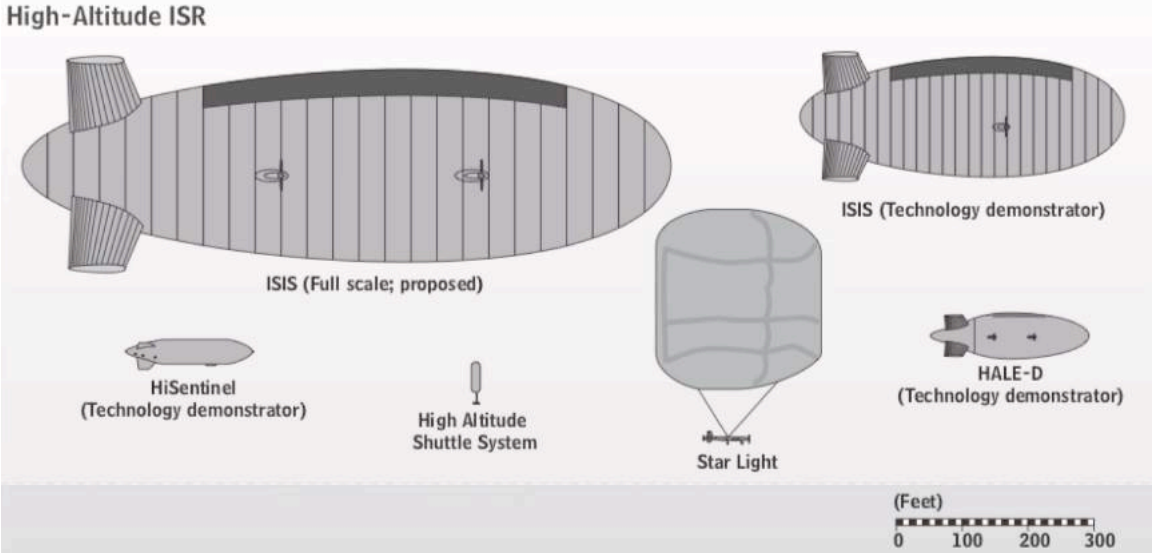
StarLight was funded by DoD as one of three "steerable" stratospheric balloon projects that were conducted during the period from 2002 to 2011. A 2012 DoD report described these programs as follows:

> "The primary objective of these steerable balloon efforts has been to develop a balloon with station-keeping ability that can provide capabilities similar to those desired from conventional high-altitude airships. None of the DoD programs have successfully fielded a steerable balloon under DoD funding."

Two of the contenders, GNSS's Navy-sponsored StarLight and JP Aerospace's Air Force-sponsored Near-Space Maneuvering Vehicle (NSMV / Ascender 175), had propulsion systems intended for station keeping at high altitude above a designated geo-location. Near Space Corporation's (NSC's) Army-sponsored High-Altitude Shuttle System (HASS) had no propulsion system. With a hybrid solar electric power system, StarLight was designed for longer duration missions than the other contenders.

Two of the contenders were two-component systems consisting of a balloon and a suspended, detachable payload recovery vehicle (PRV) containing all airship and mission systems. The PRV was designed to fly back to a designated landing point and be reused on a subsequent mission. The StarLight PRV was powered and had significant range, while the HASS PRV was a glider.

As shown in the following chart, the StarLight balloon was the largest among contemporary high altitude ISR airships (HiSentinel and HALE-D) and the other DoD two-component steerable balloon system (HASS).



Relative scale of StarLight and other U.S. high-altitude ISR airships. Source: Adapted from Congressional Budget Office, Nov. 2011

Candidate military missions for StarLight included intelligence, surveillance and reconnaissance (ISR) and communications. GNSS identified particular military applications such as border patrol, visual and thermal reconnaissance and forward air control. In addition, GNSS identified potential civil applications such as traffic control, pipeline and power line inspection, aerial law enforcement, forest fire detection and aerial photography.

NAVAIR and GNSS expected that flying hour costs of StarLight would be less than one-tenth the cost of current high altitude aircraft and unmanned aerial systems (UAS).

3. StarLight design

Like the HiSentinel stratospheric airships, the StarLight balloon is launched only partially inflated. The StarLight balloon system does not require a hangar and can launch out of an ISO container or from a ship. With a lift gas expansion ratio of more than 15:1 between sea

level and the stratosphere, the balloon assumes its fully-inflated shape as it nears its operating altitude. At that point, the SRV flight controls are active and the solar powered propulsion system on the SRV moves the balloon to a designated geo-location and maintains station keeping there.

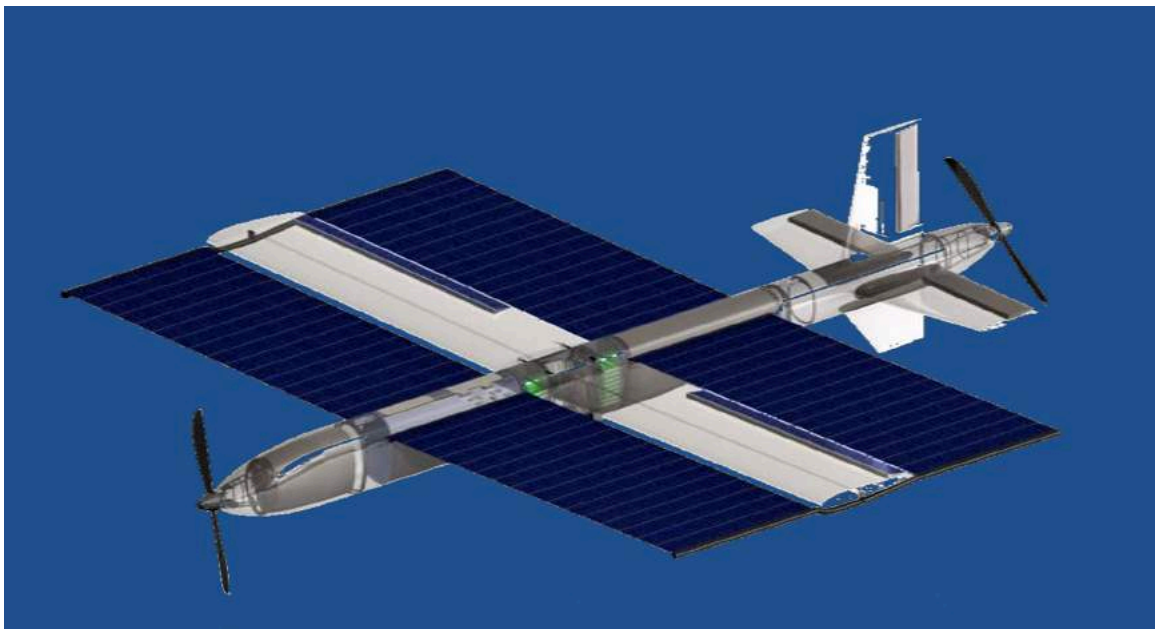
Operating altitude (flight ceiling, or pressure altitude) depends on the total mass of the SRV being carried by the balloon. StarLight altitude objectives were:

- 25.9 km (85,000 feet, 16.1 miles) with a 227 kg (500 lb) operational payload. This is an altitude surpassed only by ultra-high altitude free-floating balloons. At this altitude, StarLight had a line-of-sight radio-frequency (RF) range to the horizon of 574 km (356 miles) and an RF area coverage of slightly more than 1 million square kilometers (almost 400,000 square miles).
- 19.8 km (65,000 feet, 12.5 miles) with a 1,814 kg (4,000 lb) operational payload.

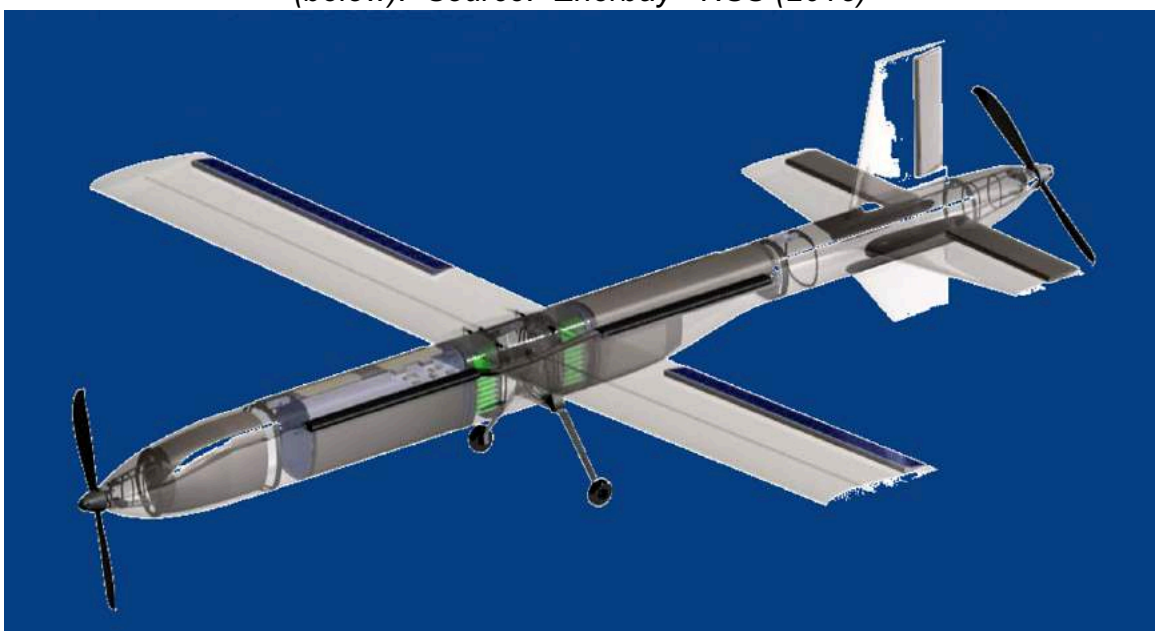
The two-component StarLight system. Source: DoD (2012)

The SRV was designed with lightweight carbon composite structures, straight wings with deployable, flexible thin film photovoltaic arrays, and electric propulsion motors at the nose and tail of the fuselage.

StarLight was designed to stay on station for 3 to 4 months. At the end of the mission, the SRV separates from the balloon and flies under its own power with a range of more than 241 km (150 miles), navigating semi-autonomously to a designated recovery site on the ground. After recovery, the SRV can be maintained and equipped for its next mission with a new balloon.



General arrangement of the StarLight SRV (the Fly-Down Lower Stage) with its solar panels deployed on station (above) and retracted during the fly-down (below). Source: Enerbay - NSS (2015)



4. The subscale demonstrator

DoD reported, “GNSS received funding from the Navy’s Naval Air Warfare Center under the Long Endurance, Alternative Energy Stratospheric Airship Program to design and engineer a 40% sub-scale version of the system…”

Rear quarter view of the partially complete fuselage for the 40%-scale SRV demonstrator. Source: UAS Vision

Front quarter view & nose propeller. Source: ENSS

Battery packs in the partially complete fuselage for the 40%-scale SRV demonstrator. Source: ENSS

Flight demonstrations were planned with the objective of reaching an altitude of 19.8 km (65,000 feet, 12.5 miles) carrying the sub-scale SRV with a small payload. The sub-scale demonstrator was expected to validate the efficiency of the solar electric power system, vehicle performance and control at high altitude.

5. The end of NAVAIR's StarLight funding

NAVSTAR's StarLight contract with GNSS ended in October 2011 without a complete technology demonstrator being delivered. Project status at that time was:

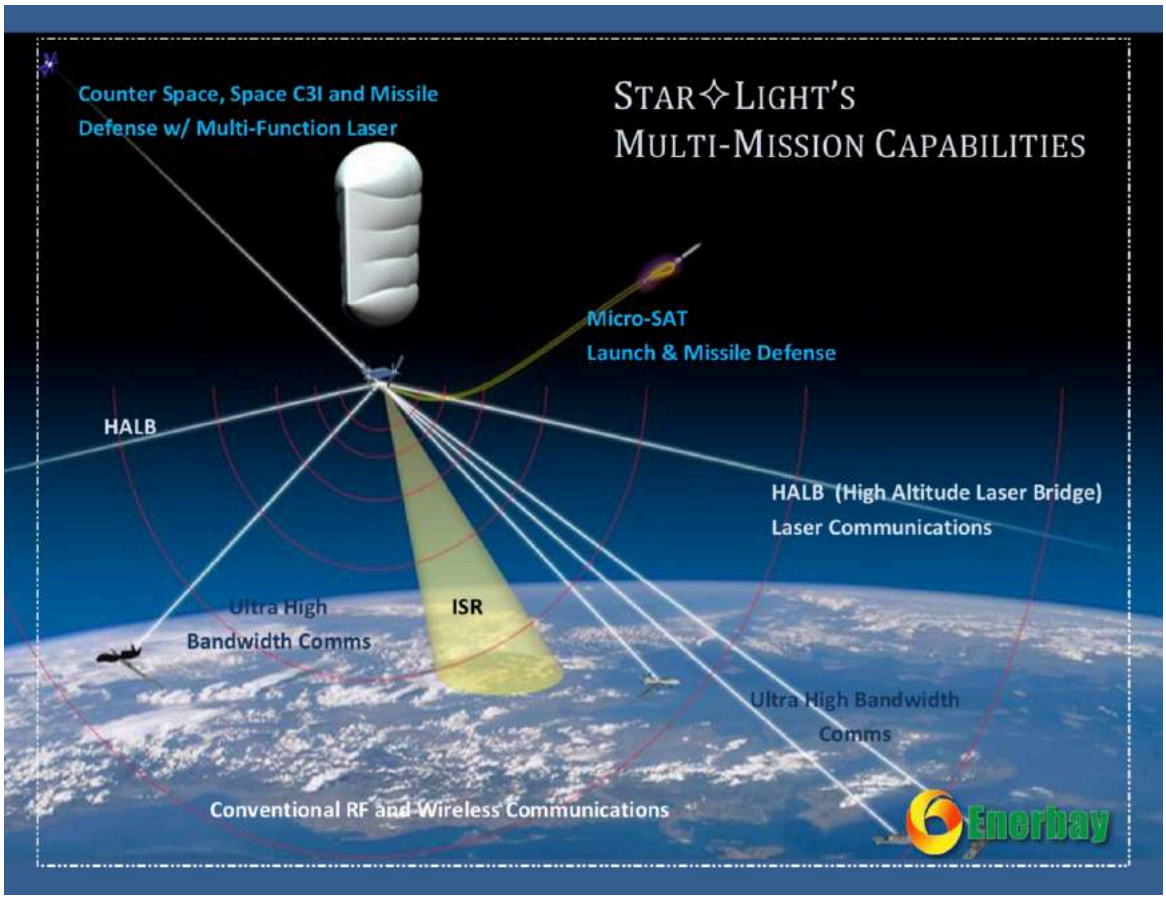
- The balloon envelope had completed its preliminary design review.
- The SRV completed critical design review, subsystems were assembled and tested, and the fuselage was largely complete. DoD estimated that overall SRV manufacturing was about 50% complete.

6. StarLight continues as part of the ENSS product line

After the NAVAIR StarLight contract ended, GNSS was acquired in 2012 by Enerbay to form Enerbay – Near Space Systems (ENSS). The new firm continued to promote StarLight and the other two platforms in in the former GNSS "Star" portfolio of "affordable, persistent, wide-area communications and sensing" LTA vehicles:

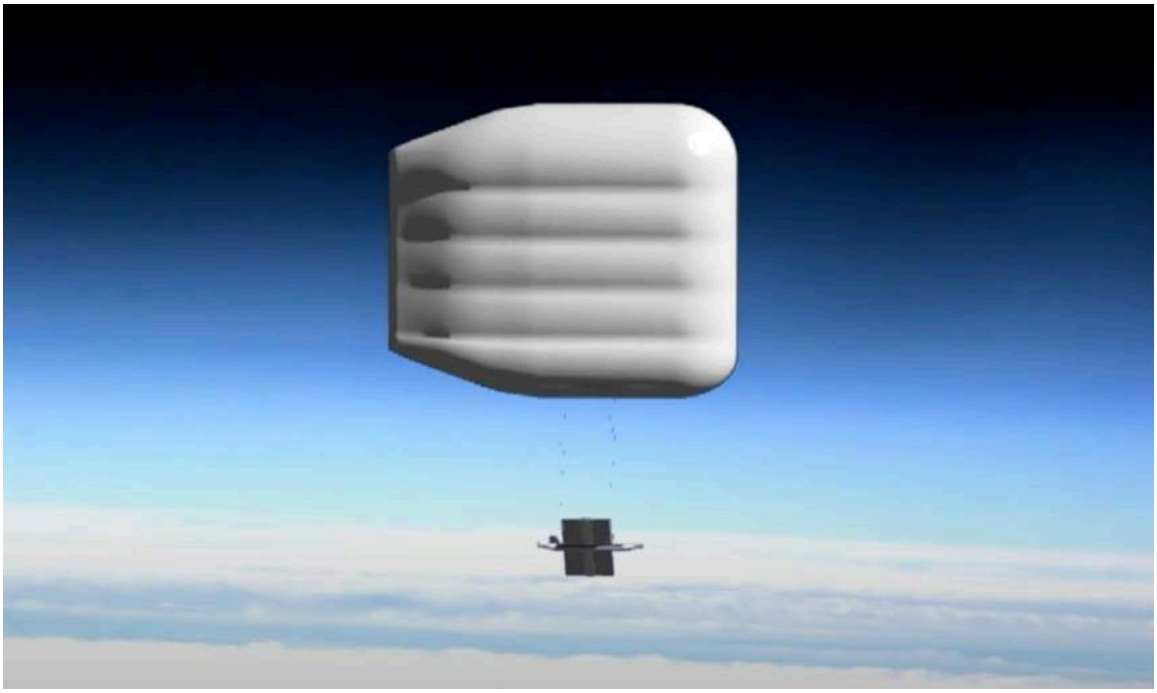
- StarTower wing-shaped, tethered aerostats
- StarShadow free flying, hybrid, optionally manned airships

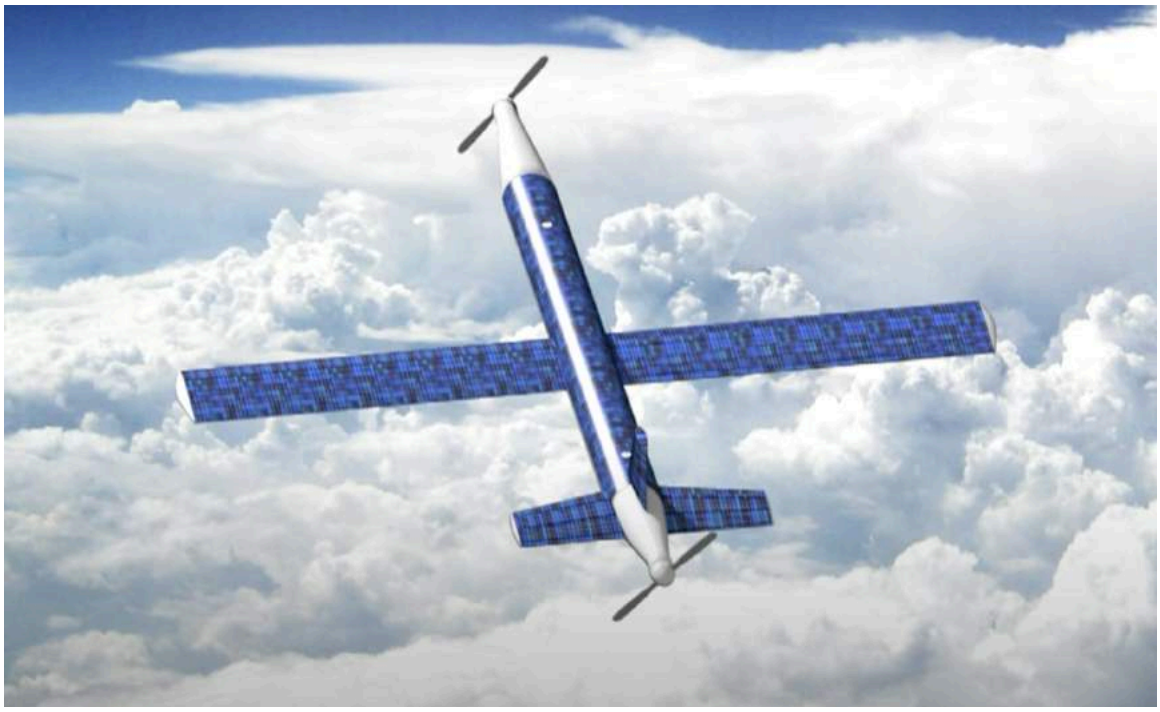
ENSS's view of StarLight's mission capabilities is depicted in the following graphic.



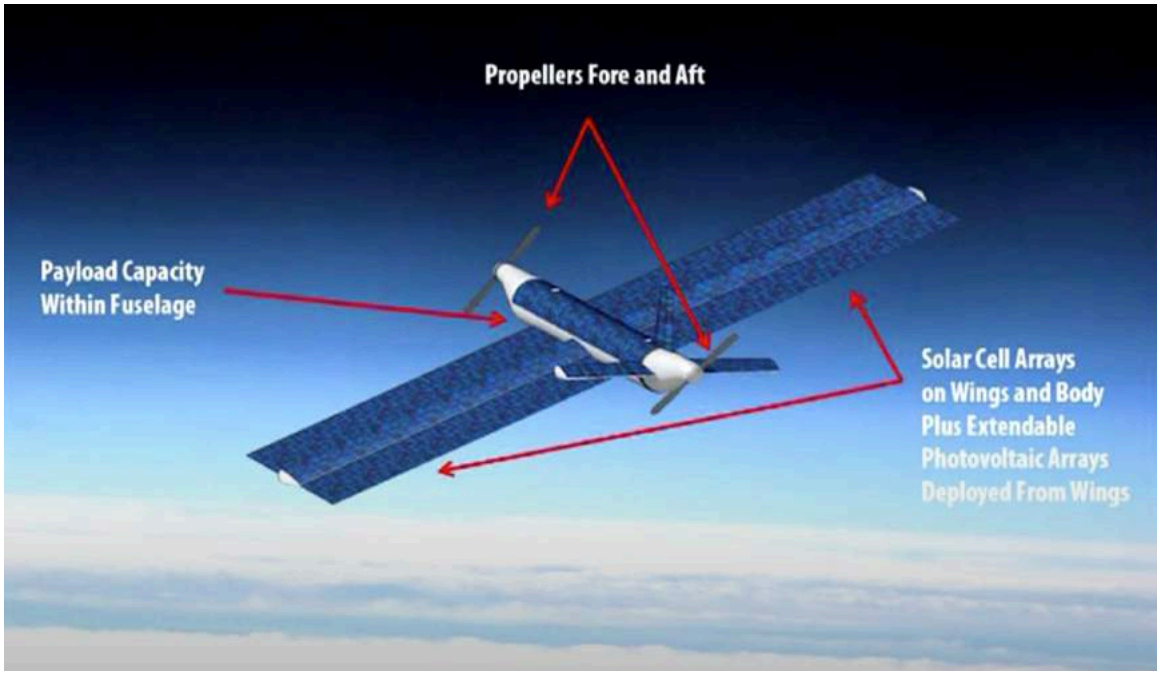
StarLight multi-mission capabilities. Source: ENSS, circa 2015

Artist's renditions of StarLight on station in the stratosphere.
Source: ENSS, circa 2015





StarLight SRV with extendable wing solar panels stowed (during ascent & fly-down).



StarLight SRV with extendable wing solar panels deployed on station.
Source, both graphics: ENSS, circa 2015

ENSS never completed the StarLight demonstrator or built a full-size stratospheric airship.

Details on the StarTower and StarShadow LTA vehicles are provided in a separate article.

7. For more information

- John Keller, “Navy asks Near Space Systems to design a stratospheric airship as an alternative to satellite-based surveillance and communications,” Military & Aerospace Electronics, 27 May 2010: https://www.militaryaerospace.com/defense-executive/article/16724445/navy-asks-near-space-systems-to-design-a-stratospheric-airship-as-an-alternative-to-satellitebased-surveillance-and-communications
- “Recent Development Efforts for Military Airships,” Congressional Budget Office, November 2011: https://www.cbo.gov/sites/default/files/112th-congress-2011-2012/reports/11-01-Airships.pdf
- “Solar Electric Hybrid Airship UAV Development Advances,” The Lighter Than Air Society, 3 March 2012: https://www.blimpinfo.com/uncategorized/solar-electric-hybrid-airship-uav-development-advances/
- “Solar Electric Hybrid Airship,” UAS Vision: https://www.uasvision.com/2012/03/08/solar-electric-hybrid-airship/
- Report to Congress, “Summary Report on DoD Funded Lighter-Than-Air Vehicles,” DoD Office of the Assistant Secretary of Defense for Research and Engineering, Appendix A-4, 1 November 2012: https://apps.dtic.mil/dtic/tr/fulltext/u2/a568211.pdf
- “Enerbay – Near Space Systems (ENSS) – Providing Affordable, Persistent, Wide-Area Communications and Sensing,” marketing presentation circa 2015: http://www.enerbay.ca/wp-content/uploads/2015/09/Near-Earth-Systems.pdf

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