SAIC and ArcXeon International - Unmanned Air Systems (UAS) Carrier

Peter Lobner, updated 8 March 2022

1. Introduction

Small unmanned air vehicles (UAV), now commonly called unmanned air systems (UAS), can carry advanced sensors and weapons, but generally have short range. In spite of their range limitations, UASs can provide valuable and cost-effective capabilities for military planners and war fighters. At a 2018 conference is Washington D.C., DARPA Deputy Director Steve Walker asked the following question: "With the ranges we are looking at in the Pacific Theater, how do we get our small UAS to the fight?" Actually, he already knew the answer.

In March 2016, DARPA awarded the first contracts in support of its Gremlins program, which DARPA describes as:

> "Gremlins (program)…… seeks to develop innovative technologies and systems enabling aircraft to launch volleys of low-cost, reusable unmanned air systems (UASs) and safely and reliably retrieve them in mid-air. Such systems, or "gremlins," would be deployed with a mixture of mission payloads capable of generating a variety of effects in a distributed and coordinated manner, providing U.S. forces with improved operational flexibility at a lower cost than is possible with conventional, monolithic platforms."

While the primary launch / recovery vehicle for this phase of the Gremlins program is a C-130 Hercules turboprop transport aircraft, the UAS launch and recovery techniques developed by the Gremlins program may be adaptable to other types of air vehicles, such as airships. Read more on the DARPA Gremlins program at the following link: https://www.darpa.mil/program/gremlins

2. The SAIC and ArcXeon Airstation UAS carrier concept

Before the DARPA Gremlins program, Science Applications International Corporation (SAIC) and ArcXeon International, LLC teamed in 2012 to develop an airship UAS carrier. SAIC senior aerospace engineer Ron Hochstetler stated, "The preeminent value of the UAS carrier airship is to enable long-duration access to an area sufficient to allow UAS to be inserted into airspace to conduct operations for as long as required."

SAIC and ArcXeon proposed a large UAS carrier airship, called the Airstation, for this type of mission. An operational UAS carrier airship would be able to automatically launch a swarm of UASs and recover, refuel / rearm and re-launch the UASs individually or in swarms for a subsequent mission. Simultaneous launch and recovery operations could be conducted. The Airstation design concept could be scaled to carry a payload of up to 40 tons.

In support of their development of the Airstation concept, SAIC and ArcXeon modified the Skybus 80K to serve as a demonstration platform carrying two small UAS.

Skybus 80K carrying two Insitu ScanEagle UAS.
Source: SAIC / ArcXeon

The product of the SAIC and ArcXeon collaboration is shown in the following concept drawing of the large Airstation UAS carrier airship.

Airstation deploying and recovering UASs. Source: SAIC, graphics by Faisla Ali & Pat Rawlings via NAA Noon Balloon, Fall 2016

Close-up view of UAV launch (forward bays) & recovery via trapeze (aft bays). Source: SAIC, graphics by Faisla Ali & Pat Rawlings

With its high level of automation, the Airstation was designed to operate with a small flight crew (2 – 4), or it could be optionally piloted. The launched UAS could be operated by pilots aboard the Airstation or via data links by pilots almost anywhere in the world.

The Airstation requires some form of variable buoyancy control system to compensate for continuing changes in mass during a mission. Changes in center of gravity will affect trim, which should be adjustable with ballonets.

- Buoyancy and trim must be managed during UAS launch and recovery operations. A Boeing RQ-21A weighs about 121 lb, a Boeing Dominator weighs 295 lb and a Textron RQ-7B weighs 467 lb. Advanced armed UASs, as shown in the above concept drawing, may weigh even more. A squadron of these could have a combined weight of several tons.
- Over the longer term, buoyancy management is needed as airship and UAS fuel and UAS armament are consumed and UAS attrition occurs.

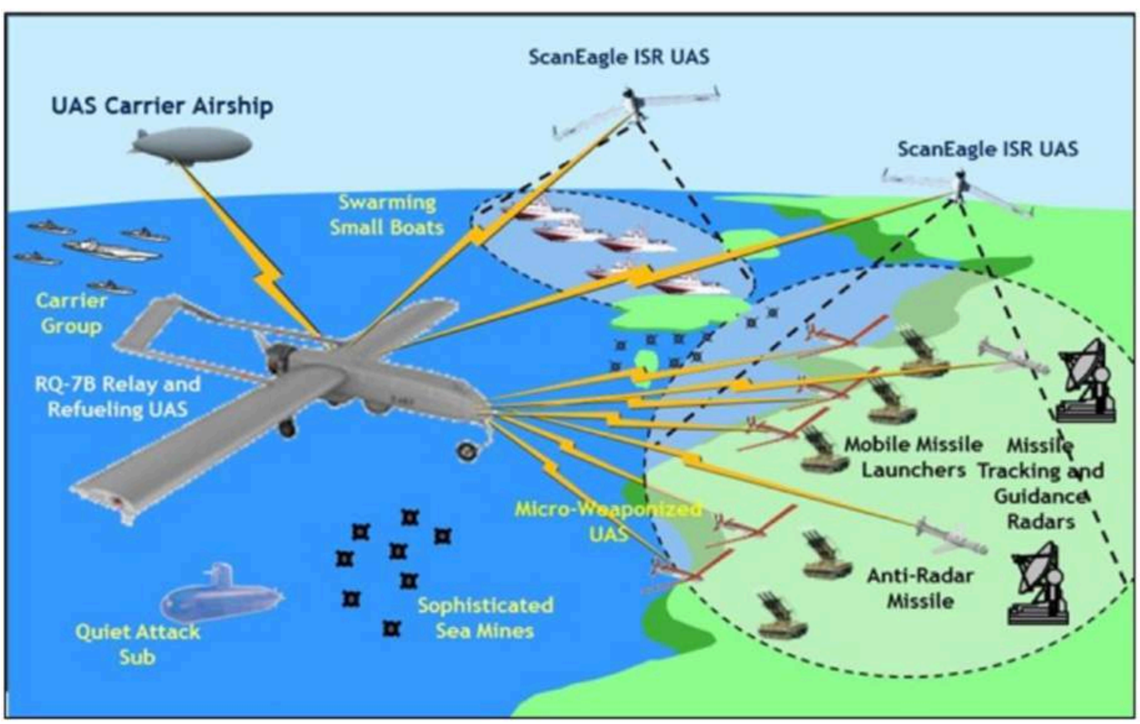
The Airstation was designed for an unrefueled flight endurance of at least 24 hours, and potentially 36 hours or more. SAIC and ArcXeon explored several techniques for inflight refueling to enable airborne missions lasting weeks. One approach was to refuel with air-liftable fuel transport bladders hoisted up from the sea surface, a capability developed by the US Navy in the 1950s. Such bladders come in a variety of sizes up to 500 gallons, which would weigh about 3,500 lb when filled with gas turbine fuel (@ 6.7 lb/gal) and 130 lb empty.

Source: *Source: Hochstetler et al. (left), ATL (right)*

This in-flight load exchange requires buoyancy compensation as heavy masses (full fuel bladders) are added to the hovering airship.

3. Concept of operations

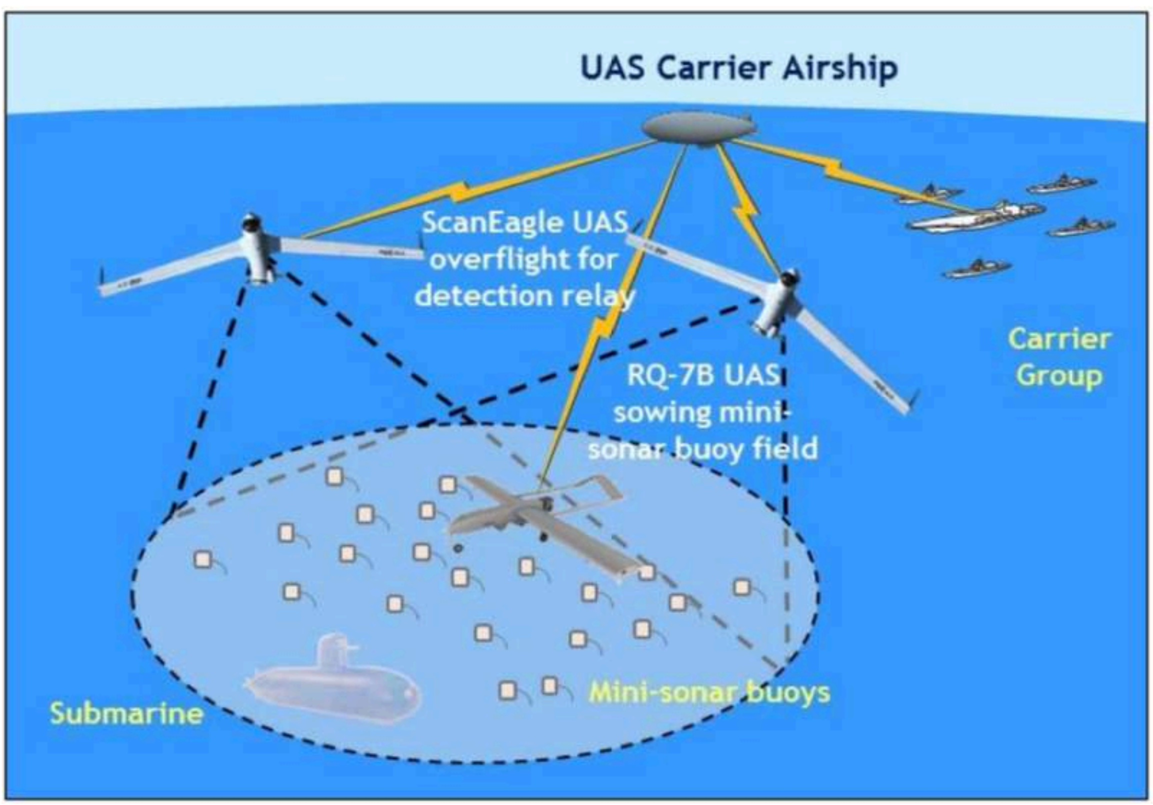
The Airstation's concept of operation (CONOPS) includes the ability to operate a variety of UASs, including one serving as a persistent data relay and refueling UAS stationed closer to the conflict zone.



Counter-A2/AD CONOPS. Source: Hochstetler et al. (2016)

With its over-the-horizon (OTH) view toward the conflict zone and its connectivity to a UAS fleet with sensor packages and weapons, the Airstation would be a valuable resource for a carrier strike group (CSG) that is being held at a distance by an adversary's anti-access and area denial (A2/AD) systems and weaponry. An Airstation operating at an altitude of 10,000 ft (3,048 m) has a radio line of sight of 141 miles (227 km), and even longer than that to a relay UAS orbiting at altitude (i.e., the RQ-7B in the above diagram). This long reach should reduce the risk of the Airstation being attacked directly while the forward UASs are mapping and attacking the adversary's A2/AD resources.

The Airstation also offers a way to strengthen fleet ASW capabilities with UAS aircraft. One type of UAS can deploy bathymetric sensors and mini-sonar buoys to establish sonar barriers at a distance from the CSG or deploy a smaller sonar buoy field to localize a submarine contact. Another type of UAS can serve as a persistent data relay. This concept of operations is shown in the following graphic.



ASW CONOPS. Source: Hochstetler et al. (2016)

These airship-based ASW capabilities would significantly strengthen the US Navy's current ASW capabilities, which depend heavily on detection by a long-range, land-based P-8 Poseidon maritime patrol aircraft or a nuclear submarine attached to the CSG. US aircraft carriers have not carried their own fixed-wing ASW aircraft since the S-3 Viking was retired in 2016. The Navy's multi-mission MH-60R Seahawk is embarked on aircraft carriers and major surface combatants and is capable of performing the ASW mission. However, the MH-60R often is configured for some other mission such as anti-surface warfare or logistics, and would require several hours to be reconfigured for the ASW mission.

Regarding survivability of an Airstation flying at the fringes of a contested area, SAIC and ArcXeon offered the following observations:

- An airship is invulnerable to sea mines and torpedoes, which would be a major hazard for naval vessels.
- Fabric hull structures are tolerant of small hole damage (low leakage even with some damage).
- The airship hull, structures, and engines can be treated for visual, radio frequency (RF), and electro-optical (EO) / infra red (IR) stealth characteristics.
- Other systems can provide electronic and kinetic self-defense.
- Weather-optimized flight route planning can help the airship avoid potentially damaging weather. However, some severe weather conditions will require the Airstation to depart the area and find safety elsewhere.

In spite of its intriguing capabilities, no contract was awarded for developing an Airstation prototype.

4. For more information

- R. Hochstetler, J. Bosma, G. Chachad & M. Blanken, "Lighter-Than-Air (LTA) 'Airstation' Unmanned Aircraft System (UAS) Carrier Concept," undated presentation: https://core.ac.uk/download/pdf/154737868.pdf

- R. Hochstetler, J. Bosma, G. Chachad & M. Blanken, "Lighter-Than-Air (LTA) 'Airstation' Unmanned Aircraft System (UAS) Carrier Concept," conference paper, 16th AIAA Aviation Technology, Integration and Operations Conference, 13 – 17 June 2016: https://aviationsystems.arc.nasa.gov/publications/2016/AIAA-2016-4223.pdf
- Graham Warwick, "Range Rovers – Airship carrier proposed as a way to extend reach of small USA," Aviation Week & Space Technology magazine, August 1 – 14, 2016: https://archive.aviationweek.com/search?QueryTerm=skybus+80K

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
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