

A CASE STUDY ON APPLICATION OF NEAR-SPACE AIRSHIP TECHNOLOGY IN THE BATTLEFIELD: LIBYA OPERATION

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Abstract- Near-space is the region surrounding the earth which is too dense for a satellite to fly and also too thin for air breathing vehicles to fly. The near-space region which is located between 65,000 and 325,000 feet is really underutilized despite its unique potential. Unmanned near-space airships and high altitude balloons can be used to exploit the potential of near space. Lighter than air vehicles, which are used in the near-space region that are not affected by neither weather events nor ionospheric effects, can create operationally and economically significant space effects without reaching hundreds of kilometers up high. In this paper Operation Odyssey Dawn and Operation Unified Protector that were carried out in the near past in Libya by NATO and other coalition countries were analyzed. How near-space airships could have contributed was studied. It was shown that near-space airships with large effect area, high resolution and persistent coverage capabilities can greatly contribute in air operations in which low threat level is expected from high altitude.

Keywords- Near-Space, Airship, Persistency, ISR

I. INTRODUCTION

Air forces using different mediums like air, space and cyberspace keep on searching about effectively exploiting near space region of the atmosphere. Near space is really underutilized although there are lots of kinds of spacecrafts located in space region and lots of kinds of aircrafts within the atmosphere flying up until 65.000 feet. Near space region which is located between 65.000-325.000 feet carries an incredible potential allowing to create space effects without going up to hundreds of kilometers high. Therefore; near-space region can be considered as a promising region of the atmosphere for battlespace environment of the future.

Near-space airships are lighter than air vehicles that use hot air or lighter than air gas to create lift (in some models aerodynamic shape also contribute in lift), used between 65.000-325.000 feet. Near-space airships are maneuverable vehicles and use aerodynamic surfaces and thrust systems for maneuvering or station keeping. For maneuvering or station keeping required energy is supplied from the sun by its solar energy panels placed over its hull. The electrical energy is also stored in batteries for night time operation and telemetry.

Space effects that are created by near-space airships are high altitude perspective, large footprint area, persistent ISR, Command/control, remote sensing and high resolution imaging intelligence [1]. Beside intelligence activities, near-space airships can greatly contribute beyond-horizon communication and surveillance by means of large footprint area, can also contribute to air to surface attack by means of modern air munitions and can contribute to precision navigating and positioning by means of persistency. In this study the contribution potential of near-space

airships is analyzed if they had been used Operation Odyssey Dawn and Operation Unified Protector conducted in Libya by NATO and other coalition forces. Near-space airships are shown to be an important game changer especially in low high-altitude-surface-to-air-missile-threat operations.

II. CASE STUDY ON LIBYA OPERATION:

A. Libya Operation Progress

NATO used air and space power in Libya operation (no boots on the ground). NATO forces joined planning and execution right after the beginning of supporting sorties of France and the US air forces. After the air-force-only operation decision, more importance were given on to ISR missions to provide situational awareness at first hand. ISR capabilities were proven again to be the most important factor on the success of the operation besides its features to direct air and space power.

According to North Atlantic Council's (NAC) directive on Libya mission no civilian casualties or no attacks on civilian infrastructures were accepted and also ordered to act quickly [2]. In order to prevent civilian casualties and collateral damage most significant means is to determine the target locations precisely. Near space airships can be considered as an important tool in future operational environment with its capabilities on precision targetting, high resolution imaging and large area surveillance.

B. Imaging Intelligence and Targetting

In Libya operation significant portion of ISR support sorties were conducted by USA Air Force. U-2 high altitude aircrafts, E-8 JSTARS (Joint Surveillance Target Attack Radar System) Ground surveillance aircrafts, P-3C maritime patrol aircrafts and unmanned aircraft systems such as Predator and

Global Hawk were used [3]. USA conducted 27% of all the sorties and 70% of ISR missions. In order to execute 9500 air to surface attack sorties avoiding collateral damage, at least 10.000 ISR sorties must have been flown for pre-strike, post-strike recce and surveillance missions.

In modern air warfare number of produced targets are more important than the number of sorties. When the targets in OUP analyzed, especially in the air to ground missions conducted in the Brega-Ajdabiya road, not only armored vehicles, tanks and artillery units but also weapon-systems-mounted pick-ups were also targeted. Those pick-ups were highly maneuverable and very hard to distinguish. Because both sides of the conflict were using the similar pick-ups and weapon systems. Distinguishing civilian and military assets were really hard and using high resolution sensors was a must to prevent civilian casualties. For dynamic targeting in large Libya operation area real-time and high resolution image intelligence needs proved the requirement for the persistent surveillance systems with large footprint area. Now that the question comes to mind is how the near-space airships would have contributed to the operation, had it been used in Ajdabiya-Brega operation.





Figure-1 Military vehicles used in Libya Civil War

In Figure-1 some military vehicles used by Qaddafi and opposition forces are seen. Friend or foe distinction of these vehicles by pre and post strike recce sorties requires high resolution imaging intelligence support. In NATO STANAG 3769 document minimum metric ground resolution values are listed in order to identify and analyze the targets. According to the list for precise identification of troop units 1,2 m and for description 0,3m resolution values are required [4]. High resolution is a must capability to prevent collateral damage, to avoid fratricide and for effective air to ground attack. In order to identify the capacity of near-space airships to reach required resolution values, diffraction limited resolution values can be calculated: For an optical system diffraction resolution value can be calculated by this formula [5]:

$$\Delta x = \frac{2.44h\lambda}{D} \quad (1)$$

where Δx :resolution, h:altitude, λ :wavelength and D:camera aperture radius.

Table-1 Diffraction Limited Resolution for unmanned aircraft and near-space airship [1].

System	$\lambda:0.5\mu\text{m}$ (visible)	$\lambda:3\mu\text{m}$ (IR)
 UAV at 10 km altitude $\Delta x = 0.04\text{m}$ (D = 0.3m)	$\Delta x = 0.24\text{m}$ (D = 0.3m)	
 Near-Space Airship at 20 km altitude $\Delta x = 0.08\text{m}$ (D = 0.3m)	$\Delta x = 0.48\text{m}$ (D = 0.3m)	

As seen on the table-1 near-space airships have the ability to create 8 cm resolution images from 20 km altitude which means the adequate resolution value for identification of troop units.

C. Persistent Surveillance At Large Area

When the footprint area is analyzed near-space airships with its high altitude (>65.000 feet) can stare at large area for long durations because of not depending on any petroleum products. Covering over 350-500 km. distance for long duration 1-4 near-space airships can be enough for not only ISR missions but also air to ground attack missions. In Figure-2 near-space airship coverage can be seen for 65.000 feet altitude. 4 near-space airships can be enough to cover whole war zone, assuming that the airships are carrying adequate number of sensors. Coverage area can be changed for different looking angles and also for different altitudes. Persistent surveillance at large area means that 10.000 ISR sorties could be replaced by utilizing near-space airships by not sacrificing and of operation objectives. It also means that allied forces could have saved from more equipment, money and resources as well as operational risks.

D. Command and Control

In figure-2 near-space airship is seen to cover not only active operation area but also relevant close areas. Thinking of Operation Unified Protector, near-space airships can create direct connection with supported units, can serve over land and sea to support arms embargo, can contribute greatly by radar systems attached on the airships. By means of radio relays, remote sensing systems and other payloads near-space airships can greatly contribute command and control function of air force. During the operation AWACS and other early warning aircrafts continuously flew over the area in order to control the airspace and also to control the no fly zone. Near-space airships with radar payloads can fly

over weeks and months without the sortie or gasoline limitations. Because near-space airships are using the infinite source of energy from the sun for station keeping and for other maneuvers.

As a result Near-space airships can be used to execute battlespace management combining the battlespace awareness, Command and Control and Network centric operations in an effective manner.

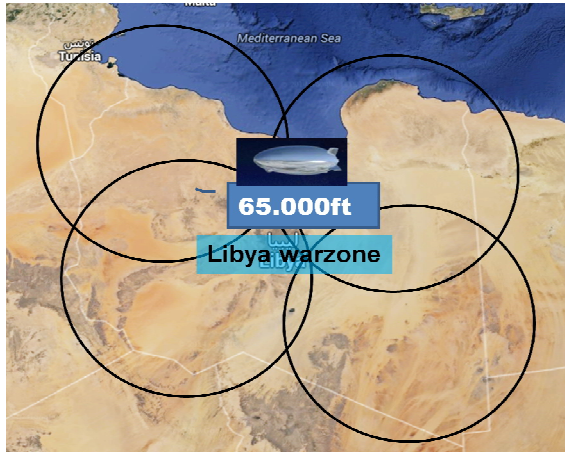


Figure-2 Near-space airship coverage area for 65.000 feet altitude

E. Economical Factors

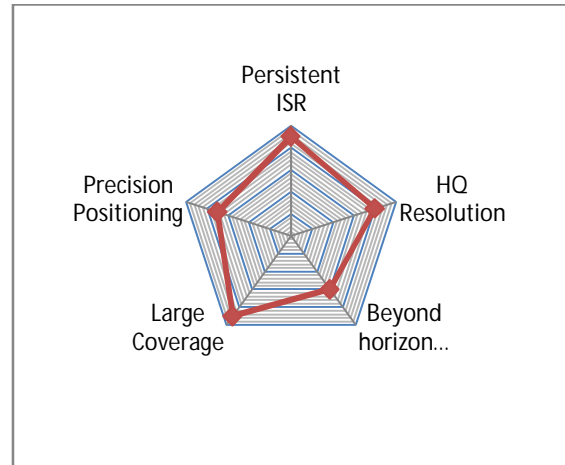
Budgets of recent operations reach very high values because of using high technology vehicles and munitions. For Libya operation leading countries such as USA roughly spent \$ 1,1 billion England \$ 250-400 million and France \$ 400-500 million. Only the AWACS cost was \$ 7,4 milyon for a month [6]. During air campaign NATO forces flew as many as 200 sorties a day. When we consider near-space airships continuing its mission for 6 months at its design altitude 2 or 3 sorties might have been enough for them throughout the whole operation. Near-space airships can be considered a game changer for the future operational environment for its ISR capabilities, command and control capabilities, potential strike capabilities and also for economical advantages.

Besides, the width of operation area is also a factor to be taken into consideration in terms of economic factors. Flying the long distance from the base to the operation area twice (going and coming) not only spent lots of fuel but also wasted lots of time. Therefore near-space airships can contribute greatly because the distance from the operating base to the battlespace theater was very long.

III. RESULTS AND DISCUSSION

Finally it can be assessed that with long duration and high resolution surveillance and targeting capabilities plug-and-play passive radar, ground moving radar, comm relay, air to ground attack

features, Near-Space Airships can greatly contribute in operations like the one conducted in Libya.



Graph-1 Near-space effects at the battlespace theater Near-space effects in the operational area is seen on Graph-1. Significance degree of these effects were analyzed based on the operational requirements of low intensity air campaign missions. Based on the operational requirements persistent ISR and large footprint area effects are the most important effects of near-space.

Reasons of the near-space airships to be the appropriate system for operation Unified Protector can be summarized as below:

- (1) Because of the destruction of the regional air defence missile system and gaining the air supremacy, high altitude surface to air missile threat was at very low level, meanwhile effectiveness of the surface to air missiles and interceptor aircrafts against near-space airships is unknown.
- (2) Large variety of remote sensing devices covering large operational area,
- (3) High resolution imaging capability for NAC's requirement to prevent collateral damage.
- (4) Mission flexibility and economical advantage of "Near-space Airships" because of using them in ISR, Command and Control, Radar intelligence, air to ground missions.
- (5) Unlike not readily available satellite intelligence systems, tactical availability of them for weeks and months.
- (6) Mission duration for manned/unmanned ISR platforms is limited because of fuel limit and human factor. But "Near-space Airships" can be used for months.
- (7) Because the distance between the operating base and battlespace theater was very long, flying that distance took too much time.
- (8) Because the operation was a coalition-backed operation budget issue was more important which could be minimized by using "Near-space Airships".

(9) The need for ISR assets was much more in Libya than the other operations because lots of civilian units were used.

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