GNSS / NSS / ENSS – StarTower & StarShadow

Peter Lobner, updated 16 June 2023

1. Introduction

The privately-held firm Near Space Systems, Inc. (NSS) was founded in 2006 in Colorado Springs, CO, and operated under the "doing business as" (dba) name of Global Near Space Services (GNSS) while pursuing development of the following three lighter-than-air (LTA) systems:

- **StarTower**: a family of wing-shaped, tethered aerostats
- **StarShadow**: a free-flying, hybrid, optionally manned airship designed to operate at medium altitudes
- **StarLight**: a free-flying stratospheric platform designed to maintain a geo-stationary position at very high altitudes

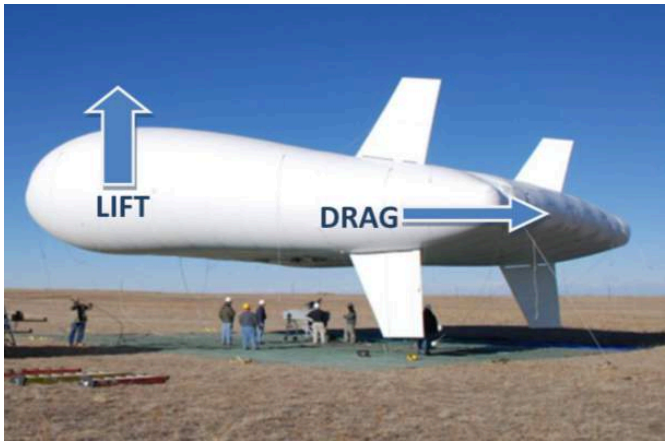
After their Naval Air Systems Command (NAVAIR) StarLight contract ended in 2011, NSS dropped the GNSS dba trade name and then was acquired in 2012 by Enerbay to form Enerbay – Near Space Systems (ENSS), all without ever leaving Colorado Springs. The new firm continued to offer the three platforms in its predecessor's "Star" portfolio of "affordable, persistent, wide-area communications and sensing" LTA vehicles.

This article addresses the StarTower & StarShadow LTA vehicles. StarLight is addressed in a separate article.

StarTower (left) & StarShadow (right). Source: GNSS & ENSS

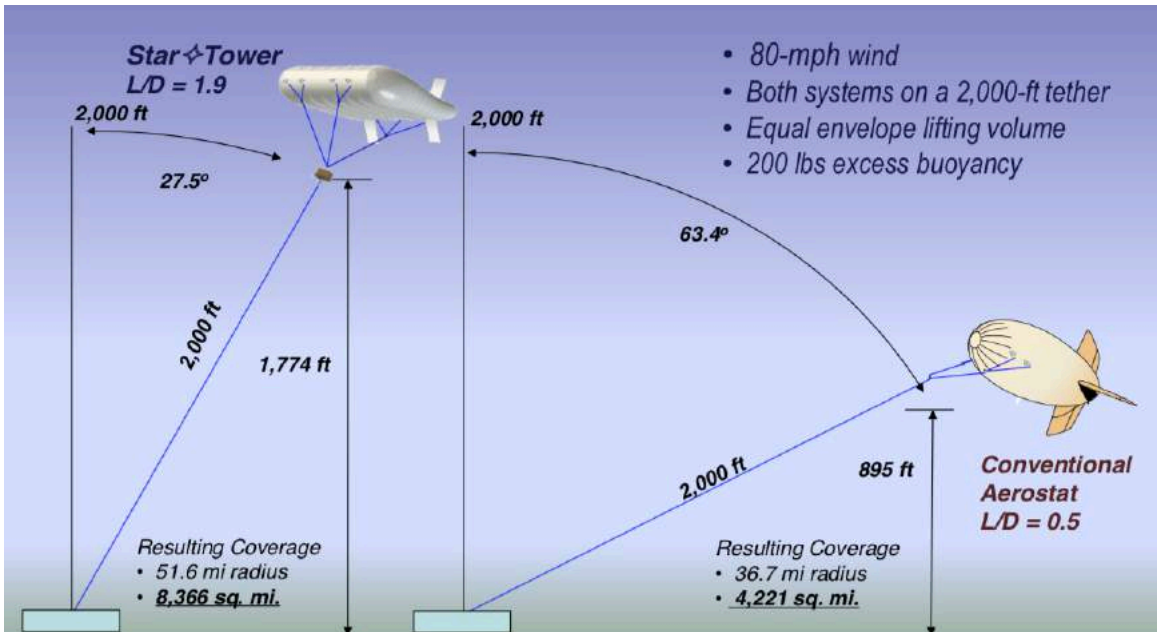
2. StarTower tethered aerostat system

StarTower is a self-contained, scalable, highly transportable, wide-area communications and surveillance system. The StarTower aerostat is a unique, scalable, wing-shaped, tethered aerostat with a 2:1 lift-to-drag (L/D) ratio. In comparison, conventional teardrop / blimp-shaped aerostats typically have L/D ratios closer to 0.5:1 (generating 2x more drag than lift). The streamlined StarTower aerostat is designed for operation in winds up to 70-knots.



StarTower aerostat generates 2X more lift than drag. Source: ENSS

With its high-lift / low-drag airfoil-shaped envelope, the StarTower aerostat is less susceptible than conventional teardrop / blimp-shaped aerostats to "blow-down" of the envelope, which reduces flight altitude and sensor coverage in all wind conditions.



Estimate of the effects of a high wind "blowdown" on StarTower & a comparable conventional aerostat. Source, both graphics: NSS

Coupled with “smart winch” and “active angle of attack” (AoA) control features, a StarTower aerostat is expected to have a lower risk of breakaway (i.e., from downdrafts and slack tethers) and loss than conventional aerostats.

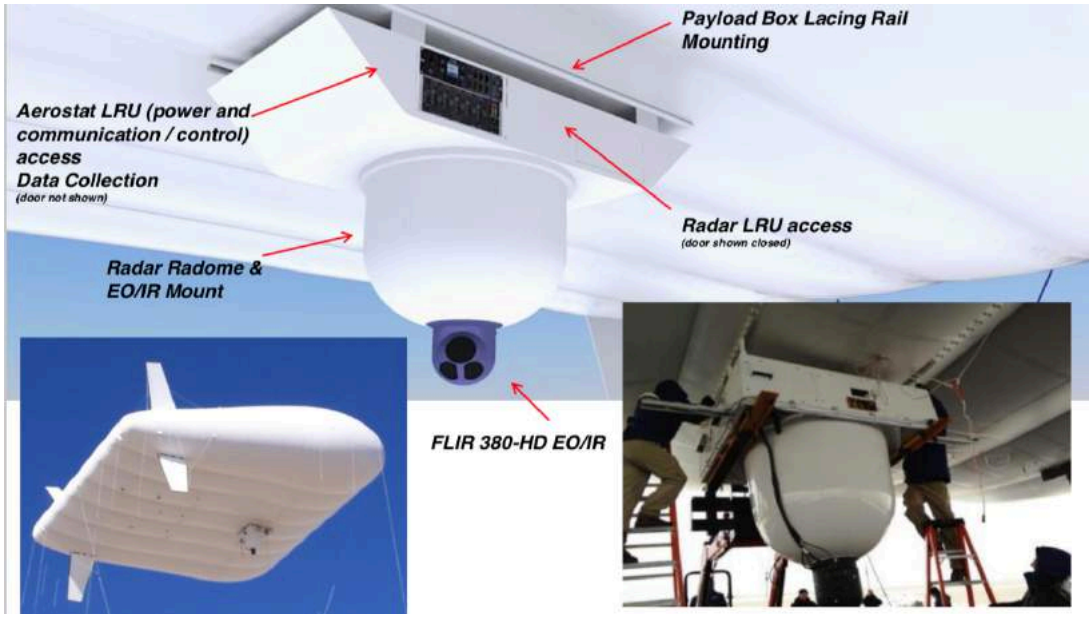
StarTower launch from a mooring trailer. Source: GNSS

General characteristics of StarTower tethered aerostat systems

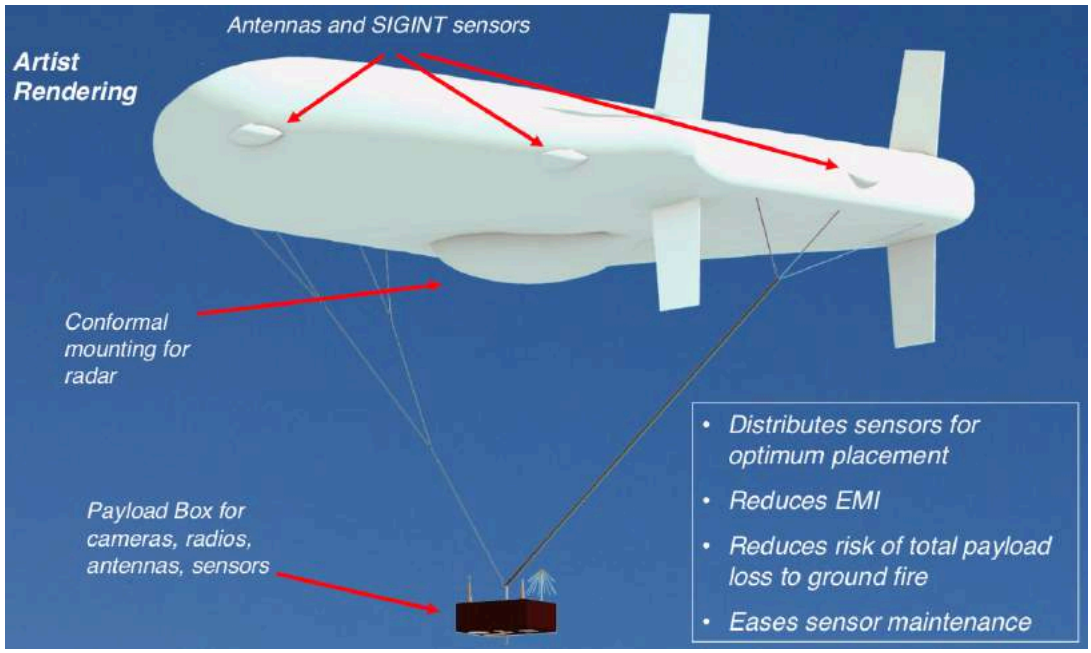
Parameter	StarTower 100-12	StarTower 100-25	StarTower 200-40 *	StarTower 200-57	StarTower 500-91	StarTower 500-116
Length	13.1 m (43 ft)	16.5 m (54 ft)	19.2 m (63 ft)	21.6 m (71 ft)	25.3 m (84 ft)	27.4 m (90 ft)
Width, max			17.2 m (56 ft)			
Height, overall			5.8 m (19 ft)			
Envelope volume	360.6 m^3 (12,734 ft^3)	713.6 m^3 (25,201 ft^3)	1,133 m^3 (40,000 ft^3) with 7 longitudinal gas cells and rigid (non-inflated) tail fins	1,622.5 m^3 (57,298 ft^3)	2,593.0 m^3 (91,571 ft^3)	3,306 m^3 (116,750 ft^3)
Ballonet			Located in 3 central cells			
Lifting gas	Helium	Helium	Helium	Helium	Helium	Helium
Excess buoyancy at operating altitude	68.0 kg (150 lb)	108.2 kg (238.5 lb)	145.1 kg (320 lb), about 15% of vehicle mass	181.4 kg (400 lb)	294.8 kg (650 lb)	417.3 kg (920 lb)
Altitude, operating, AGL	305 m (1,000 ft)	610 m (2,000 ft)	610 m (2,000 ft)	914 m (3,000 ft)	1,219 m (4,000 ft)	1,676 m (5,500 ft)
Payload	27.2 kg (60 lb)	45.4 kg (100 lb)	• Up to 102 kg (225 lb) • Multiple payload modules can be distributed around the hull and/or carries as a sling load	113.4 kg (250 lb)	226.8 kg (500 lb)	226.8 kg (500 lb)
Payload power			Up to 3 kW, delivered via tether			
Tether			686 m (2,250 ft) of powered tether with three single-mode fiber optic cables for data			
Base (launch point) elevation, max			1,676 m (5,500 ft) above mean sea level (AMSL) / 2,591 m (8,500 ft) density altitude			
Wind speed limits			• 25 knots – max for launch/recovery • 70 knots – max for operation • 90 knots – survival wind limit			
Ground crew – launch & recovery	2	4	4	5	7	7
Ground crew - ops	2	2	2	2	3	3
Setup time			3 hours, ready for inflation			

* Data from StarTower 200-40 spec. sheet via Desert Wolf. Data in other columns from GNSS StarTower presentation, circa 2010.

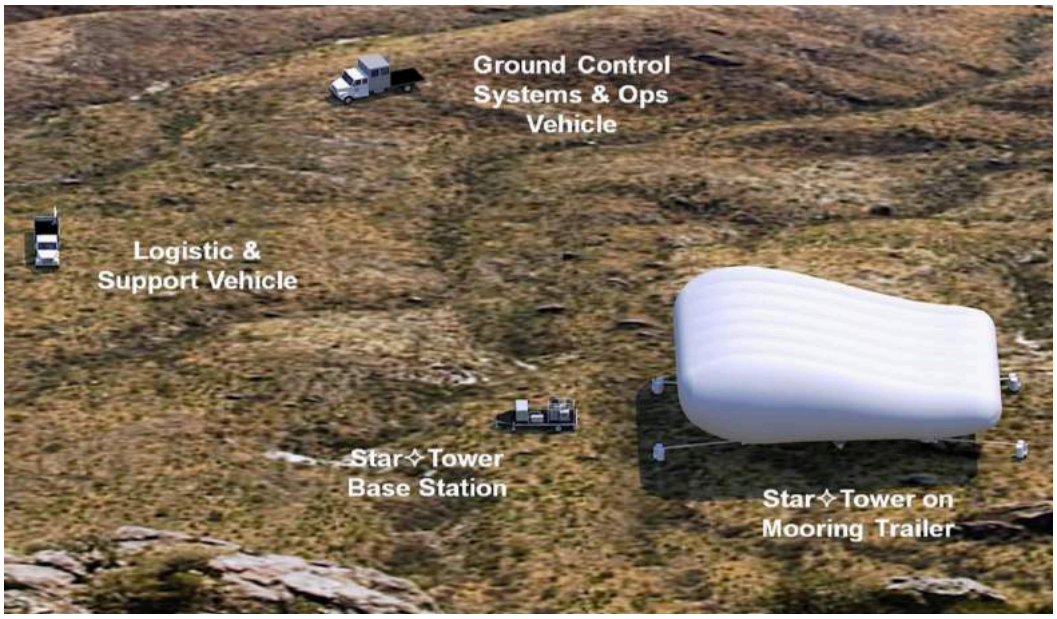
In 2015, ENSS reported that the upper limits for the largest of its StarTower family of tethered aerostat were: altitudes up to 3,048 m (10,000 ft) AGL, payloads up to 500 kg (1,102 lb), payload power up to 10 kW, and operating in wind speeds up to 70 knots.



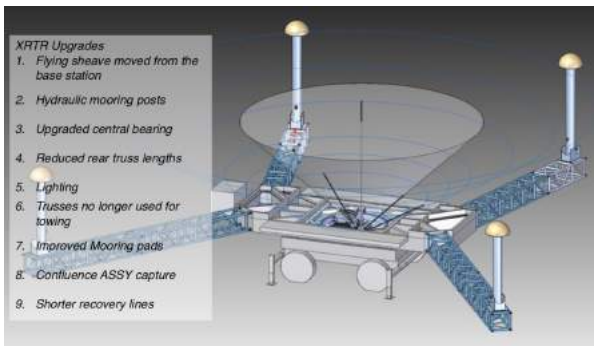
StarTower carrying a unitary payload module (an EO/IR turret and radar) mounted under the envelope.



Rendering showing StarTower carrying distributed payload modules installed on the envelope (SIGINT sensors & radar) and other payload modules carried on a sling load. Source, both graphics: NSS



General arrangement of a SkyTower operating base. The winch is on the Base Station (center). The system can be operated locally (at the Base Station) or remotely (from the Ground Control Systems & Ops Vehicle).

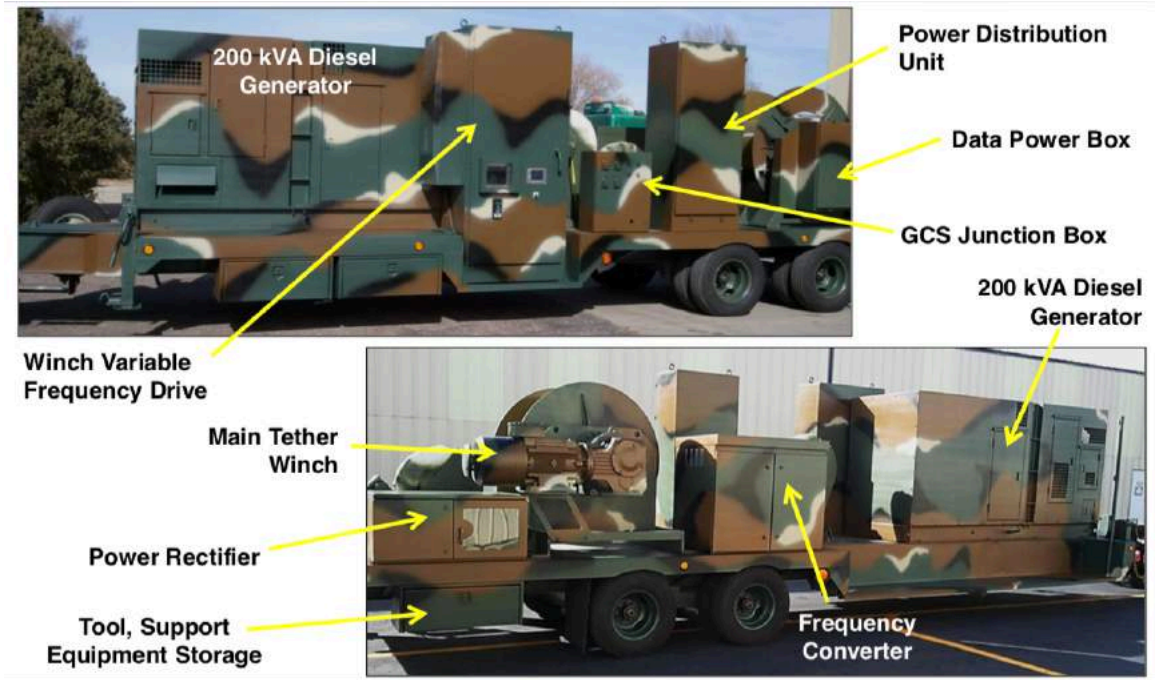


(Above) SkyTower aerostat on its mooring trailer, sitting on four mooring columns & pads.

(Left) X-Rotator mooring trailer details, showing deployed mooring columns & pads.

Source, three graphics: NSS

StarTower ST 500 Base Station



Major components of the StarTower ST 500 Base Station.
Source, both graphics: NSS

South Korea announced plans in 2013 to fill a surveillance gap by deploying a StarTower 500 aerostat system equipped with cameras and radar above several islands off the western coast, just south of the disputed maritime border between South and North Korea. There have been no reports of actual deployment.

In 2014, the firm Deep Down Inc. (now known as Koil Energy Solutions, Inc.), a specialist in deep water oil and gas production and distribution equipment and services, proposed a seaborne version of the StarTower tethered aerostat operating from a small utility vessel for applications such as border patrol, spill monitoring and surveying. StarTower was expected to be a more cost effective solution for these sea-based applications than helicopters and fixed-wing aircraft.

Concept for StarTower tethered aerostat deployment from a small utility vessel. Source: Screenshot from Deep Down Inc, video (2014)

Also in 2014, ENSS proposed the StarTower 500 aerostat system for Turkish national security applications, including a notional deployment of nine systems for border security. Turkey did not place an order for StarTower.

Source: ENSS

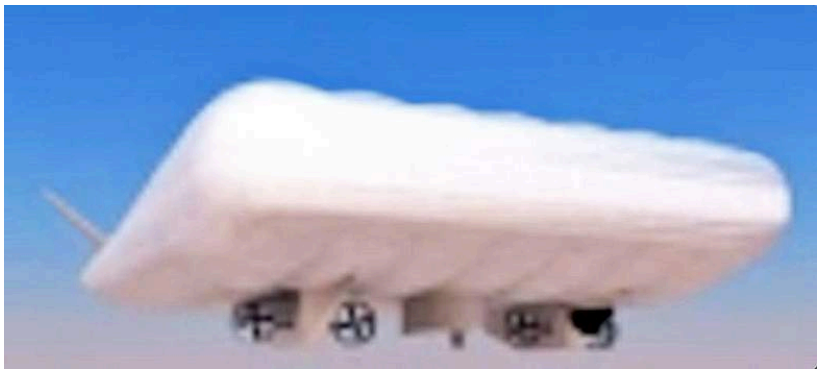
3. StarShadow hybrid, medium altitude airship

The StarShadow is as an optionally manned, hybrid, solar powered, advanced, medium altitude airship. Its aerodynamic hull shape is based on the StarTower's high-performance, airfoil-shaped gas envelope, and has a similar lift-to-drag ratio of about L/D = 2. The StarShadow hybrid airship is larger than the largest SkyTower aerostat. With large flight control surfaces and vectorable thrusters, the StarShadow is designed to be very maneuverable. StarShadow was funded by private capital and was developed as a scalable, configurable surveillance and communications platform intended for the following types of applications:

- Advanced LTE broadband aerial networks
- Wide area surveillance and communications relay
- Border, port and coastal security
- Protection of critical infrastructure
- Support of military and police actions
- Remote sensing and resource mapping

On surveillance and communications missions, the StarShadow's radio frequency (RF) coverage range depends on its operating altitude. At 4,572 m (15,000 ft) altitude, StarShadow's sensor coverage range is 110 km (70 miles).

StarShadow is designed to fly its missions autonomously, including a short takeoff and landing (STOL). StarShadow does not take off and land vertically. A command and control uplink enables the users to update the autonomous flight plan, which can be based on GPS waypoints. Alternatively, StarShadow can be flown remote-manually or by an on-board pilot.



An early version of the SkyShadow, circa 2010. Source: GNSS

StarShadow has a modular, open architecture payload system to accommodate a wide range of sensors. The payload is housed in two widely-spaced gondola pods and in belly-mounted racks, which provide easy access in the field for maintaining or changing sensors or other equipment when needed.

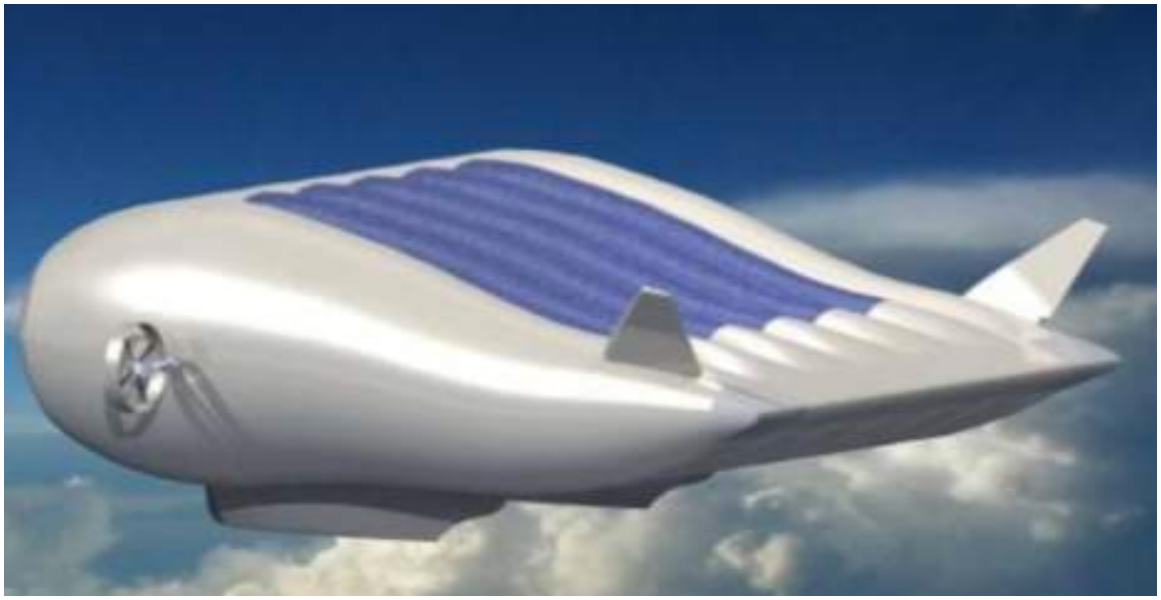
Turnaround time after a mission is expected to be about 90 minutes, based on refueling the auxiliary power unit (APU), topping off the lifting gas if needed and performing any scheduled airship or payload maintenance. Onboard self-diagnostic systems report any detected issues in real time, via the command and control data link.

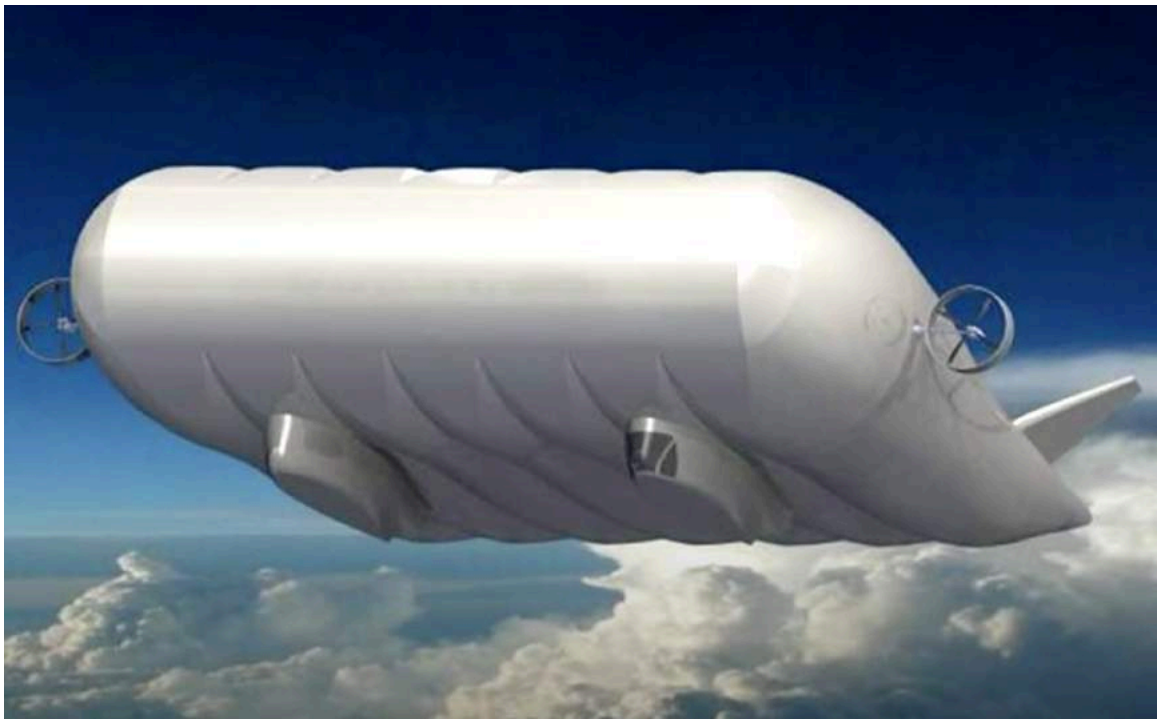
General Characteristics of the StarShadow hybrid airship

Parameter	StarShadow
Airship type	Hybrid, semi-rigid, heavier-than-air
Lifting gas	Helium or hydrogen
Propulsion system	2 x flank-mounted, electrically powered, variable pitch, thrust vectoring ducted propellers.
Electric power system	Hybrid solar electric with battery for night operations, augmented by a hydrocarbon-fueled auxiliary power unit (APU).
Flight controls	• Electro-mechanical elevon on the “beaver-tail” trailing edge • Twin rudders • Multi-chamber ballonet controls center of gravity
Accommodations	1 x optional pilot
Payload	Up to 500 kg (1,102 lb)
Payload power	Up to 8 kW
STOL takeoff run	About 30.5 m (100 ft)
Rate of climb	3.6 m/s (700 fpm) thru 3,048 m (10,000 m) MSL
Speed, cruise	42 knots (48.3 mph, 77.8 kph)
Speed, maximum	60 knots (69 mph, 111 kph)
Altitude, operating	1,524 to 4,572 m (5,000 to 15,000 ft) MSL
Altitude, maximum	6,096 m (20,000 ft) MSL
Mission endurance	Up to 3 weeks

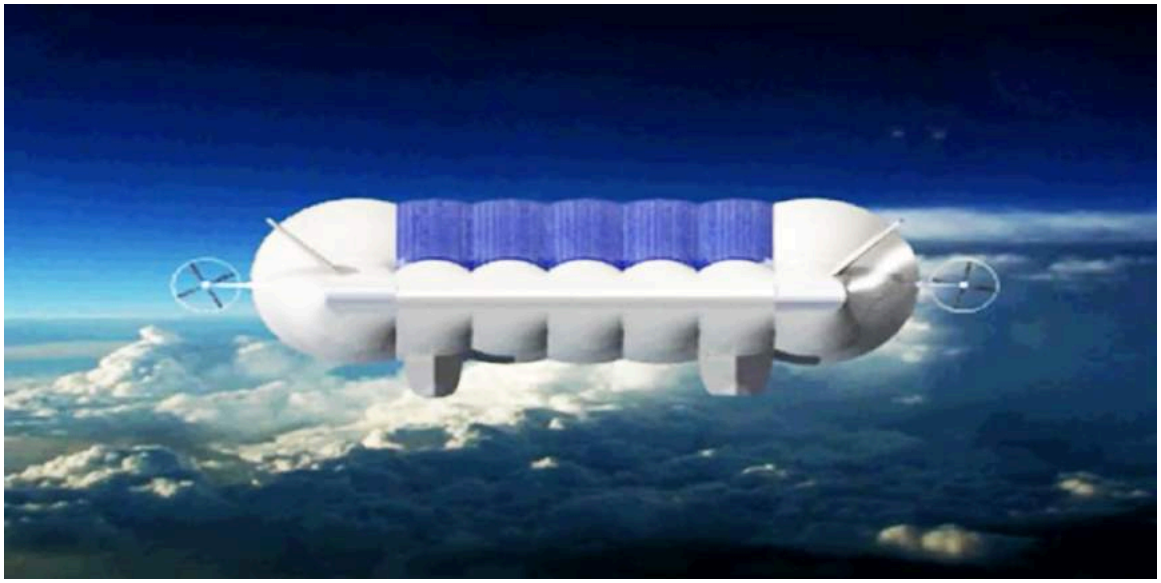
GNSS / NSS / ENSS originally planned to deliver the StarShadow in 2015. However, no StarShadow airship was ever built.

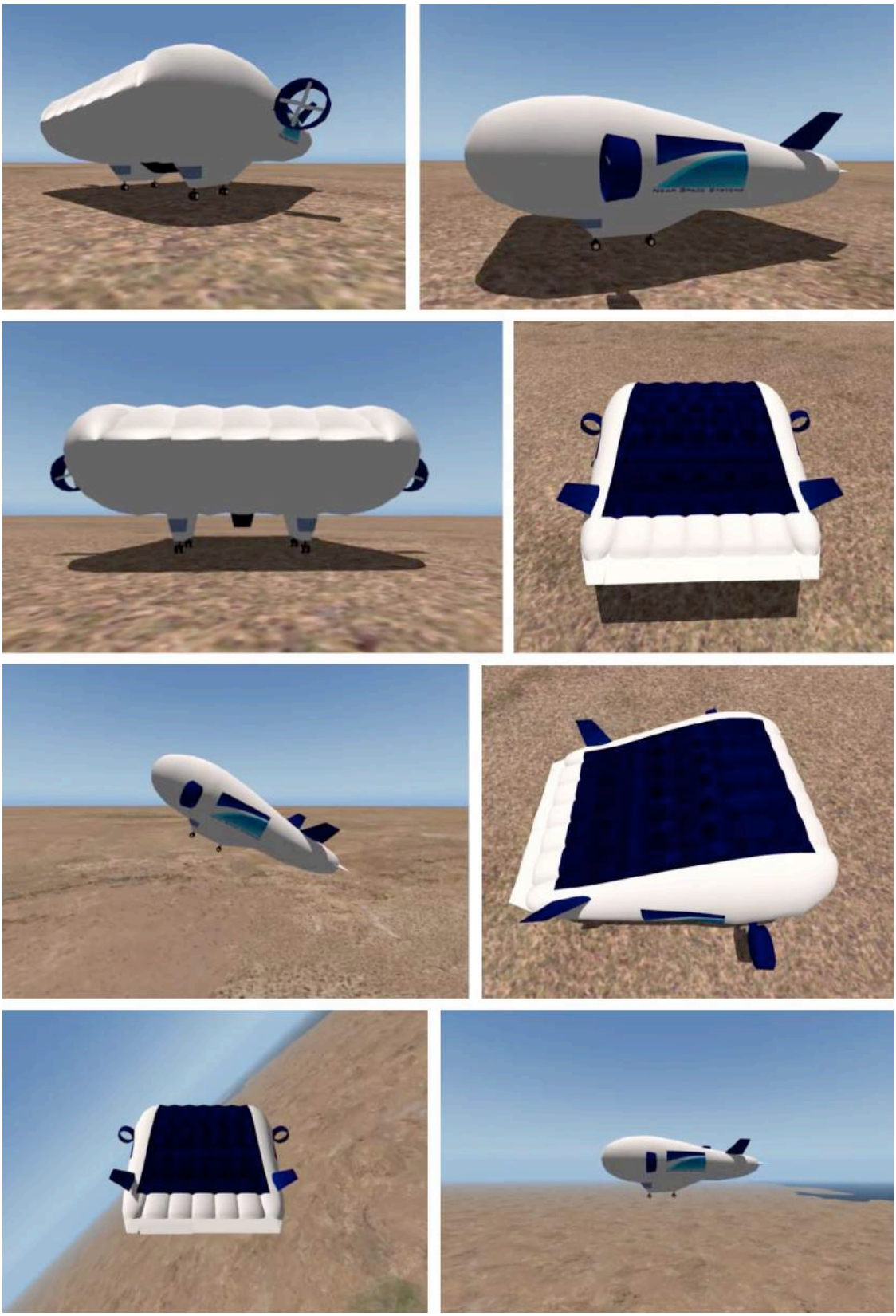
Renderings of the StarShadow hybrid airship inflight. Note the two widely spaced gondolas (above), the flexible, thin-film photovoltaic array on the top of the hull (below), and the flank-mounted, thrust vectoring, ducted fan main propulsors. Source, both graphics: ENSS





Renderings of the StarShadow hybrid airship inflight.
Note the pilot-optional cockpit in the port gondola (above).
Also note the seven lobes in the broad lifting body envelope (below) and the flexible, thin-film photovoltaic array on the five central lobes.
Source, both graphics: Screenshots from GNSS 2010 video.





StarShadow animated montage. Source: Screenshots, NSS video (2013)

4. For additional information

- "Enerbay – Near Space Systems (ENSS) – Providing Affordable, Persistent, Wide-Area Communications and Sensing," Corporate presentation, circa 2015: http://www.enerbay.ca/wp-content/uploads/2015/09/Near-Earth-Systems.pdf

StarTower

- "StarTower," GNSS presentation, circa 2010: StarTower-Intro.pdf
- A. Kanoria & R. Pant, "Winged Aerostat Systems for Better Station Keeping for Aerial Surveillance," Conference paper, IEEE International Conference for Mechanical and Aerospace Engineering, New Delhi, India, March 2011: https://www.researchgate.net/publication/257307312_Winged_Aerostat_Systems_for_Better_Station_Keeping_for_Aerial_Surveillance
- "Aerostat: Global Near Space Aerostat Systems - STAR TOWER 200-40 - the next generation aerostat system," NSS via Desert Wolf: https://www.desert-wolf.com/dw/products/unmanned-aerial-systems/aerostat-global-near-space-aerostat-systems.html
- "Tethered Aerostat Systems Application Note," U.S. Department of Homeland Security (DHS), September 2013: https://www.dhs.gov/sites/default/files/publications/TetheredAerostat_AppN_0913-508.pdf
- "Star Tower Marketing Information," ENSS, October 2013: https://www.desert-wolf.com/dw/item/download/17_2fc0084a9a71c40538d32f987a5bfb78.html
- Jon Rabiroff & Yoo Kyong Chang, "$22 million blimp to fill gap in surveillance of North Korea," The Lighter-Than-Air Society, 9 October 2013: https://www.blimpinfo.com/news/22-million-blimp-to-fill-gap-in-surveillance-of-north-korea/

- "StarTower Aerostat for Turkish National Security – StarTower 500 Aerostat System," Corporate presentation, circa 2014: https://www.fe-ra.com/files/Star_Tower_Presentation_Turkey_9.5.2014.pdf

Videos

- "StarTower, StarShadow, and StarLight by NSS - Near Space Systems, Inc.," (8:48 minutes), posted by GNSS, 12 October 2010: https://www.youtube.com/watch?v=GKTgpSPVKd8&t=525s
- "StarShadow - Near Space Systems, Inc.," (9:58 minutes), posted by GNSS, 14 November 2013: https://www.youtube.com/watch?v=bLaXMXUi1yI&feature=emb_title
- "Aerostat Launch and Recovery - offshore communications, subsea deployment, monitoring," (1:16 min), posted by Deep Down Inc., 15 January 2014: https://www.youtube.com/watch?v=nm1YkT-5OHE

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
    - GNSS / ENSS - StarLight
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/