WHITE PAPER

The "Sitallite":

The Case for Geo-Synchronous High-Altitude Pseudo-Satellites (G-HAPS) in Defense and Security

October 18, 2018

VanWyn Aerospace Logistics
175 Longwood Road South, Suite 104
Hamilton, Ontario, Canada
info@vanwyn.com
(289) 260-8825

Abstract

This white paper explores how the development of high-altitude, balloon-based payload platforms capable of maintaining geo-synchronous position (the "*Sitallite*") can provide nations with strategic advantage and improved risk mitigation in numerous defense and security scenarios. This new aircraft platform offers many of the capabilities of satellites and drones without the inherent limitations of each, at a fraction of the cost, with improved flexibility. The Sitallite has the potential to serve as a vital backup plan to satellites, for added resiliency and as a critical component in the analysis and prevention of threats to global and local security.

Introduction

There is a growing demand for continuous and reliable flow of high quality geospatial information from a variety of sensor and communications platforms across the globe. In today's rapidly evolving geo-political climate and with the impact of climate change, there is an ever-expanding number of trouble spots where the ability to rapidly deploy a variety of payloads at high altitudes for extended periods of time would provide a strategic and tactical advantage. The flourishing satellite market is evidence to the increasing demand by both government and civilian agencies to deploy such sensors and communication systems.

However, space satellites currently don't provide flexibility or cost effectiveness, often needing hundreds of millions of dollars to deploy and maintain, with years of planning in advance. At the same time, growing dependencies on the satellite infrastructure has introduced significant security vulnerabilities. Drones and other aircraft are being used increasingly to augment capabilities but are limited in the payload and length of time they can stay in the air.

Nations are increasingly forced to adapt to rapidly changing geopolitical circumstances. Whether locally or abroad, the need to maintain situational awareness and adapt to changing circumstance is critical. This awareness is increasingly being provided by more and more satellites and drones. With increased demand, high costs, threats to resiliency, and limited capacity for these services, an opportunity has opened to explore the development of High-Altitude Platform Stations (HAPS) in various situations which can maintain Geo-Synchronous position (introducing the acronym "G-HAPS").

An Increasing Demand for Hight-Altitude Platforms

Frost and Sullivan, a business consulting firm involved in market research and analysis, estimates that between 2018 and 2030 there will be an estimated 11,631 launch demands for new satellite constellation installations and replacement missions with an estimated $62 billion market. [1] As Frost and Sullivan note, because the lifespan of most satellites is between two years and five years, there will be constant launch demand, and participants will continually look to enhance their systems and infrastructure to improve capabilities.

As the demand continues to increase, the price for traditional satellite deployments continues to rise. A Global Positioning System satellite, for example, cost $43 million to build and $55 million to launch in early 1990s [11]. Today, a typical satellite launch can cost anywhere from $50 million to $400 million. The next generation GPS III satellites will cost an average of about $547 million to build. According to SpaceX, it costs $62 million every time it launches its Falcon 9, while the more powerful Falcon Heavy costs an estimated $90 million per launch. Competing launch provider United Launch Alliance has an estimated cost of $422 million per launch [12]. Despite this high cost, demand continues to rise, even with the inherent risks of launch failure or technical malfunction. To date, alternatives with comparable capabilities to satellites simply do not exist.

Governments must explore a range of cost-cutting alternative options for satellite capabilities that include looking at entirely new systems. In that search, they must constantly improve their capability to respond to natural disasters and protect themselves from sophisticated adversaries using asymmetric capabilities, including electronic and cyber warfare and advanced air and space weapons. Doing so in a timely and cost-effective manner will give an advantage to any government, much in the same way that satellites provided in the 1960s, and as was done with the more recent use of drones for commercial, industrial and military use.

The exponential growth in Intelligence Surveillance and Reconnaissance (ISR) services using drones, or Remotely Piloted Aircraft Systems (RPAS), acts as a good indicator of government needs [13]. The total number of RPAS employed worldwide reached about 29,000 in 2015, more than doubling from 2014. As of 2016, at least 10 countries, including Nigeria, have weaponized drones and the list is expected to quickly get much larger than that [14]. And as an indication for the desire to eliminate existing constraints of RPAS and bring them more in line with satellites, the U.S. Defense Advanced Research Projects Agency (DARPA) has recently selected Silent Falcon's namesake unmanned aerial vehicle to explore the feasibility of remotely charging an aircraft with a laser [15]. This would conceivably extend mission operating time indefinitely providing similar advantage to satellites.

While RPAS and satellites have found significant use, each has significant comparative advantages and disadvantages. A drone's flexibility, cost-effectiveness and ease of deployment is highly desirable. However, a satellite offers ongoing mission duration and altitude which make drones impracticable for many scenarios. As an example, to maintain surveillance over a specific area, a drone will have to constantly fly over that area and piece together numerous images. If the light changes due to cloud coverage it becomes much more difficult and time consuming to piece together the imagery. A single image from a satellite, on the other hand, can cover a much wider area and is significantly cheaper than drone imagery, comparatively. A reliable and extended communications mission is currently better served by a satellite than a drone, due to the difference in mission duration.

Introduction to High-Altitude Geo-Synchronous Balloons

A third platform, the "Sitallite" (which "sits" up in the sky) has the potential to fill the gap left between satellites and drones. With flight altitudes anywhere between 65,000 ft and 105,000 ft, this geo-synchronous high-altitude platform station (G-HAPS) is designed to transport any combination of instruments up to the stratosphere (15 miles or 80,000 ft) to perform any and all desired observation and transmission services from a static position for indefinite operation. From this vantage point, the craft can offer far greater resolution than space satellites, while providing a wider cone of coverage compared to any airborne craft. This theatre of operations is virtually empty. For reference, most airliners are certified to fly at 45,000 feet or less and some corporate jets can fly at 51,000 feet, while the current version of the U2 spy plan can fly up to 90,000 ft. At this target altitude, the Sitallite craft is far above all weather, birds and air traffic, but well below all the dangers of the ionosphere, impacting meteors, and space objects.

The Sitallite distinguishes itself by combining the best of both worlds: the station-keeping capability of a geosynchronous satellite in high orbit (22,000 miles up) with the convenience, flexibility and precision of a low-altitude aircraft without many of the limitations. The use of components such as wireless power transmission (from the ground to the craft) and air-breathing electric propulsion makes unlimited flight time possible, with a scalable power source to allow for new mission possibilities.

VanWyn Aerospace Logistics has recently launched an initiative to identify partners that will support development of such a craft with the aim to have it commercially available within a few short years.

Looking ahead and analyzing the best path forward

Space is becoming an increasingly essential element that is incorporated in conflict planning and military exercises. So much so, that U.S. President Trump officially directed the Pentagon in 2018 to establish a sixth branch of the U.S. military in space to ensure American dominance. Nations are increasingly relying more heavily on satellites for the delivery of intelligence and mission-critical capabilities and communications in theater, which in turn is becoming a significant vulnerability. To that end, the U.S. has initiated an Analysis of Alternatives (AoA) for military wideband satellite [16], which will analyze possible ways in which the military can continue to carry on with communications and capabilities during conflicts. Simply put, nations are recognizing their vulnerabilities in space and the need for a backup plan.

Proposed innovations such as the Sitallite can play an essential role in providing continuity of capabilities. Should the established systems fail, nations and agencies that are able to quickly re-establish a satellite-like infrastructure will find themselves at a strategic advantage over others, with the added possibility of shifting the balance of power either economically or militarily.

Today's Challenges Identified by U.S. DoD

In 2017, the U.S. DoD's Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) conference brought private industry together with the military decision makers.

In the Government Satellite Report [2], Ryan Schradin shared that during the conference, two of the main challenges heard repeatedly were:

1. *A need for a mobile communications solution that could deliver high throughput connectivity to a location quickly and without military personnel having to plug into existing transoceanic fiber.* As expressed by Lieutenant General Alan R. Lynn, the Director of the Defense Information Systems Agency (DISA) and Commander of the Joint Force Headquarters- Department of Defense Information Networks (DODIN) out of Fort Meade, Md, "We need more throughput. The requirement just keeps growing. Every day we have more throughput requirements. But there are not bigger pipes being rolled out. So, what's next? What comes after fiber?"

2. *A need to ensure secure communications in-theater, at a time when adversaries are actively working to take away one of the U.S. military's largest advantages – its communications and real time intelligence capabilities.*

A need has clearly been established for a redundant capability to compliment satellite networks, of which there currently is no option. Should the satellite infrastructure fail, there is simply no fallback system.

Interestingly enough, in the time it would take to plan for, develop and launch a single new satellite, VanWyn's proposed Sitallite could be made commercially available. The Sitallite is well positioned to not only become a key component of the active redundant satellite network, but to quickly extend existing capabilities as the need arises for short or long periods of time for an invaluable backup system.

Battlefield Enemies – Availability and Latency

Many soldiers are deployed in regions where there is a lack of communication infrastructure such as fiber networks [10]. Because such resources often take years to build and are therefore impractical, militaries are often forced to deal with significant deficiencies introduced by satellites: latency and lack of availability.

Latency refers to the amount of time information takes to travel from the source to its destination. With each packet of information having to travel up to a satellite and down again, many applications become unusable in conflict situations when rapid access to information is needed the most. With a 'Sitallite' platform, operating significantly closer to earth (25 km verses 35000+ km), latency can be significantly reduced simply by reducing the physical distance that packets need to travel. This benefit dramatically improves usability of systems in conflict zones and can empower agencies to innovate new services, or simply use existing ones, in support of defense. Further, the ability to upgrade the payload of a Sitallite in a matter of more hours or days (landing the craft, replacing a shelf, and quickly re-launching) ensures that any the military can continually improve its communications capabilities as technological advances occur without incurring the expense and multi-year delays associated with new satellite launches.

Determining how to pierce the "fog of war" in wartime environments is a consistent theme in militaries. The 'fog of war' relates to the uncertainty in situational awareness, exasperated by a rapidly changing environment in which opposing forces use unconventional approaches coupled with speed, force, and elements of surprise to overcome an opponent. Lack of available communications and intelligence infrastructure simply exasperates the problem – perhaps the enemy has destroyed fixed communications lines, or perhaps there is little-to-no satellite coverage to be had, due to limited availability. By having rapidly deployable satellite-like infrastructure such as that offered by the Sitallite, many of these situations can be overcome by providing additional flexibility in communications and intelligence systems and thereby allowing forces to adapt to changing threats and needs.

The Sitallite would operate in any geographic region, virtually undetectable, with no mechanical moving parts or heat signature. It could change location on command to satisfy mission needs. A Sitallite could be deployed at any time in advance of boots hitting the ground, and because of its high altitude and broad cone of coverage it wouldn't reveal landing sites, troop movements, or intentions. These new advantages could potentially allow Defense agencies to innovate entirely new capabilities.

Inevitable War in Space and Recovery

"It is absolutely inevitable that we will see conflict move into space," says Michael Schmitt, an American law scholar specializing in international humanitarian law, use of force issues, and the international law applicable to cyberspace, and a space war expert at University of Exeter in the United Kingdom [9]. Experts agree that simply due to reliance on space to host thousands of satellites for military and civilian purposes, this area of operations becomes a strategic area to control, or simply to deny the enemy the use of, should conflict arise. Satellites are simply defenseless against a possible attack in space. To prove the point of capabilities to do just that, in 2007 the Chinese government destroyed one of their own FY-1C weather satellites at an altitude of 865 km using a missile launched from Earth [4]. Other nations such as the U.S. and Russia are believed to have similar, if not more advanced, capabilities.

Whether the threat is from physical destruction such as from missiles, debris, or lasers, or alternatively from cyber-attacks, our global reliance on satellites is making nations increasingly vulnerable. If indeed Michael Schmitt's premise that war in space in 'inevitable', then it is only logical to have capability redundancy and a plan for *what happens afterwards*, even if only to consider interim measures while the satellite infrastructure is being rebuilt.

The development and use of Sitallites, with their ease of deployment, lower cost, and payload flexibility can strengthen resiliency and provide the enhanced capability that can help to plan for *when* (not *if*) the inevitable conflict in space does occur.

Arctic sovereignty

The Arctic is getting to be increasingly busy as it becomes more attractive to a variety of companies to operate. Companies in energy, mining, tourism, fisheries, cruise ships and more are increasingly making their way into this area. This increased traffic is a big challenge for communications infrastructure, while political posturing and territorial claims are making securing the North a growing priority and challenge for Northern nations. Current communications satellites operating in geo-synchronous earth orbit don't come close to covering the expanse of the Arctic [5].

Today, communications in this area is largely served by the Iridium commercial satellite constellation, but as reported by the European Space Agency (ESA) there have been several recorded cases of interruptions to the service which can last several minutes. It simply *does not provide the broadband communication that is needed*. [5]

Canada, for instance, has understood the need to improve communications at high latitudes because so much of its territory lies within that region. In 2007, Canada launched Radarsat-2, the second in a series of Canadian radar satellites, with the primary objective of performing routine surveillance of Canadian coasts and better protecting Canadian sovereignty (particularly Arctic sovereignty) including monitoring shipping traffic [8]. The cost to launch and operate this satellite has exceeded $2 Billion USD. The designed life span was 7.25 years and it has been operating nearly 11 years, with no replacement on the horizon.

The Canadian Space Agency is also developing the Polar Communications and Weather satellite (PCW) mission. The project would eventually comprise two satellites to serve some of Canada's communication needs and collect climate related information, but is currently in very early phases.

Similarly, Russia is on the move with its significant $2.3 billion investment in a cluster of 10 Arktika satellites to improve their communication and observation capabilities in the Arctic North region [6]. Even Russian energy companies such as Gazprom are developing their broadband capabilities in the region with a view to support their own private communication needs [7].

The Sitallite is well positioned to fill a need in the Arctic North. With few alternative options alongside a growing need, the use of High Altitude Geo-Synchronous Balloon Platforms could significantly increase defense and security capability in the Arctic region at a fraction of the cost of traditional satellites, and in a much more rapid timeframe, while in turn offering supplementary benefits such as improving communication to and from remote communities.

Summary

VanWyn's Sitallite is well positioned to provide nations with strategic and tactical advantage in a variety of critical defense and security scenarios. The benefits of rapid deployment, rapid recovery and re-deployment, low cost, payload flexibility, wider cone of coverage, inexhaustible supply of scalable energy, and long mission duration makes the Sitallite a very attractive option to augment existing satellite and drone capabilities, as well as realize entirely new mission possibilities. If development support from government and industry is provided soon, then the commercialization of the Sitallite can be accomplished within a few short years to realize these benefits.

Contact Information

Erinn van Wynsberghe
Founding President & CEO, VanWyn Aerospace Logistics
erinnvw@vanwyn.com
(289) 260-8825

References

[1] Research and Markets Ltd. "Small-Satellite Launch Services Market, Quarterly Update Q2 2018, Forecast to 2030. ID: 4593566." Research and Markets - Market Research Reports - Welcome, Frost & Sullivan, July 2018, www.researchandmarkets.com/research/n9sd7q/smallsatellite?w=4.

[2] Schradin, Ryan. "Why Not Satellite? Addressing Military C4ISR Needs from the Sky." GovSat: The Government Satellite Report: Satellite News with Government Views, GovSat Report, 18 May 2017, ses-gs.com/govsat/defense-intelligence/not-satellite-addressing-military-needs-sky/.

[3] Thompson, Loren. "5 Reasons Congress Surprised the Satellite Industry By Adding Military Satcoms In The 2018 Budget." Forbes.com, Forbes Magazine, 2 Apr. 2018, www.forbes.com/sites/lorenthompson/2018/04/02/5-reasons-congress-surprised-the-satellite-industry-by-adding-military-satcoms-in-the-2018-budget/#7eb398dd7a10.

[4] Jones, Sam. "Satellite Wars." Financial Times, The Financial Times Ltd., A Nikkei Company, 20 Nov. 2015, www.ft.com/content/637bf054-8e34-11e5-8be4-3506bf20cc2b.

[5] European Space Agency (ESA). "Arctic Poses Communications Challenges." European Space Agency, European Space Agency, www.esa.int/Our_Activities/Preparing_for_the_Future/Space_for_Earth/Arctic/Arctic_poses_communications_challenges.

[6] Beckhusen, Robert. “Russia Is Building Its Next Satellite Network Over the Arctic.” War Is Boring, Bright Mountain Media, Inc. (BMTM), 6 Nov. 2013, warisboring.com/russia-is-building-its-next-satellite-network-over-the-arctic/.

[7] Zak, Anatoly, and Nicolas Pillet. “Russia to Build Arctic Satellite Network.” Aftermath of Sputnik Launch, Anatoly Zak, 27 Apr. 2018, www.russianspaceweb.com/arktika.html.

[8] CBC News. “Canadian Satellite Set to Keep an Eye on Arctic | CBC News.” CBCnews.ca, CBC / Radio-Canada, 14 Dec. 2007, www.cbc.ca/news/technology/canadian-satellite-set-to-keep-an-eye-on-arctic-1.682643.

[9] Clark, Stuart. “'It's Going to Happen': Is the World Ready for War in Space?” The Guardian, Guardian News and Media Limited, 15 Apr. 2018, www.theguardian.com/science/2018/apr/15/its-going-to-happen-is-world-ready-for-war-in-space.

[10] Bland, Randall. “Latency - the Other Enemy on the Battlefield.” GovSat: The Government Satellite Report: Satellite News with Government Views, GovSat Report, 23 Sept. 2015, ses-gs.com/govsat/defense-intelligence/latency-the-other-enemy-on-the-battlefield/.

[11] Costlow, Terry. “The Future of Satellites: What Are the Options?” Defense Systems, Public Sector Media Group., 1105 Media, Inc., 21 Mar. 2014, defensesystems.com/articles/2014/03/21/satellite-communications-future-options.aspx.

[12] Tuttle, Brad. “Elon Musk Will Launch SpaceX's Falcon Heavy Rocket At a Cost | Money.” Time, Time Inc., 6 Feb. 2018, time.com/money/5135565/elon-musk-falcon-heavy-rocket-launch-cost/.

[13] Sayler, Kelley. “A World of Proliferated Drones: A Technology Primer.” Center for a New American Security (CNAS), Center for a New American Security, 10 June 2015, www.cnas.org/publications/reports/a-world-of-proliferated-drones-a-technology-primer.

[14] Dillow, Clay. “All of These Countries Now Have Armed Drones.” Fortune, Time Inc., 12 Feb. 2016, fortune.com/2016/02/12/these-countries-have-armed-drones/.

[15] Reim, Garrett. “DARPA Selects Unmanned Aerial Vehicle to Be Powered by a Laser 10km Away.” Flight Global: Pioneering Aviation Insight, Reed Business Information Limited, 2 Aug. 2018, www.flightglobal.com/news/articles/darpa-selects-unmanned-aerial-vehicle-to-be-powered-450884/.

[16] Swarts, Phillip. “Pentagon Starts Ball Rolling on Wideband Satcom Study.” SpaceNews.com, SpaceNews, 6 Jan. 2017, spacenews.com/pentagon-starts-ball-rolling-on-wideband-satcom-study/.